U.S. NATIONAL SECURITY AND MILITARY/COMMERCIAL CONCERNS WITH THE PEOPLE'S REPUBLIC OF CHINA

VOLUME I

SELECT COMMITTEE
UNITED STATES HOUSE OF REPRESENTATIVES

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UNITED STATES HOUSE OF REPRESENTATIVES

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REPORT

OF THE

SELECT COMMITTEE ON U.S. NATIONAL SECURITY AND MILITARY/COMMERCIAL CONCERNS WITH THE PEOPLE'S REPUBLIC OF CHINA

SUBMITTED BY
MR. COX OF CALIFORNIA, CHAIRMAN

January 3, 1999 — Committed to the Committee of the Whole House on the State of the Union and ordered to be printed (subject to declassification review)

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A NOTE ON REDACTION

The Final Report of the Select Committee on U.S. National Security and Military/Commercial Concerns with the Peoples Republic of China was unanimously approved by the five Republicans and four Democrats who served on the Select Committee.

This three-volume Report is a declassified, redacted version of the Final Report. The Final Report was classified Top Secret when issued on January 3, 1999, and remains so today. Certain source materials included in the Final Report were submitted to the Executive branch during the period August–December 1998 for declassification review in order to facilitate the production of a declassified report. The Select Committee sought declassification review of the entire report on January 3, 1999. The House of Representatives extended the life of the Select Committee for 90 days for the purpose of continuing to work with the Executive Branch to declassify the Final Report. A series of further extensions was voted by the House of Representatives until the final declassification review was completed in May 1999. Following an extended series of negotiations between the House of Representatives and the Executive branch, a number of material deletions have been made to the Final Report.

As a result of these deletions, a number of significant events, facts, and analyses have been omitted from this declassified Report. In several cases, important factual examples substantiating conclusions in the report have been deleted. In other cases, explicit findings of the Select Committee have been suppressed. The Select Committee's classified Final Report, therefore, remains the definitive product of its investigation and analysis.

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105th Congress

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OVERVIEW

<u>IMPORTANT NOTE:</u> This declassified report summarizes many important findings and judgments contained in the Select Committee's classified Report, issued January 3, 1999. U.S. intelligence and law enforcement agencies within the Clinton administration have determined that other significant findings and judgments contained in the Select Committee's classified Report cannot be publicly disclosed without affecting national security or ongoing criminal investigations.

1.

- **The People's Republic of China (PRC) has stolen design information on the United States' most advanced thermonuclear weapons.**
- **The Select Committee judges that the PRC's next generation of thermonuclear weapons, currently under development, will exploit elements of stolen U.S. design information.**
- **PRC penetration of our national weapons laboratories spans at least the past several decades and almost certainly continues today.**

A. The People's Republic of China (PRC) has stolen design information on the United States' most advanced thermonuclear weapons.

The People's Republic of China (PRC) has stolen classified design information on the United States' most advanced thermonuclear weapons. These thefts of nuclear secrets from our national weapons laboratories enabled the PRC to design, develop, and successfully test modern strategic nuclear weapons sooner than would otherwise have been possible. The stolen U.S. nuclear secrets give the PRC design information on thermonuclear weapons on a par with our own.

The PRC thefts from our National Laboratories began at least as early as the late 1970s, and significant secrets are known to have been stolen as recently as the mid-1990s. Such thefts almost certainly continue to the present.

- **The stolen information includes classified information on seven U.S. thermonuclear warheads, including every currently deployed thermonuclear warhead in the U.S. ballistic missile arsenal.**

- **The stolen information also includes classified design information for an enhanced radiation weapon (commonly known as the "neutron bomb"), which neither the United States, nor any other nation, has yet deployed.**

- **The PRC has obtained classified information on the following U.S. thermonuclear warheads, as well as a number of associated reentry vehicles (the hardened shell that protects the thermonuclear warhead during reentry).**

U.S. WARHEAD	U.S. NUCLEAR MISSILE	CURRENTLY DEPLOYED
W-88	Trident D-5 SLBM	Yes
W-87	Peacekeeper ICBM	Yes
W-78	Minuteman III (Mark 12A) ICBM	Yes
W-76	Trident C-4 SLBM	Yes
W-70	Lance SRBM	No
W-62	Minuteman III ICBM	Yes
W-56	Minuteman II ICBM	No

In addition, in the mid-1990s the PRC stole, possibly from a U.S. national weapons laboratory, classified thermonuclear weapons information that cannot be identified in this unclassified Report. Because this recent espionage case is currently under investigation and involves sensitive intelligence sources and methods, the Clinton administration has determined that further information cannot be made public without affecting national security or ongoing criminal investigations.

The W-88, a miniaturized, tapered warhead, is the most sophisticated nuclear weapon the United States has ever built. In the U.S. arsenal, it is mated to the D-5 submarine-launched ballistic missile carried aboard the Trident nuclear submarine. The United States learned about the theft of the W-88 Trident D-5 warhead information, as well as about the theft of information regarding several other nuclear weapons, in 1995.

The PRC has stolen U.S. design information and other classified information for neutron bomb warheads. The PRC stole classified U.S. information about the neutron bomb from a U.S. national weapons laboratory. The U.S. learned of the theft of this classified information on the neutron bomb in 1996.

In the late 1970s, the PRC stole design information on the U.S. W-70 warhead from the Lawrence Livermore Laboratory. The U.S. government first learned of this theft several months after it took place. The W-70 warhead contains elements that may be used either as a strategic thermonuclear weapon, or as an enhanced radiation weapon ("neutron bomb"). The PRC tested the neutron bomb in 1988.

The Select Committee is aware of other PRC thefts of U.S. thermonuclear weapons-related secrets. The Clinton administration has determined that further information about PRC thefts of U.S. thermonuclear weapons-related secrets cannot be publicly disclosed without affecting national security.

The PRC acquired this and other classified U.S. nuclear weapons information as the result of a 20-year intelligence collection program to develop modern thermonuclear weapons, continuing to this very day, that includes espionage, review of unclassified publications, and extensive interactions with scientists from the Department of Energy's national weapons laboratories.

The Select Committee has found that the primary focus of this long-term, ongoing PRC intelligence collection effort has been on the following national weapons laboratories:

- **Los Alamos**
- **Lawrence Livermore**
- **Oak Ridge**
- **Sandia**

The Select Committee judges that the PRC will exploit elements of the stolen design information on the PRC's next generation of thermonuclear weapons. The PRC plans to supplement its silo-based CSS-4 ICBMs targeted on U.S. cities with mobile ICBMs, which are more survivable because they are more difficult to find than silo-based missiles.

The PRC has three mobile ICBM programs currently underway — two road-mobile and one submarine-launched program — all of which will be able to strike the United States.

The first of these new People's Liberation Army (PLA) mobile ICBMs, the DF-31, may be tested in 1999, and could be deployed as soon as 2002. These mobile missiles require small warhead designs, of which the stolen U.S. design information is the most advanced in the world.

In addition, the PRC could choose to use elements of the stolen nuclear weapons design information — including the neutron bomb — on intermediate- and short-range ballistic missiles, such as its CSS-6 missiles.

The PRC has the infrastructure and technical ability to use elements of the stolen U.S. warhead design information in the PLA's next generation of thermonuclear weapons. The Select Committee concludes that the production tools and processes required by the PRC to produce small thermonuclear warheads based on the stolen U.S. design information, including the stolen W-88 information, would be similar to those developed or available in a modern aerospace or precision-guided munitions industry. The Select Committee judges that the PRC has such infrastructure and is capable of such production.

The Select Committee judges that the PRC is likely to continue its work on advanced thermonuclear weapons based on the stolen U.S. design information. The PRC could begin serial production of such weapons during the next decade in connection with the development of its next generation of intercontinental ballistic missiles.

A series of PRC nuclear weapons test explosions from 1992 to 1996 began a debate in the U.S. Government about whether the PRC's designs for its new generation of nuclear warheads were in fact based on stolen U.S. classified information. The apparent purpose of these PRC tests was to develop smaller, lighter thermonuclear warheads, with an increased yield-to-weight ratio.

The United States did not become fully aware of the magnitude of the counterintelligence problem at the Department of Energy national weapons laboratories until 1995. In 1995 the United States received a classified PRC document that demonstrated that the PRC had obtained U.S. design information on the W-88 warhead and technical information concerning approximately half a dozen other U.S. thermonuclear warheads and associated reentry vehicles.

The document was provided by a PRC national, unsolicited by the CIA — a "walk in." This individual approached the CIA outside the PRC, and turned over a number of documents. Among these was an official PRC document classified "Secret" by the PRC.

This PRC document included, among other matters, stolen U.S. design information on the W-88 thermonuclear warhead used on the Trident D-5 missile, as well as U.S. technical information on several other strategic U.S. nuclear warheads. The document recognized that the U.S. weapons represented the state-of-the-art against which PRC nuclear weapons should be measured.

By mid-1996 the CIA had determined that the individual who provided the information was secretly under the direction of the PRC intelligence services. The CIA and other U.S. intelligence community analysts have nevertheless concluded that the classified PRC document contained U.S. thermonuclear warhead design information and other technical information on U.S. nuclear weapons.

The stolen U.S. nuclear secrets give the PRC design information on thermonuclear weapons on a par with our own. Currently deployed PRC ICBMs targeted on U.S. cities are based on 1950s-era nuclear weapons designs. With the stolen U.S. technology, the PRC has leaped, in a handful of years, from 1950s-era strategic nuclear capabilities to the more modern thermonuclear weapons designs. These modern thermonuclear weapons took the United States decades of effort, hundreds of millions of dollars, and numerous nuclear tests to achieve.

Such small, modern warheads are necessary for all of the elements of a modern intercontinental nuclear force, including:

- **Road-mobile ICBMs**
- **Submarine-launched ICBMs**
- **ICBMs with multiple warheads (MRVs or MIRVs)**

The PRC has an ongoing program to use these modern thermonuclear warheads on its next generation of ICBMs, currently in development. Without the nuclear secrets stolen from the United States, it would have been virtually impossible for the PRC to fabricate and test successfully small nuclear warheads prior to its 1996 pledge to adhere to the Comprehensive Test Ban Treaty.

B. The Select Committee judges that elements of the stolen information on U.S. thermonuclear warhead designs will assist the PRC in building its next generation of mobile ICBMs, which may be tested this year.

The stolen U.S. design information will assist the PRC in building smaller nuclear warheads — vital to the success of the PRC's ongoing efforts to develop survivable, mobile missiles. Current PRC ICBMs, which are silo-based, are more vulnerable to attack than mobile missiles.

The PRC has currently underway three intercontinental mobile missile programs — two road-mobile, and one submarine-launched. All of these missiles are capable of targeting the United States.

The first of these, the road-mobile solid-propellant DF-31, may be tested in 1999. Given a successful flight-test program, the DF-31 could be ready for deployment in 2002.

The Select Committee judges that the PRC will in fact use a small nuclear warhead on its new generation ICBMs. The small, mobile missiles that the PRC is developing require smaller warheads than the large, heavy, 1950s-era warheads developed for the PRC's silo-based missiles. The main purpose of a series of nuclear tests conducted by the PRC between 1992 and 1996 was evidently to develop new smaller, lighter warheads with an increased yield-to-weight ratio for use with the PRC's new, mobile nuclear forces.

The Select Committee judges that the PRC will exploit elements of the stolen U.S. thermonuclear weapons designs on its new ICBMs currently under development. The advanced U.S. thermonuclear warheads for which the PRC has stolen U.S. design information are significantly smaller than those for which the PRC's silo-based missiles were designed. The U.S. designs, unlike those in the PRC's currently-deployed arsenal, can be used on smaller mobile missiles.

The Select Committee judges that:

- **The PRC is likely to continue to work on small thermonuclear warheads based on stolen U.S. design information**
- **The PRC has the infrastructure and ability to produce such warheads, including warheads based on elements of the stolen U.S. W-88 Trident D5 design information**
- **The PRC could begin serial production of small thermonuclear warheads during the next decade in conjunction with its new generation of road-mobile missiles**
- **The introduction of small warheads into PLA service could coincide with the initial operational capability of the DF-31, which could be ready for deployment in 2002**

These small warhead designs will make it possible for the PRC to develop and deploy missiles with multiple reentry vehicles (MRVs or independently targetable MIRVs).

Multiple reentry vehicles increase the effectiveness of a ballistic missile force by multiplying the number of warheads a single missile can carry as many as ten-fold.

Multiple reentry vehicles also can help to counter missile defenses. For example, multiple reentry vehicles make it easier for the PRC to deploy penetration aids with its ICBM warheads in order to defeat anti-missile defenses.

The Select Committee is aware of reports that the PRC has in the past undertaken efforts related to technology with MIRV applications. Experts agree that the PRC now has the capability to develop and deploy silo-based intercontinental ballistic missiles with multiple reentry vehicles (MIRVs or MRVs).

Experts also agree that the PRC could have this capability for its new mobile intercontinental ballistic missiles within a reasonable period of years that is consistent with its plans to deploy these new mobile missiles. The PRC could pursue one or more penetration aids in connection with its new nuclear missiles.

If the PRC violates the Comprehensive Test Ban Treaty by testing surreptitiously, it could further accelerate its nuclear development.

The Select Committee judges that, if the PRC were successful in stealing nuclear test codes, computer models, and data from the United States, it could further accelerate its nuclear development. By using such stolen codes and data in conjunction with High Performance Computers (HPCs) already acquired by the PRC, the PRC could diminish its need for further nuclear testing to evaluate weapons and proposed design changes.

The possession of the stolen U.S. test data could greatly reduce the level of HPC performance required for such tasks. For these reasons, the Select Committee judges that the PRC has and will continue to aggressively target for theft our nuclear test codes, computer models, and data.

Although the United States has been the victim of systematic espionage successfully targeted against our most advanced nuclear weapons designs — and although the Select Committee judges that the PRC will exploit elements of those designs for its new generation of ICBMs — the United States retains an overwhelming qualitative and quantitative advantage in deployed strategic nuclear forces. Nonetheless, in a crisis in which the United States confronts the PRC's conventional and nuclear forces at the regional level, a modernized PRC strategic nuclear ballistic missile force would pose a credible direct threat against the United States.

Neither the United States nor the PRC has a national ballistic missile defense system.

In the near term, a PRC deployment of mobile thermonuclear weapons, or neutron bombs, based on stolen U.S. design information, could have a significant effect on the regional balance of power, particularly with respect to Taiwan. PRC deployments of advanced nuclear weapons based on stolen U.S. design information would pose greater risks to U.S. troops and interests in Asia and the Pacific.

In addition, the PRC's theft of information on our most modern nuclear weapons designs enables the PRC to deploy modern forces much sooner than would otherwise be possible.

At the beginning of the l990s, the PRC had only one or two silo-based ICBMs capable of attacking the United States. Since then, the PRC has deployed up to two dozen additional silo-based ICBMs capable of attacking the United States; has upgraded its silo-based missiles; and has continued development of three mobile ICBM systems and associated modern thermonuclear warheads.

If the PRC is successful in developing modern nuclear forces, as seems likely, and chooses to deploy them in sufficient numbers, then the long-term balance of nuclear forces with the United States could be adversely affected.

C. Despite repeated PRC thefts of the most sophisticated U.S. nuclear weapons technology, security at our national nuclear weapons laboratories does not meet even minimal standards.

The PRC stole design information on the United States' most advanced thermonuclear weapons as a result of a sustained espionage effort targeted at the United States' nuclear weapons facilities, including our national weapons laboratories. The successful penetration by the PRC of our nuclear weapons laboratories has taken place over the last several decades, and almost certainly continues to the present.

More specifically, the Select Committee has concluded that the successful penetration of our National Laboratories by the PRC began as early as the late 1970s; the PRC had penetrated the Laboratories throughout the 1980s and 1990s; and our Laboratories almost certainly remain penetrated by the PRC today.

Our national weapons laboratories are responsible for, among other things, the design of thermonuclear warheads for our ballistic missiles. The information at our national weapons laboratories about our thermonuclear warheads is supposed to be among our nation's most closely guarded secrets.

Counterintelligence programs at the national weapons laboratories today fail to meet even minimal standards. Repeated efforts since the early 1980s have failed to solve the counterintelligence deficiencies at the National Laboratories. While one of the Laboratories has adopted better counterintelligence practices than the others, all remain inadequate.

Even though the United States discovered in 1995 that the PRC had stolen design information on the W-88 Trident D-5 warhead and technical information on a number of other U.S. thermonuclear warheads, the White House has informed the Select Committee, in response to specific interrogatories propounded by the Committee, that the President was not briefed about the counterintelligence failures until early 1998.

Moreover, given the great significance of the PRC thefts, the Select Committee is concerned that the appropriate committees of the Congress were not adequately briefed on the extent of the PRC's espionage efforts.

A counterintelligence and security plan adopted by the Department of Energy in late 1998 in response to Presidential Decision Directive 61 is a step toward establishing sound counterintelligence practices. However, according to the head of these efforts, significant time will be required to implement improved security procedures pursuant to the directive. Security at the national weapons laboratories will not be satisfactory until at least sometime in the year 2000.

See the chapters *PRC Acquisition of U.S. Technology*, *PRC Theft of U.S. Thermonuclear Warhead Design Information*, and *PRC Missile and Space Forces* for more detailed discussions of the Select Committee's investigation of these matters.

2.

The PRC has stolen or otherwise illegally obtained U.S. missile and space technology that improves the PRC's military and intelligence capabilities.

A. The PRC has stolen U.S. missile technology and exploited it for the PRC's own ballistic missile applications.

The PRC has proliferated such military technology to a number of other countries, including regimes hostile to the United States.

The Select Committee has found that the PRC has stolen a specific U.S. guidance technology used on current and past generations of U.S. weapons systems. The stolen guidance technology is currently used on a variety of U.S. missiles and military aircraft, including:

- **The U.S. Army Tactical Missile System (ATACMS)**
- **The U.S. Navy Stand-off Land Attack Missile-Extended Range (SLAM-ER)**
- **The U.S. Navy F-14**
- **The U.S. Air Force F-15, F-16, and F-117 fighter jets**

The stolen guidance technology has direct applicability to the PRC's intercontinental, medium- and short-range ballistic missiles, and its spacelift rockets.

The theft of U.S. ballistic missile-related technology is of great value to the PRC. In addition to ICBMs and military spacelift rockets, such technology is directly applicable to the medium- and short-range PLA missiles, such as the CSS-6 (also known as the M-9), the CSS-X-7 (also known as the M-11), and the CSS-8 that have been developed for, among other purposes, striking Taiwan.

CSS-6 missiles were, for example, fired in the Taiwan Strait and over Taiwan's main ports in the 1996 crisis and confrontation with the United States.

The Select Committee has uncovered instances of the PRC's use of this specific stolen U.S. technology that:

- **Enhance the PRC's military capabilities**
- **Jeopardize U.S. national security interests**
- **Pose a direct threat to the United States, our friends and allies, or our forces**

The Clinton administration has determined that particular uses by the PRC of this stolen U.S. technology cannot be disclosed publicly without affecting national security.

The PRC has proliferated weapons systems and components to other countries including Iran, Pakistan, Libya, Syria, and North Korea.

B. In the late 1990s, the PRC stole or illegally obtained U.S. developmental and research technology that, if taken to successful conclusion, could be used to attack U.S. satellites and submarines.

During the late l990s, U.S. research and development work on electromagnetic weapons technology has been illegally obtained by the PRC as a result of successful espionage directed against the United States. Such technology, once developed, can be used for space-based weapons to attack satellites and missiles.

In 1997, the PRC stole classified U.S. developmental research concerning very sensitive detection techniques that, if successfully concluded, could be used to threaten U.S. submarines.

C. Currently-deployed PRC ICBMs targeted on the United States are based in significant part on U.S. technologies illegally obtained by the PRC in the 1950s.

This illustrates the potential long-term effects of technology loss.

Even in today's rapidly changing technological environment, technology losses can have long-term adverse effects. Currently-deployed PRC ICBMs targeted on the United States are based on U.S. and Russian technologies from the 1950s and 1960s.

In the 1950s, a U.S. military officer and associated members of the design team for a U.S. ICBM program (the "Titan" missile program) emigrated to the PRC and illegally gave U.S. missile and missile-related technology to the PRC.

This information formed the basis for the up to two dozen PRC CSS-4 ICBMs that are currently targeted on the United States.

All but two of these missiles have been deployed by the PRC for the first time in this decade.

D. In the aftermath of three failed satellite launches since 1992, U.S. satellite manufacturers transferred missile design information and know-how to the PRC without obtaining the legally required licenses.

This information has improved the reliability of PRC rockets useful for civilian and military purposes.

The illegally transmitted information is useful for the design and improved reliability of future PRC ballistic missiles, as well.

U.S. satellite manufacturers analyzed the causes of three PRC launch failures and recommended improvements to the reliability of the PRC rockets. These launch failure reviews were conducted without required Department of State export licenses, and communicated technical information to the PRC in violation of the International Traffic in Arms Regulations.

The Select Committee has concluded that the PRC implemented a number of the recommended improvements to rocket guidance and to the fairing (or nose cone), which protects a satellite during launch. These improvements increased the reliability of the PRC Long March rockets. It is almost certain that the U.S. satellite manufacturers' recommendations led to improvements in the PRC's rockets and that the improvements would not have been considered or implemented so soon without the U.S. assistance.

It is possible or even likely that, absent the U.S. satellite manufacturers' interventions on the problems associated with the defective fairing on the PRC's Long March 2E rocket and the defective guidance system on the PRC's Long March 3B rocket, one or more other PRC launches would have failed.

The PRC Long March rockets improved by the U.S. technology assistance are useful for both commercial and military purposes. The military uses include launching:

- **Military communications and reconnaissance satellites**
- **Space-based sensors**
- **Space-based weapons, if successfully developed**
- **Satellites for modern command and control and sophisticated intelligence collection**

The Select Committee judges that the PRC military has important needs in these areas, including notably space-based communications and reconnaissance capabilities.

In addition, design and testing know-how and procedures communicated during the launch failure reviews could be applied to the reliability of missiles or rockets generally. U.S. participants' comments during the failure investigations related to such matters as:

- **Missile design**
- **Design analysis**
- **Testing procedures**
- **The application of technical know-how to particular failure analyses**

To the extent any valuable information was transferred to the PRC's space program, such information would likely find its way into the PRC's ballistic missile program. The ballistic missile and space launch programs have long been intertwined and subordinate to the same ministry and state-owned corporation in the PRC.

For example, the PRC's Long March 2 rockets and their derivatives (including the Long March 2E, on which Hughes advised the PRC) were derived directly from the PRC's silo-based CSS-4 intercontinental ballistic missiles that are currently targeted on the United States.

The various institutes and academies in the PRC involved in ballistic missile and rocket design also share design and production responsibilities. Many of the PRC personnel in these organizations have responsibilities for both commercial rocket and military missile programs. Attendees at important failure review meetings included PRC personnel from such organizations.

In fact, information passed during each of the failure analyses has the potential to benefit the PRC's ballistic missile program. The independent experts retained by the Select Committee judge that information valuable to the PRC's ballistic missile and space programs was transferred to the PRC in the failure investigations.

The rocket guidance system on which Loral and Hughes provided advice in 1996 is judged by the Select Committee to be among the systems capable of being adapted for use as the guidance system for future PRC road-mobile intercontinental ballistic missiles, although if a better system is available, it is more likely to be chosen for that mission.

The Select Committee judges that information on rocket fairings (that is, nose cones) provided to the PRC by Hughes may assist the design and improved reliability of future PRC MIRVed missiles, if the PRC decides to develop them, and of future submarine-launched ballistic missiles.

When Loral and Hughes assisted the PRC, they could not know whether the PRC would in fact use such information in their military programs.

i. In 1993 and 1995, Hughes showed the PRC how to improve the design and reliability of PRC rockets.

Hughes' advice may also be useful for design and improved reliability of future PRC ballistic missiles.

Hughes deliberately acted without seeking to obtain the legally required licenses.

In 1993 and 1995, Hughes showed the PRC how to improve the design and reliability of PRC Long March rockets with important military applications. The information provided by Hughes also may be useful for improving the reliability of future PRC ballistic missiles. Hughes deliberately acted without the legally required licenses.

In 1993 and 1995 Hughes analyzed the causes of PRC launch failures and, for both failures, illegally recommended to the PRC improvements to the fairing, a part of the rocket that protects the payload. The PRC changed the fairing of its Long March rocket to incorporate the Hughes recommendations.

Hughes also corrected deficiencies in the PRC's coupled loads analysis, a critical rocket design technology.

Hughes also identified changes needed in PRC launch operations.

The State Department's Office of Defense Trade Controls has concluded that Hughes significantly improved the PRC space launch program and contributed to the PRC goal of assured access to space. The State Department further concluded that the lessons learned by the PRC are inherently applicable to their missile program.

The State Department administers arms export licensing, and would have been the proper authority to license the Hughes failure investigations.

The State Department found that the PRC and Hughes personnel engaged in an extensive exchange of data and analyses, which, among other things, identified and corrected for the PRC deficiencies in a number of technical areas, including:

- **Anomaly analysis**
- **Accident investigation techniques**
- **Telemetry analysis**
- **Coupled loads analysis**
- **Hardware design and manufacture**
- **Testing**
- **Modeling**
- **Simulation**
- **Weather analysis**

The illegally transmitted information improved the PRC's military rockets and operations. The illegally transmitted information may assist the PRC in the design and improved reliability of future silo-based or mobile PRC ballistic missiles, including particularly missiles that require fairings (or nose cones). These would include missiles with advanced payloads (that is, multiple warheads, or certain penetration aids designed to defeat missile defenses), and submarine launched ballistic missiles.

The PRC has the capability to develop and deploy silo-based missiles with multiple reentry vehicles (MIRVs or MRVs). Within a reasonable period of years that is consistent with the PRC's possible deployment of new mobile missiles, the PRC could deploy multiple warheads on those mobile missiles, as well. The PRC also appears to have gained practical insight into U.S. coupled loads analysis, and insight into diagnostic and failure analysis techniques for identifying the causes of a launch failure. Such lessons could be applied to both rockets and missiles.

In both 1993 and 1995, Hughes failed to apply for or obtain the required Department of State licenses for its activities, because Hughes knew that the Department of State would be unlikely to grant the license and that the licensing process would in any case be lengthy.

Hughes also engaged in deliberate efforts to circumvent the Department of State licensing requirement. To this end, Hughes sought the approval of a Department of Commerce official for its 1995 activities and claims to have sought the approval of a Department of Defense monitor for some of its 1993 activities, although Hughes knew that neither official was legally authorized to issue the required license.

Hughes had important commercial interests in the PRC at the time it engaged in the failure investigations. These interests included future sales of satellites to the PRC or to parties serving the PRC market, and reducing the cost and improving the safety of launching satellites in the PRC.

ii. In 1996, Loral and Hughes showed the PRC how to improve the design and reliability of the guidance system used in the PRC's newest Long March rocket.

Loral's and Hughes' advice may also be useful for design and improved reliability of elements of future PRC ballistic missiles.

Loral and Hughes acted without the legally required license, although both corporations knew that a license was required.

Loral and Hughes analyzed for the PRC the potential causes of a 1996 PRC launch failure, identified for the PRC the true cause of the failure as a particular element within the Long March rocket's guidance unit, and provided the PRC with technical assistance that may be useful not only for the PRC's commercial and military space launch programs, but for ballistic missiles as well.

In so doing, Loral and Hughes deliberately acted without the legally required license, and violated U.S. export control laws.

Although Loral and Hughes were well aware that a State Department license was required to provide assistance related to the guidance system of a PRC rocket, neither company applied for or obtained the required license. Loral was warned of the need for a license at the time it agreed to participate in the investigation, but took no action.

Loral and Hughes also failed to properly brief participants in the failure investigation of U.S. export requirements, failed to monitor the investigation as it progressed, and failed to take adequate steps to ensure that no prohibited information was passed to the PRC.

Loral and Hughes submitted lengthy written materials analyzing the cause of the guidance system failure to the PRC and to other foreign nationals. In addition, Loral and Hughes engaged in technical discussions, including discussions about the details and causes of the guidance system failure, that were almost certainly recorded by the PRC.

While some aspects of these discussions have been identified by the Select Committee and reviewed by independent experts retained by the Select Committee, the full range and content of these discussions remains unknown. The Select Committee was unable to talk to several important participants in the failure investigation, and the PRC refused to agree to the Select Committee's request for interviews. Additional controlled information may have been received by the PRC.

The information and assistance conveyed by Loral and Hughes led to improvements to the guidance system of the PRC's Long March 3B rocket. While the launch that failed was commercial, the information transmitted by Loral and Hughes was useful, as well, for military space launch purposes.

Loral and Hughes provided valuable additional information that exposed the PRC to Western diagnostic processes that could lead to improvements in the reliability of all PRC ballistic missiles. Loral's and Hughes' advice could help reinforce or add vigor to the PRC's adherence to good design and test practices, which could be transferred to the ballistic missile program. The exposure to U.S. diagnostic and test processes outlined by Loral and Hughes has the potential to improve PRC pre- and post-flight failure analysis for the ballistic missile program.

The technology transferred by Loral and Hughes thus has the potential, if used by the PRC, to increase the reliability of future PRC ballistic missiles.

The independent experts retained by the Select Committee had access not just to the written report prepared by Loral with input from Hughes, but also to the comments of participants about meetings in Beijing. The independent experts conclude that information valuable to the PRC's space and ballistic missile programs was transferred.

Neither Loral nor Hughes disclosed to export control officers of the U.S. Government their unlicensed activities until after they were contacted by U.S. Government licensing officials demanding an explanation for their conduct. The U.S. Government officials became aware of the improper activities through an article in a widely-read industry publication. This article also came to Loral's attention prior to Loral's disclosure to the U.S. Government.

Loral and Hughes had important commercial interests in the PRC when they engaged in the 1996 failure investigation. These interests included future sales of satellites to the PRC or to parties serving the PRC market, and reducing the cost and improving the safety of launching satellites in the PRC.

E. In light of the PRC's aggressive espionage campaign against U.S. technology, it would be surprising if the PRC has not exploited security lapses that have occurred in connection with launches of U.S. satellites in the PRC.

The original policy permitting U.S. manufactured satellites to be launched in the PRC envisioned strict compliance with requirements to prevent unauthorized technology transfers.

These requirements are encompassed in U.S. regulations and licenses. Pursuant to a bilateral agreement between the United States and the PRC, the requirements include U.S. control over access to the satellite while it is in the PRC. Many of these requirements imposed on exporters are to be closely monitored by U.S. Government officials provided by the Defense Department.

The Select Committee has found numerous lapses in the intended pre-launch technology safeguards. Defense Department monitors have reported numerous security infractions by exporters. Exporters often hire private security guards to assist in the performance of their duties to prevent technology transfers, and these private guards have also reported security lapses.

In addition, it is likely that other security lapses have gone unreported. In the mid-1990s, three launches and associated pre-launch activities were not monitored by the Defense Department. Launches that were monitored have lacked proper staffing.

Because of the PRC's aggressive efforts to acquire U.S. technology, it would be surprising if the PRC has not exploited security lapses while U.S.-built satellites and associated equipment and documents were in the PRC. Prior to launch, the satellite, associated test equipment, and controlled documents are transported to the PRC and may remain in the PRC for periods as short as a couple of weeks or as long as two months. The PRC would likely exploit opportunities to gain information while the U.S. satellite and associated equipment are in the PRC before launch.

Unrestricted access to a satellite for as little as two hours could provide the PRC with valuable, non-public information about major satellite subsystems, as well as the design and manufacture of such subsystems.

There are numerous reasons for security infractions, some of which may be addressed through changes in procedures:

- **Defense Department monitors on occasion have found poor attitudes toward security among both company management and private guards**
- **Private security guards hired by satellite exporters may have an inherent conflict of interest when reporting on their current and prospective employers**
- **Both Defense Department monitors and private security guards may lack sufficient training**
- **Defense Department monitors sometimes lack continuity with a given launch**
- **Often, only one Defense Department monitor may have been present on a project**

F. Foreign brokers and underwriters of satellite and space launch insurance have obtained controlled U.S. space and missile-related technology outside of the system of export controls that applies to U.S. satellite manufacturers.

While existing laws address such exports, U.S. export control authorities may not be adequately enforcing these laws in the space insurance industry context, nor paying sufficient attention to these practices.

Satellite and space insurance is underwritten by overseas and multinational organizations to which U.S. technical information is always passed to assess insurance risks. This is particularly true where the insurers have particular reasons to be concerned about launch failures.

These insurers have, on occasion, received controlled U.S. technical information. It is not clear that manufacturers and purchasers of satellites are transmitting satellite information to such foreign brokers and underwriters in compliance with U.S. export control rules and regulations.

As insurance is critical to commercial space launches, the insurance role cannot be eliminated. Existing laws address exports to brokers and insurers. The administration of these laws must be applied to exports of sensitive U.S. technology to the space launch and satellite insurance industry.

G. The Strom Thurmond National Defense Authorization Act took important steps to correct deficiencies in the administration of U.S. export controls on commercial space launches in the PRC.

But the aggressive implementation of this law is vital, and other problems with launches in the PRC that the Act does not address require immediate attention.

The Fiscal 1999 Department of Defense Authorization Act sought to increase safeguards on technology transfer during foreign launches of U.S. satellites.

The measures set forth in the Act include transferring licensing jurisdiction to the Department of State, and increased support for the Defense Department's efforts to prevent technology loss.

However, additional measures — including better training for Defense Department monitors and improved procedures for hiring professional security personnel — will be needed.

H. It is in the national security interest of the United States to increase U.S. domestic launch capacity.

While U.S. policy since 1988 has permitted launching satellites in the PRC, U.S. national security interests would be advanced by avoiding the need for foreign launches through increased domestic launch capability.

The Reagan administration's decision to permit launches in the PRC was affected by two factors: insufficient domestic launch options in the aftermath of the *Challenger* disaster, and the perception of the PRC as a strategic balance against the Soviet Union in the context of the Cold War. These factors are no longer applicable today.

Launching Western satellites has provided the PRC with additional experience that has improved its space launch capabilities. Even in the absence of any loss of U.S. technology, such experience benefits a potential long-run competitor of the United States.

See the chapters *PRC Missile and Space Forces*, *Satellite Launches in the PRC: Hughes*, and *Satellite Launches in the PRC: Loral* for more detailed discussion of the Select Committee's investigation of these matters.

3.

United States and international export control policies and practices have facilitated the PRC's efforts to obtain militarily useful technology.

A. Recent changes in international and domestic export control regimes have reduced the ability to control transfers of militarily useful technology.

i. The dissolution of COCOM in 1994 left the United States without an effective, multilateral means to control exports of militarily useful goods and technology.

The Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies (Wassenaar) leaves international controls over the transfer of military technologies to national discretion.

The dissolution of the Coordinating Committee for Multilateral Export Controls (COCOM) in March 1994 left the United States without an effective international mechanism to control the transfer of important military technologies. Other multilateral control regimes set guidelines for particular kinds of transfers (for example, certain transfers related to missiles or weapons of mass destruction).

In the post-COCOM period, the United States dramatically liberalized export controls.

A new COCOM-like agreement, under which national exports of certain militarily useful goods and technologies are subject to international agreement, would enhance efforts to restrict technology transfers. The United States should seek to negotiate such a new arrangement.

ii. The expiration of the Export Administration Act in 1994 has left export controls under different legislative authority that, among other things, carries lesser penalties for export violations than those that can be imposed under the Act.

Following the expiration of the Export Administration Act in 1994, export controls on dual-use items have been continued under the provisions of the International Emergency Economic Powers Act. This law carries significantly lesser penalties for criminal and civil violations of export controls than those that applied under the Export Administration Act.

While the general criminal penalties of Title 18 of the U.S. Code may be imposed under either scheme, administration of export controls would be enhanced by a reauthorization of the Export Administration Act that would restore more significant penalties for export control violations.

iii. U.S. policy changes announced in 1995 that reduced the time available for national security agencies to consider export licenses need to be reexamined in light of the volume and complexity of licensing activities.

New procedures and deadlines for processing Commerce Department export license applications instituted in late 1995 placed national security agencies under significant time pressures.

Commerce officials alone are less likely to have the expertise for identifying national security implications of exports of militarily useful technologies. While national security agencies may be informed of applications, due time is needed for their consideration.

However, the time frame for consideration is not always sufficient for the Department of Defense to determine whether a license should be granted, or if conditions should be imposed.

In addition, the Intelligence Community has sought a role earlier in the licensing process in order to evaluate the technology and end user.

B. Dividing the licensing responsibilities for satellites between the Departments of Commerce and State permitted the loss of U.S. technology to the PRC.

The 1996 decision to give Commerce the lead role in satellite exporting was properly reversed by the Congress.

Divided jurisdiction between Commerce and State over satellite export licensing has facilitated the loss of U.S. technology to the PRC.

While licensing authority regarding rockets has always remained with the State Department, in 1992 certain aspects of satellite licensing were transferred to Commerce.

For nearly a three-year period thereafter, Commerce licenses did not require Department of Defense monitors for launch campaigns. Accordingly, U.S. Government officials did not monitor several launches and launch campaigns. Given the PRC's efforts at technology acquisition, it would be surprising if the PRC did not attempt to exploit this situation.

In 1995, a Commerce Department official improperly authorized the transfer, in the context of a launch failure investigation, of information regarding rocket design that would almost certainly have been prevented had the Department of State been consulted.

In October 1996, all remaining authority for commercial satellite licensing was transferred to Commerce.

Legislation passed by Congress in 1998 eliminated the split jurisdiction and assigned all licensing of satellite exports to the Department of State.

C. U.S. policies relying on corporate self-policing to prevent technology loss have not worked.

Corporate self-policing does not sufficiently account for the risks posed by inherent conflicts of interest, and the lack of priority placed on security in comparison to other corporate objectives.

To protect the national security interests of the United States, the U.S. Government imposes substantial requirements on U.S. businesses exporting technology to the PRC. These can include obtaining a license, satisfying additional conditions imposed in the license, paying for U.S. Government monitors, and providing security guards.

Under current policies, whether U.S. national security is in fact protected from the loss of export-controlled information thus depends in large part on the vigilance, good will, and efforts dedicated by business to comply with lawful requirements.

Corporations may often face inherent conflicts of interest in complying with U.S. export laws. Corporate interests that may conflict with restricting exports as required by U.S. law include:

- **Corporate goals to expand overseas markets and to satisfy current or prospective customers**
- **Urgent business priorities that compete for the attention of corporate management**
- **An unwillingness to devote the financial resources necessary for effective security**

Protecting the national security interest simply may not be related to improving a corporation's "bottom line."

In cases discussed later in this Report, two U.S. satellite manufacturers, Hughes and Loral, failed to live by the requirements of U.S. law. The failure of Hughes to obtain legally required licenses, for example, reflects a deliberate decision to assist the

PRC immediately, rather than risk the possibility that a license application would be delayed or rejected.

Such pressures may be great where important commercial opportunities or relationships may seem to a corporation to be at stake.

U.S. policies relying on corporate self-policing to prevent technology loss have not sufficiently accounted for the risks posed by inherent conflicts of interest, and by the lack of priority placed on dedicating resources to security in comparison to other corporate objectives.

D. The PRC requires high performance computers (HPCs) for the design, modeling, testing, and maintenance of advanced nuclear weapons based on the nuclear weapons design information stolen from the United States.

The United States relaxed restrictions on HPC sales in 1996; and the United States has no effective way to verify that HPC purchases reportedly made for commercial purposes are not diverted to military uses.

The Select Committee judges that the PRC has in fact used HPCs to perform nuclear weapons applications.

PRC research institutes with connections to PLA military industries have access to numerous U.S.-built HPCs that could be used for unlawful military applications. HPCs are important for many military applications, and essential for some.

One key concern is diversion of U.S. HPCs to the PRC's nuclear weapons program. If the PRC complies with the Comprehensive Test Ban Treaty, then its need for HPCs to design, weaponize, deploy, and maintain nuclear weapons will be greater than that of any other nation possessing nuclear weapons, according to the Department of Energy.

HPCs are useful for two-dimensional and critical to three-dimensional computer modeling that would be necessary for the PRC to develop, modify, and maintain its nuclear weapons in the absence of physical testing.

The utility of nuclear weapons computer modeling depends on the amount of data available from actual nuclear weapons tests, the computing capacity that is available, and programmer expertise. For this reason, in the judgment of the Select Committee, the PRC has targeted U.S. nuclear test data for espionage collection, which, if successful, would reduce its HPC performance requirements.

Complete three-dimensional models, critical to stockpile maintenance and assessment of the effect of major warhead modifications in the absence of physical testing, require HPCs of one million MTOPS (millions of theoretical operations-per-second, a measure of computer performance and speed) or more. Assessing the effects of a new warhead without testing would require three-dimensional modeling.

Although the precise utility of HPCs in the 2,000 to 10,000 MTOPS range for two-dimensional modeling is unclear, these HPCs may be powerful enough to help the PRC incorporate nuclear weapons design information that it stole from the U.S. into delivery systems without further testing.

In fact, the Select Committee judges that the PRC has been using HPCs for nuclear weapons applications. The illegal diversion of HPCs for the benefit of the PRC military is facilitated by the lack of effective post-sale verifications of the locations and purposes for which the computers are being used. HPC diversion for PRC military use is also facilitated by the steady relaxation of U.S. export controls over sales of HPCs.

Until 1998, there was no verification of the end uses of HPCs in the PRC. Modest verification procedures were announced in June 1998, but even if these are implemented fully, they will be insufficient.

Over the past several years, U.S. export controls on the sale of HPCs to the PRC have been steadily relaxed. As a result, while the PRC had virtually no HPCs in 1996, the PRC had over 600 U.S.-origin HPCs at the end of 1998.

The PRC has demonstrated the capability to assemble an HPC using U.S.-origin microprocessors. The Select Committee has concluded, however, that the PRC has virtually no indigenous high-end computer production capability. Moreover, while the PRC might attempt to perform some HPC functions by other means, these computer work-arounds remain difficult and imperfect.

Data from the Commerce Department and Defense Department indicate that HPCs from the United States have been obtained by PRC organizations involved in the research and development of:

- **Missiles**
- **Satellites**
- **Spacecraft**
- **Submarines**
- **Aircraft**
- **Military systems components**
- **Command and control**
- **Communications**
- **Microwave and laser sensors**

Given the lack of an effective verification regime, it is possible that these HPCs have been diverted for military uses, which could include the following:

- **Incorporating or adapting nuclear weapons designs**
- **Upgrading and maintaining nuclear and chemical weapons**
- **Equipping mobile forces with high-technology weapons**
- **Building a modern fleet of combat and combat support aircraft and submarines**
- **Conducting anti-submarine warfare**
- **Developing a reliable, accurate ballistic and cruise missile force**

- **Equalizing a battlefield with electronic or information warfare**
- **Improving command, control, communications, and intelligence capabilities**

Finally, the Select Committee judges that nuclear testing data and related computer codes are a target of PRC espionage, and that the PRC's nuclear weapons programs would benefit from the illegal acquisition of such information.

In conjunction with such data and codes, HPCs can be used to improve nuclear weapons designs, performance, modeling, and nuclear stockpile maintenance that would otherwise be extremely difficult or impossible given the restrictions imposed by the Comprehensive Test Ban Treaty.

E. The PRC has attempted to obtain U.S. machine tools and jet engine technologies through fraud and diversions from commercial end uses.

In one 1991 case studied by the Select Committee, the Department of Commerce decontrolled jet engines without consulting either the Defense Department or the State Department.

i. In 1994 and 1995 the PRC attempted to divert an export of machine tools by McDonnell Douglas to military uses.

The Select Committee's classified Report includes significantly more detail on this subject than this unclassified version. The Justice Department has requested that the Select Committee not disclose the details of much of its investigation into these matters to protect the Justice Department's prosecution of the China National Aero-Technology Import/Export Corporation (CATIC) and McDonnell Douglas.

ii. In 1991 the Commerce Department decontrolled Garrett jet engines without consulting either the Defense Department or the State Department.

This led to a PRC effort to acquire related jet engine production technology. The Commerce Department was prepared to approve this transfer, which was only thwarted when the Defense Department was alerted by the U.S. Embassy in Beijing.

See the chapters *High Performance Computers, U.S. Export Policy Toward the PRC,* and *Manufacturing Processes* for a more detailed discussion of the Select Committee's investigation of these matters.

4.

- **The PRC seeks advanced U.S. military technology to achieve its long-term goals.**
- **To acquire U.S. technology the PRC uses a variety of techniques, including espionage, controlled commercial entities, and a network of individuals and organizations that engage in a vast array of contacts with scientists, business people, and academics.**

The PRC has vigorously pursued over the last two decades the acquisition of foreign military technologies. These efforts represent the official policy of the PRC and its Chinese Communist Party leadership. The PRC seeks foreign military technology as part of its efforts to place the PRC at the forefront of nations and to enable the PRC to fulfill its international agenda. The PRC's long-run geopolitical goals include incorporating Taiwan into the PRC and becoming the primary power in Asia.

The PRC has not ruled out using force against Taiwan, and its thefts of U.S. technology have enhanced its military capabilities for any such use of force.

The PRC has also asserted territorial claims against other Southeast Asian nations and Japan, and has used its military forces as leverage in asserting these claims.

These PRC goals conflict with current U.S. interests in Asia and the Pacific, and the possibility of a U.S.-PRC confrontation cannot be dismissed.

A. The PRC has mounted a widespread effort to obtain U.S. military technologies by any means — legal or illegal.

These pervasive efforts pose a particularly significant threat to U.S. export control and counterintelligence efforts.

The PRC seeks military-related technology through a broad range of activities that complicate U.S. counterintelligence efforts.

Many of these efforts are less centralized than was the case with those of the Soviet Union. The number of PRC nationals who seek access to U.S. technology is much greater than the number of persons who sought similar kinds of information for the Soviet Union.

The Select Committee has determined that the Intelligence Community is insufficiently focused on the threat posed by PRC intelligence and the targeted effort to obtain militarily useful technology from the United States. Due to our sustained focus on the Soviet Union during the Cold War, intelligence collection against the PRC was not a top priority for our intelligence agencies in those years.

For the last several years, the U.S. Intelligence Community has begun to place a greater priority on the PRC. Nonetheless, the Intelligence Community lacks sufficient Chinese linguists and needs increased resources to address the challenge posed by the PRC's intelligence collection efforts.

The FBI has inadequate resources in light of the extensive numbers of PRC visitors, students, diplomats, business representatives, and others who may be involved in intelligence and military-related technology transfer operations in the United States.

B. Efforts to deny the PRC access to U.S. military technology are complicated by the broad range of items in which the PRC is interested, and by transfers to the PRC of Russian military and dual-use technologies, which may make the consequences of the PRC's thefts of U.S. technology more severe.

The PRC seeks and has acquired from the United States and elsewhere a broad range of military and related technologies.

Russia, for example, has provided the PRC with extensive military assistance and related technologies, including a number of complete military systems. The Select Committee has been advised that the sheer number of transfers of military equipment and technology to the PRC from Russia, most of which have been a product of dramatically increased PRC-Russian military cooperation since 1992, is vastly greater than the number of transfers from the United States, most of which are the result of PRC espionage.

Together, the added capabilities that the PRC has gained and continues to gain from foreign sources makes it difficult to assess how quickly the PRC will be able to make full use of any systems or technologies stolen from the United States. For example, the PRC's reported acquisition of solid-fuel and mobile missile launcher technologies, if successfully combined with stolen U.S. nuclear design information, will enable the PRC to field a robust road-mobile, intercontinental ballistic missile threat to the United States sooner than would otherwise have been possible.

C. The PRC uses commercial and political contacts to advance its efforts to obtain U.S. military, as well as commercial, technology.

The PRC has adopted policies in recent years aimed at increasing its influence within the United States in order to increase access to U.S. military, as well as commercial, technology.

To this end, the PRC has used access to its markets to induce U.S. business interests to provide military-related technology.

The PRC also uses access to its markets to induce U.S. businesses to lobby in behalf of common goals, such as liberalized export standards and practices.

Agents tied to the PRC's military industries who have illegally provided political contributions may have used these contributions to gain access to U.S. military and commercial technology.

D. The PRC has proliferated nuclear, missile, and space-related technologies to a number of countries.

The PRC is one of the leading proliferators of complete ballistic missile systems and missile components in the world.

The PRC has sold complete ballistic missile systems, for example, to Saudi Arabia and Pakistan, and missile components to a number of countries including Iran and Pakistan. The PRC has proliferated military technology to Iran, Pakistan, and North Korea.

In 1991, the PRC agreed to adhere to the April 1987 Missile Technology Control Regime (MTCR) guidelines, but the PRC has not accepted the revisions to those guidelines issued in 1993. The 1993 MTCR guidelines increase the kinds of missile systems subject to controls and call for a "strong presumption to deny" both sales of complete missile systems and components that could be used in ballistic missiles.

The PRC has provided, or is providing, assistance to the missile and space programs of a number of countries according to the Congressional Research Service. These countries include, but are not limited to:

- **Iran.** The PRC has provided Iran with ballistic missile technology, including guidance components and the recent transfer of telemetry equipment. The PRC reportedly is providing Iran with solid-propellant missile technology. Additionally, the PRC provided Iran with the 95-mile range CSS-8 ballistic missile. Since the mid-1980s, the PRC has transferred C-802 anti-ship cruise missiles to Iran. The PRC has also provided assistance to Iran's nuclear programs.

- **Pakistan.** The PRC has provided Pakistan with a wide range of assistance. The PRC reportedly supplied Pakistan with CSS-X-7/M-11 mobile missile launchers and reportedly has provided Pakistan with the facilities necessary to produce M-11 missiles. The PRC provides Pakistan with assistance on uranium enrichment, ring magnets, and other technologies that could be used in Pakistan's nuclear weapons program.

- **Saudi Arabia.** The PRC provided a complete CSS-2 missile system to Saudi Arabia in 1987. The conventionally-armed missile has a range of 1,200 to 1,900 miles.

- **North Korea.** The Select Committee judges that the PRC has assisted weapons and military-related programs in North Korea.

The Select Committee is aware of information of further PRC proliferation of missile and space technology that the Clinton administration has determined cannot be publicly disclosed without affecting national security.

See the chapter *PRC Acquisition of U.S. Technology* for more detailed discussion of the Select Committee's investigation of these matters.

PRC ACQUISITION OF U.S. TECHNOLOGY

This chapter describes the methods by which the PRC attempts to acquire U.S. technology for military purposes. The types of technology and information that the PRC and individual PRC nationals have attempted to acquire, however, are far more broad. The PRC appears to try to acquire information and technology on just about anything of value. Not all of it, by any means, presents national security or law enforcement concerns.

The PRC's appetite for information and technology appears to be insatiable, and the energy devoted to the task enormous. While only a portion of the PRC's overall technology collection activities targeted at the United States is of national security concern, the impact on our national security could be huge.

The Select Committee has discovered evidence of a number of their successes. Given the size and variety of the PRC's overall effort, and the limited U.S. resources and attention devoted to understanding and countering its unlawful and threatening elements, there is clear cause for concern that other serious losses have occurred or could occur in the future.

It is extremely difficult to meet the challenge of the PRC's technology acquisition efforts in the United States with traditional counterintelligence techniques that were applied to the Soviet Union. Whereas Russians were severely restricted in their ability to enter the United States or to travel within it, visiting PRC nationals, most of whom come to pursue lawful objectives, are not so restricted. Yet the PRC employs all types of people, organizations, and collection operations to acquire sensitive technology: threats to national security can come from PRC scientists, students, business people, or bureaucrats, in addition to professional civilian and military intelligence operations.

In light of the number of interactions taking place between PRC and U.S. citizens and organizations over the last decade as trade and other forms of cooperation have bloomed, the opportunities for the PRC to attempt to acquire information and technology, including sensitive national security secrets, are immense. Moreover, the PRC often does not rely on centralized control or coordination in its technology acquisition efforts, rendering traditional law enforcement, intelligence, and counterintelligence approaches inadequate. While it is certainly true that not all of the PRC's technology acquisition efforts are a threat to U.S. national security, that very fact makes it quite a challenge to identify those that are.

While this report, this Select Committee, and the nation's counterintelligence organizations are focused on national security issues, it is thus necessary to understand the full range of the PRC's technology acquisition effort to discern its threatening aspects.

COMMERCIAL AND INTELLIGENCE OPERATIONS

PRC ACQUISITION OF U.S. TECHNOLOGY

The Structure of the PRC Government

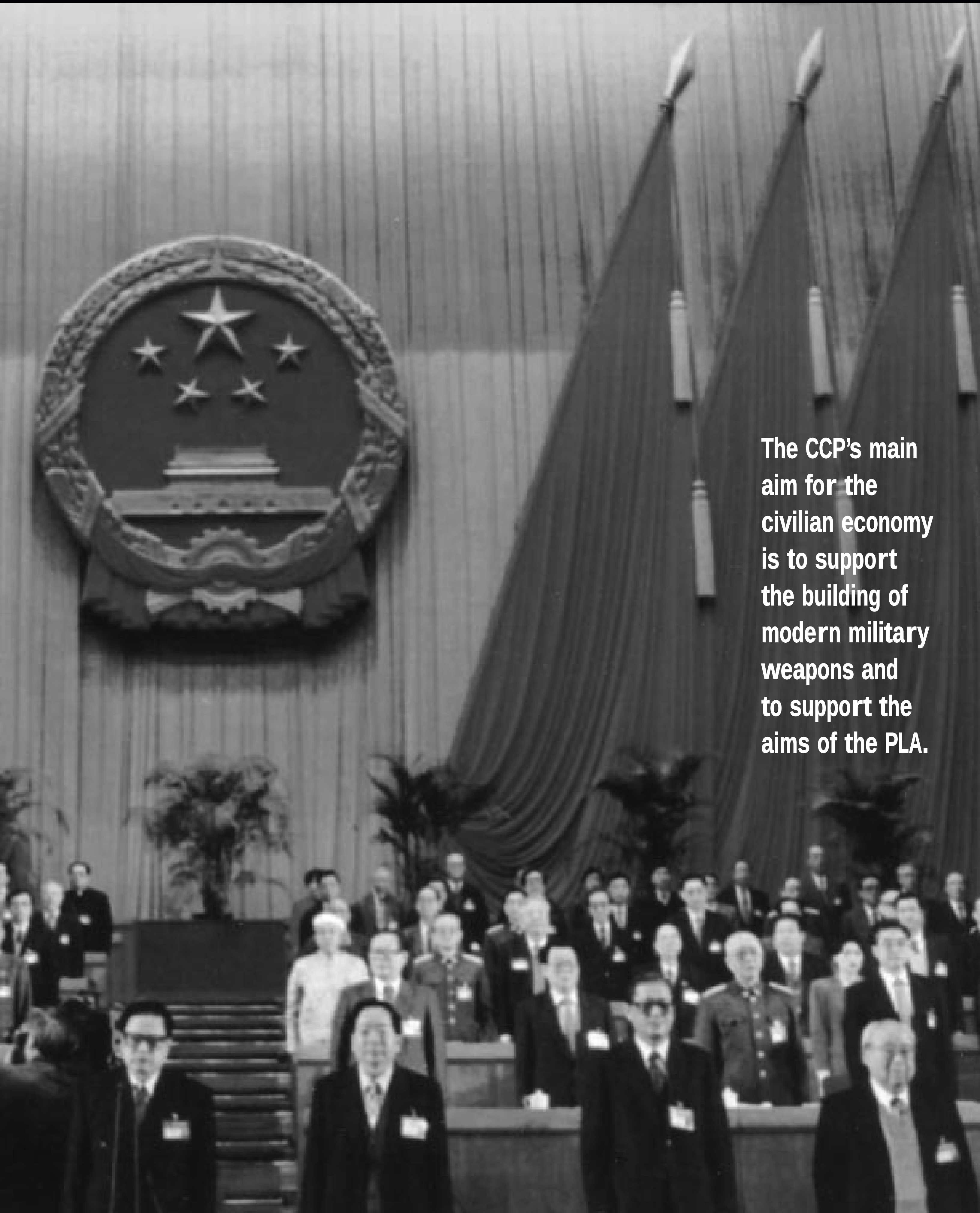
The political, governmental, military, and commercial activities of the People's Republic of China are controlled by three directly overlapping bureaucracies: the Communist Party, the State, and the People's Liberation Army.

Foremost of these, and in ultimate control of all state, military, commercial, and political activities in the PRC, is the Chinese Communist Party (CCP).[1] The Communist Party Secretary, Jiang Zemin, chairs both the Politburo and its powerful executive group, the Politburo Standing Committee. The Politburo, in turn, is supported by the CCP Secretariat.

The State governmental apparatus is under the direct control of the Communist Party Secretary, Jiang Zemin, who in his role as President serves as the official head of the State as well. Subordinate to the CCP Secretary in state affairs is the State Council, presided over by Premier Zhu Rongji, also a high-ranking member of the Communist Party.

The People's Liberation Army (PLA) is also directly under the control of the Communist Party. The top level of PLA authority is the CCP's Central Military Commission (CMC), of which Jiang Zemin, the CCP Secretary, is also the Chairman. The CMC's routine work is directed by its two Vice-Chairmen, Generals Zhang Wannian and Chi Haotian.

The 24-member CCP Politburo,[2] which ultimately controls the PRC's political, military, governmental, and commercial activities, does not usually conduct its business as a whole. Rather, due to its unwieldy size and membership consisting of per-



The CCP's main aim for the civilian economy is to support the building of modern military weapons and to support the aims of the PLA.

Chinese Communist Party (CCP) Officials

Zhu Rongji
Premier, State Council

Jiang Zemin
President; Communist Party Secretary

Hu Jintao
Vice President

Li Peng
Chairman, National People's Congress

Gen. Chi Haotian
Vice Chairman, Central Military Commission

Xu Yongyue
Minister of State Security

Deng Xiaoping
Late Chief of Communist Party

Gen. Zhang Wannian
Vice Chairman, Central Military Commission

In the People's Republic of China, members of the Chinese Communist Party's ruling body control all state, military, commercial, and political activities.

sons from outside Beijing, the Politburo acts through its powerful seven-member Standing Committee. Involvement by the entire Politburo in specific decisions normally occurs when there are major policy shifts, crises need to be addressed, or formal legitimization of a particular policy is necessary.

In contrast, the seven most senior members of the Communist Party Politburo, comprising the Politburo Standing Committee, meet frequently. The CCP Politburo Standing Committee wields the real decision-making power in the PRC.

The Communist Party Secretariat officially serves as staff support to the Politburo and oversees the implementation of Politburo decisions by State bureaucracies. The Secretariat is composed of seven members of the Politburo and is an executive rather than a decision-making body. The current ranking member of the Secretariat is Vice-President and Standing Committee member Hu Jintao.

The State Council, the top level of the PRC State governmental apparatus, consists of the Premier, Vice Premiers, State Councilors, and Secretary and Deputy Secretaries General. It directs the activities of all State ministries, commissions, and offices.

The Communist Party's eight-member Central Military Commission (CMC) heads the People's Liberation Army, which includes the PRC's army, navy, and air force, as well as espionage operations conducted through the Second Department of the PLA. The CMC has a powerful bureaucratic status roughly comparable to that of the Politburo Standing Committee and the State Council. It meets regularly to address administrative matters and to formulate military policy and strategy.

In addition to their policy- and decision-making roles in the CMC, key members of that body – by virtue of their top posts in the Communist Party – also serve a bridging function between the CCP, the State, and the PLA.

The CMC, a Communist Party body, has no equivalent in the State sector. The State Central Military Commission, an organization within the State bureaucracy, is theoretically a separate decision-making body, but in reality it has no unique powers because its membership generally mirrors that of the Party's CMC. The PRC's Ministry of Defense, the principal State bureaucracy for dealing with military affairs, is likewise composed of Communist Party CMC members, and its role is primarily a ceremonial one. The domination and control of the PLA by the Communist Party is thus complete.

COSTIND: The CCP's Use of Corporations for Military Aims

The State Council controls the PRC's military-industrial organizations through the State Commission of Science, Technology and Industry for National Defense (COSTIND). The State Council has a decisive role in Communist Party policy because of its function as interpreter, implementer, and overseer of broadly-worded and often ambiguous Politburo policy goals.

Created in 1982, COSTIND was originally intended to eliminate conflicts between the military research and development sector and the military production sector by combining them under one organization. But its role soon broadened to include the integration of civilian research, development, and production efforts into the military.

COSTIND presides over a vast, interlocking network of institutions dedicated to the specification, appraisal, and application of advanced technologies to the PRC's military aims. The largest of these institutions are styled as corporations, notwithstanding that they are directly in service of the CCP, the PLA, and the State. They are:

- **China Aerospace Corporation (CASC)**
- **China National Nuclear Corporation (CNNC)**
- **China North Industries Group (NORINCO)**
- **Aviation Industries Corporation of China (AVIC)**
- **China State Shipbuilding Corporation (CSSC)**

Until 1998, COSTIND was controlled directly by both the CMC and the State Council. In March 1998, COSTIND was "civilianized" and now reports solely to the State Council. A new entity, the General Armament Department (GAD), was simultaneously created under the CMC to assume responsibility for weapons system management and research and development.

CCP Supremacy Over the State, the PLA, and the Economy

The PRC Constitution asserts the supremacy of the Communist Party over all other government, military, and civilian entities.[3] But the CCP also relies on other, more pragmatic methods to ensure its primacy. The most evident and effective of these is having senior CCP members in control of all State government bodies.[4]

The most obvious example of the Communist Party's practical control of both the State and the PLA is Communist Party Secretary Jiang Zemin's simultaneous service as State President and CCP Central Military Commission Chairman. Other examples include Zhu Rongji's simultaneous service as Politburo Standing Committee member and Premier of the State Council, and Li Lanqing's dual roles as Politburo member and Vice-Premier of the State Council.

In addition to the CCP Politburo's control of the PRC government and military, there are hundreds of similar connections between lower-level Communist Party officials and the State, military, and commercial bureaucracies in the PRC. For example, 25 of the 29 Ministers in charge of Ministries and Commissions under the State Council are members of the CCP Central Committee.

Nowhere is the supremacy of the Communist Party more clearly enunciated than with the PLA. This supremacy is explicitly set forth in the PRC Constitution.[5] In addition, as with the State government, it is not just law but common control that guarantees PLA compliance with the Communist Party's dictates. The most obvious practical example of direct Communist Party control of the PLA is Jiang Zemin's position as Chairman of the Central Military Commission, and the entire CMC's direct control of the PLA. Jiang is also the first Communist Party Secretary to enforce CCP control over the military completely by appointing no military officers to the powerful CCP Politburo Standing Committee, although two officers remain on the Politburo.

The slogan "the Party controls the gun" is often repeated in speeches by both CCP and PLA officials, serving as a constant reminder of CCP supremacy over the military. A 1997 article in the official PLA newspaper, published in celebration of Army Day, provided a typical example:

The Western hostile forces . . . have never given up their plot to Westernize and disintegrate our country, and they always try to infiltrate and corrode us by advocating the fallacies of de-partyization of the army . . . in a vain attempt to make our army shake off the Party's absolute leadership and change its nature.[6]

Development of the CCP's Technology Policies

The CCP Politburo addresses broad technology matters through the Science and Technology Leading Group.[7] This Communist Party group is headed by the Premier and includes the Chairman of the State Science and Technology Commission[8] and the Minister of COSTIND.

Broad technology policy directives originate in the upper levels of the Communist Party hierarchy. It is up to the State Council and its organs to fine-tune and implement those policies. In addition, the State government, like the CCP itself, has a number of Leading Groups, including a Science and Technology Leading Group, that provide expertise and recommendations to the State Council and its organs. A committee of approximately 50 R&D experts meets annually and provides policy planning and technical advice to the Minister of COSTIND. COSTIND can also call upon the many academies and institutes under its direction.

The State Council and its sub-units are also consumers of military research conducted by the PRC's military research bureaucracy, composed of numerous think-tanks that provide analysis on a wide range of matters. This military research is channeled through a State Council unit known as the International Studies Research Center.

The Center acts as a conduit and central transmission point to channel intelligence, research reports, and policy documents to the top Communist Party leadership.[9]

The 863 and Super-863 Programs: Importing Technologies for Military Use

In 1986, "Paramount Leader" Deng Xiaoping adopted a major initiative, the so-called 863 Program, to accelerate the acquisition and development of science and technology in the PRC.[10] Deng directed 200 scientists to develop science and technology goals. The PRC claims that the 863 Program produced nearly 1,500 research achievements by 1996 and was supported by nearly 30,000 scientific and technical personnel who worked to advance the PRC's "economy and . . . national defense construction." [11]

The most senior engineers behind the 863 Program were involved in strategic military programs such as space tracking, nuclear energy, and satellites.[12] Placed under COSTIND's management, the 863 Program aimed to narrow the gap between the PRC and the West by the year 2000 in key science and technology sectors, including the military technology areas of:

- **Astronautics**
- **Information technology**
- **Laser technology**
- **Automation technology**
- **Energy technology**
- **New materials**

The 863 Program was given a budget split between military and civilian projects, and focuses on both military and civilian science and technology. The following are key areas of military concern:

Biological Warfare

The 863 Program includes a recently unveiled plan for gene research that could have biological warfare applications.

Space Technology

Recent PRC planning has focused on the development of satellites with remote sensing capabilities, which could be used for military reconnaissance, as well as space launch vehicles.

Military Information Technology

The 863 Program includes the development of intelligent computers, optoelectronics, and image processing for weather forecasting; and the production of submicron integrated circuits on

8-inch silicon wafers. These programs could lead to the development of military communications systems; command, control, communications, and intelligence systems; and advances in military software development.

Laser Weapons

The 863 Program includes the development of pulse-power techniques, plasma technology, and laser spectroscopy, all of which are useful in the development of laser weapons.

Automation Technology

This area of the 863 Program, which includes the development of computer-integrated manufacturing systems and robotics for increased production capability, is focused in the areas of electronics, machinery, space, chemistry, and telecommunications, and could standardize and improve the PRC's military production.

Nuclear Weapons

Qinghua University Nuclear Research Institute has claimed success in the development of high-temperature, gas-cooled reactors, projects that could aid in the development of nuclear weapons.

Exotic Materials

The 863 Program areas include optoelectronic information materials, structural materials, special function materials, composites, rare-earth metals, new energy compound materials, and high-capacity engineering plastics. These projects could advance the PRC's development of materials, such as composites, for military aircraft and other weapons.

In 1996, the PRC announced the "Super 863 Program" as a follow-on to the 863 Program, planning technology development through 2010. The "Super 863 Program" continues the research agenda of the 863 Program, which apparently failed to meet the CCP's expectations.

The Super 863 Program calls for continued acquisition and development of technology in a number of areas of military concern, including machine tools, electronics, petrochemicals, electronic information, bioengineering, exotic materials, nuclear research, aviation, space, and marine technology.

COSTIND and the Ministry of Science and Technology jointly manage the Super 863 Program. The Ministry of Science and Technology focuses on biotechnology, information technology, automation, nuclear research, and exotic materials, while COSTIND oversees the laser and space technology fields.[13]

COSTIND is attempting to monitor foreign technologies, including all those imported into the PRC through joint ventures with the United States and other Western countries. These efforts are evidence that the PRC engages in extensive oversight of imported dual-use technology. The PRC is also working to translate foreign technical data, analyze it, and assimilate it for PLA military programs. The Select Committee has concluded that these efforts have targeted the U.S. Government and other entities.

If successful, the 863 Programs will increase the PRC's ability to understand, assimilate, and transfer imported civil technologies to military programs. Moreover, Super 863 Program initiatives increasingly focus on the development of technologies for military applications. PRC program managers are now emphasizing projects that will attract U.S. researchers.

Since the early 1990s, the PRC has been increasingly focused on acquiring U.S. and foreign technology and equipment, including particularly dual-use technologies that can be integrated into the PRC's military and industrial bases.

The 16-Character Policy: 'Give Priority to Military Products'

In 1997, the CCP formally codified the 16-Character Policy. The "16-Character Policy" is the CCP's overall direction that underlies the blurring of the lines between State and commercial entities, and military and commercial interests. The sixteen characters literally mean:

- ***Jun-min jiehe*** **(Combine the military and civil)**
- ***Ping-zhan jiehe*** **(Combine peace and war)**
- ***Jun-pin youxian*** **(Give priority to military products)**
- ***Yi min yan jun*** **(Let the civil support the military)**[14]

The PRC's 16-Character Policy

In 1997, the PRC formally codified Deng Xiaoping's "16-Character Policy," which literally means: Combine the military and civil; combine peace and war; give priority to military products; let the civil support the military.

This policy, a reaffirmation and codification of Deng Xiaoping's 1978 pronouncement, holds that military development is the object of general economic modernization, and that the CCP's main aim for the civilian economy is to support the building of modern military weapons and to support the aims of the PLA. The 16-Character Policy could be interpreted, in light of other policy pronouncements that subordinate military modernization to general economic modernization, to mean a short-term strategy to use defense conversion proceeds for immediate military modernization. Or it could mean a long-term strategy to build a civilian economy that will, in the future, support the building of modern military goods. In practice, however, the policy appears to have meant a little of both approaches.[15]

The CCP's official policy on military modernization, as publicly announced since the late 1970s by then-"Paramount Leader" Deng Xiaoping, states that the PRC is devoting its resources to economic development, and that military development is subordinate to and serves that goal.[16] But as Dr. Michael Pillsbury of the National Defense University has testified publicly, the doctrinal and strategic writings of many PLA leaders and scholars are inconsistent with a subordination of military modernization efforts. In fact, according to Pillsbury, these views are "surprising, and perhaps even alarming." [17]

General Liu Huaqing, former Vice-Chairman of the CCP's Central Military Commission and a member of both the Politburo and the Standing Committee, stated in 1992 that economic modernization was dependent not only on "advanced science and technology," but also "people armed with it." Anything else was "empty talk." [18]

The PRC has indeed used the profits from its burgeoning commercial economy to purchase a number of advanced weapons systems. The most notable of these include the purchase from Russia of 50 Sukhoi Su-27 jet fighters and the production rights for 200 more, two Kilo attack submarines, and two Sovremenniy missile destroyers.[19]


Janes Defense Group

The PRC has purchased from Russia 50 Sukhoi Su-27 jet fighters, and the production rights for 200 more of the aircraft. It is able to afford such purchases as the result of profits derived from its burgeoning commercial economy.

Janes Defense Group

The PRC has used the profits from its commercial economy to purchase a number of advanced weapons systems, including Kilo attack submarines *(above)* and Sovremenniy missile destroyers *(below).*

Janes Defense Group

The PRC has also purchased weapons systems or their components from Israel, France, Britain, and the United States, including air-to-air missiles, air-refueling technology, Global Positioning System (GPS) technology, helicopter parts, and assorted avionics.[20]

In addition to providing funds for the purchase of U.S. and foreign weapons systems, implementation of the 16-Character Policy serves the PLA in other ways. Among these are:

- **Funding military R&D efforts**
- **Providing civilian cover for military industrial companies to acquire dual-use technology through purchase or joint-venture business dealings**
- **Modernizing an industrial base that can, in time of hostility, be turned towards military production**

In this connection, since the 1980s significant portions of the PRC military industry have diversified into civilian production. The production of profit-producing civilian goods helps keep the PRC military-industrial companies financially stable. The majority of them have operated "in the red" for years, bolstered only by extremely generous and forgiving loan arrangements from the PRC's central banks.[21]

The blurred lines between military and commercial technology that are the hallmarks of the 16-Character Policy have also created some problems for the PRC. An official in the State Planning Commission criticized the 16-Character Policy for an insufficient focus on the most advanced military technologies, particularly in aerospace, aviation, nuclear power, and ship-building. At the same time, the official acknowledged, military industries have been reluctant to share economically valuable technologies with civilian enterprises.[22]

Pursuant to the 16-Character Policy, the PRC's emphasis on the acquisition and development of military technology is closely related to its interest in science and technology for economic development. At times this has been reflected in tension between modernizing the PLA and developing the economy. The PRC's approach to resolving this conflict has been to seek "comprehensive national power," in which high-technology industries, economic growth, and military modernization are all interrelated.[23]

Despite the PRC's public claims, it is estimated that their actual military spending is four to seven times greater than official figures. During the 1990s, no other part of the PRC's budget has increased at the rate of military spending. A large portion of this budget is devoted to military research.[24]

The success achieved by the United States through the use of high-technology weapons in the 1990 Gulf War led PLA leaders to call for a reemphasis on military development. PLA leaders began to call for military preparedness to fight "limited war under high-tech conditions."

The PLA's call for more attention to military aims appears to have had some impact. In a 1996 speech, Li Peng, second-ranking member of the CCP Politburo, then-Prime Minister, and currently Chairman of the National People's Congress,[25] said:

> *We should attach great importance to strengthening the army through technology, enhance research in defense-related science, . . . give priority to developing arms needed for defense under high-tech conditions, and lay stress on developing new types of weapons.*[26]

Communist Party Secretary Jiang Zemin, in March 1997, publicly called for an "extensive, thoroughgoing and sustained upsurge" in the PLA's acquisition of high technology.[27] The PRC's 1998 Defense White Paper pointedly stated that "no effort will be spared to improve the modernization level of weaponry."[28]

The modernization of the PLA has placed priority on the development of:

- **Battlefield communications**
- **Reconnaissance**
- **Space-based weapons**
- **Mobile nuclear weapons**
- **Attack submarines**
- **Fighter aircraft**
- **Precision-guided weapons**
- **Training rapid-reaction ground forces**

These actions, supported by the PRC's overall economic growth, will improve the PLA's military capabilities in ways that enable the PRC to broaden its geographic focus. At the same time, the PRC has shifted its military strategy towards rapid-reaction mobility and regional, versus global, armed conflict. Under this framework, the PRC's avowed military strategy is one of "active defense," a capability for power projection to defend the PRC's territorial ambitions, which extend to not only Taiwan, but also the Senkaku Islands in the East China Sea, and the Spratly and Paracel Islands in the South China Sea.

The PRC's Use of Intelligence Services To Acquire U.S. Military Technology

The primary professional PRC intelligence services involved in technology acquisition are the Ministry of State Security (MSS) and the PLA General Staff's Military Intelligence Department (MID).

In addition to and separate from these services, the PRC maintains a growing non-professional technology-collection effort by other PRC Government-controlled interests, such as research institutes and PRC military-industrial companies. Many of the most egregious losses of U.S. technology have resulted not from professional operations under the control or direction of the MSS or MID, but as part of commercial, scientific, and academic interactions between the United States and the PRC.

Professional intelligence agents from the MSS and MID account for a relatively small share of the PRC's foreign science and technology collection. The bulk of such information is gathered by various non-professionals, including PRC students, scientists, researchers, and other visitors to the West. These individuals sometimes are working at the behest of the MSS or MID, but often represent other PRC-controlled research organizations — scientific bureaus, commissions, research institutes, and enterprises.

Those unfamiliar with the PRC's intelligence practices often conclude that, because intelligence services conduct clandestine operations, all clandestine operations are directed by intelligence agencies. In the case of the PRC, this is not always the rule. Much of the PRC's intelligence collection is independent of MSS direction. For example, a government scientific institute may work on its own to acquire information.

The MSS is headed by Minister Xu Yongyue, a member of the CCP Central Committee. The MSS reports to Premier Zhu Rongji and the State Council, and its activities are ultimately overseen by the CCP Political Science and Law Commission. It is not unusual for senior members of the CCP's top leadership to be interested in the planning of PRC military acquisitions.

The MSS conducts science and technology collection as part of the PRC's overall efforts in this area. These MSS efforts most often support the goals of specific PRC technology acquisition programs, but the MSS will take advantage of any opportunity to acquire military technology that presents itself.

The MSS relies on a network of non-professional individuals and organizations acting outside the direct control of the intelligence services, including scientific delegations and PRC nationals working abroad, to collect the vast majority of the information it seeks.

The PLA's Military Intelligence Department (MID), also known as the Second Department of the PLA General Staff, is responsible for military intelligence. It is currently run by PLA General Ji Shengde, the son of a former PRC Foreign Minister. One of the MID's substantial roles is military-related science and technology collection.

Methods Used by the PRC To Acquire Advanced U.S. Military Technology

The PRC uses a variety of approaches to acquire military technology. These include:

- **Relying on "princelings" who exploit their military, commercial, and political connections with high-ranking CCP and PLA leaders to buy military technology from abroad**
- **Illegally transferring U.S. military technology from third countries**
- **Applying pressure on U.S. commercial companies to transfer licensable technology illegally in joint ventures**

- **Exploiting dual-use products and services for military advantage in unforeseen ways**
- **Illegally diverting licensable dual-use technology to military purposes**
- **Using front companies to illegally acquire technology**
- **Using commercial enterprises and other organizations as cover for technology acquisition**
- **Acquiring interests in U.S. technology companies**
- **Covertly conducting espionage by personnel from government ministries, commissions, institutes, and military industries independently of the PRC intelligence services**

The last is thought to be the major method of PRC intelligence activity in the United States.

The PRC also tries to identify ethnic Chinese in the United States who have access to sensitive information, and sometimes is able to enlist their cooperation in illegal technology or information transfers.

Finally, the PRC has been able to exploit weaknesses and lapses in the U.S. system for monitoring the sale and export of surplus military technology and industrial auctions.

The PRC is striving to acquire advanced technology of any sort, whether for military or civilian purposes, as part of its program to improve its entire economic infrastructure.[29] This broad targeting permits the effective use of a wide variety of means to access technology. In addition, the PRC's diffuse and multi-pronged technology-acquisition effort presents unique difficulties for U.S. intelligence and law enforcement agencies, because the same set of mechanisms and organizations used to collect technology in general can be used and are used to collect military technology.

The PRC's blending of intelligence and non-intelligence assets and reliance on different collection methods presents challenges to U.S. agencies in meeting the threat. In short, as James Lilley, former U.S. Ambassador to the PRC says, U.S. agencies are "going nuts" trying to find MSS and MID links to the PRC's military science and technology collection, when such links are buried beneath layers of bureaucracy or do not exist at all.[30]

The 'Princelings'

Unlike the Soviet Union, where nepotism in the Communist Party was rare, ruling in the PRC is a family business. Relatives of the founders of the Chinese Communist Party rise quickly through the ranks and assume powerful positions in the CCP, the State, the PLA, or the business sector. These leaders, who owe their positions more to family connections than to their own merit, are widely known as "princelings."[31]

Political, military, and business leaders in the PRC exercise considerable influence within their respective hierarchies. With the exception of those who make their way to the uppermost levels of the CCP or State bureaucracies, however, their authority, clout, and influence extend only to those below them within that hierarchy. They have little ability to influence either the leaders above them within their own hierarchy or the leaders in other hierarchies.[32]

Princelings operate outside these structures. Because of their family ties and personal connections to other CCP, PLA, and State officials, they are able to "cross the lines" and accomplish things that might not otherwise be possible.[33]

Two of the currently most notable princelings, Wang Jun and Liu Chaoying, have been directly involved in illegal activities in the United States.

Wang Jun is the son of the late PRC President Wang Zhen. Wang simultaneously holds two powerful positions in the PRC. He is Chairman of the China International Trade and Investment Company (CITIC), the most powerful and visible corporate conglomerate in the PRC. He is also the President of Polytechnologies Corporation, an arms-trading company and the largest and most profitable of the corporate structures owned by the PLA. Wang's position gives him considerable clout in the business, political, and military hierarchies in the PRC.[34]

Wang is publicly known in the United States for his role in the 1996 campaign finance scandal and for Polytechnologies' indictment stemming from its 1996 attempt to smuggle 2,000 Chinese AK-47 assault rifles into the United States. He attended a White House "coffee" with President Clinton in February 1996 and was given a meeting with Commerce Secretary Ronald Brown the following day. He was also connected to over $600,000 in illegal campaign contributions made by Charlie Trie to the U.S. Democratic National Committee (DNC).[35]

Liu Chaoying is the daughter of former CCP Central Military Commission Vice-Chairman and Politburo Standing Committee member General Liu Huaqing, who has used numerous U.S. companies for sensitive technology acquisitions. General Liu has been described as the PLA's preeminent policymaker on military R&D, technology acquisition, and equipment modernization as well as the most powerful military leader in the PRC. His daughter is a Lieutenant Colonel in the PLA and has held several key and instrumental positions in the PRC's military industry, which is involved in numerous arms transactions and international smuggling operations.[36] On two occasions she has entered the United States illegally and under a false identity.

Col. Liu Chaoying is currently a Vice-President of China Aerospace International Holdings, a firm specializing in foreign technology and military sales.[37] It is the Hong Kong subsidiary of China Aerospace Corporation, the organization that manages the PRC's missile and space industry. Both organizations benefit from the export of missile or satellite-related technologies and components from the United States, as does China Great Wall Industry Corporation, Col. Liu's former employer and a subsidiary of China Aerospace Corporation, which provides commercial space launch services to American satellite manufacturers.

China Aerospace Corporation is also a substantial shareholder in both the Apstar and APMT projects to import U.S. satellites to the PRC for launch by China Great Wall Industry Corporation.[38]

A Chinese-American, Johnny Chung, during the course of plea negotiations, disclosed that during a trip to Hong Kong in the summer of 1996, he met with Col. Liu and the head of the MID, Gen. Ji Shengde. According to Chung, he received $300,000 from Col. Liu and Gen. Ji as a result of this meeting. The FBI confirmed

Associated Press

Johnny Chung, a Chinese-American, met with PLA Col. Liu and the head of the PLA's Military Intelligence Division (MID), Gen. Ji, during a trip to Hong Kong in 1996. Chung says he received $300,000 from Col. Liu and Gen. Ji as a result of this meeting.

the deposit into Chung's account from Hong Kong and that the PLA officials likely served as the conduit for the money.

The Select Committee determined that Col. Liu's payment to Johnny Chung was an attempt to better position her in the United States to acquire computer, missile, and satellite technologies. The purpose of Col. Liu's contacts was apparently to establish reputable ties and financing for her acquisition of technology such as telecommunications and aircraft parts.[39]

Within one month after meeting with Col. Liu in Hong Kong, Chung formed Marswell Investment, Inc., possibly capitalizing the new company with some of the $300,000 he had received from Col. Liu and Gen. Ji.[40] Col. Liu was designated as president of the company, which was based in Torrance, California. The company is located in southern California, in the same city where China Great Wall Industry Corporation also maintains its U.S. subsidiary.

Col. Liu made two trips to the United States, one in July 1996 and one in August 1996, apparently seeking to expand her political and commercial contacts. During Col. Liu's July trip, Chung arranged for her to attend a DNC fundraiser where she met President Clinton and executives involved in the import-export business.[41]

Shortly afterwards, Chung also arranged for her to meet with the Executive Vice President of the Federal Reserve Bank of New York.[42]

Liu's August 1996 trip to the United States came at the invitation of Chung, who had told her that he had contacted Boeing and McDonnell Douglas regarding her interest in purchasing aircraft parts.[43]

That same month, Col. Liu traveled to Washington, D.C., where Chung had contacts arrange for her to meet with representatives of the Securities and Exchange Commission to discuss listing a PRC company on U.S. stock exchanges.[44] Soon after the meeting, when Chung and Liu's alleged involvement in the campaign finance scandal became the subject of media reports, Col. Liu left the United States. Marswell remains dormant.[45]

Princelings such as Wang and Liu present a unique technology transfer threat because their multiple connections enable them to move freely around the world and among the different bureaucracies in the PRC. They are therefore in a position to pull together the many resources necessary to carry out sophisticated and coordinated technology acquisition efforts.[46]

Acquisition of Military Technology from Other Governments

To fill its short-term technological needs in military equipment, the PRC has made numerous purchases of foreign military systems. The chief source for these systems is Russia, but the PRC has acquired military technology from other countries as well. Specific details on these acquisitions appear in the Select Committee's classified report, but the Clinton administration has determined that they cannot be made public.

Russia

After years of hostile relations between the PRC and the Soviet Union, Russia has again become the PRC's main source of advanced weapons and has sold numerous weapon systems to the PRC.[47] The technologically-advanced weapons systems and components the PRC either has purchased or plans to purchase from Russia include electronic warfare and electronic eavesdropping (SIGINT) equipment, air-to-air missiles, advanced jet fighters, attack helicopters, attack submarines, and guided missile destroyers.[48] These transfers have been used to improve the capabilities of the PLA ground, air, and naval forces.

The PRC has made numerous purchases of foreign military systems. Israel has provided both weapons and technology to the PRC, most notably to assist the PRC in developing its F-10 fighter (*above*).

Israel

Recent years have been marked by increased Sino-Israeli cooperation on military and security matters.[49] Israel has offered significant technology cooperation to the PRC, especially in aircraft and missile development.[50] Israel has provided both weapons and technology to the PRC, most notably to assist the PRC in developing its F-10 fighter and airborne early-warning aircraft.[51]

The United States

The PRC has stolen military technology from the United States, but until recently the United States has lawfully transferred little to the PLA. This has been due, in part, to the sanctions imposed by the United States in response to both the 1989 Tiananmen Square massacre and to the PRC's 1993 transfer of missile technology to Pakistan.

During the Cold War, the United States assisted the PRC in avionics modernization of its jet fighters under the U.S. Peace Pearl program.[52]

After the relatively "cool" period in U.S.-PRC relations in the early 1990s, the trend since 1992 has been towards liberalization of dual-use technology transfers to the PRC.[53] Recent legal transfers include the sale of approximately 40 gas turbine jet engines, the sale of high performance computers, and licensed co-production of helicopters.[54]

Nonetheless, the list of military-related technologies legally transferred to the PRC directly from the United States remains relatively small.

Illegal transfers of U.S. technology from the U.S. to the PRC, however, have been significant.

Significant transfers of U.S. military technology have also taken place in the mid-1990s through the re-export by Israel of advanced technology transferred to it by the United States, including avionics and missile guidance useful for the PLA's F-10 fighter. Congress and several Executive agencies have also investigated allegations that Israel has provided U.S.-origin cruise, air-to-air, and ground-to-air missile technology to the PRC.[55]

Joint Ventures with U.S. Companies

This section describes the pressures brought to bear on U.S. companies linked with militarily-sensitive technology attempting to do business with the PRC, and provides examples of U.S. companies conspiring to evade export control laws in pursuit of joint ventures.

The vast majority of commercial business activity between the United States and the PRC does not present a threat to national security, but additional scrutiny, discipline, and an awareness of risks are necessary with respect to joint ventures with the PRC where the potential exists for the transfer of militarily-sensitive U.S. technology.

The U.S. 1997 National Science and Technology Strategy stated that:

> *Sales and contracts with foreign buyers imposing conditions leading to technology transfer, joint ventures with foreign partners involving technology sharing and next generation development, and foreign investments in U.S. industry create technology transfer opportunities that may raise either economic or national security concerns.*[56]

The behavior of the PRC Government and PRC-controlled businesses in dealing with U.S. companies involved with militarily sensitive technology confirms that these concerns are valid and growing. The growing number of joint ventures that call for technology transfers between the PRC and U.S. firms can be expected to provide the PRC with continued access to dual-use technologies for military and commercial advantage.

Technology transfer requirements in joint ventures often take the form of side agreements (sometimes referred to as offset agreements) requiring both that the U.S. firm transfer technology to the PRC partner, and that all transferred technology will eventually become the property of the PRC partner.[57]

Although many countries require technology transfers when they do business with U.S. firms, no country makes such demands across as wide a variety of industries as the PRC does.[58] Despite the PRC's rapid economic liberalization since 1978, it continues to implement its explicitly designed goals and policies to restrict and manage foreign investment so as to bolster the PRC's military and commercial industries through acquisition of technology.[59]

The Communist Party has long believed that forcing technology from foreign firms is not only critical to the PRC, but also is a cost that foreign firms will bear in order to obtain PRC market entry.

In the past, the PRC has favored joint ventures with U.S. high-technology companies for several reasons:

- **The U.S. excels in many areas of technology that are of special interest to the PLA and to PRC-controlled firms**
- **Many PRC scientists were educated in the United States and retain valuable contacts in the U.S. research and business community who can be exploited for technology transfer**
- **Many other countries are more reluctant than the United States to give up technology**[60]

The PRC has dedicated increasing resources to identifying U.S. high-technology firms as likely targets for joint venture overtures. Science and technology representatives in PRC embassies abroad are used to assist in this targeting of technology, and to encourage collaboration with U.S. firms for this purpose.

Unless they are briefed by the FBI pursuant to its National Security Threat List program, U.S. companies are unaware of the extent of the PRC's espionage directed against U.S. technology, and thus — at least from the U.S. national security standpoint — are generally unprepared for the reality of doing business in the PRC. They lack knowledge of the interconnection between the CCP, the PLA, the State, and the PRC-controlled companies with which they deal directly in the negotiating process.[61]

The U.S. General Accounting Office (GAO) has found that U.S. businesses have significant concerns about arbitrary licensing requirements in the PRC that often call for increased technology transfer. The GAO has also found that transparency was the most frequent concern reported by U.S. companies.[62] Because of the lack of transparency in the PRC's laws, rules, and regulations that govern business alliances, and the dearth of accessible, understandable sources of regulatory information, U.S. businesses are often subjected to technology transfer requirements that are not in writing, or are not maintained in the field, or are contained in "secret" rules that only insiders know about.[63]

The PRC's massive potential consumer market is the key factor behind the willingness of some U.S. businesses to risk and tolerate technology transfers. Some of these transfers could impair U.S. national security, as in the cases of Loral and Hughes described later in this Report. The obvious potential of the PRC market has increasingly enabled the PRC to place technology-transfer demands on its U.S. trading partners.

U.S. businesses believe that they must be in the PRC, lest a competitor get a foothold first.[64] In fact, many U.S. high-technology firms believe it is more important to establish this foothold than to make profits immediately or gain any more than limited access to the PRC market.[65] Some of the PRC's trading partners have focused on increased technology transfers to raise the attractiveness of their bids.

In addition to traditional types of technology transfer, many U.S. high-technology investments in the PRC include agreements establishing joint research and development centers or projects. This type of agreement represents a new trend in U.S. investment in the PRC and is a potentially significant development.[66]

U.S. companies involved in joint ventures may be willing to transfer technology because they believe that the only risk is a business one — that is, that the transfers may eventually hurt them in terms of market share or competition.[67] These businesses may be unaware that technologies transferred to a PRC partner will likely be shared within the PRC's industrial networks and with the PLA, or that joint ventures may be used in some instances as cover to acquire critical technology for the military.

COSTIND, which controls the PRC's military-industrial organizations, likely attempts to monitor technologies through joint ventures. In addition, U.S. businesses may be unaware that joint-venture operations are also vulnerable to penetration by official PRC intelligence agencies, such as the MSS.

In one 1990s case reviewed by the Select Committee, a U.S. high-technology company and its PRC partner used a joint venture to avoid U.S. export control laws and make a lucrative sale of controlled equipment to the PRC. Following the denial of an export license, the U.S. company attempted to form a joint venture to which the technology would be transferred. The joint venture was controlled by a PRC entity included on the U.S. Commerce Department's Entity List, which means it presents an unacceptable risk of diversion to the development of weapons of mass destruction.

Acquisition and Exploitation of Dual-Use Technologies

The acquisition of advanced dual-use technology represents yet another method by which the PRC obtains advanced technology for military modernization from the United States. The PRC's military modernization drive includes a policy to acquire dual-use technologies. The PRC seeks civil technology in part in the hope of being able to adapt the technology to military applications. This is referred to by some analysts as "spinning on."[68]

A strategy developed by the PRC in 1995 called for the acquisition of dual-use technologies with civil and military applications, and the transfer of R&D achievements in civil technology to the research and production of weapons.

The PRC collects military-related science and technology information from openly available U.S. and Western sources and military researchers. This accelerates the PLA's military technology development by permitting it to follow proven development options already undertaken by U.S. and Western scientists.

PRC procurement agents have approached U.S. firms to gain an understanding of the uses of available technology, and to evaluate the PRC's ability to purchase dual-use technology under the guise of civil programs and within the constraints of U.S. export controls. Additionally, the PRC has attempted to acquire information from the U.S. and other countries about the design and manufacturing of military helicopters.[69] The PRC could use this approach to acquire chemical and biological weapons technology.

The key organizations in the PRC's drive to acquire dual-use technology include:

- **COSTIND,** which acquires dual-use technology for PRC institutes and manufacturers by assuring foreign suppliers that the technology will be used for civil production. COSTIND uses overseas companies to target U.S. firms for acquisition of dual-use technology for the military.

- **The Ministry of Electronics Industry (MEI),**[70] which is responsible for developing the PRC's military electronics industry. Among other things, the Ministry approves and prioritizes research and development and the importation of electronics technologies that can be used to speed up the PRC's indigenous production capabilities.

- **The Ministry of Post and Telecommunications (MPT),** which is acquiring asynchronous transfer mode switches that could be used for military purposes by the PLA.[71]

- **PLA-operated import-export companies,** which also import dual-use technologies for military modernization. Polytechnologies, a company attached to the General Staff Department of the PLA, plays a major role in this effort, especially in negotiating foreign weapons purchases.[72]

- **The Aviation Industries Corporation of China (AVIC),** and its subsidiary, **China National Aero-Technology Import-Export Corporation (CATIC),** which have sent visitors to U.S. firms to discuss manufacturing agreements for commercial systems that could be used to produce military aircraft for the PLA.[73] AVIC is one of five PRC state-owned conglomerates that operate as "commercial businesses" under the direct control of the State Council and COSTIND.

Several incidents highlight CATIC's direct role in the acquisition of controlled U.S. technology. One clear example was CATIC's role as the lead PRC representative in the 1994 purchase of advanced machine tools from McDonnell Douglas, discussed more fully later in this Report.

Another possible example of the PRC's exploitation of civilian end-use as a means of obtaining controlled technology was CATIC's 1983 purchase of two U.S.-origin CFM-56 jet engines on the pretext that they would be used to re-engine commercial aircraft. Although the CFM-56 is a commercial engine, its core section is the same as the core of the General Electric F-101 engine that is used in the U.S. B-1 bomber. Because of this, restrictions were placed on the export license. However, the PRC may have exploited the technology of the CFM-56. When the U.S. Government subsequently requested access to the engines, the PRC claimed they had been destroyed in a fire.

ABC

China National Aero-Technology Import-Export Corporation (CATIC) is a PRC-owned business under the control of the PRC's State Commission of Science, Technology and Industry for National Defense (COSTIND). CATIC's office in California (*left*) has played a direct role in obtaining controlled technology from U.S. companies.

CATIC has, on several occasions reviewed by the Select Committee, misrepresented the proposed uses of militarily useful U.S. technology. The Clinton administration has determined that the specific facts in these cases may not be publicly disclosed.

In 1996, AVIC, CATIC's parent company, attempted to use a Canadian intermediary to hire former Pratt & Whitney engineers in the United States to assist in the development of an indigenous PRC jet engine. AVIC's initial approach was under the guise of a civilian project, and the U.S. engineers were not told they would be working on a military engine for the PRC's newest fighter jet until negotiations had progressed substantially. The U.S. engineers pulled out when they were told what they would be asked to do.[74]

The degree of diversion to military programs by the PRC of commercially-acquired technologies is unclear, since the PRC's parallel civil-military industrial complex[75] often blurs the true end-use of technology that is acquired. As a result, there may be more use of U.S. dual-use technology for military production than these examples suggest.

Front Companies

Another method by which the PRC acquires technology is through the use of front companies. The term "front company" has been used in a variety of ways in public reports and academic studies in different contexts, and can include:

- **U.S. subsidiaries of PRC military-industrial corporations in the PRC**
- **U.S. subsidiaries of PLA-owned-and-operated corporations**
- **Corporations set up by PRC nationals overseas to conduct technology acquisition and transfer**
- **Corporations set up outside the PRC to acquire technology for a PRC intelligence service, corporation, or institute covertly**
- **Corporations set up outside the PRC by a PRC intelligence service, corporation, or institute** solely to give cover to professional or non-professional agents who enter the United States to gather technology or for other purposes
- **Corporations set up outside the PRC by a PRC intelligence service to launder money**

- **Corporations set up outside the PRC by a PRC intelligence service to raise capital to fund intelligence operations**

- **Corporations set up outside the PRC by a PRC individual to hide, accumulate, or raise money for personal use**

- **Corporations set up outside the PRC by organs of the PRC Government to funnel money to key U.S. leaders** for the purpose of garnering favor and influencing the U.S. political process and U.S. Government decision-making

The differing meanings attached to the term "front companies" by different U.S. agencies has led to confusion, particularly because many PRC companies fall into several different categories, at the outset or at different times during their existence. In addition, U.S. agencies responsible for different aspects of national security, law enforcement, and Sino-U.S. relations often do not share even basic data concerning PRC espionage in the United States.

This may partly explain why, for example, in Senate testimony on the same day in 1997, the State Department said it could identify only two PLA companies that were doing business in the United States, while the AFL-CIO identified at least 12, and a Washington-based think-tank identified 20 to 30 such companies.[76] The Select Committee has determined that all three figures are far below the true figure.

The Select Committee has concluded that there are more than 3,000 PRC corporations in the United States, some with links to the PLA, a State intelligence service, or with technology targeting and acquisition roles. The PRC's blurring of "commercial" and "intelligence" operations presents challenges to U.S. efforts to monitor technology transfers for national security purposes.

General Liu Huaqing, who recently retired as a member of the Communist Party Politburo, the CCP Standing Committee, and the Central Military Commission, was involved with dozens of companies in Hong Kong and in Western countries engaged in illegally acquiring advanced U.S. technology.

Yet another complicating factor is the evolution of the names used by PRC-controlled corporations. Some corporations such as NORINCO and Polytechnologies were easily recognizable as subsidiaries of PRC corporations. The boards of directors of PRC companies were also easily recognizable as PLA officers in the past.[77] Recent changes, however, have made it more difficult to recognize PRC corporations.

Some analysts note that U.S.-based subsidiaries of PLA-owned companies in particular have stopped naming themselves after their parent corporation, a move prompted at least in part by criminal indictments and negative media reports that have been generated in connection with their activities in the United States. Many PLA-owned companies in the United States have simply ceased to exist in the past year or so, a phenomenon that reflects these factors as well as the fact that PRC-controlled companies often do not make money.[78]

The PRC intelligence services use front companies for espionage. These front companies may include branches of the large ministerial corporations in the PRC, as well as small one- and two-person establishments. Front companies, whatever the size, may have positions for PRC intelligence service officers. PRC front companies are often in money-making businesses that can provide cover for intelligence personnel in the United States.

PRC front companies may be used to sponsor visits to the U.S. by delegations that include PRC intelligence operatives.

There has been increasing PRC espionage through front companies during the 1990s. As of the late 1990s, a significant number of front companies with ties to PRC intelligence services were in operation in the United States.

The PRC also uses its state-controlled "news" media organizations to gain political influence and gather political intelligence.

In June 1993, after a highly-publicized trial, a former Chinese philosophy professor, Bin Wu, and two other PRC nationals were convicted in a U.S. court of smuggling third-generation night-vision equipment to the PRC. Wu worked at the direction of the MSS, which he says directed him to acquire numerous high-technology items from U.S. companies. To accomplish these tasks, Wu and the others created several small front companies in Norfolk, Virginia. From that base, they solicited technology from a number of U.S. companies, purchasing the equipment in the names of the front companies and forwarding it to the MSS through intermediaries in Hong Kong.[79]

Wu was a good example of the non-traditional PRC approach to acquiring technology in that Wu himself was not a professional intelligence agent. Identified as a pro-Western dissident by the MSS just after the Tiananmen Square massacre, he was given a choice: he could stay in the PRC and face prison, or he could accept the MSS's offer to help him and his family by supporting the PRC in its quest for high technology. Wu was also a "sleeper" agent, who was initially told to go to the United States and establish himself in the political and business community. The MSS told Wu he would be called upon and given taskings later.[80]

Wu appears to have been part of a significant PRC intelligence structure in the United States. This structure includes "sleeper" agents, who can be used at any time but may not be tasked for a decade or more.[81]

In the 1990s, the PRC has also attempted to use front companies to acquire sensitive information on restricted military technologies, including the Aegis combat system. The Aegis combat system uses the AN/SPY-1 phased array radar to detect and track over 100 targets simultaneously, and a computer-based command and decision system allowing for simultaneous operations against air, surface, and submarine threats.[82]

Direct Collection of Technology by Non-Intelligence Agencies and Individuals

PRC intelligence agencies often operate in the U.S. commercial environment through entities set up by other PRC Government and commercial organizations instead of creating their own fronts. PLA military intelligence officers do, however, operate directly in the United States, posing as military attaches at the PRC Embassy in Washington, D.C., and at the United Nations in New York.

Most PRC covert collection of restricted technology in the United States is accomplished by individuals attached to PRC Government and commercial organizations which are unaffiliated with official PRC intelligence services. These organizations collect their own technology from the United States, rather than rely on the PRC intelligence agencies to do it for them.

The Select Committee judges that the MSS may be allowing other PRC Government entities to use MSS assets to fulfill their intelligence needs. These findings further illustrate that PRC "intelligence" operations are not necessarily conducted by what are traditionally thought of as "intelligence" agencies.

The main PLA intelligence activity in the United States is not represented by PLA intelligence organizations, but by PRC military industries and regular components of the PLA. Although military-industrial corporations are not PLA-owned, they are deeply involved in arms production and acquisition of military technology.

The activities of CATIC and its U.S. subsidiaries exemplify the activities carried out by PRC military-industrial companies. Other PRC companies, such as China Great Wall Industry Corporation, collect technology for their own use and may be used as cover by PRC intelligence personnel.

PRC technology acquisition in the United States also is carried out by various science and technology commissions and organizations. COSTIND, for example, has no official U.S. subsidiary but is the primary coordinating authority over the military-industrial corporations that collect technology in the United States. COSTIND also uses the "front company" device to procure high-technology products.

The PRC State Science and Technology Commission largely oversees civilian science and technology collection. The State Science and Technology Commission also uses diplomats in the U.S. as a key collection tool. It has provided funding to a PRC scientist to establish various commercial enterprises in the U.S. as a means of collecting technology information for distribution in the PRC.

The State Science and Technology Commission was involved in efforts to elicit nuclear weapons information from a Chinese-American scientist. Science and Technology offices in the PRC's seven diplomatic agencies in the United States carry out a substantial portion of technology acquisition taskings. The primary role of these offices is to arrange contacts between PRC scientists and their American counterparts.

Various "liaison groups" constitute another PRC technology collection vehicle in the United States. The PRC's primary official liaison organization is the China

Association for International Exchange of Personnel (CAIEP). CAIEP operates seven "liaison organization" offices in the United States, including one in Washington, D.C., and one in San Francisco. It is one of several organizations set up by the PRC to illegally acquire technology through contacts with Western scientists and engineers. Others include a purported technology company and a PRC State agency.

Another significant source of the PRC's technology collection efforts outside of its formal intelligence agencies comes from Chinese business representatives loyal to the CCP who emigrate to the United States. These individuals pursue commercial interests independent of direct PRC Government control. Their primary motive is personal financial gain, and they will sell their efforts and opportunities to any willing consumer. When asked to do so, they pass U.S. technology back to the PRC. The Select Committee believes that the use of this technique is proliferating in recent years.

The PRC also acquires advanced technology through the outright theft of information. A few cases exemplify this method of technology acquisition.

Peter Lee, a Taiwanese-born, naturalized U.S. citizen who formerly worked at the Los Alamos and Lawrence Livermore National Laboratories, passed classified information to the PRC in 1997 and in 1985. In 1997, Lee passed to the PRC classified U.S. developmental research on very sensitive detection techniques that, if successfully concluded, could be used to threaten previously invulnerable U.S. nuclear submarines. In 1985, Lee stole for the PRC classified information about the use of lasers to create nuclear explosions on a miniature scale. The Lee case represents a classic non-intelligence service operation.[83] For a detailed discussion, see Chapter 2, *PRC Theft of U.S. Thermonuclear Warhead Design Information.*

The Select Committee also received evidence of PRC theft of technology data from U.S. industry during the 1990s valued at millions of dollars. The PRC used Chinese nationals hired by U.S. firms for that purpose. The Clinton administration has determined that no details of this evidence may be made public.

In 1993, PRC national Yen Men Kao, a North Carolina restaurant owner, was arrested by the FBI and charged with conspiring to steal and export classified and export-controlled high-technology items to the PRC.[84] Among the items about which Kao and several other PRC nationals were seeking information were:

- **The U.S. Navy's Mark 48 Advanced Capability Torpedo**
- **The F-404 jet engine used on the U.S. F-18 Hornet fighter**
- **The fire-control radar for the U.S. F-16 fighter**[85]

The case of Kao and his co-conspirators is one of several involving PRC commercial entities attempting to illegally acquire U.S. technology.

The PRC also relies heavily on the use of professional scientific visits, delegations, and exchanges to gather sensitive technology.

As the PRC Government has increasingly participated in the world commercial and capital markets, the number of PRC representatives entering the United States has increased dramatically. One estimate is that in 1996 alone, more than 80,000 PRC nationals visited the United States as part of 23,000 delegations.

Almost every PRC citizen allowed to go to the United States as part of these delegations likely receives some type of collection requirement, according to official sources.

Scientific delegations from the PRC are a typical method used by the PRC to begin the process of finding U.S. joint venture partners. These delegations have been known to go through the motions of establishing a joint venture to garner as much information as possible from the U.S. partner, only to pull out at the last minute.

Scientific visits and exchanges by PRC scientists and engineers and their U.S. counterparts create several risks to U.S. national security. This has been a particular concern in recent years regarding foreign visitors to the Department of Energy's national weapons laboratories.[86]

The first of these risks is that visitors to U.S. scientific and technology sites may exploit their initial, authorized access to information to gain access to protected information.[87] The Select Committee has reviewed evidence of PRC scientists who have circumvented U.S. restrictions on their access to sensitive manufacturing facilities.

Another risk is that U.S. scientists may inadvertently reveal sensitive information during professional discussions.

The PRC subjects visiting scientists to a variety of techniques designed to elicit information from them. One technique may involve inviting scientists to make a presentation in an academic setting, where repeated and increasingly sensitive questions are asked.[88] Another is to provide the visitor with sightseeing opportunities while PRC intelligence agents burglarize the visitor's hotel room for information. Still another technique involves subjecting the visitor to a grueling itinerary and providing copious alcoholic beverages so as to wear the visitor down and lower resistance to questions.[89]

In one instance, a U.S. scientist traveled to the PRC where very specific technical questions were asked. The scientist, hesitant to answer one question directly because it called for the revelation of sensitive information, instead provided a metaphorical example. The scientist immediately realized that the PRC scientists grasped what was behind the example, and knew that too much had been said.

Another common PRC tactic is to tell U.S. visitors about the PRC's plan for further research, the hope being that the U.S. scientist will release information in commenting on the PRC's plans.

The Select Committee has reviewed evidence of this technique being applied to acquire information to assist the PRC in creating its next generation of nuclear weapons.

Another risk inherent in scientific exchanges is that U.S. scientists who are overseas in the PRC are prime targets for approaches by professional and non-professional PRC organizations that would like to co-opt them into providing assistance to the PRC. In many cases, they are able to identify scientists whose views might support the PRC, and whose knowledge would be of value to PRC programs.

The Select Committee has received information about Chinese-American scientists from U.S. nuclear weapons design laboratories being identified in this manner.

Typically, the PRC will invite such a scientist to lecture and, once in the PRC, question him closely about his work. Once the scientist has returned to the U.S., answers to follow-up questions may be delivered through a visiting intermediary. Such efforts to co-opt scientists may be conducted by PRC ministries, and may involve COSTIND.

The number of PRC nationals attending educational institutions in the United States presents another opportunity for the PRC to collect sensitive technology.[90] It is estimated that at any given time there are over 100,000 PRC nationals who are either attending U.S. universities or have remained in the United States after graduating from a U.S. university. These PRC nationals provide a ready target for PRC intelligence officers and PRC Government-controlled organizations, both while they are in the United States and when they return to the PRC.[91]

PRC nationals stole a videocassette on the U.S. Theater High Altitude Air Defense system from a display at a recent international arms exhibit that was left unattended by a Defense Department contractor. A frame-by-frame analysis of this video footage could yield valuable intelligence information.

The Select Committee judges that the PRC is increasingly looking to PRC scholars who remain in the United States as assets who have developed a network of personal contacts that can be helpful to the PRC's search for science and technology information.

The PRC has also acquired technological information through open forums such as arms exhibits and computer shows. During a recent international arms exhibit, for example, PRC nationals were observed collecting all possible forms of technical information. This included videotaping every static display and designating individuals to take notes. The group also stole a videocassette from a display that was continuously playing information on the U.S. Theater High Altitude Air Defense system, when the Defense Department contractor left it unattended. Converting the stolen cassette to a frame-by-frame sequence could yield valuable intelligence information to the PRC.[92]

Illegal Export of Military Technology Purchased in the United States

The PRC is also taking advantage of the ongoing U.S. military downsizing. In particular, PRC representatives and companies in the United States pursue the purchase of high-technology U.S. military surplus goods.

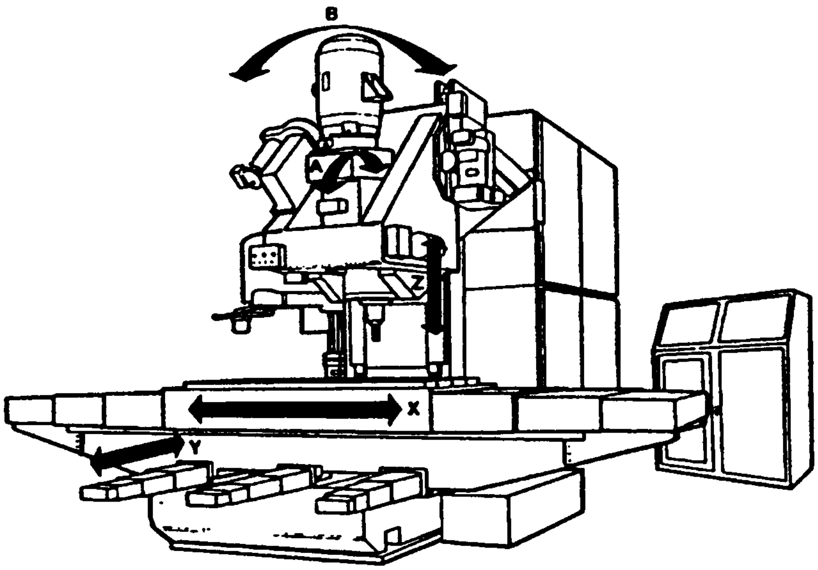
In a single 1996-1997 operation, the Los Angeles office of the U.S. Customs Service seized over $36 million in excess military property that was being shipped overseas illegally. Among the seized U.S. military surplus equipment on its way to the PRC and Hong Kong were:

- **37 inertial navigation systems for the U.S. F-117 and FB-111 aircraft**
- **Thousands of computers and computer disks containing classified Top Secret and higher information**
- **Patriot missile parts**
- **500 electron tubes used in the U.S. F-14 fighter**
- **Tank and howitzer parts**
- **26,000 encryption devices**[93]

Patriot missile parts were among more than $36 million in U.S. military property seized by the Customs Service during one 16-month period in 1996-97. The surplus equipment was in the process of being illegally shipped to the PRC and Hong Kong.

PRC representatives have been the biggest buyers of sensitive electronic surplus material. Defense Department investigators have noted a trend among the PRC buyers of this equipment: many had worked for high-technology companies in the PRC or for PRC Government science and technology organizations.[94]

The PRC has been able to purchase these goods because, in its rush to dispose of excess property, the Defense Department failed to code properly or to disable large amounts of



A multi-axis machine tool profiler designed to build wing spans for the U.S. F-14 fighter originally cost over $3 million, but was purchased by the PRC for under $25,000.

advanced military equipment, allowing PRC buyers to pay for and take immediate possession of functional high-technology equipment. Often this equipment was purchased as "scrap," for which the buyers paid pennies on the dollar.[95]

According to the U.S. Customs Service, many PRC companies that bid on military surplus technology intentionally used "American-sounding" names to mask their PRC affiliation.[96]

The PRC also has been able to exploit U.S. military downsizing by purchasing advanced technology, in the form of machine tools and production equipment from decommissioned U.S. defense factories, through industrial auctions.

For example, a multi-axis machine tool profiler, designed to build wing spans for the U.S. F-14 fighter, originally cost over $3 million but was purchased by the PRC for under $25,000.[97]

According to one industrial auctioneer, the PRC frequents industrial auctions because they offer accurate, well-maintained equipment at bargain prices and with quick delivery.[98] Moreover, once the PRC obtains this equipment, there are ample resources available in the United States to upgrade the equipment to modern standards.

A California company specializing in refurbishing machine tools, for example, was approached in recent years by representatives of CATIC's El Monte, California office. The CATIC representatives reportedly inquired about the scope of the company's refurbishment capability, including whether it could train CATIC people to rebuild and maintain the machines and whether the company would be willing to assemble the machines in the PRC. The CATIC personnel also reportedly asked if the company could convert a three-axis machine tool to a five-axis machine tool. They were told this was possible for some machines, and very often only requires replacing one computer controller with another.[99]

The U.S. company noted, however, that such a converted machine would require an export license. In response, the CATIC personnel reportedly said, rather emphatically, that they would have "no problem" with the export. The CATIC inquiries came at about the same time CATIC was negotiating the purchase of machine tools from the McDonnell Douglas Columbus, Ohio plant.[100]

CATIC's discussions with this particular U.S. company did not result in either the training of CATIC personnel or the conversion of any machine tools. It is unknown, however, what other U.S. companies were approached with similar inquiries or whether any such inquiries resulted in technological assistance to CATIC or the PRC.

The Select Committee reviewed evidence from the mid-1990s of a PRC company that obtained U.S. defense manufacturing technology for jet aircraft, knowingly failed to obtain a required export license, and misrepresented the contents of its shipping containers in order to get the technology out of the country. The Clinton administration has determined that further information on this case cannot be made public.

PRC Purchase of Interests in U.S. Companies

A more recent method used by the PRC to obtain advanced technology from the United States is through the purchase of an interest in U.S. high-technology companies or U.S. export facilities. While this method does not yet appear to be prevalent, it has been identified in at least three instances.

In 1990, CATIC acquired an interest in MAMCO Manufacturing, a Seattle, Washington, aircraft parts manufacturer. In a highly-publicized decision that year, President George Bush exercised his authority under section 721 of the Defense Production Act of 1950 (also known as the Exon-Florio provision) to order CATIC to divest itself of the MAMCO interest based on the recommendations of the Committee on Foreign Investment in the United States (CFIUS), an inter-agency committee chaired by the Secretary of Treasury and tasked to conduct reviews of foreign acquisitions that might threaten national security.[101]

CFIUS concluded that:

- **Some technology used by MAMCO, although not state-of-the-art, was export-controlled**
- **CATIC had close ties to the PLA through the PRC Ministry of Aviation (now known as Aviation Industries Corporation, or AVIC)**
- **The acquisition would give CATIC unique access to U.S. aerospace companies**

It is likely that the PRC's strategy in acquiring MAMCO was to give CATIC a venue from which to solicit business with U.S. aerospace firms, both to yield revenue and to gain access to aerospace technologies, inasmuch as CATIC has conspired to illegally acquire U.S. sensitive technology in the past. In addition, according to public reports, CATIC has been used for PRC arms sales to countries such as Iran.

The PRC's efforts to acquire MAMCO did not end with President Bush's divestiture order. CATIC requested CFIUS approval to satisfy the concerns expressed in President Bush's divestiture order by selling its MAMCO interest to the China International Trust & Investment Corporation (CITIC).

CFIUS noted that CITIC reported directly to the highest level of the PRC Government, the PRC State Council, and that CITIC did not have any colorable business rationale for wanting to acquire MAMCO. When CFIUS began questioning CITIC's business purposes and its ties to the State Council, CATIC withdrew its request.

CATIC then filed another request, this time proposing that it meet President Bush's divestiture order by selling its MAMCO interest to Huan-Yu Enterprises, a PRC company that was owned by a PRC provincial government and reported to the PRC Ministry of Electronics Industry (now known as the Ministry of Information Industry), which in turn reported directly to the PRC State Council.

A CFIUS investigation concluded that Huan-Yu was a consumer, not a producer, of aerospace parts and had no legitimate reason to acquire MAMCO. The proposed divestiture looked to CFIUS like a "sham acquisition." Faced with intense CFIUS interest, CATIC again withdrew its filing.

In 1996, Sunbase Asia, Incorporated purchased Southwest Products Corporation, a California producer of ball bearings for U.S. military aircraft. Sunbase is incorporated in the United States, but is owned by an investment group comprised of some of the PRC's largest state-owned conglomerates as well as a Hong Kong company. According to a Southwest executive, the purchase will "take [Sunbase] to the next level" of technology.[102] The Clinton administration has determined that additional information on this transaction cannot be made public.

China Ocean Shipping Company (COSCO), the PRC's state-owned shipping company which operates under the direction of the Ministry of Foreign Trade and Economic Cooperation and answers to the PRC State Council,[103] attempted to lease port space that was being vacated by the U.S. Navy in Long Beach, California. The lease proposal led to a heated debate between Congress, which wanted to prevent the lease based on national security concerns, and President Clinton, who supported the lease. Legislation passed by both houses of Congress in 1997 barred the lease and voided the President's authority to grant a waiver.[104]

Other information indicates COSCO is far from benign. In 1996, U.S. Customs agents confiscated over 2,000 assault rifles that were being smuggled into the United States aboard COSCO ships.[105] "Although presented as a commercial entity," according to the House Task Force on Terrorism and Unconventional Warfare, "COSCO is actually an arm of the Chinese military establishment." The Clinton administration has determined that additional information concerning COSCO that appears in the Select Committee's classified Final Report cannot be made public.

Methods Used by the PRC to Export Military Technology from the United States

Once the PRC acquires advanced technology in the United States, it requires secure means to export the information or hardware out of the country. Weaknesses in U.S. customs can be exploited to smuggle classified or restricted U.S. technology.

Diplomatic pouches and traveling PRC diplomats offer another avenue for illegal technology exports. Almost every PRC Government commercial and diplomatic institution in the United States has personnel who facilitate science and technology acquisitions.

The Select Committee believes that these means of communicating with the PRC could have been exploited to smuggle nuclear weapons secrets from the United States.

These are some of the further means that have been used to illegally ship sensitive technology to the PRC:

- **In 1993, Bin Wu, a PRC national, was convicted of transferring night-vision technology to the PRC.** Wu used the U.S. postal system to get technology back to the PRC. He mailed the technology he collected directly to the PRC, mostly through an intermediary in Hong Kong.[106]

- **The PRC uses false exportation documentation and has falsified end-user certificates.** In one case reviewed by the Select Committee, the Department of Commerce reported that a U.S. subsidiary of a PRC company used a common illegal export tactic when it falsely identified the machine tools it was exporting. The U.S. Customs Service also indicates that the PRC's use of false bills of sale and false end-use statements are common illegal export tactics.

- **The PRC has used at least one commercial air carrier to assist in its technology transfer efforts.** In 1996, Hong Kong Customs officials intercepted air-to-air missile parts being shipped by CATIC aboard a commercial air carrier, Dragonair. Dragonair is owned by China International Trade and Investment Company (CITIC), the most powerful and visible PRC-controlled conglomerate, and the Civil Aviation Administration of China (CAAC).[107]

- **A common PRC method for transferring U.S. technology to the PRC uses Hong Kong as the shipment point.** This method takes advantage of the fact that U.S. export controls on Hong Kong are significantly less restrictive than those applied to the rest of the PRC, allowing Hong Kong far easier access to militarily-sensitive technology.

The more relaxed controls on the export of militarily-sensitive technology to Hong Kong have been allowed to remain in place even though Hong Kong was absorbed by the PRC and PLA garrisons took control of the region on July 1, 1997. U.S. trade officials report that no inspections by the Hong Kong regional government nor by any other government, including the United States, are permitted when PLA vehicles cross the Hong Kong border.

Various U.S. Government analyses have raised concerns about the risk of the diversion of sensitive U.S. technologies not only to the PRC, but to third countries as well through Hong Kong because of the PRC's known use of Hong Kong to obtain sensitive technology.[108] Some controlled dual-use technologies can be exported from the United States to Hong Kong license-free, even though they have military applications that the PRC would find attractive for its military modernization efforts.

The Select Committee has seen indications that a sizeable number of Hong Kong enterprises serve as cover for PRC intelligence services, including the MSS. Therefore, it is likely that over time, these could provide the PRC with a much greater capability to target U.S. interests in Hong Kong.

U.S. Customs officials also concur that transshipment through Hong Kong is a common PRC tactic for the illegal transfer of technology.[109]

PRC Incentives for U.S. Companies to Advocate Relaxation of Export Controls

U.S. companies in the high-technology sector are eager to access the PRC market. The PRC often requires these U.S. firms to transfer technologies to the PRC as a precondition to market access. U.S. export regulations can be seen as an impediment to commercial opportunities.[110]

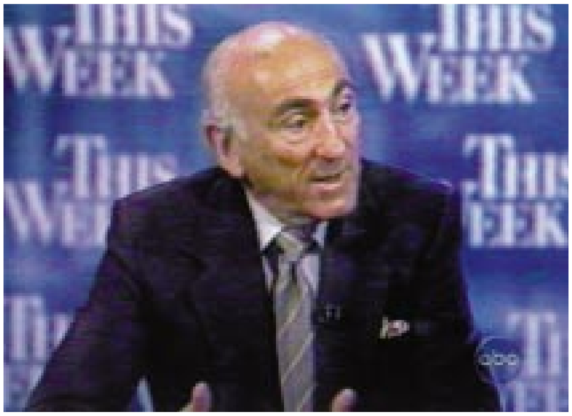
Executives wishing to do business in the PRC share a mutual commercial interest with the PRC in minimizing export controls on dual-use and military-related commodities. The PRC has displayed a willingness to exploit this mutuality of interest in several notoriously public cases by inducing VIPs from large U.S. companies to lobby on behalf of initiatives, such as export liberalization, on which they are aligned with the PRC.

The PRC is determined to reduce restrictions on the export of U.S. communications satellites for launch in the PRC. From the perspective of the PRC, provision of such launch services creates a unique opportunity to consult with U.S. satellite manufacturers, access information regarding U.S. satellite technology, and obtain resources to modernize their rockets.[111] U.S. satellite manufacturers are, in turn, anxious to access the potentially lucrative PRC market, and realize that launching in the PRC is a potential condition to market access.[112]

By agreeing to procure numerous satellites from Hughes Electronics Co. (Hughes) and Space Systems/Loral (Loral) in the early 1990s, the PRC created a mutuality of interest with two companies well-positioned to advocate the liberalization of export controls on these platforms.

For example, Bernard L. Schwartz, Chairman and CEO of Loral Space & Communications, Ltd., the parent company of Loral, met directly on at least four occasions with Secretary of Commerce Ron Brown after 1993, and accompanied him on a 1994 trade mission to the PRC.[113]

C. Michael Armstrong, the former Chairman and Chief Executive Officer of GM Hughes Electronics, the parent company of Hughes, has served as Chairman of President Clinton's Export Council since 1993, working with the Secretary of State, the Secretary of Commerce, and others to "provide insight and counsel" to the President on a variety of trade matters.[114] Armstrong also serves or has served as a member of the Defense Preparedness Advisory Council, the Telecommunications Advisory Council, and the Secretary of State's Advisory Council.[115]



Associated Press

Bernard Schwartz, Chairman of Loral Space & Communications, Ltd., and his fellow officers claim to have been distracted by other business matters in 1996 while Loral was illegally transferring export-controlled technology applicable to the PRC's rocket and missile programs. Even while under criminal investigation for these transfers, Loral obtained Presidential waivers for another launch in the PRC.

Both Armstrong and Schwartz, as well as other executives from high-technology firms, advocated the transfer of export licensing authority from the "more stringent control" of the State Department to the Commerce Department. Armstrong met with the Secretary of Defense, the National Security Advisor, and the Secretary of State on the matter, and both Schwartz and Armstrong co-signed a letter with Daniel Tellep of Lockheed- Martin Corporation to the President urging this change.[116] The changes they advocated were ultimately adopted.

Between 1993 and January 3, 1999, Loral and Hughes succeeded in obtaining waivers or export licenses for an aggregate of five satellite projects.[117]

Another example of the incentive to advocate the relaxation of export controls involves the Charoen Pokphand Group (CP Group), Thailand's largest multinational company and one of the largest investors in the PRC. CP Group executives have served as economic advisors to the PRC Government and were chosen to sit on the committees dealing with the absorption of Hong Kong.[118]

The CP Group was a founding member of Asia Pacific Telecommunications Satellite Holdings, Ltd. (APT), a consortium run by PRC-controlled investment companies, including China Aerospace Corporation. APT imports satellites manufactured by Hughes and Loral as part of the Apstar program for launch in the PRC by China Great Wall Industry Corporation.[119]

On June 18, 1996, several CP Group executives attended a coffee with President Clinton at the White House. These executives included Dhanin Chearavanont (CP Chairman and Chief Executive Officer), Sumet Chearavanont (Vice Chairman and President), and Sarasin Virapol (employee and translator). The CP executives were invited to the coffee by their Washington, D.C., lobbyist, Pauline Kanchanalak.[120]

According to one participant, Karl Jackson of the U.S.-Thailand Business Council, the CP executives "dominated the conversation at the coffee." The discussion included U.S.-PRC relations, Most-Favored-Nation trade status for the PRC, and U.S. technology. Jackson's characterization of the role that CP executives played at the event is corroborated by other participants.[121]

The PRC's Efforts to Assimilate Advanced U.S. Military Technology

The PRC's approach to U.S. technology firms proceeds from the premise that foreign firms should be allowed access to the PRC market only because such access will enable the PRC to assimilate technology, and eventually to compete with or even overtake U.S. technology. The PRC thus views foreign firms as a short-term means to acquire technology.

In theory, as the PRC is increasingly able to develop its own technology, it will need less and less foreign help. In practice, however, the PRC faces numerous challenges in integrating foreign technology into both its civilian and military industrial bases.

Among the areas in which the PRC is particularly dependent upon U.S. technology are computer hardware and microelectronics, telecommunications, commercial aircraft, and machine tools. The PRC, therefore, will most likely continue to rely heavily on joint ventures with foreign firms to provide advanced technology in these areas.

There are several reasons that the PRC has absorbed and assimilated only some, and not other, U.S. military and civilian technologies:

- **The PRC's funding of technology development, especially in applied sciences, conflicts with other priorities,** including supporting PRC state-owned enterprises as they restructure.
- **While the PRC has targeted very sophisticated U.S. military technology, including aerospace and electronics technology, it has not achieved the levels of training and maintenance** necessary to absorb it. But the emphasis on acquiring the most sophisticated technologies continues, even as some senior PRC officials call for a greater focus on "building block" technologies.
- **The PRC has a reputation for violating intellectual property rights,** making some foreign investors hesitant to transfer their most advanced technology.
- **There is a tendency of CCP and PLA officials to look toward their personal gain** and aggrandizement first, and only second to use State assets for the benefit of the PRC.

The PRC has benefitted from advanced U.S. and Western military technology in several areas, including ground force weapons, communications, remote sensing, and tactical and strategic systems. A 1995 study by the Office of Technology Assessment found that the PRC's joint ventures with the United States in commercial aircraft production appear to have enabled the PLA to machine smoother skins on its fighter aircraft.[122] Other PRC military products, such as air-to-air and surface-to-air missiles, submarines, and short-range ballistic missiles, also appear to have benefitted from foreign technical help.[123]

The PRC has also succeeded in reverse-engineering military hardware acquired from the United States and other countries, thereby defraying the high cost of weapons development. For example:

- **During the 1980s and 1990s, the PRC is presumed to have diverted U.S. military technology through civilian programs.** In 1983, the PRC is presumed to have exploited the CFM-56 jet engine technology from a civilian program. The CFM-56 contains the same core section as the engine used in the B-1B bomber.

- **The PRC developed its Z-11 helicopter** by reverse-engineering the French Aerospatiale AS-350 Ecureuil helicopter.[124]

- **The PRC's C-801 anti-ship cruise missile** is believed to be a copy of the French Exocet anti-ship cruise missile.[125]

PRC scientists have been pressured to reverse-engineer U.S. high technology rather than purchase it, even though this means that it may be difficult to maintain because of the lack of service, training, and documentation.

For example, the PRC was able to reverse-engineer a high-performance computer and produce a copy for far less than the U.S. equipment would have cost. By the time they achieved this success, however, a commercially-available desktop computer with the same power could have been purchased for a small fraction of their costs in time, money, and effort. The PRC seems willing to pay this cost in order to avoid long-term dependence on U.S. technology.

The Select Committee judges that at least some of the PRC's statements about its technical progress are distorted so as to increase the PRC's ability to gain access to foreign technology. By claiming substantial indigenous progress in areas ranging from supercomputers to stealth technology, the PRC can allay foreign fears that providing it with advanced technology will improve the PRC's capabilities. This tactic was used, the Select Committee believes, to overcome U.S. and Western objections to transfers of high performance computers to the PRC.

The Select Committee's classified report includes further material details and examples of PRC acquisition of advanced U.S. military technology, which the Clinton administration has determined cannot be made public.

U.S. Government Monitoring Of PRC Technology Acquisition Efforts In the United States

Because of the historical counterintelligence focus on the Soviet Union throughout the decades of the Cold War, the U.S. Government has never made the PRC's technology acquisition activities in the United States a priority. Moreover, because of the breadth of the PRC's decentralized collection efforts, the U.S. Government cannot completely monitor PRC activities in the United States.

Neither the Department of Commerce, the Department of the Treasury, the Federal Bureau of Investigation, the Central Intelligence Agency, nor, apparently, the Department of Defense[126] has in place a program, system, or effort specifically tasked with the ongoing collection of information concerning the following:

- **Efforts by the PRC, or by commercial entities owned or controlled by the PRC, to merge with, acquire a controlling interest in, or form a commercial partnership or joint venture with, commercial entities in the United States**

- **Efforts by the PRC, or by commercial entities owned or controlled by the PRC, to establish commercial entities in the United States**

- **Efforts by the PRC, by commercial entities owned or controlled by the PRC, or by agents thereof, directly or indirectly, to identify, locate, or acquire advanced technologies from U.S. sources**

- **Commercial connections or interactions between U.S. companies and commercial entities owned or controlled by the PRC**, specifically including connection or interaction involving advanced technologies

- **Commercial affiliations (for example, as officer, director, employee) between PRC nationals and either U.S. or foreign owned or controlled commercial entities**

Each of the U.S. Government's departments and agencies with responsibilities in this area has reported to the Select Committee that it is monitoring some aspects of PRC commercial activity in the United States, but that such monitoring is usually narrow in focus or reactive in nature. There is little or no initiative taken; rather, attention is paid to PRC commercial activity only when an allegation, problem, or issue arises that demands attention.

Because the CIA is not authorized to conduct broad collection activities within the United States, it defers to the FBI on the matter of PRC interaction with U.S. companies domestically. But there is little or no coordination within the U.S. Government of counterintelligence that is conducted against the PRC-directed efforts to acquire sensitive U.S. technology.

The Department of Commerce has contracted with private entities to produce an assessment of the PRC's technology acquisition efforts. In addition, three Commerce Department bureaus have duties that relate to PRC commercial activities in the United States. Specific activities in this regard include:[127]

- **Commerce contracted with DFI International to do research and write a report on the issue of technology transfers to the PRC through commercial joint ventures.**

- **Commerce also contracted with DFI International to establish a database of information on technology transfers from U.S. and foreign firms in the aerospace and telecommunications industries.** This project will produce periodic reports summarizing trends and analyzing implications of technology transfer on national security and international trade policy.

- **The Bureau of Economic Analysis collects and publishes significant data for statistical purposes regarding foreign direct investment in the United States.** More specifically, BEA collects data needed to prepare the U.S. balance of payments and international investment position, financial and operating data regarding foreign-owned U.S. companies, and data on U.S. businesses that have been newly-acquired or established by foreign investors. BEA does not have any direct information on the acquisition of advanced technologies by the PRC.

- **The Bureau of Export Administration controls the licensing of exports of dual-use goods and technologies pursuant to the Export Administration Act and the Export Administration Regulations.** The Bureau develops export control policies, issues export licenses, and prosecutes violators. The Bureau's controls include the regulation of the export of specified goods and technology to the PRC, including the transfer of controlled technology to PRC nationals in the United States.

- **The Bureau of Export Administration, along with the Customs Service, is also responsible for investigating possible violations of the Export Administration Act and the Export Administration Regulations, including possible improper transfers of technology to PRC nationals in the United States.** While the Bureau may obtain information during an investigation concerning commercial activities of PRC nationals, that information is not the focus of the investigation and is not collected in a manner that permits aggregation of data.[128]

The Treasury Department has an indirect role in monitoring PRC commercial activities in the United States. Through the Customs Service, Treasury investigates violations of U.S. export laws. These investigations are not part of a PRC-specific monitoring process, but are carried out based on specific facts indicating a violation of U.S. laws.[129]

In addition, any commercial entity, whether from the PRC or any other country, that wants to acquire control of a savings-and-loan or a national bank must file an application with Treasury's Office of Thrift Supervision or the Office of the Comptroller of the Currency.[130]

Treasury also chairs the Committee on Foreign Investment in the United States (CFIUS), an inter-agency committee to which the President has delegated the authority to review and investigate foreign investment transactions and conduct investigations pursuant to the Exon-Florio provision of the Omnibus Trade and Competitiveness Act of 1988. CFIUS membership includes the Secretaries of the Treasury, Commerce, Defense, and State, as well as the Attorney General, the United States Trade Representative, the Chairman of the Council of Economic Advisors, the Director of the Office of Management and Budget, the Director of the Office of Science and Technology Policy, the Assistant to the President for National Security Affairs, and the Assistant to the President for Economic Policy. Other agencies are asked to participate when a transaction falls within their areas of expertise.[131]

Notification to CFIUS of a proposed transaction is voluntary. The statute does not provide for the targeting of specific countries. If the transaction involves a foreign entity that is controlled by or is acting on behalf of a foreign government and the transaction could affect national security, a formal 45-day investigation is required. At the conclusion of an investigation, CFIUS submits a report and recommendations to the President.

The Securities and Exchange Commission collects little information helpful in monitoring PRC commercial activities in the United States. This lack of information is due only in part to the fact that many PRC front companies are privately-held and ultimately — if indirectly — wholly-owned by the PRC and the CCP itself. Increasingly, the PRC is using U.S. capital markets both as a source of central government funding for military and commercial development and as a means of cloaking U.S. technology acquisition efforts by its front companies with a patina of regularity and respectability.[132]

PRC THEFT OF U.S. THERMONUCLEAR WARHEAD DESIGN INFORMATION

The People's Republic of China (PRC) has stolen classified information on all of the United States' most advanced thermonuclear warheads, and several of the associated reentry vehicles. These thefts are the result of an intelligence collection program spanning two decades, and continuing to the present. The PRC intelligence collection program included espionage, review of unclassified publications, and extensive interactions with scientists from the Department of Energy's national weapons laboratories.

The stolen U.S. secrets have helped the PRC fabricate and successfully test modern strategic thermonuclear weapons. The stolen information includes classified information on seven U.S. thermonuclear warheads, including every currently deployed thermonuclear warhead in the U.S. intercontinental ballistic missile arsenal. Together, these include the W-88 Trident D-5 thermonuclear warhead, and the W-56 Minuteman II, the W-62 Minuteman III, the W-70 Lance, the W-76 Trident C-4, the W-78 Minuteman III Mark 12A, and the W-87 Peacekeeper thermonuclear warheads. The stolen information also includes classified design information for an enhanced radiation weapon (commonly known as the "neutron bomb"), which neither the United States, nor any other nation, has ever deployed.

In addition, in the mid-1990s the PRC stole from a U.S. national weapons laboratory classified U.S. thermonuclear weapons information that cannot be identified in this unclassified Report. Because this recent espionage case is currently under investigation and involves sensitive intelligence sources and methods, the Clinton administration has determined that further information can not be made public.

The W-88 is a miniaturized, tapered thermonuclear warhead. It is the United States' most sophisticated strategic thermonuclear weapon. In the U.S. arsenal, the W-88 warhead is mated to the D-5 submarine-launched ballistic missile carried aboard the Trident nuclear submarine. The United States learned about the theft of the W-88 Trident D-5 warhead information, as well as about the theft of information regarding several other thermonuclear weapons, in 1995.

On two occasions, the PRC has stolen classified U.S. information about neutron bomb warheads from a U.S. national weapons laboratory. The United States learned of these thefts of classified information on the neutron bomb in 1996 and in the late 1970s, when the first theft — including design information on the W-70 warhead — occurred. The W-70 warhead contains elements that may be used either as a strategic thermonuclear weapon, or as an enhanced radiation weapon ("neutron bomb"). The PRC subsequently tested the neutron bomb. The U.S. has never deployed a neutron weapon.

In addition, the Select Committee is aware of other PRC thefts of U.S. thermonuclear weapons-related secrets. The Clinton administration has determined that further information about these thefts cannot be publicly disclosed.

The Select Committee judges that the PRC will exploit elements of the stolen U.S. design information for the development of the PRC's new generation strategic thermonuclear warheads. Current PRC silo-based missiles were designed for large, multi-megaton thermonuclear warheads roughly equivalent to U.S. warheads of the late 1950s. The PRC plans to supplement these silo-based missiles with smaller, modern mobile missiles that require smaller warheads. The PRC has three mobile ICBM programs currently underway – two road-mobile and one submarine launched program – all of which will be able to strike the United States.

The first of these new People's Liberation Army (PLA) mobile ICBMs, the DF-31, may be tested in 1999 and could be deployed as soon as 2002. The DF-31 ICBM and the PRC's other new generation mobile ICBMs will require smaller, more compact warheads. The stolen U.S. information on the W-70 or W-88 Trident D-5 will be useful for this purpose.

The PRC has the infrastructure and technical ability to use elements of the stolen U.S. warhead design information in the PLA's next generation of thermonuclear weapons. If the PRC attempted to deploy an exact replica of the U.S. W-88 Trident D-5 warhead, it would face considerable technical challenges. However, the PRC could build modern thermonuclear warheads based on stolen U.S. design information, including the stolen W-88 design information, using processes similar to those developed or available in a modern aerospace or precision guided munitions industry. The Select Committee judges that the PRC has such infrastructure and is capable of producing small thermonuclear warheads based on the stolen U.S. design information, including the stolen W-88 information.

The Select Committee judges that the PRC is likely to continue its work on advanced thermonuclear weapons based on the stolen U.S. design information. The PRC could begin serial production of advanced thermonuclear weapons based on stolen U.S. design information during the next decade in connection with the development of its new generation of intercontinental ballistic missiles.

The Select Committee judges that the PRC's acquisition of U.S. classified information regarding thermonuclear warhead designs from the Department of Energy's national weapons laboratories saved the PRC years of effort and resources, and helped the PRC in its efforts to fabricate and successfully test a new generation of thermonuclear warheads. The PRC's access to, and use of, classified U.S. information does not immediately alter the strategic balance between the U.S. and PRC. Once the PRC's small, mobile strategic ballistic missiles are deployed, however, they will be far more difficult to locate than the PRC's current silo-based missiles. This will make the PRC's strategic nuclear force more survivable. Small, modern nuclear warheads also enable the PRC to deploy multiple reentry vehicles (MRVs or MIRVs, multiple independently-targetable reentry vehicles) on its ICBMs should it choose to do so.

The PRC's collection of intelligence on smaller U.S. thermonuclear warheads began in the 1970s, when the PRC recognized its weaknesses in physics and the deteriorating status of its nuclear weapons programs. The Select Committee judges that the PRC's intelligence collection efforts to develop modern thermonuclear warheads are focused primarily on the U.S. Department of Energy's National Laboratories at:

- **Los Alamos**
- **Lawrence Livermore**
- **Oak Ridge**
- **Sandia**

The FBI has investigated a number of U.S. National Laboratory employees in connection with suspected espionage.

The Select Committee judges that the U.S. national weapons laboratories have been and are targeted by PRC espionage, and almost certainly remain penetrated by the PRC today.

The United States did not become fully aware of the magnitude of the counterintelligence problem at Department of Energy national weapons laboratories until 1995. A series of PRC nuclear weapons test explosions from 1992 to 1996 began a debate in the U.S. Government about whether the PRC's designs for its new generation of nuclear warheads were in fact based on stolen U.S. classified information. The apparent purpose of these PRC tests was to develop smaller, lighter thermonuclear warheads, with an increased yield-to-weight ratio. In 1995, a "walk-in" approached the Central Intelligence Agency outside the PRC and provided an official PRC document classified "Secret" that contained specific design information on the W-88 Trident D-5, and technical information on other thermonuclear warheads. The CIA later determined that the "walk-in" was directed by the PRC intelligence services. Nonetheless, CIA and other Intelligence Community analysts that reviewed the document concluded that it contained U.S. warhead design information.

The National Security Advisor was briefed on PRC thefts of classified U.S. thermonuclear warhead design information in April 1996 (when he was the Deputy National Security Advisor), and again in August 1997. In response to specific interrogatories from the Select Committee, the National Security Advisor informed the Select Committee that the President was not briefed about the issue and the long-term counterintelligence problems at the Department of Energy until early 1998. The Secretary of Energy was briefed about the matter in late 1995 and early 1996. At the writing of this report, the Secretary of Defense has been briefed, but not the Secretaries of State and Commerce.

Congress was not provided adequate briefings on the extent of the PRC's espionage program.

Under Presidential Decision Directive 61 issued in February 1998, the Department of Energy was required to implement improved counterintelligence measures. In December 1998, the Department of Energy began to implement a series of recommended improvements to its counterintelligence program approved by

Secretary Richardson in November 1998. Based on testimony by the new head of the Department of Energy's counterintelligence program, the unsuccessful history of previous counterintelligence programs at the Department of Energy, and other information that is not publicly available, the Select Committee judges that the new counterintelligence program at the Department of Energy will not be even minimally effective until at least the year 2000.

Since the collapse of the Soviet Union, and continuing today, Russia is cooperating with the PRC in numerous military and civilian programs, including the PRC's civilian nuclear program. The Select Committee is concerned about the possibility of cooperation between Russia and the PRC on nuclear weapons. The Select Committee judges that Russian nuclear weapons testing technology and experience could significantly assist the PRC's nuclear weapons program, including the PRC's exploitation of stolen U.S. thermonuclear warhead design information. This is especially true if the PRC complies with the Comprehensive Test Ban Treaty, which does not permit the physical testing of nuclear weapons.

PRC THEFT OF U.S. THERMONUCLEAR WARHEAD DESIGN INFORMATION

The People's Republic of China's penetration of our national weapons laboratories spans at least the past several decades, and almost certainly continues today.

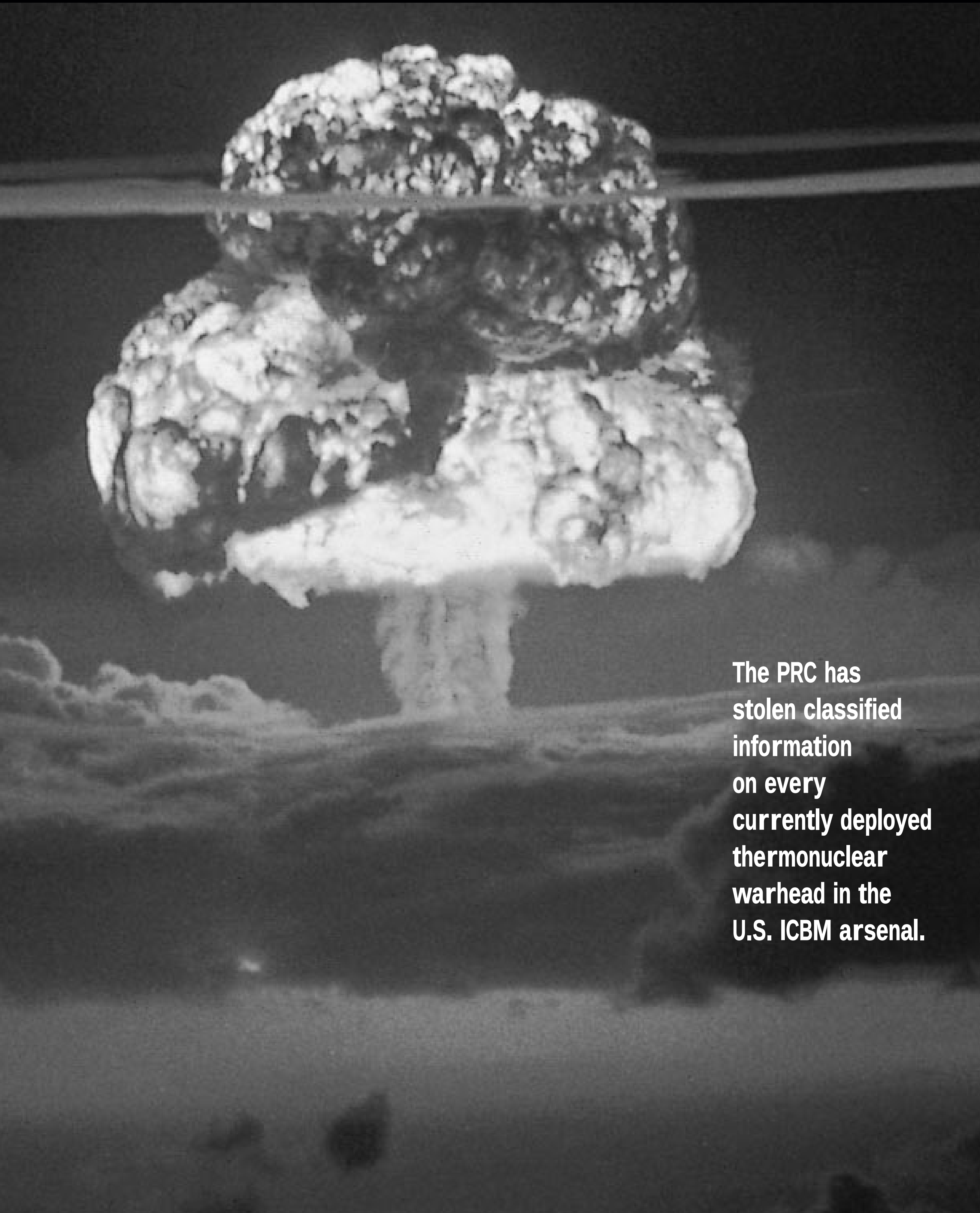
The PRC's nuclear weapons intelligence collection efforts began after the end of the Cultural Revolution in 1976, when the PRC assessed its weaknesses in physics and the deteriorating status of its nuclear weapons programs.

The PRC's warhead designs of the late 1970s were large, multi-megaton thermonuclear weapons that could only be carried on large ballistic missiles and aircraft. The PRC's warheads were roughly equivalent to U.S. warheads designed in the 1950s. The PRC may have decided as early as that time to pursue more advanced thermonuclear warheads for its new generation of ballistic missiles.

The PRC's twenty-year intelligence collection effort against the U.S. has been aimed at this goal. The PRC employs a "mosaic" approach that capitalizes on the collection of small bits of information by a large number of individuals, which is then pieced together in the PRC. This information is obtained through espionage, rigorous review of U.S. unclassified technical and academic publications, and extensive interaction with U.S. scientists and Department of Energy laboratories.

The Select Committee judges that the PRC's intelligence collection efforts to develop modern thermonuclear warheads are focused primarily on the Los Alamos, Lawrence Livermore, Sandia, and Oak Ridge National Laboratories.

As a result of these efforts, the PRC has stolen classified U.S. thermonuclear design information that helped it fabricate and successfully test a new generation of strategic warheads.


The PRC has
stolen classified
information
on every
currently deployed
thermonuclear
warhead in the
U.S. ICBM arsenal.

The PRC stole classified information on every currently deployed U.S. intercontinental ballistic missile (ICBM) and submarine-launched ballistic missile (SLBM). The warheads for which the PRC stole classified information include: the W-56 Minuteman II ICBM; the W-62 Minuteman III ICBM; the W-70 Lance short-range ballistic missile (SRBM); the W-76 Trident C-4 SLBM; the W-78 Minuteman III Mark 12A ICBM; the W-87 Peacekeeper ICBM; and the W-88 Trident D-5 SLBM. The W-88 warhead is the most sophisticated strategic nuclear warhead in the U.S. arsenal. It is deployed on the Trident D-5 submarine-launched missile.

In addition, in the mid-1990s the PRC stole from a U.S. national weapons laboratory classified U.S. thermonuclear weapons information that cannot be identified in this unclassified Report. Because this recent espionage case is currently under investigation and involves sensitive intelligence sources and methods, the Clinton administration has determined that further information may not be made public.

The PRC also stole classified information on U.S. weapons design concepts, on weaponization features, and on warhead reentry vehicles (the hardened shell that protects a warhead during reentry).

The PRC may have acquired detailed documents and blueprints from the U.S. national weapons laboratories.

The U.S. Intelligence Community reported in 1996 that the PRC stole neutron bomb technology from a U.S. national weapons laboratory. The PRC had previously stolen design information on the U.S. W-70 warhead in the late 1970s; that earlier theft, which included design information, was discovered several months after it took place. The W-70 has elements that can be used as a strategic thermonuclear warhead or an enhanced radiation ("neutron bomb") warhead. The PRC tested a neutron bomb in 1988.

Classified U.S. Nuclear Weapons Information Acquired by the PRC

Designation	Design Laboratory	Weapon Platform
W-88	Los Alamos	Trident D-5 SLBM
W-87	Lawrence Livermore	Peacekeeper/M-X ICBM
W-78	Los Alamos	Minuteman III Mark 12A ICBM
W-76	Los Alamos	Trident C-4 SLBM
W-70	Lawrence Livermore	Lance SRBM
W-62	Lawrence Livermore	Minuteman III ICBM
W-56	Lawrence Livermore	Minuteman II ICBM

The PRC may have also acquired classified U.S. nuclear weapons computer codes from U.S. national weapons laboratories. The Select Committee believes that nuclear weapons computer codes remain a key target for PRC espionage. Nuclear weapons codes are important for understanding the workings of nuclear weapons and can assist in weapon design, maintenance, and adaptation. The PRC could make use of this information, for example, to adapt stolen U.S. thermonuclear design information to meet the PRC's particular needs and capabilities.

During the mid-1990s, it was learned that the PRC had acquired U.S. technical information about insensitive high explosives. Insensitive high explosives are a component of certain thermonuclear weapons. Insensitive high explosives are less energetic than high explosives used in some other thermonuclear warheads, but have advantages for other purposes, such as thermonuclear warheads used on mobile missiles.

The PRC thefts from our national weapons laboratories began at least as early as the late 1970s, and significant secrets are known to have been stolen as recently as the mid-1990s. Such thefts almost certainly continue to the present.

The Clinton administration has determined that additional information about PRC thefts included in this section of the Select Committee's Report cannot be publicly disclosed.

The PRC's Next Generation Nuclear Warheads

The PRC has acquired U.S. nuclear weapons design information that could be utilized in developing the PRC's next generation of modern thermonuclear warheads.

The Department of Energy identifies two general design paths to the development of modern thermonuclear warheads:

- **The first path, which apparently has been followed by the Russians, emphasizes simplicity and reliability in design**
- **The second path, which the U.S. has taken, utilizes innovative designs and lighter-weight warheads**

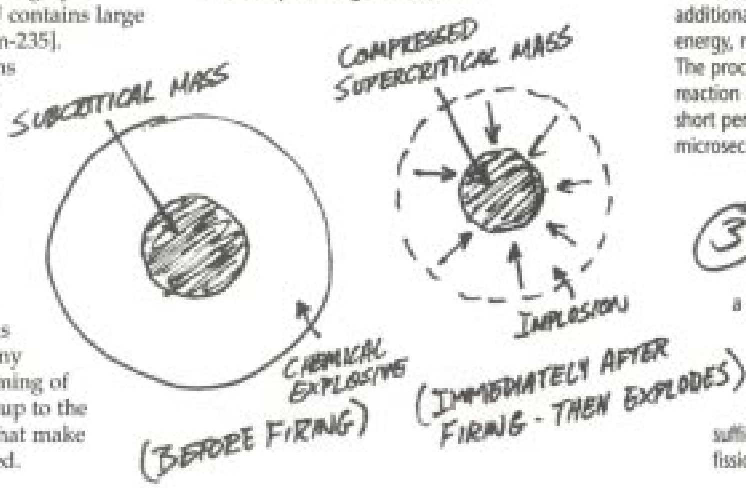
Thermonuclear Weapons 101

Nuclear explosions are produced by initiating and sustaining nuclear chain reactions in highly compressed materials that undergo fission and fusion reactions. Modern nuclear weapons have two stages: the ***primary***, which is the initial source of energy, and the ***secondary***, which is driven by the primary and provides additional explosive energy.

