BUREAU INTERNATIONAL DE L'HEURE – ANNUAL REPORT – 1976

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All communications should be addressed to :

M. le Directeur, Bureau International de l'Heure - 61, avenue de l'Observatoire - 75014 Paris

Table 9 – Offsets and step adjustments of UTC, until 1977 Dec. 31

Date (at 0h UT)	Offsets	Steps
1961 Jan. 1	-150×10^{-10}	
Aug. 1	”	+ 0.050 s
1962 Jan. 1	-130×10^{-10}	
1963 Nov. 1	”	– 0.100 s
1964 Jan. 1	-150×10^{-10}	
April 1	”	– 0.100 s
Sept. 1	”	– 0.100 s
1965 Jan. 1	”	– 0.100 s
March 1	”	– 0.100 s
July 1	”	– 0.100 s
Sept. 1	”	– 0.100 s
1966 Jan. 1	-300×10^{-10}	
1968 Feb. 1	”	+ 0.100 s
1972 Jan. 1	0	– 0.107 7580 s
July 1	”	– 1 s
1973 Jan. 1	”	– 1 s
1974 Jan. 1	”	– 1 s
1975 Jan. 1	”	– 1 s
1976 Jan. 1	”	– 1 s
1977 Jan. 1	”	– 1 s

Table 10 – Relationship between TAI and UTC, until 1977 Dec. 31

Limits of validity (at 0h UT)	TAI – UTC
1961 Jan. 1 - 1961 Aug. 1	1.422 818 0 s + (MJD - 37 300) x 0.001 296 s
Aug. 1 - 1962 Jan. 1	1.372 818 0 s + ” ”
1962 Jan. 1 - 1963 Nov. 1	1.845 858 0 s + (MJD - 37 665) x 0.001 123 2 s
1963 Nov. 1 - 1964 Jan. 1	1.945 858 0 s + ” ”
1964 Jan. 1 - April 1	3.240 130 0 s + (MJD - 38 761) x 0.001 296 s
April 1 - Sept. 1	3.340 130 0 s + ” ”
Sept. 1 - 1965 Jan. 1	3.440 130 0 s + ” ”
1965 Jan. 1 - March 1	3.540 130 0 s + ” ”
March 1 - July 1	3.640 130 0 s + ” ”
July 1 - Sept. 1	3.740 130 0 s + ” ”
Sept. 1 - 1966 Jan. 1	3.840 130 0 s + ” ”
1966 Jan. 1 - 1968 Feb. 1	4.313 170 0 s + (MJD - 39 126) x 0.002 592 s
1968 Feb. 1 - 1972 Jan. 1	4.213 170 0 s + ” ”
1972 Jan. 1 - July 1	10.000 000 0 s
July 1 - 1973 Jan. 1	11.000 000 0 s
1973 Jan. 1 - 1974 Jan. 1	12.000 000 0 s
1974 Jan. 1 - 1975 Jan. 1	13.000 000 0 s
1975 Jan. 1 - 1976 Jan. 1	14.000 000 0 s
1976 Jan. 1 - 1977 Jan. 1	15.000 000 0 s
1977 Jan. 1	16.000 000 0 s

Table 11 - Atomic time, collaborating laboratories

ASMW	Amt für Standardisierung, Messwesen und Warenprüfung, Berlin, Deutsche Demokratische Republik
ATC	Australian Telecommunications Commission, Melbourne, Australia
BEV	Bundesamt für Eich - und Vermessungswesen, Wien, Osterreich
DHI	Deutsches Hydrographisches Institut, Hamburg, Bundesrepublik Deutschland
DNM	Division of National Mapping, Canberra, Australia
F	Commission Nationale de l'Heure, Paris, France
FOA	Research Institute of National Defence, Stockholm, Sweden
IEN	Istituto Elettrotecnico Nazionale, Torino, Italia
IGMA	Instituto Geographico Militar, Buenos-Aires, Argentina
ILOM	International Latitude Observatory, Mizusawa, Japan
NBS	National Bureau of Standards, Boulder, USA
NIS	National Institute for Standards, Cairo, Egypt, Arab Rep.
NPL	National Physical Laboratory, Teddington, U.K.
NPRL	National Physical Research Laboratory, Pretoria, South Africa
NRC	National Research Council of Canada, Ottawa, Canada
OMH	Országos Mérésügyi Hivatal, Budapest, Hungary
OMSF	Instituto y Observatorio de Marina, San Fernando, España
ON	Observatoire de Neuchâtel, Neuchâtel, Suisse
ONBA	Observatorio Naval, Buenos-Aires, Argentina
ONRJ	Observatorio National, Rio de Janeiro, Brazil
OP	Observatoire de Paris, Paris, France
ORB	Observatoire Royal de Belgique, Bruxelles, Belgique
PTB	Physikalisch-Technische Bundesanstalt, Braunschweig, Bundesrepublik Deutschland
PTCH	Direction générale des PTT, Berne, Suisse
RGO	Royal Greenwich Observatory, Herstmonceux, U.K.
RRL	Radio Research Laboratories, Tokyo, Japan
SU	Laboratoire d'état de l'étalon de temps et de fréquences, URSS
TAO	Tokyo Astronomical Observatory, Tokyo, Japan
TCL	Telecommunication Laboratories, Taiwan, China
TP (1)	{ Ústav Radiotechniky a Electroniky, Praha, Československo { Astronomický Ústav, Praha, Československo
USNO	U.S. Naval Observatory, Washington, USA
VSL	Van Swinden Laboratorium, Den Haag, Nederland
ZIPE	Zentralinstitut Physik der Erde, Potsdam, Deutsche Demokratische Republik

(1) Both laboratories cooperate in the derivation of UTC(TP).

Table 12 — Laboratories keeping an independent local atomic time

Laboratory (i)	Equipment in atomic standards	Information on TA(i) – UTC(i): Interval of validity (in MJD at 0h UT)	TA(i) – UTC(i) in s
F (1)	15 commercial Cs stds	year 1976	TA(F) – UTC(OP) is published in Bulletin H by OP
NBS	11 commercial Cs stds 2 lab. primary stds 1 Hydrogen Maser (2)	year 1976	15.045 064 478 $-(39.6 \times 10^{-9})$ (MJD – 42 778)
NRC	4 commercial Cs stds 2 lab. primary stds (3), (4)	year 1976	15.000 000 000 $-(83.97 \times 10^{-9})$ (MJD – 42 774)
ON	4 commercial Cs stds 4 prototype Cs stds	year 1976	15 seconds exactly
PTB	10 commercial Cs stds 1 lab. primary std 1 Hydrogen Maser (5)	year 1976	published in PTB Time Service Bulletin
RGO	6 commercial Cs stds	42 778 – 42 930	14.999 945 91 $-(60 \times 10^{-9})$ (MJD – 42 778)
		42 930 – 43 144	14.999 936 79 $-(50 \times 10^{-9})$ (MJD – 42 930) (6)
USNO	25 commercial Cs stds 1 Hydrogen Maser	year 1976	A.1 (USNO, MEAN) – UTC(USNO, MC): provisional values in USNO series 7 ; final values in USNO series 11. (7)

Table 12 –(cont.)

Notes

(1) The standards are located as follows (at the end of 1976)

Centre National d'Études Spatiales	2 Cs
Centre National d'Études des Télécommunications	4 Cs
Centre d'Études et de Recherches Géodynamiques et Astronomiques	2 Cs
Observatoire de Paris	5 Cs
Observatoire de Besançon	1 Cs
Société Nationale Industrielle Aérospatiale (Toulouse)	1 Cs

They are intercompared by the TV method and linked to the foreign laboratories through OP (see Table 13)

(2) The laboratory primary standards control TA(NBS) via an accuracy algorithm. One of the two primary standards usually operates as a contributing member clock. 3 of the commercial standards provide the reference for WWV and WWVB but do not contribute directly to TA(NBS) ; they are available for NBStime scales back-up and are compared to TA(NBS) to within 0.1 μs.

(3) Since 1975 May 1, 15h UT, the 2.1 meter primary cesium clock, CsV, has operated continuously, producing a scale of proper time, PT(NRC CsV). Subsequent to 1975 December 28, 0h UT, the time scale UTC(NRC) and TA(NRC) ceased to be based on Cs III, the earlier NRC primary frequency standard, and were derived from PT(NRC CsV) according to the following expressions given in microseconds :

$$\text{UTC(NRC)} = \text{PT(NRC CsV)} + (\text{MJD} - 42\,774) \times 0.083 + 21.331$$

$$\text{TA(NRC)} = \text{PT(NRC CsV)} - (\text{MJD} - 42\,774) \times 0.00097 + 21.331$$

(4) During 1976, Cs III was used only for experimental purposes.

(5) TA(PTB) results from a reading of 8 Cs stds considering the comparisons with the primary freq. std CS1 of PTB. Precautions are taken in order to ensure the best uniformity of the scale. The TA(PTB) second is about 1×10^{-12} shorter than the CS1 second. UTC(PTB) +1 h= MEZ(PTB) is called the Official Time Scale (in Central European Time) which is disseminated, e. g., by the LF transmitter DCF77. 2 Cs stds and 1 Rb std provide the reference for DCF77.

(6) AT(RGO) is designated by GA2.

(7) TA(USNO) is designated by A.1 (USNO, MEAN).

Table 13 — Equipment and links of the collaborating laboratories

Laboratory	Equipment (1)	Source of UTC(i)	LORAN–C receptions (2)	VLF and LF receptions (3)	Television link with
ASMW	2 Cs	corrected mean of 2 Cs	7970-W	DCF77, HBG, OMA	ZIPE, TP
BEV	1 Cs	1 Cs	7930-X 7970-M 7970-W 7990-M 7990-X	GBR, OMA50, MSF60, HBG DCG77	other lab. in Austria
DHI	2 Cs	1 Cs	7970-W	DCF77	PTB, TP, ZIPE
DNM(4)	4 Cs	all the Cs			other lab. in Australia
FOA	3 Cs	1 Cs	7970-W	GBR	other lab. in Sweden
IEN	5 Cs	1 Cs + micro stepper	7970-W 7990-M 7990-Z	GBR, NAA, MSF60	other lab. in Italy
IGMA	1 Cs	1 Cs		NAA, NLK, GBR	ONBA
ILOM	3 Cs	Cs	9970-M		
NBS	see Table 12	8 Cs 2 lab. Cs	9930-Z	NAA, OMEGA	NRC, USNO
NPL	5 Cs 1 lab. Cs 1 H Maser	1 Cs	7970-W	GBR, MSF60	transmitting station at Rugby
NPRL	1 Cs	1 Cs		GBR, OMEGA/E	
NRC	see Table 12	Cs V	9930-Y		NBS, USNO
OMH	1 Cs	1 Cs			TP
OMSF	4 Cs	all the Cs	7990-Z	NAA	
ON	see Table 12	all the Cs	7970-W 7990-Z		
ONBA	2 Cs	2 Cs		NAA, OMEGA/T	IGMA
ONRJ	2 Cs	all the Cs		GBR, NAA, OMEGA	other lab. in Brasil
OP	5 Cs	1 Cs	7970-W 7990-Y		other lab. in France, ORB, Hewlett-Packard (Suisse)

Table 13 - (cont.)

Laboratory	Equipment (1)	Source of UTC(i)	LORAN–C receptions (2)	VLF and LF receptions (3)	Television link with
ORB	2 Cs	1 Cs	7970-W		OP
PTB	see Table 12	2 Cs	7970-W	GBR, NAA	DHI, TP and other lab.
PTCH	2 Cs	1 Cs	7970-W	DCF77, HBG	
RGO	see Table 12	selection of the Cs	7970-M 7970-W 7990-Z	GBR, MSF60	
RRL	6 Cs 2 H Masers	1 Cs	9970-M	NLK, OMEGA/ND, OMEGA/H OMEGA/JAPAN	ILOM, TAO
SU	6 Cs 3 H Masers 1 lab. Cs	4 Cs 3 H Masers 1 lab. Cs	7990-X	GBR, NAA, OMA50, RBU, MSF60	other lab. in USSR
TAO	4 Cs	1 Cs	9970-M	NLK, NWC	other lab. in Japan
TCL	3 Cs	all the Cs	9970-M	NDT, NWC	
TP	1 Cs	1 Cs		DCF77, GBR	DHI, PTB, ZIPE, ASMW, OMH
USNO	see Table 12	Cs	(5)	(5)	NRC, NBS
VSL	2 Cs	Cs	7970-M 7970-W 7930-X	DCF77	other lab. in Holland
ZIPE	1 Cs	1 Cs	7970-W	DCF77, GBR, NSS, OMA50, HBG, OMEGA/N	ASMW, DHI, TP, Borowiec (Poland)

Table 13 - (cont.)

Notes

(1) Cs designates a commercial Cs standard ; lab. Cs a laboratory Cs standard

(2) LORAN–C stations :

9930-Y	East Coast chain, Nantucket
9930-Z	" " Dana
7930-M	North Atlantic chain, Angissog
7930-X	" " Ejde
7990-M	Mediterranean chain, Simeri Crichi
7990-X	" " Lampedusa
7990-Z	" " Estartit
7970-M	Norwegian Sea chain, Ejde
7970-W	" " Sylt
9970-M	Northwest Pacific chain, Iwo Jima
5970-M	Southeast Asia

(3) OMEGA stations :

/N	Aldra, Norway
/ND	Lamoure, North Dakota, USA
/T	Trinidad, West Indies
/H	Hawaii
/L	Liberia

(4) Satellite link via Timation with RGO and combination of Timation and Television links with USNO

(5) The daily phase values Series 4 of the USNO give the values of UTC (USNO MC) - transmitting station for :

the LORAN–C chains
the LORAN–D West Coast, USA
the OMEGA stations ND, T, H, L
the VLF stations GBR, NAA, NBA, NLK

