OBSERVATOIRE DE PARIS

BUREAU INTERNATIONAL DES POIDS ET MESURES

BUREAU INTERNATIONAL DE L'HEURE

Member of the Federation of Astronomical and Geophysical data analysis Services (FAGS)

ANNUAL REPORT FOR 1987

EXTRACT: PAGES B-21 TO C-11

Published for International Council of Scientific Unions
with the financial assistance of the UNESCO

JUNE 1988

Table 9 - Offsets and step adjustments of UTC , until 1988 June 30

Date(at 0h UTC)	Offsets	Steps
1961 Jan. 1	-150×10^{-10}	
Aug. 1	"	+ 0.050s
1962 Jan. 1	-130×10^{-10}	
1963 Nov. 1	"	- 0.100s
1964 Jan. 1	-150×10^{-10}	
April 1	"	- 0.100s
Sept. 1	"	- 0.100s
1965 Jan. 1	"	- 0.100s
March 1	"	- 0.100s
July 1	"	- 0.100s
Sept. 1	"	- 0.100s
1966 Jan. 1	-300×10^{-10}	
1968 Feb. 1	"	+ 0.100s
1972 Jan. 1	0	- 0.107 7580s
July 1	"	- 1s
1973 Jan. 1	"	- 1s
1974 Jan. 1	"	- 1s
1975 Jan. 1	"	- 1s
1976 Jan. 1	"	- 1s
1977 Jan. 1	"	- 1s
1978 Jan. 1	"	- 1s
1979 Jan. 1	"	- 1s
1980 Jan. 1	"	- 1s
1981 July 1	"	- 1s
1982 July 1	"	- 1s
1983 July 1	"	- 1s
1985 July 1	"	- 1s
1988 Jan. 1	"	- 1s

Table 10 - Relationship between TAI and UTC, until 1988 June 30

Limits of validity(at 0h UTC)	TAI - UTC
1961 Jan. 1 - 1961 Aug. 1	1.422 818 0s + (MJD - 37 300) x 0.001 296s
Aug. 1 - 1962 Jan. 1	1.372 818 0s + " "
1962 Jan. 1 - 1963 Nov. 1	1.845 858 0s + (MJD - 37 665) x 0.001 123 2s
1963 Nov. 1 - 1964 Jan. 1	1.945 858 0s + " "
1964 Jan. 1 - April 1	3.240 130 0s + (MJD - 38 761) x 0.001 296s
April 1 - Sept. 1	3.340 130 0s + " "
Sept. 1 - 1965 Jan. 1	3.440 130 0s + " "
1965 Jan. 1 - March 1	3.540 130 0s + " "
March 1 - July 1	3.640 130 0s + " "
July 1 - Sept. 1	3.740 130 0s + " "
Sept. 1 - 1966 Jan. 1	3.840 130 0s + " "
1966 Jan. 1 - 1968 Feb. 1	4.313 170 0s + (MJD - 39 126) x 0.002 592s
1968 Feb. 1 - 1972 Jan. 1	4.213 170 0s + " "
1972 Jan. 1 - July 1	10s (integral number of seconds)
July 1 - 1973 Jan. 1	11s
1973 Jan. 1 - 1974 Jan. 1	12s
1974 Jan. 1 - 1975 Jan. 1	13s
1975 Jan. 1 - 1976 Jan. 1	14s
1976 Jan. 1 - 1977 Jan. 1	15s
1977 Jan. 1 - 1978 Jan. 1	16s
1978 Jan. 1 - 1979 Jan. 1	17s
1979 Jan. 1 - 1980 Jan. 1	18s
1980 Jan. 1 - 1981 July 1	19s
1981 July 1 - 1982 July 1	20s
1982 July 1 - 1983 July 1	21s
1983 July 1 - 1985 July 1	22s
1985 July 1 - 1988 Jan. 1	23s
1988 Jan. 1 -	24s

TABLE 11 - Atomic time, collaborating laboratories

AOS	Astronomical Latitude Observatory, Borowiec, Polska
APL	Applied Physics Laboratory, Laurel, USA
ASMW	Amt für Standardisierung, Messwesen und Warenprüfung, Berlin, Deutsche Demokratische Republik
ATC	Australian Telecommunications Commission, Melbourne, Australia
AUS	Consortium of laboratories in Australia
BEV	Bundesamt für Eich - und Vermessungswesen, Wien, Oesterreich
BAO	Beijing Observatory, Beijing, China
CAO	Astronomical Observatory of Cagliari University, Cagliari, Italy
CH	Consortium of laboratories in Switzerland (see Table 12)
CSAO	Shaanxi Astronomical Observatory, Lintong, China
DDR	Consortium of laboratories in Deutsche Demokratische Republik
DNM	Division of National Mapping, Canberra, Australia
F	Commission Nationale de l'Heure, Paris, France (see Table 12)
FTZ	Fernmeldetechnisches Zentralamt, Darmstadt, Bundesrepublik Deutschland
IEN	Istituto Elettrotecnico Nazionale Galileo Ferraris, Torino, Italia
IFAG	Institut für Angewandte Geodäsie, Frankfurt am Main, Bundesrepublik Deutschland
IGMA	Instituto Geografico Militar, Buenos-Aires, Argentina
ILOM	International Latitude Observatory, Mizusawa, Japan
INPL	National Physical Laboratory, Jerusalem, Israel
INTI	Instituto Nacional de Tecnologia Industrial, Buenos-Aires, Argentina
JATC	Joint Atomic Time Commission, Lintong, Shaanxi, P. R. China
KSRI	Korea Standards Research Institute, Taejon, Ch'ungnam, Rep. of Korea
NBS	National Bureau of Standards, Boulder, USA
NIM	National Institute of Metrology, Beijing, China
NML	National Measurement Laboratory, CSIRO, Sydney, Australia
NPL	National Physical Laboratory, Teddington, U.K.
NPLI	National Physical Laboratory, New-Delhi, India
NPRL	National Physical Research Laboratory, Pretoria, South Africa
NRC	National Research Council of Canada, Ottawa, Canada
NRLM	National Research Laboratory of Metrology, Ibaraki, Japan
OMH	Orszagos Mérésügyi Hivatal, Budapest, Hungary
OMSF	Real Instituto y Observatorio de la Armada, San Fernando, España
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 Miar I Jakości, Warszawa, Polska
PTB	Physikalisch-Technische Bundesanstalt, Braunschweig, Bundesrepublik Deutschland

TABLE 11 - Atomic time, collaborating laboratories (cont.)

RGO	Royal Greenwich Observatory, Herstmonceux, U.K.
RRL	Radio Research Laboratory, Tokyo, Japan
SO	Shanghai Observatory, Shanghai, China
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
TID	Tidbinbilla Deep Space Communications Center, Australia
TL	Telecommunication Laboratories, Taiwan, China
TP(1)	Ústav Radiotechniky a Elektroniky ČSAV, Praha, Československo Astronomicky ústav ČSAV, Praha, Československo
TUG	Technische Universität Graz, Oesterreich
USNO	U.S. Naval Observatory, Washington D.C., USA
VSL	Van Swinden Laboratorium, Delft, Nederland
YUZM	Bureau Fédéral des Mesures et Métaux Précieux, Belgrade, République Socialiste Fédérative de Yougoslavie
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

Laboratories (i)	Equipment in atomic standards (1)	Information on TA(i) - UTC(i) Interval of validity (in MJD at 0 h UTC)	TA(i) - UTC(i) in s
AOS	1 Ind. Cs	46796-47038	23.000 000 360 +180x10^{-9}x(MJD-46796)
		47038-47099	23.000 043 920 +280x10^{-9}x(MJD-47038)
		47099-	23.000 061 000 +230x10^{-9}x(MJD-47099)
CH	14 Ind. Cs (2)	46693-46823	23.000 039 237 +22x10^{-9}x(MJD-46693)
		46823-	23.000 042 100 +18x10^{-9}x(MJD-46823)
DDR	2 Ind. Cs (3)	year 1988	TA(DDR)-UTC(ASMW) is sent to BIH
F	19 Ind. Cs (4)	year 1987	TA(F)-UTC(OP) is published in bulletin H by OP (LPTF)
JATC	1 Lab. Cs 15 Ind. Cs 6 H Masers (5)	year 1987	TA(JATC)-UTC(JATC) is sent to BIH
NBS	1 Lab. Cs 19 Ind. Cs 1 H Maser (6)	year 1987	TA(NBS)-UTC(NBS) is published in the NBS T and F Bulletin
NRC	1 2.1 m Lab. Cs 3 1 m Lab. Cs 1 Ind. Cs (7)	year 1988	22.999 968 931
PTB	2 Lab. Cs 9 Ind. Cs (8)	year 1987	23.000 363 400
~~RGO (9)~~	~~6 Ind. Cs~~	~~year 1987~~	~~22.999 926 090~~
RRL	1 Lab. Cs 11 Ind. Cs 3 H Masers	year 1988	published in RRL Standard Frequency and Time Bulletin
SO	1 Lab. Cs 4 Ind. Cs 3 H Masers	year 1987	TA(SO)-UTC(SO) is published by the SO Atomic Time Bulletin
CSAO	4 Ind. Cs 3 H Masers	year 1988	TA(CSAO)-UTC(CSAO) is published by the CSAO Time and Frequency Services Bulletin

Table 12 - (cont.)

Laboratories (i)	Equipment in atomic standards (1)	Interval of validity (in MJD at 0 h UTC)	Information on TA(i) - UTC(i) TA(i) - UTC(i) in s
SU	2 Lab. Cs 2 Ind. Cs 8 H Clocks	year 1987	20.172 750 000
USNO	42 Ind. Cs 4 H Masers (4 VLG 11 B serial = 18,19,22,23) 3 Prototype Mercury Ion freq. Std serial = 1,2,3 (10)	year 1987	A.1(MEAN)-UTC(USNO,MC) values are available upon request. (11)

Notes of Table 12

(1) Ind. Cs designates an industry made Cs standard; Lab. Cs a laboratory Cs standard and H Maser an Hydrogen Maser.

(2) The standards are located as follows (at the end of 1987).

Office Fédéral de Métrologie (Berne)	(OFM)	7 Cs
Observatoire de Neuchâtel (Neuchâtel)	(ON)	5 Cs
Direction Générale des PTT (Berne)	(PTT)	2 Cs

They are intercompared by LORAN-C (OFM-ON) and TV method (OFM-PTT) and linked to the foreign laboratories through the Swiss Federal Office of Metrology.

(3) The standards are located as follows : ASMW, 1Cs ; ZIPE, 1 Cs.

(4) The standards are located as follows (at the end of 1987).

Centre Electronique de l'Armement (Rennes)	2 Cs
Centre National d'Etudes Spatiales	2 Cs
Centre National d'Etudes des Télécommunications	3 Cs
Centre d'Etudes et de Recherches Géodynamiques et Astronomiques	3 Cs
Electronique Serge Dassault (Trappes)	1 Cs
Hewlett-Packard (Orsay)	1 Cs
Observatoire de Paris : Laboratoire Primaire du Temps et des Fréquences (LPTF)	4 Cs
Observatoire de Besançon	2 Cs
Lab. de Physique et de Métrologie des Oscillateurs (Besançon)	1 Cs

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

Notes of Table 12 (cont.)

(5) JATC. The standards are located in the following laboratories
Shaanxi Astronomical Observatory (CSAO)
Shanghai Astronomical Observatory (SO)
Beijing Astronomical Observatory
Wuhan Time Observatory
Beijing National Institute of Metrology (NIM)

(6) The laboratory primary standards control TA(NBS) via an accuracy algorithm. Six of the commercial standards provide the reference for WWV and WWVB and two for GOES Satellite time 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 0.01 μs. The hydrogen maser is passively operated.

(7) The 2.1 meter primary cesium clock, CsV, operated continuously during 1987 producing the scale of proper time PT(NRC CsV).
The time scales UTC(NRC) and TA(NRC) were derived from PT(NRC CsV) according to the following expressions given in microseconds :

UTC(NRC) = PT(NRC CsV) - (MJD - 43144) x 0.000 97 + 52.041

TA(NRC) = PT(NRC CsV) - (MJD - 43144) x 0.000 97 + 20.972

with integral seconds disregarded.

Three 1 meter laboratory cesium clocks, CsVIA, -B, and -C, operated continuously as primary standards during 1987 producing the scales of proper time PT(NRC CsVIA), PT(NRC CsVIB) and PT(NRC CsVIC).

(8) The two Lab. Cs are functionning continuously (primary clocks).
TA(PTB) and UTC(PTB) are derived directly from a local oscillator monitored by the primary clock CS1.
MEZ(D) = UTC(PTB) + 1 h or MESZ(D) = UTC(PTB) + 2 h (summer time) is the legal time of the Federal Republic of Germany.

(9) RGO. The royal Greenwich Observatory has terminated the provision of services related to the definition and dissemination of atomic time in March 1987. All enquiries about atomic time and frequency services in the United Kingdom should be directed to the National Physical Laboratory (NPL).

(10) The time scales UTC(USNO) and TA(USNO) depend on nominally 25 Cs selected clocks (selected on the basis of observed 5-day stability).

(11) TA(USNO) is designated by A.1 (MEAN) by USNO.

Table 13 - Equipment and links of the collaborating laboratories in 1987

Laboratory (i)	Equipment (1)	Source of UTC(i)	LORAN-C reception (2)	Television link with	GPS reception
AOS	1 Ind. Cs	1 Cs		TP, ZIPE, PTBM	
APL	1 Ind. Cs 4 H Masers	1 H Maser		USNO	*
ASMW	1 Ind. Cs	1 Cs + microstepper	7970-W	ZIPE, TP, PTB	
ATC	7 Ind. Cs	1 Cs + microstepper		other lab. in Australia	*
BEV	1 Ind. Cs	1 Cs	7970-W 7990-M 7990-X 7990-Y	OMH, TUG, lab. in Czechoslovakia	
CAO	2 Ind. Cs	1 Cs	7990-M 7990-X 7990-Z	IEN, other lab. in Italy	
CH	see Table 12	all the Cs	7970-W 7990-Z	PTT	*
CSAO	4 Ind. Cs 3 H Masers	all the Cs	9970-Y	lab. in China	
DNM (3)	4 Ind. Cs	all the Cs		other lab. in Australia	*
FTZ	7 Ind. Cs	1 Cs	7970-W		
IEN	5 Ind. Cs	1 Cs + microstepper	7990-Z	CAO, other lab. in Italy	*
IFAG	4 Ind. Cs 2 H Masers	1 Cs + microstepper	7970-W		*
IGMA	4 Ind. Cs	1 Cs + microstepper		ONBA, other lab. in Argentina	* (since Aug. 1986)

Table 13 - (cont.)

Laboratory (i)	Equipment (1)	Source of UTC(i)	LORAN-C reception (2)	Television link with	GPS reception
ILOM	5 Ind. Cs	1 Cs	9970-M	~~RRL~~ CRL, TAO, NRLM	
INPL	3 Ind. Cs	1 Cs			*
JATC	see Table 12	Cs	9970-Y		
KSRI	4 Ind. Cs	1 Cs	9970-Y		* (since July 1988)
NBS	see Table 12	11 Cs 1 Lab. Cs 1 H Maser	9940-M 9960-Z		*
NIM	~~3 Ind. Cs~~ See T 12	1 Cs + microstepper	9970-Y	lab. in China	
NML	2 Ind. Cs 2 H masers	all the Cs		other lab. in Sydney region	*
NPL	7 Ind. Cs	1 Cs + microstepper	7970-W	transmitting station at Rugby	*
NPLI	5 Ind. Cs	1 Cs			*
NPRL	2 Ind. Cs	1 Cs			* (since Oct. 1987)
NRC	see Table 12	Cs V	9960-M		*
NRLM	3 Ind. Cs 2 Lab. Cs	1 Cs	9970-M 9970-X	ILOM, RRL, TAO ILOM CRL	
OMH	1 Ind. Cs	1 Cs		BEV, SU, TP	
OMSF	6 Ind. Cs	all the Cs	7990-Z		* (since May 1987)
ONBA	2 Ind. Cs	2 Cs		IGMA other lab. in Argentina	
ONRJ	2 Ind. Cs	2 Cs		other lab. in Brasil	
OP	4 Ind. Cs	1 Cs	7970-W 7990-Z 8940-M	16 Lab. in France.	*

Table 13 - (cont.)

