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Table 9 — Offsets and step adjustments of UTC, until 1978 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
1978 Jan. 1	”	− 1 s

Table 10 — Relationship between TAI and UTC, until 1978 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 -	1978 Jan. 1	16.000 000 0 s
1978 Jan. 1		17.000 000 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
PKNM	Polski Komitet Normalizacji i Miar, Warszawa, Polska
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
TUG	Technische Universität Graz, Osterreich
USNO	U. S. Naval Observatory, Washington D. C., 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 1977	TA(F) – UTC(OP) is published in Bulletin H by OP
NBS	12 commercial Cs stds 2 lab. primary stds 1 Hydrogen Maser (2)	43144 - 43325	16.045 049 985 $+ (32.4 \times 10^{-9})\ (MJD - 43144)$ $- (11.83 \times 10^{-12})\ (MJD - 43144)^2$
		43325 - 43509	16.045 055 462 $+ (8.1 \times 10^{-9})\ (MJD - 43325)$ $- (11.83 \times 10^{-12})\ (MJD - 43325)^2$
NRC	3 commercial Cs stds 1 lab. primary std (3)	year 1977	15.999 968 931
ON	4 commercial Cs stds 4 prototype Cs stds	year 1977	16 seconds exactly
PTB	10 commercial Cs stds 1 lab. primary std 1 Hydrogen Maser (4)	year 1977	published in PTB Time Service Bulletin
RGO	6 commercial Cs stds	year 1977	15.999 926 09
USNO	25 commercial Cs stds 1 Hydrogen Maser	year 1977	A.1 (USNO, MEAN) – UTC(USNO,MC): provisional values in USNO series 7 ; final values in USNO series 11. (5)

Table 12 - (cont.)

Notes

(1) The standards are located as follows (at the end of 1977)

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. Three of the commercial standards provide the reference for WWV and WWVB but do not contribute directly to TA(NBS) ; they are available for NBS time scales back-up and are compared to TA(NBS) to within 0.1 μs.

(3) The 2.1 meter primary cesium clock, Cs V, has operated continuously in 1977, producing a scale of proper time PT (NRC Cs V). The time scales UTC (NRC) and TA (NRC) have been derived from PT (NRC Cs V) in 1977 according to the following expressions given in microseconds :

$$\text{UTC (NRC)} = \text{PT(NRC Cs V)} - (\text{MJD} - 43144) \times 0.000\,97 + 52.041$$

$$\text{TA (NRC)} = \text{PT (NRC Cs V)} - (\text{MJD} - 43144) \times 0.000\,97 + 20.972$$

with integral seconds disregarded.

(4) TA(PTB) results from the data of 8 Cs stds. Its frequency is adjusted to conform with the primary freq std. CS 1 of PTB. UTC(PTB) + 1h = MEZ (PTB) is called the Official Time Scale (in Central European Time) which is disseminated, e.g., by the LF transmitter DCF77. Two Cs stds. and one Rb std. provide the reference for DCF77.

(5) 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	7970-W 7990-M 7990-X	GBR, OMA50, MSF60, HBG DCG77	TUG
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	7 Cs	1 Cs + micro stepper	7990-M 7990-Z	GBR, MSF60	other lab. in Italy
IGMA	1 Cs	1 Cs		NLK, GBR, LQB9, LQC20	ONBA
ILOM	3 Cs	Cs	9970-M		
NBS	see Table 12	8 Cs 1 lab. Cs	9930-Z 9940-M	OMEGA	NRC, USNO
NPL	5 Cs 1 lab. Cs	1 Cs	7970-W	GBR, MSF60	RGO, 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	GBR	
ON	see Table 12	all the Cs	7970-W 7990-Z		
ONBA	2 Cs	2 Cs		OMEGA/T	IGMA
ONRJ	2 Cs	all the Cs		GBR, OMEGA	other lab. in Brasil
OP	5 Cs	1 Cs	7970-W 7990-Y		other lab. in France, ORB, Hewlett-Packard (Switzerland)

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
PKNM	3 Cs	all the Cs		DCF77, HBG75	ASMW, ZIPE
PTB	see Table 12	2 Cs	7970-W	GBR, DCF77	DHI, TP and other lab.
PTCH	2 Cs	1 Cs	7970-W	DCF77, HBG	
RGO	see Table 12	selection of the Cs	7930-X 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, OMA50, RBU, MSF60	other lab. in USSR, TP
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 + micro stepper		DCF77	DHI, PTB, SU, ZIPE, ASMW, OMH
TUG	1 Cs	1 Cs	7970-W 7990-M	DCF77, GBR	BEV
USNO (5)	see Table 12	Cs	(6)	(6)	NRC, NBS
VSL	3 Cs	Cs	7970-M 7970-W 7930-X	DCF77	other lab. in Holland
ZIPE	1 Cs	1 Cs	7970-W	DCF77, GBR, OMA50, HBG, OMEGA/N	ASMW, DHI, PKNM, 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
9940-M	West Coast chain, Fallon

(3) OMEGA stations :

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

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

(5) USNO Time Service Publication, Series 16, entitled Precise Time Tranfer Report, lists UTC(USNO MC) – UTC (Reference Clock). Differences from Satellite Communication terminals as well as many international timing centers are reported. USNO Time Service Publication, Series 17, entitled Transit Satellite Report, lists UTC(USNO MC) – UTC (Satellite Clock) and also the frequency offset of each satellite.

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

the LORAN – C chains
the OMEGA stations ND, T, H, L, A
the VLF stations GBR, NLK

TABLE 14 - TIME COMPARISONS BETWEEN LABORATORIES BY CLOCK TRANSPORTATION IN 1977

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

DATE 1977		MJD	TIME COMPARISONS (UNIT : 1 MICROSECOND)		UNCERT.	SOURCE
JAN	3	43146.9	UTC(NBS) - UTC(USNO) =	4.25		NBS LETTER
JAN	4	43147.4	UTC(NBS) - UTC(OP) =	-2.89		NBS LETTER
JAN	12	43155.4	UTC(NBS) - UTC(OP) =	-2.87		NBS LETTER
JAN	12	43155.9	UTC(NBS) - UTC(USNO) =	4.07		NBS LETTER
JAN	17	43160.9	UTC(USNO) - UTC(DNM) =	85.3	0.2	USNO DPV 523 (1)
JAN	19	43162.8	UTC(USNO) - UTC(ATC) =	-1.3	0.2	USNO DPV 523
JAN	27	43170.4	UTC(OP) - UTC(RGO) =	-0.47	0.04	OP LETTER
JAN	27	43170.5	UTC(OP) - UTC(NPL) =	-0.38	0.04	OP LETTER
JAN	31	43174.4	UTC(USNO) - UTC(OP) =	-6.3	1.5	USNO LETTER
FEB	2	43176	UTC(NBS) - UTC(USNO) =	3.3	0.2	NBS BULL 231
FEB	22	43196.6	UTC(USNO) - UTC(ARO) =	0.0	0.2	USNO DPV 527 (2)
FEB	22	43196.8	UTC(USNO) - UTC(NBS) =	-2.7	0.2	USNO DPV 526
FEB	23	43197.5	UTC(USNO) - UTC(NRC) =	-4.5	0.2	USNO DPV 525
MAR	24	43226.4	UTC(ILOM) - UTC(RRL) =	18.5	0.2	ILOM LETTER
MAR	28	43230.5	UTC(ASMW) - UTC(SU) =	51.93	0.05	ASMW LETTER
APR	6	43239.3	UTC(USNO) - UTC(OP) =	-5.6	1.5	USNO DPV 533 (3)
APR	12	43245.3	UTC(USNO) - UTC(NPL) =	-6.1	0.2	USNO DPV 533
APR	20	43253.7	UTC(USNO) - UTC(NBS) =	-1.2	0.2	USNO DPV 534
APR	23	43256.4	UTC(ILOM) - UTC(RRL) =	23.2	0.2	ILOM LETTER
APR	27	43260	UTC(NBS) - UTC(OP) =	-4.4	0.3	NBS LETTER
APR	27	43260	UTC(NBS) - UTC(USNO) =	1.0	0.3	NBS BULL 234
APR	27	43260.5	UTC(USNO) - UTC(IEN) =	-11.1	0.2	USNO DPV 539
MAY	18	43281.3	UTC(USNO) - UTC(OP) =	-4.7	0.1	USNO DPV 539
MAY	25	43288.5	UTC(SU) - UTC(OMH) =	-104.3	0.2	SU LETTER
JUN	2	43296	UTC(NBS) - UTC(USNO) =	0.0	0.3	NBS BULL 236
JUN	7	43301.5	UTC(USNO) - UTC(OMSF) =	-5.3	0.2	USNO DPV 542
JUN	8	43302.6	UTC(USNO) - UTC(NBS) =	0.0	0.2	USNO DPV 542
JUN	13	43307.3	UTC(USNO) - UTC(NPL) =	-5.5	0.1	USNO DPV 542
JUN	14	43308.3	UTC(USNO) - UTC(RGO) =	-2.6	0.1	USNO DPV 542
JUN	16	43310.3	UTC(USNO) - UTC(OP) =	-4.1	0.1	USNO DPV 542
JUN	27	43321.6	UTC(NPL) - UTC(VSL) =	-30.05	0.05	NPL LETTER
JUL	16	43340.9	UTC(NBS) - UTC(OP) =	-3.9	0.3	NBS LETTER
JUL	22	43346	UTC(NBS) - UTC(USNO) =	-0.5	0.3	NBS BULL 237
JUL	27	43351.3	UTC(PTB) - UTC(DHI) =	-0.15	0.03	PTB LETTER
AUG	5	43360.0	UTC(USNO) - UTC(RRL) =	-12.4	0.5	USNO DPV 551
AUG	5	43360.0	UTC(USNO) - UTC(TAO) =	29.4	0.5	USNO DPV 551
AUG	11	43366	UTC(NBS) - UTC(USNO) =	-0.3	0.3	NBS BULL 238
AUG	26	43381	UTC(NBS) - UTC(USNO) =	-0.2	0.3	NBS BULL 238
AUG	26	43381.8	UTC(USNO) - UTC(NBS) =	0.206	0.005	USNO DPV 552
SEP	7	43393.4	UTC(ILOM) - UTC(RRL) =	19.0	0.2	ILOM LETTER
SEP	7	43393.7	UTC(NBS) - UTC(NRC) =	-3.8		NRC LETTER
SEP	9	43395.2	UTC(USNO) - UTC(NBS) =	0.0	0.2	USNO DPV 556
SEP	12	43398.5	UTC(USNO) - UTC(NRC) =	-3.8	0.2	USNO DPV 555
SEP	15	43401.5	UTC(USNO) - UTC(TUG) =	2.2	0.2	USNO DPV 557
SEP	19	43405.3	UTC(USNO) - UTC(VSL) =	-40.2	0.2	USNO DPV 557
SEP	23	43409.7	UTC(USNO) - UTC(NPL) =	-2.0	0.2	USNO DPV 557
SEP	26	43412.7	UTC(OP) - UTC(PTB) =	1.67	0.05	OP LETTER
SEP	28	43414.4	UTC(OP) - UTC(ASMW) =	2.77	0.05	ASMW LETTER
SEP	28	43414.4	UTC(PKNM) - UTC(ASMW) =	13.34	0.05	ASMW LETTER
SEP	28	43414.4	UTC(SU) - UTC(ASMW) =	-50.2		SU LETTER
SEP	28	43414.4	UTC(TP) - UTC(ASMW) =	1.19	0.05	ASMW LETTER
SEP	29	43415.4	UTC(ASMW) - UTC(ZIPE) =	-0.51	0.05	ASMW LETTER
SEP	29	43415.8	UTC(OP) - UTC(ORB) =	11.58	0.05	OP LETTER

TABLE 14 - (CONT.)