The primary assembly contains a central core, called the "pit," which is surrounded by a layer of high explosives (HE). The pit typically contains plutonium-239 and/or highly enriched uranium (HEU) [HEU contains large fractions of the isotope uranium-235]. The secondary typically contains the thermonuclear fuel lithium deuteride (LiD) and other materials.

Described here are five highly simplified steps that outline the overall operation of a thermonuclear weapon. The specifics of such devices—the required amounts of the various materials, the shapes of the many components, and the precise timing of the sequence of events leading up to the explosion—are crucial details that make the process very complex indeed.

1 The primary's ***pit*** is an assembly of shells of various materials; at its center is a hollow spherical mass of fissile material arranged in a ***subcritical*** configuration. The pit is surrounded by a shell of chemical high explosives (HE). The explosion produced by a modern thermonuclear weapon begins with the detonation of the HE. The resulting symmetrical explosion creates an ***implosion***—the uniform compression of the nuclear material in the pit. As the fissile material is compressed into a smaller volume, the pit becomes ***supercritical*** and is able to sustain a neutron-producing ***chain reaction***.



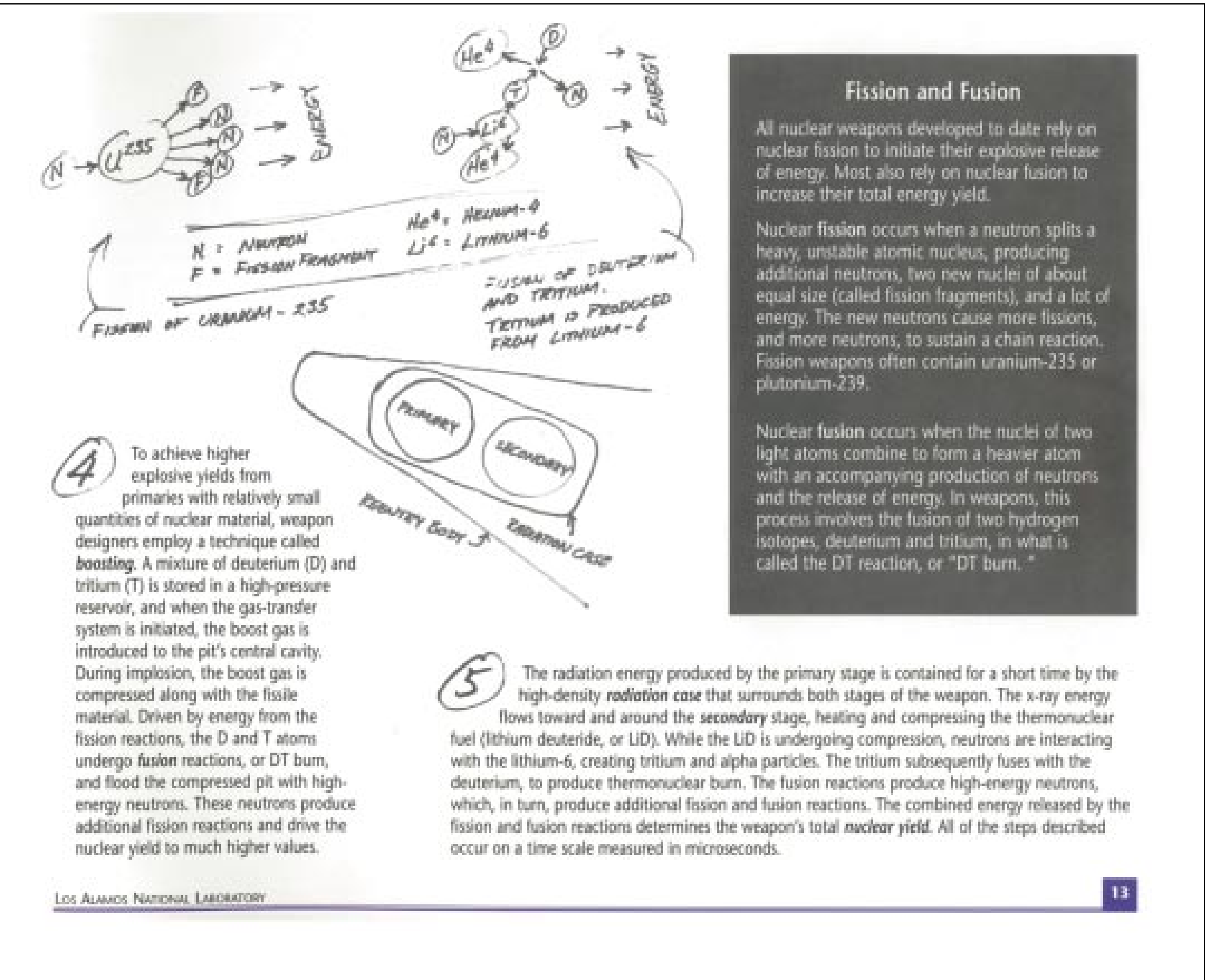
2 The fissile core is held together by a shell of heavy material, called a ***tamper***, which confines the neutrons to the region of the compressed core, increasing their probability of generating ***fission*** reactions. The neutrons strike the heavy nuclei in the fissile material and produce fission fragments, energy, and more neutrons. Each new fission reaction produces additional energy and more neutrons, which, in turn, create additional fission reactions, more energy, more neutrons, and so on. The process continues in a chain reaction and occurs during a very short period of time—only a few microseconds.

3 To induce the chain reaction, the imploding fissile mass is flooded with a source of neutrons. This flood of neutrons, called ***initiation***, ensures that the chain reaction in the fissile material will be sufficiently robust to sustain a fission chain reaction.

12 Nuclear Weapons Technology Program

Visitors to Los Alamos National Laboratory are provided a 72-page publication that provides, among other things, a primer on the design of thermonuclear weapons.

The Select Committee judges that the combination of the PRC's preference for U.S. designs, the PRC's theft of design information on our most advanced thermonuclear warheads, and the PRC's demand for small, modern warheads for its new generation of mobile intercontinental ballistic missiles will result in the PRC emulating the U.S. design path to develop its next generation of thermonuclear warheads.



Fission and Fusion

All nuclear weapons developed to date rely on nuclear fission to initiate their explosive release of energy. Most also rely on nuclear fusion to increase their total energy yield.

Nuclear **fission** occurs when a neutron splits a heavy, unstable atomic nucleus, producing additional neutrons, two new nuclei of about equal size (called fission fragments), and a lot of energy. The new neutrons cause more fissions, and more neutrons, to sustain a chain reaction. Fission weapons often contain uranium-235 or plutonium-239.

Nuclear **fusion** occurs when the nuclei of two light atoms combine to form a heavier atom with an accompanying production of neutrons and the release of energy. In weapons, this process involves the fusion of two hydrogen isotopes, deuterium and tritium, in what is called the DT reaction, or "DT burn."

4 To achieve higher explosive yields from primaries with relatively small quantities of nuclear material, weapon designers employ a technique called ***boosting.*** A mixture of deuterium (D) and tritium (T) is stored in a high-pressure reservoir, and when the gas-transfer system is initiated, the boost gas is introduced to the pit's central cavity. During implosion, the boost gas is compressed along with the fissile material. Driven by energy from the fission reactions, the D and T atoms undergo ***fusion*** reactions, or DT burn, and flood the compressed pit with high-energy neutrons. These neutrons produce additional fission reactions and drive the nuclear yield to much higher values.

5 The radiation energy produced by the primary stage is contained for a short time by the high-density ***radiation case*** that surrounds both stages of the weapon. The x-ray energy flows toward and around the ***secondary*** stage, heating and compressing the thermonuclear fuel (lithium deuteride, or LiD). While the LiD is undergoing compression, neutrons are interacting with the lithium-6, creating tritium and alpha particles. The tritium subsequently fuses with the deuterium, to produce thermonuclear burn. The fusion reactions produce high-energy neutrons, which, in turn, produce additional fission and fusion reactions. The combined energy released by the fission and fusion reactions determines the weapon's total ***nuclear yield.*** All of the steps described occur on a time scale measured in microseconds.

LOS ALAMOS NATIONAL LABORATORY 13

The PRC has already begun working on smaller thermonuclear warheads. During the l990s, the PRC was working to complete testing of its modern thermonuclear weapons before it signed the Comprehensive Test Ban Treaty in 1996.[1] The PRC conducted a series of nuclear tests from 1992 to 1996. Based on what is known about PRC nuclear testing practices, combined with data on PRC warhead yield and on PRC missile development, it is clear that the purpose of the 1992 to 1996 test series was to develop small, light warheads for the PRC's new nuclear forces.[2]

These tests led to suspicions in the U.S. Intelligence Community that the PRC had stolen advanced U.S. thermonuclear warhead design information. These suspicions were definitely confirmed by the "walk-in" information received in 1995.

The Select Committee judges that the PRC is developing for its next generation of road-mobile intercontinental ballistic missiles smaller, more compact thermonuclear warheads that exploit elements of stolen U.S. design information, including the stolen design information from the U.S. W-70 Lance warhead or the W-88 Trident D-5 warhead.

The timeline on the next two-page spread shows an unclassified history of the PRC's thermonuclear weapons development and its acquisition of classified information from the United States.

Completing the development of its next-generation warhead poses challenges for the PRC. The PRC may not currently be able to match precisely the exact explosive power and other features of U.S. weapons. Nonetheless, the PRC may be working toward this goal, and the difficulties it faces are surmountable. Work-arounds exist, using processes similar to those developed or available in a modern aerospace or precision-guided munitions industry. The PRC possesses these capabilities already.

The Impact of the PRC's Theft of U.S. Thermonuclear Warhead Design Information

Mobile and Submarine-Launched Missiles

The main application of the stolen U.S. thermonuclear warhead information will likely be to the PRC's next-generation intercontinental ballistic missiles.

The PRC is developing several new, solid-propellant, mobile intercontinental ballistic missiles. These include both road-mobile and submarine-launched intercontinental ballistic missiles.

Road-mobile ballistic missiles and submarine-launched ballistic missiles require smaller, more advanced thermonuclear warheads. The Select Committee judges it is likely that the PRC will use a new, smaller thermonuclear warhead on its next generation road-mobile, solid-propellant ICBM, the DF-31.

The DF-31 is likely to undergo its first test flight in 1999, and could be deployed as early as 2002. Introduction of the PRC's new, smaller thermonuclear warhead into PLA service could coincide with the initial operational capability of the new road-mobile DF-31 ballistic missile system.

The Select Committee judges that the PRC's thermonuclear warheads will exploit elements of the U.S. W-70 Lance or W-88 Trident D-5 warheads. While the PRC might not reproduce exact replicas of these U.S. thermonuclear warheads, elements of the PRC's devices could be similar.

Acceleration of PRC Weapons Development

The PRC's theft of classified U.S. weapons design information saved the PRC years of effort and resources in developing its new generation of modern thermonuclear warheads. It provided the PRC with access to design information that worked and was within the PRC's ability to both develop and test. And it saved the PRC from making mistakes or from pursuing blind alleys.

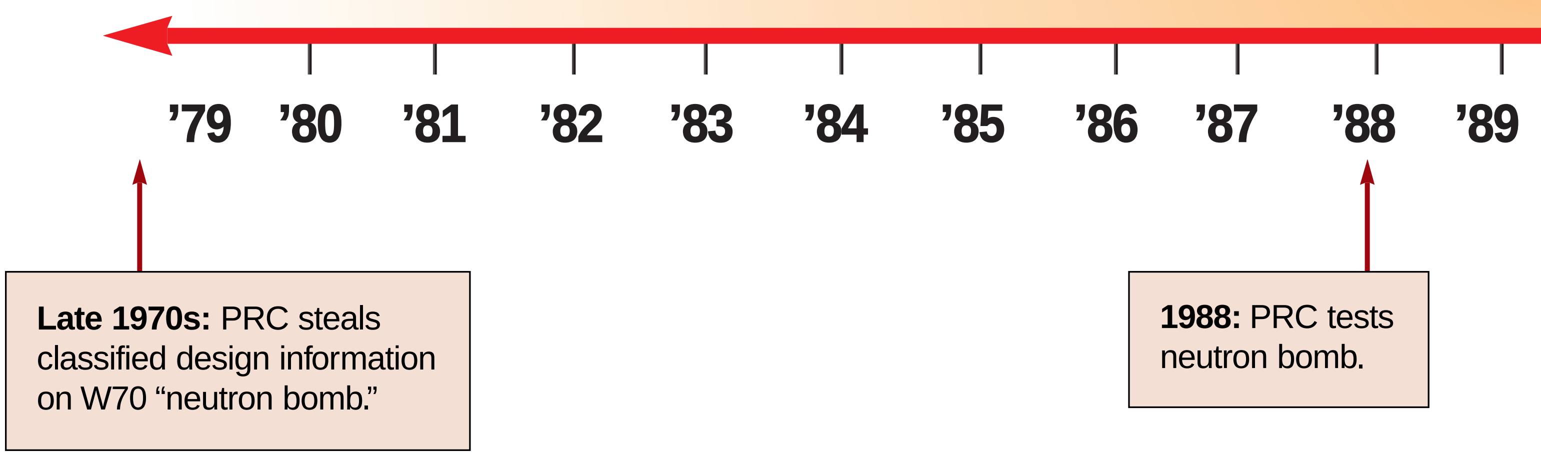
The loss of design information from the Department of Energy's national weapons laboratories helped the PRC in its efforts to fabricate and successfully test its next generation of nuclear weapons designs. These warheads give the PRC small, modern thermonuclear warheads roughly equivalent to current U.S. warhead yields.

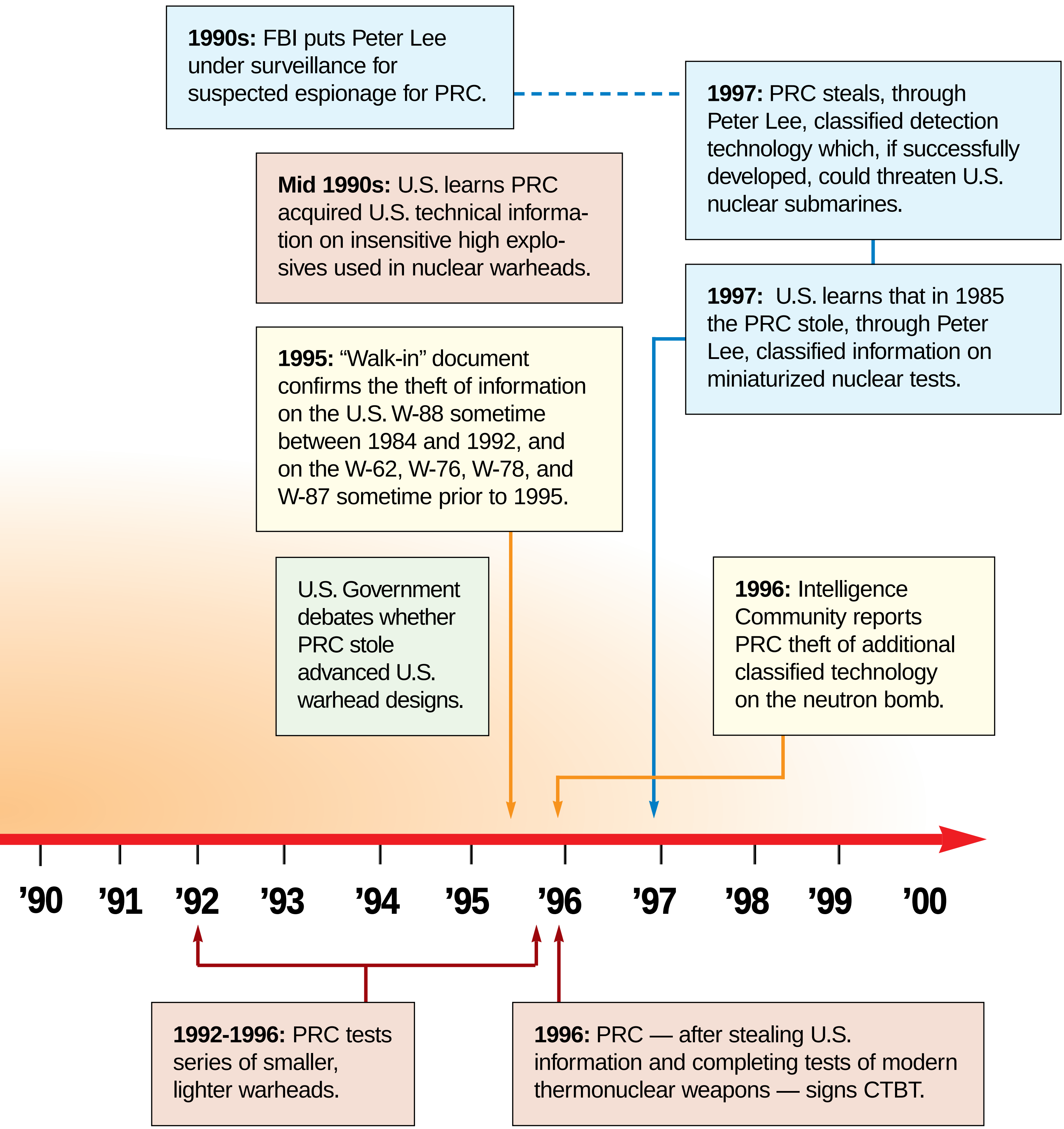
Assessing the extent to which design information losses accelerated the PRC's nuclear weapons development is complicated because so much is unknown. The full extent of U.S. information that the PRC acquired and the sophistication of the PRC's indigenous design capabilities are unclear. Moreover, there is the possibility of third country assistance to the PRC's nuclear weapons program, which could also assist the PRC's exploitation of the stolen U.S. nuclear weapons information. Nonetheless, it is patent that the PRC has stolen significant classified U.S. design information on our most modern thermonuclear warheads.

U.S. Knowledge of PRC Weapons Thefts: An Unclassified History

For decades, and continuing today, the PRC has been acquiring classified information on America's nuclear weapons program in order to develop its own program.

The United States did not become fully aware of the magnitude of the counterintelligence problem at U.S. national weapons laboratories until 1995.




1990s: FBI puts Peter Lee under surveillance for suspected espionage for PRC.
1997: PRC steals, through Peter Lee, classified detection technology which, if successfully developed, could threaten U.S. nuclear submarines.
Mid 1990s: U.S. learns PRC acquired U.S. technical information on insensitive high explosives used in nuclear warheads.
1997: U.S. learns that in 1985 the PRC stole, through Peter Lee, classified information on miniaturized nuclear tests.
1995: "Walk-in" document confirms the theft of information on the U.S. W-88 sometime between 1984 and 1992, and on the W-62, W-76, W-78, and W-87 sometime prior to 1995.
U.S. Government debates whether PRC stole advanced U.S. warhead designs.
1996: Intelligence Community reports PRC theft of additional classified technology on the neutron bomb.
'90
'91
'92
'93
'94
'95
'96
'97
'98
'99
'00
1992-1996: PRC tests series of smaller, lighter warheads.
1996: PRC — after stealing U.S. information and completing tests of modern thermonuclear weapons — signs CTBT.

While it is sometimes argued that eventually the PRC might have been able to produce and test an advanced and modern thermonuclear weapon on its own, the PRC had conducted only 45 nuclear tests in the more than 30 years from 1964 to 1996 (when the PRC signed the Comprehensive Test Ban Treaty), which would have been insufficient for the PRC to have developed advanced thermonuclear warheads on its own. This compares to the approximately 1,030 tests by the United States, 715 tests by the Soviet Union, and 210 by France.[3]

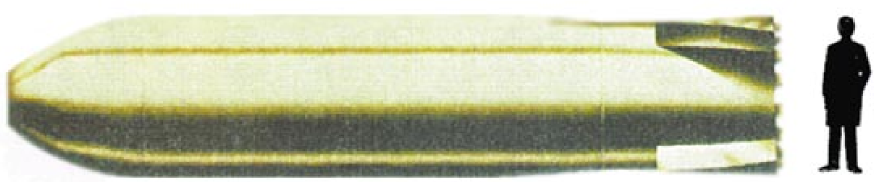
The following illustrates the evolution of smaller U.S. warheads.[4]

Size Comparison of U.S. Nuclear Warheads

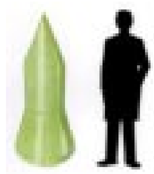
Early Development

Fatman and Littleboy

B-17



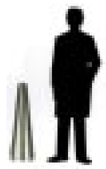
Single Warhead Development



SINGLE WARHEADS

W58 Polaris
W56 Minuteman II
W47 Polaris

Multiple Independent Reentry Vehicle (MIRV) Development



MIRV WARHEADS

W88 Trident
W87 Pershing
W78 Minuteman III
W76 Trident C-4
W68 Posiedon
W62 Minuteman III

The first U.S. nuclear warheads, such as Fatman, Littleboy and the B-17, were very large in size. Over time, as technology became more sophisticated, the warheads shrunk in size.

Effect on PRC Nuclear Doctrine

Deploying new thermonuclear weapons provides the PRC with additional doctrinal and operational options for its strategic forces that, if exercised, would be troublesome for the United States.

Smaller, more efficient thermonuclear warheads would provide the PRC with the opportunity to develop and deploy a multiple independently-targetable reentry vehicle (MIRV) should it decide to do so. These smaller designs would allow the use of lighter and faster reentry vehicles that may be better able to stress and to overcome ballistic missile defenses.

The following two pages illustrate the development of smaller, more efficient U.S. thermonuclear warheads, specifically the W-87 Peacekeeper, a warhead for which the PRC stole classified U.S. weapons information.

The PRC has expressed considerable opposition to U.S. deployment of ballistic missile defenses.

Other advantages of increased warhead yield-to-weight ratios include extended missile ranges and accuracy improvements. Smaller warheads result in a more compact missile payload, extending the range of ballistic missiles. This permits the use of smaller-diameter sea-launched ballistic missiles and mobile missiles to strike long-range targets. Longer range could enable PRC ballistic missile submarines to strike the U.S. from within PRC waters, where they can operate safely.

Multiple Warhead Development

The deployment of multiple warheads on a single missile requires smaller warheads that the PRC has not possessed.

The Select Committee has no information on whether the PRC currently intends to develop and deploy multiple independently targetable reentry vehicle systems. However, the Select Committee is aware of reports that the PRC has undertaken efforts related to multiple warhead technology.

Experts believe that the PRC currently has the technical capability to develop and deploy silo-based ballistic missiles with multiple reentry vehicles (MRVs) and multiple independently-targetable reentry vehicles (MIRVs). Experts also agree that the PRC could develop and deploy its new generation of mobile intercontinental ballistic missiles with MRVs or MIRVs within a short period of years after a decision to do so, and consistent with the presumed timeframe for its planned deployment of its next-generation intercontinental ballistic missiles.

Proliferation

The PRC is one of the world's leading proliferators of weapons technologies. Concerns about the impact of the PRC's thefts of U.S. thermonuclear warhead design information, therefore, include the possible proliferation of the world's most sophisticated nuclear weapons technology to nations hostile to the United States.

Russian Assistance to the PRC's Nuclear Weapons Program

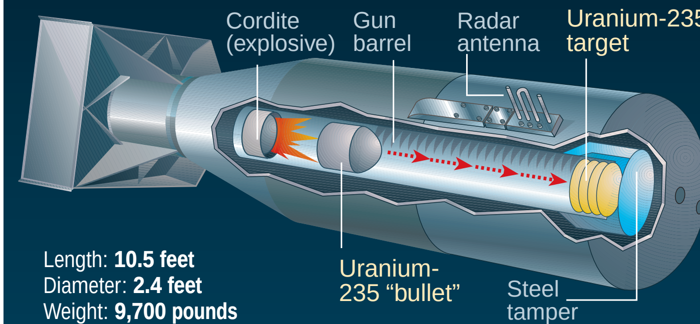
After the fall of the Soviet Union, the PRC and Russian scientists became increasingly cooperative in civilian nuclear technology, and apparently, military technology. The Select Committee is concerned that the growing cooperation between Russia and the PRC is an indication of current or future nuclear weapons cooperation. The Select Committee judges that Russia's nuclear weapons

THE BOMB THEN AND NOW

A typical nuclear weapon today is more accurate and is nine times more destructive than the Hiroshima bomb.

"Little Boy"

The uranium-235 bomb that destroyed Hiroshima was flown there in a B-29 bomber and aimed with a bombsight.

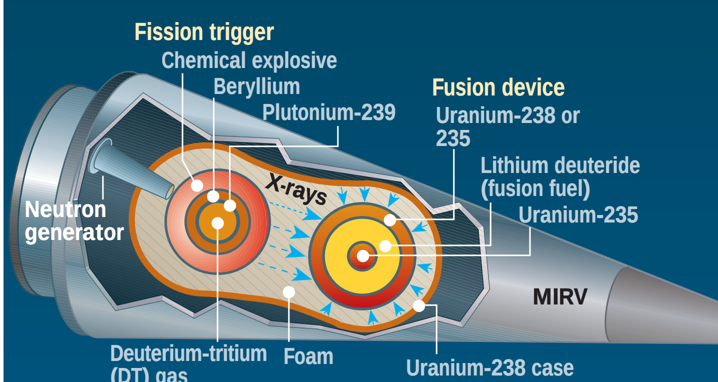


Length: **10.5 feet**
Diameter: **2.4 feet**
Weight: **9,700 pounds**
Explosive power: **12,500 tons of TNT**

Explosion process: When the bomb fell to 1,900 feet, a radar antenna set off a conventional explosive in the bomb chamber. This catapulted a uranium-235 wedge through the gun barrel into the U-235 target rings, producing a self-sustaining nuclear chain reaction.

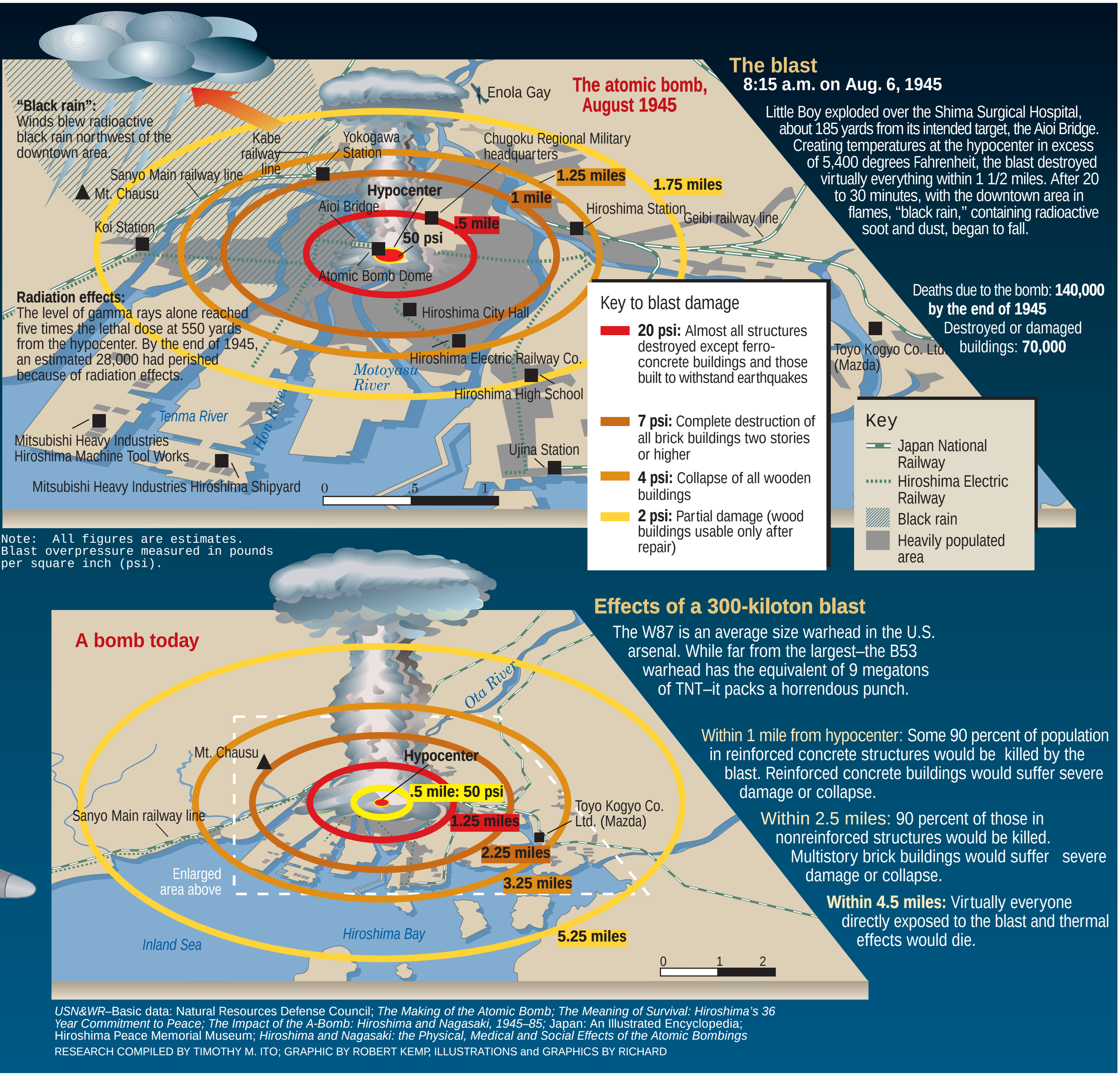
A modern thermonuclear

This W87 thermonuclear warhead is launched on an MX intercontinental missile. Packed into a multiple independently targeted re-entry vehicle (MIRV, shown below), it splits off from the missile to strike its target.



MIRV length: **5.7 feet** MIRV base diameter: **1.8 feet**
Explosive power: **300,000 tons of TNT**

Explosion process: The compression of plutonium with a chemical explosive (above, left) starts a fission explosion that, in turn, is boosted by the fusion of DT gas. X-rays then compress the second component, causing a larger fission/fusion.



U.S. News & World Report

testing technology and experience could significantly assist the PRC with its nuclear weapons program under the Comprehensive Test Ban Treaty, which does not permit physical testing.

While the PRC could share its knowledge of U.S. advanced thermonuclear warhead designs with Russia, Russia may not be interested in deviating from its past developmental path, since existing Russian warhead designs are apparently simple and reliable. The large throw-weight of Russian ballistic missiles has given them less cause for concern about the size and weight of their warheads. Russia's nuclear stockpile maintenance requirements under a Comprehensive Test Ban Treaty are thus very different than those of the United States.

The prospect of PRC-Russian cooperation, if that were to include military cooperation, would give rise to concerns in several areas, including nuclear weapons development and nuclear stockpile maintenance, nuclear weapons modeling and simulation, and nuclear weapons testing data.

How the PRC Acquired Thermonuclear Warhead Design Information from the United States: PRC Espionage and Other PRC Techniques

The Select Committee judges that the PRC's intelligence collection efforts to develop modern thermonuclear warheads have focused primarily on the following U.S. National Laboratories: Los Alamos, Lawrence Livermore, Oak Ridge, and Sandia. These efforts included espionage, rigorous review of U.S. unclassified technical and academic publications, and extensive interaction with U.S. scientists and Department of Energy laboratories.

Espionage played a central part in the PRC's acquisition of classified U.S. thermonuclear warhead design secrets. In several cases, the PRC identified lab employees, invited them to the PRC, and approached them for help, sometimes playing upon ethnic ties to recruit individuals.

The PRC also rigorously mined unclassified technical information and academic publications, including information from the National Technical Information

Center and other sources. PRC scientists have even requested reports via e-mail from scientists at the U.S. national weapons laboratories. Peter Lee, who had been a scientist at both Lawrence Livermore and Los Alamos National Laboratories and was convicted in 1997 of passing classified information to the PRC, gave the PRC unclassified technical reports upon request. The PRC also learned about conventional explosives for nuclear weapon detonation from reviewing unclassified technical reports published by Department of Energy national weapons laboratories.

PRC scientists have used their extensive laboratory-to-laboratory interactions with the United States to gain information from U.S. scientists on common problems, solutions to nuclear weapons physics, and solutions to engineering problems. The PRC uses elicitation in these meetings, where it shows familiarity with U.S. information in an effort to "prime the pump" in order to try to glean information about U.S. designs. U.S. scientists have passed information to the PRC in this way that is of benefit to the PRC's nuclear weapons program.

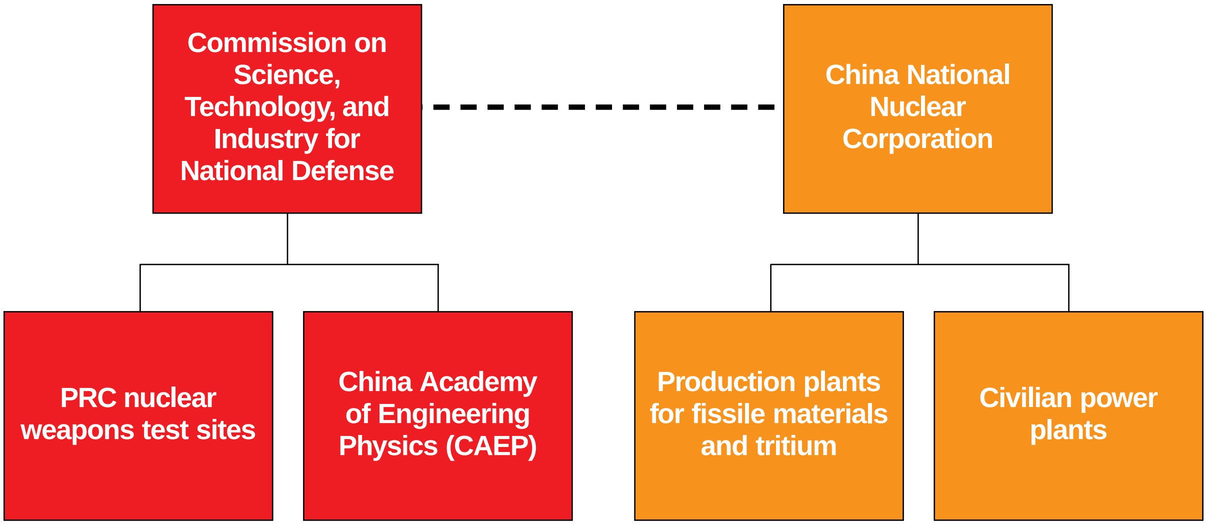
Specific examples of the loss of classified U.S. information in this manner are detailed in the Select Committee's classified Final Report. The Clinton administration has determined that these examples cannot be publicly discussed.

The PRC's espionage operations, which use traditional intelligence gathering organizations as well as other entities, are aggressively focused on U.S. weapons technology.

The PRC's Academy of Engineering Physics (CAEP), which is under the Commission of Science, Technology, and Industry for National Defense (COSTIND), is the entity in charge of the PRC's nuclear weapons program. It is responsible for the research and development, testing, and production of all of the PRC's nuclear weapons. The figure on the following page shows the organization of the PRC's nuclear infrastructure.[5]

The China Academy of Engineering Physics has pursued a very close relationship with U.S. national weapons laboratories, sending scientists as well as senior management to Los Alamos and Lawrence Livermore. Members of the China Academy of Engineering Physics senior management have made at least two trips during the mid-to-late 1990s to U.S. national weapons laboratories to acquire

Organization of the PRC's Nuclear Weapons Entities



The PRC's Academy of Engineering Physics (CAEP), which is under the Commission on Science, Technology, and Industry for National Defense, is responsible for the research and development, testing, and production of all of the PRC's nuclear weapons.

information and collect intelligence. These visits provide the opportunity for the PRC to collect intelligence. The presence of such PRC nationals at the U.S. national weapons laboratories facilitates the PRC's targeting of U.S. weapons scientists for the purpose of obtaining nuclear weapons information.

U.S. and PRC lab-to-lab exchanges were ended in the late 1980s, but were resumed in 1993. Scientific exchanges continue in many areas including high-energy physics.[6] Discussions at the U.S. national weapons laboratories in connection with the foreign visitors program are supposed to be strictly limited to technical arms control and material accounting issues. Nonetheless, these visits and scientific conferences provide opportunities for the PRC to interact with U.S. scientists outside of official meetings, and facilitate the PRC's targeting of U.S. weapons scientists.

The U.S. national weapons laboratories argue that there are reciprocal gains from the exchanges. The Department of Energy describes some of the insights gained from these exchanges as unique. On the other hand, PRC scientists have misled the U.S. about their objectives and technological developments. Despite considerable debate in Congress and the Executive branch, including several critical Government

Accounting Office reports, the U.S. Government has never made a definitive assessment of the risks versus the benefits of scientific exchanges and foreign visitor programs involving the U.S. national weapons laboratories.[7]

How the U.S. Government Learned of the PRC's Theft of Our Most Advanced Thermonuclear Warhead Design Information

The U.S. Government did not become fully aware of the magnitude of the counterintelligence problems at the Department of Energy laboratories until 1995. The first indication of successful PRC espionage against the laboratories arose in the late 1970s. During the last several years, more information has become available concerning thefts of U.S. thermonuclear warhead design information, and how the PRC may be exploiting it. A series of PRC nuclear tests conducted from 1992 to 1996 that furthered the PRC's development of advanced warheads led to suspicions in the U.S. intelligence community that the PRC had stolen advanced U.S. thermonuclear warhead design information.

The "Walk-In"

In 1995, a "walk-in" approached the Central Intelligence Agency outside of the PRC and provided an official PRC document classified "Secret" that contained design information on the W-88 Trident D-5 warhead, the most modern in the U.S. arsenal, as well as technical information concerning other thermonuclear warheads.

The CIA later determined that the "walk-in" was directed by the PRC intelligence services. Nonetheless, the CIA and other Intelligence Community analysts that reviewed the document concluded that it contained U.S. thermonuclear warhead design information.

The "walk-in" document recognized that the U.S. nuclear warheads represented the state-of-the-art against which PRC thermonuclear warheads should be measured.

Espionage Definition of a "Walk-In"

A "walk-in" is an individual who voluntarily offers to conduct espionage. *The Encyclopedia of Espionage* defines a "walk-in" as "an unheralded defector or a dangle, a 'walk-in' is a potential agent or a mole who literally walks into an embassy or intelligence agency without prior contact or recruitment." *See* the *Spy Book*, *The Encyclopedia of Espionage*, by Norman Polmar and Thomas B. Allen (RH Reference & Information Publishing, Random House).

The individual who approached the CIA in 1995 is suspected of being a "directed walk-in": a "walk-in" purposefully directed by the PRC to provide this information to the United States. There is speculation as to the PRC's motives for advertising to the United States the state of its nuclear weapons development.

Over the following months, an assessment of the information in the document was conducted by a multidisciplinary group from the U.S. Government, including the Department of Energy and scientists from the U.S. national weapons laboratories. The Department of Energy and FBI investigations focused on the loss of the U.S. W-88 Trident D-5 design information, but they did not focus on the loss of technical information about the other five U.S. thermonuclear warheads. A Department of Energy investigation of the loss of technical information about the other five U.S. thermonuclear warheads had not begun as of January 3, 1999, after the Select Committee had completed its investigation. Also, the FBI had not yet initiated an investigation as of January 3, 1999.

The PRC's Future Thermonuclear Warhead Requirements: The PRC's Need for Nuclear Test Data and High Performance Computers

Since signing the Comprehensive Test Ban Treaty (CTBT) in 1996, the PRC has faced new challenges in maintaining its modern thermonuclear warheads without physical testing. Indeed, even after signing the CTBT, the PRC may be testing sub-critical or low yield nuclear explosive devices underground at its Lop Nur test site.

The PRC likely does not need additional physical tests for its older thermonuclear warhead designs. But maintenance of the nuclear weapons stockpile for these weapons does require testing. The ban on physical testing to which the PRC agreed in 1996 has therefore increased the PRC's interest in high performance computing and access to sophisticated computer codes to simulate the explosion of nuclear weapons.[8]

The Select Committee judges that the PRC has likely developed only a very modest complement of codes from inputting its own testing data into high performance computers. The PRC would, therefore, be especially interested in acquiring U.S. thermonuclear weapons codes for any new weapons based on elements of stolen U.S. design information.

The Department of Energy reports that the PRC has in fact acquired some U.S. computer codes, including: the MCNPT code; the DOT3.5 code; and the NJOYC code.[9] MCNPT is a theoretical code that is useful in determining survivability of systems to electronic penetration and dose penetration in humans. DOT3.5 is a two-dimensional empirical code that performs the same kinds of calculations as MCNPT, except uses numerical integration. NJOYC acts as a numerical translator between DOT3.5 and MCNPT.

Given the limited number of nuclear tests that the PRC has conducted, the PRC likely needs additional empirical information about advanced thermonuclear weapon performance that it could obtain by stealing the U.S. "legacy" computer codes, such as those that were used by the Los Alamos National Laboratory to design the W-88 Trident D-5 warhead. The PRC may also need information about dynamic three-dimensional data on warhead packaging, primary and secondary coupling, and the chemical interactions of materials inside the warhead over time.

The Select Committee is concerned that no procedures are in place that would either prevent or detect the movement of classified information, including classified nuclear-weapons design information or computer codes, to unclassified sections of the computer systems at U.S. national weapons laboratories. The access granted to individuals from foreign countries, including students, to these unclassified areas of the U.S. national weapons laboratories' computer systems could make it possible for others acting as agents of foreign countries to access such information, making detection of the persons responsible for the theft even more difficult.

The Select Committee believes that the PRC will continue to target its collection efforts not only on Los Alamos National Laboratory, but also on the other U.S. National Laboratories involved with the U.S. nuclear stockpile maintenance program.

The PRC may also seek to improve its hydrostatic testing capabilities by learning more about the Dual-Axis Radiographic Hydrotest (DARHT) facility at Los Alamos.

SYGMA

As a result of an espionage program going back to at least 1979, the PRC has stolen design information on the United States' most advanced thermonuclear warheads from America's National Laboratories like the one at Los Alamos, New Mexico *(above).* The PRC also rigorously reviews unclassified technical and academic publications, and uses extensive interaction with U.S. scientists at the National Labs. The Select Committee judges that the National Labs almost certainly remain penetrated today.

U.S. Government Investigations of Nuclear Weapons Design Information Losses

Investigation of Theft of Design Information for the Neutron Bomb

The Select Committee received information about the U.S. Government's investigation of the PRC's theft of classified U.S. design information for the W-70 thermonuclear warhead. The W-70, which is an enhanced radiation nuclear warhead (or "neutron bomb"), also has elements that can be used for a strategic thermonuclear warhead. In 1996 the U.S. Intelligence Community reported that the PRC had successfully stolen classified U.S. technology from a U.S. Nuclear Weapons Laboratory about the neutron bomb.

This was not the first time the PRC had stolen classified U.S. information about the neutron bomb. In the late 1970s, the PRC stole design information on the U.S. W-70 warhead from Lawrence Livermore Laboratory. The U.S. Government first learned of this theft several months after it took place. The PRC subsequently tested a neutron bomb in 1988.

The FBI developed a suspect in the earlier theft. The suspect worked at Lawrence Livermore National Laboratory, and had access to classified information including designs for a number of U.S. thermonuclear weapons in the U.S. stockpile at that time.

In addition to design information about the W-70, this suspect may have provided to the PRC additional classified information about other U.S. weapons that could have significantly accelerated the PRC's nuclear weapons program.

The Clinton administration has determined that further information about these thefts cannot be publicly disclosed.

Investigation of Thefts of Information Related to the Detection of Submarines and of Laser Testing of Miniature Nuclear Weapons Explosions

Peter Lee is a naturalized U.S. citizen who was born in Taiwan. Lee worked at Los Alamos National Laboratory from 1984 to 1991, and for TRW Inc., a contractor to Lawrence Livermore National Laboratory, from 1973 to 1984 and again from 1991to 1997.[10]

Lee has admitted to the FBI that, in 1997, he passed to PRC weapons scientists classified research into the detection of enemy submarines under water. This research, if successfully completed, could enable the PLA to threaten previously invulnerable U.S. nuclear submarines.

Lee made the admissions in 1997 during six adversarial interviews with the FBI. According to Lee, the illegal transfer of this sensitive research occurred while he was employed by TRW, Inc., a contractor for the Lawrence Livermore National Laboratory. The classified U.S.information was developed by Lawrence Livermore as part of a joint United States-United Kingdom Radar Ocean Imaging project for anti-submarine warfare applications.

Specifically, on or about May 11, 1997, Lee gave a lecture in Beijing at the PRC Institute of Applied Physics and Computational Mathematics (IAPCM). Among the attendees were nuclear weapons scientists from the IAPCM and the China Academy of Engineering Physics (CAEP).

Lee described for the PRC weapons scientists the physics of microwave scattering from ocean waves. Lee specifically stated that the purpose of the research was anti-submarine warfare.

At one point in his presentation, Lee displayed an image of a surface ship wake, which he had brought with him from the United States. He also drew a graph and explained the underlying physics of his work and its applications. He told the PRC scientists where to filter data within the graph to enhance the ability to locate the ocean wake of a vessel.

Approximately two hours after his talk was over, Lee erased the graph and tore the ship wake image “to shreds” upon exiting the PRC institute.[11]

In 1997, the decision was made to not prosecute Lee for passing this classified information on submarine detection to the PRC. Because of the sensitivity of this area of research, the Defense Department requested that this information not be used in a prosecution.

Throughout much of the l990s, the FBI conducted a multi-year investigation of Peter Lee, employing a variety of techniques, but without success in collecting incriminating evidence. Finally, in 1997, Lee was charged with willfully providing to the PRC classified information on techniques for creating miniature nuclear fusion explosions.

Specifically, Lee explained to PRC weapons scientists how deuterium and tritium can be loaded into a spherical capsule called a target and surrounded by a “hohlraum,” and then heated by means of laser bombardment. The heat causes the compression of these elements, creating a nuclear fusion micro-explosion. This so-called “inertial confinement” technique permits nuclear weapons scientists to study nuclear explosions in miniature — something of especial usefulness to the PRC, which has agreed to the ban on full-scale nuclear tests in the Comprehensive Test Ban Treaty.

Lee's admission that he provided the PRC with this classified information about nuclear testing using miniaturized fusion explosions came in the course of the same 1997 adversarial FBI interviews that yielded his admission of passing submarine detection research to the PRC. Lee's delivery of the miniature nuclear testing information to the PRC occurred in 1985, while he was employed as a researcher at Los Alamos National Laboratory.

Lee said that during a lecture in the PRC he answered questions and drew diagrams about hohlraum construction. In addition, Lee is believed to have provided the PRC with information about inertial confinement lasers that are used to replicate the coupling between the primary and secondary in a thermonuclear weapon.

Lee was formally charged with one count of “gathering, transmitting or losing defense information,” in violation of Section 793 of Title 18 of the U.S. Code, and one count of providing false statements to a U.S. government agency, in violation of Section 1001, Title 18. On December 8, 1997, Lee pled guilty to willfully passing classified U.S. defense information to PRC scientists during his 1985 visit to the PRC. Lee also pled guilty to falsifying reports of contact with PRC nationals in 1997.

Lee was sentenced to 12 months in a halfway house, a $20,000 fine and 3,000 hours of community service.[12]

The Select Committee judges that, between 1985 and 1997, Lee may have provided the PRC with more classified thermonuclear weapons-related information than he has admitted.

The PRC apparently co-opted Lee by appealing to his ego, his ethnicity, and his sense of self-importance as a scientist.

Investigation of Theft of Design Information For the W-88 Trident D-5 Thermonuclear Warhead

The Select Committee received information about the U.S. Government's ongoing investigation of the loss of information about the W-88 Trident D-5 thermonuclear warhead design.

During the PRC's 1992 to 1996 series of advanced nuclear weapons tests, a debate began in the U.S. Government about whether the PRC had acquired classified U.S. thermonuclear weapons design information. The Department of Energy began to investigate. In 1995, following the CIA's receipt of evidence (provided by the PRC-directed "walk-in") that the PRC had acquired technical information on a number of U.S. thermonuclear warheads, including not only the W-88 Trident D-5 but five other warheads as well, the Department of Energy's investigation intensified. That investigation, however, focused on the W-88 and not the other weapons.

Early in its investigation, the Department of Energy cross-referenced personnel who had worked on the design of the W-88 with those who had traveled to the PRC or interacted with PRC scientists. One individual who had hosted PRC visitors in the past emerged from this inquiry as a suspect by the spring of 1995.

Even after being identified as a suspect, the individual, who still had a security clearance, continued to work in one of the most sensitive divisions at Los Alamos National Laboratory, Division X, which handles thermonuclear weapons designs and computer codes. In this position, the suspect requested and received permission to hire a PRC graduate student who was studying in the U.S. for the summer.

In December 1998, the suspect traveled to Taiwan. Following his return from Taiwan in December 1998, he was removed from Division X.

The FBI initiated a full investigation in the middle of 1996, which remains ongoing. At the date of the Select Committee's January 3, 1999 classified Final Report, the suspect continues to work at the Los Alamos National Laboratory, and continues to have access to classified information.

The FBI investigation of this suspect's possible involvement in the theft of classified design information on the W-88 warhead and other matters is ongoing.

The Clinton administration has determined that further information on this matter cannot be disclosed publicly.

Investigation of Additional Incidents

The Select Committee reviewed one case that offers a troublesome example of the manner in which scientific exchanges in the PRC can be exploited for espionage purposes. The incident involved the inadvertent, bordering on negligent, disclosure of classified technical information by a U.S. scientist lecturing in the PRC.

The U.S. scientist, who was representing a U.S. National Laboratory during a lab-to-lab exchange with a PRC laboratory, was pressured by PRC counterparts to provide a solution to a nuclear weapons-related problem. Rather than decline, the scientist, who was aware of the clear distinction between the classified and unclassified technical information that was under discussion, provided an analogy. The scientist immediately saw that the PRC scientists had grasped the hint that was provided and realized that too much had been said.

The PRC employs various approaches to co-opt U.S. scientists to obtain classified information. These approaches include: appealing to common ethnic heritage; arranging visits to ancestral homes and relatives; paying for trips and travel in the PRC; flattering the guest's knowledge and intelligence; holding elaborate banquets to honor guests; and doggedly peppering U.S. scientists with technical questions by experts, sometimes after a banquet at which substantial amounts of alcohol have been consumed.

On average, the FBI has received about five security-related referrals each month from the Department of Energy. Not all of these concern the PRC. These referrals usually include possible security violations and the inadvertent disclosure of classified information.

The FBI normally conducts investigations of foreign individuals working at the National Laboratories.

The Clinton administration has determined that additional information in this section cannot be publicly disclosed.

The Department of Energy's Counterintelligence Program at the U.S. National Weapons Laboratories

With additional funds provided by Congress in 1998, the Department of Energy is attempting to reinvent its counterintelligence programs at the U.S. national weapons laboratories to prevent continued loss of information to the PRC's intelligence collection activities.

Funding for the Department of Energy's counterintelligence program, including seven employees at the Department of Energy's headquarters, was $7.6 million in Fiscal Year 1998. For Fiscal Year 1999, Congress has increased that amount to $15.6 million.

With the support of the Director of Central Intelligence and the Director of the Federal Bureau of Investigation, the President issued Presidential Decision Directive 61 (PDD-61) in February 1998. PDD-61 requires that a senior FBI counterintelligence agent be placed in charge of the Department of Energy's program, which has been done.

PDD-61 also instructed that a counterintelligence report with recommendations be presented to the Secretary of Energy. The report was submitted to the Secretary on July 1, 1998, with 33 specific recommendations. The Secretary had 30 days to respond to the National Security Council. However, due to the transition from Secretary Pena to Secretary Richardson, the response was delayed. In late November 1998, the Secretary of Energy approved all substantive recommendations. In December 1998, the Directors of the U.S. National Laboratories agreed to the counterintelligence plan during a meeting with the Secretary of Energy. The Department of Energy is now implementing the plan.

The Secretary's action plan instructs the Directors of the U.S. National Laboratories to implement the recommendations. It directs the Department of Energy's Office of Counterintelligence to fund counterintelligence positions at individual laboratories so that they work directly for the Department of Energy, not the contractors that administer the laboratories.

The Department of Energy will create an audit trail to track unclassified computer use and protect classified computer networks. The action plan also directs the creation of counterintelligence training programs and a counterintelligence analysis program.

The Department of Energy will also implement stricter requirements for reporting all interactions with foreign individuals from sensitive countries, including correspondence by e-mail. Laboratory Directors will be responsible for scrutinizing foreign visitors, in coordination with Department of Energy's Counterintelligence Office.

The Department of Energy will require counterintelligence polygraphs of those who work in special access programs (SAP) and sensitive areas with knowledge of nuclear weapons design, or actually have hands-on access to nuclear weapons (about 10 percent of the total cleared population within the Department of Energy). Such persons will also undergo financial reviews and more rigorous background investigations conducted through local field offices of the FBI.

The FBI reportedly has sent several agents to the Department of Energy in the last 10 years to try to improve the counterintelligence program, but has repeatedly been unsuccessful. A significant problem has been the lack of counterintelligence professionals, and a bureaucracy that "buried" them and left them without access to senior management or the Secretary of Energy. The Department of Energy's new Counterintelligence Director now has direct access to the Secretary.

After traveling to the laboratories and interviewing counterintelligence officials, the Department of Energy's new Counterintelligence Director reported in November 1998:

> *The counterintelligence program at DOE [the Department of Energy] does not even meet minimal standards ... there is not a counterintelligence [program], nor has there been one at DOE [the Department of Energy] for many, many years.*

The Department of Energy's counterintelligence program requires additional training, funding, and accountability, according to this counterintelligence official.

At present, the Department of Energy's background investigations are conducted by an Office of Personnel Management contractor. The new Director's opinion is that the present background investigations are "totally inadequate" and "do [not] do us any good whatsoever."

Another problem area is that the Department of Energy's counterintelligence process presently does not have any mechanism for identifying or reviewing the thousands of foreign visitors and workers at the U.S. national weapons laboratories. On one occasion reviewed by the Select Committee, for example, scientists from a U.S. National Laboratory met foreign counterparts in a Holiday Inn in Albuquerque, New Mexico, in order to circumvent their laboratory's security procedures.

One responsibility of the Department of Energy's new counterintelligence program will be to find out who visits the laboratories, including those from sensitive countries, what they work on while they visit, and whether their access is restricted to protect classified information. Mechanisms have been recommended to identify visitors and fully vet them. The Department of Energy will attempt to improve the database used for background checks.

Classified information has been placed on unclassified networks, with no system for either detection or reliable prevention. There are no intrusion detection devices to determine whether hackers have attacked the Department of Energy's computer network. According to damage assessments reviewed by the Select Committee, however, attacks on the computers at the U.S. national weapons laboratories are a serious problem. E-mail is also a threat: the U.S. national weapons laboratories cannot track who is communicating with whom. For example, over 250,000 unmonitored e-mails are sent out of the Sandia National Laboratory alone each week.

In the year 2000, the Department of Energy will concentrate on increasing its analytical and investigative capabilities. Until at least the year 2000, the Department of Energy's counterintelligence program will not be adequate.

The five U.S. National Laboratories (Lawrence Livermore, Los Alamos, Oak Ridge, Sandia, and Pacific Northwest) are the primary focus of the counterintelligence plan. The Department of Energy is hiring senior counterintelligence experts who will report directly to the Directors of these laboratories.

Many of the specific recommendations in the Presidential Decision Directive are not new, and similar changes have been attempted unsuccessfully before.

Notification of the President and Senior U.S. Officials

In response to interrogatories from the Select Committee, the National Security Advisor testified in writing that the President did not learn about the issue of successful PRC espionage at the U.S. national weapons laboratories and long-term counterintelligence problems at the Department of Energy until early 1998.[13]

The Department of Energy briefed the Secretary of Energy about the matter in late 1995 and early 1996.

The Department of Energy first briefed the Deputy National Security Advisor in April 1996.

The Department of Energy briefed the Director of Central Intelligence, the Director of the FBI, the Secretary of Defense, and the Attorney General during this period.

The Department of Energy has not briefed the Secretary of State or the Secretary of Commerce. The Congress was not fully briefed until late 1998, as a result of the efforts of the Select Committee.

Associated Press

Samuel (Sandy) R. Berger, National Security Advisor, originally told the Select Committee that he briefed President Clinton about the theft of U.S. nuclear information in early 1998. Later, in May 1999, as part of the declassification process to make this report publicly available, Berger advised the Select Committee that the President was briefed in July 1997, although no written record of this meeting exists.

HIGH PERFORMANCE COMPUTERS

High Performance Computers (HPCs) are important for many military applications and essential for some. Although there is limited information on how the PRC is using HPCs for military applications, HPCs could facilitate many of the PRC's military modernization objectives.

PRC organizations involved in the research and development of missiles, spacecraft, submarines, aircraft, military system components, command and control, communications, and microwave and laser sensors have obtained HPCs from the United States. Given the lack of a proven and effective verification regime, it is possible that these HPCs have been diverted for unauthorized uses, which could include the following:

- **Upgrading and maintaining nuclear and chemical weapons**
- **Equipping mobile forces with high-technology weapons**
- **Building a modern fleet of combat and combat-support aircraft and submarines**
- **Conducting anti-submarine warfare**
- **Developing a reliable, accurate ballistic and cruise missile force**
- **Equalizing a battlefield with electronic or information warfare**
- **Improving command, control, communications, and intelligence capabilities**

To realize the full potential of the acquired HPCs, the PRC must be able to perform system integration, develop or procure application software, obtain weapon systems test data, and institute quality-controlled production processes. The contribution of HPCs to military modernization is also dependent on related technologies such as telecommunications and microelectronics.

The Select Committee judges that the PRC has been using high performance computers for nuclear weapons applications. The computer workstations recently acquired from the U.S. represent a major increase in the PRC's computing power. Although not necessary to design nuclear warheads, HPCs of 2,000 million theoretical operations per second (MTOPS) or more can be used for such applications. In addition to nuclear weapons design, another major concern is how the PRC can use U.S. HPCs to improve and maintain its nuclear weapons.

If the PRC complies with the Comprehensive Test Ban Treaty, then its need for HPCs to design, weaponize, deploy, and maintain nuclear weapons will be greater than that of any other nation, according to the U.S. Department of Energy. The exact extent to which HPCs can assist the PRC depends in part on the goals of the PRC nuclear weapons program and the degree of uncertainty it is willing to accept in warhead performance.

HPCs are useful to the two- and critical to the three-dimensional computer modeling that is necessary for the PRC to develop, modify, and maintain its nuclear weapons in the absence of testing. The utility of such modeling depends on the amount of data available from tests, the computing capacity that is available, and programmer expertise. Complete three-dimensional models, critical to stockpile maintenance and assessment of the effect of major warhead modifications in the absence of testing, require HPCs of one million MTOPS or more. Assessing the effects of a new warhead without testing would require three-dimensional modeling. In the absence of physical testing, two dimensional models are important for estimating the effects of less substantial changes to warhead designs, although the utility of such modeling decreases as the designs become more sophisticated. However, the fidelity of any two-dimensional model is inherently limited, and some level of uncertainty will always remain. Should the PRC resume physical (rather than virtual) nuclear testing, the resulting data would permit more accurate two-dimensional modeling of subsequent design changes. Although HPCs in the 2,000 to 10,000 MTOPS range are useful for such modeling, their precise utility for such applications is unclear. These HPCs may be powerful enough to help the PRC make use of design information that it stole from the United States, including design information for the

W-70 neutron bomb and the W-88 Trident D-5 thermonuclear warhead — without further physical testing.

The U.S. Government, citing rapid advances in computer technology, has steadily relaxed export controls on HPCs. A Stanford University study commissioned by the U.S. Government was a key element in the relaxation of export controls on HPCs in 1996. The study concluded that U.S.-manufactured computer technology between 4,000 to 5,000 MTOPS was uncontrollable worldwide and would become available worldwide at 7,000 MTOPS by 1997. The study also concluded that many HPC applications used in U.S. national security programs occur at about 7,000 MTOPS and at or above 10,000 MTOPS. Criticisms of this and other studies that were used to justify the 1996 HPC export control policy changes focus on flaws in the methodology of the studies and the lack of empirical evidence and analysis to support their conclusions. These critics also claim that the U.S. Government revised the export controls on HPCs without having adequate information on how countries of concern would use HPCs for military and proliferation activities.

Until June 1998, the U.S. Government's ability to verify the location and use of HPCs in the PRC was blocked by the PRC's resistance to post-shipment, on-site verification visits. A new agreement affords the U.S. Government the right to request access to some American HPCs, but includes substantial limitations on such requests and any visits. Moreover, the post-shipment visits that are allowed can verify the location of an HPC, but not how it is used.

Rapid advances in computer technology have altered traditional concepts of what constitutes an HPC. Observers in the computer industry and academia state that HPC-level performance can be obtained by linking together inexpensive commodity processors. For some applications the efficiency and effectiveness of the linked commodity processors depends on the application, skill of the programmer, and interconnection software. The resources and time needed to effectively modify and operate significant defense applications for such linked systems have not yet been demonstrated. Nonetheless, the U.S. is pursuing research and development on the use of linked systems for three-dimensional modeling for nuclear stockpile maintenance.

While it is difficult to ascertain the full measure of HPC resources that have been made available to the PRC from all sources, available data indicates that U.S. HPCs dominate the market in the PRC and there really is no domestic PRC HPC industry. While the PRC has a large market for workstations and high-end servers, there is a smaller market for parallel computers that is entirely dominated by non-PRC companies such as IBM, Silicon Graphics/Cray, and the Japanese NEC. However, there continues to be significant market resistance to Japanese HPC products in Asia, especially as U.S. products are beginning to have significant market penetration. The PRC has assembled several HPCs in recent years, using U.S.-origin microprocessing chips. The latest such HPC may perform at 10,000 MTOPS. However, the PRC's HPC application software lags farther behind world levels than its HPC systems.

Since the 1996 relaxation of U.S. export controls on HPCs, U.S. sales of HPCs between 2,000 and 7,000 MTOPS to the PRC have burgeoned. Of computers not requiring licenses under the 1996 regulations, 23 HPCs in this performance range were exported in 1996 and 123 in 1997. An additional 434 HPCs were to be exported in the first three quarters of 1998. Between 1994 and 1998, the U.S. Government approved licenses for 23 HPCs greater than 2,000 MTOPS.

Thus, the PRC may have received a total of 603 U.S. HPCs since 1996. In 1998, the United States approved licenses for two HPCs in excess of 10,000 MTOPS. Approximately 77 percent of the U.S. HPCs that have been exported to the PRC were under 4,000 MTOPS.

The aggregate of these computational resources is complemented by millions of non-export controlled low-end machines – about 4.5 million desktops, portable personal computers, personal computer servers, and workstations in 1998 alone. Ninety percent of these machines are being used by the PRC Government, industry, and educational institutions. About 60 percent of these machines are being produced by PRC companies.

HIGH PERFORMANCE COMPUTERS

High Performance Computers (HPCs) are useful in a broad range of applications. These include pharmaceutical development, automobile crash modeling, aerospace engineering, petrochemical research, financial market and credit analysis, weather prediction, academic research, and national security applications.

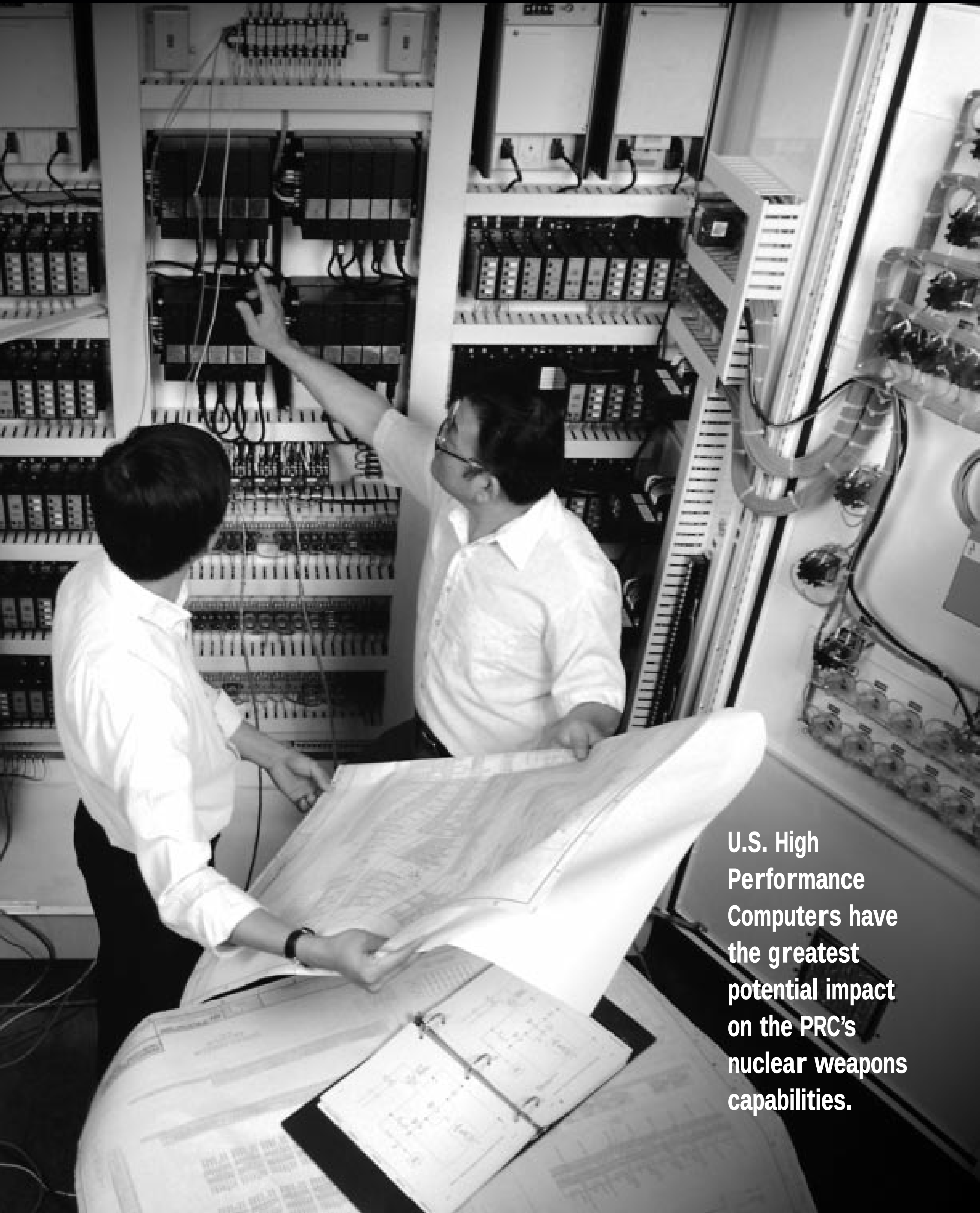
A recent report by the Defense Department defines high performance computers as:

> *the mid-range of the speed scale. These computers are used for internet servers, Local Area Network (LAN) servers, affordable number crunchers, Computer Aided Design (CAD)/Computer Aided Manufacturing (CAM), publishing, billing, databases, data mining, banking, and much more. Presently these computers are in the speed range of 1500 — 40,000 Millions of Theoretical Operations Per Second (MTOPS).*[1]

Current U.S. export controls define HPCs by establishing the threshold for license consideration at 2,000 or more MTOPS.

In the realm of national security, HPCs are valuable in the design, development, manufacturing, performance, and testing of weapons and weapons platforms. These systems include:

- **Nuclear, chemical, and biological weapons**
- **Tactical aircraft**
- **Cruise and ballistic missiles**
- **Submarines**
- **Anti-submarine warfare**
- **Command, control, and communications**
- **Information warfare**



U.S. High Performance Computers have the greatest potential impact on the PRC's nuclear weapons capabilities.

HPCs are also useful in the collection, processing, analysis, and dissemination of intelligence and in the encryption or decryption of communications.[2]

In addition, military applications such as target tracking and recognition, radar mapping, armor and anti-armor design, protective structures, aerodynamics, real-time modeling, and tactical weather prediction are substantially facilitated by the use of HPCs.[3]

While a broad array of potential applications for HPCs is known, the specific ways in which potential adversaries of the United States are using them is much harder to determine. For example, a 1998 study of the viability of U.S. export controls on HPCs stated:

> *It is difficult to acquire good information on the use of HPC[s] for national security-related applications by countries of national security concern. This is true whether one assumes foreign practice is the same as U.S. practice, or foreign practice involves different or more clever ways that might not have the same computing requirements.*[4]

In short, there is limited information about how specific countries of national security concern, including the PRC, use HPCs.[5]

Another complicating factor in determining whether and how HPCs are being used by the PRC and others for national security applications is ambiguity as to the HPC performance minimally required for specific applications. Researchers are usually interested in improving their applications if they have access to more computing power. Therefore, the "bigger and faster" computers are, the better. Speed helps make optimum use of a researcher's time.[6] Many computer programs can be executed on less capable computer hardware, although there may be penalties in level of detail and turnaround time.[7]

The requirement to use the most powerful computers available may also be closely related to program economics.[8] The use of less powerful computers leads to longer processing runs. This situation leaves expensive people and facilities idle, making the purchase of an expensive HPC necessary to employ all the resources available efficiently.[9]

There are many potential national security applications for which the PRC could use HPCs. The following figure[10] shows that the U.S. defense community uses HPCs for national security applications over a full range of MTOPS performance levels. Although nearly 44 percent of the applications currently being run in the U.S. defense community are being run at performance levels below 7,000 MTOPS, many critical applications require processing power in excess of that threshold. The relative importance of the national security applications cannot be ascertained based on the MTOPS requirement.[11] As newer computer systems with increased performance become available to the market, an increasing number of applications will appear in the higher MTOPS range (that is, above 30,000 MTOPS).[12] These applications will be similar to current applications, but will require greater resolution or ability to address larger-sized problems than is possible on current systems.[13]

Millions of Theoretical Operations Per Second (MTOPS) Range	Number of Current U.S. Department of Defense HPC Applications
Less than 2,000	61
2,000 to 7,000	24
7,000 to 10,000	8
10,000 to 20,000	30
20,000 to 30,000	47
Above 30,000	22

U.S. HPCs recently sold to PRC organizations are useful for a number of military purposes including:

- **Information warfare**
- **Cryptography**
- **Military command and control**
- **Intelligence collection**
- **Intelligence instrument research and development**
- **Development of high technology**
- **Ballistic and cruise missiles**
- **Ballistic missile defense**

- **Mobile force development**
- **Designing submarine nuclear reactors**
- **Combat simulation**

These PRC organizations are engaged in governmental, military, academic, and commercial work. In the absence of an end-use verification regime, the United States has no means of determining to what use a particular HPC is applied by such PRC organizations.

Military Objectives Contribute to the PRC's Interest in High Performance Computers

PRC military objectives require superior battlefield management, including:

- **Intelligence**
- **Surveillance**
- **Reconnaissance**
- **Guidance and control**
- **Communications**

They also require superior weapons and platform design, testing, and maintenance. Satisfying these requirements can be facilitated by HPC capabilities.[14]

The PRC is seeking HPC software for:

- **Satellite launch and missile guidance simulation**
- **Computer assisted design and manufacturing systems**
- **System simulators**
- **Applications of artificial intelligence**[15]

The PRC is convinced that the United States has the most advanced HPC technology. Thus, it seeks to acquire as much of it as it can without jeopardizing PRC national security interests by, for example, becoming susceptible to computer viruses and information attacks.[16]

The specific ways the PRC is using HPCs for military applications is difficult to determine.[17] During this investigation, reports regarding the PRC's military objectives, information concerning the application of HPCs in support of national security objectives, and data concerning HPC sales to the PRC were analyzed.

The results of this analysis provide a basis for assessing the risk to U.S. national security and regional security interests that accrues from the PRC's acquisition of HPCs. This assessment is summarized in the following paragraphs.

U.S. High Performance Computers Have the Greatest Potential Impact On the PRC's Nuclear Weapons Capabilities

The Department of Energy judges that the PRC's acquisition and application of HPCs to nuclear weapons development have the greatest potential impact on the PRC's nuclear program. This is particularly true since the PRC has agreed to the ban on nuclear testing.[18]

Existing PRC Nuclear Weapons

The computing power required to simulate the performance of a specific nuclear weapon depends on the sophistication of the design, and the availability of nuclear and non-nuclear test data for the new and aging materials the weapon contains.[19]

For existing weapons with supporting test data, more powerful computing resources allow simulations that include more physical processes and more fundamental representations.[20]

One means of enhancing model fidelity — the extent to which the model accurately represents the real phenomena — is to represent all dimensions of the process being modeled.

The explosion of a nuclear weapon is a three-dimensional process that cannot be accurately represented in one or two dimensions. Augmenting model fidelity by shift-ing from two to three dimensions requires an increase in computer performance capacity to one million MTOPS.[21]

Results from higher-fidelity models allow scientists and decision-makers to develop a better estimation and understanding of the reliability and performance of the weapon.[22]

Another factor bearing on model fidelity and confidence in model results is the extent to which the model has been validated. Validation consists of running a simulation of a previously conducted test, and verifying that the computed results are close to the test results. The more the simulated situation differs from the actual test, the less confidence can be placed in the computed results.[23]

The fewer the tests that have been conducted, the more gaps there are in the understanding of nuclear weapons science.[24]

HPCs may help scientists gain insight and understanding by allowing many simulation runs to be conducted, changing one variable value at a time to create a range of solutions for comparison to test data. HPCs allow those calculations to be completed in an acceptable length of time.[25]

The following table illustrates HPC performance demand as a function of model complexity, test data, and weapons maturity. Row 1 of the table focuses on a full exploration of the weapons design category with data from tests of pristine and aged weapons. Row 2 of the table assumes the number of tests dedicated to each warhead class is between one and six. Row 3 assumes few proof-of-concept tests or zero nuclear tests conducted of the design after components have aged for ten years.

High Performance Computer Requirements for Various Levels of Testing and Nuclear Weapons Program Maturity[26]

	Rudimentary Nuclear Weapons	Intermediate Nuclear Weapons	Advanced and Aging Nuclear Weapons
With Test Data	200-400 MTOPS *US, UK, France, Russia, PRC*	200-400 MTOPS *US, UK, France, Russia*	400-10,000 MTOPS *US, UK, France, Russia, PRC**
With Some Test Data	400-1,000 MTOPS *No country*	1,000-4,000 MTOPS *PRC, India, Pakistan*	4,000-1,000,000 MTOPS *PRC†*
Without Test Data	400-4,000 MTOPS *North Korea*	4,000-10,000 MTOPS *Israel*	>1,000,000 MTOPS *PRC†*

* If PRC has obtained U.S. or Russian nuclear test codes.

† The PRC is known to possess some test data for certain advanced nuclear weapons, but may be without test data for others.

As the table indicates, the PRC's demand for HPCs covers a broad range of computing capability, and it is unclear where the PRC's requirements fall within that broad range.

To date, the most powerful HPCs exported to the PRC from the U.S. — two in 1998 — have been at the 10,000 MTOPS level.

Even HPCs in the 2,000 to 10,000 MTOPS range are useful for nuclear weapons applications, although their precise utility is dependent on the amount of test data the PRC possesses.

New PRC Nuclear Weapons

The PRC's nuclear weapons program has advanced rapidly, largely through the theft of U.S. nuclear weapons design information.

Originally, the PRC built large, heavy nuclear weapons for air or missile delivery. The PRC is now moving to new generation nuclear weapons, and has been significantly assisted by the theft of U.S. design data. These new nuclear weapons are smaller, lighter, and have higher yield-to-weight ratios.[27] The Select Committee judges that the PRC has the infrastructure and ability to use the stolen U.S. design information to emulate elements of U.S. thermonuclear warheads for its next generation of thermonuclear warheads.

HPCs could be valuable to the PRC in connection with the production of these next generation nuclear weapons based on elements of U.S. design information, because they would enable scientists to examine many values for many uncertainties quickly.[28]

Similarly, HPCs could be useful in connection with maintaining the current PRC nuclear weapons stockpile for which test data exist, although the exact MTOPS range needed is uncertain. HPCs would permit analysis of any uncertainty with respect to the performance of these weapons.[29]

In addition, as military missions evolve and delivery platforms develop, the PRC may be forced to make modifications in tested designs to accommodate new size and weight goals. For example, a PRC focus on small-scale regional conflict would suggest the development of compact, low-yield nuclear devices. Evaluating the effects of these design changes would require sophisticated computer models run on HPCs. If the changes to the PLA's nuclear weapons are significant, the need for modeling accuracy would require three-dimensional testing, possible only with computers that have a performance capability of a million MTOPS or more. For less extensive changes, including any changes required to weaponize new nuclear warhead designs that the PRC has already successfully tested, two-dimensional modeling may be sufficient. HPCs as low as 2,000 to 7,000 MTOPS are helpful in such applications, although the optimal MTOPS level required for such modeling is unclear.

Nuclear Weapons Stockpile Stewardship

Assuming compliance with the Comprehensive Test Ban Treaty, the designers of new or modified PRC nuclear devices will have to certify the performance of aging weapons by using a combination of treaty compliant experiments and computer simulations.[30]

Identifying, predicting and mitigating the effects of aging on nuclear weapons is computationally intensive, requiring three-dimensional modeling and simulation involving many uncertainties. For the PRC, the computing demands are even greater because of the limited amount of nuclear test data to support the modeling.

Thus, HPCs at high MTOPS levels would be particularly useful in helping explore many values for many variables quickly.[31] As the United States is finding with its Stockpile Stewardship Program, maximum HPC performance in the range of millions of MTOPS is necessary for three-dimensional modeling of the aging of nuclear weapons.

For this reason, the Select Committee judges that the PRC is almost certain to use U.S. HPCs to perform nuclear weapons applications. Moreover, the PRC continues to seek HPCs and the related computer programs (known as codes) for these applications.

The U.S. national weapons laboratories are currently modernizing their test data or "legacy codes" based on data from the large number of U.S. tests. The Select Committee judges that if the PRC were to acquire nuclear test codes and data from the United States, then the PRC could access empirical data from the large number of U.S. tests that were conducted before the Comprehensive Test Ban Treaty.

The possession of stolen U.S. test data would greatly reduce the level of HPC performance required.

It is also likely that the PRC seeks access to the Los Alamos National Laboratory-based Dual Axis Radiographic Hydrodynamic Test Facility, for the reason that it uses powerful X-rays to analyze the effects of implosions during non-nuclear tests.

The PRC is also likely to seek information regarding the use of lasers for high energy density studies.

Transfer of HPC Technology Can Benefit PRC Intelligence Capabilities

The PRC is improving its capabilities in intelligence collection and unmanned aerial vehicles. The PRC is also a user of encryption technology in its government networks.[32] HPCs are useful in the design and operation of intelligence collection platforms, including unmanned aerial vehicles, and are essential to running the computer codes that process intelligence data and perform encryption tasks.

Sensors for Surveillance, Target Detection, and Target Recognition

Radars, acoustic and non-acoustic sensors, and signal and image processing appear to be continuing targets for acquisition by the PRC.[33]

Based on U.S. experience, HPCs can be used to facilitate research and development of sensors for surveillance, target detection, and target recognition. Use of HPCs in this manner results in sensor systems that are more capable of detecting stealthy platforms, such as aircraft, missiles, and submarines.[34]

In the design phase, these applications can be computationally intensive, depending upon the level of realism required. For example, U.S. computational requirements range from 500 to over 40,000 MTOPS.[35]

Also, many of the resultant systems require HPCs and advanced software for their operation. For example, a deployed X-band phased-array radar for ballistic missile search, fire control, and kill assessment requires an HPC to control the radar, detect, identify, and track targets, and compute fire control solutions of multiple high-speed targets.[36]

In general, timely detection of targets using radar requires homogeneous, tightly coupled systems. The radar system functions by creating images of remote objects and processing the resulting images for review by humans or input into automated guidance or decision support systems. This operation is computationally intensive since large volumes of data must be filtered, enhanced, and interpreted, often in real time.[37]

In the United States, some radar processing applications — for example, the processing of data from synthetic aperture radars — require 32,000 to 115,000 MTOPS.[38] Although less capable computers may be useful for these applications, they are not suitable for operational environments that require real-time detection of targets with weak radar signatures, or target discrimination in high target-density environments. Further, radar system performance requires high-quality target templates and empirical validation, in addition to HPC processing speed.[39]

Sensor Platforms for Aerial and Space-Based Reconnaissance

The PRC is interested in acquiring unmanned aerial vehicles (UAVs) that are used for day/night aerial reconnaissance, battlefield surveillance, target positioning, artillery spotting, border patrol, nuclear radiation sampling, and aerial photography.[40]

The HPC challenge is to provide a sufficient on-board-sensor data processing capability to allow wide-area searches at high resolution, while minimizing communications requirements.[41]

Satisfying such sensor data processing requirements could also be of value to the PRC's efforts to improve space-based information gathering capabilities.[42]

Cryptology

Another potential application of HPCs by the PRC is cryptology — the design and breaking of encoded communications. This application demands fast processing, and the ability to handle large amounts of data. As a point of reference, the U.S. National Security Agency uses some of the highest performance computers available. However, significant cryptologic capabilities can be achieved through the use of widely available computer equipment, such as networked workstations or parallel processors.[43]

Transfer of High Performance Computer Technology To the PRC Could Contribute to the Manufacture of Weapons of Mass Destruction, Missiles, and Other Weapons

While there is little information regarding the specific ways that HPCs are being used in the PRC to achieve military objectives,[44] open source reporting and stated PRC military modernization goals tend to support the belief that the PRC could be using HPCs in the design, development, and operation of missiles, anti-armor weapons, chemical and biological weapons, and information warfare technologies.[45]

Missiles

The PRC is developing advanced cruise missiles, anti-ship missiles, and conventional short-range ballistic missiles (SRBMs).

While the PRC could design, for example, a stealthy cruise missile without using HPCs, HPCs facilitate the design of such weapons, particularly in exploring guidance and stealth concepts.[46] For instance, the Beijing Simulation Center is using hardware-in-the-loop testing in the development of homing guided missiles. Given that such testing involves near real-time processing, HPCs are particularly useful.[47]

The PRC is also developing new tanks, and new multiple-launch rocket systems. HPCs are useful for executing the detailed, physics-based simulations of weapons effects. Such simulations are useful in assessing the effectiveness and vulnerabilities of these new systems. The calculations are complex, and HPCs are required for efficient processing.[48]

Chemical and Biological Weapons

The PRC has mature chemical and biological weapons programs that have produced a variety of chemical and biological agents since the 1960s. Such weapons could serve deterrent, retaliatory, or offensive purposes.[49]

Computer-aided design and computer-aided manufacturing (CAD/CAM), a classic use of HPCs, would be useful in planning and designing the integration of chemical warfare agent development processes with chemical industries.[50] This possibility is consistent with papers published by PRC scientists concerning chemical and manufacturing processes.[51]

The PRC can deliver chemical and biological agents with a variety of weapons systems, including missiles and artillery. Since the PRC can employ a variety of delivery means for such agents, key operational considerations for the PRC include how dispersion patterns vary as a function of delivery method and weather. This is a computationally demanding area in which HPCs are extremely useful.

The Select Committee concludes from evidence it has received that the PRC is interested in HPC modeling of dispersion patterns of chemical and biological weapons based on different weapons delivery systems and varying weather conditions.[52] In addition, the PRC could be employing HPCs to model the negative effects on the opponent of casualties, and of cumbersome protective gear for a given dispersion pattern of chemical and biological weapons.[53]

Finally, the PRC may also be using HPCs to design chemical agent detection sensors and protective measures. Such applications can require computational power ranging from 2,000 to 30,000 MTOPS.[54]

Information Warfare

Several PRC scholars and leading military strategists indicate that the PRC has an ambitious, albeit nascent, offensive information warfare program. Currently, the PRC's primary focus for information warfare is military conflict. Concluding that information is becoming a key determinant of military power and victory in war, the PRC has identified the development of information warfare capabilities as a key modernization goal of the PLA.

> *The PRC should . . . fully bring into play the guiding role of information warfare research in building the military and seek measures by which to launch vital strikes in future warfare, so as to damage the enemy's intelligence gathering and transmission abilities, and weaken the enemy's information warfare capacity.*[55]

HPCs could prove valuable to the PRC in the evolution of this strategy by exploring U.S. information networks and their vulnerabilities, and the technologies that are associated with information warfare such as jammers, microwave weapons, and anti-satellite weapons.[56]

Transfer of High Performance Computer Technology To the PRC Could Support Attainment Of Other PRC Military Objectives

The effectiveness of military operations depends heavily on support functions that include:

- **Command, control, and communications**
- **Weather prediction**
- **Cartography**
- **Combat forces training**[57]

HPCs can be used to enhance all of these functions.

In military operations, size, weight, and power consumption limitations are all stressing requirements that may necessitate the use of customized or embedded HPCs, rather than commercially available systems.[58]

Command, Control, and Communications

Leading PRC military strategists and political/military scholars in the PRC have publicly recommended that the PLA give high priority to the development of improved automated command, control, and communications networks.[59]

The recommendations include:

- **That the command, control, and communications system at and above the battalion level of various service arms be turned into an integrated mutually linked network**
- **That the traditional vertical and tiered command system be converted into a network command structure, in order to meet the demands of time and flexibility in command**

- **That the centralized type command system should be developed into a dispersed command**[60]

Another PRC writer has stated that multi-dimensional interconnected networks on the ground, in the air (and outer space), and underwater — as well as terminals, modems, and software — are not only instruments, but also weapons.[61]

The PLA has begun research on the technologies necessary to develop an Integrated Battlefield Area Communications System.[62] In addition, research is underway on related subjects such as real-time intelligent decision-making for fighter aircraft maneuver simulation systems.[63]

Full implementation of these goals will require exceptional computational power. However, this power can be efficiently provided by distributed computer systems.[64] Battle management functions are also readily scalable, making them suitable for initial implementation on commercially available computer equipment.

Meteorology for Military Operations

Weather modeling and prediction is essential in military operations in that it effects force deployments, protection against chemical, biological, and nuclear environments, weapons effectiveness, and logistics.[65]

While a typical global weather model with 75-mile resolution can be executed on a workstation with performance in the 200 MTOPS range, typical tactical weather models with 30-mile resolution require computers rated in excess of 10,000 MTOPS. Calculation of weather forecasts in littoral areas to resolve complex air-ocean interactions is even more demanding.[66]

Cartography for Military Operations

Depending on the perceived requirements of military commanders, cartography requires high computational levels. For instance, processing topographic data in a timely manner to support military operations may require up to 24,000 MTOPS. For military planning purposes in which time is not a factor, cartographic applications can be accomplished at lower MTOPS levels — less than 4,600 MTOPS — and computer hardware can be selected based on cost rather than speed and memory capacity.[67]

Military Training Systems

Research underway at the PRC's Harbin Institute of Technology indicates the PRC is focused on large-scale training systems.[68] The computer performance requirements in this regard depend on the level of fidelity that is needed, the complexity of the training objectives, and the time that is available. For training objectives that require realism and representation of large-scale forces, HPC performance may exceed 10,000 MTOPS.[69]

National Security Implications of High Performance Computer Use by the PRC Military

The Select Committee judges that the PRC is attempting to achieve parity with U.S. systems and capabilities through its military modernization efforts. The PRC intends by this effort to increase its regional power projection capabilities and augment its ability to hold the neighboring countries of Taiwan, India, and Japan at risk.

The PRC's use of HPCs for its military modernization poses risks to U.S. national security. Significant improvements in PRC information warfare and military operations may increase the threat to U.S. military systems and personnel in a way that cannot be easily countered.[70] HPCs of varying capability could assist the PRC in this endeavor.[71]

Further, the PRC is likely to modernize its nuclear arsenal, with the help of HPCs. In this regard, it is believed that, if the PRC maintains its current path, it will still be a second-class nuclear power compared to the United States and Russia for the next several decades. However, if Washington and Moscow were to reduce their nuclear forces to about 1,000 warheads, as President Yeltsin has suggested, the PRC could conceivably expand its nuclear forces in an attempt to reach numerical parity.

The PRC's continuing chemical and biological weapons programs, and improvement of weapons delivery platforms such as cruise missiles, may also be the beneficiaries of increased HPC capability. Continued development or use of chemical or biological weapons by the PRC could have serious strategic and tactical implications for the United States.[72]

If it is to fully exploit HPC hardware capabilities for military applications, the PRC requires improved system integration, quality production processes, and development of doctrine and tactics.[73] The PRC also requires technologies that are interdependent with HPCs in military applications, such as telecommunications and microelectronics.

Control or monitoring of these HPC-related services and technologies may provide additional opportunities to influence the pace of the PRC's attainment of its military modernization objectives.

U.S. Export Policy Has Gradually Relaxed Controls on High Performance Computers

In 1988, exporters of HPCs were required to obtain a Department of Commerce license to export computers with a performance level — called a Composite Theoretical Performance (CTP) — of 12.5 MTOPS or more to most destinations. A supercomputer was defined as any computer with a performance level of 195 MTOPS or greater.[74]

Foreign policy controls were imposed on supercomputers performing at 195 MTOPS and higher in May 1992, based on a bilateral arrangement with Japan, the other major supercomputer-exporting country.[75]

As required by the Export Enhancement Act of 1992, the Trade Promotion Coordinating Committee submitted to Congress a report entitled "Toward a National Strategy" in September 1993.[76] That report presented a strategic plan that included as one key element changing the standard for a supercomputer from 195 MTOPS to 2,000 MTOPS.[77]

In February 1994, the Department of Commerce raised the licensing threshold for the export of supercomputers to most destinations from 195 MTOPS to 1,500 MTOPS or higher. At the same time, the United States announced that it had reached agreement with Japan, the other partner in the "supercomputer regime," regarding the new supercomputer definition of 1,500 MTOPS. The United States also announced that it would continue to seek Japan's agreement to further increase the supercomputer threshold to 2,000 MTOPS.[78]

In April 1994, the Department of Commerce established a new General License "GLX," which would allow certain shipments of any items, including computers up to 1,000 MTOPS that formerly required an individual validated license, to civil end users and nonproliferation end uses in formerly proscribed destinations, including the PRC. The purpose of the new general license was to reduce paperwork and licensing delays for exporters, while focusing controls on exports of "direct strategic concern." The Department of Commerce stated that it established the "GLX" designation to bridge the transition between the termination of COCOM in March 1994 and the establishment of a successor regime.[79]

In January 1995, the Department of Commerce again revised certain supercomputer requirements. Specifically, Commerce noted that it would conduct annual reviews of the supercomputer definition, threshold levels, safeguards, supercomputer country groupings, and supercomputer licensing requirements. The reviews would examine HPC controls in light of national security and proliferation concerns, technical advancements, and changes in market conditions, and would consider recommendations to revise the controls. The regulations included the following country requirements:

- **A "general license" — meaning no license required —** was available for all supercomputer exports to supplier countries, which then included only Japan
- **A validated license or re-export authorization was required to export, re-export, or transfer within the country** for: Australia, Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Spain, and the United Kingdom
- **In addition to a validated license or re-export authorization, a safeguard plan signed by the ultimate consignee, and a certification from the government of the importing country** (for supercomputers equal to or greater than 1,950 MTOPS) was required for several countries. These included Austria, Finland, Iceland, Mexico, Singapore, the Republic of Korea, Sweden, Switzerland, and Venezuela

- **A validated license or re-export authorization was required to export or re-export supercomputers to the PRC, and applications were generally to be denied.** In the event a license was issued, it would include among the licensing conditions certain safeguards selected from the security conditions listed in the Export Administration Regulations[80]

Some Reviews That Contributed to High Performance Computer Policy Changes in 1996 Have Been Criticized

On January 25, 1996, after the first periodic review, the Department of Commerce published revised controls for computers in the Export Administration Regulations and identified four computer country groups for export purposes. In announcing the January 1996 revision, the Executive branch stated that one goal of the changes was to permit the government to calibrate control levels and licensing conditions to the national security or proliferation risk posed at a specific destination.[81]

The Stanford Study

A key element of the 1995 Executive branch review of HPC export controls was a Stanford University study that was commissioned jointly by the Commerce and Defense Departments.[82] Among other things, the study was tasked to assess the availability of HPCs in selected countries, and the capabilities of those countries to use HPCs for military and other defense applications.[83] The study, released in November 1995, concluded:

- **U.S.-manufactured computer technology between 4,000 and 5,000 MTOPS** was widely available and uncontrollable worldwide

- **U.S.-manufactured computer technology up to 7,000 MTOPS** would become widely available worldwide and uncontrollable by 1997

- **Many HPC applications used in U.S. national security programs** occur at about 7,000 MTOPS and at or above 10,000 MTOPS[84]

The study also concluded that it would be too expensive for the U.S. Government and industry to maintain the effective control of computing systems with performance levels below 7,000 MTOPS. Further, the study stated that attempts to control computer exports below this level would become increasingly ineffectual, would harm the credibility of export controls, and would unreasonably burden a vital sector of the computer industry. The study also raised concerns about the ability of the U.S. Government to control HPC exports in the future, in light of advances in computing technology and its dispersal worldwide.[85]

However, the Stanford study had several methodological limitations. It lacked empirical evidence or analysis to support its conclusion that HPCs were "uncontrollable" given both worldwide availability and insufficient resources to control them. Neither the study nor the U.S. Government made estimates of these resources. Also, the study did not assess the capabilities of countries of concern to use HPCs for designated military and proliferation applications, even though that was required by the tasking.[86]

Seymour Goodman, one of the authors of the 1995 Stanford study, acknowledged that U.S. Government data were inadequate to make this assessment, and the study recommended that better data be gathered.[87] Furthermore, the study noted that data used from the High Performance Computing Modernization Office were not optimal for the study's purposes, although it stated that the data were sufficient to "conjecture" that the majority of national security applications were already possible at uncontrollable levels. Also, the study stated that time constraints did not allow a comprehensive review of defense applications.[88]

In addition to the Stanford study, Executive branch officials have said that they also relied on other analytical products as part of the HPC review process.[89] These included:

- **A Defense Department review of military applications**[90]
- **An August 1995 Institute for Defense Analyses (IDA) technical assessment of clustering computers**[91]
- **Defense-developed criteria for weapons of mass destruction proliferation behavior**[92]
- **Internet information related to the computer market**[93]

Some officials also referred to two 1995 Commerce Department studies on the worldwide "supercomputer" market and technology trends. These documents supported the conclusion that foreign availability of HPCs, especially in countries of proliferation concern, was limited in 1995, but that technology trends would make HPC technology more readily available throughout the world in the future.[94] As a result, it appeared that denying HPC access to proliferating countries in the next century would become increasingly difficult, and perhaps impossible.

Another factor that may have figured in the decision to relax HPC export controls is that the National Security Agency (NSA) — which had been quite active in the past in HPC controls, including reviewing Commerce license applications to the Commerce Department for exports of HPCs — changed its approach. Around 1993, the NSA began to ease its involvement in computer export controls. By 1995, NSA had moved away from its activities in the supercomputer area, and had backed out of the high performance computer export control debate entirely.

The stated justification for this change in policy was concern for the health of the U.S. computer industry and the industry's need for exports.

Defense Department Review of Military Applications for HPCs

Pentagon officials advised the General Accounting Office that there was no document that summarized the results of the Department of Defense review of military applications for HPCs.[95] One Defense Department official stated that these results were incorporated into the Stanford study.[96] An August 24, 1995 Defense Technology Security Administration (DTSA) memorandum summarized some general points of a Defense Department "Supercomputing Study" that reviewed military applications.[97] The DTSA memorandum concluded:

- **The maximum practical computing performance level available to Defense Department research laboratories** at the time was the Cray C90 vector computer at 21,000 MTOPS (for a full 16-processor configuration)

- **Massively parallel processors** provide higher composite theoretical performance, but not all of it is usable processing
- **High performance computing would play a critical role in the Defense Department's future plans to maintain technological superiority,** and the Cray vector computer was the primary computer used for the most computing-intensive applications
- **Researchers need high performance computing** to resolve significant problems in a reasonable time, and to reach effective conclusions rapidly regarding next steps to be taken
- **Massively parallel processors (such as the IBM SP2 and Cray T3D) had limited applicability** to most of the Defense Department's then-current research efforts. Software did not exist to permit massively parallel processors to simultaneously be used on those applications
- **Workstations are critical to Defense Department programs.** They are used to prepare programs and data for HPC runs and to analyze HPC data runs. However, they were not replacing HPCs, either in networked or clustered configurations
- **Symmetric multi-processors (such as the SGI Power Challenge and the DEC Alpha) would be major factors in future Defense Department research** in spite of the higher performance of the Cray vector computers, because the lower overall costs of symmetric multi-processors make them affordable in a constrained defense budget environment
- **Symmetrical multi-processors were not being run effectively at Defense Department laboratories with more than 12 single processor workstation levels** of between 200 and 500 MTOPS. Other symmetrical multi-processors were being run at levels between 1,000 and 5,000 MTOPS; vector computers were being run at levels between 10,000 and

20,000 MTOPS; and massively parallel processors were being run at levels over 5,000 MTOPS because of their scalability in parallel signal processing applications

- **There was no significant relationship between the maximum composite theoretical performance of the vector computers and the massively parallel processors.** Therefore, export control levels should not be set on the basis of the maximum number of processors that can be included in a massively parallel processor[98]

Institute of Defense Analyses Technical Assessment

An IDA technical assessment reported that a consensus of computing experts, supported by available data, believed that supercomputing restrictions for systems above 10,000 MTOPS, but below about 20,000 MTOPS, could be circumvented to some extent by aggregating lower performance processors. However, the IDA assessment stated that it was difficult to go beyond this level as of 1996, except for a small set of "embarrassingly parallel problems" — that is, problems that could easily be broken up into parts that could be solved simultaneously.[99]

The assessment predicted that, by 1996, users should be able to interconnect systems with a total of 40,000 to 80,000 MTOPS. Such a configuration could be programmed, according to IDA, "to yield computational capabilities approximating that of a single 20,000 CTP computer for a given problem or constrained set of problems." A user may achieve this by investing from six months to a year's worth of effort, although the resulting system would be neither user-friendly nor economically competitive in the world market.[100]

The IDA assessment also stated that the security risk would depend on whether there are militarily critical problems that demand high performance computing capability between 10,000 and 20,000 MTOPS, and that cannot be attacked for some technical reason by aggregation. If such problems exist, IDA advised, the issue would become how much benefit to U.S. national security it is to delay or degrade a foreign entity's ability to achieve certain results for a given class of problems. The IDA study concluded that a user faced with limited computing power would simply run the program for a longer period of time or run it with coarser granularity.[101] (Granularity of an application refers to the amount of computation relative to the amount of movement of data between processors.[102] When this relationship becomes a processing bottleneck in the interconnect between processors, problems that are more easily broken up into parts — that is, "coarsely grained" — are those that can be run effectively.[103])

The IDA assessment and its sponsors, Dr. Joseph Golden, Director of Multinational Technology Programs in the Office of the Deputy Undersecretary of Defense for International and Commercial Programs, and Norman Jorstad, Director of IDA's Technology Identification and Analysis Center, provided only minimal support and documentation (four articles) for the study's conclusions.[104]

As IDA officials subsequently explained to General Accounting Office, IDA had assembled a group of specialists from the U.S. Government and the computer industry who discussed the issues and produced the report following a series of meetings. While the specialists might have assembled documentation, IDA retained none of it.[105]

A Defense Technology Security Administration official commented in July 1998 that the agency had concerns about the study.[106]

Defense Department Proliferation Criteria

In the 1995 effort to develop the country tier system, Defense Department officials assessed countries for the HPC export control review process on the basis of six criteria and assigned each country to a particular HPC country tier.[107] Part of the information used in this process was a ranking of each country in the world by the level of risk associated with that country's proliferation record. The PRC was ranked at the highest level of risk.

Former Deputy Assistant Secretary of Defense for Counterproliferation Policy Mitchel Wallerstein explained to the General Accounting Office that the Defense Department did not conduct a threat assessment regarding HPCs because it was not tasked do so.[108] Wallerstein later said that he had consulted with a counterpart on the Joint Staff about the risk associated with the levels of HPC being considered for export, and that, while the Joint Staff had concerns, the risk was considered reasonable.[109]

The six assessment criteria used by the Defense Department to create HPC country tiers were:

- **Evidence of ongoing programs of U.S. national security concern, including proliferation of weapons of mass destruction** with associated delivery systems and regional stability and conventional threats
- **Membership in or adherence to nonproliferation and export control regimes**
- **An effective export control system** including enforcement and compliance programs and an associated assessment of diversion risks
- **Overall relations with the United States**
- **Whether United Nations sanctions had been imposed**
- **Prior licensing history**[110]

Details of the 1996 High Performance Computer Export Control Policy Changes

The export control policy announced in October 1995 and implemented in January 1996 removed license requirements for most HPC exports with performance levels up to 2,000 MTOPS.[111]

The policy also organized countries into four "computer tiers." Tier 1 represents the lowest level of concern to U.S. security interests, and each subsequent tier represents a higher level.[112]

The revised HPC policy was applied as follows:

- ***Tier 1 (28 countries)*: Western Europe, Japan, Canada, Mexico, Australia, New Zealand.** No prior government review or license for any computer exports, but U.S. companies must keep records regarding higher performance shipments (that is, over 2,000 MTOPS) and these records will be provided to the U.S. Government as directed.

- ***Tier 2 (106 countries)*: Latin America, the Republic of Korea, Association of Southeast Asian Nations, Hungary, Poland, Czech Republic, the Slovak Republic, Slovenia, South Africa.** No prior government review or license for computer exports up to 10,000 MTOPS, with record-keeping and reporting by U.S. companies as directed by the U.S. Government. Prior government review and an individual license are required for HPCs above 10,000 MTOPS. Above 20,000 MTOPS, the U.S. Government may require safeguards at the end-user location.

- ***Tier 3 (50 countries)*: the PRC, India, Pakistan, the Middle East/Maghreb, the former Soviet Union, Vietnam, and the rest of Eastern Europe.** No prior government review or license is required for computer exports up to 2,000 MTOPS. Prior government review and a license are required for HPC exports for military and proliferation-related end uses and end users. No government review or license is required for civil end users of computers between 2,000 MTOPS and 7,000 MTOPS, with record-keeping and reporting by U.S. companies as directed by the U.S. Government. Prior government review and a license are required for HPC exports above 7,000 MTOPS to all end users. Above 10,000 MTOPS, additional safeguards may be required at the end-user location.

- ***Tier 4 (7 countries)*: Iraq, Iran, Libya, North Korea, Cuba, Sudan, and Syria.** There is a virtual embargo on all computer exports.[113]

The U.S. Government continues to implement the Enhanced Proliferation Control Initiative, which seeks to block exports of computers of any level in cases involving exports to end uses or end users of proliferation concern, or risks of diversion to proliferation activities.[114] Criminal as well as civil penalties apply to violators of the Initiative.[115]

Export Administration Act Provisions and Export Administration Regulations Currently Applicable to High Performance Computers

Specific provisions of the Export Administration Act of 1979, as amended, and the Export Administration Regulations apply to HPCs. In addition, Export Administration Regulations that regulate dual-use exports generally apply to HPCs.

The Commerce Department's Bureau of Export Administration maintains the Commerce Control List that includes items (commodities, software, and technology) subject to the authority of the Bureau. HPC technology is included on the Commerce Control List under Category 4, "Computers." HPCs specifically fall under 4A003 (which includes "Digital computers," "electronic assemblies," and "related equipment, and specially designed components") and D001 ("Software specially designed or modified for the 'development', 'production' or 'use' of equipment or 'software' controlled by" various other export control categories).[116]

The Export Administration Regulations identify six bases for controlling HPC technology, in order of restrictiveness. Those requiring licenses for a larger number of countries or items are listed first:

- **National security**
- **Missile technology**
- **Crime control**
- **Anti-terrorism**
- **Nuclear nonproliferation**
- **Computers**[117]

The Export Administration Regulations state the terms of the Composite Theoretical Performance license exception and the country tier structure. They also detail the new requirements on notification, post-shipment verifications for Tier 3 countries mandated by the Fiscal 1998 National Defense Authorization Act, and other restrictions and reporting requirements.[118]

The Export Administration Regulations contain special provisions for exports, re-exports, and certain intra-country transfers of HPCs, including software and technology. License requirements reflected in this section are based on particular destinations, end users, and end uses. These license requirements supplement those that apply for other control reasons, such as nuclear nonproliferation.[119]

License applications for HPC technology covered by this section are also to be reviewed for nuclear nonproliferation licensing policy. The Commerce Department may also require end-use certifications issued by the government of the importing country and safeguard conditions on the license.[120]

The Export Administration Regulations state security conditions and safeguard plans for the export, re-export, or in-country transfer of HPCs that the Bureau of Export Administration may impose to certain destinations. Up to 36 safeguard conditions are available.[121] These include the following:

- **Applicant's responsibility for providing adequate security** against physical diversion of the computer during shipment
- **No re-export or intra-country transfer of the computer** without prior written authorization of the Bureau of Export Administration
- **Inspection of usage logs daily** to ensure conformity with conditions of the license and retention of records of these logs for at least a year
- **Independent auditing of the end user** quarterly by an independent consultant, including auditing of computer usage and implementation of safeguards[122]

The Export Administration Regulations contain prohibitions against exports, re-exports, and selected transfers to certain end users and end uses. They state that the exporter may not export or re-export any item without a license to any destination, other than those specified in the regulations, if at the time of the export, the exporter knows the item will be used directly or indirectly in proscribed activities.[123]

These activities include nuclear, missile, chemical, and biological end uses.[124] The Export Administration Regulations define "knowledge" of a circumstance not only as positive knowledge that the circumstance exists or is substantially certain to occur, but also an awareness of a high probability of its existence or future occurrence.[125] Such awareness is inferred from evidence of the conscious disregard of facts known to a person, and is also inferred from a person's willful avoidance of facts.[126]

The Export Administration Act provides that the Secretary of Commerce and his designees may conduct, outside the United States, pre-license investigations and post-shipment verifications of items licensed for export.[127]

The Second Stanford Study

Two of the three authors of the 1995 Stanford study were again engaged and funded by the Departments of Commerce and Defense to prepare a second paper as a contribution to the periodic review of HPC export controls.[128]

This paper, released in April 1998, concluded that rapid advances in computer technology were continuing. However, it also suggested that a proposed change in licensing procedure — to review each HPC at its highest attainable level, rather than its configuration at the time of the export — would remove the concern that HPCs were being upgraded without the knowledge of exporters or the U.S. Government.[129]

As of the date of this report, no further Executive branch action has been reported or notified to Congress concerning further revisions to export controls on HPCs.

Arms Export Control Act Provisions and International Traffic In Arms Regulations Currently Applicable to Computers

The Arms Export Control Act and International Traffic In Arms Regulations treat certain computers differently than the dual-use computers that are regulated by the Export Administration Act and Export Administration Regulations.[130]

The United States Munitions List, which is included in the International Traffic in Arms Regulations, controls computers that have been modified for rugged conditions and "Tempested" — made ready for secure use — specifically for military systems.[131] It also controls software specifically designed for military uses and technical data, which is often paper converted to software.[132]

The State Department, which has license authority over Munitions List items, restricts the export of computers designed for military uses and does not distinguish among computers based on MTOPS or other performance measures.[133]

Concerns Over High Performance Computer Exporters' Ability to Review End-Users in the PRC Prompted the Requirement for Prior Notification

The January 1996 revisions to the Export Administration Regulations governing HPCs made several other important changes. Most importantly, they made exporters responsible for determining whether an export license is required, based on the MTOPS level of the computer, and for screening end users and end uses for military or proliferation concerns.[134]

Thus, U.S. companies that wish to export HPCs are now authorized to determine their own eligibility for a license exception.[135]

Prior to this change, only U.S. HPC exports to Japan were allowed without an individual license. At that time, a violation of the Export Administration Regulations could be identified by an export of an HPC that occurred without a license.

Since the change, in order to prove a violation of the regulations, the Commerce Department must demonstrate that an exporter improperly used the Composite Theoretical Performance license exception and knew or had reason to know that the intended end user would be engaged in military or proliferation activities.[136]

Also, the revised Export Administration Regulations required that exporters keep records and report to the Commerce Department on exports of computers with performance levels at or above 2,000 MTOPS. In addition to existing record-keeping requirements, the regulations added requirements for the date of the shipment, the name and address of the end user and of each intermediate consignee, and the end use of each exported computer. Although these records have been reported to the Commerce Department on a quarterly basis for the past two years, some companies have reported inconsistent and incomplete data for resellers or distributors as end users.[137]

Since U.S. HPCs obtained by countries of proliferation concern could be used in weapons-related activities, the Congress enacted a provision in the Fiscal Year 1998 National Defense Authorization Act[138] that required exporters to notify the Commerce Department of all proposed HPC sales over 2,000 MTOPS to Tier 3 countries. The Act gives the U.S. Government an opportunity to assess these exports within 10 days and determine the need for a license. Following such notification, the Departments of Commerce, State, Defense, and Energy, and the U.S. Arms Control and Disarmament Agency, can review a proposed HPC sale and object to its proceeding without an export license. The Commerce Department announced regulations implementing the law on February 3, 1998.[139]

A November 1998 Defense Department study, however, identified potential problems with the 10-day notification procedure. The study noted that the Defense Department provides comments on export notices referred to it regarding those end users for which the Defense Department has information. The study also noted that:

> *The operating assumption is that, if there is no information on the end-user, then the end-user is assumed to be legitimate. This is probably true in most cases; however, there is no means to verify that high performance computers are not making their way to end-users of concern to the United States.*[140]

Furthermore, the Defense Department study expressed concern that foreign buyers might circumvent current Export Administration Regulations provisions requiring attestation to the buyer's knowledge that the export will have no military or proliferation end user or end use.[141] By designating a company in the United States to act on its behalf, the foreign company could have its U.S. designee submit the HPC notification to the Commerce Department; the U.S. designee and not the foreign buyer would then be responsible for all compliance with notification procedures.[142] The U.S. designee would be responsible only for shipping the item and would not take title of the item.[143]

Under the Export Administration Regulations, the U.S. designee could complete the notification to its knowledge, which might be useless if the U.S. designee is in fact ignorant of the actual end use. The Defense Department study noted the obvious problems with this system.

The study also observed that the 10-day notification period was insufficient to ensure that U.S. designees and foreign buyers are providing accurate and complete information.[144]

Finally, the Defense Department study warned that foreign buyers of U.S. computer technology might circumvent the notification procedure by notifying the Commerce Department that they are purchasing a system that is not above the 7,000 MTOPS threshold, but later upgrading the system with processors that are below the 2,000 MTOPS level. There would be no requirement to notify the Commerce Department of the acquisition of the lower than 2,000 MTOPS upgrades to the previously-notified system.[145]

The U.S. Government Has Conducted Only One End-Use Check for High Performance Computers in the PRC

The Fiscal 1998 National Defense Authorization Act now requires the Commerce Department to perform post-shipment verifications on all HPC exports of HPCs to Tier 3 countries with performance levels over 2,000 MTOPS.[146]

Post-shipment verifications are important for detecting and deterring physical diversions of HPCs, but they do not always verify the end use of HPCs.[147]

The PRC traditionally has not allowed the United States to conduct post-shipment verifications, based on claims of national sovereignty, despite U.S. Government efforts since the early 1980s.[148] This obduracy has had little consequence for the PRC, since HPC exports have continued to be approved and, in fact, have increased in recent years.

In June 1998, the PRC agreed with the United States to cooperate and allow post-shipment verifications for all exports, including HPCs.[149] PRC conditions on the implementation of post-shipment verifications for HPCs, however, render the agreement useless.[150] Specifically:

- **The PRC considers requests from the U.S. Commerce Department to verify the actual end-use of a U.S. HPC to be non-binding**

- **The PRC insists that any end-use verification, if it agrees to one, be conducted by one of its own ministries, not by U.S. representatives**
- **The PRC takes the view that U.S. Embassy and Consulate commercial service personnel may not attend an end-use verification, unless they are invited by the PRC**
- **The PRC argues scheduling of any end-use verification — or indeed, whether to permit it at all — is at the PRC's discretion**
- **The PRC will not permit any end-use verification of a U.S. HPC at any time after the first six months of the computer's arrival in the PRC**

The Select Committee has reviewed the terms of the U.S.-PRC agreement and found them wholly inadequate. The Clinton administration has, however, advised the Select Committee that the PRC would object to making the terms of the agreement public. As a result, the Clinton administration has determined that no further description of the agreement may be included in this report.

According to Iain S. Baird, Deputy Assistant Secretary of Commerce for Export Administration within the Bureau of Export Administration, post-shipment verifications are conducted by the PRC's Ministry of Foreign Trade and Economic Cooperation for U.S. computers having over 2,000 MTOPS that are exported to the PRC. He says such verifications are done in the presence of the U.S. commercial attaché.[151]

Commerce reported on November 17, 1998, that no post-shipment verifications would be performed on HPCs that were exported to the PRC from November 18, 1997 through June 25, 1998 because the PRC/U.S. agreement applies only prospectively from June 26.

Since June 26, the Commerce Department reported, only one post-shipment verification has been completed and one was pending as of November 12, 1998. Commerce also stated that "Post shipment verifications were not done on most of the others [HPCs] because the transactions do not conform to our arrangement with the PRC for end use checks."[152]

Thus, post-shipment verifications will not be done on any HPCs exported to the PRC prior to the agreement, nor on any HPCs shipped that are exported in the future under the Composite Theoretical Performance license exception (that is, those between 2,000 and 7,000 MTOPS) to civilian end users.

According to Commerce Department Under Secretary for Export Enforcement William Reinsch, a pending regulatory change will instruct HPC exporters to seek end-use certificates from the PRC Government. Where PRC end-use certificates are obtained, this regulation purportedly would allow more post-shipment verifications to be requested consistent with the PRC-U.S. agreement.[153]

Reinsch stated that the PRC has indicated that it would be willing to issue end-use certificates. However, the PRC office in question reportedly has a staff of five, which would severely limit the number of post-shipment verifications it could implement.[154]

According to a September 1998 report from the General Accounting Office, U.S. Government officials agreed that the manner in which post-shipment verifications for computers traditionally have been conducted has limited their value because they establish only the physical presence of an HPC, not its actual use. In any event, according to national weapons laboratory officials within the Energy Department, it is easy to conceal how a computer is being used.[155]

Even when U.S. Government officials perform the post-shipment verification, the verifying officials have received no specific computer training and are capable of doing little more than verifying the computer's location. It is possible to verify an HPC's use by reviewing internal computer data, but this is costly and intrusive, and requires sophisticated computer analysis.[156]

The General Accounting Office report also noted that the U.S. Government makes limited efforts to monitor exporter and end-user compliance with explicit conditions that are often attached to HPC export licenses for sensitive end users. The U.S. Government relies largely on the HPC exporters to monitor end use, and may require them or the end users to safeguard the exports by limiting access to the computers or inspecting computer logs and outputs.[157]

The end user may also be required to agree to on-site inspections, even on short notice, by the U.S. Government or exporter. These inspections would include review of the programs and software that are being used on the computer, or remote electronic monitoring of the computer.[158]

Commerce officials stated to GAO that they may have reviewed computer logs in the past, but do not do so anymore, and that they have not conducted any short-notice visits. They also acknowledged that they currently do not do any remote monitoring of HPC use anywhere and that, ultimately, monitoring compliance with safeguards plans and their conditions is the HPC exporter's responsibility.[159]

Some U.S. High Performance Computer Exports to the PRC Have Violated U.S. Restrictions

During the 1990s, there have been several cases of export control violations involving computer technology shipments to the PRC. One ongoing case concerns the diversion of a Sun Microsystems HPC from Hong Kong to the PRC.[160]

On December 26, 1996, a Hong Kong reseller for Sun Microsystems, Automated Systems Ltd., sold an HPC to the PRC Scientific Institute, a technical institute under the Chinese Academy of Sciences — a State laboratory specializing in parallel and distributed processing. At some point after the sale but before delivery, the computer was sold to Changsha Science and Technology Institute in Changsha, Hunan Province. The machine was delivered directly to that Institute in March 1997.[161]

Automated Systems of Hong Kong claimed to Sun officials in June 1997 that it had understood that the Changsha Institute was "an educational institute in Wuhan Province providing technological studies under the Ministry of Education." The end use there, according to Automated Systems, was to be for "education and research studies in the college and sometimes for application development for outside projects." Sun was recommended to contact the end user, the Changsha Institute, for more specific end-use information.[162]

The HPC sale came to the attention of the Deputy Assistant Secretary for Export Enforcement, Frank Deliberti. He queried the U.S. Embassy in Beijing about the Changsha Institute. Deliberti gave the information he obtained to Sun Microsystems, which then initiated efforts to have its computer returned.[163]

During the same period, the Foreign Commercial Officer at the U.S. Embassy in Beijing consulted his contacts at the PRC's Ministry of Foreign Trade and Economic Cooperation. The Ministry denied that the Changsha Institute was affiliated with the PRC military.[164]

Subsequently, the Ministry called the FCO to inform him that the actual buyer of the computer was an entity called the Yuanwang Corporation, and that Sun Microsystems had been aware of this corporation's PRC military ties. Reportedly, Yuanwang is an entity of the Commission on Science, Technology, and Industry for National Defense (COSTIND). So far as the PRC's Ministry of Foreign Trade and Economic Cooperation reportedly could determine, the end-use statements that had been provided to Sun through Automated Systems of Hong Kong were totally fictitious. The Changsha Science and Technology Institute, according to the Ministry, did not exist.[165]

The official position of the Ministry of Foreign Trade and Economic Cooperation was that the PRC Government would not help to obtain the return of the computer. The role of the PRC Government, the Ministry asserted, had been merely to help two private parties rectify a misunderstanding. In any event, the computer was returned to the United States on November 6, 1997.[166] The Commerce Department investigation reportedly is continuing.[167]

A number of other violations of U.S. laws and regulations concerning computers exported to the PRC have been investigated by the Commerce Department:

New World Transtechnology

On December 20, 1996, New World Transtechnology of Galveston, Texas, pled guilty to charges that it violated the export control laws and engaged in false statements by illegally exporting controlled computers to a nuclear equipment factory in the PRC in August 1992. The company was also charged with attempting to illegally export an additional computer to the PRC through Hong Kong in October 1992. The company was sentenced to pay a $10,000 criminal fine and a $600 special assessment fee.[168]

Compaq Computer Corporation

On April 18, 1997, the Commerce Department imposed a $55,000 civil penalty on Compaq Computer Corporation of Houston, Texas, for alleged violations of the Export Administration Regulations. The Commerce Department alleged that, on three separate occasions between September 17, 1992 and June 11, 1993, Compaq exported computer equipment from the United States to several countries, including the PRC, without obtaining required export licenses. Compaq agreed to pay the civil penalty to settle the allegations.[169]

Digital Creations

On June 12, 1997, Digital Creations Corporation of Closter, New Jersey, was sentenced to pay an $800,000 criminal fine for violating the Export Administration Act and Regulations in connection with exports of computers to the PRC. Digital had previously pled guilty in December 1994 to charges that it had violated the Export Administration Regulations by illegally exporting a Digital Equipment Corporation computer to the PRC without obtaining the required export license.[170]

Lansing Technologies Corporation

On June 17, 1997, Lansing Technologies Corporation, of Flushing, New York, pled guilty to charges that it violated the Export Administration Regulations in 1992 by exporting a Digital Equipment Corporation computer vector processor and a data acquisition control system to the PRC without obtaining the required export licenses from the Commerce Department.[171]

Other serious violations of HPC export control laws and regulations have occurred in recent years, but these concerned Russia. On July 31, 1998, for example, the Department of Justice announced that IBM East Europe/Asia Ltd. entered a guilty plea. IBM received the maximum allowable fine of $8.5 million for 17 counts of violating U.S. export laws through the sale of HPCs to a Russian nuclear weapons laboratory known as Arzamus-16. In another example, an ongoing U.S. Government investigation of Silicon Graphics Incorporated/Convex is examining whether a violation of law occurred in a sale of HPCs to another Russian nuclear weapons laboratory, Chelyabinsk-70.[172]

High Performance Computers at U.S. National Weapons Laboratories Are Targets for PRC Espionage

No other place in the world exceeds the computational power found within the U.S. national weapons laboratories. For this reason, both the computational power and the data it can generate have been the focus of the PRC's and other countries' intelligence collection efforts.

The desire for access to this computing power and data, in turn, is one of the reasons so many foreign nationals want to visit the laboratories.

According to David Nokes, the network administrator at Los Alamos National Laboratory, all operating systems have vulnerabilities that can be exploited by a knowledgeable, valid user.[173] Nokes also says that there are a few solutions to issues of HPC network security. These include:

- **Allowing only U.S. students to use the networks**
- **Limiting physical access to high performance computer networks at universities**
- **Enhancing physical security and security education at universities**[174]

U.S. National Weapons Laboratories Have Failed to Obtain Required Export Licenses for Foreign High Performance Computer Use

When foreign nationals use the U.S. national weapons laboratories' HPCs, their activities should generally be considered "deemed exports." The "deemed export" rule [15 CFR 734.2 (b) (ii)] covers those situations in which an export-controlled technology or software-source code information is released to a visiting foreign national, for which a license would have been required. In such situations, an "export" is "deemed" to have occurred.

The Select Committee is concerned that HPC system managers in the U.S. national weapons laboratories lack an essential understanding of the deemed export rule. This lack of understanding was substantiated by interviews with representatives from the Department of Commerce who had no recollection of ever having seen an application for a deemed export from any of the U.S. national weapons laboratories.

When PRC nationals visit and use the HPCs at a U.S. national weapons laboratory, their access should be limited to the same computing capabilities to which the PRC itself is restricted, especially for military uses.[175] The Select Committee discovered, however, that the laboratories do not even measure the computational power of their HPCs in MTOPS. Moreover, many of the laboratories have difficulty in converting to MTOPS from the units they use to measure the power of an HPC.

The Department of Commerce could not recall a laboratory ever having sought guidance on how to compute an HPC's MTOPS rating. Significantly, the Select Committee discovered that a rather modest HPC (by Department of Energy standards) in a U.S. National Laboratory used by foreign nationals had a substantially higher MTOPS rating than the controlled threshold. No licenses, however, had ever been obtained.

The "deemed export" rule also applies in those instances in which a PRC national or entity accesses an HPC remotely via the Internet.

In the absence of an effective audit system, which monitors the codes being run by the PRC user, the U.S. national weapons laboratories cannot verify that they are in compliance with the law, or that PLA or PRC intelligence is not using the HPCs for the design or testing of nuclear or other weapons.

PRC Students Have U.S. Citizen-Like Access To High Performance Computers at the National Weapons Laboratories

The U.S. national weapons laboratories rely upon nuclear weapons test simulation software and computers provided by the Accelerated Strategic Computer Initiative (ASCI). Five major U.S. universities support ASCI through the Academic Strategic Alliances Program (ASAP).

As a result, hundreds of research students and staff at these universities have access to the HPCs used by the national weapons laboratories for U.S. nuclear weapons research and testing. As many as 50 percent of these research students and staff are foreign nationals, some of whom may have foreign intelligence affiliations.

Holders of Immigration and Naturalization Service "green cards" — PRC nationals who have declared their intent to remain permanently in the U.S. — are treated as U.S. citizens for export control purposes. They are then given U.S. citizen-like HPC access, free to return to the PRC once their objectives are fulfilled.

In November 1998, the Secretary of Energy issued an Action Plan that includes a task force to review HPC usage by foreign nationals and provide a report to the Secretary within six months. The Department of Energy is currently preparing an implementation plan to address counterintelligence issues identified in a July 1998 report, entitled "Mapping the Future of the Department of Energy's Counterintelligence Program," including HPC usage by foreign nationals.

Many Types of Computer Technology Have Been Made Available to the PRC That Could Facilitate Running Programs Of National Security Importance

One of the bases for the 1996 increase in export control thresholds was that individual PCs were widely available on the open market in the United States, but not able to be exported to the potentially huge PRC market.[176] What was an HPC in 1993 (those capable of 195 or more MTOPS) was no longer even considered necessary to control for weapons proliferation concerns.[177]

By 1997, PCs and workstations assembled in the PRC captured approximately 60 percent of the PRC's domestic market.[178] All of these locally-assembled computers used imported parts — over 70 percent contained United States-produced Pentium microprocessors.[179]

Three of the largest manufacturers in the PRC were affiliates of IBM, Hewlett Packard, and Compaq, with a combined market share of approximately 21 percent.[180]

A large share (but probably not more than 20 percent) of the PC assembly in the PRC was done by small, independent assembly shops.[181]

The largest individual producer of PCs and workstations in the PRC is the Legend enterprise, a spin-off of the Chinese Academy of Sciences.[182] This domestic computer assembly industry dovetails well with Beijing's overall plans for economic modernization. Beijing reportedly desires an independent PRC source of most high-technology items to avoid reliance on foreign providers for these goods.

To participate more fully in the PRC market, United States firms have been pressured by the PRC government to relinquish technological advantage for short-term market opportunities. The PRC requires that foreign firms be granted access to the PRC market only in exchange for transferring technology that would enable the state-run enterprises to eventually capture the home market and begin to compete internationally.

However, the PRC's strategy of coercing technology from foreign firms has not enabled state-run industries to close the technology gap with more developed nations. In the context of establishing domestic production of computers for sale in the PRC, this PRC "technology coercion" policy appears to have worked.[183] The PRC now has a growing industrial base of small computer assemblers. For the most part, these companies are not State-run. The technology that was "coerced" from U.S. computer manufacturers as a cost of entering the PRC market apparently better serves the expansion needs of small, relatively independent enterprises and not the intended needs of central planners in Beijing.

90 percent of PRC consumers of PCs and workstations are business, government, and educational entities, with individual purchases accounting for only 10 percent of the PRC's PC market.[184] To illustrate the size of the individual purchaser segment of the PRC's market, it is estimated that only 5 million individuals out of the PRC's 1.2 billion have the expendable funds required to purchase a low-end PC in the PRC.[185]

Despite the limited number of individual purchasers, the actual size of the PRC PC and workstation market was 2.18 million units in 1996; 3 million units in 1997; and 4.5 million units in 1998. It is anticipated the PRC PC and workstation market will grow at the rate of 1.5 million to 2 million units per year through the year 2000. According to figures provided by the Asia Technology Information Project, an independent research foundation, non-PRC manufacturers of PCs and workstations, including U.S. manufacturers, could expect to partake of a portion of the almost 2 million units expected to be imported for sale in the PRC in 1998.[186]

The PRC Has a Limited Capability to Produce High Performance Computers

The PRC has demonstrated the capability to produce an HPC using U.S.-origin microprocessors over the current threshold of 7,000 MTOPS. The PRC "unveiled" a 10,000 MTOPS HPC — the Galaxy III — in 1997 based on Western microprocessors.

But PRC HPC application software lags farther behind world levels than its HPC systems. Also, despite the existence of a few PRC-produced HPCs based on Western components, the PRC cannot cost-effectively mass-produce HPCs currently. There really is no domestic HPC industry in the PRC today.

While it is difficult to ascertain the full measure of HPC resources that have been made available to the PRC from all sources, available data indicates that U.S. HPCs dominate the market in the PRC.[187]

Although the PRC has a large market for workstations and high-end servers, there is a smaller market for parallel computers which is entirely dominated by non-PRC companies such as IBM, Silicon Graphics/Cray, and the Japanese NEC. However, there continues to be significant market resistance to Japanese HPC products in Asia, especially as U.S. products are beginning to have significant market penetration.[188]

U.S. High Performance Computer Exports To the PRC Are Increasing Dramatically

A review of Commerce Department information regarding the total of HPC license applications that were received for the time frame January 1, 1992 to September 23, 1997, revealed the following:

- **Only one HPC export license to Hong Kong (with a value of $300,000) was rejected**
- **100 HPC export licenses to the PRC (with a total value of $11,831,140) were rejected by Commerce**
- **37 HPC export licenses to Hong Kong (with a total value of $55,879,177) were approved**
- **23 HPC export licenses to the PRC for HPCs within the 2,000 to 7,000 MTOPS range (with a total value of $28,067,626) were approved**
- **Two of the 23 HPC export licenses to the PRC for HPCs within the 11,000 to 12,800 MTOPS range (with a total value of $2,550,000) were approved in 1998**[189]

The approximate total value of the HPCs exported, of whatever description, to both Hong Kong and the PRC, for the six-year period ending September 23, 1997, was only $86 million.[190]

The nine-month period between January 1998 and September 1998, however, saw U.S. exporters notify the Commerce Department of their intention to export 434 HPCs (in the 2,000 to 7,000 MTOPS range) to the PRC (total value $96,882,799).[191] Nine times the number of HPCs were exported in one-ninth the time.[192]

During approximately the same time frame (calendar year 1998) it is estimated that 9,680,000 individual PCs and workstations were sold in the PRC. The market share that U.S. exporters could reasonably expect to benefit from was approximately 3,872,000 units, worth approximately $1.8 billion.[193]

Apparently, the proximate cause of U.S. computer manufacturers aggressively lobbying for the raising and maintaining of export thresholds above the PC level was to capture this $1.8 billion per year market share.

The United States dominates the PRC's HPC market, but U.S. exports clearly do not dominate the PRC's personal computer and workstation market.[194] The difference between the 460-unit, $100 million HPC market described above, stretched over a six-year period, and the yearly 3.8 million-unit PC and workstation market, with a value of $1.8 billion, is dramatic.

The performance levels of U.S. HPCs reported to be exported to the PRC over the past year continued to be predominantly in lower-end machines, as shown in the following table. For example, 77 percent of U.S. HPCs (a total of 388 machines) have performance levels below 4,000 MTOPS.

Number of U.S. HPCs Reported to Be Exported to the PRC Under License Exception, by MTOPS[195] *September 1997 - September 1998*

MTOPS	Total
2,000 to 2,999	302
3,000 to 3,999	86
4,000 to 4,999	71
5,000 to 5,999	28
6,000 to 6,999	15
> 7,000	0
Total	**502**

The PRC Is Obtaining Software From U.S. and Domestic Sources

In June 1997, it was estimated that 96 percent of software programs sold in the PRC were pirated versions of commercially available U.S. programs. These programs were designed for use on PCs and workstations, and are not considered useful for the very sophisticated programming done on HPCs.

Some major U.S. software producers have begun contracting with PRC programming firms. These PRC software firms are comprised of recently-graduated PRC university students. They are attempting to write programs in Chinese to capitalize on a huge domestic market.[196]

Two factors mitigate against the success of the PRC developing its domestic programming industry.

The first factor is that street-level "software pirates" sell dozens of U.S. computer programs at a time on one CD-ROM for a small fee (reportedly $20). In other words, one can meet most or all of one's programming needs in the PRC for a nominal fee. It is anticipated that it will be difficult, if not impossible, for a domestic software industry to recoup the start up costs associated with just one software program, let alone the dozens needed to compete with the street level dealers.

The second factor is that these pirated U.S.-produced, English language programs are more mature, widespread, and robust than PRC programs.[197] It is axiomatic that any new product will have "bugs in the system." It is considered unlikely that new, unproven, and possibly weak software programs will effectively compete with cheap, proven, and robust software that is widely available at such nominal fees. It is conceivable that the PRC will abandon instituting a domestic programming industry altogether.[198]

Potential Methods of Improving End-Use Verification

According to a 1996 RAND study, there are non-intrusive and intrusive approaches to assessing the manner in which a buyer is actually applying dual-use technologies. Among the non-intrusive methods are:

- **Memoranda of understanding and agreements**
- **National technical means of verification**
- **Limitations designed into the transferred technologies**
- **Transparency measures**

Among the intrusive methods are:

- **Inspections**
- **Tagging**[199]

Tagging

Tagging is achieved by attaching an active system to the item that is to be exported, rather than just a passive tag for identification during an inspection. The active system would both monitor the object tagged and communicate that information back to the United States. The RAND study noted that in practice, this means the objects to be tagged must be physically large systems, such as a machine-tool cell, or a major component of some larger system, such as a turbine engine in a helicopter.[200]

According to the RAND study, the tag should be capable of at least communicating information about the item's physical location. Some sensors may provide other kinds of information, as well. The information could be communicated to a satellite or over a data link. Early versions of such devices were already in use in 1996 to monitor nuclear materials and technologies.[201]

These "smart" tags exploit the potential of several technologies, according to the RAND study. They combine encryption, the Global Positioning System, and emerging global wireless communications systems, such as Iridium or Orbcomm. These technologies would allow the tags to report back on the status and location of the tagged object. In principle, such tags could report the position of an object at any given time in order to verify limitations on their location. Such tags could also report on the activities of a "smart" system to which they are attached. For example, a machine-tool cell could report whether the machine had been used to make parts resembling aircraft components.[202]

Such tags could have many applications in a cooperative regime. Their application and use in a prohibited environment would be more difficult and consequential.[203]

The RAND study cautioned that all sellers of a particular technology must participate in the tagging and that this would probably also require cooperation of the buyers. Otherwise, buyers would gravitate to untagged items, if they were available. Attempts to conceal system location or deviate from a pattern of cooperation would be considered evidence of a potential failure of performance by the buyer. The study concluded that tagging may become an important oversight method for controlling technology transfers, but that it should never become the sole means of oversight.[204]

Technical Safeguards

In 1994 several types of technical safeguards were in advanced development in the United States. The technologies required for these safeguards were expected to enter testing within the next two years. They included:

- **Controlled-execution UNIX** — a modified computer operating system that could run only certain pre-approved programs; likely to be most useful for computers sold to facilities such as weather-forecasting centers, oil companies, automobile manufacturers, and banks

- **"Black box" monitoring hardware** — inexpensive, secure, long-term audit recording devices, possibly based on write-once optical storage units that could be embedded in mass-produced workstations; analogous to the black box flight-data recorders that are installed in aircraft and used for post-crash accident analysis

- **"Meltdown" software** — modified operating system programs designed to require updating by the manufacturer at fixed times; if not updated, the computer refuses to run

- **Automated auditing tools** — pattern-recognition or rule-based software; would assist monitoring agencies to more effectively inspect huge collections of data from system activity logs and detect the (presumably few) incidents worth detailed analysis

Although these technical safeguards seem feasible, none had been proved to be inexpensive, sensitive enough to detect most illegal activity, and difficult to circumvent by determined adversaries. The auditing tools under development showed great promise, however. Authorities were pessimistic about the likelihood that technical high-performance computer safeguards would be widely adopted and able to succeed in the near future.

Other Possibilities

Officials of the Mitre Corporation made several suggestions to strengthen U.S. national security in the context of HPC export controls. These included:

- **Improving and enforcing end-use and end-user verification**
- **Controlling embedded HPC systems that are useful in military applications**
- **Monitoring or precluding the expansion capability of computer hardware**
- **Marketing aggressively all generic computing capabilities, such as scanning, to the PRC** to maximize profits and to keep the PRC market-dependent on the United States
- **Focusing on control of any hardware, software, tools, and services that uniquely support PRC military applications** that are strategic in nature or could facilitate the tactical turning point in a conflict[205]

CHANGING HIGH PERFORMANCE COMPUTER TECHNOLOGY IS MAKING EXPORT CONTROL MORE DIFFICULT

New designs in HPCs and systems of computers, as well as availability of more advanced and less costly processors, software, and peripheral equipment, is rendering the challenge of applying export controls to HPCs more difficult.

For certain types of computer designs, the ability to add processors or boards could increase the machine's performance beyond authorized levels. In addition, advances in computer processor communications technology have facilitated the clustering of personal computers and workstations into effective parallel computers.

The usefulness of clustered computers is application-dependent. Some U.S. Government and computer industry experts have concluded that for many problems, networks of workstations could not compete with appropriately designed high performance computers.[206] Most traditional HPCs achieve far greater efficiency than parallel machines, due to their use of custom-made components.

Foreign access to high performance computers through networks is possible because of inadequate security measures.

Vector Architectures

Vector architecture relies on custom-designed processors to move a complex problem through computer processing units in sequential stages. This type of machine is designed to handle arithmetic operations efficiently on elements of arrays, called vectors.[207]

Vector systems are especially useful in high-performance scientific computing.[208] Vector systems, also called "pipeline" architectures, work like an assembly line. They work best with many similar tasks that can be broken down into steps.

The memory interface in vector machines is custom-made, and subject to export controls.

Vector machines are useful for cryptography, modeling fluids, and in the design of weapons. In particular, vector systems are suited to problems in which data at one point influence other variables in the problem, a common situation in national security applications.[209]

It is more straightforward for a programmer to use a vector system than a system comprised of parallel processors (discussed below), since it is easier to obtain maximum performance with one or a few high-power processors than with a collection of many lower capability processors.[210]

Since one of the main concerns with any HPC system is the rate of speed with which data can be retrieved from memory, another advantage is that a vector machine has a very fast memory.[211]

Still further advantages of vector systems are that they feature high memory bandwidth and low memory latency — that is, very large amounts of data can travel to and from memory very efficiently. A related advantage is that vector systems have the ability to seek multiple memory locations at the same time. This translates into very fast computational speed.

A disadvantage of a vector machine is that vector system software is not really portable. It cannot be readily transported to other vector machines.[212]

The main disadvantage of vector systems, however, is their high cost. Significant improvements in software and hardware allow the purchase of a parallel processing system for $40,000, as opposed to $1 million for a comparable vector computer.[213]

At the Defense Department's High Performance Computer Management Office, vector systems are being phased out in favor of parallel processing systems. Out of a total of 40 HPCs in the High Performance Computer Management Office inventory, fewer than 10 are now vector systems.[214]

Parallel Processing: The Connection of Computers Into a Powerful Central Resource

A parallel processing computer is a collection of processors that are connected through a communications network.[215] The type of processor, the network configuration, and the operating system that coordinates the activities distinguish parallel processing systems.

Many national security applications involve problems that can be separated into independent variables, and it is for these types of problems that parallel processing is best suited.[216]

The fastest parallel machines are all based on commodity processors — that is, processors that are commercially available on the market.[217] This approach has been applied to virtually every area of theoretical and applied physics.[218]

Massively Parallel Processors

A massively parallel processor is a collection of computers, or central processing units, linked together.[219] Each computer that is part of the whole massively parallel processor has its own memory, input/output system, and central processing unit.[220] Massively parallel processors now use commodity processors, and can utilize commodity interconnects to communicate between the individual computers that make up the system.[221] Some massively parallel processors use custom-made, very fast interconnect switches that are not commodities and are subject to export control.[222]

An advantage of a massively parallel processor is that an unlimited quantity of processors can be incorporated into the design of the machine. In a massively parallel processor, the more processors, the greater the computing speed of the machine.[223]

Because each processor is equipped with its own memory, massively parallel processors have much more memory than traditional supercomputers. The extra memory, in turn, suits these machines to data-intensive applications, such as imaging or comparing observational data with the predictions of models.[224]

A disadvantage of massively parallel processors is that memory latency is a bigger problem because the processors have to share the available memory. Another disadvantage is that each one of the computers that is part of the system has to be instructed what to do individually.[225] This phenomenon requires specialized, extremely proficient programmers to create efficient communications between the individual computers.

The commercial availability of inexpensive, powerful microprocessors has given massively parallel processors a boost in their competition with vector machines for the supercomputer market. IBM, for example, more than doubled the number of its computers in the Top 500 list (discussed below) between November 1997 and June 1998 by introducing the SP2, which strings together up to 512 of the company's RSI6000 workstation microprocessors.[226]

If optimum speed is desired, this massively parallel configuration is the best of all HPC designs.[227] The fastest high performance computer now available is the ASCI Blue Pacific.[228] That machine is part of the Department of Energy's Accelerated Strategic Computing Initiative (ASCI) program and is located at Lawrence Livermore National Laboratory. Developed in conjunction with IBM, it is a 5,856-processor machine, boasting a top speed of 3.8 teraflops[229] (Tflops) with 2.6 terabytes (Tbytes) of memory.[230] In the next phase of the ASCI initiative, IBM will deliver a 10-Tflops machine to the Department of Energy in mid-2000.[231]

Symmetrical Multiprocessor Systems

Symmetrical multiprocessor systems use multiple commodity central processing units (CPUs) that are tightly coupled via shared memory. The number of processors can be as low as two and as many as about 128.[232]

Symmetrical multiprocessor systems treat their multiple CPUs as one very fast CPU.[233] The CPUs in a symmetrical multiprocessor system are arranged on a single motherboard and share the same memory, input/output devices, operating system, and communications path.

Although symmetrical multiprocessor systems use multiple CPUs, they still perform sequential processing,[234] and allow multiple concurrent processes to be executed in parallel within different processors.[235]

An advantage of symmetrical multiprocessor systems is that the programming required to control the CPUs is simplified because of the sharing of common components.[236]

Another major advantage is cost. A Silicon Graphics symmetrical multiprocessor system, for example, with 18 microprocessors, each rated at 300 megaflops (MFLOPS)[237] or more, and a peak speed of more than 5 gigaflops (GFLOPS), costs about $1 million, whereas a Cray C90 costs about $30 million.[238]

Even though the Silicon Graphics machine is about a third as fast as the Cray machine, it is still very popular with consumers of these types of machines. The University of Illinois Supercomputing Center reportedly likes the price, flexibility, and future promise of symmetrical multiprocessor systems so much that it plans to use them exclusively within two years. Its older Crays were "cut up for scrap" at the beginning of this year, and its massively parallel computers will be phased out by 1997.[239]

One disadvantage of a symmetrical multiprocessor system is that all the CPUs on a single board share the resources of that board. This sharing limits the number of CPUs that can be placed on a single board.[240]

Although the programming model that a symmetrical multiprocessor system provides has proved to be user-friendly, the programmer must exercise care to produce efficient and correct parallel programs. To limit latency in individual jobs, most software requires enhancement — for example, employing special programming techniques to prevent components of the computer program from competing for system resources — thereby increasing inefficiency.

For this reason, symmetrical multiprocessor systems are not good platforms for high-performance real-time applications.[241]

In a symmetrical multiprocessor system design, as is true with a massively parallel processor system, the number of CPUs determines how fast a machine potentially will operate. This fact causes a problem for export controls because it is possible to add CPUs to the boards of a symmetrical multiprocessor system, or boards to a massively parallel processor system, and push the machine over export control thresholds after the original export-licensed purchase.[242]

Clusters of Commercial Off-the-Shelf Computers and Networks

Recent advances in the process of computer-to-computer communication, or networking, allow computers to be linked together, or "clustered." Networking has allowed the clustering of personal computers and workstations into well-balanced effective parallel computers, with much higher computing capabilities than any one of the clustered computers.[243]

Four thresholds have been crossed in connecting commercial-off-the-shelf components to create parallel computers:

- **Using commercial-off-the-shelf components to create parallel computers is simple** because of the ease of hardware configuration and the availability of all necessary system software from market vendors
- **It is versatile because a wide range of possible network designs** with excellent communication characteristics and scalability to large sizes is now available
- **Clustered systems performance has now matured** to the point that network communication speed is within 50 percent of that in vendor-assembled parallel computers[244]
- **Commercial-off-the-shelf clusters are now affordable**

According to officials at the Lawrence Livermore National Laboratory, networking represents only a 10 percent additional cost over the cost of the computing hardware for large systems. Thus, up to approximately 50,000 MTOPS, the computing capability available to any country today is limited only by the amount of money that is available to be spent on commercial-off-the-shelf networking.[245]

A typical commercial-off-the-shelf networking technology contains five essential elements. They are all inexpensive and widely available. The three hardware elements are switches (approximate cost: $2,000), cables (approximate cost: $100), and interface cards (approximate cost: $1,500). The two software elements are low-level network drivers for common operating systems, and industry standard communication libraries. The hardware and software technology necessary to successfully cluster commercial-off-the-shelf CPUs into effective parallel computers is well developed and disseminated in open, international collaborations worldwide.[246]

The concept of clustering commercial-off-the-shelf computers has been a subject of open academic study for over a decade. Today, the Beowulf Consortium acts as a focal point for information on clustering technology and has links to many projects. One Beowulf project is the Avalon computer at Los Alamos National Laboratory. Avalon can operate at 37,905 MTOPS[247] and was built in four days in April 1998 entirely from commodity personal computer technology (70 DEC Alpha CPUs) for $150,000.

Although commercial-off-the-shelf networking technology has only recently become effective, it has been adopted rapidly. There currently are at least seven competing high-performance network technologies (over 100 megabytes per second or higher): Myrinet, HIPPI, FiberChannel, Gigabit Ethernet, SCI, ATM, and VIA. One network vendor reported over 150 installations in the United States and 17 foreign countries including Australia, Brazil, Canada, the Netherlands, England, France, India, Israel, Italy, Japan, the Republic of Korea, and the PRC.[248]

Gigabit Ethernet is of particular interest because it is being developed by a cooperative, worldwide industry effort called the Gigabit Ethernet Alliance. 74 companies have pledged to develop products for the open standard — that is, the source software is available openly to software developers. Foreign companies are alliance members and also participate as members of the steering committee and the certification process for compliance. Gigabit Ethernet is projected to be a $3 billion market by the year 2000, which at today's prices translates into approximately 300,000 network switches per year.[249]

On October 15, 1997, a group of experts met to discuss computer performance metrics for export control purposes. The computer and high-tech industries were represented by Hewlett-Packard, Silicon Graphics/Cray Research, IBM, Digital Equipment Corporation, Intel, Sun Microsystems, the Center for Computing Sciences, the Institute for Defense Analyses, and Centerpoint Ventures. The U.S. Government was represented by the National Institute of Standards and Technology, the Naval Research Laboratory, the Defense Advanced Research Projects Agency, the National Security Agency, Lawrence Livermore National Laboratory, the Defense Technology Security Administration, and the Department of Commerce Bureau of Export Administration.[250]

The consensus of the discussion was that commercial-off-the-shelf networking is not so significant a threat to replace HPCs as might at first appear to be the case:

> ***Networks of workstations using [commercial-off-the-shelf] networking technology differ from supercomputers. Some problems will run easily and effectively on such networks, while other classes of problems important to national security concerns will not run effectively without a major software redesign effort.*** *For many problems no amount of software redesign will allow networks of workstations to compete with appropriately designed high performance computers.*
>
> ***Even if a "rogue state" assembled such a large network of workstations by legitimately acquiring large numbers of commodity processors, the actual effort to produce the software necessary to realize the full potential of such an aggregate system would take several years.*** *During this time, the state of the art of computational technology would have increased by approximately an order of magnitude.*

> *After considerable discussion, most of the participants were in agreement that there was a fundamental difference between a system designed by a single vendor that was built as an aggregate of many commodity processors and included the software to enable these processors to cooperatively work on solving single problems of national concern, and a large collection of commodity processors not subject to export control that are externally networked together.*[251]

According to one expert, many universities have clustered systems, as they are easy to establish. For $70,000, a 12-node system with two Pentium II processors at 300 megahertz (MHz) each would produce a system with 7,200 GFLOPS. However, the system must be properly structured to perform well, and performance will vary depending on the application, the programmer's ability, and the connection of the machines. An integrated system from Silicon Graphics/Cray will achieve between 10-20 percent of peak performance at best.[252]

An example of a powerful commercial-off-the-shelf network can be found at the Illinois Supercomputing Center. Four eight-processor and two 16-processor machines from Silicon Graphics are connected in a cluster with a peak speed of nearly 20 GFLOPS.[253]

According to one expert, it does not require any special expertise to network workstations using commercial-off-the-shelf technology. The software engineering techniques are being taught to undergraduates as part of standard courses in advanced computing, but anyone with programming knowledge should be able to create a network as well.[254]

The parallel supercomputers of today have peak speeds of over 100 billion floating point operations per second (100 GFLOPS). This is roughly 100 times the peak speed of a Cray YMP class machine, which was the standard for high-performance computing of just five years ago.[255]

However, it is difficult to achieve a high percentage of this peak performance on a parallel machine.

Whereas a tuned code running on a Cray might reach 80-90 percent of peak speed, codes running on parallel computers typically execute at only 10-20 percent of peak.[256] There are two reasons for this:

- **The first is that Cray-class computers incorporate extremely expensive, custom-designed processors with vector-processing hardware.** These processors are designed to stream large amounts of data through a highly efficient calculational pipeline. Codes that have been tuned to take advantage of this hardware ("vectorized" codes) tend to run at high percentages of peak speed.[257]

  Parallel machines, on the other hand, are generally built from much simpler building blocks. For example, they may use the same processors that are used in stand-alone computer work-stations. Individually, these processors are not nearly so sophisticated or so efficient as the vector processors. Thus, it is not possible to achieve so high a percentage of peak speed.[258]

  Some parallel machines contain custom processors (TMC CM-5 vector units) or custom modifications of off-the-shelf processors (Cray T-3D modified DEC alpha chips). Even in those cases, however, the percent of peak achievable on a single node is still on the order of 50 percent or less. In parallel computer design, there is constant tension between the need to use commodity parts as the computational building blocks in order to achieve economies of scale, and the desire to achieve ever-higher percentages of peak performance through the implementation of custom hardware.[259]

- **The second reason that parallel computers run at lower percentages of peak speeds than vector supercomputers is communications overhead.** On parallel computers, the extraordinary peak speeds of 100 GFLOPS or more are achieved by linking hundreds or even thousands of processors with a fast communications network.

Virtually all parallel computers today are "distributed memory" computers. This means that the random access memory (RAM) is spread though the machine, typically 32 megabytes at each node. When a calculation is performed on a parallel machine, access is frequently needed to pieces of data on different nodes.