Laboratory (i)	Equipment (1)	Source of UTC(i)	LORAN-C reception (2)	Television link with	GPS reception
ORB	2 Ind. Cs	1 Cs	7970-W		* (since Feb. 1987)
PKNM	4 Ind. Cs	corrected mean of 4 Cs	7970-W (5)		
PTB	see Table 12	Ind. Cs + microstepper steered by PTB primary st.	7970-W	ASMW, TP, ZIPE and other lab.	*
RGO (6)	see Table 12	selection of the Cs	7970-M 7970-W 7990-Z 9980-X		*
RRL	see Table 12	8 Cs	9970-M	ILOM, TAO, NRLM	*
SO	see Table 12	1 Cs + microstepper	9970-Y	lab. in China	
STA	3 Ind. Cs	1 Cs	7970-W	other lab. in Sweden	* (since May 1987)
SU	see Table 12	2 Lab. Cs 1 Cs 8 H Clocks	7970-W 7990-X 7990-Y 9970-X	TP, OMH	
TAO	8 Ind. Cs	1 Cs + microstepper	9970-M 9970-Y	ILOM, RRL NRLM	*
TL	5 Ind. Cs	1 Cs + microstepper	9970-Y		*
TP	1 Ind. Cs	1 Cs + microstepper	7970-W	PTB, AOS, SU, ZIPE, ASMW, OMH	
TUG	3 Ind. Cs	1 Cs	7970-W 7990-M	BEV	*
USNO(7)	see table 12	Master clock is H Maser + freq. synthesizer steered to UTC(USNO) (see table 12)	(8)	APL	*

Table 13 - (cont.)

Laboratory (i)	Equipment (1)	Source of UTC(i)	LORAN-C reception (2)	Television link with	GPS reception
VSL	4 Ind. Cs	1 Cs + microstepper	7970-M 7970-W 9980-X	11 Lab. in Netherlands	*
YUZM	1 Ind. Cs	Cs	7990-M		
ZIPE	1 Ind. Cs	1 Cs	7970-W	AOS, ASMW, TP, PTB	

Notes of Table 13

(1) Ind. Cs designates an industry made Cs standard;
Lab. Cs a laboratory Cs standard, H. Maser an Hydrogen Maser, and Rb designates a Rubidium standard.

(2) LORAN-C stations :

7970-M	Norwegian Sea chain,	Ejde
7970-W	" "	Sylt
7990-M	Mediterranean chain,	Simeri Crichi
7990-X	" "	Lampedusa
7990-Y	" "	Kargabarun
7990-Z	" "	Estartit
8940-M	French chain,	Lessay
9940-M	West Coast chain,	Fallon
9960-M	Northeast Coast chain,	Seneca
9960-X	" "	Nantucket
9960-Z	" "	Dana
9970-M	Northwest Pacific chain,	Iwo Jima
9970-X	" "	Hokkaido
9970-Y	" "	Gesashi
9980-M	North Atlantic chain,	Angissoq
9980-X	" "	Ejde

Notes of Table 13 (cont.)

(3) DNM. In the future, the laboratory will appear with the acronym ORR.

(4) VLF link until 1987 Oct.1, then GPS link.

(5) Reception of the Soviet Union LORAN chain 8000.

(6) RGO. See note (9) of the Table 12. GPS data not available.

(7) USNO Time Service Publication, Series 16, entitled Precise Time Transfer Report, lists UTC(USNO MC) - UTC(Reference Clock). Difference from Satellite Communication terminals and international timing centers using the Global Positioning System 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. Series 17 is available via the Automated Data Service and the General Electric Mark 3 international computer network (RC28 catalog).

(8) The daily phase values (published weekly, Series 4 of USNO) gives the values of UTC(USNO MC) - transmitting station for :

the LORAN-C chains	the US TV Network NBC
the OMEGA stations AR, AU, H, L, ND	the GPS satellite systems

These data are also available via the Automated Data Service (ADS) and the General Electric Mark 3 international computer network (RC28 catalog).
The ADS may be accessed on :

BELL 103/212 (300 or 1200 Baud)	202-653-1079
CCITT V.21 (300 Baud)	202-653-1095
CCITT V.22/V.22 bis (1200 or 2400 Baud)	202-653-1783

* Laboratories with GPS receiver equipment.

TABLE 14 - ABSOLUTE TIME COMPARISONS BETWEEN LABORATORIES IN 1987

A - CLOCK TRANSPORTATION

Unless otherwise stated, the transportation was carried out by the first mentioned laboratory.

DATE		MJD	TIME COMPARISONS		UNCERT.	SOURCE	
1987			(Unit : 1 microsecond)				
JAN	20	46815.05	UTC(TAO) - UTC(RRL) =	-1.618	0.003	TAO	message
FEB	16	46842.66	UTC(CH) - UTC(PTB) =	2.68	0.03	CH	letter
FEB	24	46850.63	UTC(CH) - UTC(PTB) =	2.63	0.03	CH	letter
FEB	25	46851.05	UTC(RRL) - UTC(TAO) =	1.512	0.005	RRL	letter
MAR	24	46878.08	UTC(TAO) - UTC(RRL) =	-1.571	0.003	TAO	message
APR	22	46907.21	UTC(RRL) - UTC(TAO) =	1.197	0.005	RRL	letter
MAY	20	46935.05	UTC(TAO) - UTC(RRL) =	-0.731	0.005	TAO	message
MAY	22	46937.12	UTC(TAO) - UTC(NRLM) =	-16.714	0.008	TAO	message
MAY	26	46941.02	UTC(TAO) - UTC(ILOM) =	-32.618	0.020	TAO	message
JUN	18	46964.05	UTC(NPL) - UTC(SU) =	20.858	0.025	NPL	letter
JUN	24	46970.05	UTC(RRL) - UTC(TAO) =	0.006	0.005	RRL	letter
JUL	23	46999.07	UTC(TAO) - UTC(RRL) =	0.631	0.005	TAO	message
AUG	25	47032.06	UTC(RRL) - UTC(TAO) =	-1.185	0.005	RRL	letter
SEP	13	47051.74	UTC(STA) - UTC(SU) =	22.034	0.020	STA	letter
SEP	16	47054.35	UTC(YUZM) - UTC(OP) =	0.072		YUZM	telex
SEP	18	47056.32	UTC(STA) - UTC(SU) =	21.949	0.020	STA	letter
SEP	22	47060.05	UTC(TAO) - UTC(RRL) =	1.435	0.005	TAO	message
NOV	2	47101.10	UTC(RRL) - UTC(TAO) =	-1.529	0.005	RRL	letter
NOV	4	47103.09	UTC(TAO) - UTC(NRLM) =	-19.267	0.010	TAO	message
NOV	10	47109.00	UTC(TAO) - UTC(ILOM) =	-33.383	0.020	TAO	message
NOV	24	47123.04	UTC(TAO) - UTC(RRL) =	1.411	0.005	TAO	message

B - GPS TIME COMPARISONS WITH DIFFERENTIAL CALIBRATION OF RECEIVER DELAYS

Unless otherwise stated, under the heading SOURCE is designated the laboratory which has organized the measurement of delays.

DATE		MJD	TIME COMPARISONS		UNCERT.	SOURCE
1987			(Unit : 1 microsecond)			
APR	14	46899.00	UTC(NBS) - UTC(USNO) =	-5.016	0.008	NBS
JUN	3	46949.00	UTC(OP) - UTC(OMSF) =	2.830	0.008	BIPM
SEP	1	47039.00	UTC(OP) - UTC(INPL) =	37.312	0.017	BIPM
DEC	30	47159.00	UTC(NBS) - UTC(OP) =	0.018	0.018	NBS, BIPM

TABLE 15 - INDEPENDENT ATOMIC TIMES

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

Unit is one microsecond

DATE 1987	MJD	TAI - TA(i) AOS	CH (1)	DDR	F	JATC
JAN 4	46799	-1.37	-40.28	-14.52	32.872	-3.16
JAN 14	46809	-2.88	-40.12	-14.51	33.263	-3.21
JAN 24	46819	-4.57	-40.34	-14.47	33.707	-3.34
FEB 3	46829	-6.33	-40.760	-14.32	34.193	-3.24
FEB 13	46839	-8.27	-40.918	-14.31	34.714	-3.12
FEB 23	46849	-10.18	-41.083	-14.33	35.169	-3.10
MAR 5	46859	-11.89	-41.232	-14.38	35.643	-3.03
MAR 15	46869	-13.50	-41.380	-14.32	36.136	-2.76
MAR 25	46879	-15.16	-41.523	-14.24	36.634	-2.70
APR 4	46889	-16.66	-41.684	-14.29	37.125	-3.01
APR 14	46899	-18.55	-41.877	-14.43	37.568	-2.99
APR 24	46909	-20.16	-42.085	-14.61	38.041	-2.89
MAY 4	46919	-21.79	-42.276	-14.83	38.538	-2.83
MAY 14	46929	-23.80	-42.481	-15.07	39.003	-2.75
MAY 24	46939	-25.78	-42.675	-15.34	39.469	-2.62
JUN 3	46949	-28.01	-42.889	-15.66	39.942	-2.50
JUN 13	46959	-30.05	-43.090	-15.95	40.387	-2.38
JUN 23	46969	-32.40	-43.313	-16.30	40.812	-2.36
JUL 3	46979	-34.63	-43.501	-16.68	41.263	-2.28
JUL 13	46989	-37.06	-43.718	-17.12	41.752	-2.19
JUL 23	46999	-39.01	-43.891	-17.49	42.256	-2.02
AUG 2	47009	-41.32	-44.058	-17.97	42.750	-1.95
AUG 12	47019	-43.53	-44.238	-18.46	43.233	-1.97
AUG 22	47029	-45.60	-44.426	-18.84	43.725	-1.88
SEP 1	47039	-47.63	-44.575	-19.38	44.197	-1.70
SEP 11	47049	-49.95	-44.750	-19.84	44.713	-1.47
SEP 21	47059	-52.13	-44.923	-20.21	45.226	-1.35
OCT 1	47069	-54.51	-45.119	-20.74	45.679	-1.22
OCT 11	47079	-56.62	-45.293	-21.18	46.151	-1.10
OCT 21	47089	-58.78	-45.461	-21.60	46.607	-0.93
OCT 31	47099	-60.93	-45.634	-22.00	47.041	-0.77
NOV 10	47109	-63.08	-45.793	-22.40	47.466	-0.78
NOV 20	47119	-65.58	-45.973	-22.74	47.882	-0.77
NOV 30	47129	-67.74	-46.170	-23.14	48.302	-0.68
DEC 10	47139	-69.97	-46.335	-23.43	48.686	-0.54
DEC 20	47149	-72.35	-46.494	-23.74	49.044	-0.57
DEC 30	47159	-74.36	-46.660	-24.04	49.449	-0.53

(1) CH . Introduction of GPS time link on MJD=46829

TABLE 15 - (CONT.)

Unit is one microsecond

DATE 1987	MJD	TAI - TA(i) NBS	NIM	NRC	PTB	RGO
JAN 4	46799	-45094.572	-	23.195	-359.351	65.34
JAN 14	46809	-45094.912	-	23.140	-359.348	65.27
JAN 24	46819	-45095.206	-	23.128	-359.338	65.38
FEB 3	46829	-45095.487	-	23.220	-359.301	65.37
FEB 13	46839	-45095.790	-	23.169	-359.252	65.59
FEB 23	46849	-45096.099	-	23.109	-359.266	65.62
MAR 5	46859	-45096.413	-5.33	23.134	-359.260	65.67
MAR 15	46869	-45096.701	-5.28	23.173	-359.225	65.68
MAR 25	46879	-45096.999	-5.31	23.224	-359.158	65.75
APR 4	46889	-45097.288	-5.56	23.280	-359.133	-
APR 14	46899	-45097.584	-5.82	23.266	-359.120	-
APR 24	46909	-45097.874	-6.03	23.244	-359.096	-
MAY 4	46919	-45098.151	-6.16	23.205	-359.076	-
MAY 14	46929	-45098.434	-6.34	23.143	-359.065	-
MAY 24	46939	-45098.698	-6.55	23.049	-359.074	-
JUN 3	46949	-45098.986	-6.67	22.935	-359.090	-
JUN 13	46959	-45099.254	-6.70	22.857	-359.069	-
JUN 23	46969	-45099.542	-6.89	22.751	-359.120	-
JUL 3	46979	-45099.814	-7.10	22.652	-359.090	-
JUL 13	46989	-45100.067	-7.14	22.521	-359.092	-
JUL 23	46999	-45100.318	-7.18	22.393	-359.053	-
AUG 2	47009	-45100.576	-7.28	22.245	-359.061	-
AUG 12	47019	-45100.838	-7.28	22.104	-359.053	-
AUG 22	47029	-45101.118	-7.38	21.909	-359.007	-
SEP 1	47039	-45101.391	-7.33	21.754	-359.044	-
SEP 11	47049	-45101.687	-7.35	21.593	-359.083	-
SEP 21	47059	-45101.970	-7.41	21.472	-359.070	-
OCT 1	47069	-45102.284	-7.50	21.310	-359.114	-
OCT 11	47079	-45102.600	-7.44	21.193	-359.124	-
OCT 21	47089	-45102.933	-7.38	21.099	-359.146	-
OCT 31	47099	-45103.264	-7.33	21.002	-359.163	-
NOV 10	47109	-45103.571	-7.30	20.906	-359.147	-
NOV 20	47119	-45103.911	-7.34	20.763	-359.143	-
NOV 30	47129	-45104.261	-7.43	20.650	-359.139	-
DEC 10	47139	-45104.620	-7.40	20.549	-359.147	-
DEC 20	47149	-45105.000	-7.39	20.482	-359.127	-
DEC 30	47159	-45105.380	-7.40	20.628	-359.135	-

TABLE 15 - (CONT.)

Unit is one microsecond

DATE 1987	MJD	TAI - TA(i) RRL	SO	SU (2)	USNO
JAN 4	46799	-3.230	-47.56	2827275.40	-34531.860
JAN 14	46809	-3.329	-47.50	2827274.96	-34532.407
JAN 24	46819	-3.354	-47.75	2827275.04	-34532.926
FEB 3	46829	-3.379	-47.96	2827275.58	-34533.451
FEB 13	46839	-3.442	-47.94	2827275.10	-34533.998
FEB 23	46849	-3.487	-47.70	2827274.40	-34534.570
MAR 5	46859	-3.525	-47.70	2827274.31	-34535.111
MAR 15	46869	-3.586	-47.86	2827273.75	-34535.664
MAR 25	46879	-3.613	-47.67	2827273.53	-34536.222
APR 4	46889	-3.619	-47.71	2827273.39	-34536.769
APR 14	46899	-3.606	-47.59	2827273.25	-34537.296
APR 24	46909	-3.588	-47.38	2827273.43	-34537.838
MAY 4	46919	-3.557	-47.07	2827273.32	-34538.365
MAY 14	46929	-3.522	-46.88	2827273.28	-34538.892
MAY 24	46939	-3.463	-46.66	2827273.08	-34539.417
JUN 3	46949	-3.383	-46.49	2827273.24	-34539.954
JUN 13	46959	-3.251	-46.37	2827273.10	-34540.448
JUN 23	46969	-3.218	-46.21	2827272.84	-34540.968
JUL 3	46979	-3.179	-45.99	2827272.77	-34541.483
JUL 13	46989	-3.135	-45.84	2827272.92	-34542.020
JUL 23	46999	-3.063	-45.71	2827272.93	-34542.515
AUG 2	47009	-2.905	-45.58	2827272.79	-34543.030
AUG 12	47019	-2.844	-45.44	2827272.47	-34543.548
AUG 22	47029	-2.752	-45.29	2827272.35	-34544.084
SEP 1	47039	-2.656	-45.05	2827272.48	-34544.594
SEP 11	47049	-2.582	-45.02	2827272.42	-34545.158
SEP 21	47059	-2.488	-44.93	2827272.40	-34545.667
OCT 1	47069	-2.431	-44.84	2827272.46	-34546.172
OCT 11	47079	-2.396	-44.80	2827272.24	-34546.749
OCT 21	47089	-2.390	-44.61	2827272.24	-34547.294
OCT 31	47099	-2.372	-44.58	2827272.15	-34547.836
NOV 10	47109	-2.352	-44.55	2827272.17	-34548.357
NOV 20	47119	-2.395	-44.61	2827272.23	-34548.877
NOV 30	47129	-2.489	-44.64	2827271.89	-34549.450
DEC 10	47139	-2.562	-44.65	2827271.79	-34550.009
DEC 20	47149	-2.598	-44.73	2827271.78	-34550.557
DEC 30	47159	-2.640	-44.87	2827271.49	-34551.102

(2) SU . The values of TAI-TA(SU) for December 1986, given as "provisional" in the Annual Report for 1986, are confirmed.

TABLE 16 - PRIMARY FREQUENCY STANDARDS USED AS CLOCKS

Unit is one microsecond

TAI-LAB.STD.