TABLE 14 – TIME COMPARISONS BETWEEN LABORATORIES BY CLOCK TRANSPORTATION IN 1976

UNLESS OTHERWISE STATED, THE TRANSPORTATION WAS CARRIED OUT BY THE FIRST MENTIONED LABORATORY

DATE		MJD	TIME COMPARISONS		UNCERT.	SOURCE	
1976			(UNIT : 1 MICROSECOND)				
MAR	6	42843.7	UTC(OP) – UTC(ORB) =	-22.2	0.1	OP LETTER	(1)
MAR	9	42846.7	UTC(OP) – UTC(VSL) =	17.3	0.1	OP LETTER	(1)
MAR	26	42863.5	UTC(ILOM) – UTC(RRL) =	35.6	0.2	ILOM LETTER	
APR	20	42888.0	UTC(NBS) – UTC(USNO) =	6.6	0.1	USNO DPV 481	(2)
APR	20	42888.7	UTC(USNO) – UTC(NBS) =	-6.7	0.2	USNO DPV 482	
MAY	4	42902.5	UTC(USNO) – UTC(ONBA) =	-1860.2	0.2	USNO DPV 485	
MAY	5	42903.8	UTC(USNO) – UTC(IGMA) =	-1.2	0.2	USNO DPV 485	
MAY	19	42917.3	UTC(IEN) – UTC(OP) =	6.1	0.1	IEN LETTER	
JUN	1	42930	UTC(NBS) – UTC(USNO) =	6.4	0.1	NBS BULL 227	
JUN	10	42939.3	UTC(USNO) – UTC(VSL) =	1.8	1.0	USNO DPV 494	
JUN	11	42940.3	UTC(USNO) – UTC(DHI) =	-4.8	1.0	USNO DPV 494	
JUN	16	42945.5	UTC(USNO) – UTC(IEN) =	-12.5	1.0	USNO DPV 494	
JUN	17	42946.3	UTC(USNO) – UTC(ON) =	11.6	1.0	USNO DPV 494	
JUN	18	42947.5	UTC(USNO) – UTC(NRC) =	-4.6	1.0	USNO DPV 493	
JUN	18	42947.6	UTC(USNO) – UTC(OP) =	-6.7	1.0	USNO DPV 494	
JUN	18	42947.8	UTC(USNO) – UTC(ARO) =	0.9	1.0	USNO DPV 493	(3)
JUN	21	42950	UTC(NBS) – UTC(OP) =	-0.4	0.1	NBS BULL 227	
JUL	2	42961	UTC(ASMW) – UTC(ON) =	7.6		ASMW AND ON	
JUL	6	42965.6	UTC(USNO) – UTC(RGO) =	-5.0	1.0	USNO DPV 494	
JUL	7	42966.3	UTC(USNO) – UTC(NPL) =	-49.3	1.0	USNO DPV 494	
JUL	21	42980.5	UTC(ASMW) – UTC(ZIPE) =	-27.64	0.05	ASMW LETTER	
JUL	24	42983.8	UTC(USNO) – UTC(OP) =	-6.1	1.0	USNO DPV 495	
SEP	13	43034.1	UTC(USNO) – UTC(RRL) =	-7.2	1.2	USNO DPV 505	
SEP	13	43034.1	UTC(USNO) – UTC(TAO) =	33.1	0.2	USNO DPV 505	
SEP	29	43050	UTC(NBS) – UTC(OP) =	-1.8	0.1	NBS BULL 227	
OCT	1	43052.7	UTC(NBS) – UTC(USNO) =	5.2	0.2	NBS BULL 228	
OCT	19	43070.5	UTC(USNO) – UTC(NRC) =	-6.1	0.2	USNO DPV 510	
OCT	22	43073.6	UTC(USNO) – UTC(IGMA) =	3.5	0.2	USNO DPV 510	
OCT	26	43077.5	UTC(OP) – UTC(TP) =	-16.50	0.04	OP LETTER	
OCT	26	43077.6	UTC(ASMW) – UTC(TP) =	-36.26	0.05	ASMW LETTER	
OCT	26	43077.6	UTC(OP) – UTC(ASMW) =	19.8	0.1	OP LETTER	
OCT	27	43078.8	UTC(USNO) – UTC(UNBA) =	-1988.2	0.2	USNO DPV 510	
OCT	28	43079	UTC(NBS) – UTC(USNO) =	5.20	0.05	NBS LETTER	
NOV	2	43085.0	UTC(USNO) – UTC(ONRJ) =	-148.2	0.2	USNO DPV 510	
NOV	18	43100.6	UTC(NBS) – UTC(USNO) =	4.8	0.2	NBS BULL 229	
DEC	1	43113	UTC(NBS) – UTC(USNO) =	4.7	0.2	NBS BULL 229	
DEC	2	43114.6	UTC(OP) – UTC(PTB) =	2.2		OP AND PTB	
DEC	9	43121	UTC(SU) – UTC(ASMW) =	-30.92		SU LETTER	
DEC	17	43129.3	UTC(SU) – UTC(OP) =	-55.61		SU AND OP	

COMPLEMENTARY RESULTS FOR THE PREVIOUS YEAR

DATE		MJD	TIME COMPARISONS		UNCERT.	SOURCE
1975						
DEC	10	42756.4	UTC(SU) – UTC(ASMW) =	-74.34	0.05	ASMW AND SU
DEC	10	42756.4	UTC(SU) – UTC(ZIPE) =	-65.48	0.05	SU AND ZIPE

(1) TRANSPORTATION ORGANIZED JOINTLY BY USNO AND OP

(2) UTC(USNO) IS WRITTEN INSTEAD OF UTC(USNO MC)
DPV=DAILY PHASE VALUES, SERIES 4, PUBLISHED BY USNO

(3) ARO : ALGONQUIN RADIO OBSERVATORY , LAKE TRAVERSE , ONTARIO , CANADA

TABLE 15 - INDEPENDENT ATOMIC TIMES

TA(I) DENOTES THE ATOMIC TIME OF THE LABORATORY I

UNIT IS ONE MICROSECOND

DATE 1976	MJD	TAI - TA(I) F	NBS	NRC	ON	PTB	RGO	USNO
JAN 2	42779	-82.5	-45068.1	0.4	13.8	-358.9	55.8	-34391.1
JAN 12	42789	-82.8	-45067.5	1.2	13.9	-358.8	56.4	-34390.9
JAN 22	42799	-83.1	-45066.8	1.9	14.1	-358.8	56.9	-34390.7
FEB 1	42809	-83.2	-45066.9	2.8	14.4	-358.7	57.4	-34390.7
FEB 11	42819	-83.6	-45065.9	3.7	14.5	-358.7	57.7	-34390.5
FEB 21	42829	-83.9	-45065.1	4.5	14.6	-358.6	58.3	-34390.3
MAR 2	42839	-84.2	-45064.4	5.5	14.5	-358.5	58.8	-34390.0
MAR 12	42849	-84.4	-45064.0	6.3	14.8	-358.4	59.3	-34389.9
MAR 22	42859	-84.7	-45063.3	7.3	14.7	-358.4	59.6	-34389.6
APR 1	42869	-84.9	-45062.9	7.9	14.9	-358.3	60.2	-34389.5
APR 11	42879	-85.2	-45062.2	8.9	14.8	-358.3	60.6	-34389.1
APR 21	42889	-85.5	-45061.5	9.8	14.8	-358.3	61.0	-34388.9
MAY 1	42899	-86.0	-45061.1	10.7	14.8	-358.1	61.4	-34388.6
MAY 11	42909	-86.3	-45060.6	11.5	14.8	-358.0	62.0	-34388.3
MAY 21	42919	-86.8	-45059.9	12.4	14.8	-358.0	62.5	-34388.1
MAY 31	42929	-87.1	-45059.5	13.1	14.8	-357.8	62.9	-34388.0
JUN 10	42939	-87.5	-45059.0	13.9	14.8	-357.9	63.4	-34387.7
JUN 20	42949	-87.8	-45058.4	14.7	14.6	-357.9	63.5	-34387.5
JUN 30	42959	-88.1	-45058.1	15.4	14.5	-358.0	63.9	-34387.3
JUL 10	42969	-88.5	-45057.6	16.3	14.4	-357.9	64.4	-34387.0
JUL 20	42979	-88.8	-45057.2	16.9	14.5	-357.8	64.9	-34386.9
JUL 30	42989	-89.1	-45056.7	17.8	14.5	-357.8	65.3	-34386.6
AUG 9	42999	-89.5	-45055.9	18.7	14.4	-357.9	65.5	-34386.3
AUG 19	43009	-89.8	-45055.4	19.4	14.4	-357.8	66.0	-34386.0
AUG 29	43019	-90.2	-45054.9	20.2	14.3	-357.8	66.5	-34385.7
SEP 8	43029	-90.6	-45054.5	21.0	14.3	-357.8	67.0	-34385.4
SEP 18	43039	-91.0	-45053.9	21.8	14.3	-357.8	67.4	-34385.2
SEP 28	43049	-91.4	-45053.3	22.7	14.1	-357.9	67.9	-34384.9
OCT 8	43059	-91.8	-45052.7	23.5	14.1	-357.9	68.4	-34384.6
OCT 18	43069	-92.3	-45052.1	24.5	14.0	-358.0	68.6	-34384.3
OCT 28	43079	-92.6	-45051.9	25.2	14.1	-357.9	68.9	-34384.2
NOV 7	43089	-93.0	-45051.4	26.0	14.2	-357.9	69.2	-34384.0
NOV 17	43099	-93.5	-45050.9	26.9	14.2	-357.9	69.5	-34383.7
NOV 27	43109	-93.9	-45050.5	27.8	14.3	-357.8	69.9	-34383.5
DEC 7	43119	-94.4	-45049.9	28.7	14.3	-357.8	70.3	-34383.4
DEC 17	43129	-94.8	-45049.5	29.5	14.4	-357.7	70.5	-34383.2
DEC 27	43139	-95.3	-45048.9	30.5	14.3	-357.8	70.6	-34382.8

TABLE 16 - PRIMARY STANDARDS USED AS CLOCKS

UNIT IS ONE MICROSECOND

DATE 1976		MJD	TAI-LAB.STD. NBS 4	NRC CSV
JAN	2	42779		21.7
JAN	12	42789		22.5
JAN	22	42799		23.2
FEB	1	42809		24.1
FEB	11	42819		25.0
FEB	21	42829		25.8
MAR	2	42839	-2.4	26.7
MAR	12	42849	-1.8	27.5
MAR	22	42859	-0.8	28.5
APR	1	42869	-0.2	29.2
APR	11	42879	0.6	30.1
APR	21	42889	1.5	31.1
MAY	1	42899	2.0	31.9
MAY	11	42909	2.7	32.7
MAY	21	42919	3.5	33.6
MAY	31	42929	4.0	34.3
JUN	10	42939	4.6	35.0
JUN	20	42949	5.3	35.8
JUN	30	42959	5.7	36.6
JUL	10	42969	6.2	37.4
JUL	20	42979	6.8	38.1
JUL	30	42989	7.4	38.9
AUG	9	42999	8.2	39.8
AUG	19	43009	8.9	40.5
AUG	29	43019	9.5	41.3
SEP	8	43029	10.0	42.0
SEP	18	43039	10.3	42.8
SEP	28	43049	11.5	43.7
OCT	8	43059	12.3	44.6
OCT	18	43069	13.1	45.5
OCT	28	43079	13.5	46.2
NOV	7	43089	14.1	47.0
NOV	17	43099	14.8	47.9
NOV	27	43109	15.4	48.8
DEC	7	43119	16.2	49.7
DEC	17	43129	16.3	50.5
DEC	27	43139	17.5	51.4

TABLE 17 - COORDINATED UNIVERSAL TIME

UTC(I) DENOTES THE APPROXIMATION TO UTC KEPT BY THE LABORATORY I

UNIT IS ONE MICROSECOND

DATE 1976	MJD	UTC - UTC(I) ASMW (1)	AUS (2)	OHI	ONM (3)	FOA (4)	IEN	ILOM (5)
JAN 2	42779	0.3		-0.2	9.0	34.4	-8.1	-31.7
JAN 12	42789	0.8		-0.3	8.8	32.6	-8.1	-32.6
JAN 22	42799	1.2		-0.4	11.0	30.3	-8.1	-33.7
FEB 1	42809	2.0		-0.4	12.4	28.9	-7.8	-34.3
FEB 11	42819	2.4		-0.3	15.0	27.0	-7.9	-34.9
FEB 21	42829	2.9		-0.3	0.0 *	25.1	-7.9	-35.7
MAR 2	42839	3.1		-0.2	2.3	23.2	-8.3	-36.7
MAR 12	42849	3.5		-0.2	5.1	21.4	-8.2	-38.3
MAR 22	42859	3.7		-0.2	5.7	19.3	-8.2	-39.6
APR 1	42869	4.0		-0.1	5.6	17.2	-8.1	-41.4
APR 11	42879	4.4		-0.1	11.1	15.1	-8.6	-42.6
APR 21	42889	4.7		-0.1	0.0 *	13.0	-8.5	-43.6
MAY 1	42899	5.3	-18.7	0.1	-3.7	11.2	-8.6	-44.7
MAY 11	42909	5.3	-18.4	0.2	-4.1	9.2	-8.8	-45.4
MAY 21	42919	5.7	-18.2	0.2	0.0 *	5.9	-8.3	-46.4
MAY 31	42929	6.3	-18.0	0.2	-0.3	4.8	-8.4	-47.7
JUN 10	42939	6.9	-17.8	0.3	2.3	2.5	-8.4	
JUN 20	42949	7.5	-17.6	0.3	3.4	0.0	-8.4	
JUN 30	42959	8.0	-17.4	0.3	8.6	-2.3	-8.5	
JUL 10	42969	8.4	-17.1	0.4		-4.5	-8.5	
JUL 20	42979	8.9	-17.1	0.6		-5.7	-8.5	-1.4
JUL 30	42989	9.0	-16.7	0.8		-8.9	-8.7	-2.1
AUG 9	42999	9.9	-16.3	1.1		-11.0	-8.8	-2.8
AUG 19	43009	10.5	-16.0	1.3		-12.6	-8.8	-3.6
AUG 29	43019	11.5	-15.5	1.5		-14.0	-8.3	-4.2
SEP 8	43029	12.4	-15.2	2.1		-15.2	-8.7	
SEP 18	43039	13.4	-15.0	2.6		-16.7	-8.5	
SEP 28	43049	14.3	-14.6	2.9		-18.3	-8.4	
OCT 8	43059	15.4	-14.2	3.4		-19.9	-8.4	
OCT 18	43069	16.4	-13.7	3.6		-21.5	-8.3	
OCT 28	43079	17.6	-13.6	4.2		-22.9	-8.1	
NOV 7	43089	18.7	-13.3	4.4		-24.2	-8.0	
NOV 17	43099	20.0	-12.9	4.0		-25.7	-8.2	-11.0
NOV 27	43109	21.3	-12.6	3.3		-27.3	-8.2	-12.1
DEC 7	43119	22.8	-12.3	2.6		-28.7	-8.3	-13.2
DEC 17	43129	24.1	-12.1	1.7		-30.1	-8.3	-14.0
DEC 27	43139	25.3		0.6		-31.6	-8.4	-14.9

TABLE 17 - (CONT.)

