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[1] : Tables also available through the internet network ftp 62.161.69.5 or http://www.bipm.org

[2] : Tables only available through the internet network ftp 62.161.69.5 or http://www.bipm.org

Practical information about the BIPM Time Section

The Time Section of the BIPM issues two periodic publications. These are the monthly *Circular T* and the *Annual Report of the BIPM Time Section.* In addition, BIPM TWSTFT Reports give technical details about the TWSTFT links computed at the BIPM. The complete texts of *Circular T*, the TWSTFT Reports and most tables of the present Annual Report are available from BIPM website, www.bipm.org.

La Section du temps du BIPM produit deux publications périodiques : la Circulaire T, *mensuelle, et le* Rapport annuel de la Section du temps du BIPM. *De plus, des rapports techniques sur les liens TWSTFT calculés par le BIPM sont publiés régulièrement. Les circulaires, les rapports du TWSTFT et la plupart des tableaux de ce rapport annuel sont disponibles par utilisation du site internet du BIPM, www.bipm.org.*

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Electronic access to the BIPM Time Section, data and publications

A large number of publications and data files from the BIPM Time Section are available from the website (http://www.bipm.org) or by anonymous ftp (62.161.69.5 or ftp2.bipm.org, user anonymous, e-mail address as password). If using ftp, cd pub/tai to access the tai directory and the subdirectories listed below.

The Time Section ftp server

The files are found in the three subdirectories **data**, **publication**, and **scale**; further details are given below.

In the following directories XY represents the last two digits of the year number (19XY or 20XY) ZT equals to 01 for Jan., 02 for Feb. ....12 for Dec. And XX, XXX are ordinal numbers.

Data- all data used for the computation of TAI, arranged in yearly directories, starting May 1999. See readme.txt for details.

Publication- the latest issues of the Time Section

publications	**filename**
Leap seconds	leaptab.txt
Acronyms of laboratories	acronyms.txt
Circular T	cirt.XXX
Fractional frequency of EAL from primary frequency standards	etXY.ZT
Weights of clocks participating in the computation of TAI	wXY.ZT
Rates relative to TAI of clocks participating in the computation of TAI	rXY.ZT
Values of the differences between TAI and the local atomic scale of the given laboratory, including relevant notes	TAI - lab
Values of the differences between UTC and its local representation by the given laboratory, including relevant notes	UTC - lab
Values of the differences between TAI and UTC and the respective local scales, evaluated for two-month periods until the end of 1997	TAI - XYZ
[UTC(lab1) - UTC(lab2)] obtained by the TWSTFT link, as published in the BIPM TWSTFT reports	lab1 - lab2.tw
BIPM Two-Way Satellite Time and Frequency Transfer Reports	twstftXX.pdf
Most recent schedules for common-view observations of GPS and	schgps.XX
GLONASS satellites	schglo.XX

Older files can be accessed directly from the ftp site (62.161.69.5 or ftp2.bipm.org).

Scale- time scales data

Content	**filename**
TT(BIPMXY) computed in the year 19XY or 20XY	TTBIPM.XY
Starting 1993:	
Difference between the normalized frequencies of EAL and TAI	EALTAIXY.ar
TAI frequency	FTAIXY.ar (for 1993,1994)
Measurements of the duration of the TAI scale interval	UTAIXY.ar (starting 1995)
Mean duration of TAI scale interval	SITAIXY.ar
[*TAI - GPS time*] and [*UTC - GPS time*]	UTCGPSXY.ar
[*TAI - GLONASS time*] and [*UTC - GLONASS time*]	UTCGLOXY.ar
Time Dissemination Services	TIMESERVICES.DOC
Time Signals	TIMESIGNALS.DOC
Rates of clocks contributing to TAI	RTAIXY.ar
Weights of clocks contributing to TAI	WTAIXY.ar
Until 1992:	
Local representations of UTC: Values of [*UTC - UTC(lab)*]	UTC.XY
Local values of [*TAI - TA(lab)*]	TA.XY

For the period 1993-1998, these files are issued from tables in the BIPM Time Section Annual Report. The Annual Reports published up to 1998 additionally include the following tables:

Frequency offsets and step adjustments of UTC
Relationship between TAI and UTC
Acronyms and locations of the timing centres which maintain a UTC(*k*) and/or TA(*k*)
Equipment and source of UTC(*k*) of the laboratories contributing to TAI
International GPS tracking schedules (until the Annual Report for 1997)
International GLONASS tracking schedules (until the Annual Report for 1997)
Corrections for homogeneous use of the clock rates published
in the current and previous annual reports
Statistical data on the weights of the clocks contributing to TAI

Starting with the BIPM Time Section Annual Report for 1999, some tables traditionally included in the printed version are only available in electronic form. At present, the Annual Report includes the following tables:

Frequency offsets and step adjustments of UTC
Relationship between TAI and UTC
Acronyms and locations of the timing centres which maintain a UTC(*k*) and/or TA(*k*)
Equipment and source of UTC(*k*) of the laboratories contributing to TAI
Corrections for homogeneous use of the clock rates published in the current and previous annual reports
Statistical data on the weights of the clocks contributing to TAI
Information compiled about worldwide time signals and time dissemination services
Report on the scientific work of the BIPM Time Section.

For any comment or query send a message to: tai@bipm.org

Leap seconds

Secondes intercalaires

Since 1 January 1988, the maintenance of International Atomic Time, TAI, and of Coordinated Universal Time, UTC (with the exception of decisions and announcements concerning leap seconds of UTC) has been the responsibility of the International Bureau of Weights and Measures (BIPM) under the authority of the International Committee for Weights and Measures (CIPM). The dates of leap seconds of UTC are decided and announced by the International Earth Rotation Service (IERS), which is responsible for the determination of Earth rotation parameters and the maintenance of the related celestial and terrestrial reference systems. The adjustments of UTC and the relationship between TAI and UTC are given in Tables 1 and 2 of this volume.

Depuis le 1er janvier 1988, l'établissement du Temps atomique international, TAI, et du Temps universel coordonné, UTC, (à l'exception de l'annonce des secondes intercalaires de l'UTC) est placé sous la responsabilité du Bureau international des poids et mesures (BIPM) et du Comité international des poids et mesures (CIPM). Le choix des dates et l'annonce des secondes intercalaires de l'UTC constituent quelques-unes des missions du Service international de la rotation terrestre (IERS), qui est responsable de la détermination des paramètres de la rotation terrestre et de la conservation des systèmes de référence terrestre et céleste associés. Les ajustements de l'UTC et la relation entre le TAI et l'UTC sont donnés dans les tableaux 1 et 2 de ce volume.

Further information about leap seconds can be obtained from the IERS:

Des renseignements sur les secondes intercalaires peuvent être obtenus auprès de l'IERS à l'adresse suivante :

IERS Earth Orientation Product Center
Dr Daniel GAMBIS
Observatoire de Paris
61, avenue de l'Observatoire
75014 Paris, France

Telephone: + 33 1 40 51 22 26
Telefax: + 33 1 40 51 22 91
iers@obspm.fr
http://hpiers.obspm.fr/
Anonymous ftp: hpiers.obspm.fr or 145.238.100.28

Establishment of International Atomic Time and of Coordinated Universal Time

1. Data and computation

International Atomic Time (TAI) and Coordinated Universal Time (UTC) are obtained from a combination of data from some 230 atomic clocks kept by about 65 laboratories spread worldwide. The data are regularly reported to the BIPM by about 50 timing centres which maintain a local UTC, UTC(k) (see Table 3).
The data are in the form of time differences [*UTC*(*k*) - *Clock*] taken at 5 day intervals at 0h UTC for Modified Julian Dates (MJD) ending in 4 and 9, at 0h UTC ; these dates are referred here as 'standard dates'. The equipment maintained by the timing centres is detailed in Table 4.

An iterative algorithm produces a free atomic time scale, EAL (Echelle Atomique Libre), defined as a weighted average of clock readings. The processing is carried out and subsequently treats one month blocks of data [1], [2] (two-month blocks were used before 1998). The weighting procedure and clock frequency prediction are chosen so that EAL is optimized for long-term stability. No attempt is made to ensure the conformity of the EAL scale interval with the second of the International System of Units.

2. Accuracy

The duration of the scale interval of EAL is evaluated by comparison with the data of primary caesium standards, correcting their proper frequency as needed to account for known effects (e.g. general relativity, blackbody radiation). TAI is then derived from EAL by adding a linear function of time with a convenient slope to ensure the accuracy of the TAI scale interval. The frequency offset between TAI and EAL is changed when necessary to maintain accuracy, the magnitude of the changes being of the same order as the frequency fluctuations resulting from the instability of EAL. This operation is referred to as the 'steering of TAI'. Table 5 gives the normalized frequency offsets between EAL and TAI. Measurements of the duration of the TAI scale interval and estimates of its mean duration are reported in Tables 6 and 7.

3. Availability

TAI and UTC are made available in the form of time differences with respect to the local time scales UTC(k), which approximate UTC, and TA(k), the independent local atomic time scales. These differences, [*TAI* - *TA*(*k*)] and [*UTC* - *UTC*(*k*)], are computed for the standard dates and are available from the BIPM website (see p. 5 of this volume).

The computation of TAI is carried out every month and the results are published monthly in *Circular T*. When preparing the Annual Report, the results shown in *Circular T* may be revised taking into account any subsequent improvements made to the data.

4. Time links

The BIPM organizes the international network of time links, which takes the form of local stars within a continent, joined by long-distance links (see Figure).
In 2002, the network of time links used by the BIPM was non-redundant and relied on observation of GPS satellites in common views and on two-way satellite time and frequency transfer (TWSTFT). Most

time links are based on GPS satellite common views. Nine TWSTFT links have been progressively introduced in the computation of TAI since July 1999 ; two TWSTFT European links (ROA/PTB and IEN/PTB) and three Asia-Pacific links (NMIJ/CRL, NTSC/CRL and TL/CRL) have been introduced in the computation of TAI during 2002. In all cases, the respective GPS links are calculated as a backup. All GPS links in TAI are corrected using the ionospheric maps and precise operational satellite ephemerides produced by the International GPS Service (IGS). The ultimate precision of one single measurement of [$UTC(k_1)$ - $UTC(k_2)$], obtained at the BIPM with these procedures, is about 2 ns for short distances and 4 ns for long distances. The BIPM also publishes an evaluation of [*UTC - GPS time*] which is accessible via the BIPM website.

The BIPM regularly publishes an evaluation of [*UTC - GLONASS time*], also available from the BIPM website, using current observations of the GLONASS system at the NMi Van Swinden Laboratorium, the Netherlands.

International GPS tracking schedules are published by the BIPM about every six months, and tracking schedules for GLONASS are also established. The list of the schedules is reported in this volume and their content is available from the website (see p. 5 of this volume).

5. Time scales established in retrospect

For the most demanding applications, such as millisecond pulsar timing, the BIPM issues atomic time scales in retrospect. These are designated TT(BIPMxx) where 19xx or 20xx is the year of computation [3]. The successive versions of TT(BIPMxx) are both updates and revisions: they may differ for common dates. These time scales are available on request from the BIPM or via website (see p.5 of this volume).

Notes

Tables 8 and 9 of this report give the rates relative to TAI and the weights of the clocks contributing to TAI in 2002.

The yellow pages, at the end of this volume, give indications about time signal emissions and time dissemination services.

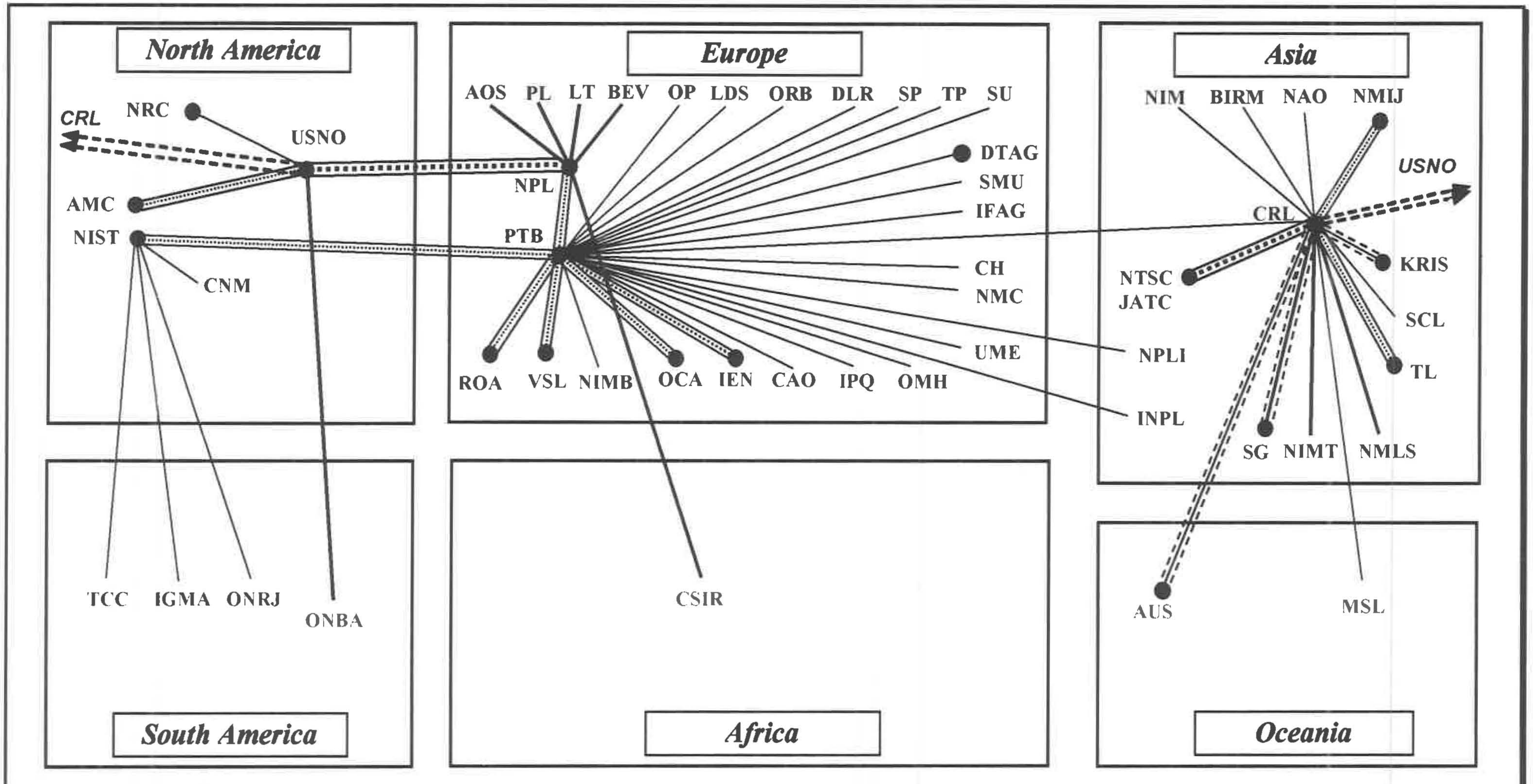
The report of the BIPM Time Section for the period July 2001- June 2002, published in the *Director's Report on the Activity and Management of the BIPM*, 2002, Tome 3 is reproduced after the yellow pages. All the publications mentioned in this report are available on request from the BIPM.

References

[1] C. Thomas and J. Azoubib, TAI computation : study of an alternative choice for implementing an upper limit of clock weights, *Metrologia*, 1996, **33**, 227-240.

[2] J. Azoubib, A revised way of fixing an upper limit to clock weights in TAI computation, *Report to the 15th meeting of the CCTF*, available on request.

[3] B. Guinot, Atomic time scales for pulsar studies and other demanding applications, *Astron. Astrophys.*, 1988, **192**, 370-373.



ORGANIZATION OF THE INTERNATIONAL TIME LINKS

December 2002

- TWSTFT
- TWSTFT back-up link
- TWSTFT link in preparation
- OCA/PTB link not used for computation of TAI
- Laboratory equipped with TWSTFT
- GPS CV single-channel
- GPS CV single-channel back-up link
- GPS CV multi-channel
- GPS CV multi-channel back-up link

BIPM

Etablissement du Temps atomique international et du Temps universel coordonné

1. Données et mode de calcul

Le Temps atomique international (TAI) et le Temps universel coordonné (UTC) sont obtenus par une combinaison de données provenant de quelque 230 horloges atomiques conservées par environ 65 laboratoires répartis dans le monde entier, et fournies régulièrement au BIPM par environ 50 laboratoires de temps qui maintiennent un UTC local, UTC(k) (liste donnée dans le tableau 3). Ces données prennent la forme de différences de temps [UTC(k) - Horloge] *enregistrées de 5 jours en 5 jours pour les dates juliennes modifiées (MJD) se terminant par 4 et 9, à 0h UTC, 'dates normales'. L'équipement maintenu par ces laboratoires de temps est décrit dans le tableau 4.*

Un algorithme itératif qui traite en temps différé des blocs de 1 mois de données [1], [2] produit une échelle atomique libre, EAL, définie comme étant une moyenne pondérée de lectures d'horloges (jusqu'en 1997 des blocs de deux mois étaient utilisés). Le choix de la pondération et du mode de prédiction de fréquence optimise la stabilité de l'EAL à long terme. Il n'est pas tenté d'assurer la conformité de l'intervalle unitaire de l'EAL avec la seconde du Système international d'unités.

2. Exactitude

La durée de l'intervalle unitaire de l'EAL est évaluée par comparaison aux données d'étalons de fréquence à césium primaires, après correction de leur propre fréquence pour tenir compte des effets connus (par exemple relativité générale, rayonnement du corps noir). Ensuite le TAI se déduit de l'EAL par l'addition d'une fonction linéaire du temps dont la pente est convenablement choisie pour assurer l'exactitude de l'intervalle unitaire du TAI. Le décalage de fréquence entre le TAI et l'EAL est changé quand c'est nécessaire pour maintenir l'exactitude, les changements ayant le même ordre de grandeur que les fluctuations de fréquence qui résultent de l'instabilité de l'EAL. Cette opération est désignée par l'expression 'pilotage du TAI'. Le tableau 5 donne les différences de fréquences normalisées entre l'EAL et le TAI. Des mesures de la durée de l'intervalle unitaire du TAI et des estimations de sa durée moyenne sont données dans les tableaux 6 et 7.

3. Disponibilité

Le TAI et l'UTC sont disponibles sous forme de différences de temps avec les échelles locales de temps UTC(k), approximation de l'UTC, et TA(k), temps atomique local indépendant. Ces différences, [TAI - TA(k)] *et* [UTC - UTC(k)], *calculées pour les dates normales sont disponibles sur le site Internet du BIPM.*

Le calcul du TAI est fait tous les mois et les résultats sont publiés mensuellement dans la Circulaire T *du BIPM. Quand le Rapport annuel est préparé, les résultats de la* Circulaire T *peuvent être révisés, en tenant compte des améliorations de données connues après la publication de la* Circulaire T.

4. Liaisons horaires

Le BIPM organise le réseau international de comparaisons horaires selon un schéma en étoile au niveau des continents, et en liaisons à longue distance.

En 2002, le système des liaisons horaires utilisé par le BIPM était non-redondant et reposait sur l'observation des satellites du GPS en vues simultanées et sur la technique d'aller et retour sur satellite de télécommunications (TWSTFT). La plupart des liaisons se font par vues simultanées des satellites du GPS. Depuis Juillet 1999 neuf liaisons TWSTFT ont été progressivement introduites dans le calcul du TAI ; deux liaisons TWSTFT Européennes (ROA/PTB et IEN/PTB) et trois autres dans la région Asie-Pacifique (NMIJ/CRL, NTSC/CRL et TL/CRL) ont été introduites dans le calcul du TAI en 2002. Dans tous les cas, les respectives liaisons par le GPS sont calculées et sauvegardées. Toutes les liaisons GPS sont corrigées à l'aide des cartes ionosphériques et des éphémerides précises et opérationnelles des satellites produites par l'IGS . La précision ultime d'une mesure unique [UTC(k_1) - UTC(k_2)] *est alors d'environ 2 ns pour les liaisons à courte distance et d'environ 4 ns pour les liaisons à longue distance. Le BIPM publie aussi une évaluation de* [UTC - temps du GPS] *dont les valeurs sont disponibles sur le réseau internet.*

Le BIPM publie régulièrement une évaluation de [UTC - temps du GLONASS], *accessible par anonymous ftp and sur le site web du BIPM et déduite des observations habituelles du système GLONASS, réalisées au NMi Van Swinden Laboratorium, Pays-Bas.*

Le BIPM publie tous les six mois des programmes de poursuite des satellites du GPS, ainsi que des programmes pour les satellites du GLONASS. La liste de ces programmes est reproduite dans ce rapport et leur contenu est disponible sur le réseau internet.

5. Echelles de temps établies rétrospectivement

Pour les applications les plus exigeantes, comme le chronométrage des pulsars milliseconde, le BIPM produit des échelles de temps rétrospectivement, désignées par TT(BIPMxx), 19xx ou 20xx étant l'année du calcul [3]. Les versions successives de TT(BIPMxx) ne sont pas seulement des mises à jour, mais aussi des révisions, de sorte qu'elles peuvent différer pour les dates communes. Ces échelles de temps sont disponibles sur demande faite au BIPM ou par utilisation du réseau internet.

Notes

Les tableaux 8 et 9 de ce rapport donnent les fréquences relatives au TAI et les poids des horloges qui ont contribué au calcul en 2002.

Les pages jaunes, à la fin de ce volume, concernent les émissions de signaux horaires.

Le rapport (juillet 2001 - juin 2002) de la section du temps du BIPM publié dans le Rapport du directeur sur l'activité et la gestion du Bureau international des poids et mesures (BIPM), 2002,Tome 3, est reproduit après les pages jaunes. Toutes les publications qui y sont mentionnées sont disponibles sur demande au BIPM.

Les références sont données dans le texte anglais, page 9.

Table 1. Relative frequency offsets and step adjustments of UTC, up to 31 December 2003

Date (at 0h UTC)	Offsets	Steps/s
1961 Jan. 1	-150×10^{-10}	
1961 Aug. 1	"	+0.050
1962 Jan. 1	-130×10^{-10}	
1963 Nov. 1	"	-0.100
1964 Jan. 1	-150×10^{-10}	
1964 Apr. 1	"	-0.100
1964 Sep. 1	"	-0.100
1965 Jan. 1	"	-0.100
1965 Mar. 1	"	-0.100
1965 Jul. 1	"	-0.100
1965 Sep. 1	"	-0.100
1966 Jan. 1	-300×10^{-10}	
1968 Feb. 1	"	+0.100
1972 Jan. 1	0	-0.107 7580
1972 Jul. 1	"	-1
1973 Jan. 1	"	-1
1974 Jan. 1	"	-1
1975 Jan. 1	"	-1
1976 Jan. 1	"	-1
1977 Jan. 1	"	-1
1978 Jan. 1	"	-1
1979 Jan. 1	"	-1
1980 Jan. 1	"	-1
1981 Jul. 1	"	-1
1982 Jul. 1	"	-1
1983 Jul. 1	"	-1
1985 Jul. 1	"	-1
1988 Jan. 1	"	-1
1990 Jan. 1	"	-1
1991 Jan. 1	"	-1
1992 Jul. 1	"	-1
1993 Jul. 1	"	-1
1994 Jul. 1	"	-1
1996 Jan. 1	"	-1
1997 Jul. 1	"	-1
1999 Jan. 1	"	-1

Table 2. Relationship between TAI and UTC, up to December 2003

Limits of validity (at 0h UTC)	[*TAI - UTC*] / s
1961 Jan. 1 - 1961 Aug. 1	1.422 8180 + (MJD - 37300) x 0.001 296
1961 Aug. 1 - 1962 Jan. 1	1.372 8180 + " "
1962 Jan. 1 - 1963 Nov. 1	1.845 8580 + (MJD - 37665) x 0.001 1232
1963 Nov. 1 - 1964 Jan. 1	1.945 8580 + " "
1964 Jan. 1 - 1964 Apr. 1	3.240 1300 + (MJD - 38761) x 0.001 296
1964 Apr. 1 - 1964 Sep. 1	3.340 1300 + " "
1964 Sep. 1 - 1965 Jan. 1	3.440 1300 + " "
1965 Jan. 1 - 1965 Mar. 1	3.540 1300 + " "
1965 Mar. 1 - 1965 Jul. 1	3.640 1300 + " "
1965 Jul. 1 - 1965 Sep. 1	3.740 1300 + " "
1965 Sep. 1 - 1966 Jan. 1	3.840 1300 + " "
1966 Jan. 1 - 1968 Feb. 1	4.313 1700 + (MJD - 39126) x 0.002 592
1968 Feb. 1 - 1972 Jan. 1	4.213 1700 + " "
1972 Jan. 1 - 1972 Jul. 1	10 (integral number of seconds)
1972 Jul. 1 - 1973 Jan. 1	11
1973 Jan. 1 - 1974 Jan. 1	12
1974 Jan. 1 - 1975 Jan. 1	13
1975 Jan. 1 - 1976 Jan. 1	14
1976 Jan. 1 - 1977 Jan. 1	15
1977 Jan. 1 - 1978 Jan. 1	16
1978 Jan. 1 - 1979 Jan. 1	17
1979 Jan. 1 - 1980 Jan. 1	18
1980 Jan. 1 - 1981 Jul. 1	19
1981 Jul. 1 - 1982 Jul. 1	20
1982 Jul. 1 - 1983 Jul. 1	21
1983 Jul. 1 - 1985 Jul. 1	22
1985 Jul. 1 - 1988 Jan. 1	23
1988 Jan. 1 - 1990 Jan. 1	24
1990 Jan. 1 - 1991 Jan. 1	25
1991 Jan. 1 - 1992 Jul. 1	26
1992 Jul. 1 - 1993 Jul. 1	27
1993 Jul. 1 - 1994 Jul. 1	28
1994 Jul. 1 - 1996 Jan. 1	29
1996 Jan. 1 - 1997 Jul. 1	30
1997 Jul. 1 - 1999 Jan. 1	31
1999 Jan. 1 -	32

TABLE 3. ACRONYMS AND LOCATIONS OF THE TIMING CENTRES WHICH MAINTAIN A LOCAL APPROXIMATION OF UTC, UTC(K), AND/OR AN INDEPENDENT LOCAL TIME SCALE, TA(K)

AMC	Alternate Master Clock station, Colorado Springs, Colo., USA
AOS	Astrogeodynamical Observatory, Space Research Centre P.A.S. Borowiec, Poland
APL	Applied Physics Laboratory, Laurel, Mass., USA
AUS	Consortium of laboratories in Australia
BEV	Bundesamt für Eich- und Vermessungswesen, Vienna, Austria
BIRM	Beijing Institute of Radio Metrology and Measurement, Beijing, P. R. China
CAO	Stazione Astronomica di Cagliari (Cagliari Astronomical Observatory) Cagliari, Italy
CH	METrology and Accreditation Switzerland (METAS)
CNM	Centro Nacional de Metrología, Querétaro, Mexico
CRL	Communications Research Laboratory, Tokyo, Japan
CSIR	Council for Scientific and Industrial Research, Pretoria, South Africa
DLR	Deutsche Zentrum für Luft- und Raumfahrt (German Aerospace Centre) Oberpfaffenhofen, Germany
DTAG	Deutsche Telekom AG, Darmstadt, Germany
F	Commission Nationale de l'Heure, Paris, France
GUM	Główny Urząd Miar (Central Office of Measures), Warsaw, Poland
IEN	Istituto Elettrotecnico Nazionale Galileo Ferraris, Turin, Italy
IFAG	Bundesamt für Kartographie und Geodäsie (Federal Agency for Cartography and Geodesy), Fundamental station, Wettzell, Kötzting, Germany
IGMA	Instituto Geográfico Militar, Buenos Aires, Argentina
INPL	National Physical Laboratory, Jerusalem, Israel
IPQ	Institute Português da Qualidade, Monte de Caparica, Portugal.
JATC	Joint Atomic Time Commission, Lintong, P.R. China
JV	Justervesenet, Norwegian Metrology and Accreditation Service, Kjeller, Norway
KRIS	Korea Research Institute of Standards and Science, Daejeon, Rep. of Korea
LDS	University of Leeds, Leeds, United Kingdom
LT	Lithuanian National Metrology Institute, Vilnius, Lithuania
MSL	Measurement Standards Laboratory, Lower Hutt, New Zealand
NAO	National Astronomical Observatory, Misuzawa, Japan
NIM	National Institute of Metrology, Beijing, P.R. China
NIMB	National Institute of Metrology, Bucharest, Romania
NIMT	National Institute of Metrology, Bangkok, Thailand
NIST	National Institute of Standards and Technology, Boulder, Colo., USA
NMC	National Centre of Metrology, Sofiya, Bulgary
NMIJ	National Metrology Institute of Japan, Tsukuba, Japan
NML	National Measurement Laboratory, Sydney, Australia
NMLS	National Metrology Laboratory of SIRIM Berhad, Shah Alam, Malaysia

TABLE 3. ACRONYMS AND LOCATIONS OF THE TIMING CENTRES WHICH MAINTAIN A LOCAL APPROXIMATION OF UTC, UTC(K), AND/OR AN INDEPENDENT LOCAL TIME SCALE, TA(K) (CONT.)