DATE 1987	MJD	PTB (1)		NRC (2)			
		CS1	CS2	CsV	CsVI A	CsVI B	CsVI C
JAN 4	46799	4.064	3.632	40.622	30.168	41.263	32.476
JAN 14	46809	4.066	3.619	40.556	30.109	41.317	32.499
JAN 24	46819	4.073	3.623	40.535	30.103	41.442	32.583
FEB 3	46829	4.106	3.647	40.618	30.117	41.580	32.702
FEB 13	46839	4.099	3.610	40.557	30.109	41.654	32.760
FEB 23	46849	4.131	3.611	40.487	30.101	41.706	32.779
MAR 5	46859	4.151	3.618	40.502	30.061	41.742	32.796
MAR 15	46869	4.188	3.615	40.531	30.039	41.762	32.840
MAR 25	46879	4.230	3.605	40.572	30.010	41.749	32.863
APR 4	46889	4.263	3.604	40.609	30.105	41.750	32.995
APR 14	46899	4.284	3.577	40.595	30.091	41.817	32.932
APR 24	46909	4.294	3.558	40.564	30.062	41.890	33.060
MAY 4	46919	4.315	3.545	40.513	30.018	41.970	33.102
MAY 14	46929	4.324	3.523	40.441	29.960	42.029	33.117
MAY 24	46939	4.329	3.494	40.338	29.911	42.084	33.163
JUN 3	46949	4.311	3.460	40.213	29.829	42.097	33.161
JUN 13	46959	4.302	3.434	40.125	29.773	42.156	33.168
JUN 23	46969	4.283	3.395	40.012	29.731	42.205	33.108
JUL 3	46979	4.282	3.355	39.904	29.680	42.241	33.004
JUL 13	46989	4.309	3.327	39.762	29.581	42.267	32.908
JUL 23	46999	4.309	3.286	39.624	29.470	42.321	32.834
AUG 2	47009	4.350	3.265	39.467	29.390	42.337	32.730
AUG 12	47019	4.370	3.244	39.316	29.266	42.341	32.628
AUG 22	47029	4.364	3.188	39.111	29.170	42.324	32.514
SEP 1	47039	4.347	3.175	38.947	28.957	42.308	32.379
SEP 11	47049	4.335	3.142	38.776	28.920	42.235	32.273
SEP 21	47059	4.320	3.120	38.644	28.859	42.173	32.198
OCT 1	47069	4.317	3.083	38.474	28.825	42.128	31.985
OCT 11	47079	4.272	3.049	38.348	28.800	42.074	31.736
OCT 21	47089	4.263	3.023	38.244	28.850	42.056	31.451
OCT 31	47099	4.252	2.991	38.138	28.962	41.987	31.683
NOV 10	47109	4.255	2.959	38.032	28.955	42.210	31.578
NOV 20	47119	4.258	2.943	37.879	28.899	42.372	31.477
NOV 30	47129	4.246	2.929	37.757	28.983	42.567	31.371
DEC 10	47139	4.271	2.939	37.646	29.054	42.722	31.232
DEC 20	47149	4.268	2.892	37.569	29.146	42.893	31.142
DEC 30	47159	4.258	2.855	37.706	29.316	43.313	31.046

TABLE 16 - (CONT.)

NOTES

(1) The time scales under the headline PTB are coordinate time scales at sea level derived from the scales of proper time produced by standards CS1 and CS2 of PTB. The gravitational correction is -0.00066 μs/d .

(2) The time scales under the headline NRC are the scales of proper time PT(NRC Cs V), PT(NRC Cs VI A), PT(NRC Cs VI B), PT(NRC Cs VI C) produced directly by standards Cs V, Cs VI A, Cs VI B, Cs VI C of NRC. The gravitational frequency correction to these time scales of proper time to obtain coordinate times at sea level is -0.00097 μs/d .

TABLE 17 - COORDINATED UNIVERSAL TIME

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

Unit is one microsecond

DATE 1987	MJD	UTC - UTC(i) AOS	APL	ASMW	AUS	BEV (1)	CAO
JAN 4	46799	-0.47	-0.980	-0.25	-5.983	-8.60	-3.66
JAN 14	46809	-0.18	-1.003	-0.15	-6.123	-9.04	-3.81
JAN 24	46819	-0.07	-0.960	0.00	-6.227	-9.49	-3.71
FEB 3	46829	-0.03	-0.921	0.14	-6.294	-9.49	-2.95
FEB 13	46839	-0.17	-0.911	0.19	-6.521	-9.54	-2.76
FEB 23	46849	-0.28	-0.910	0.20	-6.517	-9.37	-2.77
MAR 5	46859	-0.19	-0.907	0.18	-6.686	-9.28	-2.81
MAR 15	46869	0.01	-0.893	0.29	-6.844	10.53	-2.54
MAR 25	46879	0.14	-0.876	0.39	-6.947	10.19	-2.30
APR 4	46889	0.44	-0.858	0.39	-7.039	9.83	-1.86
APR 14	46899	0.35	-0.872	0.29	-7.177	9.29	-1.73
APR 24	46909	0.54	-0.861	0.12	-7.298	8.82	-1.60
MAY 4	46919	0.71	-0.851	0.14	-7.450	8.35	-1.40
MAY 14	46929	0.51	-0.844	0.13	-7.582	7.97	-1.23
MAY 24	46939	0.32	-0.838	0.10	-7.739	7.46	-1.05
JUN 3	46949	-0.11	-0.857	0.01	-7.894	7.14	-0.88
JUN 13	46959	-0.35	-	-0.07	-8.079	6.62	-0.75
JUN 23	46969	-0.90	-0.861	-0.22	-8.209	6.29	-0.54
JUL 3	46979	-1.33	-0.893	-0.44	-8.443	5.86	-0.31
JUL 13	46989	-1.96	-0.923	-0.72	-8.611	5.46	-0.09
JUL 23	46999	-2.11	-0.932	-0.70	-8.818	4.94	-0.02
AUG 2	47009	-2.62	-0.950	-0.78	-8.991	4.56	0.08
AUG 12	47019	-3.03	-0.973	-0.84	-9.177	4.07	0.16
AUG 22	47029	-3.30	-0.993	-0.81	-9.441	3.69	0.14
SEP 1	47039	-3.43	-0.989	-0.85	-9.613	3.33	0.07
SEP 11	47049	-2.95	-1.011	-0.65	-9.845	2.87	0.12
SEP 21	47059	-2.33	-1.035	-0.33	-10.081	2.48	0.14
OCT 1	47069	-1.91	-1.036	-0.16	-10.248	2.06	0.01
OCT 11	47079	-1.22	-1.046	-0.15	-10.418	1.59	-0.14
OCT 21	47089	-0.58	-1.054	-0.13	-10.574	1.16	-0.14
OCT 31	47099	0.07	-1.078	-0.06	-10.780	0.75	-0.18
NOV 10	47109	0.22	-1.082	0.00	-10.894	0.36	-0.24
NOV 20	47119	0.02	-1.095	0.15	-11.090	0.00	-0.24
NOV 30	47129	0.16	-1.116	0.25	-11.274	-0.40	-0.32
DEC 10	47139	0.23	-1.112	0.29	-11.438	-0.67	-0.32
DEC 20	47149	0.15	-1.140	0.36	-11.583	-1.20	-0.20
DEC 30	47159	0.45	-1.154	0.32	-11.749	-1.71	-0.17

TABLE 17 - (CONT.)

Unit is one microsecond

DATE 1987	MJD	UTC - UTC(i) CH (2)	CSAO	FTZ	IEN	IFAG (3)	ILOM
JAN 4	46799	1.29	-0.49	9.32	0.781	-3.513	-30.20
JAN 14	46809	1.68	-0.63	9.49	0.621	-3.543	-30.51
JAN 24	46819	1.67	-0.77	9.67	0.372	-3.506	-30.72
FEB 3	46829	1.449	-0.90	9.85	0.098	-3.435	-30.92
FEB 13	46839	1.471	-0.88	9.98	-0.119	-3.453	-31.20
FEB 23	46849	1.487	-0.90	10.13	-0.358	-3.545	-31.42
MAR 5	46859	1.517	-0.92	10.25	-0.564	-4.941	-31.69
MAR 15	46869	1.550	-0.93	10.41	-0.797	-4.850	-31.77
MAR 25	46879	1.588	-0.88	10.48	-1.061	-4.445	-31.94
APR 4	46889	1.607	-1.02	10.56	-1.257	-3.841	-32.14
APR 14	46899	1.594	-1.04	10.67	-1.489	-3.514	-32.32
APR 24	46909	1.566	-1.00	10.78	-1.721	-3.490	-32.50
MAY 4	46919	1.556	-0.91	10.84	-1.818	-3.733	-32.70
MAY 14	46929	1.531	-0.88	10.92	-1.836	-3.848	-32.92
MAY 24	46939	1.518	-0.73	11.04	-1.899	-3.672	-33.11
JUN 3	46949	1.482	-0.54	11.14	-1.982	-3.937	-33.25
JUN 13	46959	1.463	-0.60	11.28	-1.946	-4.221	-33.43
JUN 23	46969	1.421	-0.60	11.35	-1.936	-4.474	-33.61
JUL 3	46979	1.414	-0.60	11.51	-1.906	-4.450	-33.83
JUL 13	46989	1.378	-0.60	11.59	-1.929	-4.664	-33.97
JUL 23	46999	1.385	-0.50	11.62	-2.003	-5.112	-34.27
AUG 2	47009	1.399	-0.57	11.63	-1.942	-5.227	-34.43
AUG 12	47019	1.399	-0.56	11.63	-1.879	-4.913	-34.60
AUG 22	47029	1.392	-0.51	11.65	-1.786	-4.733	-34.74
SEP 1	47039	1.424	-0.22	11.62	-1.672	-5.038	-34.87
SEP 11	47049	1.430	0.01	11.82	-1.611	-5.301	-34.92
SEP 21	47059	1.438	-0.08	12.02	-1.461	-5.189	-34.92
OCT 1	47069	1.423	0.14	12.23	-1.382	-4.905	-34.75
OCT 11	47079	1.429	0.27	12.55	-1.262	-4.960	-34.86
OCT 21	47089	1.443	0.57	12.69	-1.208	-4.849	-35.02
OCT 31	47099	1.450	0.62	12.82	-1.164	-4.229	-34.96
NOV 10	47109	1.473	0.50	13.03	-1.091	-4.555	-34.95
NOV 20	47119	1.474	0.53	13.33	-1.047	-5.103	-34.90
NOV 30	47129	1.458	0.73	13.61	-1.132	-5.234	-34.90
DEC 10	47139	1.474	0.76	13.86	-1.212	-4.805	-34.94
DEC 20	47149	1.497	0.67	14.14	-1.216	-4.612	-35.02
DEC 30	47159	1.511	0.67	14.43	-1.209	-4.227	-35.10

TABLE 17 - (CONT.)

Unit is one microsecond

DATE 1987	MJD	UTC - UTC(i) INPL	JATC	KSRI (4)	NBS	NIM	NPL
JAN 4	46799	-	-1.82	7.33	-0.279	12.86	2.296
JAN 14	46809	-	-1.64	7.34	-0.336	12.42	2.393
JAN 24	46819	-	-1.63	7.34	-0.333	12.35	2.482
FEB 3	46829	-	-1.26	7.42	-0.308	12.35	2.578
FEB 13	46839	-	-1.00	7.44	-0.306	12.37	2.633
FEB 23	46849	-	-0.87	7.46	-0.308	12.32	2.687
MAR 5	46859	-	-0.77	7.52	-0.304	12.31	2.758
MAR 15	46869	-	-0.53	7.58	-0.273	12.39	2.840
MAR 25	46879	-	-0.38	7.51	-0.250	12.40	2.932
APR 4	46889	-	-0.41	7.23	-0.222	12.23	3.018
APR 14	46899	-	-0.24	7.03	-0.203	11.91	3.087
APR 24	46909	-	-0.08	7.03	-0.181	11.76	3.162
MAY 4	46919	-	0.11	7.02	-0.147	11.60	3.194
MAY 14	46929	-	0.26	6.91	-0.116	11.46	3.244
MAY 24	46939	-	0.49	7.44	-0.064	11.32	3.280
JUN 3	46949	-	0.64	-0.81	-0.032	11.32	3.293
JUN 13	46959	-	0.74	-2.47	0.017	11.30	3.309
JUN 23	46969	32.294	0.79	-4.10	0.046	11.14	3.289
JUL 3	46979	32.975	0.76	-5.74	0.098	11.12	3.283
JUL 13	46989	33.688	0.86	-7.39	0.135	11.22	3.291
JUL 23	46999	34.338	0.99	-8.90	0.178	11.27	3.316
AUG 2	47009	35.182	1.03	-10.59	0.221	11.13	3.321
AUG 12	47019	36.095	1.03	-12.28	0.249	11.15	3.353
AUG 22	47029	36.996	1.06	-13.91	0.266	11.07	3.375
SEP 1	47039	37.893	1.28	-15.50	0.289	11.11	3.430
SEP 11	47049	38.758	1.60	-18.14	0.289	11.11	3.455
SEP 21	47059	39.639	1.80	-116.87	0.312	11.02	3.515
OCT 1	47069	40.439	1.91	-117.83	0.299	10.95	3.541
OCT 11	47079	41.266	2.09	-118.62	0.290	10.95	3.570
OCT 21	47089	42.130	2.34	0.95	0.260	10.96	3.621
OCT 31	47099	43.007	2.39	0.48	0.220	10.91	3.658
NOV 10	47109	44.003	2.28	0.14	0.192	10.75	3.698
NOV 20	47119	45.000	2.21	-0.43	0.133	10.63	3.756
NOV 30	47129	45.984	2.32	-1.01	0.075	10.53	3.803
DEC 10	47139	46.983	2.16	-1.66	0.013	10.54	3.849
DEC 20	47149	47.965	1.81	-2.11	-0.060	10.55	3.874
DEC 30	47159	48.993	1.68	-2.62	-0.138	10.49	3.891

TABLE 17 - (CONT.)

Unit is one microsecond

DATE 1987		MJD	UTC - UTC(i) ORB (6)	PKNM	PTB	RGO	RRL	SO (7)
JAN	4	46799	-31.83	-3.21	4.049	-8.57	-1.450	0.70
JAN	14	46809	-32.30	-3.20	4.052	-8.64	-1.559	0.77
JAN	24	46819	-32.17	-3.22	4.062	-8.53	-1.644	0.53
FEB	3	46829	-32.008	-3.13	4.099	-8.54	-1.699	0.32
FEB	13	46839	-32.175	-3.43	4.148	-8.32	-1.792	0.36
FEB	23	46849	-32.364	-3.36	4.133	-8.29	-1.867	0.62
MAR	5	46859	-32.255	-2.98	4.140	-8.24	-1.945	0.61
MAR	15	46869	-32.903	-2.91	4.175	-8.23	-2.046	0.41
MAR	25	46879	-33.295	-3.21	4.242	-8.16	-2.113	0.56
APR	4	46889	-34.587	-3.14	4.267	-	-2.099	0.45
APR	14	46899	-34.942	-3.04	4.280	-	-1.966	0.46
APR	24	46909	-35.308	-2.77	4.304	-	-1.828	0.55
MAY	4	46919	-35.658	-3.15	4.324	-	-1.707	0.75
MAY	14	46929	-35.981	-3.55	4.335	-	-1.582	0.81
MAY	24	46939	-36.334	-3.65	4.326	-	-1.443	0.92
JUN	3	46949	-36.708	-3.85	4.309	-	-1.273	0.97
JUN	13	46959	-37.124	-4.05	4.331	-	-1.051	1.00
JUN	23	46969	-37.516	-4.15	4.279	-	-0.908	1.08
JUL	3	46979	-37.959	-3.89	4.310	-	-0.769	1.23
JUL	13	46989	-38.371	-3.91	4.308	-	-0.615	1.37
JUL	23	46999	-38.744	-3.87	4.347	-	-0.493	1.48
AUG	2	47009	-39.121	-3.54	4.339	-	-0.345	1.59
AUG	12	47019	-39.484	-3.19	4.347	-	-0.254	1.69
AUG	22	47029	-39.876	-3.20	4.393	-	-0.152	1.81
SEP	1	47039	-40.312	-3.08	4.355	-	-0.056	1.99
SEP	11	47049	-40.713	-2.97	4.317	-	0.018	2.10
SEP	21	47059	-41.152	-2.85	4.330	-	0.042	2.24
OCT	1	47069	-41.592	-2.77	4.286	-	0.049	2.37
OCT	11	47079	-42.022	-2.74	4.276	-	0.034	2.49
OCT	21	47089	-42.422	-2.84	4.254	-	0.000	2.69
OCT	31	47099	-42.839	-2.91	4.236	-	-0.032	2.75
NOV	10	47109	-43.267	-3.11	4.253	-	-0.082	2.81
NOV	20	47119	-43.695	-2.96	4.257	-	-0.175	2.78
NOV	30	47129	-44.143	-2.79	4.261	-	-0.319	2.80
DEC	10	47139	-44.596	-2.45	4.253	-	-0.432	2.87
DEC	20	47149	-45.105	-2.42	4.273	-	-0.518	2.94
DEC	30	47159	-45.569	-2.66	4.265	-	-0.600	2.79

TABLE 17 - (CONT.)