It may be possible to overlap this communication with another computation in a different part of the program in order not to delay the entire program while waiting for the communication, but this is not always the case. Since the timing clock continues while the communication is taking place, even though no calculational work is being performed, the measured performance of the code goes down and a lower percentage of peak performance is recorded.[260]

Domain Decomposition

"Domain decomposition" involves partitioning the data to be processed by a parallel program across the machine's processors.[261]

In distributed memory architectures, each processor has direct access only to the portion of main memory that is physically located on its node. In order to access other memory on the machine, it must communicate with the node on which that memory is located and send explicit requests to that node for data.[262] Figuring out the optimal domain decomposition for a problem is one of the most basic and important tasks in parallel computing, since it determines the balance between communication and computation in a program and, ultimately, how fast that program will run.[263]

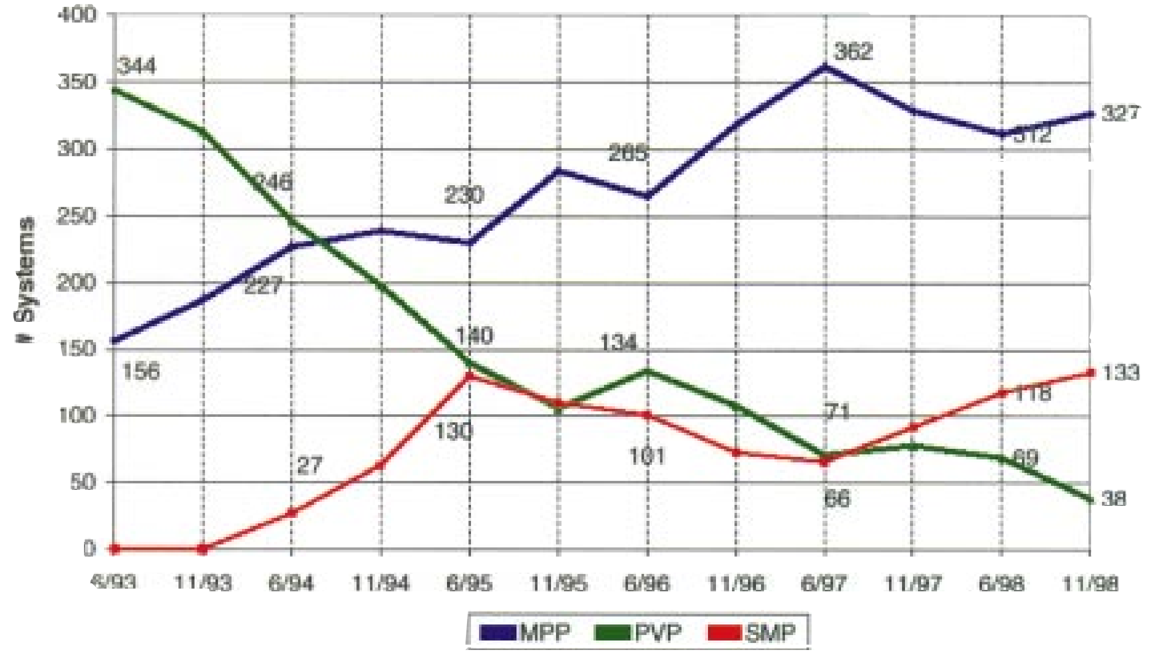
Memory access constitutes an inherent bottleneck in shared-memory systems.[264]

Highly Parallel Technology

Microprocessor-based supercomputing has brought about a major change in accessibility and affordability. Massively parallel processors continue to account for more than half of all installed supercomputers worldwide, but there is a move toward shared memory, including the use of more symmetrical multiprocessor systems and of distributed-shared memory. There is also a tendency to promote scalability through the clustering of shared memory machines because of the increased efficiency of message passing this offers. The task of data parallel programming has been helped by standardization efforts such as Message Passing Interface and High-Performance Fortran.[265]

Highly parallel technology is becoming popular for the following reasons. First, affordable parallel systems now out-perform the best conventional supercomputers. Cost is, of course, a strong factor, and the performance per dollar of parallel systems is particularly favorable.[266] The reliability of these systems has greatly improved. Both third-party scientific and engineering applications, as well as business applications, are now appearing. Thus, commercial customers, not just research labs, are acquiring parallel systems.[267]

Architectures of the Top 500 Most Powerful Supercomputers in Use



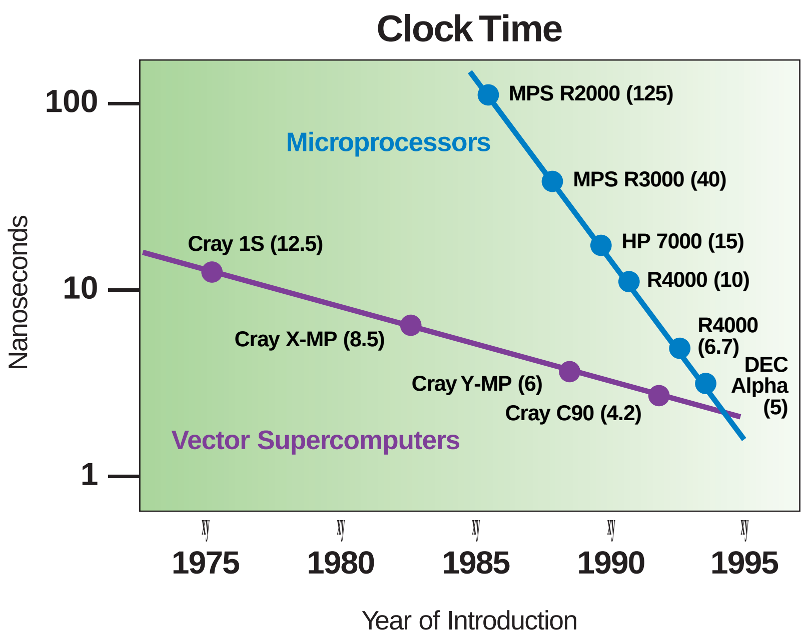
Since late 1993, massively parallel processors (MPP) and symmetrical multiprocessor systems (SMP) began to overtake vector systems (PVP) as the most powerful computer systems in use. Affordable parallel systems now out-perform the best conventional supercomputers. While cost is one reason, the reliability of such systems has greatly improved.

Twice a year the "Top 500 list," a compendium of the 500 most powerful computer systems, is published.[268] On the previous page is an example of the numbers and types of systems in the biannual list of the top 500 fastest computers. As this chart points out, massively parallel processors and symmetrical multiprocessor systems are on the rise, while vector systems are losing ground.[269]

Microprocessor Technology

While vector and massively parallel computers have been contending for the supercomputing market, an important new factor has become the availability of extremely powerful commodity microprocessors, the mass-produced chips at the heart of computer workstations.

Ten years ago, workstation microprocessors were far slower than the processors in supercomputers. The fastest microprocessor in 1988, for example, was rated at one million floating point operations per second (MFLOPS) while Cray's processors were rated at 200 MFLOPS.[270] A floating-point operation is the equivalent of multiplying



Ten years ago, workstation microprocessors were far slower than the processors in supercomputers. Today, Cray's processors have improved by a factor of 10, to two gigaflops in the new T90. But the faster microprocessor runs at 600 MFLOPS, an improvement by a factor of 600.

two 15-digit numbers. Today, Cray's processors have improved by a factor of ten, to two gigaflops in the brand-new T90; but the fastest microprocessor runs at 600 MFLOPS, an improvement by a factor of 600.

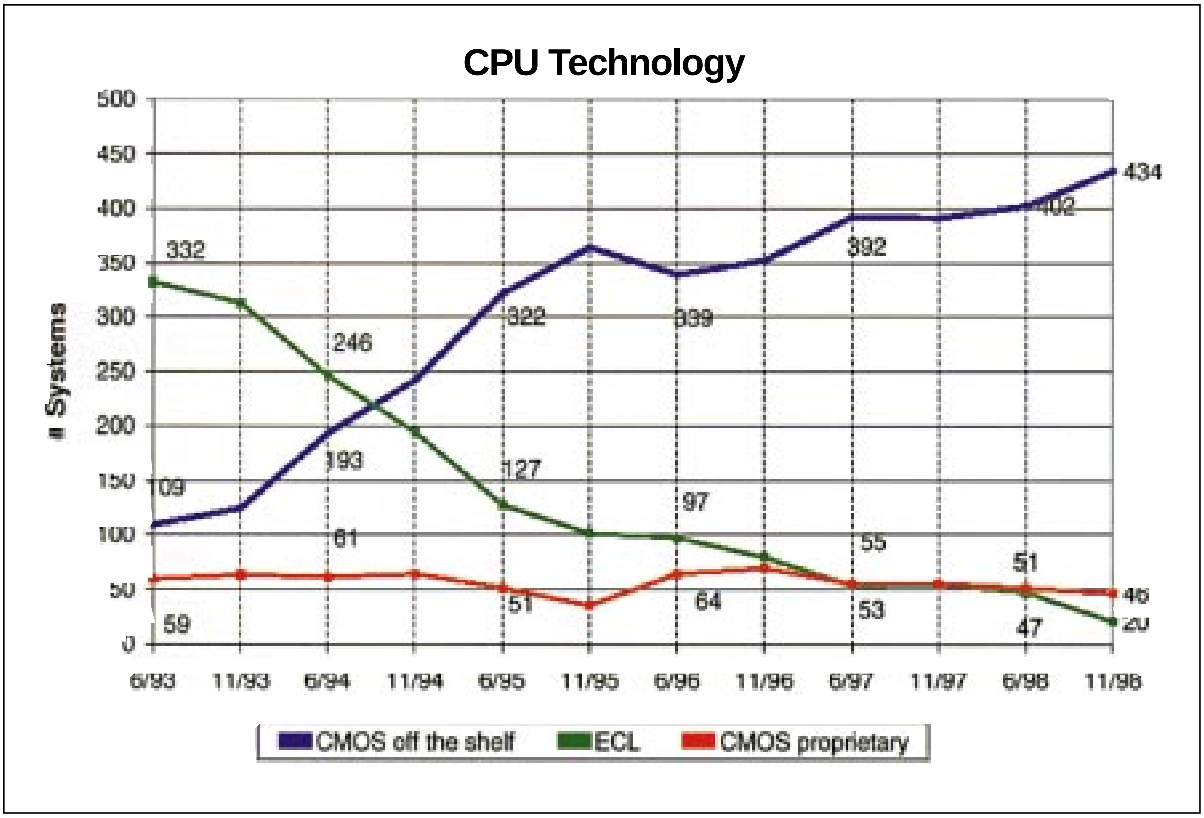
Commercial off-the-shelf microprocessor power is available for a fraction of the cost of a traditional vector processor. Unlike vector processors, which consist of complex collections of chips and are only fabricated by the hundreds each year, commercial off-the-shelf microprocessors are designed for mass production based on two decades of experience making integrated circuits. Research and development costs for each commercial off-the-shelf microprocessor are spread over hundreds of thousands of chips.[271]

Microprocessors, also known as CPUs, are integrated circuits. They can be divided into broad categories of logic family technologies. The selection of a certain logic technology in the design of an integrated circuit is made after determining an application and weighing the advantages of each type of logic family. Among these are:

- **Emitter-Coupled Logic (ECL)** is used for circuits that will operate in a high-speed environment, as it offers the fastest switching speeds of all logic families; it is the first type HPC chip. ECL, however, is power-hungry, requires complex cooling techniques, and is expensive.[272]

- **Complementary Metal-Oxide Semiconductor Logic (CMOS)** is relatively inexpensive, compact and requires small amounts of power. CMOS off-the-shelf is the standard PC or workstation chip; proprietary CMOS is custom-built, specially designed for the particular HPC and incompatible with PCs and workstations.

Realizing the differences between logic technologies gives a perspective to understanding where CPU technology is headed, and the reasons that the market is driving one technology faster than another. As the following chart illustrates, commercial off-the-shelf, inexpensive CPUs are coming to dominate the high performance computing world.[273]



Inexpensive commercial, off-the-shelf CPUs utilizing complementary metal-oxide semiconductor logic (CMOS) in their circuitry are beginning to dominate the high performance computing world, beating out CPUs using the faster emitter-coupled logic (ECL). The latter technology, however, is power-hungry and requires complex cooling techniques that make it more expensive.

Interconnect Technology

In multiprocessor systems, actual performance is strongly influenced by the quality of the "interconnect" that moves data among processors and memory subsystems.[274]

Traditionally, interconnects could be grouped into two categories: proprietary high-performance interconnects that were used within the products of individual vendors, and industry standard interconnects that were more readily available on the market, such as local area networks.[275] The two categories featured different capabilities, measured in bandwidth and latency.

Recently, a new class of interconnect has emerged: clustering interconnects. These offer much higher bandwidth and lower latency than local area networks. Their shortcomings are comparable to proprietary high-performance interconnects, including lower bandwidth, higher latency, and greater performance degradation in large configurations or immature system software environments.[276]

Message Passing Interface

Message Passing Interface (MPI) is a program containing a set of sub-routines that provide a method of communication that enables various components of a parallel computer system to act in concert. The communications protocol that MPI uses is the same utilized by the Internet. According to Dr. Jeff Hollingsworth of the University of Maryland Computer Science Department, an example of how each of the different software applications interact with the hardware would be as follows:[277]

Application (Code)

MPI

TCP/IP

Linux

Windows NT (Operating system)

Hardware

Some software, says Hollingsworth, is sold in a version that is compatible with MPI. One example is automobile crash simulation software. This software, which is essentially code to simulate a physical system in three dimensions, is adaptable to other scientific applications such as fluid dynamics, according to Hollingsworth.[278]

Hollingsworth states that software that is not already “MPI ready” can be modified into code that can be run in an MPI, or parallel, environment. Modifying this software to enable it to run in an MPI environment can be very difficult, or quite easy, says Hollingsworth, depending on “data decomposition.”[279]

The ease of converting software that is not "MPI ready" into an "MPI ready" version is dependent on the expertise of the software engineers and scientists working on the problem. For a single application and a single computer program, the level of expertise required to convert a computer program in this way is attainable in graduate level, and some undergraduate level, college courses, according to Hollingsworth.[280]

It has not been possible to determine which, if any, commercially available software is both MPI ready and applicable to defense-related scientific work.

PRC MISSILE AND SPACE FORCES

Since its beginning, the PRC's ballistic missile and space program has received considerable foreign expertise and technology. This support has helped the PRC become a major ballistic missile and space power. The PRC has received considerable assistance from Russia (and previously from the Soviet Union) and the United States, as well as from other nations such as France and Germany.

From 1956 to 1960, the Soviet Union was the major supplier of ballistic missile technology and knowledge to the PRC. The Sino-Soviet split in 1960 ended this cooperation. Today, however, Russia is a major supplier of space launch technology to the PRC. This assistance could be expanded to help the PRC in its efforts to develop road-mobile ICBMs, which would provide the PLA with more confidence in the survivability of its retaliatory nuclear force.

Technology and knowledge acquired from the United States has also assisted the PRC's missile and space programs, although this assistance was never officially sanctioned. Qian Xuesen was a Chinese citizen who was trained in the United States and who worked on classified programs including the Titan ICBM program. After being accused of spying for the PRC in the 1950s, Qian was permitted to return to the PRC, where he became the "father" of the PRC's ballistic missile and space programs. The illegal acquisition of U.S. technology for the PLA's ballistic missiles and space programs has continued aggressively during the past two decades, up to the present day.

The PRC has stolen design information on the United States' most advanced thermonuclear weapons, elements of which could be emulated by the PRC in its next generation ICBMs.

The PRC has stolen U.S. missile guidance technology that has direct applicability to the PLA's ballistic missiles.

Assistance from U.S. companies has improved the reliability of the PRC's military and civilian rockets, and the transfer of some of these improvements to its ballistic missiles is possible.

Western nations, including the United States, Germany, and France, have provided significant support to the PRC's satellite programs. German companies provide the communications package for the PRC's DFH-3 communications satellites. U.S.-manufactured radiation-hardened chips are also used on the PRC's meteorological satellites, used for both military and civilian purposes, to increase the on-orbit life of the satellites.

The PRC is a major ballistic missile proliferator. While the PRC agreed in 1991 to abide by the Missile Technology Control Regime, the PRC transferred complete ballistic missile systems to Pakistan in 1992, and has provided other nations with ballistic missiles production-related technologies. The PRC has not agreed to the MTCR's revised limits on transfers of ballistic missile components.

The PRC has transferred ballistic missile technology to Iran, Pakistan, North Korea, Saudi Arabia, Libya, and other countries.

PRC MISSILE AND SPACE FORCES

Introduction

> *"By the next century, as high-tech space technology develops, the deployment of space-based weapons systems will be bound to make 'mastery of space' and 'mastery of outer space' prerequisites for naval victory."*
>
> *PLA Navy Senior Colonel*
> *Shen Zhongchang*

In 1956, advisors from the Soviet Union convinced the leadership of the People's Republic of China (PRC) to include ballistic missile development in the PRC's Twelve Year Plan for the Development of Science and Technology (1956-1967). Having just fought a war against the United States in Korea and having come face-to-face with U.S. military supremacy, the PRC decided that combining long-range ballistic missiles and nuclear weapons offered its best chance to build weapons capable of neutralizing the United States' and the Soviet Union's formidable advantage.

Since that time, the PRC has embarked on an extensive ballistic missile and space program.

From its beginning in the 1950s, the PRC has also adapted its ballistic missile program into a major international space program. Since its first space launch in 1971, the PRC has developed ten variations of rockets that have allowed it to place 44 satellites into orbit.

Today, the PRC is embarked on a modernization plan for its ballistic missile and space forces. This expansion includes the exploitation of space-based military recon-

Since their origin, the PRC missile and space programs have been tied together. The PRC can apply the same system refinements and modifications to both its rockets and ICBMs.

naissance and communications satellites and space-based weapons.[1] In addition, the PRC has set for itself the goal of putting men in space this year.

This chapter provides an analysis of the PRC's missile and space forces, and the impact that Western technology has had on those forces. It details the PRC's ballistic missile forces; its space forces, including its rockets and satellites; and the interaction between the two groups.

This chapter also serves as an introduction to the capabilities of the PRC's missile and space programs, and the degree to which foreign assistance and technology may affect the course of their future development.

This chapter is derived from an extensive chapter in the Select Committee's classified Report, much of which, due to national security concerns, cannot be reproduced here.

The PLA's Ballistic Missile Forces

Development of the PLA's Ballistic Missile Forces

The early development of the PLA's indigenous ballistic missile programs was marked by Soviet assistance, and by the guidance of a Chinese citizen who had returned to the PRC after working on the U.S. Titan intercontinental ballistic missile (ICBM) program.[2]

The Soviet Union's Contribution to the PLA's Ballistic Missile Force

The PRC received its first ballistic missiles in 1956, with the acquisition of two Soviet R-1 missiles. These were copies of the German cryogenic liquid-propellant V-2 missiles used in World War II. The PRC quickly acquired more advanced missiles in the form of the R-2 in 1957. The R-2 had considerable technical improvements over the R-1, including a greater range and a larger payload, as well as the use of storable liquid propellants.

In addition to the ballistic missiles themselves, the Soviet Union provided the PRC with blueprints for the R-2 missiles, and with advisors to assist in the PRC's development of a copy of the R-2. With this Soviet technical assistance, the PRC was able to produce and deploy these missiles.

During this period, PRC engineers and students received training at the Moscow Aviation Institute (MAI). While at MAI, these students were trained in aeronautical engineering, and acquired experience with more advanced Soviet missiles such as the SS-3 and the SS-4. In many instances, the information gained about more advanced Soviet missiles came when the students made copies of restricted notes, and quizzed their professors about the Soviet missiles.

In 1960, the Sino-Soviet split ended all cooperation, including missile cooperation, between the PRC and the Soviet Union. This left the PRC to continue its missile programs on its own, using the know-how it had gained from the Soviet Union, and the expertise of its American-trained scientists.

The Role of Qian Xuesen in the Development Of the PRC's Ballistic Missile and Space Programs

The PRC's ballistic missile and space programs received substantial assistance during their early development from Qian Xuesen (also known as Tsien Hsue-Shen), a Chinese citizen who was trained in the United States and had worked on classified U.S. missile programs, including the Titan intercontinental ballistic missile program.

Qian Xuesen became instrumental in the PRC's ballistic missiles program, where he is known as the "father of China's ballistic missile force." A biography of Qian published in the PRC states that he "made significant contributions to the rapid development of Chinese rockets [and] missiles, as well as space flight."[3]

Born in Shanghai in 1911, Qian left China in 1935 during the Japanese occupation. He received his Masters degree from the Massachusetts Institute of Technology (MIT) and his Ph.D. from the California Institute of Technology (Cal Tech). At Cal Tech, Qian worked as a member of the rocket research group of the Guggenheim Aeronautical Laboratory, and at the Jet Propulsion Laboratory (JPL).

While at the Guggenheim Aeronautical Laboratory he made "pioneering contributions" to aviation engineering theory in the areas of supersonic and transonic aerodynamics, as well as thin shell stability theory for ballistic missile structures.[4]

Qian Xuesen is known as the "father of the PRC's ballistic missile force." Once a Colonel in the U.S. Army Air Force, Qian eventually worked on America's Titan ICBM (*right*) before returning to the PRC in the early 1950s amid charges that he was a PRC spy. Qian later helped design the PLA's nuclear-armed CSS-4 ICBMs that are currently targeted at the U.S.

At JPL, Qian was recognized as one of the world's foremost experts on jet propulsion. During this time, he worked on Private A, which was the first solid propellant missile that performed successfully in the United States.[5]

Based on his rocket work at Cal Tech, Qian was recruited to join the U.S. Army Air Force in the development of its long-range missile programs.[6] Commissioned a Colonel in the U.S. Army Air Force,[7] he eventually began working on the Titan intercontinental ballistic missile.[8]

During the 1950s, allegations arose that Qian was spying for the PRC.[9] He lost his security clearances and was removed from work on U.S. ballistic missiles.[10] The allegations that he was spying for the PRC are presumed to be true.

Qian was invited back to the PRC and, after negotiations between the U.S. Government and the PRC, Qian was allowed to return to the PRC in 1955. Four other Chinese members of Qian's Titan design team also returned with him to the PRC.[11]

There were additional allegations that Qian attempted to ship classified documents to the PRC before he left in 1955.[12]

Once back in the PRC, Qian became the leading figure in the PRC's ballistic missile effort.[13] Qian and his associates were able to apply the knowledge they gained from working on U.S. ballistic missile programs to the PRC's ballistic missile programs.

Qian became the chief project manager in all of the PRC's ballistic missile programs, and was the lead designer of the CSS-4 intercontinental ballistic missile. The CSS-4 is the nuclear-armed ICBM currently targeted on the United States. (All but two of the PRC's approximately 20 CSS-4 ICBMs have been deployed during the 1990s.)

Qian was also the first director of the PRC's Fifth Academy, which was responsible for aeronautics and missile development research.[14] Today, the Fifth Academy is known as the China Aerospace Corporation (CASC), and its current Director is PRC Minister Liu Jiyuan.[15]

Qian was also instrumental in the development of the PRC's space program. In 1958, he began presenting his concepts for a satellite to the Communist Party leadership. In 1962, Qian began training PRC scientists in the design and development of satellites. The satellite, which would become known as the Dong Fang Hong-1, was launched on April 24, 1970. Qian was personally commended by Mao Zedong and other PRC leaders for his contributions to the design and launch of the satellite.[16]

The CCP leadership awarded Qian the honorary rank of Lieutenant General in the People's Liberation Army. It is a rank commensurate with his place as a senior scientist in the PRC's ballistic missile program.[17]

In 1991, President Jiang Zemin provided Qian with the "State Scientist of Outstanding Contribution" award, which is the highest honor a scientist in the PRC can achieve.[18]

Development of the PLA's Intermediate- and Short-Range Ballistic Missiles

The PRC began developing three ballistic missiles in the early 1960s. The first two, which would become known in the West as the CSS-2 and CSS-3, showed strong Soviet design influences, especially in the guidance and propulsion subsystems. The

PRC Ballistic Missiles

U.S. Designator	CSS-2	CSS-3	CSS-4	CSS-5/ JL-1	CSS-6	CSS-X-7	CSS-8	DF-31	JL-2
PRC Designator	DF-3	DF-4	DF-5	DF-21	DF-15	DF-11	8610	DF-31	JL-2
Range (in miles)	1,926	3,417	7,457	1,119	373	186	143	4,871	4,871
Propellant Type	Liquid	Liquid	Liquid	Solid	Solid	Solid	Solid/ Liquid	Solid	Solid

The PRC began developing its ballistic missile system in the early 1960s. The first missile, the CSS-2, showed strong Soviet design influences. Launched from mobile launchers, it has a range of up to 1,926 miles. The CSS-3 was the PRC's first intercontinental range missile, but with a range of 3,417 miles it cannot reach the United States. The CSS-4 is the PRC's main ICBM threat against the U.S. With a range in excess of 7,457 miles, it can hit most of the U.S. During the 1990s, the PRC has deployed approximately 20 CSS-4s in silos, most of which are targeted at the U.S. An improved version of the CSS-4, known as the CSS-4 Mod 2, could allow the PRC to deploy multiple warheads.

third missile, which would become known as the CSS-4, uses advanced gyroscopes for increased accuracy. The chart on the previous page illustrates current and future PRC ballistic missile systems.

The **CSS-2** mobile missile is designated by the PLA as the Deng Feng 3 (that is, **East Wind 3**). It has evolved into a 1,700- to 1,900-mile range single-stage liquid-propellant ballistic missile. The PLA deploys CSS-2 ballistic missiles on mobile launchers. The PRC sold several dozen of these CSS-2 missiles, armed with conventional warheads, to Saudi Arabia in 1988.

Associated Press

The CSS-2, manufactured in the early 1960s, was among the PRC's first ballistic missiles. It showed strong Soviet design influences, especially in the guidance and propulsion subsystems.

The **CSS-3** (PLA designation DF-4, or **East Wind 4**) was the PRC's first missile with "intercontinental" range. The CSS-3 is a two-stage liquid-propellant intercontinental ballistic missile. It has a range of more than 3,400 miles,[19] but is considered a "limited range" ICBM because it cannot reach the United States. It uses the medium-range CSS-2 as its first stage. Targets for the PLA's CSS-3 missiles could include:

- **India**
- **Russia**
- **The U.S. Naval Facility at Diego Garcia**
- **The U.S. Air Force Base at Guam**

The CSS-3 missiles are based in silos, and in mountainside tunnels where they are rolled out and erected for launch.[20] The CSS-3 missile has been deployed by the PLA since 1980.[21]

The PLA's Current "East Wind" Intercontinental Ballistic Missiles

The **CSS-4** (PLA designation DF-5, or **East Wind 5**) is currently the PRC's main ICBM nuclear threat against the United States.

The CSS-4 program began in the 1960s. It was originally envisioned that the missile would use liquid oxygen and kerosene propellants, similar to those used in the Soviet R-7 (SS-6) missile and in the U.S. Atlas. In the early 1960s, however, the program transitioned into the use of storable propellant.

Progress in the CSS-4 program was slowed by the Great Leap Forward in 1963 and the Cultural Revolution from 1966-1976, which compounded the technical challenges of developing an ICBM. The CSS-4's development program continued to progress over the next 20 years.

The PRC first attempted a flight test of the CSS-4 in the 1970s. Following several flight test failures, the PRC continued its development of the CSS-4 through its development of the Long March 2 rocket. Of the next nine Long March 2 launches from 1973 through 1978, five were successful.

The CSS-4 uses nitrogen tetroxide (NTO) as the oxidizer and a lightweight, aluminum-copper alloy airframe. It is equipped with four YF-20 engines in its first stage, and a single YF-20 engine in its second stage. Unlike previous PRC missiles that use jet vanes in the exhaust for steering control, the CSS-4 uses steerable exhaust nozzles for control. It has been reported to the Select Committee that the CSS-4 uses a gimbaled guidance system for control.[22]

Starting in 1981, the PRC began deploying CSS-4 missiles in silos. Only two operational missiles were deployed in the 1980s, on what the PRC called "trial operational deployments."

Associated Press

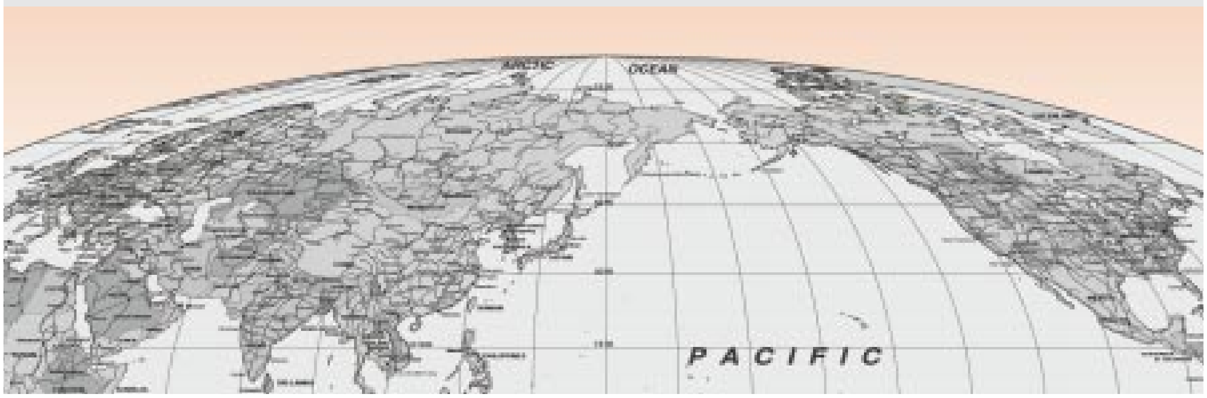
The CSS-4 is the nuclear-armed ICBM currently targeted at the United States. Of the approximately 20 of these ICBMs in the PLA arsenal, all but two were deployed during the 1990s, and most are targeted at the United States.

During the 1990s, the PRC has deployed a total of approximately 20 CSS-4 ICBMs in silos, most of which are targeted on the United States. The Select Committee judges that despite the 1998 announcement that the PRC and the U.S. would no longer target each other with nuclear weapons, the PRC's missiles remain targeted at the United States.

Approximate Distances to Selected Targets in the U.S. and Europe Within Range of the PRC's CSS-4 ICBM

(Distances measured using Great Circle arcs from latitude 35.09N, longitude 112.37E, the area in which PRC CSS-4 silos are reportedly located)

CITY	DISTANCE IN MILES
Anchorage	4,392
Honolulu	5,370
Seattle	5,788
Los Angeles	6,641
Chicago	6,982
Detroit	7,006
Boston	7,096
St. Louis	7,151
New York	7,200
Washington, D.C.	7,301
Dallas	7,613
Moscow	3,707
London	5,216
Paris	5,244



Today, the CSS-4 has a range in excess of 7,400 miles. The PRC has begun deploying an improved version of the CSS-4, known as the **CSS-4 Mod 2**.[23] The Mod 2 has improved range capabilities over the CSS-4. The additional range may provide the PRC with greater confidence that the missile will reach long distance targets such as Washington, D.C., although this and other U.S. cities are already within the range of the CSS-4.

This improved range may also translate into an improved throw-weight that could allow the PRC to deploy multiple warheads on the CSS-4 Mod 2, rather than the single warheads that are currently carried on the CSS-4.

The PLA's Future "East Wind" Intercontinental Ballistic Missiles

Missiles in silos are vulnerable to attack because their precise location can be known in advance. Concerns about the survivability of its silo-based CSS-4 ballistic missile forces have led the PLA to begin a modernization program that includes the development of road-mobile, solid-propellant ballistic missiles.

The use of a solid-propellant missile in place of the liquid-fueled CSS-4 will permit the PRC to launch its missiles with shorter notice. That is because the liquid fuel for the current CSS-4 must be stored separately from the missile until launch. Then, prior to launch, the CSS-4 missile must be fueled.

Substitution of a mobile missile for the silo-based CSS-4 will make it possible to hide the missile's location, thus protecting it from attack.

The PLA is currently developing two road-mobile intercontinental ballistic missile systems. It also has under development a submarine-launched ballistic missile. The Select Committee judges that within 15 years, this modernization program could result in the deployment of a PLA intercontinental ballistic missile force consisting of up to 100 ICBMs.

The PRC's planned new mobile intercontinental ballistic missiles, and its planned new submarine-launched intercontinental ballistic missiles, require smaller warheads than the large, heavy, 1950s-era warheads developed for the PRC's current silo-based missiles. Because U.S. thermonuclear warheads are significantly smaller, they are capable of use on mobile missiles and submarine-launched missiles. The Select Committee judges that the PRC will exploit elements of the stolen U.S. thermonuclear warhead design information on these new ICBMs.

If any of the PRC's planned missiles were to carry multiple warheads, or if the CSS-4 were modified to carry multiple warheads, then a fairing (that is, a covering for the missiles in the nose cone) could be required. See the chapter entitled *Satellite Launches in the PRC: Hughes* for a discussion of the PRC's acquisition of fairing technology from the United States.

The aggressive development of a MIRV system by the PRC could permit the deployment of upwards of 1,000 thermonuclear warheads on ICBMs by 2015. See the chapter entitled *PRC Theft of Thermonuclear Warhead Design Information* for information on the PRC's development of nuclear warheads that may exploit elements of U.S. thermonuclear weapons design information.

The first of the three new intercontinental ballistic missiles that are being developed by the PRC is the **DF-31** (or **East Wind 31**). It is estimated that the DF-31 will be a three-stage, mobile, solid-propellant ballistic missile. It will be deployed on a mobile erector-launcher.

The DF-31's 5,000-mile range will allow it to hit all of Hawaii and Alaska and parts of the state of Washington, but not other parts of the continental United States.[24] Due to its limited intercontinental range, the DF-31 is most likely intended as the replacement for the PRC's aging CSS-3 force, rather than for the longer range CSS-4 ICBM.

The DF-31 missile may be tested this year. Given a successful flight program, the DF-31 could be ready for deployment as early as 2002.

The collapse of the Soviet Union has changed the PRC's strategic outlook, prompting the development of extended range missiles. To this end, the PRC is planning an even longer-range, mobile ICBM to add to its already deployed CSS-4 missiles. This new missile is believed to have a range of more than 7,500 miles, allowing the PRC to target almost all of the United States. These missiles can be deployed anywhere within the PRC, making them significantly more survivable.

The **JL-2** (Julang 2, or **Great Wave 2**) is a submarine-launched version of the DF-31. It is believed to have an even longer range, and will be carried on the PLA Navy's Type 094-class submarine. 16 JL-2 missiles will be carried on each submarine.[25]

The JL-2's 7,500 mile range will allow it to be launched from the PRC's territorial waters and to strike targets throughout the United States.[26]

This range would allow a significant change in the operation and tactics of the PRC's nuclear-powered ballistic missile submarines. Instead of venturing into the open ocean to attack the United States, the Type 094-class submarines could remain near PRC waters, protected by the PLA Navy and Air Force.

Additionally, if the JL-2 were to employ a shroud to protect its warhead as do the majority of submarine-launched ballistic missiles today, this would be the first use of a shroud or fairing on a PRC missile.

The PRC's Medium- and Short-Range Ballistic Missiles

The PRC is also deploying, or developing for future deployment, a series of short- and medium-range ballistic missiles, including both liquid- and solid-propellant technologies. Some are armed with conventional warheads and others with nuclear warheads. These missiles present a threat to U.S. forces deployed in the region, and to U.S. allies and friends in the region.

The PRC's short- and medium-range ballistic missiles include the CSS-6 short-range ballistic missile, the CSS-X-7 short-range ballistic missile, and the CSS-5 medium-range ballistic missile. The PRC is also developing new versions of its short-range ballistic missiles, and may produce these systems in larger quantities than earlier-generation PRC ballistic missiles.

The PLA's CSS-6 (DF-15 or East Wind 15; also known as the M-9) is an advanced, solid-propellant, short-range ballistic missile that uses 1990s technology. It has a range of 375 miles. It is a road-mobile missile, launched from a transporter-erector-launcher. The CSS-6 may be fitted with nuclear warheads or with an enhanced radiation weapon (neutron bomb).

Janes Defense Group

The CSS-6 ballistic missile is an advanced, solid-propellant short-range weapon that uses 1990s technology. It may be fitted with either strategic nuclear warheads or neutron bomb warheads. The majority of the PLA's CSS-6 missiles are deployed adjacent to Taiwan.

According to published reports, the majority of the PRC's CSS-6 missiles are deployed adjacent to Taiwan.

The PRC may attempt various means to improve the CSS-6's accuracy. The PRC claims to be planning to use the Global Positioning System (GPS) on its "M" missiles, which likely include the CSS-6, CSS-X-7, and other short-range ballistic missiles.

On two recent occasions, the PRC has launched a number of CSS-6 missiles towards Taiwan as a means of political intimidation. In July 1995, the PRC fired CSS-6 missiles to a location north of Taiwan in an attempt to influence Taiwan's parliamentary elections. In March 1996, the PRC again launched CSS-6 missiles to areas north and south of Taiwan's two major ports in an effort to influence its presidential elections.

The PRC is also developing the **CSS-X-7** (DF-11 or **East Wind 11**; also known as the M-11) short-range ballistic missile. The CSS-X-7 is a mobile, 185-mile range solid-propellant ballistic missile that is launched from a transporter-erector-launcher. This missile has been exported to Pakistan. The main advantage of the CSS-X-7 over the CSS-6 is its ability to carry a larger payload.

The CSS-5 (DF-21, or East Wind 21) medium-range ballistic missile is now deployed by the PRC. The CSS-5 is a road-mobile, solid-propellant ballistic missile with a range of 1,100 miles. The CSS-5 is assessed to carry a nuclear warhead payload. An improved version, known as the **CSS-5 Mod 2**, is under development in the PRC. The range of these missiles, if fitted with a conventional warhead, would be sufficient to hit targets in Japan.

The CSS-5 has also been developed in a submarine-launched ballistic missile version. The Western designation of this missile is **CSS-NX-3**; its PLA designation is **JL-1** (Julang 1, or **Great Wave 1**). This missile is assessed to have a range of 1,200 miles. Missiles of this type will be launched from the PLA Navy *Xia*-class nuclear-powered ballistic missile submarine.

While the *Xia* submarines were completed in 1981, the PRC has yet to deploy the CSS-NX-3 missile.[27] Due to the missile's 1,000-mile range, the CSS-NX-3 is best suited for theater targets, although it could threaten the U.S. if the PRC chose to deploy it in open-ocean operations.

The PRC has also developed the **CSS-8** (8610) short-range ballistic missile. The CSS-8 is derived from the Soviet SA-2 surface-to-air missile. The PRC has sold the missile to Iran.

The PRC's CSS-NX-3 ballistic missile will be launched from the PLA Navy's Xia-class submarines (*above*). With a range of more than 1,000 miles, the ballistic missile could threaten the U.S. if the PRC chose to deploy it in open-ocean operations. The CSS-NX-3 is best suited for theater targets.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The PRC has stolen American guidance technology used on a variety of U.S. military hardware, including the F-15 (*above, left*), F-16 (*below, left*), and F-117 "stealth" aircraft (*above*).

Stolen U.S. Technology Used on PRC Ballistic Missiles

The PRC has stolen U.S. missile guidance technology that has direct applicability to the PLA's ballistic missiles and rockets. The stolen guidance technology is used on a variety of U.S. missiles and military aircraft:

- **The 90-mile range U.S. Army Tactical Missile System**
- **The U.S. Navy's Stand-off Land Attack Missile-Extended Range (SLAM-ER)**
- **The U.S. Navy F-14 fighter jet**
- **The U.S. Air Force F-15 fighter jet**
- **The U.S. Air Force F-16 fighter jet**
- **The U.S. Air Force F-117 fighter jet**

The PRC's Strategic Forces Doctrine

Following the detonation of its first nuclear weapon in 1964, the PRC publicly declared that it would never use nuclear weapons first against the homeland of a nuclear power or a non-nuclear nation. The PRC pointedly does not include Taiwan in this formulation. The PRC's announced strategic doctrine is based on the concept of "limited deterrence," which is defined as the ability to inflict unacceptable damage on an enemy in a retaliatory strike.[28]

The PRC's currently deployed ICBMs are so-called "city busters": that is, they are useful for targeting entire cities or large military bases, rather than smaller, hardened targets such as U.S. ICBM silos. The intercontinental-range CSS-4s are deployed in their silos without warheads and without propellants during day-to-day operations.[29]

Strategic doctrine, however, can change, and the PRC's movement towards a nuclear missile force of several kinds of mobile, long-range ballistic missiles will allow it to include a range of options in its nuclear force doctrine. The acknowledged high accuracy of U.S. ballistic missiles, as well as the large number of increasingly accurate Russian missiles, may have left the PRC unsatisfied with the vulnerability of its silo-based forces. The PRC's new mobile missiles will be difficult to locate once they have been dispersed from their garrisons, giving them far better protection from attack. These new, mobile, long-range missiles can also be launched on much shorter notice than the PRC's current force, due to their planned use of solid propellants.

Because they will be much more difficult to locate and destroy than the PRC's current silo-based ICBM force, these new mobile ICBMs will present a more credible threat against the U. S. in the event a crisis develops over a regional conflict in East Asia.

According to the Commission to Assess the Ballistic Missile Threat to the United States:

> *In a crisis in which the U. S. confronts China's conventional and nuclear forces at the regional level, China's modernized strategic nuclear ballistic missile force would pose a credible threat against the United States.*

Deterring the U. S. can be important to China's ability to use force to achieve its goal of being the preeminent power in East Asia.

China demonstrated a willingness to use ballistic missiles in the Taiwan crisis of 1995/96.

The question of a senior Chinese official — was the U. S. willing to trade Los Angeles for Taiwan — suggests their understanding of the linkage between China's regional and strategic ballistic missile capabilities.[30]

The deployment of the PRC's new nuclear-powered ballistic missile submarine could also lead to a shift in PRC doctrine, as these submarines will likely be deployed with their nuclear warheads already mated to the missiles. The long range of the JL-2 submarine-launched intercontinental ballistic missile will allow the PRC to conduct patrols close to its base, and under the protective cover of the PLA Navy and Air Force. This would provide the PLA submarine fleet with a more survivable nuclear force.

The fact that these new nuclear weapons will be far more survivable than the PRC's current silo-based forces could signal a major shift in the PRC's current nuclear strategy and doctrine.

The PRC might allow the first use of nuclear weapons on its own territory, which the PRC views as including Taiwan.

The PRC has tested an enhanced radiation weapon (neutron bomb) that minimizes blast effects, while maximizing human casualties. The PRC probably originally developed the neutron bomb for use on its own territory against invading Soviet forces. Similarly, the neutron bomb would be useful in a conflict with Taiwan, since the PRC undoubtedly would intend to occupy the territory it was attacking. The PRC may have plans to deploy neutron bombs.

These enhancements to the PRC's nuclear forces, together with its expanding economic capabilities, present the PRC with additional options for changes in its strategic doctrine. The PRC's growing economy, for instance, could allow it to produce and deploy more missiles than earlier planned. Additionally, the Select Committee judges that if the PRC made a decision to do so, it could build multiple warheads for its ballistic missiles.

Moreover, the PRC's concerns about the vulnerability of its nuclear weapons could lead the PRC to develop an early warning system in order to support a launch-on-warning posture.

The secretive nature of the Chinese Communist Party's Central Military Commission, as well as the PLA's other decision-making bodies, means that changes in PRC nuclear force doctrine may not be apparent.

Clearly, the PRC views its conventional ballistic missile forces as potential weapons for use during regional conflicts. This strategy was implied by the PRC in the course of its CSS-6 short-range ballistic missile exercises during the March 1996 presidential elections in Taiwan. During the exercise, the PRC launched four CSS-6 ballistic missiles towards points north and south of Taiwan's major ports.

The PRC's Opposition to U.S. Missile Defenses

Statements by PRC Government officials make it clear that the PRC is opposed to the development of either theater or national missile defense systems that could counter Beijing's nuclear forces.

If the PRC were intent upon overwhelming these defenses, there are several options it could take in an attempt to preserve the offensive capability of its missile forces.

One of the PRC's responses could be to expand the size of its ballistic missile force, to increase the chances that some of its nuclear weapons overcome a nation's defenses. This would be an expensive option requiring the PRC to invest in the production of significant additional missiles and infrastructure.

A cheaper response to U.S. missile defenses for the PRC could be the development of penetration aids (PENAIDS) for its ballistic missiles. These PENAIDS could include:

- **Decoys** that create multiple radar targets, which must be tracked until discrimination of the actual nuclear warhead can be accomplished. Simple decoys are effective during exoatmospheric flight of the nuclear warhead, but burn up during reentry into the atmosphere.

- **Chaff** consisting of aluminum strips that are designed to reflect radar beams, thereby confusing a radar as to the location of the PLA warhead.

- **Jammers** used to jam the radar system during the flight of the PLA nuclear warhead.

- **Radar absorbing materials,** which can also be used to reduce the radar cross section of the PLA nuclear warhead.

- **The PLA nuclear warhead itself could be reoriented** to present the lowest radar cross section.[31]

The PRC is expected to pursue one or more PENAIDs in connection with its new nuclear missiles.

Given the PRC's aggressive opposition to missile defenses, the Select Committee judges that the PRC is collecting information about U.S. missile defense systems in order to help its development of PENAIDS.

Another option for countering U.S. missile defenses would be the development of a maneuvering reentry vehicle (MARV). The maneuvering capability could be used to complicate hit-to-kill or conventional warhead ballistic missile defense systems.

The PRC could also develop multiple independently-targetable reentry vehicles (MIRVs) or multiple reentry vehicle (MRV) platforms. This would effectively increase the size of the PLA's nuclear force without the full expense required to deploy additional missiles. The PRC's theft from the United States of design information for the W-88 miniaturized nuclear warhead makes it possible that existing or future PLA missiles, which might have been too small in diameter to carry multiple warheads, could now do so.

Furthermore, existing PLA missiles, including the CSS-4 Mod 2, could be capable of carrying the new, smaller warheads in a MIRV or MRV configuration. Within a short period of time after a decision to proceed, the PRC has the ability to deploy missiles with multiple reentry vehicles (MIRVs or MRVs). The PRC has demonstrated similar concepts and technologies in the Smart Dispenser that it developed to place multiple Iridium satellites into orbit. The Select Committee did not, however, review sufficient evidence to permit a judgment whether the PRC will in the future decide to deploy a MIRV or MRV system.

THE IRIDIUM SMART DISPENSER CONTROVERSY

In May 1998, allegations were made that Motorola had provided the PRC with technology that would allow it to build a multiple, independently targetable reentry vehicle (MIRV) missile-dispensing platform. The allegations were that the Smart Dispenser used by the PRC to place two Iridium communications satellites into orbit would provide the PRC with technology that would be directly applicable to MIRV dispensing.[32]

The Smart Dispenser is an on-orbit maneuvering stage with its own independent guidance system. The Select Committee has determined that Motorola did not provide the PRC with information on how to design the Smart Dispenser; rather, the PRC built the Smart Dispenser indigenously to Motorola's specifications. However, the Select Committee's independent technical expert noted that the PRC has demonstrated all of the techniques that are required for developing a MIRV bus, and that the PRC could develop a MIRV dispensing platform within a short period of time after making a decision to proceed.

The PRC's Acquisition of Foreign Ballistic Missile Technology

The PRC constantly searches for technology for its ballistic missile programs. Any technology or know-how that the PRC can acquire from foreign sources will save the PRC time and money in the development of its future weapons systems.

The prospect of ballistic missile and nuclear weapons cooperation between Russia and the PRC would be especially troubling because of the advanced technical capabilities of the Russian strategic nuclear forces. Thus far, Russia has been the only nation to deploy a mobile intercontinental ballistic missile force. These missiles include the road-mobile solid-propellant SS-25 ICBM and the rail-mobile SS-24 ICBM. Any cooperation in the area of solid-propellant mobile missiles would clearly benefit the PRC's new road-mobile ICBM programs.

Additionally, the Russians have advanced guidance and control capabilities. Assistance in the guidance and control field could help the PRC improve the accuracy of its current and future missile forces.

Furthermore, the Russians have the ability to mass-produce large, solid-propellant missiles. The manufacturing capabilities for these missiles could help the PRC produce large numbers of its next generation ICBMs. Russia's use of advanced solid-propellant materials could benefit the PRC's ICBM and submarine-launched ballistic missile programs, allowing them to build lightweight, longer-range ballistic missiles.

The Russian designer of the SS-X-27 has claimed that the missile's advanced penetration capabilities will allow it to defeat any nation's ballistic missile defenses.[33] While the validity of such a statement cannot be judged against a U.S. national missile defense system that is not yet deployed, or even finally designed, Russia's provision of these presumably advanced penetration technologies to the PRC could assist PRC efforts to counter a U.S. national missile defense system.

While the Select Committee has no evidence that the Russians or any other nation of the former Soviet Union have provided the PRC with complete ballistic missiles or missile subsystems, there have been reported instances of the PRC approaching Russia and Ukraine about acquiring SS-18 and SS-25 intercontinental ballistic missiles. Reportedly, the PRC was turned down.[34]

The PRC's Indigenous Ballistic Missile Design Capabilities

The PRC is judged to have a fairly sophisticated capability to design ballistic missiles and rockets. This assessment is based on the fact that the PRC is able to develop missiles and rockets that are capable of delivering large payloads to their intended destination with reasonable accuracy and reliability. However, these design capabilities are not in all cases as sophisticated as those of Western nations.

The Select Committee's independent technical expert noted that while PRC scientists and engineers may have a textbook understanding of problems, there is a difference between a textbook understanding and the application of this knowledge to specific problems. Interactions with U.S. and foreign scientists and engineers, therefor, could assist the PRC engineers and scientists in overcoming these limitations.

PRC Missile Proliferation

The PRC is one of the world's leading proliferators of complete ballistic missile systems, as well as missile components.

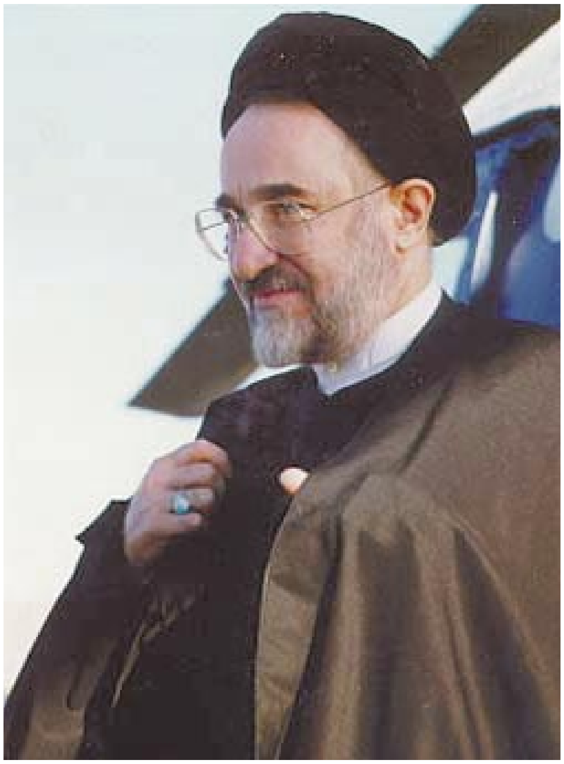
Despite the fact that, in 1991, the PRC agreed to adhere to the April 1987 Missile Technology Control Regime (MTCR) guidelines that call for restraint on the sale of missiles capable of delivering a 225-pound payload to 185 miles, the PRC has sold complete ballistic missile systems or missile components to a number of countries, including but not limited to Iran, Pakistan, and Saudi Arabia.[35]

In 1993, the MTCR States issued new expanded guidelines that called for a "strong presumption to deny" both sales of complete missile systems and sales of components that could be used in ballistic missile systems. Furthermore, the new guidelines call for restrictions on transfers of missiles that can deliver a weapons of mass destruction payload to 185 miles.[36] However, the PRC has accepted neither these revised guidelines, nor the annex on the transfer of components and other commodities such as propellants and test equipment.[37]

Notwithstanding the PRC's purported adherence to the MTCR Category I restrictions, the PRC has provided, or is providing, assistance to the missile and space programs of Iran, North Korea, Pakistan, Saudi Arabia, and other countries. The PRC also continues to offer Category II missile components for sale to international customers. In addition, the PRC has provided assistance to the nuclear programs of Iran and Pakistan.

Iran

During the 1990s, the PRC sold Iran significant numbers of 90-mile range CSS-8 ballistic missiles, along with associated support equipment. In addition, PRC companies provided Iran with ballistic missile production technology. The PRC also reportedly sold Iran guidance components,[38] and more recently telemetry equipment, for ballistic missiles.[39] The PRC reportedly is currently providing Iran with solid-propellant missile technology.[40] During the 1980s and 1990s, the PRC has transferred C-802 anti-ship cruise missiles to Iran.[41] The PRC has also provided assistance to Iran's nuclear weapons programs.[42]



During the 1990s, the PRC sold Iran significant numbers of CSS-8 ballistic missiles, along with associated support equipment. The PRC reportedly is currently providing Iran with solid-propellant missile technology.

Pakistan

The PRC has provided Pakistan with a wide range of weapons assistance. The PRC has reportedly supplied Pakistan with CSS-X-7 (or M-11) ballistic missiles, mobile missile launchers, and the facilities necessary to produce M-11 missiles. The PRC has also provided Pakistan with assistance on uranium enrichment, ring magnets, and other technologies useful for Pakistan's nuclear weapons program.[43]

Saudi Arabia

The PRC provided complete CSS-2 missiles to Saudi Arabia in 1987. The conventionally armed missile has a range of 1,500 to 1,800 miles.[44]

The Select Committee's classified Final Report contains additional information on PRC proliferation that the Clinton administration has determined cannot be made public.

The PRC's Military and Civil Space Program

The PRC's military and civilian space launch program began in the 1950s, concurrent with its development of long-range ballistic missiles. At that time, a small research effort was begun at the Chinese Academy of Sciences to develop indigenous space launch and satellite production capabilities.

Eight Versions of the Long March in Use Today by the PRC

Since 1970 the PRC has launched 12 different versions of the Long March rocket. The eight rockets depicted above, plus one not shown, are in use today. Three new versions of the rocket are said to be in development.

The PRC's early efforts were aided by technology and knowledge transferred from the Soviet Union.

From that beginning, the PRC has developed a comprehensive space program that includes a family of rockets, numerous satellites, and a telemetry, tracking, and control network. These efforts have paid off, as the PRC is now a major space power. It offers international launch services and is working on placing men in space.

The PRC's first satellite launch occurred on April 24, 1970, using a CSS-3 intercontinental ballistic missile. The ICBM was modified by adding a third stage, which was used to place the satellite into orbit. This new rocket was named the **Long March 1**.

The 380-pound satellite it carried was named Dong Fang Hong-1 (East Is Red 1). The satellite orbited for approximately 26 days, transmitting to Earth the song "The East is Red." [45]

After the PRC's second successful launch of a satellite on March 3, 1971, again using the modified CSS-3 ICBM, the PRC set out to launch heavier payloads into orbit. For this purpose, the PRC turned to the longer-range, more powerful CSS-4 ICBM. This rocket was named the **Long March 2**.

The first three launches of the Long March 2 rocket, from 1973 through 1974, were failures. Finally, on July 26, 1975, the PRC successfully launched the **Long March 2C** and placed its third satellite into orbit.

During the balance of the 1970s, the PRC launched nearly a dozen satellites on the Long March 2, many of which undoubtedly were for military purposes. Nearly half of these launches were unsuccessful, however, resulting in the destruction of many payloads.

The Long March 2 and its derivatives are the main rockets used by the PRC today, in both its military and civilian space programs. Because the Long March 2 was derived directly from the CSS-4 intercontinental ballistic missile, the two share much in common. The Long March 2 rocket and the CSS-4 ICBM use the same airframe structure, the same cluster of four YF-20 engines (known as the YF-21) in the first stage, and the same single YF-22 engine combined with the YF-23 vernier engines that form the YF-24 in the second stage.[46] However, unlike the CSS-4, the Long March 2 was modified to deliver payloads to orbit rather than a nuclear weapon to a target.

In order to meet space launch requirements for heavier payloads and higher orbits, the PRC improved the performance of the Long March rocket. Among other changes, the PRC increased the amount of propellant the rocket could carry, improved the performance of the first and second stage engines, added new cryogenic liquid-propellant third stage engines, and attached additional boosters that were strapped on to the basic rocket. These changes led to the development of three new modifications to the Long March rocket.

The **Long March 3** was developed in 1977 to meet the requirements for launching communications satellites into geosynchronous orbit. It was the PRC's first rocket built for this purpose.[47] The Long March 3 uses the same first and second stages as the Long March 2C, except that aerodynamic fins are added to the base of the first stage.[48] It also uses the same YF-21 and YF-24 engines.[49] The main change from the Long March 2C is the addition of a restartable, cryogenic liquid-propellant third stage.[50] This stage is designed to boost the payload into a geostationary transfer orbit.

The **Long March 4** was developed by the PRC in the late 1970s to launch meteorological satellites for military and civilian purposes into sun-synchronous orbits. The new rocket used improved first and second stage engines, and a first stage that was 13 feet longer than the standard Long March 2 first stage.[51]

When the PRC announced in 1986 that is was entering the commercial satellite launch market, it decided to develop a rocket that could provide heavy-lift capabilities to low earth orbit. However, the PRC's operational rockets at the time were exceptionally limited in their ability to place payloads in this orbit. The Long March 2C, for example, could only place a 1,350-pound payload into low earth orbit.[52] In comparison, the U.S. Delta 3925 rocket could place 2,140 pounds into low earth orbit. The U.S. space shuttle could transport 15,400 pounds into low earth orbit.[53]

Moreover, the majority of commercial payloads at the time were for geosynchronous satellites.[54] But to place heavy payloads into geosynchronous orbit requires a third stage, which the Long March 2C still lacked, or a satellite perigee kick motor.

To meet the geosynchronous payload lift requirement, the PRC developed the **Long March 2E** rocket, which was first launched successfully in 1992. The Long March 2E uses a stretched version of the Long March 2C first and second stages, increasing the amount of propellant carried, which increases the burn-time of the engines.[55] The Long March 2E also uses improved versions of the YF-20 engines used on the Long March 2C. Known as the YF-20B, these engines offer improved thrust.[56] The Long March 2E also uses four strap-on liquid-propellant boosters. These boosters are attached to the rocket's first stage. Each booster is fitted with a YF-20B engine.

The Long March 2E (*far left*), carrying Hughes satellites, crashed in 1992 and 1995. In the aftermath of those crashes, Hughes engineers worked with the PRC to improve the rocket's fairing, which had twice ripped apart under launch conditions. The Long March 2E uses a stretched version of the Long March 2C (*left*), increasing the burn-time of the engines and adding four boosters.

To permit the Long March 2E to place a satellite into geosynchronous orbit, the PRC mated the satellite payload with a perigee kick motor, which acted as a third stage. Because there was no indigenous PRC kick motor, however, foreign launch customers had to use Western-manufactured kick motors. This required a separate export license. The PRC later developed its own family of kick motors, allowing customers to choose between Western- or PRC-manufactured versions.

Finally, the Long March 2E employs an enlarged "hammerhead" fairing to protect the satellite payloads, which exceed the upper stage's diameter. The Long March 2E can place 5,450 pounds into low earth orbit and 2,140 pounds into geosynchronous transfer orbit.[57]

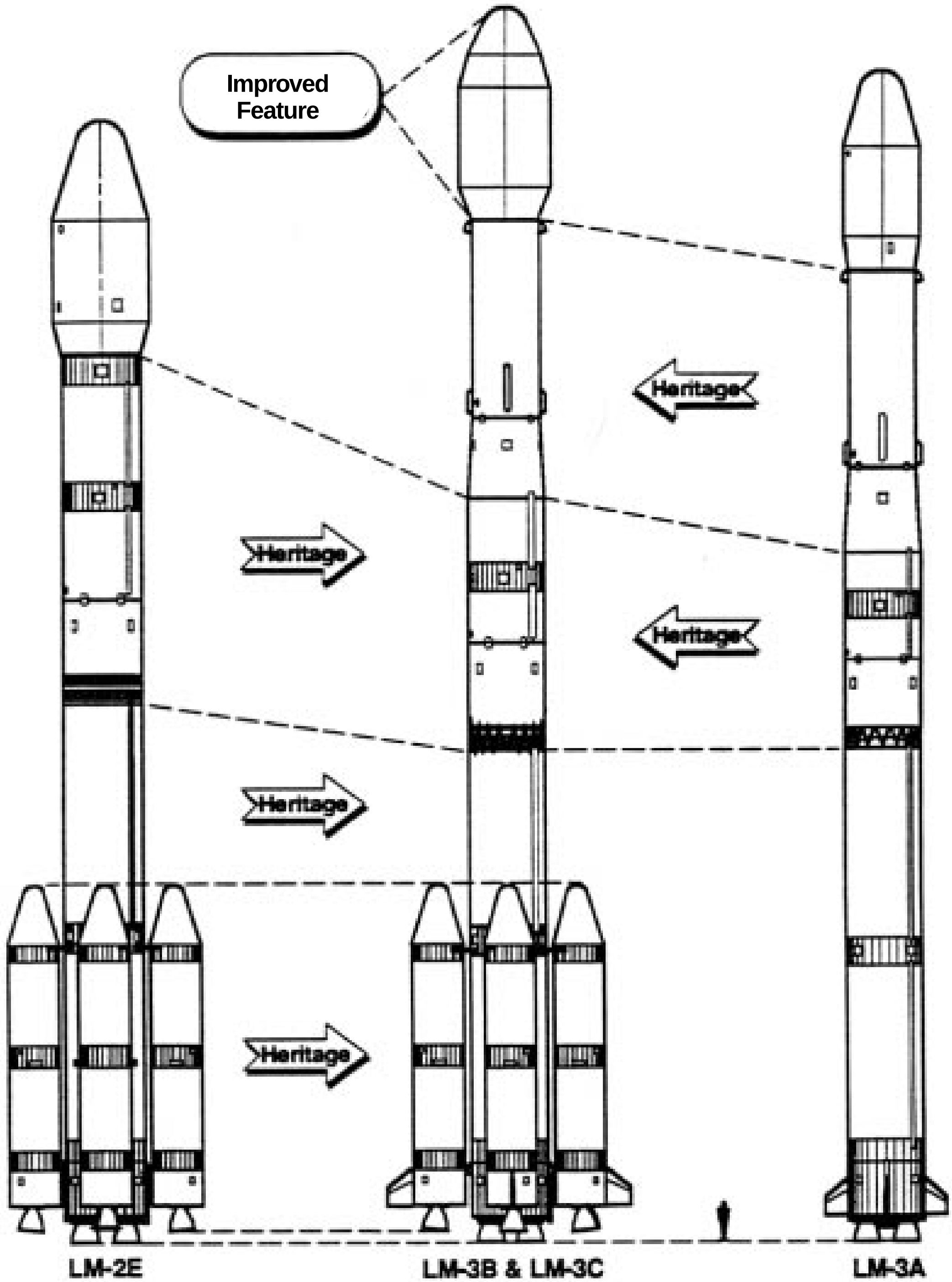
The Long March 2E has suffered a series of in-flight failures (see table overleaf). The December 1992 and January 1995 failures resulted in the destruction of two Hughes-manufactured satellites. The results of the failure analyses conducted by Hughes as a result of these launch failures are discussed in the chapter entitled *Satellite Launches in the PRC: Hughes*.

Launch History of the PRC's Long March 2E[58]

LAUNCH DATE	SATELLITE	MANUFACTURER	OWNER	RESULTS
Jul. 16, 1990	Dummy AUSSAT Satellite and Badr-1	PRC	Dummy AUSSAT Satellite – PRC Badr-1 – Pakistan	Perigee kick motor failed in the Dummy AUSSAT Satellite Badr-1 achieved orbit
Aug. 31, 1992	Optus-B1	Hughes	Optus (Australia)	Success
Dec. 21, 1992	Optus-B2	Hughes	Optus (Australia)	Failure-fairing collapse
Aug. 24, 1994	Optus-B3	Hughes	Optus (Australia)	Success
Jan. 25, 1995	Apstar-2	Hughes	Asia-Pacific Telecommunications (PRC-controlled)	Failure-fairing collapse
Nov. 28, 1995	Asiasat-2	Lockheed-Martin	Asiasat (Hong Kong)	Success
Dec. 28, 1995	Echostar-1	Lockheed-Martin	Echostar Inc. (U.S.)	Success

Two years after the first successful launch of the Long March 2E, the PRC successfully launched the **Long March 3A**, a cheaper, higher performance rocket that would better meet both its military and commercial geosynchronous launch requirements. The Long March 3A was the first of a family of **Long March 3A**, **3B** and **3C** rockets.

The Long March 3A family of rockets uses a strengthened Long March 3 first stage. In the case of the Long March 3B and 3C, this permits the mounting of additional strap-on boosters. The Long March 3A, 3B, and 3C rockets also use a new, lighter weight, and cheaper inertial measurement unit. Furthermore, these rockets employ large "hammerhead" fairings to protect their satellite payloads. The failure analysis of the Long March 3B launch, carrying the Intelsat 708 satellite manufactured by Loral, is discussed in the chapter of this Report entitled *Satellite Launches in the PRC: Loral*.



This illustration shows the design evolution of the Long March 3B and 3C from the LM 2E and LM 3A. The LM 3B incorporates the strap-on boosters from the LM 2E and the third stage from the LM 3A.

Launch History of the Long March 3B Rocket[59]

LAUNCH DATE	SATELLITE	MANUFACTURER	OWNER	RESULTS
Feb. 14, 1996	Intelsat 708	Loral	Intelsat	Failure
Aug. 19, 1997	Agila	Loral	Mabuhay Philippines Satellite Company	Success
Oct.16, 1997	Apstar-2R	Loral	APT (PRC-controlled)	Success
May 30, 1998	ChinaStar 1	Lockheed-Martin	China Oriental Telecom Satellite Co. (PRC-controlled)	Success
July 18, 1998	SinoSat	Aerospatial	Sino Satellite Communications Co. (PRC-controlled)	Success

The PRC's Commercial Space Launch Program

The PRC's entry into the commercial space launch market coincided with a dark period for the U.S. launch industry that included the 1985 and 1986 launch failures of several Delta and Titan expendable rockets, and the 1986 explosion of the Space Shuttle *Challenger*. At the time of the *Challenger* accident, the U.S. space launch industry was in the midst of a plan to phase out all expendable rockets in favor of the Space Shuttle, which was projected to be more economical.[60] But that plan was cancelled with the *Challenger* explosion. Instead, the United States imposed a hiatus in shuttle launches until September 1988, and a permanent decision that the Space Shuttle would not be used to launch commercial payloads.[61]

The lack of available U.S. commercial space launch capacity forced satellite manufacturers to seek alternative launch providers. The Soviet Union had the capacity to launch commercial satellites, but U.S. policy would not support the launching of U.S.-manufactured satellites on Soviet rockets. The European consortium of Arianespace had no extra capacity. This left the PRC as the only alternative for launching geosynchronous communications satellites.

In 1987, the United States viewed the PRC as a counterbalance to Soviet military power in Asia. Accordingly, the "Green Line" policy had been adopted to per-

The PRC's entry into the space launch market coincided with a dark period for the U.S. launch industry which included the 1986 explosion of the Space Shuttle *Challenger*. With the *Challenger* accident, the United States imposed a hiatus in shuttle launches, and made a permanent decision that the Space Shuttle would not be used to launch commercial payloads.

mit some technology transfers to the PRC, while limiting transfers of technologies that could improve the PLA's ballistic missile and anti-submarine warfare capabilities.[62] In 1988, President Reagan agreed to allow the PRC to launch U.S.-manufactured satellites on the condition that the PRC sign three bilateral agreements with the U.S. on competitive pricing, liability, and the protection of U.S. technology.[63]

The PRC's first success in the commercial market occurred in 1987. In that year, Matra of France contracted with the PRC to place a scientific payload in orbit, using a Long March 2C rocket. These French scientific experiments were launched on August 5, 1987 aboard a PLA military photo-reconnaissance satellite. The recoverable capsules of the PLA's reconnaissance satellites made them an ideal platform for microgravity experiments.[64]

The PRC's first commercial launch of a U.S.-manufactured communications satellite occurred on April 7, 1990. The Asiasat — a Hughes HS 376 model satellite — was launched into orbit aboard a Long March 3 rocket.[65]

From that point, in addition to their military launch schedule, the PRC has attempted 28 launches of Western-manufactured satellites.[66] Of these satellites, 27 were U.S-manufactured: only the French-manufactured Sinosat, launched successfully on July 18, 1998, was produced by a non-U.S. manufacturer.[67] Twenty-three of the PRC's attempts to launch U.S. satellites were successful. Four have ended in failure.[68] These four failures are detailed below.

PRC Commercial Launch Failures

SATELLITE	LAUNCH DATE	ROCKET	FAILURE MODE
Optus B2	Dec. 21, 1992	Long March 2E	Fairing collapse
Apstar-2	Jan. 25, 1995	Long March 2E	Fairing collapse
Intelsat 708	Feb. 15, 1996	Long March 3B	Inertial measurement unit malfunction
Chinasat 7	Aug. 18, 1996	Long March 3	Third stage malfunction

Recently, the PRC has made an effort to sell low-earth orbit satellite launches:

- **The PRC has entered into contracts with Motorola for the launch of Iridium satellites**, including a contract to launch replacement satellites. Iridium satellites have been successfully launched six times on the Long March 2C/SD (that is, the Long March 2C with a "Smart Dispenser" (SD) stage added). The "Smart Dispenser" allows the PRC to launch two Iridium satellites into orbit at a time.

- **The PRC has pursued a contract with Loral for the launch of Globalstar satellites**. The PRC offered a version of its Long March 2E equipped with a "Top Stage" (TS) that would dispense twelve Globalstar satellites. While Loral had originally contracted for a launch on the Long March 2E/TS, it cancelled that contract following the crash of the Long March 3B in February 1996.

The PRC's Future Space Launch Capabilities

The PRC also recognizes the importance of space in future conflicts, for purposes that include both command and control, and military reconnaissance. The PRC is believed to be developing a new, larger rocket that will be able to carry larger payloads into orbit.

PRC papers have discussed the use of cryogenic liquid propellant engines for this future rocket. One of the engines the PRC could use is the RD-120. The PRC is known to have acquired at least one of these engines from Russian during the 1990s.[69] The RD-120 is a liquid oxygen/kerosene engine that is used on the second stage of the Zenit rocket, which is used on the multinational Sea Launch program.

Difficulties with the development of the new engines for this rocket may have prompted the PRC to focus, in the nearer term, on the proposed Long March 2E(A) and Long March 3B(A) versions of the Long March rocket that will utilize improved strap-on boosters to achieve greater payload-to-orbit capability. It should be noted that these are the two systems that were the subject of the failure review investigations in which Loral and Hughes participated. See the chapters *Satellite Launches in the PRC: Hughes and Loral* for a detailed discussion of how these failure reviews assisted the PRC.

PRC Space Weapons

The PRC is believed to be developing space-based and ground-based anti-satellite laser weapons. Such weapons would be of exceptional value for the control of space and information. The Select Committee judges that the PRC is moving toward the deployment of such weapons.

Based on the significant level of PRC-Russian cooperation on weapons development, it is possible that the PRC will be able to use nuclear reactors to pump lasers with pulse energies high enough to destroy satellites.

In addition, Russian cooperation could help the PRC to develop an advanced radar system using lasers to track and image satellites.

The Select Committee judges that the PRC has the technical capability to develop direct ascent anti-satellite weapons. The CSS-2 could be modified for use in this role. This would be similar to the approach taken by the Soviets with their SS-9 ASAT system.

The PRC's Manned Space Program

The PRC has conducted research since the 1950s, including biological and life support research, on placing astronauts into orbit. Pursuant to its 921 Project, the PRC's plans since the 1980s have included concepts for Space Shuttle-like spacecraft, recoverable capsules, and a space station.[70]

In 1996, two PRC astronauts began training at the Gagarin Cosmonaut Training Center, Star City, Russia. The PRC appears set to launch these two astronauts into space sometime this year to mark the fiftieth anniversary of Communist rule in China.

For its manned space program, the PRC will use Soyuz capsules purchased during Yeltsin's visit to the PRC in April 1996. A Soyuz capsule will be carried on top of the Long March 2E, using a payload shroud (that is, a fairing) equipped with a launch escape system. (See the chapter *Satellite Launches in the PRC: Hughes* for a discussion of fairing improvements to the Long March 2E.)

If the PRC is successful in placing men in orbit, it will be only the third nation, after Russia and the United States, to have done this.

The PRC's Communications Satellite Programs

Since the beginning of its domestic communications satellite programs, the PRC has suffered a string of problems with the performance of its communications satellites, as well as the rockets designed to place those satellites into orbit.

During the mid-to-late 1980s, the PRC was able to place four of its communications satellites into geosynchronous orbit. Today, however, the PRC has only one active domestically-manufactured telecommunications satellite on orbit. This satellite has reportedly suffered on-orbit problems that may have reduced its capabilities.[71]

The PRC's inability to place reliable communications satellites (COMSATs) into orbit has created serious gaps in the PRC's satellite communications capabilities, both for civilian and military purposes. The PRC has addressed the greatest part of its satellite communications requirement by leasing communications channels on Western-manufactured communications satellites.

The PRC first began developing its own communications satellites in the early 1970s, based on Western technology. All of these satellites were designed by the China Academy of Space Technology (CAST) for military purposes. They have all been operated by China Satellite Launch and Tracking Control General (CLTC), which is subordinate to COSTIND.[72]

The PRC's inability to design and produce advanced communications satellites has also led it to seek Western components and technology for its domestic communications satellite industry. The Select Committee judges that the use of Western technology cut in half the time required for the PRC to progress from an experimental communications satellite to the advanced DFH-3 satellites, which were first launched in 1994.

The following table shows a chronology of the PRC's history of launching PRC communications satellites.

History of the PRC's Domestic Communications Satellite Launches

PRC SATELLITE	DATE	PRC ROCKET	RESULT
DFH-2	Jan. 29, 1984	Long March 3	Rocket Failure
DFH-2	Apr. 8, 1984	Long March 3	Success
DFH-2	Feb. 1, 1986	Long March 3	Success
DFH-2A	Mar. 7, 1988	Long March 3	Success
DFH-2A	Dec. 22, 1988	Long March 3	Success
DFH-2A	Feb. 4, 1990	Long March 3	Success
DFH-2A	Dec. 28, 1991	Long March 3	Rocket Failure
DFH-3	Nov. 29, 1994	Long March 3A	Satellite Failure
DFH-3	May 11, 1997	Long March 3A	Satellite Problem

The PRC's first generation communications satellite was the **DFH-2** (Dong Fang Hong-2, or **East Is Red 2**). These satellites were designed to provide the PRC with test experience. The satellite design was similar to that used on the Hughes HS376 satellites, employing a spin-stabilized body and a de-spun horn antenna.

The first attempt to launch a DFH-2 satellite, in January 1984, was not successful due to the failure of the Long March 3 rocket that was to carry it into orbit. The second launch attempt on April 8, 1984 successfully placed a communications satellite into orbit. A third DFH-2 satellite was launched on February 1, 1986. This satellite provided communications services until it reached the end of its service life.

In 1988, the PRC launched an improved version of this satellite, known as the **DFH-2A**. The new satellite used the same spin-stabilized body, this time equipped with an improved antenna array that increased the number of communications channels available.

These satellites were able to handle five television channels and 3,000 phone calls simultaneously. The first three of these satellites were named "Chinasats" by the

Janes Defense Group

The DFH-3 (East Is Red 3) is the PRC's most modern communications satellite. It is useful for military communications.

PRC, and were successfully launched twice in 1988 and once in 1990. A fourth DFH-2A satellite launch in 1990 was unsuccessful, when the failure of the rocket's third-stage engine left the satellite stranded in an incorrect orbit.

The PRC's third generation communications satellites, known as the **DFH-3**, are the PRC's most modern communication satellites. The DFH-3 is useful for military communications. These satellites have three-axis stabilized bodies, 24 C-band transponders and are designed to have an 8-year on-orbit life. Due to the increased weight of these satellites as compared to the DFH-2A, the DFH-3 satellites are launched on the more capable Long March 3A rocket.

The first launch of the DFH-3 satellite on November 29, 1994 was unsuccessful when the satellite failed to attain the proper orbit, rendering it useless for its intended communications function.

The PRC's second attempt to launch a DFH-3 satellite on May 11, 1997 successfully placed the satellite into a geosynchronous orbit at 125 degrees east longitude.[73] The PRC, however, reportedly may have suffered problems with the satellite.[74]

The PRC's Use of Foreign Components on Communications Satellites

The PRC's limited communications satellite construction capabilities led it from the first to seek Western manufacturers for reliable components. Even the PRC's most modern communications satellite, the DFH-3, which was first successfully launched in 1997, contains a large number of Western components:

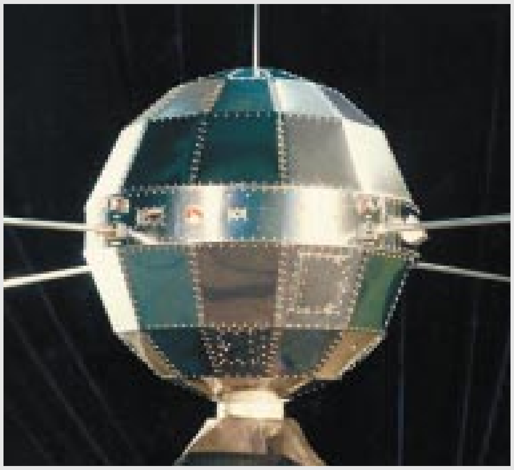
- **The DFH-3 is reported to use a control processor built by Matra-Marconi**[75]
- **Messerschmitt Boelkow Blohm (MBB) provided the DFH-3 solar panel substrates** to the China Academy of Space Technology (CAST), and CAST-produced solar cells were mounted on them. The solar panel assemblies were then returned to MBB for assembly into deployable solar arrays[76]
- **Daimler Chrysler Aerospace Group provided the DFH-3's antenna assembly,** consisting of a deployable dual gridded reflector, feed and interconnecting structure[77]

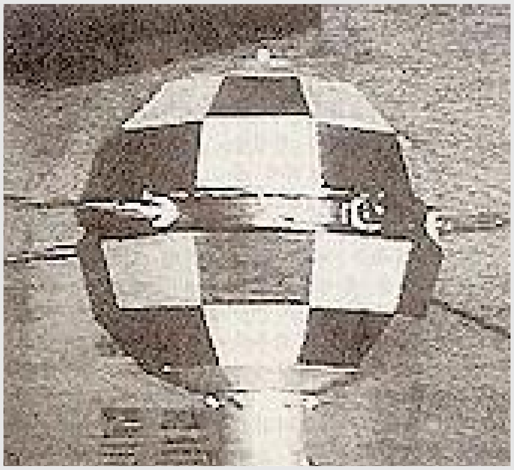
- **Officine Galileo provided the Infrared Earth sensor to determine pitch/roll in geosynchronous orbit[78]**
- **The DFH-3's payload test equipment, according to 1993 reports, consisted of five racks and consoles with 80% U.S. (Hewlett Packard) and German equipment**
- **The equipment racks for the test equipment were provided by Germany's Ant Corporation[79]**

PRC SATELLITE TECHNOLOGY ASSISTANCE AND NORTH KOREA

The PRC, through the China Academy of Space Technology (CAST), provides complete satellites and technology to other nations.

On August 31, 1998, North Korea launched a three stage Taepo Dong-1 ballistic missile. The North Koreans claim to have launched their first satellite, known as Kwangmyongsong No. 1 (Bright Star 1), on this Taepo Dong-1 missile. Comparing the picture of the Kwangmyongsong No. 1 satellite released by North Korea with that of the PRC's Dong Fang Hong 1 satellite (*below*), the two bear a striking resemblance.





Several U.S. companies have also marketed their communications satellite technologies to the PRC. Loral, for example, offered the PRC a direct broadcast satellite (DBS) capability in 1996 using either a Loral-produced satellite bus or the DFH-3 series satellite bus.[80] A 1995 Memorandum of Agreement between Loral and China Aerospace Corporation offered the PRC direct broadcast satellites, regional mobile satellite services systems, and the joint development of an advanced high capacity communications satellite. Under this agreement, Loral would provide design and technical support, while the final integration of the satellite was to have occurred in Germany or the PRC.[81]

Hughes and Loral competed for the Asia-Pacific Mobile Telecommunications (APMT) satellite, and Hughes was awarded the contract. APMT is a Singapore-based, PRC-controlled consortium. At least 51% of APMT is owned by PRC Government agencies, including China Aerospace Corporation, the China Academy of Launch Vehicle Technology, China Satellite Launch and Tracking Control General, and Chinasat, a subsidiary of the PRC Ministry of Post and Telecommunications.[82] See the *Asia-Pacific Mobile Telecommunications Satellite* section of this chapter, below.

The PRC's Reliance on Western Communications Satellites

Due to the failures of the PRC's rockets, and of its satellites, the PRC has become dependent on Western-manufactured communications satellites.

The PRC's dependency began as the early DFH-2A satellites reached the end of their on-orbit lives, while the fourth DFH-2A satellite failed to reach orbit. This created a gap in the PRC's satellite communications capabilities. As a result, the PRC was forced to look to foreign communications satellite manufacturers for supplemental capacity.

In December 1992, the PRC purchased Spacenet 1 on-orbit from GTE to replace its aging DFH-2A/1 and DFH-2A/2 satellites. The PRC renamed it "ChinaSat-5." This satellite was to provide supplemental capabilities until the PRC's first DFH-3 satellite was launched in 1994.

The failure of the PRC's first DFH-3 satellite to reach orbit, and the imminent expiration of the useful life of ChinaSat-5, forced the PRC to purchase a Hughes HS-376 satellite to provide additional communications channels. But this satellite launch in August 1996, aboard a Long March 3 rocket, was also a failure. The third stage left the satellite stranded in an unusable orbit.[83]

The second DFH-3 satellite that the PRC launched in May 1997 reportedly has now developed on-orbit problems.[84]

These failures have left the PRC dependent on Western-manufactured satellites, which it purchases through multinational consortia in which the PRC maintains a controlling interest. These include the Asia Pacific Satellite Telecommunications Co., and China Orient Telecomm Satellite Co, Ltd. Satellites acquired by the PRC in this way include the Apstar-1, Apstar-1A, Apstar-2R, and ChinaStar-1.

It is likely that these failures have made the PLA dependent on Western communications satellites as well.

PRC Use of Very Small Aperture Terminals (VSATs)

The PRC has acquired Western-manufactured very small aperture terminals (VSATs) that could be used for military satellite communications.

VSATs are small satellite communications antennas used to transmit voice, data, video, fax, and computer-to-computer communications between multiple users. One VSAT terminal can be used to transmit communications from multiple users to different recipients via communications satellites.

The small size of VSAT terminals allows easy transportation between different locations and assembly in remote areas. These VSAT networks could improve the PLA's military command and control capabilities, by allowing mobile, reliable communications virtually anywhere.

The majority of VSAT terminals in use today in the PRC are U.S. manufactured. Hughes is by far the largest provider of VSAT networks to the PRC. The other significant U.S. supplier is Scientific Atlantic. Other providers include NEC of Japan and Spar of Canada.[85]

The PLA's Reconnaissance Satellite Program

The PLA has developed a photo reconnaissance satellite, known as the **FSW** (for Fanhui Shi Weixing, or **Recoverable Test Satellite**). The current version of the Recoverable Test Satellite uses a recoverable capsule similar in concept to those used in the early U.S. Corona program. This PLA reconnaissance satellite provides the PRC with the ability to photograph U.S. military installations.

The first version of the satellite was successfully launched on November 26, 1975, using a Long March 2C rocket. After three days in orbit, the satellite capsule reentered and was successfully recovered by the PRC. Subsequent redesigns of the FSW-1 satellites allowed the PRC to increase its on-orbit life to five days before reentry. The PRC launched fifteen FSW-1 satellites, the last occurring in October 1993.[86]

The PRC's current, enhanced version of this satellite is known as the **FSW-2**. The FSW-2 is larger than the FSW-1 and has a longer on-orbit life. The FSW-2 military reconnaissance satellite has been launched three times since 1992.[87] The most recent launch occurred in October 1996.

The PRC has also offered the FSW satellites as microgravity research platforms — that is, scientific experiments are mounted on the military reconnaissance satellite itself. The commercial proceeds from such "piggy back" launches may in turn be used to subsidize the efforts of PRC entities. Starting in 1987, several FSW satellites have carried microgravity experiments for commercial customers, including France and Germany.[88]

The PRC has also announced that it is going to deploy a new, more capable military reconnaissance satellite.

CBERS: A PROTOTYPE OF THE PRC'S ACQUISITION OF WESTERN TECHNOLOGY

The CBERS-1 satellite program is an open program that has received considerable publicity. The Select Committee judges that the PRC is interested in promoting Western interest in this presumably civil satellite because it offers a means of acquiring technology that could be useful for future military reconnaissance satellites.

CBERS stands for the China-Brazil Earth Resources Satellite. The CBERS-1 satellite is a joint venture with Brazil for the development of a remote imaging satellite that will include a variety of Western technologies.

The CBERS remote imagery satellite is designed to include wide field imagery, a charge-coupled device (CCD) camera from the United States manufactured by Fairchild, and an infrared multispectral camera. The satellite is designed to provide global coverage at a variety of spatial resolutions and spectral bands to meet a range of commercial needs.

The CBERS-1 satellite, if successfully completed and deployed, will be able to image any location on the Earth within three days in the visible region, and 26 days in the infrared region.

The PRC's Other Military Satellite Programs

The PRC has developed and deployed a variety of other satellites for military purposes since its first launches in the 1970s.

It has been reported that the PRC may have developed a series of electronic intelligence (ELINT) satellites in the early 1970s.[89] These satellites would have been useful for collecting data on Soviet defense, among other purposes.

The PRC has also developed two different types of meteorological satellites for military and civil purposes, known as **Feng Yun (Wind and Cloud)**.

- **The FY-1 series of satellites**, first launched in 1988, are polar-orbiting. The FY-1 satellites have suffered a series of on-orbit failures. The first satellite operated for only 39 days of its one-year planned design life; the second satellite lost attitude control five months into its on-orbit life, was recovered 50 days later, and was again lost due to radiation damage.

- **The FY-2 satellites** were designed to provide meteorological information from geosynchronous orbit. The first satellite of this class, however, was lost due to an explosion during ground processing.[90] The second of this class was launched on June 10, 1997 and was successfully placed into orbit.[91]

While the PLA has, to date, relied on the U.S. Global Positioning System (GPS) and the Russian Global Navigation Satellite System (GLONASS) navigation satellites, the PRC has announced plans for its own navigation satellite system, known as the **Twin Star**.

The GPS system of satellites, which provides three-dimensional positioning and timing data throughout the globe, consists of 24 satellites with several on-orbit spares. The Russian GLONASS system is intended to use 21 satellites with three on-orbit spares, but the financial crisis in Russia has reduced the number of operational satellites currently on orbit.

In comparison, the PRC's proposed Twin Star positioning system program, as planned, would utilize two satellites in geosynchronous orbit for positioning, messaging, and timing services.[92] The Twin Star system represents the PRC's attempt to become independent of the United States' GPS and the Russian GLONASS navigation satellites.

The Asia-Pacific Mobile Telecommunications (APMT) Satellite

Hughes is currently designing a geosynchronous communications satellite for a PRC-controlled consortium, Asia-Pacific Mobile Telecommunications, Ltd. (APMT). The stated purpose is to provide regional mobile communications throughout Asia.[93]

Unlike previous communications satellites, however, this satellite uses a very large antenna array, which has raised concerns that the satellite could be used not simply for telecommunications, but also for space-based signals intelligence (SIGINT) collection.

This would give the PRC the capability to eavesdrop electronically on conversations not only in the PRC, but also in neighboring countries. Since the APMT satellite's antenna array is significantly larger than any that has been provided to the PRC by any nation, it is likely that the PRC would seek to exploit the APMT design for a future PRC SIGINT satellite.

Other concerns have been raised about the participation of the son of a PLA general in the program's technical interchange meetings, as described in greater detail later in this chapter.

When Hughes was awarded this contract, PRC entities had at least a 51 percent share in the international consortium that made up APMT. PRC entities involved included China Aerospace Corporation, China Launch and Tracking Control General, Chinasat, a subsidiary of the PRC Ministry of Posts and Telecommunications, and UNICOM, the PRC's second telephone network. Originally, two Singaporean companies, Singapore Telecommunications, Ltd. and Singapore Technologies Telemedia, owned twenty-five percent of APMT.[94] In 1998, however, Singapore Telecommunications pulled out of the APMT project, stating that the project no longer met its business requirements.[95] Thailand is also listed by Hughes as an "other" shareholder in APMT.[96] In 1998, Hughes reported that the shareholders for APMT included:

- **China Aerospace Corporatio**n
- **China Academy of Launch Vehicle Technology**
- **China Satellite Launch & Tracking Control General**
- **China Communications Systems Co. Limited**
- **China Resources Holdings Co. Ltd (PRC)**
- **Communications Authority of Thailand**

- **Telephone Organization of Thailand**
- **China Telecommunications Broadcast Satellite Corporation**
- **China Asia-Pacific Mobile Telecommunications Satellite Co. Ltd.**
- **Asia-Pacific Mobile Telecommunications (Singapore) Pte. Ltd.**
- **Sunburst Technologies Investments Pte. Ltd. of Singapore**
- **Mitsubishi Corporation of Japan**
- **NTT Mobilecommunications Network Inc. of Japan**
- **Future Hi-Tech Co., Ltd. of Thailand**[97]

In the early 1990s, APMT held a competition among satellite manufacturers for a regional mobile communications satellite system that would use 50,000 small, portable handsets similar to cellular telephones. The system called for a communications satellite in geosynchronous orbit, which would transmit communications between handsets or rout them through "gateways" into the local telephone network.[98] Among the competitors were Hughes and Loral.[99]

Hughes won the APMT contract. In 1996, Hughes requested an export license from the Commerce Department for the APMT satellite.[100] If approved for export, the APMT satellite was to be launched on a Long March 3B rocket from the PRC.[101] Hughes' design proposal, as originally submitted to the Commerce Department, included two HS 601 satellite buses with a 12-year design life. The satellites were to be equipped with a 40 foot L-band antenna.[102] The license was originally approved by the Commerce Department in 1996.[103]

In April 1998, Hughes submitted a second license request to the Commerce Department due to changes in the satellite bus design.[104] Hughes wanted to use the more powerful HS-GEM bus, in place of the HS 601, which would have permitted them to achieve design commonalities and hence production efficiencies with another satellite sale to the United Arab Emirates (UAE). The design change for the UAE satellite was the result of a requirement by Hughes' Thuraya satellite customer, who wanted to reduce the power used by the handsets when transmitting. This required an increase in the sensitivity and power of the satellites and their antenna.[105] The original contract also called for two on-orbit satellites. This was modified to one on-orbit satellite and one spare satellite.[106]

The 40-foot antenna, which uses a truss-like outer ring and mesh reflector surface, is the unique aspect of the APMT satellite design. It has led to concerns that the PRC could use the APMT satellite for signals intelligence collection against a wide spectrum of communications.[107]

The satellite, however, is designed to collect and process only communications in the same bandwidth as is allocated to the handsets.[108] Communications satellite antennas are designed to receive their own frequency and reject all others. To do otherwise would add unnecessary expense and complexity to the satellite.

In an attempt to reduce interference from other satellites using the same frequency bands, the APMT satellite antenna will use "left-hand circular polarization" which gives its signals a unique signature. The satellite will not collect other signals that use right, vertical, horizontal, or no polarization. These factors thus limit the satellite's ability to engage in signals intelligence to the collection of information transmitted by APMT system users. That volume of information, however, would be substantial.

When the handsets in the proposed APMT system are used, even for handset-to-handset conversations that are not bounced off the satellite, copies of the transmissions are downloaded to a central ground station. This capability is typically required of most satellite communications systems. Only Iridium, which uses inter-satellite cross-links, does not downlink its communications to a ground station. This downlink would allow the PRC to monitor the communications of APMT's users across the Asian region.

APMT AND THE ASIAN FINANCIAL CRISIS

The APMT program is one of the few commercial communications satellite programs that has remained strong despite the Asian financial crisis. Projections of an oversupply problem for Asia, and an accompanying plunge in transponder lease rates, appeared before the 1998 recession began. Asian currencies fell, as did demand for new satellite capacity. This oversupply was compounded when India did not pass legislation as expected to open their nation to the direct-to-home satellite market. That failure left some Asian satellites with empty beams aimed at India. Additional questions arose during this time about whether there are sufficient customers for these satellites to earn revenue. The Asian market is flooded with transponder capacity, creating a buyers' market.[109]

At least ten Asia-Pacific region communications satellite programs have been deferred due to the economic crisis.[110] These include the Measat 3, Agila 3, AsiaSat 4, Thaicom 4, LSTAR 1, LSTAR 2, and the M2A communications satellites.[111]

Yet another concern with Hughes' proposed APMT sale is that it could help the PRC learn about the deployment of large antenna structures. This could assist the PRC in the development of future reconnaissance satellites. Mechanisms used to deploy large antenna systems have been protected from PRC scrutiny in the past. Visual access to the satellite, as well as the risk of unauthorized discussion with engineers such as has occurred in the past, could give the PRC access to this sensitive technology for the first time.

The Role of PLA General Shen Rongjun and His Son in APMT

The complex relationship between the Shen family and the Asia-Pacific Mobile Telecommunications (APMT) satellite has raised concerns about the possible use of the satellite for military intelligence purposes, and the possibility that technology discussed in the technical interchange meetings would be transferred to the People's Liberation Army (PLA).[112]

In May 1994, PLA Lieutenant General Shen Rongjun, the Deputy Director of the People's Republic of China Commission of Science, Technology and Industry for National Defense (COSTIND), traveled to the United States and attended several business meetings with Hughes. Gen. Shen's responsibilities at COSTIND included the acquisition of satellite systems for the PRC. During this visit to the United States, General Shen's son, Shen Jun, who was living in Canada at the time, attended a business lunch with his father where he was introduced to Frank Taormina of Hughes. Taormina would later assist Shen Jun in obtaining a job at Hughes.[113]

Shen Jun is the older of two sons born to Gen. Shen. He spent 10 of his early years living at the Taiyun Satellite Launch Center in Shanxi province. Shen Jun received his Bachelor's and Master's degrees in computer science from the Changsha Institute of Technology.[114] The Changsha Institute of Technology is also known as the National Defense University of Science and Technology, and is run by the PLA.

For two years, Shen Jun received training and worked in the field of missiles and satellites under PLA supervision.

Shen Jun began working in North America in 1989 as a research assistant at the University of Waterloo, where he would later receive his Ph.D. in computer science in 1993.[115]

During his lunch meeting with Taormina in 1994, Shen Jun remarked that he was applying for a job with Hughes Canada. Taormina suggested to Shen Jun that he submit his resume to Taormina at Hughes in Los Angeles, where he could probably get a better job. While Shen Jun says he was not certain whether Taormina had a relationship with his father, he assumes that this was so, since Taormina was a Hughes vice president in charge of marketing and commercial business.[116]

Shen Jun was hired at Hughes in August 1994 after interviewing with Steve Hagers, who would become his boss.[117] At the time, a division of Space Systems/Loral was also considering hiring Shen for a position that would have allowed him access to classified information.

Originally, Shen Jun was hired at Hughes as a scientist in the information technology division. His primary duty was to investigate new software systems that were available in the commercial market for potential use by Hughes.[118] However, by June 1995, Shen Jun was transferred into Hughes' business development unit, where Hughes used him to conduct market research, general marketing of satellites in Asia, and, specifically, marketing of the APMT program.[119]

Another of Shen Jun's roles was to act as an interpreter for Hughes. While Hughes acquired a license from the U.S. State Department for Shen Jun to work as an interpreter in late 1996, Shen says he did not attend any of the preliminary design review meetings for APMT.[120] Shen Jun states that he did translate for Hughes during at least one or two meetings in the proposal stage. During this period, Shen Jun had a foreign national badge and did not have access to certain Hughes facilities.[121]

Shen Jun also claims that he did not talk with his father, Gen. Shen Rongjun, on a regular basis and had only discussed the APMT satellite with him on a couple of occasions, and even then only at a very general level. Shen Jun claims he talks infrequently with his father, and that he usually talks with his mother when he talks with his family because his father is busy. Furthermore, Shen Jun claims not to know his father's current occupation since the reorganization of COSTIND. Shen Jun, acknowledges, however, that he has had "very high level" discussions with his father on APMT such as "how is the thing … nothing deep, because it's a sensitive issue."[122]

Gen. Shen Rongjun's interactions with the APMT program are more obviously extensive. General Shen has been an advocate at COSTIND for purchasing Western satellites for the PLA, especially since the PRC's domestic satellites began failing in the early 1990s. Based on his position and responsibilities, Gen. Shen was directly involved in the decision to choose Hughes to work on the APMT program.

Similarities Between the PRC's Ballistic Missile and Rocket Technology

Background

The technologies used in rockets and ballistic missiles are essentially the same, except in the areas of payload and flight profile.[123] The common elements of rockets and ballistic missiles include:

- **Propulsion**
- **Structure**
- **Staging**
- **Guidance and control**

- **Ground support and launch equipment**
- **Systems integration**[124]

These commonalities have led to considerable interaction between rocket and ballistic missile programs. Nations that possess space launch capabilities are considered to have all the essential elements to develop a ballistic missile, and vice versa.

Historically, most rockets have been derived from ballistic missiles. In the United States, for example, the current Titan, Atlas, and Delta rockets were derived from ballistic missiles developed in the 1950s and 1960s. Russia's Start rocket is essentially an SS-25 intercontinental ballistic missile (ICBM) that has been modified with an additional upper stage and a payload fairing in place of its reentry vehicle.[125] Some rockets were even launched from silos, such as the Soviet-era SL-7 and SL-8. These Soviet rockets made use of the SS-4 and SS-5 intermediate-range ballistic missiles, respectively, as first stages.[126]

Since their origin, the PRC missile and space programs have been tied together. Like the space programs in the United States and the Soviet Union, the PRC space program got its early start by modifying ballistic missiles into rockets. These early attempts set a pattern of cooperation that continues today. The interaction can be seen in the overall design of the ballistic missiles and the rockets and in certain subsystems, such as propulsion.

In some areas, however, there are divergences. These divergences will increase in the future as the PRC's rockets and ballistic missiles employ different technologies, such as solid-propellant motors for ICBMs and cryogenic liquid-propellant engines for rockets.

The PRC's first rocket, known as the Long March 1, was a derivative of its limited range CSS-3 ICBM. The PRC launched two satellites aboard the Long March 1: one in 1970, and the second in 1971.

The PRC's CSS-4 ICBM has been the model for all PRC rockets since 1973. The first, the Long March 2A, has evolved into a family of rockets, including the Long March 2C, 2E, and 3; the Long March 3A family; and the Long March 4. The Long March 2C rocket is the most closely related to the CSS-4 ICBM. Indeed, it was derived directly from it. The two vehicles share the same first stage engines, structure, and dimensions.[127]

The PRC has also modified the CSS-3 into a small satellite launch vehicle known as the Long March 1D. The modifications include improvements to the YF-2 engines, a new second stage engine utilizing the YF-40 engines from the Long March 4, and a solid-propellant third stage similar to the apogee kick motor used on the Long March 3. The PRC has yet to use this new rocket for commercial space launches. The Long March 1D has, however, been used for military purposes.

Propulsion Systems

The propulsion system requirements for rockets and ballistic missiles are the same. Liquid-propellant engines or solid-propellant motors can be used on either. Both first and second stage engines are interchangeable between ballistic missiles and rockets. The flight environments that ballistic missiles and rockets pass through are the same, thus allowing their engines to be designed similarly. Traditionally, however, rockets use either additional stages or kick motors to place their payloads into orbit. Strap-on boosters can also be used for both rockets and ballistic missiles.

For its next generation ballistic missiles, the PRC is moving towards solid propellants. This will offer faster reaction times compared to liquid-propellant missiles. Moreover, solid-propellant missiles tend to be lighter weight. Solid propellants are less commonly used for rocket applications, since they provide less boosting power to place large payloads into orbit. Furthermore, the challenge of restarting solid-propellant motors once stopped makes them unattractive for upper stage use. The light weight of solid propellants, however, does make them useful for placing satellites into geosynchronous orbits, because they may be employed as kick motors and also as strap-on boosters on rockets.

The PRC's space program is reported to be moving away from storable liquid-propellant engines to cryogenic liquid-propellant engines. The PRC is reported to be working on a rocket that would use cryogenic liquid-propellant engines for its first and second stages. These engines provide greater boosting power over storable liquid propellants and solid propellants.[128]

Airframes

The airframe structure that forms the aerodynamic shell within which all elements of the rocket and ballistic missile are integrated is the same for both rockets and ballistic missiles.[129]

Ballistic missile and rocket structures must use materials that are lightweight and strong.[130] Lightweight materials are preferred because the smaller the structural fraction of the weight of the missile or rocket, the more weight can be dedicated to payload or range.[131]

The structure must also be strong enough to withstand the aerodynamic loads that affect the missile or rocket during boost and ground handling operations.[132] Because these loads are similar during the boost phase of flight, the structural requirements for ballistic missiles and rockets are the same, placing the same premium on materials, design, and fabrication.[133]

Ballistic Missile and Rocket Stages

The staging mechanisms on ballistic missiles and rockets are the same. In both cases, the purpose of using stages is to carry aloft the smallest amount of weight necessary to accelerate the payload to its target.

By discarding parts of the rocket or missiles that are no longer necessary, including unused propellant, stage separation makes space flight more efficient. For ballistic missiles with low accuracy (for example, "city buster" nuclear weapons as opposed to those designed to hit ICBM silos), the mechanisms for payload separation can be similar to those used on rockets.

Guidance Systems

The guidance and control subsystem of a rocket and of a ballistic missile monitors the flight path and adjusts for the effects of high altitude winds or gravitational attractions. The purpose, in both cases, is to deliver a payload to preselected points, either in orbit or on the earth, at preselected velocities.

The accuracy capabilities of a ballistic missile's guidance system may exceed those required for placing satellites into orbit, but the guidance system for a ballistic missile can be used on a rocket. A rocket guidance system, on the other hand, is not usually designed for the same degree of accuracy as is required for ballistic missiles, and therefore may not be suitable for use in some ballistic missile missions where a high degree of accuracy is required. In most cases, however, a rocket guidance system would be sufficiently accurate for delivering nuclear weapons to large targets such as cities.[134]

Many of the PRC's ballistic missiles and rockets share the same guidance systems.

The Select Committee has learned from Western scientists participating in the failure review following the 1996 Long March 3B crash that the guidance system used on the Long March 2C, Long March 2E, and Long March 3 rockets is also used on the CSS-4 intercontinental ballistic missile.[135]

The strap-down guidance system that is used on the PLA's M-series of ballistic missiles, such as the CSS-6 (also known as the M-9) and CSS-X-7 (also known as the M-11), is also used on the PRC "Smart Dispenser." [136] The PRC has used the Smart Dispenser to dispense two Iridium communications satellites on six different occasions.

The PRC had proposed to Loral to use this same guidance system on the PRC's "Top Stage" dispenser to dispense twelve Globalstar communications satellites from atop a Long March 2E rocket.[137] The PRC marketed the Top Stage to Loral as having a mature guidance system, since its inertial measurement unit had been tested on more than 50 flights of the M-series missiles.[138] After the crash of the Long March 3B carrying Loral's Intelsat 708 payload, however, Loral withdrew from its Globalstar contract with the PRC, and the 12-satellite dispenser was never used.

The Long March 3A, 3B, and 3C rockets use a different inertial measurement unit than do the Long March 2 family of rockets, the Long March 3, and the CSS-4 ICBM. The new guidance system for the Long March 3A, 3B, and 3C was developed in 1985, and is cheaper and lighter than the Long March 2 and Long March 3 guidance system.

The Long March 2 and 3 inertial measurement unit, for example, is so heavy that a crane is required to place it into position in the rocket. The Long March 3A, 3B, and 3C inertial measurement system is sufficiently smaller that it can be manually installed in the rocket.

Comparison of Two Different Inertial Measurement Units Used in Guidance System of Long March Rockets[139]

Features of the Inertial Measurement Unit	Used in the Guidance System of	
	LM 2C/2E/3	LM 3A/3B/3C
Number of Gimbals	3	4
Number of Gyroscopes	3	2
Number of Accelerometers	3	3
Number of Torque Motors for Each Gimbal	2	1
Dimensions (mm)	500 x 600 x 800	300 x 300 x 400
Mass (kg)	140	48
Maiden Flight	1974 on Long March 2C	1994 on Long March 3A
Manufactured by	CALT (LM 2C/2E) CAST (LM 3)	CALT

Additionally, the Long March 2 guidance system and the guidance system for the Long March 3A, 3B, and 3C share almost none of the same components. The Long March 2 guidance system uses a double solder for connectors, whereas the Long March 3B uses a single solder. The Long March 2 guidance system is also a three-axis stabilized platform, whereas the Long March 3B is a four-axis stabilized platform.[140]

A relatively small and lightweight inertial measurement unit would be required for the PRC's next generation of ICBMs. While the Long March 3B inertial measurement unit is capable of being used for that purpose, it is considered an unlikely choice. Nonetheless, the experience that the PRC has gained with the Long March 3B in designing a small and lightweight inertial measurement unit that works will almost certainly benefit its designs of ICBM guidance systems in the future.

Ground Support

Ground support and launch procedures can be the same for rockets and ballistic missiles. The crews that launch ballistic missiles and rockets can be the same (and, indeed, PLA personnel are involved in both rocket and ICBM launches in the PRC).

The ground support equipment, such as the launch tower, the missile stand, the propellant handling equipment, and the transportation trains, can all be the same for rockets and ballistic missiles.

Payload preparation and handling is an area where procedures do differ, since satellites often require a complex checkout sequence before launch which ballistic missile warheads do not.[141]

The various institutes and academies in the PRC involved in the design and production of ballistic missiles also share design and production responsibilities for rockets. The China Academy of Launch Technology (CALT) is responsible for research and development of ballistic missiles and rockets. The Beijing Institute of Control Devices is responsible for both ballistic missile and rocket design. Moreover, all of these academies and institutes are managed within the same organizational hierarchy. These common responsibilities will allow the PRC to gain experience for both their ballistic missile and rocket programs through the launching of Western communications satellites.

The PRC's launch sites are also used for both military and commercial purposes. The Taiyun Satellite Launch Center was originally designed for launches of the CSS-4 ICBM. Today it launches the Long March 2C/SD rocket carrying Iridium satellites and the Long March 4 into polar orbits.[142]

Systems Integration

The system for integrating the propulsion, guidance and control, payload, and structure is the same for rockets and ballistic missiles.[143] Analytical and diagnostic tools, such as structural analysis software, are the same for both and are widely available.[144]

Payload

The payload is the area of most significant potential difference between rockets and ballistic missiles.

Satellites are usually complex, fragile systems that are designed to remain in orbit for fixed periods of time. Satellite payloads usually are not required to withstand the aerodynamic stresses of reentry. Single warheads, on the other hand — including nuclear, chemical, and biological warheads, as well as conventional bombs — are designed to survive the intense stresses of atmospheric reentry.

Rockets normally use a fairing to protect the satellite payload from the aerodynamics stresses of launch (although a satellite can be designed, in some instances, to withstand the aerodynamic stresses of launch and therefore would not require a fairing). But in many cases, such as in the deployment of multiple warheads, or submarine launched missiles, ballistic missiles can include a shroud that is similar to a fairing. Both fairings and shrouds are aerodynamic shells that are placed over the payload — satellite or warhead — to reduce drag and aerodynamic stresses during launch.

To place the desired payloads into orbit, rockets generally operate at higher velocities than ballistic missiles. These higher velocities are often attained by high performance third stages, or by kick motors. An ICBM payload, on the other hand, is not intended to achieve orbit around the earth. Rather, the nuclear warhead reentry vehicle is considered to be a rocket whose orbit intersects the earth at the target.

Conclusion

Because of the many commonalities between rockets and ballistic missiles, the PRC can apply the same system refinements and modifications to both its rockets and ICBMs. It is likely that the failure rates of CSS-4 ICBM test flights, and the remedies the PRC adopts to address technical problems with the CSS-4 ICBM, are the same as or similar to those of the Long March series of rockets.

TO THE READER: All references to classified material have been deleted from these footnotes. Only open source materials have been cited.

Chapter 1 - PRC Acquisition of U.S. Technology

1 In practice, it is just as accurate to say the PRC Government is made up of just two bureaucracies (since the PLA is actually the "fist" of the CCP), or even one bureaucracy (since both the PLA and the State are subservient to the CCP). The distinctions between are them largely artificial. For general information on this topic. *See* CRS Report, "Chinese Government Structure and Function, Policies on Military and Industrial Modernization, and Technology Acquisition," November 10, 1998; Kenneth Lieberthal, *Governing China*, W.W. Norton & Company, Inc., 1995.

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3 *See* Constitution of the People's Republic of China, Articles 2, 3.

4 Lieberthal, *Governing China*, refers to this technique as "interlocking directorates."

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U.S. NATIONAL SECURITY AND MILITARY/COMMERCIAL CONCERNS WITH THE PEOPLE'S REPUBLIC OF CHINA

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SATELLITE LAUNCHES IN THE PRC: HUGHES

Hughes Space and Communications International, Inc. (Hughes) attempted to launch two communications satellites from the PRC on Long March rockets which exploded before reaching orbit, one in 1992 and one in 1995. Allegations regarding technology transfer arose in connection with failure analysis investigations conducted by Hughes employees in the aftermath of these failed launches. Specifically, in 1992 and 1995, China Great Wall Industry Corporation, a PRC government entity, launched two Hughes satellites manufactured for Australian (Optus B2) and Asian (Apstar 2) customers from a PRC launch facility in Xichang, PRC.

Both satellites were launched on a Long March 2E rocket. In both cases, an explosion occurred after take-off and before separation of the satellite. Hughes investigated the causes of both of these failed launches and determined that the rocket was the cause of the failures.

In the course of the investigations, Hughes communicated technical information regarding the rocket to the PRC that assisted the PRC in improving the Long March 2E rocket. The activities of Hughes employees in connection with the investigation of the failed launch in 1992 resulted in the transmission to the PRC of technical information that appears to have been approved by a U.S. Government representative but not properly licensed. In the case of the 1995 Hughes failure investigation, Hughes employees exported technical information that also was approved by a U.S. Government representative but should not have been authorized for export to the PRC.

In both cases, Hughes disclosed information to the PRC that related to improving the Long March 2E fairing, a portion of the rocket that protects the payload during launch. Such information was outside the scope of the original licenses Hughes obtained from the State and Commerce Departments, respectively, with respect to the export and launch of the Optus B2 and Apstar 2 satellites. Hughes claims that the 1993 Optus B2 failure analysis disclosures were cleared in advance by U.S. Government officials, but neither Hughes nor the pertinent U.S. Government agencies retained records that would substantiate this claim fully.

The lessons learned by the PRC from Hughes during the 1995 Apstar 2 failure investigation are directly applicable to fairings on other rockets, including those used to launch PRC military satellites.

Although the Long March 2E has not been used since 1995, it is possible that the PRC may have transferred the lessons learned from this launch failure investigation to its ballistic missile programs. These lessons could lead to the development of a more reliable fairing for use with advanced payloads on military ballistic missiles.

Hughes obtained a clearance for the 1995 disclosures that was improperly issued by a Commerce Department official. Hughes was confident that the cause of the 1992 launch failure on the PRC's Long March 2E rocket was the fairing. Hughes then ascertained with more certainty that the fairing was responsible for the 1995 launch failure. Hughes required that the PRC take appropriate corrective measures so that future launches of Hughes satellites on the Long March 2E rocket could occur and be insured.

Hughes employees conveyed to the PRC the engineering and design information necessary to identify and remedy the structural deficiencies of the fairing. At the time of the 1992 failure, the export of both the satellite and any information that might improve the rocket were subject to State Department licensing jurisdiction.

Hughes knew that the fairing was part of the rocket and that a State Department license was required to discuss improvements with the PRC. Although Hughes did not have a license to disclose information to the PRC relating to improvement of the fairing, Hughes, nonetheless, made such disclosures. Hughes claims that each disclosure was authorized by the Defense Technology Security Administration monitor. Contemporaneous Hughes records partially support this assertion. The monitor says he doubts that he in fact approved the disclosure, but says he cannot fully recall these matters.

Neither Hughes nor any relevant U.S. Government agency has been able to produce records substantiating all of the claimed approvals. Even if such approvals were in fact given, they would have exceeded the authority of the Defense Technology Security Administration monitor since he was not empowered to expand the scope of the license granted by the State Department. The monitor also should have known that a separate license was needed for the launch failure analysis activities. By the time of the 1995 failure investigation, partial jurisdiction for commercial satellites had been transferred to the Commerce Department, but licensing for improvements to any part of the rocket, such as the fairing, remained with the State Department.

Hughes officials who were responsible for the launch failure investigation in 1995 knew that technical information that would improve the rocket, including the fairing, was still subject to State Department jurisdiction and was not licensed for export. Nonetheless, Hughes sought Commerce Department approval to disclose information regarding the fairing to the PRC. A Commerce Department official, without consulting with Defense Department or State Department experts, approved that disclosure, he says, on the assumption that the fairing was part of the satellite, not the rocket. He now acknowledges that this decision was a mistake.

The Defense Department recently determined that the information Hughes made available to the PRC was sufficiently specific to inform the PRC of the kinds of rocket changes and operational changes that would make the Long March 2E, and perhaps other rockets, more reliable. In particular, Hughes assisted the PRC in correcting the deficiencies in its models of the stresses or loads (such as buffeting and wind shear) that the rocket and payload experience during flight.

There are differing views within the U.S. Government as to the extent to which the information that Hughes imparted to the PRC may assist the PRC in its ballistic missile development. There is agreement that any such improvement would pertain to reliability and not to range or accuracy. It is not clear, at present, whether the PRC will use a fairing that was improved as a result of Hughes' disclosures in a current or future ballistic missile program. Currently-deployed PRC ballistic missiles do not use fairings, and the PRC's future mobile land-based intercontinental ballistic missiles will probably not use a fairing. However, fairings are used by the PRC in launching military communications satellites and could be used for a submarine-launched ballistic missile.

In the opinion of the Select Committee's independent expert, Dr. Alexander Flax, fairing improvements could also be of benefit to multiple independently-targeted reentry vehicle (MIRV) development, should the PRC decide to move in that direction. (See the *Technical Afterword* at the end of this chapter for additional details on the possible uses of fairings in intercontinental ballistic missiles.)

Hughes also provided the PRC with practical insight into diagnostic and failure analysis techniques for identifying and isolating the cause of a launch failure. Whether or not the structural improvements to the fairing suggested by Hughes are of immediate use to the PRC's missile programs, that information expanded the PRC's repertoire of available technical solutions to future problems that it may encounter in its space and missile programs.

Finally, the Select Committee's independent expert has concluded that Hughes provided the PRC with the benefit of its engineering experience and know-how. As a result, PRC engineers better understand how to conduct a failure analysis and how to design and build more reliable fairings for rockets: "This will stand them in good stead in developing fairings (or shrouds) for ballistic missiles."

OPTUS B2, APSTAR 2 LAUNCH FAILURES

PRC GAINS SENSITIVE KNOWLEDGE FROM HUGHES INVESTIGATIONS

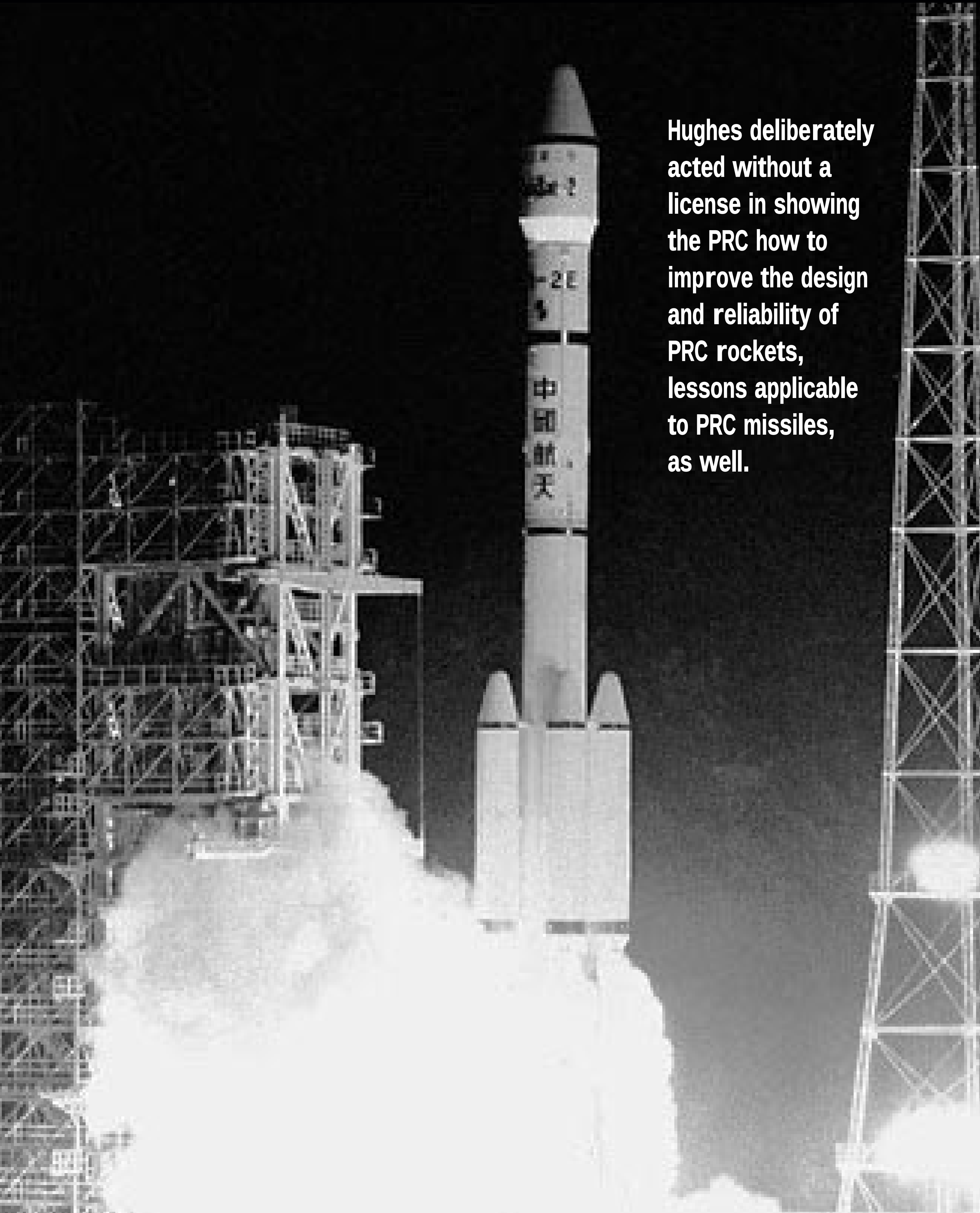
In 1992 and 1995, two Hughes Space and Communications International, Inc. (Hughes) satellites were launched from the People's Republic of China on Long March 2E rockets and failed to achieve orbit. It has been alleged that, in the failure investigations that followed, Hughes provided technical information to the PRC that assisted the PRC in improving the Long March 2E. This portion of the report examines the events that underlie those allegations.

The 1992 failure involved the Optus B2 satellite, while the Apstar 2 satellite was destroyed in 1995.

For each event, provided below is a brief discussion of the export licenses for the satellite, and the restrictions that the licenses contained.[1] A short discussion of the actual events of the failed launches follows, along with a detailed review of the failure investigations that Hughes conducted and of the U.S. Government's actions that related to those investigations.

Hughes' efforts during the investigations to provide technical information to the PRC for the purpose of assuring success in future launches are explained, as is the extent of the U.S. Government's knowledge and approval of Hughes' actions.

Finally, the actual improvements that were made to the Long March 2E by the PRC, and assessments of the potential damage to national security resulting from those improvements, are discussed.



Hughes deliberately acted without a license in showing the PRC how to improve the design and reliability of PRC rockets, lessons applicable to PRC missiles, as well.

The Prohibition Against Technology Transfer In Foreign Launches

International Traffic in Arms Regulations and the U.S. Munitions List

Section 38 of the Arms Export Control Act[2] (AECA) authorizes the President to control the export and import of defense articles and services. The International Traffic in Arms Regulations (April 1, 1992 edition) contain the following definitions of defense articles and defense services:[3]

> **Section 120.7 Defense article.**
>
> *Defense article means any item designated in Section 121.1. This term includes models, mockups, and other such items which reveal technical data directly relating to items designated in section 121.1*
>
> **Section 120.9 Defense service.**
>
> *Defense service means:*
> *(a) The furnishing of assistance (including training) to foreign persons whether in the United States or abroad in the design, engineering, development, production, processing, manufacture, use, operation, overhaul, repair, maintenance, modification or reconstruction of defense articles, whether in the United States or abroad….*

The U.S. Munitions List also enumerates articles that are controlled under the authority of the AECA in relevant part as follows:

> **Section 121.1 General. The United States Munitions List**
>
> *(a) The following articles, services and related technical data are designated as defense articles and services….*

Category IV – Launch Vehicles [rockets]….

(b) Launch vehicles and missile and anti-missile systems including but not limited to guided, tactical and strategic missiles, launchers, and systems….

(h) All specifically designed or modified components, parts, accessories, attachments and associated equipment for the articles in this category….

Department of Defense Monitoring Role

U.S. Air Force Instruction 10-1210, "Technology Safeguard Monitoring for Foreign Launches of US Commercial Satellites," identifies the Defense Technology Security Administration[4] as having responsibility for the objectives of the technology safeguard program, which include:

to support the US non-proliferation policy for space and missile technology, . . . the International Traffic in Arms Regulations, and the US Munitions List.[5]

Defense Technology Security Administration monitors are responsible for "controlling the disclosure of technical information."[6]

The U.S. Air Force Technology Safeguard Monitor Handbook describes the role of the Defense Technology Security Administration monitor in debris recovery and accident investigations as follows: "If an anomaly (i.e., crash) occurs during the launch campaign you will need to prevent technology transfer throughout the debris recovery and accident investigation."[7] It continues:

after an anomaly occurs, the chance for technology transfer is the highest. As a US government technology safeguard monitor you will be overseeing the accident investigation discussions. Failure analysis discussions are sensitive because both sides want explanations and ask technical questions. The worst case for possible technology transfer occurs when both the spacecraft [satellite] and

> *launch vehicle [rocket] are suspect; however, technology transfer is still a problem even if the anomaly was clearly caused by a launch vehicle [rocket] problem.*

Optus B2

The Optus B2 Licenses

On May 2, 1991, the U.S. Department of State issued export license 483414, renewing license 384476, dated March 16, 1989. The 1991 license permitted the export of two Hughes Model HS-601 satellites (see illustration) to Australia for delivery in space to Aussat (later renamed Optus), Australia's national communications satellite company.

The foreign intermediate consignee was Hughes, in care of China Great Wall Industry Corporation, Xichang Satellite Launch Center, Xichang, PRC.

The license was qualified by a letter dated May 2, 1991 from the Office of Defense Trade Controls of the State Department that sets forth limitations and provisos. In relevant part:

> *1. Hughes (which term includes all Hughes employees and agents) must conform strictly to the terms of Hughes own technology control plan with the China Great Wall Industry Corporation, as well as to the terms of the Satellite Technology Safeguards Agreement between the U.S. Government and the People's Republic of China (the Agreement) and the U.S. Government's measures for the implementation of that agreement.*

* * *

> *5. Unless it obtains the prior separate approval of the Office of Defense Trade Controls of the U.S. Department of State, Hughes must not provide any hardware or technical assistance*

Dept. of Defense

Built as the Hughes HS-601, this satellite became the Optus B2. It was to be placed in orbit from Xichang in the PRC for use by Australia's national communications satellite company. The December 21, 1992 launch failed, however, when the Long March 2E rocket veered off course and crashed, destroying the satellite. Hughes then tried to help the PRC fix the problems with the Long March.

> *whatsoever to its Chinese counterparts which might assist China to design, develop, or enhance the performance of any of its contemplated or existing Long March launch vehicles or missiles.*

The Optus B2 Fails To Achieve Orbit

On December 21, 1992, the Hughes-manufactured Optus B2 satellite was launched from Xichang Launch Center in the PRC.

The following description of the failure is excerpted from the Hughes report:

> *A normal performing launch vehicle [rocket] would have passed through the point of maximum dynamic pressure at 62 seconds after liftoff. The failure occurred approximately 48 seconds after liftoff. The launch vehicle [Long Mrach 2E rocket] was in the transonic buffeting period of its flight, at an altitude of approximately 7000 meters, when the failure occurred . . .*[8]

Debris recovery began almost immediately and continued for about three weeks.

Officials from the China Academy of Launch Vehicle Technology (CALT) and Hughes began to investigate the cause of the crash. Hughes President and CEO Steven Dorfman appointed Vice President Donald Cromer to lead the Hughes investigation to determine the cause of the failure.[9]

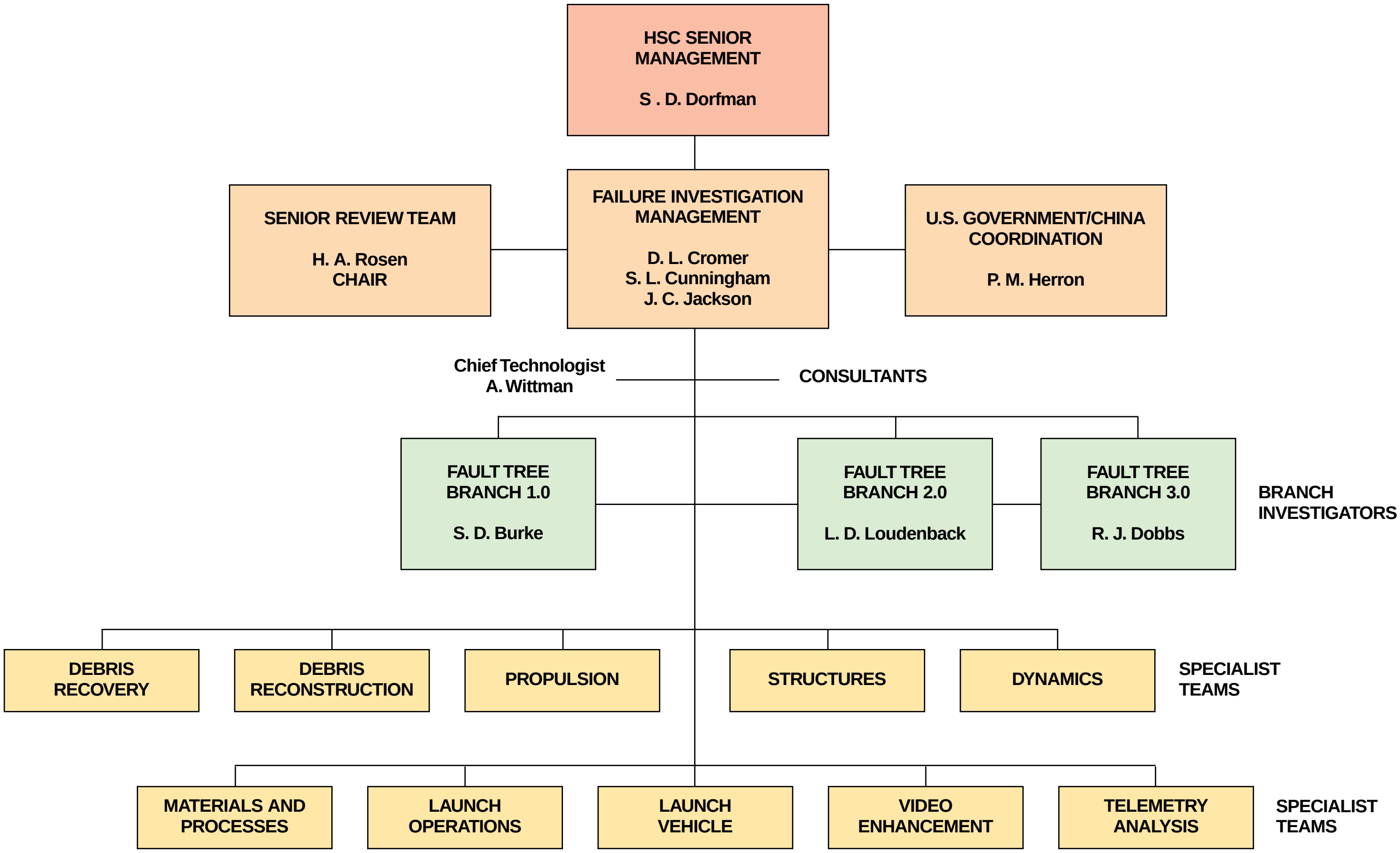
Before joining Hughes, Cromer, had been an Air Force Lieutenant General, and had managed the Space Division of Air Force Systems Command. In that position, he was responsible for the design, development, and acquisition of Air Force space launch, command and control, and satellite systems.[10]

Cromer's principal assistant in directing the Optus B2 failure investigation was Dr. Stephen L. Cunningham, a senior-level Hughes executive and Ph.D. physicist who has worked in satellite programs at Hughes since 1977.[11]

Hughes' Optus B2
Failure Investigation Organizational Structure

SENIOR TECHNICAL REVIEW TEAM

Team Role	Team Member	Position
Chair	Harold Rosen	Vice President, Engineering
Member	Jerry Dutcher Pete Herron John Ellison Bob Meese Steve Robinson Al Wittman Ted Smith	Business Unit Leader, GSEO Optus B3 Program Manager Propulsion Product Line Leader Business Unit Leader, SIS Chief Technologist Chief Technologist Consultant, Launch Vehicle
Advisor	Ernie LaPorte Bob Steinhauer Mal Meredith Hal McDonnell Steve Archer Bob Roney	Consultant, General Long March 2E Launch Vehicle Consultant, General Galaxy Program Representative UHF Program Manager Consultant (retired Hughes VP)



Failure Investigation Teams

Hughes established several teams to conduct the Optus B2 launch failure investigation. The teams comprised 27 individuals, and their activities covered over 20 days of meetings with the PRC, including at least 15 days of meetings in the PRC.

A Failure Investigation Team was chartered to examine all aspects of the failure, including both the satellite and the rocket.

A second team, called the Spacecraft Focus Team, was to limit its focus to the satellite.

A third team, the Independent Review Team, was made up of experts from outside the Hughes organization. It was charged with reviewing the work of the other two Hughes teams and with making an independent assessment of the failure.

Finally, because Hughes recognized that the findings of its teams could be in conflict with those of the PRC accident investigators representing the China Academy of Launch Vehicle Technology (CALT), it established the International Oversight Team made up of three members: one from Intelsat, one from the China Aerospace Corporation (CASC), and the Chairman of the Hughes Independent Review Team.

The Hughes teams were organized by functional specialties as illustrated in the chart on the previous page.[12]

The organization chart identifies Peter M. Herron, who was the Optus B2 Assistant Program Manager, as responsible for U.S. Government/PRC coordination for the failure investigation. In this role, Herron was the person responsible for obtaining U.S. Government approval for all information transfers from Hughes to the PRC during the failure investigation.[13]

Failure Investigation Begins

The failure investigation began immediately, and proceeded as shown on the following page.[14]

As the debris recovery progressed, Defense Technology Security Administration monitors who were present for the launch continued to monitor the recovery efforts.[15]

Hughes' Optus B2/Long March 2E Failure Investigation Schedule

EVENT	1992	1993									
	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
Launch Failure	▲ 21										
Failure Team Reviews	▲ ▲	▲ ▲ ▲	▲ ▲ ▲	▲ ▲ ▲ ▲	▲ ▲ ▲ ▲						
Debris Recovery	▲—	—▲									
Team Visit China		▲ 7-12									
Debris Received		▲ 21									
Launch Vehicle Telemetry 1 Received		▲ 29									
Interim Spacecraft Report			▲ 19								
Telemetry Team Visit China				▲ 1							
UHF F1 Launch (Atlas)				▲ 11							
Preliminary Spacecraft Report				▲ 30							
China Closeout Meeting						▲ 11					
Astra 1C Launch (Ariane)						▲ 12					
Launch Vehicle Telemetry 2 Received						▲ 15					
Galaxy C2 Launch (Ariane)							▲ 24				
Optus Briefing — HSC								▲ 12			
Optus Briefing — CALT								▲ 15			
UHF F2 Launch (Atlas)										▲ 3	
Underwriters Briefing										▲ 30	
Final Spacecraft Report						▲ Coordination Draft					▲

The Hughes Optus B2 launch failure investigation spanned nearly a full year during 1992-93.

Defense Technology Security Administration monitors were also present during the subsequent failure investigation, both in Beijing and Xichang, whenever Hughes employees had meetings with PRC officials.

U.S. Air Force Lieutenant Colonel Allen Coates was one of the Defense Technology Security Administration monitors. He was present in Beijing from January 4 to 14, 1993 as a Defense Technology Security Administration monitor for the failure investigation.

Lt. Col. Coates specifically recalls informing Hughes senior management, including Vice President Donald Cromer, Chief Technologist Al Wittmann, Chief Scientist Robert Steinhauer, and Optus B2 Assistant Program Manager Peter Herron of the restrictions in Hughes' export license regarding the transfer of any information related to the design of the satellite or the rocket.[16] He additionally advised Hughes personnel there, specifically Herron, and possibly Steinhauer and Wittmann, that Hughes could not discuss modifications to the fairing.[17] At that time, Al Wittmann, Chief Technologist at Hughes, reported directly to CEO Steven Dorfman.[18]

In the early stages of the investigation, the PRC focused its analytic efforts on the rocket, and Hughes examined the satellite. Both the PRC and Hughes were seeking to determine whether their respective hardware was responsible for the failure. Because the first visible sign of an explosion appeared as a flame at the top of the rocket, there was some question as to whether the satellite could have exploded.

As part of the investigation, Wittmann, Hughes' Chief Technologist, and the other engineers first looked into the possibility that the satellite fuel tank structures failed. They later determined the fuel tanks did not fail.[19]

Upon his return from the PRC, Wittmann had an accident that forced him to recuperate at home. During his recuperation, he was assisted by Spencer Ku, another Hughes engineer. In reviewing some of Ku's analysis, it occurred to Wittmann that statements made to him by PRC personnel regarding the structure and materials strength of the rocket's fairing (that is, the portion of the rocket including the nose cone that surrounds the satellite) were not realistic.[20]

Wittmann was sure in January 1993, while still in recuperation, that the fairing[21] that surrounds the satellite failed, thus collapsing and crushing the satellite.[22]

As the investigation progressed, Hughes scientists became more and more certain that the fairing on the Long March 2E rocket had indeed failed, causing the launch failure.

Hughes' Export Administrators Deal with the Licensing Question

Hughes' Technology Export Control Coordinator, Donald Leedle, was the focal point in the company from 1992 until 1996 for technology licensing issues. A program or contracts manager who needed to export a satellite would consult him for information regarding licensing requirements. He was responsible for maintaining current knowledge of governmental regulations related to export licensing.[23]

Leedle describes himself as one of the most knowledgeable Hughes employees on the subject of the International Traffic in Arms Regulations as they relate to communications satellites. He says he was responsible for briefing Hughes program managers on these regulations. He was also responsible for coordinating licensing conditions and requirements for the Hughes programs. He consulted with Hughes Electronics' corporate International Traffic in Arms Regulations expert, Dar Weston, when necessary.[24]

Leedle says that the Optus B2 licenses, as many as 18, had been approved before he was involved in the Optus program. Some licenses had expired, however, and he was involved in the renewal by the State Department of the expired licenses.[25]

In response to a general question about the need for a license for a failure investigation, Leedle says that an accident investigation might be covered by the original license, or it might need a new license, but such a decision would be made by the U.S. Government. He advises that technical data would require different State Department licenses than the satellite hardware. Further, he says that Hughes was not permitted under the International Traffic in Arms Regulations to make suggestions that would help improve PRC rockets.[26]

Leedle is aware that rockets are included on the Munitions List and that a fairing is a part of the rocket.[27]

Sometime after the Optus failure, Leedle met with a group of Hughes employees, among them Hughes attorney Jennifer Smolker[28] and Peter Herron, who had been the Assistant Program Manager for the Optus B2 satellite, to determine whether a license was needed for the failure investigation.[29] Hughes CEO Dorfman describes Smolker as "the first point of accountability, from my perspective, on the whole licensing process." [30]

In April 1993, Leedle most likely contacted Donald E. Majors, Director for International Affairs at Hughes' Washington, D.C. office, regarding Hughes communications with the PRC concerning Long March 2E rocket fairing deficiencies. Although he does not specifically recall the conversation, he says that he talked frequently to Majors during that period.[31]

On April 9, 1993, Majors wrote a memorandum to Leedle on "License Requirements for Long March Fairing Discussions," in which he summarized informal discussions with the State Department regarding the Optus B2 launch failure investigation.[32] The text read:

> ***1.*** *In response to our informal inquiry, the cognizant State Department licensing official expressed the following views:*
>
> ***a. Information or professional opinion on fairing deficiencies as a potential cause of the Optus B2 launch failure probably constitutes technical data as defined in ITAR [International Traffic in Arms Regulations]. If Hughes decides this is in fact the case, an export license would be required to provide such information or opinion to the PRC.*** *If Hughes decides otherwise, the subject is moot.*
>
> ***b.*** *If a license is required, chances of obtaining it would be good if Hughes could make an unequivocal case that the technical data to be transferred could not be used for any purpose other than increasing the safety of the spacecraft during a new launch.*
>
> ***c. A license request would almost certainly be denied if even the slightest possibility or inference, real or perceived,***

> ***remained undispelled that the technical data could directly or indirectly impact PRC ballistic missile interests.***
>
> **2.** *Should [Hughes] elect to submit a license application on this subject we recommend that (a) all the technical data to be transferred be precisely stated and (b) detailed rationale be included to counter all potential arguments that the data could in some way enhance PRC ballistic missile capabilities.*
>
> ***3. Considering the extreme sensitivity that certain USG agencies attach to technology transfers to the PRC, we should also give some thought to an advance softening up process.*** *This could include advance technical level briefings for friends and adversaries alike, and a degree of precoordination of the data to be released.* [Emphasis added]

Majors' memorandum to Leedle was also sent to Herron and Smolker. Additionally, copies of the memorandum were forwarded to the following Hughes executives: CEO Steven Dorfman, P. C. Dougherty, M. J. Houterman, W. D. Merritt and J. S. Perkins.

Majors' office served as the Washington liaison between Hughes corporate offices and the State Department on licensing issues. His primary contact on satellite issues at the State Department licensing office was Kenneth Peoples.[33]

Peoples had issued State Department export license number 483414 to Hughes for the export of the Aussat B (later Optus B) satellite. He says that the license defined authorized activities, and that any activity not specifically authorized by a license is prohibited.[34]

Peoples advises that rockets are on the Munitions List and that a fairing, the nosecone that protects the satellite, is a part of a rocket.[35] Peoples does not specifically recall speaking to Majors about the fairing, but he describes the recommendation in Majors' memorandum as "excellent advice." The fact that rocket information was on the Munitions List in 1993 was well-known, he says, and Peoples has difficulty accepting that Hughes officials would not have been aware at that time that a license would be needed to convey to the PRC information related to rockets.[36]

Mere unlicensed discussion of technical data with foreign nationals is sufficient to constitute a violation of the International Traffic in Arms Regulations, in Peoples' opinion. In addition to the license restrictions, Hughes was prohibited from transferring technology to the PRC by provisions of the U.S./PRC nation-to-nation agreement on technology transfer.[37]

Stephen Cunningham, who led the Optus B2 launch failure investigation, had also been the Program Manager for the Optus B1, which was launched in the PRC in August 1992. He is familiar with the International Traffic in Arms Regulations and the Munitions List. Cunningham agrees that Hughes needed prior, separate approval from the State Department to provide any technical assistance that might assist the PRC in enhancing the performance of its Long March rockets.[38]

Around the time of Majors' April 9, 1993 memorandum, Cunningham recalls "specific discussions with [Defense Technology Security Administration monitor Lt. Col.] Al Coates regarding whether the fairing we are talking about had any relevance to ballistic missiles, and we did not receive a specific answer from Al Coates, but he said he would go find out from his sources." [39]

Cunningham says that Hughes hypothesized that the fairing on a commercial satellite had no relevance to ballistic missiles:

> *We were all very sensitive to the issue on anything that would help the ballistic missile interest, but — and there are a lot of things in the commercial satellite business that are irrelevant to weapons use and so the real question was, in our minds, is the fairing that we are talking about in the category of commercial use only or is it in the category of missile technology?* [40]

On April 19, 1993, ten days after the Majors∆ memorandum, a senior level staff meeting took place at Hughes to discuss how to deal with the fairing issue. Officials at the highest levels of Hughes, including possibly Vice President Cromer, attended the meeting, which was held to discuss a planned trip to the PRC regarding both the Optus B2 failure and the future launch by the PRC of Optus B3, the satellite that was to replace the destroyed Optus B2.[41]

Cunningham's participation in the trip to the PRC was in connection with his duties to discuss and resolve issues related to the Optus B2 failure. While on the same trip, his colleague Peter Herron was involved in negotiations regarding the Optus B3.[42]

By April 1993, Cunningham says, "We strongly believed that the fairing caused the problem . . . We believed that the fairing had to be modified in order to get insurance to launch." [43]

Herron had prepared view graph slides, outlining the issues and alternatives for senior management to consider at the strategy meeting. One of the slides used in the briefing stated the following:

> *We are concerned about several aspects of the design [of the Long March 2E fairing]. What do they fix? How do they validate the redesign?*
>
> *The USG will require a specific license if we want to discuss the design problems. It is unlikely that we could get the license.*
>
> *We would have to show that there would be no resultant improvement in the Chinese ICBMs.*[44]

A 'Political' Business Solution

Hughes' Director of Launch Service Acquisition, John S. Perkins, was responsible for the negotiation of the Optus B3 launch services contract with the PRC. In that role, he had contact with the team investigating the Optus B2 failure. Although he was not part of the Optus B2 failure investigation team, he was in the PRC conducting Optus B3 negotiations while the failure investigation was proceeding.[45]

Perkins recalls being aware during the failure investigation that some Hughes engineers thought that the fairing on the Long March 2E rocket may have failed. He recalls that there were discussions within the company that Hughes would require the PRC to improve the fairing, and that without improvements to the fairing, the Optus B3 would not be launched.[46] Perkins says that the negotiations for an agreement to announce the conclusion of the Optus B2 failure investigations took several weeks of "wordsmithing to subtly try to imply the other party was at fault, without being at fault, to point the finger at us or to point the finger at the Chinese." [47]

The negotiations for Optus B3 were difficult, because the PRC would not acknowledge any fault in the Optus B2 failure. It is Perkins' belief that the Defense Technology Security Administration eventually approved some discussions with the PRC about fairing improvements.[48]

Perkins also participated in discussions with the PRC that led to a written agreement that took the following form:

MINUTES OF MEETING HELD IN BEIJING ON 11 TO 12 MAY 1993 BETWEEN HUGHES AND CGWIC REGARDING THE CONCLUSION OF THE OPTUS B2 FAILURE INVESTIGATIONS

1. *On December 21, 1992 the Optus B2 satellite was launched on an LM-2E Launch Vehicle from Xichang Satellite Launch Center, China. At approximately 48 seconds into the flight, the Optus B2 spacecraft exploded.*

2. *Based on analysis of the Launch Vehicle telemetry, inspection of the Launch Vehicle fairing debris and special tests, it was determined by CGWIC/CALT [China Great Wall Industry Corporation/ China Academy of Launch Vehicle Technology] that there is no design or manufacturing or integration flaw in the Launch Vehicle or the fairing which caused the failure. Hughes accepts this conclusion.*

3. *Based on analysis of the Launch Vehicle telemetry, inspection of the spacecraft debris, and special tests, it was determined by Hughes that no design or manufacturing flaw can be found in the spacecraft which caused the failure. CGWIC/CALT accepts this conclusion.*

4. *Both CGWIC/CALT and Hughes agreed to conclude the Optus B2 investigation and use their best effort to launch another Optus satellite by June 94.*

5. During the Optus B2 failure investigation, both CGWIC and Hughes observed strictly the requirements of the USA/PRC agreements on technical security.

6. Both parties expressed the same willingness to promote the existing friendly cooperation between them. Hughes expressed the willingness to purchase Long March launch services for other future satellite programs, and CGWIC expressed the willingness to influence its partners to purchase Hughes' satellites.

Signed on the 12th day of May 1993

Donald L. Cromer	***Wang Dechen***
John S. Perkins	***Chen Shouchun***

Perkins describes this agreement as an agreement not to publicly blame the fairing as the cause of the failure. Perkins says of the agreement:

> *Politically we could not write down on paper that the fairing had failed and that they were at fault. It was a non-starter in China. They were very concerned that we would say that. This document was trying to say we are not going to say that. Now, go fix the fairing.* [49]

Hughes' intermediary in the PRC was Bansang "Bill" W. Lee, who worked in the Hughes Beijing office from 1991 until around October 1994 as a salaried employee.[50] As Hughes' chief representative in Beijing, he had three duties: marketing Hughes satellites in the PRC; serving as a liaison between various Hughes organizations and the PRC; and providing logistics support for all Hughes visitors to the PRC.[51]

Although Bansang Lee was not actually a member of the Optus B2 failure investigation team, he was present at meetings in the PRC and was involved in the negotiations that led to the May 12 agreement between Hughes and China Great Wall Industry Corporation not to blame each other for the launch failure. He was also involved in negotiations for the Optus B3 launch.[52]

Lee's major involvement in the failure investigation was crafting an acceptable public explanation as to the cause of the failure. The PRC would not accept that the Long March 2E rocket was at fault, and Hughes was almost certain that the satellite had not caused the failure. Lee says that in the May 12, 1993 agreement each side stated: "I have no objection to your position . . . and you have no objection to my position. Basically, the conclusion is no conclusion." [53]

Lee says that his involvement in efforts between April and October 1993 was generally along the lines of persuading each side not to point fingers at the other. He says that he was not directly involved in attempts by Hughes to convince the PRC that the fairing was the problem, although he was aware that a number of people within Hughes believed that. He was also aware of at least one, Harold Rosen, who did not hold that belief.[54]

Lee further says that in the negotiations, during which Lee served as Hughes CEO Dorfman's liaison to PRC Minister Liu Jiyuan,[55] Minister Liu confirmed Hughes' understanding that once a suitable agreement had been signed, the PRC would be willing to consider making modifications to the Long March 2E rocket before the next launch.[56]

In addition, Lee says that Hughes "is not saying how to fix it, but wording [sic] requirement that they have to finally fix it." Lee says he was aware that a number of Hughes engineers, particularly Al Wittmann, believed that the fairing had indeed failed.[57]

In June 1993, Hughes Chief Technologist Al Wittmann wrote a paper analyzing how he thought the fairing had failed, and how the fairing could be improved to prevent a similar failure in the forthcoming Optus B3 launch. The paper sought permission within Hughes to communicate the results of his analysis to the PRC. Wittmann says he discussed the recommendations in his paper with Peter Herron, who was coordinating the launch failure investigation with the PRC; Hughes Vice President Donald Cromer; and Stephen Cunningham, who was heading up the launch failure investigation.[58]

Wittmann recommended that Hughes not launch the Optus B3 on the Long March 2E rocket unless the PRC made improvements to the fairing. He says that 70 to 80 percent of the Hughes team members agreed with him, and that Cromer, Cunningham, and Herron supported his view that the Optus B3 should not be launched without changes to the fairing.[59]

When Wittmann discussed his paper with Herron, Herron responded by telling Wittmann that, unless the fairing recommendations in the paper were simplified considerably, he was not willing to ask the U.S. Government for approval to share it with the PRC. Wittmann says Cunningham had also asked him to revise the paper for the same reason.[60]

Hughes CEO Dorfman also recalls discussions with Wittmann about the fairing:

> **Q:** *Would you describe the changes that . . .Wittmann may have brought to your attention as changes which would improve the fairing?*
>
> **A:** *Well, the only thing I can remember is that Mr. Wittmann . . . felt that the fairing . . . had an overlap problem, and that there would be a gap that could be caused during ascent between the two halves of the fairing, and that that gap might cause a pressure differential which would separate the fairing.*
>
> **Q:** *Would that suggestion constitute, in your view, an improvement to the fairing?*
>
> **A:** *I don't know.*
>
> **Q:** *Is it a modification to the fairing?*
>
> **A:** *If they made a change, it would have been a modification.*
>
> **Q:** *So Mr. Wittmann recommended something which, if it had been accomplished, would have been a modification to the fairing?*
>
> **A:** *Yes.*[61]

Additionally, Hughes Vice President Cromer recalls the following discussion with Wittmann about the fairing:

Q: *When Mr. Wittmann first approached you about his concerns regarding the fairing, do you recall some of the technical aspects that he mentioned . . . ?*

A: *Yes.*

Q: *Can you tell us what some of those were?*

A: *He was concerned about two aspects particularly. One is the strength of the rivets that held the fairing together and this was an issue of having adequate strength to withstand the launch loads but still having sufficient ability to open the fairing when you needed to. So it's a balance of strength versus separating the fairing under the right conditions. Also the nose cap and its design and how it might be affected by the loads during the ascent.* [62]

Hughes launch failure investigators Herron and Cunningham subsequently prepared a group of viewgraph slides that simplified the contents of Wittmann's paper. Herron, who was responsible for coordinating with the PRC, then submitted these to Defense Technology Security Administration monitor Al Coates for approval. Coates' signature approving the transfer of this information to the PRC appears on a facsimile transmittal sheet, dated June 25, 1993.

Lt. Col. Coates says he does not recall approving this transfer, and he doubts that he would have ever approved the disclosure of such prohibited information. He further says he did not have the authority to approve the disclosure of information that could have improved the PRC rocket. He also says that it was always clear to Hughes that no data that could improve the rocket could be transferred to the PRC.[63]

Generally, Coates recalls that the Defense Technology Security Administration always emphasized in briefings for Hughes employees the prohibition against improving the rocket. He says that Hughes personnel were very knowledgeable about the export control process, and that Herron undoubtedly knew of the restrictions regarding rocket improvements.[64]

Coates specifically recalls telling Herron that he could not discuss the design of the fairing with the PRC.[65]

Coates says he maintained a program file at the Defense Technology Security Administration that contained all his approvals related to the Optus B2.[66] Such a file could not be found among the materials provided to the Committee by the Defense Technology Security Administration.

Hughes failed to respond to the Committee's interrogatories (which included a request for documents) regarding these approvals.

Donald Leedle, who was responsible for Hughes' technology export control, says Herron contacted him to inform him that Coates had approved communicating the information on improving the fairing to the PRC. In Leedle's deposition, the following exchange regarding improvements to the Long March 2E rocket occurred:

> **Q:** *Does this document suggest specific changes to the Long March 2E fairing for the Hughes satellite that would improve the fairing?*
>
> **A:** *At the bottom of the page it says. 'Add a bracket or block to prevent any possibility of overlap of the two fairing halves.'*
>
> **Q:** *What about on page 2?*
>
> **A:** *'Increase the strength of the rivets along the separation line.'*
>
> **Q:** *So, in your view, does this document propose specific technical improvements to the fairing?*
>
> **A:** *I think they are fairly generic. Add a bracket and strengthen a rivet is not very specific.*
>
> **Q:** *Are those improvements to the fairing?*
>
> **A:** *They may be.*
>
> **Q:** *Is Mr. Herron suggesting in his letter that they are?*

A: *He certainly feels that if these things are accomplished, that there is less likelihood of it failing.*

Q: *So would you view this letter as Mr. Herron's statement that these changes would improve the fairing?*

A: *Well, I'm not sure – 'improve' is a difficult word. It would prevent failure – It might prevent a failure.*

Q: *Mr. Wittmann suggested improvements to the fairing in his letter, correct?*

A: *Uh-huh.*

Q: *Mr. Herron in a letter to Mr. Lee is now suggesting changes need to be made to the fairing. Those changes presumably would improve the fairing, would they not?*

A: *I don't know the answer to that.*

Q: *I'm asking you to look at Mr. Herron's letter – you had discussions with Mr. Herron – and tell me whether you think he is suggesting things that would improve the fairing?*

A: *He is making recommendations to prevent a failure.*

Q: *By 'prevent a failure,' would you say that improving the fairing would help prevent a failure?*

A: *Something would have to be done to the fairing to prevent a failure.*

Q: *Improving the fairing is what this letter is about; is that correct?*

A: *Uh-huh.*

Q: *And you've already told us that the fairing is a part of the launch vehicle; is that correct?*

A: *That's correct.*

> ***Q:*** *So the improvements to this fairing, it logically follows, would result in improvements to the launch vehicle. Do you agree?*
>
> ***A:*** *If they were actually improvements.*[67]

In Cunningham's deposition, the following exchange about improvements to the fairing took place:

> ***Q:*** *So, in your view, that doesn't constitute an improvement in the fairing?*
>
> ***A:*** *If they do these correctly, and they have to define correctly, this would improve the fairing. But if they do – but without further analysis, this would not improve the fairing. This in itself does not improve the fairing.*
>
> ***Q:*** *Is it a modification of the fairing?*
>
> ***A:*** *Yes.*
>
> ***Q:*** *I want to go back just briefly to Exhibit 1, paragraph 120.9, defense service; it's on the second page of Exhibit 1.*
>
> > *'120.9 (a), Defense service means: the furnishing of assistance to foreign persons,' skip a little bit, 'whether in the United States or abroad in the design, development, engineering, manufacture, production, assembly, testing, repair, maintenance, modification, operations, demilitarization, destruction, processing or use of defense articles.'*
>
> *Is — would these suggested improvements constitute a modification of the fairing?*
>
> ***A:*** *Yes, they would.*
>
> ***Q:*** *To modify a fairing or to modify a defense article, do you need a license — according to what you read in ITAR [International Traffic in Arms Regulations] earlier?*

> **A:** *Yes, we do.*
>
> **Q:** *And did you obtain a license to provide this information to the Chinese?*
>
> **A:** *No.*[68]

Leedle says he was surprised that Herron, Hughes' Assistant Program Manager for the Optus B2 and the person responsible for coordinating the failure investigation with both the U.S. Government and the PRC, bypassed him and approached the Defense Department's Coates directly. Leedle acknowledges that the purpose of Wittmann's fairing recommendations was to prevent the rocket from failing in future launches. Leedle and Cunningham acknowledge that improvements to the rocket required a State Department license, and that, to the best of their knowledge, no such license was ever applied for.[69]

On July 15, 1993, Hughes CEO Dorfman wrote expressing his concerns about the cause of the Optus B2 launch failure to PRC Minister Liu Jiyuan, President of China Aerospace Corporation, in care of Hughes' Bansang Lee, stating in part:

> *After listening to Wang Dechen's [the PRC designer of the Long March 2E rocket] presentation last week, I've become very concerned that we will not convince our customer and insurers that it is safe to launch Optus B3.*
>
> *I emphasize that you must 1) demonstrate a thorough and objective evaluation of potential causes for the accident, and 2)* ***make appropriate design and process changes to prevent recurrence,*** *even if a definitive cause cannot be identified.*
>
> ***Our people have made some specific suggestions which I urge you to consider.***[70] [Emphasis added]

On July 18, 1993, Bansang Lee reported to Dorfman the results of the meeting with Minister Liu at which he delivered Dorfman's letter. Lee wrote about the PRC's strong negative reaction to Hughes' statements that appeared to blame the PRC rocket for the Optus B2 failure, in violation of the May 12 agreement:

> *Mr. John Perkins letter of July 9, 1993 clearly pointed out the [Long March 2E rocket's] fairing was the cause of the launch failure . . .*
>
> *It is true that it looks like the whole world appears to believe the trouble was caused by the rocket . . . CGWIC [China Great Wall Industry Corporation] has reasons to believe that Hughes is making a trap to get them . . . If they agree to make any change to the fairing now, they are walking into the trap themselves.*[71]

As Bansang Lee continued to negotiate, he says he thought that Hughes Chief Scientist Robert Steinhauer, who had worked closely with the PRC for almost ten years, might be able to help allay the PRC's concerns.

