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Table 9 — Offsets and step adjustments of UTC, until 1979 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
1979 Jan. 1	"	- 1 s

Table 10 — Relationship between TAI and UTC, until 1979 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 - 1979 Jan. 1	17.000 000 0 s
1979 Jan. 1	18.000 000 0 s

Table 11 - Atomic time, collaborating laboratories

APL	Applied Physics Laboratory, Laurel, U S A
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
STA	Swedish Telecommunications Administration, Stockholm, Sweden
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
DDR(1)	3 commercial Cs stds	year 1978	(2)
F (3)	17 commercial Cs stds	year 1978	TA(f) - UTC(OP) is published in Bulletin H by OP
NBS	13 commercial Cs stds 2 lab. primary stds 1 Hydrogen Maser (4)	43 509 - 43 874	17.045 056 552 $+ (24.8 \times 10^{-9})(\mathrm{MJD} - 43\,509)$ $- (11.83 \times 10^{-12})(\mathrm{MJD} - 43\,509)^2$
NRC	3 commercial Cs stds 1 lab. primary std (5)	year 1978	16.999 968 931
ON	7 commercial Cs stds 3 prototype Cs stds	year 1978	17 seconds exactly
PTB	10 commercial Cs stds 1 lab. primary std 1 Hydrogen Maser (6)	year 1978	published in PTB Time Service Bulletin
RGO	6 commercial Cs stds	year 1978	16.999 926 09
USNO	25 commercial Cs stds 1 Hydrogen Maser	year 1978	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 :

ASMW : 2 Cs

ZIPE : 1 Cs

They are intercompared by TV Method.

(2) Given in ASMW Bulletin.

(3) The standards are located as follows (at the end of 1978)

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
Hewlett - Packard (Orsay)	1 Cs
Observatoire de Paris	6 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).

(4) 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 0.1μs.

(5) The 2.1 meter primary cesium clock, Cs V, has operated continuously in 1978, producing a scale of proper time PT (NRC Cs V). The time scales UTC (NRC) and TA (NRC) have benn derived from PT (NRC Cs V) in 1978 according to the following exprcssions given in microseconds :

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

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

with integral seconds disregarded.

Three new smaller primary Cs clocks (Cs VI, A, B, C) commenced continuous operation late in 1978. Evaluation of them is in progress.

(6) 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(D) is the legal time (in Central European Time) of the Federal Republic of Germany which is desseminated, e. g., by the LF transmitter DCF 77. Two Cs stds and one Rb std provide the freference for DCF 77.

CS 1 has been operating continuously since August 1978.

(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
APL(4)	3 Cs	1 Cs			USNO
ASMW	2 Cs	corrected mean of 2 Cs	7970-W	DCF77, OMA	ZIPE, TP, PTB
BEV	1 Cs	1 Cs	7970-W 7990-M	GBR, OMA50, MSF60, HBG DCF77	TUG
DHI	2 Cs	1 Cs	7970-W	DCF77	PTB, TP, ZIPE
DNM(5)	3 Cs	all the Cs			other lab. in Australia
FOA (6)	3 Cs	1 Cs	7970-W	GBR	other lab. in Sweden
IEN	7 Cs	1 Cs + micro stepper	7990-M 7990-Z	GBR	other lab. in Italy
IGMA	2 Cs	Cs		GBR, OMEGA/ND	ONBA
ILOM	3 Cs	Cs	9970-M	GBR	
NBS (7)	see Table 12	8 Cs 1 lab. Cs	9930-Z 9940-M	OMEGA/ND OMEGA/H	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/L	
NRC (7, 8)	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 (8)	6 Cs	1 Cs	7970-W 7990-Y		15 lab. in France, ORB, Hewlett-Packard (Switzerland), PTCH

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	corrected mean of 3 Cs	7970-W	DCF77, OMA50, RBU66	ASMW, ZIPE
PTB	see Table 12	2 Cs	7970-W	GBR, DCF77	ASMW, DHI, TP and other lab.
PTCH	2 Cs	1 Cs	7970-W	DCF77, HBG	OP and other lab. in Switzerland
RGO	see Table 12	selection of the Cs	7930-X 7970-M 7970-W 7990-Z	GBR, MSF60	NPL
RRL	6 Cs 2 H Masers	1 Cs	9970-M	OMEGA/ND, OMEGA/H OMEGA/ J	ILOM, TAO
STA(6)	3 Cs	1 Cs	7970-W		other lab. in Sweden
SU	6 Cs 3 H Masers 1 lab. Cs	4 Cs 3 H Masers 1 lab. Cs	7990-X 9970-M	GBR, OMA50, RBU, MSF60, OMFGA/J	other lab. in USSR, TP
TAO	4 Cs	1 Cs	9970-M	NWC, WWV, WWVH	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	OMEGA, GBR	BEV
USNO (7, 9)	see Table 12	Cs	(10)	(10)	APL, NBS, NRC
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, PTB 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 :

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

(4) Weekly Cesium transfers are carried out between APL and USNO

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

(6) Since 1978 July, the National Primary Calibration Center for Time and Frequency in Sweden has been taken over by the Swedish Telecommunications Adminsitration (STA)

(7) Satellite link via Hermes between NBS, NRC and USNO

(8) Satellite link via Symphonie between NRC and OP

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

(10) 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 A, H, L, ND, T
the VLF station GBR
the US TV Networks

TABLE 14 - TIME COMPARISONS BETWEEN LABORATORIES BY CLOCK TRANSPORTATION IN 1978

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

DATE		MJD	TIME COMPARISONS	UNCERT.	SOURCE
1978			(UNIT : 1 MICROSECOND)		
MAR	31	43598.5	UTC(USNO) - UTC(NRC) = -3.6	0.2	USNO DPV 585 (1)
APR	12	43610.9	UTC(USNO) - UTC(NBS) = -0.7	0.2	USNO DPV 587
APR	25	43623.5	UTC(USNO) - UTC(RGO) = 0.0	0.2	USNO DPV 590
MAY	4	43632.3	UTC(USNO) - UTC(OP) = 1.2	0.2	USNO DPV 590
MAY	7	43635.5	UTC(USNO) - UTC(OMSF) = -3.2	0.2	USNO DPV 590
MAY	13	43641.3	UTC(USNO) - UTC(NPL) = 4.2	0.2	USNO DPV 590
MAY	29	43657.9	UTC(OP) - UTC(NRC) = -4.31	0.2	OP LETTER
JUN	1	43660	UTC(NBS) - UTC(USNO) = 0.49	0.3	NBS BULL 247
JUN	14	43673	UTC(SU) - UTC(TP) = -52.61	0.1	SU LETTER
JUN	14	43673.6	UTC(VSL) - UTC(PTB) = 56.66	0.05	VSL LETTER
JUN	22	43681.0	UTC(TAO) - UTC(ILOM) = -40.77	0.01	TAO LETTER
JUN	27	43686.2	UTC(TAO) - UTC(RRL) = -27.94	0.01	TAO LETTER
JUN	27	43686.3	UTC(TAO) - UTC(NRLM) = -45.72	0.01	TAO LETTER (2)
JUL	11	43700	UTC(SU) - UTC(IEN) = -64.26	0.1	SU LETTER
JUL	18	43707.7	UTC(USNO) - UTC(NRC) = -3.8	0.2	USNO DPV 600
JUL	19	43708	UTC(NBS) - UTC(NRC) = -1.7	0.3	NBS BULL 250
AUG	4	43724	UTC(NBS) - UTC(OP) = 1.8	0.3	NBS BULL 250
SEP	7	43758	UTC(NBS) - UTC(NRC) = -3.8	0.3	NBS BULL 253
SEP	7	43758.3	UTC(USNO) - UTC(NPL) = 3.1	0.2	USNO DPV 609
SEP	14	43765.4	UTC(USNO) - UTC(TUG) = 5.2	0.2	USNO DPV 609
SEP	14	43765.6	UTC(USNO) - UTC(BEV) = 8.8	0.2	USNO DPV 609
SEP	18	43769.4	UTC(USNO) - UTC(DHI) = 1.3	0.2	USNO DPV 609
SEP	18	43769.5	UTC(USNO) - UTC(PTB) = 0.9	0.2	USNO DPV 609
SEP	26	43777.6	UTC(USNO) - UTC(NBS) = -1.9	0.2	USNO DPV 609
SEP	27	43778	UTC(NBS) - UTC(USNO) = 1.50	0.3	NBS BULL 251
SEP	27	43778.3	UTC(PKNM) - UTC(TP) = -1.16	0.05	PKNM LETTER
SEP	28	43779.0	UTC(USNO) - UTC(TAO) = -0.4	0.2	USNO DPV 611
SEP	28	43779.2	UTC(USNO) - UTC(RRL) = -17.6	0.2	USNO DPV 611
SEP	28	43779.3	UTC(USNO) - UTC(NRLM) = -46.4	0.2	USNO DPV 611
OCT	12	43793.9	UTC(USNO) - UTC(ATC) = -12.3	0.2	USNO DPV 614 (3)
OCT	18	43799.0	UTC(TAO) - UTC(ILOM) = -36.74	0.02	TAO LETTER
OCT	21	43802.0	UTC(USNO) - UTC(DNM) = 110.7	0.2	USNO DPV 615 (3)
OCT	26	43807.2	UTC(TAO) - UTC(NRLM) = -47.50	0.02	TAO LETTER
OCT	26	43807.3	UTC(TAO) - UTC(RRL) = -17.19	0.02	TAO LETTER
OCT	26	43807.5	UTC(OP) - UTC(NRC) = -5.22	0.05	OP LETTER
OCT	30	43811.1	UTC(USNO) - UTC(RRL) = -18.1	0.2	USNO DPV 614 (4)
OCT	31	43812.5	UTC(USNO) - UTC(NRC) = -4.5	0.2	USNO DPV 615
NOV	13	43825.8	UTC(IEN) - UTC(OP) = 10.6	0.1	IEN LETTER
NOV	20	43832	UTC(IEN) - UTC(SU) = 66.96	0.1	SU LETTER
NOV	22	43834	UTC(SU) - UTC(ZIPE) = -54.49	0.1	SU LETTER
NOV	22	43834.3	UTC(IEN) - UTC(TP) = 11.7	0.1	IEN LETTER
NOV	22	43834.4	UTC(ASMW) - UTC(ZIPE) = -1.91	0.05	ASMW LETTER
NOV	25	43837	UTC(SU) - UTC(ASMW) = -53.61	0.1	SU LETTER
DEC	13	43855	UTC(SU) - UTC(PKNM) = -53.40	0.1	SU LETTER