Unit is one microsecond

DATE 1987	MJD	UTC - UTC(i) STA (8)	SU (9)	TAO (10)	TL	TP (11)
JAN 4	46799	1.82	25.40	0.220	210.44	-0.13
JAN 14	46809	1.71	24.96	0.061	211.50	-0.18
JAN 24	46819	1.74	25.05	-0.040	212.39	0.00
FEB 3	46829	1.56	25.58	-0.112	213.16	0.08
FEB 13	46839	1.57	25.10	-0.232	214.11	-0.06
FEB 23	46849	1.37	24.41	-0.352	215.28	0.00
MAR 5	46859	1.24	24.31	-0.469	216.57	0.11
MAR 15	46869	1.18	23.75	-0.517	217.84	0.23
MAR 25	46879	1.02	23.53	-0.537	219.18	0.27
APR 4	46889	0.91	23.39	-0.559	220.39	0.22
APR 14	46899	0.75	23.25	-0.605	221.43	0.31
APR 24	46909	0.62	23.43	-0.655	222.71	0.70
MAY 4	46919	0.46	23.32	-0.703	224.01	0.76
MAY 14	46929	0.360	23.28	-0.733	225.11	0.73
MAY 24	46939	0.225	23.08	-0.768	226.22	0.74
JUN 3	46949	0.121	23.24	-0.827	227.58	0.89
JUN 13	46959	0.138	23.10	-0.856	228.89	1.14
JUN 23	46969	0.162	22.84	-0.907	230.30	1.36
JUL 3	46979	0.228	22.77	-0.977	232.10	1.47
JUL 13	46989	0.337	22.92	-1.051	233.88	1.68
JUL 23	46999	0.464	22.93	-1.109	235.52	1.86
AUG 2	47009	0.629	22.79	-1.163	236.94	2.04
AUG 12	47019	0.746	22.47	-1.228	238.56	2.15
AUG 22	47029	0.812	22.35	-1.270	240.38	2.32
SEP 1	47039	0.925	22.48	-1.290	242.10	2.31
SEP 11	47049	1.013	22.42	-1.331	243.80	2.29
SEP 21	47059	1.118	22.40	-1.361	245.33	2.37
OCT 1	47069	1.205	22.46	-1.412	246.79	2.38
OCT 11	47079	1.146	22.24	-1.454	248.24	2.61
OCT 21	47089	0.971	22.24	-1.494	249.76	2.73
OCT 31	47099	0.753	22.15	-1.551	251.13	2.88
NOV 10	47109	0.544	22.17	-1.575	252.41	3.07
NOV 20	47119	0.364	22.23	-1.614	253.77	3.32
NOV 30	47129	0.169	21.89	-1.657	255.25	3.49
DEC 10	47139	-0.018	21.80	-1.685	256.65	3.63
DEC 20	47149	-0.114	21.78	-1.721	258.06	3.79
DEC 30	47159	-0.071	21.49	-1.739	259.36	4.01

TABLE 17 - (CONT.)

Unit is one microsecond

DATE 1987	MJD	UTC - UTC(i) TUG (12)	USNO	VSL	YUZM (13)	ZIPE
JAN 4	46799	4.60	-4.845	4.031	-103.23	-0.40
JAN 14	46809	4.98	-4.885	4.004	-104.69	-0.27
JAN 24	46819	-3.76	-4.909	4.016	-105.81	-0.14
FEB 3	46829	-3.684	-4.926	4.020	-106.73	0.02
FEB 13	46839	-3.404	-4.983	4.013	-107.53	-0.05
FEB 23	46849	-3.07	-5.059	4.005	-108.16	0.06
MAR 5	46859	-2.70	-5.098	4.039	-108.89	0.05
MAR 15	46869	-2.43	-5.156	4.069	-110.01	0.12
MAR 25	46879	-2.34	-5.199	4.066	-110.79	0.24
APR 4	46889	-2.02	-5.221	4.067	-111.26	0.21
APR 14	46899	-1.73	-5.239	4.051	-111.77	0.08
APR 24	46909	-1.498	-5.260	4.088	-112.33	-0.02
MAY 4	46919	-1.235	-5.262	4.159	-112.84	-0.10
MAY 14	46929	-0.972	-5.264	4.179	-113.12	-0.14
MAY 24	46939	-0.691	-5.271	4.129	-113.65	-0.17
JUN 3	46949	-0.434	-5.276	4.095	-113.88	-0.24
JUN 13	46959	-0.162	-5.241	4.066	-114.14	-0.26
JUN 23	46969	0.107	-5.221	4.034	-113.86	-0.31
JUL 3	46979	0.386	-5.175	4.086	-113.66	-0.29
JUL 13	46989	0.666	-5.133	4.109	-113.70	-0.37
JUL 23	46999	0.923	-5.090	4.108	-113.60	-0.30
AUG 2	47009	1.188	-5.063	4.092	-113.48	-0.38
AUG 12	47019	1.402	-5.049	4.059	-113.59	-0.54
AUG 22	47029	1.639	-5.023	4.085	-113.81	-0.53
SEP 1	47039	1.930	-4.985	4.119	-114.01	-0.36
SEP 11	47049	2.185	-4.967	4.148	-113.34	-0.15
SEP 21	47059	2.467	-4.903	4.211	0.94	0.00
OCT 1	47069	2.729	-4.870	4.226	1.63	0.02
OCT 11	47079	2.977	-4.860	4.210	1.70	-0.29
OCT 21	47089	3.225	-4.846	4.189	2.21	-0.31
OCT 31	47099	3.480	-4.822	4.196	2.50	-0.31
NOV 10	47109	3.736	-4.766	4.226	2.44	-0.35
NOV 20	47119	4.003	-4.732	4.195	2.79	-0.36
NOV 30	47129	4.252	-4.706	4.183	2.92	-0.45
DEC 10	47139	4.515	-4.660	4.232	2.85	-0.42
DEC 20	47149	-4.233	-4.625	4.208	2.29	-0.48
DEC 30	47159	-3.964	-4.591	4.233	2.09	-0.38

TABLE 17 - (CONT.)

NOTES

(1) BEV . Time step of UTC(BEV) of -20 μs on MJD=46864.54.

(2) CH . Introduction of GPS time link on MJD=46829.

(3) IFAG. Rate adjustment of UTC(IFAG) of 40 ns/day on MJD=46794.00
Change of master clock on MJD=46853.38 and time step of UTC(IFAG) of 1.5 μs on MJD=46855.4 .

(4) KSRI. Change of master clock on MJD=46948 and time steps of 97 μs on MJD=47052.46 and of -120 μs on MJD=47080.10.

(5) OMSF. The time step of UTC-UTC(OMSF) between MJD=46909 and MJD=46919 by about 0.40 μs is an adjustment made by the BIH, as a consequence of the implementation of GPS reception at OMSF.

(6) ORB . Introduction of GPS time link on MJD=46829.

(7) SO . Change of master clock and time step of UTC(SO) of -14 μs on MJD=46796.00.

(8) STA . Introduction of GPS time link on MJD=46929.

(9) SU . The values of UTC-UTC(SU) for December 1986, given as "provisional" in the Annual Report for 1986, are confirmed.

(10) TAO . Change of master clock on MJD=46863.

(11) TP . Time step of UTC(TP) of 4 μs on MJD=46796.00.

(12) TUG . Time step of UTC(TUG) of 9 μs on MJD=46814.33 and of 9 μs on MJD=47143.73.
LORAN-C time link from MJD=46799 to MJD=46819, and from MJD=46849 to MJD=46899.

(13) YUZM. Time step of UTC(YUZM) between MJD=47049 and 47059; the precise amount is not know. The new origin of UTC-UTC(YUZM) is given by a clock transportation on MJD=47054.35.

TABLE 17 A - COORDINATED UNIVERSAL TIME (VLF)

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

Unit is one microsecond

DATE 1987		MJD	UTC - UTC(i)
JAN	4	46799	
JAN	14	46809	
JAN	24	46819	
FEB	3	46829	
FEB	13	46839	
FEB	23	46849	
MAR	5	46859	
MAR	15	46869	
MAR	25	46879	
APR	4	46889	
APR	14	46899	
APR	24	46909	
MAY	4	46919	
MAY	14	46929	
MAY	24	46939	
JUN	3	46949	No data available for 1987
JUN	13	46959	
JUN	23	46969	
JUL	3	46979	
JUL	13	46989	
JUL	23	46999	
AUG	2	47009	
AUG	12	47019	
AUG	22	47029	
SEP	1	47039	
SEP	11	47049	
SEP	21	47059	
OCT	1	47069	
OCT	11	47079	
OCT	21	47089	
OCT	31	47099	
NOV	10	47109	
NOV	20	47119	
NOV	30	47129	
DEC	10	47139	
DEC	20	47149	
DEC	30	47159	

TABLE 18 - COMPARISONS BETWEEN ABSOLUTE TIME COMPARISONS AND THE BIH RESULTS

The Table gives the differences between the absolute time comparisons results and those derived from the data of Table 17 (before rounding-off)

A - CLOCK TRANSPORTATION

DATE 1987	MJD	TIME COMPARISONS	DIFFERENCE CLOCK TR. - BIH (Unit : 1 microsecond)
JAN 20	46815.05	UTC(TAO) - UTC(RRL)	-0.008
FEB 16	46842.66	UTC(CH) - UTC(PTB)	0.01
FEB 24	46850.63	UTC(CH) - UTC(PTB)	-0.01
FEB 25	46851.05	UTC(RRL) - UTC(TAO)	0.005
MAR 24	46878.08	UTC(TAO) - UTC(RRL)	0.001
APR 22	46907.21	UTC(RRL) - UTC(TAO)	-0.010
MAY 20	46935.05	UTC(TAO) - UTC(RRL)	0.013
MAY 22	46937.12	UTC(TAO) - UTC(NRLM)	-0.068
MAY 26	46941.02	UTC(TAO) - UTC(ILOM)	-0.261
JUN 18	46964.05	UTC(NPL) - UTC(SU)	1.199
JUN 24	46970.05	UTC(RRL) - UTC(TAO)	0.027
JUL 23	46999.07	UTC(TAO) - UTC(RRL)	0.014
AUG 25	47032.06	UTC(RRL) - UTC(TAO)	-0.031
SEP 13	47051.74	UTC(STA) - UTC(SU)	0.662
SEP 16	47054.35	UTC(YUZM) - UTC(OP)	0.0 *
SEP 18	47056.32	UTC(STA) - UTC(SU)	0.636
SEP 22	47060.05	UTC(TAO) - UTC(RRL)	0.026
NOV 2	47101.10	UTC(RRL) - UTC(TAO)	-0.015
NOV 4	47103.09	UTC(TAO) - UTC(NRLM)	-0.018
NOV 10	47109.00	UTC(TAO) - UTC(ILOM)	-0.009
NOV 24	47123.04	UTC(TAO) - UTC(RRL)	0.013

* New origin. See Table 17.

B - GPS TIME COMPARISONS WITH DIFFERENTIAL CALIBRATION OF RECEIVER DELAYS

DATE 1987	MJD	TIME COMPARISONS	DIFFERENCE GPS COMP. - BIH (Unit : 1 microsecond)
APR 14	46899.00	UTC(NBS) - UTC(USNO)	0.020
JUN 3	46949.00	UTC(OP) - UTC(OMSF)	0.012
SEP 1	47039.00	UTC(OP) - UTC(INPL)	0.018
DEC 30	47159.00	UTC(NBS) - UTC(OP)	-0.014

TABLE 19 - INTERNATIONAL ATOMIC TIME , BI-MONTHLY RATES OF TAI-CLOCK FOR 1987

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

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

LAB.	CLOCK		46849	46909	46969	47029	47099	47159
AOS	19	7	-164.96	-165.80	-205.25	-220.18	-220.83	-225.65
APL	14	773	-140.49	-141.22	-134.66	-142.12	-143.13	-146.56
APL	42	6	1.92	0.91	-0.02	-2.07	-1.21	-1.28
APL	42	13	1.99	2.78	-0.28	-1.59	0.71	0.85
APL	42	14	8.24	0.84	0.18	-2.49	-1.69	-0.53
ASMW	16	76	25.56	22.14	-17.59	-54.25	-57.15	-28.72
AUS	12	590	122.57	121.01	119.27	120.93	126.01	125.74
AUS	12	1708	-164.11	-188.27	-183.96	***	***	***
AUS	12	1823	-5.97	-6.79	-11.51	-23.18	-41.21	-32.87
AUS	12	2196	***	-48.91	***	***	***	***
AUS	14	902	-107.14	***	***	-116.64	-109.85	-95.32
AUS	14	1443	5.39	2.10	***	***	***	-2.01
AUS	14	1694	54.39	***	***	***	***	***
AUS	14	1719	27.35	28.30	26.93	28.81	***	32.39
AUS	14	1777	31.53	39.22	***	***	-152.25	-143.60
AUS	14	1844	43.43	40.78	38.94	31.46	31.66	39.23
AUS	14	2010	-49.82	-50.53	-44.66	-45.79	-47.01	-43.20
AUS	14	2020	-55.50	-53.21	-48.38	-45.56	-45.57	-46.21
AUS	44	1	25.39	28.59	***	***	***	0.39
AUS	44	2	38.06	38.33	35.22	36.11	36.87	37.76
AUS	44	3	***	***	-26.23	-30.17	***	***
BEV	16	71	-17.85	-32.16	-42.39	-43.87	-42.46	-39.91
CAO	16	52	***	***	-9.45	***	***	***
CAO	16	183	18.48	22.66	17.31	11.28	-5.07	0.13
CH	12	285	-28.60	***	***	-15.31	-16.92	-12.23
CH	12	863	-31.11	-28.89	-39.29	-44.64	-43.97	-32.87
CH	13	14	-4.91	10.32	-0.38	6.50	-0.46	10.68
CH	14	1156	32.77	15.07	1.81	***	***	***
CH	16	64	-2.99	-8.65	-24.91	-45.77	-24.97	3.56
CH	16	69	-91.83	-93.37	-105.93	-103.06	-108.75	-106.43
CH	16	77	15.60	13.66	8.48	9.96	2.18	5.81
CH	16	114	8.53	2.08	-8.57	***	***	-8.60
CH	16	140	115.23	111.37	58.70	-27.02	-5.28	70.63
CH	17	206	60.54	63.41	***	***	***	***
CH	17	208	-34.83	-32.00	-33.68	-29.67	-22.04	-27.50

TABLE 19 - (CONT.)

LAB.	CLOCK	46849	46909	46969	47029	47099	47159
CH	21 179	-65.07	-60.56	-60.11	-56.23	-55.11	-56.58
CH	21 194	115.53	111.96	104.39	100.76	100.53	100.42
CH	21 217	-141.10	-129.99	-128.06	-116.34	-103.57	-92.95
CH	21 243	23.54	17.45	3.95	-10.05	-0.96	-2.15
CSAO	12 1646	63.02	55.16	62.28	52.07	65.47	38.44
CSAO	12 1647	91.90	98.28	122.40	136.89	147.05	100.36
CSAO	12 1648	106.37	80.35	92.57	82.48	91.79	77.44
F	12 158	-181.63	***	***	***	***	***
F	12 439	***	***	-138.04	-139.85	-152.09	-159.35
F	12 475	230.75	223.66	210.37	***	***	***
F	12 2405	-329.13	-353.24	-358.88	-325.41	-326.73	-342.27
F	14 51	***	-134.82	-142.01	-158.93	-179.52	-176.21
F	14 134	-24.42	-19.89	-16.01	-2.55	5.56	-27.75
F	14 158	***	***	***	***	52.74	55.40
F	14 195	-100.45	-79.28	-75.85	-74.89	-74.05	-87.45
F	14 500	***	-7.84	-4.84	7.98	5.78	***
F	14 753	204.92	210.81	212.12	223.01	216.19	208.75
F	14 1120	-58.07	-58.95	-65.26	-55.83	-61.21	-58.06
F	14 1407	-145.93	-131.49	-129.24	-122.87	-133.41	-146.66
F	14 1645	***	***	21.58	14.81	3.87	-10.41
F	14 1712	***	***	***	***	-104.29	-111.09
F	16 106	***	-140.37	***	***	-305.02	***
F	16 187	-34.31	-25.72	-33.40	-41.21	-35.04	-33.54
FTZ	14 312	28.08	20.56	19.26	***	***	16.92
FTZ	14 895	15.03	9.87	14.64	11.24	12.42	22.75
FTZ	14 1217	16.43	10.49	10.10	4.20	19.01	27.06
FTZ	14 1482	***	***	20.84	29.72	42.61	42.42
FTZ	14 1656	***	15.86	16.37	13.83	20.34	24.43
FTZ	14 1674	14.96	14.52	18.27	14.39	18.52	16.75
FTZ	16 130	14.76	16.93	19.95	11.34	14.56	18.20
IEN	12 303	113.93	107.91	109.16	112.48	121.47	121.88
IEN	12 609	58.31	57.44	***	***	***	***
IEN	14 893	10.66	9.17	13.46	27.38	36.95	25.69
IEN	14 1230	-78.07	-79.84	-68.24	-37.78	-34.58	-71.38
IEN	16 84	153.86	144.52	***	117.65	123.79	141.71
IFAG	14 1105	-119.76	-118.32	-110.48	-120.87	-123.17	-130.25
IFAG	16 131	123.42	***	75.81	69.92	72.25	81.46
IFAG	16 138	***	***	***	***	-17.61	14.48
IFAG	16 173	128.07	145.61	152.90	149.47	168.17	***
ILOM	11 176	5632.61	6185.31	6754.68	9752.04	9885.70	8153.18

TABLE 19 - (CONT.)