UNIT IS ONE MICROSECOND

DATE 1976		MJD	UTC - UTC(I)						
			NBS	NPL	NPRL (6)	NRC	OMH (7)	ONSF	ON
JAN	2	42779	-3.6	-43.4	114	0.0	-847.8	-3.0	13.8
JAN	12	42789	-3.5	-43.5	116	0.0	-847.5	-2.3	13.9
JAN	22	42799	-3.2	-43.7	115	-0.2	-847.2	-2.3	14.1
FEB	1	42809	-3.7	-44.0	110	-0.1	-847.2	-1.6	14.4
FEB	11	42819	-3.1	-44.2	114	-0.1	-847.1	-2.0	14.5
FEB	21	42829	-2.6	-44.3	114	-0.1	-847.1	-2.6	14.5
MAR	2	42839	-2.4	-44.5	115	0.0	-846.8	-3.2	14.5
MAR	12	42849	-2.4	-44.8	116	0.0	-846.8	-3.6	14.8
MAR	22	42859	-2.0	-45.0	115	0.2	-845.3	-4.2	14.7
APR	1	42869	-2.0	-45.1	115	-0.1	-846.5	-4.6	14.9
APR	11	42879	-1.7	-45.2	119	0.1	-845.5	-5.3	14.8
APR	21	42889	-1.4	-45.2	116	0.2	-845.6	-5.0	14.8
MAY	1	42899	-1.4	-45.4	115	0.2	-846.5	-6.0	14.8
MAY	11	42909	-1.3	-45.3	115	0.2	-845.3	-5.7	14.8
MAY	21	42919	-1.0	-45.3	117	0.2	-845.7	-5.5	14.8
MAY	31	42929	-1.0	-45.3	117	0.1	-845.1	-5.0	14.3
JUN	10	42939	-0.9	-45.5	117	0.0	-845.6	-4.6	14.8
JUN	20	42949	-0.7	-45.4	118	0.0	-846.4	-4.0	14.6
JUN	30	42959	-0.8	-45.4	117	-0.1	-845.1	-3.4	14.5
JUL	10	42969	-0.7	-45.4	116	-0.1	-845.2	-2.6	14.4
JUL	20	42979	-0.7	-45.5	117	-0.3	-844.4	-1.7	14.5
JUL	30	42989	-0.5	-45.6	116	-0.3	-844.6	-1.4	14.5
AUG	9	42999	-0.2	-45.8	118	-0.2	-842.9	-1.4	14.4
AUG	19	43009	-0.1	-45.3	117	-0.3	-841.3	-1.3	14.4
AUG	29	43019	0.0	-45.9	117	-0.4	-842.2	-1.4	14.3
SEP	8	43029	0.0	-45.8	117	-0.5	-842.4	-1.4	14.3
SEP	18	43039	0.2	-45.9	116	-0.5	-16.7	-1.5	14.3
SEP	28	43049	0.4	-45.9		-0.4	-17.2	-1.8	14.1
OCT	8	43059	0.6	-45.9	117	-0.4	-17.4	-2.0	14.1
OCT	18	43069	0.8	-45.0	115	-0.3	-17.7	-2.3	14.0
OCT	28	43079	0.7	-45.9	115	-0.5	-17.3	-2.5	14.1
NOV	7	43089	0.7	-45.0	114	-0.5	-13.2	-2.7	14.2
NOV	17	43099	0.8	-46.0	115	-0.4	-13.5	-2.9	14.2
NOV	27	43109	0.9	-46.0	112	-0.4	-18.6	-3.1	14.3
DEC	7	43119	1.0	-45.2	112	-0.3	-19.1	-3.2	14.3
DEC	17	43129	1.1	-45.5	109	-0.3	-19.6	-3.2	14.4
DEC	27	43139	1.2	-46.8	109	-0.2	-20.6	-3.3	14.3

TABLE 17 - (CONT.)

UNIT IS ONE MICROSECOND

DATE 1976		MJD	UTC - UTC(I)						
			OP	ORB (8)	PTB	PTCH (9)	RGO	RRL (10)	SU (11)
JAN	2	42779	-0.3	-31.8	0.4	16.0	1.6	-5.4	48
JAN	12	42789	-0.5	-30.7	0.4	15.5	1.6	-5.3	50
JAN	22	42799	-0.7	-29.4	0.3	15.2	1.6	-5.3	51
FEB	1	42809	-0.7	-28.6	0.2	15.4	1.4	-4.7	48
FEB	11	42819	-1.0	-27.3	0.1	15.3	1.2	-4.1	51
FEB	21	42829	-1.2	-26.1	0.1	15.0	1.1	-3.8	52
MAR	2	42839	-1.4	-25.1	0.0	14.5	1.1	-3.5	51
MAR	12	42849	-1.6	-23.5	0.0	14.7	0.9	-4.1	51
MAR	22	42859	-1.3	-22.3	-0.1	14.0	0.7	-4.3	52
APR	1	42869	-1.8	-21.4	-0.2	13.5	0.7	-4.5	54
APR	11	42879	-1.9	-20.1	-0.2	13.1	0.5	-4.5	52
APR	21	42889	-1.9	-13.9	-0.2	12.1	0.2	-4.2	54
MAY	1	42899	-2.0	-18.0	-0.1	-48.8	0.1	-3.9	54
MAY	11	42909	-2.1	-15.9	-0.1	-48.2	0.1	-3.2	55
MAY	21	42919	-2.2	-15.7	-0.1	-47.4	0.0	-2.8	56
MAY	31	42929	-2.2	-13.9	-0.1	-45.5	-0.2	-2.9	55
JUN	10	42939	-2.3	-12.7	-0.1	-45.0	-0.2	-2.3	57
JUN	20	42949	-2.3	-11.0	-0.1	-45.6	-0.5	-2.6	53
JUN	30	42959	-2.3	-9.8	-0.2	-45.1	-0.7	-3.4	58
JUL	10	42969	-2.2	-9.1	-0.2	-44.3	-0.3	-3.2	59
JUL	20	42979	-2.1	-7.8	-0.3	-43.7	-0.7	-2.7	59
JUL	30	42989	-2.0	-6.8	-0.4	-43.3	-0.9	-2.6	57
AUG	9	42999	-2.1	-5.9	-0.5	-42.9	-1.2	-2.6	59
AUG	19	43009	-2.2	-4.7	-0.3	-42.2	-1.2	-2.8	58
AUG	29	43019	-2.2	-3.4	-0.3	-41.2	-1.1	-2.9	57
SEP	8	43029	-2.2	-2.7	-0.2	-40.3	-1.1	-3.3	53
SEP	18	43039	-2.2	-1.5	-0.2	-39.5	-1.3	-1.3	57
SEP	28	43049	-2.3	-0.3	-0.2	-39.0	-1.3	-1.6	57
OCT	8	43059	-2.3	0.7	-0.3	-38.2	-1.3	-0.3	56
OCT	18	43069	-2.4	1.5	-0.4	-37.4	-1.6	-2.8	55
OCT	28	43079	-2.3	2.7	-0.2	-36.7	-1.7	-7.2	54
NOV	7	43089	-2.3	4.2	-0.2	-35.4	-1.9	-7.4	54
NOV	17	43099	-2.3	5.1	-0.2	-34.3	-2.2	-7.3	53
NOV	27	43109	-2.3	5.8	-0.1	-33.2	-2.2	-7.9	51
DEC	7	43119	-2.3	6.4	0.0	-32.0	-2.4	-3.5	54
DEC	17	43129	-2.3	7.2	0.0	-30.9	-2.7	-9.1	54
DEC	27	43139	-2.5	8.2	0.0	-29.9	-3.0	-9.6	53

TABLE 17 - (CONT.)

UNIT IS ONE MICROSECOND

DATE 1976		MJD	UTC - UTC(I) TAO (12)	TCL (12)	TP	USNO	VSL (13)	ZIPE
JAN	2	42779	32.9	77.1	-7.6	4.8	23.3	-9.0
JAN	12	42789	33.2	77.1	-7.7	4.8	22.1	-9.1
JAN	22	42799	33.3	76.8	-8.0	4.7	20.9	-9.2
FEB	1	42809	34.1	78.4	-3.3	4.7	19.3	-9.1
FEB	11	42819	34.7	80.3	-8.6	4.7	18.7	-9.4
FEB	21	42829	35.2	31.2	-9.0	4.6	17.5	-9.8
MAR	2	42839	35.5	31.1	-9.2	4.7	15.4	-10.4
MAR	12	42849	35.4	79.9	-9.8	4.6	15.4	-10.7
MAR	22	42859	35.5	78.8	-10.3	4.8	14.1	-11.1
APR	1	42869	35.4	77.3	-10.3	4.6	13.1	-11.4
APR	11	42879	35.6	75.5	-10.8	4.8	12.1	-12.0
APR	21	42889	36.2	75.5	-11.3	4.9	11.0	-12.6
MAY	1	42899	36.9	74.9	-11.7	4.9	10.0	-13.2
MAY	11	42909	37.5	74.3	-12.3	5.0	9.1	-13.4
MAY	21	42919	38.0	74.7	-12.6	5.1	3.1	-14.5
MAY	31	42929	37.9	74.4	-12.3	5.0	7.2	-14.3
JUN	10	42939	36.7	73.4	-13.2	5.0	5.2	-15.5
JUN	20	42949	35.3	73.4	-13.5	5.0	5.0	-15.2
JUN	30	42959	36.9	72.9	-14.2	5.1	4.0	-16.8
JUL	10	42969	37.0	73.6	-14.5	5.1	3.1	-17.7
JUL	20	42979	37.5	70.3	-14.7	5.0	2.1	-13.5
JUL	30	42989	37.7	70.9	-15.0	5.2	1.1	-19.7
AUG	9	42999	37.6	71.5	-15.5	5.2	-0.1	-20.2
AUG	19	43009	37.5	72.5	-15.9	5.3	-1.1	-21.2
AUG	29	43019	37.4	72.7	-16.3	5.5	-2.3	-21.9
SEP	8	43029	37.2	73.9	-16.3	5.5	-3.5	-22.5
SEP	18	43039	40.6	74.9	-17.3	5.4	-4.6	-23.3
SEP	28	43049	40.6	75.8	-17.8	5.5	-5.5	-24.1
OCT	8	43059	40.8	75.8	-18.4	5.7	-5.4	-24.5
OCT	18	43069	41.1	77.7	-18.7	5.9	-7.3	-25.6
OCT	28	43079	41.0	78.0	-18.9	5.7	-3.1	-25.1
NOV	7	43089	41.5	78.4	-19.2	5.7	-3.8	-25.9
NOV	17	43099	37.0	78.0	-19.6	5.8	-9.6	-27.7
NOV	27	43109	37.1	78.3	-19.8	5.8	-10.3	-28.1
DEC	7	43119	37.1	78.4	-20.3	5.8	-11.2	-28.3
DEC	17	43129	37.4	78.8	-20.6	5.8	-12.0	-28.3
DEC	27	43139	37.5	79.3	-21.3	5.9	-13.0	-28.8

TABLE 17 - (CONT.)

NOTES

(1) ASMW. A time-step of UTC(ASMW) of -17.0 µs was made by ASMW on 1976 January 1st.

(2) AUS. UTC(AUS) is the coordinated universal time of Australia kept by DNM. UTC - UTC(AUS) is derived from UTC(USNO)-UTC(AUS) obtained using the NTS 1 (TIMATION III) satellite .

(3) DNM. By VLF, 0.0 denotes arbitrary origins.

(4) FOA. A time-step of UTC(FOA) of -100.0 µs was made by FOA on 1976 January 1st.

(5) ILOM. Change of master clock between May and July. The origin of UTC - UTC(ILOM) is given by the clock transportation 1976 March 26. Interruptions of the LORAN-C receptions.

(6) NPRL. By VLF. The origin was given by a clock transportation on 1974 April 9.

(7) OMH. A time-step of UTC(OMH) of -826.0 µs was made by OMH on 1976 September 13.

(8) ORB. A time-step of UTC(ORB) of +70.0 µs was made by ORB on 1976 January 1.

(9) PTCH. The origin of UTC - UTC(PTCH) is not known ; UTC - UTC(PTCH) = 0 was arbitrarily fixed on 1972 Nov. 18. Change of clock on MJD = 42 899 and time-step of UTC(PTCH) of +58.3 µs.

(10) RRL. From MJD = 42 939 to MJD = 42 969 and from MJD = 43 039 to MJD = 43 089, the LORAN-C reception of Iwo Jima was replaced by VLF receptions. The apparent steps are due to the time link and not the local clocks.

(11) SU. Data based on clock transportations and interpolated with the help of VLF receptions.

(12) TAO, TCL. From MJD = 42 939 to MJD = 42 969 and from MJD = 43 039 to MJD = 43 089, the LORAN-C reception of Iwo Jima was replaced by the LORAN-C reception of Marcus. The apparent steps are due to the time link and not to the local clocks.

(13) VSL. A time-step of UTC(VSL) of + 33.3 us was made by VSL on 1975 Dec. 31.

TABLE 18 - COMPARISONS BETWEEN THE CLOCK TRANSPORTATIONS AND THE BIH RESULTS

THE TABLE GIVES THE DIFFERENCES BETWEEN THE CLOCK TRANSPORTATION RESULTS AND THOSE DERIVED FROM THE DATA OF TABLE 17 (BEFORE ROUNDING-OFF)

DATE		MJD	TIME COMPARISONS	DIFFERENCE CLOCK TR. - BIH (UNIT = 1 MICROSECOND)
1976				
MAR	6	42843.7	UTC(OP) - UTC(ORB)	0.6
MAR	9	42846.3	UTC(OP) - UTC(VSL)	0.1
APR	20	42888.0	UTC(NBS) - UTC(USNO)	0.3
APR	20	42888.7	UTC(USNO) - UTC(NBS)	-0.4
MAY	19	42917.3	UTC(IEN) - UTC(OP)	-0.5
JUN	1	42930	UTC(NBS) - UTC(USNO)	0.4
JUN	10	42939.3	UTC(USNO) - UTC(VSL)	0.7
JUN	11	42940.3	UTC(USNO) - UTC(DHI)	-0.1
JUN	16	42945.5	UTC(USNO) - UTC(IEN)	0.9
JUN	17	42946.3	UTC(USNO) - UTC(ON)	1.9
JUN	18	42947.5	UTC(USNO) - UTC(NRC)	0.5
JUN	18	42947.6	UTC(USNO) - UTC(OP)	0.6
JUN	21	42950	UTC(NBS) - UTC(OP)	1.3
JUL	2	42961	UTC(ASMW) - UTC(ON)	1.2
JUL	6	42965.6	UTC(USNO) - UTC(RGO)	0.8
JUL	7	42966.5	UTC(USNO) - UTC(NPL)	1.2
JUL	21	42980.5	UTC(ASMW) - UTC(ZIPE)	0.0
JUL	24	42983.8	UTC(USNO) - UTC(OP)	1.0
SEP	13	43034.1	UTC(USNO) - UTC(RRL)	1.7
SEP	13	43034.1	UTC(USNO) - UTC(TAO)	1.5
SEP	29	43050	UTC(NBS) - UTC(OP)	0.9
OCT	1	43052.7	UTC(NBS) - UTC(USNO)	0.1
OCT	19	43070.5	UTC(USNO) - UTC(NRC)	0.1
OCT	26	43077.5	UTC(OP) - UTC(TP)	0.1
OCT	26	43077.6	UTC(ASMW) - UTC(TP)	0.1
OCT	26	43077.6	UTC(OP) - UTC(ASMW)	0.0
OCT	28	43079	UTC(NBS) - UTC(USNO)	0.2
NOV	18	43100.6	UTC(NBS) - UTC(USNO)	-0.2
DEC	1	43113	UTC(NBS) - UTC(USNO)	-0.1
DEC	2	43114.6	UTC(OP) - UTC(PTB)	0.0
DEC	9	43121	UTC(SU) - UTC(ASMW)	0.0
DEC	17	43129.3	UTC(SU) - UTC(OP)	0.7

