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ANNUAL REPORT FOR 1970

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Table 10 - Offsets and step adjustments of UTC.

Date (at 0 h UT)	Offsets	Steps
1961 Jan. 1	-150×10^{-10}	
Aug. 1	"	$+0^{S}.050$
1962 Jan. 1	-130×10^{-10}	
1963 Nov. 1	"	$-0^{S}.100$
1964 Jan. 1	-150×10^{-10}	
April 1	"	$-0^{S}.100$
Sept. 1	"	$-0^{S}.100$
1965 Jan. 1	"	$-0^{S}.100$
March 1	"	$-0^{S}.100$
July 1	"	$-0^{S}.100$
Sept. 1	"	$-0^{S}.100$
1966 Jan. 1	-300×10^{-10}	
1968 Feb. 1	"	$+0^{S}.100$

Table valid until 1971 July 1

Table 11 - Relationship between AT and UTC, since 1961

Limits of validity (at 0 h UT)	AT-UTC (J.D. : Julian Day Number)
1961 Jan. 1 - 1961 Aug. 1	$1^{S}.422\ 818\ 0 + (JD-2437\ 300.5) \times 0^{S}.001\ 296$
Aug. 1 - 1962 Jan. 1	$1^{S}.372\ 818\ 0 +$ "
1962 Jan. 1 - 1963 Nov. 1	$1^{S}.845\ 858\ 0 + (JD-2437\ 665.5) \times 0^{S}.001\ 123\ 2$
1963 Nov. 1 - 1964 Jan. 1	$1^{S}.945\ 858\ 0 +$ "
1964 Jan. 1 - April 1	$3^{S}.240\ 130\ 0 + (JD-2438\ 761.5) \times 0^{S}.001\ 296$
April 1 - Sept. 1	$3^{S}.340\ 130\ 0 +$ "
Sept. 1 - 1965 Jan. 1	$3^{S}.440\ 130\ 0 +$ "
1965 Jan. 1 - March 1	$3^{S}.540\ 130\ 0 +$ "
March 1 - July 1	$3^{S}.640\ 130\ 0 +$ "
July 1 - Sept. 1	$3^{S}.740\ 130\ 0 +$ "
Sept. 1 - 1966 Jan. 1	$3^{S}.840\ 130\ 0 +$ "
1966 Jan. 1 - 1968 Feb. 1	$4^{S}.313\ 170\ 0 + (JD-2439\ 126.5) \times 0^{S}.002\ 592$
1968 Feb. 1 -	$4^{S}.213\ 170\ 0 +$ "

Table valid until 1971 July 1

Table 12 - Relationship between AT and SAT

Limits of validity (at 0 h UT)	AT-SAT	Limits of validity (at 0 h UT)	AT-SAT
1967 Jan. 1 - 1967 March 1	$+5^{S}.354\ 600$	1969 July 1 - 1969 Sept. 1	$+7^{S}.554\ 600$
March 1 - June 1	554 600	Sept. 1 - Nov. 1	754 600
June 1 - Sept. 1	754 600	Nov. 1 - 1970 Feb. 1	954 600
Sept. 1 - Dec. 1	954 600	1970 Feb. 1 - April 1	8.154 600
Dec. 1 - 1968 March 1	6.154 600	April 1 - July 1	354 600
1968 March 1 - May 1	354 600	July 1 - Sept. 1	554 600
May 1 - Aug. 1	554 600	Sept. 1 - Nov. 1	754 600
Aug. 1 - Nov. 1	754 600	Nov. 1 - 1971 Feb. 1	954 600
Nov. 1 - 1969 Feb. 1	954 600	1971 Feb. 1 - April 1	9.154 600
1969 Feb. 1 - April 1	7.154 600	April 1 - July 1	354 600
April 1 - July 1	354 600		

Table valid until 1971 July 1

Table 13 - Time comparisons between laboratories by clock transportations in 1970. (for abbreviations, see p. 23)

Date 1970	J.D. 2400 000.5+	Time comparisons (unit = 1 microsecond)	Authority
Jan. 16	40602.3	UTC (USNO) - UTC (NBS) (1) = - 0.3 ± 0.1	USNO, DPRV, 160
23	609.2	UTC (USNO) - UTC (RRL) = - 1063.9 ± 0.2	" "
23	609.2	UTC (USNO) - UTC (TAO) = - 205.0 ± 0.2	" "
Feb. 16	633.4	UTC (USNO) - UTC (OP) = - 129.9 ± 0.5	" 161
17	634.3	UTC (USNO) - UTC (RGO) = + 46.5 ± 0.5	" "
21	638.4	UTC (USNO) - UTC (ON) = - 120.1	USNO (2)
Mar. 31	676.9	UTC (USNO) - UTC (APO) (3) = + 29.5 ± 0.5	USNO, DPRV, 170
Apr. 15	691.3	UTC (USNO) - UTC (ROJ) = - 25.1 ± 0.5	" "
20	696.2	UTC (USNO) - UTC (TAO) = - 191.4 ± 0.2	" "
20	696.3	UTC (USNO) - UTC (RRL) = - 1052.5 ± 0.2	" "
25	701.1	UTC (USNO) - UTC (TCL) (4) = - 5.7 ± 0.2	" 171
May 12	718.5	UTC (OP) - UTC (ON) = + 15.0	Ebauches S.A
12	718.6	UTC (USNO) - UTA (NRC) = + 156.0 ± 0.2	USNO, DPRV, 176
27	733.5	UTC (OP) - UTC (ON) = + 13.5	Ebauches S.A
Jun. 18	755.7	UTC (USNO) - UTC (NBS) = + 1.3 ± 0.1	USNO, DPRV, 178
22	759.3	UTC (USNO) - UTC (OP) = - 137.0 ± 0.5	" "
22	759.6	UTC (USNO) - UTC (RGO) = + 45.1 ± 0.5	USNO (5)
Jul. 22	789.3	UTC (USNO) - UTC (TCL) (4) = - 7.7 ± 0.2	USNO, DPRV, 184
29	796.1	UTC (USNO) - UTC (RRL) = - 1043.1 ± 0.2	" "
29	796.1	UTC (USNO) - UTC (TAO) = - 179.1 ± 0.2	" "
Aug. 15	813.3	UTC (USNO) - UTC (OP) = - 139.4 ± 0.2	U.S. Coast Guard
Sept. 9	838.9	UTC (OP) - UTC (RGO) = + 177.1 ± 0.1	O.N.E.R.A (6)
10	839.5	UTC (OP) - UTA (NRC) = + 298.1 ± 0.1	"
10	839.7	UTC (USNO) - UTC (OP) = - 136.2 ± 0.1	"
14	843.8	UTC (USNO) - UTC (OP) = - 136.2 ± 0.1	"
15	844.5	UTC (OP) - UTC (RGO) = + 177.1 ± 0.1	"
16	845.6	UTC (USNO) - UTC (ROJ) = - 54.8 ± 0.5	USNO, DPRV, 191
25	854.0	UTC (USNO) - UTC (APO) (3) = + 28.7 ± 0.5	" 192
28	857.2	UTC (USNO) - UTC (MSO) = + 17.4 ± 0.5	" "
29	858.5	UTC (USNO) - UTC (RGO) = + 40.3 ± 0.5	USNO (5)
Oct. 12	871.5	UTC (USNO) - UTC (DHI) = - 135.2 ± 0.5	USNO, DPRV, 196
13	872.4	UTC (USNO) - UTA (PTB) = - 320.0 ± 0.5	" "
20	879.3	UTC (USNO) - UTC (OP) = - 137.4 ± 0.5	" "
23	882.0	UTC (RRL) - UTC (ILOM) = + 647.5 ± 0.1	RRL, ILOM
Nov. 12	902.1	UTC (USNO) - UTC (RRL) = - 1033.2 ± 0.2	" 199
12	902.1	UTC (USNO) - UTC (TAO) = - 167.1 ± 0.2	" "
15	905.2	UTC (USNO) - UTC (TCL) (4) = - 7.3 ± 0.2	" "
Dec. 3	923.6	UTC (USNO) - UTC (NBS) = - 0.8 ± 0.1	" 202

(1) - The measurement has been carried out with respect to the clock ## 8 of NBS, the suitable correction communicated by NBS has been applied.

(2) - Clock transportation carried out by USNO; the result has been reported by Neuchâtel observatory.

(3) - APO(previously called PMG) Australian Post Office, Research Laboratories, Melbourne, Australia.

(4) - TCL : Telecommunication Laboratories, Taiwan, Republic of China.