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

(2) NRLM : NATIONAL RESEARCH LABORATORY OF METROLOGY,MINISTRY OF INTERNATIONAL TRADE AND INDUSTRY,JAPAN

(3) MEASUREMENT MADE BY NAVAL ELECTRONIC SYSTEMS ENGINEERING CENTER

(4) MEASUREMENT MADE BY U.S. COAST GUARD ONSOD

IN ADDITION,WEEKLY CESIUM CLOCK TRANSPORTATIONS ARE CARRIED OUT BETWEEN APL AND USNO

TABLE 15 - INDEPENDENT ATOMIC TIMES

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

UNIT IS ONE MICROSECOND

DATE 1978		MJD	TAI - TA(I) DDR	F	NBS	NRC
JAN	1	43509	-1.38	-93.08	-45057.65	27.40
JAN	11	43519	-1.19	-92.83	-45058.19	27.21
JAN	21	43529	-1.14	-92.85	-45058.35	27.36
JAN	31	43539	-0.92	-92.75	-45058.58	27.35
FEB	10	43549	-0.56	-92.54	-45058.78	27.34
FEB	20	43559	-0.33	-92.32	-45058.98	27.35
MAR	2	43569	-0.45	-92.30	-45059.06	27.54
MAR	12	43579	-0.11	-91.93	-45059.54	27.30
MAR	22	43589	0.26	-91.67	-45059.76	27.28
APR	1	43599	0.39	-91.47	-45059.84	27.27
APR	11	43609	0.65	-91.39	-45059.84	27.26
APR	21	43619	0.81	-91.26	-45060.00	27.27
MAY	1	43629	1.11	-91.10	-45060.22	27.26
MAY	11	43639	1.48	-90.74	-45060.56	27.06
MAY	21	43649	1.71	-90.49	-45060.86	27.02
MAY	31	43659	1.82	-90.28	-45061.12	26.96
JUN	10	43669	2.16	-89.99	-45061.55	26.81
JUN	20	43679	2.48	-89.84	-45061.77	26.78
JUN	30	43689	2.92	-89.49	-45062.09	26.72
JUL	10	43699	3.27	-89.20	-45062.57	26.71
JUL	20	43709	3.42	-88.92	-45062.94	26.64
JUL	30	43719	4.02	-88.61	-45063.23	26.58
AUG	9	43729	4.49	-88.28	-45063.65	26.48
AUG	19	43739	4.92	-87.92	-45063.92	26.15
AUG	29	43749	5.21	-87.69	-45064.18	26.04
SEP	8	43759	5.54	-87.49	-45064.44	25.91
SEP	18	43769	5.96	-87.20	-45064.75	25.71
SEP	28	43779	6.29	-87.03	-45064.95	25.48
OCT	8	43789	6.60	-86.77	-45065.16	25.22
OCT	18	43799	7.01	-86.56	-45065.46	25.24
OCT	28	43809	7.49	-86.25	-45065.78	25.09
NOV	7	43819	8.00	-85.95	-45066.05	25.02
NOV	17	43829	8.34	-85.64	-45066.36	24.91
NOV	27	43839	8.81	-85.35	-45066.70	24.92
DEC	7	43849	9.35	-85.05	-45066.93	24.82
DEC	17	43859	9.76	-84.71	-45067.27	24.82
DEC	27	43869	10.40	-84.56	-45067.46	24.65

TABLE 15 - (CONT.)

UNIT IS ONE MICROSECOND

DATE 1978	MJD	TAI - TA(I) ON	PTB	RGO	USNO
JAN 1	43509	15.02	-359.04	72.87	-34402.94
JAN 11	43519	15.08	-359.04	72.94	-34403.41
JAN 21	43529	14.86	-359.20	72.93	-34403.70
JAN 31	43539	14.72	-359.26	72.92	-34404.05
FEB 10	43549	14.72	-359.29	72.77	-34404.50
FEB 20	43559	14.82	-359.24	72.86	-34405.08
MAR 2	43569	14.49	-359.38	72.85	-34405.37
MAR 12	43579	14.61	-359.27	73.06	-34406.13
MAR 22	43589	14.72	-359.23	73.11	-34406.68
APR 1	43599	14.67	-359.29	73.06	-34407.19
APR 11	43609	14.55	-359.35	73.09	-34407.56
APR 21	43619	14.51	-359.46	73.11	-34407.94
MAY 1	43629	14.43	-359.60	73.20	-34408.42
MAY 11	43639	14.57	-359.55	73.20	-34409.02
MAY 21	43649	14.64	-359.58	73.13	-34409.49
MAY 31	43659	14.63	-359.76	73.05	-34409.94
JUN 10	43669	14.70	-359.79	73.13	-34410.40
JUN 20	43679	14.69	-359.96	73.01	-34410.82
JUN 30	43689	14.64	-359.85	72.91	-34411.27
JUL 10	43699	14.76	-359.96	72.79	-34411.74
JUL 20	43709	14.95	-360.05	72.77	-34412.20
JUL 30	43719	15.01	-360.19	72.72	-34412.63
AUG 9	43729	15.12	-360.24	72.67	-34413.11
AUG 19	43739	15.26	-360.32	72.45	-34413.49
AUG 29	43749	15.34	-360.34	72.32	-34413.93
SEP 8	43759	15.37	-360.42	72.23	-34414.27
SEP 18	43769	15.55	-360.50	72.17	-34414.75
SEP 28	43779	15.64	-360.53	71.89	-34415.16
OCT 8	43789	15.59	-360.77	71.74	-34415.59
OCT 18	43799	15.46	-360.93	71.63	-34415.96
OCT 28	43809	15.43	-361.00	71.57	-34416.46
NOV 7	43819	15.38	-361.07	71.50	-34416.97
NOV 17	43829	15.33	-361.08	71.48	-34417.47
NOV 27	43839	15.29	-361.22	71.33	-34417.89
DEC 7	43849	15.20	-361.28	71.15	-34418.29
DEC 17	43859	15.10	-361.34	71.17	-34418.71
DEC 27	43869	15.16	-361.30	71.20	-34419.16

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 given to ± 0.01 μs.

TABLE 16 - PRIMARY STANDARDS USED AS CLOCKS

UNIT IS ONE MICROSECOND

DATE 1978		MJD	TAI-LAB.STD.	
			PTB CS1	NRC CSV
JAN	1	43509		48.02
JAN	11	43519		47.82
JAN	21	43529		47.96
JAN	31	43539		47.94
FEB	10	43549		47.92
FEB	20	43559		47.92
MAR	2	43569		48.10
MAR	12	43579		47.86
MAR	22	43589		47.82
APR	1	43599		47.81
APR	11	43609		47.78
APR	21	43619		47.78
MAY	1	43629		47.77
MAY	11	43639		47.55
MAY	21	43649		47.50
MAY	31	43659		47.43
JUN	10	43669		47.27
JUN	20	43679		47.24
JUN	30	43689		47.17
JUL	10	43699		47.14
JUL	20	43709		47.06
JUL	30	43719	-358.01	46.99
AUG	9	43729	-358.08	46.89
AUG	19	43739	-358.18	46.54
AUG	29	43749	-358.28	46.43
SEP	8	43759	-358.37	46.28
SEP	18	43769	-358.48	46.07
SEP	28	43779	-358.64	45.83
OCT	8	43789	-358.82	45.56
OCT	18	43799	-358.99	45.57
OCT	28	43809	-359.10	45.42
NOV	7	43819	-359.19	45.34
NOV	17	43829	-359.26	45.22
NOV	27	43839	-359.40	45.22
DEC	7	43849	-359.44	45.11
DEC	17	43859	-359.48	45.10
DEC	27	43869	-359.46	44.92

NOTE

The NBS-4 standard operated continuously as a clock in 1978. However the uses of NBS-4 as a clock and as a standard are distinct from each other.