On August 5, 1993, Bansang Lee wrote to Hughes CEO Dorfman suggesting that Steinhauer bring the Optus B2 failure report to the PRC and meet with the chief designer of the Long March 2E rocket, Wang Dechen, to go over the findings.[72]

On August 15, 1993, Hughes and China Great Wall Industry Corporation issued a joint news release, reported in *Space News,* stating that although no design flaws were found, both companies would make improvements to their products. *Space News* quotes an insurance broker as saying that, "evidence points to a structural flaw in the rocket's fairing which probably imploded during launch." It also quotes a U.S. satellite underwriter as saying the companies

> *had narrowed the cause of the launch failure to a few possibilities, but struck a compromise on the announcement because they are still doing business together.*
>
> *Hughes also wants to support the Long March because the company is concerned about becoming overdependent on the Arianespace launch consortium of Evry, France.*[73]

On August 23, 1993, Steinhauer went to the PRC and met with the designer of the Long March 2E rocket, Wang Dechen. Since 1985, Steinhauer had been Hughes' primary contact with the PRC on the use of their rockets. He also served as a consultant to the Optus B2 failure investigation team from January 1993 through October 1993, attending many of the failure investigation team meetings, and also meeting with the PRC regarding the failure investigation.

The purpose of Steinhauer's August meeting in the PRC was to try to help resolve things between the two companies. In particular, Steinhauer focused on Wang Dechen, the designer of the Long March 2E. Hughes believed that Wang Dechen was the key PRC individual who had to be turned around.

On September 14, 1993, Hughes Chief Scientist Steinhauer wrote a memorandum to Hughes Vice President Cromer suggesting a hard negotiating position with the PRC on the issue of the fairing failure. The memorandum said: ". . . Hughes should make an unequivocal statement to Minister Liu Jiyuan that Optus B3, or any other Hughes spacecraft, will not fly on the LM-2E without modifications to their launch vehicle fairing."

The memorandum also describes Wang Dechen as "digging in his heels" against the idea of a unified presentation identifying the failure cause for the insurance community. Cunningham advises that earlier in the investigation Wang Dechen had publicly stated that the rocket was not the cause of the failure.[74]

Hughes Vice President Donald Cromer says that it was his decision whether Hughes would launch Optus B3 on a Long March 2E rocket. His decision was that Hughes would not launch unless the China Academy of Launch Vehicle Technology made improvements to the fairing.[75]

In a September 9, 1993 message to Cromer, Bansang Lee made a number of recommendations related to future business relations between Hughes and the PRC in preparation for the Optus B3 insurance underwriters' briefing that was scheduled later in September. Bansang Lee wrote:

> *In reality by insisting that the rocket has a problem at the fairing will do [sic] harm to Hughes in the following major areas:*

> *It will be even more difficult for the rocket to obtain insurance. This will make the Optus B3 program more expensive and more difficult to resolve.*
>
> *Furthermore, it will make the APT II [the PRC-controlled Asia Pacific Telecommunications Satellite Co.'s next Hughes satellite] more difficult to obtain insurance as well. This will hurt Hughes a lot more than CGWIC [China Great Wall Industry Corporation].*
>
> *We will have a 'war' to fight, not only with CGWIC, but with China in general. This will not only hurt our satellite business in China but will generally be harmful to all Hughes activities in China for years to come.*
>
> *What do we get out from [sic] this? I could not think of any [sic] that is good and useful to Hughes. The only small thing that I could think of is that in the future we could claim better reliability statistics on our satellites.*
>
> *If we swallow this one and let our Chinese friends off the hook, it will actually do more good for Hughes . . .*[76]

On September 10, 1993, Hughes Vice President Cromer asked Bansang Lee to bring Cromer's concerns to the attention of the highest levels of the PRC:

> *However, of even greater disappointment is the continued insistence by Wang Dechen [the PRC's Long March 2E rocket designer] that we change the conclusion of our failure investigation. He has signed an agreement that he accepts the results of our investigation yet he continues to demand we modify the results to suit his view of the accident . . .*
>
> *We (Hughes and CALT) must make a full disclosure of all relevant facts and data surrounding the accident to the insurance community . . .*

> *It is mandatory that we both make whatever changes are necessary to add margin to our designs. We are doing so on the satellite side and are prepared to disclose these at the insurance briefing. The Chinese must be able to state that they will do likewise . . .*
>
> *They cannot be superficial improvements — they must be substantial and directly related to a possible failure cause.*[77]

On September 15, 1993, the Hughes official coordinating the launch failure investigation with the PRC, Peter Herron, wrote to Bansang Lee about the insurance briefings. Herron asked Lee to inform the PRC that Hughes was willing to remove all information from the insurance briefing related to the Long March 2E rocket from its presentation at the insurance briefing. But Hughes would do this only if the China Academy of Launch Vehicle Technology presented the data that Hughes was deleting. In his letter, Herron wrote:

> *While we would not plan to talk about the fairing debris, it is important for full disclosure that CALT [China Academy of Launch Vehicle Technology] also address the following:*
>
> *Debris — The CALT report makes blanket statements that there were no delaminations. However, it is obvious that there were a number of small delaminations, both on the inside of the cylindrical portion of the fairing and along one edge of the nose cap. They [CALT] must explain why they think these occurred and what the relationship to the event [crash of the Long March 2E] is, if any . . .*[78]

By late September, Hughes and the PRC had decided, pursuant to their May 1993 agreement, that Hughes would not brief the issue of the fairing to the insurers.

The PRC had earlier signaled to Hughes' Bansang Lee that it would consider making modifications to the fairing for the Optus B3 launch.[79] Hughes Vice President Cromer confirms that Hughes made a decision to go forward with

Optus B3 because the China Academy of Launch Vehicle Technology had committed itself to modifications to the Long March 2E rocket's fairing.[80]

On September 30, 1993, Hughes and PRC representatives met with the Optus B3 space insurance underwriters in London to discuss the conclusions and results of the Optus B2 failure investigation. Cunningham, as the head of the Hughes failure investigation, led the company's presentation.[81]

At the time of the insurance briefing, the Hughes final investigation report was not yet finished. Although Cunningham was the author of the Hughes Optus B2 Failure Report, he says he did not distribute the report to anyone outside of Hughes, and he does not know whether anyone else at Hughes did so.[82]

Cunningham says that the Hughes failure investigation report was sufficiently technical that Defense Technology Security Administration approval would have been necessary for it to be exported. He does not know whether the report was ever given to the PRC, but he doubts it was.[83]

Cunningham says that the U.S. insurance underwriters may have been separately briefed by Hughes about its concern that the Long March 2E fairing was defective and needed modifications. Hughes claims that the Defense Technology Security Administration was not present at the insurance briefing because it chose not to attend. Defense Department monitor Coates claims he was told by Hughes that no PRC representatives would be present at the briefing.[84]

Hughes Vice President Cromer testified that C. Michael Armstrong, at that time Chairman and Chief Executive Officer of Hughes Electronics Corporation, was generally aware of the analysis of the 1992 failure. Cromer updated Armstrong on the progress of the investigation.[85]

Armstrong, however, testified that although he was aware of the Optus B2 failure, he could not recall any information about a failure investigation.[86]

The Optus B3: Hughes' Efforts to Improve the Long March Continue

Between October 1993 and August 1994, when the Optus B3 was successfully launched, Hughes continued its efforts to have the PRC improve the Long March 2E fairing.

On October 13, 1993, Peter Herron, in his role as Program Manager for Optus B3, wrote to Bansang Lee regarding changes to the Long March 2E. Herron wrote, in part:

> *4. We need to discuss the possible changes to the LM-2E [Long March 2E]. How do we get the changes made?*
>
> *I suspect it is unlikely that CALT [China Academy of Launch Vehicle Technology] will recommend changes to the fairing, since that might be seen by them as an admission that something was wrong. (Why else make a change?)*
>
> *They have stated that they would make changes that their customers require. This was stated in the press release, was stated by Wang Liheng at the dinner with Don Cromer in September, and was stated by Wang Dechen during the meeting with the underwriters in London. However, we are not LV [rocket] experts and are not in a position to make recommendations for improvements.*
>
> ***Further, the USG would not be likely to allow us to make recommendations in the current environment.***
>
> *This is my idea. Last summer we requested that CALT respond to our concern with the nose cap (you will recall the four viewgraphs we prepared and showed to Wang Dechen [the PRC's Long March 2E designer] as well as the bad reaction that resulted).*
>
> *I think we can use these same viewgraphs to request that CALT examine some 'Hughes requested' changes to the fairing.*

> *Specifically, we can ask for CALT ideas on how they would implement changes that would,*
>
> *1. Add a bracket or block to prevent any possibility of overlap of the two fairing halves,*
>
> *2. Increase the strength of the rivets along the separation line. . .* [Emphasis added]

The Defense Department's Lt. Col. Coates says that, had he been asked, he would not have approved the transmittal of this information to the PRC. He also says that Hughes personnel knew that each separate transmission of information to the PRC required specific approval.[87]

On October 20, 1993, Peter Herron, Hughes' program manager for the Optus B3, wrote to Chen Shouchun, Vice President of the China Great Wall Industry Corporation, regarding Optus B3 meetings scheduled for November 1993 at Hughes. One topic of Herron's letter is "... discussions of ways to improve margins for the next launch. CALT [the China Academy of Launch Vehicle Technology] has already committed to make some changes to the LM-2E [Long March 2E rocket] in accordance with our needs."

Hughes and the PRC held design meetings in November 1993, to discuss the proposed modifications to the fairing.

The Optus B3 was licensed by the Commerce Department, not the State Department. Other than the license for the Optus B3, which was approved by the Commerce Department, Herron did not submit any Optus B3 fairing improvement documents to the U.S. Government for approval.

Steven Burke, a structural analysis engineer at Hughes and principal investigator on the Optus B2 investigation, recalls attending a number of Optus B3 design review meetings with the PRC. During the early portion of the Optus B2 failure investigation, Burke had been responsible for analyzing Optus B2 rocket telemetry data supplied by the PRC. Burke and fellow engineer Spencer Ku had determined, along with Hughes' Chief Technologist Al Wittmann, that the fairing had caused the failure.[88]

On May 9, 1994, Burke wrote a detailed technical paper entitled "Optus B3/LM-2E Fairing Design Review," discussing a meeting with the PRC that occurred on May 2, 1994 regarding fairing improvements to the Long March 2E needed for the upcoming Optus B3 launch. He says the meetings were both political and technical in nature: political in that the PRC was unwilling to admit fault, while from a technical perspective, they were willing to make changes.

Burke further says that as a result of the Hughes investigation, Hughes had asked the PRC to strengthen the weak parts of the fairing.[89]

In the paper, Burke wrote that the PRC proposed changes to what it termed the "already adequate" capabilities of the fairing. His paper continued, identifying PRC proposals for the following changes to the Long March 2E rocket's fairing:

> *a. Increased number of nose cap attachment screws from 21 to 41. Increased number of cover strip attachment screws from 12 to 23.*
>
> *Comment: These changes add strength to joints that would not need strengthening if the dome were stiff enough.*
>
> *In my opinion, these changes do not address the real problem with the nose cap design, nor do they constitute an effective "crutch" that would preclude another fairing failure. They do offer some integrity enhancement, but against loads that could best be limited by maintaining the as-designed dome configuration.*
>
> *In short, these [the fairing changes proposed by the PRC] are token changes that are easy to implement but do not preclude another fairing failure because they neither stiffen the sawcut edges of the dome halves nor stiffen the dome base frame at its discontinuities.*[90]

Burke's paper went on to discuss other technical deficiencies and questioned how Hughes could get the PRC to propose truly effective changes to the Long March 2E rocket's fairing design.[91]

Burke recalls Peter Herron, who was now Program Manager for the Optus B3 satellite, telling him that Herron had provided documentation to the PRC suggesting changes to the Long March 2E rocket's fairing during the Optus B2 failure investigation.[92]

On July 30, 1994, Herron wrote to the PRC requesting additional information about the PRC changes to the fairing. Herron showed his letter to Burke, and asked for his views on the additional modifications proposed by the China Academy of Launch Vehicle Technology. Burke says that he and others provided Herron with questions on the CALT proposed changes.[93]

On August 4, 1994, Hughes' Chief Technologist Al Wittmann wrote to Vice President Donald Cromer, stating that he believed the changes to the fairing proposed by the PRC were adequate for the upcoming Optus B3 launch.[94]

In August 1994, Burke says he attended a Hughes senior management meeting to review the changes made by the PRC to the fairing for the scheduled Optus B3 launch. The briefing slides for the meeting are dated August 8, 1994. By the time of this meeting, Burke says that Wang Dechen, the PRC designer for the Long March 2E rocket, had told him that the PRC had made improvements to the rocket's fairing. Burke further says that his review of the documents from the August 8 briefing show that the changes made were a combination of PRC ideas and Hughes ideas.[95]

According to Donald Leedle, responsible for Hughes' technology export controls, a design review in which Hughes provided information to the PRC should have required a State Department license.[96]

The Optus B3 was launched successfully on August 28, 1994, aboard a PRC Long March 2E rocket.

Apstar 2

The Apstar 2 License

On November 18, 1993, Hughes submitted an application for export license to the Bureau of Export Administration, U.S. Department of Commerce. On February 1, 1994, license number D204878 was validated. The license permitted the export of one Hughes Model HS-601 commercial communications satellite to the Asia Pacific Telecommunications Satellite Company, Ltd., Hong Kong.

The intermediate consignee was China Great Wall Industry Corporation, Beijing, PRC.

The license permitted a temporary export to China Great Wall Industry Corporation for the purpose of launch. The transaction value was $93 million.

The Commerce Department license restricted the export of detailed design, engineering, or manufacturing data to China Great Wall Industry Corporation. It further required a State Department license for activities and technical data covered by the State Department Munitions List.[97]

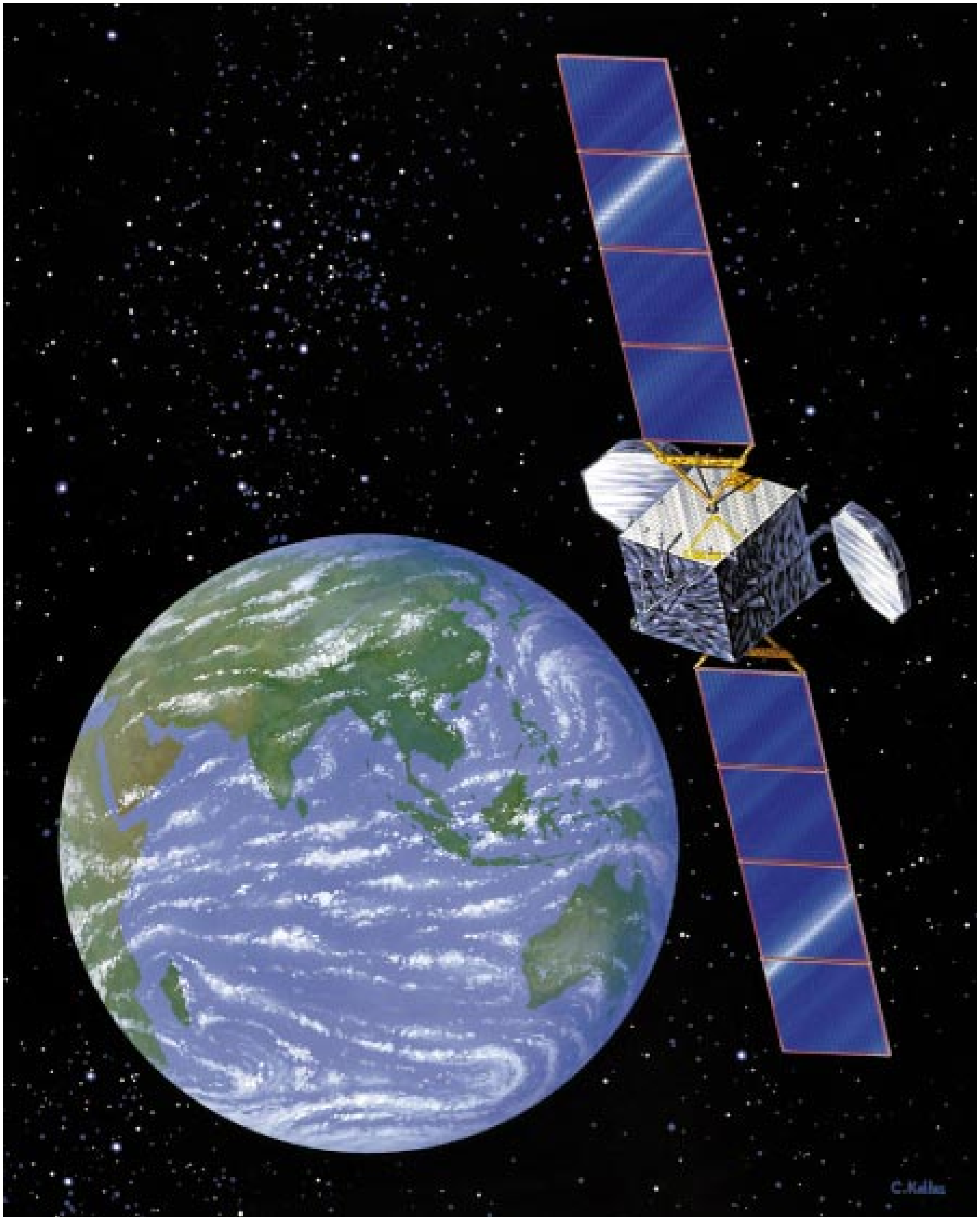
The Apstar 2 Failure

On January 26, 1995, a Long March 2E rocket, carrying the Apstar 2 satellite, manufactured by Hughes, was launched from Xichang, PRC. The Long March 2E rocket, with the satellite atop it, exploded approximately 50 seconds after liftoff.

This was the fifth flight of the Long March 2E rocket, and the second failure. The prior failure in December 1992 was of a Long March 2E rocket carrying the Optus B2 satellite, also manufactured by Hughes.

In both cases, observation of the flight data and the rocket debris indicated that an explosive force had destroyed the forward part of the rocket where the satellite and the covering fairing, which is a part of the rocket, were located.[98]

Because of similarities to the Optus B2 failure in 1992, Hughes engineers believed right away that the PRC rocket fairing had again failed.[99] Additionally, Hughes had added instrumentation to the satellite after the Optus B2 failure. The added instrumentation helped Hughes determine the cause of the failure.[100]



Dept. of Defense

Another Hughes HS-601 satellite was built for the PRC-controlled Asia Pacific Telecommunications Satellite Company Ltd. Designated Apstar 2, this satellite also failed to reach orbit when the Long March 2E carrying it crashed on January 26, 1995. Once again, Hughes assisted the PRC in fixing the problems with the Long March.

Failure Investigation Teams

Hughes Vice President Donald Cromer appointed a Failure Investigation Team, headed by Stephen Cunningham and Peter Herron, to look into the cause of the failure. Many of the participants on this investigative team, including structural specialists Al Wittmann and Spencer Ku, also had participated in the Optus B2 failure investigation.[101]

The Failure Investigation Team is described in the Apstar 2 Failure Investigation Report as follows:

> *The first team was responsible for the overall Hughes investigation and was chartered to examine any and all aspects of the failure, including the spacecraft, perigee stage, launch vehicle integration, launch vehicle telemetry, and fairing design.*
>
> *In addition, the team was responsible for all of the external interfaces, including China Academy of Launch Vehicle Technology (CALT), customers, insurance companies, and the U.S. Government.*[102]

Failure Investigation Schedule

The failure investigation began immediately and continued until around June 1995. The schedule on the following page was excerpted from the Apstar 2 Failure Investigation Report.[103]

The Need For A License

At the outset of the investigation, Hughes officials considered that a State Department license might be needed in order to conduct the failure investigation even though the launch had been licensed by the Commerce Department.[104]

Soon after the failure investigation began, Hughes provided the State Department a satellite debris recovery plan for the failure. On February 3, 1995,

Hughes' Apstar 2 Investigation Schedule

	1995																				
	January				February				March					April				May			
Fridays	6	13	20	27	3	10	17	24	3	10	17	24	31	7	14	21	28	5	12	19	6
Launch Failure			26	▲																	
Debris Recovery				▲	—	—	▲														
REVIEWS																					
Meetings at Launch Site			27	▲		▲	9,	10													
Joint Meetings in Beijing							▲	13,	14		▲	15,	16						22,	24	▲
Joint Meetings in LA															▲						
Hughes Review Meetings				2	▲	16	▲	▲	23	▲		▲	24	▲	7	▲	21			▲	19
International Team Mtgs																27	▲		22,	24	▲
ANALYSES																					
Debris Analysis							▲	—	—	—	—	▲	▲	▲							
Pre-Launch TM Analysis				▲	—	▲															
Post-Launch TM Analysis							▲	—	—	▲		▲	—	▲							
Video Analysis					▲	▲			▲	▲											
Structure Analysis							▲	—	—	▲		▲	—	▲							
Coupled Loads Analysis								▲	▲	▲	—	—	—	▲							
Aerodynamic Analysis												▲	—	—	—	▲					
REPORTS																					
Outline Final Report																				24	▲
Final Failure Report																					

The Apstar 2 failure investigation began immediately after the Long March 2E launch failure on January 26, 1995, and continued through May, 1995.

Hughes attorney Jennifer Smolker wrote to inform the Commerce Department of the launch failure, stating that future discussions with the PRC might require a State Department license and that Hughes would submit a State Department license, if necessary.[105]

On February 21, 1995, Donald Leedle, Hughes' Technology Export Control Coordinator, sent a memorandum to Apstar 2 Program Manager Mike Hersman and attorney Smolker regarding the failure investigation. Leedle's memorandum stated that the Commerce Department license only authorized the transfer of certain data.[106]

As had been done in connection with the Optus B2 failure investigation, Leedle's memorandum stated that Hughes was initiating informal communications with the State Department to determine whether a license would be required. The memorandum also stated that Hughes was awaiting data from Herron, who was working on the failure investigation, before formally applying for any such license. Finally, Leedle wrote that he had met with Commerce Department licensing officer Gene Christiansen and learned that, except for minor satellite data, all other data to be exchanged with the PRC fell under State Department jurisdiction.[107]

Christiansen says that, when Hughes officials initially approached him following the Apstar 2 launch failure, they communicated to him that they only wanted to share basic "form, fit, and function" data with the PRC. Leedle recalls that in his early discussion with Christiansen regarding information requested by the PRC, Christiansen stated that with the exception of limited satellite and telemetry data, all other PRC requested data would require a State Department license.[108]

Despite the shift to Commerce Department in 1993 of licensing jurisdiction for certain commercial satellites, the State Department still was solely responsible in 1995 for the licensing of any technical data that could improve PRC rockets.[109] Leedle, whose responsibilities at Hughes included technology export controls, acknowledges having been aware at the time that any rocket improvements required a State Department license.[110]

Leedle's statement is consistent with a document that Hughes' Dar Weston, a specialist in the International Traffic in Arms Regulations, sent to Apstar 2 Program Manager Mike Hersman on January 3, 1994. The document described the provisions of the Apstar 1 and 2 licenses, and the restrictions in the International Traffic in Arms Regulations, and stated that no detailed design, production, or manufacturing data may be released. The document also stated that such information is controlled by the State Department, regardless of which agency has jurisdiction over the satellite, and that release of such information would require specific Office of Defense Trade Controls approval of a separate application.[111]

Leedle recalls that Hughes' Washington, D.C. representative, Joe Rougeau, made informal contact with the State Department following the Apstar 2 launch failure. He says Rougeau initiated the State Department contacts because Hughes was unsure in the early stages of the investigation whether a State Department or a Commerce Department license was needed for the investigation.[112]

The role of Hughes' Chief Technologist, Al Wittmann, in the Apstar 2 failure investigation was essentially the same as in the Optus B2 investigation. Wittmann, who had proposed the modifications to the Long March 2E rocket after the Optus B2 failure, says he recognized by looking at photographs of the Apstar 2 debris that changes to the Long March 2E rocket's fairing had been made by the PRC since Optus B2. He says the changes were obviously insufficient.[113]

Wittman said that the PRC had not implemented all the changes he had suggested for the Optus B3 launch in 1994.[114] Following the Optus B2 failure, Hughes engineers recommended reinforcing the fairing. But the Select Committee learned that the PRC chose to install additional rivets instead of structural changes. The Select Committee understands that the PRC did not implement the recommended changes to reinforce the fairing prior to the Apstar 2 launch because to do so would have been an admission of fault in the Optus B2 failure.

Wittmann's analysis immediately focused on the fairing as the cause of the Apstar 2 launch failure. He says that, had the PRC implemented all his suggested changes to the Optus B3, the Apstar 2 would not have failed to achieve orbit.[115]

According to Wittmann, he and the PRC engineers viewed the fairing structure differently. The PRC viewed the nose cone portion of the fairing as a one-piece, complete hemisphere. Wittmann, on the other hand, says the nose cone was manufactured in two sections with a slit in the middle.[116]

Commerce Department Conference

On March 3, 1995, Hughes personnel met with Commerce Department licensing officer Christiansen and his supervisor, Jerry Beiter, regarding the Apstar 2 failure investigation.[117]

Beiter was then the Chief Technology Officer at the Commerce Department. The following Hughes employees attended the meeting: Peter Herron, co-leader of Hughes' failure investigation team; Donald Leedle, Hughes' Technology Export Control Coordinator; Pat Bowers, an assistant to the Director of International Affairs, Donald Majors; and Sara Jones, an export control officer at Hughes. Bowers was responsible primarily for dealing with the State Department on licensing issues.[118] Jones was primarily responsible for coordinating licenses with the Commerce Department.[119]

The purpose of the meeting was to discuss proper licensing jurisdiction relating to the Apstar 2 failure investigation.

Beiter's recollection of the meeting is that the Hughes representatives wanted to learn what information they could discuss with the PRC related to the failure investigation. He says that information related to rockets was covered by State Department jurisdiction during this period. Beiter also recalls that at the meeting the Hughes representatives mainly wanted permission to raise topics with the PRC related to their satellite.[120]

Beiter specifically recalls advising Hughes at the meeting that any data regarding the design of the PRC rocket would require a State Department license. He also says that he has no doubt that the Hughes representatives were well aware at the time of the meeting that information related to the fairing had to be licensed by the State Department.[121]

At the end of the meeting, the Hughes and Commerce Department officials agreed, according to Leedle, that any data that could improve the PRC rocket would require a State Department license.[122]

Sara Jones, of Hughes' Washington, D.C. office, recalls attending the meeting on March 3, 1995 with Beiter and Christiansen. Jones had prepared the Apstar 2

Commerce Department application. She says she was present at the meeting because she was the Hughes Commerce Department liaison. Jones recalls that she was not conversant with the technical aspects discussed at the meeting.[123]

Jones says that the purpose of the meeting was to determine whether the Commerce Department was the appropriate licensing authority for the Apstar 2 failure investigation. She adds that an additional purpose was to determine whether the data Hughes wanted to transfer to the PRC should be licensed by the Commerce Department or the State Department.[124]

According to Jones, the meeting was mainly devoted to a discussion of the Hughes satellite as part of the failure investigation. She says that Hughes representatives were there to discuss the satellite because Hughes built the satellite.[125]

Jones stated that she was aware that Hughes was prohibited from advising the PRC about correcting problems related to its rockets. Jones advises that knowledge of this rocket prohibition was fairly standard information within Hughes.[126]

Bowers, Hughes' State Department liaison in Washington, D.C., says that any time detailed design, development, production, or manufacturing technical data was involved, a State Department license would be required, although someone had to determine whether the data was "detailed." [127]

A memorandum of this meeting with Christiansen and Beiter was prepared six days later, on March 9, 1995, by the Hughes official responsible for technology export controls, Donald Leedle. Leedle, however, says that he probably drafted it with assistance from Peter Herron, one of the leaders of the Apstar 2 failure investigation, due to the technical nature of the issues discussed.[128] Leedle's memorandum included no indication that Hughes officials at the meeting advised Christiansen or Beiter that they had any indication that the Long March 2E fairing had caused the Apstar 2 failure.

Same Fairing Failure Identified by Hughes

Hughes engineer Spencer Ku was Hughes' principal structural investigator on the Apstar 2 failure investigation.[129]

Ku had suggested fairing design fixes to Al Wittmann, Hughes' Chief Technologist, during the Optus B2 investigation in 1993.[130]

Ku says that, after arriving in the PRC to review the Apstar 2 debris in 1995, he could tell by observation that the fairing had indeed been modified since the 1992 failure.[131]

On April 7, 1995, Ku briefed Stephen Cunningham and Peter Herron, the co-leaders of the failure investigation, that as in the Optus B2 failure, his analysis was pointing to the fairing as the cause of the Apstar 2 failure. Ku says the changes made by the PRC in the number of rivets had not been adequate to prevent the Apstar 2 launch failure.[132]

On April 18, 1995, Ku wrote a memorandum to Cunningham describing how the fairing caused the Apstar 2 launch to fail.[133]

A 'Political' Business Solution, Again?

As in the aftermath of the 1992 failure, Hughes executives were quite concerned about the sensitivity the PRC attached to placing any blame on the rocket for the Apstar 2 accident. On April 4, 1995, Hughes Electronics Senior Vice President Gareth Chang wrote a memorandum to Hughes CEO Steven Dorfman regarding the Apstar 2 failure, stating:

> *As we get closer to reaching a conclusion on the cause of the Apstar 2 launch failure I am concerned that we think through all of our actions so that we minimize fallout to the greatest possible extent. I would like to make the following suggestions:*
>
> ***First, we need to personally share our findings with the Chinese leadership. A senior Hughes executive, armed with detailed scientific and technical evidence, should meet with General Shen of COSTIND and Chairman Liu of CASC before anything is said to the media.***
>
> *Statements to the media should only be made by highly qualified, senior technical experts with easy-to-follow evidence. Our case must be convincing, logical and credible. Local managers and*

PR consultants should do no more than field media questions and transmit them to California or hand out properly approved media materials.

Care needs to be taken to properly brief the insurance industry on our findings, either just before or concurrent with the media briefings.

Our findings will receive worldwide media attention and will undoubtedly be challenged by a variety of people. We need to be thoroughly prepared — and to respond in a thoughtful and professional manner.

We cannot allow this accident to damage our relationships in China — or anywhere else in the world — especially in view of several near-term satellite and regional service opportunities.

I suggest the appropriate people get together within the next few days to make sure that we have all of our ducks in a row.[134]
[Emphasis added]

As of late April 1995, Hughes had identified several problems associated with the Long March 2E fairing.

In crafting a suitable approach for the discussions, a strategy memorandum on the subject was sent on April 20, 1995. Peter Herron, in his capacity as co-leader of the Hughes failure investigation team, sent a document to Hughes Vice President Donald Cromer containing in part the following points:

- *Offer to brief CALT in advance of Int'l team meeting due to revised emphasis on fairing as cause of the failure.*
- *Emphasize to Chinese that:*
  - *— We helped them get into the business*
  - *— Improved their U.S./PRC agreement*
    - *— We need to get on with the business of launch (sic) Hughes satellites on Long March launchers.*[135]

The Commerce Department Approves Data Release to the PRC

On April 28, 1995, Peter Herron, Donald Leedle, and Tony Colucci of Hughes met again with Christiansen at the Commerce Department to bring him up to date on the progress of the Apstar 2 failure investigation.

A May 9, 1995 memorandum by Leedle regarding the meeting explains that Hughes had concluded its analysis of the failure and was requesting that the Commerce Department review the information regarding its conclusion prior to making the failure analysis available to the PRC.[136]

Notwithstanding the agreement with Christiansen in March that the State Department had licensing jurisdiction for any technical data regarding the rocket, Herron, Leedle, and Colucci presented Christiansen charts outlining the inadequacies of the Long March 2E rocket's fairing design that they proposed to present to the PRC.[137]

Hughes Technology Export Control Coordinator Leedle describes his company's intentions for this approach to the Commerce Department as follows:

> ***Q:*** *Did he [Peter Herron, Hughes' co-leader of the failure investigation] give you any indication at all that he or anyone else at Hughes intended to communicate to the Chinese that improvements were needed in the fairing?*
>
> ***A:*** *Again, we are talking about the word 'improvements.' Our results of the findings were that there were deficiencies in the design of the fairing that we thought were the probable causes of failure. That's all that I think we could comment on.*
>
> ***Q:*** *Okay. Do you recall at the time whether or not you believed that any information related to the fairing, especially if it was going to be communicated to the Chinese, required a Department of State license?*
>
> ***A:*** *No, I don't think we did.*

Leedle acknowledges being aware at the time that improvements to the PRC's rocket required a State Department license. He says, however, that he and Herron nonetheless decided to rely on Christiansen's determination of Commerce's jurisdiction to approve passage of the data.[138] At the meeting, Christiansen advised that the fairing-related charts could be passed to the PRC. The charts presented to Christiansen expressed the same concerns that Hughes had expressed to the PRC in 1993 about the need for stronger rivets on the fairing. According to a Hughes official the conclusions in the charts could be helpful to the PRC, but the Defense Technology Security Administration had granted a similar approval in 1993.

The same official acknowledges that two of the fairing-related problems were not discussed with the Defense Technology Security Administration in 1993.

Hughes Tries to Get the PRC to Accept Its Findings

Hughes was still experiencing difficulty in getting the PRC to accept its findings regarding the fairing as the cause of the launch failure.

The talks between Hughes and the PRC remained at an impasse. Hughes felt that it could not afford to allow the China Academy of Launch Vehicle Technology to present its argument to the insurance companies and Hughes' customers, such as the PRC-controlled Asia Pacific Telecommunications Satellite consortium, without providing all of the evidence — especially when the evidence pointed to a failure of the Long March 2E rocket and not the Hughes satellite.

The PRC engineers, however, did not want to present any findings that led to the conclusion that the Long March 2E fairing was to blame for the failure. The PRC engineers feared that if this were to occur, then they would not be able to get insurance for future Long March launches.

In a May 14, 1995 trip report from Peter Herron to Hughes Vice President Cromer regarding a briefing Herron attended with Professor He of the PRC-controlled Asia Pacific Telecommunications Satellite consortium and other APT executives, Herron stated, in part:

- *We briefed He and Bao [Bao Miaoquin, Chief Engineer of APT] on the failue investigation for about 3 hours. He made several points re: Apstar 2R.*
- *Likely CASC [China Aerospace Corporation] reaction:*

— *We know from history and experience that CASC is mistrustful of Hughes, especially due to the Optus failure . . .*

— *The future — is there a way out? CASC wants to sell rockets and get (I didn't say buy) spacecraft technology. They know we can hurt their rocket business, and they don't think we are serious about tech transfer.*

- *My only idea for a deal for both sides is:*

  — *Conclude that the failure was due to wind shear (winds aloft). That actually is our conclusion. We think the fairing works (just barely) when the winds are calm. CASC would need to do the following:*

    — *Pay us the outstanding $8 million from Apstar 2 incentives*

    — *Buy Apstar 2R from Hughes*

    — *Provide good design review for the (Long March) 3B and 3C fairings*

- *Tilting APMT [the pending Asia Pacific Mobile Telecommunications satellite deal] our way would be a real plus.*
- *We would not provide our fairing concerns to others. We would not fly on the [Long March 2E rocket] without changes, reviews, and wind tunnel tests.*[139]

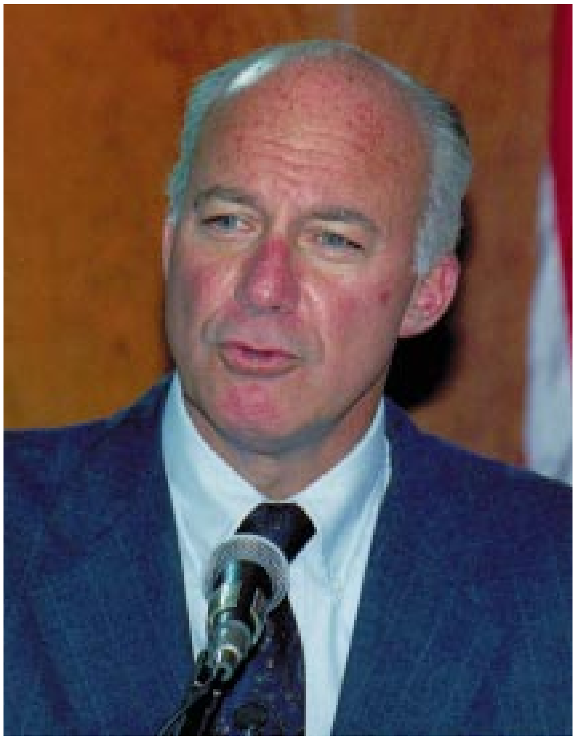
During the Hughes efforts to overcome the reluctance of the PRC to accept responsibility for the cause of the failure, Herron sent a message to his co-leader on the Hughes failure investigation team, Stephen Cunningham, on June 28, 1995. The message indicated that two Hughes employees, Shen Jun and Bruce Elbert, had conveyed a message to COSTIND's General Shen Rongjun (Shen Jun's father) regarding the fairing as causing the Apstar 2 failure. (See also the section entitled "The Role of PLA General Shen Rongjun and His Son in APMT," in the chapter *PRC Missiles and Space Forces*.)

In part, Herron's message stated:

> *Last night I talked to both KC [K.C. Lang] (in Beijing) and to Bruce Elbert/Jun Shen (in Singapore).*
>
> *KC. He was bothered by the failure resolution page, because it closed out the option of compromising on the interstage or interface (between the rocket and the satellite payload) as the cause of the problem.*
>
> *He said he would make a strong push to [Hughes CEO] Steve [Dorfman] and [Hughes Electronics Senior Vice President] Gareth [Chang] to have SDD [Steve Dorfman] go to PRC to negotiate for us. He referred to an unnamed source who advised him to request Steve's presence.*
>
> *KC obviously feels we have to share the blame.*
>
> *I said we would never do that, Gen Shen had said he would not accept a B2 [Optus B2] style compromise, and that one of the attached press clips from the insurance people said the insurance industry would not, either.*
>
> *Further, it makes absolutely no sense for any Hughes exec to meet in PRC without a good basis for an agreement. (I further think the unnamed source is KC himself. He is an amiable guy who wants to please.)*
>
> *Elbert and Shen. They delivered the message to Gen Shen. He was pleased to receive it. See the above phone message. Gen Shen said he'll call a meeting as soon as he is back to try and resolve the issue. Not on the phone message (from Jun) is that Gen Shen says his people believe one thing and we believe another, and that he doesn't know how to sort it out. He is willing to admit fault if he can be convinced that the fairing failed.*[140]

The next day Cromer wrote the following letter to Hughes Electronics President Michael Armstrong, Senior Vice President Gareth Chang, and Hughes CEO Dorfman:

> *I believe we are now at the crossroads for resolving the Apstar failure investigation. Attatchment 1 is a summary of where we are and recommended next steps. We have provided Attachment 1 to K.C. Lang to share with key people in Beijing to stimulate a response and get their input.*
>
> *Bruce Elbert was in Singapore with Jun Shen and they have already talked with Gen. Shen. He was pleased to get the input and said he would call a meeting as soon as he is back to try and resolve the issue. Gen. Shen says his people believe one thing and we believe another, and that he doesn't know how to sort it out. He is willing to admit fault if he can be convinced that the fairing failed. He also said that he was willing to work with Mike [Armstrong], Gareth [Chang], Steve [Dorfman] and Don [Cromer] to try and resolve the dilemma.*
>
> *I have also attached a copy of our Independent Review Team Report (Attachment 2). It clearly supports our internal team's conclusions about the fairing being the most probable cause of the failure.*
>
> *Given all this, I believe we need to be firm and insistent that they acknowledge 'what is' and clear the air so we can get on with our business. The insurance community and our customers are not about to let us skate on this issue again. Any level of outside probing will quickly reveal all the facts of this accident and its close resemblance to the Optus B2 failure. Our investigation results will speak for our case. It is a well documented and substantiated investigation that clearly exonerates the spacecraft. I will keep you informed as this last critical phase unfolds, and will probably need your assistance to force a resolution in our favor.*[141]



Hughes President and Chief Executive Officer Steven Dorfman (*left*) led Hughes' launch failure review that resulted in unlicensed transfers to the PRC of information directly applicable to improving PRC rockets and missiles. Hughes deliberately acted without the required State Department license. C. Michael Armstrong (*right*), then Chairman and Chief Executive Officer at Hughes Electronics Corp., wrote to National Security Adviser Samuel L. Berger: "Efforts by the State Department to keep commercial communications satellites on the State Department Munitions List should not be allowed to succeed."

By July 1995, Hughes had definitively concluded that the failure of the Long March 2E rocket on the Apstar 2 launch was caused by the rocket's fairing. Specifically, Hughes determined that the aerodynamic forces from the velocity of the rocket, combined with the winds aloft and high wind shear, ripped the fairing apart.

PRC Minister Liu Jiyuan, Director of China Aerospace Corporation, reacted emotionally to statements by Hughes indicating that the Long March 2E fairing was the cause of the failure. Minister Liu, who is influential in awarding communications satellite contracts in the PRC, said that China Aerospace Corporation would never do business with Hughes again.

CIA Analyst Visits Hughes

On July 19, 1995, an analyst from the Central Intelligence Agency's Directorate of Intelligence visited the Hughes facility in El Segundo, California, known as the "High Bay," which is an assembly and testing facility for communications satellites.[142] The CIA analyst was researching a draft National Intelligence Estimate relating to the impact of technology transfers on the PRC's military capabilities.[143]

The CIA analyst recalls that during a tour of the High Bay, he had an opportunity to talk to a Hughes engineer about the Apstar 2 failure investigation.

During this conversation, the CIA analyst began to be concerned that, as part of Hughes' launch failure investigation, technology that could improve the PRC's Long March rockets would inevitably be transferred to the PRC.[144]

In discussing the failure investigation, the CIA analyst says the Hughes engineer mentioned that Hughes has provided information to the PRC that related to methods and computer modeling to reduce rocket vibration, because vibration may have been a contributing factor to the Long March 2E failure.[145]

The CIA analyst says he believed that any improvements in this area would certainly assist the PRC in improving the performance of its ballistic missiles.[146] When he asked the Hughes engineer whether the information that Hughes was providing to the PRC might contribute to the improvement of PRC rockets, the Hughes engineer advised that this was Hughes' intent.

But Hughes officials advised, the engineer said, that all required coordination with the Commerce Department had been undertaken.[147] The CIA analyst also recalls the following regarding his discussion with the Hughes engineer about the cause of the Long March 2E rocket failure during the attempted launch of the Apstar 2 satellite:

> *Well, the discussion was sort of concluded with a general view by the individual [the Hughes engineer] that the system had failed because of external pressure [on] the fairing, which could have been due to aerodynamic loading and/or vibrational loading, but that conclusions were based largely*

on modeling with imprecise or insufficient information about the fairing itself, insufficient telemetry data.

There had been a recommendation to the Chinese to conduct additional tests, including wind tunnel tests.

[T]hey had some ground-based data on the wind velocity as a function of altitude. They were recommending the Chinese try to replicate that in the wind tunnel.[148]

The CIA analyst's recollection of his discussion with the Hughes engineer in 1995 seems consistent with the reports Hughes provided to the Commerce Department, which cited wind shear (aerodynamic loading) and vibrational (buffeting) factors as the cause of the Long March 2E failure.[149]

The reports Hughes provided to the PRC after approval by the Commerce Department's Christiansen stated in part:

The initial failure occurred in the LM-2E fairing and was due to some combination of:

* * *

Aerodynamic forces, buffeting, and/or aeroelastic effects on the launch vehicle during the transonic phase [that is, accelerating through the sound barrier] accentuated by winds aloft.

Regarding the potential transfer of technology, the CIA analyst recalls the following:

. . . I had been told actually by the Hughes people that their export license established restrictions on the flow of technology to China in that it regulated the kinds of interactions that they could have, the sort of proscripted interactions.

And what this engineer described to me was a break from that path, that people rolled up their sleeves at this point and just got together in a free-flow exchange.[150]

The CIA analyst recalled this about his conversation with the Hughes engineer regarding the "coupled loads" analysis that Hughes had conducted with the PRC:

> *. . . [The Hughes engineer] indicated that he had fully described the analysis, the process – not only the process that he had done, but the process that they [the PRC] should do.*
>
> *In other words, the Chinese had done analysis on their own and Hughes had done analysis on its own, and for reasons which weren't fully clear to me, the two came together and they shared the results.*
>
> *So it wasn't a one-way thing, it was a two-way thing; and they discussed who was right and who was wrong, but also what could be done better in the future.*[151]
>
> *A lot of it's just basic engineering physics, but code – the key here, we're talking about a big chunk of software on a big computer. The code was Hughes' proprietary code.*
>
> *. . . the Chinese had told Hughes what the maximum vibrational load that the satellite would face under any normal launch circumstance would be. Hughes believed that their satellite could survive under that maximum load, but it was close. It was far in excess of the load estimated by the Russians or the French, and certainly way in excess of the U.S. And so if they exceed that by much, that could be a problem. So part of his effort was to make sure it didn't exceed that or did exceed that.*[152]

A 'Consolidated Solution'

On July 23, 1995, Hughes and the PRC released a joint press statement regarding the Apstar 2 failure. The statement was signed by PRC Minister Liu and Hughes CEO Dorfman.

In the statement, Hughes and the PRC essentially agreed to disagree over the cause of the failure. Hughes cited high winds affecting the fairing as the most probable cause of the accident. The PRC cited a satellite and rocket interface problem. The release, the text of which follows, was signed by Dorfman and Liu:

JOINT PRESS RELEASE ON APSTAR 2/LM-2E FAILURE INVESTIGATION BY CHINA GREAT WALL INDUSTRY CORPORATION AND HUGHES SPACE AND COMMUNICATIONS INTERNATIONAL, INC.

23 July 1995

Apstar 2, an HS-601 communications satellite built by Hughes Space and Communications International, Inc. (HSCI), was launched by an LM-2E launch vehicle provided by PRC Great Wall Industry Corporation (CGWIC) at Xichang Satellite Launch Center on 26 January 1995. After a normal flight for about fifty seconds, an explosion occurred and resulted in the total loss of both the launch vehicle and the satellite.

After the failure, experts and engineers from CGWIC and HSCI have exerted extensive, scientific and earnest investigations for the past six months to pinpoint the cause of the failure.

Both CGWIC and HSCI confirm that the launch met the requirements stated in the Apstar 2/LM-2E Interface Control Document.

CGWIC and HSCI concluded in their reports that there are two (2) possible causes for the failure:

1. Under the shear wind aloft conditions in winter season, the resonance exerted due to the unique interface of the satellite and the upper stage with the launch vehicle caused local structural damage to the satellite.

2. Under the shear winds aloft conditions in winter season, the fairing of the launch vehicle suffered local structural damage.

In the spirit of being responsible to the customers and the space insurance community, CGWIC and HSCI will work *together to eliminate the above mentioned possible causes of failure and to enhance the monitoring of shear wind aloft before launch.*

CGWIC and HSCI reaffirm their long term and friendly cooperation and are determined to continue with confidence to expand the cooperation in areas of mutual business interests.[153]

Final Failure Investigation Report Released to the PRC by the Commerce Department

On August 15, 1995, Peter Herron, co-leader of the Hughes failure investigation team, wrote a letter to Commerce Department licensing officer Gene Christiansen enclosing the following documents:

- **The final Hughes Long March 2E Apstar 2 failure investigation report**
- **The Hughes Independent Spacecraft Review Team Final Report**
- **An executive summary of the Hughes failure investigation**

The cover letter mentioned that Herron and Donald Leedle, Hughes' Technology Export Control Coordinator, planned to meet with Christiansen on August 17 to discuss releasing these documents to the PRC.

The Executive Summary of the Hughes failure investigation stated:

As part of the Apstar 2 failure investigation, an independent review team was formed with a charter to review all aspects of the failure and provide an interface with the International Oversight Team. The six member team, led by Ernest La Porte, has had an extensive experience base in launch vehicles, spacecraft, fairings, and launch operations. The review period was from February to June 1995.

The major findings are that the spacecraft and interstage were not the cause of the failure, but the fairing is the most probable cause.

It is clear from the telemetry record that the LM-2E fairing suffered catastrophic failure at a time when the payload was intact and undamaged. The LM-2E booster fairing failed due to deficient design with respect to aerodynamic loads caused by high winds and wind shear.

The most probable failure scenario was initiated by high aerodynamic loads initially causing the fairing downrange vertical separation line to open and the dome to crack. As the fairing continued to collapse, it caused the spacecraft structure to fail, crushing the propellant tanks. The resulting fire caused the destruction of the spacecraft and the secondary destruction of the booster.

The most probable root cause of the failure is the deficiency in the fairing longitudinal split line design requirements and/or design. The causes of the Optus B2 failure in December 1992 and the Apstar 2 failure in January 1995 are identical.

There are a number of concerns relative to the design of the LM-2E fairing. These include the rivet strength of the separation zipper, the nose cap split line and the hammerhead fairing aerodynamic shape. There are additional concerns regarding the launch vehicle to spacecraft interfaces, such as design of the launch vehicle Marmon clamp separation band, fairing vent area, flying a high angle of attack and lack of detailed launch weather criteria.

The major recommendation is for [Hughes] to require major design reviews for new launch vehicles such as Proton, LM-3B, and Delta 3. Also [Hughes] should require the launch vehicle supplier to be responsive, cooperative and open to requests for design and test data.[154]

In response, Christiansen sent a Commerce Department form to Leedle on August 24, 1995 indicating that Hughes was authorized to release the Apstar 2 reports to the PRC. The form, called a Commodity Classification Form, stated:

> *These two reports and executive summary have been reviewed and determined to contain no design or production data specific to the spacecraft, the launch vehicle or the interface of these two systems.*[155]

The Commodity Classification form also stated that the data simply documented the findings of the PRC's telemetry and utilized a logic sequence to fix the probable cause of the failure, without instructing how to redesign the fairing.[156]

'THE FAIRING IS PART OF THE LAUNCH VEHICLE'

A rocket's nose cone, which protects the satellite inside, is known as a fairing. The same nose cone, if used on a ballistic missile to protect the nuclear warhead payload, is called a shroud.

Whether the launch vehicle is a rocket or a ballistic missile, the function of the nose cone is specialized to protect the payload — satellite or nuclear warhead — from external aerodynamic loads, vibration, noise, temperature extremes, and other environments that may be encountered as the vehicle is launched and accelerates through the atmosphere.

In the case of rockets, the fairing protects the satellite. In the case of ballistic missiles, the shroud would most likely be used to protect multiple independently-targeted reentry vehicles (MIRVs). (See the *Technical Afterword* to this chapter for a description of the similarities between the design and construction of the fairing for a rocket and a shroud for a ballistic missile.)

In 1995, Hughes argued to the Commerce Department that the fairing was part of the satellite and, therefore, Hughes' advice to the PRC regarding the fairing did not require a State Department license. A Commerce Department official, without asking any other U.S. Government agency, agreed.

The Select Committee requested that the Department of Defense, the Department of State, the Department of Commerce, CIA, and NASA provide responses to the question:

Although Sara Jones of Hughes' Washington, D.C. office was responsible for applying for Commerce Department licenses, it was Leedle who went directly to Christiansen to obtain the Commerce Department Commodity Classification approval for the Apstar 2 report. Jones states that Leedle had not handled a Commerce Department commodity classification himself in the past.[157]

Christiansen acknowledges that he knew, at the time he developed the Commodity Classification approval, that data concerning PRC rockets required a State Department license.[158]

Christiansen also testifies that Hughes was prohibited by the Commerce Department Commodity Classification Approval from providing data to the PRC

"Is the fairing part of the launch vehicle, or part of the satellite?" Their answers are summarized as follows:

Defense: "The fairing is part of the launch vehicle. It is designed and manufactured by the launch provider to encapsulate payloads (including, but not limited to, satellites). The fairing must be designed as an integral part of the launch vehicle system as its structure, in many respects, determines the success of the launch." [134]

State: "The Department considers the fairing to be an integral part of the space launch vehicle. The forward end of a space launch vehicle typically has a payload fairing, which protects both the satellite and the space launch vehicle from aerodynamic loading and heating during the launch vehicle's ascent through the densest part of the atmosphere." [135]

Commerce: "Fairings are regarded as part of the launch vehicle. Under U.S. implementation of multilateral controls, fairings are under the export jurisdiction of the Department of State." [136]

CIA: "The CIA considers the payload fairing to be part of the space launch vehicle because the fairing is needed to fly the vehicle and satellite through the atmosphere. Furthermore, the fairings are typically designed and built by the launch vehicle provider, not the satellite manufacturer." [137]

NASA: "The fairing is routinely acquired as a component of the launch vehicle service." [138]

related to technical design, rocket production, or anything related to the rocket. He adds that it was also incumbent upon Hughes to limit the scope of its discussion with PRC personnel, and to determine whether a State Department license was required.[159]

Christiansen acknowledges that he chose not to initiate any discussion or review of the matter with State Department or Defense Department officials before granting approval for Hughes to provide the fairing information and report to the PRC. The basis for this, he says, is that the Hughes information contained no design or production data. Christiansen acknowledges that his approval was a mistake, since the Hughes report represents an in-depth analysis of the design deficiencies of the fairing, and the executive summary discusses design changes that should be made to the fairing for future PRC launches.[160]

The PRC Long March rocket was still on the State Department Munitions list when Christiansen granted the approvals. Nonetheless, Hughes officials asked Christiansen if he would approve the materials for release, and he did.

Implementing the 'Consolidated Solution'

On October 17, 1995, Hughes employees K.C. Lang and Nissen Davis prepared a trip report regarding a visit by Hughes Electronics CEO Michael Armstrong and Senior Vice President Gareth Chang to the PRC between October 9 and 12. The report stated, in part:

> ***[Meeting with] GEN. Shen Rongjun, Deputy Director, Commission of Science Technology and Industry for National Defense (COSTIND)***
>
> ***Launch Failure Investigation.*** *Both sides need to examine and correct all possible causes. Shen has insisted on destruction testing the new LM-2E fairing design and hoped Hughes would do likewise for its new interface design. CMA [C. Michael Armstrong] said he and Chang would take personal*

responsibility for a consolidated solution communicated to insurance industry in Munich at end of October. [Armstrong] will convene meeting in L.A. on Oct 17, the day he returns to US, to achieve complete team agreement on 'consolidated solution.' Chang and Herron are principals to insure coordination.

[Meeting with] Min Liu Jiyuan, President of China Aerospace Corporation (CASC)

Launch failure. *[Armstrong] related agreement with Shen that consolidated solution is best. Chinese should accept Hughes engineering conclusions and Hughes should accept theirs. Joint approach should be presented to market and insurance community. Liu agreed but worried whether Hughes people will honor agreement. Before statement goes to Munich it should be tested in Beijing with HSC. [Armstrong] assumed personal responsibility for accountability, named G. Chang and Peter Herron to manage project for him.*[161]

By December 1995, Hughes' Independent Review Team had concluded that the probable cause of the failure was the fairing's longitudinal split line design requirements, the design itself, or both. The causes of the Optus B2 failure in December 1992 and Apstar 2 failure in January 1995, they found, were identical.

Hughes and the PRC agreed on a solution to address all concerns. Hughes agreed to modify the interface adapter, and the PRC agreed to strenghten the fairing and enhance the monitoring of high altitude wind conditions.

The PRC still refused, however, to accept the findings of Hughes' Independent Review Team that the fairing was the cause of the failure.

Moreover, the international insurance community expressed some skepticism regarding the PRC's claim that it had corrected the problem with the fairing. This was because the PRC stated that its repairs were completed in summer 1995, well before the final failure analysis was completed.

U.S. Government Actions Following the Apstar 2 Launch Failure

On January 26, 1995, the day of the Apstar 2 launch failure, U.S. Air Force Major Victor J. Villhard prepared a report stating that there were no technology safeguards in place for the Apstar 2 failure investigation.[162] He also stated that, since Apstar 2 had been exported under a Commerce Department license, no U.S. Government monitoring to prevent technology transfer had been required.

The memorandum outlined the possible technology gains for the PRC that could result from the lack of guidelines.[163]

Mark N. Rochlin was a Defense Technology Security Administration monitor for Motorola Iridium launches in the PRC in 1995. On May 31, 1995, he wrote a memorandum for the record in which he described incidents of technology transfer that he observed in Beijing in March and April 1995.[164] The memorandum stated:

> ***SUBJECT: Long March Accident Investigation***
>
> *1. During my last two trips to Beijing in March and April, I had the opportunity to hear failure investigation briefings presented by China Great Wall Industries [sic] Corp and the China Academy of Launch Vehicle Technology (CGWIC and CALT). These briefings were presented to launch service buyers other than Hughes, and were in significant detail.*
>
> *2. It is my opinion, based upon the briefings and from discussions with Mr. Gao Rufei (CGWIC) that* ***the technical exchange that has already occurred with Hughes exceeds the conditions of the license issued to Hughes by the Department of Commerce.*** *Future discussion necessary to continue the investigation will grow increasingly technical and will be similarly out of bounds. It has been revealed by Space Systems Loral, that they have been asked to perform a role in the investigation and that they are concerned about*

the character of the work being performed and their requirement to adhere to established guidelines. It follows that it is necessary for the United States Government to ensure compliance with the conditions of the license and the appropriate investigative agencies become involved.

3. CGWIC and Space Systems Loral were reminded of the Government to Government Agreement that provided for tech safeguards and of the personal liability to adhere to established guidelines.

//Signature//
Mark N. Rochlin
Lieutenant Colonel, US Army
Assistant for Aerospace Technology

CC:

***Col Alexandrow, DTSA** [Defense Technology Security Administration]*
Mr. Maloof, DTSA

***Col Oldenburg, Dept of State, OES/STH** [Office of Oceans and International Environmental and Scientific Affairs/Office of Science, Technology, and Health]* [165] [Emphasis added]

Rochlin says that, during the meeting in Beijing, he was told that Loral had been approached by Hughes to participate in the Apstar 2 failure investigation.[166] Rochlin says that it was apparent to him from the comments of Loral's Nick Yen that Hughes had already transferred significant technical information to the PRC in the Apstar 2 investigation and Loral was concerned about the technical areas Hughes was getting into, because he knew that only a Commerce Department license was in effect for the Apstar 2.[167]

Rochlin also says that Gao Rufei of China Great Wall Industry Corporation had mentioned the coupled loads analysis on Apstar 2. Based on the nature of the information Gao discussed, Rochlin believed that a State Department license was required.

Rochlin says he told a Loral representative and a representative of China Great Wall Industry Corporation that he believed that Hughes had already acted outside the scope of its Commerce Department license. He reminded both representatives that they should adhere to the U.S./PRC government-to-government agreements, and that they were personally liable for violations of the International Traffic in Arms Regulations.[168]

Rochlin says he retired from the Army several days after writing the memorandum, so he does not know whether the Defense Technology Security Administration took any action based on it. However, he says he did discuss the incidents and the information in the memorandum with the agency's Director, David Tarbell, and the Deputy Director, Peter Sullivan. He further recalls giving a copy of the memorandum to Michael Maloof, who was the Defense Technology Security Agency point of contact for coordination with enforcement agencies, to whom Rochlin believed such information might be referred for investigation.[169]

Defense Department Assessments of Damage to National Security

On December 7, 1998, the Department of Defense completed an initial assessment of the January 1995 Apstar 2 launch failure. The assessment was based on the Hughes Apstar 2 reports that had been provided to the Defense Department by the Commerce Department in June 1998.[170]

The Defense Department assessment concludes that the technical information provided to the PRC by the Hughes Apstar 2 failure analysis can be applied to either PRC rockets or ballistic missiles. The Defense Department considers that the assistance rendered to the PRC by Hughes in the 1995 Apstar 2 failure investigation was a "defense service," and clearly beyond the scope of the export jurisdiction of the Commerce Department.[171]

According to the Defense Department, "the conclusions outlined in the Hughes/Apstar materials provided to the PRC (and reviewed by the Defense Department for this assessment) were sufficiently specific to inform the PRC of the kinds of launch vehicle design or operational changes that would make the Long March 2E (and perhaps other launch vehicles as well) more reliable," [172] and could assist the PRC military in development of a more reliable fairing for use with ballistic missiles.[173]

Damage to National Security from the Apstar 2 Failure Investigation

The Hughes Failure Investigation Team included several sub-teams that were assigned the following areas:

- **Spacecraft debris**
- **Material properties**
- **Video analysis**
- **Telemetry**
- **Coupled loads**
- **Structures**
- **Aerodynamics**

Of these sub-teams, the last three most clearly involved rocket design considerations.

The following account of the activities of these three sub-teams is taken directly from the report of the Hughes Failure Investigation Team.

Coupled Loads: This sub-team reviewed all of the coupled loads analysis information that was available for the Long March 2E rocket/HS-601 satellite combination. They compared the flight data from the satellite accelerometers that have flown on the Long March, the Atlas, and the Ariane. They traveled to Beijing to work beside the CALT engineers to review and participate in the Coupled Loads Analysis methodology. They expanded the standard satellite dynamic model (normally good to 75 Hz) to be valid up to 100 Hz.

Structures: The structures sub-team analyzed the strength requirements and capabilities of the satellite, the interstage, and the rocket's fairing. They performed stress analysis and buckling analysis on the primary structure elements based on detailed knowledge of the satellite and on design information supplied by CALT. They analytically determined the strength requirements and capabilities of the rivets in the fairing zipper. They analytically determined the deformation characteristics and the strength of the dome structure. They analyzed the capabilities of the satellite and rocket clamp bands.[174]

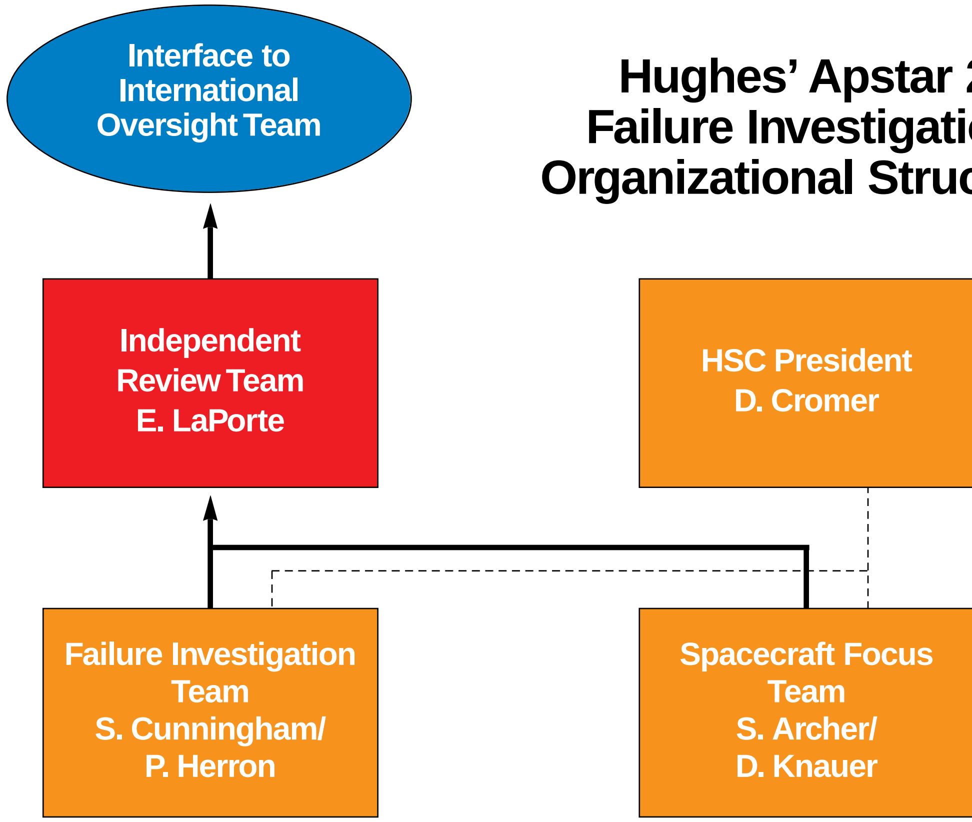
Aerodynamics: The aerodynamics sub-team was formed in order to understand the forces applied to the fairing which, in turn, are transmitted to the satellite. This team used the expertise of the Hughes Missile Systems Group to determine the flow field around the fairing, the pressure distribution, and the resulting forces and moments on the fairing and launch vehicle. This team also reviewed the NASA SF8001 guidelines that classify the Long March 2E fairing configuration as "separated, unstable." The guideline strongly recommends a comprehensive wind tunnel test program.[175]

The Defense Department believes it is likely that the Failure Investigation Team's seven sub-teams provided some of the principal interfaces between Hughes and the PRC in the preparation of individual analytical pieces of the decision tree approach to defining the likely root cause of the failure. In one case, for example, Hughes reported that a sub-team worked "beside" PRC engineers "to review and participate in coupled loads analysis methodology" (quotation in original).[176]

Each of these sub-teams carried out technical efforts that involved identifying the causes of failure of the Long March 2E fairing, and may have contributed directly to redesign of the fairing to bring its structure up to adequate levels of strength. Moreover, there is indication in the Hughes report on the launch failure that not only the results of Hughes team and sub-team work, but also the methods and know-how based on experience in the areas of airload determination and structural analysis and design, may have been imparted to the PRC.

At a minimum, it appears evident from the Hughes Failure Investigation Team report that the PRC member of the International Oversight Team could have had access to all of it. Indeed, such access is guaranteed by the International Oversight

Hughes' Apstar 2 Failure Investigation Organizational Structure



Team's charter. The statement in the report that the Coupled Loads Analysis sub-team "traveled to China to work beside the CALT engineers to work and participate in the Coupled Loads Analysis methodology" indicates a much more focused channel for possible technical information exchange with the PRC.

The conclusion reached by the Hughes Failure Investigation Team was that the initial failure of the Long March 2E launch of the Apstar 2 occurred in the rocket fairing. This failure was caused by the aerodynamic forces, buffeting, and aeroelastic (that is, interactions between structural dynamics and airloads) effects that are encountered as the rocket enters the transonic phase of flight. These effects were accentuated by the winds aloft and wind shear that were high on the day of the launch.

The Hughes Failure Investigation Team also noted the importance of the fact that the 1992 failure of the Long March 2E carrying the Optus B2 satellite occurred under the same (winter) wind conditions that prevailed at the time of the 1995 Apstar 2 launch failure of the same PRC rocket. The Hughes team pointed out that the three successful Long March 2E launches all took place when such wind conditions did not prevail.

It was further concluded on the basis of structural analyses that the fairing failed either in the rivets of the fairing zipper or in the fiberglass nose dome. Hughes engineers actually made a detailed stress analysis of the redesign of the rivets in the fairing zipper.

Damage to National Security From the Sharing of Coupled Loads Analysis

Coupled loads analysis simulates and assesses the interplay of the loads on the rocket during flight, including interaction between the satellite and the rocket which are stacked one on top of the other.

This analysis is based on a finite element model, a mathematical representation of the specified grid points that define the physical body of the satellite. Finite element analysis is the analysis of structural stress about the satellite body grid points.

Coupled loads analysis combines the satellite and rocket models for loads analysis. Information contained in the Hughes/Apstar materials indicates that, based on that analysis, Hughes learned that the PRC coupled loads analysis was deficient.

As with satellites and rockets, coupled loads analysis and finite element analysis are applied in the design and testing of missiles to the interaction of the components of a missile and warhead during launch.

The Defense Department believes it is reasonable to infer that, during the close collaboration between Hughes and PRC engineers, Hughes imparted to the PRC sufficient know-how to correct the overall deficiencies in their approach to coupled loads analysis and the PRC's finite elements model.[177]

Much of the work during the investigation appears to have been done in the PRC in close collaboration with PRC experts. Hughes clearly was concerned about the serious flaws in PRC modeling and analysis of aerodynamic loads on the Long March rocket's fairing. According to the Hughes/Apstar materials, among the lessons Hughes said it learned was that it cannot rely exclusively on the PRC to perform coupled loads analysis.

Damage to National Security From Providing the PRC With Information Concerning Deficiencies in the Fairing, and Resultant Improvements to PRC Rockets and Ballistic Missiles

The Defense Department determined that, according to the Hughes/Apstar materials, deficiency in PRC design of the rocket fairing was cited as the most likely "root cause" of the Long March 2E failure. Hughes' conclusions highlighted numerous areas of concern focusing on improving the Long March rocket design.

The conclusions included:

- **Concerns about the fairing design**
- **The rivet strength of the zipper**
- **Weaknesses in the nose cap split line**
- **The shape of the fairing**

There were also concerns about certain Long March rocket interfaces (such as the design of the clamp separation band) and inadequate vent area in the rocket's fairing.[178]

The Defense Department found that, over the course of about five months in early 1995, Hughes conducted a broad and in-depth investigation that involved significant and detailed technical interchanges between Hughes and PRC experts.[179] These interactions specifically addressed a full range of possible causes for the failure that included a comprehensive analysis of the Hughes satellite and the PRC rocket fairing and flight loads.

The investigation's conclusions that were provided to the PRC were very specific and identified the need for modifications in the Long March rocket fairing design and in PRC launch operations.[180]

The PRC made several changes to the Long March 2E fairing in 1995 to address possible failure causes, including:

- **Structural changes to strengthen the fairing**
- **Improved coupled loads analysis**
- **Tighter winds-aloft launch go/no-go criteria, to prevent launches in winds above a specific threshold**

Further, the PRC modified the Long March 2E guidance system by adding a wind-bias trajectory compensation to limit the Long March 2E's angle of attack.

All of the above changes by the PRC directly addressed Hughes' recommendations conveyed to the PRC in the course of the failure investigation.

The Defense Department assessment concluded that:

> *[T]he [PRC] modifications in the LM-2E fairing, coupled loads analysis, and launch operations apparently addressed the problems because the PRC successfully launched two non-Hughes commercial communications satellites on LM-2E vehicles in November and December 1995.*
>
> *Although the LM-2E has not been used since then, the lessons learned from the APSTAR 2 investigation are directly applicable to fairings on other launch vehicles, including those used to boost PRC military satellites. . .*
>
> *[A]lthough it is possible that the PRC may be able to transfer the benefits of this launch failure investigation to its ballistic missile programs, the utility to those programs would be limited largely to development of a more reliable fairing for use with advanced payloads on military ballistic missiles.*

Other Information Learned By the PRC, and Defense Department Reaction

The Hughes investigation provided the PRC with details about the satellite design and some manufacturing/inspection practices to prove that the satellite was not responsible for the failure, and that a faulty Long March rocket fairing design was the likely root cause of the failure.

The joint investigation also provided the PRC with insight into U.S. diagnostic techniques for assessing defects in rocket and satellite design.

The Defense Department concluded that there was no evidence of any limits on the Apstar 2 investigation imposed by the Commerce Department or any other U.S. Government agency. As a consequence, the PRC and Hughes engaged in technical exchanges, such as those concerning coupled loads analysis and finite elements analysis, that would allow the PRC to gain specific insight into specific rocket design, operational problems, and corrective actions.[181]

In addition, the Defense Department report stated that

> *. . . based on DOD's experience monitoring technical interchange meetings and related activities in connection with foreign launches of U.S. commercial satellites, it is reasonable to conclude that during the course of the five-month Hughes investigation there were significant interactions with the PRC of a highly technical and specific nature that are not reflected in the Hughes/Apstar materials reviewed by DOD.*[182]

The Defense Department assessment also noted that its findings and conclusions are "necessarily preliminary in nature," given the incompleteness of the information available. For example, the Defense Department assessment properly noted the assistance a Hughes "subteam" provided in coupled loads analysis, but also that "the precise nature of the analyses performed and the composition of skills of the team members cannot be ascertained from the Hughes/Apstar materials reviewed by the Defense Department." [183]

State Department Assessments of Damage to National Security

The State Department very recently completed its assessment of the assistance provided by Hughes to the PRC. The text of the State assessment is reproduced on the following pages:

United States Department of State
Washington, D.C. 20520

SENSITIVE BUT UNCLASSIFIED
MEMORANDUM
December 18, 1998

SUBJECT: Review of APSTAR II/Long March 2E Failure Investigation Data

We have completed our review of the documents associated with the APSTAR II/Long March 2E launch failure, and offer the following analysis for your review.

SUMMARY

The launch failure investigation began in January 1995 immediately following the failed launch of the Chinese LM-2E space launch vehicle (SLV) with the Hughes Space and Communications (HSC) designed APSTAR II communications satellite payload onboard. The investigation involved the formation of several groups of technical experts by both the Chinese and Hughes. Additionally, both parties contracted an independent investigation team of private consultants and space industry experts. Throughout the course of the investigation, Chinese and Hughes personnel engaged in an extensive exchange of technical data and analyses. There were no US Government monitors overseeing these activities.

After a thorough review of the data provided to the Office of Defense Trade Controls (DTC), this office has concluded that:

> The Chinese were deficient (to varying degrees) in the areas of anomaly analysis, accident investigation techniques, telemetry (TLM) analysis, coupled loads analysis (CLA), hardware design and manufacture, testing, modeling and simulation, and weather analysis.
>
> HSC [Hughes] assisted the Chinese in identifying their shortcomings in these areas, through provision of detailed technical analyses and critiques of Chinese failure analysis. The interaction between HSC [Hughes] and the Chinese on the APSTAR II failure investigation resulted in significant improvement to the Chinese spacelift program and contributed to China's goal of assured access to space. The

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> lessons learned by the Chinese are inherently applicable to their missile programs as well, since SLVs and ICBMs share many common technologies.

Our review of the APSTAR II failure investigation centered upon documentation provided by Hughes Space and Communications to DTC. The data included memoranda, faxes, technical reports, etc. Thus, our final assessment is based on solely upon the exchange of written information between Hughes personnel and their Chinese counterparts. Accordingly, we have categorized our analysis by the kinds of work Hughes performed for the Chinese.

ANOMALY ANALYSIS/ACCIDENT INVESTIGATION

The differences between Hughes Space and Communications and Chinese approaches to conducting the accident investigation were substantial. The Hughes teams followed an in-depth and exacting process for conducting and documenting an accident investigation. They provided descriptive accounts of failure analysis, highlighted with explanations to include empirical evidence, fault elimination, deductive reasoning, etc. Throughout the course of the investigation, Hughes identified faults with Chinese practices and techniques.

> HSC [Hughes] identified that the LV [launch vehicle] clamp band was not seated correctly during flight, owing to slippage possibly caused by vibrations and the use of a lubricant on the band. It recommended the Chinese review this area prior to future launches. (Hughes Failure Investigation Report, para 4.3.3, July l995).

> HSC [Hughes] identified a possible design flaw in the venting system of the payload fairing (PLF), compared the system to western standards, and recommended the Chinese review this area prior to future launches. (Hughes Failure Investigation Report, para 4.3.3, July 1995).

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> HSC [Hughes] identified a possible design flaw in the nose dome of the fairing. Analysis of the PLF debris from both the APSTAR II and OPTUS B2 uncovered similarities in the probable failure of the nose dome. (Hughes Failure Investigation Report, para 4.3.3, July 1995).
>
> HSC [Hughes] identified the effect of wind shear on both the APSTAR II and OPTUS B2 launches. Moreover, they identified western standards for command and control to remedy the negative effects of wind velocity on a vehicle in flight. (Hughes Failure Investigation Report, para 4.3. 1, July 1995).
>
> HSC [Hughes] conduct of debris investigation was superior to Chinese analysis. Numerous rebuttals to Chinese analysis of launch debris identified inaccuracies, misrepresentations, and incomplete analyses of debris which were critical to fault identification. HSC [Hughes] results were supported by technical drawings, photographs, modeling, etc. (HSC Response to CALT Video, 8 May 95: Hughes Independent Spacecraft Review Team Final Report, July 1995; Hughes Failure Investigation Report, July 1995).

TELEMETRY ANALYSIS

Telemetry (TLM) analysis helps re-create the events leading to an anomaly — one of the most critical elements of any accident investigation. Throughout the course of this investigation, Hughes Space and Communications provided detailed explanations of its TLM analyses and identified probable errors in Chinese analyses.

> HSC [Hughes] identified the TLM data as "the most important source of information regarding the failure." HSC [Hughes] analysis of TLM data directly pointed to failure of the PLF in-flight for APSTAR II, as well as to the previous in-flight failure of the

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> OPTUS B2. HSC [Hughes] laid out the history of the flight via TLM analysis, identifying "77 points" (i.e. significant events) which were critical to its analysis. (HSC APSTAR II Failure Presentation to CGWIC, 13 Feb 95; Hughes Failure Investigation Report, para 4.1.1, 4.3.3, Section 5, July 1995).
>
> HSC [Hughes] identified Chinese TLM analysis as deficient in several areas: the Chinese did not identify LV [launch vehicle] trajectory corrections due to wind shear effects; incorrectly interpreted accelerometer data; failed to identify a probable anomaly with the clamp band; and missed a probable fault with the PLF venting process. (HSC APSTAR II Failure Presentation to CGWIC, 13 Feb 95; HSC APSTAR Failure Review: Status Report, Pt II, 12-13 Apr 95; CALT APT Failure Investigation Report, 25 Jun 95; Hughes Independent Spacecraft Review Team Final Report, para 3.3.1, 3.3.3, 3.4.2, 3.4.3, 3.4.6, July 1995).

COUPLED LOADS ANALYSIS

The Hughes Space and Communications coupled loads analysis (CLA) team "spent extended time in Beijing with the CALT CLA team to understand and validate CLA methodology." In the course of these exchanges, Hughes shared modeling and calculation data, made comparisons to Western standards, and identified areas of concern in the Chinese CLA modeling processes. Both Hughes and the Independent Oversight Team (IOT), hired by Hughes and the Chinese, found discrepancies in Chinese CLA. Indeed, the Independent Spacecraft Review Team provided a telling insight into Chinese CLA efforts by stating, "…there was definite confusion in understanding the static and dynamic envelopes for the complete stack assembly."

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> HSC [Hughes] conducted joint re-analysis of CLA after reviewing the flight's TLM data. In several cases, it either re-affirmed or did not concur with pre-flight modeling conducted by the Chinese.
>
> This included sharing of modeling, calculations, methodologies, etc. (HSC APSTAR II Failure Investigation to CGWIC, 13 Feb 95; LM-2E Failure Module, 8 May 95; Hughes Failure Investigation Report, para 4.1.2, July 1995).
>
> HSC [Hughes] specifically identified concerns with Chinese CLA early in the investigation: "Low fidelity of CLA mode definition … Uncertainty in loads." (APSTAR II Failure Review, Other Concerns, 12 Apr 95).
>
> HSC [Hughes] compared and contrasted Chinese CLA with Western aerospace analyses of Ariane and Atlas. (HSC APSTAR II Failure Briefing, May 1995).
>
> An IOT member, when referring to possible failure of the PLF, stated, "… (failure) could be the combination of incorrect design loads … (the Chinese) need further understanding of the impact both of static and dynamic loads upon the payload fairing…" (Memorandum from Mr. Ernest L. LaPorte to HSC and CGWIC, 14 Jun 95).

HARDWARE DESIGN/MANUFACTURING

Hughes uncovered design and/or manufacturing flaws in the payload fairing, and determined that they directly contributed to the failure of two Chinese space launch vehicles. Additionally, Hughes identified possible problems with the Chinese manufactured launch vehicle clamp band and interface adapter.

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The Structures Team conducted technical analyses on the PLF and identified flaws in the rivets used to secure the zipper area of the PLF (Hughes Failure Investigation Report, para 3.2.2, 3.4, 3.5.3, 4.2.1, 4.3.3, July 1995).

The Aerodynamics Team reviewed Chinese wind tunnel modeling and testing. It provided comparison with and reaffirmed open-source information from NASA, which identified design flaws in the PLF (Hughes Failure Investigation Report, para 3.2.2, 3.5.4, 4.3, 4.3.2, July 1995).

The Structures Team identified possible design flaws and possible improper installation of the launch vehicle clamp band (Hughes Failure Investigation Report, para 3.2.2, 3.5.3, 4.3.3, July 1995).

HSC [Hughes] recommended, that the Chinese conduct a thorough review of quality control procedures prior to any anomaly analysis investigation (Hughes Independent Spacecraft. Review Team Final Report, para 3.3. 1, July 1995).

HSC [Hughes] identified possible material and design faults with the Chinese manufactured interface adapter, the Environment and Interfaces Team (EIT), analysis of TLM supported this conclusion. Additionally, EIT identified a possible anomaly in Chinese ground operations procedures for the installation of the clamp band (Hughes Independent Spacecraft Review Team Final Report, para 3.3.1, 3.4.3, 3.4.6, July 1995).

HSC [Hughes] provided a critical assessment of the Chinese designed interface adapter an inadequate design by HSC standards (Hughes Independent Spacecraft Review Team Final Report, Lessons Learned, July 1995).

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(Also: see ANOMALY ANALYSIS/ACCIDENT INVESTIGATION above, for other design/manufacturing issues).

TESTING

Hughes made recommendations for improvements to Chinese testing methodologies and verified results of Chinese tests of hardware.

HSC [Hughes] recommended vibration testing of the spacecraft - launch vehicle adapter stack for future launches to preclude clamp band anomalies; the EIT supported this as well (Hughes Independent Spacecraft Review Team Final Report, para 3.3.1, 3.4.6, July 1995).

Hughes personnel suggested: "that for future applications, with this or new launch vehicles, a vibration or modal test be performed combining the adapters, perigee stage and spacecraft to resolve loads, modes, deflections and accelerometer testing." (Hughes Independent Spacecraft Review Team Final Report, July 1995).

In October 1995, following the conclusion of their joint investigation with Hughes, Chinese technical experts publicly made a series of commitments to their insurers to improve their spacelift program. In each case, the Chinese had previously (through June 1995) concluded that no problems existed. Hughes, on the other hand, insisted from the outset of the investigation that there were problems, and provided the technical analyses to support their claims.

PAYLOAD FAIRING: To strengthen their design, the Chinese made the following changes to the PLF: added bolts to the nose cap; included a support beam for the dome; added a frame and-seal cap between the dome pieces; switched to a manual locking

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> mechanism for a hatch door. Additionally, the Chinese increased their complement of ground tests and changed their ground operating procedures for the PLF.
>
> WIND SHEAR ALOFT: The Chinese planned to increase monitoring and measuring times; prepared to modify SLV trajectory based upon modified wind prediction models.
>
> COUPLED LOADS ANALYSIS: Stated plans to strengthen payload and launch vehicle compatibility analyses.

CONCLUSIONS

Hughes assistance directly supported the Chinese space program in the areas of anomaly analysis/accident investigation, telemetry analysis, coupled loads analysis, hardware design and manufacturing, testing, and weather analysis. Moreover, the assistance provided by Hughes is likely to improve the standing of the Chinese in the commercial launch market, as they make improvements in spacelift reliability and performance.

Hughes personnel knew the Chinese had problems in their space program. The Failure Investigation Team concluded that the Chinese launch failure hypothesis (provided independently from and prior to the Hughes failure report) failed to identify several key anomalies with the launch vehicle. Thus, we conclude Chinese anomaly analysis was not up to Western standards.

Comparing the APSTAR II failure to the January 1995 [actually February 1996] *failure of a Long March-3B (INTELSAT payload) reveals similarities between the two cases. In both instances, the investigation teams identified common themes with regard to Chinese deficiencies in launchoperations, anomaly analysis, modeling and simulation, manufacturing, and quality control, etc. However, we conclude the APSTAR II investigation*

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provided more detailed assistance to the Chinese than the more general support provided during the Long March 3B investigation. The two investigation reports, centering on different variants of the Long March vehicle family, offer strong evidence that the Chinese spacelift program suffers from poor reliability. The reports reveal that U.S. contractors knew where the Chinese program suffered from inadequacies. Moreover, the contractors often corrected errors in incomplete or incorrect analysis or filled in gaps where the Chinese simply lacked the technical knowledge.

Essentially, the APSTAR II failure investigation (and to some extent, the investigation of the Long March 3B) served as a tutorial for the Chinese, allowing them to improve on areas in which their spacelift program was weak. The Lessons Learned section of the Independent Spacecraft Review Team final report also offers commentary on the serious concerns HSC [Hughes] had with China's spacelift program: "HSC should never compromise on doing a coupled loads analysis. If politics, government constraints or vendor issues do not permit the analysis then it is our recommendation that this is not a suitable launch."

The impact and extent of any damage to U.S. national security as a result of the Hughes accident investigation into the APSTAR II launch failure is difficult to quantify. However, we believe the assistance provided by Hughes to China will prove to be significant to the degree it contributes to the increased reliability of their launch vehicles. The recent record of Chinese space launches in fact shows an improvement in reliability. The longer term effect of increased launch reliability will be to improve the rate of successful deployment of Chinese satellites and, in turn, to facilitate China's access to space for commercial and military programs.[184]

(end of memo)

Damage to National Security Identified by The Select Committee's Technical Consultant[185]

A senior technical consultant to the Select Committee, Dr. Alexander Flax, concluded that although the configuration of ballistic missile fairings (or shrouds) may be substantially different from the fairings employed on rockets, the methods for determining quasi-steady as well as vibratory and acoustic noise-generated flight loads would be the same.

The vibration spectrum of resonant frequencies varies as the launch trajectory is traversed. This complex of changing resonant conditions must be analyzed in relation to the changing aerodynamic, acoustic, buffeting, and wind shear forces that come into play along the launch trajectory. The resulting loads are resisted by the intricate structure of the fairing, and getting the distribution of loads and stresses right is not a simple task.

There is as much experience-based art as science in the successful application of the well-established numerical analysis and design methods available. It was the benefit of this experience and know-how that Hughes engineers could have made available to their PRC counterparts.

The Hughes engineers who worked on the failure investigation obviously believed that the PRC lacked an adequate understanding of buffeting loads. The final report of the Focus Team stated:

> *It also appears that [Hughes] had a limited understanding of CALT's [the China Academy of Launch Vehicle Technology's] capabilities in the area of aerodynamic buffeting analysis/ loading. They are in the launch business, they know their job, and it's their problem cannot be an acceptable position in future use of Chinese launch services.*

More explicitly, the report stated, "It is known that CALT [the China Academy of Launch Vehicle Technology] did not adequately take buffeting into account."

The Hughes engineers also believed the arbitrary split at the interface between satellite and rocket in the responsibilities for coupled load analyses led to errors in the analyses. The following strong view is expressed in the report:

> *[Hughes] should never compromise on doing a coupled load analysis. If politics, government constraints, or vendor issues do not permit the analysis then it is our recommendation that this is not a suitable launch.*

Thus, the PRC experience and knowledge learned during the Apstar 2 failure investigation about the aerodynamic and other loading conditions and environments on rocket fairings, and the structural design process taking these conditions into account, would stand them in good stead in developing fairings (or shrouds) for ballistic missiles. Shrouds and fairings, even if differently configured, employ many common types of sub-components, including supports, rivets, domes, and explosive bolts.[186]

Fairings or shrouds are not common on single-warhead land-based ballistic missiles, although there are exceptions. Many submarine-launched ballistic missiles (SLBMs) use fairings. While no currently deployed PRC intercontinental ballistic missiles use fairings, it is likely that the next generation of PRC intercontinental ballistic missiles or SLBMs will employ fairings or shrouds.

In 1997, the PRC was reportedly developing two intercontinental ballistic missiles, which could possibly carry multiple independently targeted reentry vehicles (that is, multiple warheads on a single ballistic missile). While experts do not believe that the PRC is currently developing multiple independently targeted reentry vehicles (MIRVs) or multiple reentry vehicles (MRVs), they do agree that the PRC has the technical capability to develop missiles with MRV or MIRVs within a period of years of a decision to do so.[187]

If the PRC decided to deploy MRV or MIRVed missiles, it is likely that the payloads would be protected by a shroud, since only one MIRVed missile, the Russian SS-20, does not employ a shroud.

Charlie Trie, the PRC, and Hughes Electronics

Associated Press

In May 1996 Yah Lin "Charlie" Trie, a former Little Rock, Arkansas restaurateur and friend of President Clinton, received $100,000 from the CP Group, shareholders in the PRC-controlled APT satellite program. A search of his Little Rock, Arkansas office by U.S. Law Enforcement officials yielded a handwritten note in Mandarin on stationery from a Hong Kong hotel. The note included the entries: "Hughes, U.S. Government, Export Control Licenses, Bribery Problem — Government Official."

Yah Lin "Charlie" Trie, a former Little Rock, Arkansas restaurateur and friend of President Clinton, was indicted on January 28, 1998 and charged with participating in a conspiracy by, among other activities, attempting to obtain benefits by circumventing the Federal Election Campaign Act.[188]

In the early 1990s, Trie formed an import-export business known as Daihatu International Trading Corporation, and used that business to make frequent trips to the PRC.[189] He arranged for at least eight delegations of PRC government officials and others to visit the United States.[190] Trie visited the White House at least 23 times from 1993 through 1996.[191]

Trie, his family, and his businesses contributed a total of $220,000 to the Democratic National Committee between 1994 and 1996. During that same period, Trie and his businesses received a total of approximately $1.5 million by wire transfer from foreign sources.

In May 1996, he received $100,000 from the CP Group, shareholders in the PRC-controlled Asia Pacific Telecommunications consortium and the Apstar satellite program. Trie was also involved in extensive fundraising activities, including fundraising for the Presidential Legal Expense Trust, which later decided to return all of Trie's donations.[192]

Trie's political activities paved the way for his appointment to the Commission on United States/Pacific Trade and Investment Policy, which was to advise the President "on the steps the United States should take to achieve a significant opening of Japan, China and other Asian and Pacific markets to U.S. business."[193] In a March 1996 letter to the President, Trie expressed concern over U.S. intervention in the tense situation that arose from military exercises being conducted by the PRC near the coast of Taiwan.[194]

Justice Department officials have obtained from a search of Trie's Little Rock, Arkansas, office handwritten notes in Mandarin on stationery from the Hong Kong International Hotel. No analysis of the handwriting has been provided to the Select Committee. The note contains approximately 16 separate items. The first three items read as follows:

HUGHES U.S. GOVERNMENT

EXPORT CONTROL LICENSES

BRIBERY PROBLEM — GOVERNMENT OFFICIAL

The Select Committee attempted to contact Trie through his attorney, but Trie refused to provide the Select Committee with any information or testimony because of his upcoming trial. Similarly, the Justice Department has declined to provide the Select Committee with any further information.

Further Investigation Warranted

Further investigation is warranted along several paths, including:

- **The kind of information that may have been passed to the PRC beyond what appeared in the materials reviewed by the Defense Department**
- **The application, if any, of coupled loads analysis to improving the accuracy and range, as well as the reliability, of PRC ballistic missiles**
- **The likelihood that the PRC will in fact incorporate this know-how into their future missile and space programs**

The Defense Department report also calls for further investigation of the details of the information provided by Hughes.[195]

NOSE FAIRINGS ON ROCKETS AND BALLISTIC MISSILES

The front end of a rocket is usually a structure, known as a *fairing* or *shroud*, that serves to protect the satellite being launched from the external aerodynamic loads, vibration, noise, temperature extremes, dirt, dust, rain, snow, and micrometeorites that may be encountered as the satellite is launched and accelerates through the atmosphere into space.

The design of a fairing is governed by a myriad of factors including its weight, contribution to overall vehicle drag, structural strength, cost, and the size and shape of satellites it is to enclose.

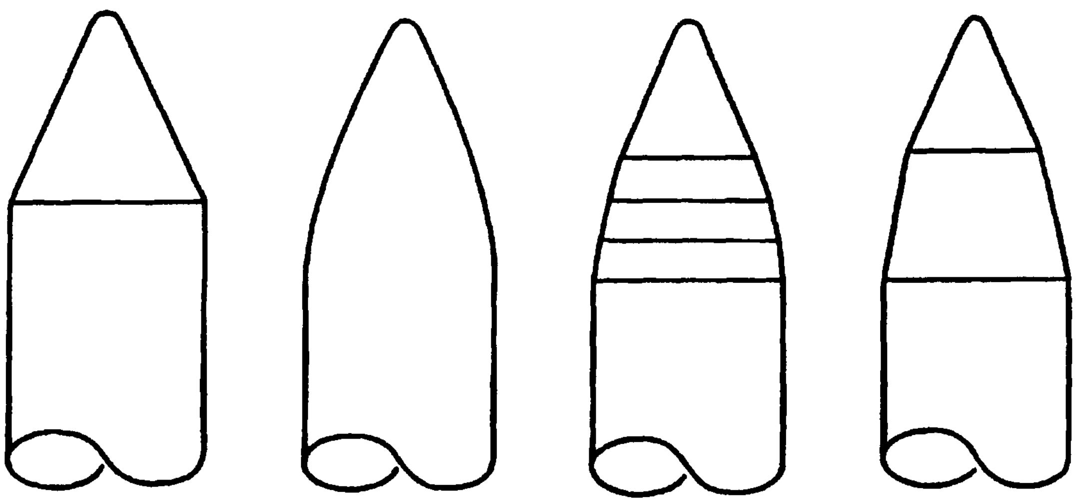
The relationship between fairing shape and just two of these factors — weight and drag — for a class of fairings of simple geometrical shape is shown above.

The question of whether minimum weight or minimum drag should be given greater emphasis depends on the details of the launch. If the fairing can be dropped early in the flight, low drag is more important. If satellite payload protection is needed through a large part of the launch trajectory, then the weight of the fairing becomes more significant in launch performance.

Given a specific fairing design, and a specific launch trajectory, the weight-drag tradeoff influences the altitude at which the satellite is separated from the rocket.

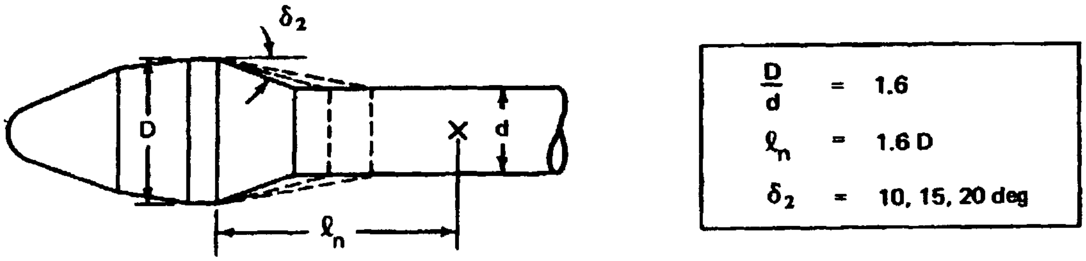
Cost and ease of manufacturing can also be factors in shaping fairings. The following graphic shows the evolution of fairings for the NASA Saturn rockets. The evolution was toward a single frustum/cone, and it occured on the basis of compromises of effects on vehicle performance with volume enclosed, fairing manufacturability, and cost.

U.S. Fairing Development Over Time



Fairings developed for NASA's Saturn rockets evolved toward a single frustum/cone as a compromise among such factors as the effects on vehicle performance, manufacturability, and cost.

Overshadowing these factors, however, is the requirement that the fairing be shaped to enclose the payload being launched. For large payloads, such as the current generation of communication satellites, the satellite containment requirement often leads to the use of hammerhead fairings (see illustration below) in which the maximum diameter of the fairing exceeds the diameter of the uppermost stage of the rocket. This type of fairing is subject to severe buffeting loads as it traverses the transonic speed region due to unstable aerodynamic flow separation and shock waves in the transonic region.



For large payloads such as today's communication satellites, hammerhead fairings are often used. The maximum diameter of the fairing exceeds the diameter of the uppermost stage of the launch rocket, and is subject to severe buffeting loads as it traverses transonic speeds.

Land-based ballistic missiles with single warheads usually do not have fairings (or shrouds, as such components are more often called in missile terminology) covering the warhead. However, ballistic missiles with multiple reentry vehicles (MRVs) and multiple independent reentry vehicles (MIRVs) usually do have shrouds, although with advanced nuclear weapon design, the density of the payload is high and the volumes to be enclosed are usually smaller than for communication satellites. Consequently, hammerhead designs do not seem to have been used for the shrouds on ballistic missile systems carrying multiple warheads.

However, it should not be assumed that single warhead missiles never use fairings, while multiple warhead missiles always use them. The U.S. Minuteman II ICBM faired its single, relatively blunt reentry vehicle in order to present a lower radar cross section at a time when a widely-deployed Soviet ABM system seemed to be in the offing. Moreover, this fairing was not shed until well into atmospheric reentry.

Another possible use of fairings would be to protect road-mobile missiles from the rigors of the environments to which they would be exposed, although covers that would be discarded before launch would be more likely.

Finally, in some cases, a shroud or partial shroud in the form of a nose cap might be used for drag reduction in the case of a blunt reentry vehicle. Again, the likelihood of hammerhead fairings being used for this purpose is not great.

In the case of the U.S. Trident submarine-launched ballistic missile, because of the limited length of the launch tubes, the shroud is blunt on launch, but a device known as an "aerospike" is extended forward from the front end to reduce drag in flight through the atmosphere.

Thus, the most likely PRC ballistic missile use of fairings would be on missiles equipped with MRVs or MIRVs, or on a submarine-launched missile. If the United States goes forward with a National Missile Defense program, the motivation to employ either MRVs or MIRVs may become compelling for the PRC. In the same vein, the incentives to employ various types of penetration aids (chaff, balloons, decoys, distributed jammers, etc.) will increase, and shrouds may be used to protect them and their deployment mechanisms.

Although the detailed configuration of ballistic missile fairings may be substantially different from the fairings used on rockets, the methods for determining quasi-steady as well as vibratory and acoustic noise-generated flight loads, and for designing the structure to resist these loads, would be the same.

Thus, the PRC experience and knowledge of the aerodynamic and other loading conditions and environments on rocket fairings, and the structural design process taking these conditions into account, would stand them in good stead in developing fairings (or shrouds) for ballistic missiles.

While the basic theories and experimental methods for determining flight loads and environmental conditions on rockets are in the public domain, the successful application of these theories and methods in design often requires know-how and engineering judgment derived from experience. Thus, for example, a recent text (*Space Vehicle Mechanics, Elements of Successful Design,* Peter L. Conley, Editor, John Wiley & Sons, Inc., New York, 1998, pg. 589), in discussing the qualification factors to which rocket components are to be designed and tested, cites some differences between the military and NASA standards, and then goes on to say:

> *MIL-STD 1540 and NASA-STD 7001 both state that the document should be tailored by the user to fit a particular space vehicle program. Even these definitive documents leave room for debate.*

SATELLITE LAUNCHES IN THE PRC: LORAL

O**n February 15, 1996, a Long March 3B rocket carrying the U.S.-built Intelsat 708 satellite crashed** just after lift off from the Xichang launch center in the People's Republic of China. This was the third launch failure in 38 months involving the PRC's Long March series of rockets carrying U.S.-built satellite payloads. It also was the first commercial launch using the new Long March 3B. These events attracted intense attention from the international space launch insurance industry, and eventually led to a review of the PRC launch failure investigation by Western aerospace engineers.

The activities of the Western aerospace engineers who participated on the review team — the Independent Review Committee — sparked allegations of violations of U.S. export control regulations. The review team was accused of performing an unlicensed defense service for the PRC that resulted in the improvement of the reliability of the PRC's military rockets and ballistic missiles.

The Intelsat 708 satellite was manufactured by Space Systems/Loral (Loral) under contract to Intelsat, the world's largest commercial satellite communications services provider. Loral is wholly owned by Loral Space & Communications, Ltd.

China Great Wall Industry Corporation, the PRC state-controlled missile, rocket, and launch provider, began an investigation into the launch failure. On February 27, 1996, China Great Wall Industry Corporation reported its determination that the Long March 3B launch failure was caused by a broken wire in the inner frame of the inertial measurement unit within the guidance system of the rocket. In March 1996, representatives of the space launch insurance industry insisted that China Great Wall Industry Corporation arrange for an independent review of the PRC failure investigation.

In early April 1996, China Great Wall Industry Corporation invited Dr. Wah Lim, Loral's Senior Vice President and General Manager of Engineering and Manufacturing, to chair an Independent Review Committee that would review the PRC launch failure investigation. Lim then recruited experts to participate in the Independent Review Committee: four senior engineers from Loral, two from Hughes

Space & Communications, one from Daimler-Benz Aerospace, and retired experts from Intelsat, British Aerospace, and General Dynamics.

The Independent Review Committee members and staff met with PRC engineers during meetings in Palo Alto, California, and in Beijing. During these meetings the PRC presented design details of the Long March 3B inertial measurement unit, and the committee reviewed the failure analysis performed by the PRC.

The Independent Review Committee took issue with the conclusions of the PRC investigation because the PRC failed to sufficiently explain the telemetry data obtained from the failed launch.

The Independent Review Committee members proceeded to generate a Preliminary Report, which was transmitted to China Great Wall Industry Corporation in May 1996 without prior review by any U.S. Government authority. Before the Independent Review Committee's involvement, the PRC team had concluded that the most probable cause of the failure was the *inner frame* of the inertial measurement unit. The Independent Review Committee's draft report that was sent to the PRC pointed out that the failure could also be in two other places: the inertial measurement unit *follow-up frame*, or an open loop in the feedback path. The Independent Review Committee recommended that the PRC perform tests to prove or disprove all three scenarios.

After receiving the Independent Review Committee's report, the PRC engineers tested these scenarios and, as a result, ruled out its original failure scenario. Instead, the PRC identified the follow-up frame as the source of the failure. The PRC final report identified the power amplifier in the follow-up frame to be the root cause of the failure.

According to the Department of Defense, the timeline and evidence suggests that the Independent Review Committee very likely led the PRC to discover the true failure of the Long March 3B guidance platform.

At the insistence of the State Department, both Loral and Hughes submitted "voluntary" disclosures documenting their involvement in the Independent Review Committee. In its disclosure, Loral stated that "Space Systems/Loral personnel were acting in good faith and that harm to U.S. interests appears to have been minimal." Hughes' disclosure concluded that there was no unauthorized export as a result of the participation of Hughes employees in the Independent Review Committee.

The materials submitted by both Loral and Hughes in their disclosures to the State Department were reviewed by several U.S. government offices, including the State Department, the Defense Technology Security Administration, the Defense Intelligence Agency, and other Defense Department agencies.

The Defense Department assessment concluded that "Loral and Hughes committed a serious export control violation by virtue of having performed a defense service without a license . . . "

The State Department referred the matter to the Department of Justice for possible criminal prosecution.

The most recent review of the Independent Review Committee matter was performed by an interagency review team in 1998 to reconcile differences in the assessments of the other agencies. That interagency team concluded:

- **The actual cause of the Long March 3B failure may have been discovered more quickly by the PRC as a result of the Independent Review Committee report**
- **Advice given to the PRC by the Independent Review Committee could reinforce or add vigor to the PRC's design and test practices**
- **The Independent Review Committee's advice could improve the reliability of the PRC's rockets**
- **The technical issue of greatest concern was the exposure of the PRC to Western diagnostic processes, which could lead to improvements in reliability for all PRC missile and rocket programs**

INTELSAT 708 LAUNCH FAILURE

LORAL INVESTIGATION PROVIDES PRC WITH SENSITIVE INFORMATION

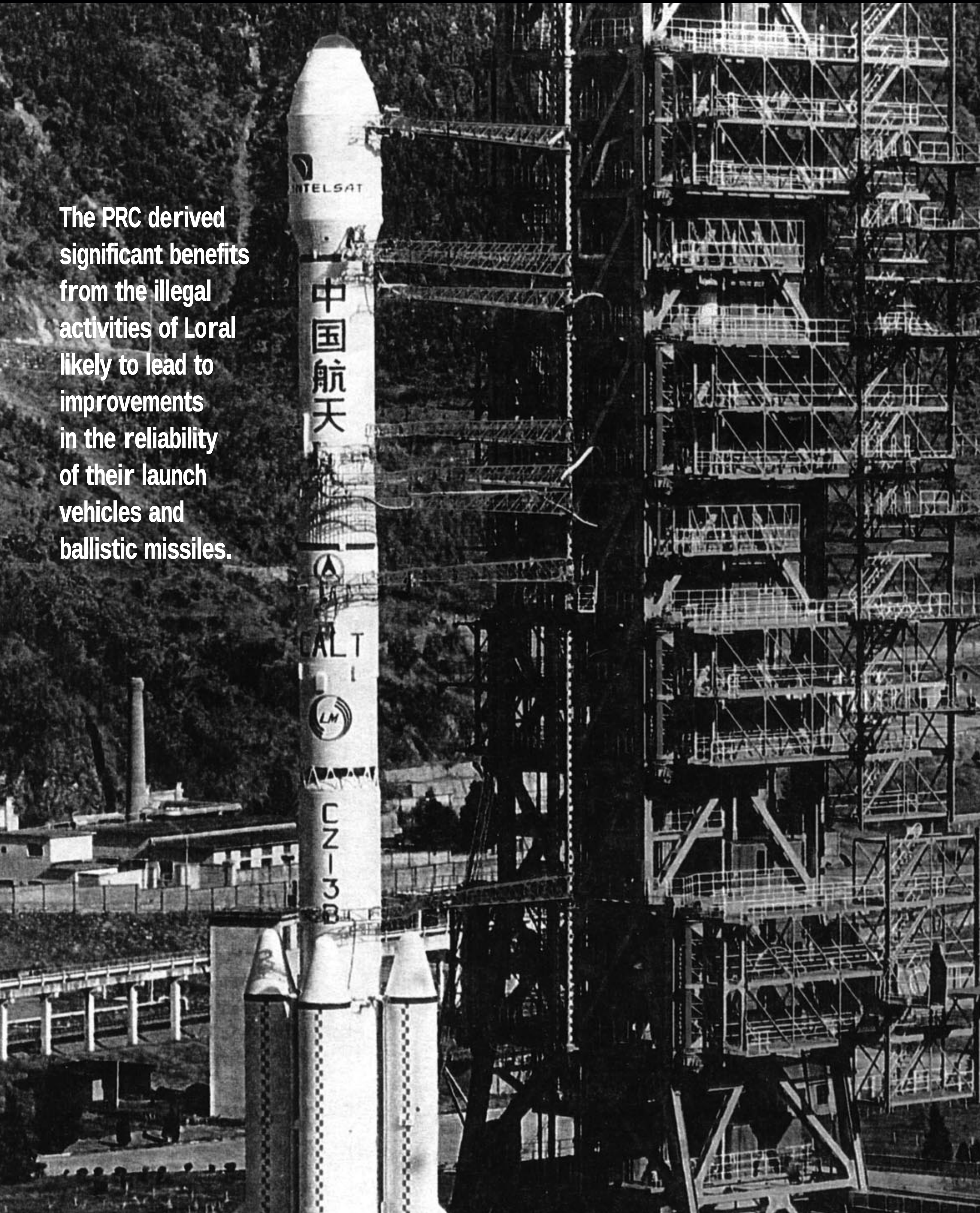
Overview of Events

On February 15, 1996, the Intelsat 708 satellite was launched on a Long March 3B rocket from the Xichang Satellite Launch Center in the PRC.[1] Even before clearing the launch tower, the rocket tipped over and continued on a flight trajectory roughly parallel to the ground.[2] After only 22 seconds of flight, the rocket crashed into a nearby hillside, destroying the rocket and the Intelsat satellite it carried.

The crash created an explosion that was roughly equivalent to 20 to 55 tons of TNT. It destroyed a nearby village. According to official PRC reports, six people died in the explosion,[3] but other accounts estimate that 100 people died as a result of the crash.[4]

The Intelsat 708 satellite was manufactured by a U.S. company, Space Systems/Loral (Loral), under contract to Intelsat, the world's largest commercial satellite communications services provider.[5] In October 1988, Intelsat had awarded a contract to Loral to manufacture several satellites in a program known as Intelsat VII. That contract had a total value of nearly $1 billion.

Intelsat subsequently exercised an option under that contract for Loral to supply four satellites — known as the Intelsat VIIA series — including the Intelsat 708 satellite.[6]



The PRC derived significant benefits from the illegal activities of Loral likely to lead to improvements in the reliability of their launch vehicles and ballistic missiles.

Photographic Series of Intelsat 708 Launch/Crash

- On February 15 1996, the Intelsat 708 satellite manufactured by Loral was readied for launch atop a PRC Long March 3B rocket at Xichang (1).
- Immediately after lift-off, the rocket began to tip over and veer off course (2).
- Video footage of the launch showed the rocket pitching into a horizontal flight trajectory (3, 4, 5, 6).
- It crashed into a nearby hillside (7) destroying the rocket and Intelsat payload. The rocket's impact with the ground created an explosion equivalent to 20 to 55 tons of TNT, destroying a nearby village and killing an estimated 100 people.

1

2

3

4

5

Intelsat 708 Wreckage Recovery

PLA soldiers were involved in recovering wreckage from the Intelsat 708 launch crash. Members of the Intelsat and Loral team in the PRC were not allowed by PRC officials to visit the site until late in the afternoon of the launch failure. Examination of recovered debris by Loral engineers in the U.S. determined that the satellite's encryption devices were not recovered from the crash site.

In April 1992, Intelsat contracted with China Great Wall Industry Corporation for the PRC state-owned company to launch the Intelsat VIIA series of satellites into the proper orbit using PRC Long March rockets.[7] Low price and "politics" were important factors in selecting the PRC launch services.[8]

In March 1996, following the Intelsat 708 launch failure, Intelsat terminated its agreement with China Great Wall Industry Corporation for additional launch services.[9]

The PRC's Launch Failure Investigation

China Great Wall Industry Corporation created two groups of PRC nationals to investigate the launch failure. These were the Failure Analysis Team and the Failure Investigative Committee. These two committees reported to an Oversight Committee.

On February 27, 1996, China Great Wall Industry Corporation reported its determination that the Long March 3B launch failure was caused by a failure in the inertial measurement unit within the control system of the rocket.[10] The inertial measurement unit is a component that provides an attitude reference for the rocket, basically telling it which way is up.[11]

The Asia Pacific Telecommunications Insurance Meeting

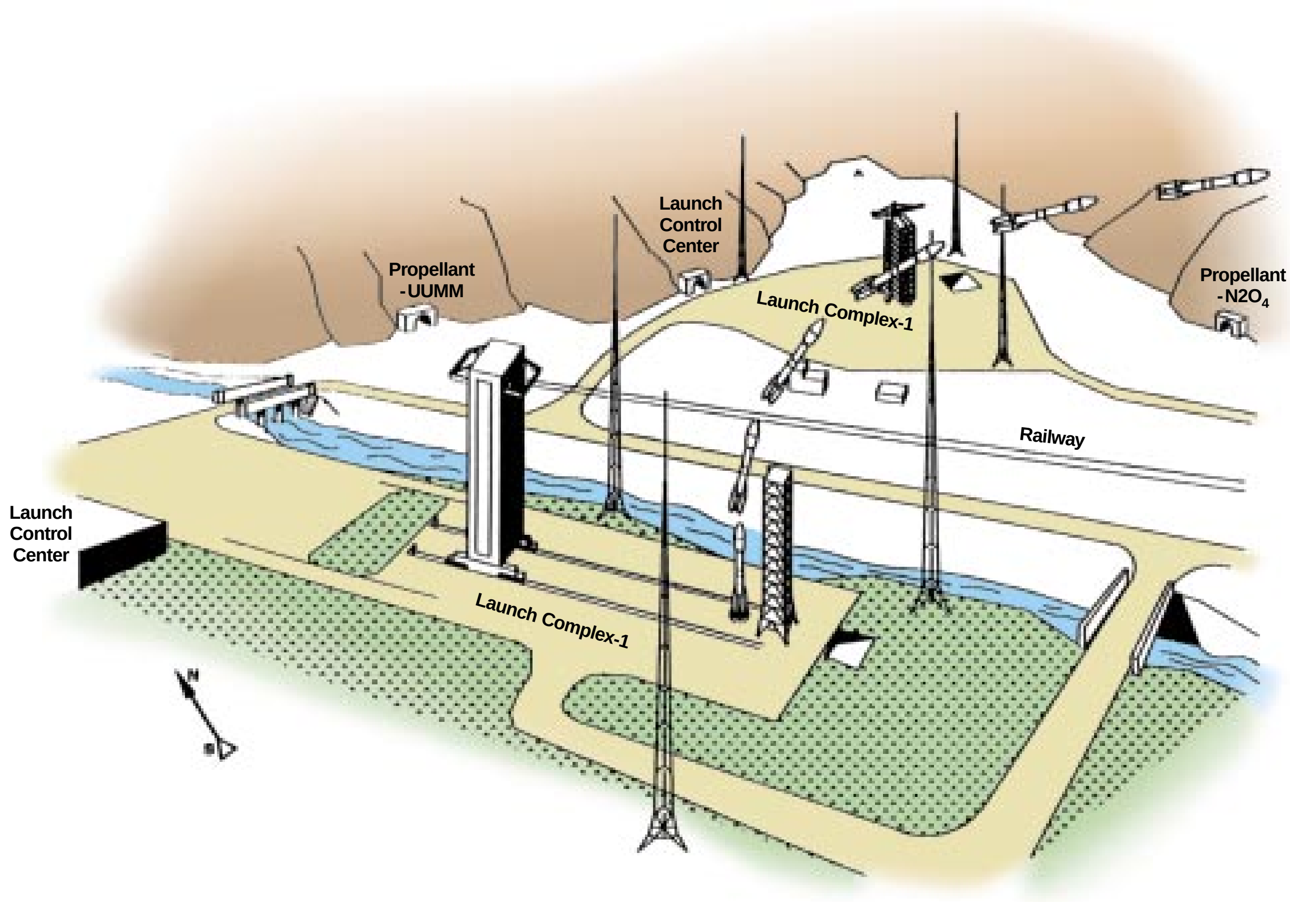
On March 14, 1996, a group of space launch insurance representatives met in Beijing with representatives of Hughes, the PRC-controlled Asia Pacific Telecommunications Satellite Co., Ltd., and China Great Wall Industry Corporation. The purpose of the meeting was to examine the risks associated with the upcoming launch of the Apstar 1A satellite that was scheduled for July 3, 1996 on a Long March 3 rocket, in the wake of the February 15 Long March 3B crash.[12]

The PRC assured those at the meeting that the launch was not at risk because the Long March 3 rocket uses a different kind of inertial measurement unit than the one that failed on the Long March 3B.[13]

At that meeting, Paul O'Connor, from the J&H Marsh & McLennan insurance brokerage firm, reportedly insisted that the PRC do two things before the space insurance industry would insure future launches from the PRC: first, produce a final report on the cause of the Long March 3B launch failure; and second, arrange for an independent review of the PRC failure investigation.[14]

The PRC's Creation of an 'Independent Review Committee'

In early April 1996, China Great Wall Industry Corporation invited both Loral and Hughes Space & Communications (Hughes) to participate in an Independent Review Committee that would review the PRC launch failure investigation.[15] The PRC then invited Dr. Wah Lim, Loral's Senior Vice President and General Manager of Engineering and Manufacturing, to chair the committee.[16]



This illustration depicts the Long March 3B veering off course soon after lift-off and crashing in nearby foothills seconds later. The PRC's China Great Wall Industry Corporation (GCGWIC) repared this illustration as a part of a presentation to show what it (incorrectly) claimed was the cause of the failure of the LM-3B launch. Loral and Hughes later shared the true cause of the failure withGCGWIC.

Lim impaneled the Independent Review Committee with experts from Loral, Hughes, and Daimler-Benz Aerospace, and retired experts from General Dynamics, Intelsat, and British Aerospace.[17]

The Independent Review Committee's Meetings

The Independent Review Committee held two sets of official meetings.[18] The first set of meetings was from April 22 to 24, 1996, at Loral's offices in Palo Alto, California.[19] The second set of meetings was from April 30 to May 1, 1996, in Beijing.[20]

At these meetings, the Independent Review Committee members reviewed the extensive reports furnished by China Great Wall Industry Corporation documenting the PRC launch failure investigation, and provided the PRC with numerous technical questions regarding the material.[21] The committee's activities also included tours of PRC assembly and test facilities for guidance and control equipment. The Independent Review Committee members caucused at their hotel in Beijing on April 30 to discuss and assess the PRC investigation privately.[22]

An aborted third round of Independent Review Committee meetings was scheduled for June 1996. However, the U.S. Government issued a cease and desist letter to both Loral and Hughes, ordering the companies to stop all activity in connection with the failure review. The letter also requested each company to disclose the facts related to, and circumstances surrounding, the Independent Review Committee.[23]

The Independent Review Committee activity was not authorized by any U.S. Government export license or Technical Assistance Agreement.[24] Loral had obtained two export licenses (No. 533593 and No. 544724) from the State Department in 1992 and 1993 to allow the launch of the Intelsat 708 satellite in the PRC. Neither of those licenses authorized any launch failure investigative activity.[25]

Loral was aware from the start of the Independent Review Committee's meetings that it did not have a license for the Independent Review Committee activity.[26]

The Independent Review Committee meetings were not attended by any U.S. Government monitors, as almost certainly would have been required had there been an export control license.

The Independent Review Committee's Report

Lim had promised the PRC that the Independent Review Committee would report its preliminary findings by May 10, 1996.[27] This deadline was driven by Loral's need to determine, by that date, whether its Mabuhay satellite would be launched on a PRC rocket as planned.

Following the meeting of the Independent Review Committee in Beijing, the committee members collaborated by facsimile and e-mail to generate a report of their findings. Loral engineer Nick Yen, who was the Secretary for the Independent Review Committee, collected input from the committee members and compiled the report. British committee member John Holt drafted the technical section of the report, with inputs from the other committee members.[28]

A draft of the Independent Review Committee Preliminary Report was completed by May 7, 1996; the Preliminary Report was completed on May 9, 1996.

Substance of the Preliminary Report

The Independent Review Committee's Preliminary Report was approximately 200 pages in length. It comprised:

- **Meeting minutes**
- **Independent Review Committee questions and China Great Wall Industry Corporation answers**
- **Findings**
- **Short-term and long-term recommendations**
- **The Independent Review Committee charter and schedule**
- **The Independent Review Committee membership roster**
- **Appendices**[29]

The thrust of the recommendations presented in the report was:

Short-Term Recommendations[30]

1) **An explanation of the total flight behavior is essential** to fully confirm the failure mode. A mathematical numerical solution is recommended immediately, to be followed by a hardware in-the-loop simulation test when possible.

2) **The detailed design of the motor and its wiring should be studied** to either: a) preclude harness motion during gimbal motion or b) alleviate the impact of unavoidable deflection on solder joint integrity.

3) **Higher quality control and quality standards** in the manufacturing process need to be implemented and adhered to.

4) **The China Academy of Launch Technology should re-examine the environmental test plan for all avionics equipment.** It is the Independent Review Committee's opinion that the environmental tests performed by the China Academy of Launch Technology might not be adequate for meeting the requirements of the expected maximum flight loads, including acoustic noises, or detecting the defects in the flight hardware.

5) **The Independent Review Committee is very concerned over the range safety issues in the areas of operation safety, launch safety and personal safety in general.** Due to the difference in operations and requirements by various customers/satellite contractors of China Great Wall Industry Corporation, it is not suitable for the Independent Review Committee to make generic recommendations for overall implementation requirements. However, China Aerospace Corporation and China Great Wall Industry Corporation should carefully review the Action Items, #19, #20, and #21,

of the first committee meeting and propose a well thought implementation plan to be reviewed, agreed, and accepted by China Great Wall Industry Corporation's individual customer/prime satellite contractor.

Long-Term Recommendations[31]

1) **Quality control philosophy and practice of the fabrication, assembly and test of the inertial measurement unit should be strengthened.** Personnel should be trained periodically in careful handling and cleanliness concerns. Cleanliness and careful test handling should be emphasized and maintained at all times.

2) **Good design and good quality control can achieve the desired reliability of hardware. However, a design with adequate redundancy** can also achieve the same desired reliability. Therefore, it should be strongly considered in avoiding critical single point (or path) failure.

The Report Goes to the PRC

On May 7, 1996, Loral's Nick Yen, the Secretary of the Independent Review Committee, faxed the draft Preliminary Report to the committee members, and to China Great Wall Industry Corporation.

On May 10, 1996, the final Independent Review Committee Preliminary Report, less attachments, was faxed by Yen to China Great Wall Industry Corporation.[32] The same day, the complete Preliminary Report was express-mailed by Yen to the Independent Review Committee members.[33]

On May 13, Yen also faxed the Preliminary Report to a hotel in Beijing for Paul O'Connor of J&H Marsh & McLennan, who was a guest there.[34]

None of these transmitted documents was submitted to the U.S. Government for review prior to its transmission to the PRC.[35]

Defense Department Analyst Discovers the Activities of the Independent Review Committee

The May 13-19, 1996, issue of *Space News*, a widely-read industry publication, contained an article stating that Wah Lim, as Chairman of the Independent Review Committee, had faxed the committee's report of the failure review to the PRC.[36]

On or about May 14, 1996, Robert Kovac, an Export Analyst in the Defense Department's Defense Technology Security Administration (DTSA), read the *Space News* article and became concerned that the Independent Review Committee's activities were not conducted under a license. Kovac was particularly alarmed that, according to the article, a failure review report had been distributed to the PRC.

Kovac immediately acted on his concern. He called Loral's Washington representative and asked whether the Independent Review Committee's activities had been conducted under a license. Loral's response was to propose a meeting with Kovac and others for the following day.

On May 15, 1996, Loral's Export Control Officer met with licensing personnel at the State Department and the Defense Department to report on the Independent Review Committee's activities.

The Defense Department advised the Loral officials to halt all Independent Review Committee activity and consider submitting a "voluntary" disclosure to the State Department.

The State Department made similar recommendations, and sent letters to both Loral and Hughes soon afterward that reported that the State Department had reason to believe that the companies may have participated in serious violations of the International Traffic in Arms Regulations.

The State Department also requested that the companies immediately cease all related activity that might require approval, provide a full disclosure, and enumerate all releases of information that should have been controlled under the International Traffic in Arms Regulations.

Loral and Hughes Investigate the Matter

On May 23, 1996, Loral engaged the law firm of Feith & Zell of Washington, D.C., to conduct a limited investigation, as counsel for Loral, of the events related to the Independent Review Committee. That investigation included document collection and review, and interviews of Loral employees. On June 17, 1996, a "voluntary" disclosure was submitted to the State Department by Feith & Zell on behalf of Loral.[37]

In that disclosure, Loral stated that its procedures for implementing export control laws and regulations were deficient, but that Loral was implementing corrective measures. Also, Loral's disclosure concluded that "Loral personnel were acting in good faith and that harm to U.S. interests appears to have been minimal." [38]

Hughes' General Counsel's office began an investigation into the Independent Review Committee matter in early June 1996, after receiving the State Department letter advising that Hughes may have been a party to serious violations of the International Traffic in Arms Regulations. Hughes' investigation report was submitted to the State Department on June 27, 1996. The Hughes report concluded that there was no unauthorized export as a result of the participation of Hughes employees in the Independent Review Committee.

The Hughes employees reportedly advised Loral employees to obtain the appropriate State Department approvals prior to furnishing the documents to the PRC.[39]

The Aftermath: China Great Wall Industry Corporation Revises Its Findings on the Cause of the Accident

In September 1996, China Great Wall Industry Corporation discarded its original analysis, and in October 1996 made its final launch failure presentation to officials at Loral.

China Great Wall Industry Corporation determined that the root cause of the failure was a deterioration in the gold-aluminum wiring connections within a power amplifier for the follow-up frame torque motor in the inertial measurement unit. This was the very problem the Independent Review Committee had identified in their meetings with PRC officials and in the Preliminary Report.

U.S. Government Assessments of the Independent Review Committee's Report, and Referral to the Department of Justice

The materials submitted by both Loral and Hughes in their 1996 disclosures to the State Department were reviewed by several U.S. Government offices, including the State Department, the Defense Department, the Central Intelligence Agency, and an interagency review team.

The 1997 Defense Department assessment concluded that "Loral and Hughes committed a serious export control violation by virtue of having performed a defense service without a license . . . ."

Based on this assessment, the Defense Department recommended referral of the matter to the Department of Justice for possible criminal prosecution.

In July 1998, a U.S. Government interagency team conducted a review of the Independent Review Committee's activities and reported the following:

- **The actual cause of the Long March 3B failure may have been discovered more quickly by the PRC as a result of the Independent Review Committee's report**
- **Advice given to the PRC by the Independent Review Committee could reinforce or add vigor to the PRC's design and test practice**s
- **The Independent Review Committee's advice could improve PRC rocket and missile reliability**
- **The technical issue of greatest concern was the exposure of the PRC to a Western diagnostic process**[40]

The interagency review also noted that the Long March 3B guidance system on which Loral and Hughes provided advice is not a likely candidate for use in future PRC intercontinental ballistic missiles. The Long March 3B guidance system is well suited for use on a rocket.

Details of the Failed Long March 3B-Intelsat 708 Launch and Independent Review Committee Activities

The specific details of the events surrounding the Long March 3B-Intelsat 708 launch failure and the Independent Review Committee are described in the remainder of this Chapter.

Background on Intelsat and Loral

Intelsat

The International Telecommunications Satellite Organization (Intelsat), headquartered in Washington, D.C., is an international not-for-profit cooperative of 143 member nations and signatories that was founded in 1964. Intelsat is the world's largest commercial satellite communications services provider. Its global satellite systems bring video, Internet, and voice/data services to users in more than 200 nations and on every continent.[41]

The member nations contribute capital in proportion to their relative use of the Intelsat system, and receive a return on their investment. Users pay a charge for all Intelsat services, depending on the type, amount, and duration of the service. Any nation may use the Intelsat system, whether or not it is a member. Intelsat operates as a wholesaler, providing services to end-users through the Intelsat member in each country. Some member nations have chosen to authorize several organizations to provide Intelsat services within their countries. Currently, Intelsat has more than 300 authorized customers.[42]

Intelsat includes two members from the PRC: China Telecom is a signatory, and Hong Kong Telecom is an investing entity. Their investment shares are 1.798 percent and 1.269 percent, respectively, giving the PRC a country total of 3.067 percent, which makes it the eighth largest ranking member nation.[43]

On January 2, 1999, Intelsat had a fleet of 19 high-powered satellites in geostationary orbit. These satellites include the Intelsat 5 and 5A, Intelsat 6, Intelsat 7 and 7A, and the Intelsat 8 and 8A families of satellites. The newest generation of Intelsat satellites, the Intelsat 9 series, is in production.[44]

Nine satellites were manufactured in the Intelsat VII and VIIA series. Loral manufactured this series of satellites, and they were launched during the period from 1993 to 1996.[45]

Intelsat VII and VIIA Series Satellites[46]

SATELLITE	ROCKET	LAUNCH DATE	LAUNCH RESULTS
701	Ariane 44 (France)	22 October 1993	Success
702	Ariane 44 LP(France)	17 June 1994	Success
703	Atlas II AS (US)	6 October 1994	Success
704	Atlas II AS (US)	10 January 1995	Success
705	Atlas II AS (US)	22 March 1995	Success
706	Ariane 44 LP(France)	17 May 1995	Success
707	Ariane 44 P (France)	14 March 1996	Success
708	Long March 3B (PRC)	15 February 1996	Failure
709	Ariane 44 LP (France)	15 June 1996	Success

Loral Space and Communications

Loral Space and Communications, Ltd., is one of the world's leading satellite communications companies and has substantial interests in the manufacture and operation of geosynchronous and low-earth-orbit satellite systems. The company is headquartered in New York City and is listed on the New York Stock Exchange. Bernard Schwartz is its Chairman. The company employs approximately 4,000 people.[47]

Loral Space and Communications, Ltd., owns Space Systems/Loral, one of the world's leading manufacturers of space systems. It also leads an international joint venture for the Globalstar system of satellites that is expected to be placed in service in 1999. Globalstar will support digital telephone service to handheld and fixed terminals worldwide. Loral Space and Communications, Ltd., together with its partners, will act as the Globalstar service provider in Canada, Brazil, and Mexico. Together with Qualcomm, it holds the exclusive rights to provide in-flight phone service using Globalstar in the United States. Loral Skynet, acquired from AT&T in March 1997, is a leading domestic satellite service provider.[48]

Space Systems/Loral

Space Systems/Loral (Loral) designs, builds, and tests satellites, subsystems, and payloads; provides orbital testing, launch services, and insurance procurement; and manages mission operations from its Mission Control Center in Palo Alto, California. Loral was formerly the Ford Aerospace and Communications Corporation. In 1990, Ford Aerospace was acquired by a group including Loral Space and Communications, Ltd., and re-named Space Systems/Loral. Loral is located in Palo Alto, California, and Robert Berry is its President.[49]

At the time of the Intelsat 708 failure, Loral was 51 percent owned by Loral Space and Communications, Ltd. The remainder was owned equally by four European aerospace and telecommunications companies: Aerospatiale, Alcatel Espace, Alenia Spazio S.p.A., and Daimler-Benz Aerospace AG. In 1997, Loral Space and Communications, Ltd. acquired the foreign partners' respective ownership interests in Loral.[50]

Loral is the leading supplier of satellites to Intelsat. Loral's other significant customers include the PRC-controlled Asia Pacific Telecommunications Satellite Co., Ltd., CD Radio, China Telecommunications Broadcast Satellite Corporation, Globalstar, Japan's Ministry of Transport, Mabuhay Philippines Satellite Corporation, MCI/News Corp., the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration, PanAmSat, Skynet, and TCI. Loral employs approximately 3,100 people, has annual sales of approximately $1.4 billion, and has a backlog of orders for approximately 80 satellites.[51]

Intelsat 708 Launch Program

On April 24, 1992, Intelsat awarded a contract to China Great Wall Industry Corporation for the launch of Intelsat VIIA satellites into geosynchronous transfer orbit.[52]

On or about September 18, 1992, the State Department issued a license to Loral for the export to the PRC of technical data in support of technical discussions for the launch of an Intelsat VIIA satellite.[53] On or about July 14, 1993, the State Department issued an export license to Loral for the export of the Intelsat VIIA (708) satellite and associated equipment necessary for the launch.[54]

Sometime in 1994, representatives from Intelsat and Loral performed a site survey at the Xichang launch facility in the PRC. One of the Intelsat representatives who was involved in the launch described the facility as "primitive but workable."

On or about January 11, 1996, the Intelsat 708 satellite was shipped to Xichang.

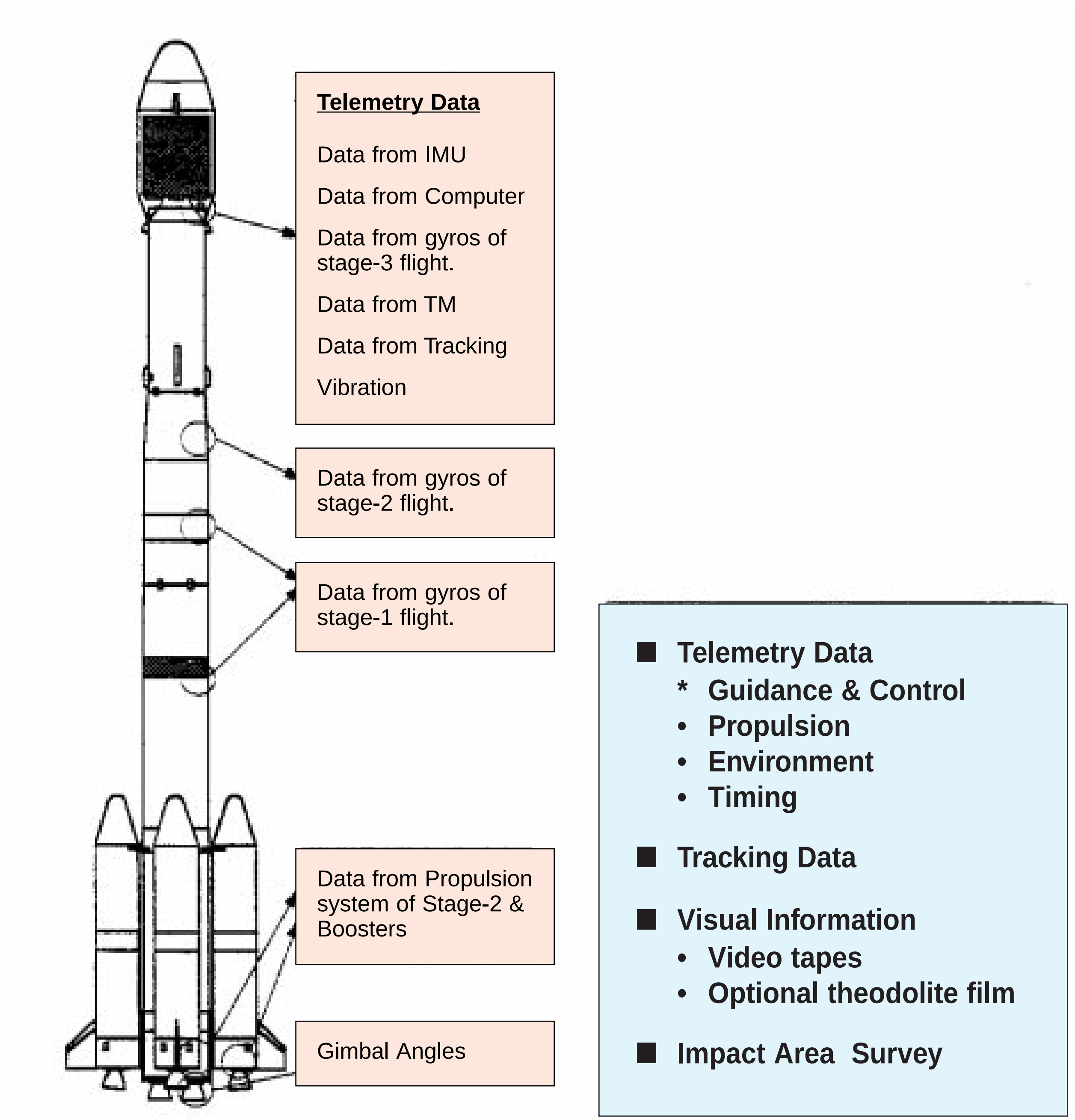
The Intelsat 708 Launch Failure

On February 15, 1996, at approximately 3:00 a.m. local time, a PRC-manufactured Long March 3B rocket carrying the Intelsat 708 satellite crashed into a mountain side approximately 22 seconds after liftoff from the Xichang launch site. [55] Employees and family members of Loral witnessed the launch failure from Palo Alto through a video feed from the launch site.[56]

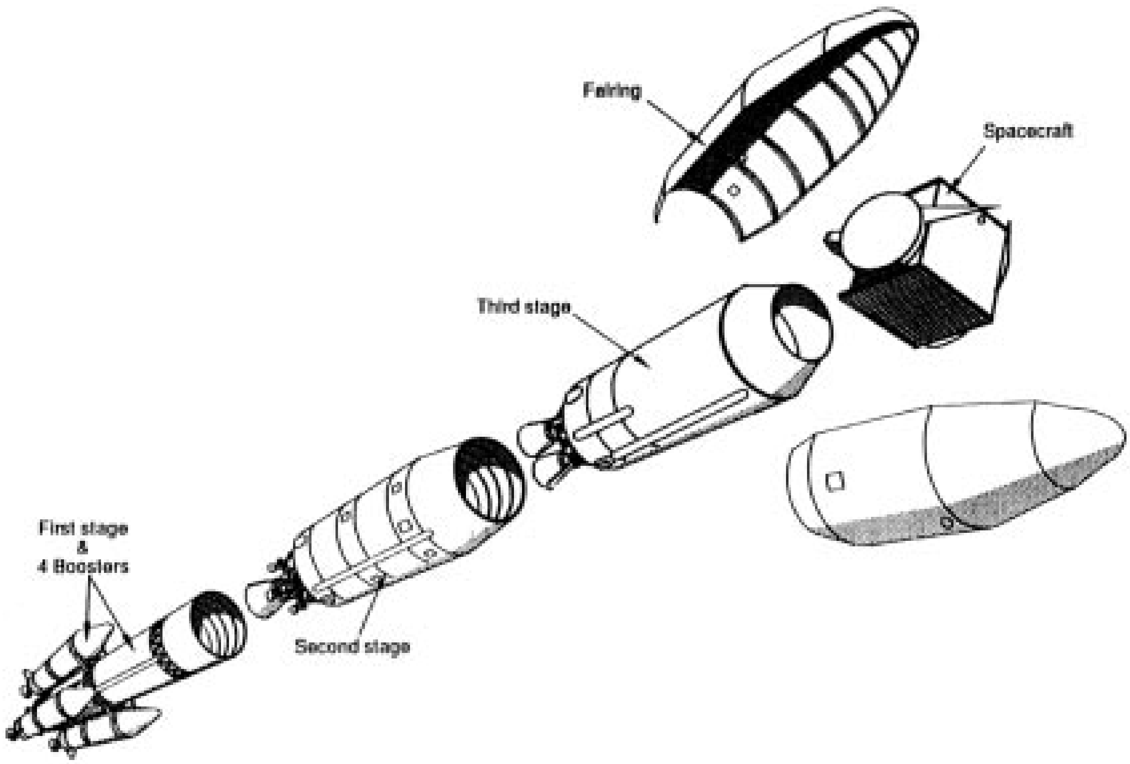
Members of the Intelsat and Loral team in the PRC were not allowed by PRC officials to visit the rocket debris field until late in the afternoon of that same day.

At least three different explanations have been offered as to why the Loral and Intelsat employees were not allowed onto the debris field for approximately 12 hours:

- **The first explanation** was that Loral and Intelsat employees were kept away from the debris field until safety hazards from the crash site could be neutralized
- **The second, as reported in the news media,** was that the delay had been imposed to give PRC officials time to seek out U.S. satellite encryption devices intended to protect the satellite command processor from unauthorized messages once the satellite was in orbit[57]
- **The third explanation, offered by at least one Loral employee,** was that the time delay gave the PRC an opportunity to clean up the probable human carnage that resulted from the crash



Western analysts relied in part on telemetry data from the failed Long March 3B rocket to disprove the PRC's assertion about the cause of the crash, and to point to the true cause of the failure.



The Long March 3B used for the failed Intelsat 708 launch consisted of three stages plus the payload satellite enclosed by a fairing. In a normal launch, the stages of the rocket would fall away one by one as the satellite flew higher and reached its orbit. In the Intelsat 708 launch, the entire rocket veered off course and crashed before the three stages and the payload separated.

Once they were allowed to go to the site, members of the Loral team began collecting and separating satellite debris from the rocket debris. A rough inventory was done, and the satellite debris subsequently was crated and shipped back to Loral in Palo Alto for analysis.[58]

Upon examination by Loral engineers in Palo Alto, it was determined that the satellite's encryption devices had not, in fact, been recovered from the crash site.

Events Leading Up to the Creation of the Independent Review Committee

On or about February 27, 1996, two weeks after the failure, PRC engineers announced that they believed that the cause of the Intelsat 708 launch failure was the inertial platform of the control system.[59] This information was made public in an attempt to demonstrate that the PRC had identified the cause of the launch failure.

The interested parties included the aerospace industry in general, but particularly Loral, Hughes Space and Communications Corporation (Hughes), and the space launch insurance industry.

Hughes was scheduled to launch its Apstar 1A satellite on a Long March 3 rocket on or about April 1, 1996, less than two months after the Intelsat 708 crash. Even though the Apstar 1A satellite was scheduled for a different rocket, concern was still high in the insurance community.

On March 14, 1996, a meeting was held in Beijing involving Hughes; the PRC-controlled Asia Pacific Telecommunications Satellite Co., Ltd., owner of the Hughes-manufactured Apstar 1A; and the insurance underwriters for the Apstar 1A.[60]

The main information the PRC authorities, including the Asia Pacific Telecommunications Satellite representatives, sought to convey to the insurance underwriters was that their failure investigation relating to the Intelsat 708 launch had shown the cause to be a failure of the inertial measurement unit.[61] This is the rocket subsystem that provides attitude, velocity, and position measurements for guidance and control of the rocket.[62]

The PRC representatives stated that the inertial measurement unit used on the Long March 3B that failed was different from the unit used on the Long March 3, which was the rocket that would be used to launch the Apstar 1A. They concluded, therefore, that there should be no cause for concern regarding the Apstar 1A launch.[63]

Nonetheless, representatives of the insurance underwriters stated that insurance on the Apstar 1A launch would be conditioned on delivery of a final report on the root causes of the Long March 3B failure and a review of that report by an independent oversight team.[64]

Paul O'Connor, Vice President of J&H Marsh & McLennan space insurance brokerage firm, later reported to Feith & Zell, a law firm representing Loral on possible export violations, that insurers had paid out almost $500 million in claims involving prior PRC launch failures, and wanted the PRC to provide full disclosure about the cause of the Intelsat 708 failure.[65]

From April 10 through 12, 1996, China Great Wall Industry Corporation held a meeting in Beijing concerning the Long March 3B failure investigation.[66] Loral sent three engineers to the meeting: Dr. Wah Lim, Vice President and General Manager of Manufacturing; Nick Yen, Integration Manager, Intelsat 708 Program; and Nabeeh Totah, Manager of Structural Systems.[67] Intelsat sent as its representative, Terry Edwards, Manager of Intelsat's Launch Vehicle Program Office. China Great Wall Industry Corporation provided Intelsat and Loral with three volumes of data and eight detailed reports on the current status of the failure investigation. The PRC's Long March 3B Failure Analysis Team presented the failure investigation progress, and the preliminary results up to that date, to Intelsat and Loral.[68]

On or about April 10, 1996, Bansang Lee, Loral's representative in the PRC, on behalf of China Great Wall Industry Corporation, asked Lim to be the Chairman of an independent oversight committee.

On or about April 10, 1996, Lim telephoned Robert Berry, Loral's President, from the PRC. Lim reportedly told Berry that representatives of China Great Wall Industry Corporation had asked him to chair an independent oversight committee reviewing the PRC analysis of the Intelsat 708 launch failure.[69]

Berry says he gave permission for Lim to act as the chairman of the independent oversight committee because of serious safety issues associated with the PRC launch site that had been brought to his attention after the Intelsat 708 failure.[70]

Before leaving Beijing, Lim created a charter for the committee, and he changed its name to the "Independent Review Committee." [71] Eventually, the Independent Review Committee was constituted with the following members and staff:

Membership of the Independent Review Committee[72]

NAME	EMPLOYER	POSITION ON IRC
Wah Lim	Senior VP & GM of Engineering & Manufacturing, Loral	Chairman
John A. Holt	Retired Managing Director, Space Systems Group, British Aerospace	Member
Karl Kachigan	Retired Chief Engineer & Director of ATLAS Launch Vehicle, General Dynamics	Member
Frederick Ormsby	Retired Department Manager, Spacecraft Engineering & Launch Vehicle Program Office, Intelsat	Member
John Smay	Chief Technologist, Hughes	Member
Robert Steinhauer	Chief Scientist, Hughes	Member
Reinhard Hildebrandt	Team Leader, Flight Operations & Post Flight Evaluation, DASA Daimler-Benz Aerospace	Member
Nick Yen	Department Manager, Launch Vehicle & Launch Operations, Loral	Secretary
Nabeeh Totah	Director, Spacecraft Engineering Laboratory, Loral	Technical Staff
Jack Rodden	Principal Engineer, Loral	Technical Staff
Fred Chan	Director, Controls Engineering, Loral	Technical Staff

The Government Security Committee Meeting at Loral

On April 11, 1996, a quarterly Government Security Committee meeting was held at Loral.[73]

The Government Security Committee was established by Loral in cooperation with the Department of Defense in 1991, when 49% of Loral's stock was owned by foreign investors.[74] The express purpose of the Government Security Committee was to monitor Loral's practices and procedures for protecting classified information and technology controlled under the International Traffic in Arms Regulations.[75]

The meeting attendees recounted to the Select Committee that Loral President Berry arrived at the April 11 Government Security Committee meeting after most of the others had gathered for it.[76] Berry announced at that time that he had just finished with a telephone call from Lim (in the PRC) and had given Lim the authority to chair the Independent Review Committee.[77]

According to Berry, he told the meeting that Lim had advised him that the PRC was interested in Lim chairing the Independent Review Committee. Berry testified that he approved Lim's request to participate during that telephone conversation. Berry testified that he was aware that a report would be prepared and distributed to the PRC and insurance companies. However, he had an understanding with Lim that the report would not contain any technical data or technical assistance.[78] A discussion among the meeting attendees ensued.

The minutes reflect that Dr. Stephen Bryen, an outside member of the Government Security Committee, recommended that "any report prepared as a result of [Loral's] participation in the failure review be submitted to the State Department prior to dissemination to the Chinese." [79]

Bryen testified that he was disturbed by the idea of a failure investigation involving the PRC, and that this would involve technology transfer which required State Department approval. Bryen testified that there was a lot of discussion on the matter, but all agreed that nothing would happen without State Department approval.[80]

Duncan Reynard, Loral's Export Control Manager, recalls that Bryen said:

> *You know, if there's anything written generated by this group of people, you should run it by ODTC [Office of Defense Trade Controls, Department of State] before you release it.*[81]

Reynard says Loral Technology Transfer Control Manager William Schweickert, Loral General Counsel and Vice President Julie Bannerman, and he attended the Government Security Committee meeting. All three agreed with Bryen's statement. Reynard says that he felt some responsibility in connection with Bryen's comment; however, there was no indication from anyone that a report was going to be prepared. Reynard says that if he had known that a report was going to be prepared, with the intention of disseminating it to foreigners, Loral would have sought the appropriate U.S. Government approval.[82]

Reynard says that neither he, as Export Control Manager, nor Bannerman, the General Counsel, nor Schweickert, the Technology Control Manager, took any proactive measures to follow up on this matter.

Reynard says that "we didn't know what was happening — we didn't — we were waiting for somebody to tell us." [83] According to interview notes of Reynard prepared by an attorney from Loral's outside counsel, Feith & Zell, Reynard said that no one asked him to look into the matter raised by Dr. Bryen.[84]

Loral's General Counsel, Julie Bannerman, testified that no one conducted any research to determine whether the intended activities of the Independent Review Committee were legal, or within Loral's company policy. Bannerman also testified that the primary responsibility for matters relating to Bryen's statements would have rested with Loral's export control office, namely Reynard and Schweickert.[85]

Even though there was a formal mechanism for assigning action items in Government Security Committee meetings, no action item was generated at the April 11 meeting in connection with the Independent Review Committee. No one was assigned to inform Lim of the Government Security Committee's decision that Loral's participation in the Independent Review Committee needed to be approved by the Department of State.[86]

One of the participants at the Government Security Committee meeting was Steve Zurian of Trident Data Systems. Zurian says that Trident has been a security advisor to Loral for nine years and provides export consulting to the company. Trident's responsibilities include attending the Government Security Committee meetings, taking notes, and drafting the minutes. Zurian says that he and Caroline Rodine, another Trident employee, attended the April 11, 1996, and the July 11, 1996, Government Security Committee meetings.

Zurian says that it was the consensus of the attendees at the April 11, 1996, Government Security Committee meeting that Loral should seek and obtain approval from the Department of State before participating in the Independent Review Committee, and that Loral President Berry agreed with the decision.

Zurian says that at the July 11, 1996, Government Security Committee meeting, Berry said that Loral had followed up on Bryen's recommendation to obtain State Department approval to participate in the Independent Review Committee. (As Loral admitted in its June 27, 1996 disclosure to the Department of State, however, this was not the case.)[87]

Zurian's draft of the July 11, 1996, meeting minutes reflects Berry's remarks about obtaining State Department approval. Zurian says that he and Rodine reviewed their notes of the meeting, specifically regarding Berry's remarks, and both agree that the draft minutes are accurate.

Zurian says that it is possible that Loral's management failed to tell Berry that they had not obtained the appropriate State Department approval. He attributes Berry's erroneous understanding to his staff's failure to advise him of the facts.

But numerous Loral personnel, including Berry, Bannerman, and Reynard, were aware of Loral's deliberations with the Department of State regarding the limits on Loral's participation in PRC failure analyses.[88]

On April 3, 1996, for example, Loral proposed to the State Department certain language that restricted Loral's participation in possible failure analyses in connection with two upcoming Long March launches from the PRC, for the Mabuhay and Apstar satellites. Loral's proposal was that it would not comment or ask questions in the course of those failure analyses.[89]

It also should be noted that on or about January 24, 1996, a few weeks prior to the Intelsat 708 failure, Loral received and reviewed the Apstar technical data export license, which stated:

> *Delete any discussion or release under this license of any technical data concerning launch vehicle [rocket] failure analysis or investigation.*[90]

On or about February 22, 1996, a week after the Intelsat 708 failure, Loral received and reviewed the Mabuhay technical data export license that also stated:

> *Delete any discussion or release under this license of any technical data concerning launch vehicle [rocket] failure analysis or investigation.*[91]

The Apstar 1A Insurance Meeting

On April 15 and 16, 1996, a meeting of representatives of companies providing reinsurance for the upcoming Apstar 1A satellite launch took place in Beijing. The Apstar 1A launch, and the issues arising from the Long March 3B rocket failure, were discussed. The launch failure presentations by PRC representatives made substantially the same points as had been made at the March 14, 1996, meeting: that the Long March 3B failure was due to the inertial measurement unit, and that this was not a concern for the Apstar 1A launch because it would be launched by a Long March 3 rocket utilizing a different inertial measurement unit with a previous record of successful launches.[92]

At the same meeting, in response to the requirement that had been stated by the insurance underwriters at the March 14 Beijing meeting, the PRC representatives announced the creation of an independent oversight committee (shortly thereafter named the Independent Review Committee) to review the findings and recommendations of the PRC's failure investigation.[93]

Wah Lim and Nick Yen of Loral, the designated Chairman and Secretary of the Independent Review Committee, were present at the meeting and discussed the role of the committee and its members. The two prospective members from Hughes — John Smay, the company's Chief Technologist, and Robert Steinhauer, its Chief Scientist — were also present, as was Nabeeh Totah of Loral, who would serve as one of four Loral technical staff members to the Independent Review Committee.[94]

During the April 15 and 16 insurers' meeting, the participants were taken on a tour of the Long March rocket assembly area. They were also shown, in a partially opened state, units described by the PRC as the older Long March 3 inertial measurement unit and the newer Long March 3B inertial measurement unit. Thus, almost half of the Independent Review Committee participants had exposure at this time to the findings and views of the PRC derived from their failure investigation, prior to the first official Independent Review Committee meeting.[95]

On April 17, 1996, Wah Lim sent a letter to all Independent Review Committee members and to China Great Wall Industry Corporation, confirming that the first meeting of the committee would be in Palo Alto, California from April 22 to 24, 1996.

The April 1996 Independent Review Committee Meetings in Palo Alto

Meeting on April 22, 1996

On April 22, 1996, the first Independent Review Committee meeting convened at Loral in Palo Alto. The foreign committee members, John Holt and Reinhard Hildebrandt, were not present. No PRC officials were present, due to a delay caused by visa problems.

Wah Lim called the meeting to order, and the meeting began without a technology transfer briefing.

The matter of a technology transfer briefing was subsequently raised, which prompted Lim to leave the meeting. Approximately ten minutes later, William Schweickert, Loral's Technology Control Manager, arrived and provided a technology export briefing to the Independent Review Committee members who were present. According to one of the participants, it appeared that Schweickert gave a presentation concerning the rules that should be followed at a PRC launch site, rather than a briefing covering technical data exchanges.