NPL	National Physical Laboratory, Teddington, United Kingdom
NPLI	National Physical Laboratory, New Delhi, India
NRC	National Research Council of Canada, Ottawa, Canada
NTSC	National Time Service Center of China, Lintong, P.R. China
OMH	Országos Mérésügyi Hivatal (National Office of Measures) Budapest, Hungary
ONBA	Observatorio Naval, Buenos Aires, Argentina
ONRJ	Observatório Nacional, Rio de Janeiro, Brazil
OP	Observatoire de Paris (Paris Observatory), Paris, France
ORB	Observatoire Royal de Belgique (Royal Observatory of Belgium) Brussels, Belgium
PL	Consortium of laboratories in Poland
PTB	Physikalisch-Technische Bundesanstalt, Braunschweig, Germany
ROA	Real Instituto y Observatorio de la Armada, San Fernando, Spain
SCL	Standards and Calibration Laboratory, Hong Kong
SG	Standards, Productivity and Innovation Board, Singapore
SMU	Slovenský metrologićký ústav (Slovak Institute of Metrology) Bratislava, Slovakia
SP	Sveriges Provnings- och Forskningsinstitut (Swedish National Testing and Research Institute), Borås, Sweden
SU	Institute of Metrology for Time and Space (IMVP), NPO "VNIIFTRI" Mendeleevo, Moscow Region, Russia
TCC	TIGO Concepción Chile
TL	Telecommunication Laboratories, Chung-Li, Taiwan
TP	Institute of Radio Engineering and Electronics, Academy of Sciences of the Czech Republic, Prague, Czech Republic
UME	Ulusai Metroloji Enstitüsü, Marmara Research Center, (National Metrology Institute), Gebze Kocaeli, Turkey
USNO	U.S. Naval Observatory, Washington D.C., USA
VSL	Van Swinden Laboratorium, Delft, the Nederlands

Note: Most of the timing centres in the table can be accessed through the BIPM web site, at “Useful links”.

TABLE 4. EQUIPMENT AND SOURCE OF UTC(K) OF THE LABORATORIES CONTRIBUTING TO TAI IN 2002.

Ind. Cs : Industrial Cs standard

Lab. Cs : Laboratory Cs standard

H-maser : Hydrogen maser

* means 'yes'

Lab k	Equipment	Source of UTC(k) (1)	TA(k)	Time Links		
				GPS	GLONASS	Two-Way
AOS	1 Ind. Cs	1 Cs + micro-phase-stepper		*	*	
AUS	13 Ind. Cs 4 H-masers 1 Linear Ion Trap Standard (2)	1 Cs	*	*		*
BEV	3 Ind. Cs 2 Ind. Rb	1 Cs		*		
BIRM (b)	2 Ind. Cs 2 H-masers	1 H-maser		*	*	
CAO	2 Ind. Cs	1 Cs		*		
CH	6 Ind. Cs (3)	all the Cs	*	*		
CNM	2 Ind. Cs	1 Cs		*		
CRL	18 Ind. Cs 1 Lab. Cs 3 H-masers	12 Cs	*	*	*	*
DTAG	3 Ind. Cs	1 Cs		*		
IEN	5 Ind. Cs	1 Cs + micro-phase-stepper	*	*	*	*
IFAG	5 Ind. Cs 3 H-masers	1 Cs + micro-phase-stepper		*		
IGMA	3 Ind. Cs	1 Cs + micro-phase-stepper		* (a)		

TABLE 4. EQUIPMENT AND SOURCE OF UTC(K)... (CONT.)

Ind. Cs : Industrial Cs standard

Lab. Cs : Laboratory Cs standard

H-maser : Hydrogen maser

* means 'yes'

Lab k	Equipment	Source of UTC(k) (1)	TA(k)	Time Links		
				GPS	GLONASS	Two-Way
INPL	3 Ind. Cs	1 Cs		*		
JATC	6 Ind. Cs (4)	1 Cs + micro-phase-stepper	*	*	*	*
KRIS	4 Ind. Cs 1 H-maser	1 Cs + micro-phase-stepper	*	*	*	
LDS	1 Ind. Cs	1 Cs		*	*	
LT	1 Ind. Cs	1 Cs		*		
MSL	3 Ind. Cs	1 Cs		*	*	
NAO	4 Ind. Cs 1 H-maser	1 Cs + micro-phase-stepper		*		
NIM (b)	3 Ind. Cs	1 Cs + micro-phase-stepper		*		
NIMB (5)	Ind. Cs	1 Cs		* (a)		
NIMT	1 Ind. Cs	1 Cs		*		
NIST	20 Ind. Cs 2 Lab. Cs 5 H-masers	11 Cs 5 H-maser	*	*	*	*
NMC	1 Ind. Cs	1 Cs		* (a)		
NMIJ	4 Ind. Cs 1 Lab. Cs 2 H-masers	1 Cs		*	*	*

TABLE 4. EQUIPMENT AND SOURCE OF UTC(K)... (CONT.)

Ind. Cs : Industrial Cs standard

Lab. Cs : Laboratory Cs standard

H-maser : Hydrogen maser

* means 'yes'

Lab k	Equipment	Source of UTC(k) (1)	TA(k)	Time Links		
				GPS	GLONASS	Two-Way
NMLS (6)	5 Ind. Cs	1 Cs		*	*	
NPL	3 Ind. Cs 2 H-masers	1 H-maser		*		*
NPLI (b)	3 Ind. Cs	1 Cs		*	*	
NRC	2 Ind. Cs 3 Lab. Cs 2 H-masers	1 Lab. Cs + micro-phase-stepper (7)	*	*		*
NTSC (8)	6 Ind. Cs	all the Cs	*	*	*	*
OMH	1 Ind. Cs	1 Cs		*		
ONBA	2 Ind. Cs	1 Cs + micro-phase-stepper		*		
ONRJ	3 Ind. Cs	1 Cs		*		
OP	6 Ind. Cs 3 Lab. Cs 2 H-masers	1 Cs + micro-phase-stepper	* (9)	*		
ORB	3 Ind. Cs 2 H-masers	1 H-maser		*		
PL (10)	6 Ind. Cs	1 Cs	*	*		
PTB	3 Ind. Cs 3 Lab. Cs (11) 3 H-masers	1 Lab. Cs	* (12)	*		*
ROA	5 Ind. Cs	all the Cs		*		*

TABLE 4. EQUIPMENT AND SOURCE OF UTC(K)... (CONT.)

Ind. Cs : Industrial Cs standard

Lab. Cs : Laboratory Cs standard

H-maser : Hydrogen maser

* means 'yes'

Lab k	Equipment	Source of UTC(k) (1)	TA(k)	Time Links		
				GPS	GLONASS	Two-Way
SCL	2 Ind. Cs	1 Cs + micro-phase-stepper		*		
SG (13)	3 Ind. Cs	1 Cs + micro-phase-stepper		*		
SMU	1 Ind. Cs	1 Cs		*		
SP	6 Ind. Cs 1 H-maser (14)	1 Cs + micro-phase-stepper		*		
SU	1 Lab. Cs 10 H-masers	6 H-masers	* (15)	*	*	
TCC (16)	2 Ind. Cs 2 H-masers	1 Cs		*		
TL (b)	5 Ind. Cs 2 H-masers	1 Cs + micro-phase-stepper		*	*	*
TP	4 Ind. Cs	1 Cs + output frequency steering		*		
UME	3 Ind. Cs	1 Cs		*		
USNO	71 Ind. Cs 16 H-masers	UTC(USNO,MC) is an H-maser + frequency synthesizer steered to UTC(USNO) (17)	* (17)	*	*	*
VSL	4 Ind. Cs	1 Cs + micro-phase-stepper		*	*	*

NOTES

(1) When several clocks are indicated as source of UTC(k), laboratory k computes a software clock, steered to UTC. Often a physical realization of UTC(k) is obtained using a Cs clock and a micro-phase-stepper.

(2) AUS Some of the standards are located as follows (at the end of 2002):
* National Measurement Laboratory (NML, Sydney) 4 Cs, 2 H-masers.
Australian laboratories intercompared by GPS are:
* National Measurement Laboratory Melbourne branch (NMLMEL, Melbourne) 1 Cs,
* Canberra Deep Space Communication Complex (CDSCC, Canberra) 1 Cs, 2 H-masers, 1 Linear Ion Trap Standard (LITS)
* Telstra Corporation Ltd (TELSTRA, Melbourne) 4 Cs,
* Australian Defence Force Calibration Laboratory (ADF, Sydney) 1 Cs,
* Australian Land Information Group, Yarragadee Observatory (Yarragadee, Western Australia) 1 Cs.
Australian laboratories intercompared by TV are:
* VMS International (Sydney) 1 Cs,

(3) CH The standards are located as follows (at the end of 2002):
* METrology and Accreditation Switzerland (METAS, Bern) 5 Cs,
* Observatoire de Neuchâtel (ON, Neuchâtel) 1 Cs,
They are intercompared by GPS (METAS) and linked to the foreign laboratories through the METrology and Accreditation Switzerland.

(4) JATC The standards are located at National Time Service Center, (NTSC). The link between UTC(JATC) and UTC(NTSC) is obtained by internal connection.

(5) NIMB National Institute of Metrology, Bucharest, Romania

(6) NMLS National Metrology Laboratory of SIRIM, Berhard, Malaysia..

(7) NRC In 2002, UTC(NRC) was derived from NRC Cs VI A

(8) NTSC National Time Service Center, NTSC formerly CSAO.

(9) OP The French atomic time scale TA(F) is computed by the BNM-SYRTE with data from 23 industrial caesium clocks located as follows (at the end of 2002) :
* Centre Electronique de l'Armement (CELAR, Rennes) 1 Cs,
* Centre National d'Etudes Spatiales (CNES, Toulouse) 3 Cs,
* France Telecom Recherche et Developpement (Lannion) 3 Cs,
* Agilent (Massy) 2 Cs,
* Observatoire de la Côte d'Azur (OCA, Grasse) 2 Cs,
* Observatoire de Paris (BNM-SYRTE, Paris) 6 Cs,
* Observatoire de Besançon (OB, Besançon) 3 Cs,
* Tekelec Technologies (TKL, Les Ulis, Paris) 1 Cs,
* Direction des Constructions Navales (DCN, Brest) 2 Cs.
All laboratories are linked via GPS receivers

NOTES (CONT.)

(10) PL	Stands for a consortium of Polish time laboratories:	
	* Główny Urząd Miar (Central Office of Measures) (GUM, Warsaw)	3 Cs
	* Astrogeodynamical Observatory, Space Research Centre P.A.S (AOS, Borowiec)	1 Cs
	* Instytut Łączności (Institute of Telecommunications) (IŁ, Warsaw)	1 Cs
	* Centrum Badawczo-Rozwojowe TPSA (Research & Development Centre of the Polish Telecom) (CBR, Warsaw)	1 Cs
	An independent atomic time scale TA(PL) has been computed by GUM, with data from industrial caesium clocks: the six above and additionally:	
	* Time and Frequency Standard Laboratory of the Semiconductor Physics Institute (LT, Vilnius, Lithuania)	1 Cs

(11) PTB. The laboratory Cs, PTB CS1, PTB CS2 and PTB CS3, are operated continuously as clocks. PTB CS3 is no longer evaluated as a primary clock and contributes to EAL only like any commercial clock . PTB CS4 is practically no longer useful and will not be maintained. PTB CSF1 is a fountain frequency standard using laser cooled caesium atoms. It is intermittently operated as a frequency standard. Contributions to TAI are made through comparisons with one of PTB's hydrogen masers.
Until further notice, TA(PTB) and UTC(PTB) are derived from PTB CS2, TA(PTB) directly, UTC(PTB) including steering.

(12) PTB. *TA(PTB)-UTC(PTB)* is published in PTB Time Service Bulletin.

(13) SG. Standards, Productivity and Innovation Board (Singapore) formerly PSB

(14) SP.	The standards are located as follows (at the end of 2002):	
	* Swedish National Testing and Research Institute (SP, Boras)	4 Cs,
	* STUPI AB (Stockholm)	1 Cs,
	* Pendulum Instruments AB (Stockholm)	1 Cs,
	* Onsala Space Observatory (Onsala)	1 H-maser.

(15) SU. *TA(SU)-UTC(SU)* = 29.172 759 000 s from 52275 to 52639

(16) TCC. TIGO Concepción Chile.

(17) USNO. The time scales A.1(MEAN) and UTC(USNO) are computed by USNO. They are determined by a weighted average of Cs clocks and H-masers located at the USNO. A.1(MEAN) is a free atomic time scale, while UTC(USNO) is steered to UTC. Included in the total number of USNO atomic standards are the clocks located at the USNO Alternate Master Clock in Colorado Springs, CO.

(a) GPS link via local restitution of GPS time.

(b) Information based on the Annual Report for 2001, not confirmed by the laboratory.

Table 5. Differences between the normalized frequencies of EAL and TAI, up to May 2003

(File available on http://www.bipm.org under the name EALTAI02.AR, which contains values since the beginning of the steering)

Date	MJD	$[f(EAL) - f(TAI)] \times 10^{-13}$
1989 Jun 22 - 1989 Dec 29	47699 - 47889	7.95
1989 Dec 29 - 1990 Feb 27	47889 - 47949	7.90
1990 Feb 27 - 1990 Apr 28	47949 - 48009	7.85
1990 Apr 28 - 1990 Jun 27	48009 - 48069	7.80
1990 Jun 27 - 1990 Aug 26	48069 - 48129	7.75
1990 Aug 26 - 1991 Feb 22	48129 - 48309	7.70
1991 Feb 22 - 1991 Apr 23	48309 - 48369	7.625
1991 Apr 23 - 1991 Aug 31	48369 - 48499	7.55
1991 Aug 31 - 1991 Oct 30	48499 - 48559	7.50
1991 Oct 30 - 1992 Apr 27	48559 - 48739	7.45
1992 Apr 27 - 1992 Jun 26	48739 - 48799	7.40
1992 Jun 26 - 1993 Apr 22	48799 - 49099	7.35
1993 Apr 22 - 1995 Feb 21	49099 - 49769	7.40
1995 Feb 21 - 1995 Apr 22	49769 - 49829	7.39
1995 Apr 22 - 1995 Jun 21	49829 - 49889	7.38
1995 Jun 21 - 1995 Aug 30	49889 - 49959	7.37
1995 Aug 30 - 1995 Oct 29	49959 - 50019	7.36
1995 Oct 29 - 1995 Dec 28	50019 - 50079	7.35
1995 Dec 28 - 1996 Feb 26	50079 - 50139	7.34
1996 Feb 26 - 1996 Apr 26	50139 - 50199	7.33
1996 Apr 26 - 1996 Jun 30	50199 - 50264	7.32
1996 Jun 30 - 1996 Aug 29	50264 - 50324	7.31
1996 Aug 29 - 1996 Oct 28	50324 - 50384	7.295
1996 Oct 28 - 1996 Dec 27	50384 - 50444	7.280
1996 Dec 27 - 1997 Feb 25	50444 - 50504	7.265
1997 Feb 25 - 1997 Apr 26	50504 - 50564	7.250
1997 Apr 26 - 1997 Jun 30	50564 - 50629	7.230
1997 Jun 30 - 1997 Aug 29	50629 - 50689	7.210
1997 Aug 29 - 1997 Oct 28	50689 - 50749	7.190
1997 Oct 28 - 1997 Dec 27	50749 - 50809	7.170
1997 Dec 27 - 1998 Jan 31	50809 - 50844	7.160
1998 Jan 31 - 1998 Feb 25	50844 - 50869	7.150
1998 Feb 25 - 1998 Mar 27	50869 - 50899	7.140
1998 Mar 27 - 1999 Feb 25	50899 - 51234	7.130
1999 Feb 25 - 1999 Dec 27	51234 - 51539	7.140
1999 Dec 27 - 2000 May 30	51539 - 51694	7.130
2000 May 30 - 2000 Sep 27	51694 - 51814	7.120
2000 Sep 27 - 2000 Nov 26	51814 - 51874	7.110
2000 Nov 26 - 2001 Jan 30	51874 - 51939	7.100
2001 Jan 30 - 2001 Apr 30	51939 - 52029	7.090
2001 Apr 30 - 2001 Jul 29	52029 - 52119	7.080
2001 jul 29 - 2001 Sep 27	52119 - 52179	7.070
2001 Sep 27 - 2001 Nov 26	52179 - 52239	7.060
2001 Nov 26 - 2002 Jan 30	52239 - 52304	7.050
2002 Jan 30 - 2002 Mar 31	52304 - 52364	7.040
2002 Mar 31 - 2002 Jun 30	52364 - 52424	7.030
2002 Jun 30 - 2002 Jul 29	52424 - 52484	7.020
2002 Jul 29 - 2002 Sep 27	52484 - 52544	7.010
2002 Sep 27 - 2002 Nov 26	52544 - 52604	7.000
2002 Nov 26 - 2003 Jan 30	52604 - 52669	6.990
2003 Jan 30 - 2003 Mar 31	52669 - 52729	6.980
2003 Mar 31 - 2003 May 30	52729 - 52789	6.970

As the time scales UTC and TAI differ by an integral number of seconds (see Tables 1 and 2), UTC is necessarily subjected to the same intentional frequency adjustment as TAI.

Table 6. Measurements of the duration of the TAI scale interval

(File available on http://www.bipm.org under the name UTAI02.AR)

TAI is a realization of coordinate time TT. The following tables give the fractional deviation d of the scale interval of TAI from that of TT (in practice the SI second on the geoid), i.e. the fractional frequency deviation of TAI with the opposite sign: $d = -y_{TAI}$.

In this table, *d* is obtained on the given periods of estimation by comparison of the TAI frequency with that of the individual primary frequency standards (PFS) CRL-O1, NIST-F1, PTB CS1, PTB CS2, PTB CSF1, SYRTE-FO2, SYRTE-FOM, and SYRTE-JPO for the year 2002.
Previous calibrations are available in the successive annual reports of the BIPM Time Section volumes 1 to 14.

Each comparison is provided with the following information:
u_B is the combined uncertainty from systematic effects,
Ref(u_B) is a reference giving information on the stated value of u_B,
u_A is the uncertainty originating in the instability of the PFS,
$u_{link/lab}$ is the uncertainty in the link between the PFS and the clock participating to TAI, including the uncertainty due to dead-time,
$u_{link/TAI}$ is the uncertainty in the link to TAI,
u is the quadratic sum of all four uncertainty values.

In this table, a frequency over a time interval is defined as the ratio of the end-point phase difference to the duration of the interval.

The typical characteristics of the calibrations of the TAI frequency provided by the different primary standards over 2002 are indicated below.

Primary Standard	Type /selection	Typical type B std. uncertainty	Operation	Comparison with	Typical duration of comparison
CRL-01	Beam /Opt.	4×10^{-15}	Discontinuous	UTC(CRL)	10 d
NIST-F1	Fountain	1×10^{-15}	Discontinuous	H maser	30 d
PTB CS1	Beam /Mag.	8×10^{-15}	Continuous	TAI	30 d
PTB CS2	Beam /Mag.	12×10^{-15}	Continuous	TAI	30 d
PTB CSF1	Fountain	1×10^{-15}	Discontinuous	H maser	15 to 30 d
SYRTE-F02	Fountain	1×10^{-15}	Discontinuous	H maser	5 to 15 d
SYRTE-FOM	Fountain	1×10^{-15}	Discontinuous	H maser	30 d
SYRTE-JPO	Beam /Opt.	8×10^{-15}	Discontinuous	H maser	30 d

More detailed information on the characteristics and operation of individual PFS may be found in the annexes supplied by the individual laboratories.

Standard	Period of estimation	d (10^{-15})	u_B (10^{-15})	Ref(u_B)	u_A (10^{-15})	$u_{link/lab}$ (10^{-15})	$u_{link/TAI}$ (10^{-15})	Notes	u (10^{-15})
CRL-01	52469-52479	+9.4	3.9	[1]	8.4	0.8	3.		9.8
CRL-01	52569-52579	-2.6	3.9		5.0	0.8	3.		7.1
NIST-F1	52304-52329	+11.4	0.6	[2]	1.1	0.3	1.2		1.8
NIST-F1	52514-52544	+8.4	0.9		1.1	0.5	1.0		1.8
PTB CS1	52274-52304	-4.4	8.	[3]	5.	0.	1.	(1)	9.
PTB CS1	52304-52329	+2.2	8.		5.	0.	1.		9.
PTB CS1	52329-52364	+3.7	8.		5.	0.	1.		9.
PTB CS1	52364-52394	+2.0	8.		5.	0.	1.		9.
PTB CS1	52394-52424	+3.3	8.		5.	0.	1.		9.
PTB CS1	52424-52454	-1.7	8.		5.	0.	1.		9.
PTB CS1	52454-52484	+5.8	8.		5.	0.	1.		9.
PTB CS1	52484-52514	-0.4	8.		5.	0.	1.		9.
PTB CS1	52514-52544	-1.6	8.		5.	0.	1.		9.
PTB CS1	52544-52574	4.7	8.		5.	0.	1.		9.
PTB CS1	52574-52604	-1.8	8.		5.	0.	1.		9.
PTB CS1	52604-52639	-2.2	8.		5.	0.	1.		9.
PTB CS2	52274-52304	+2.6	12.	[4]	3.	0.	1.	(1)	12.
PTB CS2	52304-52329	+7.8	12.		3.	0.	1.		12.
PTB CS2	52329-52364	+10.0	12.		3.	0.	1.		12.
PTB CS2	52364-52394	+4.3	12.		3.	0.	1.		12.
PTB CS2	52394-52424	+9.1	12.		3.	0.	1.		12.
PTB CS2	52424-52454	+1.4	12.		3.	0.	1.		12.
PTB CS2	52454-52484	+1.6	12.		3.	0.	1.		12.
PTB CS2	52484-52514	+6.9	12.		3.	0.	1.		12.
PTB CS2	52514-52544	+9.9	12.		3.	0.	1.		12.
PTB CS2	52544-52574	+7.8	12.		3.	0.	1.		12.
PTB CS2	52574-52604	+8.3	12.		3.	0.	1.		12.
PTB CS2	52604-52639	+4.1	12.		3.	0.	1.		12.
PTB CSF1	52329-52354	+11.5	1.0	[5]	1.0	0.	1.2		1.9
PTB CSF1	52384-52409	+10.7	1.0		1.0	0.	1.2		1.9
PTB CSF1	52454-52474	+13.6	0.9		1.0	0.	1.5		2.0
PTB CSF1	52604-52619	+12.7	0.9		1.0	0.	2.0		2.4
SYRTE-FO2	52579-52584	+7.2	0.8	[6]	0.6	2.3	6.0	(2)	6.5
SYRTE-FO2	52604-52619	+15.8	0.8		0.4	1.5	2.0		2.6
SYRTE-FOM	52564-52594	+10.1	0.8	[6]	0.2	1.6	1.0	(2)	2.1
SYRTE-JPO	52609-52639	+14.5	8.0	[7]	1.7	0.3	1.0	(3)	8.2

Notes:

(1) Continuously operating as a clock participating to TAI.
(2) BNM-SYRTE atomic Caesium fountain.
(3) Previously reported as LPTF-JPO.

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Operation of the BNM-SYRTE primary clocks in 2002

Uncertainty budget for uB
In 2002 the fountains clocks FO2 and FOM and caesium beam clock JPO were operated intermittently. New evaluations of relative frequency uncertainties u_B were measured. Systematic effects shifting the frequency of the fountains are listed in Table I for FO2 with Cs and Table II for FOM and see ref[4] for JPO.

Physical origin	Bias $[10^{-16}]$	Uncertainty $[10^{-16}]$
2nd order Zeeman Blackbody Radiation Cold Collisions + cavity pulling others	1773.0 -173.0 -95.0 0.0	+/- 5.2 +/- 2.3 +/- 4.6 +/- 3.0
Totale (1σ) uncertainty u_B		8

Table I : Accuracy budget of the FO2-CS fountain involved in the 2002 measurements.

Physical origin	Bias $[10^{-16}]$	Uncertainty $[10^{-16}]$
2nd order Zeeman Blackbody Radiation Cold Collisions + cavity pulling others	351.9 -191.0 -34.0 0.0	+/- 2.4 +/- 2.5 +/- 5.8 +/- 3.7
Totale (1σ) uncertainty u_B		8

Table II : Accuracy budget of the FOM fountain involved in the 2002 measurements.

Evaluation of uA
The short-term frequency instability of the fountain clocks were evaluated throughout 2002 by comparison with an active H maser. Experimentally, the relative frequency stability for FO2 and FOM was measured to $\sigma_y(\tau) = 1{,}1 \ \ 10^{-13}\tau^{-1/2}$ and $\sigma_y(\tau) = 1{,}7 \ \ 10^{-13}\tau^{-1/2}$ respectively.