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

DATE		MJD	TIME COMPARISONS	UNCERT.	SOURCE
1977			(UNIT : 1 MICROSECOND)		
OCT	9	43425.6	UTC(USNO) - UTC(IGMA) = 50.1	0.2	USNO DPV 565
OCT	9	43425.6	UTC(USNO) - UTC(ONBA) = -1997.7	0.2	USNO DPV 565
OCT	26	43442.3	UTC(PKNM) - UTC(OP) = 9.31		PKNM LETTER
NOV	11	43458.0	UTC(TAO) - UTC(ILOM) = -66.29	0.02	TAO LETTER
NOV	23	43470.5	UTC(OP) - UTC(OMSF) = -4.83	0.02	OP AND OMSF (4)
NOV	30	43477	UTC(NBS) - UTC(USNO) = 0.8	0.3	NBS BULL 241
DEC	3	43480.0	UTC(TAO) - UTC(RRL) = -37.10	0.01	TAO LETTER
DEC	6	43483.9	UTC(USNO) - UTC(NBS) = -0.9	0.2	USNO DPV 567

COMPLEMENTARY RESULTS FOR THE PREVIOUS YEAR

1976					
MAY	20	42918.7	UTC(IEN) - UTC(SU) = 64.3	0.1	IEN LETTER

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

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

(3) COMPARISON CARRIED OUT BY U.S. COAST GUARD ONSOD WASHINGTON D.C.

(4) COMPARISON CARRIED OUT BY THE OFFICE NATIONAL D'ETUDES ET DE RECHERCHES AEROSPATIALES (FRANCE)

TABLE 15 - INDEPENDENT ATOMIC TIMES

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

UNIT IS ONE MICROSECOND

DATE 1977		MJD	TAI - TA(I) F	NBS	NRC	ON	PTB	RGO	USNO
JAN	6	43149	-95.20	-45049.01	30.57	15.88	-357.40	71.25	-34383.32
JAN	16	43159	-95.29	-45049.35	30.59	15.82	-357.39	71.18	-34383.85
JAN	26	43159	-95.38	-45049.44	30.78	15.70	-357.39	71.11	-34384.44
FEB	5	43179	-95.36	-45049.72	30.82	15.70	-357.34	71.07	-34385.18
FEB	15	43189	-95.32	-45049.98	30.69	15.78	-357.27	71.15	-34386.02
FEB	25	43199	-95.22	-45050.30	30.59	15.96	-357.23	71.18	-34386.86
MAR	7	43209	-95.26	-45050.44	30.51	16.00	-357.31	71.23	-34387.47
MAR	17	43219	-95.28	-45050.72	30.37	15.86	-357.40	71.38	-34388.11
MAR	27	43229	-95.32	-45050.97	30.19	15.80	-357.39	71.45	-34388.79
APR	6	43239	-95.34	-45051.27	30.05	15.82	-357.40	71.54	-34389.48
APR	16	43249	-95.41	-45051.48	29.88	15.84	-357.38	71.73	-34390.11
APR	26	43259	-95.45	-45051.77	29.83	15.69	-357.44	71.96	-34390.68
MAY	6	43269	-95.33	-45051.97	29.65	15.72	-357.55	72.27	-34391.36
MAY	16	43279	-95.29	-45052.18	29.49	15.61	-357.60	72.57	-34391.94
MAY	26	43289	-95.31	-45052.34	29.30	15.46	-357.66	72.77	-34392.57
JUN	5	43299	-95.26	-45052.74	29.22	15.36	-357.74	72.89	-34393.15
JUN	15	43309	-95.22	-45053.00	29.12	15.33	-357.83	72.94	-34393.61
JUN	25	43319	-95.19	-45053.25	28.91	15.34	-357.86	73.05	-34394.22
JUL	5	43329	-95.15	-45053.48	28.80	15.38	-357.89	73.26	-34394.80
JUL	15	43339	-95.20	-45053.69	28.71	15.40	-358.03	73.34	-34395.27
JUL	25	43349	-94.98	-45054.13	28.44	15.35	-358.07	73.57	-34395.84
AUG	4	43359	-94.89	-45054.47	28.26	15.31	-358.11	73.71	-34396.40
AUG	14	43369	-94.76	-45054.64	28.14	15.24	-358.18	73.76	-34396.93
AUG	24	43379	-94.62	-45054.86	27.91	15.23	-358.26	73.78	-34397.48
SEP	3	43389	-94.43	-45055.11	27.79	15.24	-358.31	73.69	-34397.97
SEP	13	43399	-94.39	-45055.27	27.73	15.23	-358.41	73.64	-34398.39
SEP	23	43409	-94.31	-45055.40	27.73	15.17	-358.55	73.55	-34398.81
OCT	3	43419	-94.22	-45055.68	27.65	15.13	-358.58	73.54	-34399.25
OCT	13	43429	-93.99	-45055.89	27.53	15.12	-358.61	73.53	-34399.73
OCT	23	43439	-93.93	-45055.94	27.58	15.09	-358.77	73.40	-34400.12
NOV	2	43449	-93.77	-45056.34	27.37	15.17	-358.77	73.41	-34400.66
NOV	12	43459	-93.50	-45056.39	27.35	15.21	-358.83	73.42	-34400.99
NOV	22	43469	-93.41	-45056.79	27.15	15.40	-358.88	73.34	-34401.49
DEC	2	43479	-93.28	-45057.05	27.21	15.43	-358.83	73.33	-34401.90
DEC	12	43489	-93.26	-45057.35	27.26	15.21	-358.84	73.22	-34402.20
DEC	22	43499	-93.17	-45057.37	27.35	15.09	-358.89	73.06	-34402.65

NOTE - The uncertainties of the computed values of TAI-TA(i) are of a few 0.1 μs. However, in order to avoid rounding errors, the results are henceforth given to ± 0.01 μs.

TABLE 16 - PRIMARY STANDARDS USED AS CLOCKS

UNIT IS ONE MICROSECOND

DATE 1977	MJD	TAI-LAB.STD. NBS 4	NRC CSV
JAN 6	43149	17.59	51.54
JAN 16	43159	17.39	51.55
JAN 26	43169	17.46	51.72
FEB 5	43179	17.31	51.76
FEB 15	43189	17.17	51.62
FEB 25	43199	17.04	51.51
MAR 7	43209	17.04	51.42
MAR 17	43219	16.88	51.26
MAR 27	43229	16.75	51.08
APR 6	43239	16.57	50.93
APR 16	43249	16.49	50.75
APR 26	43259	16.32	50.68
MAY 6	43269	17.04	50.50
MAY 16	43279	16.91	50.33
MAY 26	43289	16.75	50.13
JUN 5	43299		50.04
JUN 15	43309		49.93
JUN 25	43319		49.71
JUL 5	43329		49.60
JUL 15	43339		49.49
JUL 25	43349		49.21
AUG 4	43359		49.03
AUG 14	43369		48.89
AUG 24	43379		48.65
SEP 3	43389		48.52
SEP 13	43399		48.46
SEP 23	43409		48.44
OCT 3	43419	0.44	48.35
OCT 13	43429	0.28	48.23
OCT 23	43439	0.31	48.26
NOV 2	43449	-0.03	48.05
NOV 12	43459	-0.04	48.02
NOV 22	43469	-0.45	47.81
DEC 2	43479	-0.73	47.85
DEC 12	43489	-1.05	47.90
DEC 22	43499	-1.06	47.98

TABLE 17 - COORDINATED UNIVERSAL TIME

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

UNIT IS ONE MICROSECOND

DATE 1977		MJD	UTC - UTC(I)*						
			ASMW (1)	AUS (2)	DHI	FOA (3)	IEN	IGMA (4)	ILOM (5)
JAN	6	43149	1.56	-13.8	-0.24	41.91	-7.60	21	-15.9
JAN	16	43159	1.57	-14.3	-0.22	39.60	-7.72	23	-16.8
JAN	26	43169	1.52	-14.9	-0.27	37.30	-7.64	27	-18.4
FEB	5	43179	1.64	-15.7	-0.20	35.14	-7.86	30	-20.3
FEB	15	43189	1.93	-16.6	-0.06	32.92	-7.92	33	-22.4
FEB	25	43199	2.21	-17.4	0.02	30.77	-7.99	37	-24.4
MAR	7	43209	2.24	-18.1	-0.05	28.11	-8.73	39	-26.2
MAR	17	43219	1.88	-18.8	-0.20	25.75	-7.99	42	-31.0
MAR	27	43229	1.75	-19.4	-0.17	23.47	-7.85	42	-29.0
APR	6	43239	1.58	-20.1	-0.24	21.23	-7.92	45	-30.0
APR	16	43249	1.32	-20.8	-0.34	18.81	-8.01	48	-33.0
APR	26	43259	1.16	-21.4	-0.50	16.42	-8.17	48	-34.0
MAY	6	43269	1.08	-22.3	-0.63	14.34	-8.16	50	-36.5
MAY	16	43279	1.30	-23.1	-0.72	12.08	-8.27	52	-38.2
MAY	26	43289	1.53	-23.9	-0.86	9.90	-8.31	52	-39.5
JUN	5	43299	1.53	-24.7	-1.00	7.70	-8.40	52	-41.5
JUN	15	43309	1.33	-25.5	-1.10	5.39	-8.60	54	-43.3
JUN	25	43319	1.03	-26.2	-1.13	3.24	-8.82	58	-45.0
JUL	5	43329	0.66	-23.5	-1.18	1.14	-8.76	57	-47.1
JUL	15	43339	0.16	-24.2	-1.16	-1.05	-8.62	59	-49.0
JUL	25	43349	-0.10	-24.9	-1.02	-3.14	-8.60	58	-50.8
AUG	4	43359	-0.14	-25.3	-0.87	-5.89	-8.58	59	-27.7
AUG	14	43369	-0.04	-26.0	-0.64	-9.31	-8.80	61	-29.3
AUG	24	43379	0.09	-26.7	-0.50	-12.99	-8.83	61	-30.9
SEP	3	43389	0.21	-27.3	-0.31	-16.65	-8.88	61	-32.9
SEP	13	43399	0.46	-27.8	-0.18	-20.48	-9.01	60	-34.7
SEP	23	43409	0.69	-27.3	-0.17	-23.58	-9.02	54	-36.3
OCT	3	43419	0.99	-28.9	-0.12	-27.07	-9.26	53	-38.0
OCT	13	43429	1.23	-29.5	-0.01	-31.32	-9.54	49	-39.7
OCT	23	43439	1.24	-30.1	0.02	-35.43	-9.76		-41.4
NOV	2	43449	1.13	-29.9	0.12	-39.70	-9.82		-43.1
NOV	12	43459	1.12	-29.6	0.02	-43.74	-10.16		-44.3
NOV	22	43469	1.35	-29.5	-0.00	-47.64	-10.37		-45.1
DEC	2	43479	1.43	-29.2	0.01	-51.72	-10.46		-17.3
DEC	12	43489	1.51	-28.9	0.06	-55.68	-10.57		-17.7
DEC	22	43499	1.49	-28.7	0.16	-60.19	-10.70		-18.3

TABLE 17 - (CONT.)