(5) - Clock transportation carried out by USNO ; the result has been reported by a letter of USNO.

(6) - ONERA : Office National d'Etudes et Recherches Aerospatiales , France - Comparisons by airborne clock without landing.

Table 14 - Comparisons with the BIH times by radioelectric methods

Roman types : results obtained by LORAN-C,
Italics : by vlf and other methods,
Between parenthesis : without initial time comparison (arbitrary origin).

Important. Consult notes, p. 70 and the explanations p. 23 - 27.

Laboratory Time scales Date(0h UT) 1970	J.D. 2400000.5 +	DHI UTC -UTC(DHI) μs	DO UTC -UTC(DO) μs	F AT -TA(F) μs	FOA UTC -UTC(FOA) μs	IEN UTC -UTC(IEN) μs	IGMA UTC -UTC(IGMA) μs
Jan. 3	40589	+ 3.5	+276.4*	-37.2	+194.5	*(0)*	
13	599	3.6	276.7	37.4	196.0	*(- 1)*	
23	609	2.9	277.2	38.0	196.4	*(- 4)*	
Feb. 2	619	2.1	278.6	38.0	192.7	*(- 5)*	
12	629	+ 1.1	279.3	38.2	185.0	*(- 4)*	
22	639	- 0.3	+280.6	-38.7	+177.7	*(- 3)*	
March 4	649	1.4	280.9	38.8	171.6	*(- 1)*	
14	659	1.9	283.0	39.0	164.9	*(- 5)*	
24	669	3.2	284.2	39.5	158.3	*(- 2)*	
April 3	679	4.0	285.0	39.9	152.9	*(- 2)*	
13	689	- 4.9	+286.2	-40.4	+152.1	*(+10)*	*(0)*
23	699	5.7		40.5	151.2	*(+12)*	*(- 3)*
May 3	709	6.7		40.7	150.0	*(+12)*	*(- 6)*
13	719	7.7		41.3	149.3	*(+11)*	*(- 9)*
23	729	8.6		41.8	149.1	*(+11)*	*(- 8)*
June 2	739	- 9.3		-42.1	+148.7	*(+10)*	*(-11)*
12	749	10.7		42.5	148.1	*(+ 8)*	*(-14)*
22	759	11.9		42.7	148.4	*(+10)*	*(-16)*
July 2	769	12.5		42.6	149.9	*(+12)*	*(-19)*
12	779	13.1		42.7	149.7	*(+13)*	*(-23)*
22	789	-11.7		-42.9	+147.6	*(+21)*	*(-26)*
Aug. 1	799	-12		43.0	146.2	*(+26)*	*(-31)*
11	809	7		43.5	145.4	*(+27)*	*(-33)*
21	819	8		43.4	144.6	*(+35)*	*(-35)*
31	829	5		43.7	144.2	*(+36)*	*(-35)*
Sept. 10	839	- 5		-44.0	+143.3	*(+37)*	*(-34)*
20	849	-		44.3	142.4	*(+43)*	*(-37)*
30	859	-		44.9	141.2	*(+42)*	*(-36)*
Oct. 10	869	- 0.6		45.4	140.0	*(+41)*	*(-39)*
20	879	1.1		45.7	139.1	*(+42)*	*(-39)*
30	889	- 1.4		-45.9	+138.2	*(+45)*	*(-40)*
Nov. 9	899	1.7		46.3	137.5	*(+45)*	*(-40)*
19	909	2.3		46.9	137.0	*(+48)*	*(-38)*
29	919	2.9		47.2	136.9	*(+48)*	*(-43)*
Dec. 9	929	3.5		47.4	137.1	*(+46)*	*(-44)*
19	939	- 4.1		-47.8	+135.9	*(+45)*	*(-45)*
29	949	4.4		47.9	135.0	*(+49)*	*(-46)*

* See Corrigendum for 1969, p. 70.

Table 14 (cont.)

Laboratory Time scales Date (0h UT) 1970	J.D. 2400000.5 +	ILOM UTC -UTC(ILOM) μs	MSO UTC -UTC(MSO) μs	NBS AT -AT(NBS) μs	NBS UTC -UTC(NBS) μs	NIS UTC -UTC(NIS) μs	NPL UTC -UTC(NPL) μs
Jan. 3	40589	-283.9	*-159*	-45263.4	+124.8	*(+ 1)*	*(-73)*
13	599	284.1	*159*	263.0	124.8	*(+ 1)*	*(-73)*
23	609	283.8	*147*	262.4	125.0	*(- 1)*	*(-69)*
Feb. 2	619	283.6	*138*	261.7	125.2	*(0)*	*(-68)*
12	629	283.4		261.1	125.6	*(+ 2)*	*(-66)*
22	639	-283.4	*(0)*	-45260.2	+126.2	*(+ 4)*	*(-71)*
March 4	649	282.8	*(+ 9)*	259.7	126.4	*(+ 2)*	*(-76)*
14	659	282.8	*(-10)*	259.8	126.1	*(+ 1)*	*(-74)*
24	669	-	*(-36)*	258.8	126.8	*(+ 3)*	*(-75)*
April 3	679	-	*(-18)*	258.1	127.3	*(0)*	*(-76)*
13	689	-	*(- 2)*	-45257.3	+127.8	*(+ 1)*	*(-76)*
23	699	-	*(-19)*	256.4	128.4	*(0)*	*(-78)*
May 3	709	-286.1	*(-32)*	255.9	128.7	*(0)*	*(-75)*
13	719	285.9	*(-29)*	255.2	129.1	*(- 1)*	*(-72)*
23	729	286.1	*(-25)*	254.7	129.4	*(- 1)*	*(-75)*
June 2	739	-286.4	*(-32)*	-45253.9	+129.9	*(- 1)*	*(-77)*
12	749	286.9	*(-15)*	253.0	130.4	*(0)*	*(-71)*
22	759	284.4	*(-17)*	252.5	130.5	*(- 2)*	*(-63)*
July 2	769	283.1	*(-17)*	252.0	130.5	*(- 1)*	*(-62)*
12	779	280.5	*(-18)*	251.1	131.0	*(0)*	*(-56)*
22	789	-	*(-17)*	-45250.3	+131.3	*(- 2)*	*(-53)*
Aug. 1	799	-274.2	*(-13)*	250.0	131.2	*(- 2)*	*(-52)*
11	809	271.4	*(- 8)*	249.3	131.4	*(- 9)*	*(-50)*
21	819	267.8	*(+ 2)*	-	-	*(-12)*	*(-51)*
31	829	264.8	*(- 3)*	-	-	*(- 5)*	*(-46)*
Sept. 10	839	-261.8	*(- 1)*	-	-	*(+ 4)*	*(-45)*
20	849	258.9		-	-	*(+ 4)*	*(-46)*
30	859	256.8	*-151*	-45245.7	+132.9	*(+ 3)*	*(-49)*
Oct. 10	869	253.9	*152*	245.1	133.1	*(0)*	*(-47)*
20	879	250.6	*137*	244.5	133.2	*(- 1)*	*(-50)*
30	889	-248.5	*-143*	-45244.0	+133.3	*(+ 3)*	*(-54)*
Nov. 9	899	246.7	*139*	243.8	133.1	*(- 1)*	*(-51)*
19	909	244.7	*144*	243.0	133.4	*(- 1)*	*(-51)*
29	919	243.3	*135*	242.2	133.8	*(+ 4)*	*(-50)*
Dec. 9	929	241.0	*142*	241.3	134.2	*(+10)*	*(-50)*
19	939	-238.6	*-147*	-45240.7	+134.5	*(+ 8)*	*(-52)*
29	949	236.5	*145*	240.0	134.7	-	*(-54)*

Table 14 (cont.)