TABLE 17 - COORDINATED UNIVERSAL TIME

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

UNIT IS ONE MICROSECOND

DATE 1978		MJD	UTC - UTC(I)* APL (1)	ASMW	AUS (2)	DHI	FOA (3)	IEN	IGMA (4)
JAN	1	43509	246.89	1.36	-28.5	0.01	35.71	-10.67	-9
JAN	11	43519	248.43	1.45	-27.9	0.09	31.45	-10.57	-9
JAN	21	43529	249.83	1.55	-27.3	-0.01	27.12	-10.66	-10
JAN	31	43539	251.29	1.71	-26.5	0.03	23.15	-10.80	-8
FEB	10	43549	252.72	2.10	-24.3	0.31	18.64	-10.91	-5
FEB	20	43559	254.06	2.41	-24.2	0.66	16.08	-10.75	-2
MAR	2	43569	255.67	2.31	-24.1	0.91	14.63	-10.66	-4
MAR	12	43579	256.86	2.54	-25.4	1.42	13.44	-10.53	-6
MAR	22	43589	258.25	2.84	-24.6	1.76	12.39	-10.49	-8
APR	1	43599	259.69	2.66	-20.8	2.16	10.83	-10.52	-5
APR	11	43609	261.20	3.02	-20.3	2.46	9.38	-10.67	-5
APR	21	43619	262.76	3.09	-19.7	2.74	8.02	-10.66	-9
MAY	1	43629	264.24	3.23	-19.3	3.01	6.55	-10.56	-8
MAY	11	43639	265.50	3.39	-19.0	3.48	5.26	-10.43	-5
MAY	21	43649	266.98	3.42	-18.6	3.90	3.96	-10.42	-5
MAY	31	43659	268.47	3.15	-18.0	4.19	2.56	-10.60	-4
JUN	10	43669	269.89	3.10	-17.1	4.07	1.21	-10.51	-2
JUN	20	43679	271.39	3.15	-16.1	3.61	-0.39	-10.61	
JUN	30	43689	272.77	3.35	-15.1	3.24		-10.96	-3
JUL	10	43699	274.19	3.40	-14.2	2.79		-10.99	-2
JUL	20	43709	275.62	3.30	-13.2	2.38		-10.90	-3
JUL	30	43719	277.13	3.62	-12.3	1.78		-11.18	-3
AUG	9	43729	278.62	3.72	-11.4	1.42		-11.32	-3
AUG	19	43739	280.13	3.63	-10.4	1.08		-11.22	-4
AUG	29	43749	281.57	3.37	-9.3	0.62		-11.33	-4
SEP	8	43759	283.10	3.22	-8.0	0.13		-11.45	-5
SEP	18	43769	284.54	3.15	-6.9	-0.32		-11.45	-5
SEP	28	43779	286.09	3.02	-5.8	-0.75		-11.32	-5
OCT	8	43789	287.63	2.90	-9.2	-0.89		-11.25	-6
OCT	18	43799	289.27	2.80	-8.5	-0.94		-11.30	-4
OCT	28	43809	290.78	2.85	-8.0	-0.91		-11.32	-5
NOV	7	43819	292.29	2.92	-8.1	-0.83		-11.25	-6
NOV	17	43829	293.80	2.89	-8.0	-0.71		-11.16	-7
NOV	27	43839	295.36	3.02	-7.9	-0.67		-11.06	-8
DEC	7	43849	296.88	3.05	-7.7	-0.66		-11.12	-5
DEC	17	43859	298.53	2.95	-7.5	-0.46		-11.20	-5
DEC	27	43869	300.07	3.04	-7.4	-0.21		-11.23	-2

TABLE 17 - (CONT.)

UNIT IS ONE MICROSECOND

DATE 1978	MJD	UTC - UTC(I)* ILOM	NBS	NPL	NPRL (5)	NRC	OMH	OMSF
JAN 1	43509	-19.1	-1.10	1.44	75	-3.67	-45.17	-3.82
JAN 11	43519	-19.6	-1.39	1.69	71	-3.85	-44.86	-3.59
JAN 21	43529	-20.2	-1.30	1.81	73	-3.71	-44.52	-3.64
JAN 31	43539	-20.7	-1.30	2.07	74	-3.72	-44.28	-3.57
FEB 10	43549	-21.4	-1.25	2.24	68	-3.73	-44.34	-3.38
FEB 20	43559	-22.3	-1.22	2.63	68	-3.72	-45.07	-3.08
MAR 2	43569	-22.7	-1.07	2.83	67	-3.52	-44.60	-2.96
MAR 12	43579	-23.6	-1.32	3.18	68	-3.76	-44.10	-2.65
MAR 22	43589	-24.7	-1.30	3.33	68	-3.79	-43.95	-2.64
APR 1	43599	-25.7	-1.15	3.52	67	-3.79	-43.82	-2.57
APR 11	43609	-26.8	-0.93	3.64	69	-3.81	-43.68	-2.69
APR 21	43619	-27.4	-0.87	3.53	70	-3.80	-43.80	-2.90
MAY 1	43629	-28.1	-0.66	3.31	72	-3.80	-43.77	-3.08
MAY 11	43639	-28.9	-0.99	3.42	69	-4.01	-43.04	-3.10
MAY 21	43649	-29.4	-1.07	3.38	68	-4.05	-42.87	-3.34
MAY 31	43659	-29.6	-1.11	3.42	67	-4.11	-41.69	-3.53
JUN 10	43669	-30.4	-1.33	3.49	62	-4.26	-41.23	-3.51
JUN 20	43679	-31.1	-1.34	3.22	64	-4.29	-40.90	-3.70
JUN 30	43689	-32.0	-1.46	3.10	63	-4.34	-40.77	-3.94
JUL 10	43699	-32.9	-1.74	3.02	64	-4.36	-40.47	-3.93
JUL 20	43709	-33.5	-1.91	2.77	61	-4.43	-40.34	-4.08
JUL 30	43719	-34.3	-1.99	2.75	60	-4.48	-40.19	-4.20
AUG 9	43729	-35.2	-2.22	2.70	59	-4.56	-39.70	-4.44
AUG 19	43739	-35.9	-2.29	2.42	59	-4.92	-39.62	-4.56
AUG 29	43749	-36.8	-2.36	2.27	57	-5.02	-39.45	-4.79
SEP 8	43759	-37.7	-2.43	1.77	55	-5.16	-39.29	-4.79
SEP 18	43769	-38.7	-2.55	1.67	54	-5.36	-39.16	-4.85
SEP 28	43779	-39.9	-2.57	1.43	54	-5.59	-39.25	-4.83
OCT 8	43789	-40.8	-2.60	1.17	50	-5.85	-39.09	-4.55
OCT 18	43799	-41.7	-2.72	0.89	51	-5.83	-39.19	-4.33
OCT 28	43809	-42.8	-2.86	0.81	48	-5.98	-39.01	-4.32
NOV 7	43819	-43.7	-2.95	0.53	45	-6.05	-38.80	-3.91
NOV 17	43829	-44.6	-3.08	0.46	43	-6.15	-38.56	-3.69
NOV 27	43839	-45.1	-3.25	0.17	43	-6.15	-38.50	-3.42
DEC 7	43849	-45.4	-3.32	-0.09	42	-6.24	-38.35	-3.27
DEC 17	43859	-45.7	-3.49	-0.28	41	-6.24	-38.10	-3.19
DEC 27	43869	-46.5	-3.52	-0.49	39	-6.42	-38.08	-3.20

TABLE 17 - (CONT.)

UNIT IS ONE MICROSECOND

DATE 1978	MJD	UTC - UTC(I)* ON	OP	ORB	PKNM (6)	PTB	PTCH (7)	RGO
JAN 1	43509	15.02	-1.17	5.97	1.70	0.26	-18.38	-1.04
JAN 11	43519	15.08	-0.87	5.55	1.95	0.37	-17.48	-0.97
JAN 21	43529	14.86	-0.69	4.85	1.75	0.29	-16.94	-0.98
JAN 31	43539	14.72	-0.76	4.18	1.92	0.31	-16.14	-0.99
FEB 10	43549	14.72	-0.49	4.12	1.67	0.35	-15.01	-1.14
FEB 20	43559	14.82	-0.26	3.80	1.62	0.34	-14.19	-1.05
MAR 2	43569	14.49	-0.25	4.03	0.85	0.15	-13.68	-1.06
MAR 12	43579	14.61	0.08	4.23	0.65	0.25	-12.74	-0.85
MAR 22	43589	14.72	0.32	4.65	0.64	0.39	-11.77	-0.80
APR 1	43599	14.67	0.54	4.94	0.41	0.44	-11.04	-0.95
APR 11	43609	14.55	0.48	5.40	0.26	0.45	-10.35	-0.82
APR 21	43619	14.51	0.25	5.79	0.17	0.36	-9.55	-0.79
MAY 1	43629	14.43	0.05	6.18	-0.09	0.26	-8.96	-0.71
MAY 11	43639	14.57	0.05	6.11	-0.24	0.26	-8.09	-0.71
MAY 21	43649	14.64	-0.02	6.79	-0.23	0.19	-7.60	-0.78
MAY 31	43659	14.63	-0.18	7.40	-0.50	-0.03	-7.23	-0.85
JUN 10	43669	14.70	-0.27	7.56	-0.64	-0.07	-6.79	-0.78
JUN 20	43679	14.69	-0.44	7.81	-0.62	-0.13	-6.29	-0.90
JUN 30	43689	14.64	-0.43	7.94	-0.65	-0.11	-5.71	-1.00
JUL 10	43699	14.76	-0.51	7.88	-0.57	-0.19	-5.27	-1.12
JUL 20	43709	14.95	-0.61	7.78	-0.77	-0.21	-5.02	-1.14
JUL 30	43719	15.01	-0.63	8.12	-0.47	-0.27	-4.63	-1.19
AUG 9	43729	15.12	-0.61	9.33	-0.71	-0.26	-4.13	-1.24
AUG 19	43739	15.26	-0.54	8.15	-0.59	-0.26	-3.89	-1.46
AUG 29	43749	15.34	-0.61	8.42	-0.71	-0.22	-3.25	-1.59
SEP 8	43759	15.37	-0.68	9.21	-0.69	-0.23	-2.94	-1.68
SEP 18	43769	15.55	-0.72	9.86	-0.57	-0.22	-2.58	-1.74
SEP 28	43779	15.64	-0.84	10.35	-0.45	-0.27	-2.08	-2.02
OCT 8	43789	15.59	-0.89	10.58	-0.35	-0.32	-1.61	-2.17
OCT 18	43799	15.46	-0.99	11.17	0.16	-0.40	-1.14	-2.28
OCT 28	43809	15.43	-0.93	11.07	1.09	-0.39	-0.58	-2.34
NOV 7	43819	15.38	-0.88	11.05	1.30	-0.36	0.22	-2.41
NOV 17	43829	15.33	-0.80	10.91	1.04	-0.28	0.87	-2.43
NOV 27	43839	15.29	-0.81	10.44	1.04	-0.32	1.50	-2.58
DEC 7	43849	15.20	-0.81	9.98	1.39	-0.28	2.19	-2.76
DEC 17	43859	15.10	-0.70	9.52	1.44	-0.18	25.99	-2.74
DEC 27	43869	15.16	-0.78	9.14	1.61	0.02	26.46	-2.71

TABLE 17 - (CONT.)