LAB.	CLOCK	46849	46909	46969	47029	47099	47159
ILOM	14 614	-183.51	-158.80	-173.52	-212.78	-221.02	-243.85
ILOM	14 885	-19.80	-13.00	-11.98	-1.64	-4.19	-10.01
ILOM	14 1315	-86.01	-84.69	-91.23	-81.70	-84.93	-86.93
ILOM	14 2146	-32.73	-26.88	-27.63	-28.70	***	***
INPL	14 2308	***	***	***	***	***	-95.55
INPL	31 145	***	***	***	***	***	-125.05
KSRI	12 1403	-328.57	-343.88	-318.66	-302.37	-287.88	-268.15
KSRI	12 1406	217.12	224.21	285.53	271.55	242.84	134.98
KSRI	12 1903	1.45	-9.26	***	***	***	***
KSRI	14 1516	***	***	***	-114.31	-125.66	-53.72
NBS	12 352	-241.17	-236.08	-237.33	-246.65	-254.83	-261.84
NBS	13 61	-87.60	-95.63	-137.21	-139.19	-113.70	-87.71
NBS	14 323	-173.85	-177.07	-180.24	-183.12	-184.06	-183.08
NBS	14 324	-3.98	-1.55	0.69	8.14	2.02	-14.65
NBS	14 601	-97.76	-98.74	-95.74	***	***	-58.16
NBS	14 1316	-107.34	-108.18	-110.27	-110.02	-109.80	-111.62
NBS	14 1343	***	***	11027.46	11026.26	***	11029.17
NBS	14 1653	***	***	10964.88	***	***	***
NBS	14 2165	***	***	13624.05	13654.73	***	***
NBS	16 217	-54.48	-48.26	-42.41	-44.50	***	***
NBS	18 8	258.49	***	***	-22.95	-27.08	***
NBS	18 113	***	***	***	-363.47	-376.90	-381.15
NIM	12 1615	-1021.35	-975.33	-955.00	-1020.62	-1049.56	-285.41
NIM	12 1633	8.57	12.29	12.13	20.97	18.68	15.45
NIM	12 1640	-11.18	-12.98	-19.18	-5.02	18.57	18.83
NPL	12 316	***	-150.31	-166.69	-164.75	-173.38	-159.99
NPL	12 418	-114.89	-118.53	-109.08	-102.21	-134.65	-142.07
NPL	12 832	-302.69	-303.28	-300.74	-300.13	-286.05	-288.20
NPL	14 1334	***	***	***	***	-33.06	-32.33
NPL	14 1813	14.50	14.09	8.45	7.58	9.98	10.15
NPL	14 2064	-20.15	-10.62	-5.18	-7.75	0.15	-11.30
NRC	14 267	-31.49	-39.72	-40.31	-43.49	-38.03	-40.15
NRC	90 5	-1.11	1.79	-9.47	-14.90	-14.01	-8.77
NRC	90 61	-0.99	0.05	-5.74	-9.64	-2.83	5.72
NRC	90 62	9.14	2.48	4.97	2.25	-4.93	20.33
NRC	90 63	6.73	4.55	1.17	-9.67	-14.61	-10.81
NRLM	12 363	***	***	***	140.66	136.80	144.45
NRLM	14 906	-73.04	-76.70	-84.20	-93.22	-92.29	-84.67
NRLM	14 1632	-15.22	-14.30	-18.58	-20.88	-21.25	-18.21
OMH	12 1067	16.90	16.82	2.20	9.02	10.54	***

TABLE 19 - (CONT.)

LAB.	CLOCK	46849	46909	46969	47029	47099	47159
OMSF	12 1223	168.40	180.94	179.26	153.39	148.79	160.21
OMSF	14 1569	-16.20	-13.99	2.54	-21.31	-19.26	-12.50
OMSF	16 121	32.34	25.13	16.35	28.78	27.39	33.47
OMSF	16 177	-12.54	-18.93	-24.21	-22.88	-25.63	-27.60
ORB	12 205	-119.25	-147.47	-146.64	-148.52	-152.58	-155.20
ORB	12 804	***	***	-54.47	-70.78	-81.10	-90.02
PKNM	14 1144	-58.28	-43.30	-51.10	-17.00	-32.80	-36.08
PKNM	16 124	17.79	15.28	-48.38	-20.89	-35.48	-5.03
PKNM	16 125	***	***	***	6.60	-18.59	-21.85
PKNM	16 154	-77.99	-57.56	-106.14	-74.77	-101.09	-99.19
PTB	12 320	-57.53	-56.31	-60.56	-68.11	-59.96	-62.40
PTB	12 462	2.49	2.55	1.91	0.20	-3.51	-2.47
PTB	14 394	-31.99	-27.59	-28.82	-24.76	-22.89	-32.37
PTB	14 867	-188.26	-187.85	-189.92	-186.04	-184.74	-190.29
PTB	14 1103	-4.78	-1.82	-1.27	0.61	2.68	5.97
PTB	14 2379	-57.78	-60.79	-58.19	-45.77	-24.35	-25.60
PTB	16 119	11.79	-2.64	-9.20	-15.31	-5.79	11.33
PTB	92 1	1.49	2.99	-0.23	1.64	-1.65	0.21
PTB	92 2	-0.31	-0.88	-2.75	-3.23	-2.91	-1.95
RGO	12 348	-37.25	***	***	***	***	***
RGO	12 484	-198.20	***	***	***	***	***
RGO	14 202	-591.69	***	***	***	***	***
RGO	14 560	-57.04	***	***	***	***	***
RGO	14 868	-129.76	***	***	***	***	***
RGO	20 133	-329.48	***	***	***	***	***
RRL	12 1725	-56.50	***	***	***	***	***
RRL	14 764	-106.80	-112.55	-104.13	-115.09	-118.29	-113.33
RRL	14 865	-315.99	-314.84	***	***	***	-100.57
RRL	14 932	-163.30	-158.41	-148.52	-140.32	-133.55	-144.25
RRL	14 1729	-154.51	-150.66	-138.78	-131.43	***	-120.82
RRL	14 2456	-16.80	-15.54	-11.72	-6.73	-20.34	-49.66
RRL	31 131	***	***	-18.77	-12.64	-11.63	7.57
RRL	45 3	53.54	55.47	53.40	58.63	63.55	67.38
SO	12 67	-17.63	-4.19	59.46	83.02	46.24	19.84
SO	12 997	-93.99	-86.38	-85.50	-89.79	-84.77	-98.64
SO	14 574	-27.47	-28.43	-19.64	-23.59	-11.61	-42.00
SO	16 180	15.48	17.59	27.29	34.02	38.93	39.51
STA	14 900	-61.60	-68.26	-72.31	-61.93	-72.92	-69.62
STA	14 1376	-80.67	-82.52	-81.38	-70.26	-72.56	-74.27
STA	16 137	33.45	-122.41	-132.69	-128.16	-127.57	-97.06

TABLE 19 - (CONT.)

LAB.	CLOCK	46849	46909	46969	47029	47099	47159
SU	40 381	-5.54	-19.08	-8.22	-7.76	-3.68	***
SU	40 382	-5.64	-19.13	-8.23	-7.77	-3.81	***
TAO	12 204	223.63	225.46	***	***	***	***
TAO	14 390	-75.89	-71.42	-77.20	-81.49	-83.39	-74.45
TAO	14 1075	-31.20	-30.43	-34.30	-35.70	-33.57	-30.00
TAO	14 1498	-116.02	***	-131.35	-138.52	-150.85	-154.35
TAO	14 2494	-8.52	-8.54	-10.15	-12.13	-10.08	-9.34
TL	12 1145	96.73	123.45	125.06	165.04	152.82	138.77
TL	12 1455	142.86	152.08	153.65	144.16	145.09	143.40
TL	12 2276	***	-51.03	-52.75	-58.62	-55.10	-61.40
TP	12 335	6.07	8.93	10.47	16.54	8.34	18.40
TUG	12 524	89.97	91.53	94.61	90.90	90.59	89.32
TUG	14 1654	23.60	25.22	26.82	25.56	26.21	25.87
TUG	18 108	***	173.68	209.41	220.38	235.96	253.42
USNO	12 573	-11.23	-6.52	-7.50	-9.23	-8.82	-7.96
USNO	12 752	-52.11	-32.62	-42.75	-52.32	-29.86	88.23
USNO	12 778	227.27	223.86	228.82	229.01	233.30	***
USNO	14 116	***	-58.85	-59.26	-60.63	***	-92.16
USNO	14 444	***	413.04	396.66	397.94	397.70	332.01
USNO	14 571	***	***	***	21.14	***	***
USNO	14 583	***	***	***	***	***	-43.18
USNO	14 653	32.89	37.96	45.66	43.97	***	***
USNO	14 656	***	50.25	-152.16	-171.43	-171.20	-173.47
USNO	14 834	-95.12	-81.37	-87.80	-93.62	-93.82	-96.12
USNO	14 837	-19.88	-17.07	-4.21	3.49	3.32	-8.14
USNO	14 854	***	***	***	154.68	***	***
USNO	14 862	205.99	237.09	271.90	277.87	272.19	266.65
USNO	14 871	98.76	107.32	102.38	88.49	***	***
USNO	14 875	-122.08	-121.12	-122.07	-125.84	-119.86	-114.39
USNO	14 1028	***	-320.95	-293.55	-290.47	***	***
USNO	14 1035	-104.80	-94.51	-90.38	-95.63	-92.41	-87.21
USNO	14 1094	***	***	***	-173.84	-172.59	-180.21
USNO	14 1104	***	***	***	***	***	-32.68
USNO	14 1114	***	***	***	***	-61.69	***
USNO	14 1117	-71.52	-70.54	-61.07	-53.35	-60.41	-61.23
USNO	14 1300	-307.30	-300.46	-291.77	-288.94	-284.83	-290.99
USNO	14 1301	-152.64	-152.56	***	-106.64	***	***
USNO	14 1305	***	-95.44	***	***	***	***
USNO	14 1362	***	-526.65	-520.80	-526.91	-523.29	-398.69
USNO	14 1423	-45.79	-48.65	-44.20	-40.48	***	***

TABLE 19 - (CONT.)

LAB.	CLOCK	46849	46909	46969	47029	47099	47159
USNO	14 1452	49.48	***	***	***	***	***
USNO	14 1586	-98.18	-91.61	***	-64.23	-85.90	***
USNO	14 1605	39.61	45.57	46.58	47.11	40.34	43.83
USNO	14 1809	-129.03	-134.74	-141.56	-136.22	-138.51	***
USNO	14 1846	-25.67	-28.32	-24.63	-24.78	-28.17	-26.52
USNO	14 2081	***	-353.03	***	***	***	***
USNO	14 2098	7.44	6.47	***	-135.66	***	23.77
USNO	14 2100	-111.85	-116.59	-112.94	-118.08	-118.81	-120.54
USNO	14 2277	***	***	-164.88	-156.42	***	***
USNO	14 2312	-111.09	-121.25	-129.48	-117.68	***	-114.97
USNO	14 2314	***	***	***	-40.81	-43.66	-56.02
USNO	14 2481	-32.43	-29.53	-28.95	-27.26	-25.41	-22.56
USNO	14 2482	-37.51	-41.84	-37.86	-35.34	-34.20	-33.57
USNO	14 2483	-44.02	-42.96	-42.74	-42.26	-40.40	-49.09
USNO	14 2484	-78.60	-81.83	-84.64	-87.48	-92.28	-95.48
USNO	14 2485	-166.87	-168.88	-176.95	-183.29	-176.21	-181.68
USNO	14 2486	-21.92	-18.53	-18.93	***	-13.59	-20.12
USNO	14 2487	-37.75	-52.40	-45.63	-41.33	-25.11	***
USNO	18 133	-9.53	***	***	***	***	***
USNO	40 18	-3.44	***	***	***	***	***
USNO	40 19	-3.42	***	***	***	***	***
USNO	43 8	-6.41	***	1.84	1.52	8.34	***
VSL	12 349	66.43	65.88	***	***	55.00	***
VSL	12 1489	-391.18	-402.03	-408.03	-464.46	-475.98	-548.26
VSL	14 503	-143.34	-160.08	-145.77	-135.97	-145.39	-140.78
VSL	14 1034	-80.39	-80.24	-82.77	-79.73	-79.58	-80.81
YUZM	12 1189	-101.20	-69.77	-28.34	1.77	***	-5.19
ZIPE	12 979	-177.26	-190.31	-203.62	-204.16	-217.05	-223.91

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

The codes for the types are

11 HEWLETT-PACKARD 5060A
12 HEWLETT-PACKARD 5061A
13 EBAUCHES , OSCILLATOM B5000
14 HEWLETT-PACKARD 5061A OPT.4
16 OSCILLOQUARTZ 3200
17 OSCILLOQUARTZ 3000
18 FREQ. AND TIME SYSTEMS INC. 4000
19 ROHDE AND SCHWARZ XSC
20 FREQ. AND TIME SYSTEMS INC. 5000
21 OSCILLOQUARTZ 3210
25 HEWLETT-PACKARD 5062C
30 HEWLETT-PACKARD 5061B
31 HEWLETT-PACKARD 5061B OPT. 4
4x HYDROGEN MASERS
9x PRIMARY CLOCKS AND PROTOTYPES

TABLE 20 - INTERNATIONAL ATOMIC TIME , WEIGHTS OF THE CLOCKS FOR 1987

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

*** DENOTES THAT THE CLOCK WAS NOT USED

LAB.	CLOCK	46849	46909	46969	47029	47099	47159
AOS	19 7	0	200	14	10	11	13
APL	14 773	87	200	200	196	200	200
APL	42 6	200	200	200	200	200	200
APL	42 13	200	200	200	200	200	200
APL	42 14	200	196	200	200	200	200
ASMW	16 76	25	23	21	11	7	8
AUS	12 590	191	200	200	200	200	200
AUS	12 1708	200	29	39	***	***	***
AUS	12 1823	200	200	200	175	54	46
AUS	12 2196	***	0	***	***	***	***
AUS	14 902	200	***	***	0	199	62
AUS	14 1443	147	200	***	***	***	0
AUS	14 1694	0	***	***	***	***	***
AUS	14 1719	200	200	200	200	***	0
AUS	14 1777	200	153	***	***	0	175
AUS	14 1844	200	200	200	196	200	196
AUS	14 2010	112	140	121	200	200	200
AUS	14 2020	0	200	200	200	200	200
AUS	44 1	200	200	***	***	***	0
AUS	44 2	200	200	200	200	200	200
AUS	44 3	***	***	0	0	***	***
BEV	16 71	32	115	149	114	101	99
CAO	16 52	***	***	0	***	***	***
CAO	16 183	76	61	53	61	63	82
CH	12 285	19	***	***	0	200	200
CH	12 863	200	200	182	200	174	178
CH	13 14	36	25	38	34	198	178
CH	14 1156	24	15	12	***	***	***
CH	16 64	25	22	29	32	39	30
CH	16 69	200	200	171	200	190	193
CH	16 77	200	200	200	200	194	200
CH	16 114	52	54	101	***	***	0
CH	16 140	0	2	0	0	3	0
CH	17 206	200	200	***	***	***	***
CH	17 208	200	200	200	200	195	200

TABLE 20 - (CONT.)

LAB.	CLOCK	46849	46909	46969	47029	47099	47159
CH	21 179	200	200	200	200	200	200
CH	21 194	200	200	196	164	164	200
CH	21 217	81	76	70	56	42	31
CH	21 243	0	200	72	37	49	61
CSAO	12 1646	162	194	197	182	166	98
CSAO	12 1647	9	12	17	20	22	1
CSAO	12 1648	115	66	64	54	53	86
F	12 158	25	***	***	***	***	***
F	12 439	***	***	0	200	123	78
F	12 475	88	79	113	***	***	***
F	12 2405	10	8	8	11	31	47
F	14 51	***	0	198	47	21	23
F	14 134	128	105	119	125	78	58
F	14 158	***	***	***	***	0	200
F	14 195	60	61	64	72	63	93
F	14 500	***	0	200	101	133	***
F	14 753	112	200	200	143	159	195
F	14 1120	200	200	200	186	200	200
F	14 1407	186	161	200	163	165	109
F	14 1645	***	***	0	199	90	41
F	14 1712	***	***	***	***	0	198
F	16 106	***	0	***	***	0	***
F	16 187	0	170	195	194	200	200
FTZ	14 312	200	196	200	***	***	0
FTZ	14 895	200	200	200	200	200	182
FTZ	14 1217	13	21	30	41	38	154
FTZ	14 1482	***	***	0	159	60	73
FTZ	14 1656	***	0	200	200	200	200
FTZ	14 1674	200	200	200	200	200	200
FTZ	16 130	198	200	200	190	200	200
IEN	12 303	198	200	186	200	188	200
IEN	12 609	140	108	***	***	***	***
IEN	14 893	145	104	94	106	79	79
IEN	14 1230	0	200	175	21	19	24
IEN	16 84	31	28	***	0	200	47
IFAG	14 1105	196	200	168	181	200	197
IFAG	16 131	116	***	0	200	200	188
IFAG	16 138	***	***	***	***	0	12
IFAG	16 173	8	8	10	13	13	***
ILOM	11 176	0	0	0	0	0	0

TABLE 20 - (CONT.)