Laboratory Time scales Date(0h UT) 1970	J.D. 2400000.5 +	NRC UTC -UTA(NRC) μs	ON UTC -UTC(ON) μs	ONBA UTC -UTC(ONBA) μs	OP UTC -UTC(OP) μs	PTB AT -AT(PTB) μs	PTB UTC -UTA(PTB) μs
Jan. 3	40589	+277.8	+5.0		-2.7	-380.5	-183.5
13	599	278.5	4.9		1.6	380.6	183.6
23	609	279.1	5.5		1.4	380.9	183.9
Feb. 2	619	279.8	6.0		1.8	381.1	184.1
12	629	280.1	6.4		2.3	381.2	184.2
22	639	+280.7	+6.9		-2.9	-381.4	-184.4
March 4	649	280.3	7.5		3.1	381.3	184.3
14	659	281.2	8.1		3.7	381.4	184.4
24	669	281.7	7.9		4.2	381.6	184.6
April 3	679	282.4	7.9		4.8	381.4	184.4
13	689	+282.7	+7.9		-5.2	-381.3	-184.3
23	699	283.2	7.9		5.2	381.2	184.2
May 3	709	283.4	8.1		5.3	381.2	184.2
13	719	284.6	8.1		6.0	381.4	184.4
23	729	286.4	7.5		6.4	381.5	184.5
June 2	739	+287.3	+7.2		-6.7	-381.4	-184.4
12	749	288.6	6.9		7.2	381.8	184.8
22	759	289.8	6.9		7.3	381.9	184.9
July 2	769	290.3	7.1		7.2	381.6	184.6
12	779	291.4	6.9		7.4	381.7	184.7
22	789	+292.3	+7.0		-7.5	-381.7	-184.7
Aug. 1	799	293.4	7.0	———	7.5	381.8	184.8
11	809	294.2	7.1	(0)	7.5	382.0	185.0
21	819	294.7	7.1	(0)	5.1	382.1	185.1
31	829	295.0	7.3	(0)	3.0	382.2	185.2
Sept. 10	839	+295.8	+7.5	(+ 2)	-2.6	-382.3	-185.3
20	849	296.4	7.7	(+ 1)	2.2	382.4	185.4
30	859	297.1	7.9	-	2.2	382.5	185.5
Oct. 10	869	297.7	8.3	-	2.2	382.5	185.5
20	879	298.4	8.5	-	2.1	382.6	185.6
30	889	+299.4	+8.2	———	-1.8	-382.7	-185.7
Nov. 9	899	300.6	8.3	(0)	1.5	382.6	185.6
19	909	301.9	8.2	(- 4)	1.3	382.6	185.6
29	919	302.8	8.3	(-10)	-0.7	382.6	185.6
Dec. 9	929	303.3	8.4	(- 6)	+0.1	382.6	185.6
19	939	303.7	+9.0	(- 6)	+0.9	-382.4	-185.4
29	949	304.2	9.6	(- 1)	2.0	382.3	185.3

Table 14 (cont.)

Laboratory Time scales Date(0h UT) 1970	J.D. 2400000.5 +	RGO UTC -UTC(RGO) μs	ROJ UTC -UTC(ROJ) μs	RRL UTC -UTC(RRL) μs	TAO UTC -UTC(TAO) μs	TP UTC -UTC(TP) μs	USSR UTC -UTC(USSR) μs
Jan. 3	40589	+172.6	*+160*	-940.2	-83.7		*(-1036)*
13	599	172.7	*149*	938.2	81.1		*(-1076)*
23	609	172.8	*142*	936.8	78.5		*(-1110)*
Feb. 2	619	173.2	*136*	934.9	75.8		*(-1140)*
12	629	173.5	*126*	933.1	72.9		*(-1202)*
22	639	+173.6	*+124*	-931.5	-70.9		*(-1225)*
March 4	649	173.5	*117*	929.8	69.0		*(-1263)*
14	659	174.1	*112*	928.0	67.6		*(-1304)*
24	669	174.2	*105*	927.5	67.0		*(-1350)*
April 3	679	174.1	*102*	925.9	65.8		*(-1395)*
13	689	+174.4	*+104*	-924.5	-64.4	*+128*	*(-1430)*
23	699	174.8	*99*	922.7	62.2	*126*	*(-1479)*
May 3	709	174.9	*99*	920.6	59.9	*124*	*(-1521)*
13	719	175.0	*97*	918.9	58.1	*121*	*(-1562)*
23	729	175.0	*100*	916.9	55.9	*118*	*(-1586)*
June 2	739	+174.9	*+ 98*	-916.0	-54.5	*+116*	*(-1630)*
12	749	174.7	*98*	915.3	53.3	*115*	*(-1649)*
22	759	174.7	*96*	915.0	52.3	*114*	*(-1691)*
July 2	769	175.0	*97*	914.7	51.4	*112*	*(-1736)*
12	779	174.5	*94*	913.5	50.3	*110*	*(-1782)*
22	789	+174.4	*+ 91*	-912.0	-48.7	*+109*	*(-1833)*
Aug. 1	799	174.4	*93*	910.5	47.0	*107*	*(-1871)*
11	809	174.5	*93*	907.8	44.7	*108*	*(-1925)*
21	819	174.2	*91*	906.1	42.6	*104*	*(-1959)*
31	829	174.5	*94*	904.7	40.5	*104*	*(-1990)*
Sept. 10	839	+174.6	*+102*	-903.2	-38.8	*+104*	*(-2034)*
20	849	174.9	*104*	902.0	37.2	*101*	*(-2075)*
30	859	174.7	*101*	900.9	35.8	*100*	*(-2101)*
Oct. 10	869	174.8	*103*	899.5	34.1	*99*	*(-2136)*
20	879	174.8	*100*	897.8	32.3	*97*	*(-2176)*
30	889	+175.0	*+102*	-896.8	-31.2	*+ 96*	
Nov. 9	899	174.8	*(0)*	896.5	30.8	*93*	
19	909	174.9	*(+ 6)*	895.7	30.3	*93*	
29	919	174.9	*(+ 7)*	895.4	30.8	*91*	
Dec. 9	929	175.0	*(+ 5)*	893.7	30.1	*91*	
19	939	+174.9	*(0)*	-891.5	-28.9	*+ 90*	
29	949	175.0	*(+ 1)*	890.1	27.8	*89*	

Table 14 (cont.)

Laboratory Time scales Date (0h UT) 1970	J.D. 2400000.5 +	USNO AT -AT(USNO) [Mean (USNO)] μs	USNO UTC -UTC(USNO) [MC (USNO)] μs
Jan. 3	40589	-34417.7	+125.1
13	599	417.1	125.9
23	609	416.9	126.4
Feb. 2	619	416.7	126.7
12	629	416.4	127.1
22	639	-34416.0	+127.0
March 4	649	415.7	127.2
14	659	415.5	127.2
24	669	415.0	127.4
April 3	679	414.6	127.7
13	689	-34414.2	+127.8
23	699	413.9	128.2
May 3	709	413.5	128.3
13	719	413.1	128.4
23	729	412.7	128.7
June 2	739	-34412.3	+129.0
12	749	411.9	129.4
22	759	411.7	129.7
July 2	769	411.5	129.8
12	779	411.1	130.3
22	789	-34410.9	+130.6
Aug. 1	799	410.7	130.9
11	809	410.1	131.6
21	819	409.6	132.1
31	829	409.2	132.5
Sept. 10	839	-34408.9	+133.0
20	849	408.6	133.4
30	859	408.2	133.9
Oct. 10	869	407.7	134.4
20	879	407.4	134.9
30	889	-34407.0	+135.5
Nov. 9	899	406.7	135.8
19	909	406.5	136.1
29	919	406.3	136.4
Dec. 9	929	405.9	137.1
19	939	-34405.9	+137.1
29	949	405.7	137.4

Notes on table 14

DHI From July 10, irregularities of the frequency of the cesium standard. UTC(DHI) was given by a cristal clock from July 29 to Sept. 30, 15 h.

DO 1°) Corrigendum for 1969. Sign error made by the BIH led to erroneous results for 1969. Amended results are :

J.D. 2400000.5 +	UTC -UTC(DO)	J.D. 2400000.5 +	UTC -UTC(DO)	J.D. 2400000.5 +	UTC -UTC(DO)	J.D. 2400000.5 +	UTC -UTC(DO)
40229	+285.4 μs	40329	+265.1 μs	40429	+265.3 μs	40529	+275.9 μs
239	284.0	339	262.2	439	266.4	539	278.0
249	281.7	349	261.6	449	268.4	549	274.1
259	280.1	359	261.3	459	268.4	559	270.4
269	277.5	369	261.5	469	268.6	569	271.7
279	274.8	379	261.2	479	269.3	579	272.4
289	272.8	389	261.9	489	270.4	589	276.4
299	271.1	399	263.0	499	271.8		
309	269.1	409	263.3	509	272.6		
319	267.8	419	264.4	519	274.6		

2°) Facilities of DO moved to NRC, at the end of April, see p. 26.

ILOM Origin given by the clock transportation of 1970 Oct. 23.

NBS From Aug. 11 to Sept. 20, no LORAN-C receptions.