UNIT IS ONE MICROSECOND

DATE 1978	MJD	UTC - UTC(I)* RRL	STA	SU (8)	TAO	TCL	TP	TUG
JAN 1	43509	-16.3		50.0	20.2	69.0	-0.89	2.25
JAN 11	43519	-16.7	32.21	50.0	19.6	68.1	-0.48	2.36
JAN 21	43529	-16.8	29.98	51.0	19.3	68.5	-0.42	2.30
JAN 31	43539	-16.8	27.84	51.5	18.6	69.0	-0.45	2.12
FEB 10	43549	-16.9	25.68	51.5	18.2	69.7	-0.28	2.07
FEB 20	43559	-17.2	23.55	49.5	17.4	70.0	-0.47	2.02
MAR 2	43569	-17.1	21.32	51.7	17.0	70.5	-0.49	1.72
MAR 12	43579	-17.4	19.19	50.9	16.1	70.4	-0.13	1.93
MAR 22	43589	-17.7	17.14	50.5	15.2	70.9	0.04	2.04
APR 1	43599	-18.0	14.80	51.0	14.5	71.1	0.20	2.03
APR 11	43609	-18.4	12.56	50.7	13.5	71.0	0.28	2.16
APR 21	43619	-18.5	10.19	51.7	13.0	71.6	0.47	2.16
MAY 1	43629	-18.5	7.87	52.1	12.6	71.9	0.44	2.21
MAY 11	43639	-18.4	5.76	52.8	12.1	72.2	0.74	2.53
MAY 21	43649	-18.6	3.43	51.4	11.8	72.8	0.41	2.55
MAY 31	43659	-18.1	1.05	52.4	11.8	73.7	-0.09	2.68
JUN 10	43669	-18.1	-1.34	52.7	11.3	74.0	-0.53	2.90
JUN 20	43679	-18.3	-3.78	52.5	10.6	74.4	-0.93	2.95
JUN 30	43689	-18.5	-6.10	52.6	9.7	74.6	-0.66	3.05
JUL 10	43699	-18.7	-8.47	52.9	8.7	74.8	-0.29	3.13
JUL 20	43709	-18.7	-10.82	53.4	7.8	75.1	-0.14	3.23
JUL 30	43719	-18.8	-13.17	53.8	6.4	75.3	-0.25	3.31
AUG 9	43729	-19.1	-15.47	54.4	4.8	75.4	-0.37	3.62
AUG 19	43739	-19.2	-17.78	53.3	3.3	75.7	-0.35	3.67
AUG 29	43749	-19.5	-20.12	53.7	1.6	75.8	-0.28	3.78
SEP 8	43759	-19.7	-22.38	53.2	0.1	76.2	-0.32	3.84
SEP 18	43769	-20.2	-24.70	54.2	-1.5	76.5	-0.44	4.00
SEP 28	43779	-21.0	-27.10	54.1	-3.4	76.6	-0.53	4.03
OCT 8	43789	-21.5	-29.44	54.6	-4.2	76.9	-0.49	4.06
OCT 18	43799	-22.0	-31.75	55.2	-4.5	77.2	-0.52	4.10
OCT 28	43809	-22.4	-33.92	54.7	-4.8	77.5	-0.42	4.25
NOV 7	43819	-22.6	-36.03	56.1	-4.9	77.4	-0.35	4.38
NOV 17	43829	-22.9	-38.20	55.4	-5.1	76.4	-0.04	4.70
NOV 27	43839	-22.9	-40.34	55.9	-4.9	75.8	-0.00	5.04
DEC 7	43849	-22.7	-42.72		-4.5	75.3	-0.10	5.23
DEC 17	43859	-22.6	-44.92		-4.2	75.1	-0.12	5.51
DEC 27	43869	-22.9	-47.16		-4.3	73.9	-0.26	5.99

TABLE 17 - (CONT.)

UNIT IS ONE MICROSECOND

DATE 1978		MJD	UTC - UTC(I)* USNO	VSL	ZIPE
JAN	1	43509	0.34	-47.57	0.77
JAN	11	43519	0.25	-48.26	0.68
JAN	21	43529	0.33	-48.83	0.75
JAN	31	43539	0.42	-49.61	1.02
FEB	10	43549	0.38	-50.53	1.23
FEB	20	43559	0.16	-51.05	1.23
MAR	2	43569	0.25	-51.77	1.30
MAR	12	43579	-0.11	-52.38	2.09
MAR	22	43589	-0.25	-53.14	2.52
APR	1	43599	-0.30	-53.79	2.81
APR	11	43609	-0.32	-54.48	3.08
APR	21	43619	-0.28	-55.10	3.19
MAY	1	43629	-0.36	-55.81	3.35
MAY	11	43639	-0.62	-56.24	3.86
MAY	21	43649	-0.68	-56.77	4.01
MAY	31	43659	-0.70	-56.81	4.11
JUN	10	43669	-0.79	-56.75	4.47
JUN	20	43679	-0.78	-56.91	4.36
JUN	30	43689	-0.85	-57.01	4.30
JUL	10	43699	-0.90	-57.20	4.26
JUL	20	43709	-0.94	-57.25	3.95
JUL	30	43719	-1.00	-57.29	4.12
AUG	9	43729	-1.09	-57.44	4.36
AUG	19	43739	-1.08	-57.15	4.45
AUG	29	43749	-1.09	-56.70	4.18
SEP	8	43759	-1.06	-56.51	3.79
SEP	18	43769	-1.13	-56.25	3.51
SEP	28	43779	-1.14	-56.12	3.10
OCT	8	43789	-1.16	-56.07	2.60
OCT	18	43799	-1.14	-55.70	2.34
OCT	28	43809	-1.25	-55.57	2.03
NOV	7	43819	-1.34	-55.32	1.72
NOV	17	43829	-1.45	-55.40	1.15
NOV	27	43839	-1.46	-55.37	0.62
DEC	7	43849	-1.47	-55.12	0.59
DEC	17	43859	-1.48	-55.04	0.48
DEC	27	43869	-1.53	-54.81	0.65

TABLE 17 - (CONT.)

NOTES

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

(1) APL. The following Table gives UTC-UTC(APL) from MJD = 43 309

Date (MJD)	UTC-UTC(APL)	Date (MJD)	UTC-UTC(APL)
43 309	- 219.33	43 409	- 232.56
43 319	- 220.54	43 419	- 233.97
43 329	- 221.90	43 429	- 235.33
43 339	- 223.32	43 439	- 236.75
43 349	- 224.60	43 449	- 238.08
43 359	- 225.87	43 459	- 239.53
43 369	- 227.18	43 469	- 240.85
43 379	- 228.46	43 479	- 242.31
43 389	- 229.78	43 489	- 243.88
43 399	- 231.16	43 499	- 245.48

(2) AUS. UTC(AUS) is the coordinated universal time of Australia kept by DNM.

(3) FOA. A time step of UTC(FOA) of - 100 μs made by FOA on 1978 Jan. 1. End July, the time activities responsability was transferred from FOA to STA.

(4) IGMA. A clock transportation between IGMA and USNO on 1978 Feb. 23 fixed the origin.

(5) NPRL. Results obtained by VLF. The origin was given by a clock transportation on 1974 April 9.

(6) PKNM. A time step of UTC(PKNM) of - 10 μs was made by PKNM on 1978 Jan. 1.

(7) PTCH. Starting from MJD = 43 859, the origin of UTC-UTC(PTCH) is fixed by a clock transportation to ON.

(8) SU. UTC-UTC(SU) was computed using the TV link between TP and SU except in January when the GBR signal was used. A time step of UTC(SU) of + 50 μs was made by SU on 1979 Jan. 1.

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 1978		MJD	TIME COMPARISONS	DIFFERENCE CLOCK TR. - BIH (UNIT : 1 MICROSECOND)
MAR	31	43598.5	UTC(USNO) - UTC(NRC)	-0.1
APR	12	43610.9	UTC(USNO) - UTC(NBS)	-0.1
APR	25	43623.5	UTC(USNO) - UTC(RGO)	0.4
MAY	4	43632.3	UTC(USNO) - UTC(OP)	0.7
MAY	7	43635.5	UTC(USNO) - UTC(OMSF)	-0.6
MAY	13	43641.3	UTC(USNO) - UTC(NPL)	0.2
MAY	29	43657.9	UTC(OP) - UTC(NRC)	-0.37
JUN	1	43660	UTC(NBS) - UTC(USNO)	0.07
JUN	14	43673	UTC(SU) - UTC(TP)	0.70
JUN	14	43673.6	UTC(VSL) - UTC(PTB)	-0.07
JUN	22	43681.0	UTC(TAO) - UTC(ILOM)	0.90
JUN	27	43686.2	UTC(TAO) - UTC(RRL)	0.40
JUL	11	43700	UTC(SU) - UTC(IEN)	-0.33
JUL	18	43707.7	UTC(USNO) - UTC(NRC)	-0.3
JUL	19	43708	UTC(NBS) - UTC(NRC)	0.8
AUG	4	43724	UTC(NBS) - UTC(OP)	0.3
SEP	7	43758	UTC(NBS) - UTC(NRC)	-1.1
SEP	7	43758.3	UTC(USNO) - UTC(NPL)	0.2
SEP	14	43765.4	UTC(USNO) - UTC(TUG)	0.2
SEP	18	43769.4	UTC(USNO) - UTC(DHI)	0.5
SEP	18	43769.5	UTC(USNO) - UTC(PTB)	0.0
SEP	26	43777.6	UTC(USNO) - UTC(NBS)	-0.5
SEP	27	43778.0	UTC(NBS) - UTC(USNO)	0.07
SEP	27	43778.3	UTC(PKNM) - UTC(TP)	-1.09
SEP	28	43779.0	UTC(USNO) - UTC(TAO)	1.9
SEP	28	43779.2	UTC(USNO) - UTC(RRL)	2.3
OCT	13	43794.0	UTC(TAO) - UTC(ILOM)	0.44
OCT	26	43807.3	UTC(TAO) - UTC(RRL)	0.39
OCT	26	43807.5	UTC(OP) - UTC(NRC)	-0.20
OCT	30	43811.1	UTC(USNO) - UTC(RRL)	3.0
OCT	31	43812.5	UTC(USNO) - UTC(NRC)	0.2
NOV	13	43825.8	UTC(IEN) - UTC(OP)	0.2
NOV	20	43832	UTC(IEN) - UTC(SU)	0.28
NOV	22	43834	UTC(SU) - UTC(ZIPE)	0.28
NOV	22	43834.3	UTC(IEN) - UTC(TP)	0.6
NOV	22	43834.4	UTC(ASMW) - UTC(ZIPE)	0.19
NOV	25	43837	UTC(SU) - UTC(ASMW)	-0.80