COMPLEMENTARY RESULTS FOR THE PREVIOUS YEAR

1975				
DEC	10	42756.4	UTC(SU) - UTC(ASMW)	-2.3
DEC	10	42756.4	UTC(SU) - UTC(ZIPE)	-1.7

TABLE 19 – INTERNATIONAL ATOMIC TIME , BI-MONTHLY RATES OF TAI-CLOCK FOR 1976

THE RATES ARE AVERAGED OVER INTERVALS OF TWO MONTHS ENDING AT THE GIVEN DATES

UNIT IS NS/DAY , 0.0 DENOTES THAT THE CLOCK WAS NOT USED

LAB.	CLOCK	42829	42889	42959	43019	43079	43139
ASMW	13 29	51.35	30.13	44.79	55.87	101.64	130.30
F	12 133	-251.93	-252.35	0.0	0.0	0.0	0.0
F	12 158	124.41	123.44	124.55	142.90	148.17	151.36
F	12 195	0.0	0.0	-354.43	-359.51	0.0	0.0
F	12 206	0.0	-26.21	-37.19	-35.71	-58.89	-71.25
F	12 231	57.57	60.59	53.43	54.95	41.73	45.03
F	12 347	156.97	153.84	147.28	150.09	170.11	169.91
F	12 439	-86.46	-84.37	-30.32	-89.13	-90.64	-128.46
F	12 475	202.95	223.45	0.0	0.0	0.0	0.0
F	12 594	10.57	4.45	2.30	9.19	6.30	6.35
F	14 134	53.25	0.0	0.0	0.0	24.34	25.50
F	14 753	189.85	191.67	196.91	201.50	198.33	201.93
F	14 873	34.97	25.27	24.17	31.12	16.48	14.21
F	22 213	0.0	0.0	9.26	2.27	-23.06	-30.69
F	22 222	0.0	0.0	203.71	198.02	192.23	130.55
FOA	11 55	221.78	223.63	227.40	190.40	124.50	157.81
FOA	11 200	-230.15	-392.75	-410.40	-412.45	-54.79	-115.11
FOA	14 900	-184.44	-202.22	-220.53	-198.99	-151.57	-145.65
IEN	12 303	0.0	0.0	0.0	3.00	18.86	16.22
IEN	12 469	-50.76	-44.91	20.33	53.65	56.57	-6.54
IEN	12 609	40.34	-10.13	0.0	10.49	58.38	29.63
IEN	14 893	0.0	0.0	50.41	39.41	0.0	0.0
IEN	22 230	0.0	0.0	0.0	0.0	48.53	57.47
NBS	11 137	-229.42	-239.57	-243.44	-239.54	-243.55	0.0
NBS	11 167	0.0	19.43	-1.54	-4.71	4.32	16.55
NBS	12 352	131.24	117.82	0.0	0.0	0.0	98.04
NBS	14 323	0.0	0.0	-39.96	-35.31	-31.88	-33.97
NBS	14 324	399.22	405.22	400.71	403.23	398.78	0.0
NBS	14 501	-5.52	29.60	32.05	19.17	12.93	3.76
NBS	16 61	0.0	0.0	-187.56	-207.35	0.0	0.0
NBS	25 57	471.37	465.89	429.52	413.30	419.17	421.47
NBS	91 4	0.0	0.0	61.37	54.45	69.51	57.85
NPL	12 316	-92.73	-121.65	-119.54	-127.83	-113.98	-121.65
NPL	12 418	-17.55	-15.87	-2.34	-7.44	-2.53	-13.76
NPL	12 832	-71.11	-78.62	-24.19	4.41	-13.42	-52.59
NRC	12 122	-299.59	-371.51	-452.53	-458.55	-496.38	-524.87
NRC	12 267	17.49	15.13	40.35	66.22	29.05	15.63
NRC	14 911	-21.82	-31.53	-42.44	-42.92	-15.84	-14.84
NRC	90 5	82.00	85.53	78.50	73.41	83.80	87.37
OMH	22 67	10.00	3.24	5.13	74.75	-23.32	-42.53

TABLE 19 - (CONT.)

LAB.	CLOCK	42829	42889	42959	43019	43079	43139
OMSF	13 16	60.16	33.01	53.06	0.0	250.71	0.0
OMSF	14 896	389.89	359.74	0.0	0.0	0.0	0.0
OMSF	22 223	0.0	0.0	0.0	245.54	232.74	250.13
ON	12 285	37.20	27.71	21.75	2.87	18.91	24.91
ON	13 14	-3.35	13.25	65.28	17.80	38.91	57.91
ON	14 863	-86.41	-89.06	-60.50	-42.80	-53.93	-62.73
ON	24 155	0.0	-24.41	-22.58	-15.30	-14.37	-21.03
ON	99 1	42.44	23.86	4.43	8.44	27.93	70.02
ON	99 3	-6.90	-13.64	-75.10	-217.63	-276.34	-207.43
ON	99 4	203.51	191.36	137.05	139.52	134.02	171.31
ON	99 5	-55.74	-73.63	-64.52	-76.91	-93.12	-90.69
ORB	12 804	108.83	119.37	135.03	107.22	103.75	85.30
ORB	14 205	0.0	23.31	43.59	25.31	21.51	7.90
PTB	12 320	226.95	226.90	225.51	236.57	226.69	226.70
PTB	12 389	110.37	107.13	96.30	94.44	92.57	102.85
PTB	12 394	-217.30	-225.08	-227.02	-234.27	-237.04	-235.32
PTB	12 395	-111.19	-113.27	-129.03	-130.31	-129.03	-120.14
PTB	12 462	0.0	171.25	168.24	192.86	180.15	183.65
PTB	14 857	-74.57	-79.99	-79.74	-31.82	-38.96	-35.05
PTB	16 57	0.0	0.0	0.0	0.0	31.02	58.09
PTB	24 103	-22.14	-29.90	-14.38	-10.65	-17.46	-6.97
PTCH	13 23	-13.13	-47.25	0.0	0.0	0.0	0.0
PTCH	16 64	0.0	0.0	0.0	59.87	73.99	112.78
RGO	11 123	-33.46	-39.99	-38.98	-39.64	-25.89	-60.45
RGO	11 199	252.09	254.75	273.78	290.78	0.0	0.0
RGO	12 348	-43.78	-61.64	-55.56	-54.01	0.0	-16.80
RGO	12 434	392.53	394.91	404.13	139.91	139.50	113.15
RGO	14 202	0.0	-117.89	-123.12	-105.87	-108.86	-102.47
RGO	14 868	-69.97	-65.68	-53.30	-65.21	-59.37	-56.94
TP	12 335	-30.47	-38.42	-38.05	-35.89	-44.83	-37.13
USNO	12 345	293.52	300.32	280.78	286.15	283.60	280.97
USNO	12 532	30.53	42.44	34.22	32.23	33.64	31.82
USNO	12 545	-292.27	-255.99	-241.25	0.0	0.0	0.0
USNO	12 549	-48.17	-39.47	-49.59	-54.43	-53.00	-48.00
USNO	12 573	-112.56	-115.98	-135.71	-137.00	-133.59	-113.32
USNO	12 583	-504.79	-433.31	-444.74	0.0	0.0	0.0
USNO	12 591	25.31	27.41	19.29	21.25	19.62	22.01
USNO	12 592	262.82	275.24	268.55	275.83	283.19	268.55
USNO	14 571	131.40	133.04	133.32	130.57	127.10	123.12
USNO	14 654	-55.42	-32.97	-28.50	-5.53	11.78	4.74
USNO	14 656	53.24	63.92	72.82	90.71	99.37	97.37
USNO	14 650	-19.30	-3.34	9.13	-1.05	11.55	-11.35
USNO	14 778	86.43	95.11	94.11	90.55	84.65	74.56
USNO	14 783	65.91	95.58	109.38	125.65	134.52	137.22
USNO	14 797	0.0	0.0	0.0	0.0	-12.44	-31.94

TABLE 19 - (CONT.)

LAB.	CLOCK	42829	42889	42959	43019	43079	43139
USNO	14 834	24.59	32.63	35.59	36.54	36.40	22.25
USNO	14 837	0.0	145.07	158.78	168.23	179.40	0.0
USNO	14 871	0.0	0.0	0.0	0.0	0.0	46.83
USNO	14 875	0.0	0.0	0.0	0.0	0.0	-25.77
USNO	22 114	133.20	122.35	109.07	114.64	107.62	96.53
USNO	24 94	-138.32	-130.43	-204.25	-196.04	-191.30	-184.67
USNO	24 104	-39.45	-31.85	-31.19	-36.46	-41.56	-27.62
USNO	24 118	0.0	0.0	0.0	0.0	0.0	-178.38
USNO	24 207	0.0	0.0	0.0	0.0	243.94	272.51
VSL	12 503	138.43	148.41	186.51	221.55	228.89	152.23
VSL	22 34	-110.74	-110.09	-100.72	-104.39	-96.15	-80.73
ZIPE	12 979	-11.23	-43.76	-61.24	-86.47	-71.68	-41.35

NOTE - THE CLOCKS ARE DESIGNATED BY THEIR MODEL (2 DIGITS) AND SERIAL NO. THE CODES FOR THE MODELS ARE

11 HEWLETT-PACKARD 5060A
12 AND 22 HEWLETT PACKARD 5061A (22 109 EQUIVALENT TO 12 1109)
13 EBAUCHES OSCILLATOR. B 5000
14 AND 24 HEWLETT-PACKARD 5061A OPT.4 (24 104 EQUIVALENT TO 14 1104)
16 AND 26 EBAUCHES 3200
25 HEWLETT-PACKARD 5062C (ADD 1000 TO THE SERIAL NO.)
90 LABORATORY CESIUM STANDARD NRC CS V
91 LABORATORY CESIUM STANDARD NBS 4
99 PROTOTYPE CS

TABLE 20 - INTERNATIONAL ATOMIC TIME , WEIGHTS OF THE CLOCKS FOR 1976

THE WEIGHTS ARE GIVEN FOR INTERVALS OF TWO MONTHS ENDING AT THE GIVEN DATES

*** DENOTES THAT THE CLOCK WAS NOT USED

LAB.	CLOCK	42829	42889	42959	43019	43079	43139
ASMW	13 29	0	28	61	55	12	7
F	12 133	73	98	***	***	***	***
F	12 158	100	100	100	82	62	58
F	12 195	***	***	0	53	***	***
F	12 205	***	0	95	100	42	25
F	12 231	68	96	100	100	92	100
F	12 347	90	100	95	93	93	100
F	12 439	100	100	100	100	100	32
F	12 475	97	30	***	***	***	***
F	12 594	0	100	100	100	100	100
F	14 134	8	***	***	***	0	100
F	14 753	75	92	100	79	100	100
F	14 873	100	98	100	100	89	100
F	22 213	***	***	0	100	25	22
F	22 222	***	***	0	100	100	84
FOA	11 55	0	2	2	2	0	6
FOA	11 200	2	0	3	3	0	0
FOA	14 900	20	71	38	54	19	11
IEN	12 303	***	***	***	0	50	99
IEN	12 469	9	8	0	5	4	0
IEN	12 509	0	4	***	0	5	12
IEN	14 893	***	***	0	95	***	***
IEN	22 230	***	***	***	***	0	35
NBS	11 137	22	30	38	49	100	***
NBS	11 157	***	0	23	41	71	77
NBS	12 352	45	48	***	***	***	0
NBS	14 323	***	***	0	100	100	100
NBS	14 324	68	77	77	74	74	***
NBS	14 601	28	30	25	26	26	46
NBS	16 51	***	***	0	31	***	***
NBS	25 67	21	25	11	9	12	16
NBS	91 4	***	***	0	100	100	100
NPL	12 316	18	22	59	55	68	65
NPL	12 418	79	100	90	100	100	96
NPL	12 832	12	10	10	10	9	9
NRC	12 122	53	0	0	1	1	1
NRC	12 267	59	59	57	27	26	25
NRC	14 911	99	98	95	71	57	61
NRC	90 5	100	100	100	100	100	100
OMH	22 57	34	100	100	0	0	6

TABLE 20 - (CONT.)

LAB.	CLOCK	42829	42889	42959	43019	43079	43139
OMSF	13 16	0	5	5	***	0	***
OMSF	14 896	0	0	***	***	***	***
OMSF	22 223	***	***	***	0	75	83
ON	12 235	72	82	83	71	71	75
ON	13 14	13	18	5	9	11	14
ON	14 863	25	33	33	32	31	33
ON	24 156	***	0	100	100	100	100
ON	99 1	5	7	9	20	51	17
ON	99 3	31	37	0	0	1	0
ON	99 4	100	93	100	100	100	94
ON	99 5	42	55	70	93	57	47
ORB	12 804	60	59	53	50	48	36
ORB	14 205	***	0	32	45	55	42
PTB	12 320	100	100	100	96	93	100
PTB	12 389	100	100	97	100	100	97
PTB	12 394	100	100	100	100	100	100
PTB	12 335	72	85	52	37	33	100
PTB	12 462	***	0	43	57	90	100
PTB	14 867	100	100	100	100	100	100
PTB	16 67	***	***	***	***	0	9
PTB	24 103	11	11	15	29	100	97
PTCH	13 23	2	3	***	***	***	***
PTCH	15 54	***	***	***	0	64	10
RGO	11 123	74	69	100	100	91	50
RGO	11 199	19	27	35	26	***	***
RGO	12 348	100	82	100	100	***	0
RGO	12 484	21	16	13	0	1	1
RGO	14 202	***	0	100	34	100	100
RGO	14 353	55	37	65	91	32	100
TP	12 335	74	54	51	93	100	100
USNO	12 345	67	67	41	37	90	100
USNO	12 532	100	80	95	100	100	100
USNO	12 546	12	7	5	***	***	***
USNO	12 549	100	100	98	100	100	100
USNO	12 573	19	29	33	43	86	70
USNO	12 583	2	3	4	***	***	***
USNO	12 591	100	100	100	100	100	100
USNO	12 592	33	47	50	100	100	89
USNO	14 571	97	100	100	100	100	100
USNO	14 654	82	51	43	23	15	15
USNO	14 656	34	96	95	46	23	27
USNO	14 660	53	61	55	97	78	59
USNO	14 778	100	98	100	100	100	98
USNO	14 783	7	7	9	9	11	13
USNO	14 787	***	***	***	***	0	34

TABLE 20 - (CONT.)