ON Improved origin given by the clock transportation of 1970 Feb. 21 ; The results for 1969 (Annual Report for 1969, p.64) must be corrected by adding + 2.3 μs.

OP Due to changes of master clocks on Aug. 14, 11 h UT and Aug. 26, 15 h 30 UT, the linear interpolation is not valid in the vicinity of these dates. Daily values at 0h UT are :

J.D. 2400000.5 +	UTC -UTC(OP)	J.D. 2400000.5 +	UTC -UTC(OP)	J.D. 2400000.5 +	UTC -UTC(OP)
40809	- 7.5 μs	40816	- 6.1 μs	40823	- 3.9 μs
810	7.4	817	5.7	824	3.6
811	7.4	818	5.4	825	3.3
812	7.3	819	5.1	826	3.3
813	7.1	820	4.8	827	3.2
814	6.8	821	4.5	828	3.1
815	6.4	822	4.2	829	3.0

ROJ Origin given by the clock transportation of 1970 April 15.

RRL 1°) Corrigendum for 1969. Improved values of UTC(USNO) - LORAN-C, Northwest Pacific give the following results :

J.D. 2400000.5 +	UTC -UTC(RRL)	J.D. 2400000.5 +	UTC -UTC(RRL)
40489	-957 μs	40539	-949 μs
499	956	549	947
509	954	559	946
519	953	569	944
529	950	579	942

2°) From 1970 Nov. 19, the results are provisional.

TAO 1°) New origin from Jan. 3 (change of cesium tube)

2°) From 1970 Nov. 19, the results are provisional.

Table 15 - Comparisons between the clock transportations and the LORAN-C or vlf links.

The table gives the differences between the clock transportation results and those obtained by Loran-C or vlf for some pairs of laboratories. The 1969 results have been added. The clock transportations used to fix the origins are denoted by *.

Time comparisons	Date	J.D. 2440000.5 +	Difference (μ s)
UTC (USNO)			
-			
UTC (DHI)	1970 Oct. 12	871.5	0.0*
UTC (FOA)	1969 Jul. 16	418.7	0.0*
UTC (MSO)	1969 May 14	355.1	+8
	Nov. 6	531.9	-5
	1970 Sep. 28	857.2	0 *
UTC (NBS)	1969 Jan. 29	250.7	-1
	Feb. 20	272.9	+4
	Apr. 24	335.9	+3
	Aug. 13	447.0	0.0
	1970 Jan. 16	602.3	-0.9
	Jun. 18	755.7	+0.4
	Dec. 3	923.6	+1.9
UTA (NRC)	1969 Aug. 7	440.7	+0.1
	1970 May 12	718.6	-0.2
	Sep. 10	839.7	-0.9
UTC (ON)	1970 Feb. 21	638.4	0.0*
UTC (OP)	1969 Feb. 24	276.3	-0.1
	Jul. 11	413.7	+0.2
	Oct. 29	523.3	-0.3
	1970 Feb. 16	633.4	-0.5
	Jun. 22	759.3	0.0
	Aug. 15	813.3	-0.6
	Sep. 10	839.7	-0.6
	Oct. 20	879.3	-0.4
UTA (PTB)	1969 Jul. 21	423.4	+0.3
	1970 Oct. 13	872.4	+0.1
UTC (RGO)	1969 Feb. 25	277.5	0.0*
	Jul. 10	412.6	+0.1
	1970 Feb. 17	634.3	-0.1
	Jun. 22	759.6	+0.1
	Sep. 14	843.8	-0.6
	Sep. 29	858.5	-0.5
UTC (ROJ)	1969 Jul. 21	423	0 *
	Aug. 7	440.3	0 *
	Nov. 19	544.4	-25
	1970 Apr. 15	691.3	0 *
	Sep. 16	845.6	-25
UTC (RRL)	1969 Feb. 28	280.1	+5
	May 16	357.1	+1
	Sep. 16	480.2	-1

Time comparisons	Date	J.D. 2440000.5 +	Difference (μ s)
UTC (USNO)			
-			
UTC (RRL)	1970 Jan. 23	609.2	-0.6
	Apr. 20	696.3	-1.2
	Jul. 29	796.1	-1.4
	Nov. 12	902.1	-1.1
UTC (TAO)	1969 Feb. 28	280.1	+6
	May 16	357.1	-6
	Sep. 16	480.1	+1
	1970 Jan. 23	609.2	0.0*
	Apr. 20	696.2	-0.5
	Jul. 29	796.1	-0.8
	Nov. 12	902.1	-0.6
UTC (OP)			
-			
UTA (NRC)	1970 Sep. 10	839.5	-0.3
UTC (ON)	1970 Feb. 21	638.4	+0.3
	May 12	718.5	+1.0
	May 27	733.5	-0.3
UTA (PTB)	1969 Jun. 23	395.6	0.0
	1970 Oct. 13	872.4	+0.5
UTC (RGO)	1969 Feb. 25	277.5	+0.2
	Jul. 10	412.6	-0.1
	1970 Feb. 17	634.3	+0.3
	Jun. 22	759.6	+0.1
	Sep. 9	838.9	-0.1
UTA (PTB)			
-			
UTC (DHI)	1970 Oct. 12	871.5	-0.1
UTC (RGO)			
-			
UTA (NRC)	1970 Sep. 10	839.5	-0.2
UTC (ON)	1970 Feb. 21	638.4	+0.1
UTC (RRL)			
-			
UTC (TAO)	1969 Feb. 28	280.1	+1
	May 16	357.1	-7
	Sep. 16	480.1	+2
	1970 Jan. 23	609.2	+0.6
	Apr. 20	696.3	+0.7
	Jul. 29	796.1	+0.6
	Nov. 12	902.1	+0.5

Table 16 - Comparisons with the BIH times, occasional measurements.

Values of UTC-UTC(i) for some time scales
1) not permanently linked to the BIH by radioelectric means,
2) linked by vlf only,
3) not associated to atomic standards of time.

Laboratory i	Designation of the time scale of i	Date	UTC-UTC(i) μs	Remarks sources
Mount Stromlo Obs. Canberra, Australia	UTC(MSO)	1970 Sept. 28	+151.2	USNO clock transportation
PMG Research Lab. (Australian Post Office) Melbourne, Australia	UTC(APO) (1)	1970 March 31 Sept. 25	+157.1 +162.4	" "
Rep. Obs. Johannesburg South Africa	UTC(ROJ)	1970 April 15 Sept. 16	+102.8 + 78.5	" "
Telecommunication Lab. Taiwan, Republic of China	UTC(TCL)	1970 April 25 July 22 Nov. 15	+122.5 +122.9 +128.7	" "
Zentralinstitut Physik der Erde, Potsdam, D.R. of Germany	UTC(ZIPE)	1970 Jan. 13 Feb. 12 March 14 April 13 May 13 June 12 July 12 Aug. 11 Sept. 10 Oct. 10 Nov. 9 Dec. 9	+ 3 - 17 - 3 + 16 - 8 - 15 - 30 - 28 - 24 - 29 - 46 - 49	Mean of the data obtained by vlf and by television link with DHI

(1) designated by UTC(PMG) in 1969.