TABLE 19 - INTERNATIONAL ATOMIC TIME , BI-MONTHLY RATES OF TAI-CLOCK FOR 1978

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	43559	43619	43689	43749	43809	43869
APL	14 773	0.0	74.67	108.76	103.64	100.38	86.74
APL	14 793	0.0	144.01	143.32	147.46	0.0	0.0
APL	24 121	0.0	-161.37	-154.98	-156.05	-153.70	-148.57
ASMW	13 29	41.90	35.05	39.61	55.86	64.67	77.34
ASMW	16 76	-40.59	-48.02	-47.36	-37.39	-43.86	0.0
F	12 133	46.27	54.18	69.00	84.32	57.26	53.52
F	12 158	104.35	111.07	125.99	139.86	146.85	152.74
F	12 206	-130.58	-109.69	-100.51	-47.40	-33.68	1.41
F	12 231	-91.91	-71.55	0.0	0.0	-69.48	-65.03
F	12 347	-89.42	-88.10	-75.10	-23.45	-24.13	-43.50
F	12 439	0.0	27.44	44.46	39.79	39.68	96.74
F	12 594	-62.26	-58.90	-58.78	-49.91	-53.97	-44.94
F	14 134	14.92	13.88	15.59	16.41	-10.10	-3.81
F	14 753	108.85	111.44	123.61	105.63	97.50	88.05
F	14 873	-48.22	-44.32	-49.53	-48.37	-60.49	-60.48
F	16 60	-103.49	-93.72	0.0	0.0	-77.71	0.0
F	22 120	72.72	51.10	52.53	47.44	42.92	36.58
F	24 407	0.0	0.0	0.0	-111.66	-119.34	-91.91
FCA (1)	11 55	117.49	101.75	279.91			
FCA	11 200	649.36	-435.76	-458.49			
FCA	14 900	0.0	-133.17	-139.84			
IEN	12 303	-60.42	-52.44	-54.91	-67.48	-61.50	-59.07
IEN	12 469	-36.96	-8.52	-19.52	-22.66	-12.58	-23.80
IEN	12 609	-56.70	-33.27	-34.22	-81.86	-82.41	-99.97
IEN	14 893	-48.35	-43.59	-46.39	-52.26	-42.93	-43.45
IEN	16 84	-114.39	-129.37	0.0	0.0	0.0	0.0
IEN	22 230	0.0	0.0	0.0	-221.59	-201.35	0.0
NBS	11 167	0.0	0.0	0.0	-551.61	-546.36	-545.78
NBS	12 352	-25.10	-30.18	-46.45	-65.30	-61.35	-80.21
NBS	14 316	-63.12	-48.16	-62.40	-69.67	-68.99	-79.29
NBS	14 323	-122.22	-121.27	-136.33	-143.88	-125.72	-127.38
NBS	14 324	0.0	-87.86	-83.88	-70.93	-64.80	-69.64
NBS	14 601	-64.14	-54.53	-68.64	-74.11	-72.62	-77.52
NBS	16 61	-121.20	-123.20	-160.16	-176.58	-148.07	-125.87
NBS	91 4	-4.17	13.73	10.56	6.33	0.0	0.0
NPL	11 134	-100.35	0.0	0.0	0.0	0.0	0.0
NPL	12 316	-204.90	-182.84	-174.72	-156.54	-158.84	-165.49
NPL	12 418	-89.45	-91.77	-86.31	-95.93	-106.83	-104.55
NPL	12 832	-138.36	0.0	133.00	129.25	20.67	-24.44
NPL	14 334	-112.43	0.0	0.0	0.0	0.0	0.0
NRC	12 122	-313.85	-334.59	-484.98	-599.03	-550.10	-536.82
NRC	12 267	-62.42	0.0	0.0	0.0	0.0	0.0
NRC	14 911	-90.25	-91.97	-94.74	-93.32	-94.66	0.0
NRC	90 5	-1.02	-3.97	-9.64	-12.81	-17.76	-7.36
OMH	22 67	10.32	21.22	50.08	22.44	5.73	15.69

TABLE 19 - (CONT.)

LAB.	CLOCK	43559	43619	43689	43749	43809	43869
OMSF	13 17	-195.41	-199.05	0.0	0.0	0.0	0.0
OMSF	14 896	62.67	0.0	0.0	0.0	0.0	0.0
OMSF	16 121	0.0	2.50	-33.68	-26.24	-14.64	0.80
OMSF	22 223	119.53	153.09	167.20	172.19	168.71	185.58
ON	12 285	-70.78	-74.13	-75.32	-79.82	-70.04	-63.52
ON	13 14	-25.10	-54.57	-27.86	-39.61	-28.52	16.13
ON	14 863	-162.74	-158.92	-146.83	-144.35	-143.65	-144.23
ON	16 69	-41.41	-32.32	-35.20	-60.11	-67.50	-54.59
ON	16 77	-84.62	-91.25	-100.55	-141.18	-134.65	-106.37
ON	16 114	0.0	23.40	7.11	-3.68	3.92	11.12
ON	24 156	-28.05	-19.13	-11.63	-0.64	-8.61	-16.58
ON	99 1	53.19	51.44	0.0	0.0	0.0	0.0
ON	99 4	72.47	66.43	68.56	68.82	57.49	49.70
ON	99 7	-67.48	-59.11	-51.51	-68.32	-45.01	-26.38
ORB	12 804	0.0	8.86	5.92	-0.74	52.90	27.33
ORB	14 205	-102.09	-87.69	-81.02	0.0	0.0	0.0
PKNM	16 124	1.30	-45.72	-59.79	-60.15	-9.91	26.98
PKNM	24 144	22.65	0.55	-11.57	-1.81	2.28	-3.04
PTB	12 320	140.98	146.35	145.46	0.0	0.0	0.0
PTB	12 389	18.73	27.31	15.64	11.08	6.85	23.86
PTB	12 394	-322.42	-318.72	-327.13	-324.01	-330.80	-326.75
PTB	12 395	-111.28	-101.86	-110.64	-146.17	0.0	0.0
PTB	12 462	0.0	0.0	24.51	27.12	17.79	18.45
PTB	14 867	-181.62	-176.73	0.0	0.0	0.0	0.0
PTB	16 67	-65.75	0.0	0.0	0.0	0.0	68.72
PTB	24 103	-74.03	-73.65	-80.21	-69.99	-65.98	-54.84
PTB	92 1	0.0	0.0	0.0	0.0	-14.72	-6.56
PTCH	16 64	81.36	79.47	53.18	39.47	44.96	478.55
RGO	11 123	-195.02	-193.19	-201.13	-196.77	-192.99	-190.03
RGO	11 199	-34.07	-21.68	-39.83	-42.11	-65.40	-58.48
RGO	12 348	-204.82	-227.03	-222.10	0.0	0.0	0.0
RGO	12 484	0.0	0.0	0.0	0.0	-303.15	-311.16
RGO	14 202	-207.52	-206.67	-211.15	-219.31	0.0	-172.27
RGO	14 868	-145.74	-130.48	-120.57	-110.52	0.0	0.0
STA (1)	16 137	0.0	0.0	-107.53	-112.37	-87.36	-72.18
STA	14 900				0.0	-131.84	-136.56
STA	24 376	0.0	-221.38	-233.42	-233.32	-231.68	-221.44
TP	12 335	-164.95	-149.75	-138.68	-139.40	-152.27	-146.18
TUG	12 524	-7.13	5.00	13.19	13.03	7.16	28.65
USNO	11 207	-122.80	0.0	0.0	3.92	5.34	-14.38
USNO	12 147	0.0	0.0	-64.64	-73.59	-72.73	-82.08
USNO	12 345	5.60	10.81	13.55	2.41	5.23	11.45
USNO	12 346	206.81	190.71	175.87	169.64	155.36	142.31
USNO	12 532	-45.20	-53.39	-47.13	-53.04	-52.04	-48.89
USNO	12 549	-125.78	-141.37	-158.09	-162.59	-156.81	-156.77
USNO	12 573	0.0	0.0	0.0	-8.12	-25.07	0.0
USNO	12 591	0.0	230.24	194.74	194.90	177.99	172.61
USNO	12 592	153.08	142.90	150.86	142.05	157.53	0.0
USNO	12 651	-6.25	-11.04	0.0	0.0	0.0	0.0
USNO	12 761	0.0	0.0	0.0	0.0	0.0	57.32

TABLE 19 - (CONT.)