LAB.	CLOCK	46849	46909	46969	47029	47099	47159
ILOM	14 614	14	15	16	14	14	10
ILOM	14 885	192	173	186	115	186	200
ILOM	14 1315	0	200	200	186	200	200
ILOM	14 2146	200	200	200	200	***	***
INPL	14 2308	***	***	***	***	***	0
INPL	31 145	***	***	***	***	***	0
KSRI	12 1403	45	30	43	41	25	13
KSRI	12 1406	18	29	0	11	12	0
KSRI	12 1903	198	180	***	***	***	***
KSRI	14 1516	***	***	***	0	97	0
NBS	12 352	200	200	200	187	175	94
NBS	13 61	15	13	14	17	19	18
NBS	14 323	200	200	200	200	200	200
NBS	14 324	42	32	32	50	200	150
NBS	14 601	175	147	171	***	***	0
NBS	14 1316	200	200	200	200	200	200
NBS	14 1343	***	***	0	200	***	0
NBS	14 1653	***	***	0	***	***	***
NBS	14 2165	***	***	0	13	***	***
NBS	16 217	65	55	70	102	***	***
NBS	18 8	200	***	***	0	200	***
NBS	18 113	***	***	***	0	70	83
NIM	12 1615	11	5	13	0	8	0
NIM	12 1633	127	173	200	172	175	200
NIM	12 1640	163	152	148	163	56	36
NPL	12 316	***	0	48	91	87	124
NPL	12 418	70	62	67	184	72	42
NPL	12 832	180	200	200	200	128	169
NPL	14 1334	***	***	***	***	0	200
NPL	14 1813	200	200	200	200	200	200
NPL	14 2064	181	186	200	200	189	175
NRC	14 267	200	192	190	179	200	200
NRC	90 5	200	200	178	192	149	200
NRC	90 61	200	200	182	145	199	191
NRC	90 62	200	200	200	200	197	109
NRC	90 63	200	200	200	179	124	123
NRLM	12 363	***	***	***	0	200	195
NRLM	14 906	200	200	196	146	120	153
NRLM	14 1632	200	200	200	200	200	200
OMH	12 1067	55	52	53	199	200	***

TABLE 20 - (CONT.)

LAB.	CLOCK	46849	46909	46969	47029	47099	47159
OMSF	12 1223	32	33	144	74	55	56
OMSF	14 1569	54	142	105	115	105	137
OMSF	16 121	159	197	190	171	200	200
OMSF	16 177	86	100	200	200	193	200
ORB	12 205	9	13	14	47	41	59
ORB	12 804	***	***	0	47	40	35
PKNM	14 1144	47	45	38	42	41	46
PKNM	16 124	16	16	0	11	10	14
PKNM	16 125	***	***	***	0	20	30
PKNM	16 154	14	16	0	14	15	27
PTB	12 320	200	200	200	195	193	200
PTB	12 462	80	102	113	124	200	200
PTB	14 394	200	200	200	200	200	185
PTB	14 867	200	200	200	200	200	200
PTB	14 1103	200	200	200	200	200	200
PTB	14 2379	194	200	200	171	54	36
PTB	16 119	13	13	18	98	120	82
PTB	92 1	200	200	200	200	200	200
PTB	92 2	200	200	200	200	200	200
RGO	12 348	200	***	***	***	***	***
RGO	12 484	185	***	***	***	***	***
RGO	14 202	25	***	***	***	***	***
RGO	14 560	197	***	***	***	***	***
RGO	14 868	200	***	***	***	***	***
RGO	20 133	25	***	***	***	***	***
RRL	12 1725	24	***	***	***	***	***
RRL	14 764	200	200	191	179	200	200
RRL	14 865	196	200	***	***	***	0
RRL	14 932	126	150	183	150	76	79
RRL	14 1729	161	200	173	136	***	0
RRL	14 2456	200	200	200	200	165	43
RRL	31 131	***	***	0	200	200	63
RRL	45 3	0	0	0	200	200	200
SO	12 67	10	9	0	7	6	7
SO	12 997	200	195	200	200	200	163
SO	14 574	0	200	189	200	174	82
SO	16 180	200	200	165	91	80	90
STA	14 900	184	200	200	181	178	200
STA	14 1376	200	200	200	178	200	200
STA	16 137	0	0	1	1	2	2

TABLE 20 - (CONT.)

LAB.	CLOCK	46849	46909	46969	47029	47099	47159
SU	40 381	0	0	0	0	0	***
SU	40 382	0	0	0	0	0	***
TAO	12 204	6	18	***	***	***	***
TAO	14 390	180	200	200	200	200	189
TAO	14 1075	200	200	200	200	200	200
TAO	14 1498	200	***	0	197	74	70
TAO	14 2494	200	200	200	200	200	200
TL	12 1145	18	19	24	15	12	17
TL	12 1455	57	40	39	39	48	200
TL	12 2276	***	0	200	200	200	200
TP	12 335	151	187	200	200	192	184
TUG	12 524	187	200	200	200	200	200
TUG	14 1654	200	200	200	200	200	200
TUG	18 108	***	0	10	12	12	10
USNO	12 573	19	56	200	200	200	200
USNO	12 752	0	3	3	5	13	0
USNO	12 778	200	200	200	200	200	***
USNO	14 116	***	0	200	200	***	0
USNO	14 444	***	0	48	88	134	0
USNO	14 571	***	***	***	0	***	***
USNO	14 583	***	***	***	***	***	0
USNO	14 653	191	185	106	137	***	***
USNO	14 656	***	0	0	0	1	1
USNO	14 834	79	35	28	37	63	200
USNO	14 837	165	162	161	125	100	99
USNO	14 854	***	***	***	0	***	***
USNO	14 862	200	79	16	10	9	12
USNO	14 871	182	190	200	164	***	***
USNO	14 875	200	200	200	200	200	200
USNO	14 1028	***	0	17	25	***	***
USNO	14 1035	171	119	83	97	154	200
USNO	14 1094	***	***	***	0	200	194
USNO	14 1104	***	***	***	***	***	0
USNO	14 1114	***	***	***	***	0	***
USNO	14 1117	200	200	185	194	198	200
USNO	14 1300	172	199	189	199	148	143
USNO	14 1301	199	200	***	0	***	***
USNO	14 1305	***	0	***	***	***	***
USNO	14 1362	***	0	200	200	200	0
USNO	14 1423	200	200	200	200	***	***

TABLE 20 - (CONT.)

LAB.	CLOCK	46849	46909	46969	47029	47099	47159
USNO	14 1452	200	***	***	***	***	***
USNO	14 1586	200	200	***	0	27	***
USNO	14 1605	170	158	112	112	170	200
USNO	14 1809	148	200	200	200	200	***
USNO	14 1846	200	200	200	200	200	200
USNO	14 2081	***	0	***	***	***	***
USNO	14 2098	144	200	***	0	***	0
USNO	14 2100	121	200	200	200	200	200
USNO	14 2277	***	***	0	175	***	***
USNO	14 2312	3	4	17	17	***	0
USNO	14 2314	***	***	***	0	200	108
USNO	14 2481	200	200	200	200	200	200
USNO	14 2482	200	200	200	200	200	200
USNO	14 2483	200	200	200	200	200	189
USNO	14 2484	200	200	200	200	200	200
USNO	14 2485	77	93	82	100	150	200
USNO	14 2486	79	159	174	***	0	200
USNO	14 2487	174	117	102	101	84	***
USNO	18 133	0	***	***	***	***	***
USNO	40 18	0	***	***	***	***	***
USNO	40 19	0	***	***	***	***	***
USNO	43 8	0	***	0	0	0	***
VSL	12 349	0	200	***	***	0	***
VSL	12 1489	171	97	60	0	7	0
VSL	14 503	146	150	161	160	160	149
VSL	14 1034	200	200	200	200	200	200
YUZM	12 1189	9	8	10	8	***	0
ZIPE	12 979	200	168	72	72	44	34

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

The codes for the types are

11 HEWLETT-PACKARD 5060A
12 HEWLETT-PACKARD 5061A
13 EBAUCHES , OSCILLATOM B5000
14 HEWLETT-PACKARD 5061A OPT.4
16 OSCILLOQUARTZ 3200
17 OSCILLOQUARTZ 3000
18 FREQ. AND TIME SYSTEMS INC. 4000
19 ROHDE AND SCHWARZ XSC
20 FREQ. AND TIME SYSTEMS INC. 5000
21 OSCILLOQUARTZ 3210
25 HEWLETT-PACKARD 5062C
30 HEWLETT-PACKARD 5061B
31 HEWLETT-PACKARD 5061B OPT. 4
4x HYDROGEN MASERS
9x PRIMARY CLOCKS AND PROTOTYPES

TABLE 21 - MEASUREMENTS OF THE EAL AND TAI FREQUENCY

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

f(EAL) - f(STANDARD) IN 10**-13

INTERVAL MJD	CENTRAL DATE	NRC CsV	NRC CsVIA	NRC CsVIB	NRC CsVIC	PTB CS1	PTB CS2
45309-45389	1983 JAN 15	7.86	6.36	6.26	6.10	8.62	
45389-45469	1983 APR 5	8.32	7.37	8.55	8.11	8.52	
45469-45549	1983 JUN 24	7.15	6.35	8.62	6.96	8.06	
45549-45629	1983 SEP 12	7.44	6.94	7.17	6.62	7.98	
45629-45699	1983 NOV 25	7.54	6.97	7.05	6.95	8.10	
45699-45759	1984 JAN 30	8.58	8.50	8.36	8.23	8.59	
45759-45819	1984 MAR 30	8.49	8.43	8.21	8.26	8.65	
45819-45879	1984 MAY 29	-	5.78	7.41	7.38	8.43	
45879-45939	1984 JUL 28	7.18	7.30	6.84	6.57	7.91	
45939-45999	1984 SEP 26	7.04	7.45	8.08	6.38	8.19	
45999-46059	1984 NOV 25	6.40	7.07	8.20	6.95	8.43	
46059-46119	1985 JAN 24	7.19	8.81	8.45	7.72	8.66	
46119-46179	1985 MAR 25	7.51	7.52	8.05	7.82	8.19	
46179-46239	1985 MAY 24	8.27	8.03	6.52	8.17	8.36	
46239-46299	1985 JUL 23	8.47	8.04	7.03	7.08	8.17	
46299-46369	1985 SEP 26	8.58	6.86	7.55	7.03	7.93	
46369-46429	1985 NOV 30	8.47	9.22	9.90	6.74	8.57	
46429-46489	1986 JAN 29	8.70	8.93	9.69	8.21	8.58	
46489-46549	1986 MAR 30	8.62	8.68	9.62	8.16	8.36	
46549-46609	1986 MAY 29	8.81	8.39	8.78	8.63	8.05	
46609-46669	1986 JUL 28	8.11	9.25	9.02	8.80	7.85	
46669-46729	1986 SEP 26	8.05	9.77	9.35	9.17	8.02	7.61
46729-46789	1986 NOV 25	8.56	8.53	8.99	8.79	8.06	7.85
46789-46849	1987 JAN 24	7.99	8.01	9.18	8.90	8.18	7.98
46849-46909	1987 MAR 25	8.33	8.13	8.41	8.65	8.36	7.91
46909-46969	1987 MAY 24	7.03	7.46	8.70	8.26	7.99	7.69
46969-47029	1987 JUL 23	6.40	7.01	8.38	7.00	8.20	7.64
47029-47099	1987 SEP 26	6.50	7.79	7.55	6.43	7.82	7.68
47099-47159	1987 NOV 30	7.11	8.78	10.48	6.87	8.04	7.79

TABLE 21 - (CONT.)

f(EAL) - f(STANDARD) IN 10**-13

INTERVAL MJD	CENTRAL DATE	NBS NBS6	RRL CS1	SU MCsR 101	SU MCsR 102
45428-45449	1983 APR 15				8.16
45457-45474	1983 MAY 12				7.13
45489-45569	1983 JUL 14	7.34			
45579-45585	1983 SEP 5				7.59
45702-45722	1984 JAN 13			6.02	
45789-45849	1984 APR 29		6.45		
45794-45836	1984 APR 25			6.74	
45889-45949	1984 AUG 17	7.24			
45949-45967	1984 SEP 15				6.22
45959-46019	1984 OCT 16	7.70			
45983-46004	1984 OCT 21				5.93
45999-46059	1984 NOV 25		7.53		
46005-46034	1984 NOV 16				6.12
46054-46059	1984 DEC 23				6.37
46079-46139	1985 FEB 13		7.54		
46080-46096	1985 JAN 23				6.14
46100-46110	1985 FEB 9				5.78
46156-46159	1985 APR 3				6.23
46201-46216	1985 MAY 24			5.87	
46230-46244	1985 JUN 21			7.04	
46247-46277	1985 JUL 16			6.39	
46279-46300	1985 AUG 13			5.75	
46312-46335	1985 SEP 16			6.84	
46339-46367	1985 OCT 15			5.90	
46370-46381	1985 NOV 7			5.83	
46502-46516	1986 MAR 20				5.87
46509-46569	1986 APR 19		7.22		
46521-46543	1986 APR 12				5.61
46563-46580	1986 MAY 22				5.76
46585-46600	1986 JUN 11				5.28
46684-46732	1986 OCT 5			5.99	
46737-46762	1986 NOV 16			5.58	
46773-46794	1986 DEC 19				5.35
46801-46816	1987 JAN 14				5.06
46886-46914	1987 APR 14			5.37	
46919-46941	1987 MAY 15			5.67	
46947-46976	1987 JUN 15			6.11	
46959-47019	1987 JUL 13	9.65			
46977-46998	1987 JUL 11			6.09	
47061-47063	1987 SEP 24			5.59	
47083-47097	1987 OCT 21				5.76
47098-47124	1987 NOV 13				5.76
47130-47150	1987 DEC 11				5.36

TABLE 21 - (CONT.)

f(TAI) - f(STANDARD) IN 10**-13

INTERVAL MJD	CENTRAL DATE	NRC CsV	NRC CsVIA	NRC CsVIB	NRC CsVIC	PTB CS1	PTB CS2
45309-45389	1983 JAN 15	0.06	-1.44	-1.54	-1.70	0.82	
45389-45469	1983 APR 5	0.52	-0.43	0.75	0.31	0.72	
45469-45549	1983 JUN 24	-0.65	-1.45	0.82	-0.84	0.26	
45549-45629	1983 SEP 12	-0.36	-0.86	-0.63	-1.18	0.18	
45629-45699	1983 NOV 25	-0.26	-0.83	-0.75	-0.85	0.30	
45699-45759	1984 JAN 30	0.78	0.70	0.56	0.43	0.79	
45759-45819	1984 MAR 30	0.49	0.43	0.21	0.26	0.65	
45819-45879	1984 MAY 29	-	-2.22	-0.59	-0.62	0.43	
45879-45939	1984 JUL 28	-0.82	-0.70	-1.16	-1.43	-0.09	
45939-45999	1984 SEP 26	-0.96	-0.55	0.08	-1.62	0.19	
45999-46059	1984 NOV 25	-1.60	-0.93	0.20	-1.05	0.43	
46059-46119	1985 JAN 24	-0.81	0.81	0.45	-0.28	0.66	
46119-46179	1985 MAR 25	-0.49	-0.48	0.05	-0.18	0.19	
46179-46239	1985 MAY 24	0.27	0.03	-1.48	0.18	0.36	
46239-46299	1985 JUL 23	0.47	0.04	-0.97	-0.92	0.17	
46299-46369	1985 SEP 26	0.58	-1.14	-0.45	-0.97	-0.07	
46369-46429	1985 NOV 30	0.47	1.22	1.90	-1.26	0.57	
46429-46489	1986 JAN 29	0.70	0.93	1.69	0.21	0.58	
46489-46549	1986 MAR 30	0.62	0.68	1.62	0.16	0.36	
46549-46609	1986 MAY 29	0.81	0.39	0.78	0.63	0.05	
46609-46669	1986 JUL 28	0.11	1.25	1.02	0.80	-0.15	
46669-46729	1986 SEP 26	0.05	1.77	1.35	1.17	0.02	-0.39
46729-46789	1986 NOV 25	0.56	0.53	0.99	0.79	0.06	-0.15
46789-46849	1987 JAN 24	-0.02	0.00	1.17	0.89	0.17	-0.04
46849-46909	1987 MAR 25	0.32	0.12	0.40	0.64	0.35	-0.10
46909-46969	1987 MAY 24	-0.99	-0.55	0.69	0.25	-0.03	-0.32
46969-47029	1987 JUL 23	-1.61	-1.01	0.37	-1.01	0.19	-0.37
47029-47099	1987 SEP 26	-1.51	-0.22	-0.46	-1.58	-0.19	-0.34
47099-47159	1987 NOV 30	-0.91	0.77	2.46	-1.14	0.02	-0.23