Evaluation of ul/lab
The uncertainty due to the H maser link lab for FO2 or FOM was evaluated to $0{,}1 \ \ 10^{-15}$ and dead times uncertainties were included in ul/lab for each fountain clocks measurements.

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Status of CRL-O1 in 2002

CRL-O1 is an optically pumped primary frequency standard. It has been developed under the cooperation between CRL Japan and NIST US. Its design is based on NIST 7 [1, 2]. It has been operational since April 2000. Now we are preparing a paper on the accuracy evaluation of this standard [3].

Physical Effect	Bias (10^{-15})	Uncertainty (10^{-15})
Second-order Doppler	$\delta\nu_D$~-300	2
Second-order Zeeman	$\delta\nu_{QZ}$~+1.5×10^5	0.2
Cavity pulling	$\delta\nu_C$~0	0.6
Cavity phase (end-to-end)	$\delta\nu_E$~±150	0.2
Blackbody	$\delta\nu_B$~-19.5	0.5
Gravitation	$\delta\nu_G$~8.2	0.1
Uncorrected biases	0	3.4
Combined type B Uncertainty		≤4.0

Table 1: Uncertainty budget for uB

Effect	Uncertainty (10^{-15})
Magnetic Field Inhomogeneity	0.03
Rabi Pulling	0.02
Ramsey Pulling	0.002
Bloch-Siegert Shift	0.3
Fluorescent Light Shift	0.5
Majorana Transitions	1.3
Collisions	1.6
Beam Flux Variation	0.1
Microwave Leakage	1.0
DC Stark Shift	0.01
Spectral Purity	0.1
Modulation Synchronous Effects	
Detector/Demodulator	1.0
AM on Laser	1.0
Switching Transients	2.0
Combined Type B Uncertainty	3.4

Table 2: Details on the uncertainty of uncorrected biases

References

[1] Lee W. D., Shirley J. H., Lowe J. P., Drullinger R. E., IEEE Trans. Instrum. Meas., Vol.44, No.2, pp.120-123 Apr. 1995.
[2] Shirley J. H., Lee W. D., Drullinger R. E., Metrologia, 2001, 38, 427-458.
[3] A. Hasegawa et al., to be submitted to Metrologia.

Operation of NIST-F1 in 2002

NIST-F1, the Cs fountain primary frequency standard at the National Institute of Standards and Technology (NIST), has been in operation since November 1998 [1], and the first formal report to the BIPM was made in November 1999 [2]. During a formal evaluation the frequency of one of the hydrogen masers at NIST is measured by NIST-F1 and the results, along with all relevant uncertainties, are reported to the BIPM. NIST-F1 is not operated as a clock and is run only intermittently. The standard is constantly evolving, and both hardware and software improvements are continually being made. In some formal evaluations we have used a range of atom densities along with a least squares fit to determine the frequency at zero density. However, if no major changes have been made to the fountain since the previous evaluation, we may make mainly low density measurements and use the previous slope, along with any new high density data, to perform an extrapolation to zero density. The typical frequency shift from the lowest measured density to zero density is on the order of $1x10^{-15}$. Each formal evaluation also includes a magnetic field map, and a check of such things as microwave leakage and light leaks.

NIST operates an ensemble of five active, cavity tuned hydrogen masers. This provides a very stable frequency reference, which allows us to accurately characterize the performance of the reference maser. With this information, and the fact that the masers are quite stable, we can tolerate a relatively large amount of fountain dead time [3, 4]. This allows us to use longer evaluation intervals in order to reduce the frequency uncertainty introduced by the noise in transferring the result to TAI. Frequency noise in the NIST internal measurement system has an uncertainty well under $1x10^{-16}$, and therefore the uncertainty introduced by the dead time dominates the value of $u_{link/lab}$, which ranged from $3x10^{-16}$ to $5x10^{-16}$ in 2002.

The year 2002 was a difficult year for the fountain. Four formal evaluations were attempted, but only two (February and August) were successful. Among the problems that had to be addressed were an intermittent failure in the microwave synthesizer that required the addition of a monitoring system, the repump laser had to be replaced twice, the cesium oven and a vacuum pump had to be replaced, and the optical power amplifier failed and was replaced with a Ti-Sapphire laser. However, a number of improvements were also made. These include the microwave monitoring system, new software, a detection system light level servo, new detection windows, and improvements to the vacuum system. Improvements in run time continued, with the February run reaching 90%. The August run was hampered because the fountain was running out of Cs. The combined uncertainty was $1.29x10^{-15}$ for the February run, with the statistical uncertainty, u_A, being equal to $1.11x10^{-15}$, and the systematic uncertainty, u_B, being equal to $0.65x10^{-15}$. The significant contributors to the systematic uncertainty in the February evaluation were; spin exchange at $4.8x10^{-16}$, blackbody shift at $3x10^{-16}$, fluorescent light shift and microwave leakage at $2x10^{-16}$, and Zeeman and gravitation shift at $1x10^{-16}$.

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2 S.R. Jefferts, D.M. Meekhof, J.H. Shirley, T.E. Parker, C. Nelson, F. Levi, T.P. Heavner, G. Costanzo, A. DeMarchi, R.E Drullinger, L.W. Hollberg, W.D. Lee, and F.L. Walls, "Accuracy Evaluation of NIST-F1," *Metrologia*, vol. 39, pp 321-336, 2002.

3 T.E. Parker, D.A. Howe and M. Weiss, "Accurate Frequency Comparisons at the $1x10^{-15}$ Level," *in Proc. 1998 IEEE International Freq. Control Symp.*, pp 265-272, 1998.

4 R.J. Douglas and J.S. Boulanger, "Standard Uncertainty for Average Frequency Traceability," *in Proc. 11th European Freq. and Time Forum.*, pp 345-349, 1997.

Operation of the PTB primary clocks in 2002

PTB's primary clocks with a thermal beam

In 2002, the PTB CS1 and CS2 were in continuous clock operation without any modification or disturbance. Their operation parameters were checked regularly, beam reversals were performed. No indications were found calling for a modification of the previously stated relative frequency uncertainties, u_B, which are $8 \cdot 10^{-15}$ and $12 \cdot 10^{-15}$ for CS1 and CS2, respectively [1]. The short-term frequency instability of the clocks was evaluated throughout 2002 by comparison with an active hydrogen maser. The average instability, $\sigma_y(\tau = 1\text{h})$, of $78 \cdot 10^{-15}$ and of $66 \cdot 10^{-15}$, of CS1 and CS2, respectively, was in good agreement with the expectations which are based on signal strength, linewidth, and detector noise. A slight deviation from purely white frequency noise at long averaging times is observed in CS1, explaining the uncertainty $u_A(\tau=30\text{d}, \text{CS1})$ of $5 \cdot 10^{-15}$, whereas $u_A(\tau=30\text{d}, \text{CS2}) = 3 \cdot 10^{-15}$ is assumed. CS1 and Cs2 are operated continuously, and time differences UTC(PTB)-clock in the standard ALGOS format are reported so that $u_{l/lab}$ is zero.

PTB's caesium fountain clock CSF1

The CSF1, was operated intermittently, but on more than 340 days in 2002. The u_B contributions given in the table [3] reflect standard operation conditions which are fulfilled when the TAI scale unit is compared to the CSF1 second. They use to be slightly larger when the CSF1 is operated in an experimental mode, e. g. when a larger than the standard atom number is used.

Physical origin	Correction [10^{-15}]	Uncertainty [10^{-15}]
C-field	-46.2	< 0.1
Collisional shift	5.8	< 0.7
Blackbody shift	16.6	0.2
First-order Doppler effect	-	0.5
Majorana transition	-	< 0.1
Rabi-pulling	-	< 0.1
Ramsey-pulling	-	< 0.1
Microwave leakage	-	0.2
Microwave spectral impurities,	-	0.2
Electronics	-	0.2
Light shift	-	0.1
Other collisions		
Total 1σ uncertainty u_B		1.0

The CSF1 frequency instability was typically $\sigma_y(\tau=1\text{h}) = 3{,}5 \cdot 10^{-15}$ during the four periods of routine operation in 2002. Frequency differences of the kind y(CSF1 - HM) for averaging times of 15 or 20 days in between standard dates were reported, in parallel with time differences UTC(PTB) - HM in ALGOS format. HM is one of the hydrogen masers available at PTB. $u_A(\tau=15\text{d}, \text{CSF1})$ is conservatively estimated as $1 \cdot 10^{-15}$, $u_{l/lab}$ is negligible.

References

1. Heindorff T., Bauch A., Hetzel P., Petit G., Weyers S., Metrologia, 2001, 38, 497-502
2. Weyers S., Hübner U., Schröder R., Tamm Chr., Bauch A., Metrologia, 2001, 38, 343-352
3. Weyers S., Bauch A., Schröder R., Tamm Chr., Proc. of Symp. Frequ. Stand. and Metrol., St. Andrews, Sept. 2001, World Scientific (2002), 64-71.

Table 7. Mean fractional deviation of the TAI scale interval from that of TT

(File available on http://www.bipm.org under the name SITAI02.AR)

The fractional deviation d of the scale interval of TAI from that of TT (in practice the SI second on the geoid), and its relative uncertainty, are computed by the BIPM for all the intervals of computation of TAI, according to the method described in 'Azoubib J., Granveaud M., Guinot B., Metrologia 13, 1977, pp. 87-93', using all available measurements from the most accurate primary frequency standards CRL-O1, NIST-7, NIST-F1, NRLM-4, PTB CS1, PTB CS2, PTB CS3, PTB CSF1, SYRTE-FO2, SYRTE-FOM and SYRTE-JPO consistently corrected for the black-body radiation shift.

In this computation, a model for the instability of EAL is needed. Starting in 1998, it has been expressed as the quadratic sum of three components: a white frequency noise $6.0\times10^{-15}/\sqrt{(\tau)}$, a flicker frequency noise 0.6×10^{-15} and a random walk frequency noise $1.6\times10^{-16}\times\sqrt{(\tau)}$, with τ in days. The relation between EAL and TAI is given in Table 5.

Month	Interval	$d/10^{-15}$	uncertainty/10^{-15}
Jan. 2000	51539-51574	+4.5	2.1
Feb. 2000	51574-51599	+4.8	1.7
Mar. 2000	51599-51634	+5.6	1.9
Apr. 2000	51634-51664	+6.4	2.1
May 2000	51664-51694	+6.8	2.2
Jun. 2000	51694-51724	+6.2	2.1
Jul. 2000	51724-51754	+6.6	2.0
Aug. 2000	51754-51784	+7.4	1.4
Sep. 2000	51784-51814	+7.1	1.5
Oct. 2000	51814-51844	+7.2	1.5
Nov. 2000	51844-51874	+7.4	1.7
Dec. 2000	51874-51909	+5.4	1.8
Jan. 2001	51909-51939	+5.5	2.0
Feb. 2001	51939-51964	+4.8	1.5
Mar. 2001	51964-51999	+5.7	1.8
Apr. 2001	51999-52029	+6.6	1.6
May 2001	52029-52059	+6.7	1.8
Jun. 2001	52059-52089	+8.2	1.5
Jul. 2001	52089-52119	+8.9	1.2
Aug. 2001	52119-52149	+8.4	1.6
Sep. 2001	52149-52179	+9.2	1.4
Oct. 2001	52179-52209	+8.2	1.7
Nov. 2001	52209-52239	+10.2	1.1
Dec. 2001	52239-52274	+9.3	1.7
Jan. 2002	52274-52304	+9.7	1.9
Feb. 2002	52304-52329	+10.2	1.5
Mar. 2002	52329-52364	+10.6	1.4
Apr. 2002	52364-52394	+9.7	1.7
May 2002	52394-52424	+10.2	1.7
Jun. 2002	52424-52454	+9.5	1.9
Jul. 2002	52454-52484	+10.8	1.5
Aug. 2002	52484-52514	+8.9	1.9
Sep. 2002	52514-52544	+8.8	1.4
Oct. 2002	52544-52574	+8.6	1.7
Nov. 2002	52574-52604	+9.7	1.6
Dec. 2002	52604-52639	+10.5	1.5

Independent local atomic time scales

Local atomic time scales are established by the time laboratories which contribute with the appropriate clock data to the BIPM. The differences between TAI and the atomic scale maintained by each laboratory are available on http://www.bipm.org or via anonymous ftp 62.161.69.5. For each time laboratory 'lab' a separate file TAI-lab is provided ; it contains the respective values of the differences [*TAI-TA*(*lab*)] in nanoseconds, for the standard dates, starting on 1 January 1998.

The file NOTES.TAI provides information concerning the time laboratories contributing to the calculation of TAI since 1 January 1998. This file should be considered as complementary to the individual files TAI-lab.

For dates between April 1996 and December 1997, the values of [*TAI-TA*(*lab*)] are given in yearly files, each one giving also values of [*UTC-UTC*(*lab*)].

Local representations of UTC

The time laboratories which submit data to the BIPM keep local representations of UTC. The computed differences between UTC and each local representation are available on http://www.bipm.org or via anonymous ftp 62.161.69.5. For each time laboratory 'lab' a separate file UTC-lab is provided ; it contains the values of the differences [*UTC-UTC*(*lab*)] in nanoseconds, for the standard dates, starting on 1 January 1998.

The file NOTES.UTC provides information concerning the time laboratories since 1 January 1998. This file should be considered as complementary to the individual files UTC-lab.

For dates between April 1996 and December 1997, the values of [*UTC-UTC*(*lab*)] are given in yearly files, each one giving also values of [*TAI-TA*(*lab*)].

International GPS and GLONASS Tracking Schedules

(Files available on http://www.bipm.org)

GPS Schedule no 38 File SCHGPS.38	implemented on MJD = 52366 (2002 April 2) at 0h UTC	Reference date MJD = 50722 (1997 October 1)
GPS Schedule no 39 File SCHGPS.39	implemented on MJD = 52576 (2002 October 29) at 0h UTC	Reference date MJD = 50722 (1997 October 1)
GLONASS Schedule no 13 File SCHGLO.13	implemented on MJD = 52366 (2002 April 2) at 0h UTC	Reference date MJD = 50722 (1997 October 1)
GLONASS Schedule no 14 File SCHGLO.14	implemented on MJD = 52576 (2002 October 29) at 0h UTC	Reference date MJD = 50722 (1997 October 1)

[*TAI - GPS time*] and [*UTC - GPS time*]

The GPS satellites disseminate a common time scale designated 'GPS time'. The relation between GPS time and TAI is

$$[TAI - GPS\ time] = 19\ \text{s} + C_0,$$

where the time difference of 19 seconds is kept constant and C_0 is a quantity of the order of tens of nanoseconds, varying with time.

The relation between GPS time and UTC involves a variable number of seconds as a consequence of the leap seconds of the UTC system and is as follows:

from 1999 January 1, 0h UTC until further notice:

$$[UTC - GPS\ time] = -13\ \text{s} + C_0.$$

Here C_0 is given at 0h UTC every day.

C_0 is computed as follows. The GPS data recorded at the Paris Observatory for highest-elevation satellites are first corrected for precise satellite ephemerides and for ionospheric delays derived from IGS maps, and then smoothed to obtain daily values of [*UTC*(*OP*) - *GPS time*] at 0h UTC. Daily values of C_0 are then derived by linear interpolation of [*UTC* - *UTC*(*OP*)]. The combined standard uncertainty of the daily C_0 values is of the order of 10 ns.

A table giving daily values of C_0 at 0h UTC and the parameters used in its characterization (σ: standard deviation charcterizing the dispersion of individual measurements; *N*: the number of measurements) is available from the BIPM website (see page 6) under the name UTCGPS02.AR.

[*UTC - GLONASS time*] and [*TAI - GLONASS time*]

The GLONASS satellites disseminate a common time scale designated 'GLONASS time'. The relation between GLONASS time and UTC is

$$[UTC - GLONASS\ time] = 0\ s + C_1,$$

where the time difference 0 s is kept constant by the application of leap seconds so that GLONASS time follows the UTC system, and C_1 is a quantity of the order of several hundred nanoseconds (tens of microseconds until 1997 July 1), which varies with time.

The relation between GLONASS time and TAI involves a variable number of seconds and is as follows:

from 1999 January 1, 0h UTC, until further notice:

$$[TAI - GLONASS\ time] = 32\ s + C_1.$$

Here C_1 is given at 0h UTC every day.

C_1 is computed as follows. The GLONASS data recorded at the NMi Van Swinden Laboratorium, Delft, The Netherlands for the highest-elevation satellites are smoothed to obtain daily values of [*UTC*(*VSL*) - *GLONASS time*] at 0h UTC. Daily values of C_1 are then derived by linear interpolation of [*UTC* - *UTC*(*VSL*)] provided on the BIPM internet network.

To ensure the continuity of C_1 estimates, the following corrections are applied:
+1285 ns from 1997 January 1 (MJD 50449) to 1999 March 22 (MJD 51259)
+107 ns for 1999 March 23 and March 24 (MJD 51260 and MJD 51261)
0 ns since 1999, March 25 (MJD 51262).
The combined standard uncertainty of the daily C_1 values is of the order of several hundred nanoseconds.

A table giving daily values of C_1 at 0h UTC and the parameters used in its characterization (σ: standard deviation charcterizing the dispersion of individual measurements; *N*: the number of measurements) is available from the BIPM website (see page 6) under the name UTCGLO02.AR

Table 8A. Rates relative to TAI of contributing clocks in 2002

(File available on http://www.bipm.org under the name RTAI02.AR)

Mean clock rates relative to TAI are computed for one-month intervals ending at the dates given in the table.
When an intentional frequency adjustment has been applied to a clock, the data prior to this adjustment are corrected, so that Table 8A gives homogeneous rates for the whole year 2002. For studies including the clock rates of previous years, corrections must be brought to the data published in the Annual Report for 1988 to 2001, and in the BIH Annual Reports for the previous years. These corrections are given in Table 8B.
Unit is ns/day , *** denotes that the clock was not used.

lab.	clock		52304	52329	52364	52394	52424	52454
AUS	36	249	***	***	***	-2.30	-5.80	-6.80
AUS	36	299	20.44	19.97	19.80	20.07	19.49	19.88
AUS	36	340	0.11	-0.43	0.42	0.10	-1.97	-0.16
AUS	36	654	-27.77	-28.58	-26.10	-25.93	-26.85	-26.24
AUS	36	1035	5.27	6.28	6.57	7.50	6.85	***
AUS	36	1141	2.21	1.50	1.50	2.92	-0.39	1.08
AUS	40	5401	16.48	14.76	15.41	17.47	18.19	18.88
AUS	40	5402	-18.88	***	***	-19.49	-18.91	-21.57
AUS	40	5403	***	***	***	3.77	8.29	9.83
AUS	99	1	***	***	***	***	***	18.69
BEV	16	71	17.72	-18.33	-6.46	-3.77	-40.68	-63.40
BEV	35	1065	0.14	-0.09	1.53	1.37	1.27	1.74
BEV	35	1793	***	***	***	***	***	24.08
CAO	35	939	0.05	-0.96	0.50	-2.67	-8.31	-5.52
CAO	35	1270	1.05	0.54	-0.33	0.45	-5.98	-4.37
CH	17	206	-11.97	-3.09	-6.02	-5.12	9.18	9.05
CH	21	194	-44.87	-38.22	-36.12	-37.98	-37.46	-37.14
CH	21	217	145.08	163.66	165.39	170.00	165.89	165.91
CH	31	403	-57.22	-50.31	-50.58	-49.54	-51.24	-51.42
CH	35	413	-10.62	-10.55	-11.15	-14.87	-15.98	-16.26
CH	35	771	7.81	7.95	7.79	8.05	9.04	9.89
CH	36	354	45.29	45.83	45.80	47.02	47.19	47.47
CNM	35	1705	***	***	***	3.27	2.61	2.60
CNM	36	1537	-18.07	***	***	-19.02	-21.25	-17.29
CRL	35	112	-0.47	-0.12	0.10	-0.10	-0.52	0.04
CRL	35	144	14.56	15.47	15.84	15.48	15.93	16.72
CRL	35	332	13.26	12.83	13.20	12.67	13.04	12.41
CRL	35	342	7.23	7.77	7.18	7.78	7.77	7.79
CRL	35	343	13.73	13.53	14.52	12.57	13.42	14.17
CRL	35	715	-4.07	***	***	***	***	***
CRL	35	732	-1.36	-0.72	-1.05	-0.55	-0.94	-0.01
CRL	35	907	13.33	13.49	13.87	13.49	13.91	13.46
CRL	35	908	7.46	9.07	9.16	8.77	8.37	8.09
CRL	35	1778	***	***	***	***	***	***
CRL	35	1789	***	***	***	***	***	6.31

Table 8A. (Cont.)

lab.	clock		52484	52514	52544	52574	52604	52639
AUS	36	249	-2.53	***	***	-2.92	-3.57	-4.61
AUS	36	299	19.78	21.00	18.86	20.33	18.90	18.91
AUS	36	340	1.46	0.21	0.83	0.91	0.02	-0.30
AUS	36	654	-26.40	-25.57	-25.15	-24.85	-24.04	-24.67
AUS	36	1035	***	8.11	5.14	3.24	4.83	6.36
AUS	36	1141	-0.21	1.84	1.73	2.35	0.90	3.58
AUS	40	5401	***	***	25.09	***	***	28.43
AUS	40	5402	-19.70	-22.94	-14.25	-13.07	-15.71	-17.95
AUS	40	5403	13.14	***	***	7.69	4.68	-1.43
AUS	99	1	17.97	***	***	-25.15	-26.20	***
BEV	16	71	***	2.54	1.65	-12.56	25.39	15.37
BEV	35	1065	1.46	0.69	-0.37	0.10	0.38	1.14
BEV	35	1793	***	-0.47	-1.39	-0.80	-1.16	-0.55
CAO	35	939	-8.37	***	***	-0.19	-0.64	***
CAO	35	1270	***	***	***	-5.83	-6.10	***
CH	17	206	***	***	***	***	***	***
CH	21	194	-39.15	-34.81	-39.37	-34.55	-36.72	-31.79
CH	21	217	169.32	166.61	163.13	165.23	164.61	168.73
CH	31	403	-52.50	-52.19	-53.10	-54.40	-55.61	-56.12
CH	35	413	-15.46	-16.94	-17.63	-17.70	-18.13	-18.18
CH	35	771	10.00	10.06	9.46	8.90	9.09	8.09
CH	36	354	46.95	47.11	46.38	46.84	46.51	46.60
CNM	35	1705	2.36	2.32	2.28	2.35	0.81	-0.51
CNM	36	1537	-20.95	-18.70	-19.17	-19.01	-19.63	-18.30
CRL	35	112	-0.82	-0.11	-1.01	-0.18	-0.64	-0.43
CRL	35	144	16.77	14.89	15.45	15.13	15.82	15.94
CRL	35	332	12.95	12.61	12.85	12.63	13.52	13.27
CRL	35	342	6.94	7.56	7.75	7.12	7.60	7.38
CRL	35	343	14.40	14.23	14.98	13.79	14.12	13.92
CRL	35	715	6.49	5.21	7.47	6.73	6.58	6.78
CRL	35	732	-0.07	-0.01	0.29	0.32	0.68	1.17
CRL	35	907	12.36	12.49	12.48	13.71	13.80	12.93
CRL	35	908	9.35	9.03	6.70	7.14	7.77	7.36
CRL	35	1778	8.45	8.44	8.70	8.42	7.89	8.25
CRL	35	1789	6.78	6.75	6.77	6.28	6.90	7.50

Table 8A. (Cont.)

lab.	clock		52304	52329	52364	52394	52424	52454
CRL	35	1790	***	***	***	***	***	-6.46
DTAG	36	136	1.33	1.59	1.39	1.88	1.45	0.32
DTAG	36	345	-0.83	-0.38	1.21	-0.83	-1.28	-0.07
DTAG	36	465	1.87	2.76	2.52	2.45	2.50	1.67
F	16	106	***	***	***	***	***	***
F	35	122	9.78	10.20	10.46	11.34	12.68	12.46
F	35	124	2.28	2.88	2.34	1.42	2.24	2.47
F	35	131	2.22	1.02	0.87	0.60	-0.40	***
F	35	158	16.85	15.97	16.06	16.17	16.25	***
F	35	172	7.49	8.17	7.67	8.02	8.90	8.36
F	35	198	8.19	7.71	7.17	7.60	8.32	8.27
F	35	355	1.02	***	***	0.85	0.33	1.03
F	35	385	12.20	13.07	13.38	14.80	14.09	13.79
F	35	396	5.91	7.44	6.74	7.48	6.92	6.79
F	35	469	***	***	***	0.01	-0.10	0.61
F	35	489	***	***	***	14.17	16.87	17.04
F	35	536	***	***	***	***	3.79	3.44
F	35	609	-4.04	-5.14	-4.83	-6.06	-5.92	-6.44
F	35	774	-23.57	-22.55	-22.69	-22.13	-21.54	-21.81
F	35	781	***	***	***	***	***	***
F	35	819	23.30	21.32	21.91	21.45	21.45	20.23
F	35	859	-2.47	-1.56	0.03	-1.43	-0.95	-2.08
F	35	1177	-10.01	-9.77	-11.39	-10.67	-10.74	-10.95
F	35	1178	7.53	7.07	6.13	5.28	5.27	4.74
F	35	1222	6.70	6.35	7.07	7.15	***	***
F	35	1321	10.02	10.16	10.74	10.55	10.31	10.12
F	35	1556	-15.69	-16.58	-15.91	-15.57	-15.12	-14.67
F	40	805	-57.48	-56.82	-56.68	***	***	***
F	40	816	-26.05	-27.90	-26.85	-27.11	-26.80	***
IEN	35	219	12.33	11.46	11.69	***	13.53	12.75
IEN	35	505	***	***	-8.91	***	-9.82	-8.54
IEN	35	1115	-9.65	-8.66	-7.92	***	-9.15	-8.34
IEN	35	1373	-0.03	0.31	0.85	***	0.88	0.86
IFAG	36	1034	-13.88	-11.06	-9.49	-12.32	-17.99	-17.58
IFAG	36	1167	-7.11	-8.61	-9.66	-9.48	-7.53	-6.06
IFAG	36	1173	1.19	1.78	0.72	0.62	2.07	-0.54
IFAG	36	1629	2.56	3.59	3.00	3.69	6.47	5.28
IFAG	36	1732	***	***	***	***	***	***
IFAG	36	1798	***	***	***	***	***	***
IFAG	40	4401	60.45	28.15	20.80	46.30	55.78	73.87
IFAG	40	4403	27.50	13.83	8.42	33.80	54.16	88.81
IFAG	40	4413	99.56	126.79	49.41	61.35	80.97	101.41
IGMA	14	2403	-3.91	-2.53	6.63	-13.17	-14.10	***
IGMA	16	112	40.20	42.91	39.38	50.95	36.88	47.32
IGMA	35	631	14.75	14.80	12.54	***	***	***

Table 8A. (Cont.)