LAB.	CLOCK	43559	43619	43689	43749	43809	43869
USNO	14 571	47.33	40.58	37.22	36.86	36.59	38.37
USNO	14 656	0.0	0.0	-39.36	-32.94	-32.30	-37.90
USNO	14 752	-111.36	-109.97	-120.19	0.0	0.0	0.0
USNO	14 778	2.87	-4.65	3.54	-6.78	-6.52	0.0
USNO	14 787	-109.91	-112.75	-105.00	-90.74	0.0	0.0
USNO	14 834	-78.08	-89.88	-75.80	-76.00	-77.10	-84.37
USNO	14 871	-50.04	-89.05	-47.35	-36.36	-29.97	-37.96
USNO	14 875	-105.66	-114.30	-111.84	-107.63	-106.33	-103.02
USNO	16 68	-25.12	-51.47	-102.04	-125.75	-105.88	-89.15
USNO	16 78	0.0	0.0	0.0	-173.31	-147.94	0.0
USNO	22 114	7.30	-7.58	-12.15	11.40	16.58	23.47
USNO	22 363	0.0	0.0	0.0	-1.04	-1.44	-6.49
USNO	22 450	0.0	0.0	0.0	0.0	0.0	-68.93
USNO	24 25	0.0	0.0	0.0	0.0	0.0	-6.34
USNO	24 28	0.0	0.0	0.0	0.0	-231.28	-239.06
USNO	24 35	0.0	0.0	0.0	0.0	217.18	0.0
USNO	24 94	-224.38	-220.38	-210.71	-211.04	-196.11	-182.07
USNO	24 104	-40.49	-53.77	-59.69	-60.68	-65.51	-69.21
USNO	24 118	-138.69	-194.86	-197.77	-180.44	-174.78	-174.36
USNO	24 264	109.05	92.00	81.50	94.92	94.70	100.11
USNO	24 301	0.0	0.0	0.0	0.0	3.69	0.0
USNO	24 305	-40.62	-51.14	-64.10	-39.49	-31.49	-30.45
USNO	24 343	-24.93	-36.94	-34.02	-9.96	-3.88	3.89
USNO	24 377	0.0	0.0	-7.68	15.88	0.0	0.0
USNO	24 449	0.0	0.0	0.0	0.0	0.0	23.91
USNO	40 10	0.0	0.0	0.0	-2.23	35.94	158.98
VSL	14 503	-296.94	-216.31	-213.82	-174.41	-186.58	-160.71
VSL	22 34	-71.17	-67.79	-24.44	3.00	18.57	11.22
VSL	24 190	0.0	-49.03	-40.48	-37.42	-42.19	0.0
ZIPE	12 979	-145.20	-128.58	-114.97	-105.25	-116.61	-120.59

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.)
40	HYDROGEN MASER	
90	LABORATORY CESIUM STANDARD NRC CS V	
91	LABORATORY CESIUM STANDARD NBS 4	
92	LABORATORY CESIUM STANDARD PTB CS 1	
99	PROTYPE CS	

NOTE - (1) In 1978 July, the responsibility for the time activities was transferred from FOA to STA.

TABLE 20 - INTERNATIONAL ATOMIC TIME , WEIGHTS OF THE CLOCKS FOR 1978

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

*** DENOTES THAT THE CLOCK WAS NOT USED

LAB.	CLOCK	43559	43619	43689	43749	43809	43869
APL	14 773	***	0	11	21	35	44
APL	14 793	***	0	100	100	***	***
APL	24 121	***	0	100	100	100	100
ASMW	13 29	44	72	91	86	50	40
ASMW	16 76	35	33	29	41	100	***
F	12 133	16	14	12	17	37	53
F	12 158	100	100	56	32	25	27
F	12 206	82	42	24	9	6	4
F	12 231	100	78	***	***	0	100
F	12 347	0	100	92	8	8	11
F	12 439	***	0	42	94	100	11
F	12 594	100	100	100	100	100	100
F	14 134	51	100	100	100	66	67
F	14 753	95	74	81	82	100	60
F	14 873	100	100	100	100	94	100
F	16 80	100	99	***	***	0	***
F	22 120	26	15	14	20	52	60
F	24 407	***	***	***	0	100	44
FCA (1)	11 55	4	3	0			
FCA	11 200	0	0	0			
FCA	14 900	***	0	100			
IEN	12 303	79	81	69	71	9	100
IEN	12 469	100	23	35	51	58	91
IEN	12 609	25	11	12	12	14	12
IEN	14 893	100	100	100	100	99	100
IEN	16 64	0	56	***	***	***	***
IEN	22 230	***	***	***	0	30	***
NBS	11 167	***	***	***	0	100	100
NBS	12 352	64	86	49	22	28	20
NBS	14 316	53	74	91	95	100	62
NBS	14 323	100	100	89	60	82	100
NBS	14 324	***	0	100	93	68	97
NBS	14 601	100	99	91	100	100	100
NBS	16 61	0	100	15	11	15	20
NBS	91 4	32	20	26	38	***	***
NPL	11 134	41	***	***	***	***	***
NPL	12 316	46	44	71	35	32	31
NPL	12 418	95	100	100	99	97	100
NPL	12 832	13	***	0	100	0	1
NPL	14 334	97	***	***	***	***	***
NRC	12 122	58	55	0	0	1	1
NRC	12 207	7	***	***	***	***	***
NRC	14 911	100	100	100	100	100	***
NRC	90 5	100	100	100	100	100	100
ONH	22 67	11	16	19	53	41	40

TABLE 20 - (CONT.)

LAB.	CLOCK	43559	43619	43689	43749	43809	43869
OMSF	13 17	60	100	***	***	***	***
OMSF	14 896	19	***	***	***	***	***
OMSF	16 121	***	0	10	20	33	37
OMSF	22 223	25	35	39	28	26	20
ON	12 285	100	100	100	100	98	100
ON	13 14	18	18	18	21	44	19
ON	14 863	100	100	93	100	100	100
ON	16 69	100	100	44	38	28	47
ON	16 77	100	100	100	25	17	19
ON	16 114	***	0	50	38	62	92
ON	24 156	100	100	100	97	95	98
ON	99 1	12	9	***	***	***	***
ON	99 4	100	100	100	100	96	98
ON	99 7	100	100	25	29	37	44
ORB	12 804	***	0	100	100	12	19
ORB	14 205	20	23	31	***	***	***
PKNM	16 124	0	4	7	10	10	8
PKNM	24 144	4	9	15	22	30	73
PTB	12 320	100	100	100	***	***	***
PTB	12 389	100	100	96	100	100	89
PTB	12 394	100	100	100	100	100	100
PTB	12 395	0	5	4	6	***	***
PTB	12 462	***	***	0	100	100	100
PTB	14 867	100	100	***	***	***	***
PTB	16 67	9	***	***	***	***	0
PTB	24 103	100	100	100	98	100	99
PTB	92 1 (2)	***	***	***	***	100	100
PTCH	16 64	7	7	9	29	24	0
RGO	11 123	21	22	22	39	80	100
RGO	11 199	0	82	83	96	36	36
RGO	12 348	7	10	56	***	***	***
RGO	12 484	***	***	***	***	0	97
RGO	14 202	75	100	100	100	***	0
RGO	14 868	82	88	98	48	***	***
STA (1)	16 137	***	***	0	100	40	26
STA	14 900				***	0	100
STA	24 376	***	0	92	100	100	100
TP	12 335	40	49	63	100	93	100
TUG	12 524	100	94	100	100	100	80
USNO	11 207	0	***	***	0	100	43
USNO	12 147	***	***	0	100	100	95
USNO	12 345	0	100	100	96	100	100
USNO	12 346	100	76	35	29	22	17
USNO	12 532	100	100	100	100	100	100
USNO	12 549	100	87	78	43	40	47
USNO	12 573	***	***	***	0	45	***
USNO	12 591	***	0	10	17	17	17
USNO	12 592	86	50	79	92	87	***
USNO	12 651	100	97	***	***	***	***
USNO	12 761	***	***	***	***	***	0

TABLE 20 - (CONT.)

LAB.	CLOCK	43559	43619	43689	43749	43809	43869
USNO	14 571	96	100	100	100	100	100
USNO	14 656	***	***	0	100	100	100
USNO	14 752	100	100	98	***	***	***
USNO	14 778	100	100	100	97	100	***
USNO	14 787	43	59	81	71	***	***
USNO	14 834	86	56	55	64	100	99
USNO	14 871	100	37	36	30	23	22
USNO	14 875	100	100	100	100	100	100
USNO	16 68	62	41	7	5	6	7
USNO	16 78	***	***	***	0	19	***
USNO	22 114	100	89	100	72	79	56
USNO	22 363	***	***	***	0	100	100
USNO	22 450	***	***	***	***	***	0
USNO	24 25	***	***	***	***	***	0
USNO	24 28	***	***	***	***	0	98
USNO	24 35	***	***	***	***	0	***
USNO	24 94	32	33	36	66	54	44
USNO	24 104	5	5	82	100	100	86
USNO	24 118	13	27	91	84	100	100
USNO	24 264	100	85	52	74	100	100
USNO	24 301	***	***	***	***	0	***
USNO	24 305	40	35	27	44	74	65
USNO	24 343	73	94	100	71	51	38
USNO	24 377	***	***	0	23	***	***
USNO	24 449	***	***	***	***	***	0
USNO	40 10	***	***	***	0	0	0
VSL	14 503	10	0	8	6	5	4
VSL	22 34	100	100	26	9	6	6
VSL	24 190	***	0	100	100	100	***
ZIPE	12 979	31	38	25	19	26	53

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.)
40 HYDROGEN MASER
90 LABORATORY CESIUM STANDARD NRC CS V
91 LABORATORY CESIUM STANDARD NBS 4
92 LABORATORY CESIUM STANDARD PTB CS 1
99 PROTYPE CS

NOTES - (1) In 1978 July, the responsibility for the time activities was transferred from FOA to STA.

(2) The weight of 92001 was estimated for the interval 43749-43809 using the TAI calibration results from PTB-CS1.

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 - 41759	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	42867 - 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
PTB	PTB CS1	43570 - 43586	-0.05	0.90	
PTB	PTB CS1	43650 - 43680	-0.39	0.90	
PTB	PTB CS1	43720 - 43755	-0.32	0.90	
PTB	PTB CS1	43769 - 43827	-0.42	0.80	
PTB	PTB CS1	43828 - 43862	0.06	0.70	
NRC	NRC CSV	43769 - 43849	(1)		0.50
NBS	NBS 6	43798 - 43811	-1.20 (4)	0.45	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 EAL-STD. IN 10**-13	NORMALIZED FREQ. DIF. OF TAI-STD. IN 10**-13	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. IN 10**-13	TAI-STD.	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	7.31	-2.09	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	43479 - 43599	9.00	-0.20	0.64	0.90	30
PTB	PTB CS1	43538 - 43618	8.97	-0.23	1.06	0.10 (2)	31
PTB	PTB CS1	43626 - 43706	8.09	-1.11	1.00	0.10	31
PTB	PTB CS1	43699 - 43779	8.01	-1.19	1.00	0.10	31
PTB	PTB CS1	43758 - 43838	7.53	-1.60	0.90	0.10	31
PTB	PTB CS1	43805 - 43885	8.38	-0.63	0.90	0.10	31
NRC	NRC CSV	43769 - 43849	7.93	-1.17	1.00	0.50	32
NBS	NBS 6	43769 - 43849	8.48	-0.62	0.74	0.90	33

NOTES - (1) The same correlation index is attributed to the calibrations which are inter-correlated. 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 calibrations indexed 19 and 31.