LAB.	CLOCK	42829	42889	42959	43019	43079	43139
USNO	14 834	92	100	100	100	100	90
USNO	14 837	***	0	66	54	38	***
USNO	14 871	***	***	***	***	***	0
USNO	14 875	***	***	***	***	***	0
USNO	22 114	21	17	14	17	36	62
USNO	24 94	28	27	36	55	100	100
USNO	24 104	100	100	100	100	100	90
USNO	24 118	***	***	***	***	***	0
USNO	24 207	***	***	***	***	0	15
VSL	12 503	17	18	15	9	6	0
VSL	22 34	29	27	20	18	44	79
ZIPE	12 979	10	10	9	5	9	14

NOTE - THE CLOCKS ARE DESIGNATED BY THEIR MODEL (2 DIGITS) AND SERIAL NO. THE CODES FOR THE MODELS ARE

11 HEWLETT-PACKARD 5060A
12 AND 22 HEWLETT PACKARD 5061A (22 109 EQUIVALENT TO 12 1109)
13 EBAUCHES OSCILLATOR, B 5000
14 AND 24 HEWLETT-PACKARD 5061A OPT.4 (24 104 EQUIVALENT TO 14 1104)
16 AND 26 EBAUCHES 3200
25 HEWLETT-PACKARD 5062C (ADD 1000 TO THE SERIAL NO.)
90 LABORATORY CESIUM STANDARD NRC CS V
91 LABORATORY CESIUM STANDARD NBS 4
99 PROTOTYPE CS

TABLE 21 - DATA FROM PRIMARY STANDARDS

NO GRAVITATIONAL FREQUENCY CORRECTION IS APPLIED UNLESS OTHERWISE STATED

LAB.	STANDARD	CALIBRATION INTERVAL MJD	NORMALIZED FREQ. DIF. OF TA(I) - STD. IN 10**-13	SIGMA1 IN 10**-13	SIGMA2 IN 10**-13
NRC	NRC CS3	40221 - 40587	(1)	(2)	(2)
NRC	NRC CS3	40587 - 40709			
NRC	NRC CS3	40709 - 40952			
NRC	NRC CS3	40952 - 41072			
NRC	NRC CS3	41072 - 41139			
PTB	PTB CS1	40283 - 40300	29.28	13.31	2.00
PTB	PTB CS1	40332 - 40340	19.50	11.70	2.00
PTB	PTB CS1	40405 - 40472	8.03	12.19	2.00
NBS	NBS 3	40358 - 40362	0.0	5.00	
PTB	PTB CS1	40509 - 40637	16.01	1.04	1.66
PTB	PTB CS1	40769 - 40789	15.11	1.87	1.66
PTB	PTB CS1	40909 - 40929	13.28	1.95	1.66
PTB	PTB CS1	41469 - 41489	10.84	0.60	1.66
PTB	PTB CS1	41630 - 41637	8.45	1.15	1.66
PTB	PTB CS1	41749 - 41769	9.41	0.95	1.66
NBS	NBS 5	41709 - 41713	0.10	3.00	3.50
NBS	NBS 5	41724 - 41728	-1.20	2.10	2.50
NBS	NBS 5	41759 - 41763	-1.40	5.00	2.50
NBS	NBS 5	41775 - 41779	0.20	2.50	2.50
NBS	NBS 5	41962 - 41966	-2.60	2.00	2.00
PTB	PTB CS1	41816 - 41861	9.12	1.00	(3)
PTB	PTB CS1	41908 - 41921	9.35	1.00	
NBS	NBS 4	41924 - 41928	-6.20	5.00	2.50
NBS	NBS 4	42047 - 42051	-1.20	2.80	0.50
NBS	NBS 4	42084 - 42088	-0.10	2.80	0.50
NBS	NBS 4	42128 - 42132	-2.70	2.80	0.50
NBS	NBS 4	42170 - 42174	-1.70	2.80	2.50
NBS	NBS 4	42209 - 42213	-1.80	2.80	0.50
NBS	NBS 4	42239 - 42243	-0.20	2.80	0.50
NBS	NBS 4	42274 - 42278	-2.30	2.80	0.50
NBS	NBS 4	42317 - 42321	0.40	2.80	0.50
NBS	NBS 4	42352 - 42356	0.0	2.90	0.50
NBS	NBS 4	42394 - 42398	-1.00	2.80	0.50
NBS	NBS 4	42429 - 42433	-1.40	2.80	0.50
NBS	NBS 5	42048 - 42052	-2.70	2.00	0.50
PTB	PTB CS1	42264 - 42297	9.06	1.50	
PTB	PTB CS1	42383 - 42407	10.34	1.50	
PTB	PTB CS1	42448 - 42465	10.04	1.60	
NRC	NRC CSV	42539 - 42619	(1)		0.50
PTB	PTB CS1	42610 - 42622	8.62	1.00	

TABLE 21 - (CONT.)

PTB	PTB CS1	42652 - 42663	11.02	1.50	
NRC	NRC CSV	42679 - 42759	(1)		0.50
PTB	PTB CS1	42761 - 42792	9.89	1.50	
PTB	PTB CS1	42887 - 42911	9.21	1.00	
PTB	PTB CS1	42953 - 42987	9.20	1.00	
PTB	PTB CS1	43016 - 43061	9.62	1.00	
NBS	NBS 6	42883 - 42929	8.30(4)	0.30	0.85
NRC	NRC CSV	42899 - 42979	(1)		0.50
PTB	PTB CS1	43077 - 43096	9.96	1.00	
PTB	PTB CS1	43171 - 43204	-0.60	1.20	

(1) THE RESULTS ARE DIRECTLY REFERRED TO TAI , SEE TABLE 22.

(2) THE UNCERTAINTY OF THE CALIBRATION RESULTS IS 15*10**-13.

(3) STARTING FROM THIS CALIBRATION , THE TOTAL UNCERTAINTY IS GIVEN IN COLUMN SIGMA1 FOR THE PTB CS1 CALIBRATIONS.

(4) THE REPORTED VALUE REFERS TO THE FREQUENCY OF UTC(NBS)-STD.

PTB		43205-43260	-1.10	1.00
"		43266-43316	-0.95	1.10
"		43395-43416	-1.20	1.10
"		43497-43512	-0.66	0.90
"		43570-43586	-0.05	0.90
NBS	NBS-6			

TABLE 22 - DATA USED FOR EVALUATING THE DURATION OF THE TAI SCALE INTERVAL

GRAVITATIONAL FREQUENCY CORRECTIONS ARE APPLIED . THE FREQUENCIES ARE EXPRESSED AT SEA LEVEL .

LAB.	STANDARD	CALIBRATION INTERVAL MJD	NORMALIZED FREQ. DIF. OF TAI-STAND. IN 10**-13	RANDOM UNCERT. IN 10**-13	SYSTEMATIC UNCERT. IN 10**-13	CORREL. INDEX (1)
NRC	NRC CS3	40221 - 40587	3.31	13.30	7.00	1
NRC	NRC CS3	40587 - 40709	5.51	13.30	7.00	1
NRC	NRC CS3	40709 - 40952	10.01	13.30	7.00	1
NRC	NRC CS3	40952 - 41072	1.51	13.30	7.00	1
NRC	NRC CS3	41072 - 41139	4.21	13.30	7.00	1
PTB	PTB CS1	40255 - 40335	28.36	13.32	2.00	2
PTB	PTB CS1	40296 - 40376	20.16	11.72	2.00	2
PTB	PTB CS1	40402 - 40482	11.39	12.19	2.00	2
NBS	NBS 3	40320 - 40400	11.80	5.05	2.50	3
PTB	PTB CS1	40509 - 40637	16.96	1.05	1.66	4
PTB	PTB CS1	40739 - 40819	14.55	1.94	1.66	4
PTB	PTB CS1	40879 - 40959	14.13	2.04	1.65	4
PTB	PTB CS1	41439 - 41519	12.52	0.80	1.66	4
PTB	PTB CS1	41593 - 41673	12.08	1.33	1.66	4
PTB	PTB CS1	41719 - 41799	11.98	1.08	1.66	4
NBS	NBS 5	41671 - 41751	12.24	3.09	2.70	5
NBS	NBS 5	41686 - 41766	11.42	2.23	2.70	5
NBS	NBS 5	41721 - 41801	10.91	5.05	2.70	5
NBS	NBS 5	41737 - 41817	12.41	2.61	2.70	5
NBS	NBS 5	41924 - 42004	9.07	2.13	2.70	5
PTB	PTB CS1	41795 - 41875	10.74	1.07	0.0	6
PTB	PTB CS1	41874 - 41954	10.81	1.16	0.0	7
NBS	NBS 4	41886 - 41966	4.11	5.05	2.50	8
NBS	NBS 4	42009 - 42089	10.82	2.90	0.50	9
NBS	NBS 4	42046 - 42126	11.84	2.90	0.50	9
NBS	NBS 4	42090 - 42170	9.86	2.90	0.50	9
NBS	NBS 4	42132 - 42212	10.11	2.90	0.50	9
NBS	NBS 4	42171 - 42251	8.20	2.90	0.50	9
NBS	NBS 4	42201 - 42281	9.53	2.90	0.50	9
NBS	NBS 4	42236 - 42316	6.96	2.90	0.50	9
NBS	NBS 4	42279 - 42359	9.45	2.90	0.50	9
NBS	NBS 4	42314 - 42394	9.17	2.90	0.50	9
NBS	NBS 4	42356 - 42436	8.46	2.90	0.50	9
NBS	NBS 4	42391 - 42471	8.08	2.90	0.50	9
NBS	NBS 5	42010 - 42090	9.32	2.13	0.50	10
PTB	PTB CS1	42239 - 42319	8.74	1.56	0.0	11
PTB	PTB CS1	42355 - 42435	11.38	1.57	0.0	12
PTB	PTB CS1	42419 - 42499	11.70	1.69	0.0	13
NRC	NRC CSV	42539 - 42619	9.95	1.00	0.50	14
PTB	PTB CS1	42575 - 42655	9.44	1.16	0.0	15

TABLE 22 - (CONT.)

PTB	PTB CS1	42619 - 42699	12.00	1.62	0.0	16
NRC	NRC CSV	42679 - 42759	9.36	1.00	0.50	17
PTB	PTB CS1	42739 - 42819	11.15	1.57	0.0	18
PTB	PTB CS1	42858 - 42938	10.15	1.11	0.10 (2)	19
PTB	PTB CS1	42924 - 43004	9.36	1.09	0.10	19
PTB	PTB CS1	43009 - 43089	9.50	1.07	0.10	19
NBS	NBS 6	42666 - 42946	11.82	0.47	0.85	20
NRC	NRC CSV	42899 - 42979	9.07	1.00	0.50	21
PTB	PTB CS1	43047 - 43127	10.31	1.12	0.0	22
PTB	PTB CS1	43154 - 43234	-0.51	1.27	0.0	23

(1) The same correlation index is attributed to the calibrations which are intercorrelated. The systematic uncertainty expresses the degree of correlation.

(2) The value 0.10 of the systematic uncertainty was used by the BIH to express the correlation between the three calibrations indexed 19.

TABLE 23 - MEAN DURATION OF THE TAI SCALE INTERVAL IN SI SECOND AT SEA LEVEL

THE UNCERTAINTY IS AN ESTIMATION OF THE MAXIMUM ERROR

FOR THE MONTHS	MEAN DURATION	UNCERTAINTY
1970 JAN - FEB	1 - 13.3*10**-13	1.1*10**-13
1970 MAR - APR	- 13.0	1.1
1970 MAY - JUN	- 12.9	1.1
1970 JUL - AUG	- 12.7	1.1
1970 SEP - OCT	- 12.5	1.1
1970 NOV - DEC	- 12.4	1.1
1971 JAN - FEB	1 - 12.2*10**-13	1.1*10**-13
1971 MAR - APR	- 12.1	1.1
1971 MAY - JUN	- 12.0	1.1
1971 JUL - AUG	- 11.8	1.1
1971 SEP - OCT	- 11.7	1.0
1971 NOV - DEC	- 11.5	1.0
1972 JAN - FEB	1 - 11.4*10**-13	1.0*10**-13
1972 MAR - APR	- 11.3	1.0
1972 MAY - JUN	- 11.1	0.9
1972 JUL - AUG	- 11.0	0.9
1972 SEP - OCT	- 10.9	0.9
1972 NOV - DEC	- 10.8	0.8
1973 JAN - FEB	1 - 10.7*10**-13	0.8*10**-13
1973 MAR - APR	- 10.7	0.7
1973 MAY - JUN	- 10.6	0.7
1973 JUL - AUG	- 10.5	0.7
1973 SEP - OCT	- 10.4	0.7
1973 NOV - DEC	- 10.3	0.7
1974 JAN - FEB	1 - 10.3*10**-13	0.7*10**-13
1974 MAR - APR	- 10.2	0.7
1974 MAY - JUN	- 10.1	0.7
1974 JUL - AUG	- 10.0	0.7
1974 SEP - OCT	- 10.0	0.7
1974 NOV - DEC	- 10.1	0.6
1975 JAN - FEB	1 - 10.2*10**-13	0.6*10**-13
1975 MAR - APR	- 10.2	0.6
1975 MAY - JUN	- 10.1	0.6
1975 JUL - AUG	- 10.1	0.6
1975 SEP - OCT	- 10.2	0.6
1975 NOV - DEC	- 10.2	0.6
1976 JAN - FEB	1 - 10.2*10**-13	0.6*10**-13
1976 MAR - APR	- 10.3	0.6
1976 MAY - JUN	- 10.1	0.5
1976 JUL - AUG	- 10.0	0.6
1976 SEP - OCT	- 10.0	0.6
1976 NOV - DEC	- 10.0	0.6

1977 Jan - Feb
Mar - Apr
May - Jun
Jul - Aug
Sep - Oct
Nov - Dec

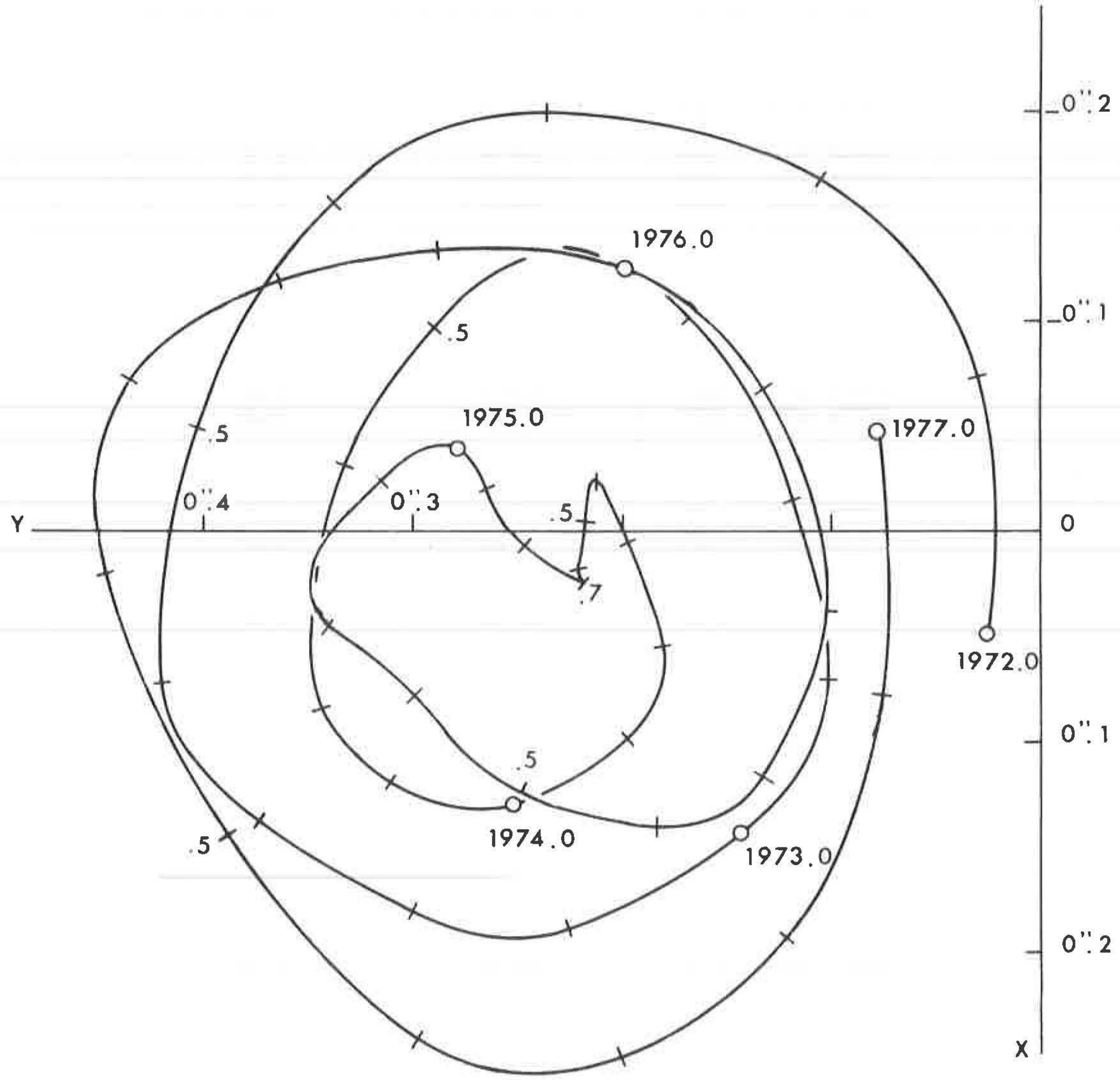

Fig. 1 - Path of the pole from 1972.0 to 1977.0

Smoothed values of Table 6C, obtained by Vondrak's method, with the coefficient of smoothing which equalizes the internal and external deviations in x and y.