UNIT IS ONE MICROSECOND

DATE 1977	MJD	UTC - UTC(I)* NBS	NPL (6)	NPRL (7)	NRC	OMH	OMSF	ON
JAN 6	43149	1.13	-2.10	106	-0.50	-21.50	-2.90	15.88
JAN 16	43159	1.12	-2.43	105	-0.47	-23.23	-2.81	15.82
JAN 26	43169	1.35	-2.67	107	-0.29	-25.72	-2.58	15.70
FEB 5	43179	1.39	-2.74	108	-0.25	-28.78	-2.04	15.70
FEB 15	43189	1.43	-2.77	109	-0.38	-31.40	-1.50	15.78
FEB 25	43199	1.43	-2.80	109	-0.47	-34.08	-0.95	15.96
MAR 7	43209	1.60	-2.77	107	-0.56	-36.76	-0.92	16.00
MAR 17	43219	1.62	-2.96	104	-0.70	-39.98	-0.87	15.86
MAR 27	43229	1.68	-3.14	105	-0.88	-42.96	-0.94	15.80
APR 6	43239	1.69	-3.22	105	-1.01	-46.01	-0.99	15.82
APR 16	43249	1.77	-3.28	103	-1.18	-49.63	-0.92	15.84
APR 26	43259	1.79	-3.50	102	-1.24	-51.85	-1.33	15.69
MAY 6	43269	1.88	-3.71	102	-1.42	-53.17	-1.31	15.72
MAY 16	43279	1.96	-3.85	100	-1.58	-53.12	-1.39	15.61
MAY 26	43289	2.09	-4.07	100	-1.76	0.0	-1.66	15.46
JUN 5	43299	1.98	-4.13	99	-1.85	-52.49	-2.26	15.36
JUN 15	43309	2.00	-3.90	98	-1.94	-53.07	-2.92	15.33
JUN 25	43319	2.04	-3.71	97	-2.16	-51.16	-3.71	15.34
JUL 5	43329	2.02	-3.41	98	-2.26	-50.95	-4.47	15.38
JUL 15	43339	1.88	-3.16	97	-2.36	-50.50	-5.23	15.40
JUL 25	43349	1.52	-2.95	95	-2.63	-50.13	-6.18	15.35
AUG 4	43359	1.25	-2.70	94	-2.80	-48.08	-6.96	15.31
AUG 14	43369	1.16	-2.48	94	-2.93	-47.62	-7.79	15.24
AUG 24	43379	1.00	-2.33	92	-3.16	-47.93	-8.23	15.23
SEP 3	43389	0.82	-2.22	89	-3.28	-47.47	-8.46	15.24
SEP 13	43399	0.73	-2.03	87	-3.33	-46.56	-8.55	15.23
SEP 23	43409	0.66	-1.75	91	-3.34	-46.76	-8.52	15.17
OCT 3	43419	0.44	-1.41	84	-3.42	-46.51	-8.47	15.13
OCT 13	43429	0.28	-0.76	82	-3.53	-46.54	-8.28	15.12
OCT 23	43439	0.29	-0.54	79	-3.49	-47.08	-7.88	15.09
NOV 2	43449	-0.05	-0.20	78	-3.69	-46.57	-6.62	15.17
NOV 12	43459	-0.06	-0.16	76	-3.72	-45.97	-5.99	15.21
NOV 22	43469	-0.40	0.46	78	-3.91	-45.81	-5.17	15.40
DEC 2	43479	-0.63	0.87	77	-3.86	-45.58	-4.59	15.43
DEC 12	43489	-0.88	1.11	76	-3.80	-45.44	-4.26	15.21
DEC 22	43499	-0.86	1.29	74	-3.71	-45.29	-3.89	15.09

TABLE 17 - (CONT.)

UNIT IS ONE MICROSECOND

DATE 1977	MJD	UTC - UTC(I)* OP	ORB	PKNM	PTE	PTCH (8)	RGO	RRL
JAN 6	43149	-2.13	9.77		0.43	-29.28	-2.65	-9.4
JAN 16	43159	-2.20	10.04		0.40	-29.18	-2.73	-8.7
JAN 26	43169	-2.30	9.85		0.37	-29.02	-2.80	-8.8
FEB 5	43179	-2.34	9.54		0.39	-28.85	-2.84	-9.1
FEB 15	43189	-2.36	9.76		0.43	-28.78	-2.76	-9.6
FEB 25	43199	-2.31	10.38		0.45	-28.71	-2.73	-9.9
MAR 7	43209	-2.37	10.61		0.34	-28.72	-2.68	-10.1
MAR 17	43219	-2.44	10.37		0.22	-28.70	-2.53	-10.3
MAR 27	43229	-2.52	10.26		0.22	-28.65	-2.46	-10.5
APR 6	43239	-2.55	10.44		0.19	-28.41	-2.37	-10.8
APR 16	43249	-2.57	10.26		0.13	-28.08	-2.18	-10.7
APR 26	43259	-2.68	9.97		-0.03	-28.08	-1.95	-10.6
MAY 6	43269	-2.66	9.94		-0.21	-27.89	-1.64	-11.0
MAY 16	43279	-2.68	9.81		-0.24	-27.77	-1.34	-11.1
MAY 26	43289	-2.67	9.92		-0.29	-27.90	-1.14	-11.0
JUN 5	43299	-2.67	9.93		-0.34	-27.67	-1.02	-11.5
JUN 15	43309	-2.71	10.06		-0.41	-27.63	-0.96	-11.8
JUN 25	43319	-2.65	10.15		-0.42	-27.77	-0.86	-12.1
JUL 5	43329	-2.64	10.54		-0.43	-27.77	-0.65	-12.6
JUL 15	43339	-2.69	9.85		-0.48	-28.22	-0.56	-13.1
JUL 25	43349	-2.47	10.06		-0.45	-28.18	-0.34	-13.2
AUG 4	43359	-2.38	10.35		-0.40	-28.15	-0.20	-13.1
AUG 14	43369	-2.30	9.93		-0.35	-28.62	-0.15	-13.6
AUG 24	43379	-2.23	10.00		-0.29	-27.64	-0.13	-13.9
SEP 3	43389	-2.11	9.94		-0.22	-27.17	-0.22	-14.4
SEP 13	43399	-2.05	9.77		-0.22	-26.49	-0.27	-14.8
SEP 23	43409	-2.07	9.86		-0.27	-25.91	-0.36	-14.8
OCT 3	43419	-2.05	9.56		-0.22	-25.18	-0.37	-15.0
OCT 13	43429	-1.88	8.90		-0.18	-24.72	-0.38	-15.1
OCT 23	43439	-1.89	8.69	-11.30	-0.26	-24.09	-0.51	-15.5
NOV 2	43449	-1.79	8.39	-10.88	-0.19	-23.44	-0.50	-15.6
NOV 12	43459	-1.68	7.86	-10.55	-0.17	-22.75	-0.49	-15.6
NOV 22	43469	-1.51	7.67	-9.41	-0.13	-21.66	-0.57	-15.7
DEC 2	43479	-1.40	7.25	-9.34	0.05	-20.69	-0.58	-15.7
DEC 12	43489	-1.37	6.56	-8.74	0.18	-19.96	-0.68	-15.7
DEC 22	43499	-1.26	5.94	-8.58	0.27	-19.10	-0.85	-16.1

TABLE 17 - (CONT.)

UNIT IS CNE MICROSECOND

DATE 1977		MJD	UTC - UTC(I)*						
			SU (9)	TAO	TCL	TP (10)	TUG	USNO	VSL
JAN	6	43149	53.3	37.9	79.8	0.79		5.52	-13.82
JAN	16	43159	54.0	38.2	80.5	0.57		5.45	-15.52
JAN	26	43169	53.8	37.7	80.2	0.52		5.19	-17.16
FEB	5	43179	54.4	37.1	79.7	0.53		4.90	-18.94
FEB	15	43189	54.6	36.1	79.1	0.53		4.39	-20.72
FEB	25	43199	55.0	35.4	79.0	0.74		3.97	-22.51
MAR	7	43209	54.2	34.7	78.9	1.09		3.78	-23.74
MAR	17	43219	54.0	34.1	78.6	0.87		3.45	-24.22
MAR	27	43229	53.6	33.5	78.2	0.91		3.21	-25.16
APR	6	43239	53.0	32.9	77.8	0.75		2.93	-26.08
APR	16	43249	52.6	32.7	77.7	0.66		2.71	-26.79
APR	26	43259	53.3	32.4	76.8	0.52		2.54	-27.93
MAY	6	43269	52.6	31.6	74.8	0.60		2.30	-28.94
MAY	16	43279	52.2	31.2	73.2	0.40		2.03	-29.86
MAY	26	43289	52.0	31.1	71.9	0.26		1.91	-30.76
JUN	5	43299	52.0	30.3	69.9	0.33		1.67	-31.80
JUN	15	43309	52.0	29.7	66.4	0.04		1.48	-32.70
JUN	25	43319	52.0	29.5	66.9	0.20		1.42	-33.25
JUL	5	43329	51.8	29.2	66.4	0.06		1.27	-33.98
JUL	15	43339	52.0	28.9	66.5	-0.02		1.12	-34.78
JUL	25	43349	52.1	28.9	67.0	-0.09		0.97	-35.45
AUG	4	43359	51.8	28.9	67.8	-0.14		0.84	-36.16
AUG	14	43369	51.7	28.4	67.9	-0.08		0.71	-36.99
AUG	24	43379	51.5	27.9	67.9	-0.18	2.34	0.55	-37.95
SEP	3	43389	51.5	26.9	68.0	-0.22	2.55	0.43	-38.65
SEP	13	43399	51.4	26.2	68.0	-0.27	2.66	0.46	-39.38
SEP	23	43409	51.2	25.8	68.5	-0.34	2.62	0.45	-40.21
OCT	3	43419	50.8	25.1	68.7	-0.18	2.56	0.40	-40.90
OCT	13	43429	50.5	24.4	68.9	-0.32	2.59	0.30	-41.62
OCT	23	43439	50.2	23.4	68.8	-0.67	2.47	0.29	-42.40
NOV	2	43449	50.2	23.0	69.3	-0.64	2.54	0.18	-43.04
NOV	12	43459	51.6	22.6	69.9	-0.64	2.42	0.24	-43.91
NOV	22	43469	50.8	22.1	70.5	-0.73	2.47	0.14	-44.21
DEC	2	43479	50.5	21.7	71.6	-0.80	2.58	0.14	-45.40
DEC	12	43489	50.2	21.4	72.1	-0.90	2.54	0.26	-46.13
DEC	22	43499	50.9	20.8	70.5	-0.80	2.48	0.25	-46.84

TABLE 17 - (CONT.)