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
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 - 10.0*10**-13	0.6*10**-13
1975 MAR - APR	- 10.0	0.6
1975 MAY - JUN	- 9.9	0.6
1975 JUL - AUG	- 10.0	0.5
1975 SEP - OCT	- 10.0	0.5
1975 NOV - DEC	- 9.9	0.5
1976 JAN - FEB	1 - 9.9*10**-13	0.6*10**-13
1976 MAR - APR	- 9.9	0.5
1976 MAY - JUN	- 9.9	0.5
1976 JUL - AUG	- 9.6	0.5
1976 SEP - OCT	- 9.6	0.5
1976 NOV - DEC	- 9.4	0.5
1977 JAN - FEB	1 + 0.8*10**-13	0.5*10**-13
1977 MAR - APR	+ 1.0	0.5
1977 MAY - JUN	+ 0.9	0.5
1977 JUL - AUG	+ 0.8	0.5
1977 SEP - OCT	+ 0.7	0.5
1977 NOV - DEC	+ 0.6	0.5
1978 JAN - FEB	1 + 0.5*10**-13	0.5*10**-13
1978 MAR - APR	+ 0.5	0.5
1978 MAY - JUN	+ 0.7	0.5
1978 JUL - AUG	+ 0.8	0.5
1978 SEP - OCT	+ 0.9	0.5
1978 NOV - DEC	+ 0.6	0.5

NOTE - The values for 1970 and 1971 are unchanged. They were published in the Rapport Annuel pour 1977.

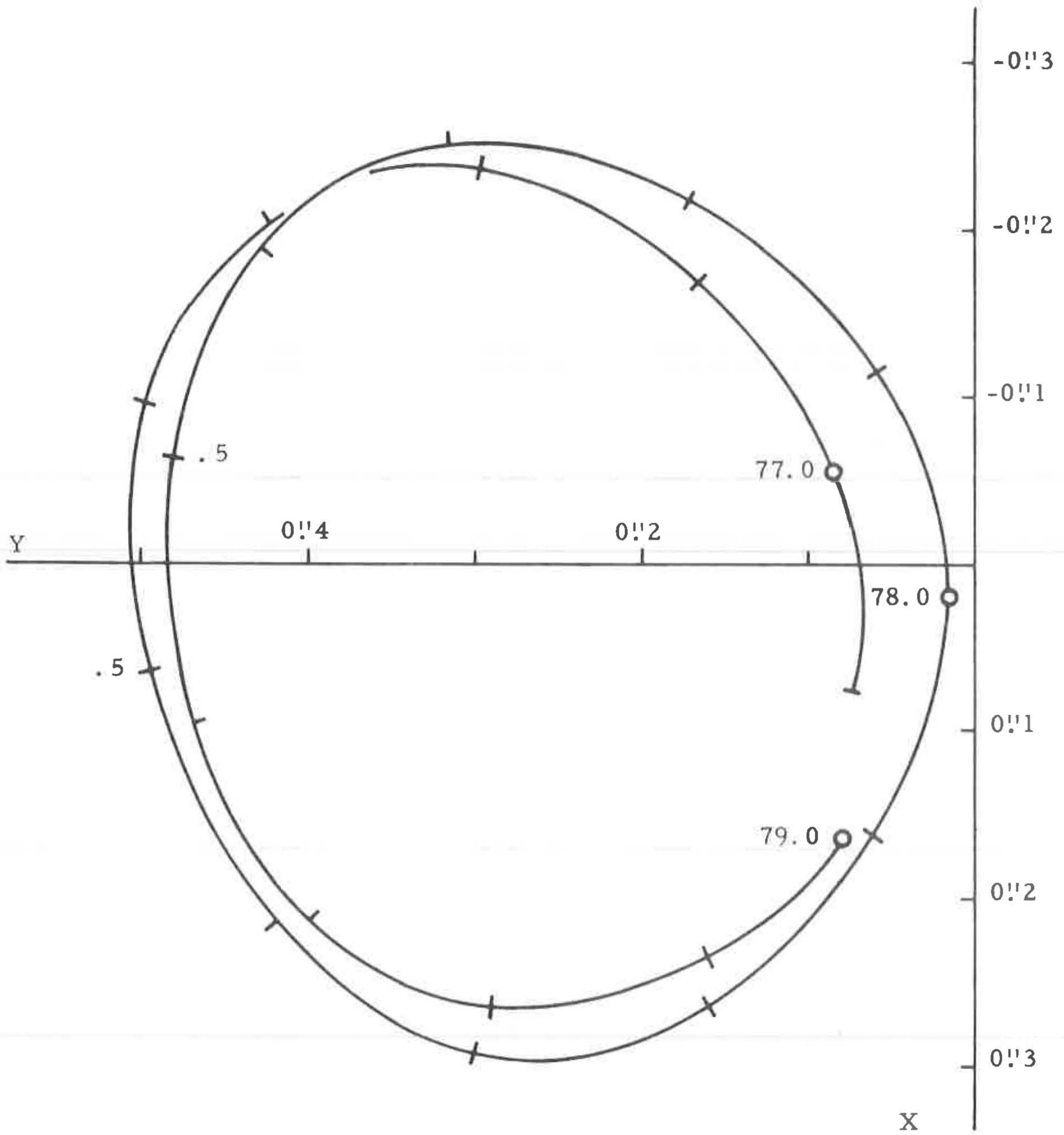

Fig. 1 - Path of the pole from 1977.0 to 1979.0

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.

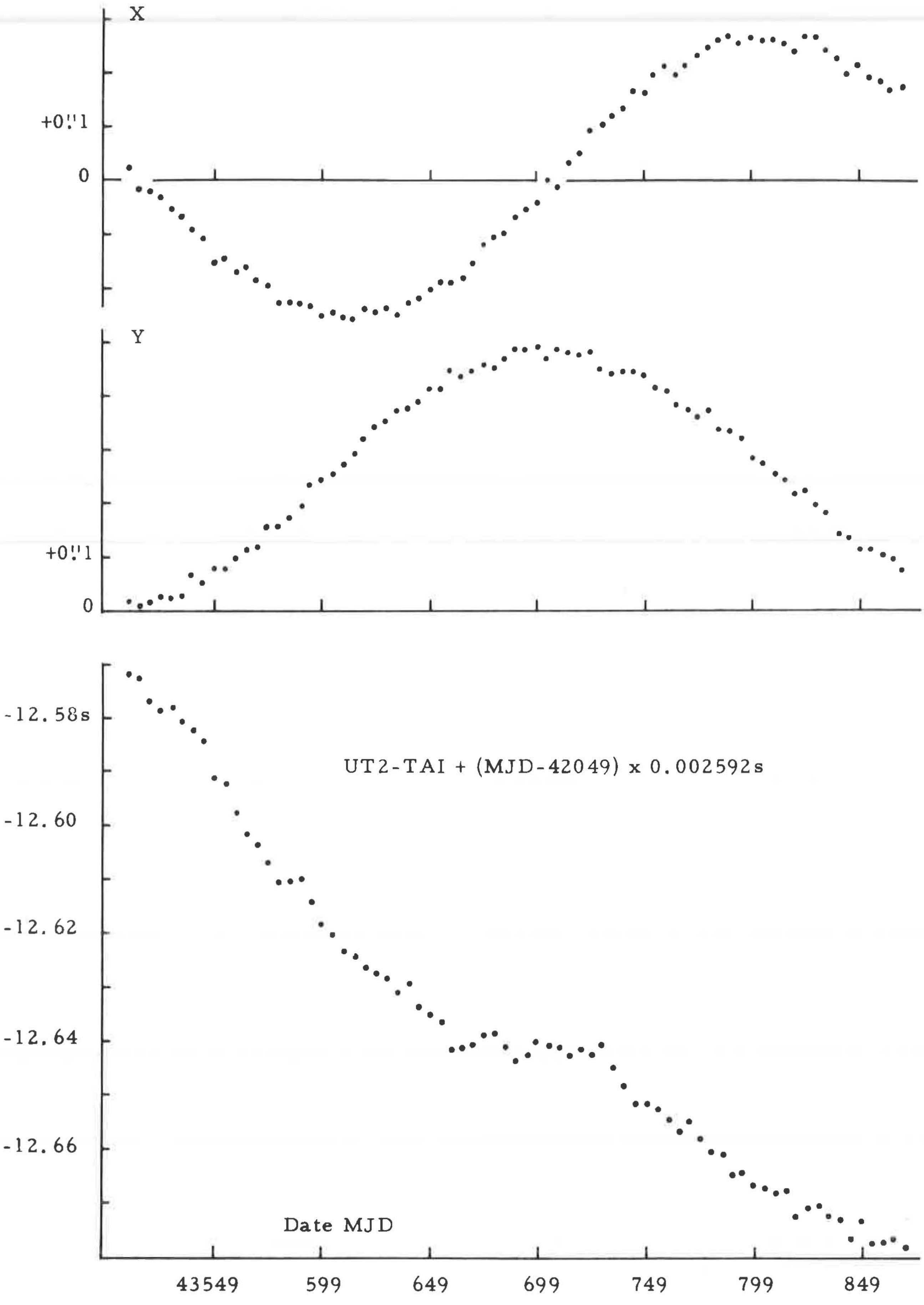

Fig. 2 - Raw data of x, y, UT2-TAI (table 6C for 1978), 5-day means

PART C

TIME SIGNALS (1979)

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 1979.