Schweickert provided the Independent Review Committee members with a three-page technology export briefing.[96] Schweickert says that he had never prepared a briefing for a failure review before. Thus, he says he used the export licenses for the launch of the Intelsat 708 as a basis for the briefing. (Schweickert says that he learned about the imminent arrival of the PRC visitors only a few days earlier.) However, according to notes of an interview of Schweickert prepared by an attorney from Feith & Zell, Loral's outside attorneys, Schweickert looked at the licenses relating to the Mabuhay and Apstar IIR satellite programs for assistance in preparing the Independent Review Committee briefing. Those licenses were more current than the Intelsat 708 license issued in 1992.

Schweickert stated that these two licenses required the presence of Defense Department monitors during any discussions with the PRC. He said he knew Defense Department monitors would not be present at the Independent Review Committee meeting. As a result, he said, he would have to be "careful" in preparing his export briefing. Schweickert also said that there was not enough time to get a license.

Schweickert told the Independent Review Committee members that Loral did not have a license for the meeting. According to Schweickert, he discussed what he thought the Independent Review Committee could do without a license — such as receive technical information from China Great Wall Industry Corporation, request clarification of certain items, ask questions, and indicate acceptance or rejection of the PRC's conclusions.

Schweickert did not attend any of the Independent Review Committee meetings, other than to give the briefing on the first day.

Duncan Reynard, Loral's Export Control Manager, did not learn of the Independent Review Committee meeting on April 22, 1996 until Schweickert told him that same day. Reynard says that Schweickert told him he had prepared a briefing for the meeting, and he asked Reynard to review it. According to interview notes of Reynard prepared by an attorney from Feith & Zell, Reynard did not see Schweickert's briefing until late in the day on April 22, 1996.[97] Reynard says he reviewed Schweickert's briefing and said it was "okay." [98]

Reynard says he was not surprised to find out that PRC representatives would be visiting Loral. Reynard says he "assumed the briefing and the people that would normally attend something like that were knowledgeable enough to know how to handle that kind of a meeting." [99]

Reynard also says that his understanding of the meeting was that the PRC representatives were going to make a presentation concerning their failure investigation of the Intelsat 708 satellite.[100]

It should be noted that, during this first Independent Review Committee meeting at Loral's offices, Loral's President, Executive Vice President, and Export Control Manager were all absent. They had traveled to Europe in connection with an unrelated business trip, and for vacation.[101]

The Independent Review Committee members who were present spent the first day at Palo Alto reviewing the PRC failure analysis. The documents consisted of approximately 14 reports dealing with technical material, analysis, and failure modes.[102]

Meeting on April 23, 1996

On April 23, 1996, the two foreign members of the Independent Review Committee and the PRC engineers arrived at Loral. The PRC representatives included:

- **Huang Zouyi,** China Great Wall Industry Corporation
- **Professor Chang Yang,** Beijing Control Device Institute
- **Li Dong,** China Academy of Launch Vehicle Technology
- **Shao Chunwu,** China Academy of Launch Vehicle Technology[103]

The majority of this second day was spent trying to understand the PRC failure investigation. Many Independent Review Committee members say there was difficulty in understanding the PRC representatives' presentation because of language problems. As a result, many clarifying questions were asked of the PRC representatives. However, Feith & Zell interview notes of one Independent Review Committee member specifically stated that a "good translator" was present at that meeting.

The PRC officials stated that they believed the failure mode was located in the inertial guidance system of the Long March 3B rocket.[104] Specifically, they believed the failure was caused by a break in a wire to a torque motor controlling the inner gimbal in the inertial measurement unit. While the Independent Review Committee members told the PRC representatives that they did not necessarily disagree with this analysis, the minutes of the Palo Alto meeting reflect that the committee recommended additional investigation by the PRC to verify its failure analysis.[105]

During the meeting, the PRC representatives presented information about the Long March 3B rocket design. The Independent Review Committee members asked questions to better understand the technology used by the PRC, as it was not as advanced as Western designs. Hughes Chief Scientist Robert Steinhauer described the afternoon session as a "tutorial." [106]

Meeting on April 24, 1996

On April 24, 1996, the PRC representatives attempted to answer some of the questions presented by the Independent Review Committee on the previous day. There was also continued discussion of the launch failure analysis, and plans were made to continue the meeting in Beijing on April 30 and May 1, 1996.[107]

The Hughes committee members, Steinhauer and Smay, did not attend the meeting on April 24.[108]

The following is the agenda for the April 24 Palo Alto Independent Review Committee meeting:

9:00 AM	REVIEW OF PROGRESS TO DATE	IRC
9:30 AM	REVIEW OF LM-3/LM-3B DIFFERENCES	CGWIC
10:30 AM	BREAK	
10:45 AM	CONTINUE REVIEW OF LM-3/LM-3B	CGWIC
12:00 PM	LUNCH	
1:00 PM	ACTION ITEMS FOR LM-3/APSTAR 1A	IRC
3:00 PM	BREAK	
3:15 PM	WRAP UP AND PREPARATION FOR BEIJING MEETING	IRC
4:00 PM	OPEN DISCUSSION	ALL
5:00 PM	END	

United States Trade Representative Meeting on April 23, 1996

On April 23, 1996, Nick Yen, Loral's Intelsat 708 Launch Operations Manager and Secretary of the Independent Review Committee, and Rex Hollis, an employee in Loral's Washington, D.C. office, met with various U.S. Government officials at the offices of the U.S. Trade Representative in Washington, D.C.

In a memorandum prepared by Yen dated May 15, 1996, memorializing this April 23, 1996 meeting, Yen described the purpose of the meeting as an informal briefing on the activities leading up to and including the launch failure.[109]

According to Yen's memorandum, the U.S. Government representatives at the meeting were interested in the accuracy of claims by the PRC authorities about the extent of the damage caused to a nearby village by the rocket's explosion. They were also interested in the course of action that was being taken to correct safety problems and deficiencies at the launch site.

According to the memorandum, which was prepared after the State Department inquiries about possible export violations by Loral and three weeks after the meeting, Yen mentioned that an independent review committee headed by Wah Lim had been created.[110]

The memorandum reflected that Yen told the meeting attendees that, since launch site safety related to how the rocket behaves, the Independent Review Committee would review the findings, conclusions, and corrective actions performed by the PRC Failure Investigation Committee, and set the necessary safety implementation requirements for China Great Wall Industry Corporation to consider for its future customers, not just Loral.[111]

Yen did not tell the attendees that Loral did not have a license to participate in the investigation.

The memorandum stated that one of the U.S. Trade Representative officials, Don Eiss, requested a copy of the Independent Review Committee formal report when it became available. According to the memorandum, Yen told Eiss that he would have to consult with Lim prior to the dissemination of the report. There is no indication that the report was ever disseminated to any of these U.S. Government representatives. The memorandum reflected no substantive discussion concerning the Independent Review Committee report.[112]

The meeting was not about export licensing for failure analyses, and no U.S. official at this meeting has been identified as an export licensing officer. Loral, in its Voluntary Disclosure, admitted that:

> *[T]his meeting cannot be taken as U.S. government consent to Loral's activities on the IRC (particularly as the State Department personnel were not from the Office of Defense Trade Controls).*[113]

The April and May 1996 Independent Review Committee Meetings in Beijing

Meeting on April 30, 1996

On April 30, 1996, the second series of Independent Review Committee meetings convened, this time in Beijing. Hughes committee member Robert Steinhauer did not attend this meeting. The committee members stayed at the China World Hotel, and were transported by van from their hotel to the meeting location.

The meeting was held in a large room in a building on the China Great Wall Industry Corporation campus. In attendance were representatives from various PRC aerospace organizations.

According to Independent Review Committee members, various PRC representatives made presentations concerning different aspects of their launch failure investigation.

Many of the committee members say that it was difficult to understand parts of the presentation. In some instances, the presentations were made in Chinese and interpreted for the committee members. Some of the committee members say that, in their opinion, the interpreters did not have technical backgrounds. According to some of the committee members who testified, this lack of technical training contributed to the difficulty in understanding the PRC presentations.

Members' Caucus at the China World Hotel

On the evening of the first day, the Independent Review Committee members and technical staff held a caucus in a meeting room at the China World Hotel. The purpose of the meeting was to discuss the presentations that had been made by the PRC, to consider the possible causes of the launch failure, and to decide on what to present to the PRC participants the following day.

The caucus meeting ran from about 7:00 p.m. to at least 10:00 p.m. No PRC personnel were present. However, according to testimony presented to the Select Committee, the discussion was almost certainly secretly recorded by the PRC.

Topics of discussion included, among others:

- **Proposed failure modes**
- **Redundancy**
- **High fidelity testing**
- **Gimbals**
- **Gyroscopes**
- **Torque motors**
- **Telemetry data**
- **The oscillatory behavior of the flight**

During the caucus, the Independent Review Committee members expressed views that were incorporated in attachment IV of their Preliminary Report. One committee member described the meeting as a "brainstorming" session.

The same member stated, "I'm sure we felt that we had to get together and try to summarize and understand and agree among ourselves what we thought we had heard and seen that day, and that was the whole idea . . . It gave us a chance to talk among ourselves and review what we had heard and perhaps raise questions."

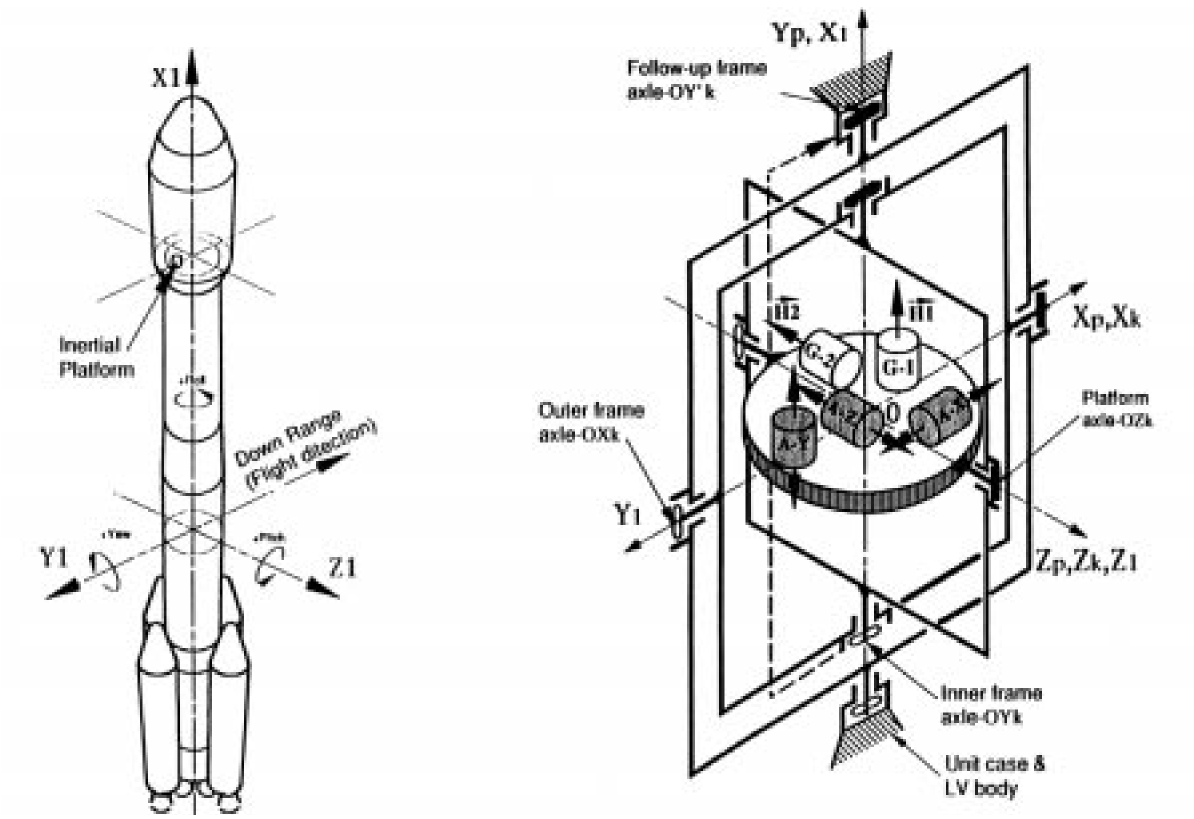
Striking is one Independent Review Committee member's admission that there were probably things said in these supposedly closed meetings of the committee that they would not have said in front of the PRC officials.

According to a document reflecting discussions in the caucus meeting, the Independent Review Committee members were focusing on the following failure modes:

- **Broken wires in general, as postulated by the China Academy of Launch Technology**
- **Frozen follow-up gimbals, a failure mode not considered by the PRC**
- **Open loop in the feed back path**[114]

As early as February 29, 1996, China Great Wall Industry Corporation had identified that there was a problem with the inertial platform.[115] In a March 28, 1996, Information Release from China Great Wall Industry Corporation, the PRC announced that they were one experiment away from completing the simulation experiments on the Long March 3B failure scenarios.[116] The Information Release stated that they had analyzed the telemetry data and the failure mechanism. Through this analysis, they had isolated four inertial platform failure modes:

- **A broken wire to the torque motor for the inner frame**
- **A blocking of the inner frame axis**
- **An open loop of the follow-up frame**
- **Environmental stress**



An artist's rendition of the inertial measurement unit (IMU) used on the ill-fated Long March 3B rocket that carried the Intelsat 708 satellite. The IMU is a key component of the rocket's guidance system. Loral and Hughes engineers ultimately traced the cause of the crash to a failure in the IMU.

From its analysis of the telemetry data, China Great Wall Industry Corporation determined that during the 22-second flight of the Long March 3B, there were three distinct cycles, each of which lasted a little over seven seconds. Witnesses at the launch confirmed that the rocket veered three times before impact. China Great Wall Industry Corporation theorized that the rocket veered as the result of a faulty wire (or flawed solder joint) in the inertial platform, which intermittently disconnected and reconnected at the end of each of the three cycles.[117]

By the time of the Beijing insurance meeting on April 15, 1996, China Great Wall Industry Corporation had eliminated two of the four failure modes identified in March. Specifically, they isolated the problem to the inner frame and posed the following possibilities:

- **Electrical circuitry problems:** open loop through the inner frame; broken wire; poor contact; or false welding
- **Mechanical problems:** the axis of inner frame clamping; foreign object blocking[118]

Viewgraphs supplementing their report stated that the inertial platform veered three times during the 22-second flight, and that the first periodic motion occurred in the torque motor on the inner frame axle of the platform.[119] China Great Wall Industry Corporation presented similar information to the Independent Review Committee participants at the first meeting of the committee in Palo Alto from April 22 to 24, 1996.

At the second Independent Review Committee meeting in Beijing, China Great Wall Industry Corporation continued to emphasize the inner frame as the problem. In fact, they provided the Independent Review Committee participants a failure tree that specifically eliminated all but the inner frame as a potential failure mode.[120]

In the words of one Independent Review Committee participant, "I think if they had not had the IRC, they would have sold that one down the line."

The Independent Review Committee was not convinced. First, several committee participants thought the disconnecting and reconnecting wire theory either was not plausible or was "highly unlikely." In addition, China Great Wall

Industry Corporation was only able to replicate the first seven to eight seconds of the flight, rather than the full 22-second flight. Finally, China Great Wall Industry Corporation had not resolved a fundamental question as to why the telemetry data in the follower frame was flat, rather than oscillating.[121]

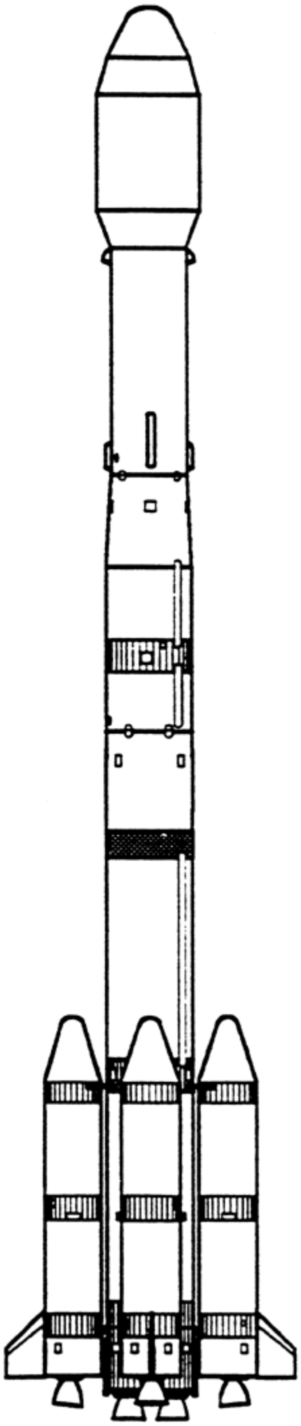
In a continuing effort to persuade China Great Wall Industry Corporation to explain the behavior of the full 22 seconds of flight, the Independent Review Committee provided comments to the PRC after the first day of the Beijing meeting. The Independent Review Committee stated that "China Academy of Launch Technology should consider to perform a simulation test using an open feed back path as the initial condition. It is also very critical for CALT [China Academy of Launch Technology] to explain why the follow-up gimbal resolve[r] (angle sensor) stayed flat throughout the flight." [122]

While the Independent Review Committee generally acknowledged China Great Wall Industry Corporation's proposed failure modes, they did so only after modification. For example, the PRC proposed a "broken wire to the torque motor for the inner frame," while the Independent Review Committee proposed a "broken wire in general as postulated by CALT." While the PRC proposed a "blocking of the inner frame axis," the Independent Review Committee proposed "frozen follow-up gimbals." [123]

Meeting on May 1, 1996

May 1, 1996, was the second day of the Independent Review Committee Beijing meetings. The following is the agenda for the second day's of that meeting:

8:20	IRC MEMBERS LEAVE HOTEL	CGWIC
9:00	IRC'S REVIEW TO THE ANSWERS	IRC
11:00	DETAILED DISCUSSIONS OF LM-3 AND LM-3B FAILURE ISOLATION ANALYSIS AND IMU FOR LM-3 & LM-3B MANUFACTURING AND TEST PROCEDURE ETC.	ALL
12:00	LUNCH BREAK (BUFFET)	
13:00	TOUR OF THE ASSEMBLY WORKSHOP OF L/V, THE IMU TEST FACILITY	ALL
16:00	WRAP UP SESSION	IRC/CGWIC
17:00	SUMMARY OF FINDINGS TO DATE AND CONCLUSION IF AVAILABLE	IRC
19:00	DINNER	HOSTED BY CASC



LM-3B

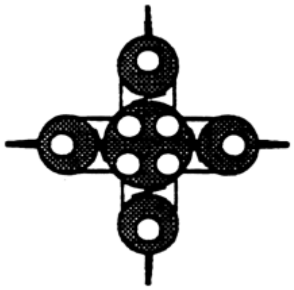
LM-3B: Long March 3B launch vehicle
3-stage launcher for GTO missions.

Lift-off mass:	425,500 kg.	
Lift-off thrust:	5,923 kN.	
Overall length:	54.84 m.	
Diameters:	Stage-1 & Stage-2:	3.35 m.
	Stage-3:	3.00 m.
	Boosters:	2.25 m.
Max. span:	11.45 m.	

Fairing diameter:	4.00 m.
Static envelope:	3.65 m.
Fairing length:	9.56 m.
Adaptor:	1194 mm.

GTO payload capability: 5,000 kg.
Hp=200 km.
Ha=35,786 km.
i=28.5 deg.

Launch site: Sichang Satellite Launch Center (XSLC), Sichuan Province, China



This illustration provides information on the dimensions of the Long March 3B rocket and fairing. It was prepared by the PRC's China Great Wall Industry Corporation as a part of a presentation on the LM-3B launch failure.

During the morning session, a "splinter meeting" was held to specifically discuss the inertial platform. The meeting was attended by the five Independent Review Committee members, and a small group of PRC engineers.[124] During the meeting, the committee participants sought clarifications concerning the signal flow diagrams in order to determine the cause of the open circuit.

During the Independent Review Committee meetings in Beijing, several of the Independent Review Committee members toured the PRC manufacturing and assembly facilities for the Long March 3B inertial measurement unit. During those tours, the Independent Review Committee members commented to the PRC engineers about the quality control practices used by the PRC. These comments on quality control were reiterated in the Independent Review Committee Preliminary Report sent to China Great Wall Industry Corporation on May 10, 1996.[125]

The Independent Review Committee Preliminary Report

Writing the Report

Upon completion of the Beijing Independent Review Committee meeting on May 1, 1996, the process of writing the report began. Wah Lim delegated the task of writing the major portion of the report to John Holt, the British committee participant, because he seemed to have the best understanding of the issues related to the Long March 3B inertial measurement unit.[126]

On or about May 2, 1996, Holt faxed his draft summary to Nick Yen, the Secretary of the Independent Review Committee, at Loral. Yen then disseminated Holt's draft summary to the other Independent Review Committee members. The committee members subsequently provided their comments on Holt's draft to Yen and Lim.[127]

Loral Sends the Draft Report to the PRC

Yen assimilated all of the material into a draft Preliminary Report during the period May 2 to 6, 1996. He completed the draft Preliminary Report around May 6 or 7, 1996. Yen then showed the report to Loral's Wah Lim, the Chairman of the Independent Review Committee. Lim suggested changes, and told Yen to send it to the Independent Review Committee members, and to the China Great Wall Industry Corporation.

On May 7, 1996, Yen distributed the draft Preliminary Report to the Independent Review Committee members and technical staff for additional comments.[128]

On the same day, Yen also faxed a copy of the draft to China Great Wall Industry Corporation in the PRC.[129]

According to interview notes of Lim taken by a Feith & Zell attorney, Lim acknowledged that he instructed Yen to send the draft Independent Review Committee report to everyone, including the PRC, on May 7, 1996.[130]

It should be noted that Lim refused to be interviewed or deposed during this investigation.

The Contents of the Draft Report

The Independent Review Committee's Preliminary Report repeated the committee's concerns that China Great Wall Industry Corporation's conclusions were debatable. As a short-term recommendation, the Independent Review Committee stated:

> *An explanation of the total flight behavior is essential to fully confirm the failure mode.*[131] *A mathematical numerical solution is recommended immediately, to be followed by a hardware in the loop simulation test when possible . . .*[132]

In addition, the draft Preliminary Report documented the Independent Review Committee's view that an intermittently reconnecting wire — the PRC's theory — was not necessary for the rocket to behave in the manner in which it did.

Specifically, the Independent Review Committee postulated that a single disconnection–without reconnection–would be "a much simpler, and more plausible, explanation." [133]

The Independent Review Committee repeated its concern that "the open circuit could be at various other physical locations," suggesting that the problem might not be in the inner frame,[134] as was posited by the PRC.

The Independent Review Committee participants questioned China Great Wall Industry Corporation's assertions that the flat data from the follower frame were bad data.[135] They therefore requested that China Great Wall Industry Corporation confirm that the follower frame had functioned properly during flight.

Ten days after China Great Wall Industry Corporation received the Independent Review Committee's Preliminary Report, it abandoned testing of the inner frame, and started vigorously testing the follower frame.

One month later, China Great Wall Industry Corporation determined that the cause of the failure was an open feed back path in the follower frame. This finding was confirmed in a presentation by China Great Wall Industry Corporation to Loral, Hughes, and others in October 1996.

In addition to these observations, the Independent Review Committee document recommended that a "splinter" meeting be held the following day to examine more closely the failure modes related to the inertial guidance system of the Long March 3B.[136] John Holt, John Smay, Jack Rodden, Fred Chan, and Nick Yen were selected to participate in the meeting.[137]

Notification to Loral Officials That a Report Had Been Prepared

On or about May 6, 1996, Lim spoke during a Loral staff meeting about the work of the Independent Review Committee, and mentioned that a report was going to be submitted to the insurance companies on or about May 10, 1996.

Julie Bannerman, Loral's General Counsel, says that she was concerned about the possibility that the company might incur some liability to the insurance companies because Loral employees would be associated with representations that were made in the report. Bannerman advises that, for this reason, she wanted to add a disclaimer to the report.[138]

Thus, Bannerman believes that she asked Lim to provide her a copy of the report prior to its dissemination, although she has no specific recollection of making the request.[139]

Bannerman says she does not recall any mention at the Loral staff meeting that the report was being provided to the PRC.[140]

Loral Review and Analysis of the Independent Review Committee Report

Loral General Counsel Julie Bannerman says that she found a copy of the Independent Review Committee draft Preliminary Report on her desk on May 9, 1996. She does not know who put the document on her desk, but believes that it was probably Wah Lim.[141]

Bannerman says that she looked at the report and realized that it contained technical information she did not understand. As a result of the concern this caused her from an export control perspective, she says she began preparing a memorandum to send to Loral's outside legal counsel, Feith & Zell in Washington, D.C., for review.[142]

During the preparation of her memorandum, Bannerman says that she telephoned Loral Export Control Manager William Schweickert because she wanted to mention his April 22, 1996, export briefing in the memorandum. Schweickert provided her with the requested information, which she included in approximately one line in the memorandum, but she does not recall whether she advised Schweickert that a draft report had been prepared by the Independent Review Committee.[143]

Bannerman says that she faxed her memorandum and the draft Preliminary Report to Mark Feldman, an attorney at Feith & Zell. She did not call Feldman prior to transmitting the document.[144]

Bannerman says that she was concerned that the draft Preliminary Report might include technical data or defense services that required an export license (which Loral did not have), or that it represented activities that might require a license. However, she says she could not make that judgment. She did not consider it necessary at this point in time to call Lim because "the issue at hand was present in the document." Bannerman advises that she did not speak with Lim on May 9, 1996.[145]

Bannerman recalls believing that, since the draft Preliminary Report was in her possession, it would not be disseminated outside Loral. Bannerman says that, at this point — May 9, 1996 — she was not aware that the draft Preliminary Report had been disseminated to anyone.[146]

The Final Preliminary Report is Sent to the PRC

Loral's General Counsel, Julie Bannerman, says that on May 10, 1996, Loral Export Control Officer Duncan Reynard returned from vacation and came to her office. Bannerman showed him the Independent Review Committee report, since she wanted his advice on how to handle the document.[147]

Bannerman says that Reynard's immediate comments concerned the quality of the report, not necessarily its substance. Bannerman says that she and Reynard called Mark Feldman at Loral's outside counsel, Feith & Zell, to see if he had yet reviewed the report. According to Bannerman, Feldman said that he had reviewed it, was concerned about the structure and apparent purpose of the document, and thought that some issues required resolution.[148]

Bannerman says she believed the report would not be sent outside Loral until she and Reynard had more information.[149]

Bannerman says that she and Reynard advised Loral President Berry of the situation, and he concurred in their recommendation not to allow dissemination of the report.[150]

Bannerman says that her recollection is uncertain on this point, but she believes that Reynard was responsible for preventing any dissemination of the draft Preliminary Report, and was going to talk to Wah Lim about that. Bannerman also believes that she may have called Lim and told him not to disseminate the report. She says that her recollections of the remainder of that day are vague, but that she recalls going home with the understanding that the "mission had been accomplished." [151]

Reynard says his recollection is that Bannerman was going to speak to Lim, and he was going to speak with Yen. Reynard says that, after the meeting with Bannerman, he went to Yen's office at approximately 11:30 a.m. that same day, May 10, where he saw a number of reports on Yen's table. Reynard says that Yen confirmed that the documents were copies of the draft Preliminary Report. Reynard says that Yen told him that he was preparing the reports for dissemination to the Independent Review Committee members.[152]

Reynard says he told Yen that the reports could not go out until Loral had State Department approval, or a license, and that Yen said he understood this. Reynard said he did not ask Yen whether the reports had been sent out, because they were on Yen's desk. Reynard says he took some copies of the report, so that he could show them to U.S. Government officials.[153]

Yen finished the final Preliminary Report on May 10, 1996. He took it, and a cover letter addressed to China Great Wall Industry Corporation, to Lim for his review. Lim looked at the report quickly and signed the cover letter.

Yen faxed the report to China Great Wall Industry Corporation in the PRC shortly afterward that same day.

Later that day, Lim asked Yen if the report had been sent to the China Great Wall Industry Corporation. When Yen replied that it had, Lim indicated that Loral might have to apply for a license for the Independent Review Committee activity.

Another Copy of the Report Is Sent to Beijing

On May 13, 1996, Lim's office instructed Yen to send the report to Paul O'Connor at J&H Marsh & McLennan in Washington, D.C. After receiving the report in its Washington office, J&H Marsh & McLennan requested the report be faxed to O'Connor in Beijing. Apparently Lim specifically approved faxing the report to O'Connor in Beijing.

Lim's May 13, 1996, letter transmitting the final Independent Review Committee Preliminary Report to O'Connor says, in part:

> *This [Report] will not be delivered to CGWIC [China Great Wall Industry Corporation] and its launch service agencies until the export license or an equivalent authorization is obtained.*" [154]

This letter is inconsistent with Yen's having already transmitted the draft Report to China Great Wall Industry Corporation six days earlier, on May 7. It is also inconsistent with Lim's letter three days earlier, on May 10, transmitting the final Independent Review Committee Preliminary Report to China Great Wall Industry Corporation, which was faxed to the PRC on that date by Yen.

It should be noted that Wah Lim refused to be interviewed in this investigation, despite the issuance of a subpoena.[155] Moreover, the Department of Justice has requested that further details of this aspect of the Select Committee's investigation not be publicly disclosed because it would compromise the criminal prosecution of Loral, Hughes, and their employees. Since the details can be made public as part of such a prosecution, the Select Committee has agreed to this request.

Loral Management Actions After Delivery of the Report to the PRC

Loral General Counsel Bannerman recalls a meeting in Loral President Berry's office, possibly on May 14, 1996, concerning the Independent Review Committee matter.

Bannerman believes that Loral's Executive Vice President, Pat Dewitt, may have called the meeting to discuss a May 14, 1996, memorandum prepared by Loral Export Control Manager Reynard. The memorandum raised concerns about possible violations of the International Traffic in Arms Regulations on the part of Loral.[156]

Loral President Berry and Weh Lim, the Chairman of the Independent Review Committee, were also present at the meeting.

During the meeting, Bannerman says Dewitt was concerned about whether or not the Preliminary Report had been disseminated. She says he asked Lim to confirm that it had not.[157]

Bannerman says Lim made a telephone call at that point in the meeting, but she does not know to whom. Bannerman does not recall that Lim actually confirmed at this meeting that the Preliminary Report had not been sent. However, she says the meeting participants "received the message" that Lim had stopped the report from being disseminated.[158]

Bannerman believes a meeting was set up for the following day, May 15, 1996, in order to receive a telephone report from Reynard, who was in Washington meeting with U.S. Government representatives concerning the report.[159]

Reynard says he recalls the meeting on May 14, 1996, in Berry's office, during which he gave copies of a memorandum he prepared to Bannerman, Berry, and Dewitt.[160]

Reynard says the purpose of the memorandum was to get people's attention on the Independent Review Committee report and necessary action. He says the bold print in the memorandum indicated that he was strongly trying to get people's attention. The final page of the memorandum contained recommended courses of action.[161]

One of the memorandum topics concerned an article that appeared in *Space News*. The article reported that the Independent Review Committee's report had been released to the PRC on May 10, 1996. Reynard says that he considered the article to be inaccurate because, to the best of his knowledge, the report had not been released.[162]

Another topic of the memorandum concerned possible violations of the International Traffic in Arms Regulations, but Reynard does not think there was any "real" discussion of that specific concern at the meeting.[163]

Reynard says that at this point he did not know the report had been disseminated to the PRC. Reynard says the meeting did not last long, and that Berry told him at the meeting to go to Washington and to do whatever was necessary regarding the Independent Review Committee's report.[164]

On May 14, 1996, Yen received a call from Lim requesting that Yen be present at a meeting on May 15, 1996, in Berry's office. The purpose of the meeting was to have a telephone conference with Reynard, who was in Washington meeting with State Department and Defense Technology Security Administration officials regarding the Independent Review Committee activity.

Defense Department Official Discovers the Activities Of the Independent Review Committee

After reading an article in *Space News* that described Loral's involvement in a launch failure investigation, Defense Technology Security Administration official Robert Kovac called Loral's Washington Representative, Harold Bradshaw, on or about May 14, 1996. Kovac inquired about the license that Loral relied upon to conduct the investigation. When Bradshaw could not provide an answer to Kovac's question, a meeting was scheduled for May 15, 1996.[165]

Meeting with the Defense Technology Security Administration

On May 15, 1996, Loral's Reynard and Bradshaw met with Kovac and two other officials of the Defense Department's Defense Technology Security Administration. Later that day, Reynard and Bradshaw met with representatives of the State Department's Office of Defense Trade Controls.

At the meeting with the Defense Department officials, the Defense Technology Security Administration reviewed the Preliminary Report and expressed concerns about the technical data it contained.

The Defense Technology Security Administration participants were shocked that the Preliminary Report contained references to technical discussions with the PRC concerning inertial navigation systems. Kovac told the Loral representatives that, in his opinion, Loral had potentially violated the law and was in the process of violating it "big time" by providing the report to the PRC.

Kovac specifically asked Reynard whether the document had been provided to the PRC. Reynard replied that it had not. But it had, he said, been disseminated to the Independent Review Committee members.

Kovac specifically advised that Loral should submit a voluntary disclosure to the State Department.

Kovac had follow-up conversations with Bradshaw, but no other conversations with Reynard.

In Kovac's opinion, the State Department DSP-5 license, No. 544593, issued to Loral for the export of technical data in support of technical discussions for the launch of an Intelsat VIIA satellite, did not allow Loral to provide any technical assistance to the PRC.

Meeting with the State Department

On May 15, 1996, following their meeting with the Defense Technology Security Administration. Loral's Reynard and Bradshaw met with Dr. Kenneth Peoples, the State Department licensing officer for the Intelsat 708 satellite launch.

Bradshaw had asked for a meeting at the State Department's Office of Defense Trade Controls to discuss Loral's involvement in a failure analysis with the PRC.

Based on Loral's presentation about the launch failure investigation of the Intelsat 708 satellite, Peoples believed there was a serious possibility the International Traffic in Arms Regulations had been violated.

Peoples recommended that Loral provide a letter to William Lowell, Director of the State Department's Office of Defense Trade Controls, concerning the matter. Loral subsequently delivered a box of documents relating to this matter to the State Department.

Reynard's Telephone Call to Loral

On May 15, 1996, Loral officers Bannerman, Berry, Yen, and Dewitt — but not Lim — were present in a meeting room at the company to receive a telephone call from Loral's Export Control Officer, Duncan Reynard, who was in Washington. Bannerman recalls that Reynard called and briefed them on his meeting with U.S. Government officials.[166]

Bannerman's recollection is that the meeting was related to the Independent Review Committee. However, she does not recall whether the meeting was convened to initiate discussions about instituting a Loral investigation of the Independent Review Committee matter, or whether the purpose was to just to speak with Reynard.

Bannerman says that they (Loral) got the message that all Independent Review Committee activity should be ceased.[167]

Bannerman says she has no recollection of any discussion during this meeting about whether the Independent Review Committee report had been sent to the PRC. Bannerman's recollection is that it was decided that Loral would initiate an investigation into the matter upon Reynard's return from Washington.[168]

Bannerman says the message received from Reynard during this meeting was that Loral was not only to stop all Independent Review Committee activity, but also to retrieve all copies of the documents that had been disseminated. Bannerman says she cannot recall Reynard making any comments about whether the Independent Review Committee report had been disseminated to the PRC.[169]

Bannerman says that Yen was present for Reynard's telephone call, and that Yen did not say that he had disseminated the Independent Review Committee report to the PRC.[170]

Others present also recall that Reynard said that the Independent Review Committee was not a good idea, and that Loral should prepare a voluntary disclosure.

After the telephone conference with Reynard ended, Lim asked Yen to retrieve the Independent Review Committee reports that had been distributed to the foreign committee members. But Lim did not ask Yen to retrieve the copies that had been sent to the other Independent Review Committee members, or to China Great Wall Industry Corporation.

Bannerman says she has no specific recollection of meeting with Reynard upon his return from Washington. However, she believes she probably did, and that Reynard initiated a preliminary investigation into the matter.[171]

Loral Management Discovers the Independent Review Committee Report Has Been Sent to the PRC

Bannerman says that Reynard told her on May 20, 1996, that Yen had admitted earlier that day he had disseminated the report to the PRC.[172]

Reynard advises that he confronted Yen in a small office at Loral, and asked him directly whether he had disseminated the report. Yen admitted, says Reynard, that he had transmitted the report to the PRC on May 10, 1996.[173]

Reynard says he did not ask Yen why Yen had not told anyone at Loral previously that he had disseminated the document to the PRC.

After receiving the information that the report had been sent to the PRC, Bannerman believes she advised Pat Dewitt, Loral's Chief Financial Officer, about the situation. She says she does not remember whether they told Berry about the matter at this time.[174]

Bannerman recalls making a decision that she wanted outside counsel to conduct an investigation, and that she did not interview Lim or Yen about the matter because outside counsel was going to investigate. Bannerman says she believed that the matter required delicate handling.[175]

Loral's 'Voluntary' Disclosure

Investigation by Loral's Outside Counsel

From May 29 through 31, 1996, an attorney from Loral's outside counsel for export matters, Feith & Zell, visited Loral's facility in Palo Alto and interviewed almost all of the Loral personnel referred to by name in the disclosure. Two Feith & Zell attorneys returned to Palo Alto from June 4 through 6, 1996, to hold follow-up interviews and review additional documents. Feith & Zell eventually completed the investigation and prepared a disclosure that was submitted on June 17, 1996, to the State Department.[176]

Loral Submits Its 'Voluntary' Disclosure to the State Department

The disclosure by Loral chronicles the company's version of the involvement of Loral personnel in the Intelsat 708 launch failure investigation. It analyzes the Independent Review Committee meetings held in both Palo Alto and Beijing, as well as the preparation and dissemination of the Preliminary Report.[177]

This submission was in response to a May 29, 1996 letter from William Lowell of the State Department, advising Eric Zahler, General Counsel of Loral Space and Communication, Loral's parent corporation, that there was reason to believe that Loral may have participated in serious violations of the International Traffic in Arms Regulations by providing unauthorized defense services to the PRC in connection with the February 1996 launch failure investigation.[178]

Lowell recommended that Loral:

- **Take immediate steps to cease all related activity that may require approval**
- **Provide a full disclosure**
- **Enumerate all releases that were controlled under the International Traffic in Arms Regulations**[179]

The following outlines the substance of Loral's Voluntary Disclosure and its appendices and exhibits.

Outline of Loral 'Voluntary' Disclosure

Summary — Nature and Extent of Issues	Loral's disclosure claims that the Independent Review Committee's activity raises three questions: (1) Did Loral furnish China Great Wall Industry Corporation with "technical data"; (2) did Loral furnish China Great Wall Industry Corporation with a "defense service"; (3) did Loral furnish non-U.S. members of the Independent Review Committee with "technical data"
Identities and Addresses of Individuals and Organizations	List of all persons and organizations involved in the Independent Review Committee matter (Appendix B)
Export License Numbers	Licenses for the Intelsat VIIA satellite program. There is no Technical Assistance Agreement authorizing Independent Review Committee activity.
Munitions List Items	Loral's disclosure that a central issue is whether the Independent Review Committee activities constituted a "defense service" in connection with a rocket.
Facts and Circumstances	An outline is presented of Loral's involvement in the Independent Review Committee activities.
Summary of Key Mistakes	Loral acknowledges it was a serious mistake to not seek prior State Department approval. Loral notes that Government Security Committee instructions regarding the need to seek advance State Department approval were not followed. Loral acknowledges that the export control briefing at first Independent Review Committee meeting was deficient, and that the Preliminary Report was sent to China Great Wall Industry Corporation without any review by Loral export control staff.
Corrective Actions	The thrust of corrective measures propsed is: (a) improve export control training of all Loral staff who engage in or authorize communications with foreign persons (b) tighten procedures to ensure communication and follow-up between Loral export control staff and program staff (c) reinvigorate corporate policy on the priority of export control law compliance
Mitigating Factors	Loral claims as mitigating factors, if the State Department should find that Loral violated export regulations, that the Government Security Committee functioned well. Any wrongdoing, Loral claims, was unintentional; they had no intent to provide technical assistance to China Great Wall Industry Corporation; there was minimal harm to U.S. interests; Loral takes compliance seriously; and they are taking corrective measures.
Conclusions	Loral acknowledges that several deficiencies had been revealed in Loral's export control procedures. Loral claims its staff acted in good faith. Loral asserts the harm to U.S. interests appears to have been minimal.

Supporting Material with Loral 'Voluntary' Disclosure

Appendix A	Certification by Loral President, Robert Berry.
Appendix B	List of all persons and organizations involved in the Independent Review Committee matter.
Green Binder	Copies of all materials furnished by the Independent Review Committee members to China Great Wall Industry Corporation.
Blue Binder (3 volumes)	Copies of all materials furnished to the Independent Review Committee by China Great Wall Industry Corporation.
Yellow Binder	Miscellaneous materials.
Red Binder	Loral export procedures and training materials.

Loral's disclosure to the State Department was silent as to why Yen disseminated a draft copy of the Independent Review Committee Preliminary Report to China Great Wall Industry Corporation on May 7, 1996.

Also, no reason was provided as to why Yen disseminated the final version of the Independent Review Committee Preliminary Report to China Great Wall Industry Corporation on May 10, 1996.

In addition, Loral's disclosure failed to identify — among other issues — the following facts:

- **During the time in which the Independent Review Committee was formed** and conducted its activities, Loral did not adequately staff its export control function.[180]
- **In January 1995, Loral assigned responsibility** for drafting its "Export Control Operating Procedures" by January 25, 1996. As of July 1996, those procedures had not been drafted.[181]
- **Even though the issue of Loral's participation in the Independent Review Committee was discussed** at the April 11, 1996 Government Security Committee meeting, no one communicated the substance of that discussion to any of the participants in, or to the Chairman of, the Independent Review Committee.

- **No one, other than the participants in the Independent Review Committee,** ascertained the type and extent of the Independent Review Committee's failure review activities.[182]
- **No one conducted any research to determine whether the intended activities of the Independent Review Committee were legal** or consistent with Loral's company policy.[183]
- **Adequate notice was not given** regarding the impending visit of PRC engineers to Loral's facility in Palo Alto.[184]
- **Loral failed to adequately review the export control briefing** to be delivered to the Independent Review Committee, even though the drafter of that briefing had never prepared an export control briefing in connection with a failure review.[185]
- **No one ensured that the delivery of that briefing** to the participants of the Independent Review Committee was adequate.[186]
- **At the time of the first Independent Review Committee meeting in Palo Alto, Loral's President, Executive Vice President, and Export Control Manager** traveled to Europe in connection with an unrelated business trip and vacation.[187]
- **No one monitored the Independent Review Committee's failure review activities in the PRC.**[188]
- **Once it was determined that a report had been drafted, no one effectively communicated to the responsible Loral employees** that the report should not be transmitted to the PRC prior to review by Loral's General Counsel or the U.S. Government.[189]
- **Officers at Loral's parent, Loral Space and Communications, Ltd., were not involved in oversight** of

Loral's participation in the Independent Review Committee and acknowledge that they were distracted by other business matters, primarily the sale of Loral's defense assets to Lockheed-Martin.[190]

- **No one was reprimanded, subjected to the company's administrative action, or fired** in connection with the matter.[191]

The 'voluntary' disclosure failed to disclose the following indications that Loral employees were generally aware of the export restrictions related to failure reviews:

- **Nick Yen, the Independent Review Committee Secretary, was aware of the export control hazards** that attended failure reviews, as evidenced by the fact that he had reported his concerns regarding Hughes' participation in the 1995 Apstar failure review.[192]

- **The technical data license for the Intelsat 708 stated: "The contractor must not provide any technical assistance whatsoever** to its Chinese counterparts which might assist China to design, develop, or enhance the performance of any of its contemplated or existing space launch missiles or facilities." [193]

- **Numerous Loral personnel, including the Executive Vice President, General Counsel, Export Control Manager, and Yen, were aware of, or participated in, contemporaneous discussions with the State Department regarding the permissible bounds** of Loral participation in PRC failure analyses. These discussions were embodied in an April 3, 1996 Loral proposal to the State Department of license language that would restrict Loral's participation in possible failure analyses in connection with the upcoming Mabuhay and Apstar Long March launches. Loral's proposal was that it would not comment or ask questions in the course of any such failure analyses.[194]

- **On or about January 24, 1996, a few weeks prior to the Intelsat 708 failure, Loral received and reviewed the Apstar technical data export license** issued to Loral by the U.S. Government. The license barred Loral from passing any technical data to the PRC in connection with a failure investigation. The license stated: "[D]elete any discussion or release under this license of any technical data concerning launch vehicle [i.e., rocket] failure analysis or investigation." [195] This came to Loral senior management's attention shortly after the license was received.

- **On or about February 22, 1996, a week after the Intelsat 708 failure, Loral received and reviewed the Mabuhay technical data export license** issued to Loral by the U.S. Government. The license barred Loral from passing any technical data to the PRC in connection with a failure investigation. The license stated: "[D]elete any discussion or release under this license of any technical data concerning launch vehicle [i.e., rocket] failure analysis or investigation." [196] This came to Loral senior management's attention when the license was received.

The Loral disclosure acknowledged that it was a serious mistake not to have sought State Department approval for the Independent Review Committee activities. The disclosure did not admit to any violations of the International Traffic in Arms Regulations, although it recognized that the issue of assistance to China Great Wall Industry Corporation raised problems under these regulations. The disclosure advised that Loral's policy was to seek State Department approval before proceeding with activities such as the Independent Review Committee.[197]

The disclosure stated that Loral was taking a series of corrective actions to ensure that similar mistakes do not happen again. The thrust of those measures was to:[198]

- **Improve export control training** of all staff who engage in or authorize communications with foreign persons.

- **Tighten procedures to ensure communication and follow-up** between export control staff and program staff.
- **Reinvigorate the corporate policy that compliance with export control laws** and regulations takes priority over business concerns.

The PRC Gives Its Final Failure Investigation Report

On October 21 and 22, 1996, China Great Wall Industry Corporation made its final launch failure presentation to officials at Loral.[199] The meeting was sponsored by Loral's Mabuhay Program, which subsequently launched the Mabuhay satellite on the Long March 3B rocket on August 19, 1997.

On September 10, 1996, China Great Wall Industry Corporation had announced its final failure determination: that the cause of the February 11, 1996 Long March 3B crash was the absence of current output from the servo-loop of the follow-up frame of the inertial guidance platform.[200]

It should be noted that the follow-up frame failure mode had been rejected by China Great Wall Industry Corporation during the Beijing Independent Review Committee meetings.[201] Yet, even though this mode had been rejected by China Great Wall Industry Corporation during the Beijing meetings, the Independent Review Committee included it in its final Preliminary Report as a possible failure mode.[202]

During the October 21 and 22, 1996 Long March 3B failure review presentation at Loral, China Great Wall Industry Corporation produced documents that showed it had started testing for the follow-up frame failure mode on or about May 20, 1996 — slightly more than two weeks after the conclusion of the Beijing Independent Review Committee meetings, and ten days after receiving the Independent Review Committee's Preliminary Report.[203]

China Great Wall Industry Corporation finished testing the follow-up frame failure mode on or about June 20, 1996.

Assessments by U.S. Government Agencies And Referral to the Department of Justice

Loral and Hughes each submitted information to the State Department in their disclosures regarding the Independent Review Committee. The State Department reviewed this material, and generated an assessment of the information contained in the documents that were submitted.

The State Department also asked the Department of Defense and CIA to review the materials and generate their own assessments.

The Defense Department conducted two analyses: one in August 1996, and another — by the Defense Technology Security Administration — in May 1997.

The Central Intelligence Agency provided views to the State Department in June 1996, but limited its analysis to proliferation concerns. In addition, in 1998 an interagency review team was asked to address a subset of questions that remained after the earlier assessments.

Defense Department 1996 Assessment

In August 1996, the Department of Defense prepared a classified assessment of the Independent Review Committee materials. That assessment reported that the Defense Department would have recommended against issuing a license for the sharing of technical information with the PRC by Loral and Hughes. It concluded that there existed the potential for moderate harm to national security interests.

The assessment cited 18 violations that it believed had occurred during the Independent Review Committee's exchanges of information with the PRC. These examples were taken from the minutes of the second Independent Review Committee meeting, and from the draft and final versions of the Preliminary Report.

In conclusion, the Department of Defense assessment stated:

> *It is likely that the all-Chinese Failure Analysis Team [PRC] pursued recommendations made by Independent Review Committee in its draft report . . . and that the pursuit of these recommendations directly resulted in the Chinese team finding the correct cause of failure in the Long March 3B guidance system . . .*

Evidence suggests that the Independent Review Committee very likely led the Chinese to discover the true failure of the Long March 3B guidance platform.[204]

Central Intelligence Agency Assessment

On June 17, 1996, the Central Intelligence Agency reported to the State Department that the Independent Review Committee report did not disclose any significant missile-related technology or know-how to the PRC's ballistic missile program. The Central Intelligence Agency judged that the Independent Review Committee's actions posed no proliferation concerns. The Central Intelligence Agency assessment was based on a review of the Independent Review Committee's preliminary report that State had received from Loral and focused only on proliferation concerns related to the PRC's ballistic missiles.

Department of State Assessment

On March 25, 1997, the State Department, after considering the views of the other agencies, reported its assessment of the Independent Review Committee's materials. That report stated: "[State] believes information passed to China . . . could significantly improve the manufacturing, production, reliability, and maintainability" of the Long March 3B guidance system.

Defense Technology Security Administration 1997 Assessment

The Defense Department's Defense Technology Security Administration issued a classified assessment of the Independent Review Committee activities on May 16, 1997. That report stated:

Loral and Hughes committed a serious export control violation by virtue of having performed a defense service without a license in the course of conducting an investigation for China of the failure of the February 1996 launch of the Long March 3B.

This activity also violated the U.S.-China Space Launch Technology Safeguards Agreement.

The defense service consisted of a full range of investigatory, engineering and corrective analyses to assist the Chinese in identifying the root cause of the failure and corrective measures.

> *The significant benefits derived by China from these activities are likely to lead to improvements in the overall reliability of their launch vehicles [i.e., rockets] and ballistic missiles and in particular their guidance systems.*[205]

Based on its assessment, the Defense Technology Security Administration recommended that the matter be referred to the U. S. Department of Justice for possible criminal investigation.

Interagency Review Team Assessment

In 1998 an interagency review team was asked to respond to questions regarding the Long March 3B and its guidance system. At the conclusion of the Select Committee's investigation, the interagency review team's conclusions remained in draft form. However, members of the team briefed the Select Committee staff and provided documents requested by the Select Committee.

The technical issue of greatest concern to the interagency review team was that the Independent Review Committee exposed the PRC to Western diagnostic processes. In addition, the Independent Review Committee provided the PRC with alternative possible causes of the failure that the PRC had apparently not previously considered in their investigation.

The interagency review team also found that the Independent Review Committee outlined for the PRC the general approach to isolating the true failure mode. This may have been of significant help to the PRC, and may have led it to discover the true failure mode more quickly. This could have prevented a failure in one or more subsequent rocket flights involving the same guidance system. (The Long March 3A, 3B, and 3C rockets all use the same guidance system.)[206]

More important still, the team members believed, was the exposure to the diagnostic test process outlined by Loral and Hughes that could improve PRC pre-flight and post flight failure analysis for their ballistic missile programs. This, in turn, could increase future ballistic missile reliability.[207]

Outline of What Was Transferred to the PRC

During their engagement, the Independent Review Committee members communicated with the PRC in several ways:

- **In-person conversations**
- **In-person briefing presentations**
- **Written questions and answers**
- **Provision of other written materials:**
  - **Briefing charts**
  - **Meeting minutes**
  - **Agendas**
  - **Independent Review Committee charter and membership**
  - **Independent Review Committee Preliminary Report**[208]

The written records of these communications have been scrutinized by the several U.S. Government agencies that generated assessments of the Independent Review Committee's activities.

Independent Review Committee Meeting Minutes

The minutes for the Independent Review Committee meetings in Palo Alto and in Beijing contained questions, answers, action items, Independent Review Committee comments, agendas for the next meeting, and an Independent Review Committee preliminary assessment.[209] They were transmitted to China Great Wall Industry Corporation as follows:[210]

- **On April 25, 1996,** Yen faxed the minutes of the Independent Review Committee meeting in Palo Alto, California, to China Great Wall Industry Corporation.[211]

- **On May 6, 1996,** Yen faxed the minutes of the Independent Review Committee meetings in Beijing to China Great Wall Industry Corporation.[212]

Independent Review Committee Preliminary Report

The Independent Review Committee Preliminary Report, and a draft version, were transmitted to the PRC in May 1996, as follows:

- **On May 7, 1996,** Yen faxed a draft of the Preliminary Report to China Great Wall Industry Corporation, as well as to the Independent Review Committee members.[213]
- **On May 10, 1996,** Yen faxed the final version of the Preliminary Report, less attachments, to China Great Wall Industry Corporation. He shipped complete copies to all Independent Review Committee members via express-mail.[214]
- **On May 13, 1996,** Yen faxed the final Independent Review Committee Preliminary Report to a hotel in Beijing for Paul O'Connor of the J&H Marsh & McLennan insurance brokerage firm.[215]

Loral's Inaccurate Instructions on Releasing Public Domain Information to Foreigners

During a brief presentation at the first Independent Review Committee meeting in Palo Alto, the Loral Technology Transfer Control Manager gave instructions to the committee members regarding the dissemination of public domain information to the PRC.[216] Statements from State Department officials indicate that the Loral instructions were not accurate. Other elements of the Loral Technology Transfer Control Officer's presentation, not addressed here, were also inadequate.

Instructions to the Independent Review Committee Regarding Public Domain Information

When, on April 22, 1996, the Independent Review Committee met for the first time at the offices of Loral in Palo Alto,[217] one of the first speakers was Loral's Technology Transfer Control Manager, William Schweickert. Schweickert presented a two-page briefing on technology export control as it applied to the Independent Review Committee.

Two of the Independent Review Committee members were not present at that time, and the PRC visitors also were not present.[218]

The first page of the briefing material began by stating that Loral did not have an export license covering the Independent Review Committee failure review in which the audience was participating.[219]

It went on to list what could be done by the Independent Review Committee without a license. This list included:

- **"Receive technical information from CGWIC [China Great Wall Industry Corporation]"**
- **"Request clarification"**
- **"Ask questions"**
- **"Indicate acceptance or rejection of conclusions"**
- **"Discussions must be limited to the data presented or to information in the public domain"** [220]

The second chart listed the activity the Independent Review Committee could not engage in without a license. This list included:

- **"Disclosure of launch vehicle/satellite detail design, manufacturing processes or computer source code data"**
- **"Disclosure of analytical tools, methodology, algorithms not in the public domain"**
- **"Disclosure of information that will enhance the launch site facilities or launch vehicle/missile capabilities of the PRC"** [221]

The instruction in the briefing chart that said, "discussions must be limited to the data presented or to information in the public domain" indicates that the Independent Review Committee members can freely discuss information in the public domain.[222] This statement was not correct.

State Department Views on Public Domain Information

In general, a U.S. citizen may transfer public domain information to a foreign national. However, such a transfer is not allowed if it occurs in the performance of a defense service, which is defined in Part 120 of the International Traffic in Arms Regulations.

In a defense service, a person or a company does a service for, or on behalf of, a foreign party, directly related to a commodity on the munitions list.

The expertise and experience of the person making the disclosure, and the circumstances of the disclosure, are important in determining whether a defense service has been performed through such a disclosure. As an example, simply giving a foreign national an article from the Encyclopedia Britannica is not an export requiring a license. If, however, the article is provided to a foreign national by an experienced engineer in the context of specific technical discussions, a defense service that requires a license may have been performed.

Thus, it is possible to perform a defense service while using only public domain information. A person with technical expertise or experience may guide or shape a discussion, leading it in some way by using the public domain information that is being provided. In this way, the person may convey some knowledge, some ability, or some expertise, and thus may be performing a defense service.

Defense Department Concludes That the Independent Review Committee's Work Is Likely to Lead to the Improved Reliability of PRC's Ballistic Missiles

The Defense Technology Security Administration stated in its 1997 assessment of the Independent Review Committee activities that "[t]he significant benefit derived by China from these activities are likely to lead to improvements in the overall reliability of their launch vehicles [rockets] and ballistic missiles and in particular their guidance systems." [223]

The Defense Department 1996 assessment stated:

> *The [Independent Review Committee] second meeting minutes provides two alternate causes for the guidance system failure that were previously ruled out or not cited by [the China Academy of Launch Vehicle Technology].*

> *Furthermore, [the Independent Review Committee] recommends specific testing to confirm/deny these alternative causes that otherwise would likely not have been done by China.*
>
> *If true failure turns out to be one of these alternatives, then the [Independent Review Committee] will have solved the guidance problem for [the China Academy of Launch Vehicle Technology] and possibly prevented a future failure of a [rocket] or developmental missile.*

The Defense Department 1996 assessment further stated:

> *The [Independent Review Committee] Preliminary Report recommends specific guidance platform problems that should be studied and fixed. This could improve the success of their guidance platforms for [rockets] and missiles.*

THE LONG MARCH 3B GUIDANCE SYSTEM AND BALLISTIC MISSILES

The Long March 3B guidance system is judged by the Select Committee to be among the systems capable of being adapted for use in the PRC's planned road-mobile intercontinental ballistic missiles. According to the Select Committeeís technical expert, the lightweight and compact design of the Long March 3B guidance system makes it among the systems capable of being used on a small, solid-propellant missile like the PRC's DF-31 intercontinental ballistic missiles. The accuracy of the Long March 3B guidance system is sufficient to target U.S. cities, although there is no basis for assuming greater guidance accuracy than would be achieved with larger, heavier inertial measurement units such as those used on the PRC's currently deployed CSS-4 intercontinental ballistic missile. If the Long March 3B inertial measurement unit were utilized on an intercontinental ballistic missile (ICBM), its advantage would be its lower cost, smaller size, lighter weight, and proven track record. Its disadvantage would be that the Long March 3B inertial measurement unit would require modification to be rugged enough for use on the road-mobile DF-31. If another, better system is available, however, it is more likely to be chosen for that mission.

The interagency review team, in its July 1998 assessment, stated that the advice given to the PRC by the Independent Review Committee could reinforce or add vigor to the PRC's design and test practices. In December 1998, the U.S. Government internally reported that the Independent Review Committee may have improved the reliability of the Long March 3B guidance system and, by extension, other rockets that use this guidance system. And if the PRC acquired or developed a manufacturing or testing process for their rocket program that could benefit their missile programs, they could incorporate it into those programs.

The Cross-Fertilization of the PRC's Rocket and Missile Design Programs

Chang Yang attended both the Palo Alto and Beijing Independent Review Committee meetings. Chang, a PRC engineer, is the Vice-Director of the Beijing Institute of Control Devices. Given the cross-fertilization between the PRC's rocket guidance system designers and intercontinental ballistic missile guidance system designers, Chang's participation in the Independent Review Committee likely ensured that any significant information imparted by the Independent Review Committee members was used to improve the PRC's ballistic missile systems. Chang certainly could have passed on significant information to the engineers working on ballistic missile guidance systems.

The interagency review team found that the technical issue of greatest concern was exposing the PRC to Western diagnostic processes, as suggested by Loral and Hughes.[224] This exposure could improve the PRC's pre- and post-flight failure analysis for their ballistic missile programs. This, in turn, could increase the PRC's future ballistic missile reliability.[225]

The interagency review team also reported that the Independent Review Committee provided the PRC with alternative possible causes of the failure that the PRC had apparently not previously considered, at least to that point in their investigation.[226]

Finally, the interagency review team reported that advice given to the PRC by the Independent Review Committee could help to reinforce or add vigor to the PRC's adherence to good design and test practices.[227] This information could be used by the PRC to assess the failure of any future ballistic missiles or rockets.[228]

The Defense Technology Security Administration determined that:

> *The IRC's activities encompassed a wide range of investigatory, engineering, and corrective analyses, including the provision of "Action Items" identifying additional research and testing approaches and specific recommendations for improvement in [rocket] design, manufacturing, testing and quality assurance processes.*[229]

Because of the level of interaction between the China Academy of Launch Vehicle Technology's rocket and intercontinental ballistic missile programs and the affiliations of the PRC members involved in the Independent Review Committee, the experience gained in diagnostic and failure investigation techniques during their participation in the Independent Review Committee could assist the PRC in its future rocket and ballistic missile development and testing programs.

The Independent Review Committee Aided the PRC In Identifying the Cause of the Long March 3B Failure

China Great Wall Industry Corporation's final investigation report indicated that the true failure mode was discovered by the end of May 1996 after repeated tests and analysis. China Great Wall Industry Corporation reported that the root cause of the failure was most probably the lack of output in the three gold-aluminum engagement joints inside the power amplifier module (HMS501J) for the servo-loop of the follow-up frame. The PRC final investigation report said, "the joint deterioration caused the loop failed to work [sic]." [230]

The Defense Technology Security Administration assessment of the Independent Review Committee activities stated: "[The Department of Defense] considers it highly probable that, as a result of the [Independent Review Committee's] activities, the PRC has determined the root failure cause and is making progress toward correcting underlying design, manufacturing, test and quality assurance processes for the [Long March 3B's] guidance unit." [231]

The interagency review team assessed in July 1998 that the true failure mode may have been discovered more quickly by the PRC as a result of the Independent Review Committee's report.[232]

According to the Department of Defense, the Independent Review Committee very likely led the PRC to discover the true failure of the Long March 3B guidance system:

> *Stating it simply, it can be shown that before [the] IRC [Independent Review Committee], the Chinese team had narrowed the most-probable failure scenario to a particular area of the inertial platform (inner frame gimbal).*
>
> *It can also be shown that in the IRC draft report delivered to China, that the IRC pointed out that the failure could also be in two other places (namely the follow-up frame gimbal or in an open-loop feedback path) and stated that China should explain some as-yet unexplained data output (concerning the follow-up frame); [the] IRC went on to recommend that China perform tests that would prove/disprove all three scenarios.*
>
> *It can be shown that after the IRC report (and suspension of IRC activities), the Chinese team performed specific tests for these scenarios, and that shortly after the IRC report, these tests resulted in the Chinese team ruling out their original failure scenario (the inner frame gimbal) and resulted in isolating the follow-up frame gimbal as the source of the failure.*[233]

The PRC Implemented All of the Independent Review Committee's Recommendations

At the Pre-Shipment Review on April 14, 1997 for the upcoming PRC launch of Loral's Mabuhay satellite, the China Academy of Launch Vehicle Technology announced that it was taking 44 corrective actions to address the cause of the Long March 3B failure.

These corrective measures included discarding all remaining HMS501J power amplifier modules from the batch used on the Long March 3B flight that failed.[234]

All of the Independent Review Committee's recommendations from its Preliminary Report are addressed by these 44 corrective actions. *Selected recommendations and PRC corrective actions are detailed on the overleaf:*[235]

PRC Corrective Actions Address Independent Review Committee Recommendations

INDEPENDENT REVIEW COMMITTEE RECOMMENDATION *	CHINA ACADEMY OF LAUNCH VEHICLE TECHNOLOGY CORRECTIVE ACTION
Short Term #4: **Improve environmental testing.**	• "Platform's acceptance test will be stricter, and the acoustic test will be involved in the acceptance tests...." (CALT Action #7)
Short Term #2: **Study detailed design of torque motor and wiring** to reduce impact of harness motion or deflection of solder joints. *Long Term #2:* **Review designs and avoid single point failures – increase redundancy.**	• "All of the platform's movable connections will adopt double-jointed and double-wired connection, such as the torque motor's brushes. As for fixed connections, double-jointed and double-wired connections will be adopted as many as possible." (CALT Action #9) • "The conductive slip ring is one of the important components inside the platform ... CALT had adopted measures to increase the conductive lip ring's reliability, and upgraded reliability technology and screening measures to guarantee its normal working status." (CALT Action #10)
Long Term #2: **Review designs and avoid single point failures – increase redundancy.**	• "CALT had increased grounding points of platform's power supply circuits. All of the platform's four stabilization circuits will triple-redundantly powered." (CALT Action #11)
Short Term #2: **Study detailed design of torque motor and wiring** to reduce impact of harness motion or deflection of solder joints. *Short Term #3:* **Improve quality control in manufacturing.** *Long Term #1:* **Strengthen quality control practices and training.**	• "To improve soldering technology, tooling and working environment to operate and detect easier. For example, adding special tooling, strengthening inspection measures to assure the welding quality." (CALT Action #15)
Short Term #3: **Improve quality control in manufacturing.** *Long Term #1:* **Strengthen quality control practices and training.**	• "To strengthen soldering quality check, including pre-soldering raw material detect, post-soldering non-destructive tension test and sampling destructive test for key parts." (CALT Action #16)

* The Independent Review Committee recommendations are listed in their entirety under the heading "Substance of the Preliminary Report" in the "Overview of Events" earlier in this chapter.

PRC Corrective Actions Address Independent Review Committee Recommendations (continued)

INDEPENDENT REVIEW COMMITTEE RECOMMENDATION *	CHINA ACADEMY OF LAUNCH VEHICLE TECHNOLOGY CORRECTIVE ACTION
Short Term #4: **Improve environmental testing.**	• "To strengthen flight resume criterion after failure." (CALT Action #33)
Short Term #3: **Improve quality control in manufacturing.** *Long Term #1:* **Strengthen quality control practices and training.**	• "To supervise the manufacturing of key/critical elements so as to assure its quality." (CALT Action #34)
Long Term #1: **Strengthen quality control practices and training.**	• "To strengthen technical exchange among all Long March families." (CALT Action #37)
Short Term #3: **Improve quality control in manufacturing.**	• "To strengthen education of quality control to all of the employees and to link their incomes with quality." (CALT Action #38)
Short Term #5: **Improve range safety.**	• "To improve safety control measurement in launch site." (CALT Action #40)

* The Independent Review Committee recommendations are listed in their entirety under the heading "Substance of the Preliminary Report" in the "Overview of Events" earlier in this chapter.

Loral does not believe that the PRC's actions resulted from the Independent Review Committee. Loral stated in an update to its State Department disclosure provided at the request of the Select Committee that "none of the Chinese's [sic] announced improvements to its Long March 3B rockets was the result of Loral's participation in the Independent Review Committee." [236]

However, the corrective actions presented by the PRC in April 1997 are much more comprehensive than the list of corrective actions presented a year earlier at the Apstar 1A pre-flight briefing in April 1996.[237]

At the Apstar 1A briefing, which preceded the Independent Review Committee activities, the PRC listed:

- **Six "comprehensive enhancements for [the] inner frame axle circuit"**
- **Several general reliability design review actions to be completed in 1997**
- **Ten "production assurance" corrective actions**[238]

The 1996 briefing expressly matched only two corrective actions from the 1997 briefing: to increase reliability of the inertial measurement unit's slip rings (1997 corrective action #10 of 44) and to perform a review of the Long March 3B design toward improving the overall reliability (1997 corrective action #21 of 44).[239]

The Independent Review Committee Helped the PRC Improve the Reliability of Its Long March Rockets

The Defense Technology Security Administration stated in its assessment of the Independent Review Committee activities that "[t]he significant benefits derived by China from these activities are likely to lead to improvements in the overall reliability of their launch vehicles [rockets] . . . and in particular their guidance systems."[240] Likewise, the interagency review team reported in their assessment that the advice given by the Independent Review Committee could improve PRC space rocket reliability.[241]

By identifying the true Long March 3B failure mode, and additional modifications for the Long March 3B inertial measurement unit, it is likely that the Independent Review Committee helped the PRC avoid future failures of the Long March 3B.

U.S. COMPANIES' MOTIVATIONS TO LAUNCH SATELLITES IN THE PRC

Competitive International Launch Industry

The international space launch services industry is very competitive. Europe, China, Russia, Ukraine, and Japan are active competitors in this market. The main competitor to U.S. companies for commercial launch services is Europe's Arianespace. The Congressional Research Service reports that "Europe has a 50-60% share of the commercial launch services market, while the United States has 30-40%, and China and Russia share the rest." Ukraine and Japan have not yet launched satellites on a commercial basis, although both have contracts to do so.[242]

Several factors motivate U.S. companies to launch satellites in the PRC. International consortia with PRC investors can apply pressure for, or force the use of, PRC launch services. The backlog of available rockets elsewhere is a factor, and the comparatively low price is also an inducement.[243]

Launch Backlog

ROCKET	WAIT (YRS)	# OF SATELLITES IN BACKLOG	LAUNCH RATE PER YEAR
Delta II	3.2	42	13
Zenit	3.0	3	1
Atlas	2.9	26	9
Long March	2.7	16	6
Ariane	2.4	41	17
Proton	2.3	21	9

Source: Aerospace Industries Association datasheet titled "China/Satellite Launch Fact Sheet" dated 6/3/98.

PRC Commercial Launch Services

The PRC offers several versions of its Long March rockets for commercial launch services through China Great Wall Industry Corporation. According to the Congressional Research Service, "China reportedly has about 10% of the worldwide market for commercial space launches." [244]

The PRC is the locus of an expanding marketplace for satellite-based telecommunications services, including mobile telephone services, direct broadcast television and digital data services. This has spawned numerous enterprises that hope to capitalize on this market and that include PRC investment.

Frequently, these wholly or partly PRC-owned customers for launch services require that their satellites be launched by China Great Wall Industry Corporation. Examples include the Asia Pacific Telecommunications Satellite Company, Mabuhay, and Asiasat. This is the leading reason for U.S. satellite manufacturers to launch their satellites in the PRC.

PRC Launches Are Subsidized

Because of the PRC's non-market economy, the potential for technology transfer, and political concerns, the United States agreed in 1989 to grant export licenses for launches of U.S.-built satellites in China only on several conditions. These conditions included an agreement by the PRC "to price its launch services 'on a par' with Western companies." [245]

That six-year agreement was signed in 1989 and expired in 1994. A new seven-year agreement was signed on March 13, 1995.

According to the Congressional Research Service, the "Bilateral Space Launch Services Trade Agreement" with the PRC specifies:

- **Geostationary Earth Orbit satellite (GEO)[246] launches must be priced on a par with Western prices**
- **If the price is within 15%, it will normally be considered consistent with this obligation**

- **Prices more than 15% below will be examined in detail**
- **Low Earth Orbit satellite (LEO)[247] launches must be priced on a par with Western prices [248]**

The PRC was accused of violating this agreement in a 1990 contract to launch the Arabsat satellite for $25 million. The main competitor for that launch, Arianespace, turned to the French and U.S. governments to prohibit the export of the satellite, which included U.S.-built components, to the PRC. The Arabsat consortium eventually terminated its contract with the PRC, and launched on an Arianespace rocket.[249]

According to the U.S. Trade Representative, "Arabsat became the first in a series of PRC bids that have been as low as half those offered by Western bidders."[250]

The Intelsat VIIA launch services were won by China Great Wall Industry Corporation "with a bid of $56 million, far below the $100-110 million bid by Arianespace."[251]

The price China Great Wall Industry Corporation bid for launching the Loral-built Mabuhay satellite was 22-26% below Western prices.[252]

Additionally, the PRC bids to launch the Apstar-1, Apstar-2, Asiasat-2, and Echostar satellites were all 22-36% below Western bids.[253]

In May 1997, the U.S. Trade Representative stated that it believed the PRC had violated the pricing provisions of the bilateral agreement in connection with the launch of the Loral-built Mabuhay satellite. The PRC disagreed with this allegation.[254]

CHRONOLOGY OF KEY EVENTS

1988

October 4	**Intelsat awards Intelsat VII contract to Loral** for up to nine satellites. This fixed-price contract had a total value of nearly $1 billion. Intelsat had released the RFP for this procurement on October 1, 1987.

1992

April 24	**Intelsat awards contract to China Great Wall Industry Corporation** (CGWIC) for launch services – eventually covering the launch of the Intelsat 708 satellite in February 1996. Intelsat had released an RFQ for this procurement on July 16, 1991.
May 11	**Loral submits export license application** to State Department covering export to the PRC of technical data supporting launch.[255]
September 18	**State Department issues export license** No. 533593 for Loral export of technical data supporting a satellite launch (Form DSP-5).[256]
September 4	**Loral submits export license application** to State Department for export of the Intelsat 708 satellite to the PRC.[257]

1993

Mid-1993	**Intelsat exercises option for Intelsat 708 satellite from Loral.** The 708 satellite is identical to the 706 and 707 units. The 706 was the first in the Intelsat VIIA program.
July 14	**State Department issues license** No. 544724 for export of Intelsat satellite to the PRC for launch (Form DSP-5).[258]

1994

1994	**Loral and Intelsat employees take site survey trip to Xichang, PRC** to inspect facilities for upcoming Intelsat 708 launch. Facilities described as primitive but workable.

1995

April 7-8	**Loral briefing package is provided to China Aerospace Corporation (CASC)** describing Loral and its capabilities, along with a proposed ten-year joint technology development program between Loral and CASC.[259]
June 6	**Loral requests waiver to transport the Intelsat 708 satellite** on a foreign flag aircraft to the PRC.
June 9	**Loral signs Memorandum of Agreement with CASC** for a ten-year joint technology development program.[260]
November 2	**Loral sends letter to CASC "In Furtherance of the Technology Cooperation Agreement,"** enclosing performance specification documents for a solar panel, a propellant tank and a pressurant tank, and expressing interest in CASC manufacturing such articles for future Loral satellite programs.[261]

1996

January 11	**Intelsat 708 satellite is shipped** to Xichang, PRC, launch site.[262]
January 16	**Loral Export Control Manager William Schweickert sends e-mail to Loral Export Control Officer Duncan Reynard describing security issues/infractions** that Col. Nicholas Alexandrow of the Defense Technology Security Administration (DTSA) discussed with Schweickert that morning. The issues were raised by DTSA monitor Steven Prichard at the Xichang launch site and include unescorted PRC nationals, violations of the Site Security Plan and the Technology Transfer Control Plan (TTCP), and lack of cooperation by Loral staff.[263]
January 24	**Loral received and reviewed the Apstar technical data export license,** which prohibited any discussion or release under the license of any technical data concerning rocket failure analysis or investigation.

February 15	**Intelsat 708 launch failure occurs** in Xichang at 3 a.m. local time.[264] U.S. personnel taken to crash site at 10 a.m.[265] Not allowed to visit the debris field until late in the afternoon.
February 16	**Debris recovery operation begins** at crash site and includes Loral, Intelsat, Pinkerton, and PLA personnel.[266]
February 17	**Loral memorandum from Muhammad Wahdy of Loral and acknowledged by DTSA's Prichard** documents debris recovery. This report estimated that 30 percent of the command processors, which contain the encryption electronics, were recovered.
February 19	**Debris is shipped to Palo Alto,** California, by Loral personnel.
February 21	**J&H Marsh & McLennan Vice President Paul O'Connor** sends letter to China Great Wall Industry Corporation (CGWIC) suggesting CGWIC implement an aggressive public relations campaign for underwriters.[267]
February 22	**J&H Manager in Paris, Jacques Masson, sends letter to O'Connor** reporting discussions with French insurance community regarding the impact of Intelsat 708 failure on future insurance programs. Mentions need to create an "independent inquiry board."[268] **Loral received and reviewed the Mabuhay technical data export license,** which prohibited any discussion or release under the license of any technical data concerning rocket failure analysis or investigation.
February 26	**Insurance underwriters for Apstar-1A program become increasingly disappointed** regarding the lack of an independent and international failure review committee.[269]

	Paul O'Connor (J&H) provides CGWIC with a failure review committee schedule modeled after an Ariane failure review plan.[270] O'Connor urged CGWIC to allow J&H to obtain failure review conclusions first.[271]
February 27	**CGWIC issues a press release** that identifies the cause of the launch failure to be the inertial platform in the Long March 3B control system.[272]
February 28	**O'Connor (J&H) outlines for CGWIC minimum requirements** for the Apstar-1A reinsurance program to continue.[273]
March 4	**Intelsat engineer Daniel Lilienstein writes memorandum to Intelsat** management documenting unsafe conditions at Xichang launch site during Intelsat 708 launch.[274]
March 9	**Hughes personnel Pulcher, Lanzit, Arthur, Yiu, and Dome visit Xichang launch site** in connection with upcoming Apstar-1A launch.[275]
March 10	**Hughes personnel Pulcher, Lanzit and Arthur meet with representatives of CGWIC,** China Launch and Tracking Control General Administration (CLTC), China Academy of Launch Vehicle Technology (CALT), Asia Pacific Telecommunications (APT), and several insurance underwriters in Xichang regarding the upcoming Apstar-1A satellite launch.[276]
March 14	**Apstar-1A insurance meeting is held in Beijing,** involving representatives of APT, CGWIC, J&H, Hughes, CLTC, and CALT. J&H official O'Connor presents insurance demands: (1) a final PRC report on the cause of the Long March 3B launch failure, and (2) an independent review of the PRC investigation.[277]

CGWIC sends letter to Loral President Berry inviting Loral to attend meeting of the PRC Failure Investigation Committee in Beijing on March 20-22, 1996.[278]

March 18 — **Loral letter to CGWIC** advises that Loral and Intelsat cannot attend the Failure Investigation Committee meeting on such short notice.[279]

March 20 — **CGWIC sends letter to Loral** inviting Loral and Intelsat to the Failure Investigation Committee meeting in Beijing at the end of March or beginning of April.[280]

J&H Manager Jacques Masson in Paris identifies potential participants in an independent review committee for the Intelsat 708 failure investigation.[281]

March 21 — **Loral letter to CGWIC** advises that Loral can only attend the Failure Investigation Committee meeting if invited by Intelsat.[282]

Insurance underwriter, ACE Ltd., advises J&H that CGWIC's actions regarding the Intelsat 708 failure investigation were unacceptable and the Apstar-1A insurance contract was in jeopardy.[283]

March 27 — **CGWIC letter to Loral invites Loral** to Failure Investigation Committee meeting in Beijing from April 10-12 as guests of Intelsat.[284]

March 28 — **CGWIC issues press release** listing four possible failure modes: (1) broken wire to inner torque motor, (2) blocking of inner frame axis, (3) open loop of follow-up frame, (4) environmental stress.[285]

March 29 — **Loral letter to CGWIC advises that Loral will attend** the Failure Investigation Committee meeting and will send Loral personnel Wah Lim, Nabeeh Totah and Nick Yen.[286]

March	**Intelsat Board of Governors decides** to terminate all existing launch service agreements with CGWIC.
April 3	**Letter to U.S. Department of Commerce,** Bureau of Export Administration and U.S. Department of State, Office of Defense Trade Controls (ODTC), wherein Duncan Reynard, Loral, requests clarification as to which agency has licensing jurisdiction over matters concerning the Mabuhay and Apstar IIR programs. **Additionally, Loral recommends that ODTC reissue licenses** for these two programs to include the following language: "Questions and comments about Long March launch failures or investigations must be reviewed and approved prior to release in accordance with the procedures in the Technology Transfer Control Plan which was provided with the applicant's license application."
April 4	**CGWIC letter invites Hughes** to participate in an Independent Oversight Team.[287]
April 5	**CGWIC reports to J&H that an Independent Review Committee is being established** to meet the insurance community's minimum requirements to insure the upcoming Apstar-1A launch.[288]
April 10-12	**Intelsat and Loral personnel are observers at the Failure Investigation Committee meeting in Beijing.** PRC presents the results of their investigation into the launch failure (three volumes of data, reports, and conclusions). Loral personnel present: Lim, Totah, and Yen. Intelsat personnel present: Terry Edwards.[289]
April 11	**CGWIC contacts Bansang Lee (Loral's representative in the PRC)** to invite Lim to chair an Independent Review Committee (IRC). Lee passes invitation to Lim.[290]

Government Security Committee (GSC) meeting at Loral in Palo Alto. Loral President Robert Berry reports that he and others have been invited to review the PRC investigation into the Intelsat 708 launch failure. The U.S. review team will not provide advice or direction on how to correct deficiencies, but will advise the PRC that it must be more open and truthful about their launch problems. GSC member Steven Bryen suggests that Loral obtain State Department approval for any responses provided to the PRC by this review team.[291]

April 14 — **The Independent Review Committee (IRC) charter is established** to review the work of the PRC's Failure Investigation Committee. A copy of the charter is faxed to Hughes IRC member Robert Steinhauer.[292]

April 15-16 — **Apstar-1A reinsurance meeting is held in Beijing,** including representatives of APT, Hughes, CGWIC, and the insurance industry.[293] Specific attendance includes: Hughes personnel Steinhauer, John Smay, Pulcher, Lanzit, Wong, Guan, and Lang; Loral personnel Wah Lim and Nick Yen; J&H personnel Swanson, O'Connor, Quinn, Davis, Zhang, Masson, and Chan.

April 16 — **Wah Lim briefs the Apstar-1A reinsurance meeting** audience on the IRC creation, membership, and charter.[294] One of Lim's briefing charts states: "IRC Objectives – To ensure the success of future Long March series launches: . . . Recommend to China Aerospace Corporation & CGWIC any other areas of improvement."[295]

April 17 — **Lim sends a letter to CGWIC inviting the PRC** to attend an IRC meeting in Palo Alto, on April 22-23, 1996.[296]

Lim sends a letter to Steinhauer at Hughes confirming the dates for the IRC meetings in Palo Alto and Beijing.[297]

April 19	**Loral legal counsel** Julie Bannerman, Export Control Officer Duncan Reynard, and Technology Control Manager William Schweickert learn of imminent arrival of PRC visitors.[298]
April 22	**Reynard first learns that morning about PRC visitors** coming (that day) for an IRC meeting. He learns this from Schweickert. **The IRC meeting in Palo Alto begins.**[299] Short technology export briefing given by Schweickert at the beginning of the first day. The briefing advises the IRC members that they have no export license for the activity, and what actions are permitted.[300] The PRC visitors are not present on the first day. IRC members John Holt and Reinhard Hildebrandt are not present on the first day. The IRC members discuss the PRC launch failure investigation as documented in reports previously furnished by the PRC. Also, the IRC members draft numerous questions for the PRC.[301]
April 23	**The IRC meeting in Palo Alto continues for a second day.** The PRC visitors are present. British IRC member Holt is present. The IRC questions regarding the PRC failure analysis are presented.[302] **German IRC member Hildebrandt and PRC visitors arrive** in afternoon.[303] **Loral's Yen briefs U.S. Government officials,** including State Dept. staff: Oldenberg, Bemis, and Chih; Dept. of Transportation: Welles; Dept. of Commerce: Farmer, Chandler; and Dept. of Treasury: Murphy on the Long March 3B failure, the IRC and the intent of the IRC to issue a report.[304]
April 24	**The IRC meeting in Palo Alto adds a third day** to accommodate the PRC visitors' delayed arrival. Hughes IRC members John Smay and Robert Steinhauer are not present.[305]

April 25	**Steinhauer meets with Professor Huang** in Torrance, California, to learn what happened at IRC meeting on April 24. Also discussed PRC manufacturing processes for the inertial measurement unit (IMU) on the Long March 3B.[306] **Yen faxes minutes of the first IRC meeting to CGWIC.**[307]
April 30–May 1	**The second IRC meeting is held in Beijing.** Ten to 20 PRC nationals are present to answer questions from the IRC. U.S. participants are Loral's Lim, Totah, and Yen, Smay from Hughes, and Frederick Ormsby.[308]
April 30	**The IRC meets in Beijing.** Meeting covers introductions, overview, and answers to the IRC questions from the first meeting in Palo Alto.[309] That evening the IRC members caucus at their hotel to discuss issues and plan for the next day.[310] They decide during the caucus to ask for a splinter meeting.
May 1	**The IRC meeting in Beijing continues.** Splinter meeting held on subject of control systems and the inertial platform. Splinter meeting attended by Fred Chan, Jack Rodden, Holt, and Yen. The IRC members are given tours of several facilities: IMU assembly and IMU test facilities.[311] That evening they dine as guests of the PRC.[312]
May 2	**Rodden, Chan, and Smay go sightseeing with Madame Zhou,** the PRC representative for the Asia Pacific Telecommunications Company.[313]
May 2-5	**British IRC member Holt sends draft** he wrote by e-mail to Hughes IRC member Smay on May 2. On May 4, Smay sends e-mail to Holt providing comments on the draft – that e-mail message is also faxed to Lim at Loral.[314] On May 5, Holt sends e-mail to Smay thanking him for his comments.[315]

May 3	**Totah sends memorandum to Lim including comments,** conclusions and short-term and long-term recommendations concerning the failure.[316]
	Totah sends handwritten memorandum to Lim advising that he has made comments on Holt's draft, and that the draft was incomplete.[317]
	Holt sends fax to Lim, including four pages of draft material on the cause of the failure.[318]
	Smay writes 20 pages of draft material for the IRC Preliminary Report, including an outline and brief paragraphs for a few sections. Smay assigns a section titled "Recommended Design Fixes" to Steinhauer for drafting.[319]
May 4	**Ormsby sends letter to Lim with comments on IRC meetings** in Beijing, and includes three recommendations for PRC investigation and analysis.[320]
	Smay sends e-mail to Holt with comments on Holt's draft. This e-mail was also faxed to Lim.[321]
May 5	**German IRC member Hildebrandt sends fax to Lim with his contributions to the "Preliminary Assessment Report,"** including stating the need for "an intensive quality inspection" in the PRC IMU integration process and describing Western methodologies for reducing wiring connection problems. Lim's secretary faxes a copy to Yen.[322]
May 6	**Holt sends five-page fax to Lim** with comments and contributions to the IRC report.[323]
	Smay sends the section of the IRC Report that he compiled to Yen.[324]
	Yen faxes the minutes from the IRC meetings in Beijing to CGWIC.[325]

May 7	**Yen faxes a draft of the Preliminary IRC Report to CGWIC** and to the IRC members.[326] Lim directed Yen to do this.[327] **Lim sends a letter to CGWIC, including minutes of IRC meetings** on April 30 and May 1, along with action items and preliminary assessments that were made during and after those meetings. Lim indicates that the IRC will provide a formal report to CGWIC by May 10, 1996.
May 8	**Holt sends a fax to Yen** with comments and contributions to the IRC report, and thanking Yen for the draft of the Preliminary Report.[328] **Steinhauer sends a one-page fax to Yen** with comments and contributions to the IRC report, mentioning "de-emphasis of safety issues." Steinhauer states: "In general, I agree with report and its findings." [329]
May 9	**Holt sends a one-page "urgent" fax to Yen** with Holt's final thoughts on the IRC review. Holt does not concur with CALT's theory about an intermittent wire break because there is no evidence of reconnection.[330] **Hildebrandt sends a one-page fax to Yen stating that he has just received the fax of the draft IRC Preliminary Report.** Hildebrandt offers a minor proofreading comment and states that he agrees with the draft.[331] **Steinhauer sends an e-mail to other Hughes employees** saying that the IRC Preliminary Report is going to Beijing that night.[332]
May 10	**Lim provides a copy of the draft Preliminary Report** to Loral General Counsel Bannerman for her review, and he assumes that the draft was okay since he receives no comments from her.[333]

Yen faxes a cover letter and final version of IRC Preliminary Report, less attachments, to CGWIC. Yen also ships complete copies to all IRC members via express mail.[334]

Loral General Counsel Bannerman attempts to halt distribution of the IRC report after Yen faxes the report to the PRC.[335]

Lim sends a letter to IRC members advising of Yen's completion of the "formal IRC Preliminary Report" and that a copy has been sent to them. Lim states that the report is currently being reviewed by the Loral General Counsel's office and asks the IRC members not to discuss the report with non-IRC members.[336]

May 13

Yen faxes the final IRC Preliminary Report to a hotel in Beijing, for O'Connor of the Johnson & Higgins insurance brokerage firm.[337]

Yen also sends a copy of the Preliminary Report to O'Connor's office in Washington, D.C.[338]

Reynard first learns that the report has been sent to IRC members and possibly to J&H.[339]

Lim sends letter to He Xing of CGWIC advising that the IRC has completed the formal Preliminary Report and the report is currently under review by Loral legal counsel. Says he is sending a copy of the report to O'Connor.[340]

Lim sends letter to O'Connor advising that the report will not be furnished to CGWIC until an "export license or an equivalent authorization is obtained." [341]

May 14

Reynard sends memorandum to Berry criticizing the IRC draft report as poorly organized, poorly written, and filled with inaccurate statements and illogical conclusions. Says that the Loral employees involved in this IRC work have already committed serious violations of the International Traffic in Arms Regulations (ITAR) and and the Missile Technology Control Regime (MTCR).[342]

Bob Kovac of DTSA reads article in *Space News* about Loral IRC investigation and calls Loral's Harold Bradshaw, who subsequently sets up a meeting the next day.

May 15

Yen sends fax to IRC members announcing that the IRC Preliminary Report has been submitted to the U.S. Government for review. During that review, the IRC members are not to disclose or discuss the content of this report with anyone, especially the PRC. The letter also asks that Holt and Hildebrandt (the non-U.S. IRC members) return all correspondence previously received from the IRC Secretary. Distribution: Lim, Ormsby, Steinhauer, Holt, Totah, Kachigan, Smay, Hildebrandt, Chan, and Rodden.[343]

Yen writes trip report to Keer regarding Yen's April 23, 1996 meeting at the U.S. Trade Representative offices in Washington, D.C.[344]

Reynard notifies DTSA (Kovac) and State Department's Office of Defense Trade Controls (Kenneth Peoples) in person and in writing about the IRC and its report. He tells them that an executive summary section of the draft IRC report has been mistakenly sent to CGWIC. Bradshaw (from Loral's Washington, D.C. office) is also present.

Reynard denies that the IRC report has been sent to the PRC. Kovac tells Reynard that Loral may have violated the law, that they must halt all IRC activity, and that they should submit a voluntary disclosure to State Department. Reynard furnishes a copy of the report to Kovac.

Reynard meets with Peoples. Loral's presentation to Peoples is very general. Reynard may have told Peoples that some part of the IRC report was sent to the PRC – Peoples' recollection is unclear.

Reynard sends handwritten fax to Berry summarizing advice from State and DTSA. Includes the words: "Question: did *anything* go to CASC or CGWIC? – we need an *honest* answer to this." [345]

Bannerman sends memorandum to Loral Counsel Zahler reporting Reynard's meetings with U.S. government.[346]

May 16 **Steinhauer sends fax to Lim confirming plans to attend IRC meeting in Beijing** on June 4-5. The fax further says Steinhauer is in agreement with the preliminary report dated May 10 and "Don't really believe that there is a lot of technology transfer present . . . Hope that your filter at SS/Loral understands situation." [347]

May 17 **Bradshaw sends fax to Reynard** with copies of export licenses #544724 and #533593, commenting that DOD is upset and Loral seems to fail to take provisos seriously.[348]

Reynard receives from Bannerman several boxes of documents that have been collected from Loral personnel re the IRC activity. Reynard decides to generate an index of these documents over the weekend with the aid of his son.

May 20 **Reynard advises Bannerman of his catalogue of the documents. Bannerman tells Reynard to stop that activity.** She intends to have outside counsel perform that job. Reynard stores the documents and later turns them over to Poliner of Feith & Zell.

Lim and Yen admit to Reynard that they sent the IRC report to the PRC on May 10.

May 21 **Reynard sends letter to William Lowell at the State Department,** which briefly describes the circumstances of the IRC and its meetings with the PRC, and Reynard's recent meetings with State Department and DTSA. It says each agency received a copy of the IRC report and that Loral subsequently discovered that the executive summary of the report was mistakenly faxed to CGWIC. Loral is investigating the matter.[349]

May 23 — **Loral outside counsel, Feith & Zell, commences investigation** of the IRC matter.[350]

May 27 — **Yen sends letter to all IRC members** advising of Loral correspondence with State Department, and that all future IRC activities are on hold.[351]

May 29 — **State Department's William Lowell faxes a letter to Higgins, Corporate General Counsel, Hughes Electronics, to notify Hughes that the State Department has reason to believe that Hughes may have participated in serious violations of the ITAR** by providing unauthorized defense services to the PRC in relation to the February 1996 launch failure of a Long March rocket. Lowell recommends Hughes take immediate steps: cease all related activity that may require approval, provide a full disclosure and enumerate all releases that would be controlled under ITAR.[352]

Lowell also sends a letter to Zahler, VP, Secretary and General Counsel, Loral, advising that there is reason to believe that Loral may have participated in serious violations of ITAR. Lowell recommends Loral take immediate steps: cease all related activity that may require approval, provide a full disclosure and enumerate all releases that would be controlled under ITAR.[353]

May 29-31 — **Feith & Zell attorneys visit Loral offices** in Palo Alto to interview Loral personnel.[354]

May 30 — **Loral representative** in Washington, D.C., Bradshaw, and Loral outside counsel Feith meet with Lowell at State.[355]

May 31	**Loral Counsel Zahler sends a letter to Lowell at State Department** advising of Loral investigation and retention of outside counsel, and stating that Loral personnel will be interviewed.[356]
June 3	**Reynard sends a memorandum to Lim** instructing him and Yen to retrieve all copies of anything sent out to the IRC Members. Also to ask the IRC Members to certify that no derivative copies were made or distributed.[357]
June 4-6	**Feith & Zell attorneys** conduct follow-up interviews in Palo Alto.[358]
June 4	**Kuelbs from Hughes General Counsel's office sends a letter** to Lowell responding to his letter dated May 29. Hughes reports that they are beginning an internal investigation of the matter.[359]
June 6	**Lim sends letter to O'Connor** asking him to retrieve all IRC-generated documents that the IRC transmitted to him by fax, express mail, or by distribution at any meetings, and to confirm that no derivative copies were made.[360] **Lim sends a letter to all IRC Members** asking them to return all IRC-generated documents and to confirm that no derivative copies were made.[361] **Lim sends a letter to Zhixiong, CGWIC,** asking that they return IRC documents and confirm no derivative copies were made.[362]
June 12	**Smay and Steinhauer send a letter to Lim** advising they cannot comply with request to return the IRC documents, per Hughes Counsel's instructions.[363]
June 17	**Loral submits a Voluntary Disclosure to State Department** through outside counsel, Feith & Zell, regarding suspected ITAR violations surrounding the activities of the IRC.[364]

	CIA submits report to State Department on Independent Review Committee Preliminary Report in response to State Department request. No proliferation concerns.
June 27	**Hughes documents its internal investigation into activities related to the IRC:** "Report of Investigation of Alleged Violations of International Traffic in Arms Regulations (ITAR)" for hand delivery to Lowell (State Department).[365]
July 18	**CGWIC sends a letter to IRC members** advising closure of IRC due to U.S. Government ban.[366]
August	**Department of Defense issues assessment** of Independent Review Committee activity. Moderate harm to national security.
September 26	**Hughes furnishes the State Department a list of nearly 150 names** referenced in the June 27, 1996 Hughes report on the IRC and its exhibits. This was in response to a request from the State Department dated September 23, 1998.[367]
October 21-22	**PRC presents a report on the Long March 3B Failure Investigation** by CGWIC at a Mabuhay program meeting at Loral in Palo Alto. DTSA monitor, Major Smith, was invited to that meeting.[368]

1997

March 19	**Central Intelligence Agency issues assessment of IRC matter** that conflicts with the Defense Department assessment.
March 25	**The State Department issues assessment** based on Defense Department and CIA analyses. Significant improvement to the Long March 3 guidance system. State also reviewed the CIA's assessment and disagreed with it.

May 16	**DOD/DTSA assessment on the IRC matter is issued.** DTSA finds that the IRC performed unauthorized defense services that are likely to lead to improvements in reliability of rockets and missiles. Recommended referral to the Justice Department for criminal prosecution.[369]
August 19	**Agila 2 satellite, formerly named Mabuhay, is successfully launched** from Xichang, PRC, on a Long March 3B. Loral manufactured the satellite.[370]
October 16	**Apstar-2R satellite is successfully launched** from Xichang, PRC. Loral manufactured the satellite.[371]

1998

February 18	**President Clinton approves a waiver** for the Loral-built Chinasat 8 satellite to be exported to the PRC for launch.
May 7	**Hughes documents background information regarding the IRC activities.** This report is furnished to the Space Subcommittee of the House Science Committee on May 8, 1998.[372]
June 15	**Congressional staffs from the House National Security Committee, International Relations Committee, and Science Committee are briefed** on the export control process by officials from the State Department. David Tarbell, Director of DTSA, testifies that a rocket failure analysis was a defense service and therefore subject to license.[373]
October	**Hughes reports on its Internet web site** that "Hughes employees drafted no portion of the report that was prepared by the committee . . ." and the "Hughes employees did not write any portion of this [IRC] report."

TECHNICAL ASPECTS OF TECHNOLOGY TRANSFER DURING THE LORAL FAILURE INVESTIGATION

Background

The February 14, 1996 failure of the PRC Long March 3B during the launching of the Intelsat 708 communications satellite, built by Loral, set in motion a number of accident investigation and reporting activities. These brought PRC engineers and designers face-to-face with Western engineers and technical experts in satellite and related rocket technologies.

The initial technical analyses of the accident were conducted by two groups of PRC scientists and engineers. These analyses were presented in several sessions in March, April, and May 1996 to representatives of the satellite launch insurers, re-insurers, Intelsat and Loral.

Initially, greater priority seems to have been placed on briefings and discussions with representatives of Hughes and the PRC-controlled Asia Pacific Telecommunications Co., Ltd., and their respective insurers and re-insurers. This was because Hughes was the builder and Asia Pacific Telecommunications was the owner of the Apstar 1A satellite, which was the next satellite scheduled to be launched (on April 1) on a Long March rocket (albeit the Long March 3, a different version from the 3B). Before that scheduled next launch could take place, these organizations would need to be convinced that the Apstar 1A would not be exposed to the same defects or hazards as those in the Long March 3B rocket that had caused the failure of the Intelsat 708 launch.

Loral, too, was highly motivated to remedy the defects in the Long March 3B because its upcoming Mabuhay satellite launch was the next scheduled aboard the Long March 3B.

On March 9, 1996, Hughes representatives toured the launch site facilities, which had suffered some damage as a result of the Intelsat 708 accident, and subsequently held discussions concerning the findings of the PRC accident investigations.

On March 14, 1996, a meeting was held with the insurance underwriters for the Apstar 1A in Beijing. Hughes and Asia Pacific Telecommunications representatives were also in attendance. The main information the PRC rocket authorities and the APT representatives sought to convey to the insurance underwriters was that the accident investigation of the Intelsat 708 launch failure had shown that the Long March accident was caused by the failure of the inertial measurement unit. This is the subsystem that provides attitude, velocity, and position measurements for guidance and control of the rocket.

The PRC representatives stated that the inertial measurement unit used on the Long March 3B that failed was different from the one used on the Long March 3, which was the rocket that would be used to launch the Apstar 1A, and that therefore there should be no cause for concern for the launch of the Apstar 1A.

Representatives of the insurance underwriters then stated that insurance of the Apstar 1A launch would be conditioned on delivery of a final report on the root causes of the Long March 3B failure, and a review of that report by an independent oversight team.

A subsequent meeting with the insurers and re-insurers was scheduled to take place in Beijing around mid-April, at which time the PRC representatives were to present in detail the results of their accident investigation of the Long March 3B.

The Apstar 1A re-insurers meeting took place on April 15 and 16. It included both items normally addressed in preflight reviews as related to the upcoming Apstar 1A launch, and the issues arising from the Long March 3B rocket failure in the Intelsat 708 launch.

The latter issues were largely covered in presentations by Huang Zuoyi, President of Great Wall Aerospace, a California-based subsidiary of China Great Wall Industry Corporation. These presentations substantially made the same points as were made at the March 14 meeting: the Long March 3B failure was in the inertial measurement unit, and this was not cause for concern for the Apstar 1A launch since it would be launched by a Long March 3 rocket having a different (and older) inertial measurement unit with a previous record of successful launches.

At this same meeting, in response to the re-insurers' earlier-stated requirement, China Great Wall Industry Corporation announced the creation of an Independent Review Committee to review the findings and recommendations of the PRC committees investigating the Long March 3B failure.

Dr. Wah Lim of Loral was to be the Independent Review Committee Chairman, and Nick Yen, also of Loral, was to be the Secretary. Both were present at the meeting and discussed the role of the Independent Review Committee, and the roster of members of the committee. The two prospective members from Hughes, Dr. John Smay and Robert Steinhauer, were also present, as was Nabeeh Totah, a senior technical staff member at Loral, who would serve as one of four technical experts provided by Loral to support the Independent Review Committee.

During this meeting, the participants were taken on a tour of the Long March rocket assembly area and were shown, in partially-opened state, units described by the PRC as the older Long March 3 inertial measurement unit and the newer Long March 3B inertial measurement unit. Thus, almost half of the Independent Review Committee participants (members plus supporting experts) had prior exposure to the findings and views of the PRC representatives derived from their accident investigations, and they had opportunities to raise questions and issues with the PRC representatives well before the first meeting of the Independent Review Committee.

The Long March Series of Rockets

The PRC Long March rocket evolved from the PLA's long-range ballistic missiles, much as most of the U.S. heavy-lift rockets were derived from earlier ballistic missiles: the Atlas E and F; the Titan II; and the Thor (the forerunner of the Delta rocket).

Much of the civil and commercial satellite traffic needs to be put into geosynchronous orbit over the equator at 22,000 miles above the Earth's surface. At this altitude, the satellite orbital speed is exactly that needed to keep a constant position over a point on the surface of the rotating earth below. A common method of achieving these orbits is for the rocket to first place the satellite into a highly elliptical geosynchronous transfer orbit, and then for the satellite itself to circularize the orbit at geosynchronous altitude, using a so-called kick rocket motor on board the satellite.

The need to achieve geosynchronous transfer orbit with increasingly heavy payloads has led rocket designers to add high-energy liquid oxygen/liquid hydrogen upper stages on top of the original lower stages that still use the fuels and oxidizers of their ballistic missile antecedents. In addition, increased thrust levels have been added to these first stages by means of strap-on booster rocket motors. The Long March series of rockets has gone through just this set of evolutionary steps, paralleling in this respect its American counterparts.

Guidance Systems for Ballistic Missiles and Rockets

The requirements for guidance accuracy for intercontinental ballistic missiles depend on a nation's strategic objectives and policies, but they are generally more demanding than the accuracy that is required to place a satellite into geosynchronous transfer orbit. For example, for a ballistic missile with a target range of 5,500 miles, an error of one foot per second in the velocity at last-stage burnout (23,000 feet per second) would lead to an error in target impact of about one mile. A satellite on orbit, on the other hand — if such accuracy in its orbital parameters is required — can measure its position over an extended period of time with the aid of ground tracking, and adjust for orbital velocity differences of this magnitude with on-board thrusters using only a few pounds of fuel.

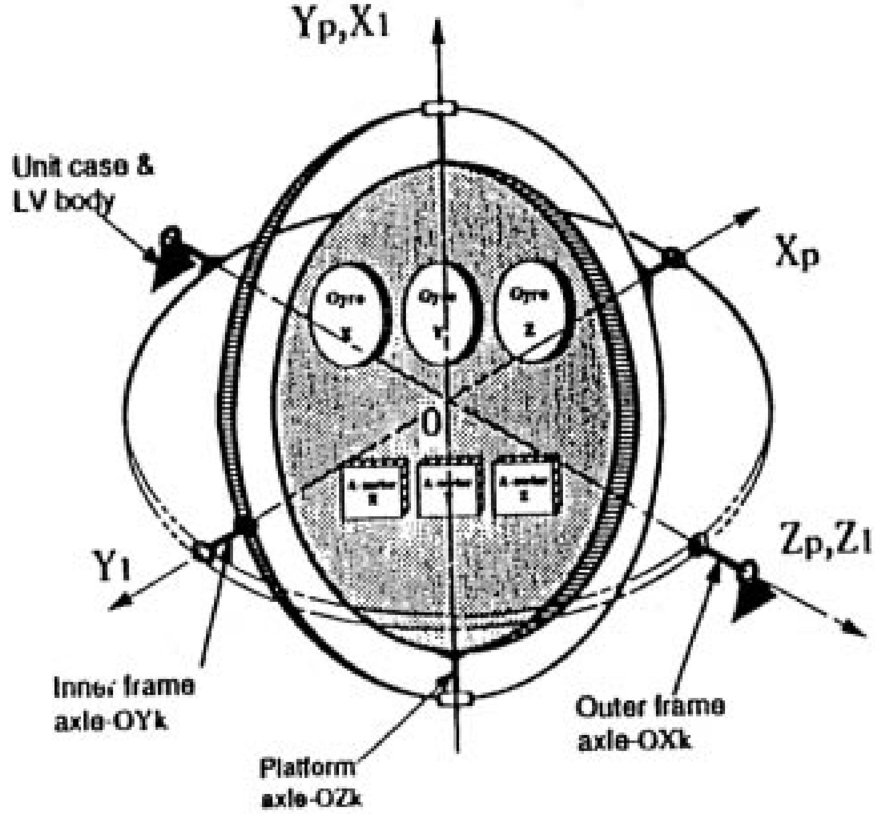
It appears that in the PRC, guidance systems for rockets were initially based on instruments and inertial platform technologies taken over from the predecessor ballistic missile programs. But the PRC's development of inertial guidance for rockets has, as in the West, developed over time in directions somewhat different than inertial guidance for intercontinental ballistic missiles.

Over time, inertial guidance systems for rockets have incorporated simpler, cheaper, lighter, and more reliable components, as well as concepts such as ring-laser gyros and strapdown technology in which there is no inertial platform required to maintain a fixed position in space. In contrast, the latest U.S. ICBM inertial guidance system is the Advanced Inertial Reference Sphere (AIRS), used on the Peacekeeper missile. It is probably the most accurate inertial measurement unit ever developed and manufactured. The inertial measurement units used on earlier ballistic missiles used an inertial platform mounted on a set of gimbaled axis frames. The AIRS, on the other hand, consists of a beryllium sphere floating in a fluorocarbon fluid within an outer shell, with no gimbals or bearings at all, housing highly accurate gyros and accelerometers. The AIRS is complex, difficult to manufacture, and very expensive.

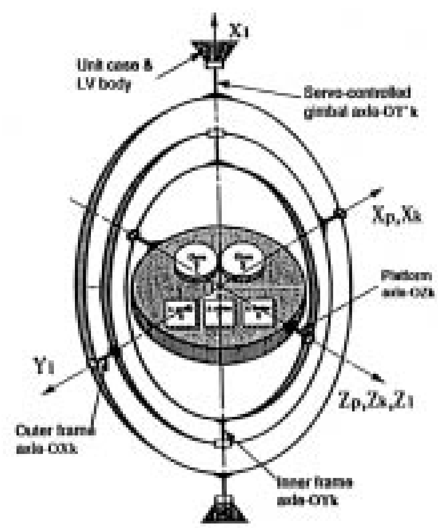
The PRC representatives had indicated (or allowed the impression to be conveyed) to their Western customers and their insurers that the inertial measurement unit used on the several versions of the Long March 2 and 3, up to the 3B, was essentially identical to the inertial measurement unit used on their long-range ballistic missile. Rather than basing their claims of the inertial measurement unit's reliability on the more slender record of space launches alone at the time the Long March was first offered to foreign customers for launch services, the PRC may have offered this information to enhance the record of reliability of the inertial measurement unit. This permitted the PRC to show that the Long March had a longer and larger record of successful flights than would be assumed on the basis of its use in space launches only.

As presented by the PRC participants, the older inertial measurement unit used in the Long March 3 weighed 140 kilograms, and measured 500 x 600 x 800 mm. It had three gimbal axes and three single-axis gyroscopes on its inertial platform. It was also said to have a high degree of redundancy to preclude single point failures. The newer Long March 3B inertial measurement unit was presented as having a weight of 48 kilograms, and dimensions of 300 x 300 x 400 mm. It had four gimbal axes with only two (two-axis) gyroscopes on its inertial platform.

The fourth gimbal axis in the newer Long March 3B unit is associated with the addition of a follow-up frame to the platform mechanism. The follow-up frame precludes the occurrence of gimbal lock. This can take place in inertial platform assem-



IMU of LM-3



IMU of LM-3A/3B/3C

An artist's rendition of the difference in design between the inertial measurement unit used on the Long March 3 as compared to that used on the Long March 3A, 3B, and 3C rockets. The two illustrations are not shown to the same scale; the Long March 3 inertial measurement unit is much larger, and weighs nearly three times more.

blies when the rocket undergoes large angles of inclination, and two of the frames of a three-gimbal inertial platform mechanism move into the same plane.

Thus, the Long March 3B inertial measurement unit, as described and displayed by the PRC participants, is an essentially different subsystem from the inertial measurement unit of the Long March 3. In fact, it was reported that some members of the insurance community felt that the PRC had an obligation to inform them of this change affecting the reliability and performance of the Long March series of rockets, and should have done so before the Intelsat 708 launch.

The Meetings of the Independent Review Committee

The first meeting of the Independent Review Committee was held in Palo Alto, California, on April 21 and 22, 1996. Some members of the committee and its supporting experts had already had considerable prior exposure to the facts of the accident that occurred during the flight of the Long March 3B rocket carrying the Intelsat 708 satellite.

According to its charter, the Independent Review Committee was nominally an entity responsive to the China Aerospace Corporation, the parent company of China Great Wall Industry Corporation. The President of China Aerospace Corporation convened the Independent Review Committee. It was he who appointed the Independent Review Committee's Chairman, Dr. Wah Lim of Loral.

During the first day of the first Independent Review Committee meeting, those committee members present were briefed by a Loral export control officer concerning export control limitations that would apply to Independent Review Committee activities. In the recollection of several of those present, there were few questions and little discussion of the briefing — a surprising situation, in view of the seeming dissonance between the Independent Review Committee charge in its charter and the restrictions expressed in the export control briefing.

In that briefing, members of the Independent Review Committee were told that disclosure of information that would enhance rocket or missile capabilities of the PRC would not be permissible. But as one participant in the Independent

Review Committee activity said, "You can't help but get a little bit too detailed in the interest of finding out what the cause of the failure is. It's possible there could have been [circumstances] where you ask leading questions which you're not supposed to."

The first meeting was devoted to familiarizing the members of the Independent Review Committee, especially those who had not taken part in the earlier April 15 and 16 meeting, with the circumstances of the Long March 3B failure, the data acquired from telemetry, and the findings of the PRC accident investigation up to that time. The Independent Review Committee asked many questions having to do with understanding and interpreting the following:

- **Telemetry data**
- **The particulars of the inertial measurement unit hardware**
- **The details of the Long March 3B pre-launch procedures and launch operations**
- **The vibration and acoustic environment to which the inertial measurement unit was exposed in flight and in ground testing**
- **The scope and technical details of the analyses pursued in the PRC accident investigation**

Many of the Independent Review Committee's questions could not be answered immediately, and were listed for consideration at the second meeting of the committee that was to be held in Beijing on April 30 and May 1, 1996.

The PRC presentations at the Independent Review Committee meeting on April 21 and 22 repeated the main accident investigation finding reported in the meeting of April 15 and 16: that the cause of the failure was in the inertial measurement unit. Further, the failure in the inertial measurement unit was ascribed by the PRC participants to the loss of current to the torque motor of the *inner* frame gimbal axis. This loss of current, in turn, was hypothesized to be due to a break in the wire (or soldered joint) that supplied power to the torque motor.

In support of this hypothesis, the PRC participants presented "hardware in the loop" simulation results. The simulation showed agreement with telemetered inertial platform data from the failed flight for about the first six seconds after liftoff. On this basis, the Independent Review Committee granted in its statements and reports to the PRC that the loss of current to the *inner* frame gimbal torque motor was the most probable cause of the failure.

However, the telemetered flight data indicated three cycles of reversals of platform motion over the approximately twenty-two seconds of flight from liftoff to impact. These data were not matched by the simulations. To explain this cyclic motion, the PRC representatives assumed that the break in the circuit to the *inner* frame axis torque motor was such that electrical contact could be successively made and broken three times during the flight.

From the first time this explanation was offered, the members of the Independent Review Committee were skeptical of it, and repeatedly questioned it. The PRC participants, on the other hand, never abandoned it from the beginning to the end of the Independent Review Committee activity.

The Independent Review Committee's refusal to accept the adequacy of the PRC participants' explanations, analyses, and simulations to determine the root cause of the failure, and the committee's insistence on the need to simulate the periodic platform motions for the entire 22 seconds of flight, are the main issues raised in the minutes of its first meeting. These topics remained as prominent issues in the committee's preliminary report.

Because the U.S. Government directed cessation of its activities earlier than planned, the preliminary report was the last report issued by the Independent Review Committee.

The other significant issues that were given serious attention by the Independent Review Committee at its first meeting, as reflected in the minutes of the meeting, included the list of questions that the PRC participants were to answer at the following meeting to be held in Beijing. These questions concerned the following areas:

- **Quality assurance and control,** including acceptance testing procedures for the inertial measurement unit

- **The design and manufacture of inertial measurement units,** and their assembly into the rockets
- **The validity of the test environments** (vibration, noise, and thermal) in the Long March 3B vehicle equipment bay where the inertial measurement unit was located
- **Range safety at the launch site**

The second meeting of the Independent Review Committee took place in Beijing on April 30 and May 1, 1996. On the major issue of the cause of the Long March 3B failure during in the launch of the Intelsat 708 satellite, the PRC participants' conclusions remained unchanged.

The most probable root cause of the accident, the PRC asserted, was a break in the circuit carrying current to the torque motor of the *inner* frame gimbal. This break they attributed to a failure in the wire directly connected to the torque motor, or one of its soldered joints.

T**o explain the three cycles of platform motion observed in telemetry, the PRC still advanced the hypothesis** that the motion of the wire and the platform caused electrical contact to be made and broken three times. In the failure-tree analysis presented by the PRC participants to examine all possible causes of the Long March 3B launch failure, all failure possibilities not involving the torque motor of the *inner* frame gimbal axis were ruled out.

The PRC participants also presented a list of proposed fixes to the Long March 3B inertial measurement unit. This list included:

- **Improvements in soldering**
- **The cutting of wires** to allow length sufficient to allow for the maximum platform frame travel to be encountered
- **Non-destructive pull tests of soldered joints**
- **X-ray inspection of wires**
- **Improved acceptance testing, and addition of acoustic environment**

- **Redundancy in design**
- **Greater attention to quality supervision of suppliers**

Most of these items follow from the erroneously postulated broken-wire failure mode.

However, the PRC's proposed improvements in acceptance testing, with the addition of an acoustic environment, are of more general application — they could apply no matter where in the inertial measurement unit the failure might have occurred. Most of these corrective measures relate to some extent to questions raised by the Independent Review Committee at its first meeting.

Technical Information and Advice Transferred in Independent Review Committee Meetings and Reports

It is not possible to consider all of the technical information and advice that may have been imparted to the PRC representatives during the period of Independent Review Committee activity, since verbatim records of the meetings were not kept at either of the main meetings or at any of the meetings of subgroups (including "splinter groups" involving Independent Review Committee members, staff, and PRC personnel, and meetings involving only Independent Review Committee members and staff) that were held. Therefore, this assessment is based on the Select Committee's review of available records of the Independent Review Committee meetings, its communications with Independent Review Committee members mainly relating to composing and reviewing reports, and its interviews with individual participants in the Independent Review Committee's activities more than two years after that committee had ceased its activities.

Moreover, the perspective adopted in this assessment is that of viewing all of the information as a whole, in the context of the Long March 3B failure and PRC actions not only to find and correct the failure, but also to convince customers, insurers, and re-insurers that the causes of the failure had, in fact, been found and corrected.

From a technology transfer standpoint, it is noteworthy that the Independent Review Committee charter called on the committee not only " . . . to perform an independent assessment of the most probable cause or causes of failure," but also to ". . .

review the corrective action plans proposed by the [PRC's Failure Investigation Committee] and make its assessments and recommendations to [China Aerospace Corporation] and [China Great Wall Industry Corporation]." [Emphasis added]

Clearly, the charge to the Independent Review Committee went beyond making judgments about whether or not the PRC had convincingly determined the cause of failure. The Independent Review Committee members were not only to go beyond reviewing the PRC failure analysis to making *an independent assessment of the most probable cause or causes of failure,* they were also to review and make *assessments and recommendations concerning the corrective measures to remove the causes of failure.*

Taken literally, corrective measures could be none other than the means of improving the design, manufacturing, or operation of the PRC Long March 3B rocket. By extension, these improvements could improve the design, manufacture, or operation of other PRC rockets as well, and, less directly, of present or future PRC military equipment.

Moreover, the charter called for the Independent Review Committee to "*. . . provide the [China Great Wall Industry Corporation] with copies of any and all working papers collected during its review process.*" [Emphasis added]

It is important to recognize that one of the benefits of a comprehensive accident investigation is that many potentially faulty design features, parts, or procedures ("accidents waiting to happen") may be found and corrected, whether or not they can actually be shown to have played any part in the accident under investigation.

A recent example is that in the investigation of the flight failure of TWA 800, deficiencies were found in the electrical systems of the fuel tank pumps that might have caused or contributed to the failure, or might be the cause of a failure in the future. These deficiencies are being corrected in spite of the fact that they have not been proved to be the cause of the accident.

Thus, included in this assessment are information and advice to the PRC on correcting faults or deficiencies in the design, manufacture, or operation of the Long March 3B, and on improving PRC quality assurance and reliability — as well as information and advice that could apply to PRC rockets or ballistic missiles with design features similar to the Long March 3B — whether or not they are related to what was ultimately determined to be the most likely cause of the Long March 3B accident.

In the period after the Independent Review Committee activities were terminated, the PRC participants, continuing their "hardware in the loop" simulations, found that even with artificially-imposed making and breaking of contact of the electrical connection to the *inner* frame gimbal torque motor, they could not simulate the periodic behavior of the inertial platform for the entire 22-second flight duration.

As later reported by the PRC participants, the series of "hardware in the loop" simulations and analyses that took place from May 20 to June 20, 1996 led to the identification and verification of the *follow-up* frame gimbal axis torque motor circuit as the site of the failure. They did find that by breaking the circuit to the *follow-up* frame torque motor, the entire 22 seconds of flight including the cyclic motions of the inertial platform could be simulated.

The conclusion was then reached that the root cause of the failure was to be found in the electrical circuits associated with the *follow-up* frame gimbal torque motor.

According to PRC officials, examination of these circuits in inertial measurement units from the same production batch as that aboard the failed flight of the Long March 3B led to the discovery of a faulty gold-aluminum junction in the power module that drove this torque motor. The deterioration of the gold-aluminum joint was cited as the cause of the break in the circuit of the follow-up frame gimbal torque motor that led to the inertial measurement unit failure. These findings and conclusions were briefed to the satellite manufacturing, operating, and insurance communities in October 1996.

In the last Independent Review Committee report sent to the PRC after the committee's second meeting, it was suggested that the making and breaking of electrical contacts was not necessary to explain the cyclic motion of the rocket's inertial platform. Rather, once a circuit failure had occurred, it was possible for the platform to perform a natural limit cycle motion. Limit cycles are a well-recognized phenomenon in the dynamics of mechanical, electrical, and electromechanical nonlinear systems.

Although this argument was introduced while the break in the circuit to the inner frame torque motor was considered to be the most probable root cause for the observed inertial platform behavior, it obviously could apply to any other frame or torque motor.

During the second Independent Review Committee meeting, attention was called to the flat behavior of the angle measurement (resolver) of the follow-up frame. The Independent Review Committee stated that it was "very critical" to explain this behavior.

The PRC participants stated that the flat behavior was due to a bad choice of resolution for this telemetry channel — an explanation they obviously changed their mind about later.

Also in the same meeting, the Independent Review Committee called further attention to the follow-up frame by suggesting the possibility that it might have been frozen — that is, mechanically jammed. Although it did not turn out to be the final explanation, this failure mode could have produced about the same kind of inner frame angle resolver telemetry trace as a break in the circuit powering the follow-up frame gimbal axis torque motor. This was an alternate possible cause for the anomaly in the telemetry trace of follow-up frame angle.

Moreover, in their last report, the Independent Review Committee once more suggested that the PRC look again at the validity of their explanation of the flat trace of the follow-up frame angle resolver.

In its comments, questions, and advice on the inertial measurement unit failure mode, and on the simulations and analyses conducted to establish that mode, the Independent Review Committee:

- **Consistently rejected the making and breaking of electrical contact** by the wire delivering current to the torque motor for the inner frame as a plausible explanation for the observed cyclic motion of the inertial platform

- **Insisted that, although the wire break in the circuit carrying current to the inner frame torque motor might be**

considered the most probable root cause for the failure, it could not be accepted as conclusive until additional analyses and "hardware in the loop" simulations could demonstrate that the cyclic motions of the inertial platform over the entire 22 seconds of flight could be accounted for on the basis of this cause

- **Forcibly called attention to the indications in telemetry that the follow-up frame angle measurement was flat,** and remained skeptical of the PRC explanations for this anomaly

- **Pointed out that successive making and breaking of electrical contact in a torque motor circuit was not a necessary condition** for development of cyclic motion of the platform

It is, of course, not possible to say how much these technical comments, suggestions, and challenges influenced the PRC. But they were all in the direction of moving the PRC representatives away from their fixation on the broken wire in the inner frame gimbal axis torque motor as the predominant, if not sole, failure mode to which they had given significant attention in their investigation since mid-March.

Another area that the Independent Review Committee focused on was reliability and quality assurance. In their plant tours, several of the Independent Review Committee members saw what they considered to be flight inertial measurement unit hardware being carelessly handled and touched. In the preliminary report, in the short term, the Independent Review Committee recommended that higher quality control and quality standards be applied in the manufacturing process.

In the detail design of the inertial platform wiring, the Independent Review Committee recommended studies to either preclude wiring harness motion during gimbal motion, or alleviate the effect of unavoidable deflection on solder joint integrity.

Also, the Independent Review Committee recommended that the PRC reexamine the environmental conditions (vibration, noise, and thermal) used in qualification and acceptance testing of the inertial measurement unit.

The distinction between qualification tests and acceptance tests must be made:

- **Qualification tests** are a part of the design and development of the inertial measurement unit. Their purpose is to verify the basic design and manufacturing processes. A high degree of fidelity in simulating flight environments is sought in qualification testing.

- **Acceptance tests** are carried out on *each unit* produced. Acceptance test environments are generally at lower levels of intensity than qualification tests. Depending upon the particulars of specific designs and their potential vulnerabilities, they may be of lower fidelity in representing flight environments in detail.

In fact, vibration tests as part of acceptance testing may often be regarded as tests of workmanship in production. The Independent Review Committee referred specifically to the workmanship verification function in Attachment IV to the minutes of its second meeting as follows: "Quality control was not thorough; the open wire problem should have been caught earlier in the environmental acceptance or screening test[s]."

For the longer term, the Independent Review Committee recommended that quality control philosophy and practices in fabrication, assembly, and testing should be strengthened and personnel should be trained accordingly. These recommendations would also affect reliability and quality assurance. The committee also recommended that consideration be given to increasing the redundancy of the platform.

While these recommendations of improved quality control and greater redundancy can be regarded as general maxims for achievement of improved reliability, it must be borne in mind that they are being made in the context of the expert Independent Review Committee's detailed review of the deficiencies in design, manufacture and testing of the specific inertial measurement unit on the Long March 3B.

The Independent Review Committee also made recommendations concerning the vibration, acoustic, and thermal environments to which the inertial measurement unit (and other avionics) were designed and tested. In their last report, they recommended that the PRC reexamine their environmental test plan for all avionics equipment, expressing the view that the tests might not be adequate for meeting "expected maximum flight loads including acoustic noises or detecting the defects in flight hardware."

The Intelsat 708 Encryption Boards Were Never Recovered

The Intelsat 708 satellite carried two FAC-3R encryption boards, one in each of its command processor units. These boards are considered Controlled Cryptographic Items by the Department of Defense, and the algorithm is classified "Secret."

Encryption boards are used to protect the command and control links between the ground station and satellite. They are required even on satellites that carry unclassified U.S. Government communications traffic. These devices do not encrypt the communications traffic that is otherwise processed by the satellite payload.[374]

Shortly after the Intelsat 708 launch failure, Loral's Communications Security custodian reported to the Department of Defense that the status of the encryption boards was being changed to "destroyed."

This was not seen as unusual by Department of Defense, however, because its prescribed policy requires that encryption boards be reported as "destroyed" when they are launched into orbit.

The Department of Defense did not require Loral to produce any evidence that the FAC-3R boards were in fact destroyed.[375]

After recovering debris from the crash site, Loral engineers grossly estimated the percentages of various subsystems and components that had been recovered.[376] In that estimate, Loral engineer Muhammad Wahdy estimated that 30% of the command processors were recovered.[377] Loral personnel then packaged the debris and shipped it to Palo Alto, where engineers examined the debris to specifically determine if the encryption boards were recovered.[378]

That examination determined that the FAC-3R boards were not, in fact, recovered from the crash site.[379]

The two FAC-3R encryption boards used on the Intelsat 708 satellite were mounted near the hydrazine propellant tanks and most likely were destroyed in the explosion. Additionally, the two FAC-3R boards had no distinguishing markings other than a serial number, making it extremely difficult to locate them amongst the crash debris.[380]

It is not known, however, whether the FAC-3R boards were recovered by the PRC. If they were, it would be difficult for the PRC to determine the cryptographic algorithm that was imprinted on them.

Reverse-engineering of a damaged board would be even more difficult. Any successful reverse-engineering would be resource intensive for the PRC.

If the PRC were able to determine the cryptographic algorithm contained on the FAC-3R board, it would gain insight into the state of the U.S. military in the 1960s, although such algorithms remain in use today.[381]

When the National Security Agency designs and recommends algorithms for use in equipment, it assumes that the equipment will be lost or compromised sometime during its operational lifetime. The National Security Agency relies on unique cryptographic keys for each separate satellite to keep command and control links secure. Because the FAC-3R boards on Intelsat 708 were uniquely keyed, the National Security Agency remains convinced that there is no risk to other satellite systems, now or in the future, resulting from having not recovering the FAC-3R boards from the PRC.[382]

Summary Assessment

In the period after the Independent Review Committee activities were terminated, the PRC participants, continuing their "hardware in the loop" simulations, rejected their own findings that the cause of the launch failure related to the *inner* frame of the inertial measurement unit. Instead, the PRC followed the path identified for them by the Independent Review Committee to conclude that the true cause of the launch failure was related to the *follow-up* frame.

The PRC engineers found that, even with artificially imposed making and breaking of contact of the electrical connection to the inner frame gimbal torque motor, they could not simulate the periodic behavior of the inertial platform for the entire 22-second flight duration. (As later reported by the PRC, the series of "hardware in the loop" simulations and analyses that led to the identification and verification of the follow-up frame gimbal axis torque motor circuit as the site of the failure took place from May 20 to June 20, 1996.)

The PRC participants then concluded that the root cause of the failure was to be found in the electrical circuits associated with the follow-up frame gimbal torque motor. The PRC engineers found that by breaking the circuit to the follow-up frame torque motor, the entire 22 seconds of flight, including the cyclic motions of the inertial platform, could be simulated.

According to the PRC engineers, examination of these circuits in inertial measurement units from the same production batch as the one used on the failed flight led to the discovery of a faulty gold-aluminum junction in the power module that drove this torque motor. The deterioration of the gold-aluminum joint was cited as the cause of the break in the circuit of the follow-up frame gimbal torque motor that led to the inertial measurement unit failure. These findings and conclusions were briefed to the satellite manufacturing, operating, and insurance communities in October 1996.

The Independent Review Committee's comments and suggestions could well have helped the PRC to come to the correct conclusion in their accident investigation more directly and quickly than they otherwise would have.

Taken together, the following actions by the Independent Review Committee would have had the effect of steering the PRC investigators away from their protracted narrow focus on the wrong failure mode:

- **The Independent Review Committee's continuing skepticism** concerning the make-and-break of electrical contact in the connection to the inner frame axis torque motor as a plausible explanation of the observed telemetry data (this was the PRC participants' initial explanation for the launch failure)

- **The committee's insistence that the failure mode investigation could not be considered complete and convincing** until the entire 22 seconds of flight had been simulated (in contrast to the PRC participants' initial reliance on data from only the first seven seconds of flight)

- **The committee's pointing to the existence of dynamical limit cycles of platform motion that could result from a single break** in a torque motor circuit, without repeated making and breaking of electrical contact (again in contrast to the PRC participants' approach)

- **The committee's persistent calling of attention to the potential significance of the flat output of the follow-up frame** angle resolver (the actual location of the cause of the launch failure)

The search for the true failure mode in an accident investigation is not a simple, straightforward procedure. In some respects, it is like finding the way through a maze. It is all too easy to start down a wrong path and to stay on it for too long. Insights, hunches, and clues based on technical judgments and experience in prior failure mode analyses, simulations, and accident investigations can be helpful. Advice from individuals or groups drawn from outside the program that has suffered a failure is often sought, even in organizations that have world-class technical competence. Even opinions from such an outside group confirming that the investigation is on the right track have value.

In the complex task of failure investigation, the right failure mode and adequate corrective measures are often not arrived at the first time. Sometimes there are repeated failures from the same cause because the failure mode analysis was inaccurate or incomplete. (An example was the failure of the PRC Long March 2E fairing, first in the Optus B2 launch in 1992, and then again in the Apstar 2 failure in 1995.) Absent a dissenting view voiced by an authoritative independent group such as the Independent Review Committee, the pressures for getting on with the next launch of the Long March 3B could have prevailed, the flawed analysis of the failure mode could have been accepted, and another failure could have resulted. At the least, the contribution of the Independent Review Committee to the PRC accident investigation may have been simply to speed up the investigation.

The Independent Review Committee's recommendations seem to have affected PRC rocket reliability. The PRC briefed subsequent Long March launch customers and their insurers (for example, in the case of Loral's Mabuhay satellite launch) concerning measures being taken to improve the reliability of the Long March 3B inertial measurement unit (and avionics generally) and acceptance testing.

The measures the PRC took to improve the reliability of the Long March 3B go beyond those listed in the PRC briefings at the second meeting of the Independent Review Committee in Beijing (some of which may have been influenced by questions raised earlier by the committee). For example, in the Beijing meeting, wiring connections on the platform were to be double-soldered. The later briefings indicate that all platform-moveable connections are to be double-jointed (a stress-relieving measure of the type referred to in the Independent Review Committee report's recommendation to "alleviate the impact of unavoidable deflection on solder joint integrity") and double-wired.

Also, the recommendation of the Independent Review Committee for steps to attack quality control philosophy and practice broadly, and to train personnel, are reflected in the PRC statement of intent to strengthen education in quality control for all employees, and to establish income incentives to quality. These measures to improve quality control and reliability may be the standard fare of management literature, but the context of the Independent Review Committee recommendations is that they are made with regard to a specific set of processes and practices employed in the manufacture and assembly of the Long March 3B that they reviewed.

To the extent that these practices and processes are representative of those employed on other rockets or ballistic missiles or their components built by the same or related organizations, the quality control and *reliability* of these PRC rockets and missiles could also be improved.

To answer definitively whether the Independent Review Committee's technical advice and recommendations had the effect of assisting the PRC in improving the *accuracy* of PRC ballistic missiles, it would be necessary to know whether the Long March 3B inertial measurement unit is used on any ballistic missile and whether, in fact, the Long March 3B inertial measurement unit has advantages in accuracy or other measures over others available to the PRC. The guidance accuracy requirements for an intercontinental ballistic missile based on what is assumed to be PRC missile doctrine (essentially, a "city busting" strategy) would not be considerably greater than the accuracy requirements for a rocket used to launch satellites. Because the Long March 3B inertial measurement unit is lighter and smaller than the units used on the PRC's intercontinental ballistic missiles (such as the currently-deployed CSS-4), it would not need to have greater accuracy to be advantageously applied for its weight and size advantages.

Because the PRC strategic forces doctrine apparently targets U.S. cities, this does not require especially demanding accuracy. For this, the inertial measurement unit on the Long March 3B may be sufficient — in which case its size, weight, and, potentially, reliability advantages may weigh more heavily in its favor. Of course, if the PRC has available other lighter and smaller guidance units that are more accurate, those are more likely to be chosen for the mobile intercontinental ballistic missile mission.

For shorter-range ballistic missiles, the Long March 3B inertial measurement unit might possibly be advantageously used. But it would have to compete against a variety of even more compact, strapdown systems of sufficient accuracy for short ranges. Therefore, the application of the Long March 3B inertial measurement unit or some variant of it to some future PRC ballistic missile development remains possible.

To the extent that ballistic missile manufacturing processes and practices are similar to those for rockets, an incremental potential benefit to future PRC ballistic missile programs could come from increased production efficiency, and improved reliability through adoption of improved quality control and reliability-enhancing measures in design and manufacturing that were introduced after the accident investigation, including some that the Independent Review Committee advocated.

LAUNCH SITE SECURITY IN THE PRC

The U.S. satellite manufacturer is responsible for the physical security of U.S. satellites that are exported to the PRC, and for guarding against the unauthorized or illegal transfer of U.S. technology during technical discussions that occur in the PRC. The U.S. Government oversees this function by assigning a representative of the Defense Technology Security Administration (DTSA), now known as the Technology Security Directorate of the Defense Threat Reduction Agency, to the launch site in the PRC.

This Defense Department "monitor" is responsible for ensuring that the satellite manufacturer properly implements a Technology Transfer Control Plan that is intended to provide and maintain protection against the unauthorized transfer of U.S. technology. Defense Department monitors also are required to attend all meetings of a technical nature that may occur between the satellite manufacturer's employees and representatives of the PRC launch provider leading up to and during the launch.

In the course of their duties, Defense Department monitors are required to report regularly to the U.S. Air Force's Space Command and Technology Security Directorate Headquarters on their activities at the launch site, including any security infractions they have detected. According to the Director of the Defense Technology Security Administration and Defense Department monitor reports, these infractions represent instances that require the monitor's attention, but do not necessarily constitute violations of the export license that should be reported to the State Department. The guidance that is provided to Defense Department monitors provides that, should they encounter a security infraction at a launch site, they should first try to work out the problem with the satellite manufacturer's personnel, including its security guard force. If this effort does not result in resolution of the problem to the satisfaction of the monitor, then the monitor is to call Headquarters and advise a supervisor. The supervisor may then call the company to insist that it remedy the security problem.

Defense Department monitors have reported many minor to severe security infractions at launch sites in the PRC. While the Select Committee's limited review has found no witness to confirm that a transfer to the PRC of controlled U.S.

technology has occurred as a result of ineffective launch site security, given the difficulty of proving that an improper transfer has occurred, it cannot be inferred that no such transfer has taken place. Moreover, the security infractions that have been documented demonstrate the potential for technology transfers to occur. Testimony by the Department of Defense on the potential for a technology transfer to occur as a result of access to a satellite in the PRC provides a perspective for considering these security infractions.

The Defense Department concluded that visual or photographic access to a satellite would allow confirmation of the existence of various attributes of a satellite already in the public domain.

With additional, longer-term unguarded access, the Defense Department estimated that a foreign intelligence collector could gain physical access to the satellite and obtain technical information of value regarding the satellite.

U.S. satellite manufacturers hire a security force to provide physical security for a satellite while it is awaiting launch in the PRC. In recent years, only one security guard company has bid on and received contracts to provide this service in the PRC.

The conduct, professionalism, and abilities of that company's personnel have been sharply criticized both by Defense Department monitors and the satellite companies.

Because of the potential that technology transfers associated with the launch of a U.S. satellite in the PRC can occur, it is critical that the Defense Department monitors, the physical security guards, and the satellite manufacturers provide effective protection of U.S. technology associated with launches in the PRC. The Strom Thurmond National Defense Authorization Act for FY 1999 has addressed several of the criticisms received both from inside and outside the Defense Department regarding its monitoring program. However, the Clinton administration has not yet issued regulations to implement the Act.

PROTECTING SENSITIVE INFORMATION AT PRC LAUNCH SITES

The United States relies on a variety of means to protect controlled military-related technology during PRC launches of U.S. satellites. These include bilateral agreements between the United States and the PRC, export licenses for satellites and related technology, the presence of private security guards at PRC launch sites, and monitoring of launch-related activities and communications by U.S. Defense Department representatives.

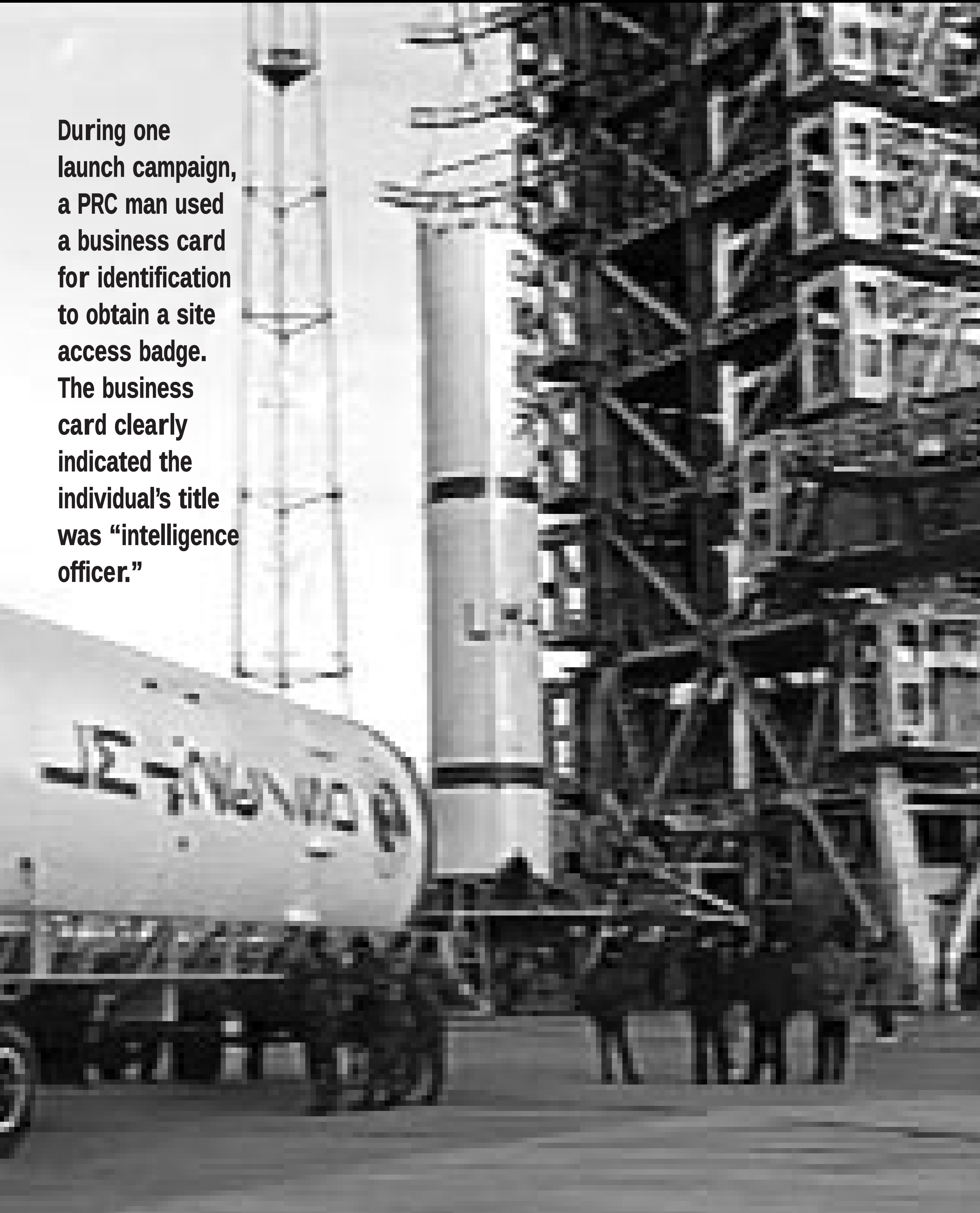
Background

U.S.-PRC Bilateral Agreement

In 1988, prior to authorizing the first launches of U.S. satellites from the PRC, the United States entered into a bilateral agreement with the PRC to prevent unauthorized disclosures of controlled technology. Under that agreement, the PRC agreed to give the United States access to and complete control over the satellite and related information while it is in the PRC for launch. The PRC also agreed not to seek to obtain unauthorized information.[1]

Export Licenses for PRC Launching of U.S. Satellites

Under U.S. law (including the Arms Export Control Act, the International Traffic in Arms Regulations, and regulations issued by the Department of Commerce),[2] a private party wishing to launch a U.S. satellite from the PRC must first obtain an export license to do so. The license limits the access that the PRC can have to the satellite, restricts the information that can be shared with the PRC, and requires that the private



During one launch campaign, a PRC man used a business card for identification to obtain a site access badge. The business card clearly indicated the individual's title was "intelligence officer."

party develop and abide by a plan to protect controlled information from unauthorized disclosure. Private security guards are often hired for this purpose.

Defense Department Monitors

The United States requires that Defense Department representatives must be present at the PRC launch site, and that the expense of these monitors must be borne by the U.S. satellite manufacturer. These Defense Department officials are responsible for overseeing the physical security of the satellite and associated equipment and documents. They are also required to monitor the technical interchange meetings that occur between U.S. and PRC engineers throughout the satellite development and launch campaign.

Each of these mechanisms for protecting sensitive, controlled U.S. information from unauthorized disclosure is discussed in this chapter.

Unauthorized Access Allows Opportunities to Gain Information Concerning U.S. Satellites and Other Controlled Technology

Launch site security is intended to protect controlled military-related technology, including information that could be gleaned from a U.S. satellite and its associated documents, equipment, and technical personnel, against disclosure to the PRC. Protecting controlled information that might be stolen or inadvertently disclosed during the launch or pre-launch period is a demanding and important task.

Efforts to protect U.S.-controlled technology during the launch and pre-launch period in the PRC are complicated by several factors.

First, the launch and related pre-launch activities (often called the "launch campaign") in the PRC take place largely on a PLA military base. The Xichang Space Launch Center, from which many U.S.-manufactured satellites are launched, is located within a PLA military installation. Yet the U.S. satellite manufacturer is required to maintain control over certain portions of the facilities and to make them secure during the time a U.S. satellite and its associated documents and equipment are located there.

Associated Press

Efforts to protect U.S.-controlled technology are complicated by the fact that the launches of U.S. satellites take place on PLA military bases.

Second, U.S. satellite manufacturing companies take considerable amounts of controlled equipment and technical data to the military facility in order to assist them in their work to prepare the satellite for launch. All this controlled information is required to be kept under lock and seal when not in use and protected.

Yet PRC workers have legitimate reasons for having access to some of these U.S. materials at various times, making the security function particularly demanding.

Third, the U.S. engineers and support personnel who accompany the satellite must live and operate far away from home, often under relatively uncomfortable conditions. Some U.S. companies are unaccustomed to doing business in such a demanding security environment.

One satellite manufacturing company security official says that his company takes every possible precaution, but notes that, if the PRC really wanted to monitor everything that went on for the duration of the launch campaign, it probably could easily do so.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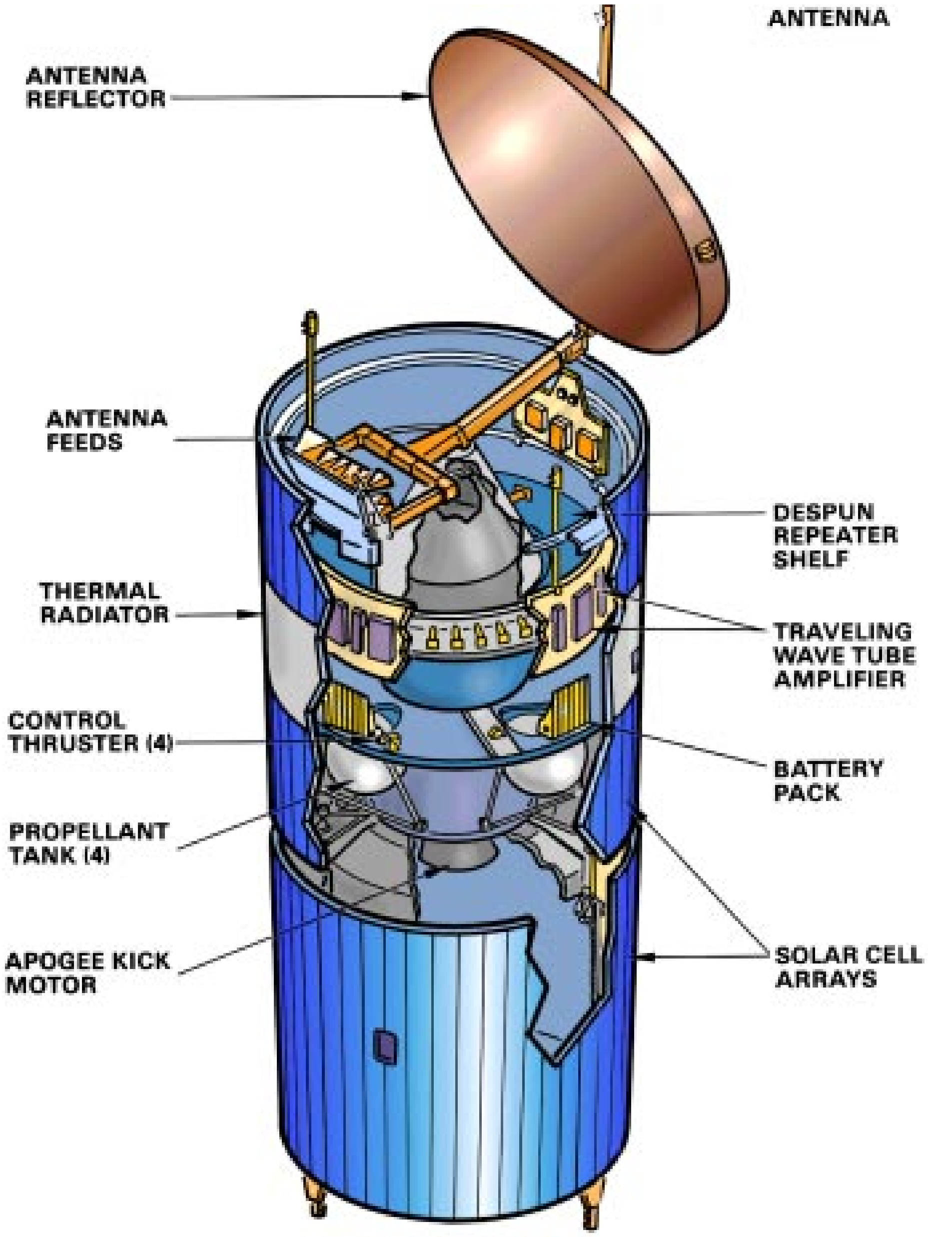
At the Taiyuan space launch center, underground steam and electrical access tunnels measuring three feet by five feet snake beneath and through buildings where U.S. satellites are prepared for launch.



Access to U.S. communication satellites has undoubtedly permitted the PRC to gain invaluable information about their configuration and design. In as little as two hours, PRC technical personnel can penetrate the interior of a satellite without leaving any traces.

The official also recalls that, during one launch campaign at Xichang when building access badges were being made for local PRC personnel, a PRC man gave the official a business card as identification. The card clearly indicated the PRC man's title was "intelligence officer."[3] The individual was not allowed access to the satellite.

There are indications that the PRC carefully monitors the activities of the U.S. personnel at the launch site. For example, Lockheed-Martin's Director of Security explains that the power facility for the Xichang Space Launch Center is located adjacent to the satellite processing building. At one point when U.S. personnel supplied power to the satellite for testing purposes, a number of PRC personnel emerged from the facility's power building to determine what was happening. This was an indication, in his view, of how closely the PRC was monitoring satellite operations.[4]

Access by the PRC to U.S. communications satellites could permit the PRC to gain information about the configuration and design of Western-manufactured satellites. If the PRC has only visual or photographic access to a U.S. communications satellite — the most common violation of U.S. security guidelines — only information that confirms known capabilities and is already in the public domain may be obtained. If the PRC had unrestricted access to a U.S. communications satellite for at least two hours, the PRC military could gain valuable information that is not otherwise available in the public domain.

The PRC could accomplish even exploitation that penetrated the interior of the satellite, given two hours of time, without leaving any traces.

With this kind of exploitation, the PRC could gain new information about major satellite subsystems, as well as the design and manufacture of each subsystem.

While unmonitored PRC access to a U.S. satellite for more than five or six hours would produce diminishing returns, there is almost nothing about a U.S. satellite that the PRC could not learn from unrestricted access for 24 hours.

Among the reasons the PRC would be interested in exploiting the technology in U.S. communications satellites is to determine the satellite manufacturer's techniques for passive thermal control. Thermal control is critical to satellite life. The PRC would also likely be interested in:

- **Encryption**
- **The materials used in satellites**
- **Engine and propellant data**
- **Electrical design and protection**

Additionally, the PRC could seek to acquire information about the dimensions and part numbers for satellite components or assemblies, as well as dimensional tolerances. Obtaining part numbers could allow the PRC to try to acquire U.S. technology directly from the manufacturer that would improve the performance and provide for longer on-orbit life for PRC satellites.

Launch-related equipment, documents, and personnel accompany the satellite to the PRC military facility for the launch campaign. Technical interchange meetings between U.S. and PRC experts also occur. All of these materials and exchanges relating to controlled technology or information are required to be monitored by the Defense Department.

Unauthorized PRC access to controlled equipment or materials, including blueprints or testing equipment, could benefit the PRC's own military space launch activities.

Unauthorized PRC participation in technical discussions, as well as PRC eavesdropping into technical discussions among U.S. experts, could have similar military benefits to the PRC. For example, the chapters of this Report concerning Loral and Hughes discuss in detail the potential gains to the PRC from technical discussions held in connection with unauthorized failure analyses performed by these companies' experts.

Inadequacy of Current Safeguards

The Select Committee's investigation has identified numerous security lapses in connection with U.S. satellite launches in the PRC that could have provided the opportunity for improper transfers of controlled information.

U.S. policy permitting the launch of U.S. satellites from the PRC rests in large measure on the assumption that companies will comply with legal requirements governing controlled information, and that such information will not be transferred to the PRC during a launch campaign. However, as noted below, reporting available to the Select Committee indicates that there have been lapses in security.

There is also reason to believe that not all lapses in security may have been reported. During the course of the Select Committee's investigation, no witness has been found to confirm that a transfer to the PRC of controlled technology has occurred as a result of ineffective launch site security. However, given the difficulty of proving that an improper transfer has occurred, it cannot be inferred that no such transfer has taken place.

Security lapses reported by the Defense Department at a number of launches in the PRC include the following:[5]

- **A PRC national set up all secured and unsecured fax, voice and data communications for a U.S. satellite manufacturing company at the PRC launch site**
- **Doors, windows or equipment unsealed or unattended**
- **Unsecured windows — in one instance a window may have been unsecured for 21 days**

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- **Multiple instances of equipment left unattended**
- **Doors discovered with seals ripped off**
- **Controlled documents missing or unattended**
- **A laptop computer containing digital pictures of the satellite left unattended in a hotel room**
- **Notebooks containing controlled information left unattended in areas where the PRC had access**
- **Filing cabinets containing controlled documents left open or without proper seals**
- **Documents improperly removed from cabinets**
- **Controlled equipment improperly discarded in trash**
- **Multiple examples of documents shipped without proper locks/seals**

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Hand-carried containers often lacked seals or security locks *(left and above)*. In some instances technical data was improperly displayed on the outside of cases.

- **Satellite test data left in cabinets without seals**
- **Satellite diagrams and other sensitive documents left out in the open**
- **Schematic of satellite bus equipment module and related documents left out**
- **Test valve document left out**
- **X-ray position diagrams found in improper location**
- **Notes left on blackboards**
- **Improper access by PRC workers**
- **PRC workers spent long periods of time (an hour or more) in areas where they were not supposed to be present**
- **No access list of PRC personnel provided to monitor**
- **PRC workers in controlled areas without proper escorts or badges**
- **PRC technicians worked unsupervised in the area of the satellite**
- **PRC personnel had improper access to fairing doors that provided visual/physical access to the satellite**
- **Unauthorized photographs were taken of the satellite**
- **Controlled information not properly inventoried**
- **Telephones used without proper security procedures**
- **Improper practices with security cameras**
- **Security cameras mis-positioned, giving the PRC potential access to the satellite container without detection**
- **Failure to man proper location when security camera inoperable**


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Buildings in Xichang where American satellites are prepared for launch pose security risks. Large windows offer numerous points of entry, as do underground steam pipe tunnels accessed through nearby manhole covers.