UNIT IS ONE MICROSECOND

DATE 1977		MJD	UTC - UTC(I)* ZIPE (11)
JAN	6	43149	1.88
JAN	16	43159	1.95
JAN	26	43169	1.97
FEB	5	43179	2.22
FEB	15	43189	2.55
FEB	25	43199	2.99
MAR	7	43209	3.06
MAR	17	43219	3.00
MAR	27	43229	3.36
APR	6	43239	3.61
APR	16	43249	3.50
APR	26	43259	3.35
MAY	6	43269	3.27
MAY	16	43279	3.35
MAY	26	43289	3.27
JUN	5	43299	2.90
JUN	15	43309	2.57
JUN	25	43319	2.02
JUL	5	43329	1.38
JUL	15	43339	0.86
JUL	25	43349	0.65
AUG	4	43359	0.34
AUG	14	43369	0.09
AUG	24	43379	0.16
SEP	3	43389	-0.10
SEP	13	43399	-0.02
SEP	23	43409	0.26
OCT	3	43419	0.42
OCT	13	43429	0.32
OCT	23	43439	0.45
NOV	2	43449	0.42
NOV	12	43459	0.37
NOV	22	43469	0.62
DEC	2	43479	0.75
DEC	12	43489	0.57
DEC	22	43499	0.55

NOTES

* In general, the uncertainties are ten times larger (or more) than the unit of the last reported digit. See Table 18.

(1) ASMW. A time-step of UTC(ASMW) of + 25.0 µs was made by ASMW on 1977 January 1st.

(2) AUS. On MJD = 43 139, UTC-UTC(AUS) = 12.4 µs. UTC(AUS) is the coordinated universal time of Australia kept by DNM.

(3) FOA. A time-step of UTC(FOA) of -75.0 µs was made by FOA on 1977 January 1st.

(4) IGMA. By VLF. The following table gives UTC-UTC(IGMA) for the year 1976. The origin is given by the clock transportations on 1976 May 5 and October 22.

MJD	UTC-UTC(IGMA)
42 779	- 2.1
42 789	- 3.8
42 799	- 2.0
42 809	- 1.7
42 819	- 0.2
42 829	+ 1.1
42 839	+ 0.7
42 849	+ 2.3
42 859	+ 2.6
42 869	- 1.5
42 879	+ 2.3
42 889	+ 3.6
42 899	+ 4.0
42 909	+ 3.8
42 919	+ 4.9
42 929	+ 4.6

TABLE 17 - (CONT.)

MJD	UTC-UTC(IGMA)	MJD	UTC-UTC(IGMA)
42 939	+ 4.9	43 029	+ 7.3
42 949	+ 5.3	43 039	+ 7.6
42 959	+ 5.4	43 049	+ 7.5
42 969	+ 5.3	43 059	+ 8.0
42 979	+ 6.0	43 069	+ 8.6
42 989	+ 6.1	43 079	+10.1
42 999	+ 6.1	43 089	+10.4
43 009	+ 6.9	43 099	+13.5
43 019	+ 7.2	43 109	+15.4

For the year 1977, the origin is given by the clock transportation on 1977 October 10.

(5) ILOM. From MJD = 43 219 to MJD = 43 259, the LORAN-C reception of Iwo Jima was replaced by VLF receptions ; the results in this interval were improved using two clock transportations.

(6) NPL. A time-step of UTC(NPL) of - 44.0 µs was made by NPL on 1977 January 1st.

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

(8) PTCH. The origin of UTC-UTC(PTCH) is not known ; UTC-UTC(PTCH) = 0 was arbitrarily fixed on 1972 November 18.

(9) SU. Results based on LORAN-C receptions from MJD = 43 149 to MJD = 43 439. From MJD = 43 449 to MJD = 43 499, the TV link between TP and SU is used.

(10) TP. A time-step of UTC(TP) of - 21.6 µs was made by TP on 1977 January 1st.

(11) ZIPE. A time-step of UTC(ZIPE) of - 30.0 µs was made by ZIPE on 1977 January 1st.

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 1977	MJD	TIME COMPARISONS	DIFFERENCE CLOCK TR. - BIH (UNIT : 1 MICROSECOND)
JAN 3	43146.9	UTC(NBS) - UTC(USNO)	-0.19
JAN 4	43147.4	UTC(NBS) - UTC(OP)	0.44
JAN 12	43155.4	UTC(NBS) - UTC(OP)	0.43
JAN 12	43155.9	UTC(NBS) - UTC(USNO)	-0.28
JAN 27	43170.4	UTC(OP) - UTC(RGO)	0.03
JAN 27	43170.5	UTC(OP) - UTC(NPL)	-0.01
JAN 31	43174.4	UTC(USNO) - UTC(OP)	1.1
FEB 2	43176	UTC(NBS) - UTC(USNO)	-0.3
FEB 22	43196.8	UTC(USNO) - UTC(NBS)	-0.1
FEB 23	43197.5	UTC(USNO) - UTC(NRC)	0.0
MAR 28	43230.5	UTC(ASMW) - UTC(SU)	0.14
APR 6	43239.3	UTC(USNO) - UTC(OP)	-0.1
APR 12	43245.3	UTC(USNO) - UTC(NPL)	-0.1
APR 20	43253.7	UTC(USNO) - UTC(NBS)	-0.3
APR 27	43260	UTC(NBS) - UTC(OP)	0.0
APR 27	43260	UTC(NBS) - UTC(USNO)	0.3
APR 27	43260.5	UTC(USNO) - UTC(IEN)	-0.5
MAY 18	43281.3	UTC(USNO) - UTC(OP)	0.0
JUN 2	43296	UTC(NBS) - UTC(USNO)	0.3
JUN 7	43301.5	UTC(USNO) - UTC(OMSF)	-1.3
JUN 8	43302.6	UTC(USNO) - UTC(NBS)	-0.4
JUN 13	43307.3	UTC(USNO) - UTC(NPL)	0.0
JUN 14	43308.3	UTC(USNO) - UTC(RGO)	-0.1
JUN 16	43310.3	UTC(USNO) - UTC(OP)	0.1
JUN 27	43321.6	UTC(NPL) - UTC(VSL)	-0.24
JUL 16	43340.9	UTC(NBS) - UTC(OP)	0.6
JUL 22	43346	UTC(NBS) - UTC(USNO)	0.1
JUL 27	43351.3	UTC(PTB) - UTC(DHI)	0.40
AUG 5	43360.0	UTC(USNO) - UTC(RRL)	1.6
AUG 5	43360.0	UTC(USNO) - UTC(TAO)	1.3
AUG 11	43366	UTC(NBS) - UTC(USNO)	0.1
AUG 26	43381	UTC(NBS) - UTC(USNO)	0.2
AUG 26	43381.8	UTC(USNO) - UTC(NBS)	-0.23
SEP 7	43393.4	UTC(ILOM) - UTC(RRL)	-0.1
SEP 7	43393.7	UTC(NBS) - UTC(NRC)	0.3
SEP 9	43395.2	UTC(USNO) - UTC(NBS)	-0.3
SEP 12	43398.5	UTC(USNO) - UTC(NRC)	0.0
SEP 15	43401.5	UTC(USNO) - UTC(TUG)	0.0*
SEP 19	43405.3	UTC(USNO) - UTC(VSL)	0.2
SEP 23	43409.7	UTC(USNO) - UTC(NPL)	0.2
SEP 26	43412.7	UTC(OP) - UTC(PTB)	-0.14
SEP 28	43414.4	UTC(OP) - UTC(ASMW)	-0.15
SEP 28	43414.4	UTC(SU) - UTC(ASMW)	-0.1
SEP 28	43414.4	UTC(TP) - UTC(ASMW)	0.08
SEP 29	43415.4	UTC(ASMW) - UTC(ZIPE)	0.0
SEP 29	43415.8	UTC(OP) - UTC(ORB)	-0.14

TABLE 18 - (CONT.)

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)
1977			
OCT 26	43442.3	UTC(PKNM) - UTC(OP)	0.0*
NOV 11	43458.0	UTC(TAO) - UTC(ILOM)	0.51
NOV 23	43470.5	UTC(OP) - UTC(OMSF)	-1.24
NOV 30	43477	UTC(NBS) - UTC(USNO)	0.1
DEC 3	43480.0	UTC(TAO) - UTC(RRL)	0.31
DEC 6	43483.9	UTC(USNO) - UTC(NBS)	0.1

COMPLEMENTARY RESULTS FOR THE PREVIOUS YEAR

DATE	MJD	TIME COMPARISONS	DIFFERENCE
1976			
MAY 20	42918.7	UTC(IEN) - UTC(SU)	0.1

* THIS CLOCK TRANSPORTATION WAS USED BY THE BIH TO FIX THE ORIGIN OF UTC-UTC(I).

TABLE 19 - INTERNATIONAL ATOMIC TIME , BI-MONTHLY RATES OF TAI-CLOCK FOR 1977

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	43199	43259	43319	43379	43439	43499
ASMW	13 29	56.03	42.94	7.31	10.16	28.83	26.16
ASMW	16 76	-36.86	-57.56	-62.05	-89.06	-80.38	-62.98
F	12 133	0.0	-14.89	-8.41	-12.27	13.50	38.00
F	12 158	63.56	68.51	80.00	86.72	92.91	96.80
F	12 206	-142.73	-152.27	-140.03	-161.56	-134.09	-130.55
F	12 231	-55.20	-67.29	0.0	0.0	-95.58	-83.61
F	12 347	94.67	0.0	0.0	0.0	0.0	0.0
F	12 439	-222.35	-226.77	-230.92	0.0	0.0	0.0
F	12 594	-83.10	-83.85	-78.66	-70.11	-72.75	-67.44
F	14 134	-53.14	-29.84	-9.46	-4.15	-0.50	14.81
F	14 753	118.91	117.70	124.95	134.39	128.58	120.37
F	14 873	-82.18	-75.68	-66.99	-55.28	-52.45	-48.99
F	16 80	0.0	0.0	0.0	0.0	0.0	-103.44
F	22 120	0.0	108.68	105.17	111.29	103.94	76.35
F	22 213	0.0	0.0	0.0	-282.76	-276.25	-278.85
F	22 222	105.29	0.0	0.0	0.0	0.0	-673.05
FOA	11 55	63.09	104.56	83.48	230.48	99.82	144.36
FOA	11 200	-358.28	0.0	0.0	0.0	-368.87	-407.88
FOA	14 900	-224.93	-236.31	-220.70	0.0	0.0	0.0
IEN	12 303	-73.31	-60.43	-74.70	-64.09	-79.74	-80.53
IEN	12 469	7.35	63.22	0.0	0.0	0.0	-41.02
IEN	12 609	-115.75	-113.32	-118.74	-86.58	-97.07	-95.46
IEN	14 893	-36.39	-30.04	-34.79	-39.77	-45.95	-45.03
IEN	22 230	13.00	76.59	65.61	91.73	0.0	0.0
NBS	11 137	0.0	-374.81	-362.69	-369.34	-366.99	-374.65
NBS	11 167	-45.63	-42.88	-52.95	-48.61	-44.12	0.0
NBS	12 352	3.84	-11.18	-27.62	-39.30	-5.96	-21.32
NBS	14 316	0.0	0.0	-35.72	-43.82	-44.15	-55.50
NBS	14 323	-102.60	-99.58	-95.23	-95.16	-85.81	-93.33
NBS	14 601	-83.75	0.0	-50.61	-62.34	-55.49	-61.10
NBS	25 67	365.41	0.0	0.0	0.0	0.0	0.0
NBS	91 4	-11.84	-12.63	0.0	0.0	0.0	-24.44
NPL	11 134	0.0	0.0	0.0	0.0	0.0	-118.20
NPL	12 316	-196.31	-191.23	-222.27	-194.91	-196.39	-175.78
NPL	12 418	-102.57	-102.66	-100.41	-87.37	-86.76	-78.13
NPL	12 832	-118.67	-118.27	-103.23	-73.59	-141.18	-130.78
NPL	14 334	0.0	0.0	0.0	0.0	0.0	-102.31
NRC	12 122	-617.72	-632.75	-643.17	-657.80	-658.55	-653.11
NRC	12 267	-57.82	-17.98	43.25	11.29	13.55	-17.84
NRC	14 911	-96.18	-106.14	-102.68	-102.45	-94.60	-90.02

TABLE 19 - (CONT.)