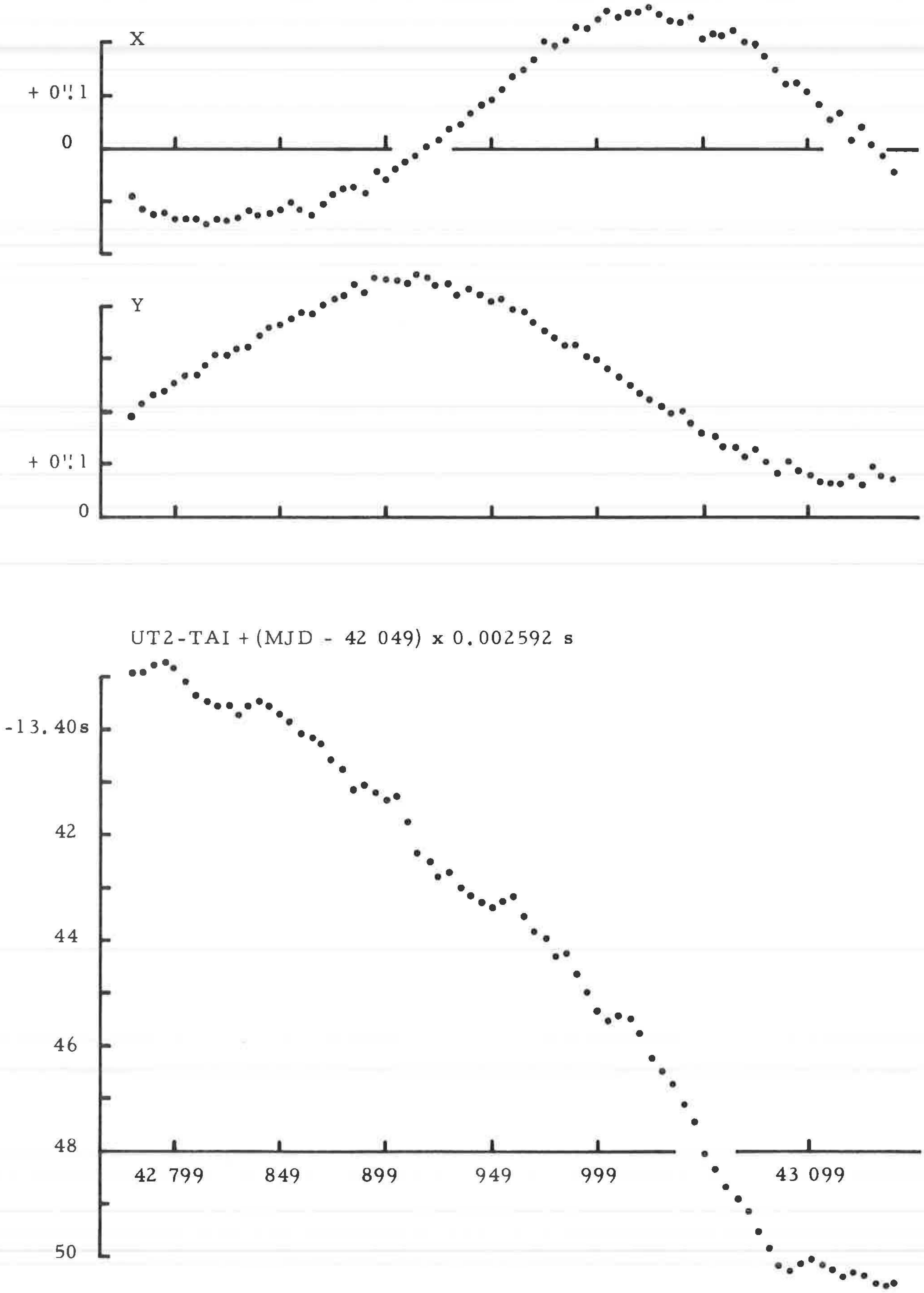

Fig. 2 - Raw data of x, y, UT2-TAI (table 6C for 1976), for every 5 days.

PART C

TIME SIGNALS (1976/1977)

The time signal emissions, unless otherwise stated, follow the UTC system, in accordance with the Recommendation 460-1 of the International Radio Consultative Committee (CCIR), reproduced thereafter.

The information on time signals is based on inquiries made in February 1977.

CCIR RECOMMENDATION 460-1

STANDARD-FREQUENCY AND TIME-SIGNAL EMISSIONS

(Question 1/7)

(1970 - 1974)

The C.C.I.R.,

CONSIDERING

(a) that the Administrative Radio Conference, Geneva, 1959, allocated the frequencies 20 kHz ± 0·05 kHz, 2·5 MHz ± 5 kHz (2·5 MHz ± 2 kHz in Region 1), 5 MHz ± 5 kHz, 10 MHz ± 5 kHz, 15 MHz ± 10 kHz, 20 MHz ± 10 kHz and 25 MHz ± 10 kHz to the standard-frequency and time-signal service, requesting the C.C.I.R. to study the question of establishing and operating a world-wide standard-frequency and time-signal service;

(b) that additional standard frequencies and time signals are emitted in other frequency bands;

(c) the provisions of Article 44, Section IV, of the Radio Regulations;

(d) the continuing need for close cooperation between Study Group 7 and the Inter-Governmental Maritime Consultative Organization (I.M.C.O.), the International Civil Aviation Organization (I.C.A.O.), the General Conference of Weights and Measures (C.G.P.M.), the Bureau International de l'Heure (B.I.H.) and the concerned Unions of the International Council of Scientific Unions (I.C.S.U.);

(e) the desirability of maintaining world-wide coordination of standard-frequency and time-signal emissions;

(f) the need to disseminate standard frequencies and time signals in conformity with the second as defined by the 13th General Conference of Weights and Measures (1967);

(g) the continuing need to make Universal Time (UT) immediately available to an accuracy of one-tenth of a second;

UNANIMOUSLY RECOMMENDS

1. that all standard-frequency and time-signal emissions conform as closely as possible to Coordinated Universal Time (UTC) (see Annex I); that the time signals should not deviate from UTC by more than one millisecond; that the standard frequencies should not deviate by more than 1 part in 10^{10}, and that the time signals emitted from each transmitting station should bear a known relation to the phase of the carrier;

2. that all standard-frequency and time-signal emissions should contain information on the difference between UT1 and UTC (see Annexes I and II);

3. that this document be transmitted by the Director, C.C.I.R., to all Administrations Members of the I.T.U., to I.M.C.O., I.C.A.O., the C.G.P.M., the B.I.H., the International Union of Geodesy and Geophysics (I.U.G.G.), the International Union of Radio Science (U.R.S.I.) and the International Astronomical Union (I.A.U.);

4. that the standard-frequency and time-signal emissions should conform to RECOMMENDS 1 and 2 above as from 1 January 1975.

ANNEX I

TIME SCALES

A. Universal Time (UT)

In applications in which an imprecision of a few hundredths of a second cannot be tolerated, it is necessary to specify the form of UT which should be used:

UT0 is the mean solar time of the prime meridian obtained from direct astronomical observation;

UT1 is UT0 corrected for the effects of small movements of the Earth relative to the axis of rotation (polar variation);

UT2 is UT1 corrected for the effects of a small seasonal fluctuation in the rate of rotation of the Earth;

UT1 is used in this document, since it corresponds directly with the angular position of the Earth around its axis of diurnal rotation. GMT may be regarded as the general equivalent of UT.

B. International Atomic Time (TAI)

The international reference scale of atomic time (TAI), based on the second (SI), as realized at sea level, is formed by the Bureau International de l'Heure (B.I.H.) on the basis of clock data supplied by cooperating establishments. It is in the form of a continuous scale, e.g. in days, hours, minutes and seconds from the origin 1 January 1958 (adopted by the C.G.P.M. 1971).

C. Coordinated Universal Time (UTC)

UTC is the time-scale maintained by the B.I.H. which forms the basis of a coordinated dissemination of standard frequencies and time signals. It corresponds exactly in rate with TAI but differs from it by an integral number of seconds.

The UTC scale is adjusted by the insertion or deletion of seconds (positive or negative leap-seconds) to ensure approximate agreement with UT1.

D. DUT1

The value of the predicted difference UT1-UTC, as disseminated with the time signals is denoted DUT1; thus DUT1 $\approx$ UT1 $-$ UTC. DUT1 may be regarded as a correction to be added to UTC to obtain a better approximation to UT1.

The values of DUT1 are given by the B.I.H. in integral multiples of 0·1 s.

The following operational rules apply:

1. Tolerances

1.1 The magnitude of DUT1 should not exceed 0·8 s.

1.2 The departure of UTC from UT1 should not exceed ± 0·9 s.*

1.3 The deviation of (UTC plus DUT1) from UT1 should not exceed ± 0·1 s.

2. Leap-seconds

2.1 A positive or negative leap-second should be the last second of a UTC month, but first preference should be given to the end of December and June, and second preference to the end of March and September.

2.2 A positive leap-second begins at $23^h\ 59^m\ 60^s$ and ends at $0^h\ 0^m\ 0^s$ of the first day of the following month. In the case of a negative leap-second, $23^h\ 59^m\ 58^s$ will be followed one second later by $0^h\ 0^m\ 0^s$ of the first day of the following month (see Annex III).

2.3 The B.I.H. should decide upon and announce the introduction of a leap-second, such an announcement to be made at least eight weeks in advance.

3. Value of DUT1

3.1 The B.I.H. is requested to decide upon the value of DUT1 and its date of introduction and to circulate this information one month in advance.**

3.2 Administrations and organizations should use the B.I.H. value of DUT1 for standard-frequency and time-signal emissions, and are requested to circulate the information as widely as possible in periodicals, bulletins, etc.

3.3 Where DUT1 is disseminated by code, the code should be in accordance with the following principles (except § 3.5 below):

- the magnitude of DUT1 is specified by the number of emphasized second markers and the sign of DUT1 is specified by the position of the emphasized second markers with respect to the minute marker. The absence of emphasized markers indicates DUT1 = 0;
- the coded information should be emitted after each identified minute.

Full details of the code are given in Annex II.

3.4 Alternatively, DUT1 may be given by voice or in Morse code.

3.5 DUT1 information primarily designed for, and used with, automatic decoding equipment may follow a different code but should be emitted after each identified minute.

3.6 In addition, UT1 — UTC may be given to the same or higher precision by other means, for example, in Morse code or voice, by messages associated with maritime bulletins, weather forecasts, etc.; announcements of forthcoming leap-seconds may also be made by these methods.

3.7 The B.I.H. is requested to continue to publish, in arrears, definitive values of the differences UT1 — UTC, UT2 — UTC.

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* The difference between the maximum value of DUT1 and the maximum departure of UTC from UT1 represents the allowable deviation of (UTC + DUT1) from UT1 and is a safeguard for the B.I.H. against unpredictable changes in the rate of rotation of the Earth.

** In exceptional cases of sudden change in the rate of rotation of the Earth, the B.I.H. may issue a correction not later than two weeks in advance of the date of its introduction.

ANNEX II

CODE FOR THE TRANSMISSION OF DUT1

A positive value of DUT1 will be indicated by emphasizing a number (n) of consecutive second markers following the minute marker from second marker one to second marker (n) inclusive; (n) being an integer from 1 to 8 inclusive.

$$\text{DUT1} = (n \times 0{\cdot}1)\ \text{s}$$

A negative value of DUT1 will be indicated by emphasizing a number (m) of consecutive second markers following the minute marker from second marker nine to second marker ($8 + m$) inclusive, (m) being an integer from 1 to 8 inclusive.

$$\text{DUT1} = -(m \times 0{\cdot}1)\ \text{s}$$

A zero value of DUT1 will be indicated by the absence of emphasized second markers.

The appropriate second markers may be emphasized, for example, by lengthening, doubling, splitting or tone modulation of the normal second markers.

Examples:

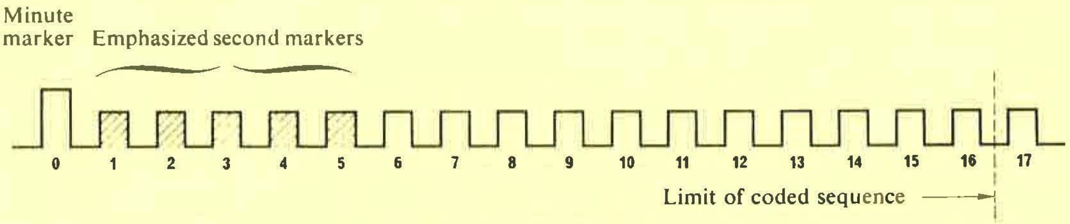

FIGURE 1

DUT1 = +0·5 s

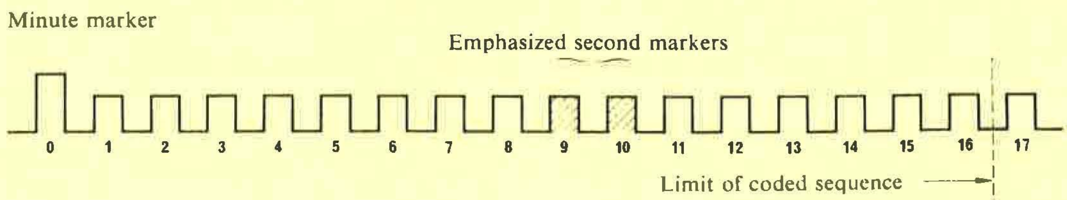

FIGURE 2

DUT1 = −0·2 s

ANNEX III

DATING OF EVENTS IN THE VICINITY OF A LEAP-SECOND

The dating of events in the vicinity of a leap-second shall be effected in the manner indicated in the following figures:

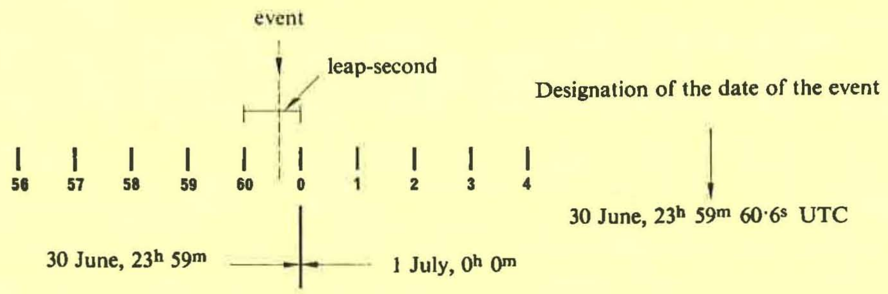

FIGURE 3

Positive leap-second

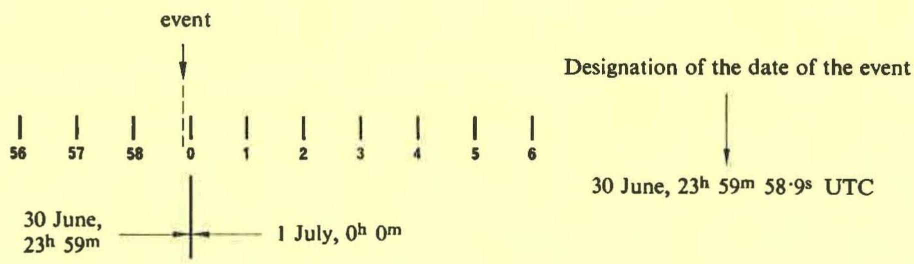

FIGURE 4

Negative leap-second

COMMENTS ON CCIR RECOMMENDATION 460-1

These comments are made by the Director of the BIH.