TABLE 21 - (CONT.)

f(TAI) - f(STANDARD) IN 10**-13

INTERVAL MJD	CENTRAL DATE	NBS NBS6	RRL CS1	SU MCsR 101	SU MCsR 102
45428-45449	1983 APR 15				0.36
45457-45474	1983 MAY 12				-0.67
45489-45569	1983 JUL 14	-0.46			
45579-45585	1983 SEP 5				-0.21
45702-45722	1984 JAN 13			-1.78	
45789-45849	1984 APR 29		-1.55		
45794-45836	1984 APR 25			-1.26	
45889-45949	1984 AUG 17	-0.76			
45949-45967	1984 SEP 15				-1.78
45959-46019	1984 OCT 16	-0.30			
45983-46004	1984 OCT 21				-2.07
45999-46059	1984 NOV 25		-0.47		
46005-46034	1984 NOV 16				-1.88
46054-46059	1984 DEC 23				-1.63
46079-46139	1985 FEB 13		-0.46		
46080-46096	1985 JAN 23				-1.86
46100-46110	1985 FEB 9				-2.22
46156-46159	1985 APR 3				-1.77
46201-46216	1985 MAY 24			-2.13	
46230-46244	1985 JUN 21			-0.96	
46247-46277	1985 JUL 16			-1.61	
46279-46300	1985 AUG 13			-2.25	
46312-46335	1985 SEP 16			-1.16	
46339-46367	1985 OCT 15			-2.10	
46370-46381	1985 NOV 7			-2.17	
46502-46516	1986 MAR 20				-2.13
46509-46569	1986 APR 19		-0.78		
46521-46543	1986 APR 12				-2.39
46563-46580	1986 MAY 22				-2.24
46585-46600	1986 JUN 11				-2.72
46684-46732	1986 OCT 5			-2.01	
46737-46762	1986 NOV 16			-2.42	
46773-46794	1986 DEC 19				-2.65
46801-46816	1987 JAN 14				-2.94
46886-46914	1987 APR 14			-2.64	
46919-46941	1987 MAY 15			-2.34	
46947-46976	1987 JUN 15			-1.09	
46959-47019	1987 JUL 13	1.64			
46977-46998	1987 JUL 11			-1.92	
47061-47063	1987 SEP 24			-2.42	
47083-47097	1987 OCT 21				-2.26
47098-47124	1987 NOV 13				-2.26
47130-47150	1987 DEC 11				-2.66

TABLE 22 - MEAN DURATION OF THE TAI SCALE INTERVAL IN SI SECOND AT SEA LEVEL.

FOR THE MONTHS	MEAN DURATION	UNCERTAINTY (one sigma)
1981 JAN - FEB	1 - 0.3*10**-13	0.5*10**-13
1981 MAR - APR	- 0.4	0.5
1981 MAY - JUN	+ 0.0	0.5
1981 JUL - AUG	+ 0.6	0.5
1981 SEP - OCT	+ 0.8	0.5
1981 NOV - DEC	+ 0.5	0.5
1982 JAN - FEB	1 + 0.1*10**-13	0.5*10**-13
1982 MAR - APR	+ 0.0	0.5
1982 MAY - JUN	+ 0.2	0.5
1982 JUL - AUG	+ 0.5	0.5
1982 SEP - OCT	+ 0.5	0.5
1982 NOV - DEC	+ 0.3	0.5
1983 JAN - FEB	1 - 0.1*10**-13	0.5*10**-13
1983 MAR - APR	- 0.2	0.5
1983 MAY - JUN	- 0.1	0.5
1983 JUL - AUG	+ 0.1	0.5
1983 SEP - OCT	+ 0.1	0.5
1983 NOV - DEC	+ 0.0	0.5
1984 JAN - FEB	1 - 0.2*10**-13	0.5*10**-13
1984 MAR - APR	- 0.0	0.5
1984 MAY - JUN	+ 0.2	0.5
1984 JUL - AUG	+ 0.3	0.5
1984 SEP - OCT	+ 0.4	0.5
1984 NOV - DEC	+ 0.3	0.5
1985 JAN - FEB	1 + 0.2*10**-13	0.5*10**-13
1985 MAR - APR	+ 0.2	0.5
1985 MAY - JUN	+ 0.2	0.5
1985 JUL - AUG	+ 0.1	0.5
1985 SEP - OCT	+ 0.1	0.5
1985 NOV - DEC	- 0.1	0.5
1986 JAN - FEB	1 - 0.3*10**-13	0.5*10**-13
1986 MAR - APR	- 0.2	0.5
1986 MAY - JUN	- 0.2	0.5
1986 JUL - AUG	- 0.1	0.5
1986 SEP - OCT	- 0.1	0.5
1986 NOV - DEC	- 0.0	0.5
1987 JAN - FEB	1 - 0.0*10**-13	0.5*10**-13
1987 MAR - APR	+ 0.0	0.5
1987 MAY - JUN	+ 0.2	0.5
1987 JUL - AUG	+ 0.3	0.5
1987 SEP - OCT	+ 0.3	0.5
1987 NOV - DEC	+ 0.2	0.5

ADDENDUM TO TABLE 17 - COORDINATED UNIVERSAL TIME

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

Unit is one microsecond

DATE 1987	MJD	UTC - UTC(i) IGMA (1)	INTI (2)	ONBA (3)	NPRL (1)
JAN 4	46799	-12.979	22	-64.37	-23.11
JAN 14	46809	-13.009	22	-65.53	-23.52
JAN 24	46819	-12.829	21	-66.23	-23.93
FEB 3	46829	-12.659	22	-66.98	-23.53
FEB 13	46839	-12.606	22	-67.79	-23.51
FEB 23	46849	-12.518	20	-68.64	-23.86
MAR 5	46859	-12.433	21	-68.86	-24.07
MAR 15	46869	-12.258	-	-69.84	-24.39
MAR 25	46879	-12.096	21	-70.38	-24.87
APR 4	46889	-11.935	20	-71.08	-25.23
APR 14	46899	-11.825	19	-71.59	-25.43
APR 24	46909	-11.683	20	-71.81	-25.76
MAY 4	46919	-11.600	20	-72.31	-26.29
MAY 14	46929	-11.421	19	-72.85	-26.72
MAY 24	46939	-11.315	18	-73.55	-26.90
JUN 3	46949	-11.337	19	-74.80	-27.24
JUN 13	46959	-11.311	20	-75.84	-27.09
JUN 23	46969	-11.218	19.85	-76.98	-27.19
JUL 3	46979	-11.133	19.42	77.68	-27.24
JUL 13	46989	-11.045	18.34	-78.88	-27.30
JUL 23	46999	-10.907	17.44	-9.92	-27.38
AUG 2	47009	-10.785	16.42	-80.93	-27.64
AUG 12	47019	-10.668	15.83	-81.96	-27.78
AUG 22	47029	-10.492	15.94	-83.10	-28.09
SEP 1	47039	-10.354	16.08	-84.32	-28.31
SEP 11	47049	-10.164	16.33	-85.58	-28.68
SEP 21	47059	-9.976	16.40	-86.76	-28.98
OCT 1	47069	-9.804	16.07	-87.82	-29.30
OCT 11	47079	-9.216	15.86	-88.96	-29.56
OCT 21	47089	-9.118	16.98	-90.20	-29.95
OCT 31	47099	-9.036	16.89	-91.40	-30.40
NOV 10	47109	-9.013	17.19	-92.58	-30.80
NOV 20	47119	-9.009	17.26	-93.34	-31.15
NOV 30	47129	-8.928	17.15	-94.11	-31.58
DEC 10	47139	-8.812	16.52	-94.59	-32.07
DEC 20	47149	-8.692	16.58	-	-32.27
DEC 30	47159	-8.618	16.61	-	-32.59

NOTES

(1) IGMA, NPRL . GPS tracking results, computed respectively by IGMA and NPRL.
(2) INTI . Since MJD=46969, the listed values use the GPS receptions at IGMA.
(3) ONBA . The step of 2000 μs between MJD=46789 and MJD=46799 is a delay correction of reception times at ONBA. The listed values, referred to clock ONBA1, use the GPS receptions at IGMA.

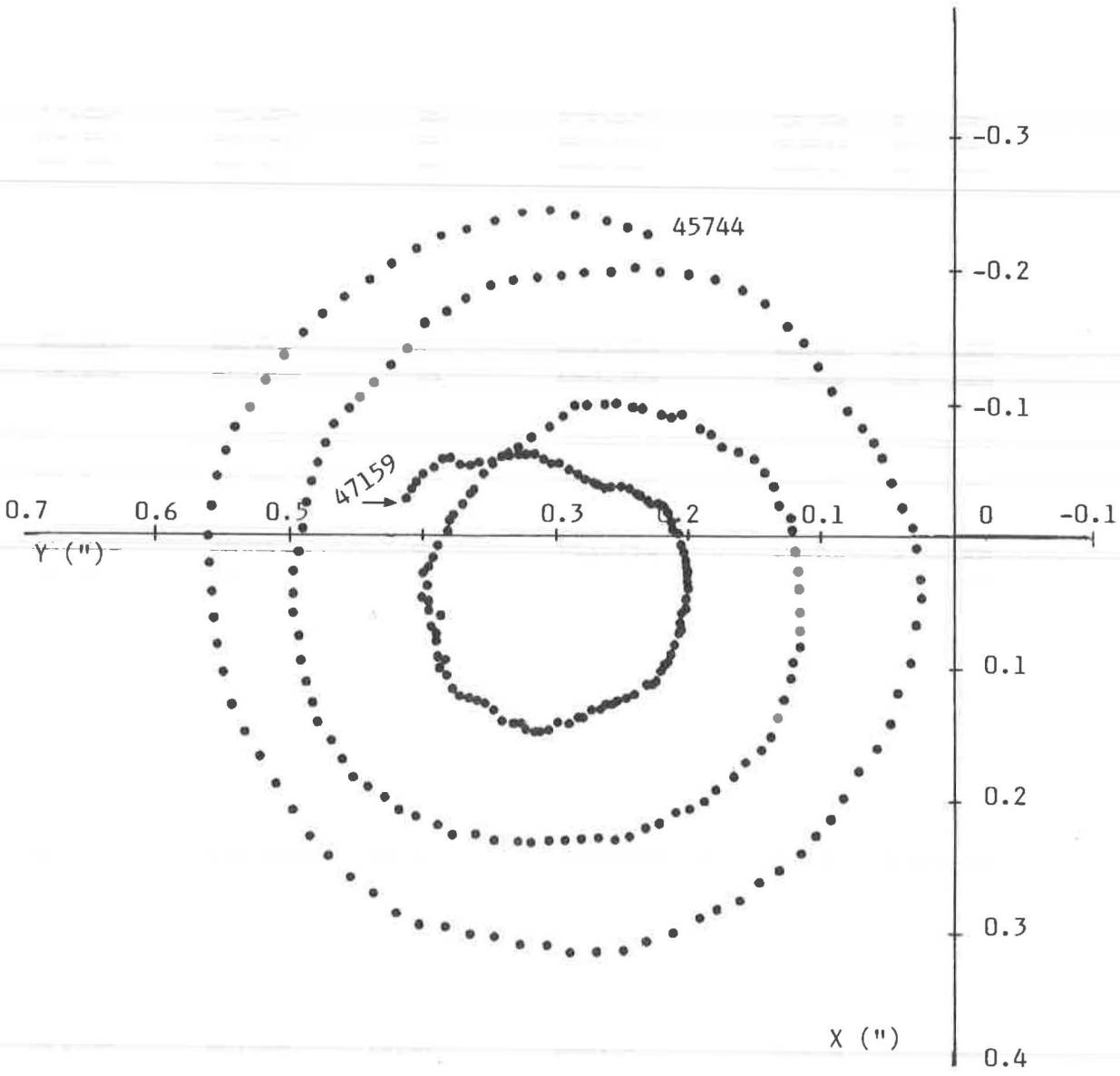


Figure 1 - Path of the pole from 1984 Feb.14 to 1987 Dec.30 (MJD 45744 - 47159). Raw values of Table 6.

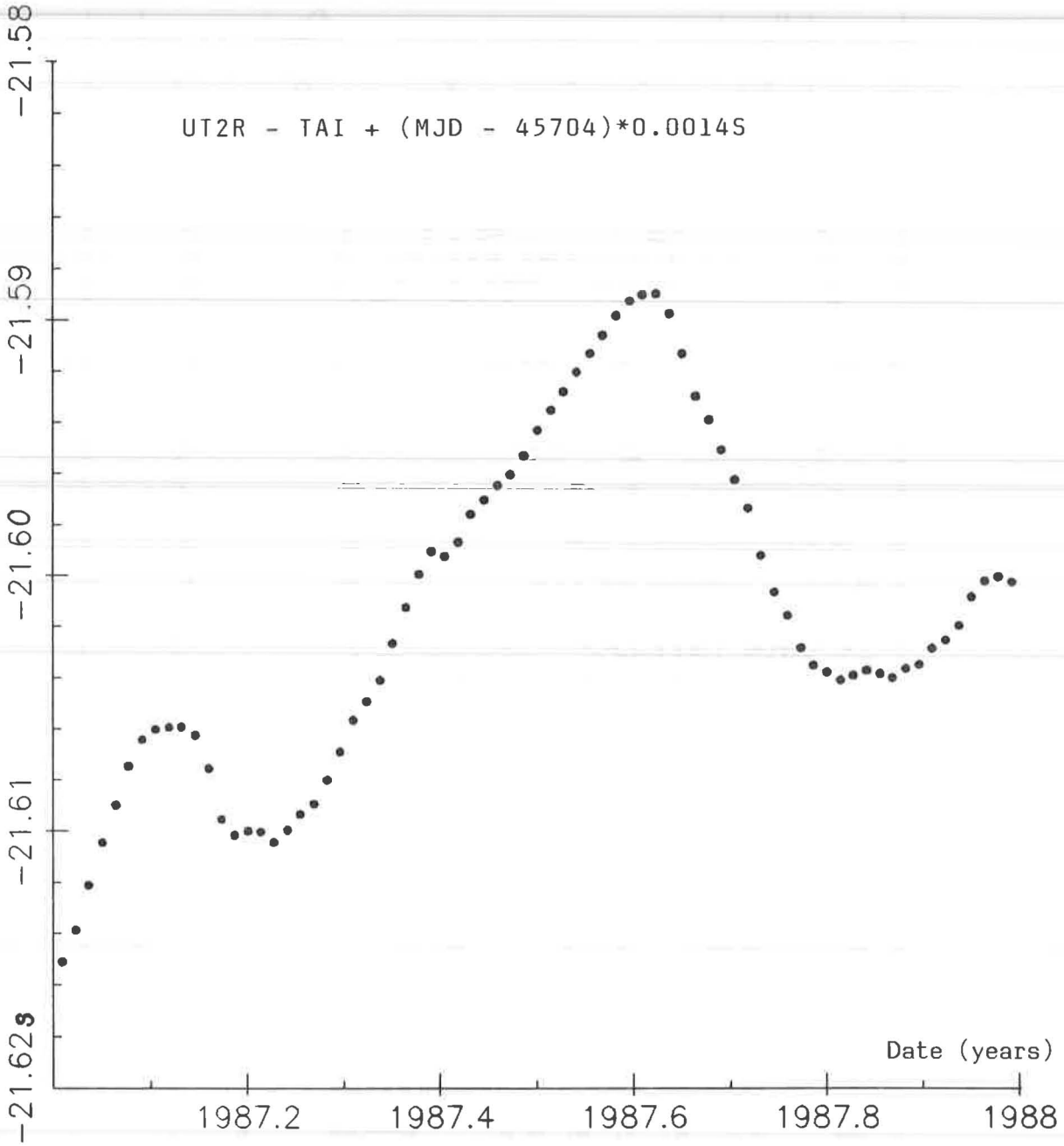


Figure 2 - Universal time from 1987 Jan.4 to Dec.30 (MJD 46799 - 47159). Raw values of Table 6.