LAB.	CLOCK	43199	43259	43319	43379	43439	43499
NRC	90 5	1.55	-14.73	-15.46	-18.01	-6.63	-4.70
OMH	22 67	-243.61	-303.72	0.0	67.15	15.95	28.69
OMSF	13 17	0.0	-239.29	-207.78	-213.94	-221.04	-213.01
OMSF	14 896	40.47	91.57	98.92	105.92	53.85	77.18
OMSF	22 223	158.98	167.43	166.23	147.02	142.32	151.73
ON	12 285	-53.14	-67.51	-75.59	-82.53	-79.59	-65.66
ON	13 14	-26.32	-27.33	-33.27	-64.03	-71.05	-10.12
ON	14 863	-164.39	-163.83	-156.62	-141.54	-159.56	-158.98
ON	24 156	-24.34	-27.82	-22.98	-11.48	-20.83	-23.58
ON	99 1	-11.04	-11.36	-28.66	-24.52	-4.17	14.28
ON	99 4	75.04	64.35	68.84	84.75	65.47	64.98
ON	99 5	-137.09	0.0	0.0	0.0	0.0	0.0
ORB	12 804	5.10	-6.60	4.08	-4.03	-22.25	-44.70
ORB	14 205	-55.12	-65.18	-64.91	-61.04	-76.38	-105.49
PKNM	15 124	0.0	0.0	0.0	0.0	0.0	-79.98
PKNM	15 125	0.0	0.0	0.0	0.0	0.0	-10.56
PKNM	24 144	0.0	0.0	0.0	0.0	0.0	-32.98
PTB	12 320	136.40	137.86	139.95	148.01	146.62	144.25
PTB	12 389	21.23	18.04	10.01	8.15	6.71	16.79
PTB	12 394	-315.65	-326.27	-329.06	-327.90	-329.25	-320.72
PTB	12 395	-198.19	-203.42	-202.94	-204.89	-202.62	-171.96
PTB	12 462	67.33	76.58	87.89	0.0	0.0	0.0
PTB	14 867	-172.63	-176.38	-180.43	-179.46	-178.62	-179.24
PTB	16 67	0.0	0.0	-108.17	-135.04	-121.21	-60.44
PTB	24 103	0.0	0.0	-84.76	-84.27	-89.10	-76.43
PTCH	16 64	12.61	12.37	5.64	-4.30	60.09	85.72
RGO	11 123	-140.75	-140.46	-152.39	-150.64	-164.76	-169.61
RGO	12 348	-150.86	-163.11	-154.12	-225.84	-242.35	-207.09
RGO	12 484	21.94	-1.18	48.05	63.07	54.92	49.62
RGO	14 202	-187.15	-196.58	-203.23	-201.66	-220.99	-215.95
RGO	14 868	-127.41	-115.94	-105.62	-84.16	-85.13	-86.58
TP	12 335	-125.93	-131.07	-132.75	-130.73	-147.54	-143.47
TUG	12 524	0.0	0.0	0.0	0.0	1.27	0.70
USNO	11 207	521.99	1305.01	1336.19	733.04	-925.61	90.61
USNO	12 346	183.60	178.46	186.36	198.21	0.0	208.39
USNO	12 532	-55.78	-50.29	-57.59	-59.77	-53.93	-48.23
USNO	12 549	-143.66	-139.56	-135.13	-140.12	-138.56	-129.12
USNO	12 573	-199.44	-215.24	-218.42	-217.75	-195.95	-178.34
USNO	12 591	-79.01	-55.24	0.0	0.0	0.0	0.0
USNO	12 592	174.93	160.76	174.97	167.06	168.88	153.46
USNO	12 651	-31.88	-25.32	-17.01	-12.83	-3.75	0.86
USNO	14 571	36.19	42.04	28.37	18.78	28.53	37.63
USNO	14 660	-108.78	-93.85	-67.71	-79.27	-24.78	0.0
USNO	14 752	0.0	0.0	0.0	0.0	0.0	-108.23
USNO	14 778	-15.52	-15.43	-10.63	-4.07	0.01	0.16

TABLE 19 - (CONT.)

LAB.	CLOCK	43199	43259	43319	43379	43439	43499
USNO	14 783	53.26	68.00	79.64	91.82	0.0	0.0
USNO	14 787	-123.60	-130.48	-122.41	-100.68	-83.56	-99.78
USNO	14 834	-83.90	-75.35	-68.73	-62.60	-56.81	-62.11
USNO	14 871	-48.36	-57.06	-53.99	-54.97	-47.48	-51.57
USNO	14 875	-114.90	-119.30	-115.92	-114.27	-111.90	-108.72
USNO	16 68	0.0	0.0	0.0	0.0	0.0	-39.73
USNO	16 78	0.0	0.0	0.0	0.0	0.0	-58.62
USNO	22 104	-110.78	-102.39	-168.26	-76.13	-66.59	-53.51
USNO	22 114	-6.07	-7.94	-12.06	4.17	8.93	6.03
USNO	22 325	0.0	0.0	70.14	0.0	0.0	0.0
USNO	24 25	-574.63	-580.37	-579.29	-581.89	-569.68	-568.74
USNO	24 28	-82.62	-78.57	-71.50	-68.07	0.0	0.0
USNO	24 54	0.0	0.0	0.0	-553.20	-454.00	0.0
USNO	24 94	-252.69	-276.30	-268.54	-260.41	-241.89	-235.40
USNO	24 118	-272.83	-257.74	-237.84	-216.01	-189.45	-183.10
USNO	24 264	0.0	0.0	81.86	88.97	0.0	105.35
USNO	24 305	0.0	0.0	0.0	-16.12	-20.79	-39.14
USNO	24 343	0.0	0.0	0.0	-51.80	-28.70	-33.71
VSL	12 503	36.85	107.83	0.0	0.0	0.0	0.0
VSL	14 503	0.0	0.0	0.0	0.0	-247.05	-257.94
VSL	22 34	-172.86	0.0	-90.65	-76.67	-74.27	-74.94
VSL	24 190	0.0	-36.11	-40.77	-47.49	-48.14	0.0
ZIPE	12 979	-126.84	-128.42	-132.90	-167.42	-163.47	-156.43

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	(22 001 EQUIVALENT TO 12 1001)
13	EBAUCHES OSCILLATOM. B 5000	
14 AND 24	HEWLETT-PACKARD 5061A OPT.4	(24 001 EQUIVALENT TO 14 1001)
16 AND 26	EBAUCHES 3200	(26 001 EQUIVALENT TO 16 1001)
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 1977

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

*** DENOTES THAT THE CLOCK WAS NOT USED

LAB.	CLOCK	43199	43259	43319	43379	43439	43499
ASMW	13 29	4	6	10	21	22	24
ASMW	16 76	0	29	37	15	18	25
F	12 133	***	0	100	100	65	22
F	12 158	61	84	98	100	97	88
F	12 206	34	46	67	72	67	91
F	12 231	65	39	***	***	0	98
F	12 347	73	***	***	***	***	***
F	12 439	17	14	15	***	***	***
F	12 594	100	100	100	100	100	100
F	14 134	100	37	19	17	17	21
F	14 753	100	100	100	100	100	98
F	14 873	98	100	100	98	100	84
F	16 80	***	***	***	***	***	0
F	22 120	***	0	100	100	100	34
F	22 213	***	***	***	0	100	100
F	22 222	96	***	***	***	***	0
FOA	11 55	6	7	15	0	0	3
FOA	11 200	0	***	***	***	0	8
FOA	14 900	8	9	18	***	***	***
IEN	12 303	100	92	86	100	84	94
IEN	12 469	6	8	***	***	***	0
IEN	12 609	2	6	7	7	18	79
IEN	14 893	0	100	100	100	100	100
IEN	22 230	11	0	4	4	***	***
NBS	11 137	***	0	97	100	100	99
NBS	11 167	35	22	25	43	100	***
NBS	12 352	100	53	25	18	24	35
NBS	14 316	***	***	0	98	100	77
NBS	14 323	83	82	76	91	99	99
NBS	14 601	63	***	0	70	100	100
NBS	25 67	25	***	***	***	***	***
NBS	91 4	100	100	***	***	***	0
NPL	11 134	***	***	***	***	***	0
NPL	12 316	95	100	54	68	74	51
NPL	12 418	100	100	100	96	100	100
NPL	12 832	11	27	26	22	0	16
NPL	14 334	***	***	***	***	***	0
NRC	12 122	3	7	9	13	21	29
NRC	12 267	27	21	1	5	5	8
NRC	14 911	46	46	73	100	100	100

TABLE 20 - (CONT.)

LAB.	CLOCK	43199	43259	43319	43379	43439	43499
NRC	90 5	100	95	100	97	99	100
OMH	22 67	0	0	***	0	4	9
OMSF	13 17	***	0	14	30	50	72
OMSF	14 896	0	5	7	10	11	14
OMSF	22 223	100	100	100	77	63	63
ON	12 285	100	100	99	100	85	94
ON	13 14	20	30	36	38	20	2
ON	14 863	39	59	57	92	79	100
ON	24 156	100	100	100	99	96	100
ON	99 1	11	9	13	31	81	52
ON	99 4	71	41	39	65	76	100
ON	99 5	39	***	***	***	***	***
ORB	12 804	30	25	87	98	73	21
ORB	14 205	56	54	100	100	84	23
PKNM	16 124	***	***	***	***	***	0
PKNM	16 125	***	***	***	***	***	0
PKNM	24 144	***	***	***	***	***	0
PTB	12 320	100	100	100	100	100	100
PTB	12 389	100	100	99	100	100	100
PTB	12 394	100	97	100	100	100	100
PTB	12 395	100	100	100	100	100	61
PTB	12 462	49	42	49	***	***	***
PTB	14 867	100	100	100	100	100	100
PTB	16 67	***	***	0	15	35	2
PTB	24 103	***	***	0	100	100	96
PTCH	16 64	14	20	27	48	0	9
RGO	11 123	65	59	43	41	81	45
RGO	12 348	6	7	11	0	3	6
RGO	12 484	1	1	8	19	20	20
RGO	14 202	100	99	100	100	48	44
RGO	14 868	87	57	31	20	21	39
TP	12 335	100	100	100	100	81	84
TJG	12 524	***	***	***	***	0	100
USNO	11 207	0	0	0	0	0	0
USNO	12 346	96	100	100	98	***	0
USNO	12 532	100	100	100	100	100	100
USNO	12 549	99	100	100	100	100	100
USNO	12 573	72	82	87	93	79	49
USNO	12 591	89	71	***	***	***	***
USNO	12 592	100	64	61	57	100	84
USNO	12 651	0	100	100	100	100	100
USNO	14 571	100	100	88	95	99	100
USNO	14 660	60	60	46	45	13	***
USNO	14 752	***	***	***	***	***	0
USNO	14 778	90	95	100	100	100	100

TABLE 20 - (CONT.)