Once the U.S. satellite is mated to the PRC rocket, a fairing encloses the equipment to protect it during launch. PRC personnel had improper access to fairing doors that provided both visual and physical access to U.S. satellite technology.

- **Lax attitudes toward security exhibited by U.S. personnel, including failures to record or investigate potential violations**
- **Blueprints of Vandenberg Air Force Base facilities exposed in the presence of PRC personnel**
- **Unauthorized discussions with PRC personnel**

Defense Technology Security Administration Director Tarbell confirms that Defense Department monitors have provided reports that there had been circumstances of short-duration, unescorted PRC access to U.S. communications satellites in the PRC.[6] However, Tarbell says that he is not aware of any evidence that this access resulted in a technology transfer that would significantly affect national security.[7]

A Defense Department monitor wrote the following comments in his final report during a 1998 PRC launch campaign:

> *This assignment for DTSA [the Defense Technology Security Administration] has proven to be exceptionally taxing and difficult. We are trained, given the necessary tools/skills and expected to protect U.S. technology from improper disclosure/compromise.*
>
> *Our responsibilities as monitors become transparent when aerospace companies (some not all) are given a Commerce License. It is viewed by industry as a license to steal and the monitors are a necessary evil to pacify management and our government.*
>
> *There is a general consensus within the public sector that, if restrictive measures and significant penalties are not levied against industries (specifically aerospace) by the Commerce Department (or higher), our technology will be compromised to such a staggering level and that our highest level of technology advancements will be available to our international competitors before it comes off the research and development floor.*
>
> *We as a nation cannot allow or afford to have industry police itself when it comes to national security . . .*
>
> *History is filled with unnecessary shortcuts in safeguard/ security procedures resulting in the loss of American lives and federal grand jury investigations into illegal transfer of our technology by major corporations in an effort to increase their profit . . .*[8]

In an October 27, 1992 memorandum, Sumner Benson, Director of the Defense Technology Security Administration Technology Policy Directorate, expressed the following concerns regarding the security situation relating to the launch in the PRC of the FREJA satellite:

U.S. Defense Department monitors are required at PRC launches of American satellites. According to one monitor, a U.S. Commerce Department license to launch in the PRC "is viewed by industry as a license to steal," and the monitors are seen as "a necessary evil to pacify management and our government."

During the subject launch campaign, PRC personnel had unmonitored access to the FREJA satellite after it had been mated with the PRC LM2C launch vehicle [Long March 2C rocket]. Because PRC access was unmonitored, the [Defense Department] technology security monitors cannot state with certainty that no technology was transferred.

During a three day period from 26-28 September 1992, the [Defense Department] representatives noted PRC activity in the Vehicle Equipment Bay (VEB), located in the lower section of the FREJA clean room at the top of the LM2C [Long March 2C] booster.

Neither the [Defense Department] representatives nor the Swedish Space Corporation (SSC) representatives [the purchaser of the satellite] had been informed about this activity, and it had not been included in Combined Operations Procedures. The PRC were apparently working on their navigation and guidance equipment, but access to the lower side of the FREJA satellite was possible from the VEB.

When the [Defense Department] representative became aware of and attempted to monitor this activity, he was prevented from doing so by the PRC launch site commander.

Through a series of meetings with PRC representatives of the launch site, the launch site parent organization (CLTC) and PRC Defense Department (COSTIND), the [U.S. Defense Department] representative determined that the PRC:

> *Did not believe that unilateral work on their equipment was combined operations activity and therefore advanced notification and monitoring was not required;*
>
> *Felt that the [Defense Department] monitor was overzealous in wanting to monitor the PRC activity in the VEB;*

Did not feel monitoring was necessary because they [the PRC] could be trusted not to try to acquire any technology even when they had access to the satellite; and finally,

Felt that they [the PRC] had not violated the Technology Safeguards Agreement. [9]

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A Defense Department monitor deliberately attempted to break into a PRC satellite processing building, such as the one shown above, to determine whether he would be detected. The monitor was able to penetrate the facility and approach the security supervisor undetected until tapping him on the shoulder.

In another instance, a Defense Department monitor indicated that he deliberately attempted to break into the satellite processing building in the PRC to determine whether he would be detected. The monitor was able to penetrate the facility and approach the security supervisor undetected until tapping him on the shoulder.[10]

Safeguarding U.S.-Built Satellites and U.S. Rocket Technology at PRC Launches

Country-to-Country Agreements

In 1988, and again in 1993, the United States entered into agreements with the PRC for the purpose of precluding the unauthorized transfer of sensitive technology associated with the export of U.S.-manufactured satellites for launches in the PRC.

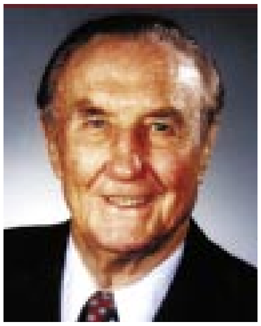
The agreements specify that at no time will there be unmonitored or unescorted access by PRC nationals to any of the equipment or associated technical data.[11] Additionally, only “form, fit and function data” [12] that describe mechanical and electrical mating requirements for attaching the satellite to the rocket are authorized for release to PRC nationals.[13] The agreements further indicate that the U.S. Government shall oversee and monitor implementation of Technology Transfer Control Plans, which are required to be developed by the satellite manufacturer. The PRC is required to permit and facilitate that monitoring.

Access to all satellite equipment and technical data is required to be controlled on a 24-hour basis by U.S. persons who have received training in security procedures from the U.S. Government. These U.S. persons must exercise this control throughout launch preparations, satellite transportation, mating/demating, test and checkout, satellite launch, and required return of equipment to the United States.[14]

Export Licenses

With the passage of the Strom Thurmond National Defense Authorization Act for Fiscal Year 1999, all satellites and related items have been transferred to the United States Munitions List, and their export is controlled by the State Department under the Arms Export Control Act.[15]

Prior to this Act, the Department of Commerce had jurisdiction for licensing the export of some commercial satellites from 1993 through 1996, and over export licenses for all commercial satellites from 1996 through 1998.[16]



The FY99 National Defense Authorization Act is named for U.S. Senator Strom Thurmond (R-SC). It provides that U.S. business interests must not be placed above national security interests.

During the period 1993 through 1996, the Department of Commerce issued three export licenses for commercial communications satellites to be launched in the PRC that did not require the presence of Defense Department monitors, and did not require the U.S. exporter to reimburse the Defense Department for the expenses of providing monitoring in the PRC.[17]

Although the U.S. licenses routinely stipulate the presence of a Defense Department monitor, this requirement has not always been well-received by the satellite manufacturer.

For example, in one instance, a satellite manufacturing company demonstrated a negative attitude toward the presence of a Defense Department monitor as required under a license issued by the Department of Commerce. The Defense Department monitor explained that he had a disagreement with a program manager and the company site security supervisor over the manner in which a computer board would be shipped. The security site supervisor told the monitor that his company had a Department of Commerce license for that particular satellite launch and, therefore, the Defense Department monitor was in the PRC as a courtesy.[18]

Licenses issued by the Department of State include detailed provisos concerning technology transfer and security. For example, one license issued to Hughes stipulated:

> *Hughes must develop a plan(s) to comply with the applicable provisos of this [license]. These plans must address the technology safeguards implementation, security support, tranportation, debris recovery and other issues.* [19]

The Defense Department's Responsibilities for Safeguarding U.S. Technology at Launches

The Defense Department provides oversight in safeguarding technology at launch sites in the PRC. The Defense Department does this in part by overseeing implementation of Technology Transfer Control Plans and Security Plans prepared by the U.S. satellite manufacturers as required under export licenses.

The Defense Department also is responsible for monitoring all technical interchange meetings between U.S. and PRC personnel.[20] These meetings can occur as early as two years prior to a launch and continue during the launch campaign, as well as after a launch. Provisos in the U.S. export license for the PRC indicate the limits of the technical data that may be exchanged in these meetings. A Defense Department monitor is required to attend technical interchange meetings when PRC nationals are in attendance in order to assure that only data permissible under the license is exchanged.

Deficiencies Observed in the Current System

U.S.-PRC Technical Discussions Occur Prior to The Issuance of Export Licenses

When a U.S. satellite manufacturer applies for an export license for the satellite and related technical data, the Department of State or the Department of Commerce notifies the Defense Department that monitors will be needed to oversee the launch and the technical interchange meetings. However, technical discussions are conducted over the telephone or through informal personal discussions and marketing meetings prior to the license being issued.

This illustrates the fact that U.S. satellite manufacturers are on the honor system, to a large extent, in ensuring that no licensable technical data is exchanged in the absence of a Defense Department monitor.[21]

Although Defense Technology Security Administration Director David Tarbell agrees that "anything is possible," he believes it is not likely that a technology transfer would occur during early contractual discussions of this type. Tarbell says that conversations in these early stages would relate to the type of satellite the buyer wants, not how the satellite would be launched.[22]

Technology Transfer Control Plans and Security Plans Vary Throughout the Space Industry

The current U.S. Government export control system requires industry to formulate a variety of required plans, including Technology Transfer Control Plans and

Security Plans. These plans are provided to the Defense Department for review and approval. However, the plans vary from company to company, despite the fact that the launch facilities are the same, and the processing procedures of each company are similar.

Tarbell comments that, although standardization of the plans would be desirable, some degree of flexibility should be allowed, and any standardization should not rise to the level of rulemaking.[23]

Temporary Assignments of Defense Department Monitors Disrupt Continuity of Launch Site Security

Because the Defense Department did not have the resources to allow its permanent staff to participate as monitors on a regular basis, the Defense Technology Security Administration decided that the monitors for communications satellite launch campaigns in the PRC and U.S.-PRC technical interchange meetings should be drawn from the Air Force Space Command.[24] According to one former Defense Department official, an individual often is chosen to be a monitor by Space Command because he or she is between jobs or may be expendable.[25]

The duration and living conditions of these assignments make them even more unappealing. In addition, these assignments are unpopular with commanding officers because they do not enhance the Space Command mission, and because participation by their personnel could be construed as indicating that they have excess resources at their disposal.

The lack of a permanent corps of Defense Department monitors with relevant technical experience has drawn criticism from the space industry.[26]

An aggravating circumstance is the frequent rotation of monitors throughout the launch campaign. During the five-to-eight week duration of one PRC launch, for example, as many as five monitors were rotated in and out of the site.[27] Additional monitors may have participated in technical interchange meetings that occurred prior to the launch.[28]

Dept. of Defense

The Air Force Space Command provides monitors for each satellite in the PRC because the Defense Department decided it did not have the resources to allow its permanent staff to participate as monitors on a regular basis. According to one former Defense Department official, monitors are often chosen by the Space Command because they are between jobs or are expendable. Actual launch site security personnel do not work for the Defense Department, but are contracted from private firms by the company exporting the satellite.

Frequent rotation results in a lack of continuity and consistency in monitoring decisions during the technical interchange meetings and the launch. The information discussed during a technical interchange meeting is often based on the information discussed during a preceding meeting.

Thus, a new monitor coming into a meeting without having attended the previous meeting is not aware of what particular information the previous monitor may have either prohibited or allowed the participants to discuss. Additionally, as one former Defense Department monitor opined, "The knowledge base that's required from one technical meeting to the other sets the precedents for the next one." [29]

The same is true at the launch site. A series of Defense Department monitors coming and going disrupts continuity. According to one security official, ". . . to have three different DTSA [Defense Department] representatives is very difficult from a security perspective because . . . they each have their own areas of specialty, they each have their own background and limited experience." [30]

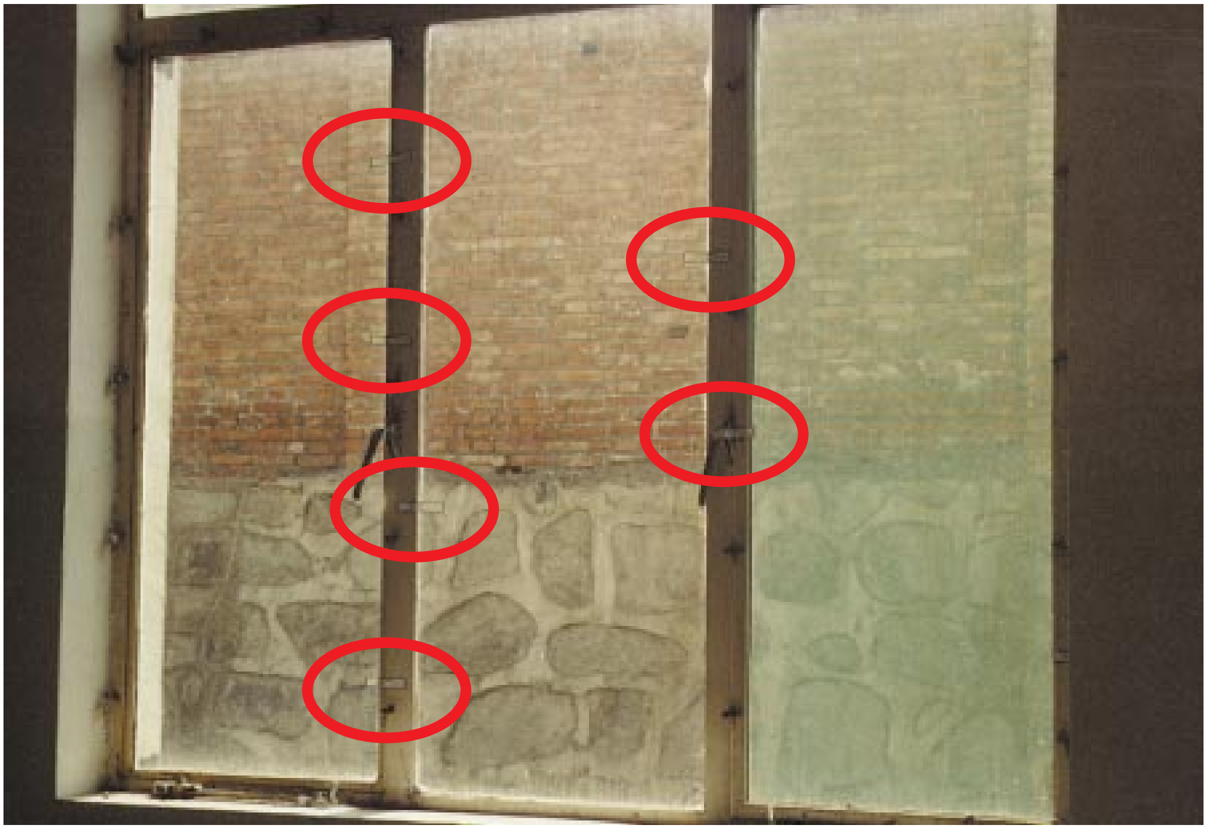
For example, while the first Defense Department monitor assigned to the launch when the satellite arrives in the PRC is responsible for ensuring that the facility is secure, in one instance a replacement monitor toured the facility and made a series of changes to the physical security plan that had been found to be satisfactory by the previous monitor.[31]

An Inadequate Number of Defense Department Monitors Is Assigned to PRC Launches

While the number of Defense Department monitors assigned to a launch site has varied over the years, it has been standard practice to assign only one or two monitors at a time to launches in the PRC.

However, a July 1993 order of the Secretary of the Air Force directed that:

> *Air Force Space Command will identify* ***two to five*** *qualified technology safeguard monitors for each satellite program, depending on the program's scope, complexity and duration.*
>
> *Further, for each launch campaign (typically five to eight weeks), Space Command will* ***ensure that two to four monitors are present at the launch site at all times.***
>
> *To accomplish this, Space Command will assign one lead monitor to remain at the foreign launch base for the duration of the mission, and will typically form two teams of two monitors each to accompany the lead monitor. Each team of two will be at the foreign launch site for about five weeks, (nominally), plus a week of travel time for each team (counting both legs of the trip).*[32] [Emphasis added]



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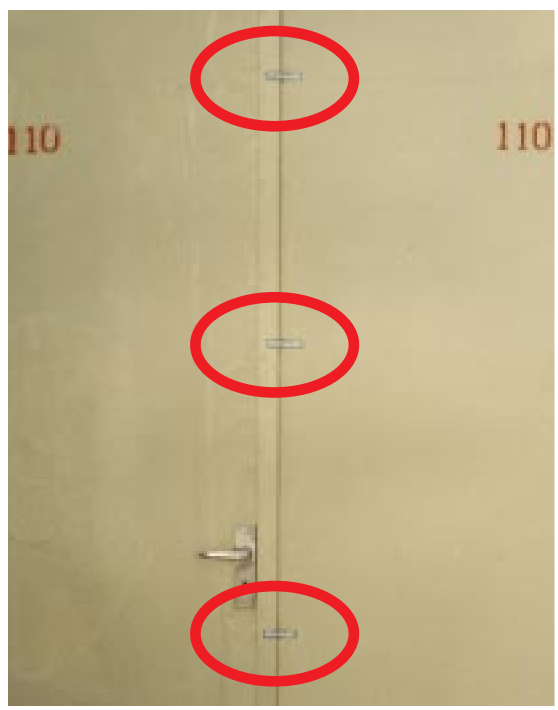

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Paper seals were used to secure doors at PRC satellite preparation facilities. These were later replaced with peel-away "void" seals. When it was very cold, the seals could be taken off and replaced, leaving no evidence of a security breach.

Some company representatives believe that one Defense Department monitor is adequate during the course of a normal launch campaign to cover technical interchange meetings and to monitor technology at the site. This, they say, is largely because most of the technical discussions have already occurred during the years leading up to the launch. One company's security manager says meetings with the PRC at a launch never would occur without the presence of the Defense Department monitor.[33] In the event of a launch failure, however, more monitors may be necessary.

The sole Defense Department monitor at the Intelsat 708 failure had difficulty working alone to oversee interactions between the PRC, Loral employees, and the private security force to ensure that no technology would be transferred as a result of the failure. The monitor recalls that:

> *Following the destruction of the Long March 3B, Loral upper management completely took over the operation of satellite piece recovery and ignored my advice to delay piece recovery until the area became safe and a meeting between PRC, Loral and myself could control the situation.*
>
> *As a result, at least two technicians returned from the crash site complaining of bulging eyes and severe headache requiring a 5-minute oxygen treatment.*
>
> *I believe we were lucky we recovered 63.5 percent of the vehicle [rocket] along with the [satellite's] encryption-decryption equipment.*[34]

This same monitor says he was not able to keep the Loral program manager from traveling to the crash site unaccompanied before the site was declared safe.[35]

Uneven Prior Technical Experience Of the Defense Department Monitors

Without a permanently assigned corps of Defense Department monitors, matching the experience of the monitor to the necessary tasks is difficult. Program officers, instead of engineers, have been used as monitors.[36]

Some company personnel noted that the Defense Department monitors have different backgrounds, and their technical expertise, therefore, varies.[37] By and large, the security managers interviewed by the Select Committee believed that the Defense Department monitors had the necessary technical expertise to keep pace with discussions between the company engineers and the PRC.[38]

The space industry has indicated that the Defense Department should maintain an adequate staff of trained professionals in monitoring technology transfer at foreign launches, with the end result being more uniformity overall.[39]

The Defense Department monitors participate in a three-day training course to prepare for assignments. The training is conducted by Air Force Space Command and includes such topics as the International Traffic in Arms Regulations, Export Administration Regulations, Memorandums of Agreement, Licensing Provisos, Technology Transfer Control Plans, Security Plans, Daily Logs, Incident Reports and Trip Reports.[40] Training also includes formal briefings by the Defense Department, and continues on an ad hoc basis with regard to particular licenses.[41] As launch numbers have increased, there have been more training sessions that incorporate lessons learned during past launches to prepare monitors for future assignments.[42]

Inadequate Headquarters Review of Monitor Reports

The July 1993 order of the Secretary of the Air Force directed that the lead Defense Department monitor for each launch campaign must maintain a complete daily log of events during that campaign. This daily log must include records of each meeting between the U.S. satellite manufacturer and the foreign launch provider, and it must summarize all decisions affecting technology security.[43]

The monitors are instructed to fax their daily logs to both Space Command and the Defense Technology Security Administration (now the Technology Security Directorate).[44] Because the fax machines often are not reliable at PRC launch sites, Space Command also faxes the monitor logs to the Defense Technology Security Administration to ensure that they are received.[45]

The lead Defense Department monitor is required to report the satellite processing status and plans, along with any safeguarding problems and recommendations, to the

Defense Technology Security Administration (now the Technology Security Directorate), and also to Space Command at least once a week during a launch campaign.[46]

Space Command is responsible for the receipt and storage of reports that the Defense Department monitors prepare and send while they are on assignment at a launch site abroad.[47]

The Director of the Defense Technology Security Administration, David Tarbell, says he is not aware whether Defense Department monitors' reports are first received at his agency and reviewed, or whether they are sent directly to Space Command prior to being warehoused there.[48]

Although Space Command schedules the monitors and is considered to be a flow-through point for reports from the monitors, Space Command's interaction with the monitors is administrative, not substantive, and similar to that of a program manager. Yet, Space Command receives daily activity logs from Defense Department monitors that contain information concerning security incidents and infractions at the launch site.[49]

Tarbell stressed that it is the Defense Department monitor's responsibility to assure that serious incidents are brought directly to Headquarters' attention.[50] Less significant security infractions are reported to both Space Command and the Defense Technology Security Administration via the monitor's daily logs.

Actual entries from Defense Department monitors' logs appear at the end of this chapter.

According to Defense Technology Security Administration officials, only two security matters reported by Defense Department monitors have been raised to the attention of the Director in the past 13 months.[51]

Lack of Headquarters' Support

Some Defense Department monitors have reported difficulties in contacting Defense Technology Security Administration management in the United States while they are on a PRC launch campaign.

One Defense Department monitor noted in his daily log, during a PRC launch operation in 1998: ". . . Attempted to contact the DTSA office in Washington, however, all personnel were TDY [away on temporary duty]." [52]

Another Defense Department monitor also attempted to contact the Defense Technology Security Administration in Washington on another date, and also was told all personnel were away on temporary assignments.[53]

The Defense Department monitor assigned to the Loral-Intelsat 708 launch in the PRC reports that he attempted unsuccessfully to resolve repetitive security infractions during that launch. He indicated that he then attempted to contact Space Command in Colorado, and wrote several memoranda to his superiors at the Defense Technology Security Administration.[54] That official then had to telephone Loral directly to have the deficiencies reviewed and corrected.[55] Following the phone call, the Defense Department monitor acknowledged security had "greatly improved." [56]

The Loral site security supervisor for the Intelsat 708 launch indicates that the Defense Technology Security Administration did not support the monitor in attendance at that launch. The monitor reportedly had no security plans provided to him by the agency beforehand, and had to make on-the-spot decisions concerning the release of documents.[57]

Lack of Intermediate Sanction Authority

One Defense Department monitor explains that several types of security violations can occur during a launch campaign or a technical interchange meeting.[58] Most incidents fall into the category of infractions that do not rise to the level of a license violation, but may include such things as controlled documents being left out in the open, unescorted visitors, and broken security seals on doors or windows.

Tarbell characterized infractions as instances that run the gamut "from very, very minor things to things that require DTSA's attention, but don't rise to the level of an export control violation that we should report to the State Department." [59] Tarbell says that Defense Technology Security Administration guidance to monitors encourages them to try to resolve problems on site and, if that is not effective, to contact the agency immediately so that it can resolve the situation with the company.[60]

Loral Space & Communications Ltd.

CONSOLIDATED STATEMENTS OF CASH FLOWS

(In thousands, except per share data)

	Year ended December 31, 1997	Nine months ended December 31, 1996	Year ended March 31, 1996
Operating activities:			
Net income (loss)	$ 40,004	$ 8,677	$ (13,765)
Gain on the sale of K&F stock	(79,591)		
Equity in net loss of affiliates	47,273	4,709	8,628
Minority interest	4,834		
Deferred taxes	419	(926)	3,838
Accretion on GTL CPEOs	(1,739)		
Depreciation and amortization	62,764	1,051	
Changes in operating assets and liabilities, net of acquisitions:			
Contracts in process and inventories	(152,794)		
Deposits	(107,670)		
Other assets	(28,615)	(9,252)	
Accounts payable	68,574	(1,832)	
Customer advances	(57,778)		
Accrued expenses	(36,602)	(4,506)	
Taxes payable	24,073		
Long-term liabilities	(17,200)	(1,124)	
Cash used in operating activities	(230,248)	(3,003)	(1,319)
Investing activities:			
Acquisition of businesses, net of cash acquired	(545,642)		
Proceeds from the sale of K&F stock, net of expenses	78,591		
Investment in affiliates	(237,899)	(6,425)	(105,231)
Other assets	(63,482)		(9,800)
Proceeds from the sale of property, plant and equipment		5,003	
Capital expenditures	(255,340)	(540)	
Cash used in investing activities	(1,022,772)	(1,962)	(115,031)
Financing activities:			
Borrowings under revolving credit facility, net	32,812		
Proceeds from issuance of term loan	275,000		
Proceeds from convertible preferred equivalent obligations		583,292	
Proceeds from exercise of stock options and issuances to employee savings plan	7,338		
Contribution from minority partner	9,100		
Preferred dividends	(25,435)		
Proceeds from the Distribution		612,274	
Transaction expenses related to the Distribution		(12,286)	
Advances from Loral Corporation prior to the Distribution		2,425	116,362
Cash provided by financing activities	298,815	1,185,705	116,362
(Decrease) increase in cash and cash equivalents	(954,205)	1,180,740	12
Cash and cash equivalents—beginning of period	1,180,752	12	
Cash and cash equivalents—end of period	$ 226,547	$1,180,752	$ 12
Non-cash transactions:			
Mandatory exchange of Convertible Preferred Equivalent Obligations	$ 583,282		
Issuance of Series C Preferred Stock to acquire equity interest in SS/L	$ 149,600		
Issuance of Loral common stock to acquire equity interest in SS/L and Globalstar partnership interests	$ 148,387	$ 100,313	
Deferred purchase price to acquire Globalstar partnership interests	$ 24,787		
Assets transferred from Loral Corporation at the Distribution		$ 31,383	
Liabilities assumed from Loral Corporation at the Distribution		$ 27,313	
Transfer of GTL common stock to acquire equity interest in SS/L		$ 5,138	
Supplemental Information:			
Interest paid	$ 40,866		
Taxes paid	$ 8,901	$ 1,528	

Because satellite manufacturers are interested in keeping launch costs low and pushing schedules, they often view security as an obstruction to their mission. One Loral program manager told a Defense Department monitor that "security is ninth on my list of priorities."

Tarbell says that he believes that his agency has a significant sanction available — the ability to stop a launch. In addition, Tarbell also indicates that he believes that the Defense Technology Security Administration has additional enforcement powers by virtue of its relationship to the licensing process and the Arms Export Control Act.

However, there appear to be no intermediate sanctions available to discourage relatively common, repetitive security infractions.

Conflicting Industry Priorities

Tarbell acknowledges that the satellite manufacturer's program management staff is interested in pushing the schedule, making sure costs are low, finishing the project, and limiting risk to the project. This forces the satellite firm to make judgments that push as hard as possible against the barriers of security and technology transfer. This is why, in Tarbell's view, Defense Department monitors are necessary.[61]

One Loral site security manager indicates that industry project managers consider security to be an obstruction to the completion of their mission. It is an extra cost and poses additional obstacles to them.[62] One Loral program manager repeatedly stated to a monitor that "Security was ninth on my list of priorities." [63]

A former security manager for Loral says that he argued against having the program manager being placed in charge of satellite security during the Intelsat 708 launch in the PRC, because a program manager's main objective of launching the satellite will take precedence over security.[64] He was overruled twice, even after several reports were received during the launch campaign that the Defense Department monitor was having problems with the program manager's lax attitude toward security issues.[65]

During the Loral-Intelsat 708 launch campaign, complaints were made that the program manager invited PRC nationals into the satellite processing building and allowed them to be photographed standing in front of the satellite.[66] The PRC nationals were alleged to be employees of the local hotel, as well as members of the PRC technical team.[67] Comments were made that the program manager's Chinese heritage invoked his sense of pity concerning the quality of life of the PRC nationals near the launch site, and motivated him to invite the visitors for a photo session.[68] No record of this incident appears in Defense Technology Security Administration files.

Although U.S. laws and regulations require 24-hour security of satellites in the PRC, the private security guards hired by satellite companies were found sleeping on the job, under the influence of alcohol, and routinely leaving the launch site to meet with prostitutes while on duty.

Satellite Manufacturers, Not the Defense Department, Supervise Site Security Personnel

At the launch site, the security force reports to the U.S. satellite manufacturer's representatives (because the security personnel's contractual obligations run to the company that pays them, not to the U.S. Government). Therefore, the security force cannot be considered to constitute an independent security function.[69] Yet some industry officials insist that the program manager should be responsible for the entire launch campaign, including security.[70]

Reliance on Private Contractor Security Is Inadequate

United States commercial satellite manufacturers routinely contract with a private security firm to provide security, including protection against technology transfers, at PRC launch sites. Since few, if any, other security firms currently provide this specialized service, Pinkerton Aerospace Division has been used almost exclusively by U.S. satellite firms launching in the PRC. Of the ten security firms identified in a recent business journal, for example, only Pinkerton currently offers foreign launch site security services.[71] Another firm, Launch Security Services International, provided such services prior to going out of business in 1996.[72]

Both the Defense Department monitors and industry representatives have complained about the quality of work and the conduct of some members of the contractor security forces.[73]

Allen Coates

Procedures called for television security cameras to be disconnected or turned away from satellite processing activity *(below).* Infractions of these procedures occurred on a regular basis.

One Defense Department monitor experienced a range of problems with the private security guard force on a PRC launch, including:

- **Sleeping on the job**
- **Reporting to work under the influence of alcohol**
- **Poor reporting on daily logs and at shift changes**
- **Racial and gender slurs towards PRC nationals in the local village**
- **Routine bus trips into the town to meet prostitutes**
- **Overall lack of respect for management**

The Defense Department monitor indicates that the solicitation of prostitutes became so intense that he was approached by a PRC foreign affairs officer who was assigned to the launch to report that one of the guards had been seen soliciting prostitution in front of the local police department.[74]

One security guard even reported for duty carrying a sleeping bag.[75]

Another Defense Department monitor describes a situation during a launch campaign in the PRC in which the contractor security guards moved a table out of the line of sight of a video surveillance camera, in order to use it as a bed.

Since the table on which the security guard was sleeping also obstructed entry and exit to the room, the Defense Department monitor called the guard on the telephone to request that the table be moved away from the door, and back into the position where it had previously been located.

The guard reportedly responded that he was "not in the furniture moving business." [76] In response, the Defense Department monitor had to leave his duties and walk to the remote building to confront the guard and ensure that the table was moved.

Insufficient Numbers of Security Guards at PRC Launch Sites

Each U.S. satellite manufacturer is permitted to develop its own security plans for launches in the PRC, with subsequent approval by the Defense Department. As a result, the number of security guards at PRC launch sites varies.

One U.S. satellite company security official indicates he believes that attempting to take less than ten contract security guards to a launch in the PRC is "rolling the dice" in terms of the ability to provide effective safeguards. Taking less than nine is, in his view, "crazy." Most satellite manufacturers take 12 or 13 security officers to a PRC launch.[77]

However, one Loral site security supervisor says he was asked by the program manager to try to reduce costs and investigate the possibility of reducing the number of contractor security staff, since the program manager had observed that security guards often were idle. The supervisor agreed to require only nine security officers — even though he had never been to the PRC launch site, and even though he was aware that 12 security guards had been used at the same facility for the previous Loral launch. The Loral site security supervisor says that he experienced no problems maintaining proper security with only nine officers.[78]

Some satellite manufacturers attempt to augment the contractor security force by using their own technical staff to provide escorts for nationals during a launch campaign. During launches in the PRC, this has resulted in periods when PRC visitors were unescorted and unattended, because the technicians were called away or not attentive to their escort duties.[79]

Correcting Security Deficiencies

In recent months, an effort has been underway to standardize security practices among U.S. companies launching satellites in the PRC. Security managers from Hughes and Loral have been trying to form a working group with the Defense Department "to try to standardize . . . some of our practices." [80]

Tarbell notes that U.S. satellite companies have expressed great interest in working with the Defense Department to achieve some standardization in their approaches to site security.[81]

Additionally, some companies hold "lessons learned" sessions after a launch occurs to incorporate circumstances and responses encountered during a launch, including site security, into future launch operations.

Following the failure of the Intelsat 708 launch, for example, the security manager reviewed the Defense Department's reports and findings and made changes to the company's security system. He concluded that Loral needed "a much more intensive educational program to inform everybody that there will be a very stringent document control system with bright red covers and locked safes and daily inventories.[82] Additionally, the Loral security manager requested that a representative from the Defense Department speak to company management to discuss how the company could improve its security procedures.

The 1999 Defense Authorization Act

The Strom Thurmond National Defense Authorization Act for Fiscal Year 1999 provides that U.S. business interests must not be placed above U.S. national security interests, and that the export or transfer of advanced communication satellites and related technologies from U.S. sources to foreign recipients should not increase the risks to the national security.

Further, the Act states that the United States should not export missile equipment or technology to the PRC that would improve its missile or space launch capabilities, and should pursue policies that protect and enhance the U.S. space launch industry.

In furtherance of these interests, the Act calls for mandatory Defense Department monitors and reimbursement of related costs by the U.S. satellite manufacturer, in any case in which a license is approved for the export of a satellite for launch in a foreign country. The stated purpose is to prevent the unauthorized transfer of technology, including technical assistance and technical data.[83]

The Secretary of Defense is also directed by the Act to establish a program for recruiting, training and maintaining a staff dedicated to monitoring launches of satellites in foreign countries. The Act calls for mandatory Technology Transfer Control Plans approved by the Defense Department, and Encryption Technology Transfer Control Plans approved by the National Security Agency.[84]

The Technology Security Directorate within the Defense Department's Defense Threat Reduction Agency is developing plans for implementation of the Act. Tarbell indicated that the plans are undergoing funding review within the Defense Department. Tarbell also indicated that the Technology Security Directorate is reviewing the range of satellite-related activities in which it should be involved.[85]

Excerpts from Defense Department Monitors' Reports of Security Breaches at PRC Launches of U.S. Satellites

Loral-Mabuhay (1995): Report of DTSA Defense Department Monitor Major P. Smith

8-6-95

1. Meeting with PRC in a conference room **with drawings for the TEMPO program still on the white board**.
2. Discussed issue with Nick Yen, who promised that the conference room will be "clean" for future meetings.

Loral-Intelsat 708 (1996): Reports of Defense Department Monitor Captain S. Prichard

1-5-96

1. **Security Plan, Debris Recovery Plan, and a document detailing the responsibilities of the contractor security, escort, badging, logging, and detex procedures were not available for immediate reference prior to satellite arrival**. **When received, they were not signed, nor contained sufficient detail.**

1-5-96

1. **International Traffic in Arms Regulations-sensitive equipment not locked or sealed on aircraft when it arrived**.
2. **Security cordon around aircraft not established**.
3. **Container opened on ground** to obtain tie-downs and chains.
4. Ground security was unaware that sensitive material was aboard flight.
5. **Sensitive documentation packed in cardboard boxes on regular pallets** wrapped in plastic film.
6. **Monitor was only physical security deterring PRC entry for entire afternoon**.

1-7-96

1. **Inadequate locks and seals**.
2. Medical doctor is a PRC national and allowed to spend considerable amount of time in processing building.

1-14-96

1. **Open box containing International Traffic in Arms Regulations documents arriving on board aircraft**.
2. **International Traffic in Arms Regulations classified documents contained within a notebook discovered in the corner of the Satellite**

Excerpts from Defense Department Monitors' Reports of Security Breaches at PRC Launches of U.S. Satellites (continued)

Processing Building 2 airlock, an area used by PRC workers.

1-15-96
1. **Unescorted PRC technician in telephone wiring room. A technician escorting him finally returned after two minutes**.

1-16-96
1. **23 PRC nationals in satellite area without escorts**. Security was understaffed, and technicians were supposed to be escorts but were busy doing other tasks.
2. **Unsecured windows**.
3. **Badges not returned. Security has no idea who is in the building**.
4. "A serious attitude and a significant increase in security knowledge is needed."

2-4-96
1. **Broken door seals**.

2-6-96
1. **Crash doors left open**, security unaware.
2. **Incidents reported to security are only logged, and not investigated**.
3. **Events are not always logged because only one page is filled**.

2-14-96
1. **"Security is ninth on my list of priorities."** (Emphasis added)

2-16-96
1. Following destruction of LM-3B [Long March 3B], upper management [of Loral] completely took over the operation of satellite recovery without coordinating appropriately with monitor.

Loral-Apstar 2R (1997): Reports by Defense Department Monitor Captain S. Davis

9-25-97
1. Discussed Asia Pacific Telecommunications (APT) access to satellite with E. Acosta (Palo Alto). Acosta stated that APT observed [satellite] testing in Palo Alto. **Monitor stated that his interpretation of the country to country Memorandum of Agreement (MOA) precluded that. Air Force Space Command concurred with monitor.**

10-1-97
1. **Found a laptop computer with digital pictures of the satellite left improperly controlled in the small hotel [in PRC].**

Excerpts from Defense Department Monitors' Reports of Security Breaches at PRC Launches of U.S. Satellites (continued)

10-7-97

1. Satellite Processing Building 3 Officer Gallagher (Pinkerton) notified monitor that a **PRC representative was covertly drawing pictures of the satellite**.

   Discussed with Nick Yen [Loral], explained that drawings of the satellite were considered controlled technical data that required prior approval.

   [Defense Department] Monitor asked Nick Yen to remind Director Lee that individuals seeking technical data not specifically authorized is a violation of the country to country agreement.

   The artist was identified as Wong Zwei Chan of CALT.

   Chan provided a sketch to the monitor. Upon review, Officer Gallagher was not convinced that it was the same drawing. The provided drawing did not contain sufficient detail to represent a technology transfer.

2. **The security camera** of the satellite container on the pad was initially provided by a single closed circuit TV camera. Monitor deemed this **inadequate as the top of the container could be removed undetected**.

   Instructed Loral either to establish closed circuit TV coverage of the top of the container, or to seal the container with security tape. Loral chose security tape.

10-8-97

1. **Nick Yen released technical data prior to U.S. Government review. The documents released contained test data from the umbilical check and updated ICD [interface control documentation] information.**

10-9-97

1. **Nick Yen told PRC that when they accessed the fairing doors**, Loral required a report the next day on what actions took place. Monitor stated that **U.S. monitor needed to be present too**. Monitor had discussion with K. Patterson [Loral] re: policies for fairing access to satellite.

   Monitor offered Nick Yen two solutions:

   (1) ensure that PRC notify U.S. Government prior to access and wait for [Defense Department] oversight prior to opening fairing;

   (2) Monitor offered to inspect fairing access doors and if [PRC] visual/physical access is not possible, closed circuit TV would suffice as U.S. monitoring.

   Loral opted for inspection. **Inspection concluded PRC access was possible, and that very little time would be needed**.

Excerpts from Defense Department Monitors' Reports of Security Breaches at PRC Launches of U.S. Satellites (continued)

2. At 1615 hrs, **monitor observed PRC accessing fairing doors**. Monitor notified Nick Yen, who immediately called the PRC.

3. Nick Yen explained [to PRC] that fairing access required U.S. Government oversight.

10-10-97

1. **PRC again accessed payload fairing** without prior coordination. Monitor again briefed Nick Yen who again called the PRC.

2. Nick Yen called for a U.S.-only caucus, and indicated that **he would not allow his personnel to support the monitoring as it presented a safety hazard**.

3. B. Campbell [Loral] concurred that, based on previous experience at this launch facility, the pad is hazardous even when the launch vehicle is not fueled because the PRC pressurize their launch vehicle tanks with unpurged fuel and oxidizer.

4. Monitor advised Nick Yen that he did not have the authority to waive the requirement, and would consult Major Smith (DTSA).

5. Major Smith allowed for a **safety override of U.S. monitoring requirements**.

6. Monitor advised Nick Yen that the following requirements applied to **PRC access to payload fairing:**

   (1) PRC will call the security desk prior to accessing the payload fairing and provide reason for access and expected duration;

   (2) maximum of two PRC nationals may work in the area of the open payload fairing door;

   (3) no photographic equipment allowed;

   (4) PRC may only physically enter the fairing door to the shoulder level (if further access is required U.S. Government monitor must be present);

   (5) if the PRC violates any of these rules the security officer will call U.S. Government monitor, Nick Yen, and K. Patterson immediately; and

   (6) security officer will log all fairing access.

7. Monitor discovered a **Loral subcontractor stored a computer with digital pictures of the satellite in an unsecured room in Launch Complex 2**.

Excerpts from Defense Department Monitors' Reports of Security Breaches at PRC Launches of U.S. Satellites (continued)

8. APT representative and Yang Hua Wang of China Launch and Tracking Control General **took unauthorized photographs of [satellite].**

Hughes-Aussat B-1 (1992):
Reports of Defense Department Monitor A. D. Coates

1-22-92
1. Confusion begins because Hughes is unprepared for launch causing them to arrange **multiple technical meetings [with PRC] unnecessarily and without prior notification to monitor**.

1-23-92
1. **Containers holding security equipment with only combination locks, no seals**.
2. **Security videos do not provide coverage of access fairing doors**.

1-24-92
1. Four items scheduled to be shipped without containers and uncovered.
2. Building not secure one week prior to satellite arrival.
3. Advance sea shipment inventory incorrect and **containers not locked and sealed as requested**.
4. No joint operational plans, or intent to create one.

1-28-92
1. **No Hughes management to direct PRC nationals.** [Hughes management] who are at Big Hotel one hour away appear to divorce themselves of responsibility of launch site when there. Security staff assumes ad hoc role to cover for them.
2. Continued **ad hoc decisions by Hughes without review by monitor**.
3. Lack of written procedures.

1-29-92
1. Items on 747 arrived unlocked. Had to board plane and lock before unloading.
2. Badging not addressed until day of 747 arrival.

1-30-92
1. **Documents removed from file cabinet in high bay without controls**.
2. **Satellite test data filing cabinet not sealed**.

Excerpts from Defense Department Monitors' Reports of Security Breaches at PRC Launches of U.S. Satellites (continued)

	3. On board 747, data sheets attached to safe-and-arm pyro box, satellite **test data filing cabinet not sealed / located on open pallet**, containers listed as ground support equipment attached to forklift.
1-31-92	1. Test documentation not listed on inventory.
	2. **No access list of PRC nationals** provided to monitor for Hughes-controlled area.
	3. Hughes inventory of toxic vapor detectors reveals two keep [remain] missing.
	4. **No list of documents Hughes exchanged with PRC.**
	5. No trash disposal procedure.
2-1-92	1. **Inventory sheet visible on container**.
2-3-92	1. **Hughes may have given "milspec numbers" to PRC**.
2-5-92	1. Inventory sheets on containers visible.
2-6-92	1. **Filing cabinet left open**.
	2. **Notes kept un-erased on blackboard**.
	3. **Controlled documents cannot be located**.
2-7-92	1. Inventory sheets visible on containers.
	2. Aussat satellite test equipment status papers on top of equipment.
2-8-92	1. **Satellite diagram left out in Satellite Processing Building 2**.
	2. Misuse of telephone.
	3. **Sensitive documents left out**.
2-9-92	1. Inventory sheet face up pushed under a typewriter to get it out of the way.
	2. No seal between fueling rooms. (Second violation)

Excerpts from Defense Department Monitors' Reports of Security Breaches at PRC Launches of U.S. Satellites (continued)

	3. **X-ray position diagram found**.
	4. Inventory sheet exposed.
	5. Hughes employee **personal notebook** found under briefcase **containing controlled material not inventoried and hand-carried. Worst case so far**. Requested inventory after.
2-10-92	1. Hughes employee asked to write a response, and Hughes [employee] disputes he is required to do so. **Hughes management unwilling to review security plan for requirements**.
	2. Hughes holds **discussions with PRC without notifying monitor of contacts beforehand**.
	3. **International Traffic in Arms Regulation-controlled material found in building even after monitor told none there**.
	4. **No seals on two doors**.
	5. **Hughes does not notify monitor of shipment, but notifies PRC.**
	6. Inventory lists left exposed.
2-11-92	1. Hughes asks monitor to show them their own security plans. **No one at Hughes reads their own requirements**.
	2. **Hughes indicates during security briefing that monitor's requirements are his own whims**.
2-14-92	1. **Schematic** of satellite bus equipment module and related documents **left out.**
2-15-92	1. Three inventory sheets left visible.
2-16-92	1. Invoice sheet left exposed.
	2. **Satellite Processing Building 3 large doors had security seal ripped off**, seal partially removed from emergency exit door.
2-17-92	1. Test valve document left on satellite stand.

Excerpts from Defense Department Monitors' Reports of Security Breaches at PRC Launches of U.S. Satellites (continued)

3-15-92 1. **Camera 4 goes down. Security not aware [that they are supposed] to man tower when camera goes down**.

Hughes-Aussat B-2 (1993): Reports by Defense Department Monitors Captain R.J. Byrd, J. Kuriazisl, and S. Long

10-31-92 1. Hughes security guards had expired visas.

1-20-93 1. In the case where U.S. Government representatives might be seriously injured while in Xichang, Hughes made arrangements to quickly fly injured personnel to Hong Kong; alternately [alternatively], a U.S. Marine Corps aircraft could be flown in to transport U.S. Government personnel. It is noted that an injured person would not receive treatment for at least 24 hours from HAC [Hughes] or U.S. Marine Corps aircraft evacuation.

1-20-93 1. Flip-Rite cart not covered on satellite while aboard a chartered FedEx Boeing 747 flying from Los Angeles, CA, to Xichang, China.

2. Hughes security agreed to cover the Flip Rite prior to removal from the Boeing 747.

Hughes-Optus B3 (1994): Report of Defense Department Monitors Kline and Villhard

7-8-94 1. **Window left open for an undetermined period of time. May have been as long as 21 days.**

7-10-94 1. **Trucks left unattended by U.S. citizens. Third time equipment was discovered left unattended during this campaign**.

7-12-94 1. **Non-essential PRC [personnel] allowed in controlled area** because, by making them stand not three feet from technicians, the technicians felt they had to wait outside.

2. **Sea containers stored outside Satellite Processing Building 2 were locked but not sealed** because the security supervisor did not want to seal containers they needed continuous access to.

7-22-94 1. **Found Apstar controlled document file cabinet left open**. Did not see documents logged out.

Excerpts from Defense Department Monitors' Reports of Security Breaches at PRC Launches of U.S. Satellites (continued)

7-25-94 1. PRC working in building and not logging out.

8-29-94 1. **Controlled documents not signed back in. Person it was signed out to said he could not find it**. (Simon Peng)

Lockheed Martin-Chinastar (1998):
Reports of Defense Department Monitors Captain H. N. Rollins and J. Chandler

3-25-98 1. **Satellite in Antonov aircraft overnight without U.S. security guards. Russian plane, Russian guards, Russian seal while plane stops in Russia for overnight rest.**

3-31-98 1. Concerned over relationship between Lockheed Martin, China Orient, and China Academy of Launch Vehicle Technology (CALT) because China Orient has lived and worked with Lockheed Martin in East Windsor, NJ for a year and monitor believes [there has been] a transfer of a significant amount to training technical support / data, hardware, software, etc., in contradiction to DTSA handbook.

4-5-98 1. Security found discarded equipment in trash, which is controlled.

3-23-98 to 4-17-98 1. "Lockheed Martin obtained the export license for this satellite contract through the [Commerce Department], not the [Department of State]. I believe this gave them too much discretion in sharing satellite technology with the PRC. For example, PRC engineers were present in the satellite factory in East Windsor, NJ, for the two years prior to shipment. They were present as customer representative for China Orient Telecommunications. **They witnessed all phases of assembly and test**. Beyond how the Chinastar satellite was built and performed, they had the opportunity to learn why it was built this way and the opportunity to infer any inherent weakness or vulnerability in its design." (Emphasis added)

4-27-98 1. Emergency exhaust fan in fueling room inoperable.

2. Emergency shower outside of fueling room inoperable.

Excerpts from Defense Department Monitors' Reports of Security Breaches at PRC Launches of U.S. Satellites (continued)

Motorola-Iridium (1993): Report of Defense Department Monitor Lieutenant M.L. Shaffer

11-30-93 to 12-3-93

1. "A briefing about **thermal issues** was given by Motorola in which information concerning a 'thermal maneuver' was presented. This was a perfect example of the Motorola 'it was given to the Russians so it can be given to the PRC' mentality . . . it was not pertinent information and should not have been discussed. Monitors should watch for items that are given to the PRC that reference either U.S. or Russian hardware or services." (Emphasis added)
2. During Technical Interchange Meeting, **blueprint of facilities of Vandenberg Air Force Base** was pulled out of a briefcase by a Motorola person (in the presence of China Academy of Launch Vehicle Technology (CALT), China Great Wall Industry Corporation, and Taiyuan Satellite Launch Center personnel).

Motorola-Iridium (1995): Report of Defense Department Monitors Lieutenant M.L. Shaffer and Captain E. McCarty

5-26-95

1. With DTSA approval Dan Letson (Motorola) had been monitoring CALT [China Academy of Launch Vehicle Technology] tests for about three weeks without a U.S. Government representative.

8-21-95 to 8-25-95

1. "An interesting note: During the last trip to the [PRC] Taiyuan Satellite Launch Center (21-25 August) there was a **technical thermal conversation going on. The monitor stepped out of the room for a minute and as soon as he did, 'without missing a beat,' one of the PRC engineers said to Motorola thermal engineer,** Bob Allen, 'I noticed that your solar arrays have no push springs on them for deployment. I was wondering how you deploy them on orbit?' To which Bob replied, 'I don't think I'm allowed to tell you that.' That (I was told) was the end of the conversation, which goes to show that we monitors may be more necessary for dissuading the PRC than the contractors." (Emphasis added)
2. **Motorola used the phrase in a TIM [Technical Interchange Meeting], "We have not been happy with the thermal design from the beginning." Major Smith (monitor) was concerned that the discussion would lead to the Americans redesigning the thermal**

Excerpts from Defense Department Monitors' Reports of Security Breaches at PRC Launches of U.S. Satellites (continued)

control system for CALT [China Academy of Launch Vehicle Technology]**.** (Emphasis added)

9-7-95 1. The launch tower lacks essential safety equipment such as an escape shoot and fire alarms.

Motorola-Iridium (1998): Report of Defense Department Monitors Major George R. Gunning

2-22-98 1. **Pinkerton had not read the Security Plan. They were not aware of what data and hardware was sensitive**.

2. Taiyuan Satellite Launch Center [PRC] provided walkie-talkies to Pinkerton guards. The radios lost their charge before the convoy even got started, thereby providing ineffective communications among guards.

2-24-98 1. I observed only one significant problem, **Motorola does not have a document control procedure**.

3-6-98 1. **PRC workers in area where they "had no business."** Work supposed to be completed in five minutes, and **PRC took 1.5 hours**. (Emphasis added)

3-23-98 1. Some Motorola [employees] consider the PRC their "good friends." Team leaders from Motorola develop a sense of trust that could lead to inadvertent transfer of technology.

2. **Unannounced access to controlled area**.

3-28-98 1. **Lack of vigilance** on the [part of] Motorola to protect U.S. technology. On several occasions had to remind MSC [Motorola Satellite Communications] to observe security practices such as **document control, being aware of what is said and transmitted over communications lines** and denying usual access [to] controlled areas.

2. **Motorola has been bringing in a PRC national to set up secure and unsecured fax, voice and data transmissions. "In my point of view this is a huge hole in security." "Given Motorola's lack of security training I would not be surprised to discover that unapproved technical data is being exchanged and intercepted by the PRC."** (Emphasis added)

3. PRC requested copies of Motorola procedure documents. I denied the request. "But if I had not been present they would see no problem in handing them over."

COMMERCIAL SPACE INSURANCE

The space insurance aspect of the Intelsat 708 launch failure focuses on the exchange of controlled technical information within the insurance community. Insurance underwriters and reinsurers for the Apstar 1A satellite program — the next scheduled satellite to be launched on the Long March 3B after the Intelsat 708 failure — were concerned about the reliability of the Long March rocket, and the fate of future launch insurance programs in the PRC.

Immediately after the Intelsat 708 launch failure, space insurance underwriters for the Apstar 1A insurance program pressured the PRC to create an international and Independent Review Committee (IRC). These underwriters and reinsurers insisted on this arrangement to ensure that an adequate assessment of the risks of future Long March rocket launches was made.

Representatives from J & H Marsh & McLennan, an international space insurance brokerage firm, were adamant about obtaining a report from the Independent Review Committee for the benefit of the reinsurers of the Apstar 1A satellite insurance program. Members of the space insurance community were invited to attend a meeting on April 15 and 16, 1996, in the PRC. The purpose of the meeting was to build confidence in the Long March rocket, and to discuss the status of the Apstar 1A insurance program.

The space insurance acquisition and underwriting process includes the dissemination of technical information, the consideration of market conditions, capacity, and participants, and the involvement of insurance brokers, underwriters, and reinsurers. This chapter identifies several issues relating to procedures for the disclosure and handling of sensitive information by the insurance community.

It is unclear whether, or to what extent, the transmission of controlled technical information to and from the space insurance industry is reviewed in advance or monitored by U.S. Government officials.

THE ROLE OF COMMERCIAL SPACE INSURANCE IN TECHNOLOGY TRANSFER TO THE PRC

Insurance Aspects of the Long March 3B-Loral-Intelsat 708 Failure

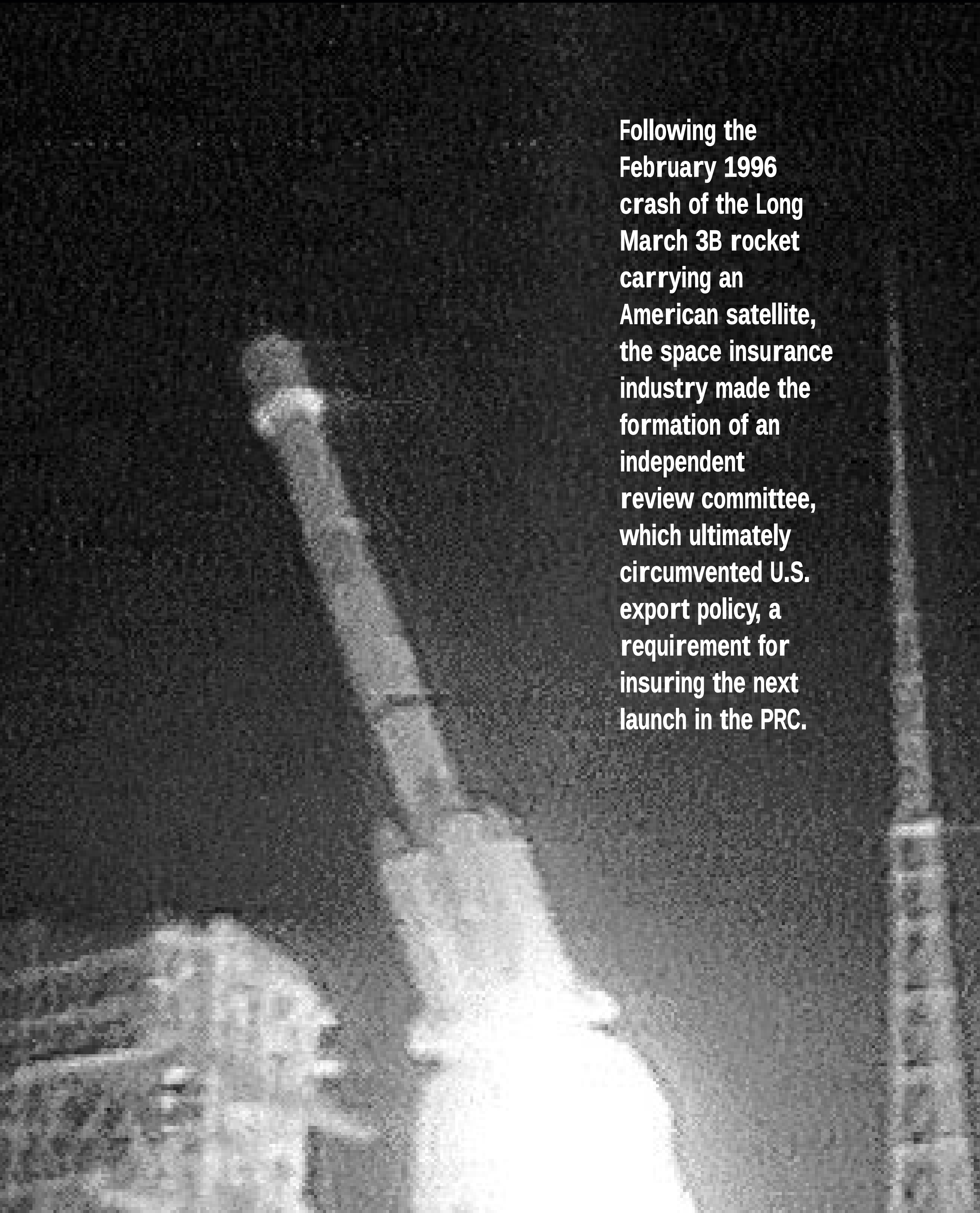
The Intelsat 708 satellite was destroyed in a Long March 3B crash on February 15, 1996.[1] It was the second in a series of nine Intelsat satellites for which International Space Brokers was the sole insurance broker.[2]

Intelsat had arranged for the People's Republic of China (PRC) to launch three of the nine satellites (Intelsat 707-9, Intelsat 708, and Intelsat 801-6) on the PRC's Long March 3B rocket.[3]

The Intelsat satellite 708 was insured for $204.7 million.[4]

Intelsat obtained space insurance for the launch phase only. The launch phase extended from intentional ignition of the rocket to separation of the satellite from the rocket.[5] Under the terms of the policy, risk transferred from the pre-launch insurers for the manufacturer of the satellite, Space Systems/Loral (Loral), to Intelsat's insurers at the intentional ignition of the Long March 3B rocket carrying Intelsat 708.[6]

There were approximately 15 to 20 insurance underwriters and many reinsurers for the package that included the Intelsat 708 satellite.[7] The lead underwriters were Marham Space Consortium[8] and Munich Re of Munich, Germany.



Following the February 1996 crash of the Long March 3B rocket carrying an American satellite, the space insurance industry made the formation of an independent review committee, which ultimately circumvented U.S. export policy, a requirement for insuring the next launch in the PRC.

Intelsat, an international satellite communications consortium headquartered in Washington D.C., had arranged to launch three of its nine series 700 satellites in the People's Republic of China. After its 708 satellite was destroyed during launch aboard a PRC Long March 3B rocket that crashed seconds after lift-off, Intelsat cancelled its contract with the PRC. The remaining two launches were reassigned to French Ariane rockets.

Other insurance underwriters who participated in the coverage of the Intelsat 708 satellite were:

- **U.S. Aviation Insurance Group**
- **AXA Reinsurance Company**
- **La Reunion Spatiale**
- **AGF Reassurances**
- **Reliance Assurances**
- **The Sumitomo Marine & Fire Insurance Company, Ltd.**
- **Great Lakes**[9]

The Intelsat 700 Series satellite insurance package was negotiated approximately six months prior to the first launch, when a data package including technical information on the Long March 3B was submitted to the underwriters.

After the launch of the Long March 3B rocket carrying the Intelsat 708, Intelsat reassigned the remaining two launches that had been slated for the PRC's Long March 3B to French Ariane rockets.[10]

Intelsat documents indicate that the decision to procure launch services from the China Great Wall Industry Corporation was based on the size of the Intelsat 708 satellite and the fact that the price was significantly below that of an Ariane launch. Intelsat documents revealed:

> *At issue are the agreements regarding commercial satellite launches negotiated by the PRC and the U.S. in January 1989 which deal with trade issues and market entry, technology safeguards, and liability.*

Prior to the first launch of an Intelsat satellite on the maiden launch of the Long March 3B rocket, a data package was submitted to underwriters because it was considered a developmental successor to the Long March 3A *(above).*

Under these agreements introductory or promotional prices are allowed for the first or, in extraordinary circumstances, the second successful commercial launch of a new launch vehicle.[11]

A Loral program manager was on-site at Intelsat during the Intelsat 708 project, and an Intelsat program manager was on-site at Loral. Intelsat insurance issues with Loral were coordinated through a Loral office located at Intelsat.[12]

Prior to the first launch of an Intelsat satellite on a PRC rocket, Intelsat requested that its broker submit a data package on the Long March 3B to underwriters because it was a developmental rocket.

The data package for the Intelsat 708 launch included a relatively large quantity of data on the Long March 3B, because of the rocket's then-recent developmental status.[13]

Michael Hewins, then Chairman of the Space and Telecom Group for J & H Marsh & McLennan,[14] says that both his firm and Asia Pacific Telecommunications Satellite Co., Ltd. were interested in the reliability of the Long March after the Long March 3B-Intelsat 708 failure. Hewins says that Professor Bao Miaoqin, Chief Engineer at the PRC-controlled Asia Pacific Telecommunications Satellite Co., was told by his superiors to use the Long March for the upcoming Apstar 1A launch, but Hewins does not have any specific information about this request.[15]

J & H Marsh & McLennan were the insurance brokers for the next PRC launch of a Long March rocket following the 1996 crash of the Long March 3B carrying Intelsat 708. That next launch, of a Long March 3, was scheduled to carry the Hughes-built Apstar 1A satellite for a PRC-controlled consortium.

China Great Wall Industry Corporation provided the requested data in order to demonstrate that the Long March 3B's development was complete. Intelsat used China Great Wall Industry Corporation's data in its presentation to underwriters. The data covered both the Long March 3B and the PRC launch facility.[16]

Terry Edwards, Manager of Intelsat's Launch Vehicle Programs Office, supervised the Intelsat 708 assessment team, and interacted with Intelsat's insurance brokers. For its part, Loral provided data directly to China Great Wall Industry Corporation on the satellite-rocket interface, while Intelsat instructed Loral to take all steps necessary to demonstrate a proper interface.

Intelsat officials say that Intelsat was aware of export control requirements and complied with them, and that the Defense Technology Security Administration monitored technical meetings among the satellite owners, rocket owners, satellite manufacturers, and insurance representatives.[17]

Intelsat's business considerations were the basis for the cancellation of the two scheduled PRC launches following the February 15, 1996 Long March 3B crash.[18] Intelsat documents stated that:

> *There is an unreasonable and unacceptably high technical and safety risk in proceeding with additional [Long March 3B] launches of Intelsat spacecraft until [China Great Wall Industry Corporation] has accomplished a sufficient number of successful operational launches of the vehicle demonstrating a reliability equal to other major providers of launch services to Intelsat.*" [19]

Intelsat has not used a PRC rocket since the failure of the Long March 3B carrying Intelsat 708.

According to Mark Quinn, former Vice President at J & H Marsh & McLennan, there were no J & H employees on-site in the PRC for the Long March 3B-Intelsat 708 failure. Quinn says he does not recall any specific discussions, and says he did not have any conversations with underwriters or reinsurers regarding that failure. Nor did Quinn discuss specific issues regarding insurability for that program with anyone. Quinn says that he contacted his clients regarding the Long March 3B-Intelsat 708 failure and also called contacts at Loral. Quinn does not recall the content of the calls, other than to ask whether market conditions had changed.[20]

The Treasurer of Intelsat, Randall Bonney, has primary contact with Intelsat's insurance brokers for insurance-related issues. Bonney is responsible for submitting the Notice of Loss to the insurance companies in the case of a failure, and he prepared the Summary Report of Loss for Intelsat 708. Intelsat's Launch Vehicle Program Office is the insurer's point of contact for technical information. Most launch service questions from insurance underwriters come through this office at Intelsat, but some may not have done so.[21]

J & H Marsh & McLennan's Hewins, then Chairman of the firm's Space and Telecom Group, recalls that Loral President Bernard Schwartz projected a broad intent to "get it right" regarding satellite launches in the PRC. However, Hewins says he had no specific discussions of the subject with Schwartz.[22]

The Formation of the Independent Review Committee

The launch failure of the Long March 3B rocket carrying the Loral-manufactured Intelsat 708 satellite occurred on February 15, 1996. Immediately, the French space insurance underwriters for the upcoming Apstar-1A launch pressured the launch service provider, China Great Wall Industry Corporation, through their insurance broker, J & H Marsh & McLennan, to create an Independent Review Committee. China Great Wall Industry Corporation was about to launch the Hughes-made Apstar-1A satellite for the PRC-controlled Asia Pacific Telecommunications Satellite Co. aboard a Long March rocket.

On February 21, 1996, Paul O'Connor, then Vice President of the Space and Telecom Group of J & H Marsh & McLennan in Washington, D.C., wrote China Great Wall Industry Corporation recommending that "CGWIC should implement an immediate and aggressive public relations (PR) campaign with space insurance underwriters" by way of a technical briefing on the Intelsat 708 mission failure.[23]

O'Connor's letter stressed the importance of quick and decisive action by China Great Wall Industry Corporation. Lost confidence on the part of the PRC's customers, he said, could cost tens of millions of dollars in business. "The space insurance underwriters should see that China Great Wall Industry Corporation is serious about getting its message out to the international community and is prepared to act quickly and with determination, rather than react to customer requests." [24]

Jacques Masson, then Manager of J & H Marsh & McLennan's Paris office, discussed the Intelsat 708 failure with the French insurance industry, specifically the underwriter La Reunion Spatiale. As Masson explained in a February 22, 1996, e-mail:

> *We should strongly recommend to implement an independent inquiry board. As far as I know from various information release [sic], Chinese have formed three committee[s]: oversight committee, investigation committee, and the failure investigation and analysis group.*
>
> *All of them are strongly linked to Chinese industry.*
>
> *The message that we shall send them, is that their credibility is at stake and without any international independent inquiry board we don't give them much chance of success. Everyone I discussed with are very strong on that point. This is the way that Arianespace is doing each time.*
>
> *I will send you by separate mail some input from previous Ariane failure inquiry board[s]. This information is confidential, however. [S]chedule quick very quick help to form it.*[25]

The underwriters for the Apstar-1A program became disappointed that the PRC's failure review committees did not have foreign or Intelsat representatives.[26] The French launch vehicle provider Arianespace, for example, typically creates an independent review committee after a launch failure to ensure international credibility and distance Arianespace from the review process. "This is interpreted by Westerners as CALT [the China Academy of Launch Vehicle Technology] wanting to 'hide' the results of the failure review and avoid independent international scrutiny," the underwriters said.[27]

J & H Marsh McLennan's O'Connor advised the PRC representatives that a typical schedule of an independent review committee for an Ariane failure would entail assessing the mission and setting up the review committee within the first week. Approximately two weeks later, a report of the committee's findings would be provided to Arianespace and the European Space Agency. Lastly, the committee would provide a briefing to customers and insurance underwriters regarding the failure investigation. Detailed information releases to relevant parties would follow.[28]

O'Connor praised China Great Wall Industry Corporation for its general dissemination of information relating to the failure to its customers and other parties. He also stressed, however, the importance of allowing J & H Marsh & McLennan to distribute information releases to the insurance underwriters on behalf of China Great Wall Industry Corporation. This step would, he urged, ensure that there is no delay in the release of information.[29]

O'Connor outlined specific items that must be satisfied for reinsurers to continue to underwrite the Apstar-1A program. The reinsurers must:

- ***"Receive fully detailed information concerning the very root cause(s) of the [Intelsat 708] mission failure and the solutions"***
- ***"Receive the advice of an independent organization concerning the analysis of the failure, and the solutions set forth by China Great Wall Industry Corporation "***

The reinsurers, O'Connor explained, believed that Intelsat should be considered to fill the role of an independent organization. China Great Wall Industry Corporation and the China Academy of Launch Vehicle Technology continued to receive, O'Connor noted, "strong international criticism . . . for failing to have an international, independent failure review team." [30]

O'Connor advised China Great Wall Industry Corporation that reinsurers had stated that the Apstar-1A program would not proceed until these concerns were satisfied.[31] On March 8, 1996, European underwriter Reliance Assurances stated to O'Connor: "We firmly believe that such a determination, together with an explanation of and concurrence with the appropriate corrective measures, is necessary to undertake an objective analysis of the insurance risk as it exists at this point in time." [32]

On March 11, 1996, Henry Stackpole, III, of Loral in Tokyo wrote that "SS/L [Loral] has . . . offered 'in house' assistance if desired in the investigation but doubt seriously it would be accepted. We appear to be clear of any Chinese thought that the satellite was a causal factor." [33]

A presentation at the Apstar-1A program insurance meeting was scheduled for March 14 and 15, 1996, in Beijing and included insurance market requirements. Attendees included:

- **Representatives from 11 reinsurers**
- **J & H Marsh & McLennan**
- **China Great Wall Industry Corporation**

According to J & H Marsh & McLennan presentation materials, requirements included an open and thorough investigation and an independent committee consisting of well-recognized industrial people.[34]

The French underwriting community identified three specific issues as the minimum necessary to raise the level of confidence sufficiently to insure future launches of the Long March 3B. The requirements were to reassess China Great Wall Industry Corporation's qualification, acceptance, and quality assurance programs, and to conduct a demonstration flight of the Long March 3B. "It seems obvious to the underwriters that the next Long March 3B launch is not insurable." [35]

On March 20, 1996, J & H Marsh & McLennan's Masson wrote Professor Bao Miaoqin, chief engineer of the PRC-controlled Asia Pacific Telecommunications Satellite Co. whose Hughes-manufactured Apstar 1A satellite was the next scheduled launch of a Long March rocket (the Long March 3):

> *The Underwriters do not believe that the limitation of the IRC [Independent Review Committee] to one body constitutes a problem. The SS/L [Loral] capability and expertise in the field of launch vehicles [rockets] constitute[s] an issue, however.*
>
> *The integrity of Loral and its expertise in the satellite system and launch vehicle interface design is well recognized, but the*

lack of clear and recognized launch vehicle expertise will put in question the validity of Loral's conclusions, however. This limitation constitutes a problem for the French Underwriters.

In [sic] the other hand, Tim Wright has questioned other European Underwriters. The reaction he got from the leader Munich Re is opposite to the French position. This limitation is acceptable providing that the expertise of each member of the Loral team is clearly identified.

We have now three Underwriters with a negative position against one Underwriter. To solve this problem, we have investigated with the French Underwriters if there is other option.

The ideal option for these Underwriters is to have an IRC that is formed by individual people who have an expertise in the launch vehicle system well recognized by the space industry.

This type of committee set up is ideal for Underwriters because it insures the expertise of the IRC and its independence. It should be noted that all independent failure reviews for western launch vehicles are constituted with individual people and not by company or organization as Intelsat.

Ideally the committee should be formed with four people, two from Europe and two from USA. The member[s] should not have an active position in the space industry but should be retired senior members. Their expertise should be recognized by the space industry and space insurance leaders . . . .

We recommend to create the IRC with Loral people and try in parallel to add two or three individual members to the IRC. In this condition, if we are not able to add more members we will have a lowest requirement satisfy [sic] for the meeting. However, if we succeed to add the individual members, we will constitute a perfect IRC.

> *If a decision is taken to follow this recommendation, we can quickly set up and submit a list of individuals who could be approached to become a member of the IRC. We have already identified some individuals in France who are potential members. The reason we are limiting our list to French experts, is that France is the leader in the Ariane program with more than 60%. Most of the experts in launch system are in France.*
>
> *In order to succeed, it is very important that we react very quickly. The IRC should be formed in 2 or 3 days, no more. We can offer a full support here in Paris to help to identify and approach the selected individuals if it becomes necessary.*
>
> *After having setup the IRC, we will need to define the mission of the IRC and prepare an action plan so that the IRC could formulate a conclusion for the meeting in Beijing.*
>
> *We think necessary that the IRC shall gather in Beijing for one week to assess the work performed by the different failure review boards.*
>
> *One important key to the success of the IRC, is the full access to the information and data.*[36]

On March 20, 1996, and in a subsequent message dated March 21, 1996, to the PRC-controlled Asia Pacific Telecommunications Satellite Co., Masson identified three potential members of the Independent Review Committee: one each from Aerospatiale, Matra Marconi, and Arianespace. Each was an expert in rocket operations and in conducting in-depth failure reviews, and was retired from the private space industry.

None of the individuals had been contacted, however, pending the proper authorization from China Great Wall Industry Corporation and the China Academy of Launch Vehicle Technology. Messr. Bignier, a leading figure in the French and European space industry and a consultant to La Reunion Spatiale who had visited the PRC twice and was familiar with the PRC space industry and "the difficult position where are CGWIC and CALT today," had also been contacted and asked to support the creation of the Independent Review Committee.[37]

On March 21, 1996, Chuck Rudd, Senior Vice President of ACE Limited, a Bermuda-based underwriter, wrote Sheila Nicoll at J & H Marsch & McLennan that ACE had been informed (by an unidentified source) that Intelsat would provide technical expertise and familiarity with China Great Wall Industry Corporation to the Independent Review Committee. Intelsat, he said, "provides a level of comfort that the failure investigation will be complete and unbiased." [38]

ACE Limited, a Bermuda-based space insurance underwriter, pulled out of the Apstar 1A insurance contract due to China Great Wall Industry Corporation's "unacceptable" response to the Long March 2E crash.

On the same day, ACE Limited officially advised J & H Marsh & McLennan that "the launch failure of the Long March 3B [constitutes] a material increase in the risk of loss under the Apstar 1A launch policy." ACE Limited stated that it found the actions of both the customer for the planned Apstar 1A launch, the PRC-controlled Asia Pacific Telecommunications Satellite Co., and the launch services provider, China Great Wall Industry Corporation, to be unacceptable:

> *The rushed invitation to attend the failure briefing confirmed to us that CGWIC [China Great Wall Industry Corporation] is not pursuing proper due diligence following a loss.*
>
> *Consequently, we firmly believe that concurrence by Intelsat of the cause and correction of the failure is paramount.*
>
> *In the event the information is incomplete and/or not fully [reviewed] by an independent party, ACE Limited will have no alternative but to cancel its participation [in the Apstar 1A syndicate].*[39]

Toward the end of March 1996, Intelsat declined to participate in the failure review. One J & H Marsh & McLennan official thought the decision was consistent with Intelsat's cancellation, after the Long March 3B-Intelsat 708 failure, of future Intelsat launches on PRC rockets until 2000.[40]

J & H Marsh & McLennan's O'Connor wrote Professor Bao Miaoqin of the PRC-controlled Asia Pacific Telecommunications Satellite Co. that:

> *The reinsurers have stated that the IOC's [International Oversight Committee, i.e., the IRC] review of the failure investigation is a mandatory item to be implemented before the technical briefing.*
>
> *Reinsurers are asking what is the status of Intelsat in the IOC. J & H has to provide reinsurers with a firm and final explanation, tomorrow, Tuesday, April 2 so we can ask APT to coordinate a response through CGWIC [China Great Wall Industry Corporation] . . .*[41]
>
> *There is no doubt about the launch agency's capability to meet the deadlines for the preparation of materials and formation of an independent international oversight committee but APT is lock and load on going ahead at this time due to absolutely strict project and financial timelines. APT has zero tolerance to further delays.*[42]

The following day, April 2, 1996, O'Connor again wrote Professor Bao Miaoqin:

> *IOC – we have received further inquiries from reinsurers today about the status and membership of one IOC. To date, we have not received any notification from CGWIC [China Great Wall Industry Corporation] on this matter and wish to remind the parties of the serious nature of this matter.*
>
> *We have not been authorized by CGWIC to approach the European candidates for the IOC membership. This matter must be settled as a matter of urgency – it cannot be delayed until April 9.*[43]

On the same day, April 2, 1996, Professor Bao Miaoqin wrote J & H Marsh & McLennan and China Great Wall Industry Corporation asking for a list of the Apstar-

1A reinsurers and Independent Review Committee members by April 9, 1996.[44]

According to J & H Marsh & McLennan's Masson, who wrote his colleague O'Connor on April 3, the underwriting community wanted "minimum conditions to be satisfied" in order to confirm insurance commitments with respect to the upcoming Apstar-1A. Masson wrote to O'Connor:

> *The UWs [underwriters] will be very critical in their assessment for two reasons:*
>
> *a) The previous failures of the [Long March 2E rocket] didn't leave a good souvenir [sic] in the UW mind. The failure reviews were not conclusive, there was no verification by an International Oversight Committee (IOC) and although the two last flights were successful, nobody was able to demonstrate why the flights were successful. Most of the UWs will let no chance to approximate conclusion. UWs are saying that for the first failure they were flexible, for the second failure they were less flexible but they gave a last chance. Now for the third failure, there is no place for any flexibility.*
>
> *b) The first element from the review board show clearly that the failure affects a single point of failure. Most of the main Western launchers (Ariane, Delta, Atlas) have a redundant Inertial platform. Single point of failure is not acceptable for western specification but there is some provisions to cope with them. Either you remove it or you demonstrate without any doubt that your reliability level of your unit is such that it is acceptable compared to the overall system reliability. Because it is out of the question that CGWIC [China Great Wall Industry Corporation] and CALT [the China Academy of Launch Vehicle Technology] soon add a redundant Inertial Platform, we have to deal with the second option. UWs will be very serious about the way CGWIC and CALT addresses this single point of failure.*
>
> *From the above reasons, we can define the minimum set of*

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Western rockets such as (*from left to right)* the Ariane (France), Delta (U.S.), and Atlas (U.S.) have a redundant inertial platform, one feature that distinguishes them from PRC rockets. For this reason, space insurance underwriters and brokers were especially concerned with the failure of the inertial platform on the Long March 3B.

requirements needed to ensure a reasonable chance that UWs are confirming their commitment:

1) *The Preflight meeting shall provide clear conclusions which are subject to no controversy. These conclusions shall be supported by a detailed and clear demonstration. The level of the conclusion shall be enough to support an isolation analysis for the [Long March 3]. This last point means that it will be acceptable to UWs to wait for the [Long March 3B] recovery plan, but it is out of question that all causes are not identified and demonstrated for the [Long March 3] isolation analysis. In other words, saying that the electrical motor is the cause of the problem is not enough. We shall know why the motor failed.*

2) *The isolation analysis will be of key analysis. UWs are not expecting to listen [to] a set of arguments telling that the two platforms are different and that [Long March 3] plat-*

form has flown more than thirty times. This is a single point of failure and this type of argument is not acceptable. If it appears that the electrical motor is the most probable cause of failure, then the same problem could happen to the [Long March 3] platform. UWs are expecting a detailed reliability analysis demonstrating what is the real level of reliability of this platform. I think however that such analysis does not need to be finished for the Preflight meeting in Beijing. At this meeting CGWIC and CALT shall show that such study is underway and that its conclusions will be ready soon (2 to 4 weeks) and in any case before Apstar-1A launch. UWs will then subject their commitment to satisfactory conclusions. We shall take some provision in the planning to let the UW to review this analysis (1 week).

3) *Just after the news of the failure of the flight Intelsat-708 was made public, the UWs required the setting up of an IOC (Independent Oversight Committee) [that is, the IRC]. This is a common practice for any failure with any western launch vehicle failure, but because there was no IOC to provide any conclusion for the previous flights' failure, UWs made strong comments that one condition before they agree to any conclusions, is that the work of the failure review board being reviewed and agreed by an IOC. The composition and the mandate of this IOC should be subject to UW approval. The UWs understand very well that it is not possible that the IOC will [have] proved their conclusions at the pre-flight in Beijing March 15, 16. The time available is not sufficient. However, as a minimum condition, they want to see that the IOC has been formed and that the mandate has been officially defined. Furthermore they will request that the IOC conclusion to be known before the launch of APSTAR-1A for they [sic] review. UWs expect a clear commitment from the Chinese official[s] which guarantee[s] that whatever the conclusions should be, the IOC*

> *will be free to publish their conclusion. UWs expect with the forming of the IOC a sign of openness from CGWIC and CALT.*[45]

On April 4, 1996, J & H Marsh & McLennan stated that it had *"not received any official advice"* from China Great Wall Industry Corporation that the Independent Review Committee would be formed, "and if and when it's formed, as to who will be invited." The J & H Marsh & McLennan Beijing office was instructed to act as a liaison for continuing communication with China Great Wall Industry Corporation officials in this regard.

O'Connor wrote on April 4, 1996, that "[i]t is difficult for us to prompt China Great Wall Industry Corporation any more than we have (which has been on a daily basis)." J & H Marsh & McLennan was "awaiting the decision of China Great Wall Industry Corporation on the final list of the space industry experts who will participate in the International Oversight Committee (IOC)."

In an issues paper for the April 15 and 16 meetings prepared by J & H Marsh & McLennan, Masson and O'Connor noted that "[r]einsurers have insisted that an IOC [Independent Oversight Committee, i.e., the IRC] be formed by the China Academy of Launch Vehicle Technology to oversee the failure review for the [Intelsat] 708 mission failure. It is standard practice for Western launch service providers to establish an IOC immediately after a mission failure." [46]

Reinsurers made the formation of an Independent Review Committee an "absolute requirement" prior to approval of the Apstar-1A launch campaign, since the China Academy of Launch Vehicle Technology had previously failed to use an Independent Review Committee for failure reviews: "[t]he [Long March 3B-Intelsat 708] failure review must be reviewed and endorsed by an IOC." Reinsurers would interpret a refusal as a sign of the China Academy of Launch Vehicle Technology's reluctance to be open about its failure review.[47] Furthermore, J & H Marsh & McLennan believed that the minimum requirements regarding the Independent Review Committee were:

- **That it be created with a defined mission prior to the**

April 15 and 16, 1996, insurance meeting

- **That its membership be independent and international, with unrestricted review authority**
- **That the final report be published and reviewed by reinsurers prior to the launch of Apstar-1A**[48]

On April 4, 1996, O'Connor wrote Professor Bao Miaoqin:

> *We understand that Intelsat has declined to participate in the IOC [i.e., IRC]. Yet, to date, there has been no announcement by CGWIC [China Great Wall Industry Corporation] on this issue. A formal announcement should be made about this matter and a satisfactory replacement for Intelsat must be found as a matter of urgency.*[49]

As of April 4, 1996, China Great Wall Industry Corporation said it was trying its best to establish an Independent Review Committee according to the minimum conditions set by the PRC-controlled Asia Pacific Telecommunications Satellite Co. and J & H Marsh & McLennan, and had developed a working schedule for such a group.[50]

According to Timothy Rush, former Intelsat program manager, the PRC set up the Independent Review Committee in order to remain in the launch services business. The parties with the most incentive to urge the creation of the Independent Review Committee were customers who needed launch services, and China Great Wall Industry Corporation. China Great Wall Industry Corporation feared that additional customers would cancel contracts unless it provided more reporting on the Long March 3B-Intelsat 708 failure.[51]

Donald Bridwell, manager of Intelsat's Major Programs Office, advised the Select Committee that "the next insurer would want to know about the failure." The next insurance broker for a PRC launch was J & H Marsh & McLennan, acting for the Hughes-built Apstar-1A.[52]

J & H Marsh & McLennan's Hewins, then Chairman of the firm's Space and Telecom Group, says he does not recall how the Independent Review Committee was formed. He does remember that he contacted the PRC-controlled Asia Pacific

Telecommunications Satellite Co., the satellite customer for the next launch of a Long March rocket, and the underwriters for that next launch of a Long March rocket, following the Long March 3B-Intelsat 708 failure. Hewins does not recall any specific information being shared with the insurance industry after the failure.[53]

J & H Marsh & McLennan's Quinn, then a Vice President in the Space and Telecom Group, states that there may have been discussions regarding improving the reliability of China Great Wall Industry Corporation's rockets in a general sense.

Quinn says he was not aware that anyone at J & H Marsh & McLennan communicated to Loral or the Independent Review Committee regarding the PRC improving its launch capabilities. The first time that Quinn recalls hearing of the Independent Review Committee was in his office with Paul O'Connor, another J & H Marsh & McLennan Vice President on the Space and Telecom Group; he recalls that "Paul [O'Connor] was involved in it."

Quinn says he does not know, however, who requested the Independent Review Committee. He speculated that it may have been Asia Pacific Telecommunications Satellite Co., Hughes, the PRC, or the insurers.[54]

The April 15-16, 1996 Insurance Meeting in Beijing

J & H Marsh & McLennan's Quinn recalls that an insurance meeting was held in Beijing on April 15 and 16, 1996 for the Apstar-1A satellite launch insurers.[55]

The China Academy of Launch Vehicle Technology and China Great Wall Industry Corporation launch service representatives presented possible causes of the failure of the Long March 3B carrying the Intelsat 708. The PRC representatives reported what they had done to date, and that work was ongoing. They summarized telemetry and tracking data.[56] According to Quinn, the meeting constituted the first time that the underwriters received any information about the Long March 3B-Intelsat 708 failure.[57]

Quinn says that representatives from Loral, Hughes, the PRC-controlled Asia Pacific Telecommunications Satellite Co., China Great Wall Industry Corporation, J & H Marsh & McLennan, and other insurance companies attended the meeting.

Quinn says that he does not recall Nick Yen, Secretary of the Independent Review Committee and a Loral employee, being present at the meeting. Loral's Dr. Wah Lim, Chairman of the Independent Review Committee, Dr. John Smay, Independent Review Committee member and employee of Hughes' Chief Technologist and another unidentified Hughes representative were present, but Quinn does not recall whether any of them made any presentations.[58]

Quinn says that PRC representatives interacted with underwriters at the meeting through presentations in a controlled environment. He recalls that a Defense Department monitor was present. Quinn says that Asia Pacific Telecommunications Satellite Co. and China Great Wall Industry Corporation made presentations to approximately 10 to 15 insurance company representatives, describing what happened in the Long March 3B-Intelsat 708 failure, and why it would not happen in the Apstar-1A satellite launch.

J & H Marsh & McLennan's Quinn says he does not recall whether the Independent Review Committee gave a presentation.[59] Quinn says that his role at the meeting was to "make sure things ran smoothly." In his view, members of the Independent Review Committee attended the meeting to "try to provide some comfort" to the insurers, but he does not know whether PRC representatives provided information or produced a report.[60]

Quinn recalls that his colleague, Paul O'Connor, played a liaison role for the meeting because he was the J & H Marsh & McLennan account manager for the Apstar-1A insurance program.[61] O'Connor assisted in inviting the attendees, and the PRC-controlled Asia Pacific Telecommunications Satellite Co. may have provided some assistance.

Intelsat's Edwards says he and two or three technical managers from Intelsat attended the meeting. Although Edwards does not recall specifically who went, all of the Intelsat attendees were from the Intelsat Launch Vehicle Programs Office. Edwards says that he does not recall whether Lim or Yen were present at any technical meetings or briefings he attended.

Two to three representatives from the China Academy of Launch Vehicle Technology were present. Six to eight representatives from China Launch and

Tracking Control, the PRC organization which tracks the status of satellites, also were present, along with two to three representatives from the Xichang launch site. Intelsat's Edwards says he did not see any subcontractors from China Great Wall Industry Corporation at the meeting, but that there might have been a representative from Loral present.[62]

Quinn says that copies of the PRC's presentation were distributed to the underwriters, Independent Review Committee members, and J & H Marsh & McLennan staff.[63] Quinn does not know the terms on which the presentation was distributed.[64] Edwards says he does not recall a written report from the PRC at the meeting in Beijing.[65]

At issue at the conclusion of the meeting was Asia Pacific Telecommunications Satellite Co.'s desire to authorize Hughes to ship a satellite to the PRC for launch, provided insurance coverage was maintained. The underwriters agreed that Asia Pacific Telecommunications Satellite Co. could so authorize Hughes, but that this action did not obligate them to offer insurance.[66]

Thus, the insurance issue was still outstanding after the April 15 and 16, 1996, meeting. The underwriters agreed to discuss the insurance aspects in greater detail and request more information from China Great Wall Industry Corporation. Asia Pacific Telecommunications Satellite Co. representatives were hopeful that the insurance issue would be resolved prior to the launch.[67]

On April 17, 1996, O'Connor wrote to Diane Dwyer, a colleague at J & H Marsh & McLennan:

> *The briefing went very well and we have a great result, the Apstar-1A satellite has been approved for shipment to the launch site, ready for launch. Final launch approval will be provided when a number of action items are completed, mostly, conditions precedent for the launch approval. All are skeptical of [China Great Wall Industry Corporation]'s ability to deliver, especially on time, but there's always a first time . . .*
>
> *Underwriters are no longer cynics, but have a cautious optimism for the ability of the Chinese to improve their game.*

> *International review committee has been established, chaired by an SS/L guy, Wah Lim.*[68]

On April 23, 1996, an information release by China Great Wall Industry Corporation noted:

> *Representatives from Hughes and Apstar-1A reinsurance program were jointly invited by China Great Wall Industry Corporation (CGWIC) and APT Satellite Co., Ltd. (APT) to participate in the Apstar-1A Pre-Flight Technical Briefing held in Beijing from April 15 to 16, 1996 . . .*
>
> *Prior to the meeting, an Independent Review Committee (IRC) constituted by specialists from international space industry had already been set up by CGWIC. Independent review of the [Long March 3B] launch failure investigation will be performed by the IRC. IRC members were invited and some were able to [be] present [at] the 2-day meeting.*[69]

The Space Insurance Industry's Involvement In the Release of the Independent Review Committee's Interim Report

J & H Marsh & McLennan's Vice President Timothy Rush says that his firm's office in Washington, D.C. did not receive the Independent Review Committee report, nor had anyone at that office reviewed it. Insured parties are required to provide underwriters with claim-related information, but Rush says that underwriters were not provided with the Independent Review Committee report in the Intelsat 708 case.[70]

Richard Hewins, then Chairman of J & H Marsh & McLennan's Space and Telecom Group, says he does not recall reviewing the Independent Review Committee report of the Long March 3B-Intelsat 708 failure, although he recalls seeing it come across his desk in the spring of 1996. Hewins says he does not know what happened to the report and does not recall the process by which he obtained it.

Furthermore, Hewins does not recall whether the report was distributed to other

J & H Marsh & McLennan offices, although he says that it may have been sent to Jacques Masson in the J & H Marsh & McLennan office in Paris, and to the firm's London office. Hewins does not recall any discussions with underwriters or re-insurers after the Intelsat 708 failure.[71]

On May 7, 1996, J & H Marsh & McLennan's Vice President Paul O'Connor advised Professor Bao Miaoqin of the PRC-controlled Asia Pacific Telecommunications Satellite Co.: "It is in APT's best interests that the interim IRC report be released by J & H Marsh & McLennan to Asia Pacific Telecommunications Satellite Co.'s reinsurers first, before China Great Wall Industry Corporation releases it to other customers and underwriters." [72]

On May 13, 1996, O'Connor wrote to his colleague at J & H Marsh & McLennan, Diane Dwyer, that: "Lim has approved release of the IRC interim report to J & H Marsh & McLennan so we can release this to all non-PRC reinsurers. Asia Pacific Telecommunications Satellite Co. has agreed with this as well. The report will be delivered to our office today. Nick [Yen] will be faxing a copy of the 30 page key part today . . . ." [73]

On May 13, 1996, O'Connor advised Yen:

> *We understand the release of the report is subject to the restrictions on use contained in the export regulations affecting the satellite and the IRC's review of the failure investigation. J & H undertakes to release copies of the report only to organizations or individuals of subscribing countries.*
>
> *J & H further undertakes not to release a copy of the report or any extracts to PRC nationals or organizations, or to APT.*[74]

On May 13, 1996, Loral's Dr. Lim contacted O'Connor:

> *Attached please find a copy of the IRC's Preliminary Report regarding the investigation of the [Long March 3B] launch failure and the [Long March 3] isolation evaluation. This report is currently under the review of our legal consul [sic]*

> *and the U.S. technology export panel.*
>
> *Prior to obtaining the proper export license, the IRC was advised that this report can be used strictly only by the U.S. companies and European companies as long as they are registered within the ITAR member countries.*
>
> *This report will not be delivered to [China Great Wall Industry Corporation] and its launch service agencies until the export license or an equivalent authorization is obtained.*[75]

On May 14, 1996, Franceska O. Schroeder, an attorney for J & H Marsh & McLennan, advised Loral's Lim:

> *Paul O'Connor of Johnson & Higgins Space & Telecom Group has asked me to contact you regarding the proper procedures for releasing the interim Independent Review Committee (IRC) Report dated May 10, 1996.*
>
> *I understand from Mr. O'Connor that in a communication from you to him dated May 13, 1996, you explain that the Report currently is under review by the "U.S. technical export panel." You further explain that the IRC has been advised that prior to obtaining proper export licenses, the Report is to be used "only by the U.S. and European companies" that are "registered within the ITAR-member countries."*
>
> *Because we do not know the identity of the "ITAR-member countries" to which you refer or the specific export control requirements imposed by the U.S. government relative to this project, we have advised Mr. O'Connor not to release the Report until we clarify with you how to proceed.*[76]

On May 14, 1996, J & H Marsh & McLennan's attorney Schroeder communicated to her clients O'Connor and Dwyer:

> *[T]he ITAR [International Traffic in Arms Regulations] governs*

the export of certain sophisticated U.S. communications satellites and associated technical data. This means that any such satellites and technical data may be exported or exported only pursuant to a license issued by the U.S. Department of State.

Even if the phrase "ITAR-subscribing country" was replaced with "Missile Technology Control Regime (MTCR)-subscribing country" (I have the list of such countries) a U.S. license still would be required for the export of ITAR-controlled satellites and technical data.

The U.S. satellite manufacturer usually bears the responsibility for obtaining such a license[s].[77]

On May 14, 1996, Loral's Yen reported to J & H Marsh & McLennan's O'Connor: "The IRC may require a technical export license for the subject matter which may result in an [*sic*] revised version in wording. However, the technical contents and assessment in the report as faxed in this package remain valid." [78]

On May 31, 1996, O'Connor advised China Great Wall Industry Corporation:

[T]he US State Department has issued a formal decision that the release of the IRC Interim report is not allowed and that the IRC's chairman, Dr. Wah Lim[,] is no longer allowed to offer public comment on the report or its contents.[79]

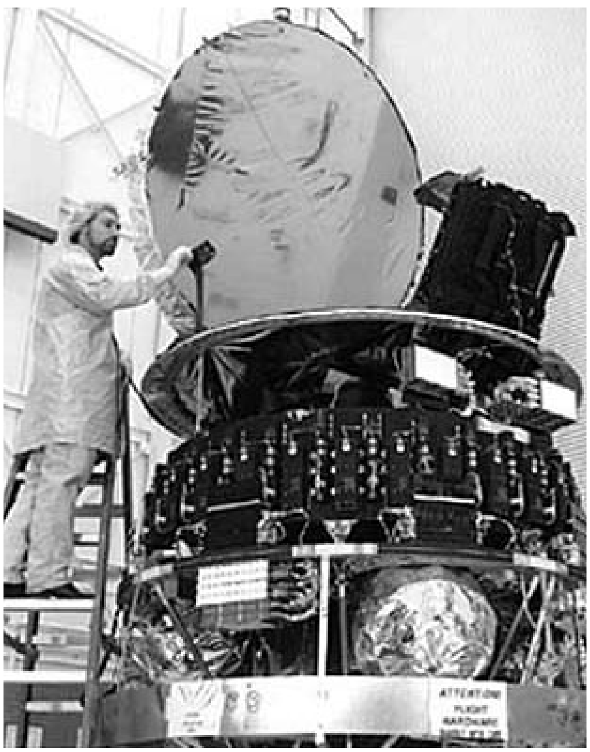
In June 1996, Masson of J & H Marsh & McLennan's Paris office wrote his firm's O'Connor:

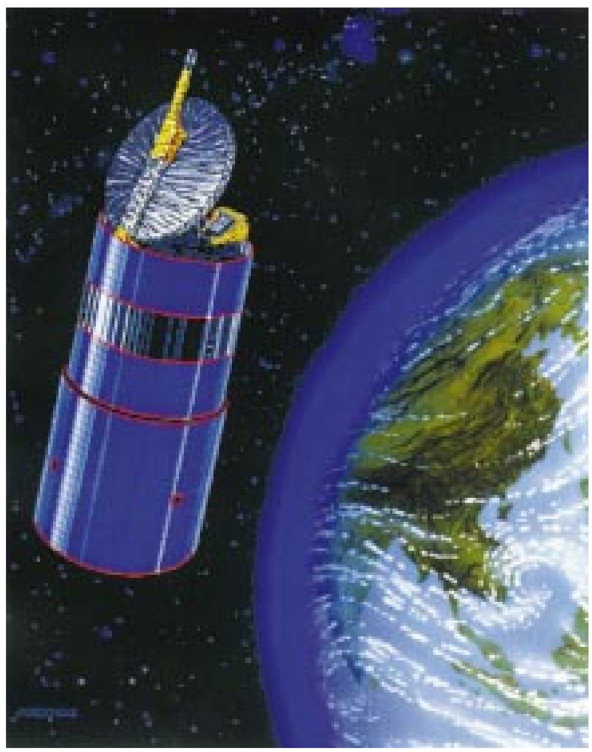
The discussions with the French underwriter, LRS [La Reunion Spatiale] and AGF [AGF Reassurances] were very lengthy and difficult. As you might know, the main problem is the IRC report availability and we had to try to find a compromise. The French do not appreciate the decision from the US government, and most importantly because France has signed the ITAR agreement with the US.

The main spirit which prevails is that [the PRC-controlled Asia Pacific Telecommunications Satellite Co.] shall not pay for the political dilemma and to some extent, that since J & H has made a great effort to solve the problem, it should be not fair that J & H should pay as well.

Any decision taken by the Underwriters will be highly political and commercial.[80]

On June 5, 1996, Masson, on behalf of the French insurance community, proposed a way in which to circumvent U.S. export policy regarding the release of the Independent Review Committee:





Insurance underwriters and reinsurers for the Apstar 1A satellite program -- the next scheduled satellite to be launched on the PRC's Long March B rocket after its 1996 crash – were concerned about the reliability of all Long March rockets. When the Independent Review Committee provided a report diagnosing the Long March 3B's problems and presenting remedies, the insurance industry proposed a way to circumvent U.S. export policy that prevented its release.

Some of the IRC members are European and to that extent they could be approached directly without going first through US officials.

My recommendation will be that [the China Academy of Launch Vehicle Technology] and [China Great Wall Industry Corporation] which mandated the IRC, asks to one or all the European IRC member to sign this certification. The certification shall state that the IRC member certifies that the conclusion of the IRC interim report is not in disagreement with the conclusions of the report RA1-3-4 on the [Long March 3 and Long March 3B] isolation analysis.[81]

On June 6, 1996, Lim advised O'Connor:

I have been instructed by our legal counsel to retrieve all IRC-generated documents which the IRC has transmitted to you by fax, express mail or by distribution at any meetings.

In addition, please confirm that no derivative copies of these documents were made or distributed, or that any such copies have been retrieved and returned to us.

The above is necessary to comply with U.S. Government requests.[82]

On June 19, 1996, Dwyer reported to Lim:

[W]e have gathered all photocopies and all documents relating to the Independent Review Committee's Interim Report. They are being shipped to you by Airborne Express overnight courier service.[83]

Included in the package were 22 copies of the Report, copies of all correspondence relating to the release of the Report and the decision not to release the Report, and copies of all correspondence relating to the need to return all copies.

CHRONOLOGY OF KEY EVENTS

1996

February 15	**The Loral-built Intelsat 708 launch fails.**
February 21	**A confidential agreement for risk management** advisory services is reached between J & H Marsh & McLennan, insurance broker for the Apstar 1A program, and China Great Wall Industry Corporation. **Paul O'Connor, J & H Marsh & McLennan Vice President, suggests that China Great Wall Industry Corporation** implement an aggressive public relations campaign for underwriters. "Quick and decisive action is required."
February 22	**Jacques Masson, Manager of J & H Marsh & McLennan's Paris office, reports discussions with French insurance community** regarding the Intelsat 708 failure's impact on future insurance programs. **Masson first mentions the necessity to create an "independent inquiry board."**
February 26	**Underwriters for the Apstar 1A program become increasingly disappointed** regarding the lack of an independent and international failure review committee. **O'Connor provides China Great Wall Industry Corporation with a failure review committee schedule** modeled after an Ariane failure review plan, and urges China Great Wall Industry Corporation to allow J & H Marsh & McLennan to obtain failure review conclusions.
February 28	**J & H Marsh McLennan's O'Connor outlines for China Great Wall Industry Corporation** minimum requirements for the Apstar 1A reinsurance program to continue.

March 11	**Loral offers to provide technical assistance to the Intelsat 708 failure investigation.**
March 20	**French underwriters state minimum requirements** for the Apstar 1A insurance program to continue. Discussions regarding Loral participation in the Independent Review Committee continue among China Great Wall Industry Corporation, J & H Marsh & McLennan, and the underwriters. **J & H Marsh & McLennan's Masson identifies potential Independent Review Committee participants.**
March 21	**Bermuda-based underwriter, ACE Limited,** advises J & H Marsh & McLennan that China Great Wall Industry Corporation's actions regarding the Intelsat 708 failure investigation are unacceptable and that the Apstar 1A insurance contract is in jeopardy.
April 1	**J & H Marsh McLennan's O'Connor reports that Intelsat declined to participate** in the Independent Review Committee.
April 5	**China Great Wall Industry Corporation reports to J & H Marsh & McLennan that an Independent Review Committee is being established** to meet the insurance community's minimum requirements to insure the upcoming Apstar 1A launch.

THE COMMERCIAL SPACE INSURANCE INDUSTRY

Introduction: The Market

Emerging commercial space technologies, along with complex and substantial financial investments, presented a new type of high-risk exposure. Thus, the space insurance underwriting community was developed, and the niche for specialized insurance was filled. The space insurance market is highly competitive, dynamic, and volatile with a relatively small group of U.S. and European insurance companies in the forefront.[84]

According to one industry representative, Dowa Fire, Marine & Space Insurance:

> *The number of launches of currently insured commercial satellites is about 20 to 30 satellites per year, so the number of contracts is limited . . . .*

Again, according to Dowa Fire, Marine & Space Insurance:

> *Since space insurance coverage began in 1965, the capacity of the market has been steadily increasing.*[85]

This upward trend has been driven by expansion in the communications satellite industry and by growing demand for cheaper, more reliable, and more capable launch systems.

Over the last 30 years, space insurance companies have collected approximately $4.2 billion in premiums and paid nearly $3.4 billion in claims. As outer space is being increasingly used for communications, broadcasting, and remote sensing, the demand for space-based activities is expected to grow, helping risks stabilize. Insurance premiums will thus decrease, and market capacity will in turn increase.[87]

Space insurance is syndicated, meaning that each individual underwriter assumes a percentage of the risk.[88] Approximately 10 to 15 large companies, and 20 to 30 smaller companies, may participate in a given insurance package. Typically, multiple insurance underwriters cover each risk for a fractional share, thereby spreading the risk throughout the global markets.[89]

An insurance package covers risk to the rocket, the satellite, and related equipment.[90] Factors such as market conditions, the type of rocket, orbital deployment conditions, and satellite characteristics determine insurance terms and conditions. While all underwriters use similar terms and conditions, commercial space insurance policies are individually crafted, principally based on the specifications of the satellite and the rocket.[91] The coverage period, premium rates, and other terms and conditions are negotiated among the client, the satellite owner or manufacturers, and the underwriters.[92]

Competition determines which insurers will participate in a specific placement, and the marketplace sets pricing for each policy. Price and availability of space insurance depends primarily on the lead underwriter's ability to understand and assess the intricacies of each risk.[93]

The estimated space insurance market capacity is between $850 million and $1 billion for each satellite program, with an estimated range of $250 to $300 million per launch.[94] Approximately seven to ten underwriters play a significant role in the market, and Europeans ordinarily account for $500-600 million out of the $1 billion available for a single satellite project.[95] Typically, an insurance underwriter will commit only 80-85 percent of its available financial resources to one program.[96]

Space insurance market conditions are cyclical in nature. Currently, the market is "soft," producing more capacity to meet risk needs, and is a buyer's market with many qualified insurers.[97] Launch service providers are more willing to introduce new launch vehicles in this type of market. In contrast, in a "hard" market, or seller's market, underwriters have the greatest influence. Successful market participants must respond to and implement changes within the dynamic satellite launch equipment, launch services, and space insurance markets.

The four primary U.S. insurance brokers are J&H Marsh & McLennan, with about 60 percent of the market, Willis Corroon Inspace, International Space Brokers, and AON, Inc.[98] Currently, there are 10 to 12 lead underwriters, including one Australian, two French, one U.S., and two British.[99] The U.S. underwriters account for 20 to 30 percent of current space insurance syndication.[100]

Each individual U.S. underwriter has a detailed technical understanding of space risks — based on its own spacecraft engineers — and a sophisticated space industry database.[101] Some European underwriters employ consultants with expertise in the technical assessment of space risks, including experienced former NASA satellite engineers.[102]

Any underwriter may spread the risk to any other insurance company or reinsurer by selling participation in a particular insurance program.[103] Reinsurers receive no technical information but rely on representations by lead underwriters as to risk.[104] Reinsurers occupy numerous layers in the insurance industry, sharing the risk of a particular contract.[105] The reinsurers depend on their relationship with the underwriters and "follow the fortunes" of the underwriters, referred to as "following-on." [106]

There are four essential types of space insurance:

- **Pre-launch insurance,** specifically property and cargo insurance,[107] covers satellites and rockets prior to launch. Pre-launch insurance usually covers risks associated with transportation of the satellite from the manufacturing facility to the launch site, assembly on the launch pad, inspection, and pre-lift-off activities. The period of coverage ends with the intentional ignition or lift-off of the rocket.[108]

- **Launch insurance** is the most common type of space insurance. It may extend from six months to one year after launch. Coverage commences where pre-launch insurance ends. Launch insurance terminates when the satellite separates from the rocket and completes an initial operational phase of functionality testing. The launch period may last approximately 20 to 30 minutes.[109]

- **In-orbit insurance** commences after the satellite has completed its initial operational phase of functionality testing, and normal operations in space begin. The life expectancy of a satellite is approximately 10 years and ends when the satellite's fuel cell depletes. In-orbit insurance usually consists of one-year renewable policies. "[I]n order for the insurance companies to renew the In-Orbit insurance, they require 'health reports' from the insured regarding the condition of the satellites. Based on these reports they accept renewed coverage." [110]

- **Third-party liability space insurance** covers legal liability arising from damage to a third party during the launch or the in-orbit operations of a satellite program. A variety of coverage options are available: personal injury, property damage, damage to U.S. Government launch facilities, loss of revenue, service interruption, and material changes to ground stations.[111]

Self-insuring for the launch phase is not a common practice. PRC-owned and manufactured commercial satellite launches in the PRC, however, usually are self-insured by the PRC.[112]

Broker Selection and the Underwriting Process

Broker Selection

The following summarizes the space insurance acquisition process and the parties involved. First, a satellite owner contracts with a satellite manufacturer to build a satellite.[113] Next, the insured client, a satellite owner or satellite manufacturer, obtains a list of brokers from the manufacturer.[114]

Then, the broker is appointed following a competitive process.

The broker may negotiate insurance, manage transactions, and, if necessary, settle claims that may arise on behalf of the client.[115] The broker acts as a conduit for all documentation and information.[116] Its primary task is to obtain technical questions from underwriters and answers from the satellite owner and manufacturer.[117] The broker may assist the satellite owner and manufacturer in developing a presentation and pricing plan for the underwriters.[118] Brokers do not suffer monetary risk in the event of launch accidents; they are paid on a commission basis.[119] Traditionally, commission size depends on the final premium negotiated for the insurance program. The higher the insurance premium, the higher the broker's commission.[120]

Insurance Acquisition

The underwriting process begins with a technical assessment of the satellite and rocket.[121] The client prepares technical reports and presentations regarding the satellite and rocket for the brokers.[122] Usually, the satellite manufacturer prepares the initial project package containing detailed technical information and launch service procedures.[123]

This package is presented to the underwriters by the broker.[124] The technical information consists of the specifics of the launch and satellite operations, coverage for partial or full loss, associated costs, and launch service availability.[125] Also, it includes the program risks, history of the rocket, modifications, and reasons for using new technology, if any.[126]

The presentation is designed to build the confidence of the underwriters in the insured client.[127] Technical questions regarding the following are often raised by the underwriters:

- **Communication systems**
- **Payload**
- **Electrical power system**
- **Attitude control system**
- **Mechanical systems, including appendage and solar arrays**[128]

Normally, two rounds of questions and answers by the satellite manufacturer and launch service provider to underwriters are sufficient to complete the bidding phase.[129] Additionally, underwriters rely on databases and their own technical staff or other experts for information.[130]

Typically, non-disclosure agreements binding underwriters accompany technical materials for the presentations.[131] Underwriting information is part of the insurance contract, and the insured is obligated to use its best efforts to provide insurers with information relating to risk of loss.[132] The insured has an obligation to notify the underwriters if any characteristic of the satellite or the launch service changes.[133]

A second briefing to the underwriters may be necessary if such a "material change" occurs affecting the terms and conditions of the policy. In the case of Intelsat 708, for example, Loral had to make such a presentation after changing the material that was used for the satellite's solar arrays to galium arsenide.[134]

The underwriters submit bids for the insurance package, including a decision to insure the satellite program, the amount of the premium, and the terms and conditions of the policy. Various risk assessment factors, including the history and reliability of the hardware to be used, are discussed. Also, previous failure and success rates, disposition of previous failures, experience of operations and operators, testing and product assurance provisions, and monitoring conditions by the satellite manufacturers or the insured are factors taken into account.[135]

Lastly, the policy is negotiated and written prior to launch.[136] The insured client, acting through the brokers, answers any outstanding questions from the underwriters.[137] Post-launch reporting advises the underwriters of the mission's progress.[138]

The entire insurance acquisition process takes about one year to complete.[139] Typically, insurance contracts are finalized from six months to three years prior to launch.[140]

Space Insurance Premiums

A space insurance deposit between 10 and 20 percent of the premium is required when the policy period commences. The balance of the premium is usually due to the underwriters no later than 30 days prior to the launch.[141]

Typically, insurance premiums range from eight to 15 percent of the total costs associated with a launch.[142] Premium rates have declined over the last few years.[143] Even though there have been a large number of substantial claims in the last few years, premiums decreased by 50 percent in 1997.[144] Claims incurred will surpass premiums collected in 1998, a disappointing year for underwriters.[145]

Launch insurance premiums depend on such factors as:

- **Reliability of the rocket**
- **Reliability of the satellite**
- **Level of complexity of the satellite**
- **Scope of coverage**
- **Amount of insurance**[146]
- **Rocket history**
- **Overall design of the satellite**
- **Product assurance plan**
- **Satellite's operational lifetime**
- **Insurance capacity**
- **Commercial versus government launched**
- **Regulatory standards for rockets**[147]

According to a September 1998 article: "[C]ustomers can pay less than 10 percent [of the total costs] with an emphasis on launch-plus-3-year or even launch-plus-5-year coverage plan . . . In-orbit policies are generally negotiated separately from launch plus 3 or 5 year policies. Rates tend to be 1.2 to 1.5 percent per year at present." [148]

Space Insurance Claims of Loss

Despite the availability of insurance, the satellite owner has every incentive to place the satellite in orbit and make it operational because obtaining an insurance settlement in the event of loss does not help the owner continue to operate its telecommunications business in the future. To increase the client's motivation to complete the project successfully, underwriters will also ask the client to retain a percentage of the risk.[149]

Insurers are advised of any occurrence likely to result in a claim. The insured is obligated to disclose any relevant issues, including the results of any failure investigations.[150] The insurers must have this information—and a substantiated theory of the failure—from the parties that were involved in the launch.[151]

The claims settlement process continues until agreement is reached on the loss sustained.[152]

In the event of a launch or satellite failure, the insurance representative of the insured client is responsible for drafting the Proof of Loss and Notice of Loss:[153]

- **The Proof of Loss** is a statement issued to the insurers and is signed and notarized by the insured client. It includes the time the loss occurred, details as to what happened, and technical information such as telemetry data, frequencies, and power levels at the time of the failure.[154]
- **The Notice of Loss** is a one-page statement that places the insurers on notice of a possible claim.[155]

Both statements are provided to the insurers by the insured client through the broker.[156]

The Applicability of Export Controls To the Space Insurance Industry

Security Clearances and the Transfer of Controlled Technical Information

The broker reviews drafts of the Proof of Loss and Notice of Loss and makes sure that all relevant information is contained therein. The broker does not alter them, but offers suggestions as to changes.[157] The broker is the last party to sign the statements prior to release of a claim payment.[158]

Security clearance requirements for space insurance industry personnel handling sensitive data are not clear.[159]

Timothy Rush, Vice President of J&H Marsh & McLennan's Space and Telecom Group and a former Intelsat employee, testified that underwriter employees do not usually have security clearances.[160]

In the case of Intelsat, data requiring protection is kept in a secure facility.[161] Intelsat authorizes insurance-related technical information to be forwarded to the Defense Department for review.[162] The Defense Department's responsibility is to monitor technical data reviews and transfers that take place in the course of the insurance process for space projects.[163]

The amount of technical data that is required to be disclosed in the space insurance process depends on the maturity of both the satellite and the rocket.[164] Mark Quinn, former Vice President for J&H Marsh & McLennan's Space and Telecom Group, states that the information provided at space insurance presentations is "not very technical in nature." [165] Newer satellites and rockets, however, present greater risks since they are not technically and operationally known quantities, and the insurers thus want additional information about them.[166]

Intelsat officials state that the PRC launch service provider receives only satellite interface information. Interface information consists of satellite dimensions and critical point locations of satellite components such as antennas. A user's handbook contains most of the information on rockets.[167]

Nevertheless, as Donald Cromer, President of Hughes Space and Communications, who had attended insurance industry briefings, testified, technical information subject to export controls "could" be communicated in such briefings.[168]

Export Licenses

According to insurance industry personnel, the obligation to obtain an export license rests with the owner of the technology. Thus, prior to Intelsat's taking title to the Loral-built Intelsat 708 satellite, Loral had the responsibility to obtain export licenses for all related exports of controlled technology.[169]

The burden is on the insured client, agrees J&H Marsh & McLennan's Michael Hewins, former Chairman of that firm's Space and Telecom Group, to obtain all appropriate export licenses, and no special licenses are required by the space insurance industry.[170] In light of the destinations of the data, insured clients must determine whether the data is sensitive and export licenses are required.[171]

Hewins, a broker with substantial space insurance experience, says he believes that no export licenses are required for the space insurance presentations that contain technical information. Further, Hewins believes that no export licenses are required for the questions and answers that are passed between the underwriters, brokers and insured clients.

Hewins says that he assumes that all information shared in the insurance process is given to all entities, foreign or domestic, unless covered by non-disclosure agreements.[172]

Another experienced broker, Timothy Rush of J&H Marsh & McLennan, says that the broker requires the originators of any technical data to certify that proper licenses have been obtained for technology transfers, or to certify that the data in question does not require such licenses for transfer.

According to Rush, brokers do not enforce licensing requirements. But, he says, brokers do help protect against technology transfers prohibited by U.S. law, by informing their insured clients of where they send any data the client submits to them under the insurance contract.[173]

Yet another J&H Marsh & McLennan broker, Mark Quinn, says that the insured client is supposed to indicate whether an export license is in place for the satellite program. However, Quinn reports that he has not seen a technology transfer license, although he assumes one exists for each project.[174]

According to Terry Edwards, Manager of Intelsat's Launch Vehicle Program Office, and Donald Bridwell, Manager of Intelsat's Major Programs in the Procurement Division: "Intelsat Headquarters Agreement does not exempt Intelsat from U.S. laws in respect to export licenses. U.S. spacecraft manufacturers are subject to U.S. export control laws." The export license, they say, covers the entire scope of the satellite project.[175]

Intelsat's Edwards also states that Defense Department monitors have a very difficult assignment.[176] Quinn adds that the Defense Department monitor who worked on his project several years ago did a very good job and knew the details of the project well.[177] However, Quinn states that he has not been present at any meeting where a Defense Department monitor has interceded to stop the transfer of technical information. He states that the briefer usually has a rehearsal briefing with a Defense Department monitor present, prior to the meeting.[178]

Space Insurance and Export Controls for PRC Launches

The space insurance process does not differ for projects that include PRC rockets and satellites.[179]

Insurance for PRC clients must comply with local regulations and is provided by re-insuring an indigenous insurer.[180] The PRC, however, does not have a developed insurance market. Therefore, a broker such as J&H Marsh & McLennan acts as an intermediary company since the PRC is not financially stable.[181]

J&H Marsh & McLennan's Hewins states that the PRC insurance companies, China Pacific Insurance Company (CPIC) and the People's Insurance Company of China (PICC), are difficult to deal with from a business standpoint. Further, CPIC and PICC are not lead underwriters in the international market, do not possess satellite insurance expertise, and tend to work on multiple projects.[182]

The J&H Marsh & McLennan Beijing office handles property and casualty insurance for the PRC, and for U.S. companies conducting business there. The J&H Marsh & McLennan London office also issues third-party liability insurance for China Great Wall Industry Corporation.[183]

CHAPTER 5 – Satellite Launches in the PRC: Hughes

1 See a more detailed discussion of U.S. export controls and licensing requirements in the chapter entitled "U.S. Export Policy Toward the PRC."

2 22 U.S.C. § 2778.

3 22 C.F.R., Part 120.

4 Recently, the Defense Technology Security Administration has been renamed the Technology Security Directorate and made a part of the new Defense Threat Reduction Agency.

5 Air Force Instruction 10-1210, ¶ 1.1.1.

6 Air Force Instruction 10-1210, ¶ 3.1.

7 Air Force Space Command Technology Safeguard Monitor Handbook, November 1997,11 4.13. No earlier version of this publication is available, although Defense Technology Security Administration monitor Lt. Col. Allen Coates advises that similar written directives were in effect at the times of the Hughes launch failures.

8 Hughes Space and Communications Company, Long March 2E/Optus B2 Failure Investigation Spacecraft Final Report, October 1993.

9 Ibid.

10 Ibid.

11 Ibid.

12 Ibid.

13 Deposition of Stephen Cunningham, December 2, 1998.

14 Hughes Long March 2E/Optus B2 Failure Investigation Spacecraft Final Report, October 1993.

15 Deposition of Stephen Cunningham, December 2, 1998.

16 Interview of Allen Coates, September 24, 1998.

17 Deposition of Allen Coates, November 20, 1998.

18 Deposition of Al Wittmann, November 6, 1998.

19 Ibid.

20 Ibid.

21 Deposition of Al Wittman, November 6, 1998.

22 Hughes Apstar2/LM-2E Independent Review Team Report, July 1995.

23 Deposition of Donald E. Leedle, October 29, 1998.

24 Ibid.

25 Ibid.

26 Ibid.

27 Ibid.

28 Smolker was responsible for licensing accountability. Deposition of Steven Dorfman, December 15, 1998.

29 Deposition of Donald E. Leedle, October 29, 1998.

30 Deposition of Steven Dorfman, December 15, 1998.

31 Deposition of Donald E. Leedle, October 29, 1998.

32 Deposition of Donald E. Majors, October 28, 1998.

33 Ibid.

34 Interview of Kenneth Peoples, October 1, 1998.

35 Ibid.

36 Ibid.

37 Ibid.

38 Deposition of Stephen Cunningham, December 2, 1998.

39 Ibid.

40 Ibid.

41 Ibid.

42 Ibid.

43 Ibid.

44 Deposition of Peter Herron, November 13, 1998.

45 Deposition of John S. Perkins, November 5, 1998.

46 Ibid.

47 Ibid.

48 Ibid.

49 Ibid.

50 Bangsang Lee was born in China in 1949. He received a Master's and Ph.D in Electrical Engineering from Princeton in 1976, and is a naturalized U.S. citizen. For several years preceding 1991, he had worked for a patent law firm that did some consulting work for Hughes. Deposition of Bansang W. Lee, November 16, 1998.

51 Deposition of Bansang W. Lee, November 16, 1998.

52 Ibid.

53 Ibid.

54 Ibid.

55 Minister Liu Jiynan is also President of China Aerospace Corporation.

56 Deposition of Bansang W. Lee, November 16, 1998.

57 Ibid.

58 Deposition of Al Wittmann, November 6, 1998.

59 Ibid.

60 Ibid.

61 Deposition of Steven Dorfman, December 15, 1998.

62 Deposition of Donald Cromer, December 17, 1998.

63 Deposition of Allen Coates, November 20, 1998.

64 Ibid.

65 Ibid.

66 Ibid.

67 Deposition of Donald E. Leedle, October 29, 1998.

68 Deposition of Stephen Cunningham, December 2, 1998.

69 Deposition of Donald E. Leedle, October 29, 1998.

70 Exhibit to deposition of Bansang W. Lee, November 16, 1998.

71 Ibid.

72 Ibid.

73 *Space News*, August 23, 1993.

74 Deposition of Stephen Cunningham, December 2, 1998.

75 Deposition of Donald Cromer, December 17, 1998.

76 Exhibit to deposition of Bansang W. Lee, November 16, 1998.

77 Ibid.

78 Ibid.

79 Deposition of Bansang W. Lee, November 16, 1998, and exhibit thereto.

80 Deposition of Donald Cromer, December 17, 1998.

81 Deposition of Stephen Cunningham, December 2, 1998.

82 Ibid.

83 Ibid.

84 Deposition of Allen Coates, November 20, 1998.

85 Deposition of Donald L. Cromer, December 17, 1998.

86 Deposition of C. Michael Armstrong, December 17, 1998.

87 Deposition of Allen Coates, November 20, 1998.

88 Deposition of Steven Burke, November 5, 1998.

89 Ibid.

90 Exhibit to deposition of Steven Burke, November 5, 1998.

91 Ibid.

92 Deposition of Steven Burke, November 5, 1998.

93 Ibid.

94 Deposition of Peter Herron, November 13, 1998.

95 Deposition of Steven Burke, November 5, 1998.

96 Deposition of Donald Leedle, October 29, 1998.

97 U.S. Department of Commerce, License # D204878, dated February 1, 1994.

98 Hughes Long March 2E/Apstar2 Failure Investigation Final Report, July 1995.

99 Deposition of Stephen Cunningham, December 2, 1998.

100 Deposition of Donald Cromer, December 17, 1998.

101 Hughes Long March 2E/Apstar2 Failure Investigation Final Report, July 1995.

102 Ibid.

103 Ibid.

104 Deposition of Stephen Cunningham, December 2, 1998.

105 Ibid.

106 Deposition of Donald Leedle, October 29, 1998.

107 Ibid.

108 Ibid.

109 Interview of Gene Christiansen, August 28, 1998.

110 Deposition of Donald Leedle, October 29, 1998.

111 Exhibit to deposition of Donald Leedle, October 29, 1998; Interview of Gene Christiansen, October 1, 1998.

112 Deposition of Donald Leedle, October 29, 1998.
113 Deposition of Al Wittmann, November 16, 1998.
114 Ibid.
115 Ibid.
116 Ibid.
117 Interview of Jerry Beiter, September 21, 1998.
118 Deposition of Pat Bowers, November 9, 1998.
119 Interview of Sara Jones, September 22, 1998.
120 Interview of Jerry Beiter, September 21, 1998.
121 Ibid.
122 Deposition of Donald Leedle, October 29, 1998.
123 Interview of Sara Jones, September 22, 1998.
124 Ibid.
125 Ibid.
126 Ibid.
127 Interview of Pat Bowers, November 9, 1998.
128 Deposition of Donald Leedle, October 29, 1998.
129 Deposition of Spencer Ku, November 6, 1998.
130 Ibid.
131 Ibid.
132 Ibid.
133 Ibid.
134 Document received from Hughes.
135 Ibid.
136 Deposition of Donald Leedle, October 29, 1998.
137 Ibid.
138 Ibid.
139 Document received from Hughes
140 Ibid.
141 Ibid.

142 Interview of CIA analyst, November 4, 1998.

143 Ibid.

144 Ibid.

145 Ibid.

146 Ibid.

147 Ibid.

148 Ibid.

149 Deposition of Donald Leedle, October 29, 1998.

150 Interview of CIA analyst, November 4, 1998.

151 Ibid.

152 Ibid.

153 Document received from Hughes.

154 Deposition of Donald Leedle, October 29, 1998.

155 Ibid.

156 Ibid.

157 Interview of Sara Jones, September 22, 1995.

158 Interview of Gene Christiansen, August 28, 1998.

159 Ibid.

160 Ibid.

161 Document received from Hughes.

162 Department of Defense Background Paper, January 26, 1995.

163 Ibid.

164 Interview of Mark N. Rochlin, December 11, 1998.

165 Department of Defense Memorandum for Record, Office of Assistant Secretary of Defense, International Security Policy, May 31, 1995, by LTC Mark N. Rochlin.

166 Interview Report of Mark N. Rochlin, December 11, 1998.

167 Ibid.

168 Ibid.

169 Ibid.

170 Department of Defense, "Department of Defense Initial Assessment of Certain Documents Concerning Investigation by Hughes Space And Communications Company into the Failure of the Launch of the Apstar

II on China's Long March 2E Launch Vehicle," December 7, 1998 (hereinafter, Department of Defense Assessment).

171 Department of Defense Assessment.

172 Ibid.

173 Ibid.

174 Hughes Long March 2E/Apstar2 Failure Investigation Final Report, July 1995.

175 Ibid.

176 Department of Defense Assessment.

177 Ibid.

178 Ibid.

179 Ibid.

180 Ibid.

181 Ibid.

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183 Ibid.

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185 Dr. Alexander Flax, "Nose Fairings on Space Launch Vehicles and Ballistic Missiles," paper prepared for the Select Committee, December 1998.

186 Briefing to the Select Committee, December 2, 1998.

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188 *United States v. Trie*, 23 F. Supp. 55, 2-3 (D.D.C. 1998).

189 Daihatu International Certificate of Incorporation (November 14, 1991).

190 Lena H. Sun, "Pacific Trade Commission Appointee Was Considered a White House Must," *Washington Post*, December 18, 1996.

191 Testimony of Jerome Campane before the U.S. Senate Committee on Governmental Affairs, July 29, 1997.

192 Deposition of Zhi Hua Dong by the U.S. Senate Committee on Governmental Affairs; June 17, 1997; testimony of Jerome Campane before the U.S. Senate Committee on Governmental Affairs, July 29, 1997.

193 Executive Order 12964, sec. 2, 31, Weekly Comp. Pres. Doc. 1095.

194 Letter from Charlie Trie to President William J. Clinton, March 21, 1996.

195 Department of Defense Assessment.

CHAPTER 6 – Satellite Launches in the PRC: Loral

1 Loral Voluntary Disclosure, June 17, 1996. Documents submitted at the insistence of the Department of State export licensing office to the Compliance Analysis Division, PM/DTC, SA-6, Room 200, Office of Defense Trade Controls, Bureau of Political-Military Affairs, United States Department of State, on June 17, 1996, by Feith & Zell, P.C., Washington, D.C., on behalf of Loral. Includes a 21 page report signed by Michael Poliner, an appendix containing a certification by Loral President Robert Berry, and several volumes of tabbed exhibits (L16); Hughes Investigation Report, "Report of Investigation of Alleged Violations of International Traffic in Arms Regulations (ITAR)," from Hughes Space and Communications Company, June 27, 1996. Includes a 24-page report, a 14-page chronology, and 53 tabbed exhibits.

2 "Crash of Intelsat VII Feb. 1996 Full Version," Videotape recording of Intelsat 708 launch failure from Intelsat.

3 "China's Space Program: A Brief Overview Including Commercial Launches of U.S.-Built Satellites," Congressional Research Service Report by Marcia Smith, June 23, 1998.

4 "China Space Chief Ready to Expend Human Lives," Nigel Hawkes, *The Times Newspapers Limited*, June 15, 1996.

5 Intelsat Internet web site, http://www.Intelsat.com; Intelsat letter to Select Committee, from Diane Hinson, VP & General Counsel, Intelsat, Re: "Responses to Questions Posed by the Select Committee," December 4, 1998, letter with attachment.

6 Intelsat letter to Select Committee, from Diane Hinson, VP & General Counsel, Intelsat, Re: "Responses to Questions Posed by the Select Committee," December 4, 1998, letter with attachment.

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8 Interview of Daniel Lilienstein, October 28, 1998.

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12 Hughes Investigation Report.

13 Ibid.

14 Ibid.

15 Loral memorandum from C. Patrick DeWitt, subject: "Minutes of the 11 April 1996 GSC [Government Security Committee] Meeting," April 15, 1996.

16 Loral Voluntary Disclosure, June 17, 1996.

17 Ibid.

18 Ibid.

19 Ibid.

20 Ibid.

21 Ibid.

22 Interview of Karl Kachigan, October 19, 1998.

23 Letter dated May 29, 1996, from William J. Lowell, Director, Office of Defense Trade Controls, State Department to Eric J. Zahler, General Counsel, Loral, and John J. Higgins, General Counsel, Hughes Electronics.

24 "DOD Assessment of Certain Unlicensed Activities by Loral Space Systems, Inc. and Hughes Aircraft Co.," May 16, 1997.

25 U.S. State Department form DSP-5, "Application/License for Permanent Export of Unclassified Defense Articles and Related Unclassified Technical Data," License No. 533593, Applicant: Loral, Date Prepared: 5/11/92, Date Approved: 9/18/92, Approved by: Ken Peoples, Destination Country: PRC, Commodity: "Technical Data in support of technical discussions for the launch of an Intelsat VIIA Spacecraft." DSP-5 form with continuation page and letter from State Department containing limitations and provisos.

26 William Schweickert's briefing presentation charts, "Long March Failure Review, Technology Export Briefing," April 22, 1996.

27 Wah Lim's briefing presentation charts, "Independent Oversight Committee Status Report" and "LM-3B Launch Failure Investigation Independent Review Committee," April 16, 1996.

28 Loral Voluntary Disclosure, June 17, 1996.

29 "Independent Review Committee Preliminary Report," May 10, 1996; Loral Voluntary Disclosure, June 17, 1996.

30 "Independent Review Committee Preliminary Report," May 10, 1996.

31 Ibid.

32 Loral Voluntary Disclosure, June 17, 1996.

33 Ibid.

34 Ibid.

35 Ibid.

36 Deselding, Peter B., "Long March Review Finished," *Space News*, May 13-19, 1996.

37 Loral Voluntary Disclosure, June 17, 1996.

38 Loral Voluntary Disclosure, June 17, 1996. On December 2, 1998, Loral responded to a Select Committee interrogatory that asked Loral to update its 1996 Voluntary Disclosure to the State Department so as to be true, correct, and complete based on the totality of information regarding the Independent Review Committee that had been learned since June 1996. Loral's response included minor revisions to reflect

additional information about Independent Review Committee activities. It continued to maintain, however, that "Based on further analysis of the law and facts, it is the Company's position that, despite the violation of company policy, Loral did not provide any 'assistance' to the PRC within the meaning of the ITAR [International Traffic in Arms Regulations] — that is, SS/L [Loral] did not provide a 'defense service' as defined by the ITAR." The updated response went on to say, "none of the PRC's announced improvements to its Long March 3B rockets was the result of Loral's participation in the IRC [Independent Review Committee]."

39 Hughes Investigation Report.

40 Interagency review team report, July 22, 1998.

41 Intelsat Internet web site, http://www.Intelsat.com. Intelsat launched the world's first commercial communications satellite in 1965, providing service to the Atlantic Ocean region. In 1969, Intelsat provided global television coverage of the Apollo lunar landing to an audience of 500 million people around the world. In 1974, Intelsat activated a direct communications link, named the "Hot Line," between the White House and the Kremlin. In 1992, Intelsat and NASA collaborated on a historical and successful space mission to retrieve and reboost the Intelsat 603 satellite, stranded after a failed launch in 1990. Most recently, Intelsat helped broadcast live coverage of the 1998 Winter Olympic games from Nagano, Japan.

42 Intelsat Internet web site.

43 Ibid.

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46 Intelsat Internet web site. Internet web site: http://msl.jpl.nasa.gov/.

47 Loral Internet web site: http://www.loral.com, http://www.ssloral.com.

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CHAPTER 7 – Launch Site Security in the PRC

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17 Previously, when satellites were on the U.S. Munitions List, Defense Technology Security Administration monitor were required to attend launches of U.S. satellites in the PRC. Following the change in licensing jurisdiction from State to Commerce, three launches were authorized in the PRC without any Defense Department monitors. Without Defense Department monitors at these launches, there can be no assurances

as to whether any controlled information was or was not transferred. Since 1996, the Department of Commerce has resumed the practice of notifying the Department of State of all launches in the PRC and Defense Department monitors are assigned to such launches.

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CHAPTER 8 – Commercial Space Insurance

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SELECT COMMITTEE OF THE UNITED STATES HOUSE OF REPRESENTATIVES

U.S. NATIONAL SECURITY AND MILITARY/COMMERCIAL CONCERNS WITH THE PEOPLE'S REPUBLIC OF CHINA

VOLUME III

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UNITED STATES HOUSE OF REPRESENTATIVES

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VOLUME III

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UNITED STATES HOUSE OF REPRESENTATIVES

U.S. EXPORT POLICY TOWARD THE PRC

The two principal statutes that govern United States export controls are the Export Administration Act of 1979, as amended, which controls "dual-use" items and is administered by the Department of Commerce, and the Arms Export Control Act, which controls munitions items and is administered by the Department of State. The last major changes to the Export Administration Act were included in the Export Administration Amendments Act of 1985, and in the Omnibus Trade and Competitiveness Act of 1988.

Since the last extension of the Export Administration Act expired on August 20, 1994, the regulations issued under that Act have been maintained in effect under the International Emergency Powers Act by Executive Order. Another Executive Order, issued in 1995, established new procedures and deadlines for processing Commerce Department export license applications.

Prior to the 1995 Executive Order, decisions on export applications that were referred to other agencies were made by consensus. The 1995 Executive Order directed the Commerce Department to send all applications to the Departments of Defense, State, and Energy and the Arms Control and Disarmament Agency for review. It also shortened the maximum processing time from 120 to 90 days. The 1995 Executive Order also revised the Advisory Committee on Export Policy structure to resolve disagreements among the agencies regarding licensing decisions.

Until its dissolution in March 1994, the Coordinating Committee on Multilateral Export Controls (COCOM) was the primary multinational export control organization through which the United States and the other 16 member countries controlled the export of items for security purposes. COCOM was created in 1949 by the United States and the other NATO countries, excluding Iceland and Spain, plus Japan. Later, Spain and Australia joined COCOM. COCOM-proscribed countries included the Soviet Union, other Warsaw Pact nations, and the People's Republic of China. Under COCOM, member countries allowed other member countries to veto their export cases that required COCOM approval.

In late 1993, the COCOM member countries agreed with the U.S. proposal to terminate COCOM and replace it with a new multilateral mechanism. The COCOM members agreed in early 1994 to continue the COCOM controls on a "national discretion" basis after the dissolution of COCOM until a new multilateral mechanism was established.

Almost two and one-half years after the dissolution of COCOM, a new multinational organization, called the "Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies," became effective in September 1996. The 33 member countries implement the Wassenaar list of controlled items to countries of concern by "national discretion." The countries of concern are Iran, Iraq, North Korea, and Libya. In addition to the Wassenaar Arrangement, the United States currently participates in three other multilateral export control regimes: the Australia Group, the Missile Technology Control Regime, and the Nuclear Suppliers Group. The items controlled under these latter three regimes are considered to be under foreign policy controls.

Beginning in 1981, the United States and COCOM members gave the PRC access to higher levels of technology compared with the Soviet Union. This policy of differentiation continued until the Tiananmen Square massacre on June 4, 1989. After Tiananmen, COCOM members did not liberalize controls on any additional items specifically for export to the PRC.

Congress passed sanctions against the PRC in response to Tiananmen, including the Foreign Relations Authorization Act for Fiscal Years 1990 and 1991, which, among other things, required a presidential "national interest" determination, or waiver, for the export of a U.S.-manufactured commercial communications satellite for launch on a PRC rocket. There have been 13 such presidential "national interest" determinations pursuant to the Tiananmen sanctions legislation.

Although the Administration transferred the licensing jurisdiction for commercial satellites from State to Commerce by actions in 1992 and 1996, Congress moved the jurisdiction back to State in the National Defense Authorization Act for Fiscal Year 1999 due to technology transfer concerns.

Since early 1994, the United States has dramatically liberalized Commerce Department export controls on items controlled for national security purposes, which has reduced licensing activity by over 55 percent since Fiscal Year 1993. These export control liberalizations have affected computers, semiconductors, semiconductor manufacturing equipment, telecommunications equipment, oscilloscopes, and other commodities.

In the National Defense Authorization Act for Fiscal Year 1998, Congress imposed several restrictions on the export of high performance computers to countries posing proliferation, diversion, or other security risks, including the PRC.

STATUTORY AND REGULATORY CONTROLS

THE EXPORT OF OUR MILITARILY SENSITIVE TECHNOLOGY

This chapter provides a brief explanation of the nature and sources of U.S. export controls. It examines the evolution of current export policy regarding the People's Republic of China and the provisions of the relevant laws, regulations, and policies applying to the categories of exports that are the primary subjects of the Report:

- **Commercial communications satellites**
- **High performance computers**
- **Machine tools**

The two principal statutes that govern U.S. export controls are: (1) the Export Administration Act of 1979,[1] as amended, which controls "dual-use" items and is administered by the Department of Commerce; and (2) the Arms Export Control Act,[2] which controls munitions items and is administered by the Department of State. In addition, exports of certain other items are governed by other statutes administered by other U.S. Government agencies, including the Office of Foreign Assets Control of the Department of the Treasury, the Nuclear Regulatory Commission, and the Department of Energy.

Export Administration Act

Export controls in the United States date back to before World War II, when restrictions on exports were imposed to ensure that adequate supplies of commodities would be available to meet wartime needs. After the war, export controls were con-

Since early 1994, the United States has dramatically liberalized export controls on items controlled for national security purposes.

tinued with the enactment of the Export Control Act of 1949 in response to the post-war shortage of many commodities and to the political situation between the United States and the Soviet Union.

Under the Export Control Act of 1949, exports from the United States to the Soviet Union and other Communist countries were controlled based on their military significance. In addition, the Act established a "short supply" export control program to deal with the post-war worldwide shortage of many goods.

The Export Control Act of 1949 continued in effect for 20 years. It was replaced effective January 1970 by the Export Administration Act of 1969 (the 1969 Act). In October 1979, the Export Administration Act of 1979 (the 1979 Act) replaced the 1969 Act. The 1979 Act was later amended by the Export Administration Amendments Act of 1981 and the Export Administration Amendments Act of 1985. Certain revisions to the 1979 Act were also included in the Omnibus Trade and Competitiveness Act of 1988.

Due to the inability of Congress and the Executive branch to reconcile conflicting views regarding export control policy, the Export Administration Act of 1979 was allowed to expire without replacement on September 30, 1990. At that time, the provisions of the 1979 Act were maintained in force by President Bush under the International Emergency Economic Powers Act,[3] as implemented through Executive Order 12730 (Continuation of Export Control Regulations, September 30, 1990).

Also, there have been two brief extensions to the 1979 Act in recent years. Public Law 103-10 extended the 1979 Act from March 27, 1993 until June 30, 1994, and Public Law 103-277 extended it again from July 5, 1994 until August 20, 1994.[4] Although a number of bills to revise and extend the 1979 Act on a more permanent basis have been introduced in Congress since 1990, an amendment bill or an extension bill has not been passed by both Houses of Congress since July 1994.

Since the last extension of the 1979 Act expired on August 20, 1994, the Export Administration Regulations issued under the 1979 Act have been maintained under the International Emergency Economic Powers Act by Executive Order 12924 (August 19, 1994).

The Export Administration Act of 1979, as amended, provides "authority to regulate exports, to improve the efficiency of export regulation, and to minimize interference with the ability to engage in commerce." The 1979 Act authorizes export controls to be used only after full consideration of the impact on the economy of the United States and only to the extent necessary:

> (A) *to restrict the export of goods and technology which would make a significant contribution to the military potential of any other country or combination of countries which would prove detrimental to the national security of the United States;*
>
> (B) *to restrict the export of goods and technology where necessary to further significantly the foreign policy of the United States or to fulfill its declared international obligations; and*
>
> (C) *to restrict the export of goods where necessary to protect the domestic economy from the excessive drain of scarce materials and to reduce the serious inflationary impact of foreign demand.*[5]

These three categories of permissible restrictions through export controls are discussed in the 1979 Act in separate sections. Section 5 of the 1979 Act deals with national security controls; section 6 with foreign policy controls; and section 7 with short supply controls.[6]

National Security Controls

National security export controls are established on the export and re-export of strategic commodities and technical data to prevent the diversion of such items to countries of concern. The United States pursues this objective through multilateral means when possible.

Until its demise in March 1994, the multilateral forum for controls on exports to controlled countries was the Coordinating Committee on Multilateral Export Controls (COCOM). The United States currently cooperates in the area of dual-use national security export controls with 32 other countries that participate in the Wassenaar Arrangement.

Section 5(b) of the 1979 Act requires the President to establish a list of "controlled countries" for national security purposes.[7] The controlled countries currently are: Albania, Armenia, Azerbaijan, Belarus, Bulgaria, Cambodia, Cuba, Estonia, Georgia, Kazakhstan, Kyrgyzstan, Laos, Latvia, Lithuania, Moldova, Mongolia, North Korea, the People's Republic of China, Romania, Russia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan, and Vietnam.[8]

Foreign Policy Controls

Foreign policy export controls are imposed for a number of reasons in furtherance of the foreign policy of the United States.[9] Such reasons include:

- **Crime control**
- **Regional stability**
- **Anti-terrorism**
- **Chemical and biological weapons nonproliferation**
- **Missile technology**
- **Nuclear nonproliferation**[10]

Items controlled pursuant to the three other current multilateral control regimes — the Australia Group, the Missile Technology Control Regime, and the Nuclear Suppliers Group — are under foreign policy controls, rather than national security controls. The exception occurs if the item is also under national security controls pursuant to the Wassenaar Arrangement or under unilateral U.S. national security controls.

Section 6(a)(3) of the 1979 Act requires foreign policy controls to expire annually, unless extended.[11] Foreign policy controls may not be extended unless the President has submitted a report to Congress in accordance with section 6(f) of the 1979 Act.[12]

Short Supply Controls

If a commodity is in short supply, export controls may be imposed under section 7 of the 1979 Act.[13] Section 7 authorizes the President to prohibit or curtail the export of goods subject to the jurisdiction of the United States where necessary to protect the domestic economy from the excessive drain of scarce materials and to reduce the serious inflationary impact of foreign demand.[14]

Controls Maintained in Cooperation with Other Nations

The 1979 Act provides:

> *It is the policy of the United States (A) to apply any necessary controls to the maximum extent possible in cooperation with all nations, and (B) to encourage observance of a uniform export control policy by all nations with which the United States has defense treaty commitments or common strategic objectives.*[15]

Until its dissolution on March 31, 1994, the Coordinating Committee on Multilateral Export Controls (COCOM) was the primary multinational export control organization through which the United States and member countries controlled exports to countries of concern.

The United States currently participates in four multilateral export control regimes: the Wassenaar Arrangement, the Australia Group, the Missile Technology Control Regime, and the Nuclear Suppliers Group.

COCOM (Coordinating Committee on Multilateral Export Controls)

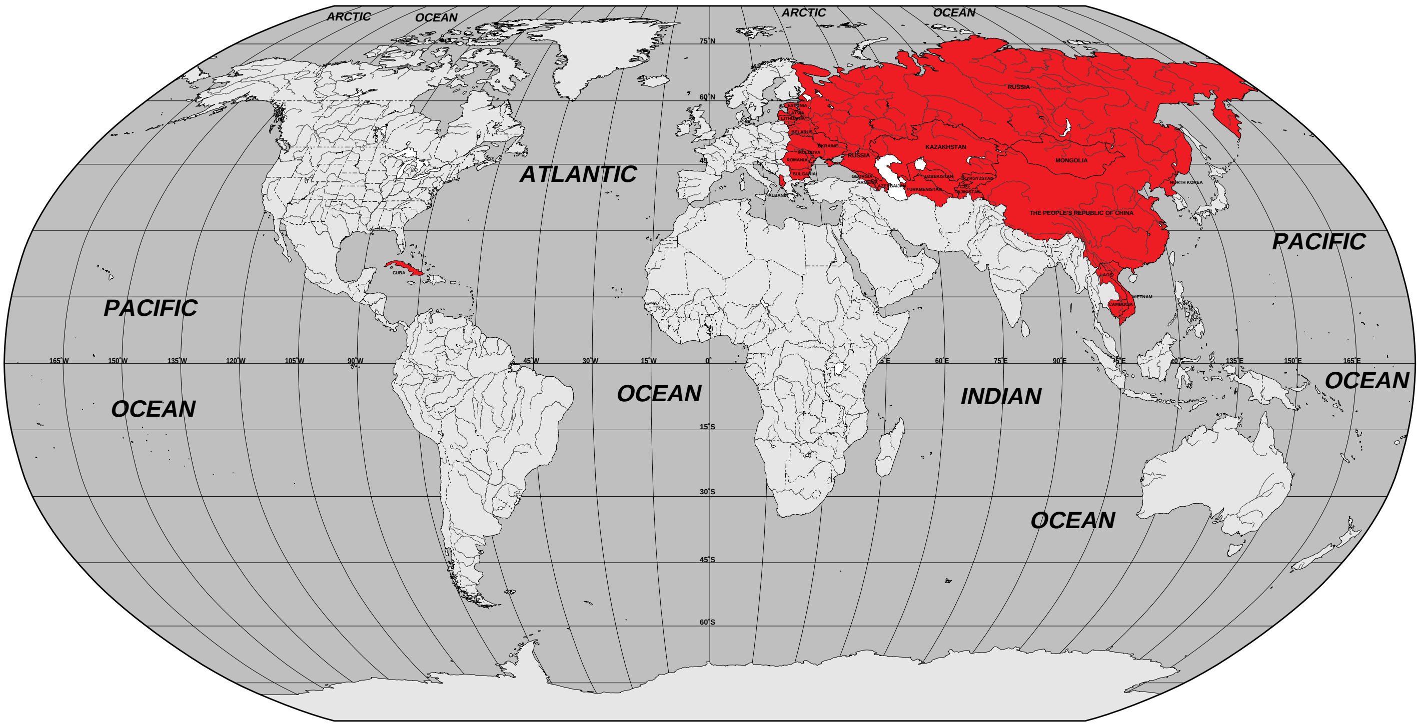
In 1949, the United States and 14 other countries created by informal agreement the Coordinating Committee on Multilateral Export Controls for security purposes.

The initial COCOM member countries were Belgium, Canada, Denmark, France, the Federal Republic of Germany, Greece, Italy, Japan, Luxembourg, the Netherlands, Norway, Portugal, Turkey, the United Kingdom, and the United States. Later, Spain and Australia joined COCOM.

COCOM maintained three control lists:

- **The International Atomic Energy List**
- **The International Munitions List**
- **The Industrial List**

COCOM-Proscribed Countries



In 1994, the COCOM-proscribed countries included Russia, other Warsaw Pact nations, and the People's Republic of China.

The Industrial List contained dual-use items (that is, items that have both civil and military applications) not included in the other two lists. COCOM performed a comprehensive review of each of the control lists at least every three to four years to reflect technological developments and changes in the ways in which end users could apply technologies.

Under COCOM, member countries surrendered some of their national sovereignty and national discretion by allowing other member countries to vote on export cases that required COCOM approval, according to Steven C. Goldman, Director of the Office of Chemical and Biological Controls and Treaty Compliance and Acting Director of the Office of Nuclear and Missile Technology Controls within the Bureau of Export Administration at the Department of Commerce.[16]

With the fall of the Berlin Wall and the changes in the Eastern European governments in 1989, President Bush approved in May 1990 a U.S. proposal to COCOM for a significant reduction in the COCOM controls and for the development of a new "core list" of strategic items to replace the existing Industrial List. In June 1990, COCOM agreed with most of the elements in the U.S. proposal, and COCOM eliminated 30 items in the Industrial List while partially decontrolling 12 additional items. COCOM also agreed to a reduced "core list" of dual-use items that would be controlled for national security purposes to proscribed countries.

In view of the changing strategic environment in Central and Eastern Europe and the Newly Independent States of the former Soviet Union, COCOM adopted criteria in December 1991 for the removal of countries from the list of proscribed countries. Hungary was removed from this list in May 1992.

The United States submitted a proposal to COCOM in 1992 to establish a COCOM Cooperation Forum to discuss international standards for export controls, and to provide a way to coordinate technical assistance efforts with the countries of Eastern and Central Europe and the former Soviet Union. COCOM agreed with this proposal in June 1992, and the COCOM Cooperation Forum held its first meeting in November 1992. One of the items discussed by the Forum was a new approach to COCOM export controls that would contribute to the economic development of reforming countries by providing more access to higher levels of controlled items.

A report to Congress, dated September 30, 1993, which was submitted by the U.S. Trade Promotion Coordinating Committee, an interagency group chaired by the Commerce Department, stated that the Clinton administration was taking action to:

> *Adapt the multilateral export control system to address proliferation threats and to ensure the consistent application of export control policies and procedures by member countries.*
>
> *Continue current vigorous efforts to reorient COCOM export controls to the post-Cold War world . . .*[17]

Shortly after this report was submitted to Congress, the Clinton Administration made a proposal to the COCOM member countries to dissolve COCOM and to create a new multilateral mechanism to achieve a number of objectives, including:

- **Preventing states such as Iraq, Iran, North Korea, and Libya** from obtaining conventional weapons and other sensitive technologies
- **Furthering the process of engaging Russia** and other Newly Independent States in developing export control systems
- **Removing disadvantages to U.S. exporters** resulting from inadequate multilateral coordination on exports of sensitive technologies to terrorist states[18]

In November 1993, the COCOM member countries agreed to the U.S. proposal to establish a new multilateral mechanism, including the proposal to phase out COCOM. The Export Administration Annual Report for 1994, and the 1995 Report on Foreign Policy Export Controls, stated that:

> *As a result of [the] end of the Cold War, it was agreed by all COCOM members that COCOM should cease to exist after March 31, 1994.*[19]

Discussions among the COCOM member countries continued in early 1994 regarding the new organization to control exports of conventional weapons and sensitive dual-use goods and technologies.

At a meeting in Wassenaar, the Netherlands in March 1994, the COCOM member countries agreed to continue the use of the COCOM control lists to control exports until the new organization was formed.

Wassenaar Arrangement

The final agreement to establish a new multilateral export control organization was approved in July 1996, over two years after the dissolution of COCOM.

The new organization, called the "Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies" (Wassenaar Arrangement), became effective in September 1996.

The 33 member countries of the Wassenaar Arrangement include: Argentina, Australia, Austria, Belgium, Bulgaria, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, the Republic of Korea, Romania, Russia, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, Ukraine, the United Kingdom, and the United States.

Negotiations regarding the items to be covered under the Wassenaar Arrangement began with the COCOM control list prior to the final agreement, according to James A. Lewis, Director of the Office of Strategic Trade and Foreign Policy Controls within the Bureau of Export Administration at Commerce.[20] Lewis says that the "essential" Wassenaar list of controlled items is not very different from the COCOM list as it existed in 1993 (that is, the same nine categories of items and the same general format and structure).[21]

Roger Majak, Assistant Secretary of Commerce for Export Administration, says the Wassenaar Arrangement includes no written agreement regarding the countries of concern.[22] However, Majak indicated that there is a verbal agreement that the countries of concern are Iran, Iraq, North Korea, and Libya.[23]

Unlike the COCOM Secretariat, the Wassenaar Secretariat — located in Vienna, Austria — does not perform a review function. That is, the Wassenaar Arrangement does not require that member countries submit export licenses for sensitive commodities and technologies to the Secretariat for review by other member countries prior to approval.

Instead, licensing by Wassenaar member countries is done by "national discretion," which means that while member countries share a common control list and a common set of objectives, each country can decide on its own how it will implement the control list and the objectives.

Commerce's Lewis says "one of the challenges for Wassenaar is achieving greater consistency in national application." [24]

Some items included in the Wassenaar control list are included in the Commerce Control List,[25] and the remainder are included in State's Munitions List.[26] Wassenaar control list items included in the Commerce Control List are considered to be subject to U.S. national security controls, although Lewis says that some of those items are subject to U.S. foreign policy controls as well.