lab.	clock		52484	52514	52544	52574	52604	52639
CRL	35	1790	-6.84	-6.28	-7.35	-7.08	-6.86	-6.95
DTAG	36	136	-1.55	0.40	***	5.30	14.05	14.22
DTAG	36	345	-0.89	-0.43	***	-0.07	-2.58	-0.35
DTAG	36	465	1.87	0.74	***	2.13	3.13	0.34
F	16	106	***	***	***	-9.20	-8.30	-6.58
F	35	122	12.40	12.57	12.98	13.20	13.38	12.83
F	35	124	2.71	2.75	2.64	2.78	2.68	2.77
F	35	131	***	***	11.10	9.92	9.62	9.81
F	35	158	***	***	12.73	13.05	13.19	12.95
F	35	172	8.70	8.74	8.75	8.92	8.54	9.10
F	35	198	9.29	8.54	7.95	9.03	9.52	9.08
F	35	355	***	***	1.00	1.08	0.74	4.82
F	35	385	14.40	14.60	15.20	14.45	15.12	14.34
F	35	396	7.07	7.89	7.40	7.24	7.39	7.34
F	35	469	0.14	1.04	2.89	3.68	***	***
F	35	489	17.57	18.18	19.35	20.13	21.18	21.79
F	35	536	4.06	3.20	3.98	4.05	4.42	4.56
F	35	609	***	***	***	***	***	***
F	35	774	-21.30	-20.31	-20.96	-22.20	-22.03	-23.07
F	35	781	23.04	22.24	21.57	21.60	21.36	21.10
F	35	819	20.96	***	***	***	***	***
F	35	859	-1.65	-1.72	-0.78	***	***	0.61
F	35	1177	-11.94	-12.09	-13.86	***	***	-14.12
F	35	1178	5.68	5.35	4.85	***	***	4.89
F	35	1222	***	4.36	6.18	3.94	5.47	5.39
F	35	1321	11.34	10.28	10.10	10.09	10.17	10.00
F	35	1556	-14.18	-13.99	-15.23	***	***	***
F	40	805	***	***	***	***	***	***
F	40	816	***	***	***	***	***	-25.72
IEN	35	219	15.00	14.53	14.44	14.60	14.86	14.36
IEN	35	505	2.81	0.01	0.17	***	***	***
IEN	35	1115	-8.02	-6.94	-7.81	-9.27	-8.42	-8.57
IEN	35	1373	0.33	-0.68	-0.04	-2.10	-0.61	0.74
IFAG	36	1034	-13.21	-17.29	***	***	***	***
IFAG	36	1167	-7.07	-4.80	-2.21	-6.78	-8.42	-7.65
IFAG	36	1173	-3.85	-4.10	-3.80	1.33	2.19	-0.11
IFAG	36	1629	3.93	5.34	4.82	6.09	5.47	4.48
IFAG	36	1732	***	***	-2.47	-2.81	-3.17	-2.91
IFAG	36	1798	***	***	-2.19	-2.07	-2.60	-3.26
IFAG	40	4401	104.35	125.65	131.03	155.03	167.39	185.58
IFAG	40	4403	112.84	100.16	68.61	75.83	84.87	112.31
IFAG	40	4413	21.52	38.05	66.78	94.70	***	***
IGMA	14	2403	***	***	***	***	***	***
IGMA	16	112	46.33	41.94	42.17	30.25	35.44	42.30
IGMA	35	631	***	***	***	***	***	***

Table 8A. (Cont.)

lab.	clock		52304	52329	52364	52394	52424	52454
IGMA	35	645	12.20	16.60	14.86	16.36	17.06	16.24
IGMA	35	674	***	***	***	***	***	***
IGMA	35	676	***	***	***	***	-4.02	-4.94
INPL	35	1652	-12.53	-8.15	-8.78	-10.23	-10.04	-10.56
KRIS	36	321	7.53	6.12	7.07	5.43	4.32	4.88
KRIS	36	739	-11.54	-12.61	-10.38	-12.45	-11.45	-12.72
KRIS	36	1135	20.15	23.15	23.16	21.98	25.04	26.99
KRIS	40	5623	30.30	30.51	30.91	31.03	30.23	30.49
LDS	35	289	6.94	6.37	6.42	5.48	4.77	4.43
LT	35	1362	1.75	-1.27	-0.95	0.98	0.77	0.52
MSL	12	933	48.64	51.65	52.03	51.80	42.95	50.25
MSL	35	1025	-0.01	-0.34	-0.11	1.72	2.94	4.14
MSL	36	274	10.13	6.15	5.34	5.71	6.08	7.69
NAO	35	779	17.62	***	***	***	0.82	***
NAO	35	1206	12.01	12.48	12.67	13.00	13.33	***
NAO	35	1214	9.57	8.61	9.30	9.40	9.89	***
NAO	35	1689	-1.75	-1.44	-1.69	-2.20	-2.03	***
NIM	35	479	4.64	4.68	4.05	2.23	3.76	3.52
NIM	35	1238	2.06	2.51	2.54	0.64	2.16	2.69
NIM	35	1239	5.24	5.82	4.73	2.55	3.77	3.74
NIMB	35	600	***	***	***	***	***	***
NIST	35	132	0.05	0.35	0.47	-0.29	-0.42	-0.17
NIST	35	182	-11.15	-11.18	-11.04	-11.07	-11.38	-10.61
NIST	35	408	-1.43	-0.51	-0.86	-0.62	-1.60	-1.26
NIST	35	1074	-7.26	-7.14	-7.53	-7.36	-6.79	-6.76
NIST	40	201	30.98	29.66	28.29	26.96	25.60	24.39
NIST	40	203	23.53	24.29	25.35	26.56	27.33	28.43
NIST	40	204	5.22	5.56	5.74	6.22	6.53	6.87
NIST	40	205	-21.97	-22.14	-22.39	-22.38	-22.63	-22.75
NIST	40	222	***	-12.86	-12.82	-12.55	-12.58	-12.43
NMC	35	1501	-1.62	-1.76	-3.13	-3.18	-2.33	-5.87
NMIJ	35	224	-9.73	-10.33	-10.58	-10.52	-10.44	-10.29
NMIJ	35	459	***	***	***	***	***	***
NMIJ	35	523	-0.55	-0.45	-0.86	0.10	-0.33	-1.54
NMIJ	35	1273	-7.85	-8.12	-8.27	-7.76	-8.06	-8.02
NMLS	35	1659	***	***	-1.11	-0.26	-0.75	0.04
NPL	35	784	5.39	6.67	6.02	5.02	5.67	5.78
NPL	35	1275	2.18	3.05	2.17	2.82	3.09	1.69
NPL	36	404	12.03	12.37	12.68	12.36	12.69	14.29
NPL	40	1701	-1.31	-1.07	-0.93	-0.60	-0.54	-0.41
NPL	40	1708	1.40	1.01	1.26	1.86	1.97	2.24
NPLI	35	725	9.86	10.52	10.82	9.75	10.60	10.39
NRC	35	234	16.03	15.33	15.55	16.74	16.92	16.08
NRC	35	372	***	***	***	***	***	***
NRC	40	304	-3.12	-0.93	-1.01	-0.03	0.13	-0.34

Table 8A. (Cont.)

lab.	clock		52484	52514	52544	52574	52604	52639
IGMA	35	645	***	***	***	***	***	***
IGMA	35	674	***	1.82	1.38	1.10	0.93	0.05
IGMA	35	676	-3.50	-5.31	-4.89	-5.31	-5.34	-5.24
INPL	35	1652	-11.15	-11.09	-10.96	-11.15	-11.36	-9.99
KRIS	36	321	6.04	4.64	***	5.77	5.38	5.46
KRIS	36	739	-11.79	-11.81	***	-11.05	-12.43	-12.39
KRIS	36	1135	29.08	26.05	***	26.55	30.23	30.09
KRIS	40	5623	31.17	31.57	***	32.23	32.47	32.76
LDS	35	289	5.13	4.10	4.63	4.58	3.53	5.61
LT	35	1362	0.31	-0.51	-0.32	1.35	-0.19	0.05
MSL	12	933	43.99	38.86	43.62	43.51	45.62	52.44
MSL	35	1025	3.40	3.44	-0.85	-7.51	-7.90	-7.24
MSL	36	274	9.95	8.49	6.00	5.30	6.58	5.44
NAO	35	779	***	-0.46	-0.81	1.03	0.74	1.31
NAO	35	1206	***	13.29	13.25	14.03	13.61	14.56
NAO	35	1214	***	11.35	10.08	11.23	9.78	10.44
NAO	35	1689	***	-1.04	-2.22	-2.10	-1.44	-1.36
NIM	35	479	4.08	4.21	4.23	4.06	***	***
NIM	35	1238	3.59	3.59	4.18	3.84	***	***
NIM	35	1239	3.89	3.82	4.27	3.70	***	***
NIMB	35	600	***	***	***	***	-13.56	60.79
NIST	35	132	0.04	-0.58	-0.31	0.00	-0.68	0.18
NIST	35	182	-10.52	-10.80	***	***	***	-11.62
NIST	35	408	-2.17	-1.93	-0.06	-0.74	-1.33	-1.15
NIST	35	1074	-7.15	-6.61	-6.91	-5.49	-9.35	-8.98
NIST	40	201	22.98	22.12	20.88	19.76	18.39	17.31
NIST	40	203	27.39	30.01	30.88	32.03	32.83	34.00
NIST	40	204	6.88	6.97	6.98	7.53	7.59	8.17
NIST	40	205	-23.06	-23.02	-23.34	-23.34	-23.66	-23.71
NIST	40	222	-12.45	-12.19	-12.18	-12.00	-12.08	-11.79
NMC	35	1501	-5.70	-5.51	-3.90	-3.40	-2.65	-1.77
NMIJ	35	224	-10.43	-8.79	***	1.83	1.81	1.79
NMIJ	35	459	***	***	***	0.36	1.42	1.25
NMIJ	35	523	-0.06	-3.62	***	***	***	***
NMIJ	35	1273	-8.12	-6.78	***	-9.98	-10.07	-9.39
NMLS	35	1659	-0.60	3.25	1.25	-0.54	-1.35	-1.25
NPL	35	784	5.24	5.11	5.65	5.13	5.06	4.91
NPL	35	1275	1.58	1.41	1.18	1.72	2.03	0.85
NPL	36	404	13.72	13.02	14.73	9.32	9.33	8.58
NPL	40	1701	-0.46	0.33	-0.25	0.21	0.34	0.52
NPL	40	1708	2.26	2.54	2.49	2.31	0.82	1.78
NPLI	35	725	9.01	9.15	8.49	10.85	***	***
NRC	35	234	16.69	16.65	15.92	16.53	16.24	15.96
NRC	35	372	***	***	***	23.45	23.04	22.19
NRC	40	304	-0.60	-0.03	0.77	***	***	***

Table 8A. (Cont.)

lab.	clock		52304	52329	52364	52394	52424	52454
NRC	90	61	-0.17	0.74	0.01	0.51	-0.45	-0.69
NTSC	35	1007	-10.45	-9.17	-9.89	-9.10	-9.74	-9.16
NTSC	35	1008	16.73	17.63	17.05	16.92	18.36	18.71
NTSC	35	1011	-7.36	-5.90	-6.25	-6.41	-6.56	-6.47
NTSC	35	1016	0.95	2.46	1.47	2.84	2.28	2.10
NTSC	35	1017	-0.09	0.23	-0.09	0.57	-0.31	-0.01
NTSC	35	1018	13.55	14.18	13.47	12.22	13.25	13.04
OMH	36	849	2.38	2.71	2.01	2.74	2.42	4.39
ONRJ	35	903	3.05	3.33	2.53	4.66	2.84	2.46
ORB	35	201	4.95	2.07	***	-0.80	2.10	2.06
ORB	35	202	6.40	5.58	4.70	3.11	6.87	5.00
ORB	35	593	65.10	64.90	62.34	61.42	61.64	63.85
ORB	40	2601	-4.59	-3.61	-3.39	-4.16	-6.72	-6.91
PL	18	746	***	-15.41	95.66	183.57	***	***
PL	35	441	-1.30	0.04	-1.21	-1.00	0.22	0.51
PL	35	502	-1.85	-2.66	-3.43	-4.12	-4.58	-5.27
PL	35	761	-3.15	-4.87	-4.63	-4.65	-2.66	-5.12
PL	35	1120	-0.74	-0.31	-1.23	-0.99	-0.79	-0.20
PL	35	1660	-3.85	-3.97	-3.47	-3.50	-3.42	-2.78
PL	35	1746	***	***	***	***	-3.35	-2.66
PL	36	1395	***	***	-8.71	-10.31	-10.07	-8.32
PTB	35	128	-0.97	-0.54	-1.33	-2.33	-1.96	-2.56
PTB	35	415	4.53	5.58	4.37	5.22	4.74	2.75
PTB	35	1072	12.95	12.03	13.37	12.83	12.62	12.80
PTB	40	502	***	***	***	***	***	***
PTB	40	505	-6.14	-5.83	-5.30	-5.32	-4.65	-4.78
PTB	40	510	***	-0.53	0.50	1.62	2.15	3.91
PTB	40	537	4.01	5.99	7.75	***	***	***
PTB	92	1	1.80	1.32	0.99	1.22	1.21	1.52
PTB	92	2	1.29	0.79	0.65	1.10	0.72	1.18
PTB	92	3	0.38	0.10	-0.39	0.88	-0.38	0.28
ROA	14	1569	34.85	36.82	***	***	36.65	50.63
ROA	35	583	***	***	***	***	-1.02	-1.67
ROA	35	718	***	***	***	***	***	***
ROA	36	1488	0.95	-0.70	***	***	8.08	7.92
ROA	36	1490	8.57	5.91	***	***	5.18	5.74
SCL	35	621	-1.16	-1.09	-1.28	0.46	-0.08	-0.04
SCL	35	745	***	-0.89	-6.92	-6.39	-6.85	-7.40
SG	35	1035	3.73	3.41	3.97	3.84	4.94	4.89
SG	35	1127	0.03	-0.17	-0.58	-1.04	0.14	0.17
SG	36	522	-8.84	-8.97	-10.43	-9.04	-8.57	-10.35
SMU	36	1063	-4.56	-6.05	-6.02	-5.81	-6.43	-6.06
SP	16	137	16.59	16.29	-1.77	85.87	108.46	82.47
SP	19	197	***	***	***	***	***	***
SP	35	641	-17.15	-17.12	-26.88	***	***	***

Table 8A. (Cont.)

lab.	clock		52484	52514	52544	52574	52604	52639
NRC	90	61	-0.95	-0.25	0.48	0.70	-0.87	-0.06
NTSC	35	1007	-8.85	-9.29	-9.00	-8.11	-8.61	-8.85
NTSC	35	1008	18.50	18.01	19.26	18.08	19.22	17.63
NTSC	35	1011	-6.66	-6.69	-6.18	-5.59	-5.79	-6.48
NTSC	35	1016	3.25	2.94	2.44	3.53	2.94	1.86
NTSC	35	1017	0.95	0.94	1.25	1.58	-1.05	-0.62
NTSC	35	1018	12.33	12.74	12.44	12.58	12.83	12.79
OMH	36	849	6.76	4.41	3.55	4.10	4.57	1.96
ONRJ	35	903	1.23	1.96	1.48	2.21	2.43	2.43
ORB	35	201	2.03	3.19	1.80	2.30	3.39	3.77
ORB	35	202	6.47	9.37	7.98	4.95	6.32	8.71
ORB	35	593	63.86	63.25	63.99	64.00	65.31	64.92
ORB	40	2601	-4.12	-4.81	-2.31	-0.05	-0.42	-0.66
PL	18	746	***	***	***	***	***	***
PL	35	441	0.42	0.85	1.00	1.18	1.55	1.71
PL	35	502	-5.50	-6.48	-5.85	***	***	***
PL	35	761	-4.12	-0.59	-2.86	-3.25	-2.73	-2.62
PL	35	1120	-0.96	-0.95	-0.52	-1.20	-2.00	-1.51
PL	35	1660	-1.49	-0.44	-0.20	-0.56	-1.48	-1.47
PL	35	1746	-3.73	-3.24	-3.92	-4.46	-5.01	-4.04
PL	36	1395	-8.98	-9.15	-8.86	***	***	***
PTB	35	128	-2.47	-1.42	-1.36	-2.86	-2.43	-2.28
PTB	35	415	2.73	4.24	2.53	1.48	1.15	3.02
PTB	35	1072	12.76	12.80	12.60	12.98	13.62	12.89
PTB	40	502	44.07	45.91	47.73	49.38	50.87	52.01
PTB	40	505	-3.87	-3.00	-2.38	-2.14	-2.06	-0.92
PTB	40	510	3.53	4.76	6.09	7.13	11.99	10.17
PTB	40	537	***	***	***	***	***	***
PTB	92	1	0.89	1.51	1.65	1.05	1.56	1.71
PTB	92	2	1.27	0.78	0.55	0.82	0.85	1.19
PTB	92	3	-0.21	0.05	0.13	0.45	1.04	0.73
ROA	14	1569	53.68	60.01	69.54	74.39	66.57	63.63
ROA	35	583	-0.31	-0.84	-0.15	0.09	-0.06	0.24
ROA	35	718	-8.00	-9.39	-10.66	-10.14	-10.16	-11.11
ROA	36	1488	10.06	6.56	5.33	6.14	5.96	6.68
ROA	36	1490	8.02	7.43	8.08	6.83	8.69	9.32
SCL	35	621	0.05	0.03	-0.12	0.33	0.22	-0.26
SCL	35	745	-6.77	-6.59	-6.77	-7.95	-7.16	-8.01
SG	35	1035	4.38	4.36	4.66	4.53	5.49	4.55
SG	35	1127	0.18	0.37	0.37	0.74	1.49	0.62
SG	36	522	-9.15	-8.58	-10.20	-8.69	-9.45	-9.84
SMU	36	1063	-5.35	-5.05	-6.78	-5.59	-6.08	-5.14
SP	16	137	44.03	39.76	54.55	82.04	111.65	123.03
SP	19	197	***	81.61	90.04	85.70	89.41	89.73
SP	35	641	19.84	17.11	14.98	14.88	11.84	11.89

Table 8A. (Cont.)

lab.	clock	52304	52329	52364	52394	52424	52454
SP	35 1188	17.91	17.44	16.23	19.92	20.22	19.63
SP	35 1642	14.76	14.30	14.74	15.90	14.85	15.19
SP	36 1175	-1.42	0.41	-0.39	-0.65	-0.66	0.41
SP	40 7218	***	***	***	***	***	***
SP	40 7299	***	***	***	***	***	***
SU	40 3802	2.25	2.94	3.12	3.86	4.32	4.84
SU	40 3803	-18.60	-20.28	***	***	***	***
SU	40 3805	44.50	45.60	46.82	47.70	48.62	49.85
SU	40 3807	39.52	39.94	40.01	40.87	***	***
SU	40 3810	35.82	37.59	37.47	39.23	40.65	41.93
SU	40 3825	50.81	***	***	***	***	***
SU	40 3827	***	***	***	***	***	***
SU	40 3831	***	***	***	***	***	***
SU	40 3837	30.38	30.90	31.48	32.14	32.57	33.01
TCC	35 1028	***	***	***	***	***	***
TCC	40 8620	***	***	***	***	***	***
TCC	40 8624	***	***	***	***	***	***
TL	35 160	-13.79	-14.45	-12.92	-12.02	-12.76	-12.46
TL	35 300	11.89	10.78	12.24	12.11	12.77	11.91
TL	35 474	***	***	***	***	***	***
TL	35 809	-3.37	-2.98	-3.38	-4.02	-3.90	-3.55
TL	35 1012	-18.04	-18.38	-14.83	-12.56	-12.66	-11.76
TL	35 1498	15.61	15.22	14.98	16.36	15.34	16.20
TL	35 1500	9.55	11.68	10.14	9.66	9.76	10.44
TL	35 1712	***	***	***	***	***	***
TL	40 3052	***	***	***	***	***	54.50
TL	40 3053	37.10	37.27	39.28	40.04	40.62	42.08
TP	35 163	16.12	16.29	16.86	18.25	19.62	19.88
TP	35 1227	3.02	1.73	2.34	2.76	1.87	3.02
TP	36 154	10.53	12.16	11.98	11.75	14.27	12.95
TP	36 326	-4.90	-5.27	-5.44	-5.83	-5.36	-4.89
UME	35 251	-0.63	-0.68	-0.75	-1.02	-0.48	-1.15
UME	35 252	-1.02	-0.86	-0.63	-1.06	-0.91	-0.09
UME	35 872	-0.07	1.39	-0.28	-0.27	1.39	0.41
USNO	35 101	-5.09	-5.15	-4.84	-4.85	-4.98	-4.82
USNO	35 104	17.82	18.36	18.25	18.60	18.62	18.83
USNO	35 106	-13.66	-13.40	-13.58	-12.94	-12.83	-13.60
USNO	35 108	7.97	7.04	8.71	7.42	7.60	7.38
USNO	35 114	22.79	23.14	23.72	22.38	20.80	19.68
USNO	35 120	1.23	0.59	0.42	0.87	0.92	0.15
USNO	35 142	4.45	4.88	4.91	4.80	6.38	5.55
USNO	35 146	-3.42	-4.17	-3.64	-3.24	-3.43	-3.39
USNO	35 148	6.93	7.67	7.48	7.93	8.22	8.80
USNO	35 150	3.03	2.67	3.97	3.93	3.37	3.10
USNO	35 152	12.38	12.20	12.19	12.63	11.19	11.74

Table 8A. (Cont.)

lab.	clock	52484	52514	52544	52574	52604	52639
SP	35 1188	19.32	19.61	19.48	18.84	16.09	15.48
SP	35 1642	14.05	12.84	14.88	15.33	13.98	14.17
SP	36 1175	-0.07	1.55	1.25	-0.30	-1.61	-1.04
SP	40 7218	***	***	***	-12.39	***	***
SP	40 7299	***	41.47	***	***	***	***
SU	40 3802	5.33	5.87	6.29	6.81	6.67	7.68
SU	40 3803	***	***	***	***	***	-21.93
SU	40 3805	50.71	51.82	52.50	53.75	54.57	55.94
SU	40 3807	***	***	***	***	***	***
SU	40 3810	43.10	44.86	45.05	47.74	49.64	51.82
SU	40 3825	59.37	60.54	61.33	62.48	63.69	67.15
SU	40 3827	***	67.87	67.70	67.73	67.13	67.61
SU	40 3831	***	10.42	10.93	11.92	12.62	13.98
SU	40 3837	33.55	34.02	34.39	35.13	35.32	36.30
TCC	35 1028	***	***	***	***	***	-8.17
TCC	40 8620	***	***	***	***	***	6.20
TCC	40 8624	***	***	***	***	***	-12.62
TL	35 160	-13.45	-12.94	-13.00	-11.81	-10.01	-9.44
TL	35 300	11.90	11.65	11.96	12.18	11.49	11.36
TL	35 474	***	***	***	***	***	23.73
TL	35 809	-5.85	-6.20	-5.69	-6.00	***	***
TL	35 1012	-12.20	-11.96	-12.39	-11.72	-11.63	-12.69
TL	35 1498	14.10	14.04	15.44	14.35	15.62	14.67
TL	35 1500	10.08	9.11	9.84	8.65	10.12	9.44
TL	35 1712	0.23	0.16	0.81	0.57	0.14	0.26
TL	40 3052	52.99	55.74	57.96	58.98	60.74	62.46
TL	40 3053	42.14	43.17	45.04	46.18	47.39	***
TP	35 163	20.81	20.74	20.90	21.10	21.95	21.98
TP	35 1227	2.78	3.37	3.10	2.78	3.24	2.76
TP	36 154	12.73	12.67	13.54	11.90	11.89	12.78
TP	36 326	-3.68	-5.95	-5.83	-5.43	***	***
UME	35 251	-0.52	-1.87	-1.97	***	***	***
UME	35 252	-1.17	0.09	-0.08	0.21	-0.38	0.48
UME	35 872	0.88	-0.44	-1.02	-0.88	-1.83	-0.81
USNO	35 101	-5.34	-4.77	-5.80	-4.55	-4.38	-4.63
USNO	35 104	18.26	17.83	17.93	18.14	18.94	17.67
USNO	35 106	-13.39	-12.64	-13.94	-14.01	-13.79	-14.71
USNO	35 108	7.82	8.04	8.04	7.00	8.34	8.38
USNO	35 114	17.46	16.47	15.50	13.99	***	***
USNO	35 120	0.22	0.47	-0.80	0.82	0.73	0.83
USNO	35 142	5.90	5.66	4.93	5.51	5.69	5.35
USNO	35 146	-3.18	-3.27	-4.14	-3.70	-3.56	-3.60
USNO	35 148	9.50	8.71	9.47	9.75	9.39	9.48
USNO	35 150	3.15	4.14	4.23	3.50	3.94	3.15
USNO	35 152	11.83	11.82	11.41	11.06	11.98	11.71

Table 8A. (Cont.)

lab.	clock		52304	52329	52364	52394	52424	52454
USNO	35	153	14.94	14.26	14.99	14.74	14.06	13.71
USNO	35	156	16.91	16.72	17.29	16.30	15.86	16.69
USNO	35	161	-18.61	-18.51	-18.72	-18.23	-18.33	-18.88
USNO	35	164	-3.73	-3.41	-3.87	-3.11	-3.62	-3.96
USNO	35	165	2.92	2.82	2.96	2.20	2.92	1.82
USNO	35	166	-1.05	-2.15	-1.20	-0.81	-1.20	-1.56
USNO	35	167	3.48	4.21	3.34	4.12	3.87	3.31
USNO	35	169	14.88	15.39	15.15	14.55	14.27	14.41
USNO	35	171	0.17	0.11	0.76	0.05	0.13	***
USNO	35	173	-12.84	-12.51	-13.59	-12.75	-12.82	-13.23
USNO	35	213	12.83	13.43	12.53	12.05	11.95	12.36
USNO	35	217	-2.18	-2.46	-1.92	-2.07	-2.00	-1.52
USNO	35	225	0.74	1.10	1.49	0.32	-1.42	-1.17
USNO	35	226	20.80	20.96	20.50	21.15	21.85	21.61
USNO	35	227	6.08	5.98	5.96	5.45	5.19	5.74
USNO	35	229	4.38	3.95	4.21	4.52	4.88	6.27
USNO	35	231	-12.07	-13.21	-13.24	-13.69	-14.14	-13.75
USNO	35	233	-0.25	-0.76	0.13	0.44	0.02	-0.71
USNO	35	242	17.60	17.79	18.39	19.35	18.56	18.76
USNO	35	244	16.53	16.75	16.91	17.43	15.99	16.70
USNO	35	249	4.98	4.13	5.58	5.11	4.84	4.16
USNO	35	253	4.35	4.89	4.28	4.70	5.66	5.74
USNO	35	254	9.50	10.17	8.95	9.25	9.42	9.15
USNO	35	255	7.11	7.53	6.62	6.99	7.68	7.09
USNO	35	256	15.62	15.30	15.48	16.23	15.27	15.34
USNO	35	260	12.73	12.25	12.53	13.94	12.09	12.71
USNO	35	268	2.53	2.72	2.24	1.85	2.40	1.44
USNO	35	270	-11.15	-10.50	-10.64	-10.63	-10.73	-10.33
USNO	35	279	2.53	1.99	1.58	2.07	1.12	1.46
USNO	35	389	-26.00	-23.79	-24.47	-24.69	-23.71	-23.97
USNO	35	392	6.06	7.25	6.72	6.62	6.96	6.77
USNO	35	394	10.29	11.23	11.42	11.73	10.25	10.76
USNO	35	416	-24.29	-24.07	-24.51	-24.28	-23.96	-24.34
USNO	35	417	8.65	8.39	8.44	7.87	7.84	7.74
USNO	35	703	-1.96	-3.42	***	***	***	-1.91
USNO	35	717	-8.39	-8.69	-8.65	-9.22	-9.35	-9.14
USNO	35	762	-4.74	-5.01	-5.28	-5.54	-5.83	-5.53
USNO	35	763	-15.95	-16.83	-15.95	-15.23	-15.76	-15.94
USNO	35	765	-11.95	-11.49	-11.62	-11.66	-11.53	-11.72
USNO	35	1096	25.01	22.83	24.52	25.26	24.77	25.71
USNO	35	1097	9.43	9.19	10.13	10.31	10.96	10.16
USNO	35	1125	22.52	22.69	22.75	22.27	22.78	22.53
USNO	35	1327	5.95	6.02	6.86	5.89	6.49	6.57
USNO	35	1328	5.61	5.54	4.57	5.15	4.84	5.16
USNO	35	1331	-5.90	-5.28	-5.09	-5.28	-4.81	-4.79