LAB.	CLOCK	43199	43259	43319	43379	43439	43499
USNO	14 783	32	44	49	37	***	***
USNO	14 787	42	44	62	64	41	40
USNO	14 834	54	45	51	74	100	100
USNO	14 871	100	94	100	100	100	100
USNO	14 875	100	100	100	100	100	100
USNO	16 68	***	***	***	***	***	0
USNO	16 78	***	***	***	***	***	0
USNO	22 104	100	100	0	0	8	6
USNO	22 114	45	42	34	59	100	100
USNO	22 325	***	***	0	***	***	***
USNO	24 25	0	100	100	100	97	100
USNO	24 28	0	100	100	100	***	***
USNO	24 54	***	***	***	0	0	***
USNO	24 94	92	91	100	100	85	57
USNO	24 118	100	88	40	20	11	9
USNO	24 264	***	***	0	100	***	0
USNO	24 305	***	***	***	0	100	38
USNO	24 343	***	***	***	0	28	60
VSL	12 503	5	0	***	***	***	***
VSL	14 503	***	***	***	***	0	79
VSL	22 34	81	***	0	84	100	100
VSL	24 190	***	0	100	100	100	***
ZIPE	12 979	28	27	26	28	22	23

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	(22 001 EQUIVALENT TO 12 1001)
13	EBAUCHES OSCILLATOM. B 5000	
14 AND 24	HEWLETT-PACKARD 5061A OPT.4	(24 001 EQUIVALENT TO 14 1001)
16 AND 26	EBAUCHES 3200	(26 001 EQUIVALENT TO 16 1001)
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 FRCM PRIMARY STANCARDS

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	2.80	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.)

LAB.	STANDARD	CALIBRATION INTERVAL MJD	NORMALIZED FREQ. DIF. OF TA(I) - STD. IN 10**-13	SIGMA1 IN 10**-13	SIGMA2 IN 10**-13
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	
NRC	NRC CSV	43159 - 43239	(1)		0.50
PTB	PTB CS1	43205 - 43260	-1.10	1.00	
PTB	PTB CS1	43266 - 43342	-0.95	1.10	
PTB	PTB CS1	43395 - 43416	-1.20	1.20	
NRC	NRC CSV	43419 - 43499	(1)		0.50
PTB	PTB CS1	43497 - 43512	-0.66	0.90	
NBS	NBS 6	43526 - 43552	-2.00 (4)	0.40	0.90

(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.

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 IN 10**-13 EAL-STD.	TAI-STD.	RANDOM UNCERT. IN 10**-13	SYSTEMATIC UNCERT. IN 10**-13	CORREL. INDEX (1)
NRC	NRC CS3	40221 - 40587	3.31	3.31	13.30	7.00	1
NRC	NRC CS3	40587 - 40709	5.51	5.51	13.30	7.00	1
NRC	NRC CS3	40709 - 40952	10.01	10.01	13.30	7.00	1
NRC	NRC CS3	40952 - 41072	1.51	1.51	13.30	7.00	1
NRC	NRC CS3	41072 - 41139	4.21	4.21	13.30	7.00	1
PTB	PTB CS1	40255 - 40335	28.36	28.36	13.32	2.00	2
PTB	PTB CS1	40296 - 40376	20.16	20.16	11.72	2.00	2
PTB	PTB CS1	40402 - 40482	11.39	11.39	12.19	2.00	2
NBS	NBS 3	40320 - 40400	11.80	11.80	5.05	2.50	3
PTB	PTB CS1	40509 - 40637	16.96	16.96	1.05	1.66	4
PTB	PTB CS1	40739 - 40819	14.55	14.55	1.94	1.66	4
PTB	PTB CS1	40879 - 40959	14.13	14.13	2.04	1.66	4
PTB	PTB CS1	41439 - 41519	12.52	12.52	0.80	1.66	4
PTB	PTB CS1	41593 - 41673	12.08	12.08	1.33	1.66	4
PTB	PTB CS1	41719 - 41799	11.88	11.88	1.08	1.66	4
NBS	NBS 5	41671 - 41751	12.24	12.24	3.09	2.70	5
NBS	NBS 5	41686 - 41766	11.42	11.42	2.23	2.70	5
NBS	NBS 5	41721 - 41801	10.91	10.91	5.05	2.70	5
NBS	NBS 5	41737 - 41817	12.41	12.41	2.61	2.70	5
NBS	NBS 5	41924 - 42004	9.07	9.07	2.13	2.70	5
PTB	PTB CS1	41795 - 41875	10.74	10.74	1.07	0.0	6
PTB	PTB CS1	41874 - 41954	10.81	10.81	1.16	0.0	7
NBS	NBS 4	41886 - 41966	4.11	4.11	5.05	2.50	8
NBS	NBS 4	42009 - 42089	10.82	10.82	2.90	0.50	9
NBS	NBS 4	42046 - 42126	11.84	11.84	2.90	0.50	9
NBS	NBS 4	42090 - 42170	9.86	9.86	2.90	0.50	9
NBS	NBS 4	42132 - 42212	10.11	10.11	2.90	0.50	9
NBS	NBS 4	42171 - 42251	8.20	8.20	2.90	0.50	9
NBS	NBS 4	42201 - 42281	9.53	9.53	2.90	0.50	9
NBS	NBS 4	42236 - 42316	6.96	6.96	2.90	0.50	9
NBS	NBS 4	42279 - 42359	9.45	9.45	2.90	0.50	9
NBS	NBS 4	42314 - 42394	9.17	9.17	2.90	0.50	9
NBS	NBS 4	42356 - 42436	8.46	8.46	2.90	0.50	9
NBS	NBS 4	42391 - 42471	8.08	8.08	2.90	0.50	9
NBS	NBS 5	42010 - 42090	9.32	9.32	2.13	0.50	10
PTB	PTB CS1	42239 - 42319	8.74	8.74	1.56	0.0	11
PTB	PTB CS1	42355 - 42435	11.38	11.38	1.57	0.0	12
PTB	PTB CS1	42419 - 42499	11.70	11.70	1.69	0.0	13
NRC	NRC CSV	42539 - 42619	9.85	9.85	1.00	0.50	14
PTB	PTB CS1	42575 - 42655	9.44	9.44	1.16	0.0	15

TABLE 22 - (CONT.)

LAB.	STANDARD	CALIBRATION INTERVAL MJD	NORMALIZED FREQ. DIF. OF EAL-STD.	TAI-STD. IN 10**-13	RANDOM UNCERT. IN 10**-13	SYSTEMATIC UNCERT. IN 10**-13	CORREL. INDEX (1)
PTB	PTB CS1	42619 - 42699	12.00	12.00	1.62	0.0	16
NRC	NRC CSV	42679 - 42759	9.36	9.36	1.00	0.50	17
PTB	PTB CS1	42739 - 42819	11.15	11.15	1.57	0.0	18
PTB	PTB CS1	42858 - 42938	10.15	10.15	1.11	0.10 (2)	19
PTB	PTB CS1	42924 - 43004	9.36	9.36	1.09	0.10	19
PTB	PTB CS1	43009 - 43089	9.50	9.50	1.07	0.10	19
NBS	NBS 6	42866 - 42946	11.82	11.82	0.47	0.85	20
NRC	NRC CSV	42899 - 42979	9.07	9.07	1.00	0.50	21
PTB	PTB CS1	43047 - 43127	10.31	10.31	1.12	0.0	22
PTB	PTB CS1	43154 - 43234	9.49	-0.51	1.27	0.0	23
NRC	NRC CSV	43159 - 43239	9.03	-0.97	1.00	0.50	24
PTB	PTB CS1	43199 - 43279	8.42	-1.53	1.05	0.0	25
PTB	PTB CS1	43274 - 43354	8.02	-1.69	1.10	0.0	26
PTB	PTB CS1	43365 - 43445	6.93	-2.49	1.49	0.0	27
NRC	NRC CSV	43419 - 43499	8.67	-0.58	1.00	0.50	28
PTB	PTB CS1	43464 - 43544	7.89	-1.31	1.06	0.0	29
NBS	NBS 6	43519 - 43559	9.40	0.20	0.73	0.90	30

(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	- 13.1	1.1	
1970 MAY - JUN	- 12.9	1.1	
1970 JUL - AUG	- 12.7	1.1	
1970 SEP - OCT	- 12.6	1.1	
1970 NOV - DEC	- 12.4	1.1	
1971 JAN - FEB	1 - 12.3*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	- 11.6	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 - 10.8*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 - 10.2*10**-13	0.6*10**-13	
1974 MAR - APR	- 10.1	0.6	
1974 MAY - JUN	- 10.0	0.6	
1974 JUL - AUG	- 9.9	0.6	
1974 SEP - OCT	- 10.0	0.6	
1974 NOV - DEC	- 10.0	0.6	
1975 JAN - FEB	1 - 10.1*10**-13	0.6*10**-13	
1975 MAR - APR	- 10.1	0.6	
1975 MAY - JUN	- 10.0	0.6	
1975 JUL - AUG	- 10.0	0.5	
1975 SEP - OCT	- 10.0	0.5	
1975 NOV - DEC	- 10.0	0.6	
1976 JAN - FEB	1 - 10.0*10**-13	0.6*10**-13	
1976 MAR - APR	- 10.0	0.5	EAL
1976 MAY - JUN	- 9.9	0.5	
1976 JUL - AUG	- 9.7	0.5	
1976 SEP - OCT	- 9.6	0.5	
1976 NOV - DEC	- 9.5	0.5	
1977 JAN - FEB	1 + 0.7*10**-13	0.5*10**-13	- 9.3
1977 MAR - APR	+ 0.9	0.5	- 9.1
1977 MAY - JUN	+ 0.8	0.5	- 9.0
1977 JUL - AUG	+ 0.7	0.6	- 8.9
1977 SEP - OCT	+ 0.5	0.6	- 8.[illegible]
1977 NOV - DEC	+ 0.3	0.6	- 8.[illegible]