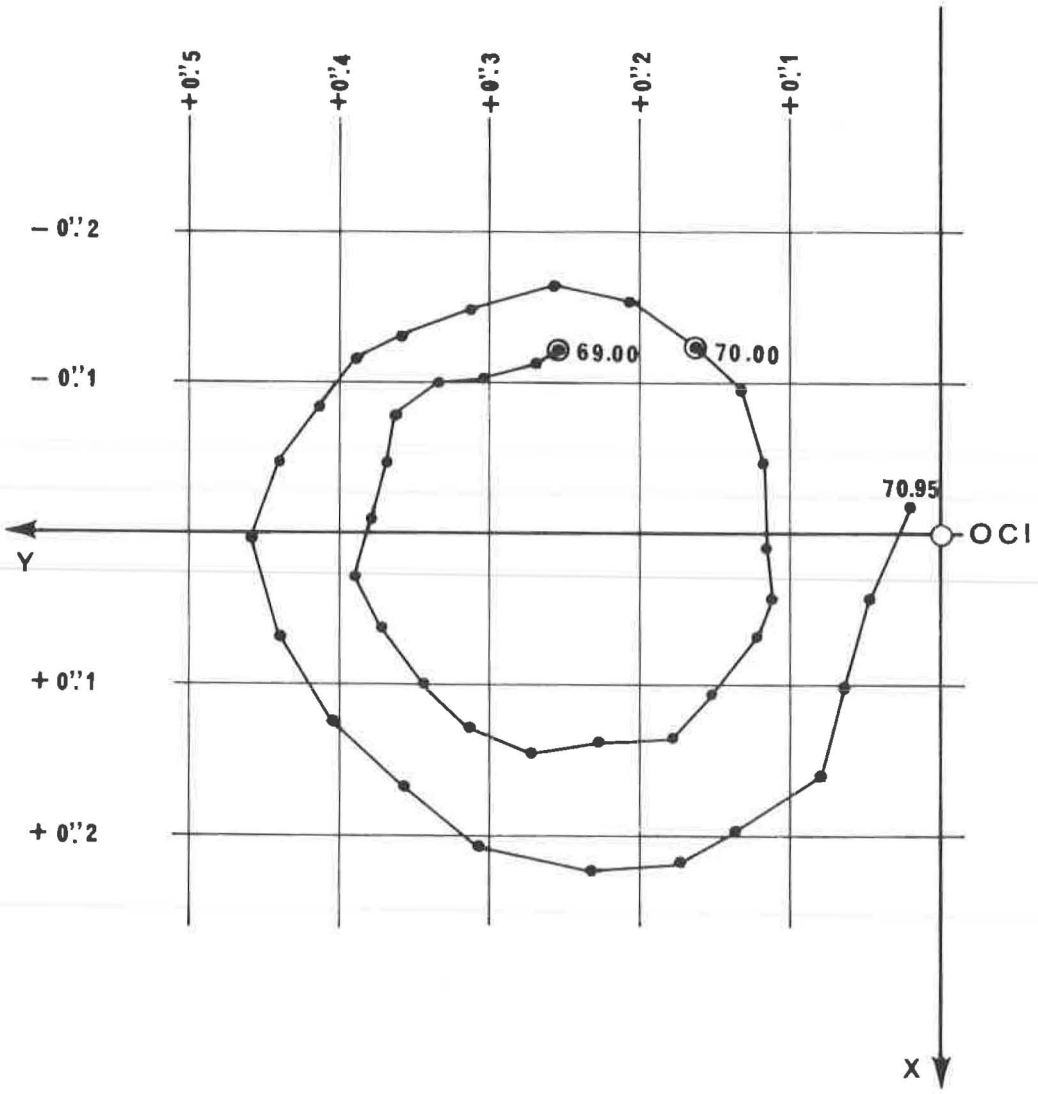

Fig. 1. - Path of the pole from 1969.00 to 1970.95 (unsmoothed values computed for every 1/20 th of a year for the preservation of the reference system).

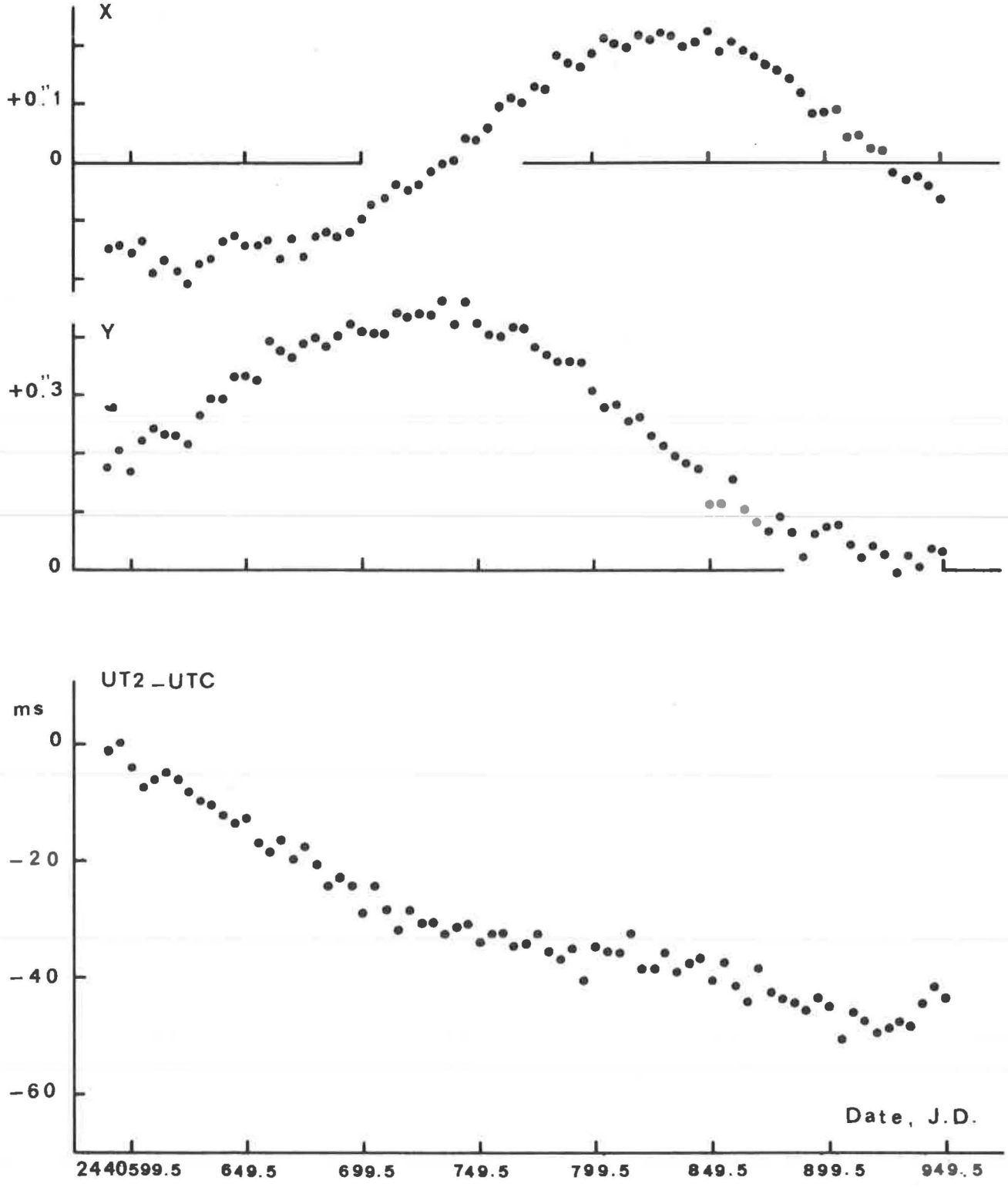

Fig. 2. - Raw values of x, y, UT2-UTC for every 5 days.

PART III

TIME SIGNALS

(1)

In the following tables, characteristics of the main time signal emissions are shown. They are established with all informations received until april 1971. The adresses of the authorities responsible for the emissions are given next page.

The carriers of the following time signals are standard frequencies.

Station	Accuracy of the carrier's frequency in 10^{-10}	Notes
CHU	0.2	carrier's offset : -300×10^{-10} (1)
DCF77	0.2	
FFH	2	carrier's offset : -300×10^{-10}
GBR	0.2	carrier's offset : -300×10^{-10}
HBG	0.02	
IAM	0.5	carrier's offset : -300×10^{-10}
IBF	0.5	
JJY	0.5	carrier's offset : -300×10^{-10}
LOL1	0.2	carrier's offset : -300×10^{-10}
MSF (60 kHz)	0.2	
MSF (h.f.)	1	
NBA	0.5	carrier's offset : -300×10^{-10}
NSS	0.5	carrier's offset : -300×10^{-10}
OMA (all frequencies)	10	carrier's offset : -300×10^{-10}
VNG	1	carrier's offset : -300×10^{-10}
WWV	0.1	carrier's offset : -300×10^{-10}
WWVB	0.1	
WWVH	0.5	carrier's offset : -300×10^{-10}
ZUO	0.5	

(1) — It is reminded that the possible new definition of UTC on 1972 Jan. 1st may change some of the informations given in this section. When the new definition is adopted, the offset of the carriers will disappear.