Table 8A. (Cont.)

lab.	clock		52484	52514	52544	52574	52604	52639
USNO	35	153	14.33	13.98	14.43	13.93	14.12	13.75
USNO	35	156	15.78	16.11	16.90	15.93	16.32	16.15
USNO	35	161	-18.50	-19.17	-18.62	-18.89	-18.46	-18.35
USNO	35	164	-3.90	-4.19	-3.51	-4.87	-4.71	-5.01
USNO	35	165	2.70	2.41	1.98	1.98	2.32	2.44
USNO	35	166	-1.32	-1.77	-2.84	-3.22	-2.89	-2.97
USNO	35	167	3.45	3.57	3.08	3.56	3.26	3.55
USNO	35	169	15.03	15.49	13.85	14.83	14.78	14.53
USNO	35	171	***	***	***	0.06	-0.61	0.53
USNO	35	173	-12.87	-12.75	-12.63	-12.45	-12.88	-12.53
USNO	35	213	11.47	11.74	11.08	10.45	10.51	11.01
USNO	35	217	-2.07	-2.19	-0.92	-1.57	-1.48	-1.32
USNO	35	225	-1.29	-1.34	-0.66	-1.07	-0.72	-0.68
USNO	35	226	21.42	21.88	21.85	21.15	21.74	22.01
USNO	35	227	5.23	5.24	4.93	5.28	5.22	5.03
USNO	35	229	5.99	5.44	6.89	6.74	7.97	7.63
USNO	35	231	-13.73	-13.34	-13.60	-12.77	-12.38	-12.83
USNO	35	233	-0.46	-0.13	-0.39	0.04	-0.48	0.22
USNO	35	242	17.93	19.35	19.50	18.99	20.35	19.90
USNO	35	244	16.40	17.27	17.00	18.13	17.84	18.33
USNO	35	249	5.04	4.65	3.20	2.34	4.07	4.65
USNO	35	253	5.50	6.06	8.89	10.10	6.59	7.33
USNO	35	254	9.62	9.19	8.02	8.33	8.70	9.29
USNO	35	255	7.23	7.09	7.03	7.21	6.87	6.78
USNO	35	256	14.74	13.84	14.59	14.20	13.22	13.63
USNO	35	260	12.26	11.99	12.67	12.91	12.62	13.41
USNO	35	268	2.11	0.97	2.65	0.98	1.72	1.94
USNO	35	270	-10.17	-10.14	-10.30	-10.83	-11.74	-11.02
USNO	35	279	1.85	1.34	0.79	1.34	1.28	1.37
USNO	35	389	-24.39	-24.42	-24.32	-24.31	-23.83	-23.36
USNO	35	392	7.15	6.73	6.53	7.47	7.00	7.53
USNO	35	394	10.88	11.51	11.31	10.50	10.56	10.88
USNO	35	416	-24.15	-24.36	-23.87	-23.65	-24.28	-24.20
USNO	35	417	8.30	9.16	8.80	8.50	8.96	8.83
USNO	35	703	-2.62	-3.94	-4.90	-5.87	-6.78	-6.97
USNO	35	717	-8.61	-8.90	***	***	***	-15.54
USNO	35	762	-5.80	-5.99	-6.02	-4.41	-4.65	-5.00
USNO	35	763	-15.57	-15.23	-15.75	-15.90	-15.59	-14.95
USNO	35	765	-11.98	-10.47	-10.17	-10.10	-10.11	-9.68
USNO	35	1096	26.30	24.87	24.53	25.03	24.87	26.07
USNO	35	1097	9.75	8.99	10.50	11.53	10.69	10.25
USNO	35	1125	22.73	22.14	22.98	23.08	22.87	22.62
USNO	35	1327	6.99	6.77	7.43	7.13	7.64	7.83
USNO	35	1328	4.71	3.99	4.80	4.85	4.74	4.81
USNO	35	1331	-5.05	-5.22	-4.98	-5.94	-5.70	-5.68

Table 8A. (Cont.)

lab.	clock		52304	52329	52364	52394	52424	52454
USNO	35	1438	1.53	1.65	1.60	1.50	1.52	1.83
USNO	35	1459	-1.42	-1.09	-0.92	-1.65	-1.41	-2.00
USNO	35	1462	8.72	9.43	9.22	9.29	10.53	9.89
USNO	35	1463	6.89	6.84	7.55	7.35	6.06	6.96
USNO	35	1468	***	***	***	***	-0.44	-0.71
USNO	35	1481	0.73	1.77	1.21	1.30	2.11	2.83
USNO	35	1543	9.75	10.45	10.24	10.30	10.92	10.44
USNO	35	1573	***	***	3.57	3.95	4.62	4.79
USNO	35	1575	-5.60	-5.60	-5.05	-4.64	-5.11	-4.21
USNO	35	1655	-13.02	-14.69	-15.22	-14.98	-15.18	-13.63
USNO	35	1692	9.05	8.82	7.68	7.31	7.53	6.82
USNO	35	1694	-0.87	0.48	0.45	0.73	0.84	1.02
USNO	35	1696	5.85	5.35	4.85	5.20	4.54	4.54
USNO	35	1697	-0.60	-0.88	-0.22	-1.01	-0.43	-0.42
USNO	35	1698	11.82	12.01	13.02	12.56	13.34	12.92
USNO	40	701	-27.60	-27.52	-27.38	-27.33	-27.33	-27.19
USNO	40	702	-9.83	-9.96	-9.87	-10.05	-9.92	-9.92
USNO	40	703	1.00	1.08	1.14	0.69	0.76	0.75
USNO	40	704	4.13	4.18	4.41	4.58	4.74	5.00
USNO	40	705	-40.88	-40.97	-41.08	-41.51	-41.68	-41.82
USNO	40	708	11.98	12.43	12.85	13.13	13.66	14.06
USNO	40	709	-30.90	-31.26	-30.55	-30.88	-30.56	-29.90
USNO	40	710	33.67	34.11	31.41	34.87	35.32	35.94
USNO	40	711	114.56	116.03	117.72	119.37	120.92	122.76
USNO	40	712	-7.77	-7.66	-7.50	-7.46	-7.54	-7.36
USNO	40	713	-8.52	-8.26	-8.28	-7.95	-7.78	-7.56
USNO	40	714	-44.30	-43.62	-43.73	-43.45	-43.28	-43.10
USNO	40	715	-16.42	-16.22	-15.99	-15.87	-15.67	-15.36
USNO	40	716	209.83	209.60	208.50	207.72	206.29	204.96
USNO	40	718	129.90	128.83	127.73	126.55	125.64	124.86
USNO	40	719	***	***	***	***	***	***
VSL	35	179	6.86	6.42	7.23	6.26	6.07	6.28
VSL	35	456	19.36	19.76	19.59	19.20	18.98	18.05
VSL	35	548	10.25	10.71	9.42	10.02	10.24	9.60
VSL	35	731	17.53	16.60	16.65	***	***	***

Table 8A. (Cont.)

lab.	clock	52484	52514	52544	52574	52604	52639
USNO	35 1438	2.29	2.49	2.44	2.70	2.45	2.43
USNO	35 1459	-1.54	-1.79	-1.76	-2.48	-2.71	-2.10
USNO	35 1462	10.25	9.69	9.61	9.85	9.34	11.04
USNO	35 1463	6.48	7.29	5.48	5.12	5.80	5.72
USNO	35 1468	0.05	0.04	-0.81	-0.23	-0.68	0.03
USNO	35 1481	2.65	2.43	3.06	2.96	3.30	2.97
USNO	35 1543	9.53	10.49	10.32	10.48	10.11	10.20
USNO	35 1573	4.38	4.76	4.95	5.48	4.87	5.13
USNO	35 1575	-4.35	-3.49	-4.06	-3.68	-2.87	-3.61
USNO	35 1655	-14.70	-14.51	-13.80	-14.45	-14.83	-13.43
USNO	35 1692	6.53	6.89	5.72	6.63	6.15	5.48
USNO	35 1694	1.31	1.29	1.04	0.97	1.15	1.88
USNO	35 1696	4.54	4.26	4.39	3.55	4.47	4.31
USNO	35 1697	-0.29	-0.46	-0.66	***	-0.31	-0.49
USNO	35 1698	12.87	13.58	12.78	12.85	12.87	12.96
USNO	40 701	-27.56	-27.60	-27.29	-27.20	-27.61	-27.70
USNO	40 702	-10.04	-10.03	-10.16	-10.07	-10.19	-10.21
USNO	40 703	0.71	0.73	0.74	0.90	0.89	0.97
USNO	40 704	5.06	5.31	5.36	5.81	5.85	6.12
USNO	40 705	-42.00	-42.15	-42.48	-42.54	-42.88	-42.91
USNO	40 708	14.17	14.63	14.86	15.39	15.59	15.97
USNO	40 709	-29.94	-29.46	-29.37	-28.02	-29.18	-27.20
USNO	40 710	36.26	36.76	37.12	37.73	38.08	38.68
USNO	40 711	124.33	126.19	127.78	129.56	131.09	132.97
USNO	40 712	-7.38	-7.16	-7.16	-6.90	-6.91	-6.68
USNO	40 713	-7.33	-7.12	-6.83	-6.70	-6.56	-6.35
USNO	40 714	-42.95	-42.77	-42.73	-42.42	-42.41	-42.13
USNO	40 715	-15.40	-15.21	-15.10	-14.80	-14.78	-14.49
USNO	40 716	205.63	205.63	205.31	205.47	205.22	205.22
USNO	40 718	123.83	123.14	122.34	121.85	121.26	120.72
USNO	40 719	***	***	***	***	-62.21	-60.87
VSL	35 179	6.47	7.01	7.18	7.88	6.72	7.90
VSL	35 456	17.77	17.12	18.49	***	***	***
VSL	35 548	10.05	9.71	9.93	10.50	9.97	9.86
VSL	35 731	16.40	18.09	17.59	17.54	17.32	17.54

The clocks are designated by their type (2 digits) and serial number in the type. The codes for the types are:

12 HEWLETT-PACKARD 5061A
13 EBAUCHES, OSCILLATOM B5000
14 HEWLETT-PACKARD 5061A OPT. 4
16 OSCILLOQUARTZ 3200
17 OSCILLOQUARTZ 3000
15 DATUM/SYMMETRICOM Cs III
4x HYDROGEN MASERS
9x PRIMARY CLOCKS AND PROTOTYPES
21 OSCILLOQUARTZ 3210
23 OSCILLOQUARTZ EUDICS 3020
30 HEWLETT-PACKARD 5061B
31 HEWLETT-PACKARD 5061B OPT. 4
34 H-P 5061A/B with 5071A tube
35 AGILENT 5071A High perf.
36 AGILENT 5071A Low perf.
50 FREQ. AND TIME SYSTEMS INC. 4065A

Table 8B. Corrections for an homogeneous use of the clock rates published in the current and previous Annual Reports.

Each line refers to the same clock working without interruption.

	2002	2001		2000		1999	
	clock nø	clock nø	corr. (ns/d)	clock nø	corr. (ns/d)	clock nø	corr. (ns/d)
AUS	36 340	36 340		36 340		36 340	3.28
CH	17 206	17 206		17 206		17 206(1)	
IGMA	16 112	16 112	-0.50	16 112	-0.50	16 112(2)	-0.50
IEN	35 1373	35 1373		35 1373	-9.30	35 1373	-9.30
LT	35 1362	35 1362	+3.28(3)				
NPL	40 1701	40 1701	-1.00	40 1701	-1.80	40 1701(4)	-3.60
NRC	40 304	40 304	-19.01	40 304	-19.01	40 304(5)	
ORB	40 2601	40 2601	-4.30(6)				
PL	35 502	35 502	+11.49	35 502	+11.49	35 502(7)	+4.92
	35 761	35 761		35 761	-4.32(8)		
	35 1120	35 1120		35 1120	+7.61	35 1120	+7.61
	35 1660	35 1660	-1.02(9)				
ROA	14 1569	14 1569		14 1569		14 1569(10)	
	36 1488	36 1488		36 1488	-7.66		
SU	40 3802	40 3802	-26.00(11)				
	40 3803	40 3803	+2.00(12)				
	40 3810	40 3810	+2.00(12)				
	40 3825	40 3825	+2.00(13)				

(1) A correction of +78.00 ns/d has to be applied in 1994, 1993 and in 1992.
(2) A correction of -0.50 ns/d has to be applied for the last 5 two-month intervals of 1996, in 1997 and 1998.
(3) A correction of +3.28 ns/d has to be applied for the last 5 months of 2001.
(4) A correction of -5.20 ns/d has to be applied in 1998. A correction of -8.00 has to be applied in 1997, a correction of -9.2 ns/d has to be applied in 1996, a correction of -5.55 ns/d has to be applied in 1995, 1994, 1993 and 1992, and a correction of +21.45 ns/d has to be applied in 1991.
(5) A correction of -19.01 ns/d has to be applied for the last four months of 1999.
(6) A correction of -4.30 ns/d has to be applied for the last four months of 2001.
(7) A correction of +4.92 ns/d has to be applied in 1998 and 1997.
(8) A correction of -4.32 ns/d has to be applied for the last two months of 2000.
(9) A correction of -1.02 ns/d has to be applied for the last four months of 2001.
(10) A correction of - 6.00 ns/d has to be applied in 1994.
(11) A correction of -26.00 ns/d has to be applied for the last four months of 2001.
(12) A correction of +2.00 ns/d has to be applied for the last four months of 2001.
(13) A correction of +2 ns/d has to be applied for the last two months of 2001.

Table 9A. Relative weights (in percent) of contributing clocks in 2002

(File available on http://www.bipm.org under the name WTAI02.AR)

Clocks weights are computed for one-month intervals ending at the dates given in the table.

***** denotes that the clock was not used

lab.	clock		52304	52329	52364	52394	52424	52454
AUS	36	249	*****	*****	*****	0.000	0.000	0.000
AUS	36	299	0.271	0.337	0.371	0.462	0.467	0.475
AUS	36	340	0.233	0.230	0.237	0.249	0.183	0.200
AUS	36	654	0.533	0.479	0.349	0.300	0.297	0.289
AUS	36	1035	0.663	0.372	0.252	0.185	0.173	*****
AUS	36	1141	0.515	0.523	0.473	0.704	0.000	0.351
AUS	40	5401	0.325	0.200	0.212	0.226	0.192	0.158
AUS	40	5402	0.000	*****	*****	0.000	0.000	0.000
AUS	40	5403	*****	*****	*****	0.000	0.000	0.000
AUS	99	1	*****	*****	*****	*****	*****	0.000
BEV	16	71	0.000	0.000	0.000	0.000	0.000	0.000
BEV	35	1065	0.562	0.544	0.415	0.409	0.522	0.627
BEV	35	1793	*****	*****	*****	*****	*****	0.000
CAO	35	939	0.235	0.120	0.150	0.071	0.000	0.017
CAO	35	1270	0.173	0.173	0.120	0.151	0.000	0.024
CH	17	206	0.001	0.001	0.001	0.001	0.001	0.001
CH	21	194	0.029	0.000	0.009	0.008	0.007	0.006
CH	21	217	0.009	0.000	0.001	0.001	0.001	0.001
CH	31	403	0.034	0.031	0.033	0.028	0.027	0.025
CH	35	413	0.005	0.007	0.015	0.035	0.043	0.051
CH	35	771	0.605	0.668	0.654	0.699	0.571	0.599
CH	36	354	0.016	0.020	0.035	0.609	0.462	0.363
CNM	35	1705	*****	*****	*****	0.000	0.000	0.000
CNM	36	1537	0.083	*****	*****	0.000	0.000	0.000
CRL	35	112	0.666	0.808	0.870	0.893	0.877	0.901
CRL	35	144	0.877	0.870	0.870	0.893	0.877	0.784
CRL	35	332	0.481	0.529	0.620	0.670	0.739	0.831
CRL	35	342	0.000	0.000	0.000	0.000	0.877	0.901
CRL	35	343	0.534	0.752	0.677	0.563	0.564	0.545
CRL	35	715	0.000	*****	*****	*****	*****	*****
CRL	35	732	0.877	0.870	0.870	0.893	0.877	0.901
CRL	35	907	0.391	0.346	0.333	0.423	0.419	0.401
CRL	35	908	0.228	0.237	0.257	0.312	0.301	0.294
CRL	35	1778	*****	*****	*****	*****	*****	*****
CRL	35	1789	*****	*****	*****	*****	*****	0.000

Table 9A. (Cont.)

lab.	clock		52484	52514	52544	52574	52604	52639
AUS	36	249	0.000	*****	*****	0.000	0.000	0.000
AUS	36	299	0.770	0.631	0.562	0.699	0.468	0.346
AUS	36	340	0.248	0.274	0.291	0.270	0.314	0.274
AUS	36	654	0.270	0.237	0.203	0.164	0.150	0.140
AUS	36	1035	*****	0.000	0.000	0.000	0.000	0.023
AUS	36	1141	0.204	0.214	0.243	0.229	0.217	0.149
AUS	40	5401	*****	*****	0.000	*****	*****	0.000
AUS	40	5402	0.000	0.029	0.013	0.010	0.012	0.014
AUS	40	5403	0.000	*****	*****	0.000	0.000	0.000
AUS	99	1	0.000	*****	*****	0.000	0.000	*****
BEV	16	71	*****	0.000	0.000	0.000	0.000	0.000
BEV	35	1065	0.627	0.586	0.404	0.340	0.372	0.333
BEV	35	1793	*****	0.000	0.000	0.000	0.000	0.559
CAO	35	939	0.012	*****	*****	0.000	0.000	*****
CAO	35	1270	*****	*****	*****	0.000	0.000	*****
CH	17	206	*****	*****	*****	*****	*****	*****
CH	21	194	0.007	0.007	0.009	0.011	0.019	0.020
CH	21	217	0.001	0.001	0.001	0.001	0.002	0.005
CH	31	403	0.022	0.022	0.025	0.027	0.028	0.029
CH	35	413	0.045	0.040	0.034	0.029	0.025	0.020
CH	35	771	0.358	0.284	0.285	0.314	0.312	0.278
CH	36	354	0.354	0.340	0.425	0.474	0.597	0.543
CNM	35	1705	0.000	0.458	0.592	0.713	0.000	0.000
CNM	36	1537	0.000	0.033	0.052	0.071	0.092	0.100
CRL	35	112	1.027	1.121	1.126	1.163	1.163	1.054
CRL	35	144	0.556	0.439	0.448	0.422	0.487	0.451
CRL	35	332	1.142	1.121	1.126	1.163	1.163	1.106
CRL	35	342	0.904	1.121	1.126	1.163	1.163	1.106
CRL	35	343	0.461	0.660	0.574	0.577	0.596	0.540
CRL	35	715	0.000	0.000	0.000	0.000	0.135	0.180
CRL	35	732	0.710	0.835	0.725	0.785	0.866	0.526
CRL	35	907	0.232	0.185	0.182	0.180	0.316	0.473
CRL	35	908	0.271	0.279	0.187	0.242	0.241	0.197
CRL	35	1778	0.000	0.000	0.000	0.000	0.754	0.886
CRL	35	1789	0.000	0.000	0.000	1.098	1.163	0.841

Table 9A. (Cont.)

lab.	clock		52304	52329	52364	52394	52424	52454
CRL	35	1790	*****	*****	*****	*****	*****	0.000
DTAG	36	136	0.073	0.075	0.081	0.094	0.114	0.141
DTAG	36	345	0.052	0.073	0.087	0.102	0.107	0.132
DTAG	36	465	0.008	0.012	0.014	0.019	0.024	0.030
F	16	106	*****	*****	*****	*****	*****	*****
F	35	122	0.197	0.183	0.146	0.131	0.090	0.083
F	35	124	0.877	0.870	0.870	0.849	0.811	0.839
F	35	131	0.073	0.068	0.068	0.070	0.086	*****
F	35	158	0.877	0.870	0.870	0.893	0.877	*****
F	35	172	0.476	0.335	0.389	0.469	0.344	0.395
F	35	198	0.117	0.140	0.167	0.275	0.281	0.385
F	35	355	0.877	*****	*****	0.000	0.000	0.000
F	35	385	0.081	0.108	0.109	0.153	0.310	0.437
F	35	396	0.773	0.493	0.420	0.426	0.443	0.558
F	35	469	*****	*****	*****	0.000	0.000	0.000
F	35	489	*****	*****	*****	0.000	0.000	0.000
F	35	536	*****	*****	*****	*****	0.000	0.000
F	35	609	0.000	0.095	0.101	0.082	0.085	0.082
F	35	774	0.233	0.317	0.378	0.458	0.420	0.469
F	35	781	*****	*****	*****	*****	*****	*****
F	35	819	0.187	0.137	0.174	0.184	0.161	0.137
F	35	859	0.057	0.052	0.049	0.048	0.046	0.045
F	35	1177	0.153	0.194	0.219	0.344	0.342	0.350
F	35	1178	0.200	0.201	0.238	0.260	0.252	0.225
F	35	1222	0.723	0.540	0.530	0.542	*****	*****
F	35	1321	0.877	0.870	0.870	0.893	0.877	0.901
F	35	1556	0.503	0.339	0.364	0.471	0.567	0.632
F	40	805	0.006	0.008	0.009	*****	*****	*****
F	40	816	0.015	0.018	0.024	0.046	0.090	*****
IEN	35	219	0.000	0.504	0.601	*****	0.000	0.000
IEN	35	505	*****	*****	0.000	*****	0.000	0.000
IEN	35	1115	0.877	0.831	0.495	*****	0.000	0.000
IEN	35	1373	0.417	0.514	0.361	*****	0.000	0.000
IFAG	36	1034	0.038	0.038	0.032	0.056	0.041	0.036
IFAG	36	1167	0.005	0.005	0.005	0.005	0.005	0.005
IFAG	36	1173	0.021	0.020	0.018	0.019	0.019	0.020
IFAG	36	1629	0.096	0.107	0.091	0.091	0.094	0.114
IFAG	36	1732	*****	*****	*****	*****	*****	*****
IFAG	36	1798	*****	*****	*****	*****	*****	*****
IFAG	40	4401	0.000	0.000	0.000	0.000	0.000	0.000
IFAG	40	4403	0.000	0.000	0.000	0.000	0.000	0.000
IFAG	40	4413	0.000	0.000	0.000	0.000	0.000	0.000
IGMA	14	2403	0.002	0.002	0.001	0.001	0.001	*****
IGMA	16	112	0.007	0.007	0.006	0.006	0.009	0.008
IGMA	35	631	0.111	0.151	0.107	*****	*****	*****

Table 9A. (Cont.)

lab.	clock		52484	52514	52544	52574	52604	52639
CRL	35	1790	0.000	0.000	0.000	0.406	0.583	0.671
DTAG	36	136	0.109	0.131	*****	0.000	0.000	0.000
DTAG	36	345	0.126	0.148	*****	0.000	0.000	0.000
DTAG	36	465	0.032	0.038	*****	0.000	0.000	0.000
F	16	106	*****	*****	*****	0.000	0.000	0.000
F	35	122	0.073	0.090	0.119	0.113	0.130	0.155
F	35	124	0.849	1.059	1.126	1.163	1.163	1.106
F	35	131	*****	*****	0.000	0.000	0.000	0.000
F	35	158	*****	*****	0.000	0.000	0.000	0.000
F	35	172	0.354	0.385	0.522	0.644	1.163	1.106
F	35	198	0.381	0.606	0.604	0.676	0.565	0.491
F	35	355	*****	*****	0.000	0.000	0.000	0.000
F	35	385	0.443	0.413	0.332	0.330	0.285	0.322
F	35	396	0.538	0.746	0.852	0.972	1.134	1.021
F	35	469	0.000	0.514	0.000	0.062	*****	*****
F	35	489	0.000	0.039	0.039	0.037	0.032	0.027
F	35	536	0.000	0.000	0.605	0.851	0.843	0.793
F	35	609	*****	*****	*****	*****	*****	*****
F	35	774	0.389	0.256	0.281	0.277	0.272	0.249
F	35	781	0.000	0.000	0.000	0.000	0.157	0.152
F	35	819	0.125	*****	*****	*****	*****	*****
F	35	859	0.044	0.072	0.148	*****	*****	0.000
F	35	1177	0.259	0.314	0.000	*****	*****	0.000
F	35	1178	0.200	0.195	0.196	*****	*****	0.000
F	35	1222	*****	0.000	0.000	0.000	0.000	0.095
F	35	1321	1.142	1.121	1.126	1.163	1.098	0.930
F	35	1556	0.444	0.453	0.480	*****	*****	*****
F	40	805	*****	*****	*****	*****	*****	*****
F	40	816	*****	*****	*****	*****	*****	0.000
IEN	35	219	0.000	0.000	0.121	0.171	0.215	0.256
IEN	35	505	0.000	0.000	0.003	*****	*****	*****
IEN	35	1115	0.000	0.000	0.167	0.144	0.193	0.219
IEN	35	1373	0.000	0.000	0.179	0.073	0.096	0.108
IFAG	36	1034	0.032	0.029	*****	*****	*****	*****
IFAG	36	1167	0.064	0.065	0.045	0.054	0.052	0.046
IFAG	36	1173	0.018	0.017	0.019	0.024	0.035	0.032
IFAG	36	1629	0.111	0.109	0.122	0.149	0.139	0.148
IFAG	36	1732	*****	*****	0.000	0.000	0.000	0.000
IFAG	36	1798	*****	*****	0.000	0.000	0.000	0.000
IFAG	40	4401	0.000	0.000	0.000	0.000	0.000	0.000
IFAG	40	4403	0.000	0.000	0.000	0.000	0.000	0.000
IFAG	40	4413	0.000	0.000	0.000	0.000	*****	*****
IGMA	14	2403	*****	*****	*****	*****	*****	*****
IGMA	16	112	0.007	0.007	0.008	0.006	0.007	0.006
IGMA	35	631	*****	*****	*****	*****	*****	*****