Regarding high performance computers, Lewis indicates that Wassenaar member countries have agreed to control the export of computers capable of 2,000 millions of theoretical operations per second (MTOPS) and above, and that most member countries do not require licenses to export computers below this level of capability.[27] Lewis says that, at a recent Wassenaar meeting held to discuss control list items, the United States was the only member country that opposed moving this level up to 4,000 MTOPS.[28]

Under the Wassenaar Arrangement, member countries provide semi-annual reports to the Wassenaar Secretariat of export licenses regarding covered items they have approved or denied. Member countries receive three levels of semi-annual reports from the Wassenaar Secretariat. The member countries are provided semi-annual reports regarding approvals that include the control number and a brief description of the commodity or technology, the quantity approved, and the country of receipt. They are also provided with semi-annual reports regarding denials that include the same information. In addition, members receive semi-annual reports regarding denials of sensitive items that include the names of the intended recipients.

The Wassenaar Arrangement has a "no undercut agreement" on denials, according to Lewis, although he says "it could use a little work."[29] Under this agreement, when a member country reports a denial of a sensitive item to the Wassenaar Secretariat, no member will approve the sale of the same item to the same end user without first consulting the country that initially denied the export.

Included in the July 1996 agreement to establish the Wassenaar Arrangement was a provision for a 1999 review of the "overall functioning" of the regime.[30] Commerce's Lewis says this review will be conducted in the spring of 1999.[31] Commerce's Bureau of Export Administration has, however, only begun to review the effectiveness of the Wassenaar Arrangement in preparation for this two-year review.

Commerce Assistant Secretary Majak says that "[o]n the dual use side. . . [the Wassenaar Arrangement] has been successful in defining a common list and some common target control levels, but the implementation of those control levels by the member countries has been very uneven and in many respects unsatisfactory."[32]

Australia Group

The Australia Group was established in 1984 as an informal forum for member countries that seek to discourage and impede chemical weapons and biological weapons proliferation. The Australia Group pursues these goals by harmonizing national export controls on chemical weapons precursor chemicals, biological weapons pathogens, and dual-use equipment that may be used for chemical or biological weapons, and by sharing information on proliferation programs.[33] The Australia Group meets annually in Paris.

Currently, 30 countries are members of the Australia Group — Argentina, Australia (which chairs the Group), Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, the Slovak Republic, the Republic of Korea, Spain, Sweden, Switzerland, the United Kingdom, and the United States. All member countries are signatories of the 1993 Chemical Weapons Convention.

The Australia Group has established export controls on 54 chemical precursors and a list of chemical weapons-related production equipment. Regarding biological weapons, the Group has established export controls on certain microorganisms, toxins, and biological weapons-related production equipment.[34]

Member countries implement export controls that are identified and agreed upon by the Australia Group by "national discretion," which means that member countries individually decide how to implement the controls.

Export license applications for Australia Group items that are approved by a member country are not reported to other member countries. Goldman indicates that there is a "no undercut agreement" on denials by Australia Group members.[35]

Australia Group items are included in the Commerce Control List of the Export Administration Regulations. Such items on the Commerce Control List are considered to be subject to foreign policy controls.

Missile Technology Control Regime

The Missile Technology Control Regime (MTCR) was created in April 1987 by Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. The purpose of the MTCR is to limit the proliferation of missiles capable of delivering weapons of mass destruction.

Licensing by Missile Technology Control Regime member countries is done by "national discretion."

The Missile Technology Control Regime currently has 29 member countries. In addition to the seven original countries, the members are Argentina (joined in 1993), Australia (1990), Austria (1991), Belgium (1990), Brazil (1995), Denmark (1990), Finland (1991), Greece (1992), Hungary (1993), Iceland (1993), Ireland (1992), Luxembourg (1990), the Netherlands (1990), New Zealand (1990), Norway (1991), Portugal (1992), Russia (1995), South Africa (1995), Spain (1989), Sweden (1991), Switzerland (1992), and Turkey (1997).

MTCR controls are based upon Guidelines and an Equipment and Technology Annex. The Annex consists of a list of missile-related items subject to controls, and is divided into two categories:

- **Category 1** includes missile subsystems and production equipment for missile systems. Category 1 items are controlled by the Department of State under the U.S. Munitions List

- **Category 2** includes dual-use components, materials, and other commodities

Goldman, of Commerce's Bureau of Export Administration, says that approximately 70 percent of the items listed in Category 2 are included in the U.S. Munitions List, and about 30 percent of the items are included in the Commerce Control List.[36]

While the People's Republic of China is not a member of the MTCR, it agreed in 1992 to adhere to the original Guidelines, and the Equipment and Technology Annex agreed to in 1987 by the MTCR member countries.[37]

The PRC decision followed the imposition by the United States of missile proliferation sanctions on the PRC in 1991 because the PRC had transferred M-11 short-range ballistic missile technology to Pakistan.[38]

The PRC has not, however, agreed to adhere to revisions to the Guidelines and Annex that have been adopted since 1987.[39]

Nuclear Suppliers Group

The Nuclear Suppliers Group was established in 1992. Member countries have agreed to adhere to Guidelines and implement an Annex with respect to exports of nuclear and nuclear-related dual-use commodities.

Also, member countries adhere to safeguards established by the International Atomic Energy Agency.

The Nuclear Suppliers Group currently consists of 34 member nations — Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, the Republic of Korea, Romania, Russia, the Slovak Republic, Spain, South Africa, Sweden, Switzerland, Ukraine, the United Kingdom, and the United States.

According to Stephen C. Goldman of Commerce's Bureau of Export Administration, the Nuclear Suppliers Group export controls are similar to those that existed under COCOM's International Atomic Energy List.[40] Unlike the COCOM controls, however, the Nuclear Suppliers Group export controls are implemented on a "national discretion" basis.

The Nuclear Suppliers Group works on the basis of a consensus of the member countries, and the Guidelines call for consultations among member countries regarding sensitive export cases.

License applications for items covered by the Nuclear Suppliers Group that are approved by a member country are not reported to other member countries. However, there is a "no undercut rule" on denials by member countries.

Enhanced Proliferation Control Initiative

In December 1990, President Bush approved the Enhanced Proliferation Control Initiative. This initiative was established to control items —

- **When the exporter knows** that the export will be used in the design, development, production, or stockpiling of missiles or chemical or biological weapons; or
- **When the exporter is informed** by the Department of Commerce that there is a serious risk of diversion.

Earlier, President Bush had issued Executive Order 12735 (Chemical and Biological Weapons Proliferation, November 16, 1990), which directed the imposition of additional controls on items used in the design, development, production, delivery, stockpiling, or use of missiles and chemical and biological weapons.[41]

In December 1993, the Department of Commerce published additional guidance for exporters on the "knows or is informed" licensing requirement of the Enhanced Proliferation Control Initiative.[42]

In February 1997, the Department of Commerce began publishing an "Entity List" to inform exporters of some of the organizations and companies that may be involved in proliferation activities. The "Entity List" appears in Supplement No. 4 to part 744 of the Export Administration Regulations, and is revised and updated on a periodic basis.[43] This "Entity List" does not, however, include all of the organizations, companies, or individuals that are on the "watch lists" maintained by the Office of Export Enforcement at the Department of Commerce or by the Nonproliferation Center at the Central Intelligence Agency.

The Enhanced Proliferation Control Initiative's "knows or is informed" provision is known as a "catch-all" provision. This control imposes a licensing requirement in those cases where the exporter has "knowledge" of the end use or end user relating to missile and chemical or biological weapons activities.

A Department of Commerce Fiscal Year 1999 budget proposal document for the implementation of a Bureau of Export Administration internal compliance program stated:

> *Significant easing of the U.S. and multilateral export controls on West-East trade since the early 1990's; the implementation of the Enhanced Proliferation Control Initiative (EPCI) in 1991; and, the simplification of the Export Administration Regulations (EAR) which resulted in a conversion from general licenses to license exceptions have* ***shifted the burden of screening many export transactions to the exporter.***
>
> *Unfortunately, many companies have not established adequate procedures to ensure transactions no longer requiring export licenses are* ***properly screened for proscribed end-uses and end users.***[44] [Emphasis added]

The Enhanced Proliferation Control Initiative does not apply to items controlled under the Wassenaar Arrangement, according to Goldman.[45] However, the United States has obtained agreement from other member countries (except Canada) under the Australia Group, the Missile Technology Control Regime, and the Nuclear Suppliers Group to implement "catch-all" controls to some extent regarding controlled items.

Export Administration Regulations

The Export Administration Regulations are designed to implement the 1979 Act and control certain exports, reexports, and other activities.[46] They are issued and administered by the Bureau of Export Administration of the Department of Commerce.[47]

The Export Administration Regulations control "dual-use" commodities — that is, technology that can be used in military and other strategic uses, as well as in commercial applications.[48] However, the Export Administration Regulations also include some items that have solely civil uses.[49]

On May 11, 1995, the Bureau of Export Administration published a comprehensive revision and reorganization of the Export Administration Regulations after a two and one-half year effort. The revision made changes in the types of export licenses, eliminating the "general license" categories and replacing them with "License Exceptions." Also, the "special license" provisions (for example, Project License, Distribution License, Service Supply Procedure, Humanitarian License, Aircraft and Vessel Repair Station Procedure, and Special Chemical License) were removed and replaced by a "Special Comprehensive License." [50]

The Commerce Control List specifies the commodities, software, and technology that are subject to the Export Administration Regulations.[51] In addition, the General Technology and Software Notes provide guidance relevant to these items.[52] Prior to the dissolution of COCOM in March 1994, the Commerce Control List was closely related to the COCOM Industrial List.[53]

The Commerce Control List is organized into ten categories:

- Category 0: **Nuclear Materials, Facilities, and Equipment**
- Category 1: **Materials, Chemicals, Microorganisms, and Toxins**
- Category 2: **Materials Processing**
- Category 3: **Electronics**
- Category 4: **Computers**
- Category 5: **Telecommunications and Information Security**
- Category 6: **Sensors and Lasers**
- Category 7: **Navigation and Avionics**
- Category 8: **Marine**
- Category 9: **Propulsion Systems, Space Vehicles and Related Equipment**[54]

The Commerce Country Chart contains licensing requirements based on the proposed country of destination and the "Reason for Control." [55] The Country Chart is designed to be used in conjunction with the Commerce Control List in determining whether a license is required to export a given item to a particular country.[56] The Country Chart provides as "Reasons for Control":

- **Anti-terrorism**
- **Chemical and biological weapons**
- **Crime control**
- **Encryption items**
- **Missile technology**
- **National security**
- **Nuclear nonproliferation**
- **Regional stability**
- **Short supply**
- **Computers**
- **Other significant items**[57]

The Export Administration Regulations also identify 14 "License Exceptions." [58] A "License Exception" is an authorization to export or re-export without a Commerce license certain items that are subject to the Export Administration Regulations.[59]

One of the new 1995 License Exceptions — "License Exception CIV" [60] — authorizes the export and re-export of certain items that are controlled for national security reasons, provided the items are destined to civil end-users for civil end-uses in a group of countries that includes the PRC.[61]

Another License Exception — "License Exception CTP" — authorizes export and re-export of computers to various countries, including the PRC, according to criteria provided in the Export Administration Regulations.[62]

For example, the new 1995 License Exception CTP can be relied upon to export computers having a composite theoretical performance greater than 2,000 MTOPS (millions of theoretical operations per second), but less than or equal to 7,000 MTOPS, to other than military or nuclear, biological, or missile end-users and end-uses in the PRC.[63]

Arms Export Control Act

The U.S. Government controls the export and import of "defense articles" and "defense services" pursuant to the Arms Export Control Act.[64]

Section 38 of the Arms Export Control Act authorizes the President to control the export and import of defense articles and defense services.[65]

The statutory authority of the President to promulgate regulations with respect to exports of defense articles and defense services was delegated to the Secretary of State by Executive Order 11958, as amended.

International Traffic in Arms Regulations

The Arms Export Control Act is implemented by the International Traffic in Arms Regulations (ITAR), which are administered by the State Department's Office of Defense Trade Controls within the Bureau of Political-Military Affairs. These regulations are found at 22 CFR parts 120-130.

The Arms Export Control Act provides that the President shall designate the articles and services that are deemed to be "defense articles" and "defense services."[66] These items, as determined by the State Department with the concurrence of the Department of Defense, are included on the U.S. Munitions List.[67]

No items may be removed from the U.S. Munitions List without the approval of the Secretary of Defense, and there must be 30 days advance notice to Congress.[68]

In addition to unilateral U.S. controls, the U.S. Munitions List includes controls on missile technology that are based on the multilateral Missile Technology Control Regime and its Annex.[69]

Omnibus Trade and Competitiveness Act of 1988

The "Exon-Florio" provision of the Omnibus Trade and Competitiveness Act of 1988[70] amended the Defense Production Act[71] to establish a procedure for the President to investigate the national security effects of proposed mergers, acquisitions, and takeovers of U.S. companies by foreign interests. If there is credible evidence that the foreign interest exercising control might take action that threatens to impair the national security, the President may suspend or prohibit the transaction.[72]

The Exon-Florio provision allows a maximum of 90 days to complete a review of a proposed transaction.[73] The determination whether an investigation should be undertaken must be completed in 30 days. An investigation, if undertaken, must be completed in 45 days. The decision whether action is to be taken to block the transaction must be made within another 15 days.[74]

President Reagan designated the interagency Committee on Foreign Investment in the United States to administer the Exon-Florio provision in Executive Order 12661 (Implementing the Omnibus Trade and Competitiveness Act of 1988 and Related International Trade Matters, December 27, 1988). Under that Executive Order, the Secretary of the Treasury chairs the interagency committee.

Economic Espionage Act of 1996

The Economic Espionage Act of 1996 (P.L. 104-294, October 11, 1996) was enacted for two purposes:

- **To thwart attempts by foreign entities to steal the trade secrets of U.S. companies**
- **To authorize the U.S. Government to investigate and prosecute persons, including domestic American companies, who are engaged in economic espionage**[75]

The Economic Espionage Act was a response to an appeal by the Director of the Federal Bureau of Investigation for Congress to enact new legislation to criminalize the theft of trade secrets.[76]

Under the Economic Espionage Act, penalties for economic espionage by a foreign government or its agent include:

- **Fines for an individual of up to $500,000**
- **Jail sentences of up to 15 years**
- **Fines for an organization of up to $10 million**[77]

The Economic Espionage Act applies extraterritorially to activities of non-U.S. citizens abroad, if such activities conducted abroad are illegal under the Act, and if they are connected to an act in the United States that furthered the activity abroad.[78]

Economic espionage is defined as:

> *foreign power-sponsored or coordinated intelligence activity directed at the U.S. government or U.S. corporations, establishments or persons, designed to obtain unlawfully or clandestinely sensitive financial, trade, or economic policy information, proprietary economic information, or critical technologies, or, to influence unlawfully or clandestinely sensitive economic policy decisions.*[79]

Countries identified publicly by the U.S. Government as being involved in economic espionage include the People's Republic of China, which is reported to be enhancing its collection efforts in this area.[80]

Export Licenses for Militarily Sensitive Technology: Department of Commerce

The Bureau of Export Administration within the Department of Commerce processes export license applications pursuant to the 1979 Act and the Export Administration Regulations.

The Bureau of Export Administration conducts a complete review of the license application, including any documentation submitted along with the application. This review includes an examination of the item to be exported, the proposed end use of the item, and all parties to the transaction.

Export License Processing Until December 1995

Prior to the issuance of Executive Order 12981 (Administration of Export Controls, December 5, 1995), Commerce's Bureau of Export Administration routinely referred certain license applications to:

- **The Department of State**
- **The Department of Defense**
- **The Department of Energy**
- **The Arms Control and Disarmament Agency**

Whether the Commerce Department made a referral to one of these other agencies depended upon the item to be exported and the country of destination. The protocol for these referrals evolved over the years. It was subject to change as items were controlled or decontrolled, and as concerns regarding destination countries changed.

For example, applications to export items controlled for national security purposes to end users in the People's Republic of China or Russia were routinely referred to the Department of Defense for review. License applications for items controlled for foreign policy purposes (such as regional stability, anti-terrorism, and crime control) to specific countries were referred to the State Department for review. The Department of Energy would receive referrals of license applications for items controlled by the Nuclear Suppliers Group as nuclear nonproliferation commodities.

If the reviewing departments and agencies differed regarding a specific license application, further consultation would occur in the structure of the Advisory Committee on Export Policy (ACEP). This consultation could also occur in any special groups that had been established to address specific types of items (for example, the Subgroup on Nuclear Export Coordination), or in less formal discussions between the particular departments or agencies.

The ACEP structure operated at three levels prior to December 1995:

- **The Operating Committee** of the ACEP, the first level for resolution of differences, was chaired by a Commerce Bureau of Export Administration official, and included representatives from the Departments of Commerce, Defense, State, and Energy, as well as other departments and agencies as appropriate.

- **The ACEP itself**, the second level, was chaired by the Assistant Secretary of Commerce for Export Administration. Members of the ACEP included the same representatives of departments and agencies as the Operating Committee.

- **The Export Administration Review Board**, the third level, was chaired by the Secretary of Commerce, and consisted of cabinet-level officials.

The ACEP structure operated on a consensus basis at each level. Interagency differences that could not be resolved at the Export Administration Review Board level could be sent to the President for final resolution.[81]

Export license application processing deadlines were established by the Export Administration Amendments Act of 1985. The maximum processing time for a license application that required referral to another department or agency was 120 days. If a license application did not require referral to another department or agency, the maximum processing time was 60 days.[82]

Prior to the issuance of Executive Order 12981 in December 1995, the 1979 Act required that the Commerce Department seek information and recommendations from other U.S. Government departments and agencies that had important interests in exports in determining whether a dual-use export license should be granted or denied.

Prior to December 1995, the Commerce Department referred many, but not all, license applications to the Departments of State, Defense, and Energy, and the U.S. intelligence community for review.

Nevertheless, a number of U.S. Government reports over the years identified problems and disagreements involving U.S. Government agencies regarding which applications the Department of Commerce should refer to them.[83] One 1993 study noted that this disagreement resulted in part from ambiguities in the 1979 Act. In contrast, the Nuclear Non-Proliferation Act of 1978 required the Department of Commerce to consult with the Department of Energy under specific procedures regarding applications for items with nuclear-related capabilities.

License Processing Since Executive Order 12981 in December 1995

Executive Order 12981 was issued on December 5, 1995. It established new procedures and deadlines for the processing of export license applications by the Department of Commerce pursuant to the 1979 Act and the Export Administration Regulations.

Among other things, the Executive Order made a major change regarding the referral by the Commerce Department of license applications to other departments and agencies. The effect of this change was to permit the Departments of State, Defense, and Energy, and the Arms Control and Disarmament Agency, to review any license application submitted to the Commerce Department.

As was the case prior to Executive Order 12981, the Commerce Department is free to refer license applications to other departments and agencies as it deems appropriate.[84]

The Executive Order also changed the composition and operation of the Advisory Committee for Export Policy (ACEP) for resolving interagency disputes on license applications. Instead of operating on a consensus basis at each level as previously had been the case, the Executive Order authorized the Operating Committee Chair to make decisions on license applications at the Operating Committee level.

These decisions could be appealed to the ACEP. The Executive Order established that decisions on license applications at the ACEP level and at the Export Administration Review Board level would be made by majority vote.[85]

The Executive Order also changed the time requirements. It specified that all license applications submitted to the Commerce Department must be resolved, or referred to the President, no later than 90 days after the license application. This represented a 30-day, or 25 percent, reduction in the maximum time that was previously allowed to process a license application.[86]

In October 1996, export license applications for commercial communication satellites and any jet engine "hot-section" technology for the development, production, and overhaul of commercial aircraft engines were transferred from the State Department's Munitions List to the Commerce Department's Control List.[87] President Clinton issued Executive Order 13020 (Amendment to Executive Order 12981, October 12, 1996) regarding the procedure for interagency processing of these applications. Executive Order 13020 also called for a majority vote decision of the Operating Committee on disputed applications, rather than a decision by the Operating Committee Chair.[88]

By Executive Order 13026 (Administration of Export Controls on Encryption Products, November 15, 1996), President Clinton amended the process for export licensing of encryption products. The new system requires the Commerce Department to refer license applications for encryption products controlled under the Commerce Control List to the Department of Justice for review. The Executive Order includes the Justice Department as a full voting member of the Operating Committee, the ACEP, and the Export Administration Review Board when those bodies are reviewing encryption export license applications.[89]

Carol A. Kalinoski, the Commerce Department official who currently is the Chair of the ACEP Operating Committee, indicates that meetings are currently held at least weekly. The agenda for each Operating Committee meeting generally ranges between 60 and 70 license application cases. Out of that number, approximately 20 to 40 typically are new cases. The Operating Committee handled 704 export license application cases in fiscal year 1998, 634 in fiscal year 1997, and 385 in fiscal year 1996.[90]

Kalinoski says that Operating Committee meetings are getting "harder." This is occurring because the Operating Committee is reviewing license applications that are more complex than in the past. End-user concerns are a primary cause of export license disagreements.[91]

Only five percent of the license applications reviewed by the Operating Committee are escalated to the Advisory Committee on Export Policy. Currently, there is a meeting of the ACEP about every two months. Kalinoski says there has not been an appeal to the Export Administration Review Board since December 1988.[92]

The number of license applications received by the Department of Commerce has dropped dramatically over the past ten years. Commerce received 97,902 license applications in fiscal year 1988, 26,126 in fiscal year 1993, and 11,472 in fiscal year 1997.[93] Commerce's Bureau of Export Administration explained this decline in export license applications in its 1997 Annual Report to Congress by stating:

> ***Dramatic licensing liberalizations*** *implemented following the September 30, 1993 release of the Trade Promotion Coordinating Committee's (TPCC) report to Congress on developing a "National Export Strategy" has reduced licensing activity by over 55% over the past four fiscal years.* [Emphasis added]

Pre-License Checks and Post-Shipment Verifications

The Department of Commerce or another department or agency may request a pre-license check to establish the identity and reliability of the recipient of the items requiring an export license.[94]

The 1979 Act provides that the Secretary of Commerce and designees may conduct overseas pre-license checks and post-shipment verifications of items licensed for export: [95]

- **A pre-license check** is conducted during the licensing process[96]
- **A post-shipment verification** is an on-site visit to the location to which the controlled item has been shipped under an export license, in order to ascertain that the item is being used by the appropriate end user and for the appropriate purpose

The Commerce Department's procedures for conducting pre-license checks and post-shipment verifications are similar.

A pre-license check or post-shipment verification is initiated by sending a cable with relevant information about the case to the appropriate U.S. Embassy overseas.

Specific officials at the Embassy usually have been pre-designated to conduct these checks, although special teams from Washington, D.C. also periodically conduct end-use checks.

The Embassy official initially collects background information on the end user. Next, the Embassy official visits the end user and interviews senior employees there. Upon completing the visit, the Embassy official is required to cable the Commerce Department with the information collected and an evaluation as to whether the end user is considered a reliable recipient of U.S. technology.

Based on the cabled information, the Commerce Department evaluates whether the result of the check is favorable or unfavorable.[97]

Over the years, several studies have criticized how the authority for pre-license checks and post-shipment verifications has been implemented.[98] These criticisms have included:

- **Lack of technical expertise among Embassy officials**
- **Omission of vital information in requesting cables**
- **Performance of checks by unsupervised foreign nationals**
- **Delayed or denied access to some foreign facilities, including those in the PRC**
- **Lack of strategic plans for checks and verifications**
- **Failure to follow guidelines**
- **Presence of unreliable data**

Roles of Other Departments and Agencies In Commerce's Export Licensing Policy

Department of State

Within the Department of State, the Export Control and Nonproliferation Office is responsible for reviewing most dual-use license applications referred from the Department of Commerce.

Normally, the license applications are received via a dedicated electronic link with the Commerce Department. As appropriate, the State Department coordinates the license application with its own offices and, when necessary, with U.S. Embassies overseas. Once the State Department formulates its position on a license application, it typically transmits the recommendation back to the Commerce Department via the same dedicated electronic link.

Depending on the technology involved, some dual-use license applications are processed by other State Department organizations instead of the Export Control and Nonproliferation Office:

- **License applications relating to missile technology** are reviewed by the Missile Technology Export Control Group, an interagency group chaired by the Office of Chemical, Biological, and Missile Nonproliferation within State's Bureau of Political-Military Affairs
- **Dual-use applications for items controlled for chemical and biological weapons reasons** are reviewed by SHIELD, an interagency group chaired by State
- **License applications relating to items that are controlled for nuclear nonproliferation reasons** are reviewed by the Subgroup on Nuclear Export Coordination (SNEC), another interagency group chaired by State

As appropriate, each of these interagency groups also reviews license applications involving other technologies that are destined to a country or end user of concern.[99]

Department of Defense

At the Department of Defense, the Technology Security Operations Directorate in the Defense Technology Security Administration (DTSA)[100] reviews the end users that are identified on Commerce Department export license applications.

The Defense Department uses information from a variety of sources, such as the U.S. Customs Service, the Federal Bureau of Investigation, the Central Intelligence Agency, and the Defense Intelligence Agency, to vet the end user. Also, a "tiger team" meets at the Defense Department each morning to review a synopsis of dual-use license applications that is transmitted electronically from Commerce.

Typically, the Defense Department has seven days to determine whether to recommend that it be given time to review a license application more closely. Invoking the seven-day period to ask for more information from the Commerce Department essentially places a hold on the license for a period of up to 30 days. During that time, the Defense Department works on developing information that eventually will lead to a recommendation for its position on the license application. Within the Defense Department, the License Directorate determines which Defense organizations will be afforded the opportunity to comment on the license application.

Central Intelligence Agency

Commerce Department officials may refer license applications for dual-use items to the CIA's Nonproliferation Center for help in identifying sensitive end users.[101]

Commerce Department officials say that they refer to the CIA all license applications for exports to the People's Republic of China.[102]

In 1996, the Commerce Department began referring to the CIA information it receives from exporters about end users for all high performance computer exports to certain countries — even if an export license is not required. However, the CIA has recommended 22 general types of foreign end users that the Commerce Department should exempt from Nonproliferation Center review. These include some foreign government entities whose activities are considered to be benign, public service organizations, and some foreign trade organizations.[103]

Enforcement

Alleged violations of the 1979 Act or the Export Administration Regulations are investigated by the Department of Commerce's Office of Export Enforcement.[104]

Consisting of about 100 special agents and other personnel, the Office of Export Enforcement operates from eight field offices located in key areas of the United States. In addition to conducting criminal and administrative investigations, it performs:

- **Pre-license checks**
- **Post-shipment verifications**

- **Liaison with other law enforcement agencies**
- **Outreach programs to educate businesses engaged in export activities**

In 1993, the Commerce Department and the U.S. Customs Service signed a Memorandum of Understanding to enhance their cooperation on export enforcement. The agreement contains provisions to facilitate information sharing, to coordinate enforcement activities, and to delineate responsibilities between the two agencies.

Voluntary Disclosures

In addition to reliance on standard methods of enforcement, the Commerce Department has procedures for exporters to self-disclose their own violations.

While the Export Administration Regulations provide that voluntary self-disclosure may be considered a mitigating factor in determining the appropriate administrative penalties, the regulations also make clear that the weight to be given a self-disclosure is entirely within the discretion of the Commerce Department, and that it will not prevent transactions from being referred to the Department of Justice for criminal prosecution.[105]

Penalties for Violation of the Export Administration Regulations

Since the 1979 Act expired in August 1994, the Export Administration Regulations have been enforced under the authority of the International Emergency Economic Powers Act. The penalties that can be imposed under this law are less than the penalties provided under the 1979 Act.

Penalties Under the 1979 Act (Expired Since 1994)

The 1979 Act provided for criminal and civil penalties, as well as administrative sanctions such as debarment from the privilege of exporting.

Criminal penalties for knowing violations under the 1979 Act included:

- **Maximum fines of five times the value of exports or $50,000, whichever is greater**
- **Imprisonment for a maximum of five years**[106]

Willful criminal violations were punishable by:

- **Maximum fines of $250,000**
- **Imprisonment of five to ten years**
- **Fines of up to $1 million for companies**[107]

Civil penalties under the 1979 Act included:

- **Fines of up to $10,000 per violation**
- **In cases involving violations of national security controls, fines of up to $100,000 per violation**[108]

Civil penalties under the 1979 Act were held by at least one federal court to be subject to a strict liability standard, with no necessity to show knowledge or intent.[109]

Administrative Sanctions

Administrative sanctions imposed under the Export Administration Regulations include denial of export privileges for up to ten years.[110] Persons convicted under specified national security laws, including the 1979 Act, may also lose export license privileges for up to ten years.[111]

When necessary to prevent the occurrence of an imminent violation, the Assistant Secretary of Commerce for Export Administration can issue an order temporarily denying export privileges without a hearing.[112]

All Commerce Department export licenses and license exceptions are subject to revision, suspension, or revocation without notice whenever it becomes known that the Export Administration Regulations have been violated, or that a violation is about to occur.[113]

A further sanction prescribed in the Export Administration Regulations is the exclusion of professionals involved in the export process — such as attorneys, accountants, consultants, and freight forwarders — from practice before the Bureau of Export Administration.[114]

Finally, illegal exports are subject to seizure together with any vessel, vehicle, or aircraft used in the export or attempt to export.[115]

Penalties Under the International Emergency Economic Powers Act

The criminal and civil penalties under the International Emergency Economic Powers Act (IEEPA) are substantially less than those provided under the 1979 Act. The maximum civil fine is $10,000 per violation.[116] The maximum criminal penalties under IEEPA are $50,000 and/or ten years' imprisonment.[117]

Commerce Undersecretary for Export Administration William A. Reinsch notes that the maximum civil fine under IEEPA — $10,000 per violation — may not be a significant cost for a major company.[118]

Customs Enforcement

The U.S. Customs Service is the principal border enforcement agency in the U.S. Government. It has the authority to search any shipment that crosses the U.S. border, whether entering or exiting the country.

One role of the Customs Service is to work with the State Department's Office of Defense Trade Controls in conducting end-use checks — the BLUE LANTERN program. The State Department sets criteria for when these end-use checks should be performed, but asks the Customs Service to carry them out. (In contrast, the Commerce Department schedules its own end-use checks and uses its own staff to implement them, although they are coordinated with the Customs Service and overseas attaches.)

The Customs Service receives leads from a variety of sources, including information from licenses issued by the Commerce Department and the State Department. In turn, it also shares information with Commerce and State.

The Customs Service maintains overseas offices, including one in Hong Kong, to support its investigations. Foreign national employees hired by the Customs Service are subject to full background investigations.

Commodity Classification Requests Under the Commerce Control List

The Commerce Control List consists of categories of items grouped by Export Control Classification Number.[119] If an exporter is uncertain regarding the correct Export Control Classification Number for a commodity to be exported, the exporter may obtain the appropriate number by submitting a "Classification Request" to the

Bureau of Export Administration at Commerce.[120] The Commerce Department handles approximately 5,000 classification requests each year.

The Commerce Department rarely coordinates commodity classification requests with other U.S. Government departments or agencies. However, pursuant to procedures approved by President Clinton in April 1996, the Commerce Department shares responsibility with the State Department and the Defense Department for classification requests involving:

> *items/technologies specifically designed, developed, configured, adapted and modified for a* ***military application,*** *or derived from items/technologies specifically designed, developed, configured, adapted or modified for a* ***military application.***[121]
> [Emphasis added]

The Commerce licensing officer handling a commodity classification request would need to determine whether the request met the above criteria for referral.

Since the adoption of the April 1996 procedures, the Commerce Department indicated it had referred to the State Department only 22 classification requests out of a total of 3,374 in 1997 (that is, 0.65 percent). It referred four out of 3,191 in 1998 (that is, 0.13 percent).[122]

Commerce's commodity classification process is different from the commodity jurisdiction process administered by the State Department. At State, all commodity jurisdiction requests are sent to the Departments of Defense and Commerce.

Iain S. Baird, Deputy Assistant Secretary of Commerce for Export Administration, says that copies of classification requests are maintained and filed "consistent with normal recordkeeping." However, Baird adds that the classification requests are disbursed by the licensing divisions, and these records are archived periodically along with other documents.[123] Also, records of classification requests are not kept in the Export Control Automated Support System database maintained by Commerce.

The Commerce Department was unable to comply with a request from the Select Committee for copies of classification requests acted on since 1992, as such documents are not readily accessible. Commerce plans to include information concerning classification requests in the anticipated redesign of the Commerce database.[124]

If, in response to a commodity classification request, the Commerce Department incorrectly decides an item does not require a license to be exported, the classification decision is not reviewed by another department or agency, and the exporter is free to export the item without a license. Only if Commerce decides the item requires a license to be exported will the Departments of State, Defense, and Energy, and the Arms Control and Disarmament Agency, have an opportunity to review the license application (including the commodity classification) pursuant to Executive Order 12981.

Since the State Department does not review the classification decision when the Commerce Department determines that no license is required under the Commodity Control List, it is possible that the State Department, if consulted, might have determined the item to be a defense article or defense service covered under the U.S. Munitions List.

Export Licenses for Militarily Sensitive Technology: Department of State

Procedures for Referral to Other Departments and Agencies of Requests to Export U.S. Munition List Items

Any license application submitted to the Department of State's Office of Defense Trade Controls to export a "defense article" or "defense service" on the U.S. Munitions List may be reviewed by the Department of Defense.

William Lowell, Director of the Office of Defense Trade Controls at State, describes the process as follows: When an application arrives at the State Department, it is assigned to a licensing officer[125] who reviews relevant information and then recommends approval or denial of the application, or approval with conditions.[126] The licensing officer's decision typically is accepted, unless another entity recommends denial.[127]

If the State Department licensing officer needs additional information to understand the technology covered by an application, the licensing officer sends the application to the Defense Department.[128] There, the Defense Technology Security Administration determines who else in the Defense Department should review the application, and provides the State Department with a coordinated Defense Department review.

In 1997, the State Department referred about 30 percent of its cases to the Defense Department.[129] The Commerce Department is not involved in the review of U.S. Munitions List license applications.[130]

There is no memorandum of understanding between the State and Defense Departments on this subject. Lowell says none is needed, given the good relations between the departments. The State Department refers applications to the Defense Department in hardcopy form, as Defense is not connected electronically to State for this purpose. Nevertheless, the Defense Department sends its comments and final position on applications to State via a Defense database.

According to Lowell, the Defense Department has a veto in the State Munitions List system on exports, based on national security grounds. The State Department also has a veto on exports, based on foreign policy grounds. State and Defense tend to defer to one another, and appeals are extremely rare.[131]

By contrast, in the Commerce Department licensing process, none of the five participating departments and agencies — Commerce, Defense, State, Energy, and the Arms Control and Disarmament Agency — has a veto over license applications.[132] In all cases except at Commerce's Operating Committee level (where the decision of the Commerce Department Chair prevails), a majority vote determines the outcome at the Advisory Committee for Export Policy and the Export Administration Review Board levels. The decision of the Operating Committee Chair, and the result of a vote by the ACEP or the Export Administration Review Board, can be appealed by any of the five participating agencies.

There is no provision in the International Traffic in Arms Regulations to consider either commercial factors or the foreign availability of a U.S. Munitions List item, according to Lowell.[133] This is because independent of whether foreigners can sell an item, the U.S. Government may wish to preserve a technology lead, or would not want certain countries to obtain the military technology from the United States. According to the regulations:

> *The intended use of the article or service after its export (i.e., for a military or civilian purpose) is not relevant in determining whether the article or service is subject to the [International Traffic in Arms Regulations] controls. . .* [134]

For dual-use items covered by the Export Administration Regulations, the foreign availability of a commodity can be the basis for removing export controls on that commodity. It cannot, however, override national security.[135]

Commodity Jurisdiction Process

The commodity jurisdiction process involves a State Department decision as to whether and where a commodity belongs on the Munitions List. Before making its determination that an item is covered by the Munitions List, the State Department may consult the Defense Department, the Commerce Department, other U.S. Government agencies, and industry where appropriate. The determination includes an assessment of whether an article or service has predominantly civil or military applications.[136]

The State Department is required to submit a report to Congress at least 30 days before any item is removed from the U.S. Munitions List by the commodity jurisdiction process. An exporter can invoke the State Department's commodity jurisdiction procedure for either of the following reasons:

- **If doubt exists as to whether an article or service is covered by the U.S. Munitions List or the Commerce Control List**
- **To consider a redesignation of an article or service that is covered by the Munitions List**

However, a commodity jurisdiction decision cannot be used as the sole basis to justify an export, according to William Lowell, Director of the Office of Defense Trade Controls at the Department of State.[137]

Lowell says that the administration of the Munitions List via the commodity jurisdiction process started informally in the 1960s or 1970s.[138] Today, there are several hundred commodity jurisdiction cases per year. In the spring of 1996, the National Security Council disseminated new procedures on commodity jurisdiction and commodity classification approved by President Clinton. The new procedures require State to refer all commodity jurisdiction cases to Defense and Commerce, and include an escalation process. Under this process, a State Department decision can be appealed to the assistant secretary level, then to the under secretary level, and then to the President.[139] Since the new procedure was announced in early 1996, two cases have been appealed to the White House, according to Lowell and Rose Biancaniello, Deputy Director for Licensing at the Office of Trade Controls.[140]

Lowell says that although State sometimes sees a commodity classification case from the Commerce Department, referral from Commerce to State does not occur systematically. Lowell says that it has always been State's view that there should be more interagency coordination on Commerce's commodity classification cases, and that State's commodity jurisdictions cannot be determined by any agency other than State.[141]

Registration of Exporters

A fundamental difference between the State Department and Commerce Department export control systems, according to the State Department's Lowell, is that exporters of munitions are required by law to register with the State Department in order to apply for a license.

The names of the registrants are vetted with the law enforcement community, and maintained in a database of about 10,000 names. The database also contains registered munitions manufacturers who are assigned a State Department identification code.[142]

Congressional Oversight and Required Reports

Lowell notes that another difference between Commerce Department and State Department export licensing systems is the greater level of congressional oversight of U.S. Munitions List exports compared to Commerce Control List exports.

For example, the State Department is required by the Arms Export Control Act to provide Congress with quarterly reports of U.S. Munitions List exports by country. The foreign affairs committees respond to these reports with many questions.[143]

Moreover, exports of "major defense equipment" — equipment costing over $200 million or involving over $50 million in research and development — must be reported to Congress.[144] Exports of such equipment to the PRC are subject to a 30-day waiting period.

The State Department must also report to Congress regarding political fees, contributions, and commissions paid by U.S. companies overseas. It must also provide Congress with an annual report, pursuant to the Foreign Assistance Act, showing the total dollar value of exports and commodities it licenses by country per year.

The State Department processes over 150 sales of major defense equipment per year, according to Lowell. The State Department must clear these cases with Congress before it may allow the export.[145] In 1997, Congress was sent approximately 140 cases, about 40 percent of the dollar value of all the U.S. Munitions List cases. These received considerable scrutiny and were reviewed widely, with some going to the congressional armed services committees.

The State Department is not legally required to explain any licensing decision to the applicant, according to Office of Defense Trade Controls officials. However, if the decision can be explained in an unclassified way, State may explain the decision to the applicant. A company can ask for a case to be reviewed, but most often this occurs by the company calling its Representative in Congress, like any other constituent. If the case involves a denial because it exceeds the level of sophistication that may be sent to a particular country, the State Department can inform the company, which sometimes can reconfigure the item to be acceptable for export.[146]

Foreign-Origin Items with U.S. Content

U.S. Munitions List items do not lose their controlled identity when incorporated into foreign systems, according to Lowell.[147]

State has nothing like Commerce's *de minimis* rule that determines whether U.S. control of foreign-origin items is appropriate based on the percentage of U.S. content. Rather, the Department of State controls technology using a "look-through" policy: if another country wants to sell a controlled "defense article" (for example, an aircraft) with U.S. parts, it will need U.S. approval.

This requirement was not stated in the original Arms Export Control Act, but a 1996 amendment to section 3 of the Act — authorizing re-transfers between NATO partners without advance U.S. consent — indicates that the general rule is to require prior U.S. approval.

Carol Schwab of the State Department Legal Adviser's office affirms State's legal position that there is no basis in the Arms Export Control Act for a country to terminate U.S. controls by re-transferring equipment containing U.S.-origin components to a third party.[148]

Enforcement

Penalties for Violation of the Arms Export Control Act and ITAR

The Arms Export Control Act provides criminal penalties for willful violations, including one or both of the following:

- **Fines up to $1 million**
- **Imprisonment for not more than ten years**

Civil fines under the International Traffic in Arms Regulations are the same as those provided under the 1979 Act and the Export Administration Regulations, except that the maximum civil penalty imposed on the export of "defense articles" and "defense services" is $500,000.[149]

Administrative sanctions under the International Traffic in Arms Regulations include:

- **Debarment from participating directly or indirectly in the export of defense articles**
- **Interim suspension**
- **Seizure or forfeiture of illegally exported articles**

- **Seizure of any vessel, vehicle, or aircraft involved in illegal exports**[150]

Voluntary Disclosures

The International Traffic in Arms Regulations contain provisions for exporters to self-disclose their violations. Voluntary self-disclosure may be considered as a mitigating factor in determining the appropriate administrative penalties. However, the weight to be given to a self-disclosure is entirely within the discretion of the State Department. Self-disclosure does not prevent the State Department from referring transactions to the Department of Justice for criminal prosecution.[151]

BLUE LANTERN Checks

The People's Republic of China does not allow the conduct of BLUE LANTERN checks, the State Department's equivalent of Commerce's pre-license checks and post-shipment verification.

Lowell says that the State Department is not concerned for two reasons:

- **First, most items that State has approved for export to the PRC are commercial communications satellites for launch in the PRC**

- **Second, State licenses the export of U.S. munitions directly to the military of other countries,** and does not have the same requirement as Commerce to check on end users and end uses in order to avoid diversions from civil to military applications[152]

Lowell says that only a small number of State Department licenses are reviewed for civilian end users, such as private security forces. On the other hand, Lowell says, the State Department does use BLUE LANTERN checks to detect diversions of its approved exports.

The State Department also uses BLUE LANTERN end-use checks to reduce brokering and to check on dealers on its Watch List. To obtain a BLUE LANTERN check, the State Department cables the Embassy to check out the end user, and the Embassy cables back with details on the check.[153]

Export Control Policy Toward the PRC

Background

From 1949 to 1971, exports from the United States to the PRC were subject to restrictive export controls. The export control policy was liberalized in 1972, when the Coordinating Committee on Multilateral Export Controls (COCOM) agreed to change the licensing status of the PRC to allow it to be treated the same as the Soviet Union. Subsequently, beginning in 1981, the PRC was given access to higher levels of technology than the Soviet Union.[154]

In December 1985, COCOM adopted what was called a "green line" policy toward the People's Republic of China. That policy gave preferential licensing treatment for the export to the PRC of 27 categories of controlled items as compared with other COCOM-proscribed countries. Further liberalizations in the "green line" licensing policy toward the PRC by COCOM continued until early 1989.

In response to the repressive actions taken by the PRC in Tiananmen Square on June 4, 1989, COCOM decided in October 1989 to cancel plans for additional liberalization of export controls toward the PRC. However, COCOM did not make any changes to the PRC "green line" policy that was in effect at the time.

Following Tiananmen Square, the Bush Administration imposed a policy of denial regarding applications for exports to military and police entities in the PRC. In addition, the Bush Administration decided not to support further liberalization of the "green line" policy toward the PRC by COCOM.[155]

A COCOM meeting in June 1990 eliminated or significantly reduced the differences between items that could be exported to the PRC under the "green line" policy and the items that could be exported to other proscribed destinations. The PRC benefited from the decontrols adopted by COCOM for all proscribed destinations subsequent to that meeting. COCOM did not, however, adopt any additional favorable treatment specifically for the export of items to the PRC.[156]

Launches of Satellites on PRC Rockets

In September 1988, President Reagan approved a plan to permit the export of U.S. commercial communications satellites to the PRC for launch on PRC rockets. In order for such export licenses to be approved, however, the PRC was required to meet three U.S. conditions:

- **The United States and the PRC must agree on specific technology transfer safeguards**
- **The PRC must agree to take steps that would protect the U.S. launch industry from future unfair PRC pricing and trade practices**
- **An agreement had to be negotiated establishing PRC responsibility for liability in case a commercial launch caused third-party damage**

Regarding the first condition, a Memorandum of Agreement on Satellite Technology Safeguards was signed in December 1988 between the United States and the PRC.[157] The purpose of this agreement was to preclude the unauthorized transfer to the PRC of sensitive U.S. satellite technology. The agreement specified the security procedures to be followed for the proposed launch of two Aussat satellites and one Asiasat satellite, all three of which were manufactured by Hughes Aircraft Company. The agreement also addressed the disclosure of authorized technical data, and restrictions on the transfer of unauthorized technical data and assistance.

Regarding the second condition, the December 1988 Memorandum of Agreement provided that the PRC was not to launch more than nine communications satellites for international customers during the six-year period ending on December 31, 1994.[158] The agreement required the PRC to support the application of market principles to international competition among providers of commercial launch services, including the avoidance of below-cost pricing, government inducements, and unfair trade practices.

Regarding the third condition, PRC liability for satellite launches,[159] the December 1988 agreement provided, subject to conditions, that the PRC was to assume the responsibility for, and was required to compensate the United States for, any and all amounts for which the U.S. Government might become liable under the Convention on International Liability for Damage Caused by Space Objects.

A second Memorandum of Agreement on Satellite Technology Safeguards between the United States and the PRC was signed in February 1993.[160] This agreement specified the security procedures to be followed for the launch of "U.S.-manufactured satellites" in the PRC, and was not limited, as was the December 1988 agreement, to specific satellites.

When the 1988 Memorandum of Agreement on PRC commercial launch services expired on December 31, 1994, a third Memorandum of Agreement was signed in January 1995.[161] This new agreement indicated that the PRC was not to launch more than 11 principal payloads to geosynchronous earth orbit or geosynchronous transfer orbit for international customers during the seven-year period ending on December 31,

Associated Press

Prior to the June 4, 1989 massacre at Tiananmen Square in Beijing, the United States and other COCOM members differentiated between the People's Republic of China and the Soviet Union — and gave the PRC access to higher levels of technology.

2001. This January 1995 agreement was amended in October 1997 to include an annex regarding the pricing of commercial launch services to low earth orbit.[162]

Paul Freedenberg, a former Assistant Secretary for Trade Administration and Under Secretary for Export Administration at Commerce in the Reagan Administration, has commented on the 1988 policy decision to use PRC rockets for U.S. commercial communications satellites:

> *No one in the Reagan administration thought of this new policy as a long term policy, let alone the beginning of a decade-long dependence on Chinese rockets. Unfortunately, that's precisely what it's become.*[163]

Satellite Launches in the PRC Following Tiananmen Square

In addition to the policy adopted by the Bush Administration after Tiananmen Square — to deny export license applications to military and police entities in the PRC, and not to seek further COCOM liberalization in export controls toward the PRC — Congress passed PRC sanctions legislation in the fall of 1989.

In the Fiscal Year 1990 Appropriations Act for the Departments of Commerce, Justice, and State, the Judiciary, and Related Agencies (P.L. 101-162, November 21, 1989), Congress prohibited the reinstatement or approval of any export license applications for the launch of U.S.-built satellites on PRC-built rockets in the PRC. This prohibition can be waived in either of two cases:

- **If the President makes a favorable report to Congress on the PRC's political and human rights reforms**
- **If the President determines that issuance of the license is in the national interest**[164]

Pursuant to this provision, President Bush submitted a "national interest" determination to Congress on December 19, 1989, regarding the Aussat-1, Aussat-2, and Asiasat commercial communications satellites.

In early 1990, Congress passed the Foreign Relations Authorization Act for Fiscal Years 1990 and 1991 that included additional sanctions provisions regarding the Tiananmen Square crackdown.[165] Among other things, the Act suspended the issuance of licenses by the Department of Commerce or the Department of State for export to the PRC of:

- **Any defense article on the U.S. Munitions List**
- **Any crime control and detection instruments and equipment**
- **Any satellite of United States origin that is intended for launch from a rocket owned by the PRC**

The Act also provided the President with the authority to terminate the suspension of export licenses for U.S.-origin satellites by making a "national interest" determination and transmitting it to Congress.

The first "national interest" determination under the Foreign Relations Authorization Act was made by President Bush on April 30, 1991. This "national interest" determination, or "waiver," covered the Freja satellite that was to be built for Sweden. It also included a reissuance of the waiver for the Hughes-built Aussat satellites that had been identified in the December 19, 1989 "national interest" determination.

Between 1989, when Congress imposed the requirement for a Presidential "national interest" determination, and the beginning of 1998, 12 "national interest" waivers were granted for launches of commercial communications satellites on PRC rockets. President Bush made three of these "national interest" determinations, on December 19, 1989, April 30, 1991, and September 11, 1992. President Clinton made nine of these "national interest" determinations: July 2, 1993, July 13, 1994, February 6, 1996 (three determinations), June 23, 1996, July 9, 1996, November 19, 1996, and November 23, 1996.[166]

The most recent "national interest" determination regarding the launch of a U.S.-manufactured commercial communications satellite on a PRC rocket was made by President Clinton on February 18, 1998.[167] This waiver applied to the Chinasat-8 satellite manufactured by Space Systems/Loral (Loral).

The Chinasat-8 satellite waiver became controversial after the *New York Times* reported on April 13, 1998, that President Clinton had approved the "national interest" determination, or waiver, despite an ongoing Department of Justice criminal investigation of Loral's alleged earlier unauthorized transfer of missile guidance technology to the PRC.

The *Times* also reported that the Chairman of Loral Space & Communications Ltd., Bernard L. Schwartz, was the largest individual donor to the Democratic Party in 1997.[168]

On May 22, 1998, the White House publicly released a number of documents regarding the Chinasat-8 waiver. One of the released documents, a decision memorandum for the President, discussed the pending criminal investigation and concluded:

> *We believe that the advantages of this project outweigh the risk, and that we can effectively rebut criticism of the waiver. . . .*
>
> *The project is in the national interest because the development of China's civil communications infrastructure will promote access by Chinese citizens in remote areas to people and ideas in democratic societies. . . .*
>
> *The current project also will help the competitiveness of U.S. satellite exporters in a most important satellite market.*[169]

This decision memorandum for the President was accompanied by a transmittal memorandum, dated February 18, 1998, from Phil Caplan (Executive Clerk, Office of the White House) which stated:

> *Chuck Ruff, the cousel to the President, notes that there have been* ***extensive*** *discussions with Justice on this matter.*
>
> *The Department [of Justice] realizes the potential adverse impact on a potential criminal prosecution but has chosen not to oppose the waiver.*

Therefore, in balancing national security and criminal justice interests, Chuck agrees that the balance, under these special circumstances, is properly struck by granting the waiver.[170] [Emphasis added]

Robert S. Litt, Principal Associate Deputy Attorney General in the Department of Justice, recalls he had two conversations with Charles F. C. Ruff, the Counsel to the President, on this matter. Litt also indicates that there were one or more conversations between Mark M. Richard, Deputy Assistant Attorney General in the Criminal Division, and James E. Baker, the Special Assistant to the President and Legal Adviser to the National Security Council. Litt does not characterize these conversations as "extensive."

Regarding whether the Justice Department had chosen not to oppose the waiver, Litt says:

Certainly the Department was put on notice that there was a waiver application, and in that sense, we had an opportunity to weigh in.

On the other hand, as I said, I didn't believe that we were being asked for our views on whether or not the waiver should be granted as a matter of policy.[171]

The transmittal memorandum from Caplan to the President also stated:

Commerce must issue a second license within 90 days of this waiver; if the Justice Department's evidence warrants, Commerce could withhold this license and block the project.[172]

Litt does not recall whether Justice was contacted by the Commerce Department prior to the approval of the Chinasat-8 license application by Commerce on March 23, 1998.[173]

A January 1998 draft of a National Security Council memorandum for the President regarding the request for a "national interest" waiver for the Loral Chinasat-8 communications satellite project included a reference to the ongoing review of the

PRC's transfers to Iran of C-802 anti-ship cruise missiles.[174] These transfers by the PRC were included in the list of "Essential Factors for the President to Consider in Deciding Whether to Waive Restrictions on U.S.-Origin Exports to China for the Chinasat-8 Satellite Program" that was attached as Tab A to the State Department's memorandum to the NSC regarding the Chinasat-8 waiver.[175]

The reference to the transfers was deleted from the memorandum that ultimately was sent to the President.[176]

Missile Proliferation Sanctions on the PRC

The National Defense Authorization Act for Fiscal Year 1991 requires mandatory U.S. sanctions against foreign persons who export an item on the Missile Technology Control Regime (MTCR) Annex to a country that is not an MTCR member country.[177]

The sanctions are to be applied even though the Annex item is not subject to U.S. export controls.

If the exported items are MTCR Category I items (that is, missile systems and key subsystems), all export licenses are required to be denied for two years. If the exported items are MTCR Category II items (dual-use items), all export licenses for controlled missile technology items are required to be denied for two years.[178]

The State Department Bureau of Political-Military Affairs announced the imposition of missile proliferation sanctions on entities in the PRC and Pakistan in May 1991, because of PRC transfers to Pakistan of technology related to the M-11 short-range ballistic missile.[179] These sanctions denied export licenses for two years for:

- **High-speed computers**
- **Commercial communications satellites for launch by the PRC**
- **Missile technology or equipment**

The sanctions were effective on June 25, 1991, and applied to the following foreign entities:

- **China Great Wall Industry Corporation**
- **China Precision Machinery Import-Export Corporation**
- **The Space and Upper Atmosphere Research Commission of Pakistan**[180]

The sanctions also denied U.S. Government contracts relating to such items.[181]

These May 1991 sanctions were lifted by President Bush on March 23, 1992, after the PRC agreed to adhere to the initial MTCR 1987 Guidelines and Annex.[182] But MTCR Category II (dual use) sanctions were again imposed on entities in the PRC and Pakistan on August 24, 1993, as a result of the PRC's sale of M-11 missile-related equipment to Pakistan.[183]

The August 1993 missile proliferation sanctions were imposed on the PRC Ministry of Aerospace Industry, including China Precision Machinery Import-Export Corporation (CPMIEC), and the Pakistani Ministry of Defense.[184] The sanctions also applied to the divisions, subunits, and any successor organizations to these entities, including:

- **China National Space Administration**
- **China Aerospace Corporation**
- **Aviation Industries of China**
- **China Precision Machinery Import-Export Corporation**
- **China Great Wall Industries Corporation or Group**
- **Chinese Academy of Space Technology**
- **Beijing Wan Jun Industry Corporation**
- **China Haiying Company**
- **Shanghai Astronautics Industry Bureau**
- **China Chang Feng Group**[185]

The August 1993 sanctions affected seven planned launches of U.S. commercial communications satellites in the PRC.

On November 1, 1994, President Clinton lifted the sanctions after the PRC issued a statement agreeing not to export ground-to-ground missiles inherently capable of delivering at least a 500-kilogram payload with a range of at least 300 kilometers.[186]

Authority to impose missile proliferation sanctions pursuant to the National Defense Authorization Act for Fiscal Year 1991 has been delegated by the President to the Secretary of State. There have been reports of additional possible violations of the missile technology control provisions of this Act by the PRC.[187] No additional sanctions, however, have been imposed as a result.

U.S. Munitions List Changes Regarding Satellites

COCOM used three lists to control the export of items to proscribed destinations: the International Munitions List, the Industrial List, and the International Atomic Energy List.[188] "Dual-use" items were identified on the Industrial List, if not included in another COCOM list. Except for the United States, most COCOM countries conformed their national lists to correspond to the COCOM International Munitions List and the Industrial List.[189]

In the United States, the State Department's Munitions List contained items listed in COCOM's International Munitions List, and a few items listed in COCOM's Industrial List. The Commerce Control List, meanwhile, included most but not all of the items on COCOM's Industrial List.

Relaxation of Satellite Export Rules

When President Bush pocket-vetoed the Omnibus Export Amendments Act of 1990 (H.R. 4653), which contained amendments to the 1979 Act, he issued a Memorandum of Disapproval that directed:

> *By June 1, 1991, the United States will remove from the U.S. munitions list all items contained on the COCOM dual-use list [that is, the COCOM Industrial List] unless significant U.S. national security interests would be jeopardized.*[190]

At the time, commercial communications satellites were on the COCOM "dual-use" Industrial List, not the COCOM International Munitions List. But in the United States, they were included on the State Munitions List rather than on the Commerce Control List. In accordance with the directive in the Memorandum of Disapproval, therefore, the State Department formed an Interagency Space Technical Working Group in August 1991 to evaluate whether jurisdiction over the export of such satellites should be removed from the U.S. Munitions List, and placed instead on the Commerce Control List.

On October 23, 1992, the Departments of State and Commerce issued regulations transferring only certain commercial communications satellites from the State Munitions List to the Commerce Control List.[191] The regulations provided that satellite parts, components, accessories, attachments, and associated equipment, including ground support equipment, would remain on the State Department Munitions List. These items could, however, be included on a Commerce Department export license application if the items were needed for a specific launch of a commercial communications satellite under Commerce Department jurisdiction.

All detailed design, development, manufacturing, and production technical data for satellites continued to be controlled under the State Department Munitions List. Technical data, including marketing data, necessary to launch, operate, and maintain satellites and associated ground equipment for satellites was to be controlled under the Commerce Control List by the Department of Commerce.

The October 1992 regulatory changes did not transfer all commercial communications satellites to the jurisdiction of the Commerce Department. Commercial communications satellites that had any of the following nine characteristics would continue to be licensed by the State Department:

- **Anti-jam capability**
- **Antennas with certain characteristics**
- **Intersatellite data relay links**

- **Space-borne baseband processing equipment**
- **Cryptographic items controlled under the U.S. Munitions List**
- **Radiation-hardened devices**
- **Certain on-orbit propulsion systems**
- **Certain attitude control and determination systems**
- **Permanent orbit transfer engines (that is, kick motors)**[192]

The Trade Promotion Coordinating Committee Recommends Moving Satellites to Commerce Department Jurisdiction

The Export Enhancement Act of 1992 required the President to establish the Trade Promotion Coordinating Committee:

> *(1) to provide a unifying framework to coordinate the export promotion and export financing activities of the United States Government; and*
>
> *(2) to develop a governmentwide strategic plan for carrying out the Federal **export promotion** and **export financing** programs.*[193] [Emphasis added]

The 1992 Act stated that the Trade Promotion Coordinating Committee would include representatives from the Departments of Commerce, State, Treasury, Agriculture, Energy, and Transportation, the Office of the United States Trade Representative, the Small Business Administration, the Agency for International Development, the Trade and Development Program, the Overseas Private Investment Corporation, and the Export-Import Bank of the United States.

The Secretary of Commerce chairs the Trade Promotion Coordinating Committee.

One of the duties of the Committee was to develop and implement a strategic plan for U.S. trade promotion efforts. The 1992 Act indicated that the strategic plan should:

- **Establish a set of priorities for Federal activities in support of U.S. exports**
- **Review current programs to promote U.S. exports**
- **Identify areas of overlap and duplication**
- **Propose an annual unified Federal trade promotion budget**
- **Review efforts by the states to promote U.S. exports**

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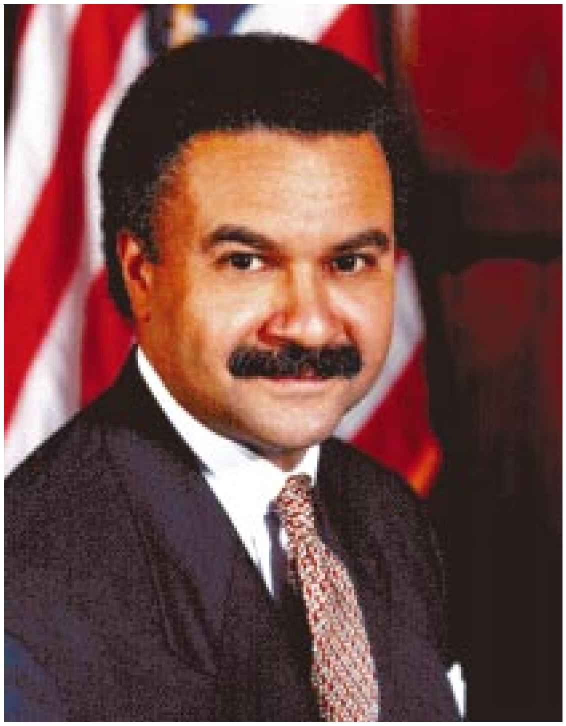

Secretary of Commerce Ronald H. Brown issued the first Trade Promotion Coordinating Committee report in the fall of 1993. The report cited "numerous consultations with exporters," but did not indicate whether the national security implications of the proposed liberalization of export controls had been analyzed.

The 1992 Act stated that the Trade Promotion Coordinating Committee was to "coordinate export promotion and export financing activities of the U.S. Government." The Act did not state expressly that the Committee was a mechanism to conduct a review of the Commerce Department's export control program under the Export Administration Act, or a review of the State Department's export control program under the Arms Export Control Act.

However, under the direction of Secretary of Commerce Ronald H. Brown, the Trade Promotion Coordinating Committee seized the opportunity to review the nation's export controls. The controls were viewed in terms of "regulatory obstacles to exports" in developing the congressionally-mandated strategic plan report.[194] On September 29, 1993, Commerce Secretary Brown issued the first Trade Promotion Coordinating Committee report, "Toward a National Export Strategy — Report to the United States Congress."

This report indicated that there had been "numerous consultations with exporters" in preparation of the section on export controls. But it did not indicate whether the Department of Defense, or the Intelligence Community, analyzed the national security implications of the proposed liberalizations of export controls. Chapter 5 of the report, "Regulatory Obstacles to Exports," quoted the President:

> *[F]or some time the United States has imposed stringent export controls on many of our most competitive exports . . . One reason I ran for President was to tailor export controls to the realities of a post-Cold War world.*
>
> *Let me be clear. We will continue to need strong controls to combat the growing threat of proliferation of weapons of mass destruction and dangerous conventional weapons, as well as to send a strong signal to countries that support international terrorism. But we also need to make long overdue reforms to ensure that we do not unfairly and unnecessarily burden our important commercial interests.*[195]

Chapter 5 of the report described a number of specific actions the Clinton administration was taking to liberalize export controls on computers (see the chapter on *High Performance Computers* for a more detailed discussion of the Select Committee's investigation of these matters) and telecommunications products. In addition, it stated that the administration was taking the following action:

The administration will review immediately those COCOM International Industrial List items that currently are contained on the US Munitions List (e.g., civil developmental aircraft, commercial satellites) in order to expedite moving those items to the Commerce Control List.[196]

An outgrowth of the Trade Promotion Coordinating Committee is the Advocacy Center within Commerce's International Trade Administration. The Advocacy Center is designed as a coordination point to marshal the resources of the U.S. Government agencies in the Trade Promotion Coordinating Committee to assist the sales of U.S.

products and services abroad. The Advocacy Center's web site home page indicates that assistance can include "a visit to a key foreign official by a high-ranking U.S. government official" and "direct support by U.S. officials (including Commerce and State Department officers) stationed at U.S. embassies." Businesses interested in being considered for acceptance as a "client" of the Advocacy Center are requested to submit a "background data form" and a "bribery agreement form" to Commerce's Advocacy Center.[197]

The 1996 Transfer of Jurisdiction Over Commercial Satellites To Commerce

In January 1995, the Department of Commerce began to work with other departments and agencies to transfer the rest of the commercial communications satellites, including those which possessed any of the nine militarily sensitive characteristics, from the State Department's Munitions List to the Commerce Department's Control List.

This effort included a joint industry meeting in March 1995 with Commerce Department representatives hosted by C. Michael Armstrong, Chairman and Chief Executive Officer of GM Hughes Electronics.[198] Also, Armstrong submitted in March 1995 a report, "White Paper on Commercial Communications Satellites: Issues and Answers," to Anthony Lake, Assistant to the President for National Security Affairs.[199]

Associated Press

In 1995 the State Department, then headed by Warren Christopher, objected to transferring control of commercial communications satellite licenses from the Department of State to the Department of Commerce.

An interagency working group chaired by the State Department started in April 1995 to review and clarify the commercial satellite jurisdiction issue.[200]

During 1995, the Clinton administration was lobbied by companies interested in transferring the responsibility for commercial satellite export licensing from the State Department to the Commerce Department. For example, Armstrong sent a letter to Samuel R. Berger, Assistant to the President for National Security Affairs, in September 1995, following a meeting with him on September 20, that stated:

> *Efforts by the State Department to keep commercial communications satellites on the State Department Munitions List should not be allowed to succeed.*[201]

Also, Armstrong, along with Bernard L. Schwartz, Chairman of Loral, and Daniel M. Tellep, Chairman and Chief Executive Officer of Lockheed Martin Corporation, sent a letter to the President on October 6, 1995, that stated:

> *Continuing to license export of these technologies under the more stringent and cumbersome Munitions List places American companies at a distinct disadvantage in global markets.*[202]

After a series of meetings of the State-chaired interagency working group formed in April 1995, there was no interagency agreement on the commercial satellite jurisdiction issue. In particular, Secretary of State Warren Christopher and the State Department objected to the transfer to Commerce.

At this point, the National Security Council "took charge of the process" and conducted "high-level, informal discussions" that resulted in the March 1996 decision by President Clinton to include all commercial communications satellites in the Commerce Control List, with interagency appeal procedures that appear to have satisfied Secretary Christopher.[203]

Commercial communications satellites having the nine identifying characteristics that remained under the jurisdiction of State's U.S. Munitions List were transferred formally to the Commerce Control List in October 1996. At the same time, the jurisdiction for jet engine "hot section" technology for the development, production, or overhaul of commercial aircraft engines was moved from the U.S. Munitions List to the Commerce Control List.

Commerce's *Federal Register* notice regarding this change imposed foreign policy controls on all commercial communications satellites and jet engine hot section technology under the Commerce Control List. The *Federal Register* notice also clarified that technical data provided to the launch provider (form, fit, function, mass, electrical, mechanical, dynamic/environmental, telemetry, safety, facility, launch pad access, and launch parameters) for commercial communications satellites would be under the Commerce Control List.

In addition, the October 1996 notice clarified that all other technical data, defense services, and technical assistance for satellites and rockets — including compatibility, integration, or processing data — would continue to be controlled under the State Department's Munitions List.[204]

Other items that were moved from the U.S. Munitions List to the Commerce Control List included:

- **Commercial products with image intensifier tubes (1994)**
- **Commercial encryption items (December 1996)**
- **Satellite fuels (April 1998)**[205]

The 1999 Return of Jurisdiction Over Commercial Satellites to the State Department

The Strom Thurmond National Defense Authorization Act for Fiscal Year 1999 directed that all satellites and related items that are included in the Commerce Control List should be transferred on March 15, 1999 back to the State Department's Munitions List and controlled under the Arms Export Control Act.[206]

The Act also required that all export licenses for satellites and related items have a Technology Transfer Control Plan that is approved by the Secretary of Defense and an Encryption Technology Transfer Control Plan that is approved by the Director of the National Security Agency.[207]

The Act included a requirement for a detailed report to Congress that must accompany any Presidential "national interest" determination pursuant to the Foreign Relations Authorization Act for Fiscal Years 1990 and 1991 to waive the Tiananmen Square sanctions and permit the export of satellites for launch in the PRC.[208] The detailed justification must include:

- **Detailed description of all militarily sensitive characteristics integrated within, or associated with, the satellite**
- **Estimated number of U.S. contractor personnel required in the PRC to carry out the satellite launch**
- **Detailed description of the U.S. Government's plan to monitor the satellite launch, including the estimated number of required U.S. personnel**
- **Estimated cost to the Department of Defense for monitoring the satellite launch, and the amount to be reimbursed to the Defense Department**
- **Reasons why the satellite launch in the PRC is in the national security interest of the United States**
- **Impact of the proposed export on employment in the United States on a state-by-state basis**
- **Impact of the proposed export on reducing the current U.S. trade deficit with the PRC**
- **Impact of the proposed export on the PRC transition from a nonmarket to market economy**
- **Impact of the proposed export on opening new markets in the PRC to U.S. products**
- **Impact of the proposed export on reducing significant PRC trade barriers to U.S. export and foreign direct investment**[209]

In early December 1998, *Space News* reported that the White House and the Commerce Department, in coordination with the U.S. aerospace industry, were developing an executive order that would give Commerce the right to appeal State licensing decisions on license applications regarding items on the U.S. Munitions List.[210]

At the present time, these applications are not referred to Commerce for review. The proposed executive order reportedly would allow Commerce to review the license applications and to appeal State's decisions on them. As reported, the change would permit Commerce to review State license applications for all items in the U.S. Munitions List, including commercial communications satellites.

High Performance Computers

After Tiananmen Square in June 1989, COCOM did not adopt any further favorable treatment applying specifically to the export of items to the PRC. And as a result of the transfer of ballistic missile technology by the PRC to Pakistan in May 1991, President Bush imposed restrictions on the export to the PRC of computers above a composite theoretical performance of 41 MTOPS (millions of theoretical operations per second) in June 1991.[211]

In May 1992, the United States imposed foreign policy controls on "supercomputers" (defined then as 195 MTOPS and above).[212] This decision was based on a 1991 bilateral agreement with Japan, the other major supercomputer exporting country.[213] Supercomputers are also subject to special safeguard conditions.

President Clinton wrote to a number of industry leaders who attended a White House luncheon in mid-September 1993 regarding the issue of export controls. In his letter to Edward McCracken, Chief Executive Officer, Silicon Graphics, the President stated:

> *As a part of [the Trade Promotion Coordinating Committee] process, the National Security Council has led an effort to develop specific export controls reforms . . .*
>
> *I am optimistic that the steps we take will help liberalize controls on many of our most competitive exports, while protecting important national security concerns . . .*

I am also engaged in seeking major reforms to COCOM, which should lead to significant liberalization of controls on computers, telecommunications and machine tools . . .[214]

The first Trade Promotion Coordinating Committee report, "Toward a National Export Strategy," which was issued by Secretary of Commerce Brown in September 1993, indicated that the Clinton Administration was planning to make a number of proposals to COCOM, including:

- **Proposing an increase in the level of computers** that would not require an export license to most destinations from 12.5 MTOPS to 500 MTOPS
- **Proposing an increase in the definition of a supercomputer** from 195 MTOPS to 2,000 MTOPS and an update to the safeguard requirements for supercomputers[215]

Discussions were held within COCOM during December 1993 and January 1994 regarding computers.

The COCOM member countries reached an agreement in January 1994 to raise the level of computers that would not require an export license to most destinations, including the PRC, from 12.5 MTOPS to 260 MTOPS. On February 24, 1994, Commerce published in the *Federal Register* an amendment to the Export Administration Regulations that reflected this COCOM decision.[216]

The February 1994 *Federal Register* notice also lifted the licensing requirement for computers with a performance level of 500 MTOPS or less that were exported to "free world countries" as listed in the Nuclear Nonproliferation Special Country List.[217] And it raised the supercomputer threshold from 195 MTOPS to 1,500 MTOPS and above.[218] Prior to February 1994, exporters were required to obtain a Commerce Department license to export to most destinations computers with a performance level of 12.5 MTOPS or more.[219]

On March 30, 1994, one day before the demise of COCOM, the Administration announced that it would be taking another step to "balance" the proliferation of dangerous weapons and sensitive technologies with U.S. economic growth: removing the licensing requirement for the export of computers and telecommunications equipment with less than 1,000 MTOPS to civil and nonproliferation end-users in the formerly COCOM-controlled countries (except North Korea), effective April 4, 1994.[220] This included the PRC, the former Soviet Union, and countries in Eastern Europe.[221]

The Clinton administration indicated that this action was consistent with national security requirements, because licenses still would be necessary for the export of "high-end" computers and for the transfer of such items to military end-users.[222]

In October 1995, the President announced that further changes in export controls for high performance computers would be made to "balance" national security and nonproliferation interests with the rapid developments in computer technology. Also, the Clinton administration cited the need for a computer export control policy that would remain effective for 18 to 24 months.

The computer export control changes were based on a study prepared by Seymour Goodman and others with the Center for International Security and Arms Control at Stanford University.[223] The study was performed under a sole-source contract awarded by the Bureau of Export Administration within the Department of Commerce. The cost of the contract was approximately $60,000, which was funded by both Commerce and Defense.[224]

The Department of Defense did not prepare a formal threat assessment related to changes in the export control policy for high performance computers to the People's Republic of China. However, Mitchel B. Wallerstein, then Deputy Assistant Secretary for Counter-Proliferation Policy at the Department of Defense, remembers a conversation with his Joint Staff counterpart:

> *I will say that he had concerns, but he made it clear that on the whole, given the alternatives, that he felt that the risks were not unreasonable.*[225]

The concept underlying the Clinton administration's 1995 decision to liberalize computer export controls based on the level of computer performance that would be available 18 to 24 months in the future is called "forward looking foreign availability" by Reinsch.[226] He explains that this concept was applied to computers "because of the applicability of Moore's law." Moore's law — devised by Gordon Moore, one of the founders of Intel — essentially is that microprocessor capabilities double every 18 months. The concept of "forward looking foreign availability" has not been applied by the Department of Commerce to the liberalization of controls on items other than computers.[227]

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Department of Commerce Under Secretary for Export Administration William Reinsch says the concept underlying the 1995 decision to liberalize computer export controls is known as "forward looking foreign availability." Thus, controls are based on the level of computing performance that it is expected will become available in the next 18 months to two years.

Neither Reinsch nor other Commerce officials were apparently aware of the PRC's possible use of HPCs in nuclear weapons development when the policy decision to liberalize computer export controls was made. Commerce published the changes in computer export controls as amendments to the Export Administration Regulations in the *Federal Register* on January 25, 1996.[228] The *Federal Register* notice stated that, in developing these reforms,

> *the Administration has determined that computers capable of up to 7,000 million theoretical operations per second (MTOPS) will become widely available in open international markets within the next two years [i.e., by January 1998]. The Administration has also determined that computers with performance capabilities at and above 10,000 MTOPS have a significant number of strategic applications.*

The revised Export Administration Regulations identified four Computer Country Groups for export controls on computers:

- **Tier 1 — most industrialized countries.** Exporters may ship computers with any level of performance without a license to these countries. The exporter is required to maintain records and must submit certain information to the Commerce Department if requested regarding shipments of computers with 2,000 MTOPS and above.

- **Tier 2 — countries with mixed proliferation and export control records.** Exporters may ship computers up to 10,000 MTOPS without a license to these countries. The exporter is required to maintain records on computer exports at 2,000 MTOPS and above, and to submit this information to the Commerce Department if requested. Exports of computers over 10,000 MTOPS require a license from the Commerce Department. (*Hong Kong is included in Tier 2.)*

- **Tier 3 — countries posing proliferation, diversion, or other security risks.** Exporters are allowed to ship computers up to 7,000 MTOPS without a license to these countries. The exporter must obtain a license from the Commerce Department to export computers above 2,000 MTOPS to military and proliferation end uses and end users, or to export computers above 7,000 MTOPS for all end uses and end users. Also, exporters must maintain records of exports of computers from 2,000 MTOPS to 7,000 MTOPS. (*The People's Republic of China is included in Tier 3.)*

- **Tier 4 — terrorist countries.** A license is required for exports or re-exports of any computer, regardless of MTOP level, to Cuba, Iran, Iraq, Libya, and North Korea. Exports or re-exports of computers to Syria and Sudan with a performance of 6 MTOPS and above are permitted with a license from the Commerce Department. *(Cuba, Iran, Iraq, Libya, North Korea, Sudan, and Syria are included in Tier 4.)*[229]

The National Defense Authorization Act for Fiscal Year 1998 required that exporters provide advance notification to the Commerce Department for the export or re-export of a high performance computer over 2,000 MTOPS and up to 7,000 MTOPS to end users in Tier 3 countries.[230] The PRC is included in the list of Tier 3 countries. Prior to this Act, the Export Administration Regulations allowed exports of high performance computers up to 7,000 MTOPS to civil end-users in the PRC with no notice to Commerce.

Under the 1998 Act, the Commerce Department is required to notify the Departments of Defense, Energy, and State, and the Arms Control and Disarmament Agency, within 24 hours of receipt of advance notification from an exporter.[231] If within nine days Defense, Energy, State, or ACDA provides specific objections in writing to Commerce, then Commerce is to inform the exporter by the tenth day after receipt of the advance notification that an export license will be required for the proposed export.

The 1998 Act provides that the President can revise the composite theoretical performance threshold level of 2,000 MTOPS regarding export of computers to Tier 3 countries. This would take effect 180 days after the President submits a report, with a justification for the revision, to the appropriate congressional committees.

Finally, the Act requires the Commerce Department to perform post-shipment verifications on all exports of high performance computers over 2,000 MTOPS to Tier 3 countries.

In addition to high performance computer export controls, the Clinton administration has undertaken export licensing liberalization efforts in a number of other categories, including:

- **Semiconductors**
- **Semiconductor manufacturing equipment**
- **Telecommunications equipment**
- **Nuclear-controlled items (e.g., oscilloscopes)**
- **Chemicals**[232]

In January 1994, Commerce's Bureau of Export Administration published the first quarterly edition of "Deregulation in Export Controls," which measured the "progress being made in eliminating dual-use licensing obstacles." [233]

Machine Tools

Under COCOM, export controls on machine tools did not change significantly from the mid-1970s until 1990. In 1990, the COCOM member countries agreed to a U.S. proposal — the "core list" proposal that is discussed above — that resulted in significant reductions in the COCOM Industrial List, including those relating to machine tools.

This relaxation in export controls permitted about 75 percent of advanced machine tools produced in the United States to be exported without a license. Prior to the 1990 COCOM changes, only about 10 percent of these did not require a license.[234]

For the most part, the 1990 export control changes pertained to the degree of positioning accuracy of the machine tool as measured in microns (that is, millionths of a meter). In general, the pre-1990 COCOM controls required an export license for machine tools that had a positioning accuracy exceeding 10 microns.[235] Depending on the type of machine tool, the post-1990 COCOM controls — generally continued under the Wassenaar Arrangement — require an export license if the machine tool has a positioning accuracy exceeding 6 microns. [236] Grinding machines are controlled at 4 microns.[237]

Machine tools capable of simultaneous five-axis motion were controlled under COCOM, and remain so under the Wassenaar Arrangement.[238]

Under the Wassenaar Arrangement, certain dual-use commodities, including machine tools, require the unanimous consent of the member states to renew the controls that are currently in effect.

Unless changed or extended again, the current export control criteria for machine tools will remain valid until December 5, 2000.[239]

Treatment of Hong Kong

In 1992, the United States granted preferential licensing treatment to Hong Kong as a result of its designation as a COCOM "cooperating country."[240] The same year, the United States expressed its support for Hong Kong's autonomous status in the United States-Hong Kong Policy Act of 1992.[241]

The 1992 Act called upon the U.S. Government to continue to treat Hong Kong as a separate territory in regard to economic and trade matters. It also provided for Hong Kong's continued access to sensitive U.S. technologies for so long as such technologies are protected.

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On July 1, 1997, legal control of Hong Kong reverted to the People's Republic of China, and troops from the People's Liberation Army entered Hong Kong. U.S. export policy, however, has continued to give Hong Kong the pre-1997 liberal controls on militarily sensitive technologies. As a result, export controls on the PRC were effectively liberalized on July 1, 1997, permitting the transfer of many additional technologies of potential use to the PLA without prior review by the Department of Commerce.

The result of the 1992 Act has been to continue a less restrictive export control policy for Hong Kong than for the rest of the PRC. Many more dual-use items may be exported to Hong Kong without prior Commerce review than may be exported to the PRC without review. Even when prior review is required, Commerce more readily grants export licenses to Hong Kong.

In contrast, more categories of dual-use items require prior review before export to the PRC, and the U.S. Government has refused to export certain items to the PRC that would have been allowed to go to Hong Kong without prior review or approval.[242]

Hong Kong reverted to the PRC in July 1997 under a negotiated arrangement between the PRC and the United Kingdom. Under the terms of a 1984 Joint Declaration, Beijing and London pledged that Hong Kong would become a Special Administrative Region of the PRC with a "high degree of autonomy" for 50 years. The U.S. Government has made clear its intent to change its export control policy towards Hong Kong only if there is evidence that Hong Kong authorities are unable to operate an effective export control system. The U.S. Government has pledged to monitor various indicators of Hong Kong's autonomy in export controls.[243] The Commerce Department has reported to the General Accounting Office that it has established comprehensive benchmarks and gathered baseline information on each benchmark, and that it intends to evaluate this data on a monthly basis.[244]

State Department officials Lowell and Biancaniello say that the current level of diversion activity in Hong Kong is consistent with that which occurred in the period prior to Hong Kong's reversion to PRC sovereignty. However, Biancaniello says that checks are done more to ensure that all pre-reversion policies were still in place.[245]

The more relaxed controls on the export of militarily-sensitive technology to Hong Kong have been allowed to remain in place even though Hong Kong was absorbed by the PRC and PLA garrisons took control of the region on July 1, 1997. U.S. trade officials report that no inspections by the Hong Kong regional government nor by any other government, including the United States, are permitted when PLA vehicles cross the Hong Kong border.

Various U.S. Government analyses have raised concerns about the risk of the diversion of sensitive U.S. technologies not only to the PRC, but to third countries as well through Hong Kong because of the PRC's known use of Hong Kong to obtain sensitive technology.[246] Some controlled dual-use technologies can be exported from the United States to Hong Kong license-free, even though they have military applications that the PRC would find attractive for its military modernization efforts.

The Select Committee has seen indications that a sizeable number of Hong Kong enterprises serve as cover for PRC intelligence services, including the MSS. Therefore, it is likely that over time, these could provide the PRC with a much greater capability to target U.S. interests in Hong Kong.

U.S. Customs officials also concur that transshipment through Hong Kong is a common PRC tactic for the illegal transfer of technology.[247]

John Huang, Classified U.S. Intelligence, and the PRC

In late 1993, the U.S. Department of Commerce hired John Huang as the Principal Deputy Assistant Secretary of Commerce for International Economic Policy.[248]

Prior to starting at the Department of Commerce, Huang had been the Lippo Group's principal executive in the United States. Lippo's principal partner in the PRC is China Resources (Holdings) Co., a PRC-owned corporation based in Hong Kong.[249]

According to Nicholas Eftimiades, a Defense Intelligence Agency analyst writing in his personal capacity, and Thomas R. Hampson, an investigator hired by the Senate Governmental Affairs Committee, China Resources is "an agent of espionage, economic, military, and political."[250]

China Resources is also one of several PRC companies (including China Aerospace Corporation) that share a controlling interest in Asia Pacific Mobile Telecommunications Satellite Co., Ltd (APMT).[251] The PRC-controlled APMT is preparing to use China Great Wall Industry Corporation to launch a constellation of Hughes satellites on PRC rockets.[252] The launches scheduled to date have required

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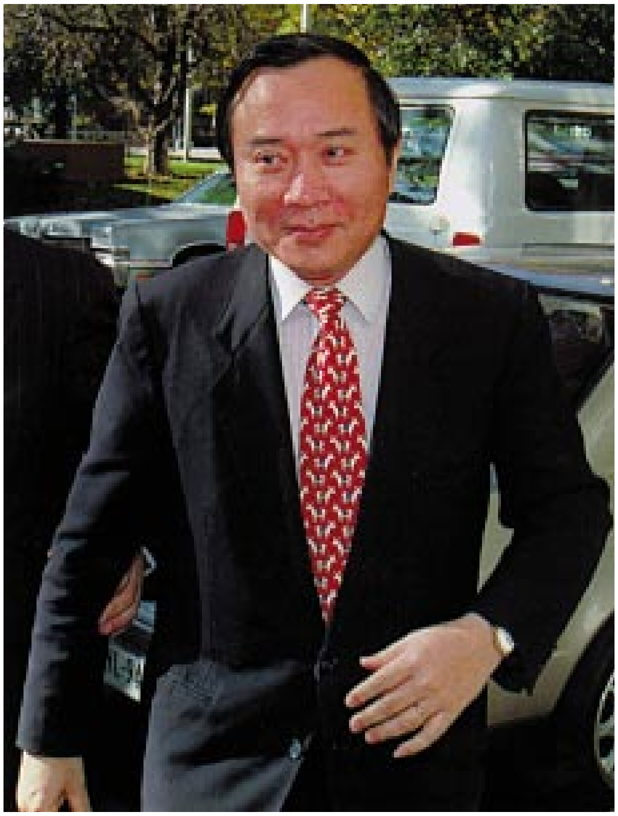


In late 1993, John Huang was appointed to be the Clinton administration's Principal Deputy Assistant Secretary of Commerce for International Economic Policy. He had been the chief U.S. executive for the Lippo Group, a partner of the PRC-owned China Resources Company.

Commerce Department approval and presidential waivers of the Tiananmen Square sanctions.[253]

While at the Department of Commerce, Huang was provided with a wealth of classified material pertaining to the PRC, Taiwan, and other parts of Asia. He had a Top Secret clearance, but declined suggestions by his superiors that he increase that clearance to the Sensitive Compartmented Information (SCI) level (the level held by his predecessor).[254]

Between October 1994 and November 1995, Huang received 37 briefings from a representative of the Office of Intelligence Liaison at the Department of Commerce.[255] While Huang's predecessor was briefed weekly, Huang received approximately 2.5 briefings per month.[256]

The vast majority of Huang's briefings focused on the PRC and Taiwan, including "raw intelligence" that disclosed the sources and methods of collection used by the U.S. intelligence community.[257] The Office of Intelligence Liaison representatives indicated that Huang was not permitted to keep or take notes on raw intelligence reports and did not ask many questions or otherwise aggressively seek to expand the scope of his briefings.[258]

During the briefings, Huang reviewed and commented on raw intelligence reports about the PRC. Huang also signed receipts to retain finished intelligence products. The classified finished intelligence that Huang received during his tenure at Commerce included PRC economic and banking issues, technology transfer, political developments in the PRC, and the Chinese Communist Party leadership. Huang commented on or kept copies of materials on these topics.

Huang was also given access by the Office of Intelligence Liaison to diplomatic cables classified at the Confidential or Secret level.[259] Specifically, 25 to 100 classified cables were set aside for Huang each day.[260]

No record exists as to the substance of the cables that were reviewed by Huang.[261] Huang could have upgraded the level of the cable traffic made available to him to include Top Secret information, but never did so.[262]

Huang also had access to the intelligence reading room at the Commerce Department, as well as to classified materials sent to his supervisor, Charles Meissner,[263] who had a higher level clearance.[264] The three Office of Intelligence Liaison representatives who were interviewed by the Senate Committee on Governmental Affairs indicated that they were not personally aware of any instance in which Huang mishandled or divulged classified information.[265]

Huang maintained contact with representatives of the Lippo Group while he was at the Department of Commerce. During the 18 months that he was at Commerce, Huang called Lippo Bank 232 times, in addition to 29 calls or faxes to Lippo Headquarters in Indonesia. Huang also contacted Lippo consultant Maeley Tom on 61 occasions during the same period. Huang's records show 72 calls to Lippo joint venture partner C. Joseph Giroir.[266]

During his tenure at the Commerce Department, Huang used a visitor's office across the street at the Washington, D.C. branch of Stephens Inc., an Arkansas-based brokerage firm with "significant business ties to the Lippo Group." [267] Stephens employees indicated that these visits were short in duration.[268] Huang used this office "two, three times a week" most weeks, making telephone calls and "regularly" receiving faxes and packages addressed to him.[269]

China Resources (Holdings) Co., a PRC-owned corporation that is the Lippo Group's principal partner in the PRC, has been identified as "an agent of espionage, economic, military, and political.

No one at the Commerce Department, including Huang's secretary, knew of this additional office.[270]

Huang met with PRC Embassy officials in Washington, D.C. on at least nine occasions. Six of these meetings were at the PRC Embassy.[271] When informed of these contacts, Jeffrey Garten, the Department of Commerce Under Secretary for Trade Administration, was "taken aback" to learn that Huang ever dealt with anyone at the PRC Embassy.[272] The purpose of the contacts is unknown.

On December 1, 1998, the Select Committee served Huang with a subpoena through his attorney. On December 3, 1998, Huang's attorney indicated that Huang would only testify before the Select Committee pursuant to a grant of immunity.[273] The Select Committee declined to immunize Huang from prosecution, and Huang refused to appear before the Select Committee, invoking his Fifth Amendment rights.

MANUFACTURING PROCESSES

Machine tool and jet engine technologies are priority acquisition targets for the PRC. This chapter presents two case studies relating to the PRC's priority efforts to obtain such technology — its 1994 purchase of machine tools from McDonnell Douglas, and its efforts in the late 1980s and early 1990s to obtain jet engine technology from Allied Signal's Garrett Engine Division.

McDonnell Douglas Machine Tools

In 1993, China National Aero-Technology Import and Export Corporation (CATIC) agreed to purchase a number of excess machine tools and other equipment from McDonnell Douglas, including 19 machine tools that required individual validated licenses to be exported. CATIC told McDonnell Douglas it was purchasing the machine tools to produce parts for the Trunkliner Program, a 1992 agreement between McDonnell Douglas and CATIC to build 40 MD-82 and MD-90 series commercial aircraft in the PRC.

During the interagency licensing process for the machine tools, the Defense Technology Security Administration sought assessments from the Central Intelligence Agency and from the Defense Intelligence Agency, because of concerns that the PRC could use the McDonnell Douglas five-axis machine tools for unauthorized purposes, particularly to develop quieter submarines. Since the PRC wishes to enhance its power projection capabilities and is making efforts to strengthen its naval forces, the five-axis machine tools could easily be diverted for projects that would achieve that goal.

Initially, CATIC told McDonnell Douglas it planned to sell the machine tools to four factories in the PRC that were involved in the Trunkliner commercial aircraft program. When those efforts reportedly failed, CATIC told McDonnell Douglas it planned to use the machine tools at a machining center to be built in Beijing to produce Trunkliner parts for the four factories.

In May 1994, McDonnell Douglas applied to the Commerce Department for licenses to export the 19 machine tools to the PRC. Even after it became apparent that only 20 of the 40 Trunkliner aircraft would be built in the PRC, the U.S. Government continued to accept McDonnell Douglas's assertion that the machine tools were still required to support the Trunkliner production requirements. Accordingly, Commerce approved the license applications in September 1994 with a number of conditions designed to limit the risk of diversion or misuse.

In April 1995, the U.S. Government learned from McDonnell Douglas that six of the licensed machine tools had been diverted to a factory in Nanchang known to manufacture military aircraft and cruise missile components, as well as commercial products. However, Commerce's Office of Export Enforcement (OEE) did not initiate an investigation of the diversion for six months.

The Commerce Department declined an Office of Export Enforcement Los Angeles Field Office request for a Temporary Denial Order against CATIC. The case remains under investigation by OEE and the U.S. Customs Service. With the approval of the U.S. Government, the machine tools have since been consolidated at a factory in Shanghai.

Garrett Engines

The PRC has obtained U.S. jet engine technology through diversions of engines from commercial end uses, by direct purchase, and through joint ventures. Although the United States has generally sought to restrict the most militarily sensitive jet engine technologies and equipment, the PRC has reportedly acquired such technologies and equipment through surreptitious means.

Prior to 1991, Garrett jet engines had been exported to the PRC under individual validated licenses that included certain conditions to protect U.S. national security. These conditions were intended to impede any attempt by the PRC to advance its capability to develop jet engines for military aircraft and cruise missiles.

The 1991 decision by the Commerce Department to decontrol Garrett jet engines ensured that they could be exported to the PRC without an individual validated license or U.S. Government review. In 1992, the Defense Department learned of negotiations between Allied Signal's Garrett Engine Division and PRC officials for a co-production deal that prompted an interagency review of Commerce's earlier decision. The interagency review raised a number of questions regarding the methodology Commerce had followed in its decision to decontrol the Garrett jet engines.

The PRC continues its efforts to acquire U.S. jet engine production technology. The PRC may have also benefited from the direct exploitation of specially designed U.S. cruise missile engines. According to published reports, the PRC examined a U.S. Tomahawk cruise missile that had been fired at a target in Afghanistan in 1998, but crashed en route in Pakistan.

MANUFACTURING PROCESSES

PRC EFFORTS TO ACQUIRE MACHINE TOOL AND JET ENGINE TECHNOLOGIES

The People's Republic of China's long-term goal is to become a leading power in East Asia and, eventually, one of the world's great powers. To achieve these aims, the PRC will probably enhance its military capabilities to ensure that it will prevail in regional wars and deter any global strategic threat to its security.[1]

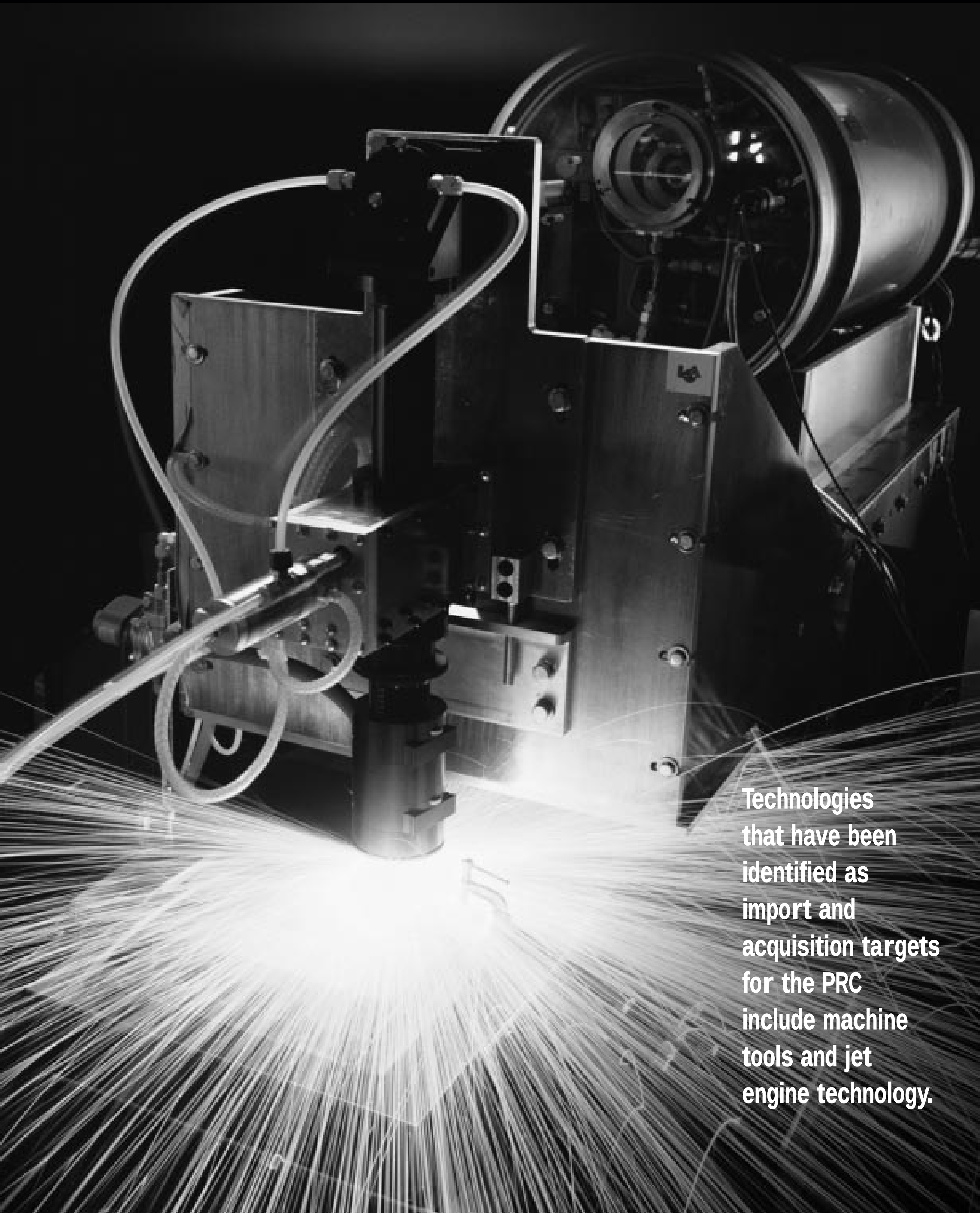
From the PRC's perspective, the 1991 Gulf War was a watershed event in which U.S. weapons and tactics proved decisive. The war provided a window on future warfare as well as a benchmark for the PRC's armed forces.[2]

After the Gulf War, senior PRC military leaders began speaking of the need to fight future, limited wars "under high-tech conditions."[3] Senior PRC political leaders support the military's new agenda.[4]

In a 1996 speech, Li Peng, second-ranking member of the Politburo, then-Prime Minister, and currently Chairman of the National People's Congress, said:

> *We should attach great importance to strengthening the army through technology, enhance research in defense-related science, . . . give priority to developing arms needed for defense under high-tech conditions, and lay stress on developing new types of weapons.*[5]

Senior PRC leaders recognize that enormous efforts must be made to "catch up" militarily with the West.[6] According to the Defense Intelligence Agency, the PRC's



Technologies that have been identified as import and acquisition targets for the PRC include machine tools and jet engine technology.

ability to achieve this goal depends in part on its "industrial capacity to produce advanced weapons without foreign technical assistance."[7]

Two technologies that have been identified as priority acquisition targets for the PRC are machine tools for civil and military requirements, and jet engine technology.[8] This chapter presents two case studies relating to the PRC's efforts to obtain such technologies — its 1994 purchase of machine tools from McDonnell Douglas, and its efforts in the late 1980s and early 1990s to obtain jet engine technology from Allied Signal's Garrett Engine Division.

These case studies illustrate the methods the PRC has used to acquire militarily-sensitive technologies through its skillful interaction with U.S. Government and commercial entities.

However, the case studies do not assess the degree to which the PRC has enhanced its aerospace and military industrial capabilities through the acquisition of U.S. technologies and equipment.

A third technology priority for the PRC — composite materials — is discussed in the Technical Afterword to this chapter.

PRC Targeting of Advanced Machine Tools

The PRC is committed to the acquisition of Western machine tool technology, and the advanced computer controls that provide the foundation for an advanced aerospace industry.

Although the PRC acquires machine tools from foreign sources in connection with commercial ventures, it also seeks foreign-made machine tools on a case-by-case basis to support its military armament programs.

Moreover, the proliferation of joint ventures and other commercial endeavors that involve the transfer or sale of machine tools to the PRC makes it more difficult for foreign governments and private industry to distinguish between civilian and military end-uses of the equipment.

The China National Aero-Technology Import-Export Corporation's (CATIC) purchase of used machine tools from McDonnell Douglas, now part of Boeing, is one illustration of the complexities and uncertainties faced by private industry and the U.S. Government in these endeavors.

Traditional machine tools cut, bend, and shape metals and non-metal materials to manufacture the components and structures of other machines. Machine tools form the foundation of modern industrial economies, and are widely used in the aerospace and defense industries.

The capability of machine tools is typically indicated by the number of linear or rotational motions — of either the tool or the workpiece — that can be continuously controlled during the machining process, and by the machining accuracy that can be achieved. The latter is measured in microns, that is, millionths of a meter.

Advanced machine tools can provide five axes of motion — typically horizontal, lateral, and vertical movement, and rotation on two perpendicular axes. Less widely used or required are six- and seven-axis machines, which are sometimes used for special applications.

Machine tools used in aircraft and defense manufacturing today are generally numerically controlled (NC). More advanced equipment is computer numerically controlled (CNC). CNC machine tools are essential to batch production of components for modern weapon systems, and can reduce machining times for complex parts by up to 90 percent compared to conventional machine tools.

In addition, these modern machines require operators with less skill and experience and, when combined with computer-aided design software, can reduce the manufacturing cycle of a product, from concept to production, from months to days.

Machine tools are essential to commercial industry, and high precision, multiple-axis machine tools broaden the range of design solutions for weapon components and structural assemblies. Parts and structures can be designed with advantages in weight and cost relative to what could be achieved with less advanced machine tools. For military and aerospace applications, the level of manufacturing technology possessed by a country directly affects the level of military hardware that can be produced, and the cost and reliability of the hardware.[9]

The military/civilian dual-use production capability of various types of machine tools is indicated in the following table.

Some Military and Civilian Uses of Machine Tools

Machine Tool Type	Conventional Military Applications	Nuclear Applications	Civilian Applications
Precision lathes	Inertial guidance system parts; high performance fuel-pump parts; tank transmissions	Parts for uranium enrichment centrifuges and laser isotope separation	Automotive transmissions; VCRs; CDs; computer components
Diamond turning lathes	Reflecting mirrors for laser gyros; harpoon missile advanced optical system	Hemishells	Molds for contact lenses; prisms for optical equipment; computer hard drives
Large center-drive lathes	Gun barrels for 120 and 150 mm cannons (external cuts)	(No critical application)	Turbine shafts; large motor shafts; propeller shafts
Mills	Stabilization and aiming systems for M1A1 tanks; Airframe and missile parts	Enrichment components	Instrument brackets; large computer frames; airframe parts
Large five-axis mills	Aircraft parts; propellers for Navy ships and submarines	(No critical application)	Aircraft parts; propellers for commercial ships
Small five-axis mills	Jet engine impellers	Enrichment components	Compressor pumps for fluids
Grinders	Radar systems for aircraft; inertial guidance system parts; helicopter main shaft bearings; gas turbine blades; high performance fuel pumps	Enrichment components, tooling and fixturing	High speed motor shafts and bearings; automotive injector valves; dies, molds, pumps

Source: Export Administration Regulations, Part 742.

Export Controls on Machine Tools

The PRC's access to foreign multi-axis machine tools and controllers has increased rapidly with liberalized international export controls.[10]

During the Cold War, the Coordinating Committee for Multilateral Export Controls (COCOM) established multilateral controls on exports to the Warsaw Pact allies and the PRC of machine tools that restricted linear positioning accuracy below 10 microns.[11] However, the consensus for relatively strict export controls dissolved after the Soviet Union's collapse.

The post-Cold War control regime is embodied in the 1996 Wassenaar Arrangement, and the 1978 Nuclear Suppliers Group Agreement (NSG) governing the export of machine tools that can be used for nuclear weapons development. This current regime has a different focus, as indicated in the following table.

Comparison of COCOM, Wassenaar, and the Nuclear Suppliers Group

Feature	COCOM	Wassenaar	NSG
Purpose	Control high-technology transfers to Communist countries	Prevent destabilizing accumulations of arms and dual-use goods. Focus on threats from transfers of armaments and dual-use goods to destinations where the risks are judged greatest	Restrict exports or reexports of items with nuclear applications
Extent of Export Controls	Communist Bloc	Countries of Concern	Non Members
Export Approval	Multilateral Consent	National Discretion	National Discretion

The Wassenaar and Nuclear Suppliers Group Agreement regimes have adopted similar control parameters for machine tools. Generally speaking, lathes and milling machines must be licensed for export if their accuracy exceeds six microns. Grinding machines are controlled at four microns. The Wassenaar Arrangement controls all machine tools capable of simultaneous, five-axis motion, regardless of machining accuracy. The Nuclear Suppliers Group Agreement exempts certain machines from this restriction.[12]

The PRC is not a proscribed destination for machine tools and other commodities under the Wassenaar Arrangement. This means that Wassenaar regime members treat exports to the PRC according to their individual national discretion. On the other hand, exports to the PRC of Nuclear Suppliers Group Agreement-covered items require individual validated licenses.[13]

Export Administration Regulations

The Wassenaar and Nuclear Suppliers Group Agreement parameters for machine tool controls have been incorporated in the U.S. Commerce Department's Commodity Control List of dual-use items (the list appears in the Export Administration Regulations).[14] Machine tools are listed under Category 2 (Material Processing), Group B (Inspection and Production Equipment).[15]

The Commodity Control List further classifies machine tools — as it does other dual-use items — by an Export Control Classification Number that reflects the item's category, group, types of associated controls, whether the item is controlled for unilateral or multilateral concerns, and a sequencing number to differentiate among items on the Commodity Control List.[16]

The PRC's Machine Tool Capabilities and Foreign Acquisitions

Observers of the PRC's machine tool capabilities do not believe that the PRC can indigenously produce high precision, five-axis machines that approach the quality of Western products.

The U.S. General Accounting Office estimates that the PRC has the capability "to manufacture less sophisticated machine tools, but cannot currently mass produce four- and five-axis machine tools that meet Western standards."[17]

According to a 1996 Defense Department assessment, however, the PRC's indigenous machine tool production capability is increasing markedly.[18]

The PRC has long sought to compensate for its deficiencies in machine tool technology by importing foreign systems. This approach has been facilitated by COCOM's dissolution and the resulting international relaxation of controls on machine tool exports.

Since the end of COCOM in March 1994, PRC military industries have acquired advanced machine tools that would be useful for the production of rocket and missile guidance components, and several five-axis machines for fighter aircraft and parts production. Five-axis machines were controlled under COCOM and are purportedly controlled by Wassenaar.[19] U.S. industry sources note that:

> *China has proved able to buy [machine tools] from a variety of foreign makers in Japan and Europe. Between 1993 and 1996, fifteen large, 5-axis machine tools were purchased by Chinese end users — all fifteen were made by Western European manufacturers.*
>
> *Furthermore, Shenyang Aircraft purchased twelve 5-axis machine tools [in 1997]. These machine tools came from Italian, German and French factories.*[20]

In addition, the PRC may be enhancing its ability to produce advanced machine tools through license production arrangements with Western manufacturers.

Other countries developing nuclear weapons and missiles have also apparently benefited from the PRC's ability to acquire advanced machine tools on the world market. As one recent Defense Department assessment noted, the PRC's "recent aerospace industry buildup and its history of weapons trade with nations under Western embargoes makes this increase in key defense capacity of great concern." [21]

The Clinton administration has determined that specific examples of this activity cannot be publicly disclosed.

CASE STUDY: McDonnell Douglas Machine Tools

Findings of the U.S. General Accounting Office

The Select Committee has determined that the U.S. Government is generally unaware of the extent to which the PRC has acquired machine tools for commercial applications and then diverted them to military end uses.

The McDonnell Douglas case illustrates that the PRC will attempt diversions when it suits its interests.

At the request of Congress, the U.S. General Accounting Office in March 1996 initiated a review of the facts and circumstances pertaining to the 1994 sale of

McDonnell Douglas machine tools to CATIC. The GAO issued its report on November 19, 1996.

The report can be summarized as follows:

- **In 1992, McDonnell Douglas and China National Aero-Technology Import and Export Corporation (CATIC) agreed to co-produce 20 MD-82 and 20 MD-90 commercial aircraft** in the PRC. Known as the Trunkliner Program, the aircraft were to serve the PRC's domestic "trunk" routes. In late 1994, a contract revision reduced the number of aircraft to be built in the PRC to 20, and added the purchase of 20 U.S.-built aircraft.

- **CATIC is the principal purchasing arm of the PRC's military** as well as many commercial aviation entities. Four PRC factories, under the direction of Aviation Industries Corporation of China (AVIC) and CATIC, were to be involved in the Trunkliner Program.

- **In late 1993, CATIC agreed to purchase machine tools and other equipment from a McDonnell Douglas plant** in Columbus, Ohio that was closing. The plant had produced parts for the C-17 transport, the B-1 bomber, and the Peacekeeper missile. CATIC also purchased four additional machine tools from McDonnell Douglas that were located at Monitor Aerospace Corporation in Amityville, New York, a McDonnell Douglas subcontractor.

- **The machine tools were purchased by CATIC for use at the CATIC Machining Center in Beijing — a PRC-owned facility that had yet to be built** — and were to be wholly dedicated to the production of Trunkliner aircraft and related work. McDonnell Douglas informed the U.S. Government that CATIC would begin construction of the machining center in October 1994, with production to commence in December 1995.

- **In May 1994, McDonnell Douglas submitted license applications for exporting the machine tools to the PRC and asked that the Commerce Department approve the applications quickly** so that it could export the machine tools to the PRC, where they could be stored at CATIC's expense until the machining facility was completed. Following a lengthy interagency review, the Commerce Department approved the license applications on September 14, 1994, with numerous conditions designed to mitigate the risk of diversion.

- **During the review period, concerns were raised about the possible diversion of the equipment to support PRC military production**, the reliability of the end user, and the capabilities of the equipment being exported. The Departments of Commerce, State, Energy, and Defense, and the Arms Control and Disarmament Agency, agreed on the final decision to approve these applications.

- **Six of the machine tools were subsequently diverted to Nanchang Aircraft Company, a PRC facility engaged in military and civilian production** over 800 miles south of Beijing. This diversion was contrary to key conditions in the licenses, which required the equipment to be used for the Trunkliner program and to be stored in one location until the CATIC Machining Center was built.

- **Six weeks after the reported diversion**, the Commerce Department suspended licenses for the four machine tools at Monitor Aerospace in New York that had not yet been shipped to the PRC. Commerce subsequently denied McDonnell Douglas's request to allow the diverted machine tools to remain in the unauthorized location for use in civilian production. The Commerce Department approved the transfer of the machine tools to Shanghai Aviation Industrial Corporation, a facility responsible for final assembly of Trunkliner aircraft. The diverted equipment was relocated to that facility before it could be misused.

- **The Commerce Department did not formally investigate the export control violations until six months after they were first reported**. The U.S. Customs Service and the Commerce Department's Office of Export Enforcement are now conducting a criminal investigation under the direction of the Department of Justice.[22]

The U.S. Government's Actions in Approving the Export Licenses

On December 23, 1993, the China National Aero-Technology Import and Export Corporation (CATIC) reached an agreement to purchase machine tools from McDonnell Douglas. CATIC officials signed the purchase agreement with McDonnell Douglas on February 15, 1994.

A May 27, 1994 e-mail message to Assistant Secretary of Commerce for Export Administration Sue Eckert from Deputy Assistant Secretary for Export Administration Iain Baird noted:

> *We received 23 applications covering all of the material involved in this project two days ago. [McDonnell Douglas] plans on shipping to CATIC.*
>
> *We have a long history with CATIC, which has been the consignee on numerous occasions — approved and denied based on licensing policies in effect at the time. CATIC was also the entity that attempted to buy the Machine Tool plant in the Northwest that was "denied" under the CFIUS process.*
>
> . . . .
>
> *Because of the sensitivity of this case, I think we should get it to the ACEP [Advisory Committee for Export Policy] ASAP. We are going to suggest to the other agencies that we forgo the 60-90 [day] review process and, instead, bring together all the relevant experts in a special [Operating Committee] meeting in 2-3 weeks to make a recommendation.*

If it is not agreed to approve the transaction at that point
(and it won't be),
we'll get the issue before the next ACEP.

Stay tuned.[23]

Subsequently, according to a June 8, 1994 memorandum to Deputy Assistant Secretary of Defense for Counterproliferation Policy Dr. Mitchel Wallerstein from Acting Director of the Defense Technology Security Administration Peter Sullivan:

An interagency meeting was held 7 June 1994. Defense, State and Commerce were in attendance; Energy and CIA were invited but did not attend.

McDonnell Douglas representatives outlined their proposal. They would like closure on their license applications by 5 July 1994.

The possibility of meeting that request seems remote. First, initial staffing within DoD was accomplished 7 June 1994, when we received the required documentation from Commerce. Second, all parties agree that the prospects for escalation within the [U.S. Government] seem high, due to the scope of the proposed program, and the precedence [sic] it may establish. We will keep you informed of additional developments.[24]

Within the Defense Department, the McDonnell Douglas license applications were a cause of concern and internal debate. Specifically, the uniformed military services (Joint Staff) initially recommended denial.

The Joint Staff based its recommendation of denial upon an analysis indicating a high probability that this technology would be diverted for PLA end use.[25] Moreover, the Joint Staff noted that, "Even with DoD recommending approval with conditions, this would be a less-than-prudent export to the PRC. This is particularly true in light of Chinese involvement in the world arms market."

The Staff of the U.S. Commander in Chief, U.S. Pacific Command, agreed, noting in an August 1, 1994 memorandum to the Joint Staff that it "concurs with the Joint Staff position to deny…"

The Licensing Officer at the Defense Technology Security Administration who was initially assigned responsibility for the McDonnell Douglas license applications also recommended denial. The Licensing Officer reiterated concerns as to CATIC's role in both civilian and military production, and stated that "[n]o quantitative data has been supplied by the exporter, which establishes a clear need for this equipment in China [the PRC]."

Intelligence Community Assessments

Because of concerns that the McDonnell Douglas machine tools would give the PRC manufacturing production capabilities in excess of what was required for the Trunkliner Program, the Department of Defense asked for information that would assist it in determining whether these machine tools could be diverted to production of PLA military aircraft.

A July 27, 1994 Defense Intelligence Agency response to a request from the Defense Technology Security Administration provided an assessment.[26] It warned that, while similar machine tools were available from foreign sources, there was a significant risk of diversion. There was also the additional risk that the PRC could reverse-engineer the machine tools, and then use them in other commercial or military production. This would be consistent with the PRC's practice of reverse-engineering other Western technology for military purposes.

On August 9, 1994, the Defense Intelligence Agency provided a supplemental report explaining the results of its thorough assessment of the applicability of the McDonnell Douglas machine tools to three known PLA fighter aircraft programs, each of which incorporated stealth technologies. The report concluded:

> *The establishment of an advanced machine tool facility presents a unique opportunity for Chinese military aerospace facilities to access advanced equipment which otherwise might be denied.*

In 1994 McDonnell Douglas machine tools suitable for aircraft and missile production were purchased from this Columbus, Ohio facility by the China National Aero-Technology Import and Export Corporation (CATIC). The plant had produced parts for the United States' B-1 bomber, C-17 transport, and Peacekeeper missile.

Similarly, placing these machine tools in one facility would reduce the financial outlay needed to acquire duplicate advanced machine tools for multiple military aircraft programs.

DIA . . . maintain[s] that the production capacity resulting from the McDonnell Douglas sale is above and beyond the requirement necessary for exclusive production of 20 MD-82 and 20 MD-90 McDonnell Douglas [aircraft], which is the stated end use in the export license application.

In fact, recent press reporting indicates China [the PRC] has dropped plans to build 20 MD-82s and will limit future production to just 20 MD-90 aircraft.[27]

The Defense Technology Security Administration had received information from informants in September 1993 — prior to CATIC's agreement to purchase the machine tools, and a full year before the license was granted — that CATIC personnel had visited McDonnell Douglas's Columbus, Ohio plant and videotaped the machine tools in use, a potentially illegal technology transfer.

The Defense Technology Security Administration reported the information to the U.S. Customs Service, and its agents later paid a visit to the Columbus, Ohio plant. However, following the visit, the U.S. Customs Service determined that no further investigative action was warranted.

During the interagency licensing process for the machine tools, the Defense Technology Security Administration also sought assessments from the Central Intelligence Agency and from the Defense Intelligence Agency, because of concerns that the PRC could use the McDonnell Douglas five-axis machine tools for unauthorized purposes, particularly to develop quieter submarines. Since the PRC wishes to enhance its power projection capabilities and is making efforts to strengthen its naval forces, the five-axis machine tools could easily be diverted for projects that would achieve that goal.

The Defense Technology Security Administration received additional information from informants indicating that CATIC had provided the Shenyang Aircraft Factory, an unauthorized location, with a list of the Columbus, Ohio equipment that had been purchased from McDonnell Douglas.[28] Circles around some of the items on the list, according to the translation of a note from Shenyang that accompanied the list, indicated that the Shenyang Aircraft Factory was interested in obtaining those items from CATIC.

The Shenyang list was reportedly obtained from the discarded trash at a CATIC subsidiary in California.

This list was viewed as proof that CATIC intended to divert the machine tools to unauthorized locations. These concerns were reported to the U.S. Customs Service in the summer of 1994.

McDonnell Douglas and the China National Aero-Technology Import and Export Corporation (CATIC) agreed in 1992 to co-produce 20 MD-82 *(above)* and 20 MD-90 *(below)* aircraft in the PRC. The PRC purchased machine tools from McDonnell Douglas, ostensibly for use in manufacturing these aircraft. But the PRC diverted them to a facility known to manufacture military aircraft and cruise missile components as well as civilian products.

Changes to the Trunkliner Program

When McDonnell Douglas applied for export licenses on May 26, 1994, the applications noted that the machine tools would be used by the Beijing CATIC Machining Center primarily for the Trunkliner program. According to those license applications, McDonnell Douglas had a contract with CATIC to co-produce 20 MD-82 and 20 MD-90 aircraft.[29]

In June 1994, McDonnell Douglas representatives provided a series of briefings to officials from the Commerce, State, and Defense Departments regarding the nature of the Trunkliner program and McDonnell Douglas's other activities in the PRC.[30] In July 1994, however, *Flight International* magazine announced that the Trunkliner Program had been significantly changed.[31]

Instead of co-producing 20 MD-82 and 20 MD-90 aircraft in the PRC, only 20 MD-90 aircraft would be built there. Although the PRC would still acquire 20 additional aircraft, those would now be built at McDonnell Douglas's Long Beach, California plant — albeit with many parts that were to be fabricated in the PRC.

Prompted by the press reports, the Defense Department sought additional information from McDonnell Douglas in late July and early August 1994 regarding how the machine tools would be employed if the number of aircraft to be co-produced in the PRC was to be reduced.[32]

In letters to the Defense Technology Security Administration dated August 8 and August 12, 1994, McDonnell Douglas provided further clarification regarding the number and complexity of the parts that were to be manufactured in the PRC.

Commerce Department Licensing Officer Christiansen recalls that Commerce was not concerned that the number of aircraft to be co-produced in the PRC might be reduced, since parts for the aircraft would continue to be fabricated in the PRC.[33]

The Defense Technology Security Administration and the Defense Department, on the other hand, were concerned since they thought the machine tools might represent significant excess manufacturing capacity that the PRC might be tempted to divert to other, unauthorized uses.

The actual agreement that reduced the number of aircraft to be assembled in the PRC was signed on November 4, 1994.[34]

Discussions in the Advisory Committee for Export Policy

The McDonnell Douglas export license applications were discussed at the June 24, 1994 meeting of the Advisory Committee for Export Policy (ACEP).

According to the minutes of that meeting, no decision was reached. The Defense Department representative at the meeting advised against approving the licenses that day, because internal Defense Department review was continuing. The Defense Department believed the applications could be approved if reasonable safeguards were put into place to prevent the machine tools from being used for unauthorized purposes.[35]

Among the other agencies in attendance, the State Department agreed with the Defense Department that further review was required. The Department of Energy deferred to the Defense Department on whether licenses should be approved.[36]

The license applications for the McDonnell Douglas machine tools were again discussed at a meeting of the Advisory Committee for Export Policy on July 28, 1994. Again, the matter was deferred until the next Advisory Committee meeting. The minutes reflect that "a final decision on this transaction would have to be remanded until the next meeting of the ACEP, or as soon as possible before that date, if all the agencies complete their reviews earlier."

According to the ACEP minutes, the respective positions of each agency on the applications were as follows:[37]

- **[The Department of Defense] said that, if it had to vote at that time, it would recommend denial of the licenses** because of concerns that the machine tools would be diverted. Moreover, there were concerns that the McDonnell Douglas machine tools would give the PRC excess production capacity, thus allowing other machine tools in its inventory to be diverted from civilian to military production.

- **[The Department of] Energy indicated that, without further review, "it would have to defer to Defense in denying this transaction and the underlying applications."**

- **[The Department of] State recommended approval,** provided that appropriate safeguards and conditions could be formulated to minimize the risk of diversion.

- **[The] Arms Control and Disarmament Agency agreed with DOD [the Defense Department]'s position, noting that it would recommend denial** of the license applications should it have to vote at that time.

- **[The Department of] Commerce recommended approval** with conditions to minimize the risk of diversion to unauthorized uses.

The License Is Issued

The Advisory Committee member agencies later agreed to issue the export licenses with 14 conditions.[38]

Those conditions required, among other things, that:

- **The machine tools were to be stored in one location pending completion of the Beijing CATIC Machining Center**

- **McDonnell Douglas was to provide quarterly reports to the Department of Commerce and the Defense Technology Security Administration should the Beijing CATIC Machining Center not be completed when the machine tools arrived**[39]

As a final part of the licensing process, a Department of State cable was sent to the U.S. Embassy/Beijing on August 29, 1994 requesting that a senior CATIC official provide a written end use assurance that the machine tools would only be used for specified purposes.[40]

In a September 13, 1994 response, the U.S. Embassy/Beijing reported that it had obtained the assurance from CATIC Deputy Director Sun Deqing. However, the cable also noted that Deqing had indicated to the embassy officials that:

> *CATIC plans to establish several specialized factories under their new CATIC Machinery Company, and that [the CATIC Machining Center] would be one of those plants. [The CATIC Machining Center] will be established either near Beijing . . . or in Shijianzhuang at the Hongxing Aircraft Company . . .*[41]

Six of the machine tools from the McDonnell Douglas plant in Columbus, some of which are pictured in a cargo container, were diverted from a not-yet-built CATIC machining center in Beijing to the Nanchang Aircraft Company, a PRC facility engaged in the production of both military and civilian aircraft 800 miles south of China's capital city.

McDonnell Douglas's Plans

McDonnell Douglas's Limited Role at the Machining Center

Although McDonnell Douglas was planning to place up to four of its employees at the Beijing CATIC Machining Center, this was not to occur until late 1995 at the earliest.

Moreover, the Machining Center was not to be a joint venture between CATIC and McDonnell Douglas. Rather, it was to be a CATIC facility that supported CATIC's responsibilities to the Trunkliner Program.

Trunkliner Program

Media reports indicated in July 1994 that McDonnell Douglas and the PRC were engaged in negotiations over the number of Trunkliner aircraft to be assembled in the PRC.[42]

Notes from a June 7, 1994 briefing that McDonnell Douglas provided to U.S. Government officials regarding its license applications indicate that McDonnell Douglas's representatives made references to the fact that the company was negotiating with the PRC over changing the mix of aircraft to be built in the PRC.[43] CATIC was to remain responsible for the fabrication of large numbers of parts both for the aircraft that would be assembled in the PRC, and for the aircraft that were to be built in the United States under an "offset" agreement.

When queried by DOD officials regarding the continued PRC need for the machine tools in light of possible changes to the Trunkliner program, McDonnell Douglas responded in an August 8, 1994 letter to Defense Technology Security Administration Acting Director Sullivan. The letter provided further explanation regarding CATIC's proposed use of the machine tools. A subsequent August 12, 1994 McDonnell Douglas letter to the Defense Technology Security Administration's Colonel Henry Wurster noted:

> *. . . The PRC factories that are participating in the Trunk Aircraft Program . . .do not have the capability individually, nor collectively, to accomplish the work share the PRC has agreed to (75 percent of the airframe) . . . If the licenses are*

> *denied, the PRC would purchase these types of machines somewhere else . . .*

Commerce Department Delays Investigating Machine Tool Diversion for Six Months

The Commerce Department's Actions in April 1995

As part of the licensing conditions for the machine tools, the machines tools were to be stored in one location pending completion of the Beijing machining center, and McDonnell Douglas was required to ". . . notify the [U.S. Government] of the location of the machine tools and update the [U.S. Government] with any changes of location prior to plant completion."

In April 4, 1995 letters to the Commerce Department's Office of Export Enforcement, Washington Field Office, and to the Technical Information Support Division/Office of Exporter Services, McDonnell Douglas reported that the machine tools were located at four different places:

- **Nine of the machine tools were located at two sites in the port city of Tianjin, a two hour drive from Beijing**
- **Four other machine tools had yet to be exported and were located at Monitor Aerospace Corporation in Amityville, New York**
- **Six machine tools were reported to be at the Nanchang Aircraft Company** [44]

According to the letters, a McDonnell Douglas employee had physically observed the machine tools in Tianjin, and confirmed that they remained in their original crates. He had not personally viewed the machine tools at the Nanchang Aircraft Company. However, the McDonnell Douglas letters reported that:

> *. . . CATIC did provide the attached letter to substantiate the list of equipment stored there. CATIC stated that the equipment has <u>not</u> been unpacked and remains in the original crates.*
> [Emphasis in original]

The April 4 McDonnell Douglas letters did not trigger any kind of investigative response.

On April 20, 1995, an interagency meeting was held in which two McDonnell Douglas officials discussed the status and locations of the machine tools. The McDonnell Douglas officials reported that there had been changes in the number of aircraft that would be built jointly with the PRC, and changes in the location of the machine tools.

Since the machine tools were not stored in one authorized location, this violated the licensing conditions. McDonnell Douglas representatives responded by stating that the machine tools had inadvertently been moved to more than one location contrary to what had been specified in the export licenses, but that the building for the machine tools had not been completed and the tools had to be stored somewhere in the interim.

Six months later the Office of Export Enforcement received additional information from Commerce Department Licensing Officer Christiansen that, in conjunction with a formal request from the Defense Technology Security Administration, finally triggered the opening of a formal investigation into the diversion.

The Commerce Department's Actions in October 1995

An October 5, 1995 e-mail from Christiansen to a number of Commerce Department officials, including Office of Export Enforcement Acting Director Mark Menefee, reported that one of the six machine tools in storage at the Nanchang Aircraft Company had been uncrated, and was in the final stages of assembly.

In clear violation of the export license, the machine tool — a hydraulic stretch press — had been installed in a building that apparently had been built specifically to accommodate that piece of equipment.

In his e-mail message, Christiansen stated:

> *For OEE [the Office of Export Enforcement], please investigate to determine who was responsible for both the diversion of the equipment originally and second who is responsible for the*

> *decision to install the equipment at Nanchang.*

The formal request from the Defense Technology Security Administration for an investigation consisted of an October 4, 1995 letter from its Director of Technology Security Operations.[45] The Defense Technology Security Administration informed the Acting Director of the Office of Export Enforcement, Mark Menefee, that:

> *During last week's ACEP [Advisory Committee for Export Policy] meeting a package of materials were handed out concerning the violation of McDonnell Douglas's export license to the Chinese.*
>
> *The facts of the case are that CATIC has intentionally misused the export licenses to put controlled technology at a facility not authorized to receive [it].*
>
> *This facility as confirmed by the Chinese is involved in the manufacture of both missiles and attack aircraft. I will be forwarding a copy of those materials to you separately.*
>
> *We believe that this is a very serious matter and that the Office of Export Enforcement should conduct a serious investigation into this matter . . .*

The Office of Export Enforcement determined that an active investigation was warranted, and opened a case file in early November 1995. The case was forwarded to the Office of Export Enforcement's Los Angeles Field Office for investigation because McDonnell Douglas Aircraft in Long Beach, California — the exporter of record for the machine tools — was located in the Los Angeles Field Office's area of responsibility.

Allegation that the Commerce Department Discouraged the Los Angeles Field Office's Investigation

On June 7, 1998, the CBS program "*60 Minutes*" suggested that the Commerce Department or other U.S. Government entities were not necessarily interested in a complete and thorough investigation of the machine tool diversion. Among other things, the program included a brief appearance by Marc Reardon, a former Los

Angeles Field Office special agent, who had initially been assigned to investigate the case. According to the official CBS transcript of the program:

> ***[CBS journalist Steve] KROFT: (Voiceover)*** *And there's still some debate over just how hard the Commerce Department tried to find out who the bad guys really were. It took them six months to open an investigation. And Marc Reardon, the Commerce Department case agent assigned to investigate, says higher ups in Washington didn't seem anxious to get to the bottom of things.*
>
> *Did you feel like you were getting support from the department?*
>
> ***Mr. Marc REARDON:*** *No. Not at all.*
>
> . . . .
>
> ***KROFT: (voiceover)*** *Reardon, who is now an investigator with the Food and Drug Administration, says he was told who to interview and what questions he could and couldn't ask.*
>
> *Has that ever happened before?*
>
> ***Mr. REARDON:*** *Not in my career.*
>
> ***KROFT:*** *What did you make of it?*
>
> ***Mr. REARDON:*** *That somebody didn't really want the truth coming out.*[46]

The Select Committee conducted an investigation of these allegations. However, the Justice Department has requested that the Select Committee not disclose the details of its investigation to protect the Justice Department's prosecution of CATIC and McDonnell Douglas.

On February 5, 1996 *U.S. News and World Report* reported that the machine tools had been diverted, and that an investigation was underway. The Commerce Department received inquiries from then-Chairman Alfonse M. D'Amato of the

Senate Committee on Banking, Housing and Urban Affairs, and from Chairman Benjamin A. Gilman of the House Committee on International Relations, concerning these reported allegations.[47] Subsequently, Chairman Floyd D. Spence of the House Committee on National Security and Representative Frank Wolf asked the General Accounting Office to review the facts and circumstances relating to the licensing and export of the machine tools. The results of the General Accounting Office review are summarized earlier in this chapter.[48]

The February 5, 1996 *U.S. News and World Report* also claimed that "a confidential U.S. Commerce Department investigative report" had been obtained and used in the article. Concerned that the disclosure of such a report to *U.S. News and World Report* may have violated the confidentiality provisions of Section 12 (c) of the Export Administration Act, the Office of Export Enforcement initiated an internal inquiry. Responsibility for the disclosure was never determined.

The Office of Export Enforcement's Los Angeles Field Office's Request for a Temporary Denial Order Against CATIC

Under the provisions of Part 766.24 of the Export Administration Regulations (EAR), the Assistant Secretary for Export Enforcement is authorized to issue a Temporary Denial Order (TDO):

> *. . . upon a showing by [the Bureau of Export Enforcement] that the order is necessary in the public interest to prevent an imminent violation of the [Export Administration Act], the [Export Administration Regulations], or any order, license or authorization issued thereunder.*[49]

In late November 1995, the Los Angeles Field Office requested that the Commerce Department issue a TDO against CATIC.[50] The TDO request was prepared as a means to compel CATIC to comply with the terms of the machine tool export licenses by preventing the approval of future export licenses.

The Commerce Department declined to issue the TDO. In a December 7, 1995 memorandum, the Office of Export Enforcement Headquarters returned the TDO case report because it contained a number of technical deficiencies, including:

- **Did not include licensing determination for each commodity that was exported.** Licensing determinations were necessary elements of proof that the commodities required a license to be exported.

- **Did not include any documentary evidence such as shipping and export control documents** to confirm that the exports had occurred.

- **Did not include a schedule** of violations that described the specific violations that allegedly had occurred.

- **Did not use the proper form and format** that Office of Export Enforcement regulations specified in the Office's Special Agent Manual.

Headquarters, noted, however, that "the violations do appear to be deliberate and substantial." It instructed the Los Angeles Field Office to give the investigation a high priority. Moreover, it instructed them to conduct additional interviews and to obtain relevant documentation.

The Los Angeles Field Office was concerned that Headquarters was using those technical deficiencies as a bureaucratic rationale for not seeking Commerce Department approval of the TDO request.

At the date of the Select Committee's Final Report (January 3, 1999), the Office of Export Enforcement and the U.S. Customs Service reportedly are continuing to investigate the machine tool diversion under the direction of the U.S. Attorney for the District of Columbia.

The PRC's Diversion of the Machine Tools

CATIC Letter Suggests Trunkliner Program at Risk

In a September 30, 1993 letter to McDonnell Douglas Aircraft Company President Robert Hood, CATIC Vice President Tang Xiaoping expressed concerns that negotiations were at an impasse for CATIC's purchase of the machine tools and other equipment.[51] The letter seemed to suggest that the Trunkliner Program would be at risk if a deal could not be worked out. According to the letter:

> *. . . I think for sure, whether or not this procurement project will be successful shall have a big influence on the trunk liner programme [sic] and long term cooperation between [Aviation Industries Corporation of China] and [McDonnell Douglas]. . .*

McDonnell Douglas characterized Tang Xiaoping's letter as nothing more than a negotiating ploy to try to get McDonnell Douglas to lower the price that it was asking for the machine tools. McDonnell Douglas officials said they did not consider the letter to be a veiled threat by CATIC to cancel or alter the Trunkliner Program if a deal for the machine tool equipment could not be worked out.

According to the Defense Department, however, CATIC had a longstanding, productive relationship with McDonnell Douglas, had made major investments in the Trunkliner Program, and was not going to jeopardize those investments and the Trunkliner Program in a dispute over the price of used machine tools.

Indeed, the purchase price that was eventually agreed to between McDonnell Douglas and CATIC was acceptable to both parties. The value of the machine tools was based upon an appraisal provided by a commercial auctioneer. McDonnell Douglas added a 20-30 percent markup. CATIC acquired all of the machine tools it had originally sought, as well as various other tools, equipment, furniture and other items as part of the $5.4 million purchase agreement.

The machine tools and other equipment purchased by CATIC were excess to McDonnell Douglas's needs. According to McDonnell Douglas, the more modern machine tools and equipment from the Columbus, Ohio plant were not sold to CATIC but were redistributed to other McDonnell Douglas facilities.

According to the March 1, 1994 appraisal, the value of 31 machine tools sold to CATIC — including the 19 machine tools that required export licenses — was $3.5 million.[52] This appraisal did not assess the value of other tools, equipment, and furnishings that were included as part of the purchase agreement.

CATIC's Efforts to Create the Beijing Machining Center with Monitor Aerospace

Doug Monitto was the President of Monitor Aerospace Corporation, an Amityville, New York-based company that manufactured aircraft components. In the fall of 1993, Monitto met with CATIC representatives in the PRC to discuss joint venture opportunities.

During those discussions, CATIC expressed an interest in subcontracting with Monitor Aerospace for the production of aircraft parts. Specifically, Monitor would assist the PRC in the production of certain aircraft parts that CATIC was to manufacture for Boeing as part of an offset contract.

Monitto says he proposed that CATIC convince Boeing to transfer $10 million of the offset work directly to Monitor for one year. During that year, Monitor Aerospace would assist CATIC in designing and laying out a new machining center.[53] Thereafter, CATIC itself, with Monitor's assistance, could provide all subsequent manufacturing for the Boeing parts.

Representatives of CATIC, Aviation Industries of China, and Monitto signed a Memorandum of Understanding (MOU) regarding the machining center joint venture on January 24, 1994.[54] CATIC officials took Monitto to an industrial park in Beijing where the machining center was to be built.

In a letter dated January 27, 1994, CATIC informed Boeing that it had signed the joint venture MOU, and asked if Boeing would consider providing Monitor Aerospace with the offset work.[55] However, Boeing, in an April 1994 letter, declined CATIC's offer.[56]

In the spring of 1994, Monitto says CATIC officials again approached him about a machining center joint venture.

Although negotiations were intermittent, Monitto says CATIC informed him in the summer of 1994 that it had purchased machine tools from McDonnell Douglas. As Monitto recalls, CATIC officials asked for his assistance in reassembling the machine tools, and placing them in a machining center. However, he says the precise location of the machining center had not been determined at that time.[57]

A July 29, 1994 letter from Monitto to Sun Deqing, CATIC's Deputy Director, states:

> *As a result of your visit we have prepared an alternative approach that will help us achieve our mutually desired goal of building a "State of the Art" profile milling machine shop in China.*
>
> *Monitor Aerospace would like to offer its assistance to CATIC in entering this new marketplace as both a partner and as a technical expert in the field.*
>
> *The most significant feature of this new approach would be the fact that Monitor would also be the launch customer of the new joint venture.*[58]

Additional discussions between CATIC and Monitor Aerospace regarding establishing the machining center appear to have continued into the fall of 1994, after the export licenses for the McDonnell Douglas machine tools had been approved.

According to a September 23, 1994 letter to CATIC's Sun Deqing, Monitto proposed that, as part of a joint venture to manufacture aircraft parts in the PRC, CATIC would:

> *. . . supply an appropriate building located in the Beijing-Tianjin metropolitan area which permits growth. CATIC will provide other necessary infrastructure and planning support, including arranging for appropriate utility hook-ups, tax concessions, customs clearance, etc.*[59]

Sometime in the fall of 1994, Monitto recalls that CATIC informed him that it intended to place the McDonnell Douglas machine tools at a facility located in the city of Shijiazhuang. Monitto drove to the facility to check out the offer but decided the location was too far from his base of operations in Beijing to be viable. It was "not something I wanted to do," Monitto comments.[60]

According to Monitto, he has had no further substantive discussions with CATIC regarding the establishment of a machining facility, although he does remain in contact with CATIC on other business-related matters. According to Monitto, McDonnell Douglas was never a party to any of his negotiations with CATIC regarding the establishment of the machining center.[61]

According to McDonnell Douglas, the first indication it had that CATIC would not establish the machining center took place during a phone call with a CATIC official in May 1995. Subsequently, in a letter dated July 5, 1995, CATIC Supply Vice President Zhang Jianli formally advised McDonnell Douglas that an agreement could not be reached with Monitor Aerospace for a machining center, and that Nanchang Aircraft Factory was interested in purchasing the six machine tools that were stored at that factory.

According to the letter:

> *You were aware that we planned to set up a joint venture with Monitor Aerospace, which would be the enduser [sic] in applying [for] the license. Unfortunately both sides couldn't reach agreement. Without this agreement we muse [sic] find other uses or purchasers in China.* [62]

According to McDonnell Douglas, it believed that CATIC was serious in its plans to build a machining center in Beijing to produce airplane parts for the Trunkliner Program.

McDonnell Douglas acknowledges, however, that it never asked for, nor was it shown, architectural drawings, floor plans, or other information to indicate that plans for the facility were progressing.

Diversion of the Machine Tools to Nanchang Aircraft Company

When the machine tools arrived in the PRC, McDonnell Douglas personnel discovered that nine of the machines were stored at two different locations in the port city of Tianjin.[63]

Moreover, a March 27, 1995 letter from Zhang Jianli, the Vice President of CATIC Supply Company, to McDonnell Douglas's Beijing office explained that six more of the machine tools had been shipped to Nanchang for storage. These machine tools, CATIC represented, remained in their crates.[64]

Two McDonnell Douglas representatives visited Nanchang to inspect the tools on August 23, 1995 and learned that one of the machine tools — a hydraulic stretch press — had been uncrated and was situated inside a building. Moreover, the building had been built *specifically to accommodate that piece of equipment.*

Although electrical power had not yet been connected,[65] the size of the building and the manner of its construction suggested to them that this facility had been custom built to house McDonnell Douglas equipment, and had been planned for several years:

- **Possibly as early as December 23, 1993,** when CATIC and McDonnell Douglas signed an agreement for the purchase of machine tools and other equipment from McDonnell Douglas's Columbus, Ohio plant

- **Perhaps even as early as late 1992,** when CATIC first expressed interest in the purchase

CATIC (USA) documents[66] indicate that an official of "TAL Industries" was primarily responsible for supervising the PRC team that coordinated and supervised the packing and crating of the machine tools and other equipment at the Columbus, Ohio plant.[67] According to its responses to a series of Select Committee interrogatories, TAL Industries is a subsidiary of CATIC Supply in the PRC. CATIC Supply, in turn, is a wholly-owned subsidiary of CATIC.[68] According to TAL Industries, CATIC Supply owns 90 percent of its stock, and CATIC (USA) owns the remaining 10 percent.[69] TAL Industries is located at the same El Monte, California address and has the same telephone number as CATIC (USA).[70]

Some of the McDonnell Douglas equipment had been sold or given by CATIC to the Nanchang Aircraft Company. At least some of these transfers of ownership must have occurred before any of the equipment was exported from the United States. In addition, the PRC team that coordinated the disassembly and packing of the equipment at the Columbus, Ohio plant included representatives from the Nanchang Aircraft Company, who apparently were responsible for overseeing the packing of the equipment it was obtaining from CATIC.

Internally, CATIC specifically referenced the cargo as Nanchang's equipment.

Separately, the Nanchang Aircraft Company's Technology Improvement Office submitted inquiries to CATIC concerning the location of various pieces of its—Nanchang's—equipment.

Since most of the Columbus, Ohio equipment that was purchased by CATIC did not require an export license,[71] CATIC's subsequent sale of that equipment to Nanchang Aircraft Company would not violate U.S. export controls.[72] But the CATIC (USA) documents pertaining to Nanchang Aircraft Company's equipment do not explicitly identify the equipment, including the six machine tools that were later found at the Nanchang Aircraft Factory in violation of the export licenses.[73]

Nanchang Accepts Responsibility

In a September 13, 1995 letter to McDonnell Douglas China Program Manager Hitt, the Vice President of the Nanchang Aircraft Company accepted full responsibility for uncrating and installing the hydraulic stretch press in a newly constructed building. According to the letter:

> *Now I would like to review the detail and apologize for the result caused by the action we made. The following is the reason why we put the [hydraulic stretch] press into the pit.*
>
> *When we heard that the agreement had not been made between CATIC and Monitor [Aerospace] concerning the cooperation. [sic] We expressed our intention to CATIC that we would like to buy some of the machines and at that time CATIC also intended to sell to us.*
>
> *But they mentioned to us for several times that the cases can not be unpacked until the amendment of enduser [sic] is gained from the Department of U.S. Commerce. We do not think that there is any problem to get the permission for the second hand press, which has not got new technology because we have the experience that when we import the press from [a foreign manufacturer of machine tools].*

> *Under this guidance of the thought, we started to prepare the fundation [sic] in order to save time.*[74]

The letter went on to argue that, because of its size, the hydraulic stretch press had to be uncrated in order to move it to Nanchang from its port of entry in Shanghai. Moreover, the stretch press had then been moved into the "pit" that it would occupy so the new building *could be built around it*. To do otherwise, the PRC letter said, would have disrupted the construction of the new building.[75]

The Nanchang Aircraft Company official also apologized for the events that had occurred, and provided assurances that no further installation of the hydraulic stretch press would take place at the Nanchang Aircraft Factory until permission to do so was given by the U.S. Government.[76]

A July 5, 1995 letter to McDonnell Douglas China Program Manager Hitt from CATIC Supply Vice President Zhang Jianli reflects CATIC's knowledge that prior U.S. Government approval for the transaction was required. According to the CATIC Supply letter:

> *Nanchang Aircraft Factory is very much interested in 6 sets of the equipment. We would like to sell to them if we are allowed to do so because we understand that the licenses are only good for the Beijing machining center as it was approved originally.*
>
> *Is it possible to request the United States Commerce department [sic] to approve selling the machines to Nanchang Aircraft Company? The machines are being stored there now,* ***and they are required not to be unpacked until we receive approval*** *from the Department of Commerce of the U.S.A.*[77] [Emphasis added]

When Hitt and a colleague visited the Nanchang Aircraft Company on August 23, 1995, the Nanchang Aircraft Company officials informed them that one of the machine tools delivered to Nanchang had been placed inside a building "to protect it from the elements."

At the insistence of McDonnell Douglas's Hitt, the PRC officials took him to the building, where he found a hydraulic stretch press installed in a building that appeared to have been specifically built for it. The building had actually been *built around* the hydraulic stretch press, since Hitt observed no openings or doorways that were large enough to have allowed the machine tool to be moved into the building from elsewhere. Parts for the machine were strewn about the building in such a manner as to indicate that efforts were underway to reassemble the machine and restore it to operational condition. Although electrical power had not been connected to operate the stretch press, trenches for the power cables had been dug and other electrical work had been completed.

Hitt says the storage explanation he originally was given by Nanchang officials was, without question, disingenuous.

Concerned over Hitt's expressions of anger at seeing the partially installed stretch press, Hitt says Nanchang officials tried to reassure him that they only intended to use the stretch press for civilian production at the factory.

Since early 1996, the McDonnell Douglas machine tools have been stored at Shanghai Aviation Industrial Corporation (SAIC).

CHRONOLOGY OF KEY EVENTS

1992

March 28 — **McDonnell Douglas and CATIC sign contract** to co-produce 20 MD-82 and 20 MD-90 series commercial aircraft in the PRC.

1993

September — **Informants tell Defense Technology Security Administration** that PRC nationals are regularly visiting McDonnell Douglas's Columbus, Ohio plant. Concerned that the visits may constitute illegal technology transfer, DTSA contacts U.S. Customs Service.

September 30 — **Letter from CATIC Executive Vice President Tang Xiaoping** to McDonnell Douglas Aircraft Company President Robert Hood suggesting that McDonnell Douglas's failure to sell machine tools to CATIC could have a "big influence" on Trunkliner Program.

October 13 — **U.S. Customs Service agent** visits Columbus, Ohio plant. Following interviews with McDonnell Douglas officials, U.S. Customs Service agent reports that no further investigative action is contemplated.

December 23 — **CATIC and McDonnell Douglas reach agreement** on sale of machine tools and other equipment from McDonnell Douglas's Columbus, Ohio plant, and four machine tools located at Monitor Aerospace, in Amityville, New York. Included are 15 machine tools that require individual validated licenses.

1994

January 24 — **Memorandum of Understanding for CATIC Machining Center joint venture** signed by Monitor Aerospace, CATIC, and Aviation Industries of China.

February 15	**CATIC officials sign purchase agreement** for machine tools and other equipment at McDonnell Douglas's Columbus, Ohio plant.
March	**Disassembly, packing and crating of McDonnell Douglas machine tools** and other equipment begins at Columbus, Ohio plant.
Spring	**Defense Technology Security Administration** learns that manufacturing equipment at McDonnell Douglas's Columbus, Ohio plant has been exported to the PRC. U.S. Customs Service is informed.
May 26	**McDonnell Douglas applies** for machine tool export licenses.
June 7	**McDonnell Douglas briefs** Commerce, State, and Defense Department representatives on Trunkliner Program and CATIC Machining Center.
June 23	**McDonnell Douglas again briefs** interagency meeting on Trunkliner program and CATIC Machining Center.
June 24	**Machine tool license applications discussed at Advisory Committee for Export Policy (ACEP) meeting.** Defense Department cautions against rushing to approve licenses pending further review. No decision reached.
July 26	***Flight International* article reports only 20 McDonnell Douglas aircraft to be built in the PRC,** with the remaining 20 to be built in the United States.
July 28	**ACEP meeting again discusses machine tool licenses.** Decision deferred until next ACEP meeting.

August 25	**ACEP meeting minutes indicate export licenses for the machine tools were approved** prior to this ACEP meeting.
August 29	**State Department asks U.S. Embassy/Beijing to obtain end use assurance** for machine tools from senior CATIC official.
Late August	**Commerce Secretary Ronald Brown** leads trade mission to the PRC.
September 13	**U.S. Embassy/Beijing reports that it obtained CATIC end use assurance** and advises that final location of the machining center has not been determined.
September 14	**Department of Commerce formally issues export licenses** to McDonnell Douglas for 19 machine tools.
October	**Construction** of machining center was reportedly to begin.
November 4	**CATIC and McDonnell Douglas sign amended contract** reducing the number of aircraft to be built in the PRC from 40 to 20, with the remaining 20 to be built in the United States.
November/ December	**Most of Columbus, Ohio machine tools** are shipped to the PRC.

1995

February	**Remaining Columbus, Ohio machine tools are shipped to the PRC.** Four machine tools still remain at Monitor Aerospace in Amityville, New York.
March 24	**McDonnell Douglas representative inspects** nine machine tools in original shipping crates at two locations in Tianjin, a port city

	two hours drive from Beijing. McDonnell Douglas's Beijing office letter to CATIC requests information on machine tools not found in Tianjin.
March 27	**CATIC letter to McDonnell Douglas's Beijing office assures** that six machine tools remain packed and in storage in Nanchang.
April 4	**McDonnell Douglas letter to the Department of Commerce reports location of machine tools** and notes that six of the machine tools are reportedly located at Nanchang Aircraft Company, four remain at Monitor Aerospace in Amityville, New York, and the remainder are stored at two locations in Tianjin.
April 20	**McDonnell Douglas briefs interagency meeting on locations of machine tools.** Commerce Department Office of Export Enforcement representative is present at meeting, and determines that no active investigation is warranted.
Late April/ Early May	**In telephone call with McDonnell Douglas China program manager, CATIC official says no agreement** could be reached with Monitor Aerospace for creation of the machining center. The Department of Commerce is informed.
May 15	**The Department of Commerce instructs McDonnell Douglas to arrange for the six machine tools at Nanchang to be shipped** to and consolidated with the nine machine tools at Tianjin. The Department of Commerce informs McDonnell Douglas that it has revoked the export licenses for the four machine tools at Monitor Aerospace in Amityville, New York.
June 1	**In a letter to CATIC, McDonnell Douglas requests CATIC take immediate action** to consolidate all machine tools at one location in Tianjin, and informs CATIC that the Commerce Department has cancelled the export licenses for the four machine tools in Amityville, New York.

July 15	**Letter from CATIC to McDonnell Douglas confirms that no agreement could be reached** with Monitor Aerospace to build the machining center, and that Nanchang Aircraft Factory was interested in purchasing six machine tools. The letter asks McDonnell Douglas to obtain U.S. Government approval for that transaction.
August 1	**McDonnell Douglas applies for Commerce Department licenses** to allow six machine tools to remain at the Nanchang Aircraft Factory.
August 23	**During a visit to the Nanchang Aircraft Factory, McDonnell Douglas representatives discover** the hydraulic stretch press uncrated and situated in a partially completed custom building designed and built around it.
September 28	**Commerce Department informs McDonnell Douglas** to remain at Nanchang Aircraft Factory.
October	**McDonnell Douglas requests amended export licenses to allow the machine tools** at Tianjin and Nanchang to be moved to Shanghai Aviation Industrial Corporation for use in the Trunkliner program.
November 7	**Commerce Department's Office of Export Enforcement opens investigation** of the machine tool diversion.
November 28	**The Office of Export Enforcement Los Angeles Field Office asks the Commerce Department to issue a Temporary Denial Order against CATIC.**
December 7	**Office of Export Enforcement denies the request** for a Temporary Denial Order against CATIC.

December	**CATIC Machining Center in Beijing was reportedly to start** producing Trunkliner parts.

1996

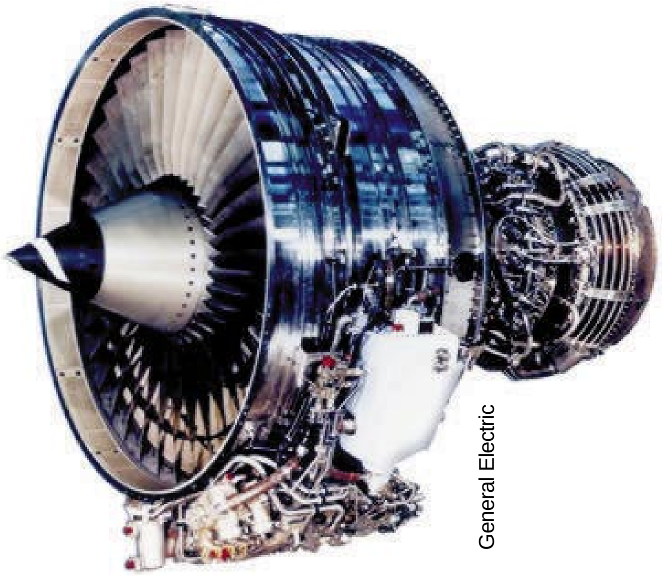
January 31	**Commerce Department is informed that five of the six Nanchang machine tools have arrived** at the Shanghai Aviation Industrial Corporation. The hydraulic stretch press remains at Nanchang.
February 6	**Amended licenses are approved by Commerce Department** to permit the machine tools to be used by the Shanghai Aviation Industrial Corporation.
Late Winter/ Early Spring	**U.S. Customs Service joins** machine tool investigation.
April 23	**U.S. Embassy official visits Shanghai Aviation Industrial Corporation** and examines the machine tools from Tianjin.
June 21	**Portions of the hydraulic stretch press** from Nanchang are reported to be at Shanghai.
July	**Marc Reardon, the Commerce Department Los Angeles Field Office case agent for the machine tool investigation, resigns.**
August 5	**The remaining parts of the hydraulic stretch press** from Nanchang are reported to be at Shanghai.

PRC Targeting of U.S. Jet Engines And Production Technology

The PRC's acquisition of aerospace and defense industrial machine tools from U.S. and foreign sources has expanded its manufacturing capacity and enhanced the quality of military and civilian commodities that the PRC can produce.[78]

These acquisitions will support the PRC's achievement of a key goal: the development of an aerospace industrial base that is capable of producing components and structural assemblies for modern manned aircraft and cruise missiles.[79]

To meet combat mission requirements, modern military aircraft and cruise missiles require advanced jet engine systems.[80] The PRC does not have an indigenous production capability for advanced jet engines. Thus, acquiring such a capability has been a national priority for the PRC throughout the 1990s.[81] Development of new commercial and military jet engines is also a priority. The PRC is also likely to be focused on production of jet engines similar to those used for both commercial aircraft and for cruise missiles.