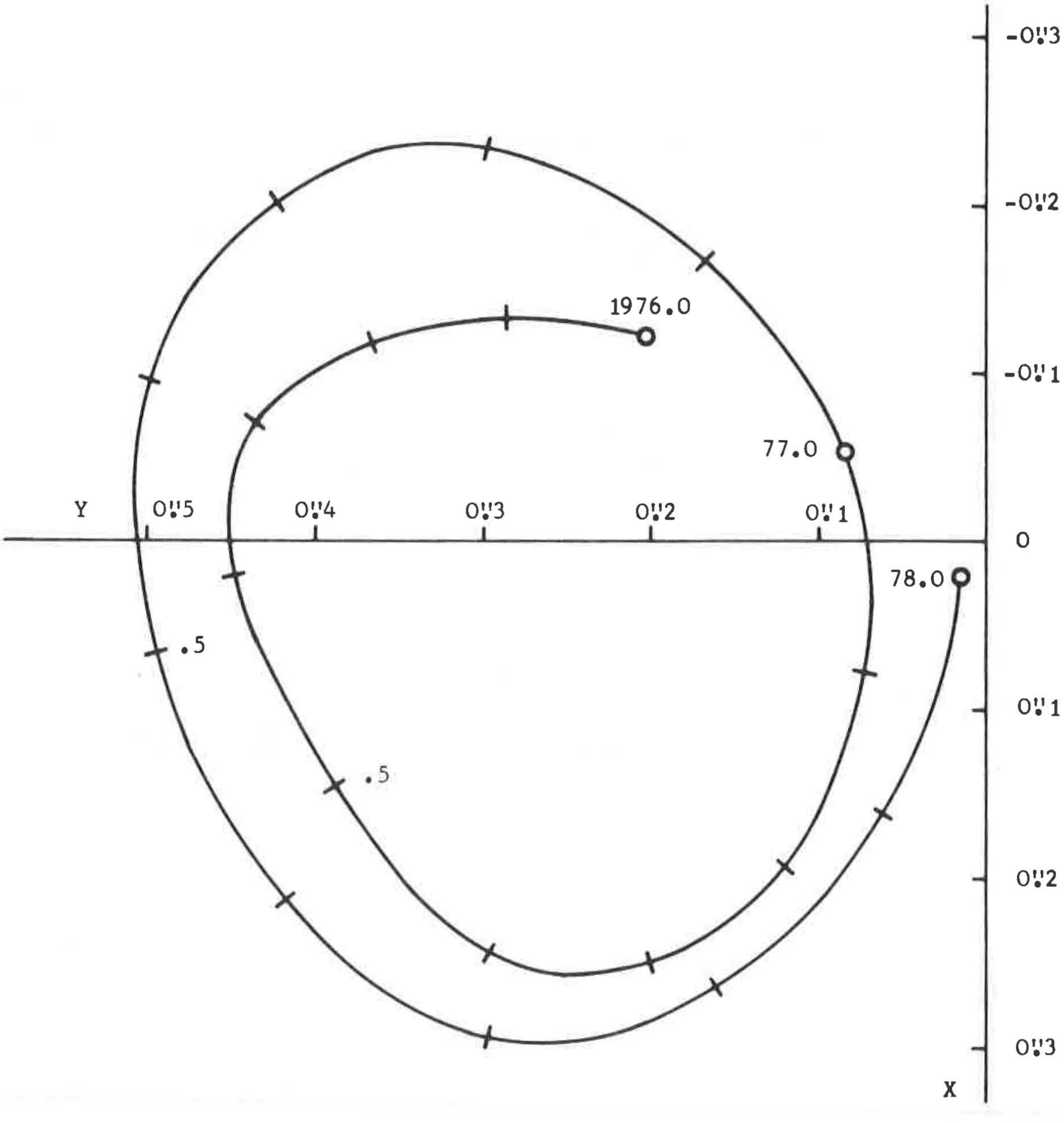

Fig. 1 – Path of the pole from 1976.0 to 1978.0

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

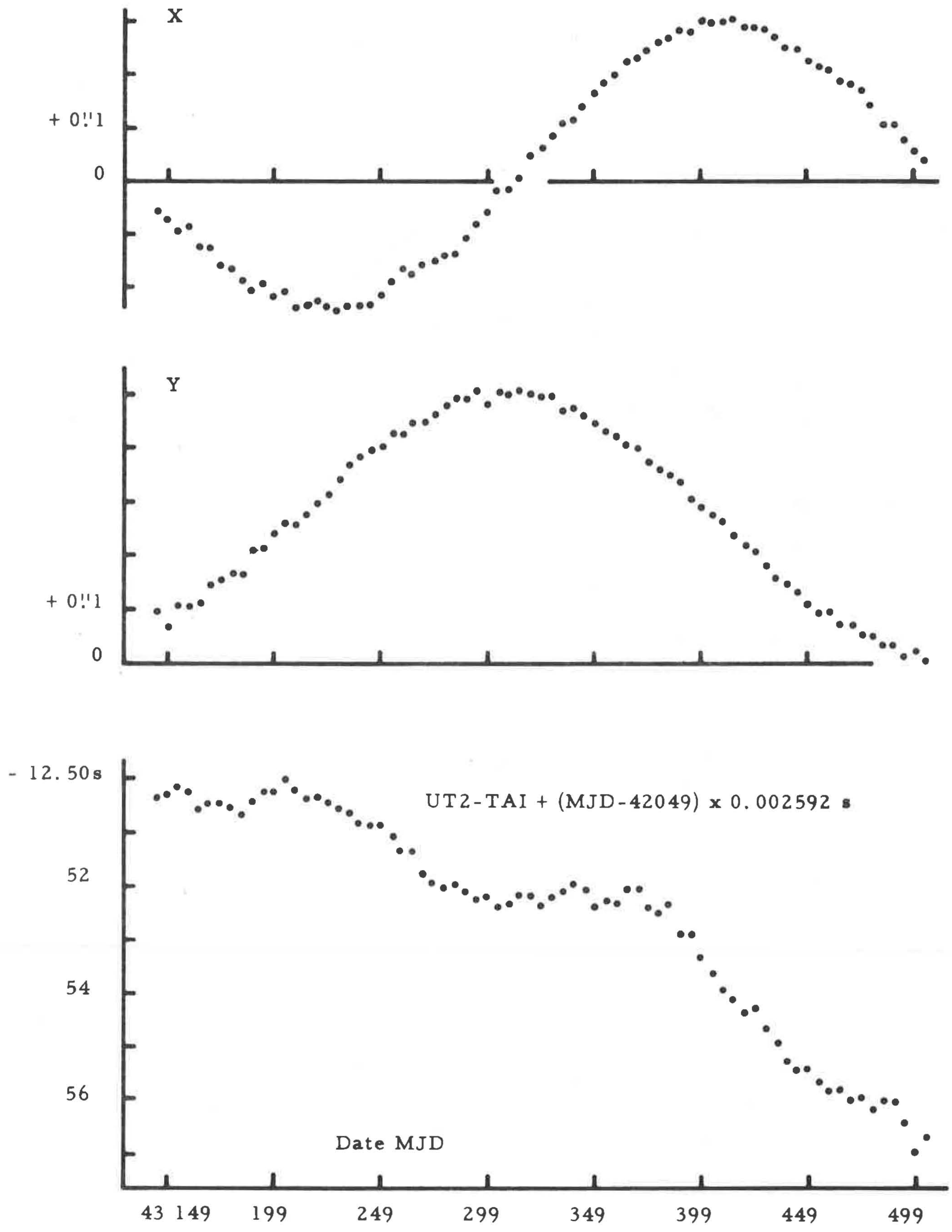

Fig. 2 - Raw data of x, y, UT2-TAI (table 6C for 1977), for every 5 days

PART C

TIME SIGNALS (1978)

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 1978.

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:

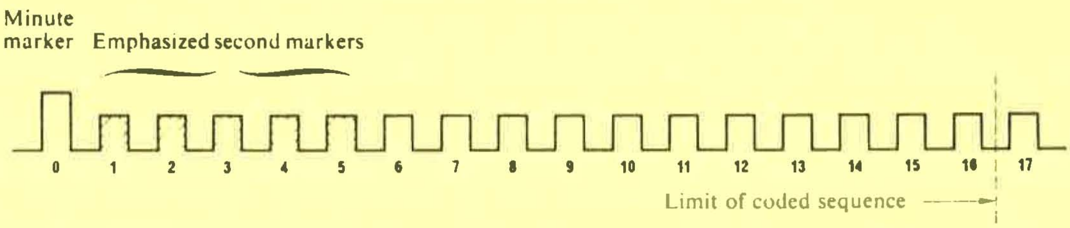

FIGURE 1

DUT1 = +0·5 s

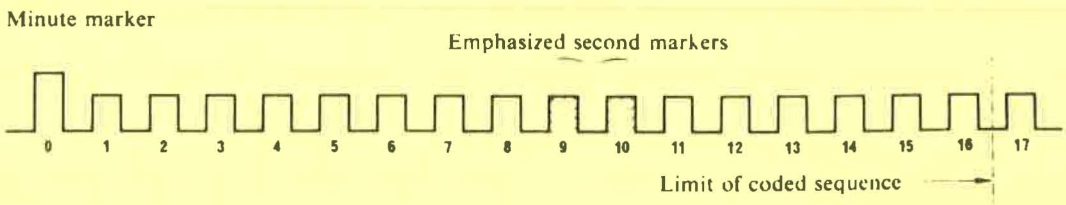

FIGURE 2

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:

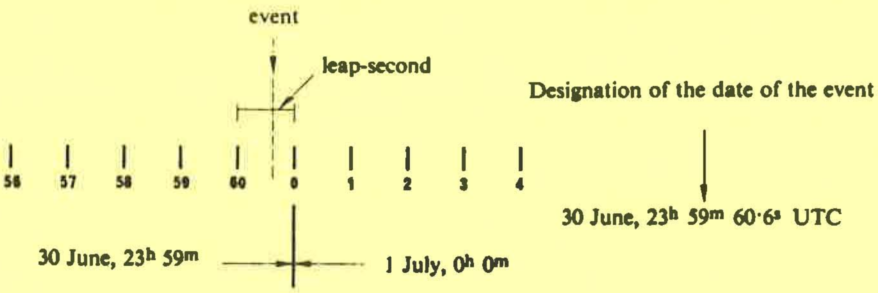

FIGURE 3

Positive leap-second

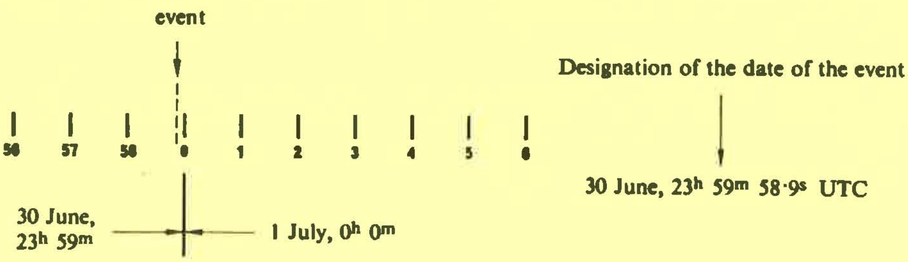

FIGURE 4

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 0.8s 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 0.90s (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	Time and Frequency Division Shanghai Observatory Academia Sinica Zi-Ka-Wei, Shanghai, China
BSF	Telecommunication Laboratories Standard Frequency and Time Section P. O. Box 71 – Chung-Li 320 Taiwan, China
CHU	National Research Council, Time and Frequency Section Physics Division (M-36) Ottawa K1A OS1, 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 D33 Braunschweig
DGI, DIZ	Amt für Standardisierung, Messwesen und Warenprüfung Fachabteilung Elektrizität Arbeitsgebiet Zeit und Frequenznormale Wallstrasse 16 DDR1026 Berlin
EBC	Instituto y Observatorio de Marina San Fernando Cadiz, Spain
FFH	Centre National d'Études des Télécommunications Groupement Transmission par Cable et Faisceau Radioélectrique Département Dispositifs et Ensembles fonctionnels 38, rue du Général Leclerc 92131 Issy-les-Moulineaux, France