Table 9A. (Cont.)

lab.	clock		52304	52329	52364	52394	52424	52454
IGMA	35	645	0.058	0.060	0.061	0.074	0.074	0.074
IGMA	35	674	*****	*****	*****	*****	*****	*****
IGMA	35	676	*****	*****	*****	*****	0.000	0.000
INPL	35	1652	0.050	0.057	0.061	0.090	0.103	0.103
KRIS	36	321	0.247	0.248	0.196	0.203	0.205	0.225
KRIS	36	739	0.185	0.139	0.145	0.139	0.134	0.111
KRIS	36	1135	0.041	0.049	0.054	0.065	0.054	0.035
KRIS	40	5623	0.361	0.422	0.322	0.300	0.404	0.856
LDS	35	289	0.250	0.339	0.389	0.468	0.380	0.303
LT	35	1362	0.086	0.103	0.117	0.140	0.165	0.198
MSL	12	933	0.000	0.000	0.000	0.000	0.000	0.010
MSL	35	1025	0.000	0.000	0.000	0.000	0.054	0.039
MSL	36	274	0.000	0.000	0.000	0.000	0.025	0.036
NAO	35	779	0.581	*****	*****	*****	0.000	*****
NAO	35	1206	0.539	0.492	0.486	0.764	0.686	*****
NAO	35	1214	0.825	0.643	0.737	0.738	0.743	*****
NAO	35	1689	0.877	0.870	0.870	0.893	0.877	*****
NIM	35	479	0.042	0.035	0.028	0.024	0.024	0.025
NIM	35	1238	0.157	0.173	0.173	0.124	0.137	0.137
NIM	35	1239	0.044	0.041	0.037	0.030	0.031	0.030
NIMB	35	600	*****	*****	*****	*****	*****	*****
NIST	35	132	0.395	0.435	0.419	0.549	0.657	0.786
NIST	35	182	0.877	0.870	0.870	0.893	0.877	0.901
NIST	35	408	0.557	0.451	0.465	0.533	0.630	0.753
NIST	35	1074	0.877	0.870	0.870	0.893	0.877	0.901
NIST	40	201	0.062	0.066	0.052	0.041	0.029	0.020
NIST	40	203	0.027	0.027	0.025	0.025	0.024	0.023
NIST	40	204	0.182	0.185	0.173	0.177	0.174	0.181
NIST	40	205	0.289	0.292	0.258	0.362	0.407	0.425
NIST	40	222	*****	0.000	0.000	0.000	0.000	0.901
NMC	35	1501	0.194	0.223	0.188	0.183	0.206	0.000
NMIJ	35	224	0.877	0.870	0.870	0.893	0.877	0.901
NMIJ	35	459	*****	*****	*****	*****	*****	*****
NMIJ	35	523	0.877	0.870	0.870	0.893	0.877	0.856
NMIJ	35	1273	0.447	0.637	0.870	0.893	0.877	0.852
NMLS	35	1659	*****	*****	0.000	0.000	0.000	0.000
NPL	35	784	0.877	0.870	0.870	0.841	0.877	0.901
NPL	35	1275	0.250	0.276	0.212	0.215	0.213	0.319
NPL	36	404	0.156	0.221	0.260	0.351	0.433	0.326
NPL	40	1701	0.877	0.870	0.852	0.659	0.531	0.471
NPL	40	1708	0.877	0.870	0.870	0.893	0.877	0.901
NPLI	35	725	0.000	0.000	0.000	0.437	0.594	0.833
NRC	35	234	0.877	0.000	0.435	0.544	0.613	0.566
NRC	35	372	*****	*****	*****	*****	*****	*****
NRC	40	304	0.679	0.000	0.146	0.102	0.082	0.078

Table 9A. (Cont.)

lab.	clock		52484	52514	52544	52574	52604	52639
IGMA	35	645	*****	*****	*****	*****	*****	*****
IGMA	35	674	*****	0.000	0.000	0.000	0.000	0.150
IGMA	35	676	0.000	0.000	0.146	0.167	0.195	0.210
INPL	35	1652	0.084	0.086	0.116	0.106	0.102	0.126
KRIS	36	321	0.199	0.184	*****	0.000	0.000	0.000
KRIS	36	739	0.143	0.154	*****	0.000	0.000	0.000
KRIS	36	1135	0.023	0.024	*****	0.000	0.000	0.000
KRIS	40	5623	0.622	0.483	*****	0.000	0.000	0.000
LDS	35	289	0.294	0.248	0.236	0.214	0.160	0.144
LT	35	1362	0.202	0.218	0.248	0.220	0.210	0.217
MSL	12	933	0.008	0.005	0.007	0.008	0.009	0.009
MSL	35	1025	0.039	0.046	0.046	0.000	0.011	0.009
MSL	36	274	0.030	0.039	0.048	0.051	0.060	0.059
NAO	35	779	*****	0.000	0.000	0.000	0.000	0.104
NAO	35	1206	*****	0.000	0.000	0.000	0.000	0.342
NAO	35	1214	*****	0.000	0.000	0.000	0.000	0.156
NAO	35	1689	*****	0.000	0.000	0.000	0.000	0.316
NIM	35	479	0.025	0.036	0.092	0.227	*****	*****
NIM	35	1238	0.130	0.154	0.231	0.233	*****	*****
NIM	35	1239	0.029	0.041	0.087	0.145	*****	*****
NIMB	35	600	*****	*****	*****	*****	0.000	0.000
NIST	35	132	0.697	0.914	0.923	1.163	1.064	0.958
NIST	35	182	1.117	1.094	*****	*****	*****	0.000
NIST	35	408	0.562	0.647	0.556	0.545	0.518	0.468
NIST	35	1074	1.142	1.121	1.126	0.000	0.000	0.164
NIST	40	201	0.012	0.010	0.010	0.010	0.010	0.009
NIST	40	203	0.022	0.022	0.022	0.021	0.021	0.018
NIST	40	204	0.168	0.203	0.278	0.304	0.356	0.363
NIST	40	205	0.369	0.387	0.408	0.428	0.403	0.349
NIST	40	222	1.142	1.121	1.126	1.163	1.163	1.106
NMC	35	1501	0.063	0.055	0.057	0.060	0.081	0.075
NMIJ	35	224	1.142	0.000	*****	0.000	0.000	0.000
NMIJ	35	459	*****	*****	*****	0.000	0.000	0.000
NMIJ	35	523	0.968	0.000	*****	*****	*****	*****
NMIJ	35	1273	0.822	0.992	*****	0.000	0.000	0.000
NMLS	35	1659	0.562	0.000	0.061	0.075	0.080	0.080
NPL	35	784	0.819	0.670	0.766	0.641	0.646	0.486
NPL	35	1275	0.409	0.361	0.322	0.341	0.359	0.269
NPL	36	404	0.295	0.296	0.303	0.000	0.073	0.044
NPL	40	1701	0.389	0.360	0.476	0.546	0.749	0.970
NPL	40	1708	1.142	1.121	1.117	1.110	0.709	0.627
NPLI	35	725	0.358	0.320	0.255	0.284	*****	*****
NRC	35	234	0.495	0.582	0.614	0.795	0.805	0.814
NRC	35	372	*****	*****	*****	0.000	0.000	0.000
NRC	40	304	0.078	0.085	0.096	*****	*****	*****

Table 9A. (Cont.)

lab.	clock		52304	52329	52364	52394	52424	52454
NRC	90	61	0.595	0.683	0.573	0.590	0.449	0.356
NTSC	35	1007	0.279	0.335	0.400	0.456	0.664	0.892
NTSC	35	1008	0.463	0.870	0.870	0.893	0.877	0.631
NTSC	35	1011	0.151	0.229	0.220	0.252	0.252	0.317
NTSC	35	1016	0.481	0.675	0.577	0.563	0.589	0.587
NTSC	35	1017	0.632	0.566	0.507	0.682	0.546	0.503
NTSC	35	1018	0.877	0.870	0.870	0.000	0.673	0.665
OMH	36	849	0.315	0.485	0.368	0.381	0.375	0.370
ONRJ	35	903	0.607	0.870	0.870	0.000	0.629	0.575
ORB	35	201	0.293	0.266	*****	0.000	0.000	0.000
ORB	35	202	0.087	0.081	0.063	0.058	0.060	0.055
ORB	35	593	0.318	0.372	0.223	0.143	0.110	0.110
ORB	40	2601	0.016	0.019	0.020	0.027	0.033	0.040
PL	18	746	*****	0.000	0.000	0.000	*****	*****
PL	35	441	0.000	0.000	0.000	0.000	0.212	0.221
PL	35	502	0.086	0.071	0.052	0.043	0.037	0.034
PL	35	761	0.065	0.050	0.038	0.056	0.064	0.088
PL	35	1120	0.877	0.870	0.870	0.829	0.858	0.901
PL	35	1660	0.087	0.101	0.122	0.162	0.202	0.251
PL	35	1746	*****	*****	*****	*****	0.000	0.000
PL	36	1395	*****	*****	0.000	0.000	0.000	0.000
PTB	35	128	0.734	0.870	0.870	0.000	0.331	0.233
PTB	35	415	0.672	0.400	0.434	0.456	0.439	0.314
PTB	35	1072	0.267	0.329	0.302	0.355	0.446	0.524
PTB	40	502	*****	*****	*****	*****	*****	*****
PTB	40	505	0.000	0.000	0.000	0.000	0.388	0.483
PTB	40	510	*****	0.000	0.000	0.000	0.000	0.039
PTB	40	537	0.000	0.000	0.000	*****	*****	*****
PTB	92	1	0.877	0.870	0.870	0.893	0.877	0.901
PTB	92	2	0.877	0.870	0.870	0.893	0.877	0.901
PTB	92	3	0.254	0.342	0.363	0.435	0.482	0.577
ROA	14	1569	0.003	0.003	*****	*****	0.000	0.000
ROA	35	583	*****	*****	*****	*****	0.000	0.000
ROA	35	718	*****	*****	*****	*****	*****	*****
ROA	36	1488	0.296	0.277	*****	*****	0.000	0.000
ROA	36	1490	0.104	0.117	*****	*****	0.000	0.000
SCL	35	621	0.877	0.829	0.870	0.000	0.376	0.360
SCL	35	745	*****	0.000	0.000	0.000	0.000	0.013
SG	35	1035	0.097	0.102	0.135	0.262	0.877	0.664
SG	35	1127	0.389	0.522	0.584	0.613	0.706	0.817
SG	36	522	0.031	0.040	0.038	0.048	0.059	0.062
SMU	36	1063	0.000	0.000	0.133	0.178	0.177	0.210
SP	16	137	0.000	0.000	0.000	0.000	0.000	0.000
SP	19	197	*****	*****	*****	*****	*****	*****
SP	35	641	0.877	0.870	0.000	*****	*****	*****

Table 9A. (Cont.)

lab.	clock		52484	52514	52544	52574	52604	52639
NRC	90	61	0.341	0.322	0.478	0.525	0.402	0.474
NTSC	35	1007	0.692	0.753	0.906	0.655	0.636	0.768
NTSC	35	1008	0.429	0.441	0.324	0.392	0.330	0.322
NTSC	35	1011	0.373	0.865	1.120	0.985	1.100	1.044
NTSC	35	1016	0.421	0.430	0.454	0.395	0.396	0.415
NTSC	35	1017	0.501	0.674	0.959	0.829	0.000	0.298
NTSC	35	1018	0.419	0.475	0.437	0.389	0.466	0.405
OMH	36	849	0.000	0.127	0.136	0.134	0.136	0.101
ONRJ	35	903	0.302	0.274	0.235	0.222	0.214	0.199
ORB	35	201	0.000	0.042	0.067	0.090	0.097	0.093
ORB	35	202	0.047	0.043	0.045	0.043	0.052	0.064
ORB	35	593	0.095	0.094	0.099	0.104	0.104	0.115
ORB	40	2601	0.040	0.047	0.101	0.000	0.050	0.040
PL	18	746	*****	*****	*****	*****	*****	*****
PL	35	441	0.226	0.239	0.264	0.277	0.265	0.240
PL	35	502	0.026	0.026	0.031	*****	*****	*****
PL	35	761	0.078	0.098	0.104	0.136	0.135	0.125
PL	35	1120	0.730	1.121	1.126	1.163	0.000	0.523
PL	35	1660	0.210	0.168	0.131	0.118	0.117	0.113
PL	35	1746	0.000	0.000	0.350	0.234	0.167	0.190
PL	36	1395	0.118	0.177	0.257	*****	*****	*****
PTB	35	128	0.164	0.180	0.248	0.242	0.274	0.269
PTB	35	415	0.212	0.225	0.204	0.123	0.086	0.076
PTB	35	1072	0.543	0.552	0.562	1.163	1.163	1.106
PTB	40	502	0.000	0.000	0.000	0.000	0.013	0.011
PTB	40	505	0.261	0.161	0.122	0.107	0.102	0.078
PTB	40	510	0.039	0.037	0.033	0.028	0.000	0.012
PTB	40	537	*****	*****	*****	*****	*****	*****
PTB	92	1	1.002	0.993	1.126	1.163	1.163	1.106
PTB	92	2	1.142	1.121	1.126	1.163	1.163	1.106
PTB	92	3	0.556	0.562	0.628	0.837	1.163	1.076
ROA	14	1569	0.000	0.000	0.001	0.001	0.001	0.001
ROA	35	583	0.000	0.000	0.270	0.301	0.375	0.384
ROA	35	718	0.000	0.000	0.000	0.000	0.074	0.069
ROA	36	1488	0.000	0.000	0.028	0.035	0.043	0.050
ROA	36	1490	0.000	0.000	0.055	0.081	0.081	0.070
SCL	35	621	0.331	0.349	0.444	0.606	0.750	0.747
SCL	35	745	0.016	0.023	0.031	0.035	0.042	0.042
SG	35	1035	0.663	0.717	0.890	1.163	0.787	0.787
SG	35	1127	1.095	1.072	1.126	1.121	0.736	0.660
SG	36	522	0.205	0.206	0.290	0.365	0.346	0.355
SMU	36	1063	0.231	0.288	0.266	0.311	0.393	0.442
SP	16	137	0.000	0.000	0.000	0.000	0.000	0.000
SP	19	197	*****	0.000	0.000	0.000	0.000	0.006
SP	35	641	0.000	0.000	0.000	0.000	0.010	0.009

Table 9A. (Cont.)

lab.	clock		52304	52329	52364	52394	52424	52454
SP	35	1188	0.314	0.265	0.136	0.143	0.141	0.164
SP	35	1642	0.877	0.870	0.870	0.880	0.877	0.901
SP	36	1175	0.383	0.356	0.322	0.387	0.393	0.430
SP	40	7218	*****	*****	*****	*****	*****	*****
SP	40	7299	*****	*****	*****	*****	*****	*****
SU	40	3802	0.202	0.159	0.139	0.127	0.113	0.103
SU	40	3803	0.416	0.135	*****	*****	*****	*****
SU	40	3805	0.025	0.023	0.019	0.019	0.018	0.017
SU	40	3807	0.539	0.477	0.443	0.318	*****	*****
SU	40	3810	0.008	0.007	0.007	0.008	0.008	0.008
SU	40	3825	0.000	*****	*****	*****	*****	*****
SU	40	3827	*****	*****	*****	*****	*****	*****
SU	40	3831	*****	*****	*****	*****	*****	*****
SU	40	3837	0.000	0.000	0.140	0.122	0.110	0.104
TCC	35	1028	*****	*****	*****	*****	*****	*****
TCC	40	8620	*****	*****	*****	*****	*****	*****
TCC	40	8624	*****	*****	*****	*****	*****	*****
TL	35	160	0.256	0.186	0.229	0.251	0.319	0.388
TL	35	300	0.077	0.113	0.121	0.159	0.168	0.209
TL	35	474	*****	*****	*****	*****	*****	*****
TL	35	809	0.877	0.822	0.870	0.893	0.877	0.901
TL	35	1012	0.112	0.085	0.079	0.074	0.066	0.055
TL	35	1498	0.676	0.690	0.657	0.893	0.877	0.833
TL	35	1500	0.003	0.003	0.002	0.003	0.003	0.003
TL	35	1712	*****	*****	*****	*****	*****	*****
TL	40	3052	*****	*****	*****	*****	*****	0.000
TL	40	3053	0.004	0.006	0.006	0.007	0.008	0.009
TP	35	163	0.000	0.370	0.440	0.230	0.108	0.088
TP	35	1227	0.554	0.745	0.667	0.782	0.745	0.859
TP	36	154	0.142	0.139	0.128	0.134	0.151	0.158
TP	36	326	0.403	0.387	0.327	0.301	0.307	0.377
UME	35	251	0.581	0.549	0.517	0.486	0.604	0.546
UME	35	252	0.353	0.529	0.618	0.838	0.877	0.901
UME	35	872	0.507	0.278	0.315	0.399	0.357	0.447
USNO	35	101	0.240	0.286	0.317	0.397	0.458	0.901
USNO	35	104	0.877	0.870	0.870	0.893	0.877	0.901
USNO	35	106	0.877	0.870	0.870	0.893	0.877	0.901
USNO	35	108	0.667	0.706	0.492	0.520	0.877	0.889
USNO	35	114	0.554	0.637	0.633	0.469	0.000	0.000
USNO	35	120	0.877	0.870	0.870	0.884	0.877	0.901
USNO	35	142	0.877	0.870	0.870	0.803	0.653	0.804
USNO	35	146	0.737	0.870	0.870	0.893	0.877	0.901
USNO	35	148	0.877	0.870	0.870	0.893	0.877	0.635
USNO	35	150	0.153	0.193	0.220	0.320	0.313	0.307
USNO	35	152	0.277	0.870	0.822	0.796	0.736	0.901

Table 9A. (Cont.)

lab.	clock		52484	52514	52544	52574	52604	52639
SP	35	1188	0.166	0.172	0.182	0.183	0.110	0.066
SP	35	1642	0.866	0.000	0.338	0.327	0.303	0.267
SP	36	1175	0.455	0.296	0.262	0.269	0.218	0.196
SP	40	7218	*****	*****	*****	0.000	*****	*****
SP	40	7299	*****	0.000	*****	*****	*****	*****
SU	40	3802	0.080	0.074	0.080	0.076	0.084	0.077
SU	40	3803	*****	*****	*****	*****	*****	0.000
SU	40	3805	0.014	0.013	0.015	0.016	0.017	0.016
SU	40	3807	*****	*****	*****	*****	*****	*****
SU	40	3810	0.007	0.007	0.008	0.009	0.009	0.008
SU	40	3825	0.000	0.000	0.000	0.000	0.034	0.013
SU	40	3827	*****	0.000	0.000	0.000	0.000	0.779
SU	40	3831	*****	0.000	0.000	0.000	0.000	0.044
SU	40	3837	0.082	0.078	0.079	0.071	0.074	0.066
TCC	35	1028	*****	*****	*****	*****	*****	0.000
TCC	40	8620	*****	*****	*****	*****	*****	0.000
TCC	40	8624	*****	*****	*****	*****	*****	0.000
TL	35	160	0.374	0.449	0.552	0.452	0.000	0.107
TL	35	300	0.218	0.262	0.411	0.979	0.844	0.633
TL	35	474	*****	*****	*****	*****	*****	0.000
TL	35	809	0.000	0.000	0.154	0.122	*****	*****
TL	35	1012	0.040	0.038	0.039	0.035	0.035	0.036
TL	35	1498	0.435	0.326	0.346	0.329	0.328	0.275
TL	35	1500	0.003	0.003	0.416	0.278	0.278	0.272
TL	35	1712	0.000	0.000	0.000	0.000	0.989	1.106
TL	40	3052	0.000	0.000	0.000	0.016	0.013	0.010
TL	40	3053	0.008	0.009	0.009	0.021	0.018	*****
TP	35	163	0.059	0.058	0.061	0.053	0.049	0.048
TP	35	1227	0.759	0.914	0.993	1.053	0.992	0.910
TP	36	154	0.188	0.188	0.200	0.219	0.248	0.225
TP	36	326	0.328	0.289	0.262	0.253	*****	*****
UME	35	251	0.557	0.381	0.369	*****	*****	*****
UME	35	252	0.959	0.918	0.878	0.799	0.797	0.948
UME	35	872	0.446	0.445	0.357	0.279	0.190	0.158
USNO	35	101	1.142	1.121	1.126	1.163	1.163	1.106
USNO	35	104	1.142	1.121	1.126	1.163	1.163	0.895
USNO	35	106	1.142	1.121	1.126	1.057	0.896	0.434
USNO	35	108	0.878	1.100	1.126	0.792	0.742	0.650
USNO	35	114	0.000	0.030	0.023	0.017	*****	*****
USNO	35	120	0.785	0.996	0.000	0.641	0.631	0.570
USNO	35	142	0.678	0.803	0.768	0.756	0.832	0.754
USNO	35	146	1.142	1.121	1.126	1.163	1.163	1.106
USNO	35	148	0.371	0.500	0.415	0.321	0.315	0.296
USNO	35	150	0.271	0.272	0.318	0.328	0.503	0.789
USNO	35	152	0.773	0.746	0.662	0.493	0.674	0.574

Table 9A. (Cont.)

lab.	clock		52304	52329	52364	52394	52424	52454
USNO	35	153	0.861	0.605	0.694	0.820	0.658	0.500
USNO	35	156	0.877	0.870	0.870	0.893	0.877	0.901
USNO	35	161	0.877	0.870	0.870	0.893	0.877	0.901
USNO	35	164	0.488	0.524	0.382	0.478	0.515	0.564
USNO	35	165	0.467	0.573	0.515	0.401	0.479	0.391
USNO	35	166	0.850	0.669	0.675	0.893	0.877	0.840
USNO	35	167	0.836	0.804	0.694	0.718	0.773	0.729
USNO	35	169	0.651	0.769	0.694	0.637	0.875	0.762
USNO	35	171	0.499	0.541	0.770	0.893	0.877	*****
USNO	35	173	0.877	0.870	0.870	0.893	0.877	0.901
USNO	35	213	0.489	0.515	0.367	0.313	0.253	0.270
USNO	35	217	0.475	0.587	0.634	0.800	0.877	0.901
USNO	35	225	0.877	0.870	0.870	0.893	0.000	0.229
USNO	35	226	0.877	0.870	0.870	0.893	0.708	0.714
USNO	35	227	0.636	0.742	0.767	0.697	0.600	0.712
USNO	35	229	0.120	0.133	0.140	0.184	0.204	0.164
USNO	35	231	0.000	0.000	0.130	0.127	0.118	0.136
USNO	35	233	0.877	0.870	0.870	0.893	0.877	0.901
USNO	35	242	0.248	0.267	0.267	0.222	0.277	0.383
USNO	35	244	0.877	0.870	0.870	0.893	0.877	0.901
USNO	35	249	0.209	0.219	0.217	0.282	0.341	0.309
USNO	35	253	0.877	0.710	0.710	0.719	0.500	0.474
USNO	35	254	0.877	0.870	0.870	0.893	0.877	0.901
USNO	35	255	0.469	0.766	0.858	0.893	0.789	0.901
USNO	35	256	0.877	0.870	0.771	0.893	0.798	0.786
USNO	35	260	0.877	0.870	0.870	0.647	0.656	0.816
USNO	35	268	0.592	0.584	0.511	0.562	0.543	0.517
USNO	35	270	0.877	0.870	0.870	0.893	0.877	0.901
USNO	35	279	0.773	0.845	0.675	0.700	0.520	0.485
USNO	35	389	0.000	0.033	0.031	0.038	0.040	0.045
USNO	35	392	0.877	0.000	0.508	0.492	0.424	0.402
USNO	35	394	0.204	0.274	0.304	0.365	0.392	0.468
USNO	35	416	0.330	0.375	0.468	0.630	0.698	0.873
USNO	35	417	0.000	0.046	0.053	0.076	0.100	0.127
USNO	35	703	0.000	0.385	*****	*****	*****	0.000
USNO	35	717	0.464	0.567	0.815	0.893	0.877	0.901
USNO	35	762	0.000	0.423	0.360	0.332	0.297	0.328
USNO	35	763	0.877	0.870	0.870	0.893	0.877	0.901
USNO	35	765	0.027	0.032	0.034	0.041	0.047	0.119
USNO	35	1096	0.136	0.160	0.171	0.148	0.165	0.177
USNO	35	1097	0.877	0.870	0.842	0.893	0.614	0.654
USNO	35	1125	0.877	0.870	0.870	0.893	0.877	0.901
USNO	35	1327	0.000	0.083	0.062	0.064	0.062	0.068
USNO	35	1328	0.580	0.606	0.596	0.658	0.877	0.901
USNO	35	1331	0.773	0.870	0.870	0.893	0.877	0.901

Table 9A. (Cont.)

lab.	clock		52484	52514	52544	52574	52604	52639
USNO	35	153	0.420	0.524	0.579	0.592	0.751	0.604
USNO	35	156	0.692	0.644	0.789	0.643	0.686	0.565
USNO	35	161	1.142	1.121	1.126	1.163	1.163	1.106
USNO	35	164	0.572	0.777	1.126	0.000	0.552	0.357
USNO	35	165	0.367	0.369	0.332	0.485	0.699	0.697
USNO	35	166	0.696	0.608	0.378	0.304	0.260	0.193
USNO	35	167	0.601	0.605	0.545	0.518	0.477	1.033
USNO	35	169	0.903	0.860	0.579	0.687	0.783	0.658
USNO	35	171	*****	*****	*****	0.000	0.000	0.000
USNO	35	173	1.142	1.121	1.126	1.163	1.163	1.106
USNO	35	213	0.210	0.230	0.197	0.205	0.184	0.166
USNO	35	217	1.142	1.121	0.962	1.083	1.029	1.106
USNO	35	225	0.156	0.131	0.148	0.140	0.145	0.145
USNO	35	226	0.610	0.615	0.895	1.160	1.127	1.106
USNO	35	227	0.693	0.829	0.693	0.749	0.849	0.670
USNO	35	229	0.137	0.171	0.148	0.146	0.128	0.125
USNO	35	231	0.135	0.165	0.202	0.238	0.294	0.494
USNO	35	233	1.142	1.121	1.126	1.163	1.163	1.106
USNO	35	242	0.433	0.409	0.397	0.455	0.408	0.349
USNO	35	244	0.878	0.819	1.126	0.719	0.740	0.517
USNO	35	249	0.276	0.319	0.000	0.000	0.194	0.193
USNO	35	253	0.574	0.494	0.000	0.000	0.070	0.067
USNO	35	254	1.142	1.121	0.000	0.482	0.443	0.414
USNO	35	255	0.760	0.768	0.917	1.163	1.163	1.106
USNO	35	256	0.515	0.275	0.263	0.288	0.184	0.172
USNO	35	260	0.758	0.722	0.761	0.757	0.739	0.634
USNO	35	268	0.511	0.421	0.431	0.349	0.382	0.383
USNO	35	270	1.142	1.121	1.126	1.163	0.000	0.720
USNO	35	279	0.579	0.944	0.652	0.647	0.590	0.540
USNO	35	389	0.044	0.052	0.061	0.076	0.130	0.543
USNO	35	392	0.345	0.385	0.452	0.514	0.697	1.106
USNO	35	394	0.476	0.471	0.934	0.842	0.750	0.678
USNO	35	416	0.891	1.071	1.126	1.163	1.163	1.106
USNO	35	417	0.130	0.138	0.165	0.247	0.607	1.095
USNO	35	703	0.000	0.000	0.000	0.032	0.028	0.026
USNO	35	717	0.939	1.121	*****	*****	*****	0.000
USNO	35	762	0.289	0.288	0.312	0.416	0.574	0.608
USNO	35	763	1.142	1.121	1.126	1.163	1.163	1.106
USNO	35	765	0.191	0.548	0.746	0.637	0.524	0.367
USNO	35	1096	0.127	0.147	0.228	0.273	0.269	0.276
USNO	35	1097	0.794	0.608	0.659	0.474	0.450	0.408
USNO	35	1125	1.142	0.900	1.126	1.163	1.163	1.106
USNO	35	1327	0.071	0.084	0.108	0.148	0.277	0.703
USNO	35	1328	1.142	0.000	0.737	0.697	0.774	0.663
USNO	35	1331	0.741	0.856	0.978	0.951	0.844	0.863