AUTHORITIES RESPONSIBLE FOR THE TIME SIGNAL EMISSIONS

Signal	Authority
CHU	National Research Council, Time and Frequency Section Physics Division (M-36) **Ottawa** 7, Ontario, Canada Attn : Mr Malcolm M. Thomson.
DAM, DAN, DAO	Deutsches Hydrographisches Institut **2 Hamburg 4**, Federal Republic of Germany.
DCF77	Physikalisch-Technische Bundesanstalt, Laboratorium 1.22 **33 Braunschweig** Bundesallee 100, Federal Republic of Germany.
DGI, DIZ	Central Institute of Physics of the Earth Department Geodesy and Gravimetry Time Service DDR 15 **Potsdam** Telegraphenberg A 17
FFH	Centre National d'Etudes des Télécommunications Groupement Etudes spatiales et Transmissions Département Dispositifs et Ensembles fonctionnels 38, rue du Général Leclerc, **92 - Issy-les-Moulineaux**, France.
FTA91, FTH42 FTK77, FTN87	Observatoire de Paris, Service de l'Heure, 61, avenue de l'Observatoire, **Paris 14ème**, France.
GBR MSF	National Physical Laboratory, Electrical Science Division **Teddington**, Middlesex, United Kingdom.
HBG	Service horaire HBG Observatoire Cantonal, CH - **2000 - Neuchâtel**, Suisse.
IAM	Istituto Superiore Poste e Telecomunicazioni Viale di Trastevere, 189 00100 - **Roma**, Italy
IBF	Istituto Elettrotecnico Nazionale Galileo Ferraris Corso Massimo d'Azeglio, 42 10125 - **Torino**, Italy
JJY, JG2AE, JG2AS	Frequency Standard Division The Radio Research Laboratories Ministry of Posts and Telecommunications Midori-cho, Koganei, **Tokyo 184**, Japon.

Signal	Authority
LOL	Director Observatorio Naval Av. Costanera Sur, Jovellanos **Buenos Aires**, Republica Argentina
LQB9, LQC20	Servicio internacional de la Hora Gral. Savio 865 Villa Maipú **San Martin**, Pcia. de Buenos Aires Republica Argentina.
NBA, NDT, NPG, NPM, NPN, NSS, NWC	Superintendant U.S. Naval Observatory **Washington**, D.C. 20390 U.S.A.
OLB5, OMA	1° - Time information : Astronomický ústav ČSAV, Budečska 6, **Praha 2**, Vinohrady, Czechoslovakia. 2° - Standard frequency information. Ústav radiotechniky a elektroniky ČSAV, Lumumbova 1, **Praha 8**, Kobylisy, Czechoslovakia.
PPE, PPR	Time Service Observatório Nacional Rua General Bruce, 586 **Rio de Janeiro**. GB.ZC-08, Brasil.
RAT, RCH, RES RID, RIM, RKM, RWM	Comité d'Etat des Normes Conseil des Ministres de l'URSS **Moscou**, USSR, Leninski prosp., 9.
VNG	Divisional Engineer Frequency Standards Division P.M.G. Research Laboratories 59 Little Collins Street **Melbourne**, VIC. 3000, Australia
WWV, WWVH WWVB	Frequency-Time Broadcast Services Section Time and Frequency Division National Bureau of Standards **Boulder**, Colorado 80302, U.S.A.
ZUO	Republic Observatory **Johannesburg** South Africa.

a - Time signals following UTC (offset : - 300 × 10^{-10}, since 1966 Jan. 1 at 0h UT).

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UT)	Form of the time signals
CHU	Ottawa Canada +45° 18' +75° 45'	3330 7335 14670	continuous	Second pulses of 300 cycles of a 1 kHz modulation. Minute pulses are 0.5 s long. A bilingual (Fr.-Eng.) announcement of time is made each minute. ΔUT code
DAM	Elmshorn Germany, F.R. +53° 46' - 9° 40'	8638.5 16980 4625 8638.5 6475.5 12763.5	11 h 55 m to 12 h 6 m 23 h 55 m to 24 h 6 m from 21 Sept. to 20 March 23 h 55 m to 24 h 6 m from 21 March to 20 Sept.	New international system, then second pulses from minutes 0.5 to 6.0 (minute pulses prolonged). A1 type. "
DAN	Norddeich Germany, F.R. +53° 36' - 7° 8'	2614	11 h 55 m to 12 h 6 m 23 h 55 m to 24 h 6 m	As DAM (see above)
DAO	Kiel Germany, F.R. +54° 26' -10° 8'	2775	11 h 55 m to 12 h 6 m 23 h 55 m to 24 h 6 m	As DAM (see above)
DGI	Oranienburg Germ.Dem.Rep. +52° 48' -13° 24'	185	5 h 59 m 30 s to 6 h 00 m 11 h 59 m 30 s to 12 h 00 m 17 h 59 m 30 s to 18 h 00 m	A2 type second pulses of 0.1 s duration for seconds 30-40, 45, 50, 58, 59, 60.
DIZ	Nauen Germ.Dem.Rep. +52° 39' -12° 55'	4525	continuous except from 8 h 15 m to 9 h 45 m	A1 type second pulses of 0.1s duration. Minute pulses prolonged to 0.5 s. Hour pulses marked by prolonged pulses for seconds 58, 59, 60. Experimental code giving UT1 - UTC.
FFH	Chevannes France +48° 32' - 2° 27'	2500	between the minutes 9 m 45 s and 20 m, 30 m and 40 m, 49 m 45 s and 60 m, from 8 h to 16 h 25 m except Saturday and Sunday.	Second pulses of 5 cycles of 1 kHz modulation. Minute pulses are followed by a 500 Hz modulation.
FTA91	Saint-André-de-Corcy France +45° 55' - 4° 55'	91.15	at 8 h, 9 h, 9 h 30 m, 13 h, 20 h, 21 h, 22 h 30 m.	A1 type second pulses during the 5 minutes preceding the indicated times. Minute pulses are prolonged.
FTH42 FTK77 FTN87	Pontoise France +49° 4' - 2° 7'	7428 10775 13873	at 9 h and 21 h at 8 h and 20 h at 9 h 30 m, 13 h, 22 h 30 m	A1 type second pulses during the 5 minutes preceding the indicated times. Minute pulses are prolongated.
GBR	Rugby United Kingdom +52° 22' + 1° 11'	16	at 3 h, 9 h, 15 h, 21 h	A1 type second pulses during the 5 minutes preceding the indicated times.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UT)	Form of the time signals
HBG	Prangins Switzerland +46° 24' – 6° 15'	75	continuous	Interruption of the carrier at the beginning of each second, during 100 ms. The minutes are identified by a double pulse, the hours by a triple pulse.
IAM	Rome Italy +41° 52' –12° 27'	5000	from 7 h 30 m to 8 h 30 m and from 13 h 0 m to 14 h 0 m 10 m every 15 m exc. Sun. Advanced by 1 hour in summer.	Second pulses of 5 cycles of 1 kHz modulation. Minute pulses of 20 cycles (Announcements and 1 kHz modulation, 5 m before the emission of time signals).
IBF	Torino Italy +45° 2' – 7° 42'	5000	During 15 m preceding 7 h, 9 h, 10 h, 11 h, 12 h, 13 h, 14 h, 15 h, 16 h, 17 h, 18 h. Advanced by 1 hour in summer.	Second pulses of 5 cycles of 1 kHz modulation. These pulses are repeated 7 times at the minute. Voice announcements at the beginning and end of each emission.
JG2AE	Koganei Japan +35° 42' – 139° 31'	8000	from 20 h 59 m to 10 h 59 m, interruptions between minutes 25 and 34	Second pulses of 1600 Hz modulation. Minute pulses are preceded by a 600 Hz modulation.
JG2AS	Chiba Japan +35° 38' – 140° 4'	40	from 0 h to 8 h, except Sunday, interruptions during communications	Al second pulses of 0.5 sec. duration. Second 59 is omitted.
JJY	Koganei Japan +35° 42' – 139° 31'	2500 5000 10000 15000	continuous, except interruptions between minutes 25 and 34.	Second pulses of 8 cycles of 1600 Hz modulation. Minute pulses are preceded by a 600 Hz modulation.
LOL1	Buenos-Aires Argentina –34° 37' + 58° 21'	5000 10000 15000	0 h to 1 h, 12 h to 13 h, 15 h to 16 h, 18 h to 19 h, 21 h to 22 h Substract 1 h from first Sunday of Oct. to the Sat. preceding the first Sunday of April	Second pulses of 5 cycles of 1000 Hz modulation. Second 59 is omitted. Announcement of hours and minutes every 5 minutes, followed by 3 m of 1000 Hz and 440 Hz modulation.
LOL2 LOL3	Buenos-Aires Argentina –34° 37' +58° 21'	8030 17180	1 h, 13 h, 21 h Summer time : see above	Al second pulses during the 5 minutes preceding the indicated times. Minute pulses are prolonged.
LQB9 LQC20	Planta Gral Pacheco –34° 26' +58° 37'	8167.5 17551.5	22 h 5 m, 23 h 50 m 10 h 5 m, 11 h 50 m	Al second pulses during the 5 minutes preceding the indicated times. Second 59 is omitted, second 60 is prolonged. After the emission, OK is transmitted if the emission is correct, NV if not correct.
MSF	Rugby United Kingdom +52° 22' + 1° 11'	60	continuous except for an interruption for maintenance from 10 h 0 m to 14 h 0 m on the first Tuesday in each month	Interruptions of the carrier of 100 ms for the second pulses, of 500 ms for the minute pulses. The signal is given by the beginning of the interruption.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UT)	Form of the time signals
MSF	Rugby United Kingdom +52° 22' + 1° 11'	2500 5000 10000	between minutes 0 and 5, 10 and 15, 20 and 25, 30 and 35, 40 and 45, 50 and 55	Second pulses of 5 cycles of 1 kHz modulation. Minute pulses are prolonged.
NBA	Balboa USA + 9° 3' +79° 39'	24 • 147.85 5448.5 11080 17697.5	Every even hour except 24 h and during Monday maintenance (1200 to 1800) 5 h, 11 h, 17 h, 23 h	CW second pulses during the 5 minutes preceding the indicated times on the American Code time format.
NDT	Yosami Japan +34° 58' - 137° 1'	17.4	to be determined	To be determined
NPG	San Francisco USA +38° 6' +122° 16'	3268 4010 6428.5 9277.5 12966 16950	6 h, 12 h, 18 h, 24 h	CW second pulses during 5 minutes preceding the indicated times on the American Code time format
NPM	Honolulu USA +21° 25' +158° 9'	131.05 4525 9050 13655 16457.5 20575 22593	6 h, 12 h, 18 h, 24 h	CW second pulses during 5 minutes preceding the indicated times on the American Code time format
NPN	Guam USA +13° 27' -144° 43'	484 4955 8150 13380 17530 21760	6 h, 12 h, 18 h, 24 h	CW second pulses during 5 minutes preceding the indicated times on the American Code time format
NSS	Annapolis USA +38° 59' +76° 27'	21.4 88 5870 8090 12135 16180 20225 25590	Every hour except during Wednesday maintenance (1300 to 1900) 5 h, 11 h, 17 h, 23 h (on Tuesday 17 h the frequency 185 kHz replaces 88 kHz) 17 h, 23 h	CW second pulses during 5 minutes preceding the indicated times on the American Code time format. Transmissions on 21.4 kHz are temporarily suspended until about August 1971.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UT)	Form of the time signals
NWC (1) See p. 87	Exmouth Australia - 21° 49' -114° 9'	22.3	4 h 30 m, 16 h 30 m	Experimental. FSK second pulses during 2 minutes preceding the indicated times on the American Code time format.
OLB5	Podebrady Czechoslovakia + 50° 9' - 15° 8'	3170	continuous except from 5 h to 11 h on the first Wednesday of every month	A1 type, second pulses
OMA	Liblice Czechoslovakia + 50° 4' - 14° 53'	50	continuous except from 5 h to 11 h on the first Wednesday of every month	Interruption of the carrier of 100 ms at the beginning of every second, of 500 ms at the beginning of every minute. The precise time is given by the instant when the amplitude is reduced by 50 %.
		2500	between minutes 5 and 15 25 and 30, 35 and 40, 50 and 60 of every hour except from 5 h to 11 h on the first Wednesday of every month	Pulses of 5 cycles of 1 kHz modulation (prolonged for the minutes). The first pulse of the 5th minute is prolonged to 500 cycles.
PPE	Rio de Janeiro Brasil - 22° 54' + 43° 13'	8721	0 h 30 m, 13 h 30 m, 20 h 30 m	Second ticks, of A1 type, during the five minutes preceding the indicated hours. The minute ticks are longer
PPR	Rio de Janeiro Brasil - 22° 59' + 43° 11'	435 8634 13105 17194.4	01 h 30 m, 14 h 30 m, 21 h 30 m	Second ticks, of A1 type, during the five minutes preceding the indicated hours. The minute ticks are longer
RAT	Moscow USSR + 55° 45' - 37° 18'	2500	between minutes 30 and 35, 41 and 45, 50 and 60 1°) from 1 h 30 m to 3 h 13 h 30 m to 0 h from 1 Sept. to 31 March 2°) from 15 h 30 m to 23 h 45 m from 1 April to 31 Aug.	Second pulses (minute pulses prolonged) Rythmic signals between minutes 1 and 6, at 0 h, 2 h, 4 h,...
		5000	between minutes 30 and 35, 41 and 45, 50 and 60 1°) from 3 h 30 m to 13 h from 1 Sept. to 31 March 2°) from 1 h 30 m to 15 h from 1 April to 31 Aug.	
RCH	Tashkent USSR + 41° 19' - 69° 15'	2500	between minutes 15 and 20, 25 and 30, 35 and 40, 45 and 50 of every hour except from 4 h 15 m to 4 h 50 m	Second pulses (minute pulses prolonged)
RES	Moscow USSR +55° 45' -37° 18'	100*	between minutes 0 and 5 of every hour except 20 h	A1 type. Second pulses (minute pulses prolonged)