In Annex I of CCIR Recommendation 460-1, the section D.1 states the tolerances. They must be understood as follows.

In 1.1, the magnitude of DUT1 should not exceed 0.8 s exactly (DUT1 is given in units of 0.1 s, and no provision in the code is made for transmission of + or – 0.9 s).

In 1.3, the deviation of (UTC plus DUT1) from UT1 should not exceed ± 0.100...s (0.1 s in the text must be considered as an exact figure, not as a rounded value).

Therefore, the departure of UTC from UT1 shoud not exceed ± 0.900...s.

EXAMPLE : DUT1 = + 0.8 s

If the interval for which this value is valid is perfectly predicted by the BIH, DUT1 covers the values of UT1 – UTC :

$$0.75\,s \leqslant UT1 - UTC \leqslant 0.85\,s.$$

Therefore 0.85 s is the normal upper limit. The difference between 0.90 s (stated in 1.2, and taking into account the above comments) and 0.85 s is a safeguard against unpredictable changes of the rotation of the Earth.

AUTHORITIES RESPONSIBLE FOR THE TIME SIGNAL EMISSIONS

Signal	Authority
ATA	National Physical Laboratory Hillside Road New Dehli – 110012, India
BPV, XSG	Zi-Ka-Wei Section Shanghaï Observatory Academia Sinica Shanghaï, China
CHU	National Research Council, Time and Frequency Section Physics Division (M-36) Ottawa K 1 A OS 1, Ontario, Canada Attn : Dr. C. C. Costain
DAM, DAN, DAO	Deutsches Hydrographisches Institut Postfach 220 2000 Hamburg 4, Federal Republic of Germany
DCF77	Physikalisch-Technische Bundesanstalt, Laboratorium 1-21 Federal Republic of Germany Bundesallee 100 D 33 Braunschweig
DGI, DIZ	Amt für Standardisierung, Messwesen und Warenprüfung Fachabteilung Elektrizität Arbeitsgebiet Zeit und Frequenznormale Wallstrasse 16 DDR 1026 Berlin
EBC	Instituto y Observatorio de Marina San Fernando Cadiz, Spain
FFH	Centre National d'Études des Télécommunications Groupement Études spatiales et Transmissions Département Dispositifs et Ensembles fonctionnels 38, rue du Général Leclerc 92131 Issy-les-Moulineaux, France
FTA91, FTH42 FTK77, FTN87	Laboratoire Primaire du Temps et des Fréquences Observatoire de Paris 61, avenue de l'Observatoire 75014 Paris, France

Signal	Authority
GBR	1/ Time information : Royal Greenwich Observatory Herstmonceux Castle Hailsham, East Sussex BN27, 1 RP United Kingdom 2/ Standard Frequency information : National Physical Laboratory Electrical Science Division Teddington, Middlesex TW11 OLW, 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 Strada delle Cacce, 91 10135 – Torino, Italy
JJY, JG2AS	Frequency Standard Division The Radio Research Laboratories Ministry of Posts and Telecommunications Koganei, Tokyo 184, Japan
LOL	Director Observatorio Naval Av. Costanera Sur, 2099 Buenos-Aires, Republica Argentina
LQB9, LQC20	Instituto Geografico Militar (IGMA) Servicio internacional de la Hora Seccion Conservacion de la Hora Calle 38 Gral Savio 865 1650 Villa Maipu, San Martin Pcia de Buenos-Aires Republica Argentina
MSF	National Physical Laboratory Electrical Science Division Teddington, Middlesex TW11 OLW United Kingdom

Signal	Authority
NMO, NPN	Superintendant U. S. Naval Observatory Washington, D. C. 20390 U. S. A.
OLB5, OMA	1/ Time information : Astronomický Ústav ČSAV, Budečská 6, 120 23 Praha 2, Vinohrady, Czechoslovakia. 2/ Standard frequency information : Ústav radiotechniky a elektroniky ČSAV, Lumumbova 1, 180 88 Praha 8, Kobylisy, Czechoslovakia
PPE, PPR	Serviço da Hora Observatorio Nacional Rua General Bruce, 586 2000 Rio de Janeiro, GB. ZC. 08, Brasil
RBU, RCH RID, RIM, RTA, RTZ, RWM UQC3, UTR3	Comité d'État des Normes Conseil des Ministre de l'URSS Moscou 117049, URSS, Leninski prosp., 9
VNG	Time and Frequency Standards Section Australian Telecommunications Commission, Research Laboratories 59 Little Collins Street Melbourne, Vic. 3000, Australia
WWV, WWVH WWVB	Time and Frequency Services Section Time and Frequency Division National Bureau of Standards Boulder, Colorado 80302, U. S. A.
YVTO	Direccion de Hidrografia y Navegacion Observatori Cagigal Apartado Postal N°6745 Caracas, Venezuela
ZUO	National Physical Research Laboratory P. O. Box 395 Pretoria South Africa

TIME – SIGNALS EMITTED IN THE UTC SYSTEM

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UT)	Form of time signals
ATA	Greater Kailash Dehli India 28° 34' N 77° 19' E	5 000 10 000 15 000	3h 30m to 14h 30m on Monday to Saturday 4h 30m to 8h 30m on second Saturday of the month and Sunday, continuous operation projected.	Second pulses of 5 cycles of a 1 kHz modulation. Minute pulses of 100 ms duration.
BPV (1) see p. C-15	Shanghaï China 31° 12' N 121° 26' E	5 000 10 000 15 000	16h to 1h continuous 1h to 16h	1/ From 1m 0s to 9h 59s and from 31m 0s to 39m 59s of every hour, second pulses of 10 cycles of 1 kHz modulation; minute marker of 9 pulses. 2/ From 15m 0s to 24m 59s and from 45m 0s to 54m 59s, 1 kHz modulation ; second markers by interruptions of 50 ms of the modulation. Minute markers by 8 of 10 ms pulses and a 150 ms pulse.
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. Minute pulses are 0.5 s long. A bilingual (Fr. Eng.) announcement of time is made each minute FSK time code on 31st to 39th seconds. Broadcast is single sideband ; upper sideband with carrier reinserted. DUT1 : CCIR code by split pulses.
DAM	Elmshorn Germany, F. R. 53° 46' N 9° 40' E	8 638.5 16 980.4 4 265 8 638.5 6 475.5 12 763.5	11h 55m to 12h 06m 23h 55m to 24h 06m from 21 Oct. to 20 April 23h 55m to 24h 06m from 21 April to 20 Oct.	New international system, then second pulses from minutes 0.5 to 6.0 (minute pulses prolonged). A1 Type DUT1 : CCIR code by doubling, after minute pulses 1 to 5
DAN	Osterloog Germany, F. R. 53° 38' N 7° 12' E	2 614	11h 55m to 12h 06m 23h 55m to 24h 06m	As DAM (see above)
DAO	Kiel Germany F. R. 54° 26' N 10° 8' E	2 775	11h 55m to 12h 06m 23h 55m to 24h 06m	As DAM (see above)
DCF77	Mainflingen Germany F. R. 50° 1' N 9° 0' E	77.5	continuous	The second marks are reduction to 1/4 of the carriers's amplitude of 0.1 s duration ; the reference point is the beginning of the pulse modulation. The second 59 marker is omitted. Time code in BCD (year, month, day, hour, minute, day of the week) by lengthening second marks from marks N° 20 to N° 58 every minute. DUT1 : CCIR code by lengthening to 0.2s.
DGI	Oranienburg Germ. Dem. Rep 52° 48' N 13° 24' E	185	5h 59m 30s to 6h 00m 11h 59m 30s to 12h 00m 17h 59m 30s to 18h 00m	A2 type second pulses of 0.1 s duration for seconds 30-40, 45-50, 55-60. The last pulse is prolonged.
DIZ (2) see p. C-15	Nauen Germ. Dem. Rep. 52° 39' N 12° 55' E	4 525	continuous except from 8h 15m to 9h 45m for maintenance if necessary	A1 type second pulses of 0.1s duration. Minute pulses prolonged to 0.5s. DUT1 : CCIR code by double pulse.
EBC	San Fernando Spain 36° 28' N 6° 12' W	12 008 12 008 6 840 6 840	10h 00m to 10h 10m (A_2) 10h 15m to 10h 25m (A_3J) 10h 30m to 10h 40m (A_2) 10h 45m to 10h 55m (A_3J)	Experimental emission (1977) second pulses of 0.1s duration of 0.1s duration of 1 kHz modulation. Minute pulses of 0.5s duration of 1 250 Hz modulation DUT1, CCIR code, double pulse. (A_2) amplitude modulation. (A_3J) single sideband, cancelled carrier.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UT)	Form of the time signals
FFH	Ste Assise France 48° 33' N 2° 34' E	2 500	continuous from 8h to 16h 25m except on Sunday	Second pulses of 5 cycles of 1 kHz modulation. Minute pulses prolonged to 0.5s. DUT1 : CCIR code by lengthening to 0.1s.
FTA91	St-André-de-Corcy France 45° 55' N 4° 55' E	91.15	at 8h, 9h, 9h 30m, 13h, 20h, 21h, 22h 30m	A1 type second pulses during the 5 minutes preceding the indicated times, Minute pulses are prolonged. DUT1, in Morse code.
FTH42 FTK77 FTN87	Ste Assise France 48° 33' N 2° 34' E	7 428 10 775 13 873	at 9h and 21h at 8h and 20h at 9h 30m, 13h, 22h 30m,	A1 type second pulses during the 5 minutes preceding the indicated times. Minute pulses are prolonged. DUT1 : in Morse code.
GBR	Rugby United Kingdom 52° 22' N 1° 11' W	16	2h 55m to 3h 00m 8h 55m to 9h 00m 14h 55m to 15h 00m 20h 55m to 21h 00m	A1 type second pulses lasting 100 ms, lengthened to 500 ms at the minute. The reference point is the start of carrier rise. Uninterrupted carrier is transmitted for 24s from 54m 30s and from 0m 6s. DUT1 : CCIR code by double pulses.
HBG	Prangins Switzerland 46° 24' N 6° 15' E	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. No transmission of DUT1.
IAM	Rome Italy 41° 47' N 12° 27' E	5 000	10m every 15m, from 7h 30m to 8h 30m and from 10h 30m to 11h 30m except Sun. Advanced by 1 hour in summer.	Second pulses of 5 cycles of 1 kHz modulation. Minute pulses of 20 cycles (Announcements 5m before the emission of time signals).
IBF	Torino Italy 45° 2' N 7° 42' E	5 000	During 15m preceding 7h, 9h, 10h, 11h, 12h, 13h, 14h, 15h, 16h, 17h, 18h. 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. Time announcement (C.E.T.) by Morse code every ten minutes beginning at 0h 0m. DUT1 : CCIR code by double pulse.
JG2AS (3) see p. C-15	Chiba Japan 35° 38' N 140° 4' E	40	from 23h 30m to 8h (exc. Sun.) and from 8h to 23h 30m on Monday. Interruptions during communications.	A1 type second pulses of 0.5s sec. duration. Second 59 is omitted. No DUT1 code.
JJY (3) see p. C-15	Koganei Japan 35° 42' N 139° 31' E	2 500 5 000 10 000 15 000	continuous, except interruption between minutes 25 and 34	Second pulses of 8 cycles of 1 600 Hz modulation. Minute pulses are preceded by a 600 Hz modulation. DUT1 : CCIR code by lengthening.
LOL1	Buenos-Aires Argentina 34° 37' S 58° 21' W	5 000 10 000 15 000	11h to 12h, 14h to 15h, 17h to 18h, 20h to 21h, 23h to 24h	Second pulses of 5 cycles of 1 000 Hz modulation. Second 59 is omitted. Announcement of hours and minutes every 5 minutes, followed by 3m of 1 000 Hz or 440 Hz modulation. DUT1 : CCIR code by lengthening.
LOL2 LOL3	Buenos-Aires Argentina 34° 37' S 58° 21' W	4 856 8 030 17 180	1h, 13h, 21h,	A1 second pulses during the 5 minutes preceding the indicated times. Minute pulses are prolonged. DUT1 : CCIR code by double pulse.
LQB9 LQC20	Planta Gral Pacheco 34° 26' S 58° 37' W	8 167.5 17 551.5	22h 5m, 23h 50m 10h 5m, 11h 50m	A1 second pulses during the 5 minutes preceding the indicated times. Second 59 is omitted, second 60 is is prolonged. After the emission, OK is transmitted if the emission is correct, NV if not correct. DUT1 : CCIR code by double pulse.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UT)	Form of the time signals
MSF	Rugby United Kingdom 52° 22' N 1° 11' W	60	continuous except for an interruption for maintenance from 10h 0m to 14h 0m 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. BCD time code (month, day, hour, minute) during minute interruptions. DUT 1 : CCIR code by double pulse.
MSF	Rugby United Kingdom 52° 22' N 1° 11' W	2 500 5 000 10 000	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. DUT1 : CCIR code by double pulse.
NMO	Lualualei Hawaii, USA 21° 26' N 158° 10' W	4 525 9 050 13 655 16 457.5 22 472	0h 55m to 1h 0m 2h 55m to 3h 0m 6h 55m to 7h 0m 21h 55m to 22h 0m	CW second pulses.
NPN	Barrigada Guam 13° 29' N 144° 50' E	4 955 8 150 13 380 21 760	5h 55m to 6h 0m 11h 55m to 12h 0m 17h 55m to 18h 0m 23h 55m to 24h 0m	CW second pulses.
OLB5	Poděbrady Czechoslovakia 50° 9' N 15° 9' E	3 170	continuous except from 6h to 12h on the first Wednesday of every month	A1 type, second pulses. No transmission of DUT1.
OMA (4) see p. C-15	Poděbrady Czechoslovakia 50° 9' N 15° 8' E	50	continuous except from 6h to 12h on the first Wednesday of every month	Interruption of the carrier of 100ms at the beginning of every second, of 500 ms at the beginning of every minute. The precise time is given by the beginning of the interruption.
	Liblice Czechoslovakia 50° 4' N 14° 53' E	2 500	between minutes 5 and 15 25 and 30, 35 and 40, 50 and 60 of every hour except from 5h to 11h 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. No transmission of DUT1.
PPE	Rio-de-Janeiro Brasil 22° 54' S 43° 13' W	8 721	0h 30m, 11h 30m, 13h 30m, 19h 30m, 20h 30m, 23h 30m,	Second ticks, of A1 type, during the five minutes preceding the indicated hours. The minute ticks are longer. DUT1 : CCIR code by double pulse.
PPR	Rio-de-Janeiro Brasil 22° 59' S 43° 11' W	435 8 634 13 105 17 194.4	1h 30m, 14h 30m, 21h 30m	Second ticks, of A1 type, during the five minutes preceding the indicated hours. The minute ticks are longer.
RBU (5) see p. C-15	Moscow USSR 55° 19' N 38° 41' E	66 2/3	between minutes 0 and 5 from 0h to 12h 5m from 14h to 23h 5m	A1 type. Second pulses. The pulses at beginning of the minute are prolonged to 0.5 s.
RCH (5)	Tashkent USSR 41° 19' N 69° 15' E	2 500	between minutes 15 and 20, 25 and 30, 35 and 40, 45 and 50 from 0h to 3h 50m from 5h 35m to 9h 30m from 10h 15m to 13h 30m from 14h 15m to 23h 50m	Second pulses. The pulses at the beginning of the minute are prolonged to 0.5s.
RID (5)	Irkutsk USSR 52° 46' N 103° 39' E	5 004 10 004 15 004	The station simultaneously operates on three frequencies between minutes 5 and 10, 15 and 20, 25 and 30, 52 and 60	Second pulses. The pulses at the beginning of the minute are prolonged to 0.5s.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UT)	Form of the time signals
RIM (5) see p. C-15	Tashkent USSR 41° 19' N 69° 15' E	5 000	between minutes 15 and 20, 25 and 30, 35 and 40, 45 and 50, from 0h to 1h 30m from 2h 15m to 3h 50m from 14h 15m to 17h 30m from 18h 15m to 23h 50m	Second pulses. The pulses at the beginning of the minute are prolonged to 0.5s.
		10 000	between minutes 15 and 20, 25 and 30, 35 and 40, 45 and 50 from 5h 35m to 9h 30m from 10h 15m to 13h 30m	
RTA (5)	Novossibirsk USSR 55° 4' N 82° 58' E	10 000	between minutes 5 and 10, 15 and 20, 25 and 29, 35 and 39, from 0h 5m to 1h 29m from 2h 5m to 4h 39m from 14h 5m to 17h 29m from 18h 5m to 23h 39m	Second pulses. The pulses at the beginning of the minute are prolonged.
		15 000	between minutes 5 and 10, 15 and 20, 25 and 29, 35 and 39 from 6h 35m to 9h 29m from 10h 5m to 13h 29m	
RWM (5)	Moscow USSR 55° 19' N 38° 41' E	4 996 9 996 14 996	The station simultaneously operates on three frequencies between minutes 30 and 35, 41 and 45, 50 and 60	Second pulses. The pulses at the beginning of the minute are prolonged to 0.5s.
RTZ (5)	Irkutsk USSR 52° 18' N 104° 18' E	50	between minutes 0 and 5, from 0h to 20h 5m from 22h to 23h 5m	A1 type second pulses. The pulses at the beginning of the minute are prolonged to 0.5s.
UQC3 (5)	Chabarovsk USSR 48° 30' N 134° 51' E	25	from 0h 43m to 0h 52m, from 3h 43m to 3h 52m from 6h 43m to 6h 52m from 17h 43m to 17h 52m	A1 type 0.1 second pulses of 0.025s duration. Second pulses are prolonged to 0.1s ; 10 second pulses are prolonged to 1s and minute pulses are prolonged to 10s. No transmission of DUT1 code.
UTR3 (5)	Gorjkiy USSR 56° 11' N 43° 58' E	25	from 5h 43m to 5h 52m from 14h 43m to 14h 52m from 18h 43m to 18h 52m	A1 type 0.1 second pulses of 0.025s duration. Second pulses are prolonged to 0.1s ; 10 second pulses are prolonged to 1s and minute pulses are prolonged to 10s. No transmission of DUT1 code.
VNG	Lyndhurst Australia 38° 3' S 145° 16' E	4 500 7 500 12 000	9h 45m to 21h 30m continuous except 22h 30m to 22h 45m 21h 45m to 9h 30m	Second markers of 50 cycles of 1 kHz modulation; 5 cycles only for second markers 55 to 58 ; second marker 59 is omitted ; 500 cycles for minute markers. During the 5th, 10th, 15th, etc... minutes, 5 cycles for second markers 50 to 58. Identification by voice announcement during 15th, 30th, 45th and 60th minutes. DUT1 : CCIR code by 45 cycles of 900 Hz modulation immediately following the normal second markers.
WWV	Fort-Collins USA 40° 41' N 105° 2' W	2 500 5 000 10 000 15 000	continuous	Pulses of 5 cycles of 1 kHz modulation. 59th and 29th 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 : CCIR code by double pulse. BCD time code given on 100 Hz subcarrier, includes DUT1 correction.
WWVB	Fort-Collins 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 and time and of the correction to obtain UT1. No CCIR code.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UT)	Form of the time signals
WWVH	Kauai 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. 59 th and 29 th second pulses omitted. Hour id entified by 0.8 second long 1 500 Hz tone. Beginning of each minute identified by 0.8 second long 1 200 Hz tone. DUT1 : CCIR code by double pulse. BCD time code given on 100 Hz subcarrier, includes DUT1 correction.
YVTO	Caracas Venezuela 10 °30' N 66° 56' W	6 100	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 52 and 57 of each minute, voice announcement of hour, minute and second.
ZUO	Olifantsfontein South Africa 25 °58' S 28° 14' E	2 500 5 000 100 000	18 h to 4 h continuous continuous	Pulses of 5 cycles of 1 kHz modulation. Second 0 is prolonged. DUT1 : CCIR code by lengthening.