Table 9A. (Cont.)

lab.	clock	52304	52329	52364	52394	52424	52454
USNO	35 1438	0.487	0.574	0.617	0.798	0.877	0.901
USNO	35 1459	0.877	0.870	0.870	0.893	0.877	0.901
USNO	35 1462	0.836	0.694	0.580	0.572	0.000	0.388
USNO	35 1463	0.877	0.870	0.870	0.893	0.877	0.901
USNO	35 1468	*****	*****	*****	*****	0.000	0.000
USNO	35 1481	0.877	0.870	0.870	0.893	0.877	0.738
USNO	35 1543	0.778	0.870	0.835	0.880	0.803	0.846
USNO	35 1573	*****	*****	0.000	0.000	0.000	0.000
USNO	35 1575	0.877	0.870	0.762	0.686	0.877	0.704
USNO	35 1655	0.000	0.160	0.180	0.245	0.295	0.320
USNO	35 1692	0.429	0.494	0.303	0.240	0.230	0.164
USNO	35 1694	0.249	0.320	0.357	0.458	0.548	0.901
USNO	35 1696	0.084	0.085	0.075	0.085	0.085	0.132
USNO	35 1697	0.877	0.852	0.870	0.830	0.877	0.901
USNO	35 1698	0.877	0.870	0.870	0.893	0.877	0.901
USNO	40 701	0.677	0.786	0.646	0.606	0.564	0.533
USNO	40 702	0.877	0.870	0.870	0.893	0.877	0.901
USNO	40 703	0.877	0.839	0.742	0.676	0.629	0.571
USNO	40 704	0.000	0.000	0.870	0.893	0.877	0.901
USNO	40 705	0.000	0.000	0.870	0.871	0.671	0.557
USNO	40 708	0.191	0.185	0.166	0.179	0.174	0.166
USNO	40 709	0.000	0.000	0.870	0.893	0.877	0.901
USNO	40 710	0.106	0.099	0.118	0.114	0.105	0.094
USNO	40 711	0.008	0.008	0.007	0.008	0.007	0.007
USNO	40 712	0.877	0.870	0.870	0.893	0.877	0.901
USNO	40 713	0.597	0.612	0.571	0.588	0.601	0.609
USNO	40 714	0.877	0.870	0.870	0.893	0.851	0.758
USNO	40 715	0.877	0.870	0.870	0.893	0.877	0.870
USNO	40 716	0.004	0.004	0.004	0.005	0.005	0.006
USNO	40 718	0.007	0.007	0.006	0.007	0.008	0.009
USNO	40 719	*****	*****	*****	*****	*****	*****
VSL	35 179	0.200	0.189	0.206	0.208	0.202	0.192
VSL	35 456	0.791	0.870	0.842	0.737	0.631	0.000
VSL	35 548	0.294	0.383	0.315	0.379	0.443	0.587
VSL	35 731	0.535	0.444	0.396	*****	*****	*****

Table 9A. (Cont.)

lab.	clock	52484	52514	52544	52574	52604	52639
USNO	35 1438	0.964	1.121	1.126	1.163	1.163	1.106
USNO	35 1459	1.142	1.121	1.126	0.760	0.491	0.428
USNO	35 1462	0.309	0.369	0.616	0.945	0.994	0.617
USNO	35 1463	0.907	0.992	0.000	0.292	0.254	0.223
USNO	35 1468	0.000	0.000	0.548	0.808	0.874	0.984
USNO	35 1481	0.489	0.487	0.438	0.426	0.366	0.381
USNO	35 1543	0.584	0.777	0.931	0.919	1.163	1.106
USNO	35 1573	0.444	0.592	0.717	0.595	0.739	0.791
USNO	35 1575	0.669	0.467	0.493	0.516	0.400	0.363
USNO	35 1655	0.336	0.411	0.488	0.485	0.445	0.365
USNO	35 1692	0.114	0.112	0.105	0.133	0.140	0.121
USNO	35 1694	0.767	0.747	0.790	0.835	0.820	0.646
USNO	35 1696	0.140	0.173	0.197	0.203	0.276	0.353
USNO	35 1697	1.142	1.121	1.126	*****	0.000	0.000
USNO	35 1698	1.142	1.087	1.126	1.163	1.150	1.032
USNO	40 701	0.489	0.891	1.126	1.163	1.163	1.106
USNO	40 702	1.142	1.121	1.126	1.163	1.163	1.106
USNO	40 703	0.486	0.523	0.667	0.937	1.163	1.106
USNO	40 704	1.094	1.013	1.037	0.856	0.840	0.744
USNO	40 705	0.428	0.387	0.356	0.324	0.291	0.250
USNO	40 708	0.145	0.146	0.157	0.153	0.158	0.149
USNO	40 709	1.087	0.829	0.759	0.000	0.329	0.166
USNO	40 710	0.075	0.070	0.070	0.064	0.060	0.051
USNO	40 711	0.006	0.006	0.006	0.006	0.006	0.005
USNO	40 712	1.142	1.121	1.126	1.163	1.163	1.106
USNO	40 713	0.523	0.529	0.539	0.567	0.623	0.573
USNO	40 714	0.596	0.580	0.736	0.798	0.890	0.843
USNO	40 715	0.765	0.808	0.935	0.930	1.065	0.953
USNO	40 716	0.007	0.011	0.016	0.023	0.033	0.050
USNO	40 718	0.009	0.010	0.013	0.015	0.017	0.018
USNO	40 719	*****	*****	*****	*****	0.000	0.000
VSL	35 179	0.323	0.453	0.517	0.594	0.824	0.658
VSL	35 456	0.214	0.137	0.153	*****	*****	*****
VSL	35 548	1.102	1.013	1.049	1.163	1.163	1.068
VSL	35 731	0.000	0.000	0.000	0.000	0.255	0.343

The clocks are designated by their type (2 digits) and serial number in the type. The codes for the types are:

12 HEWLETT-PACKARD 5061A
13 EBAUCHES, OSCILLATOM B5000
14 HEWLETT-PACKARD 5061A OPT. 4
16 OSCILLOQUARTZ 3200
17 OSCILLOQUARTZ 3000
15 DATUM/SYMMETRICOM Cs III
4x HYDROGEN MASERS
9x PRIMARY CLOCKS AND PROTOTYPES
21 OSCILLOQUARTZ 3210
23 OSCILLOQUARTZ EUDICS 3020
30 HEWLETT-PACKARD 5061B
31 HEWLETT-PACKARD 5061B OPT. 4
34 H-P 5061A/B with 5071A tube
35 AGILENT 5071A High perf.
36 AGILENT 5071A Low perf.
50 FREQ. AND TIME SYSTEMS INC. 4065A

Table 9B. Statistical data on the weights attributed to the clocks in 2002

Interval	Number of clocks			Number of clock with a given weight									maximum
				0* weight			0** weight			maximum weight			relative
2002	HM	5071A	total	HM	5071A	total	HM	5071A	total	HM	5071A	total	weight
Jan.	41	168	250	8	11	22	3	4	8	7	47	56	0.877
Feb.	41	166	248	8	6	18	4	1	10	6	47	55	0.870
Mar.	40	167	246	4	8	16	3	1	6	8	45	55	0.870
Apr.	40	164	245	5	10	21	3	4	9	7	40	49	0.893
May	39	174	256	4	18	28	3	5	12	6	47	55	0.877
June	39	171	252	3	20	30	3	3	8	6	38	46	0.901
July	40	173	253	5	23	34	3	2	7	4	20	25	1.142
Aug.	42	177	260	6	26	37	3	6	11	4	21	26	1.121
Sep.	41	176	253	6	20	31	3	7	11	4	26	32	1.126
Oct.	42	174	260	7	24	45	5	5	12	4	23	29	1.163
Nov.	41	169	253	5	19	38	3	6	10	5	20	28	1.163
Dec.	45	174	261	8	17	35	2	1	5	5	20	27	1.106

* A priori null weight (test interval of new clocks).
** Null weight resulting from the statistics.
HM designates hydrogen masers and 5071A designates Hewlett-Packard 5071A units with high performance tube.
Clocks with missing data during a one-month interval of computation are excluded.

TIME SIGNALS

The time signal emissions reported here follow the UTC system, in accordance with the Recommendation 460-4 of the Radiocommunication Bureau (RB) of the International Telecommunication Union (ITU) unless otherwise stated.

Their maximum departure from the Universal Time UT1 is thus 0.9 second.

The following tables are based on information received at the BIPM in February and March 2003.

AUTHORITIES RESPONSIBLE FOR THE TIME SIGNAL EMISSIONS

Signal	Authority
ATA	National Physical Laboratory Dr. K.S. Krishnan Road New Delhi - 110012, India
BPM	Time and Frequency Division National Time Service Center, NTSC (Formely Shaanxi Astronomical Observatory, CSAO) Chinese Academy of Sciences P.O. Box 18 - Lintong Shaanxi 710600, China
BSF	National Standard Time and Frequency Laboratory Telecommunication Laboratories Chunghwa Telecom. Co., Ltd. No. 12, Ln.551, Ming-Tsu Road Sec. 5 Yang-Mei, Taoyuan, 326 Taiwan, Rep. of China
CHU	National Research Council of Canada Institute for National Measurement Standards – Frequency and Time Standards Ottawa, Ontario, K1A 0R6, Canada
DCF77	Physikalisch-Technische Bundesanstalt Time Unit Section (4.32) Bundesallee 100 D-38116 Braunschweig Germany
EBC	Real Instituto y Observatorio de la Armada Cecilio Pujazón s/n 11.110 San Fernando Cádiz, Spain
HBG	METAS METrology and Accreditation Switzerland Electricity, Acoustic and Time Section Lindenweg 50 CH-3003 Bern-Wabern Switzerland

Signal	Authority
HLA	Time and Frequency Laboratory Korea Research Institute of Standards and Science Yusong P.O. Box 102, Taejon 305-600 Republic of Korea
IAM	Istituto Superiore delle Comunicazioni e delle Tecnologie dell'Informazione Viale America, 201 00144 - Roma, Italia
JJY	Japan Standard Time Group Communications Research Laboratory 2-1, Nukui-kitamachi 4-chome Koganei-shi, Tokyo 184-8795 Japan
LDS	School of Electronic and Electrical Engineering Leeds University Leeds LS2 9JT United Kingdom
LOL	Servicio de Hidrografía Naval Observatorio Naval Buenos Aires Av. España 2099 C1107AMA – Buenos Aires, Argentina
MSF	National Physical Laboratory Centre for Electromagnetic and Time Metrology Teddington, Middlesex TW11 0LW United Kingdom
RAB-99, RBU, RJH-63, RJH-69, RJH-77, RJH-86, RJH-90,RTZ,RWM,	Institute of Metrology for Time and Space (IMVP), GP "VNIIFTRI" Mendeleevo, Moscow Region 141570 Russia
TDF	FT R et D France Telecom Recherche et Développement Laboratoire RTA/D2M Technopole ANTICIPA 2, avenue Pierre Marzin 22307 - Lannion Cedex, France

Signal	Authority
VNG	National Standards Commission P.O. Box 282 North Ryde NSW 1670 Australia
WWV, WWVB, WWVH	Time and Frequency Division, 847.00 National Institute of Standards and Technology - 325 Broadway Boulder, Colorado 80305, U.S.A.
YVTO	Direccion de Hidrografía y Navegación Observatorio Cagigal Apartado Postal No 6745 Caracas, Venezuela

TIME SIGNALS EMITTED IN THE UTC SYSTEM

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
ATA (1)	Greater Kailash New Delhi India 28° 34'N 77° 19'E	10 000	continuous	Second pulses of 5 cycles of a 1 kHz modulation. Minute pulses of 100 ms duration. The time signals are advanced by 50 ms on UTC.
BPM	Pucheng China 35° 0'N 109° 31'E	2 500 5 000 10 000 15 000	7 h 30 m to 1 h continuous continuous 1 h to 9 h	Signals emitted in advance on UTC by 20 ms. Second pulses of 10 ms duration with 1 kHz modulation. Minute pulses of 300 ms duration with 1 kHz modulation. UTC time signals are emitted from minute 0 to 10, 15 to 25, 30 to 40, 45 to 55. UT1 time signals are emitted from minute 25 to 29, 55 to 59.
BSF (1)	Chung-Li Taiwan Rep. of China 24° 57'N 121° 09'E	5 000 15 000	continuous except interruption between minutes 35 and 40	From minute 5 to 10, 15 to 20, 25 to 30, 45 to 50, 55 to 60, second pulses of 5 ms duration without 1 kHz modulation. From minute 0 to 5, 10 to 15, ..., 50 to 55, second pulses of 5 ms duration with 1 kHz modulation. The 1 kHz modulation is interrupted 40 ms before and after the pulses. Minute pulses are extended to 300 ms duration. DUT1: ITU-R code by pulse lengthening.
CHU	Ottawa Canada 45° 18'N 75° 45'W	3 330 7 335 14 670	continuous	Second pulses of 300 cycles of a 1 kHz modulation, with 29th and 51st to 59th pulses of each minute omitted. Minute pulses are 0.5 s long. Hour pulses are 1.0 s long, with the following 1st to 10th pulses omitted. A bilingual (Fr. Eng.) announcement of time (UTC) is made each minute following the 50th second pulse. FSK code (300 bps, Bell 103) after 10 cycles of 1 kHz on seconds 31 to 39. Year, DUT1, leap second information, TAI-UTC and Canadian summer time format on 31, and time code on 32-39. Broadcast is single sideband; upper sideband with carrier reinsert. DUT1 : ITU-R code by double pulse.

(1) Information based on the Annual Report for 2001, not confirmed by the laboratory.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
DCF77	Mainflingen Germany 50° 1'N 9° 0'E	77.5	continuous	At the beginning of each second (except the 59th second) the carrier amplitude is reduced to about 25 % for a duration of 0.1 s or 0.2 s. Coded transmission of year, month, day, hour, minute and day of the week in a BCD code from second marker No 21 to No 58 (The second marker durations of 0.1 s or 0.2 s correspond to a binary 0 or a binary 1 respectively). The coded time information is related to legal time of Germany and second markers 17 and 18 indicate if the transmitted time refers to UTC(PTB) + 2 h (summer time) or UTC(PTB) + 1 h (winter time). To achieve a more accurate time transfer and better use of the frequency spectrum available, an additional pseudo-random phase-shift keying of the carrier is superimposed to the AM second markers. No transmission of DUT1.
EBC	San Fernando Spain 36° 28'N 6° 12'W	15006 4998	10 h 00 m to 10 h 25 m 10 h 30 m to 10 h 55 m except Saturday, Sunday and national holidays.	Second pulses of 0.1 s duration of a 1 kHz modulation. Minute pulses of 0.5 s duration of 1 250 Hz modulation. DUT1: ITU-R code by double pulse.
HBG	Prangins Switzerland 46° 24'N 6° 15'E	75	continuous	At the beginning of each second (except the 59th second), the carrier is interrupted for a duration of 0.1 s or 0.2 s corresponding to "binary 0" or "binary 1", respectively, double pulse each minute. The number of the minute, hour, day of the month, day of the week, month and year are transmitted in BCD code from the 21st to the 58th second. The time signals are generated by the Swiss Federal Office of Metrology and Accreditation and in accordance with the legal time of Switzerland which is UTC(CH) + 1 h (Central European Time CET) or UTC(CH) + 2 h (Central European Summer Time CEST). In addition, CET and CEST are indicated by a binary 1 at the 18th or 17th second, respectively.
HLA (1)	Taedok Science Town Rep. of Korea 36° 23'N 127° 22'E	5 000	continuous	Pulses of 9 cycles of 1 800 Hz modulation. 29th and 59th second pulses omitted. Hour identified by 0.8 s long 1 500 Hz tone. Beginning of each minute identified by a 0.8 s long 1 800 Hz tone. Voice announcement of hours and minutes each minute following the 52nd second pulse. BCD time code given on 100 Hz subcarrier. DUT1: ITU-R code by double pulse.

(1) Information based on the Annual Report for 2001, not confirmed by the laboratory.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
IAM	Roma Italy 41° 47'N 12° 27'E	5 000	7 h 30 m to 8 h 30 m 10h 30 m to 11 h 30 m except Sunday and national holidays. Advanced by 1 hour in summer.	Second pulses of 5 cycles of 1 kHz modulation. Minute pulses of 20 cycles. Voice announcements every 15 minutes beginning at 0 h 0 m. DUT1: ITU-R code by double pulse.
JJY	Miyakoji Fukushima Japan 37° 22'N 140° 51'E	40	Continuous	A1B type 0.2 s, 0.5 s and 0.8 s second pulses, spacings are given by the reduction of the amplitude of the carrier. Coded announcement of hour, minute, day of the year, year, day of the week and leap second. Transmitted time refers to UTC(CRL) + 9 h.
JJY	Fuji Saga Japan 33° 28'N 130° 11'E	60	Continuous	A1B type 0.2 s, 0.5 s and 0.8 s second pulses, spacings are given by the reduction of the amplitude of the carrier. Coded announcement of hour, minute, day of the year, year, day of the week and leap second same as JJY(40). Transmitted time refers to UTC(CRL) + 9 h.
LDS	Leeds United Kingdom 53 ° 48'N 1° 33'W	5 000	Continuous	Second pulse amplitude = 2.4 V (50 ohm), 5 ns rise time and 20 μs width. Initial clock synchronization: 50 ns of UTC.
LOL (2)	Buenos Aires Argentina 34° 37'S 58° 21'W	5 000 10 000 *15 000	11 h to 12 h 14 h to 15 h 17 h to 18 h 20 h to 21 h 23 h to 24 h	Second pulses of 5 cycles of 1000 Hz modulation. Second 59 is omitted. Annoucement of hours and minutes every 5 minutes, followed by 3 minutes of 1000 Hz or 440 Hz modulation. DUT1: ITU-R code by lengthening.
MSF	Rugby United Kingdom 52° 22'N 1° 11'W	60	Continuous, except for interruptions for maintenance from 10 h 0 m to 14 h 0 m on the first Tuesday of January, April, July and October. A longer period of maintenance during the summer is announced annually.	Interruptions of the carrier of 100 ms for the second pulses and of 500 ms for the minute pulses. The signal is given by the beginning of the interruption. BCD NRZ code, 1 bit/s (year, month, day of the month, day of the week, hour, minute) from second 17 to 59 in each minute, following the seconds interruption. DUT1: ITU-R code by double pulse.

(2) LOL. * discontinued for maintenance

Station	Location Latitude Longitude	Frequency (KHz)	Schedule (UTC)	Form of the signal
RAB-99	Khabarovsk Russia 48° 30'N 134° 50'E	25.0 25.1 25.5 23.0 20.5	02 h 06 m to 02 h 40 m 06 h 06 m to 06 h 40 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RBU	Moscow 55° 44'N 38° 12'E	200/3	Continuous	DXXXW type 0.1 s signals. The numbers of the minute, hour, day of the month, day of the week, month, year of the century, difference between the universal time and the local time, TJD and DUT1+dUT1 are transmitted each minute from the 1st to the 59th second. DUT1+dUT1 : by double pulse.
RJH-63	Krasnodar Russia 44° 46'N 39° 34'E	25.0 25.1 25.5 23.0 20.5	11 h 06 m to 11 h 40 m	A1N type signals are transmitted between minutes 9 and 20 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 9 and 11 ; 0.1 second pulses of 25 ms duration, 10 second pulses of 1 s duration and minute pulses of 10 s duration are transmitted between minutes 11 and 20.
RJH-69	Molodechno Belarus 54° 28'N 26° 47'E	25.0 25.1 25.5 23.0 20.5	07 h 06 m to 07 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RJH-77	Arkhangelsk Russia 64° 22'N 41° 35'E	25.0 25.1 25.5 23.0 20.5	09 h 06 m to 09 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RJH-86	Bishkek Kirgizstan 43° 03'N 73° 37'E	25.0 25.1 25.5 23.0 20.5	04 h 06 m to 04 h 47 m 10 h 06 m to 10 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
RJH-90	Nizhni Novgorod Russia 56° 11'N 43° 57'E	25.0 25.1 25.5 23.0 20.5	05 h 06 m to 05 h 47 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RTZ (3)	Irkutsk Russia 52° 26'N 103° 41'E	50	Winter schedule 22 h 00 m to 24 h 00 m 00 h 00 m to 21 h 00 m Summer schedule 21 h 00 m to 24 h 00 m 00 h 00 m to 20 h 00 m	A1X type second pulses of 0.1 s duration are transmitted between minutes 0 and 5. The pulses at the beginning of the minute prolonged to 0.5 s. A1N type 0.1 second pulses of 0.02 s duration are transmitted at 59th minute. The pulses at the beginning of the second are prolonged to 40 ms and of the minute to 0.5 s. DUT1+dUT1: by double pulse.
RWM (3)	Moscow Russia 55° 44'N 38° 12'E	4 996 9 996 14 996	The station operates simultaneously on the three frequencies.	A1X type second pulses of 0.1 s duration are transmitted between minutes 10 and 20, 40 and 50. The pulses at the beginning of the minute are prolonged to 0.5 s. A1N type 0.1 s second pulses of 0.02 s duration are transmitted between minutes 20 and 30. The pulses at the beginning of the second are prolonged to 40 ms and of the minute to 0.5 ms. DUT1+dUT1: by double pulse.
TDF	Allouis France 47° 10'N 2° 12'E	162	continuous, except every Tuesday from 1 h to 5 h	Phase modulation of the carrier by +1 and -1 rd in 0.1 s every second except the 59th second of each minute. This modulation is doubled to indicate binary 1. The numbers of the minute, hour, day of the month, day of the week, month and year are transmitted each minute from the 21st to the 58th second, in accordance with the French legal time scale. In addition, a binary 1 at the 17th second indicates that the local time is 2 hours ahead of UTC (summer time); a binary 1 at the 18th second indicates that the local time is 1 hour ahead of UTC (winter time); a binary 1 at the 14th second indicates that the current day is a public holiday (Christmas, 14 July, etc...); a binary 1 at the 13th second indicates that the current day is a day before a public holiday.

(3) RTZ and RMW are the radiostations emitting DUT1 information in accordance with the ITU-R code and also giving an additional information, dUT1, which specifies more precisely the difference UT1-UTC down to multiples of 0.02 s, the total value of the correction being DUT1+dUT1.

Positive values of dUT1 are transmitted by the marking of *p* second markers within the range between the 21st and 24th second so that dUT1 = +*p* x 0.02 s.

Negative values of dUT1 are transmitted by the marking of *q* second markers within the range between the 31st and 34th second, so that dUT1 = -*q* x 0.02 s.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
VNG (4)	Llandilo New South Wales Australia 33° 43'S 150° 48'E	2 500 5 000 8 638 12 984 16 000	continuous continuous continuous continuous 22 h to 10 h	Second pulses of 50 ms of 1 kHz modulation. Second pulses 55 to 58 of 5 ms of 1 kHz modulation. Second pulse at 59 is omitted. Minute pulses of 0.5 s of 1 kHz modulation. During minutes 5, 10, 15, ..., second pulses 50 to 58 are 5 ms long with 1 kHz modulation. BCD time code giving day of the year, hour and minute at the next minute is given between seconds 20 and 46. Voice announcement on 2 500, 5 000 and 16 000 kHz during minutes 15, 30, 45 and 60. Morse station identification on 8 638 and 12 984 kHz during minutes 15, 30, 45 and 60. DUT1: ITU-R code by double pulse.
WWV	Fort-Collins CO, USA 40° 41'N 105° 2'W	2 500 5 000 10 000 15 000 20 000	continuous	Pulses of 5 cycles of 1 kHz modulation. 29th and 59th second pulses omitted. Hour is identified by 0.8 second long 1 500 Hz tone. Beginning of each minute identified by 0.8 second long 1 000 Hz tone. DUT1: ITU-R code by double pulse. BCD time code given on 100 Hz subcarrier, includes DUT1 correction.
WWVB	Fort-Collins CO, USA 40° 40'N 105° 3'W	60	continuous	Second pulses given by reduction of the amplitude of the carrier, coded announcement of the date, time, DUT1 correction, daylight saving time in effect, leap year and leap second.
WWVH	Kauai HI, USA 21° 59'N 159° 46'W	2 500 5 000 10 000 15 000	continuous	Pulses of 6 cycles of 1 200 Hz modulation. 29th and 59th second pulses omitted. Hour is identified by 0.8 second long 1 500 Hz tone. Beginning of each minute identified by 0.8 second long 1 200 Hz tone. DUT1: ITU-R code by double pulse. BCD time code given on 100 Hz subcarrier, includes DUT1 correction.
YVTO	Caracas Venezuela 10° 30'N 66° 56'W	5 000	continuous	Second pulses of 1 kHz modulation with 0.1 s duration. The minute is identified by a 800 Hz tone and a 0.5 s duration. Second 30 is omitted. Between seconds 40 and 50 of each minute, voice announcement of the identification of the station. Between seconds 52 and 57 of each minute, voice announcement of hour, minute and second.

(4) VNG: Please note that transmission of the time signal VNG ceased permanently on 31 December 2002.

ACCURACY OF THE CARRIER FREQUENCY

Station	Relative uncertainty of the carrier frequency in 10^{-10}
ATA	0.1
BPM	0.01
BSF	0.1
CHU	0.05
DCF77	0.02
EBC	0.1
HBG	0.02
HLA	0.02
IAM	0.5
JJY	0.01
LDS	0.01
LOL	0.1
MSF	0.02
RAB-99,RJH-63	0.05
RBU	0.02
RJH-69, RJH-77	0.05
RJH-86, RJH-90	0.05
RTZ	0.05
RWM	0.1
TDF	0.02
VNG	0.1
WWV	0.01
WWVB	0.01
WWVH	0.01

TIME DISSEMINATION SERVICES

The following tables are based on information received at the BIPM in February and March 2003.