**In 1971, the frequency 66,6 kHz replaces the frequency 100 kHz during April, on Fridays,*
during May, on Wednesdays,
during June on Mondays, Wednesdays, Fridays.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UT)	Form of the time signals
RID	Irkutsk USSR + 52° 18' – 104°18'	10004	between minutes 15 and 20 25 and 30, 51 and 60 1°) from 9 h 15 m to 17 h 0 m 18 h 15 m to 22 h 30 m from 1 Sept. to 31 March 2°) from 13 h 15 m to 17 h 0 m 18 h 15 m to 21 h 0 m from 1 April to 31 Aug.	Second pulses (minute pulses prolonged) Rythmic signals between minutes 1 and 6 at 0 h, 2 h, 4 h,... Second pulses are also transmitted between minutes 5 and 10 at 1 h, 3 h, 5 h,..
		15004	1°) from 23 h 15 m to 8 h 30 m from 1 Sept. to 31 March 2°) 21 h 15 m to 12 h 30 m from 1 April to 31 Aug.	
RIM	Tashkent USSR +41° 19' –69° 15'	5000 or 10000	between minutes 15 and 20 25 and 30, 35 and 40, 45 and 50 from 0 h 15 m to 1 h 30 m (5 MHz) from 2 h 15 m to 3 h 30 m (5 or 10)	Second pulses (minute pulses prolonged)
		see below*	from 5 h 15 m to 5 h 30 m (10) from 6 h 15 m to 7 h 30 m (10) from 8 h 15 m to 9 h 30 m (10) from 10 h 15 m to 11 h 30 m (10) from 12 h 15 m to 13 h 30 m (5 or 10) from 14 h 15 m to 15 h 30 m (5 or 10) from 16 h 15 m to 17 h 30 m (5) from 18 h 15 m to 19 h 30 m (5) from 20 h 15 m to 21 h 30 m (5) from 22 h 15 m to 23 h 30 m (5)	
RKM	Irkutsk USSR +52° 18' –104° 18'	5004 or 10004 or	between minutes 15 and 20 25 and 30, 51 and 60 from 1 h 51 m to 3 h 0 m (10 MHz) from 3 h 51 m to 5 h 0 m (10)	Second pulses (minute pulses prolonged)
		15004	from 5 h 51 m to 7 h 0 m (10) from 7 h 51 m to 9 h 0 m (10) from 9 h 51 m to 11 h 0 m (10 or 15) from 11 h 51 m to 13 h 0 m (10 or 15)	Rythmic signals between minutes 1 and 6 at 0 h, 2 h, 4 h,... Second pulses are also transmitted between minutes 5 and 10 at 1 h, 3 h, 5 h,..
		see below*	from 13h51m to 15h0m (5) from 15h51m to 17h0m (5) from 18h15m to 19h0m (5) from 19h51m to 23h0m (5) from 23h51m to 1h0m (5 or 10)	

* *When two frequencies are simultaneously possible, the lower is transmitted from Sept. 1., to March 31, the higher from April 1 to August 31.*