General Electric

In 1983, the PRC legally acquired two GE CFM-56 jet engines, ostensibly for a civil aircraft program. The PRC later claimed that the engines were destroyed in a fire. More likely, the PRC reverse engineered part of the CFM-56 to develop a variant for use in military combat aircraft.

The PRC's activities indicate that Beijing has a particular interest in the acquisition of jet engine production technologies and equipment from U.S. sources. Moreover, the PRC has reportedly sought to compensate for shortfalls in its indigenous capabilities by acquiring complete jet engines from U.S. sources.[82]

In the mid-1980s and early 1990s, the PRC apparently adopted a three-track approach to acquiring U.S. equipment and technologies in order to advance its own military jet engine capabilities:

- **The diversion of engines from commercial end uses**
- **Direct purchase**
- **Joint ventures for engine production**

The PRC's acquisition targets suggest that it planned to acquire several families of jet engines that could be adapted to various military and commercial applications.[83]

The PRC has been particularly interested in acquiring "hot section" technology from U.S. sources.[84] The United States is the world leader in hot section technology for turbojets and turbofan engines. As a result, U.S. military aircraft can outlast and outperform foreign-built military aircraft.[85] In this regard, the PRC seeks:

> *Technology such as materials and coatings inside the turbine that can withstand extreme heat and associated cooling systems, and could be used to increase power and durability of Chinese aero-engine designs.*[86]

In 1983, the PRC legally acquired two General Electric CFM-56 jet engines, ostensibly to analyze the engines for a potential civil aircraft upgrade program. In the course of the export licensing process, the Defense Department insisted on restricting the PRC's use of the engines. Under the terms of the licensing agreement:

> *No technical data was to be transferred with the engines; the Chinese were not to disassemble the engines; and finally, if the Trident [civil aircraft] retrofit program had not begun within 1 year of the engines' arrival, the engines were to be repurchased by the manufacturer. In addition, the Chinese offered to retrofit*

engines at a Shanghai commercial aircraft facility where GE personnel would be able to monitor Chinese progress.[87]

Defense Department officials were concerned because the CFM-56 hot sections are identical to those used in the engines that power the U.S. F-16 and B-1B military aircraft.[88]

The PRC later claimed that the CFM-56 engines were destroyed in a fire.[89] More likely, however, is that the PRC violated the U.S. end-use conditions by reverse engineering part of the CFM-56 to develop a variant for use in combat aircraft.[90]

Despite the suspected reverse engineering of the two General Electric jet engines that were exported in 1983, G.E. reportedly signed a contract in March 1991 with the Shenyang Aero-Engine Corporation for the manufacture of parts for CFM-56 engines.[91] According to one source, Shenyang "put in place quality and advanced manufacturing systems to meet US airworthiness standards."[92]

The PRC aggressively attempted to illegally acquire General Electric's F404 engine, which powers the U.S. F-18 fighter.[93] The PRC likely intended to use the F404 jet engine in its F-8 fighter.[94] The PRC succeeded in acquiring some F404 technology through an indirect route by purchasing the LM-2500, a commercial General Electric gas turbine containing the F404 hot section.[95]

In addition, G.E. has reportedly proposed a joint venture with the PRC to manufacture the so-called CFM-56-Lite. The engine could power the PRC's planned AE-100 transport.[96]

The PRC also has targeted large engines for aerospace and non-aerospace applications. The PRC's acquisition plans reportedly include Pratt & Whitney JT-8 series engines and technology to support its large aircraft projects, as well as marine derivatives of the G.E. LM-2500 for naval turbine propulsion projects.[97] Regarding the JT-8 series:

In August 1986, CATIC licensed the technology for the U.S. Pratt and Whitney FT8 gas turbine engine, including joint development, production and international marketing rights. The FT8 is a development of the JT8D-219 aero-engine (used to power Boeing 727, Boeing 737, and MD-82 aircraft), and can produce 24,000 kW (33,000 hp). [It] represented another significant technical leap for China's gas turbine capability . . . Chinese students were also sponsored by Pratt and Whitney for graduate level aerospace training in the United States.[98]

The PRC's efforts to acquire compact jet engines can be traced to 1965, when the Beijing Institute of Aeronautics and Astronautics launched a project to copy the U.S. Teledyne-Ryan CAE J69-T-41A (*depicted at right).*[99]

The Teledyne-Ryan J69, jet engine, which the PRC copied in the 1960s.

The Teledyne engine powered the U.S. Air Force AQM-34N Firebee reconnaissance drone, a number of which were shot down over the PRC during the Vietnam conflict.[100]

The jet engine for the U.S. Air Force AQM-34N Firebee reconnaissance drone, a number of which were shot down over the PRC during the Vietnam War, was copied by the PRC and currently is used in PLA cruise missiles.

The PRC's copy of the U.S. turbojet, dubbed WP-11, began ground testing in 1971 and currently powers the PLA's HY-4 "Sadsack," a short-range anti-ship cruise missile.[101]

The PRC began work on cruise missile engines in the 1980s. The PRC's interest in developing long-range cruise missiles increased dramatically after the 1991 Persian Gulf War, when the performance of U.S. Tomahawk cruise missiles demonstrated the effectiveness of precision missile strikes using conventional warheads. However, technical challenges slowed Beijing's efforts. For this reason, the PRC has attempted to acquire foreign-built engines for technical exploitation. If the PRC succeeds in building cruise missile propulsion and guidance systems, then it would probably not have difficulty marketing cruise missiles to third world countries.[102]

In 1990, the PRC attempted to advance its cruise missile program by purchasing the Williams FJ44 civil jet engine (*depicted at right*).[103] This compact turbofan was derived from the engine that powers the U.S. Tomahawk cruise missile (*shown below*).

Williams FJ44

Associated Press

A year after the PRC had attempted to advance its cruise missile program by purchasing the Williams FJ44 civil jet engine, the 1991 Persian Gulf War impressed the PRC with how long-range cruise missiles like the U.S. Tomahawk, being fired in the photo above, could strike their targets with precision.

The FJ44 engine might have been immensely valuable to the PRC for technical exploitation and even direct cruise missile applications.[104] But the PRC's effort to acquire FJ44 engines was rebuffed.[105]

CASE STUDY: Garrett Engines

The redundancy inherent in the PRC's three-track approach to advancing its military jet engine capabilities — diversion of engines from commercial use, direct purchase, and joint ventures — began to bear fruit in the early 1990s.[106]

The Cold War's end and a liberalization of Cold War-era export controls on dual-use products and technologies opened new opportunities for the PRC to acquire advanced jet engines and production capabilities. A notable opportunity developed in 1991 when, as part of an overall liberalization of export controls by the Coordinating Committee for Multilateral Export Controls (COCOM), the Commerce Department decontrolled a popular jet engine manufactured by Allied Signal's Garrett Engine Division.

Prior to 1991, the Garrett engine required an individual validated license that included restrictive conditions.

The Commerce Department's decision that Garrett jet engines were decontrolled ensured that they could be exported to the PRC without a license or U.S. Government review. The decision also opened the way for a jet engine co-production arrangement sought by the PRC.

Negotiations for a co-production deal between Allied Signal and PRC officials progressed until July 1992, when the Defense Department learned of the plan.[107] The Defense Department's reaction to the news sparked an interagency review of the Commerce Department's decision to decontrol the Garrett engines.

The co-production deal was terminated after the review demonstrated the potential national security implications of transferring jet engine production capabilities to the PRC.[108]

PRC Targeting of Garrett Engines

The PRC's reported motivation for initiating the Garrett engine purchase was the PRC's requirement for a reliable, high-performance Western engine for its developmental K-8 military aircraft.[109]

The K-8, depicted below, is a multi-role aircraft that can serve as a trainer, fighter, or light ground attack bomber.[110] The K-8 project was initiated by the PRC around 1987, and later became a joint effort with Pakistan.

Janes Defense Group

Beijing has a particular interest in the acquisition of jet engine production technologies and equipment from U.S. sources. The PRC's reported motivation for initiating the purchase of Garrett engines was its need for reliable, high-performance power plants for its developmental K-8 military aircraft (shown here in Pakistani liverage). In addition to serving as a trainer, it can be used as a fighter jet or light ground-attack bomber.

PRC aerospace organizations involved in the project included:

- **China National Aero-Technology Import-Export Corporation (CATIC)**
- **China Nanchang Aircraft Manufacturing Company**
- **China National South Aero-Engine and Machinery Company**[111]

The PRC's access to the Garrett TFE-731 *(depicted below)* may have influenced its choice of small jet engines in general, and K-8 propulsion in particular. The PLA purchased a fleet of Learjets from the U.S. on the understanding that the aircraft would be for civil use. It is suspected, however, that the PLA diverted both the aircraft and the engines for military purposes, including PLA reconnaissance missions.[112]

The Garrett TFE-731 jet engine sought by the PRC was determined by the Department of Defense not to be a derivative of an older civilian-use engine, but rather a substantially improved power plant used in military aircraft such as the Spanish-manufactured CASA C-101 attack jet.

U.S. Government Approval of the Initial Garrett Engine Exports

In August 1989, Allied Signal applied for an export license to sell a variant of the TFE-731, the TFE-731-2A-2A, to the PRC. Four engines and spare parts were to be shipped.[113] The U.S. Federal Aviation Administration (FAA) had certified the TFE-731-2A-2A as a "civil" engine.[114]

According to Iain S. Baird, then-Deputy Assistant Secretary of Commerce for Export Administration, the Commerce Department had licensing authority for the civil engine regardless of its military (i.e., the PLA's K-8 military aircraft) application.[115]

The 1989 application for the export of the Garrett engines to the PRC raised concerns among officials at the Defense Technology Security Administration, which was the focal point for export policy guidance and license reviews within the Defense Department.[116]

A Defense Technology Security Administration technical analysis, for instance, indicated that the TFE-731-2A-2A had "some design and manufacturing technical data … common to the … TFE1042 and TFE1082," both of which are combat aircraft engines.[117]

Given this Defense Department judgment, a condition was placed by the Commerce Department on the export license for the TFE-731-2A-2As:

> ***"There is to be no transfer of engine design or manufacturing technical data provided with this transaction."*** [Emphasis added][118]

The case was also reviewed by COCOM. Subsequently, the Commerce Department issued an Individual Validated License (number D032648) for the Garrett engines on May 30, 1990.[119]

In December 1990, Allied Signal asked the Commerce Department for approval to sell an additional 15 of the TFE-731-2A-2A engines to the PRC.[120]

These engines were reportedly to be used for the first production run of the PLA's K-8 military aircraft, which were to be sold to Pakistan. The Defense Department and COCOM again reviewed the license application, and Defense requested conditions that would forbid the release of TFE-731-2A-2A "design methodology, hot section repair/overhaul procedures and manufacturing information."[121]

On June 12, 1991, the Commerce Department granted Individual Validated License D130990, which included the Defense Department's recommended conditions.[122]

Commerce Department Decontrol of the Garrett Jet Engines

In August 1991, Allied Signal requested that the FAA re-certify the TFE-731-2A-2A engine with a digital electronic engine controller.[123] The FAA had certified the engine in 1988 with an analog engine controller.[124]

It is unclear from the available information whether the PRC requested this upgrade of the engine to include the digital electronic engine controller, or whether Allied Signal decided to upgrade the engine on its own initiative.[125]

On September 1, 1991, the Commerce Department published revisions to the Export Administration Regulations to reflect liberalized export controls that had been agreed to by the United States and its COCOM partners.[126] The revised regulations decontrolled many jet engines, but continued to control exports of engines equipped with full authority digital engine control (FADEC) systems.[127]

These militarily-sensitive systems control jet engine operations to permit, among other things, maximum propulsion performance for manned and unmanned military air vehicles.[128]

According to Defense Department records, Allied Signal sent a one-page document to the Commerce Department on September 30, 1991 representing that the TFE-731-2A-2A did not use a FADEC system, but instead used a less capable digital electronic engine controller (DEEC). For this reason, Allied Signal officials believed the TFE-731-2A-2A was completely decontrolled under the revised Export Administration Regulations and COCOM controls.[129]

Technical experts at the Defense Technical Security Agency had already presented their analysis to Commerce Department officials, countering that the TFE-731-2A-2A contained a FADEC and therefore remained controlled under COCOM and U.S. regulations.[130]

On October 1, 1991, one day after receiving the Allied Signal document regarding the FADEC issue, the Commerce Department ruled that the TFE-731-2A-2A did not contain a FADEC. The Commerce Department then informed Allied Signal's Garrett Engine Division that it could export TFE-731-2A-2A jet engines to the PRC under a General License (a so-called G-DEST license) pursuant to the Export Administration Regulations, as long as production technology was not transferred.[131]

Defense Department records indicate that officials at the Defense Technology Security Administration concurred with the Commerce Department decision to permit this export, but mistakenly believed it was still under an Individual Validated License arrangement — that is, with the requested Defense Department conditions.[132]

Subsequently, the Commerce Department amended the October 1, 1991 decision and notified Allied Signal on November 25, 1991 that it had decontrolled the TFE-731-2A-2A entirely.[133]

Engine production technology could now be exported to the PRC without a license.[134] According to Defense Department records, Commerce Department officials relied exclusively on Allied Signal's September 30, 1991 representation concerning the engine controller for the TFE-731-2A-2A — that is, that the controller was not a FADEC, and thus was no longer controlled.[135]

Bruce C. Webb, then a senior analyst at the Commerce Department's Office of Nuclear Controls, recalls that a U.S. Government advisory group had reviewed the Allied Signal document and agreed with the company's assertion that the TFE-731-2A-2A was not equipped with an embargoed FADEC.[136] However, in response to document requests by the Select Committee, the Commerce Department was unable to provide any records of any technical reviews that it may have conducted.[137]

The Interagency Review of the Proposed Export of Garrett Engines

Iain Baird, then-Deputy Assistant Secretary of Commerce for Export Administration, claims that the Commerce Department coordinated with appropriate agencies before making the General License determination in November 1991. However, the Commerce Department was unable to provide the Select Committee with any documentary evidence to this effect.[138]

A Defense Technology Security Administration staff member suggests that other agencies learned of the decision by chance, or "dumb luck."[139] In addition, according to a December 29, 1992 Defense Department memorandum for the record:

> *Commerce approved, with DoD and CoCom concurrence, the sale of 15 Garrett TFE-731-2A-2A engines to the PRC for incorporation into military trainers being exported to Pakistan.*
>
> *In July 1992 DTSA [the Defense Technology Security Administration] learned from cable traffic that the PRC and Garrett were negotiating an arrangement to coproduce this engine in China for use in PLA military trainers.*
>
> *We learned shortly thereafter that Department of Commerce had determined in November 1991 that the engine did not require an Individual Validated License (IVL) for shipment to the PRC.*
>
> *Department of Commerce, without consulting with Department of Defense, classified the engine and technology decontrolled (or "G-DEST") under the CoCom Core List implemented on 1 September 1991.*
>
> *DTSA believes the export requires an IVL [Individual Validated License].*[140]

After receiving a copy of the July 1992 cable, the Defense Technology Security Administration initiated an interagency review of the Commerce Department General License decision regarding the Garrett engines.[141] The Commerce Department agreed to suspend its decision pending the outcome of the review.

Officials at the Defense Technology Security Administration reportedly were especially concerned over any transfer of jet engine production technology to the PRC. They were also surprised that the Commerce Department opted not to coordinate its decision, given the agency's oft-repeated concerns over any transfer of jet engine production technology to the PRC.[142]

The Commerce Department's decision to decontrol Garrett engine technology was considered in the context of several U.S. policies. Two policies in particular dominated the interagency debate: the 1991 Enhanced Proliferation Control Initiative (EPCI), and COCOM controls on jet engine technologies.

Consideration of Enhanced Proliferation Control Initiative Regulations

The Enhanced Proliferation Control Initiative was established by the Bush administration to provide a non-proliferation "safety net." It was intended to restrict the export of technologies usable for chemical and biological weapons or missiles, *regardless* of whether such technologies were controlled under existing international agreements (for example, under the 1987 Missile Technology Control Regime).

As explained by the Commerce Department:

> *Foreign policy controls are being imposed on certain exports by adopting a policy of denial for items that already require a validated license, for any reason other than short supply, where the export is determined to be for a facility involved in* ***the development, production, stockpiling, delivery, or use of chemical or biological weapons or of missiles****.*
>
> *The purpose of these controls is to prevent American contribution to, and thereby* ***distance the United States from****, the proliferation of chemical and biological weapons and* ***missile development.***

> *These controls serve to demonstrate U.S. opposition to the spread of these weapons and provide specific regulatory authority to control exports from the United States of commodities or technology where there is a significant risk that they will be used for these purposes.* [Emphasis added][143]

According to the August 1991 interim Enhanced Proliferation Control Initiative regulations, the Commerce Department should have conducted a "case-by-case" review of Allied Signal's proposed export to determine whether it "would make a material contribution to the proliferation of missiles." If the export were "deemed to make such a contribution, the license [would] be denied."[144]

Baird states that an Enhanced Proliferation Control Initiative review was not conducted for the engines, but was conducted for the production technology: "As far as the engines went, sending the whole engine up, we didn't feel it raised EPCI concerns. As far as the technology went, we did." Baird did not further explain the basis for the Commerce Department decision that the Garrett engines themselves did not require an Enhanced Proliferation Control Initiative review; nor did he explain why the technology did raise EPCI concerns.[145]

The Department of Commerce was unable to provide the Select Committee with any records of the Enhanced Proliferation Control Initiative review it conducted for the Garrett engine production technology.[146]

Allied Signal's partners in the Garrett engine transaction included:

- **The China National Aero-Technology Import-Export Corporation (CATIC)**
- **China Nanchang Aircraft Manufacturing Company**
- **The China National South Aero-Engine and Machinery Company**

A 1992 U.S. Government review of these proposed end users found that the export of Garrett engine production technology to the PRC could pose a national security threat to the United States.

The review found that PRC co-production of Garrett TFE-731-2 engines would enable Beijing to develop higher quality turbojet and turbofan engines for use in military and civilian aircraft and in cruise missiles. PRC access to this production process would also give Beijing the means to extend the range of its cruise missiles. This was of special concern because PLA missiles, rockets, and aircraft are produced at facilities also used for civilian production.

A Garrett representative confirmed that the Zhuzhou South Motive Power and Machinery Complex was the intended producer of the Garrett TFE-731-2 engine. There was concern that a flow-through of applicable production technologies to the PRC's cruise missile engine program was almost inevitable.[147]

The PLA's HY-4 cruise missile is reportedly now powered by a copy of a U.S. turbojet engine.[148] In addition, the conditions placed on the export of the Garrett engine technology of course would not prevent the PRC from reverse engineering the engine if that were the PRC's intent.[149]

Each of the PRC participants in the Garrett engine co-production venture produces military hardware. Despite the assurances of Allied Signal that the engines it proposed to produce in the PRC would be used entirely for commercial purposes, PLA personnel were prominent in the negotiations with Garrett. The CATIC representatives were the same individuals who were prominent in the Committee on Foreign Investment in the United States (CFIUS) case involving the attempted purchase of MAMCO, a Boeing contractor, by CATIC. This is the only CFIUS case in which the President reversed a sale on national security grounds.[150]

Because the PRC could incorporate complete TFE-731-2A-2A engines or modified variants directly into cruise missile airframes, export to the PRC of the engines themselves — as well as the production technology — presented a national security threat.[151]

Consideration of COCOM and Export Administration Regulations

COCOM and Export Administration Regulation reviews were conducted to assess sensitive components in the Garrett TFE-731-2A-2A jet engine.

When Allied Signal's Garrett Engine Division upgraded the TFE-731-2A-2A with the addition of a digital engine controller, it claimed that the new system did not require an export license under the revised Export Administration Regulations and COCOM controls. It was determined that COCOM had not developed an agreed-upon technical definition to distinguish restricted from unrestricted engine controllers.[152] This shortfall in the regime set the stage for an extended interagency debate over the status of the TFE-731-2A-2A vis-à-vis COCOM regulations.

The Defense Department believed the Garrett engines contained an embargoed, full authority digital engine control (FADEC) system. Moreover, the Defense Department obtained new information about improvements to the Garrett TFE-731-2A-2A that raised additional national security concerns.[153]

Regarding the FADEC issue, the Defense Department acquired analysis and technical studies from numerous sources. A Defense Technology Security Administration analysis explained, for example:

> *The Garrett engine contains what [Allied Signal] calls a Digital Electronic Engine Control (DEEC) but describes in company literature as "full-authority, automatic engine control." DTSA maintains that the DEEC is a FADEC for the following reasons:*
>
> *FAA certification officials state in writing that the "DEEC" controller is a FADEC. Also DoD experts at the Air Force Aeronautical Systems Center and the Naval Air Warfare Center have assessed that the Garrett engine controller is a FADEC.*[154]

Additional confirmation of these findings was contained in a technical paper developed by the engineering staff at the Defense Technology Security Administration:

> *In summary, the entire DoD Category 9 [aero-engines] negotiating team to COCOM during 1990-91 . . . are in agreement after detailed analysis, with assistance from experts in controls from Navy, Air Force and FAA, of data proprietary to Allied-Signal and otherwise, that the ASCA [Allied Signal Controls & Accessories division] DEEC, P/N 2118002-202 is a FADEC.*

> *Allied-Signal's memo to DTSA . . . shows this is indeed the FADEC utilized on the GED [Garrett Engine Division] TFE731-2A-2A engine.*

The Defense Department inquiry found further that Allied Signal initially did not provide accurate information to the Federal Aviation Administration during the civil certification process for the TFE-731-2A-2A:

> ***GED [Garrett] was rebuked by FAA engineers*** *in 1988 for their claim that the -2A engine was a direct derivation from a -2 engine rather than being derived from a TFE731-3. GED subsequently provided FAA with a corrected derivation showing that the engine was actually a TFE731-3 with TFE-731-3B parts and components rather than TFE731-2 components.*
>
> *Substantial improvement to the TFE731-2A engine occurred when the so-called "Extended Life Turbine Modifications" were added during December, 1991, only one month after DOC [Commerce] had notified GED it had decontrolled the engine….*
>
> ***The Extended Life Turbine (ELT) resulted from the NASA program to obtain significant reductions in noise and emission levels, i.e., decreased infrared (IR) signature.*** *The ELT has an enhanced damage tolerance and changes TFE731-series engines from an expected life of approximately 6,000 hours to 10,000 hours.*
>
> *In summary, the engine GED [Garrett] submitted for a 'paper certification' as a TFE731-2A in 1988 was not a derivative of a -2 engine but was derived from a TFE731-3 with a TFE731-3B LP compressor. The changes noted above were included in the 1988 engine, i.e., the A5 seal and both LP compressor and turbine blades changed. The ELT was added in 1991.*

> *In conjunction with the slight derating of the engine in 1988, life expectancy of this engine is greatly enhanced over a TFE731-3 turbofan engine; it is more durable, reliable, and generally* ***more appropriate for use on military aircraft.***
>
> ***No applications of this engine to civil airframes are known to have been attempted by Allied-Signal, only military.***[155]
> [Emphasis added]

The evidence obtained by the Defense Department indicated that the TFE-731-2A-2A was not simply a 20-year old engine for business jets, as Allied Signal and Commerce Department officials had claimed.[156] (Indeed, as of January 3, 1999, the TFE-731-2A-2A has never been used in a business jet.)[157]

It is true that the engine had been derived from the TFE-731-3, an engine used in both civil and military applications, including the Cessna Citation III business jet and the CASA C-101BB ground-attack jet. But the engine had been upgraded with a new turbine to lower its infrared signature, thus improving the combat survivability of the aircraft in which it would be contained — for example, through the ability to escape detection by surface-to-air missiles.[158]

Resolution of the Garrett Engine Controversy

The Garrett engine controversy was ultimately resolved through an interagency agreement at the Deputy Assistant Secretary level. Regarding the disputed engine controller, the Deputy Assistant Secretary of Defense for Counterproliferation Policy, Mitchel B. Wallerstein, described an interagency compromise in a March 21, 1994 letter to the Deputy Assistant Secretary for Export Controls at the State Department:

> *Defense is prepared to agree with the Allied (and Commerce) determination that the engine does not include a Full Authority Digital Engine Control System (FADEC) which meets the IVL [Individual Validated License] criteria….With respect to the 2A-2A engine,* ***our proposed carve out from the definition of FADEC would provide a basis for a Commerce G-DEST***

> ***classification which would allow sales of the 2A-2A engine to the PRC, including its military, without prior [U.S. Government] review and approval.*** *It is unclear whether such a definitional carve out would require multilateral coordination with our current allies before such a G-DEST classification is made.*[159]

The State Department agreed with this proposal, and stated further: "We do not believe that it is necessary to coordinate multilaterally with our COCOM partners before moving to G-DEST treatment."[160]

Peter M. Leitner, senior trade advisor at the Defense Technology Security Administration, believes that the "definitional carve out" entailed a political decision to change the definition of the engine controller in order to circumvent export regulations and, in this case, avoid a COCOM review. According to Leitner, "you come up with some unique definition of the item and try to exempt or carve out… coverage of that item in the regulations."[161]

Baird believes that COCOM reviewed the export license application for the upgraded variant of the Garrett TFE-731-2A-2A.[162] Webb believes COCOM did not review the application.[163] The Commerce Department was unable to provide records of any COCOM review conducted for the upgraded Garrett engines.[164]

Defense Department records indicate that some U.S. government officials believed a COCOM review of the upgraded engines was essential. Without such a review, the United States might be seen by its partners as attempting to "circumvent CoCom controls."[165]

Wallerstein interprets the reference to "a carve out from the definition of FADEC" to mean that the disputed FADEC engine controller would be removed or modified to ensure that the TFE-731-2A-2A could be exported without controlled technology.[166] However, Wallerstein does not recall seeing any technical proposal from Allied Signal to modify the engine controller.[167]

The documentary record suggests that the final, upgraded variant of the Garrett TFE-731-2A-2A was never submitted for a review by COCOM, which ceased operations in April 1994.[168]

The status of the Garrett engines vis-à-vis the Enhanced Proliferation Control Initiative was largely resolved on August 19, 1993 during a meeting of the Commerce Department-chaired Operating Committee on Export Policy. According to a record of the meeting:

> *Commerce, State, and Defense have agreed to treat these commodities as if they were controlled. Moreover, [Allied Signal] has agreed not to transfer any co-production technology relating to these engines to the PRC.*[169]

This interagency decision was finalized and reported in the news media in October 1995. As the *Wall Street Journal* reported then:

> *Allied Signal already has shipped about 40 built-up engines to China under the liberalized post-Cold War export rules, and isn't being deterred from exporting 18 more that the Chinese have ordered.*
>
> *But when it sounded out the U.S. Commerce Department last summer about its coproduction plan, the company was told that if it formally applied for a license to do so the application would be denied under the rules of the Enhanced Proliferation Control Initiative … The company decided not to apply for the license.*[170]

Between 1992 and 1996, Allied Signal reportedly exported 59 of these TFE-731-2A-2A jet engines to the PRC. Beijing's main interest was in acquiring a production capability for the engines; thus, it halted further orders when co-production plans were scuttled.[171]

The PRC Continues to Acquire Jet Engine Production Processes

The PRC is continuing its effort to acquire production processes for U.S. jet engines. For example, Pratt & Whitney Canada, a subsidiary of Connecticut-based United Technologies, in February 1996 became "the first foreign company to establish an aviation parts manufacturing joint venture in China (with Chengdu Engine Company)."[172] The Chengdu Engine Company manufactures components for, among other purposes, large jet engines used in Boeing aircraft.[173] The Chengdu factory also manufactures parts for the PRC's WP13 turbojet engine, which powers the PLA's F-8 fighter.[174] In 1997, a new joint venture was reportedly proposed for Chengdu.

> *A consortium of Pratt and Whitney, Northrop Grumman and Hispano-Suiza are offering a new aero-engine, the PW6000, specifically designed to power the AE-100 transport, and are planning to establish an aero-engine joint venture at Chengdu, Sichuan Province.*[175]

United Technologies operates additional aviation joint ventures with Xi'an Airfoil Technology Company and China National South Aero-Engine and Machinery Company. These ventures are largely comprised of manufacturing jet engine "cold section" components or producing relatively low-technology "hot section" components.[176] United Technologies claims that it has coordinated these aviation projects fully with the appropriate export licensing organizations in the U.S. Government.[177]

The PRC may have also benefited from direct exploitation of specially designed U.S. cruise missile engines. According to published reports, the PRC examined a U.S. Tomahawk cruise missile that had been fired at a target in Afghanistan in 1998, but crashed en route in Pakistan.[178]

THE PRC'S ACQUISITION OF MACHINE TOOLS, COMPOSITE MATERIALS, AND COMPUTERS FOR AIRCRAFT AND MISSILE MANUFACTURING

Since the Second World War, the aircraft industry has been among those sectors of the manufacturing industry in the forefront of users of advanced machine tools. Machine tool application in the aircraft industry has been dual-use. The same types of tools and manufacturing processes have been used for both military and civilian aircraft, especially large transport aircraft.

Many of the same machine tools and manufacturing processes are also used in manufacturing strategic and tactical missiles.

The requirements of the aircraft industry, although far outweighed by those of other industries in terms of production volume, have played an important role in helping to motivate the development of machine tools of high precision and versatility. For example, in the United States, some of the earliest research on numerical control of machine tools was sponsored by the U.S. Air Force. The work was done at MIT, with application to aircraft manufacturing as the objective.[179]

The PRC, too, has recognized the importance of machine tools in both its military and civilian aircraft production programs, as well as in industry generally. Particularly since the 1960s, it has embarked on a variety of programs both to acquire machine tools from foreign sources, and to develop an indigenous machine tool industry.

The United States has exported substantial numbers of advanced machine tools to the PRC for aircraft co-production programs, including the Boeing 737 and the McDonnell Douglas MD-80, under end-use agreements and controls. (Prior to the

1960s, before the ideological break with the Soviet Union, the PRC relied to a considerable extent on technology transfer in the aircraft and missile field from the Soviet Union. More recently, since the collapse of the Soviet Union, transfer of aircraft technology from Russia, driven by economics if not ideology, has been increasing.)

Manufacturing Processes for Aircraft Structures

Aircraft structures are constituted mainly of metal parts and subassemblies, employing aluminum alloys, titanium alloys and, to a much lesser extent, steel alloys.

Over the past 30 years, there has been increasing use made of fiber composites of high strength-to-weight ratio, especially in military aircraft; but metal parts remain the predominant structural material for most aircraft, military or civilian.[180]

Metal parts are typically fabricated from sheet, bars (billets), molded pieces (castings), or shaped pieces (forgings). Almost all metal parts require, at some stage of manufacturing, processing to their final dimensions and finish by cutting, metal removal, shaping, or forming. This requires the use of machine tools.

Most of these machine tools are general purpose, and can be used to process a wide variety of parts, as well as to join component parts into subassemblies and assemblies by use of riveting, welding, and bonding. The various types of automatic machinery used in these joining processes may be general purpose, or may be specifically designed or modified for the particular assembly being fabricated.

Machine tools used in aircraft manufacturing today are generally **numerically controlled (NC)**. The more advanced and modern manufacturing facilities are **computer-numerically controlled (CNC)**. Many of today's high-tech machines also have automatic tool changing capability. In factory layouts, these machines are part of *machining centers* where they are integrated with automated systems for materials and workpiece handling (for example, transportable pallets that carry the workpieces).[181]

Another level of automation and process integration that has been achieved in large-scale production only recently (for example, in the Boeing 777) is the integration of computer aided design (CAD) with computer aided manufacturing (CAM).[182] With CAD/CAM, the output of the computer design process is translated directly into numerical computer code that can be sent directly to computer-controlled machines and machining centers.

The next step in manufacturing process integration is **computer integrated manufacturing (CIM)**.[183] In this step, integrated computer controls manage the entire product flow from design to sales to delivery, including not only CAD/CAM but also:

- **Materials ordering**
- **Warehousing**
- **Inventory control**
- **Factory scheduling**

Finally, the integration is being extended to networks of geographically scattered suppliers, creating global infrastructures supporting international manufacturing enterprises.[184]

High-Tech Metal Cutting

To a considerable degree, the extent of advanced capability of computer-numerically controlled machine tools is indicated by the number of axes that can be controlled. (This is often how the sophistication of these machines is described in export control documents.)

The "number of axes" means the number of motions of either the tool or the workpiece that can be simultaniously controlled.[185] Thus, a drilling machine in which the tool can travel vertically, and the workpiece is held to a bed that can travel both horizontally and laterally, is a three-axis machine. Three-axis machines are widely used, and widely available worldwide.

A milling machine is one of the most versatile machine tools. And when a milling machine's cutter is fixed, and the workpiece is mounted on a pallet that can not only move vertically, horizontally, and laterally, but also rotate about two perpendicular axes, it becomes a five-axis milling machine. There are other combinations of tool and pallet motions that may be advantageously embodied in five-axis milling machines, depending on the particular applications of those machines.

There is no fundamental difficulty in conceiving or understanding the design and operation of these sorts of five-axis machines. It is believed that some five-axis machines may have been manufactured in the PRC.[186] However, the design and production of five-axis milling machines capable of maintaining the highest levels of accuracy and control of workpiece tolerances — during high-speed machining, over the entire range of three-dimensional motions and rotations that the machine may trace out in machining a complex part — calls for a high degree of capability in machine tool and supporting technologies (for example, materials and quality control).

It is not believed that the PRC has yet attained that level of capability. But such sophisticated five-axis machines have been exported from the United States to the PRC under license, with end-use controls, for use in co-production of commercial aircraft. In addition, the PRC may have been able to import them from one of the several non-U.S. countries that manufacture them.

The value of high precision multiple-axis machines in manufacturing is that they broaden the range of design solutions available for structural elements and for structural assemblies. In most cases, an aircraft structural designer (or computer design program) without such advanced machine capabilities would have to design less optimal parts and structures. This would mean disadvantages in terms of the extra weight of the parts and structures, and a higher unit cost relative to what could be achieved with more advanced machine tools.

However, in some instances, increased effort by highly skilled craftsmen can offset the disadvantages of using less advanced or lower-precision machine tools. In advanced industrial economies such as the United States, the high cost of such skilled labor almost always strongly favors investments in more advanced machinery. In the PRC, the cost tradeoffs in favor of advanced machinery over additional skilled labor are less.

Nevertheless, for the PRC, the advantages of having advanced machinery for manufacturing both modern civilian transport and military aircraft remain sufficient to motivate continuing efforts on their part to acquire them. In co-production arrangements with the major aircraft producers, it is usually necessary for the PRC to be provided with the same types of machines with which the parts being co-produced were originally designed.

The progress in refinement of machine tools has been substantial in recent years. For the most part, this progress is the result of advances in control systems, and in the machines' associated software. The mechanical components of machine tools have remained mostly unchanged over the past decade, although there have been a few improvements, such as higher spindle speeds. The more modest advances in the mechanical precision and versatility of machine tool control have complemented the rapid advances in computer-aided design and manufacturing. In part, the improved mechanical components themselves are the result of these vastly improved CAD/CAM capabilities; the improved machine tool components also make it possible to use CAD/CAM capabilities more effectively.

The following table indicates the improvements in the accuracy and repeatability of five-axis machines over the past decade.

Recent High-Tech Improvements in the Accuracy and Repeatability for 5 Axis Machines

	1988	1998
Linear Accuracy	0.0005 – 0.0010 inches	0.0001 – 0.0002 inches
Repeatability	50 millionths of an inch	5 to 10 millionths of an inch
Rotary Accuracy	0.01 to 0.001 degrees	Better than 0.001 degrees

Thus, 10-year-old machines are well below current best levels of accuracy.

The current thresholds for subjecting metal cutting machines to export controls are, for example, positioning accuracy of 4 to 6 microns (around 0.00012 inches) and rotary accuracy, when specified, of 0.003 degrees. Milling machines with five or more axes are subject to export controls regardless of accuracy.

In the advanced industrialized nations, machine tool accuracy has increased across the entire spectrum of computer-numerically controlled machine tools. For example, the latest grinding machine tools for use in high-volume production can produce concentric circles accurate to within five ten-thousandths of an inch. These same machines can guarantee flatness to within 50 millionths of an inch. They can bore holes with dimensions accurate to within four ten-thousandths of an inch, and then repeat the process endlessly with a variation of no more than 0.0002 inches. Today's specialty machines have even better accuracy and repeatability figures.

Metal Forming for Aircraft Manufacture

Sheet metal forming operations are important in aircraft manufacture. For example, the process known as **"stretch forming"** — in which a metal sheet is held at its edges, and stretched over a form or die that can be moved — is used to manufacture large sections of skin (up to 40 feet long) for the Boeing 757 and 767.[187]

Visitors to PRC aircraft manufacturing plants several years ago noted that there seemed to be only a limited capability for stretch forming, especially for larger, heavier workpieces.[188]

There are many variations of metal forming operations. In **"stretch-draw forming,"** a metal sheet is gripped in tension, and then pressed by upper and lower mating dies using hydraulic force.[189] Other types include:

- **Press brake bending**
- **Spinning**
- **Deep drawing**
- **Rubber forming,** in which the metal sheet is forced into a rubber medium on one side by a die on the opposite side[190]
- **Hydraulic stretch forming presses,** used to form extruded parts to shape
- **Hot forming**, of special importance in manufacturing titanium aerospace parts

One modern type of forming operation is known as superplastic forming,[191] because it takes place at a temperature above which some metals become plastic. The titanium alloy Ti-6AL-4V, which is widely used in aircraft parts, can be formed this way using a variety of forming techniques.

A more complex application of superplastic forming is done in combination with **diffusion bonding**.[192] In this process, two sheets are diffusion bonded at designated areas under high temperature. The unbonded areas of one of the sheets then undergoes superplastic forming into a die, forced by argon gas pressure. These techniques have been extended not only to titanium alloys, but to some aluminum alloys as well.

Superplasticity and diffusion bonding technologies for alloys of titanium, aluminum, and certain other metals are subject to export controls.

Non-Mechanical Manufacturing Processes

There are a number of manufacturing process to remove, shape, and finish structural and component parts that do not rely on cutting with solid tools. Instead, these processes use chemical, electrical, thermal, and other methods to cut, shape, and finish metals and other materials.

Of these methods, **chemical milling**[193] is the most widely used on metal aircraft and missile parts. In chemical milling, a mask is placed over areas of a metallic workpiece where metal is *not* to be removed. The metal workpiece is then placed in a chemical bath that etches metal away from the unmasked areas. This process is not subject to export controls, and is well within PRC capabilities.

Electrochemical machining[194] employs a negatively-charged, shaped electrode to remove material from a positively-charged metal workpiece in a conductive chemical fluid (electrolyte). This process is more complex than chemical milling, and can be used to produce complex shapes with deep cavities.

Electric discharge machining (EDM) removes electrically conductive material by means of controlled, repeated electric discharges.[195] The chips are removed by flushing with a dielectric fluid. When EDM is used for grinding, the workpiece is fed into a negatively-charged rotating wheel. This type of EDM is not subject to export controls. In another form of EDM, a moving wire is brought to within arcing distance of the metal part being cut in a dielectric fluid. This type of EDM is subject to export controls. Both types of EDM are on the U.S. Militarily Critical Control Technologies List (MCTL) if the number of rotary axes for contour control exceeds five (for the wire type), or two (for the nonwire type).

Laser beams are also used for cutting metals and other materials.[196] Either solid-state lasers or gas lasers may be used for this purpose, including:

- **CO2 lasers**
- **Ruby lasers**
- **Neodymium lasers**
- **Neodymium-YAG lasers**

Export controls apply to laser tools, and these tools are listed in the Missile Control Technology List (MCTL) if they have two or more rotary axes that can be coordinated simutaneously and have positioning accuracy better than 0.003 degrees. However, lasers of the types and power levels useful in most material machining applications are widely available worldwide, and to the PRC.

High velocity water jets generated by pressures of 60,000 pounds per square inch and above are also used for cutting materials, especially plastics and composites.[197] A related process is **abrasive water-jet machining**, in which abrasive particles such as silicon carbide are added to the water to increase the material removal rate.

Export controls apply to water-jet machine tools, and are noted in the MCTL if they have two or more rotary axes that can be coordinated simultaneously and have a positioning accuracy of better than 0.003 degrees.

The Use of Computers for Machine Control

Much of the recent improvement in machine tool capabilities is attributable to advances in the use of computers for machine control. Moreover, further advances in machine control technology are in the offing.

Although there is some uncertainty as to the level of PRC technology in this area, there has been no credible evidence that it is up to the state of the art of the highly-developed nations (the United States, Japan, and Western Europe).

The PRC's inability to achieve state-of-the-art in computer-control system technology for machine tools is not due to a lack of theoretical knowledge. PRC engineers regularly attend, and present papers at, meetings dealing with most of the frontier developments in machine tools and their control systems.[198]

Rather, the PRC has been inhibited by shortcomings in its industrial infrastructure. The PRC also lacks the ability to integrate the contributions of the many disciplines that are required to utilize the rapidly emerging new technologies. The PRC system is unable to keep up with these basically new approaches.

Control system technology for machine tools is rapidly starting to change. Among the most important changes on the horizon is the emergence of "open architecture" control systems. These systems use personal computers for machine control.

While PCs of sufficient capability for the control of sophisticated machine tools are now available in the PRC, and it is believed that motion-control boards needed for this purpose are also generally available, software for machine control is the other necessary element. The PRC would need specialized software to achieve a highly capable machine tool control system. At present, export controls are imposed on software for machine tool control that can be used to contour control independently and simultaneously on more than four axes.

In addition, there are controls on software that can adaptively use the measurement of at least one physical variable through a computational model to change one or more machining instructions.

Capabilities to produce software for PCs are widely diffused throughout the world, and are growing steadily in the PRC itself. As a result, these controls on software may not be as effective in the future, as these new trends in machine tool control develop.

An important aspect of advanced software for machine tools is that it can be used to compensate for a machine tool's mechanical errors, if the errors are repeated. This is done by mapping the machine's performance against a known standard, and then compensating for positioning errors.

As machine control systems move increasingly toward becoming PC-based, these "open architecture" systems will make error correction systems easier to implement, and more widely used.

Fiber Composite Materials and Structures

Since the early 1970s, there has been a trend toward replacing metals with fiber composites in the primary structure of aircraft.[199]

The main reason for the adoption of fiber composite materials and structures is that they weigh less than metals, but provide the same or better stiffness and strength. In addition, composite materials and structures usually last longer (that is, they have a greater time-to-failure under repeated or cyclic loading) than metal parts designed for the same maximum static loads. They also vibrate less.[200]

A disadvantage of composite materials and structures is that the manufacturing processes to use them are more complicated, and consequently they add costs. They also require more advanced nondestructive evaluation techniques for quality control and field maintenance. In light of these factors, the trend toward replacing metals with composites has thus far proceeded much more rapidly in military aircraft than in civil aircraft.

For helicopters and other vertical take-off and landing aircraft,[201] however, the trend toward fiber composites began earlier and proceeded faster. Initially, fiberglass composites were the material of choice, even though they have much lower strength and stiffness properties than the boron and carbon/graphite composites that were later utilized in fixed-wing aircraft. The reason that fiberglass composites were attractive for helicopters (and other vertical take-off and landing aircraft) is that structural weight savings on these aircraft have a relatively higher payoff in performance than on fixed-wing, horizontal take-off aircraft. Moreover, the load intensities on a helicopter's non-rotating parts tend to be lower than on high-speed fixed wing aircraft.

Among the advantages of composite structures is that a structural part can be designed to have different strength properties in different directions. That is, it can be stiffer in one direction, and more flexible in another. This permits it to be tailored to the loading conditions of specific applications.

For this reason, fiber composite structures are especially well adapted to the application of radar signature reduction techniques. It should be noted that the use of composites in and of itself is not enough to give an aircraft stealth properties; a fiber composite structure aircraft without radar signature reduction features will not necessarily have a lower radar cross-section than a metal structure.[202] The subject of stealth in relation to composite construction is discussed more fully under the heading *"Stealth and Composite Techniques,"* later in this *Technical Afterword*.

Although fiberglass composite materials have been used in aircraft manufacturing since the early 1950s, most of the applications of this material originally were for secondary structure not considered critical for flight safety. (A notable exception was the use of fiberglass/epoxy resin composites for helicopter rotor blades — experimentally in the 1950s, and then in production in the late 1970s.) Fiberglass/epoxy resin composites using S-glass, although of high strength and stiffness relative to most homogeneous plastics, did not begin to approach the strength and stiffness of aluminum alloys, much less those of high-strength steel alloys. But they could be used in secondary structures for their weight and sometimes manufacturing cost advantages relative to alternatives.

A turning point in the application of fiber composites to aircraft, rockets, and ballistic missiles took place in the early 1960s, with the discovery and development of the high strength and stiffness properties of boron fibers. Single boron fibers in tension (that is, subjected to stress in one direction) were found to be stronger and stiffer than the best available high-strength steel alloys.

The use of a boron/epoxy resin composite then followed. It can be used for aircraft, rocket, and ballistic missile structural elements that are designed to take multi-directional loads, such as are typically encountered in aircraft primary structures. Boron-epoxy resin composites are formed and cured in autoclaves (essentially, pressure cookers) under controlled high temperatures and pressures, in much the same way as the earlier fiberglass/epoxy resin composites were made. Boron-epoxy resin composites are just as strong and stiff as aluminum and steel alloy structures, if not better, and weigh less.

Very shortly after the introduction of boron fibers, carbon/graphite and Kevlar fibers were introduced. Depending on the particular application and type of loading, these offered material properties and unit weights comparable to boron fibers, and at lower cost.[203]

It required some years of development, including ground and flight testing of experimental structural components, before boron/epoxy resin composites were first used in the primary structures of production aircraft. Their first use was in the horizontal tail surfaces of the Navy F-14A aircraft, in the early 1970s. This was followed shortly by the F-15A, which used boron/epoxy composites for both its horizontal and vertical tail surface structures.

Since then, there has been a steadily increasing trend toward the use of the various high-strength, high-stiffness fiber composites, particularly graphite/epoxy, in primary structures in military aircraft. The same trend is underway, albeit at a slower rate, in civilian aircraft.

The progression in composite usage in primary structures has been as follows:[204] [205]

High-Tech Fiber Composites in Military and Civil Aircraft

Military Aircraft	Percentage of Primary Structure	Civil Aircraft	Percentage of Primary Structure
F-15A	4-5%	**Boeing 767**	3-4%
F-16	12%	**Airbus A300-600**	4%
FA-18E/F	19%	**Airbus A310-300**	8%
AV-8B	26%	**MD-11**	5%
F-22	35%	**Boeing 777**	9%
		Airbus A-340	12%

Composite Structure Fabrication Technologies

The manufacture of fiber composite structures generally begins by combining the fiber with epoxy resin, or some other so-called "matrix" material. The resulting prefabricated sheets are called *prepreg.* Successive layers of these *prepreg* sheets are then placed in a mold that is shaped to the form of the part being fabricated.

The fiber directions in successive prepreg layers are diagonal to one another, in a fashion tailored to the load and stress field to which the part will be subjected. The stack of prefabricated sheets — called a "layup" — is then cured in an autoclave (essentially, a pressure cooker) under controlled high temperature and pressure.

Initially, the task of making the layups in molds was done by hand. Later, beginning with simple, near two-dimensional parts, computer-controlled automated layup machines became available. Today, automated layup machines are capable of handling ever more complex parts.

Attachments between fiber composite structural elements have, for the most part, been made with bolts. In some cases, adhesive bonds have been used, in much the same manner as with metal parts. More recently, the layups for two or more parts have been joined in the curing process — this is called *cocuring*.

These fiber composite fabrication processes permit the manufacture of parts in nearly final form ("near net shape"). However, some cutting, drilling, and other machining and finishing operations are usually required.

Much of this is done with conventional machine tools. But the tool shape and hardness, and the cutting speeds, must be adapted to the fiber composite material being worked. Laser cutting and water jet/hydroabrasive cutting are also used extensively in finishing operations for fiber composites.

For axially-symmetrical parts — such as rocket motor cases — filament winding is used (for example, in the Minuteman missile's upper stage). Filament winding has also been used to manufacture fiberglass/epoxy helicopter rotor blades. In addition, long parts of constant cross-section can be made by the **pultru-**

sion process: pulling the fibers and matrix material through a die. This is the analogue of the extrusion process for metals.

Most of the fiber composite structures produced to date have employed polymer matrix materials that cannot be subjected to severe temperature environments. This has been a strict limitation on the kinds of structures for which fiber composites can be used. But newly-developed composite materials do not have this limitation. These new materials include:

- **Metal matrix composites**
- **Ceramic matrix composites**
- **Carbon/carbon composites**

These new fiber composites can be used in higher-temperature applications such as rocket engines, hypersonic aircraft, and ballistic missiles.[206] [207]

The PRC has been seeking to acquire or develop composite materials and structures technologies. One route has been through seeking co-production relationships for subassemblies of commercial aircraft and helicopters that have significant composite parts.[208] There are also reports of indigenous development as well.

A wide range of composite materials and structures fabrication equipment is included in the Missile Control Technology List (MCTL), and is subject to export control regimes at some threshold of capability. These include:

- **Composite filament winding**
- **Tape laying**
- **Weaving**
- **Prepreg**
- **Fiber production equipment**

The more advanced Western methods of composite structure fabrication for complex three-dimensional shapes are extremely sophisticated robotic machines — some with as many as nine axes of motion. It is not believed that the PRC has been able to develop or acquire machines of this capability as yet.

Stealth and Composite Technologies

What is stealth? Simply put, stealth is the ability to conceal an attacker from a defender's detection and defensive systems, and successfully accomplish the mission.[209] Stealth does not make the attacker invisible, only more difficult to detect.[210] To avoid detection, it is necessary to reduce or eliminate the attacker's "signature."

The "signature" is composed of five primary elements:

- **Visual signature**
- **Infrared (heat) signature**
- **Acoustic (noise) signature**
- **Radio transmission signature**
- **Radar signature**[211]

The first three signatures are relatively short range.[212] The radar signature is the most important, because it can be detected at the longest range — up to 400 miles away.[213]

In a stealth vehicle, attention is paid to all five signature sources.[214] To reduce the infrared and acoustic signatures of an aircraft, the engines are buried inside the fuselage or wings. Special non-reflective paints and paint schemes reduce the visual signature. The radio transmission signature can be reduced or eliminated by secure communications or radio silence.

Defeating radar detection is relatively simple in principle.[215] It involves designing the vehicle so that the incoming radar signal is reflected away from the defender's radar receiver, or absorbed by the vehicle itself using radar-absorbing materials.[216] Radar stealth is accomplished in five ways:

- **Designing the vehicle so that there are no surfaces pointing directly back to the source radar**
- **Using radar-absorbing materials on surfaces that could reflect back to the source radar**

- **Removing surface roughness by making the surface of the vehicle as smooth as possible**

- **Designing engine inlets to reduce reflection**

- **Burying engines and weapons inside the vehicle**[217]

The F-117 and B-2 aircraft represent the cutting edge in manned stealth aircraft, because they combine all of the elements of design, materials, and manufacturing technology to achieve stealth, including radar and infrared invisibility.[218]

Why is stealth so important to the military? Stealth vehicles are difficult to counter by a defender.[219] In military terms, stealth insures a greater probability of completing a mission and increased survivability of U. S. forces.[220] Other benefits include:

- **The ability to range over a greater area of enemy territory without being detected**
- **Reduced mission cost**
- **Increased effectiveness of other radar-jamming systems, such as chaff**[221]

The PRC probably cannot build stealth aircraft or missiles with the same capabilities as the F-117 and B-2, now or in the near future. But the PRC is likely to try to acquire most of the key elements necessary to build them.

Even acquisition of these elements will be insufficient to permit the PRC to build effectively stealthy aircraft or missiles. System integration of stealth is a major additional task facing the PRC.

The PRC's Acquisition of Stealth Design Technology

The PRC's efforts to solve the stealth design problem received a major boost when the PRC was able to import both high performance computers, and software packages known generically as "finite element" software. This software is used to assess aerodynamic forces and stresses on three-dimensional structures.

"Finite element" software also has the capacity to solve complex sets of Maxwell's equations. These equations relate to electromagnetic radiation (that is, radar) around a structure.

With high performance computers and "finite element" software, the PRC now has the capability to design aircraft which are aerodynamically feasible and then evaluate their stealth capabilities, too.

The Department of Defense has sought tighter export controls on "finite element" software.[222] This software is distinctly dual-use, with civilian applications including automobiles, off-shore oil drilling platforms, and the design of nuclear reactor plants. One of the main concerns of the Defense Department, however, is its use in stealth applications. The software is also critical for anti-submarine warfare.[223]

The PRC's Acquisition Of Composite Materials Technology

Building composite structures for aircraft is, in some ways, similar to building a fiberglass boat: the rigid fiberglass is technically a composite material, made up of layers of fiberglass fabric and epoxy resin. In composite structures for aircraft, the fabric is woven from ceramic, polymer, or carbon/carbon materials, instead of fiberglass.[224]

Large rolls of the fabric are run through machines that apply a coating of uncured resin to the fabric (known as *prepreging* the fabric). This material bonds together, forming the composite structure.

In stealth aircraft structures, radar-absorbing layers and coatings are integrated into the composite structure.

Some PRC joint ventures are adding to the PRC's ability to produce composite airframes:

- **British Petroleum America proposed to sell to the PRC proprietary technology for resins and reinforcing materials,** as well as the technology and training to operate a facility.[225] The company also planned to sell the methodology for translating manufacturing requirements into optimized semi-finished materials. BP America specifically sold the PRC technical data for hot-melt prepreg formulations,[226] and for an acrylonitrile plant.[227] The prepreg technical data was sold to the AVIC China Helicopter Corporation.[228]

- **Hexcel was willing to supply the PRC with high-temperature curing resins and the production equipment and training** to apply the resin to fabric materials.[229] Specifically, Hexcel planned to give the PRC the technology for 250 F and 350 F epoxies.[230] The company planned to transfer to the joint venture a solution-impregnation coating tower for fabrics, and hot-melt impregnating equipment for tapes.[231] The joint venture was supported by exports of carbon epoxy prepreg to the Chengdu Aircraft Industry Corporation[232] and the Xian Aircraft Company.[233] In addition, Hexcel was going to transfer Boeing Aircraft Company's specifications for advanced composites,[234] graphite,[235] Kevlar,[236] and conductive fabrics.[237]

Kevlar is used to make high-strength smooth surfaces on stealth aircraft. The graphite and conductive fabrics are used for radar-absorbent surfaces of stealth aircraft. In addition to their uses for stealth technology, the growing importance of composite structures in all aircraft construction provides an incentive to the PRC to acquire this technology even for non-stealth aircraft — military and civilian.

The PRC's Acquisition of Composite Structures Manufacturing Technology

Obtaining the design capability and the materials-production capability were still not sufficient for the PRC to build aircraft with composite structures. The missing element of the Chinese puzzle was the ability to manufacture aircraft parts with consistent performance time after time.

The answer to this question was found in a joint venture with the Sikorsky Aircraft Company.[238]

The Sikorsky Aircraft Company joint venture with the PRC proposed to build the composite tail section of the civil S-92 helicopter.[239] Sikorsky would teach the PRC to design and fabricate the tail section using proprietary technology to meet Federal Aviation Agency standards of quality and performance.

The project included teaching the PRC to fabricate aircraft components using carbon fiber materials (which are also used in stealth aircraft).[240] In addition to showing the PRC how to use the materials, Sikorsky also taught the PRC about:

- **Bag molding**
- **Mold releases**
- **Die manufacturing**[241]

The key requirements the PRC expected to obtain from the venture were precision tooling, repeatability, and a high production rate.[242]

Overall Assessment

The PRC acquisition of composite technology is an interesting case study. It indicates a broad-based set of joint-venture initiatives directed toward providing for the PRC a state-of-the-art composite materials/aerospace structure capability.

RECOMMENDATIONS

RECOMMENDATIONS OF THE SELECT COMMITTEE

TRANSMITTED ON JANUARY 3, 1999
TO THE PRESIDENT AND CONGRESS

Nuclear Weapons

1. Semi-Annual Report by the President on PRC Espionage

The Select Committee recommends that the President report to the Speaker and Minority Leader of the House, and the Majority Leader and Minority Leader of the Senate, no less frequently than every six months on the steps, including preventive action, being taken by the Department of Energy, the Department of Defense, the Federal Bureau of Investigation, the Central Intelligence Agency, and all other relevant Executive departments and agencies to respond to espionage by the People's Republic of China (PRC) as typified by the theft of sophisticated U.S. nuclear weapons design information, and the targeting by the PRC of U.S. nuclear weapons codes and other national security information of strategic concern.

2. Urgent Priority to Department of Energy Counterintelligence Program

As a matter of urgent priority, the Select Committee believes the Department of Energy must implement as quickly as possible and then sustain an effective counterintelligence program.

To this end, the Select Committee recommends the following:

3. Implementation and Adequacy of PDD-61

The appropriate congressional committees should review, as expeditiously as possible, the steps that the Executive branch is taking to implement Presidential Decision Directive 61 and determine whether the Administration is devoting, and Congress is providing, sufficient resources to such efforts and whether additional measures are required to put an adequate counterintelligence program in place at the Department of Energy at the earliest possible date.

4. Comprehensive Damage Assessment

The appropriate Executive departments and agencies should conduct a comprehensive damage assessment of the strategic implications of the security breaches that have taken place at the National Laboratories since the late 1970s (or earlier if relevant) to the present and report the findings to the appropriate congressional committees.

5. Legislation to Implement Urgent and Effective Counterintelligence

The appropriate congressional committees should report legislation, if necessary, to facilitate accomplishment of the objectives set forth above.

6. Five-Agency Inspectors General Examination of Scientific Exchange Program Risks to National Security

The Select Committee recommends that the Secretaries of State, Defense, and Energy, the Attorney General, and the Director of Central Intelligence direct their respective Inspectors General and appropriate counterintelligence officials to examine the risks to U.S. national security of international scientific exchange programs between the United States and the PRC that involve the National Laboratories. Such Executive department and agency heads shall transmit the results of these examinations, together with their views and recommendations, to the Speaker and the Minority Leader of the House, the Majority and Minority Leaders of the Senate, and appropriate congressional committees no later than July 1, 1999.

7. Congressional Examination of Whether Department of Energy Should Maintain U.S. Nuclear Weapons Responsibility

The Select Committee recommends that the appropriate congressional committees consider whether the current arrangements for controlling U.S. nuclear weapons development, testing, and maintenance within the Department of Energy are adequate to protect such weapons and related research and technology from theft and exploitation.

8. Intelligence Community Failure to Comply with National Security Act; Need for Congressional Oversight

In light of the fact that the heads of Executive departments and agencies of the intelligence community failed adequately to comply with congressional notification requirements of the National Security Act with respect to the theft of secrets from the National Laboratories, the Select Committee urges Congress to insist again on strict adherence to such legal obligations.

International Actions

With respect to international actions by the United States, the Select Committee recommends:

9. Need for PRC Compliance with the Missile Technology Control Regime

The United States should insist that the PRC adhere fully to, and abide by, the Missile Technology Control Regime and all applicable guidelines.

10. Need for U.S. Leadership to Enforce Missile Technology Control Regime

The United States must vigorously enforce, and seek multilateral compliance with, the Missile Technology Control Regime.

11. Need for U.S. Leadership to Establish Binding International Proliferation Controls

In light of the demise of the Coordinating Committee on Multilateral Export Controls (COCOM) and the insufficiency of the Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies, the United States should work, including in the context of the scheduled 1999 review of the Wassenaar Arrangement, to establish new binding international controls on technology transfers that threaten international peace and U.S. national security.

12. U. S. Action to Improve Multilateral Tracking of Sensitive Technology Exports

In light of the demise of COCOM and the insufficiency of the Wassenaar Arrangement, the Select Committee recommends that the United States take appropriate action, including in the context of the scheduled 1999 review of the Wassenaar Arrangement, to improve the sharing of information by nations that are major exporters of technology so that the United States can track movements of technology and enforce technology control and re-export requirements.

13. U.S. Action to Stem Russian Weapons Proliferation to PRC

In light of the PRC's aggressive military technology acquisition campaign and its record as a proliferator, the United States should work to reduce the transfers of weapons systems and other militarily significant technologies from Russia and other nations to the PRC. These actions should include strengthening international measures, including economic incentives, to encourage Russia to become a full partner in stemming the proliferation of weapons.

14. New Legal Requirements for Executive Branch Reporting on Proliferation

Appropriate congressional committees should report legislation requiring the Secretary of State, the Director of Central Intelligence, and the heads of other relevant Executive departments and agencies to report in a timely fashion to appropriate congressional committees, including the House Permanent Select Committee on Intelligence and the Senate Select Committee on Intelligence, on technology transfers that raise a proliferation concern and on the implementation of all the foregoing recommendations for international actions by the United States.

Satellite Launches

15. Implementation of the Strom Thurmond National Defense Authorization Act for FY 1999

The Select Committee expects that the Executive branch will aggressively implement the Satellite Export Control Provisions of the Strom Thurmond National Defense Authorization Act for FY 1999.

16. State Department Should Have Sole Satellite Licensing Authority

To protect the national security, the congressional judgment that the Department of State is the appropriate agency for licensing both exports of satellites and any satellite launch failure investigations must be faithfully and fully implemented.

17. State Department Need for Adequate Personnel and Resources for Satellite Export Licensing

To protect the national interest in foreign commerce, the Department of State must ensure, consistent with national security, that satellite export licenses and notices to Congress are acted on in a timely fashion and that exporters are informed about the progress of their applications and have access to appropriate dispute resolution procedures. In order to achieve the foregoing, the Executive branch and the Congress should ensure that the Department of State has adequate personnel and resources devoted to processing export license applications.

18. Corrective Tax Legislation for Satellite Exports

To ensure that satellite manufacturers are not disadvantaged in such collateral areas as tax credits by the transfer to the State Department of responsibility to license satellite exports, the appropriate congressional committees should report necessary legislation.

19. Heightened Requirements for Defense Department Monitoring of Foreign Launches

The Department of Defense must give high priority to its obligations under the Strom Thurmond National Defense Authorization Act, including requirements for *(i)* recruiting, training, and maintaining a staff dedicated to monitoring launches in foreign countries of U.S. satellites; and *(ii)* establishing and monitoring technology control plans to prevent any transfer of information that could be used by the PRC to improve its missile launch capabilities.

20. Defense Department, Not Satellite Firms, Should Be Responsible for Security at Foreign Launches

The Select Committee recommends that the appropriate congressional committees report legislation providing that, in connection with foreign launches of U.S. satellites, the Department of Defense shall contract for security personnel who have undergone background checks to verify their loyalty and reliability. The number of guards shall be sufficient to maintain 24-hour security of the satellite and all related missile and other sensitive technology. The satellite export licensee shall, as a condition of licensure, be required to reimburse the Department of Defense for all associated costs of such security.

21. Need for Adequate and Permanent Force of Well Trained Defense Department Monitors

The Department of Defense shall ensure sufficient training for space launch campaign monitors and the assignment of adequate numbers of monitors to space launch campaigns. The Department of Defense also shall ensure continuity of service by monitors for the entire space launch campaign period, from satellite marketing to launch, and, if necessary, completion of a launch failure analysis. In addition, the Department of Defense shall adopt measures to make service as a monitor an attractive career opportunity.

22. Need for Full and Timely Reporting of Technology Passed to PRC, and of Foreign Launch Security Violations

The Department of Defense monitors shall maintain logs of all information authorized for transmission to the PRC, including copies of any documents authorized for transmittal, and reports on launch-related activities. Such information shall be transmitted on a current basis to the Departments of Defense, State, and Commerce, and to the Central Intelligence Agency. Such documents shall be retained for at least the period of the statute of limitations for violations of the International Traffic in Arms Regulations (ITAR). In addition, the Department of Defense shall adopt clear written guidelines providing monitors the responsibility and the ability to report serious security violations, problems, and issues at the overseas launch site directly to the headquarters office of the responsible Defense Department agency.

23. Application of Export Control Laws to Space Launch Insurers

The Select Committee recommends that relevant Executive departments and agencies ensure that the laws and regulations establishing and implementing export controls are applied in full to communications among satellite manufacturers, purchasers, and the insurance industry, including communications after launch failures.

24. Expansion of U.S. Launch Capacity in National Security Interest

In light of the impact on U.S. national security of insufficient domestic, commercial space-launch capacity and competition, the Select Committee recommends that appropriate congressional committees report legislation to encourage and stimulate further the expansion of such capacity and competition.

High Performance Computers

The Select Committee supports the sale of computers to the PRC for commercial but not military purposes. The Select Committee recommends that the appropriate congressional committees report legislation that requires the following:

25. Legislation to Require Comprehensive Testing of HPCs, Clustering, and Massive Parallel Processing in National Security Applications

The Select Committee recommends that appropriate congressional committees report legislation directing the Department of Energy, in consultation with the Department of Defense, to conduct a comprehensive review of the national security implications of exporting high-performance computers (HPCs) to the PRC. This review should include empirical testing of the extent to which national security related operations can be performed using clustered, massively-parallel processing or other combinations of computers.

26. Annual Threat Assessment of HPC Exports to PRC

The Select Committee recommends that appropriate congressional committees report legislation directing the Intelligence Community to conduct an annual comprehensive threat assessment of the national security implications of the export to the PRC of HPCs and other computers that can be clustered or combined through massively parallel processing.

27. End Use Verification for PRC Use of HPCs

The Select Committee recommends that the appropriate congressional committees report legislation that requires:

- As a condition to U.S. HPC export licensing, the establishment by the PRC of an open and transparent system by September 30, 1999, which provides for effective end-use verification for HPCs sold or to be sold to the PRC and, at a minimum, provides for on-site inspection of the end-use and end-user of such HPCs, without notice, by U.S. nationals designated by the U.S. Government.
- Failure to establish such a system by that date should result in the U.S. Government's lowering the performance level of HPCs that may be exported to the PRC, the denial of export licenses for computers destined to the PRC, or other appropriate measures.
- An independent evaluation of the feasibility of improving end-use verification for HPCs in the PRC, and preventing the use of such HPCs for military purposes.

28. U.S. Leadership for Multinational HPC Export Policies

The Select Committee recommends that the appropriate congressional committees report legislation that requires efforts by the Executive branch to encourage other computer-manufacturing countries, especially those countries that manufacture HPCs, to adopt similar policies toward HPC exports to the PRC.

Export Legislation and Other Technology Controls

The Select Committee believes that it is in the national interest to encourage commercial exports to the PRC, and to protect against the export of militarily sensitive technologies. To this end:

29. Reauthorization of Export Administration Act

The Select Committee recommends that the appropriate congressional committees report legislation to reenact the Export Administration Act, with particular attention to re-establishing the higher penalties for violation of the Act that have been allowed to lapse since 1994.

30. Prioritization of National Security Concerns With Controlled Technologies; Continuous Updating

Relevant Executive departments and agencies should establish a mechanism to identify, on a continuing basis, those controlled technologies and items that are of greatest national security concern.

31. Executive Department Approvals for Exports of Greatest National Security Concern

With respect to those controlled technologies and items that are of greatest national security concern, current licensing procedures should be modified:

- To provide longer review periods when deemed necessary by any reviewing Executive department or agency on national security grounds; and
- To require a consensus by all reviewing Executive departments and agencies for license approval, subject to appeal procedures.

32. Streamlined Licensing Procedures

With respect to controlled technologies and items that are not of greatest national security concern, current licensing procedures should be modified to streamline the process and provide greater transparency, predictability, and certainty.

33. Effect of Maintaining Looser National Security Controls for Hong Kong Since Its Absorption by PRC on July 1, 1997

The Select Committee recommends that appropriate congressional committees report legislation requiring appropriate Executive departments and agencies to conduct an initial study, followed by periodic reviews, of the sufficiency of customs arrangements maintained by Hong Kong with respect to the PRC and the appropriateness of continuing to treat the Hong Kong S.A.R. differently from the PRC for U.S. export control purposes. Such a study should consider, among other things, the implications of unmonitored border crossings by vehicles of the People's Liberation Army.

34. Mandatory Notice of PRC or Other Foreign Acquisition of U.S. National Security Industries

The Select Committee recommends that appropriate congressional committees report legislation amending the Defense Production Act of 1950 to require notice to the Committee on Foreign Investment in the United States (CFIUS) by all U.S. companies that conduct national security-related business of any planned merger, acquisition, or takeover of the company by a foreign entity or by a U.S. entity controlled by a foreign entity. The amendment also should require Executive departments and agencies to notify CFIUS of their knowledge of any such merger, acquisition, or takeover.

Intelligence/Counterintelligence Issues

35. Comprehensive Counterintelligence Threat Assessment of PRC Espionage

Supplementing its recommendations with respect to security at the National Laboratories, the Select Committee further recommends that Executive departments and agencies with counterintelligence expertise undertake a comprehensive counterintelligence threat assessment of PRC espionage targeted against U.S. public and private entities.

36. Legislation to Improve Sharing of Sensitive Law Enforcement Information within the Executive Branch

The Select Committee recommends that appropriate congressional committees report legislation to authorize and direct the Department of Justice to promptly share national security information, on a classified basis, with appropriate Executive departments, agencies, and entities. To achieve this objective, the Select Committee recommends the creation of an appropriate interagency mechanism.

37. Five-Agency Inspectors General Examination of Countermeasures Against PRC Acquisition of Militarily Sensitive Technology

The Select Committee recommends that appropriate congressional committees require the Secretaries of State, Defense, Commerce, and the Treasury and the Director of Central Intelligence to direct their respective Inspectors General to investigate the adequacy of current export controls and counterintelligence measures to protect against the acquisition by the PRC of militarily-sensitive U.S. technology, and to report to Congress by July 1, 1999, regarding their findings and measures being undertaken to address deficiencies in these areas.

38. All-Source Intelligence Analysis of PRC Plans for Technology Acquisition

The Select Committee recommends that appropriate congressional committees report legislation directing the Intelligence Community to undertake and maintain a current, all-source analysis of PRC aims, goals, and objectives with respect to the acquisition of foreign, and particularly U.S., technologies, including, for example, PRC efforts to exploit the open character of U.S. society by penetrating businesses, academic and social institutions, and political practices. Such legislation should include a requirement to report on the adequacy of resources, encouragement, and priority status accorded all-source intelligence collection and analysis by relevant Executive departments and agencies concerning the PRC and PRC counterintelligence.

CHAPTER 9 – U.S. Export Policy Toward the PRC

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2 22 U.S.C. sec. 2751-2799.

3 P.L. 95-223, 91 Stat. 1628, 50 U.S.C. sec. 1701-1706.

4 P.L. 103-10 (March 27, 1993); P.L. 103-277 (July 5, 1994).

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6 Export Administration Act of 1979, as amended, sec. 5-7; 50 U.S.C. app. sec. 2404-2406.

7 Export Administration Act of 1979, as amended, sec. 5(b); 50 U.S.C. app. sec. 2404(b).

8 Export Administration Regulations, part 772, definition of "controlled country."

9 Export Administration Act of 1979, as amended, sec. 6; 50 U.S.C. app. sec. 2405.

10 Export Administration Regulations, sec. 738.2.

11 Export Administration Act of 1979, as amended, sec. 6(a)(3); 50 U.S.C. app. sec. 2405(a)(3).

12 Export Administration Act of 1979, as amended, sec. 6(f); 50 U.S.C. app. sec. 2405(f).

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50 Bureau of Export Administration Annual Report to Congress, 1996.

51 Export Administration Regulations, sec. 774.1, Supplement No. 1.

52 Export Administration Regulations, sec. 774.1, Supplement No. 2.

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58 Export Administration Regulations, part 740.

59 Export Administration Regulations, sec. 740.1.

60 Export Administration Regulations, sec. 740.5, License Exception Civil end-users (CIV); identified as "CIV - Yes" on the Commerce Control List.

61 Export Administration Regulations, sec. 740.5 and part 740, Supplement No. 1, Country Group D:1.

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63 Export Administration Regulations, part 744.

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85 Ibid.

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113 Export Administration Regulations, sec. 750.8(a) and sec. 740.2(b).

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APPENDICES

SCOPE OF THE INVESTIGATION

The Select Committee on U.S. National Security and Military/Commercial Concerns with the People's Republic of China (the Select Committee) was established pursuant to House Resolution 463, adopted on June 18, 1998 (included at Appendix C). The Resolution authorized the Select Committee to investigate a broad range of issues relating to the transfer of U.S. technology to the People's Republic of China. The Select Committee was charged with, among other things, the responsibility to investigate any transfers of technology, information, advice, goods, or services that may have contributed–

- **To the enhancement of the accuracy, reliability, or capability of the PRC's nuclear-armed intercontinental ballistic missiles or other weapons**
- **To the manufacture of weapons of mass destruction, missiles, or other weapons**
- **To the enhancement of the PRC's intelligence capabilities**

The Select Committee was also given the responsibility to assess the impact of such enhancements on U.S. regional or national security interests.

Faced with a broad mandate and limited time in which to complete its investigation and report to the House (effectively from July 1998 to the end of December 1998), the Select Committee necessarily focused on a limited number of issues. The Select Committee focused on the allegations relating to the Loral and Hughes launch failures; U.S. policies and practices regarding exports of high performance computers to the PRC; U.S. policies and practices regarding exports of machine tools and other advanced manufacturing technologies to the PRC; PRC activities targeted against U.S. technology; and the role of PRC espionage, including PRC-owned or dominated commercial entities in the United States, in the transfer of technology from the United States to the PRC.

H. Res. 463 also authorized the Select Committee to investigate PRC attempts to influence technology transfers through campaign contributions or other illegal means. In light of the fact that two other committees of the Congress have been engaged in the same inquiry and had begun their efforts long before the Select Committee's formation, the Select Committee did not undertake a duplicative review of these same issues. The Select Committee did, however, contact key witnesses who could have provided new evidence concerning such issues.

The Select Committee's efforts to obtain testimony from these witnesses were unsuccessful, however, because the witnesses either declined to testify on Fifth Amendment grounds or were outside the United States. Because the Select Committee was unable to pursue questions of illegal campaign contributions anew, no significance should be attributed, one way or the other, to the fact that the Select Committee has not made any findings on this subject. The same is true with respect to other topics as to which time constraints or other obstacles precluded systematic inquiry.

Much of the information gathered by the Select Committee is extremely sensitive, highly classified, or proprietary in nature. In addition, the Select Committee granted immunity to, and took immunized testimony from, several key witnesses. Pursuant to an agreement reached with the Justice Department, this testimony must be protected from broad dissemination in order to avoid undermining any potential criminal proceedings by the Justice Department.

In attempting to evaluate the potential national security implications of various technology transfers, the Select Committee staff met with representatives of numerous Executive departments and agencies, the National Laboratories, other laboratories engaged in government research, and various private companies, think tanks, and academic institutions. In addition, the Select Committee retained a firm of respected scientists with significant experience to provide an independent evaluation of a broad range of technology transfer issues.

Beginning in June 1998, the Select Committee received briefings and conducted hearings to receive testimony from U.S. Government officials, private sector experts, and key witnesses in the matters under investigation. The Select Committee's work continued during the August recess of the Congress, when 10 additional days of hearings were held. Full-scale investigative activity continued during September, October, November and December 1998, even while this Report was being written.

The Select Committee's proceedings were conducted in an extraordinarily bipartisan manner. The Select Committee relied heavily on a non-partisan Joint Investigative Staff of experienced investigators and technical experts to conduct its investigative activities. The Joint Investigative Staff, led by the Chief Investigative Counsel, worked closely with the Select Committee's Majority and Minority staffs.

Despite the short period of time available, the Select Committee was able to accomplish a significant amount of information collection and analysis. The staff conducted nearly 700 hours of interviews and depositions of more than 150 individuals. In 21 instances, the Select Committee issued subpoenae to require individuals to submit to questioning; in four instances use immunity was granted to compel testimony.

The Select Committee met 34 times to conduct formal business and to hear testimony, typically in executive session to hear classified and other sensitive, law enforcement, and proprietary information. More than 150 hours of testimony was heard from more than 75 different witnesses. Finally, the Select Committee reviewed over 500,000 pages of evidentiary material received from public and private sources.

INVESTIGATIVE ISSUES

The Select Committee's investigative efforts generally were highly successful, especially in view of time and resource constraints. The investigation did, however, encounter certain issues that warrant mention.

CIA and Hughes. The Select Committee's attempts to investigate allegations made by a CIA analyst were made more difficult by certain actions of the CIA. The analyst had alleged that, while visiting Hughes in 1995, he had come across information indicating that technical data had been improperly passed by Hughes to the PRC in connection with the 1995 failure investigation, and that the CIA had ignored his request for a formal report to CIA Headquarters to that effect. As part of its investigation of Hughes' conduct in 1995, the Select Committee had previously determined that it should interview several of the Hughes employees from whom the CIA analyst said he had obtained his information since they were known to have played a part in the failure investigation.

Because the CIA analyst could not remember the names of the Hughes employees with whom he had spoken, the Select Committee asked the CIA to retrieve the information from its files. The CIA did so, but also, without the prior knowledge of the Select Committee, advised Hughes not only that the Select Committee might seek to interview these employees, but also of the lines of questioning that the Select Committee probably would pursue. The Select Committee was concerned that this notification may have inadvertently given Hughes the opportunity to destroy relevant evidence and allowed its employees to be less than candid. The Select Committee considered this action by CIA to be ill-advised and an impediment to this aspect of its investigation. The Senate Select Committee on Intelligence, which was separately investigating this matter of the CIA analyst, made a formal notification of the matter to the Justice Department. Justice was also already investigating the conduct of Hughes employees. The Justice Department had not yet concluded its investigation at the time of this report.

The CIA's official explanation for its actions was that it notified Hughes as a courtesy. The CIA denies that its notification to Hughes was intended in any way to interfere with the Justice Department or Congressional investigations that were then under way.

The Select Committee is disappointed about the lack of judgment that CIA personnel showed in this matter by not coordinating the CIA's communication with Hughes on this matter with the Select Committee prior to the event. The decision to advise Hughes about the Select Committee's intentions was discussed at length within the CIA and was approved by, among others, the CIA's Principal Deputy General Counsel and Deputy Director for Congressional Affairs. Because their personal counsel advised certain CIA employees not to make themselves available to the Select Committee during the pendency of the Justice Department investigation, the Select Committee was unable to interview all the CIA personnel who were involved in this matter. However, based on the information the Select Committee has been able to obtain on this matter, the Select Committee believes that at no time in the course of the many internal discussions and exchanges of correspondence did any of the CIA employees involved voice any concern about the adverse effects their proposed course of action might have on the Justice Department or Congressional investigations that were under way, nor even of the impact that lack of notice of this action might have on relations between the CIA and those entities.

Remedial action is needed at the CIA to ensure that employees are made more sensitive to the implications of their activities as they relate to on-going investigations by Congress and law enforcement agencies. Steps also should be taken to ensure that competent legal advice is available to CIA personnel. The Select Committee understands that, in addition to the Justice Department, the House and Senate Intelligence Committees are reviewing this matter.

Privilege Claims. A significant issue that arose in connection with the Select Committee's investigation related to assertions of attorney-client privilege. While Congress traditionally has reserved to itself the right to reject such claims, the assertion of such privilege raises concerns beyond Congressional investigations. Furthermore, the contempt remedy raises timing concerns, particularly for a time-limited committee.

The most serious and contentious assertion of attorney-client privilege arose in connection with testimony taken from Eric Zahler, the General Counsel of Loral Space and Communications, the parent company of Space Systems/Loral; Julie Bannerman, Space Systems/Loral's General Counsel; and Michael Poliner, a lawyer from the firm of Feith & Zell who conducted an internal investigation of the Independent Review Committee's conduct for Loral and helped prepare the company's disclosure to the State Department. Loral agreed that it had waived the attorney-client privilege with regard to communications in its "voluntary" disclosure. However, all three witnesses refused on the basis of the attorney-client privilege to answer questions regarding any information that came into their possession after the first grand jury subpoenas were served on Loral and its employees in the Justice Department's investigation of possible criminal violations. In addition, various Hughes and Loral employees were instructed by their counsel not to answer questions related to relevant facts that they learned in the course of discussions after that date at which a Loral attorney was present.

Even under the attorney-client privilege rules that apply in the Judicial branch, a serious question arises as to whether such claims were valid. Although Loral argued to the contrary, there is substantial and compelling case law suggesting that in making a voluntary disclosure to the U.S. Government that included attorney-client communications and purported to be a full and complete rendition of the facts surrounding the Independent Review Committee incident, Loral waived the attorney-client privilege with respect to all information on the same topic that Loral or its employees communicated to the company's counsel, regardless of when that communication occurred.

Companies make voluntary disclosures in the hope that by doing so they will convince the U. S. Government not to pursue any enforcement action or, if an action is taken, that the penalty will be mitigated. Thus, it is against sound public policy to permit a company to make what may be an incomplete or inaccurate voluntary disclosure in which it reveals exculpatory attorney-client communications in the hope that no further investigation will ensue and then, when that hope is disappointed, to use the attorney-client privilege as a shield against disclosure of additional or inconsistent facts that emerge once counsel undertakes a subsequent defense in a law enforcement investigation. Such a rule would only encourage companies to file misleading disclosures and their counsel to do a less than thorough job of investigating possible illegal activity.

Nonetheless, Loral's attorneys argued to the Select Committee that to hold in favor of enforcing a waiver of attorney-client privilege regarding communications voluntarily made by a corporation would be against the public policy of encouraging voluntary disclosures. The Select Committee believes that there is a greater public interest in ensuring that disclosures are full, complete, and accurate and that a possible response, were this point of view to be accepted, would be to take appropriate action to ensure that any party that files a voluntary disclosure relating to possible export control violations be required, as part of that disclosure, to acknowledge that this constitutes a plenary waiver of the attorney-client privilege with respect to the possible violation.

Justice Department objections. When the Select Committee began its investigation, the U.S. Attorney for the District of Columbia already had been engaged for a considerable time in an investigation of the Loral and Hughes disclosures and, presumably, had collected a large body of documentation and witness testimony. When the Select Committee requested that various Executive departments and agencies comment on their understanding of certain issues involved in the Loral and Hughes cases, it discovered that these departments and agencies had not been provided information by the Justice Department about the progress of its investigation and that they believed that the pendency of the Justice Department investigation was a deterrent to their pursuing their own investigations and analyses.

As a result, the Select Committee was forced to expend a major part of its available investigative resources in retracing the Justice Department's steps, often in the face of protests from Justice Department officials that to talk to certain potential witnesses might undercut the criminal investigation. In addition, a variety of Executive departments and agencies refused initially to provide the Select Committee with copies of requests for information that had been received from the Justice Department and even, in some cases, with copies of documents that had been produced to Justice in response to those requests. Despite substantial and continuing efforts, even with the assistance of the Deputy Attorney General's office, production of much of this material to the Select Committee was delayed for substantial periods of time.

With all due deference to the importance of criminal investigations, the Select Committee believes that national security interests frequently are at least as great, if not paramount. There appears to be no established means, however, by which the Executive departments and agencies engaged in regulatory, administrative, or intelligence functions that could benefit from an awareness of what is being learned in a criminal investigation can be apprised in any timely or complete manner of such information. This is an issue that the Select Committee also believes should be addressed.

Inability to survey Defense Technology Security Administration employees regarding agency management issues. Two mid-level DTSA employees alleged that DTSA is a problem-plagued organization in which DTSA senior management rules with a heavy hand. As a consequence, morale is poor. According to the two employees, DTSA senior managers frequently overruled valid national security concerns when formulating the Defense Department's position on dual-use license applications. Among other things, they also expressed the view that DTSA's recent transfer from the Office of the Secretary of Defense to the Defense Threat Reduction Agency (DTRA) will further weaken and isolate the organization, whose role has already been diminished in the interagency licensing process. Both were critical of current DTSA management and characterized it as secretive and heavy-handed.

The Select Committee was unable to conduct a thorough evaluation of the validity of these concerns due to time limitations and the lack of cooperation by the Defense Department. The Defense Department refused to allow the Select Committee to interview DTSA personnel on these matters unless a Defense Department observer was present. The Select Committee attempted to reach an accommodation by proposing that it interview only the five or six most senior DTSA personnel and conduct a written survey of DTSA personnel regarding these morale and management issues. The Defense Department refused to permit either the interviews or the survey.

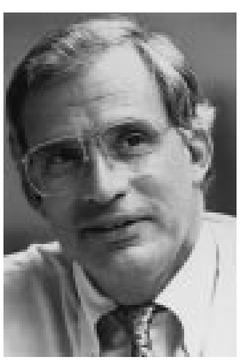
MEMBERS OF THE SELECT COMMITTEE

REP. CHRISTOPHER COX (R-CA) — Chairman

Elected:	1988
Born:	October 16, 1952, St. Paul, MN
Home:	Newport Beach, CA
Education:	BA 1973 University of Southern California; MBA, JD 1977 Harvard University
Career:	1986-88 Senior Associate Counsel to the President, the White House; 1984-88 Founder, Context Corporation; 1984-86 Partner, Latham & Watkins; 1982-83 Lecturer, Harvard Business School; 1978-82 Associate, Latham & Watkins; 1977 Clerk, U.S. Court of Appeals, Judge Herbert Choy
Committees:	Chairman, House Policy Committee; Vice Chairman, Committee on Government Reform and Oversight; Vice Chairman, Subcommittee on Investigations and Oversight, Committee on Commerce

REP. NORM DICKS (D-WA) — Ranking Democrat

Elected:	1976
Born:	December 16, 1940, Bremerton, WA
Home:	Bremerton, WA
Education:	BA 1963 University of Washington; JD 1968 University of Washington
Career:	1973-76 Administrative Assistant, U.S. Senator Warren Magnuson; 1968-73 Legislative Assistant, U.S. Senator Warren Magnuson
Committees:	Ranking Member, Permanent Select Committee on Intelligence; Ranking Member, Interior Subcommittee, Committee on Appropriations



REP. PORTER GOSS (R-FL) — Vice Chairman

Elected:	1988
Born:	November 26, 1938, Waterbury, CT
Home:	Sanibel, FL
Education:	BA 1960 Yale University
Career:	1960-62 Army Intelligence; 1960-71 Central Intelligence Agency; 1973-78 Businessman, Newspaper publisher; 1974-82 Sanibel City Council; 1974-77, 1980 Sanibel Mayor; 1983-88 Lee County Commissioner
Committees:	Chairman, Permanent Select Committee on Intelligence; Chairman, Subcommittee on Legislative and Budget Process, Committee on Rules

REP. DOUG BEREUTER (R-NE)

Elected:	1978
Born:	October 6, 1939, York, NE
Home:	Cedar Bluff, NE
Education:	BA 1961 University of Nebraska; MCA 1966 Harvard University; MPA 1973 Harvard University
Career:	1963-65 Army; 1965-66 Urban planner, U.S. Dept. of Housing and Urban Development; 1967-68 Division Director, Nebraska Economic Development Department; 1968-70 Director, Nebraska Office of Planning and Programming; 1974-78 Member, Nebraska State Legislature
Committees:	Vice Chairman, Committee on International Relations; Chairman, Subcommittee on Asia and the Pacific, International Relations Committee; Committee on Banking and Financial Services

REP. JAMES V. HANSEN (R-UT)

Elected:	1980
Born:	August 14, 1932, Salt Lake City, UT
Home:	Farmington, UT
Education:	BS 1960 University of Utah
Career:	1950-54 U.S. Navy; 1961-80 Insurance agent; 1970-80 Land developer; 1960-72 Farmington City Council; 1972-80 Member, Utah House of Representatives; 1978-80 Speaker, Utah House of Representatives
Committees:	Chairman, Committee on Standards of Official Conduct; National Security Committee; Chairman, National Parks and Public Lands Subcommittee, Committee on Resources

REP. JOHN SPRATT (D-SC)

Elected:	1982
Born:	November 1, 1942, Charlotte, NC
Home:	York, SC
Education:	AB 1964 Davidson College; MA 1966 Oxford University; LLB 1969 Yale University
Career:	1969-71 U.S. Department of Defense; 1971-82 Practicing attorney; 1973-82 President, Bank of Fort Mill; 1973-82 President, Spratt Insurance Agency
Committees:	Committee on National Security; Ranking Member, Budget Committee

MEMBERS OF THE SELECT COMMITTEE

REP. CURT WELDON (R-PA)

Elected:	1986
Born:	July 22, 1947, Marcus Hook, PA
Home:	Aston, PA
Education:	BA 1969 West Chester State College
Career:	1969-76 Teacher, Vice Principal; 1976-81 Director of Training and Manpower Development, CIGNA Corp.; 1977-82 Marcus Hook Mayor; 1981-86 Member, Delaware County Council; 1985-86 Chairman, Delaware County Council
Committees:	Chairman, Subcommittee on Military Research and Development, Committee on National Security; Committee on Science

REP. LUCILLE ROYBAL-ALLARD (D-CA)

Elected:	1992
Born:	June 12, 1941, Los Angeles, CA
Home:	Los Angeles, CA
Education:	BA 1965 California State University-Los Angeles
Career:	1986-92 Member, California Assembly
Committees:	Committee on Banking and Financial Services; Budget Committee

REP. ROBERT (BOBBY) SCOTT (D-VA)

Elected:	1992
Born:	April 30, 1947, Washington, DC
Home:	Newport News, VA
Education:	BA 1969 Harvard University; JD 1973 Boston College School of Law
Career:	1970-73 Army National Guard; 1973-76 Army Reserves; 1973-91 Practicing attorney; 1977-82 Member, Virginia House of Delegates; 1983-92 Member, Virginia State Senate
Committees:	Committee on Education and the Workforce; Ranking Member, Subcommittee on the Constitution, Committee on the Judiciary

STAFF OF THE SELECT COMMITTEE

C. Dean McGrath, Jr. *Staff Director*
former Deputy Assistant to the President and Deputy Staff Secretary, the White House;
former Associate Counsel to the President, the White House;
former Special Assistant U.S. Attorney, U.S. Department of Justice

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Brent Bahler *Director of Communications*
former Press Secretary to Senator Robert J. Dole;
former Director of Public Affairs, U.S. National Transportation Safety Board

Americo Cinquegrana *Chief Investigative Counsel*
Deputy Inspector General, Central Intelligence Agency;
former Deputy Counsel for Intelligence Policy to the Attorney General of the United States

Michael Davidson *Minority Counsel*
former U.S. Senate Legal Counsel; former Special Investigation Counsel,
U.S. Senate Government Affairs Committee

Dr. Alexander Flax *Senior Consultant**
former President of the Institute for Defense Analysis; former Director of the National Reconnaissance Office; former U.S. Delegate to the NATO Advisory Group for Aerospace Research and Development

Lewis Libby *Legal Advisor*
former Director of Special Projects, Bureau of East Asian and Pacific Affairs, U.S. Department of State; former Deputy Undersecretary for Policy, U.S. Department of Defense

Richard Meltzer *Chief Minority Counsel*
former Chief Minority Counsel, U.S. House International Affairs Subcommittee on Iranian Arms Transfers to Bosnia

Nicholas Rostow *Deputy Staff Director and Counsel*
former Legal Advisor, National Security Council

Daniel Silver *General Counsel*
former General Counsel, Central Intelligence Agency;
former General Counsel, National Security Agency

Michael Sheehy *Special Minority Counsel*
Special Minority Counsel, U.S. House Permanent Select Committee on Intelligence;
former Professional Staff Member, Iran-Contra Investigating Committee

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Resolution 463

THE SELECT COMMITTEE ON U.S. NATIONAL SECURITY AND MILITARY/COMMERCIAL CONCERNS WITH THE PEOPLE'S REPUBLIC OF CHINA

House of Representatives
June 18, 1998

SECTION 1. ESTABLISHMENT.

There is hereby created the Select Committee on U.S. National Security and Military/Commercial Concerns With the People's Republic of China, (hereafter in this resolution referred to as the 'Select Committee'). The Select Committee may sit and act during the present Congress at such times and places within the United States, including any Commonwealth or possession thereof, or in any other country, whether the House is in session, has recessed, or has adjourned, as it shall deem appropriate for the completion of its work.

SEC. 2. JURISDICTION.

(a) In General: The Select Committee shall conduct a full and complete inquiry regarding the following matters and report such findings and recommendations, including those concerning the amendment of existing law or the enactment of new law, to the House as it considers appropriate:

(1) The transfer of technology, information, advice, goods, or services that may have contributed to the enhancement of the accuracy, reliability, or capability of nuclear-armed intercontinental ballistic missiles or other weapons of the People's Republic of China, or that may have contributed to the enhancement of the intelligence capabilities of the People's Republic of China.

(2) The transfer of technology, information, advice, goods, or services that may have contributed to the manufacture of weapons of mass destruction, missiles, or other weapons or armaments by the People's Republic of China.

(3) The effect of any transfer or enhancement referred to in paragraphs (1) or (2) on regional security and the national security of the United States.

(4) The conduct of the executive branch of the United States Government with respect to the transfers or enhancements referred to in paragraphs (1) or (2), and the effect of that conduct on regional security and the national security of the United States.

(5) The conduct of defense contractors, weapons manufacturers, satellite manufacturers, and other private or government-owned commercial firms with respect to the transfers or enhancements referred to in paragraphs (1) or (2).

(6) The enforcement of United States law, including statutes, regulations, or executive orders, with respect to the transfers or enhancements referred to in paragraphs (1) or (2).

(7) Any effort by the Government of the People's Republic of China or any other person or entity to influence any of the foregoing matters through political contributions, commercial arrangements, or bribery, influence-peddling, or other illegal activities.

(8) Decision-making within the executive branch of the United States Government with respect to any of the foregoing matters.

(9) Any effort to conceal or withhold information or documents relevant to any of the foregoing matters or to obstruct justice, or to obstruct the work of the Select Committee or any other committee of the House of Representatives in connection with those matters.

(10) All matters relating directly or indirectly to any of the foregoing matters.

(b) Permitting Reports To Be Made to House in Secret Session: Any report to the House pursuant to this section may, in the Select Committee's discretion, be made under the provisions of rule XXIX of the Rules of the House of Representatives.

SEC. 3. COMPOSITION; VACANCIES.

(a) Composition: The Select Committee shall be composed of 9 or fewer Members of the House to be appointed by the Speaker of the House of Representatives, one of whom he shall designate as Chairman. Service on the Select Committee shall not count against the limitations on committee service in clause 6(b)(2) of rule X.

(b) Vacancies: Any vacancy occurring in the membership of the Select Committee shall be filled in the same manner in which the original appointment was made.

SEC. 4. RULES APPLICABLE TO SELECT COMMITTEE.

(a) Quorum: One-third of the members of the Select Committee shall constitute a quorum for the transaction of business other than the reporting of a matter, which shall require a majority of the committee to be actually present, except that the Select Committee may designate a lesser number, but not less than 2, as a quorum for the purpose of holding hearings to take testimony and receive evidence.

(b) Applicability of House Rules: The Rules of the House of Representatives applicable to standing committees shall govern the Select Committee where not inconsistent with this resolution.

(c) Rules of Select Committee: The Select Committee shall adopt additional written rules, which shall be public, to govern its procedures, which shall not be inconsistent with this resolution or the Rules of the House of Representatives.

SEC. 5. CLASSIFIED INFORMATION.

No employee of the Select Committee or any person engaged by contract or otherwise to perform services for or at the request of such committee shall be given access to any classified information by such committee unless such employee or person has—

(1) agreed in writing and under oath to be bound by the rules of the House (including the jurisdiction of the Committee on Standards of Official Conduct and of the Select Committee as to the security of such information during and after the period of his employment or contractual agreement with the Select Committee); and

(2) received an appropriate security clearance as determined by the Select Committee in consultation with the Director of Central Intelligence. The type of security clearance to be required in the case of any such employee or person shall, within the determination of the Select Committee in consultation with the Director of Central Intelligence, be commensurate with the sensitivity of the classified information to which such employee or person will be given access by such committee.

SEC. 6. LIMITS ON DISCLOSURE OF INFORMATION.

The Select Committee shall formulate and carry out such rules and procedures as it deems necessary to prevent the disclosure, without the consent of the person or persons concerned, of information in the possession of such committee which unduly infringes upon the privacy or which violates the constitutional rights of such person or persons. Nothing herein shall be construed to prevent such committee from publicly disclosing any such information in any case in which such committee determines that national interest in the disclosure of such information clearly outweighs any infringement on the privacy of any person or persons.

SEC. 7. PROCEDURES FOR HANDLING INFORMATION.

(a) The Select Committee may, subject to the provisions of this section, disclose publicly any information in the possession of such committee after a determination by such committee that the public interest would be served by such disclosure. Whenever committee action is required to disclose any information under this section, the committee shall meet to vote on the matter within five days after any member of the committee requests such a vote. No member of the Select Committee shall disclose any information, the disclosure of which requires a committee vote, prior to a vote by the committee on the question of the disclosure of such information or after such vote except in accordance with this section. In any case in which the Select Committee votes to disclose publicly any information, which has been classified under established security procedures, which has been submitted to it by the executive branch, and which the executive branch requests be kept secret, the Select Committee shall submit such classified information to the Permanent Select Committee on Intelligence.

(b)(1) As set forth in clause 7(b) of rule XLVIII, in any case in which the Permanent Select Committee on Intelligence votes to disclose publicly any information submitted pursuant to subsection (a), which has been classified under established security procedures, which has been submitted to the Select Committee by the executive branch, and which the executive branch has requested be kept secret, the Permanent Select Committee on Intelligence shall notify the President of such vote.

(2) The Permanent Select Committee on Intelligence may disclose publicly such information after the expiration of a five-day period following the day on which notice of such vote is transmitted to the President, unless, prior to the expiration of such five-day period, the President, personally in writing, notifies the Permanent Select Committee on Intelligence that he objects to the disclosure of such information, provides his reasons therefore, and certifies that the threat to the national interest of the United States posed by such disclosure is of such gravity that it outweighs any public interest in the disclosure.

(3) If the President, personally, in writing, notifies the Permanent Select Committee on Intelligence of his objections to the disclosure of such information as provided in paragraph (2), the Permanent Select Committee on Intelligence may, by majority vote, refer the question of this disclosure of such information with a recommendation thereon to the House for consideration. The Permanent Select Committee on Intelligence shall not publicly disclose such information without leave of the House.

(4) Whenever the Permanent Select Committee on Intelligence votes to refer the question of disclosure of any information to the House under paragraph (3), the chairman of the Permanent Select Committee on Intelligence shall, not later than the first day on which the House is in session following the day on which the vote occurs, report the matter to the House for its consideration.

(5) If within four calendar days on which the House is in session, after such recommendation is reported, no motion has been made by the chairman of the Permanent Select Committee on Intelligence to consider, in closed session, the matter reported under paragraph (4), then such a motion will be deemed privileged and may be made by any Member. The motion under this paragraph shall not be subject to debate or amendment. When made, it shall be decided without intervening motion, except one motion to adjourn.

(6) If the House adopts a motion to resolve into closed session, the Speaker shall then be authorized to declare a recess subject to the call of the Chair. At the expiration of such recess, the pending question, in closed session, shall be, 'Shall the House approve the recommendation of the Permanent Select Committee on Intelligence?'

(7) After not more than two hours of debate on the motion, such debate to be equally divided and controlled by the chairman and ranking minority member of the Permanent Select Committee on Intelligence, or their designees, the previous question shall be considered as ordered and the House, without intervening motion except one motion to adjourn, shall immediately vote on the question, in open session but without divulging the information with respect to which the vote is being taken. If the recommendation of the Permanent Select Committee on Intelligence is not agreed to, the question shall be deemed recommitted to the Permanent Select Committee on Intelligence for further recommendation.

(c)(1) No information in the possession of the Select Committee relating to the lawful intelligence or intelligence-related activities of any department or agency of the United States which has been classified under established security procedures and which the Select Committee, the Permanent Select Committee on Intelligence, or the House pursuant to this section, has determined should not be disclosed shall be made available to any person by a Member, officer, or employee of the House except as provided in paragraph (2).

(2) The Select Committee shall, under such regulations as the committee shall prescribe, make any information described in paragraph (1) available to any other committee or any other Member of the House and permit any other Member of the House to attend any hearing of the committee which is closed to the public. Whenever the Select Committee makes such information available (other than to the Speaker), the committee shall keep a written record showing, in the case of any particular information, which committee or which Members of the House received such information. No Member of the House who, and no committee which, receives any information under this paragraph, shall disclose such information except in a closed session of the House.

(d) The Committee on Standards of Official Conduct shall investigate any unauthorized disclosure of intelligence or intelligence-related information by a Member, officer, or employee of the House in violation of subsection (c) and report to the House concerning any allegation which it finds to be substantiated.

(e) Upon the request of any person who is subject to any such investigation, the Committee on Standards of Official Conduct shall release to such individual at the conclusion of its investigation a summary of its investigation, together with its findings. If, at the conclusion of its investigation, the Committee on Standards of Official Conduct determines that there has been a significant breach of confidentiality or unauthorized disclosure by a Member, officer, or employee of the House, it shall report its findings to the House and recommend appropriate action such as censure, removal from committee membership, or expulsion from the House, in the case of a Member, or removal from office or employment or punishment for contempt, in the case of an officer or employee.

SEC. 8. TRANSFER OF INFORMATION TO SELECT COMMITTEE.

Any committee of the House of Representatives having custody of records, data, charts, and files concerning subjects within the jurisdiction of the Select Committee shall furnish the originals or copies of such materials to the Select Committee. In the case of the Permanent Select Committee on Intelligence, such materials shall be made available pursuant to clause 7(c)(2) of rule XLVIII.

SEC. 9. INFORMATION GATHERING.

(a) In General: The Select Committee is authorized to require, by subpoena or otherwise, the attendance and testimony of such witnesses, the furnishing of such information by interrogatory, and the production of such books, records, correspondence, memoranda, papers, documents, calendars, recordings, electronic communications, data compilations from which information can be obtained, tangible objects, and other things and information of any kind as it deems necessary, including all intelligence materials however classified, White House materials, and materials pertaining to unvouchered expenditures or concerning communications interceptions or surveillance.

(b) Subpoenas, **Depositions and Interrogatories:** Unless otherwise determined by the Select Committee, the Chairman, upon consultation with the ranking minority member, or the Select Committee may—

(1) authorize and issue subpoenas;

(2) order the taking of depositions, interrogatories, or affidavits under oath or otherwise; and

(3) designate a member or staff of the Select Committee to conduct any deposition.

(c) International Authorities: Unless otherwise determined by the Select Committee, the Chairman of the Select Committee, upon consultation with the ranking minority member of the Select Committee, or the Select Committee may—

(1) authorize the taking of depositions and other testimony, under oath or otherwise, anywhere outside the United States; and

(2) make application for issuance of letters rogatory, and request through appropriate channels, other means of international assistance, as appropriate.

(d) Handling of Information: Information obtained under the authority of this section shall be—

(1) considered as taken by the Select Committee in the District of Columbia, as well as the location actually taken; and

(2) considered to be taken in executive session.

SEC. 10. TAX RETURNS.

Pursuant to sections 6103(f)(3) and 6104(a)(2) of the Internal Revenue Code of 1986, for the purpose of investigating the subjects set forth in this resolution and since information necessary for this investigation cannot reasonably be obtained from any other source, the Select Committee shall be specially authorized to inspect and receive for the tax years 1988 through 1998 any tax return, return information, or other tax-related material, held by the Secretary of the Treasury, related to individuals and entities named by the Select Committee as possible participants, beneficiaries, or intermediaries in the transactions under investigation. As specified by section 6103(f)(3) of the Internal Revenue Code of 1986, such materials and information shall be furnished in closed executive session.

SEC. 11. ACCESS TO INFORMATION OF THE SELECT COMMITTEE.

The Select Committee shall provide other committees and Members of the House with access to information and proceedings, consistent with clause 7(c)(2) of rule XLVIII, except that the Select Committee may direct that particular matters or classes of matter shall not be made available to any person by its members, staff, or others, or may impose any other restriction. The Select Committee may require its staff to enter nondisclosure agreements, and its Chairman, in consultation with the ranking minority Member, may require others, such as counsel for witnesses, to do so. The Committee on Standards of Official Conduct may investigate any unauthorized disclosure of such classified information by a Member, officer, or employee of the House or other covered person upon request of the Select Committee. If, at the conclusion of its investigation, the Committee on Standards of Official Conduct determines that there has been a significant unauthorized disclosure, it shall report its findings to the House and recommend appropriate sanctions for the Member, officer, employee, or other covered person consistent with clause 7(e) of rule XLVIII and any committee restriction, including nondisclosure agreements. The Select Committee shall, as appropriate, provide access to information and proceedings to the Speaker and the Minority Leader and an appropriately cleared and designated member of each staff.

SEC. 12. COOPERATION OF OTHER ENTITIES.

(a) Cooperation of Other Committees: The Select Committee may submit to any standing committee specific matters within its jurisdiction and may request that such committees pursue such matters further.

(b) Cooperation of Other Federal Entities: The Chairman of the Select Committee, upon consultation with the ranking minority member, or the Select Committee may request investigations, reports, and other assistance from any agency of the executive, legislative, and judicial branches of the Federal Government.

SEC. 13. ACCESS AND RESPONSE TO JUDICIAL PROCESS.

In addition to any applications to court in response to judicial process that may be made in behalf of the House by its counsel, the Select Committee shall be authorized to respond to any judicial or other process, or to make any applications to court, upon consultation with the Speaker consistent with rule L.

SEC. 14. ADMINISTRATIVE MATTERS.

(a) Personnel: The Chairman, upon consultation with the ranking minority member, may employ and fix the compensation of such clerks, experts, consultants, technicians, attorneys, investigators, clerical and stenographic assistants, and other appropriate staff as the Chairman considers necessary to carry out the purposes of this resolution. Detailees from the executive branch or staff of the House or a joint committee, upon the request of the Chairman of the Select Committee, upon consultation with the ranking minority member, shall be deemed staff of the Select Committee to the extent necessary to carry out the purposes of this resolution.

(b) Payment of Expenses: **(1)** The Select Committee may reimburse the members of its staff for travel, subsistence, and other necessary expenses incurred by them in the performance of the duties vested in the Select Committee.

(2) Not more than $2,500,000 are authorized for expenses of the Select Committee for investigations and studies, including for the procurement of the services of individual consultants or organizations thereof, and for training of staff, to be paid out of the applicable accounts of the House of Representatives upon vouchers signed by the Chairman and approved in the manner directed by the Committee on House Oversight.

SEC. 15. APPLICABILITY OF OTHER LAWS TO SELECT COMMITTEE.

The Select Committee shall be deemed a committee of the House for all purposes of the rules of the House of Representatives and shall be deemed a committee for all purposes of law, including, but not limited to, section 202(f) of the Legislative Reorganization Act of 1946 (2 U.S.C. 72a(f)), sections 102 and 104 of the Revised Statutes (2 U.S.C. 192 and 194), sections 1001, 1505, 1621, 6002, and 6005 of title 18, United States Code, section 502(b)(1)(B)(ii) of the Mutual Security Act of 1954 (22 U.S.C. 1754(b)(1)(B)(ii)), and section 734 of title 31, United States Code.

SEC. 16. DISPOSITION OF RECORDS.

At the conclusion of the existence of the Select Committee, all records of the Select Committee shall be transferred to other committees, or stored by the Clerk of the House, as directed by the Select Committee, consistent with applicable rules and law concerning classified information.

PARTIAL SCHEDULE OF SELECT COMMITTEE HEARINGS AND MEETINGS

DATE	SUBJECT MATTER	WITNESS(ES)
June 25	Business meeting (closed)	
July 15	Business meeting (closed)	
July 22	Classified (closed)	Central Intelligence Agency
July 29	Classified (closed)	Central Intelligence Agency
August 5	High Performance Computers (closed)	Department of Defense
	PRC activities in the U.S. (closed)	Federal Bureau of Investigation
August 17	Classified (closed)	Central Intelligence Agency
	PRC space program	Marcia Smith, Congressional Research Service
	Intelsat 708 Independent Review Committee	Shirley Kan, Congressional Research Services
August 18	Classified (closed)	Central Intelligence Agency

	Impact of the Intelsat 708 Independent Review Committee (closed)	Franklin Miller and David Tarbell, Department of Defense
	Impact of the Intelsat 708 Independent Review Committee (closed)	William Howell, Department of Defense
August 19	Classified (closed)	Department of Defense
August 25	PRC Missiles and Satellites (closed)	Department of Defense
August 26	Classified (closed)	Department of Defense
	Intelsat 708 Independent Review Committee (closed)	Allen Locke, Department of State
	Classified (closed)	Central Intelligence Agency
	PRC activities in the U.S. (closed)	Federal Bureau of Investigation
August 27	Contractor security preparations (closed)	Margaret Qualls, former PRC launch site security manager
	Corporate launch site security practices (closed)	Col. Steven Prichard (Ret.) former Defense Technology Security Administration Monitor
	Export control policies and practices (closed)	Dr. Peter Leitner

August 31	Defense Technology Security Administration policies and practices (closed)	Franklin Miller and David Tarbell, Department of Defense
	Export policies regarding high performance computers (closed)	William Reinsch, Department of Commerce
September 1	Classified (closed)	Col. Richard Skinner, Department of Defense
	The use of high performance computers in advanced nuclear weapons development (closed)	Notra Trulock and Thomas Cook, Department of Energy
	High performance computer export controls	Harold J. Johnson and Jeff Phillips, General Accounting Office
September 2	Effectiveness of export controls (closed)	Dr. Stephen Bryen, former Defense Techno-logy Security Administration official
	1995 transfer to the PRC of machine tools by McDonnell Douglas Corp.	Katherine Schinasi, General Accounting Office
September 11	Satellite launch insurance concerns	Timothy Rush, J&H Marsh & McLennan
September 18	Business meeting (closed)	

September 25	Classified (closed)	Department of Defense
October 2	Optus B2 launch failure analysis (closed)	Kenneth Peoples, former Department of Defense official
	Apstar 2 launch failure analysis (closed)	Eugene Christiansen and Iain Baird, Department of Commerce
October 9	Classified (closed)	Department of Defense
October 14	Counterintelligence programs at U.S. National Weapons Laboratories (Los Alamos, Livermore, and Sandia) (closed)	Dr. John Browne, Director, Los Alamos; Dr. Bruce Tarter, Director, Livermore; Dr. Paul Robinson, Director, Sandia
	U.S. National Weapons Laboratories security issues	Kenneth Fultz, John Schultz, and William Fentzel, General Accounting Office
October 15	Rumsfeld Commission testimony on PRC ballistic missile threat issues (closed)	Hon. Donald Rumsfeld, Hon. R. James Woolsey, Dr. William Schneider, Dr. Stephen A. Cambone, and Richard Haver
	PRC technology transfer programs	Kathleen Walsh, DFI International

	PRC commercial activities in the U.S.	James Mulvenon, Rand Corporation; Nicholas Eftemiades, independent expert
October 16	Professional staff briefing on status of investigation (closed)	Select Committee Staff
October 20	Business meeting (closed)	
November 12	Classified (closed)	Department of Energy; CIA
November 13	Economic implications of U.S. satellite launch policy	Raymond Williamson, Space Policy Institute; Loren Thompson, Lexington Institute; Clayton Mowry, Satellite Industry Association
December 9	Business meeting (closed)	
December 16	Classified (closed)	Department of Energy; CIA; FBI
December 17	Strategic implications of PRC theft of U.S. military technology (closed)	Hon. Caspar Weinberger, former Secretary of Defense; Hon. R. James Woolsey, former Director of Central Intelligence; Dr. Paul Wolfowitz, Dean, Johns Hopkins School of Advanced International Studies

December 21	Business meeting (closed)
December 22	Business meeting (closed)
December 23	Business meeting (closed)
December 28	Business meeting (closed)
December 29	Business meeting (closed)
December 30	Business meeting (closed)

PARTIAL LIST OF DEPOSITIONS AND INTERVIEWS CONDUCTED BY THE SELECT COMMITTEE

Satellites/Rockets

Col. Nick Alexandrow, U.S. Department of Defense*
Michael Armstrong, Hughes Space & Communications
Julie Bannerman, Space Systems/Loral
Charles R. Banta, U.S. Department of Defense
Jerald R. Beiter, U.S. Department of Commerce
Robert Berry, Space Systems/Loral
Patricia Bowers, Hughes Space & Communications
Harold D. Bradshaw, Space Systems/Loral
Donald L. Bridwell, INTELSAT
Steven O. Burke, Hughes Space & Communications
Fred Chan, Space Systems/Loral
Joseph Charles Chandler, Jr., U.S. Department of Defense
Elroy "Gene" Christiansen, U.S. Department of Commerce
Frank Cirillo, Lockheed-Martin Corp.
Lt. Col. Allen Coates, Defense Technology Security Administration*
Donald Cromer, Hughes Space & Communications
Steve Cunningham, Hughes Space & Communications
Kenneth Davis, Space Systems/Loral*
Clyde Patrick DeWitt, Space Systems/Loral
Martin Dome, Hughes Space & Communications
Steven Dorfman, Hughes Space & Communications
Terry Edwards, Intelsat
Col. Wayne Eleazer, U.S. Department of Defense
Col. David Garner, U.S. Department of Defense
Frederick H. Hauck, AXA Space
Michael Hewins, Space Ventures International
Peter M. Herron, Hughes Space & Communications
Chuck Higgins, Pinkerton Security Services
James Richard Johnson, Pinkerton Security Services
Sara Jones, Hughes Space & Communications*
Shen Jun, Hughes Space & Communications
Karl Kachigan, Analex Corporation

Kirk Douglas Keer, Space Systems/Loral
Robert S. Kovac, U.S. Department of Defense
Spencer Ku, Hughes Space & Communications
Bansang W. Lee, Hughes and Space Systems/Loral*
Donald L. Leedle, Hughes Space & Communications
Daniel Lilienstein, Intelsat
Wah Lim, Hughes and Space Systems/Loral*
Donald L. Majors, Hughes Space & Communications*
Michael Maloof, U.S. Department of Defense
Richard Park
John S. Perkins, Hughes Space & Communications
Tom Manuel, Pinkerton Security Services
Michael Poliner, Feith & Zell, P.C.
Frederick Ormsby, Intelsat*
Keith Patterson, Space Systems/Loral
Kenneth Peoples, U.S. Department of Defense/U.S. Department of State*
Steven Prichard, U.S. Department of Defense*
Margaret Qualls, Pinkerton Security Services*
Mark Quinn, Willis Corroon Inspace Inc.
Duncan L. Reynard, Space Systems/Loral
James William Reynolds, Space Systems/Loral*
Patrick Rivalan, AXA Space
Jack Rodden, Space Systems/Loral
Thomas B. Ross, Loral Space & Communications
Timothy Rush, J&H Marsh & McLennan
William Schweickert, Space Systems/Loral
Bernard Schwartz, Loral Space & Communications
Carol C. Sebring, Space Systems/Loral
John W. Smay, Hughes Space & Communications
Peter Snow, Space Systems/Loral*
Robert A.D. Steinhauer, Hughes Space & Communications
Nabeeh Totah, Space Systems/Loral
Alvin A. Ulsch III, Space Systems/Loral
Lynne P. Vollmer, AXA Space
Marjorie L. Walker, Space Systems/Loral*
Al Whittman, Hughes Space & Communications
Nick Yen, Space Systems/Loral
Eric J. Zahler, Loral Space & Communications

High Performance Computers

William J. Andahazy, Defense Consultant
Dr. Stephen Bryen, U.S. Department of Defense*
Aaron W. Cross, IBM Inc.
Tom Dunn, U.S. Department of Defense
Seymour Goodman, Stanford University
Dr. Jeff Hollingsworth, University of Maryland
Dan Hoydysh, Unisys Corp.
David Kahaner, Asian Technology Information Program
Paul Koenig, U.S. Department of Defense
Charles E. Leiserson, Massachusetts Institute of Technology

Manufacturing Processes

Iain S. Baird, U.S. Department of Commerce
Rear Admiral William D. Center, U.S. Navy
Elroy “Gene” Christiansen, U.S. Department of Commerce
Frank W. Deliberti, U.S. Department of Commerce*
John Despres, U.S. Department of Commerce*
Sue E. Eckert, U.S. Department of Commerce*
Antonio Hernandez, U.S. Department of Commerce
Robert Hitt, McDonnell Douglas
Peter Leitner, U.S. Department of Defense
R. Roger Majak, U.S. Department of Commerce
Michael F. Maloof, U.S. Department of Defense
Douglas McNeill, U.S. Department of Commerce
Mark D. Menefee, U.S. Department of Commerce
Douglas Monitto, Monitor Aerospace Corp.
Brooks D. Ohlson, World Trade Center
Dan Poneman, National Security Council
Marc G. Reardon, U.S. Department of Commerce
William Reinsch, U.S. Department of Commerce
Mingqi Zhao, CATIC USA

PRC Commercial Activities

Rich Aboulafia, Teal Group
Bruce Carlson, Federal Bureau of Investigation
Tai Ming Cheung, Kroll Associates Ltd.
Richard Cupitt, Center for International Trade & Security
David Duquette, New Century Remanufacturing

Jeffrey L. Fiedler, AFL-CIO Food & Allied Services Trade
John Foarde, U.S.-China Business Council
Dr. Bates Gill, Brookings Institute
Dr. Harlen Jencks, Lawrence Livermore National Laboratory
Duncan King, Securities & Exchange Commission
Robert Levy, Norman Levy Associates
Hon. James Lilley, U.S. Ambassador to the PRC*
Joan E. McKown, Securities & Exchange Commission
Ron Montaperto, National Defense University
Mike Nichols, Harris Communications
Roger Robinson, RWR Inc.
David A. Sirignano, Securities & Exchange Commission
Bruce C. Webb, U.S. Department of Commerce*
David Welker, AFL-CIO Food & Allied Services Trade
Bin Wu, convicted PRC technology transfer agent
Mingqi Zhao, CATIC USA

Export Controls/Policy

Iain S. Baird, U.S. Department of Commerce
John P. Barker, U.S. Department of State
Frank W. Deliberti, U.S. Department of Commerce*
Sue E. Eckert, U.S. Department of Commerce*
Steven C. Goldman, U.S. Department of Commerce
Cecil M. Hunt, U.S. Department of Commerce
Carol A. Kalinoski, U.S. Department of Commerce
Peter Leitner, U.S. Department of Defense
James Andrews Lewis, U.S. Department of Commerce
Robert S. Litt, U.S. Department of Justice
Will Lowell, U.S. Department of State
R. Roger Majak, U.S. Department of Commerce
Michael F. Maloof, U.S. Department of Defense
George Menas, U.S. Department of Defense
Dan Poneman, National Security Council
William Reinsch, U.S. Department of Commerce
Peter Sullivan, U.S. Department of Defense
David Tarbell, U.S. Department of Defense
Mitchel B. Wallerstein, U.S. Department of Defense*
Hoyt H. Zia, U.S. Department of Commerce

* *Not affiliated with organization at time of interview/deposition*

SELECT COMMITTEE VOTES TO ENFORCE REQUESTS FOR INFORMATION

The Select Committee issued more than 180 requests for information from business, government, individual witnesses, and other sources. The following are cases in which the Select Committee agreed to issue a subpoena to enforce its requests.

August 20	Steven M. Prichard, U.S. Department of Defense*
August 20	Margaret Qualls, Pinkerton Security Services*
September 25	International Space Brokers, Inc.
September 25	Dr. Wah Lim, Space Systems/Loral*
September 25	J&H Marsh & McLennan, Inc.
September 25	Monitor Aerospace, Inc.
September 28	Michael Maloof, U.S. Department of Defense
October 6	Mingqi Zhao, CATIC USA
October 16	Kenneth Davis, Space Systems/Loral
October 20	Patricia Bowers, Hughes Space & Communications
October 20	Steven O. Burke, Hughes Space & Communications
October 20	Donald Cromer, Hughes Space & Communications
October 20	Steven Cunningham, Hughes Space & Communications
October 20	Steven Dorfman, Hughes Space & Communications
October 20	Peter Herron, Hughes Space & Communications
October 20	Larry Jackson, Hughes Space & Communications
October 20	David Knauer, Hughes Space & Communications
October 20	Spencer Ku, Hughes Space & Communications
October 20	Donald Leedle, Hughes Space & Communications
October 20	Donald Majors, Hughes Space & Communications*
October 20	Beth Mersch, Hughes Space & Communications
October 20	Richard Park
October 20	John S. Perkins, Hughes Space & Communications
October 20	Harold Rosen, Hughes Space & Communications
October 22	John Smay, Hughes Space & Communications
October 20	Ted Smith, Hughes Space & Communications
October 20	Robert A.D. Steinhauer, Hughes Space & Communications
October 20	Jose Verissmo, Hughes Space & Communications
October 20	Al Wittman, Hughes Space & Communications

October 23	Brian Tau
October 23	Steven O. Burke, Hughes Space & Communications
October 28	Cadalong International Capital, Inc.
October 28	TAL Industries, Inc.
November 6	Michael Poliner, Feith & Zell, P.C.
November 12	Karl Kachigan, Analex Corporation
December 1	C. Michael Armstrong, Hughes Space & Communications*
December 1	John Huang, U.S. Department of Commerce*
December 1	Nicholas Yen, Space Systems/Loral

* *Not affiliated with organization at time of subpoena*

PARTIAL LIST OF DOCUMENTS REQUESTED BY THE SELECT COMMITTEE

Boeing Company

August 19	Documents relating to issues set forth in H. Res. 463
October 8	Privilege log describing withheld documents

Bush Presidential Library

November 3	Documents relating to President Bush's Executive Order requiring the divestiture of MAMCO by the China National Aero-Technology Import-Export Corp.

Central Committee of the Chinese Communist Party

October 20	Information on certain Chinese nationals

COMSAT

August 19	Documents relating to issues set forth in H. Res. 463

Congressional Research Service

October 7	Report on China National Aero-Technology Import-Export Corp. (CATIC)

General Accounting Office

September 1	Documents relating to issues set forth in H. Res. 463

House Permanent Select Committee on Intelligence

July 20	Documents relating to matters of concern to the Select Committee

Hughes Space & Communications

August 19	Documents relating to issues set forth in H. Res. 463

August 20	Documents relating to the launches and attempted launches of the Chinese Long March 3B and 2E rockets and information on Hughes employees and contractors

Intelsat

September 9	Documents relating to launches of Intelsat satellites in the PRC

Lockheed-Martin Missiles & Space Corp.

November 17	Documents relating to company plans to protect security of technology at launch sites

Monitor Aerospace

September 15	Documents relating to correspondence and communications with any representatives of the People's Republic of China and/or McDonnell Douglas Corp. pertaining to the establishment of a machining center in the PRC
October 8	Privilege log describing withheld documents

Motorola Corp.

July 31	Documents relating to issues set forth in H. Res. 463

Office of the Vice President of the United States

August 19	Documents relating to issues set forth in H. Res. 463

Office of the President of the United States

August 19	Documents relating to issues set forth in H. Res. 463
September 18	Documents relating to commercial activities in the United States by PRC interests, the President's Export Council, and Presidential waivers of sanctions
November 12	Information relating to issues set forth in H. Res. 463

Bernard Schwartz

August 19	Documents relating to issues set forth in H. Res. 463

Space Systems/Loral

August 19	Documents relating to issues set forth in H. Res. 463

U.S. Arms Control and Disarmament Agency

August 19	Documents relating to issues set forth in H. Res. 463

U.S. Customs Service

August 19	Documents relating to issues set forth in H. Res. 463
September 2	Documents relating to investigations or analyses of technology acquisitions by the PRC

U.S. Department of Commerce

August 10	Documents relating to Wah Leng Lim, Shen Jun and Nick Yen
August 19	Documents relating to issues set forth in H. Res. 463
September 21	Printouts from the Export Control Automated Support System (ECASS) showing all exports to the People's Republic of China, including Hong Kong
October 26	Documents relating to certain businesses and individuals
October 27	Documents relating to John Huang
October 27	Electronic copy of the Export Control Automated Support System (ECASS)
November 9	Documents relating to complaints or concerns expressed by the Office of the U.S. Attorney/Los Angeles regarding the local field office of the Office of Export Enforcement or certain personnel located within that field office
November 13	Copies of export policies and regulations, manuals and licenses
November 20	Information relating to issues set forth in H. Res. 463

U.S. Department of Defense

August 10	Documents relating to Wah Leng Lim, Shen Jun and Nick Yen
August 19	Documents relating to issues set forth in H. Res. 463
September 15	Documents relating to issues set forth in H. Res. 463

September 17	Documents relating to issues set forth in H. Res. 463
September 22	Documents relating to 1994 sale of McDonnell Douglas machine tools to China National Aero-Technology Export-Import Corp. (CATIC)
September 25	Information relating to issues set forth in H. Res. 463
September 29	Copy of video of PRC launch V-7733
October 20	Documents relating to Zhou Yuanying
October 26	Documents relating to certain businesses and individuals
November 3	Documents relating to issues set forth in H. Res. 463

U.S. Department of Energy

August 19	Documents relating to issues set forth in H. Res. 463
November 24	Documents relating to issues set forth in H. Res. 463
November 30	Information relating to issues set forth in H. Res. 463

U.S. Department of Justice

July 21	Documents relating to assessments of impact on national security resulting from involvement of U.S. companies in PRC launch failure investigations
August 19	Documents relating to issues set forth in H. Res. 463

U.S. Department of State

August 10	Documents relating to Wah Leng Lim, Shen Jun and Nick Yen
August 19	Documents relating to issues set forth in H. Res. 463
November 20	Documents relating to issues set forth in H. Res. 463
November 30	Information relating to issues set forth in H. Res. 463

U.S. Department of Transportation

August 19	Documents relating to issues set forth in H. Res. 463

U.S. Department of Treasury

August 14	Documents relating to Wah Leng Lim, Shen Jun and Nick Yen
August 19	Documents relating to issues set forth in H. Res. 463
September 1	Documents relating to Committee on Foreign Investment in the U.S. (CFIUS) reviews of PRC acquisition of U.S. entities
October 27	Documents relating to John Huang
November 20	Documents relating to issues set forth in H. Res. 463

U.S. Federal Bureau of Investigation

August 6	Documents relating to Wah Leng Lim, Shen Jun and Nick Yen
October 20	Documents relating to Zhou Yuanying
October 26	Documents relating to certain businesses and individuals

U.S. Immigration and Naturalization Service

August 10	Documents relating to Wah Leng Lim, Shen Jun and Nick Yen

U.S. National Aeronautics and Space Administration

August 19	Documents relating to issues set forth in H. Res. 463

U.S. National Security Council

August 19	Documents relating to issues set forth in H. Res. 463

U.S. Securities and Exchange Commission

September 10	Documents relating to PRC ownership of commercial enterprises in the United States

U.S. Senate, Committee on Government Affairs

October 27	Copies of the classified version of specified chapters of “The China Connection” report

GLOSSARY OF PROPER NAMES

Nicholas Alexandrow	Former USAF Colonel assigned to U.S. Defense Technology Security Administration; employed by Loral since 1996
C. Michael Armstrong	Chairman and Chief Executive Officer, Hughes Electronics, 1993-97; Chairman, AT&T, 1997 to present
Iain Baird	Deputy Assistant Secretary for Export Administration, U.S. Department of Commerce
Julie Bannerman	Loral General Counsel and Vice President
Bao Miaoqin	Chief Engineer of the PRC's Asia Pacific Telecommunications Satellite Co., Ltd.
Samuel R. (Sandy) Berger	President Clinton's National Security Adviser since 1997; Deputy National Security Adviser, 1993-1997
Robert Berry	President, Loral
Harold Bradshaw	Loral representative in Washington, D.C.
Donald Bridwell	Manager, Intelsat's Major Programs Office in the Procurement Division
Ronald H. Brown	Former U. S. Secretary of Commerce (deceased)
Steven Bryen	Member of Loral's Government Security Committee (GSC); former Director of Defense Technology Security Administration
Steven Burke	Structural engineer at Hughes who served as a principal investigator of the Long March 2E-Optus B2 crash
Fred Chan	Director, Controls Engineering, Loral; Technical Staff on Independent Review Committee for the Long March 3B-Intelsat 708 crash
Gareth Chang	Senior Vice President, Hughes Electronics
Eugene (Gene) Christiansen	Export Licensing Officer, U.S. Department of Commerce
Warren Christopher	President Clinton's first Secretary of State

Allen Coates	Lt. Col. in the U.S. Air Force (now retired); served as a U.S. Defense Technology Security Administration monitor
Donald Cromer	Vice President, Hughes Electronics; President, Hughes Space & Communications International, Inc.
Stephen L. Cunningham	PhD physicist working as a senior level executive in Hughes' satellite program since 1977; Program Manager for Optus B1; led the Long March 2E-Optus B2 crash investigation; co-leader of Hughes' Failure Investigation Team after the Long March 2E-Apstar 2 crash
Ken Davis	Security Manager at Loral
Frank Deliberti	Former Deputy Assistant Secretary for Export Enforcement, U.S. Department of Commerce
John Despres	Former Assistant Secretary for Export Enforcement, U.S. Department of Commerce
Pat Dewitt	Chief Financial Officer, Loral
Steven D. Dorfman	President and CEO, Hughes Space and Communications International, Inc.
Sue Eckert	Former Assistant Secretary for Export Administration, U.S. Department of Commerce
Terry Edwards	Manager, Intelsat's Launch Vehicle Program Office
Douglas Feith	Partner, Feith & Zell, P.C., Washington, D.C. (outside legal counsel for Loral)
Seymour Goodman	Director, Consortium for Research in Information Security and Policy under the Center for International Security and Cooperation and the School of Engineering at Stanford University
He Kerang	President, Asia Pacific Telecommunications Satellite Company, Ltd., PRC-controlled satellite owner and operator based in Hong Kong; phonetic Hee Keh-rang
Antonio Hernandez	Special Agent, Office of Export Enforcement Intelligence Division, U.S. Department of Commerce

Peter Herron	Hughes' Program Manager for Optus B3; Assistant Program Manager for Optus B2; responsible for coordination with PRC in the Long March 2E-Optus B2 crash investigation; co-leader of Hughes' Failure Investigation Team after the Long March 2E-Apstar 2 crash
Michael Hewins	Former Chairman, Space and Telecom Group, J&H Marsh & McLennan
Reinhard Hildebrandt	Team Leader, Flight Operations & Post Flight Evaluation, Daimler-Benz Aerospace, Bremen, Germany; Member of Independent Review Committee for Long March 3B-Intelsat 708 crash
Robert Hitt	PRC Program Manager, McDonnell Douglas
John Holt	Member of Independent Review Committee; retired Managing Director, Space Systems Group, British Aerospace; consultant with McLaurin-Holt Association in Great Britain
John Huang	Former Principal Deputy Assistant Secretary for International Economy Policy, U.S. Department of Commerce; was principal U.S. executive for the Lippo Group, a partner of the China Resources (Holdings) Company in the PRC
Karl Kachigan	Member of Independent Review Committee; retired Chief Engineer and Director, Atlas Launch Vehicle at General Dynamics
Bob Kovac	Licensing officer, U.S. Defense Technology Security Administration (now Technology Security Directorate)
Spencer Ku	Hughes engineer involved in the Long March 2E-Apstar 2 and Long March 2E-Optus B2 crash investigations
Bansang (Bill) Lee	Loral representative in the PRC; previously Hughes representative in the PRC; President, Plettenberg, Ltd., Beijing, PRC
Peter Lee	Taiwanese-born scientist at Los Alamos National Laboratory convicted in 1997 of passing classified weapons technology information to the PRC

Donald Leedle	Hughes' Technology Export Control Coordinator from 1992 to 1996
Peter Leitner	Senior Strategic Trade Advisor, U.S. Defense Technology Security Administration (now Technology Security Directorate)
Daniel Lilienstein	Assembly, Integration and Test Manager at Intelsat in Palo Alto, California
Wah Lim	Former Senior Vice President & General Manager of Engineering and Manufacturing, Loral; currently employed by Hughes; Chairman of Independent Review Committee
Col. Liu Chaoying	PLA colonel and officer of China Aerospace Corporation who provided Johnny Chung with $300,000; daughter of General Liu Huaquing
Gen. Liu Huaquing	Former CCP Central Military Commission Vice Chairman and Politburo Standing Committee Member until 1997. General Liu has been described as the PLA's preeminent policymaker on military R&D, technology acquisition, and equipment modernization as well as the most powerful military leader in the PRC. He has used numerous U.S. companies for sensitive technology acquisitions. Phonetic Lee-you Hwa-ching
Liu Jiyuan	PRC Minister; heads China Aerospace Corporation; phonetic Lee-you Jee-yuan
Liu Zhixiong	Vice President, China Great Wall Industry Corporation; phonetic Lee-you Zhee-sheeyong
R. Roger Majak	Assistant Secretary for Export Administration, U.S. Department of Commerce
Donald E. Majors	Director, International Affairs, Hughes' Washington D.C. office
Michael Maloof	Chief, Technical Security Operations, U.S. Defense Technology Security Administration (renamed Technology Security Directorate)
Jacques Masson	Former Manager, J&H Marsh & McLennan office in Paris

Douglas McNeill	Chief, Office of Export Enforcement, Intelligence Division, U.S. Department of Commerce
Mark Menefee	Director, Office of Export Enforcement, U.S. Department of Commerce
John Merizon	Loral Manager for Intelsat 7 and 7A programs
Doug Monitto	Former President, Monitor Aerospace
Paul O'Connor	Former Vice President, Space and Telecom Group, J&H Marsh & McLennan; Australian citizen working for British space insurance broker Willis Corroon Inspace (WCI) in Singapore
Zia Oboodiyat	Loral Executive Director for the Mabuhay program
Brooks Ohlson	Former Special Agent in Charge, Los Angeles Field Office, Office of Export Enforcement, U.S. Department of Commerce
Frederick Ormsby	Member of Independent Review Committee; retired launch vehicle engineer with Intelsat, where he was the Department Manager, Spacecraft Engineering & Launch Vehicle Program Office
Kenneth Peoples	Former Department of State Licensing Officer; currently at U.S. Defense Technology Security Administration (renamed Technology Security Directorate)
John S. Perkins	Hughes' Director of Launch Service Acquisitions; negotiated the Optus B3 contract
Dan Poneman	Former U.S. National Security Council Senior Director for Nonproliferation and Export Controls
Steven Prichard	Former USAF Captain and U.S. Defense Technology Security Administration monitor for Intelsat 708 launch campaign
Margaret Qualls	Former Pinkerton Site Security Manager
Mark Quinn	Former Vice President, J&H Marsh & McLennan's Space and Telecom Group

Marc Reardon	Former Department of Commerce Office of Export Enforcement Special Agent at Los Angeles Field Office
William Reinsch	Under Secretary for Export Administration, U.S. Department of Commerce
Duncan Reynard	Export Control Officer, Loral
Jack Rodden	Principal Engineer at Loral; Technical Staff on Independent Review Committee for Long March 3B-Intelsat 708 crash
Joe Rongeau	Hughes' Washington, D.C. representative
Timothy Rush	Vice President, J&H Marsh & McLennan's Space and Telecom Group; former Intelsat Program Manager
Bernard Schwartz	Chairman of the Board and Chief Executive Officer, Loral Space & Communications
William Schweickert	Technology Transfer Control Manager at Loral
Shen Jun	Hughes Space and Communications scientist and business development specialist on APMT satellite program; son of PRC People's Liberation Army Lt. Gen. Shen Rongjun; phonetic Shen June
Shen Rongjun	Lt. Gen., People's Liberation Army; Deputy Director, Commission of Science, Technology and Industry for National Defense (COSTIND); father of Hughes employee Shen Jun; phonetic Shen Rong-June
Shouchun Chen	Vice President, China Great Wall Industry Corporation
John Smay	Chief Technologist, Hughes Space & Communications; Member of Independent Review Committee for Long March 3B-Intelsat 708 crash
Jennifer Smolker	Hughes attorney responsible for satellite export licensing accountability
Pete Snow	Loral Site Security Manager at Long March 3B-Intelsat 708 crash in the PRC
Robert Steinhauer	Member of Independent Review Committee for Long

	March 3B-Intelsat 708 crash; Chief Scientist, Hughes Space & Communications
David Tarbell	Director, Technology Security Directorate (and Director of predecessor agency, the U. S. Defense Technology Security Administration)
Nabeeh Totah	Director, Spacecraft Engineering Laboratory, Loral; Technical Staff on Independent Review Committee for Long March 3B-Intelsat 708 crash
Yah Lin (Charlie) Trie	Taiwanese-born businessman indicted on campaign finance irregularities; financial connections to CP Group, shareholders in PRC-controlled APT satellite consortium; subject of Senate and House investigations of political fundraising
Muhammad Wahdy	Loral Satellite Test Engineer
Mitchel Wallerstein	Former Deputy Assistant Secretary of Defense for Counterproliferation Policy
Dan Weston	Hughes Electronics' in-house expert in International Traffic in Arms Regulations
Al Wittman	Hughes' Chief Technologist
Bin Wu	Former Chinese philosophy professor convicted in U.S. of smuggling night-vision equipment to PRC
He Xing	Deputy General Manager, Space Division, China Great Wall Industry Corporation; phonetic Hee-Shing
Nick Yen	Department Manager, Launch Vehicle & Launch Operations, Loral; Secretary of Independent Review Committee for Long March 3B-Intelsat 708 crash
Madame Zhou	PRC representative for PRC-controlled Asia Pacific Telecommunications Satellite Co., Ltd.
Steve Zurian	A principal of Trident Data Systems, which advised Loral on export control issues, and an attendee at meetings of Loral's Government Security Committee

GLOSSARY OF TERMS

AIT — Assembly Integration and Test; the name for the period in the manufacture of a satellite in which the satellite is physically put together and tested.

Apstar — The family name of several geosynchronous communications satellites manufactured by Hughes Space & Communications International, Inc. for APT.

APT — Asia Pacific Telecommunications Satellite Company, Ltd.; 75% owned by PRC government-backed companies. Based in Hong Kong, APT owns and operates several satellites named Apstar.

AVIC — Aviation Industries of China, formerly known as the Ministry of Aviation. AVIC is a PRC state-controlled entity that oversees research, development, and production of military and civilian aircraft in the PRC.

Ballistic Missile — A rocket-launched system carrying one or more warheads which returns to the Earth's surface along a ballistic trajectory, meaning a non-propulsive free-fall. Ballistic missiles can be designed for short-, intermediate-, or long-range (see ICBM) capability. Many of the systems and components of ballistic missiles are common to rockets used to put satellites into orbit.

Broker — A space insurance broker administers the space insurance policy between the underwriters and the satellite owner or manufacturer.

CAEP — China Academy of Engineering Physics, an institution responsible for research, development, testing, and production of the PRC's nuclear weapons. CAEP is subordinate to COSTIND.

CALT — China Academy of Launch Vehicle Technology. PRC state-controlled entity that designs and manufactures military and commercial rockets and ballistic missiles.

CASC — China Aerospace Corporation. Responsible for the design and manufacture of both PLA missiles and military and commercial space launch services and equipment. CASC is the parent organization of China Great Wall Industry Corporation (CGWIC), China Academy of Launch Vehicle Technology (CALT), China Academy of Space Technology (CAST), and other entities.

CAST China Academy of Space Technology. PRC state-controlled entity that designs and manufactures satellites and recoverable payloads.

CATIC China National Aero-Technology Import/Export Corporation (CATIC) is a PRC state-controlled industrial corporation subordinate to the Aviation Industries Corporation of China (AVIC). AVIC is responsible for managing R&D for the PRC's state-controlled aviation industry, including production of military aircraft.

CCP Chinese Communist Party. Since 1949, the ruling body of the State, the military, the communications media, and the judiciary, and the only legal political organization in the People's Republic of China's one-party political dictatorship. Also sometimes referred to as the Communist Party of China (CPC).

CGWIC China Great Wall Industry Corporation. The PRC state-controlled business element of China Aerospace Corporation that furnishes space launch services, space technology, and related equipment.

CITIC China International Trust and Investment Company. The PRC government's premier state-controlled investment bank, which reports to the PRC State Council. CITIC's President, Wang Jun, has a status equivalent to that of a government minister.

CISC Complex Instruction Set Computer. As opposed to RISC, a CISC design uses a much larger instruction set. More instructions permit more efficient compilers; however, it has a cost in terms of chip complexity.

CLTC China Launch and Tracking Control General Administration

Clustering Clustering refers to using a group or collection of control processing units (CPUs), workstations, or boards to accomplish a single task or a group of tasks at greater speed. Examples are the clustering of (1) CPUs on the same board, (2) boards in the same machine, and (3) workstations or machines. In a network, the cluster of workstations forms a virtual machine to accomplish the task collectively. In a network of machines, there is a cluster of clusters. Each machine is a cluster of CPUs, and the collection of machines is in turn a cluster.

COSTIND The Commission on Science, Technology, and Industry for National Defense. COSTIND is subordinate to the PRC State Council and oversees military research, development, and acquisition programs in the PRC.

CPU Central Processing Unit. The essential core of a computer.

CTP Composite Theoretical Performance. The current metric used for calculating relative computing performance for purposes of export control, CTP gives an estimate of peak performance of a system.

DASA Daimler-Benz Aerospace AG, the largest defense and aerospace corporation in Germany. Its parent company has since merged with Chrysler Corporation to become the DaimlerChrysler Group. The aerospace unit is now named DaimlerChrysler Aerospace AG. The new company still uses the abbreviated name DASA.

DOD U.S. Department of Defense

DTSA Defense Technology Security Administration. In 1998, DTSA was renamed the Technology Security Directorate and placed within the newly-created Defense Threat Reduction Agency (DTRA) in the U.S. Department of Defense.

FAC Failure Analysis Committee. One of three committees formed by China Great Wall Industry Corporation to investigate the launch failure of the Intelsat 708 satellite in 1996. The other committees are the Failure Investigation Committee (FIC) and Failure Oversight Committee (FOC).

Failure tree analysis A mode of analysis that seeks to account methodically for all possible causes of a failure and their interrelationships.

Fairing The “nose cone” portion on a launch vehicle and on some ballistic missiles. The fairing protects the payload from atmospheric loads.

FIC Failure Investigation Committee. One of three committees formed by China Great Wall Industry Corporation to investigate the launch failure of the Intelsat 708 satellite in 1996. The other committees are the Failure Analysis Committee (FAC) and Failure Oversight Committee (FOC).

FOC	Failure Oversight Committee. One of three committees formed by China Great Wall Industry Corporation to investigate the launch failure of the Intelsat 708 satellite in 1996. The FOC was an oversight committee that was over the FAC and the FIC.
Frame	Part of an Inertial Measurement Unit of the guidance system on a rocket or ballistic missile. A unit may contain three or four frames, each accounting for motion on a different axis. For example, a frame may account for vertical, horizontal, and one or more aspects of diagonal motion. The "Inner" frame is that closest to the instruments on the central platform of the Inertial Measurement Unit. The "Outer" frame is that farthest from the central platform. The "Follow-on" frame is a fourth frame or gimbal that is added to help to prevent a guidance system from becoming dysfunctional when the rocket or missile makes sudden movements out of the previous attitude for flight. Also called a "frame gimbal" or "gimbal."
Gigaflop	Also GFLOP. One billion floating point operations per second.
Gimbal	Part of an Inertial Measurement Unit, which in turn is part of the guidance mechanism for a rocket or missile. Also called a "frame." See "Frame" above.
GSC	Loral's Government Security Committee
HPC	High Performance Computer. The term used since 1996 for a class of computers in the mid-range of the computing performance scale. Presently these computers are in the speed range of 1,500-40,000 MTOPS. HPC replaces the now-obsolete term "supercomputer."
HSCI	Hughes Space & Communications International, Inc., referred to as "Hughes" throughout this Report. Aerospace company headquartered in El Segundo, CA; a subsidiary of Hughes Electronics Corporation. Hughes built the Optus B2 and Apstar 2 satellites.
ICBM	Intercontinental Ballistic Missile. A ballistic missile designed with a maximum range of 3,100 miles (5,000 km) or greater. ICBMs are strategic weapons and typically carry nuclear warheads.
IMU	Inertial Measurement Unit. Part of the guidance system on rockets, ballistic missiles, and certain other aerospace systems used to furnish information about changes in attitude and acceleration.

INTEC International Underwriters, Inc. is the former name of AXA Space, Inc., a Bethesda, Maryland-based space insurance underwriting company.

Intelsat The International Telecommunications Satellite Organization (Intelsat) is the world's largest commercial satellite communications services provider. Founded in 1964, Intelsat is a consortium of 143 countries that owns and manages a constellation of communications satellites.

IOT Independent Oversight Team. Hired by Hughes and the PRC during Apstar 2 launch failure analysis. Found discrepancies in PRC's Coupled Load Analysis.

IRC Independent Review Committee. See definition below.

Independent Review Committee A committee of U.S. and European scientists/engineers formed in the spring of 1996 at the request of the China Great Wall Industry Corporation to perform an independent assessment of the PRC investigation of the causes of the Intelsat 708-Long March 3B launch failure that occurred on February 15, 1996. The Independent Review Committee included scientists from Space Systems/Loral and Hughes and was chaired by Dr. Wah Lim of Space Systems/Loral.

ISB International Space Brokers. A space insurance brokerage firm based in Rosslyn, Virginia.

ITAR The International Traffic in Arms Regulations. These federal regulations, which appear at 22 CFR Part 120 et seq., implement Section 38 of the Arms Export Control Act.

Iridium The generic name of both a satellite constellation providing global commercial communications service, and the company that owns it. Iridium satellites are manufactured by Lockheed-Martin and are launched from sites around the world, including Taiyuan, PRC.

J&H J&H Marsh & McLennan, Inc. is a multinational, privately-held company formed from the combination of Johnson & Higgins and Marsh & McLennan. It controls the largest international insurance brokerage system in the world.

Launch Vehicle A launch vehicle is a rocket used to launch a satellite into orbit. It typically includes several liquid- or solid-propellant stages, along with guidance and control systems. Many of the systems and components of a launch vehicle are common to ballistic missiles.

Legacy Codes Classified U.S. computer codes derived from nuclear weapons testing data. The legacy codes are used by scientists to understand processes within a thermonuclear warhead. These codes are useful for adapting or modifying weapons designs, for evaluating new weapons designs, and for judging weapon stability over time and stockpile maintenance needs.

Lop Nur Nuclear weapons test site in the PRC

Loral Space Systems/Loral Corporation, builder of the Intelsat 708 satellite.

Mabuhay A satellite manufactured by Space Systems/Loral for the Mabuhay Philippines Satellite Corporation. The satellite was launched on August 19, 1997 from the PRC's Xichang Space Launch Complex aboard a Long March 3B rocket; later renamed Agila 2.

MEI Ministry of Electronics Industry. Now known as the Ministry of Information Industry (MII), it is the PRC government ministry responsible for the development of the electronics industry.

MID Military Intelligence Department. The primary military intelligence agency in the PRC. Also known as the Second Department of the PLA General Staff. Headed by General Ji Shengde since 1992.

MII Ministry of Information Industry. It is the PRC government ministry responsible for the development of the electronics industry. Formerly known as the Ministry of Electronics Industry (MEI).

MIRV Multiple Independently Targetable Reentry Vehicle. The technology that permits a single ballistic missile to carry multiple warheads and target them independently.

MPP Massively Parallel Processor. This is a collection of building block computers in one computer. Each building block computer could be on an individual board (each board would be a physically separate computer with only the minimum items needed to make a working computer CPU, Memory, Input/Output), and each board could talk to any other board via a common system bus. A system bus connects all the boards in the MPP computer together, allowing each board to pass data or instructions from any one board to any other. This transfer of data is done through the Input/Output portion of each board.

MSS Ministry of State Security. The principal domestic and foreign intelligence agency of the PRC. See also MID.

MTOPS Millions of Theoretical Operations per Second. A generic metric for the performance of computers. A higher number indicates faster performance. For example, a 450 Mhz Pentium II processor has an MTOPS rating of approximately 467.

MPT Ministry of Post and Telecommunications. Controls the PRC's state-controlled communications infrastructure.

MTCR Missile Technology Control Regime. Created in April 1987 by Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States to limit the proliferation of missiles capable of delivering weapons of mass destruction.

Network A network of workstations or of machines is a collection of two or more individual and complete machines that are connected externally by a dedicated communications path to and from a switch. The switch allows communications between each machine.

NIO National Intelligence Officer. A U.S. intelligence analyst with specific country or subject-matter expertise.

NSC U.S. National Security Council

ODTC Office of Defense Trade Controls, U.S. Department of State

Optus The family name of several geosynchronous communications satellites manufactured by Hughes Space & Communications Corporation for Optus Communications PTY Ltd. of Australia. The Optus B1, B2, and B3 satellites were launched on Long March 2E rockets from Xichang Space Launch Center in the PRC.

Payload	A commercial payload consists of the object(s) that are to be placed into orbit by a rocket. A military payload is usually a warhead or a military satellite for the purpose of reconnaissance or communications.
PBV	Post Boost Vehicle. The final stage of an ICBM. The PBV has its own guidance and propulsion system, and is programmed to release several reentry vehicles (see MIRV) along different ballistic trajectories so that they strike different targets. Modern PBVs also include the ability to dispense decoys and other countermeasures.
PICC	People's Insurance Company of China. Based in Beijing, PICC is a state-owned insurance company dealing in all types of insurance coverage in international insurance markets.
PLA	People's Liberation Army. The national military of the PRC and the largest standing army in the world. All branches of the PRC military, including the Army, Navy, and Air Force, are part of the PLA.
PRC	People's Republic of China. The defacto government of mainland China established by Mao Zedong in 1949. The Communist government of China was first recognized by the United States in 1979.
RISC	Reduced Instruction Set Computer. As opposed to CISC, a RISC computer uses a much shorter instruction set, meaning it allows fewer machine instructions. This permits a much simpler chip design that can run at much higher speeds.
ROC	Republic of China. The democratic successor government to the pre-Communist government of mainland China, located on the island of Taiwan. Since 1979, U.S. dealings with the ROC have been conducted pursuant to the Taiwan Relations Act.
Satellite	Military or civilian equipment designed to operate in orbit around the Earth. Satellites are used in many roles, including weather forecasting, communications (radio, television, telephone, data services), scientific research, and surveillance.
SMP	Symmetrical Multiprocessor. This is a computer with multiple CPUs that is treated as a single fast CPU. Although an SMP uses multiple CPUs, it is actually performing sequential processing.

Space Launch Vehicle — A space launch vehicle is a rocket used to launch a satellite into orbit. It typically includes several liquid- or solid-propellant stages, along with guidance and control systems. Many of the systems and components of a launch vehicle are common to ballistic missiles.

SS/L — Space Systems/Loral, referred to as "Loral" throughout this Report. Aerospace company headquartered in Palo Alto, CA; a subsidiary of Loral Space and Communications, Ltd. Loral built the Intelsat 708 satellite.

Supercomputer — An obsolete term for a powerful computer. The term was replaced in January 1996 in Export Administration Regulations with the term "high performance computer."

TEM — Technical Exchange Meeting. A technical meeting between engineers from different organizations for the purposes of discussing and exchanging technical information about the applicable project. A typical satellite design and development program involves many TEMs in order to share information, plan and coordinate engineering activities, and resolve technical issues.

Teraflop — Also TFLOP. One trillion floating point operations per second.

TFLOP — See "Teraflop" above.

TIM — Technical Interface Meeting. See "TEM" above.

Torque motor — A motor that receives information from the frames in the inertial measurement unit about changes in attitude of a rocket or missile, which in turn helps to correct the attitude of the rocket or missile, as needed. For further information, see "Frame" and "Inertial Measurement Unit" above.

TTCP — Technology Transfer Control Plan. Required in connection with U.S. satellite launches in the PRC.

Underwriter — A space insurance underwriter provides satellite owners and manufacturers with space insurance for launch and in-orbit phases of a satellite launch.

Voluntary Disclosure — Reports prepared by Loral and Hughes to explain to U.S. Government authorities the unlicensed participation by Loral and Hughes officers and employees in a PRC review of the technical causes of a PRC rocket crash. Although termed “voluntary,” the reports were prepared at the insistence of the State Department, which had previously learned through a newspaper article of violations of export control laws by Loral and Hughes.

XSLC

Xichang Space Launch Center; phonetic Shee-chang. A space-launch facility located on a PLA military base in Xichang, PRC. The Intelsat 708 satellite launch failure occurred at XSLC.

SELECT COMMITTEE OF THE UNITED STATES HOUSE OF REPRESENTATIVES