AUTHORITIES RESPONSIBLE FOR THE TIME DISSEMINATION SERVICES

AOS	Astrogeodynamical Observatory Borowiec near Poznan Space Research Centre P.A.S. PL 62-035 Kornik Poland
AUS	Standards for Time and Fraquency Project CSIRO National Measurement Laboratory PO Box 218 Lindfield NSW 2070 AUSTRALIA
BEV	Bundesamt für Eich- und Vermessungswesen Arltgasse 35 A-1160 Wien Vienna Austria
BNM-SYRTE	Bureau National de Métrologie – Systèmes de Référence Temps-Espace Observatoire de Paris 61, avenue de l'Observatoire 75014 Paris - France
CNM	Centro Nacional de Metrología Km. 4.5 Carretera a Los Cués El Marqués, Querétaro, C.P. 76241 México - Mexico
CRL	Japan Standard Time Group Communications Research Laboratory 2-1, Nukui-kitamachi 4-chome Koganei-shi, Tokyo 184-8795 Japan
CSIR	Time and Frequency Laboratory CSIR – National Metrology Laboratory P.O. Box 395 Pretoria 0001 South Africa
GUM	Time and Frequency Laboratory Główny Urząd Miar Ul. Elektoralna 2 P.O. Box P-10 PL 00-950 Warszawa - Poland
IEN	Istituto Elettrotecnico Nazionale Galileo Ferraris Strada delle Cacce, 91 I - 10135 Torino Italie
INPL	National Physical Laboratory Danciger A bldg Givat - Ram, The Hebrew university 91904 Jerusalem ISRAEL

KRISS	Time and Frequency Group Division of Optical Metrology Korea Research Institute of Standardsand Science P.O. Box 102, Yuseon Daejon 305-600. Republic of Korea
METAS	METrology and Accreditation Switzerland Electricity, Acoustic and Time Section Lindenweg 50 CH-3003 Bern-Wabern Switzerland
NIM	Time & Frequency Laboratories National Institute of Metrology 7, District 11 Heping street Beijing - Popular Republic of China
NIST	National Institute of Standards and Technology Time and Frequency Division, 847.00 325 Broadway Boulder, Colorado 80305, USA
NMLS	Time and Frequency Laboratory National Metrology Laboratory SIRIM Berhad, No. 1 Persiaran Dato' Menteri, P. O. Box 7035, 40911 Shah Alam Malaysia
NPL	National Physical Laboratory Centre for Electromagnetic and Time Metrology Teddington, Middlesex TW11 0LW United Kingdom
NRC	National Research Council of Canada Institute for National Measurement Standards Frequency and Time Standards Bldg M-36, 1200 Montreal Rd. Ottawa, Ontario, K1A OR6, Canada
NTSC	National Time Service Center Chinese Academy of Sciences P.O. Box 18, Lintong Shaanxi 710600, China
ONBA	Servicio de Hidrografía Naval Observatorio Naval Buenos Aires Servicio de Hora Av. España 2099 C1107AMA – Buenos Aires, Argentina
ONRJ	Observatorio Nacional (CNPq) Departamento Serviço da Hora Rua General Bruce, 586, Sao Cristovao 20291- 030 – Rio de Janeiro, Brasil

ORB	Royal Observatory of Belgium Avenue Circulaire, 3 B-1180 Brussels Belgium
PTB	Physikalisch-Technische Bundesanstalt Time Unit Section (4.32) Bundesallee 100 D-38116 Braunschweig Germany
ROA	Real Instituto y Observatorio de la Armada Cecilio Pujazón s/n 11.100 San Fernando Cádiz, Spain
SG	National Measurement Centre Standards, Productivity and Innovation Board (SPRING Singapore) 1 Science Park Drive, Singapore 118221 Singapore
SP	SP Swedish National Testing and Research Institute Box 857 S-501 15 BORAS Sweden
TL	National Standard Time and Frequency Laboratory Telecommunication Laboratories Chunghwa Telecom. Co., Ltd. No. 12, Ln.551, Ming-Tsu Road Sec. 5 Yang-Mei, Taoyuan, 326 Taiwan, Rep. of China
TP	Institute of Radio Engineering and Electronics Czech Academy of Sciences Chaberska 57 182 51 Praha 8 Czech Republic
USNO	U.S. Naval Observatory 3450 Massachusetts Ave., N.W. Washington, D.C. 20392-5420 USA
VSL	NMi Van Swinden Laboratorium Postbus 654 2600 AR Delft Netherlands

Time Dissemination Services

AOS

AOS Computer Time Service:

vega.cbk.poznan.pl (150.254.183.15)
Synchronization: NTP V3 primary (Caesium clock), PC Pentium, RedHat Linux
Service Area: Poland/Europe
Access Policy: open access
Contact: Jerzy Nawrocki (nawrocki@cbk.poznan.pl)
Robert Diak (kondor@cbk.poznan.pl)

Full list of time dissemination services is available on:
http://www.eecis.udel.edu/~mills/ntp/clock1.htm

AUS

Network Time Service
Computers connected to the Internet can be synchronized to UTC(AUS) using the NTP protocol. The NTP servers are either directly referenced to UTC(AUS) or via a GPS common view link.

There are presently three servers available to the general public:
ntp.nml.csiro.au Sydney
ntp.mel.nml.csiro.au Melbourne
ntp.per.nml.csiro.au Perth

Current information can be found on the web pages: www.nml.csiro.au

BEV

A NTP server is available; address: time.metrology.at;
more information on http://www.metrology.at

Provides a time dissemination service via phone and modem to synchronize PC clocks.
Uses the Time Distribution System from TUG. It has a baud rate of 1200 and everyone can use it with no cost.
Access phone number is +43 (0) 1 49110381
The system will be updated periodically (DUT1, Leap Second...).

BNM-SYRTE

BNM-SYRTE operates one primary time server using the "Network Time Protocol" (NTP) :
Hostname: ntp-p1.obspm.fr

Futher information at: http://opdaf1.obspm.fr/www/ntp_infos.html

CNM

CENAM operates a voice automatic system that provides the local time for three different time zones for North America; Central Time, Mountain Time and Pacific Time as well the UTC(CNM). The access numbers are:

+52 442 211 0506: Central Time
+52 442 211 0507: Monition Time
+52 442 211 0508: Pacific Time
+52 442 215 3902: UTC(CNM)

	Telephone Code CENAM provides a telephone code for setting time in computers. More information about this service please contact J. Mauricio López at jlopez@cenam.mx Network Time Protocol Operates one time server using the "Network Time Protocol", it is located at the Centro Nacional de Metrología, Querétaro, México. Further information at http://mensor.cenam.mx/site/InternetTime.htm
CRL	Telephone Time Service (TTS) Provides digital time code accessible by computer at 300/1200/2400 bps, 8 bits, no parity. Access phone numbers: + 81 42 327 7592.
CSIR	Telephone Time Service (TTS) Provides digital time code accessible by computer for setting time in computers. Measurement of telephone transmission delay is included. Access phone numbers: + 27 12 349 1576, + 27 12 349 1577. More information and software for accessing the service is available at http://www.nml.csir.co.za/ Network Time Service Two NTP servers are available, tick.nml.csir.co.za and tock.nml.csir.co.za with an open access policy. More information is available at http://www.nml.csir.co.za/
GUM	Telephone Time Service providing the European time code by Telephone modem for setting time in computers. Includes provision for compensation of propagation time delay. Access phone number : +48 22 654 88 72
IEN	CTD Telephone Time Code Time signals dissemination, according to the European Time code format, available via modem on regular dial-up connection. Access phone number : 0039 011 3919 263 and 0039 011 3919 264. Provides a synchronization to UTC(IEN) for computer clocks without Compensation for the propagation time. Software for the synchronization of computer clocks is available on IEN home page (www.ien.it). Internet Time Service The IEN operates two time servers using the "Network Time Protocol" (NTP); host names of the servers are npt1.ien.it and ntp2.it. More information on this service can be found on the web pages: www.ien.it/ntp/index_i.shtml.

INPL (1)

INPL is providing two electronic time dissemination services:

1. via telephone. The user must download a program from INPL ftp site (vms.huji.ac.il)
2. NTS via optic fiber to the Hebrew University which provides time on
3. the internet. For details email clock@vms.huji.ac.il

KRISS (1)

Telephone Time Service

Provides digital time code to synchronize computer clocks to Korea Standard Time (=UTC(KRIS) + 9 h) via modem.
Access phone numbers: + 82 42 863 7117, + 82 42 868 5116

Network Time Service

KRISS operates a time server using the NTP to synchronize computer clocks to Korea Standard Time via the Internet.
Host name of the server : time.kriss.re.kr (203.254.163.74)

Software for the synchronization of computer clocks is available at http://www.kriss.re.kr/time

METAS

Telephone Time Service

The coded time information is referenced to UTC(CH) and generated by a TUG type time code generator using an ASCII-character code. The time protocols are sent in a common format, the "European Telephone Time Code".
Access phone numbers: +41 31 323 32 25, +41 31 323 47 00.

Network Time Protocol

METAS operates a time server using the "Network Time Protocol"(NTP).
Host name of the server : ntp.metas.ch
Further information available at http://www.metas.ch

NIM

(1) Television Time Service

The coded time information generated by one time code generator is inserted into the TV signal. It can be obtained by using a decode TV receiver.
The time reference is UTC(NIM). Access TV channel: 1,2,8 of CCTV.

(2) Telephone Time Service

The coded time information generated by NIM time code generator, referenced to UTC(NIM). Telephone Code provides digital time code at 1200 to 9600 bauds, 8 bits, no parity, 1 stop bit.
Access phone number: 8610 6422 9086.

(3) Network Time Service

Provides digital time code across the Internet using NTP.

(1) Information based on the Annual Report for 2001, not confirmed by the laboratory.

NIST	Automated Computer Time Service (ACTS) Provides digital time code by telephone modem for setting time in computers. Includes provision for calibration of telephone time delay. Access phone numbers : +1 303 494 4774 and +1 808 335 4721. Further information at http://www.boulder.nist.gov/timefreq/. Network Time Service (NTS) Provides digital time code across the Internet using three different protocols. Geographically distributed set of time servers within the United States of America. Further information at http://www.boulder.nist.gov/timefreq/.
NMLS	Telephone Time Service The coded time information is referenced to UTC(NMLS) and generated by a TUG type telephone time code generator using an ASCII-character code. The time protocols are sent in the "European Telephone Time Code" format. The service phone number is +60 3 55197063. Current service status is free of charge. Fees are made only on the provision of the software for accessing the service via modem dial-up. Network Time Protocol Version 3 The NTP time information is referenced to UTC(NMLS) and is currently generated by two Stratum-1 NTP servers, made available for public freely. The IP address for the servers are 202.190.27.9 and 202.190.27.10.
NPL	Telephone Time Service A TUG time code generator provides the European Telephone Time Code, referenced to UTC(NPL), by telephone modem. Access phone number: 0906 851 6333. Note: this is a premium rate number and can only be accessed from within the UK.
NRC	Telephone Code Provides digital time code by telephone modem for setting time in computers. Access phone number : +1 613 745 3900. Network Time Protocol Operates two time servers using the " Network Time Protocol ", each one being on different location and network. Host names : time.nrc.ca time.chu.nrc.ca Further information at http://www.nrc.ca/inms/time/whatime.html.

NTSC

Network Time Service (NTS)

Provides a synchronization to UTC(NTSC) computer clocks within China. Software for the synchronization of computer clocks is available on the NTSC Time and Frequency home page : http://time.sxso.ac.cn
Access Policy: free
Contact: Shaowu DONG (dongsw@ms.sxso.ac.cn).

ONBA

Speaking clock access phone number 113 (only accessible in Argentina).
Hourly and half hourly radio-broadcast time signal.
Internet time service at web site www.hidro.gov.ar/hora/hora.asp

ONRJ

Telephone Voice Announcer (55) 21 5806037.
Telephone Code (55) 21 5800677 provides digital time code at 300 bauds, 8 bits, no parity, 1 stop bit (Leitch CSD5300)

Internet Time Service at the address : 200.20.186.75
SNTP at port 123
Time/UDP at port 37
Time/TCP at port 37
Daytime/TCP at port 13

WEB-based Time Services:
1) A real-time clock aligned to UTC(ONRJ) and corrected for internet transmission delay.
Further information at: http://200.20.186.71/asp/relogio/horainicial.asp
2) Voice Announcer, in Portuguese, each ten seconds, after download of the Web page at: http://200.20.186.71.

ORB

ORB provides a time dissemination via phone and modem to synchronize PC clocks on UTC(ORB). The system used is the Time Distribution System from TUG, which produces the telephone time code mostly used in Europe.
The baud rate used is 1200. The access phone number is 32 (0) 2 373 03 20. The system is updated periodically with DUT1 and leap seconds

PTB

Telephone Time Service

The coded time information is referenced to UTC(PTB) and generated by a TUG type time code generator using an ASCII-character code.
The time protocols are sent in a common format, the " European Telephone Time Code ". Access phone number : +49 531 51 20 38 .

Internet Time Service

The PTB operates two time servers using the " Network Time Protocol " (NTP). Software for the syncronization of computer clocks is available on the home pages of the PTB (www.ptb.de).
Host names of the servers: ptbtime1.ptb.de
ptbtime2.ptb.de

ROA

Telephone Code

It operates the European Telephone Code.
Access phone number : +34 956 599 429

Network Time Protocol

Server : hora.roa.es
Synchonized to UTC(ROA) better than 10 microseconds
Service policy : free

Server : ntp0.roa.es
Synchonized to UTC(ROA) better than 10 microseconds
Service policy : free
Note : server used as prototype to check new software, hardware, etc.

SG

Web-based time service:

Displays a real-time clock referenced to UTC(SG) at web-site http://www.SingaporeStandardTime.org.sg. Local times of major cities worldwide and their time differences will be available at the web-site from 1 March 2003.

Automated Computer Time Service (ACTS)

Transmits digital time code (NIST format) via telephone & modem for setting time in computers. The coded time information is referenced to UTC(SG). Includes provision for correcting telephone time delays. Access phone number : +65 7799978.
Information is available at http://www.SingaporeStandardTime.org.sg.

Network Time Service (NeTS)

Transmits digital time code via the Internet using three different protocols – Time, Daytime and NTP. Operates two time servers.
Host names : NeTS.org.sg
203.117.180.35
Information available at http://www.SingaporeStandardTime.org.sg.

SP

Telephone Time Service

The coded time information is referenced to UTC(SP) and generated by two TUG type time code generators using an ASCII-character code.
The time protocols are sent in a common format, the "European Telephone Time Code".
Access phone number: +46 33 41 57 83

Internet Time Service

The coded time information is referenced to UTC(SP) and generated by two NTP servers using the Network Time Protocol (NTP).
Access host names : ntp1.sp.se and ntp2.sp.se

Speaking Clock

The speaking clock service is operated by Telia AB in Sweden. The time announcement is referenced to UTC(SP) and disseminated from a computer based system operated and maintained at SP.
Access phone number : 90510 (only accessible in Sweden).
Access phone number : +4633 90510 (from outside Sweden).

More information about these services are found at the web site www.sp.se

TL

Speaking Clock Service
Traceable to UTC(TL). Broadcast through PSTN (Public Switching Telephone Network) automatically and provides accurate voice time signal to public users.

The Computer Time Service
Provides digital time code by telephone modem for setting time in computers.
Access phone number : +886 3 4245117.

NTP Service
TL operates a time server using the "Network Time Protocol (NTP)".
Host name of the server : time.stdtime.gov.tw

Further information at http://www.stdtime.gov.tw/english/e-home.htm

TP

Internet Time Service

IREE operates a time server directly referenced to UTC(TP).
Time information is accessible through Network Time Protocol (NTP).

Server host name: time.ure.cas.cz
More information at http:// www.ure.cas.cz/time

USNO

Telephone Voice Announcer +1 202 762-1401
Telephone Code +1 202 762-1594
provides digital time code at 1200 baud, 8 bits, no parity
Automated data service for downloading files +1 202 762-1503
Web site for time and for data files: http://www.tycho.usno.navy.mil
Network Time Protocol (NTP) see
http://www.tycho.usno.navy.mil/ntp.html
for software and site closest to you.

VSL

Telephone Time Service

The coded time information is referenced to UTC(VSL) and generated by a TUG type time code generator using an ASCII-character code. The time protocols are sent in a common format, the "European Telephone Time Code". The access phone number is 0900 6171819. This is a toll number and therefore can only be accessed in the Netherlands.

Director's Report on the Activity and Management of the BIPM, 2002, T. 3

(July 2001 – June 2002)

BIPM Publication

1 International Atomic Time (TAI) and Coordinated Universal Time (UTC)

The reference time scales TAI and UTC have been computed from data regularly reported to the BIPM by the timing centres which maintain a local UTC, monthly results have been published in *Circular T*. The *Annual Report of the BIPM Time Section for 2001*, Volume **14**, complemented by computer-readable files on the BIPM home page, give the definitive results for 2001.

2 Algorithms for time scales

The algorithm used for the calculation of the time scales is an iterative process that starts by producing a free atomic scale (EAL) from which TAI is derived. Research concerning time-scale algorithms is conducted at the Time section with the aim of improving the long-term stability of EAL and the accuracy of TAI. Studies are being undertaken to evaluate the feasibility of providing quasi real-time predictions of UTC and TAI.

2.1 EAL stability

Some 80 % of clocks are now either commercial caesium clocks of the HP 5071A type or active, auto-tuned active hydrogen masers. Since January 2001, the value of the maximum relative weight of clocks in TAI has been set to $2/N$, where N is the total number of participating clocks. It was shown, using real clock data over three and a half years, that such a choice for the maximum relative weight leads to a better discrimination between the clocks and improves the stability of the resulting time scale. We can thus expect an improvement in the stability of EAL in the near future.

Studies on the TAI algorithm continue. An estimator has been proposed to quantify the reliability achieved by assigning an upper limit to weights. It has been shown that it is possible to optimize this estimator, thus defining an optimal weighting scheme. Tests using simulated and real data have shown that this optimal choice may be used in TAI computation.

The medium-term stability of EAL, expressed in terms of an Allan deviation, is estimated to be 0.6×10^{-15} for averaging times of twenty to forty days over the period January 1999 to June 2002.

2.2 TAI accuracy

To characterize the accuracy of TAI, estimates are made of the relative departure, and its uncertainty, of the duration of the TAI scale interval from the SI second as produced on the rotating geoid by primary frequency standards. Since August 2001, individual measurements of the TAI frequency have been provided by six primary frequency standards including two caesium fountains (NIST-F1 and PTB CSF1). As a result of a collaboration with the PTB to make available the detailed results of a bilateral comparison with TAI, a joint PTB/BIPM report has been published. Such detailed reports appear in the *Annual Report of the BIPM Time Section*.

Since August 2001 the global treatment of individual measurements has led to a relative departure of the duration of the TAI scale unit from the SI second on the geoid ranging from $+0.6 \times 10^{-14}$ to $+1.0 \times 10^{-14}$, with a standard uncertainty of 0.2×10^{-14}. Because the current procedure for steering TAI does not seem to be sufficient to reduce this offset, studies are being undertaken to establish new steering procedures that will provide a more accurate TAI without impeding its stability.

3 Time links

The BIPM Time section organizes the international network of time links. The present configuration relies mostly on the classical GPS common-view technique based on C/A-code measurements obtained from single-channel receivers which has been extended for use with multichannel dual-code dual-system (GPS and GLONASS) observations, resulting in improved accuracy for time transfer. Also TWSTFT links are used in the computation of TAI. A pilot experiment is starting, aimed at testing the use of dual-frequency P-code measurements from geodetic-type GPS receivers for TAI links. In addition, the BIPM Time section continues to test other time and frequency comparison methods, such as those using phase measurements. Two active hydrogen masers have been acquired by the BIPM and installed in the TAI laboratory in December 2001; used for time- and frequency-transfer experiments, they also provide the frequency reference to the Length section.

3.1 Global Positioning System (GPS) and Global Navigation Satellite System (GLONASS) code measurements

i) Current work

The BIPM publishes an evaluation of the daily time differences [*UTC – GPS time*] and [*UTC – GLONASS time*] in its monthly *Circular T* and routinely issues GPS and GLONASS international common-view schedules. The international network of GPS common-view links used by the BIPM follows a pattern of local stars within a continent. All GPS links are corrected for ionospheric delays using IGS maps, as well as for satellite positions using IGS post-processed precise satellite ephemerides.

ii) Determination of differential delays of GPS and GLONASS receivers

As part of our work we continue to check the differential delays between GPS receivers which operate on a regular basis in collaborating timing centres. We recall that a series of differential calibrations of GPS equipment involving the European and North American time laboratories equipped with two-way time-transfer stations began in June 1997, and that in December 1999 differential calibrations of GPS/GLONASS multichannel dual-code receivers were initiated.

iii) Standards for GPS and GLONASS receivers

The Time section continues its active involvement in the work of the CCTF Group on Global navigation satellite systems Time Transfer Standards (CGGTTS). This has involved the ongoing development of technical guidelines for manufacturers of receivers used for timing in Global navigation satellite systems. A staff member of the BIPM provides the secretariat of the CGGTTS.

iv) Multichannel GPS and GLONASS time links

Six multichannel GPS links are used in the computation of TAI. The introduction of multichannel GPS+GLONASS links into TAI is still under study.

v) IGS estimated ionospheric corrections

Ionospheric parameters estimated by the IGS are now routinely used to correct all GPS links for ionospheric delays in regular TAI calculations. A study of the possible correlation between ionospheric parameters and apparent variations in the hardware delays of dual-frequency receivers is under way.

3.2 Phase and code measurements from geodetic-type receivers

It will be recalled that GPS and GLONASS time and frequency transfer may also be carried out using dual-frequency carrier-phase measurements in addition to code measurements. This technique, already in common use in the geodetic community, can be adapted to the needs of time and frequency transfer.

Studies continue at the BIPM using the Ashtech Z12-T GPS and Javad Legacy GPS/GLONASS receivers. The method developed to perform the absolute calibration of the Z12-T hardware delays allows us to use this receiver for differential calibrations of similar receivers. Work is progressing on the comparison of results from the two absolute calibration measurements of the Z12-T carried out at the U.S. Naval Research Laboratory (NRL) in May-June 2000 and April-May 2001. The JPS Legacy GPS/GLONASS receiver, acquired in 2000, also serves as a reference with which the Z12-T is compared while at the BIPM. A report summarizing the results obtained so far for the calibration of the BIPM Z12-T has been prepared. Calibration trips started in January 2001 to make differential calibrations of all similar receivers in time laboratories worldwide have continued. As of June 2002, twelve such calibrations have taken place as part of studies conducted in the framework of the IGS/BIPM Pilot Project with a view to providing accurate time and frequency comparisons using GPS phase and code measurements. One goal is to start using data from geodetic-type receivers for the time links of TAI and a pilot experiment has been initiated towards this aim. For this purpose, procedures and software have been developed in collaboration with the ORB.

One of the 3S Navigation receivers in operation at the BIPM is used to collect data for the International GLONASS Service Pilot Project (IGLOS-PP) sponsored by the IGS, in which the BIPM participates. As previously noted, the objective of this project is, among others, to produce post-processed precise GLONASS satellite ephemerides.

3.3 Two-way time transfer

Two meetings related to TWSTFT activities were held since October 2001. The BIPM collects two-way data from seven operational stations and undertakes treatment of some two-way links. Nine TWSTFT links have been introduced into the computation of TAI; four others are in preparation for their introduction into TAI. The BIPM is also involved in the calibration of two-way time-transfer links by comparison with GPS. The Time section continues the issue of BIPM TWSTFT reports. A staff member of the BIPM provides the secretariat of the CCTF Working Group on TWSTFT.

4 Pulsars

Collaboration is maintained with radio-astronomy groups observing pulsars and analysing pulsar data provided that it is of interest for us to study the potential capability of millisecond pulsars as a means of sensing the very long-term stability of atomic time. The Time section provides these groups its post-processed realization of Terrestrial Time TT (BIPM2001). The collaboration continues with the Observatoire Midi-Pyrénées (OMP) in Toulouse to complete the processing of a small programme of survey observations carried out in recent years.

5 Space-time references

Uniformity in the definition of space reference systems plays an increasingly important role in basic metrology, particularly for astro-geodetic techniques that contribute to the International Earth Rotation Service (IERS). Since 1 January 2001, a collaborative effort between the BIPM and the U.S. Naval Observatory (USNO) continues to take responsibility for the Conventions Product Centre (CPC) of the IERS. Work is in progress on the new edition of the IERS Conventions, a 150 page document summarizing the models, constants and procedures used for data analysis in the IERS, and for the astrometry-geodesy community at large.

Following the work of the BIPM/IAU Joint Committee on General Relativity for Space-time Reference Systems and Metrology (JCR) which ceased activity in 2001, efforts continue to promote the diffusion of the IAU Recommendations adopted in 2000.

Activities related to the realization of reference frames for astronomy and geodesy are being developed by E.F. Arias in cooperation with the IERS and La Plata Observatory (Argentina).

6 Other studies

In collaboration with the BNM-LPTF/OP (SYRTE, Paris Observatory), studies remain under way on the possible use for international timekeeping of highly stable and accurate space clocks, in particular those that will be operated within the ACES (Atomic Clock Ensemble in Space) experiment on board the international space station in 2005. With relative uncertainties expected in the low 10^{-16} region, such developments will be extremely important for the improvement of TAI accuracy and for experiments in fundamental physics.

Another project concerns tests of fundamental physics (Lorentz invariance) by comparing the frequencies of a hydrogen maser and a cryogenic sapphire microwave oscillator in collaboration with the Paris Observatory and the University of Western Australia. The experiment (data acquisition) is still in progress at the BNM-LPTF and a scientist of the Time section is involved in data evaluation and analysis.

Work on atom interferometry continues, in particular studies of the effects of the quantization of external degrees of freedom (atomic recoil) on the frequency and fringe contrast of primary frequency standards.

7 Publications, lectures, travel: Time section

7.1 External publications

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10. Wolf P., Relativity and Metrology, *Proc. Int. School of Phys. "Enrico Fermi" Course CXLVI Recent Advances in Metrology and Fundamental Constants* (Quinn T.J., Leschiutta S. and Tavella P. eds.), IOS Press, 2001, 575-598.
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7.2 BIPM publications

12. Annual Report of the BIPM Time Section (2001), 2002, 14, 102 pp.
13. *Circular T* (monthly), 6 pp.
14. Azoubib J., Lewandowski W., *BIPM TWSTFT Reports*, 21 pp.
15. Lewandowski W., Moussay P., Determination of the Differential Time Corrections Between GPS Time Equipment Located at the OP, IEN, ROA, PTB, NIST and USNO, *Rapport BIPM*-2002/02, 2002, 28 pp.