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UT)	Form of the time signals
RTA	Novossibirsk USSR + 55° 4' – 82° 58'	4996 or 9996 or 14996 see below*	between minutes 5 and 10, 15 and 20, 25 and 29, 35 and 39 from 0 h 5 m to 1 h 29 m (5 or 10 MHz) from 3 h 5 m to 3 h 29 m (10) from 4 h 5 m to 5 h 29 m (10) from 6 h 5 m to 7 h 29 m (15) from 8 h 5 m to 9 h 29 m (15) from 10 h 5 m to 11 h 29 m (15) from 12 h 5 m to 13 h 29 m (10) from 14 h 5 m to 15 h 29 m (10) from 16 h 5 m to 17 h 29 m (5 or 10) from 18 h 5 m to 19 h 29 m (5 or 10) from 20 h 5 m to 21 h 29 m (5 or 10) from 22 h 5 m to 23 h 29 m (5 or 10)	Second pulses (minute pulses prolonged)
RWM	Moscow USSR + 55° 45' – 37° 18'	10000 or 15000 see below*	between minutes 30 and 35, 41 and 45, 50 and 60, from 1 h 50 m to 3 h 0 m (10 or 15 MHz) from 4 h 30 m to 5 h 0 m (15) from 5 h 50 m to 7 h 0 m (15) from 7 h 50 m to 9 h 0 m (15) from 9 h 50 m to 11 h 0 m (15) from 11 h 50 m to 13 h 0 m (15) from 14 h 30 m to 15 h 0 m (10 or 15) from 15 h 50 m to 17 h 0 m (10) from 17 h 50 m to 19 h 0 m (10) from 19 h 50 m to 21 h 0 m (10) from 21 h 50 m to 23 h 0 m (10)	Second pulses (minute pulses prolonged) Rythmic signals between minutes 1 and 6 at 0 h, 2 h, 4 h,...
VNG	Lyndhurst Australia – 38° 3' + 145° 16'	4500 7500 12000	9 h 45 m to 21 h 30 m continuous except 22 h30m to 22 h 45 m 21 h 45 m to 9 h 30 m	Pulses of 50 cycles of 1 kHz modulation; 5 cycles only for seconds 55 to 58 ; second 59 omitted. For minutes 5, 10, 15, etc, 5 cycles for seconds 50 to 58. Identification by voice announcement.
WWV	Fort-Collins USA + 40° 41' + 105° 2'	2500 5000 10000 15000 20000 25000	continuous except between minutes 45 and 48	Pulses of 5 cycles of 1 kHz modulation. Second 59 is omitted. Second 0 is repeated. Coded announcement of day, hour and minute. Voice announcement of UT. Coded UT2 correction

* *When two frequencies are simultaneously possible, the lower is transmitted from Sept. 1., to March 31, the higher from April 1 to August 31.*

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UT)	Form of the time signals
WWVH	Maui (2) USA + 20° 46' +156° 28'	2500 5000 10000 15000	continuous, except between minutes 15 and 19	Pulses of 6 cycles of 1200 Hz modulation Second 59 is omitted. Second 0 is repeated. Voice announcement of UT. Coded UT2 correction
ZUO	Olifantsfontein South Africa -25° 58' -28° 14' Johannesburg South Africa -26° 11' -28° 4'	5000 10000	continuous, except between minutes 15 and 20	Pulses of 5 cycles of 1 kHz modulation. Second 0 is prolonged.

b - Time signals following SAT

DCF77	Mainflingen Germany, F.R. +50° 1' - 9° 0'	77.5	continuous , except second Tuesday of every month from 4 h to 8 h	The second marks are reduction to 1/4 of the carrier's amplitude of 0.1 s duration ; the reference point is the beginning of the pulse modulation. The second 59 is omitted.
WWVB	Fort Collins USA + 40° 40' +105° 3'	60	continuous	Second pulses given by reduction of the amplitude of the carrier. Coded announcement of the date and time and of the correction to obtain UT.

c - Other time signals

BPV*	Shanghaï China, P.R. + 31° 12' -121° 26'	5430 9351	17 h, 19 h, 21 h 6 h, 11 h, 13 h, 15 h, 17 h 21 h, 23 h	Second pulses during the 5 minutes preceding the indicated times then rythmic time signals.
		5000 10000 15000	from 10 h to 12 h from 0 h to 3 h 45 m, from 6 h to 9 h 45 m from 4 h to 5 h 45 m	Second pulses given by modulation of the carrier during the 3 minutes following the 0, 15, 30 and 45 minutes
XSG*		458 6414.5 8502 12871.5	 3 h, 9 h	ONOGO then rythmic time signals

* *no recent informations on these emissions.*

(2) - See p. 87

Notes on the characteristics of time signals

(1) NWC - Time control of the transmissions from NWC Harold E. Holt, Australia will begin on an experimental basis in January 1971.

Carrier frequencies of 22300 cycles and 22350 cycles will be phase stabilized.

50 baud frequency shift keying will be employed with bit lengths of 20 ms.

Transition between frequencies will require approximately 2 ms.

The time of the half way point of the transition will be maintained within $\pm 10\,\mu$sec of the station clock.

This point will also be identical with the phase coincident point between the two carriers.

The zero crossing of the positive slope of the 22300 cycle carrier will be controlled in time to ± one μs of the station clock.

Time signals will be broadcast in the American Code beginning 2 minutes before and ending one second after certain half hours.

The one second pulses for the American Code will consist of 300 ms of 20 ms reversals followed by 700 ms of steady signal of the 22350 cycle carrier (SPACE). The beginning of the second will occur at the half transition point at the start of the reversals (22350 → 22300).

(2) WWVH is being relocated from Maui to Kauai, Hawai (latitude : + 21° 59', longitude : + 159° 46') and expected to go into operation at the new site on or about July 1, 1971.

Time of emission of the time signals, following the UTC system.

The asterisk (*) denotes that the error on E is less than $0^{s}.0001$.
E = UTC - Signal (unit : $0^{s}.0001$)

Signal Month 1970	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
CHU (1)	+3*	+3*	+3*	+3*	-5*	-5*	-5*	0*	0*	0*	0*	-1*
DAM, DAN, DAO	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
DCF77 (DHI) (2)	0*	0*	0*	-	-	-	-	-	-	-	-	-
DGI	+3*	+3*	+3*	+3*	+3*	+3*	+3*	+3*	+3*	+3*	+3*	+3*
DIZ	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
FFH	+2	+3	+2	+3	+2	+3	+3	+4	+3	+4	+5	+5
FTA91	-8	-6	-6	-5	-8	-7	-6	-3	-3	-3	-1	-1
FTH42, FTK77, FTN87	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
HBG (3)	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*	0*
IAM	-2	-3	-4	-4	-3	-2	-2	-3	-4	-3	-2	-1
IBF (4)	-4	+1	+1	+1	+1	+1	+1	+1	+1	+1	+2	+2
JJY	-9	-10	-9	-10	-10	-10	-11	-11	-11	-11	-10	-9
LOL (all emissions)	+3	-6	-10	-8	-5	-11	-9	-8	-8	-8	-15	-13
MSF, GBR	+2*	+2*	+2*	+2*	+2*	+2*	+2*	+2*	+2*	+2*	+2*	+2*
NSS (h.f.)	+7	-5	0	+2	+1	+2	+3	+2	-3	-9	-10	-10
OLB5	+13*	+13*	+13*	+13*	+13*	+13*	+14*	+14*	+9*	+9*	+9*	+9*
OMA	+1*	+1*	+1*	+1*	+1*	+1*	+2*	+2*	+1*	+1*	+1*	+1*
PPE	+17	+15	+9	+15	+11	+13	+16	+16	+16	+12	+8	+11
RWM (5)	-232	-234	-236	-236	-238	-240	-242	-244	-245	-245	-246	-246
VNG	+2	+2	+2	+3	+3	+3	+3	+3	+3	+3	+2	+1
WWV, WWVH	+1*	+1*	+1*	+1*	+1*	+1*	+1*	+1*	+1*	+1*	+1*	+1*
ZUO	+4	+6	+1	+3	+3	+4	+5	+3	+2	+1	+2	+0

(1) - CHU is related to UTA (NRC) since 1970 May 4, 14 h UT. The step occured at this date. The values of E published in Circular D since Aug. require corrections.

(2) - DCF77 : the transmission of UTC time signals by DCF77 was discontinued in April.

(3) - HBG : the deviation between UTC and the reference clock of HBG is kept smaller than 100 μ s. The values of E refers to this clock. The point at 50 % of the amplitude is late by 450 μ son the clock.

(4) - IBF : the step between Jan. and Feb. is due to an improvement of the computation of E (no step of the emission).

(5) - RWM and other emissions from USSR.

Time of emission of the time signals, following the SAT system.

Signal		
DCF77 (PTB)	SAT-DCF77 = $0^{s}.0000$*	for 1970
WWVB	SAT-WWVB = $+0^{s}.0001$*	