OTHER TIME SIGNALS (see also page C-18)

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UT)	Form of the time signals
BPV (1) see p. C-15	Shanghai China 31° 12' N 121° 26' E	5 430 } 9 351 }	0h, 6h, 11h, 13h, 15h 17h, 19h, 21h, 22h, 23h (on 6 h and 23 h, only 9 531 kHz is used).	During 5 m before and after the indicated times A1 type rhythmic signals. Second pulse of 0.1 s duration, minute pulse of 0.5 s duration.
		5 000 10 000 15 000	16 h to 1 h continuous 1 h to 16 h	from 10m 0s to 14m 59s and 40m 0s to 44m 59s of every hour, second pulses of 0.1 s duration, minute pulses of 0.5 s duration.
XSG (1)	Shanghai China 31° 12' N 121° 26' E	458 6 414 8 502 12 871.5	3 h, 9 h	During 3 m before the indicated times, second pulses. During 5 m after the indicated times, rhythmic signals.

Notes on the characteristics of time signals

(1) BPV, XSG. No recent information on these time signals.

(2) DIZ
DUT1 information in CCIR code.
dUT1 information. This additional information specifies more precisely the difference UT1 –UTC down to multiples of 0.02 s, the total value of the correction being DUT1 + dUT1.

A positive value of dUT1 is indicated by doupling a number (p) of consecutive seconds markers from seconds marker 21 to seconds marker (20 + p) inclusive ; (p) being an integer from 1 to 5 inclusive.

$$dUT1 = p . 0.02 \text{ s.}$$

A negative value of dUT1 is indicated by doupling a number (q) of consecutive seconds markers following the minute marker from seconds marker 31 to seconds marker (30 +q) inclusive ; (q) being an integer from 1 to 5 inclusive.

$$dUT1 = -(q . 0.02) \text{s} .$$

The seconds marker 28 following the minute marker is doubled as parity bit, if the value of (p) or (q) is an even number, or if dUT1 = 0.

Time-information. During the last 20 seconds of each minute in a BCD–code an information about the value "minute" and "hour" in the UTC time scale of the following minute marker is given.

(3) JG2AS, JJY. The move of both stations to Sanwa, Japan (+36° 11', + 139° 51') is scheduled for the beginning of December 1977. Slight changes of schedule will also be made.

(4) OMA, 50 kHz.
a. Owing to the reconstruction of the transmitter site in Liblice the OMA signal 50 kHz is being radiated with reduced power (approx. 50 W) from an auxilliary transmitter in Podebrady (50° 9', - 15° 8'), as from September 23, 1974. Resumption of the transmission from Liblice is hoped for the end of 1977.

b. Time of the day (seconds, minutes and units of hours) transmission was started by the station OMA 50 kHz from July 1974 on an experimental basis. In the segment 0.55 s – 0.95 s of each second the time in BCD is encoded in the transmission through reversals of the carrier phase. Phase 0° corresponds to logical zero and phase 180° corresponds to logical one. The duration of 1 bit is 20 ms.

The users interested in continuous phase only have the possibility to suppress the coding by simple doubling of the carrier frequency. Sequential modification permitting to include the full date MJD and DUT1 in the coded transmission is envisaged, possibly during 1977.

(5) The radiostations of the USSR emit UT1 information in accordance with the CCIR code. Furthermore they give an additional information dUT1 specifying 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 20th and 25th second so that dUT1 = + 0.02 s x p. Negative values of DUT1 are transmitted by the marking of q second markers within the range between the 35th and the 40th second, so that dUT1 = - 0.02 s x q.

ACCURACY OF THE CARRIER FREQUENCY

The carriers of the following time signals are standard frequencies.

Station	Relative accuracy of the carrier frequency in 10^{-10}
ATA	1
CHU	0.05
DCF77	0.01
FFH	0.2
GBR	0.02
HBG	0.02
IAM	0.5
IBF	0.1
JJY, JG2AS	0.1
LOL1	0.2
MSF (60 kHz)	0.02
MSF (h. f.)	0.02
OMA (all frequencies)	0.5
RBU, RTZ	0.1
RID, RTA, RWM, UQC3, UTR3	0.5
RCH, RIM	1
VNG	1
WWV	0.1
WWVB	0.1
WWVH	0.1
ZUO	0.1

TIME OF EMISSION OF THE TIME SIGNALS IN 1976.

Unless otherwise stated, the value of UTC-signal are valid for the whole year 1976.

Signal	UTC–Signal (unit : 0.0001 s)	Remarks
BPV (10 MHz, 15 MHz)	-214	
CHU	0	
DAM, DAN, DAO	0	
DCF77	0	
DGI	0	
DIZ	0	- 8 from 1976 January 9 to 11 uncertainty of 0.1 s from 1976 January 19 to 23 - 3 for 1976 March 30 and 31
FFH	0	
FTA91	0	
FTH42, FTK77, FTN87	0	
GBR	0	
HBG	0	
IAM	0	
IBF	0	
JJY	0	
LOL (all emissions)	0	
LQB9	0	
LQC20	0	
MSF	0	
NSS (h.f.)	0	
OLB5	+ 8	
OMA	0	
PPE	0	
RWM (and other t.s. from USSR)	0	
VNG	0	
WWV, WWVB, WWVH	0	
ZUO	0	

TIME OF EMISSION OF BPV ON 9351 kHz, 11h UT.

From receptions made at the Deutsches Hydrographisches Institut, Hamburg.

Step adjustments, when observed, are marked by – in following table.

1976						UTC – BPV (9351 kHz) (Unit : 0.0001 s)						
Date	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	-	-	- 5594	- 4581	-	-	- 1805	-	- 482	+ 464	-	+ 2502
2	- 7232	- 6418	- 5566	- 4555	-	- 2591	- 1774	- 1202	- 455	-	-	+ 2537
3	-	-	- 5543	-	-	- 2564	-	- 1200	- 432	-	-	+ 2567
4	-	- 6367	- 5522	-	-	- 2542	-	- 1161	-	+ 581	+1663	-
5	- 7156	-	- 5484	- 4461	- 3390	-	- 1696	- 1130	-	+ 613	+1693	-
6	- 7128	-	-	- 4435	- 3362	-	- 1687	-	- 361	+ 653	-	+ 2671
7	- 7105	-	-	- 4396	- 3344	-	- 1662	-	- 336	+ 695	-	+ 2707
8	- 7076	-	-	- 4378	-	- 2396	- 1649	-	- 309	+ 730	+1772	+ 2738
9	- 7052	- 6242	- 5372	- 4359	-	-	- 1622	- 1094	- 288	-	+1791	+ 2777
10	-	- 6219	- 5350	-	- 3274	- 2342	-	- 1068	- 265	-	+1852	-
11	-	- 6166	- 5323	-	- 3241	-	-	-	-	+ 850	+1882	-
12	- 6972	- 6138	- 5255	-	- 3212	-	- 1561	- 973	-	+ 884	-	-
13	- 6945	-	-	-	- 3180	-	- 1548	- 951	- 127	+ 917	-	+ 2908
14	- 6923	-	-	- 4102	- 3152	-	- 1528	-	- 104	+ 952	-	+ 2937
15	- 6894	-	- 5182	- 4084	- -	-	- 1509	-	- 75	+ 991	+2050	+ 2967
16	- 6868	- 6026	- 5143	-	-	- 2198	- 1476	-	- 60	-	+2080	+ 2997
17	-	- 6001	- 5110	-	- 3089	- 2172	-	-	- 26	-	+	+ 3030
18	-	- 5975	-	-	-	-	-	- 866	-	+1099	+2154	-
19	- 6788	- 5952	- 5047	-	- 3042	-	- 1424	-	-	+1131	-	-
20	- 6760	- 5922	-	- 3922	- 2979	-	- 1404	- 824	+ 43	+1176	-	+ 3127
21	- 6732	-	-	- 3892	-	-	-	-	+ 80	+1216	-	+ 3158
22	- 6701	-	- 4976	-	-	-	- 1374	-	+ 108	+1251	+2296	+ 3187
23	- 6679	- 5782	- 4940	- 3836	-	-	- 1356	-	+ 132	-	+2342	+ 3216
24	-	- 5760	- 4922	-	- 2844	- 1980	-	-	+ 160	-	-	-
25	-	- 5727	- 4897	-	-	- 1938	-	- 646	-	+1338	+2403	-
26	- 6601	- 5710	- 4845	- 3737	- 2788	-	-	- 613	-	+1366	+2443	-
27	- 6574	- 5677	-	- 3715	-	-	-	- 588	+ 254	-	-	+ 3346
28	- 6540	-	-	- 3683	- 2730	- 1870	- 1273	-	+ 280	-	-	+ 3376
29	- 6522	-	-	- 3650	-	- 1842	-	-	+ 310	+1528	+2548	+ 3407
30	-		- 4733	- 3623	-	- 1800	- 1253	- 528	+ 345	-	+2589	+ 3438
31	-		- 4700		-		-	-		-		-

Dépôt légal : 2ème trimestre 1977

Imprimeur : Observatoire de Paris

Le Gérant : J. Boulon