Signal	Authority
FTH42, FTK77, FTN87	Laboratoire Primaire du Temps et des Fréquences Observatoire de Paris 61, avenue de l'Observatoire 75014 Paris, France
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, 182 51 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	Shanghaî China 31° 12' N 121° 26' E	5 000 10 000 15 000	16h to 1h continuous 1h to 16h	UTC time signal from minutes 1 to 10 and 31 to 40. Second markers of 10 cycles of 1 kHz modulation. Minute marker, beginning of the first pulse of a series of 9 pulses of 10 ms of 1 kHz modulation. UT1 time signal from minutes 10 to 15 and 40 to 45. Second pulses of 100 ms of 1 kHz modulation. The minute marker is prolonged to 500 ms.
BSF	Chung-Li Taiwan China 24° 57' N 121° 9' E	5 000 10 000	0h to 10h	(a) From min. 5 to 10, 15 to 25, 25 to 30, 45 to 50, 55 to 60, second pulses of 5 ms duration without 1 kHz modulation. (b) From min. 0 to 5, 10 to 15, . . . , 50 to 55, second pulses of 5 ms duration with 1 kHz modulation. The 1 kHz modulation is interrupted 40 ms before and after the pulses. (c) Minute pulses are extended to 300 ms. (d) DUT1, CCIR code.
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. No transmission of DUT1 when the reserve antenna is used, second marker 15 is prolonged

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UT)	Form of the time signals
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 0.1 s duration. Minute pulses prolonged to 0.5 s. DUT1 : CCIR code by double pulse.
EBC	San Fernando Spain 36° 28' N 6° 12' W	12 008	10h 00m to 10h 10m (A_2)	Second pulses of 0.1 s duration of 1 kHz modulation. Minute pulses of 0.5 s duration of 1 250 Hz modulation
		12 008	10h 15m to 10h 25m (A_3J)	DUT1, CCIR code, double pulse. (A_2) amplitude modulation.
		6 840	10h 30m to 10h 40m (A_2)	(A_3J) single sideband, cancelled carrier.
		6 840	10h 45m to 10h 55m (A_3J)	
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 0.5 s. DUT1 · CCIR code by lengthening to 0.1 s.
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 24 s 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 (1) see p. C-15	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	Sanwa Ibaraki Japan 36° 11' N 139° 51' E	40	continuous, except interruptions during communications	A1 type second pulses of 0.5 s duration. Second 59 is of 0.1 s No DUT1 code
JJY	Sanwa Ibaraki Japan 36° 11' N 139° 51' E	2 500 5 000 10 000 15 000	continuous, except interruption between minutes 35 and 39	Second pulses of 8 cycles of 1 600 Hz modulation. Minute pulses are preceded by a 600 Hz modulation DUT1 : CCIR code by lengthening

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UT)	Form of the time signals
LOL1 (1)	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 (1)	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.
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 NRZ code, 100 bits/s (month, day of month, hour, minute), during minute interruptions. BCD PWM code, 1 bit/s (year, month, day of month, day of week, hour, minute) from seconds 17 to 59 in each minute. DUT1 : 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 (3) see p. C-15	Liblice Czechoslovakia 50° 4' N 14° 53' 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.
OMA	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.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UT)	Form of the time signals
PPR	Rio-de-Janeiro Brasil 22° 59' S 43° 11' W	435 4 244 8 634 13 105 17 194,4 22 603	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 (4) see p. C-15	Moscow USSR 55° 19' N 38° 41' E	66 2/3	between minutes 0 and 5 from 0h to 13h 5m from 17h to 23h 5 m	A1 type second pulses. The pulses at beginning of the minute are prolonged to 0.5 s.
RCH (4)	Tashkent USSR 41° 19' N 69° 15' E	2 500	between minutes 0 and 10, 30 and 40 0h to 3h 40m 5h 30m to 23h 40m	Second pulses. The pulses at the beginning of the minute are prolonged to 0.5 s.
		5 000	0h to 1h 10m 2h to 3h 40m 14h to 17h 10m 18h to 23h 40m	
		10 000	5h 30m to 9h 10m 10h to13h 10m	
RID (4)	Irkutsk USSR 52° 46' N 103° 39' E	5 004 10 004 15 004	The station simultaneously operates on three frequencies between minutes 20 and 30 50 and 60.	Second pulses. The pulses at the beginning of the minute are prolonged to 0.5 s.
RIM (4)	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 (4)	Novossibirsk USSR 55° 4' N 82° 58' E	10 000	between minutes 0 and 10, 30 and 40 0h to 1h 10m 2h to 4h 40m 14h to 17h 10m 18h to 23h 40m	Second pulses. The pulses at the beginning of the minute are prolonged.
		15 000	6h 30m to 9h 10m 10h to 13h 10m	
RWM (4)	Moscow USSR 55° 19' N 38° 41' E	4 996 9 996 14 996	The station simultaneously operates on three frequencies between minutes 10 and 20, 40 and 50	Second pulses. The pulses at the beginning of the minute are prolonged to 0.5s.
RTZ (4)	Irkutsk USSR 52° 18' N 104° 18' E	50	between minutes 0 and 5, from 1h to 23h 5m	A1 type 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
UQC3	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 0.025 s duration. Second pulses are prolonged to 0.1 s ; 10 second pulses are prolonged to 1 s and minute pulses are prolonged to 10 s. No transmission of DUT1 code.
UTR3	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 0.025 s duration. Second pulses are prolonged to 0.1 s ; 10 second pulses are prolonged to 1 s and minute pulses are prolonged to 10 s. 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.
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. 59th and 29th second pulses omitted. Hour identified by 0.8 second long 1 500 Hz tone. Beginning of each minute identified by 0.8 second long 1 200 Hz tone. DUT1 : CCIR code by double pulse. BCD time code given on 100 Hz subcarrier, includes DUT1 correction.
YVTO (1)	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	18h to 4h continuous	Pulses of 5 cycles of 1 kHz modulation. Second 0 is prolonged. DUT1 : CCIR code by lengthening
ZUO	Johannesburg South Africa 26° 11' S 28° 4' E	100 000	continuous	Pulses of 5 cycles of 1 kHz modulation Second 0 is prolonged DUT1 : CCIR code by lengthening

Notes on the characteristics of time signals

(1) 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.

$$dUT1 = p.0.02\ s.$$

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.

$$dUT1 = -(q.0.02)s\ .$$

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) OMA, 50 kHz

a. The emission continued during 1977 from the auxilliary transmitter in Podebrady. In January 1978 the emission was resumed from the site in Liblice with radiated power of approx. 5 kW.

b. The transmission of the time code in the form, which was started in July 1974, was terminated as since October 1977 and replaced by a time code of another format. The mode of coding through carrier phase reversals was retained. The details of the new time code will be published during 1978.

(4) 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 21th and 24th 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 31th and the 34th 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
BSF	0.2
CHU	0.05
DCF77	0.005
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 1977.

Unless otherwise stated, the value of UTC-signal are valid for the whole year 1977.

Signal	UTC–Signal (unit : 0.0001 s)	Remarks
BPV (10 MHz, 15 MHz)	-214	
BSF	0	
CHU	0	
DAM, DAN, DAO	0	1977 March 3, 0h UT, UTC – signal = + 2436
DCF77	0	
DGI	0	
DIZ	0	Irregularities : 1977 March 10 to 15 (< 0.0007 s), 1977 Oct. 13 to 15, 1977 Oct. 24 to 28
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 at 11 h UT.

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

Date	1977 Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
					UTC – BPV (9351 kHz) (Unit : 0.0001 s)							
1	-	- 5751	- 4889	-	-	-	-	- 1001	- 296	-	+ 1557	+ 2544
2	-	- 5725	- 4865	-	- 3057	-	-		- 270	-	+ 1593	+ 2578
3	-	- 5694	-	-	- 3041	- 2164	-	- 958	-	+ 547	+ 1628	-
4	-	- 5668	-	- 3918	- 3014	- 2132	-	- 949	-	+ 577	+ 1664	-
5	- 6435	-	-	- 3890	- 2997	-	- 1395	- 921	- 194	+ 610	-	+ 2678
6	- 6400	-	-	- 3875	- 2958	-	- 1371	-	-	+ 639	-	+ 2710
7	- 6371	- 5576	- 4711	- 3842	-	-	- 1352	-	- 153	+ 668	+ 1764	+ 2743
8	-	- 5554	- 4683	-	-	- 1934	- 1326	- 863	- 128	-	+ 1802	+ 2777
9	-	- 5522	- 4625	-	- 2875	-	-	- 849	- 105	-	+ 1832	+ 2809
10	-	- 5492	- 4589	-	- 2836	- 1883	-	- 843	-	+ 743	+ 1870	-
11	- 6308	- 5461	-	-	- 2806	-	- 1259	- 822	-	+ 764	+ 1903	-
12	- 6279	-	-	- 3678	- 2760	-	- 1235	- 786	- 28	+ 806	-	+ 2909
13	- 6250	-	- 4493	- 3660	- 2734	-	- 1230	-	- 3	-	-	+ 2939
14	- 6219	- 5366	- 4458	- 3627	-	- 1791	- 1200	-	+ 22	+ 948	+ 2009	+ 2970
15	-	- 5334	-	- 3597	-	- 1748	- 1184	- 750	+ 46	-	+ 2045	+ 3004
16	-	- 5298	- 4404	-	- 2643	- 1725	-	- 712	+ 70	-	-	+ 3031
17	- 6128	- 5270	-	-	- 2622	-	-	- 704	-	+ 1051	+ 2118	-
18	- 6099	- 5240	-	- 3509	- 2592	-	- 1120	- 692	-	+ 1087	+ 2151	-
19	- 6064	-	-	-	-	-	- 1114	- 677	+ 153	+ 1118	-	+ 3129
20	- 6034	-	-	- 3443	- 2523	- 1603	- 1088	-	+ 179	+ 1152	-	+ 3160
21	- 6064	- 5145	- 4349	- 3412	-	- 1648	- 1088	-	+ 216	+ 1182	+ 2198	-
22	-	- 5116	-	-	-	- 1630	-	- 520	+ 231	-	+ 2239	+ 3135
23	-	- 5084	- 4279	-	- 2431	- 1604	-	- 498	+ 260	-	+ 2269	+ 3166
24	- 5987	- 5049	- 4256	-	- 2405	- 1585	-	- 476	-	+ 1285	+ 2303	-
25	- 5958	- 5022	- 4237	- 3294	-	-	- 1016	-	-	+ 1323	+ 2338	-
26	- 5930	-	-	- 3267	- 2330	-	- 1007	- 411	+ 342	+ 1352	-	-
27	- 5896	-	-	-	- 2310	-	- 989	-	+ 379	+ 1386	-	+ 3289
28	- 5863	- 4926	- 4138	- 3207	-	-	- 969	-	-	+ 1422	+ 2444	+ 3322
29	-	-	- 4109	- 3176	-	- 1472	- 950	- 364	+ 426	-	+ 2475	+ 3353
30	-	-	- 4080	-	-	- 1444	-	-	+ 451	-	+ 2511	+ 3382
31	- 5782	-	- 4046	-	-	-	-	- 321	-	+ 1523	-	-

Dépôt légal : 2ème trimestre 1978
Imprimeur : Observatoire de Paris
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