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;

* *The revision 460-2 of this document was adopted by the CCIR in 1978, but has not yet been published (February 1979). It differs only in making less stringent the rules for the dissemination of DUT1.*

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.

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

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

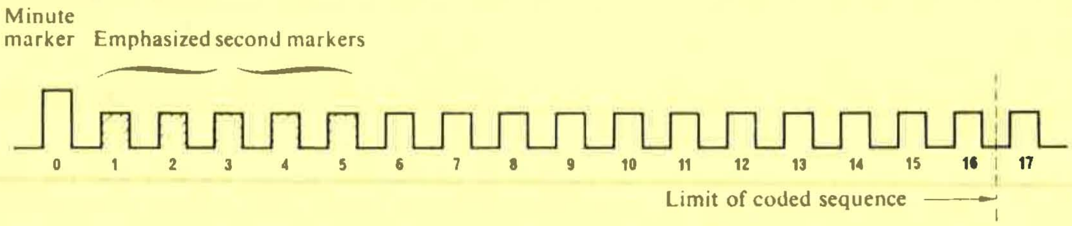

FIGURE 1

DUT1 = +0.5 s

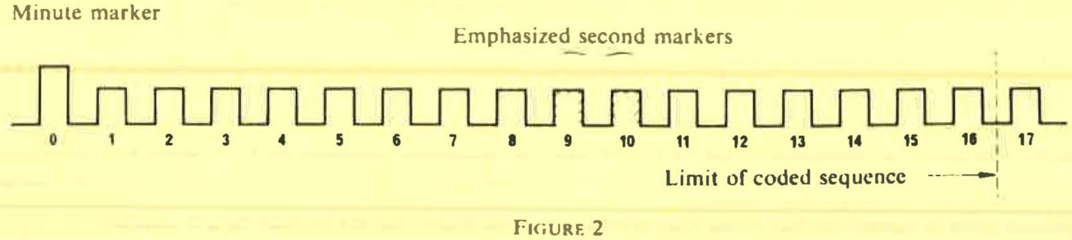

FIGURE 2

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:

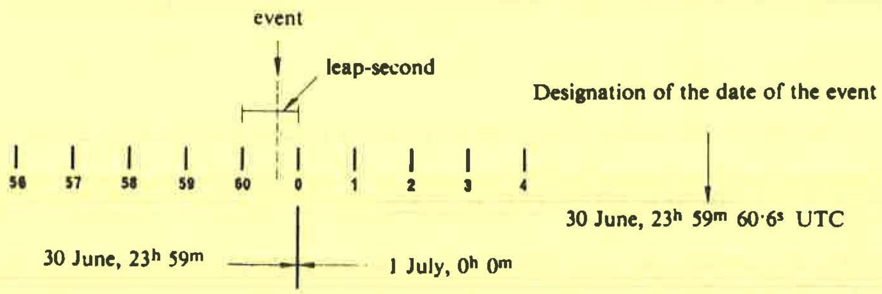

FIGURE 3

Positive leap-second

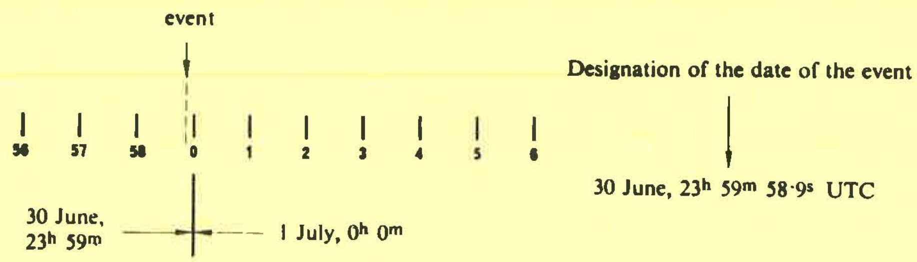

FIGURE 4

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 = + 0.8s

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

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

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	Time and Frequency Division Shanghai Observatory Academia Sinica Zi-Ka-Wei,Shanghai, China
BSF	Telecommunication Laboratories Standard Frequencv 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 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 D33 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 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. España 2099 1107 – 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 Observatório Nacional (CNPq) Rua General Bruce, 586 20921 Rio de Janeiro – RJ, Brasil
RBU, RCH RID, 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 Box 249 Clayton, Victoria 3168, 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	3 h 30 m to 14 h 30 m on Monday to Saturday 4 h 30 m to 8 h 30 m 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	Shanghaī China 31° 12' N 121° 26' E	5 000 10 000 15 000	16 h to 1 h continuous 1 h to 16 h	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 15 000	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	11 h 55 m to 12 h 06 m 23 h 55 m to 24 h 06 m from 21 Oct. to 20 April 23 h 55 m to 24 h 06 m 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	11 h 55 m to 12 h 06 m 23 h 55 m to 24 h 06 m	As DAM (see above)
DAO	Kiel Germany F. R. 54° 26' N 10° 8' E	2 775	11 h 55 m to 12 h 06 m 23 h 55 m to 24 h 06 m	Aş 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 lengthning second marks from marks N° 20 to N° 58 every minute. When the reserve antenna is used, second marker 15 is prolonged. No transmission of DUT1.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UT)	Form of the time signals
DGI	Oranienburg Germ. Dem. Rep 52° 48' N 13° 24' E	182	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 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)	Second pulses of 0.1 s duration of 1 kHz modulation. Minute pulses of 0.5 s duration of 1 250 Hz modulation DUT1, CCIR code, double pulse. (A_2) amplitude modulation. (A_3J) single sideband, cancelled carrier.
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	Rome Italy 41° 47' N 12° 27' E	5 000	7h 30m to 8h 30m 10h 30m to 11h 30m except Sat. afternoon, Sun., and national holidays. Advanced by 1h in summer.	Second pulses of 5 cycles of 1 kHz modulation. Minute pulses of 20 cycles (Announcements 5 m 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	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 3 m 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	1 h, 13 h, 21 h,	A1 second pulses during the 5 minutes preceding the indicated times. Second 29 is omitted. 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 8h 5m from 9h 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.
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.
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 0.025s 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.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UT)	Form of the time signals
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 20 000	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	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.

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

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) OMA, 50 kHz

a. The emission continued during 1978 from the main transmitter in Liblice with the exception of the interval from August 22 till December 21, during which it originated from the auxilliary transmitter in Poděbrady. The power radiated from the main transmitter in Liblice is approximately 5 kW.

b. The transmission of the time code continued during 1978 according to the format accepted since 1977. The details of this format were revealed at the 19th General Assembly of URSI in Helsinki and are to be published in the August Special Issue of Radio Science.

In the second half of 1979 the present format will be complemented to include day of week, calendar day and month.

(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.

UNCERTAINTY OF THE CARRIER FREQUENCY

The carriers of the following time signals are standard frequencies.

Station	Relative uncertainty of the carrier frequency in 10^{-10}
ATA	0.1
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	0.1
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	1
VNG	1
WWV	0.1
WWVB	0.1
WWVH	0.1
ZUO	0.1

TIME OF EMISSION OF THE TIME SIGNALS IN 1978.

Unless otherwise stated, the value of UTC-signal are valid for the whole yeaı 1978.

Signal	UTC–Signal (unit : 0.0001 s)	Remarks
BPV (10 MHz, 15 MHz)	-215	
BSF	0	
CHU	0	
DAM, DAN, DAO	0	1978 May 31, 0h UT, UTC - Signal = - 2000
DCF77	0	
DGI	0	
DIZ	0	
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 11h UT.

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

UTC – BPV(9351 kHz)
(Unit : 0.0001 s)

1978

Date	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1		-5442	-4552					-250	+ 387		+ 2153	+3104
2	-6525	-5409	-4522		-2383			-220			+ 2186	
3	-6491	-5381	-4488		-2359			-217			+ 2210	
4	-6458			-3329			- 696	-179	+ 451	+1276		+3200
5	-6431			-3302			- 663		+ 480	+1302		+3229
6	-6397	-5282	-4381	-3264			- 668		+ 508	+1330	+ 2310	+3263
7		-5251	-4342	-3226		-1369	- 632	-128	+ 540		+ 2328	+3293
8		-5218	-4312		-2186			-113	+ 544		+ 2369	
9	-6302	-5185	-4274		-2147	-1307		- 96		+1414		
10	-6273	-5155	-4246	-3123	-2134		- 563	- 80		+1441	+2428	
11	-6181			-3093			- 541	- 69	+ 611	+1468		+3413
12	-6150			-3066			- 534		+ 644	+1489		+3443
13	-6119	- 5051	-4144	-3032		-1191	- 525		+ 677	+1517	+ 2564	+3474
14		-5024	-4107	-2994		-1159	- 493	+ 24	+ 701		+ 2592	+3503
15		-4992	-4068			-1134		+ 35	+ 726		+ 2616	+3536
16	-6025	-4954	-4038		-1912			+ 51		+1607	+ 2645	
17	-5994	-4922	-4000	-2892	-1894		- 430	+ 61		+1640	+ 2671	
18	-5964			-2858	-1879		- 413	+ 94	+ 799	+1670		+3628
19	-5931			-2818			- 386		+ 826	+1701		+3658
20	-5900	-4828	-3889	-2785		-1010	- 360		+ 851	+1730	+2767	+3685
21		-4797	-3825	-2756		- 984	- 369	+143	+ 932		+2787	+3715
22		-4769	-3798		-1792			+169	+ 961			+3744
23	-5803	-4740	-3760		-1752	- 941		+186		+1876	+2867	
24	-5772	-4714		-2655			- 306	+207		+1914	+2895	
25	-5739				-1668		- 287	+226	+1015	+1936		
26	-5702			-2583	-1635		- 255		+1072	+1971		
27	-5668	-4612		-2546		- 839	- 243		+1096	+1998	+2982	+3928
28		-4590		-2514		- 814		+296			+3012	+3958
29			-3540		-1524	- 792			+1175		+3042	
30	-5565							+340			+3073	
31	-5535		-3470				- 155	+368		+2129		