The following conventional formula is used :

UT2-UT1 = 0.0220 $\sin 2\pi t$ - 0.0120 $\cos 2\pi t$ - 0.0060 $\sin 4\pi t$ + 0.0070 $\cos 4\pi t$, the unit being the second and t being the date in besselian years. UT2R is corrected for the effect of zonal tides for periods up to 35 days.

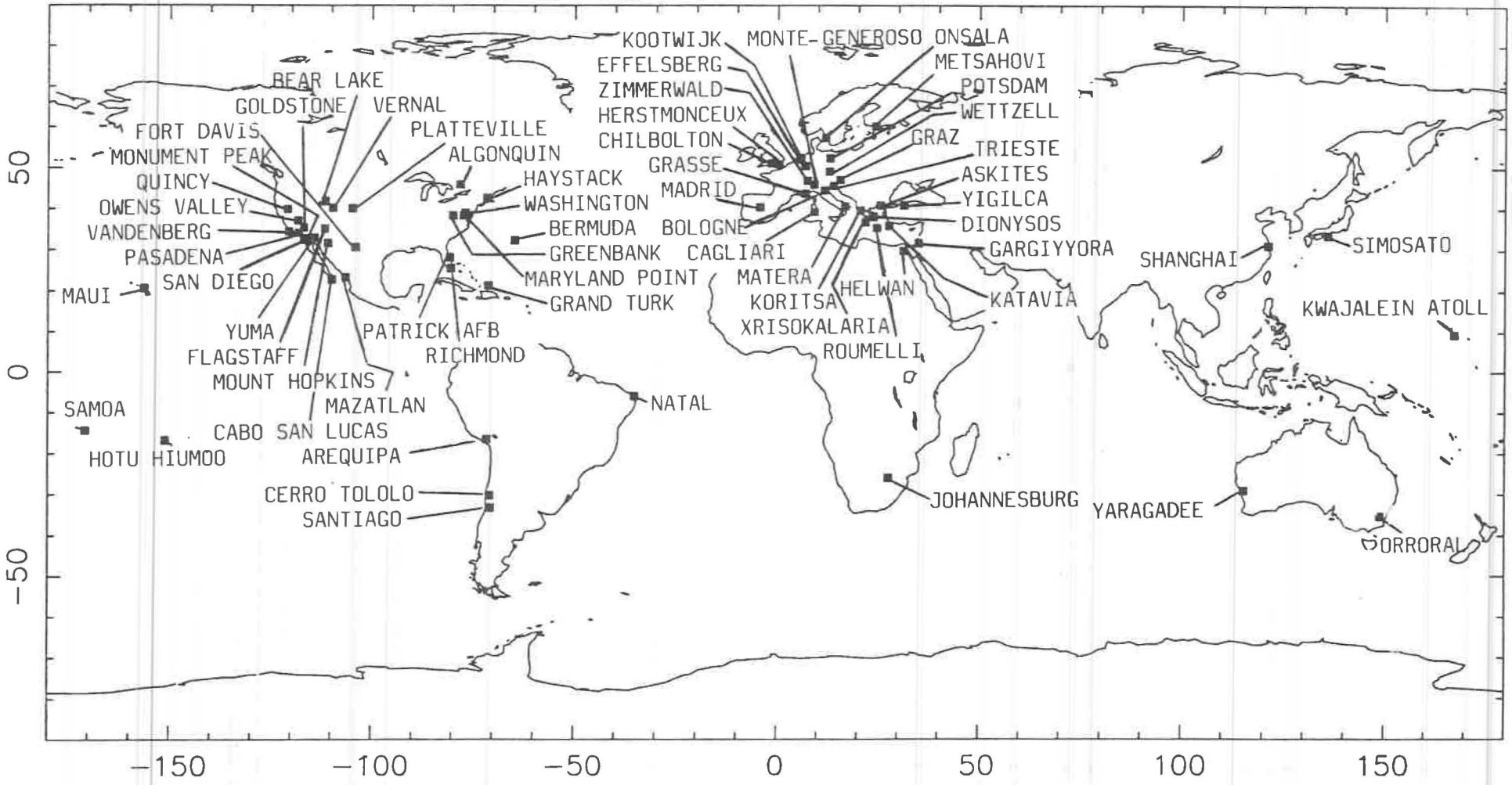


Figure 3 - Sites in the BIH Terrestrial System (1987).

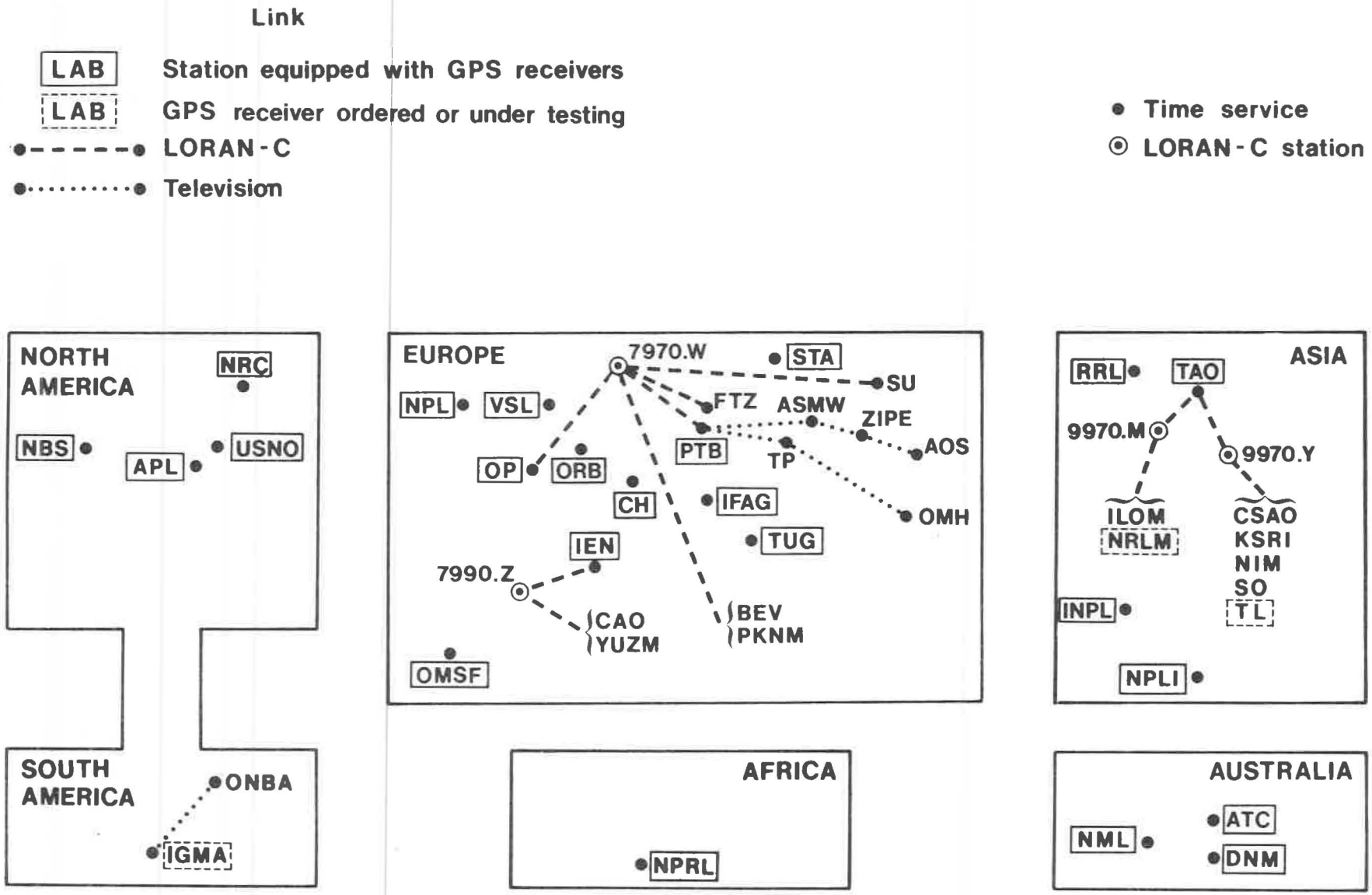


Fig. 4.- Time links used by BIH (31 December 1987)

The link GPS - 7970-W is established through OP or PTB depending on the laboratories.

PART C

TIME SIGNAL (1988)

The time signal emissions reported thereafter follow the UTC system, in accordance with the Recommendation 460-4 of the International Radio Consultative Committee (CCIR), unless otherwise stated.

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

AUTHORITIES RESPONSIBLE FOR THE TIME SIGNAL EMISSIONS

Signal	Authority
ATA	National Physical Laboratory Hillside Road New Delhi - 110012, India
BPM	Shaanxi Astronomical Observatory Academia Sinica P.O. Box 18 - Lintong Shaanxi, China
BSF	Telecommunication Laboratories Directorate General of Telecommunications Ministry of Communications P.O. Box 71 - Chung-Li 32099 Taiwan, R.O.C.
CHU	National Research Council, Time and Length Standards Section Physics Division (M-36) Ottawa K1A OR6, Ontario, Canada Attn : Dr. J. Vanier
DCF77	Physikalisch-Technische Bundesanstalt, Lab. Zeiteinheit Bundesallee 100 D-3300 Braunschweig Federal Republic of Germany
DGI, Y3S	Amt für Standardisierung, Messwesen und Warenprüfung Zeit - und Frequenzdienst der DDR Fürstenwalder Damm 388 DDR 1162 Berlin
EBC	Real Instituto y Observatorio de la Armada San Fernando Cadiz, Spain

Signal	Authority
HBG	Service horaire HBG Observatoire Cantonal CH - 2000 Neuchâtel, Suisse
HLA	Time and Frequency Laboratory Korea Standards Research Institute P. O. Box 3, Taedok Science Town Taejon, Ch'ungnam 300-31 Republic of Korea
IAM	Istituto Superiore delle Poste e delle Telecomunicazioni Ufficio 8°, Rep.2° - Viale Europa 190 00144 - Roma, Italy
IBF	Istituto Elettrotecnico Nazionale Galileo Ferraris Strada delle Cacce, 91 10135 - Torino, Italy
JJY, JG2AS	Standards and Measurements Division Communications Research Laboratory Ministry of Posts and Telecommunications Koganei, Tokyo 184, Japan
LOL	Director Observatorio Naval Av. Espana 2099 1107 - Buenos-Aires, Republica Argentina
MSF	National Physical Laboratory Electrical Science Division Teddington, Middlesex TW11 OLW United Kingdom

Signal	Authority
OLB5, OMA	1/ Time information : Astronomický ústav ČSAV, Budečksá 6 120 23 Praha 2, Vinohrady, Czechoslovakia. TELEX : 122 486 2/ Standard frequency information : Ústav radiotechniky a elektroniky ČSAV, Lumumbova 1, 182 51 Praha 8, Kobylisy, Czechoslovakia. TELEX : 122 646
PPE, PPR	Serviço da hora Observatorio Nacional (CNPq) Rua General Bruce, 586 20921 Rio de Janeiro - RJ, Brasil
RBU, RCH, RID, **RTA, RTZ, RWM,** **UNW3, UPD8, UQC3,** **USB2, UTR3**	Comité d'Etat des Normes Conseil des Ministres de l'URSS Moscou 117049, URSS, Leninski prosp., 9
TDF	Centre National d'Etudes des Télécommunications PAB - STC - Etalons de fréquence et de temps 196 avenue Henri Ravera - 92220 Bagneux, France
WWV,WWVH **WWVB**	Time and Frequency Division, 524.00 325 Broadway National Bureau of Standards Boulder, Colorado 80303, U.S.A.
YVTO	Direccion de Hidrografia y Navegacion Observatori Cagigal Apartado Postal No 6745 Caracas, Venezuela
Y3S	See DGI
ZUO	National Physical Research Laboratory P.O. Box 395 - Pretoria 0001 South Africa

TIME - SIGNALS EMITTED IN THE UTC SYSTEM

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of time signals
ATA	Greater Kailash New Delhi India 28° 34'N 77° 19'E	5 000 10 000 15 000	12 h 30 m to 3 h 30 m continuous 3 h 30 m to 12 h 30 m	Second pulses of 5 cycles of a 1 kHz modulation. Minute pulses of 100 ms duration. (the time signals are advanced by 50 ms on UTC).
BPM	Pucheng China 35° 0'N 109° 31'E	2 500 5 000 10 000 15 000	7 h 30 m to 1 h continuous continuous 1 h to 9 h	UTC time signals (the signals are emitted in advance on UTC by 20 ms). Second pulses of 10 ms of 1 kHz modulation. Minute pulses of 300 ms of 1 kHz modulation. From minutes 0 to 10, 15 to 25, 30 to 40, 45 to 55. UT1 time signals are emitted from minutes 25 to 29, 55 to 59.
BSF	Chung-Li Taiwan ROC 24° 57'N 121° 9'E	5 000 15 000	continuous except interruption between minutes 35 and 40	(a) From min. 5 to 10, 15 to 20, 25 to 30, 45 to 50, 55 to 60, second pulses of 5 ms duration without 1 kHz modulation. (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 by lengthening.
CHU	Ottawa Canada 45° 18'N 75° 45'W	3 300 7 335 14 670	continuous	Second pulses of 300 cycles of a 1 kHz modulation, with 29th and 51st to 59th pulses of each minute omitted. Minute pulses are 0.5 s long. Hour pulses are 1.0 s long, with the following 1st to 10th pulses omitted. A bilingual (Fr. Eng.) announcement of time (UTC-5 hours) is made each minute following the 50th second pulse. FSK time code after 10 cycles of 1 kHz on the 31st to 39th seconds. Broadcast is single sideband; upper sideband with carrier reinsert. DUT1 : CCIR code by split pulses.
DCF77	Mainflingen Germany, F.R. 50° 1'N 9° 0'E	77.5	continuous	At the beginning of each second (except the 59th second) the carrier amplitude is reduced to about 25 % for a duration of 0.1 s or 0.2 s. Coded transmission of year, month, day, hour, minute and day of the week in a BCD code from second marker No 21 to No 58 (the second marker durations of 0.1 s or 0.2 s correspond to a binary 0 or a binary 1 respectively). The coded time information is related to legal time of FRG and second markers 17 and 18 indicate if the transmitted time refers to UTC(PTB) + 2 h (summer time) or UTC(PTB) + 1 h. Second marker No 15 is prolonged to 0.2 s, if the reserve antenna is in use. To achieve a more accurate time transfer and better use of the frequency spectrum available, an additional pseudo random phase - shift keying of the carrier is superimposed to the AM second markers. No transmission of DUT1.

Notes : see p. C-10

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of time signals
DGI	Oranienburg Germ.Dem.Rep. 52° 48'N 13° 24'E	182	5 h 59 m 30 s to 6 h 00, 11 h 59 m 30 s to 12 h 00, 17 h 59 m 30 s to 18 h 00	A2 type second pulses of 0.1 s duration for seconds 30-40, 45-50, 55-60. The last pulse is prolonged. (one hour earlier in summer time)
EBC	San Fernando Spain 36° 28'N 6° 12'W	12 008 6 840	10 h 00 m to 10 h 25 m 10 h 30 m to 10 h 55 m	Second pulses of 0.1 s duration of a 1 kHz modulation. Minute pulses of 0.5 s duration of 1 250 Hz modulation. DUT1, CCIR code, double pulse. Type A3H.
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. Time code and other coded information.
HLA	Taedok Science Town Republic of Korea 36° 23'N 127° 22'E	5 000	1 h to 8 h on Monday to Friday (Except National Holidays in Korea)	Pulses of 9 cycles of 1800 Hz modulation. 59th and 29th second pulses omitted. Hour identified by 0.8 second long 1500 Hz tone. Beginning of each minute identified by 0.8 second long 1800 Hz tone. Voice announcement of hours and minutes each minute following 52nd second pulse. BCD time code given on 100 Hz subcarrier. DUT1 : CCIR code by double pulse.
IAM	Rome Italy 41° 47'N 12° 27'E	5 000	7 h 30 m to 8 h 30 m 10 h 30 m to 11 h 30 m Except Sunday and National Holidays	Second pulses of 5 cycles of 1 kHz modulation. Minute pulses of 20 cycles. Voice announcements every 15 m beginning at 0 h 0 m. Time announcement by Morse code beginning at 0 h 5 m. DUT1 : CCIR code by double pulse.
IBF	Torino Italy 45° 2'N 7° 42'E	5 000	During 15 m preceding 7 h, 9 h, 10 h, 11 h, 12 h, 13 h, 14 h, 15h, 16 h, 17 h, 18 h. Advanced by 1 hour in summer.	Second pulses of 5 cycles of 1 kHz modulation. These pulses are repeated 7 times at the minute. Voice announcements at the beginning and end of each emission. Time announcement (C.E.T.) by Morse code every ten minutes beginning at 0 h 0 m. 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 8 000 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.
LOL1 (1)	Buenos-Aires Argentina 34° 37'S 58° 21'W	5 000 10 000 15 000	11 h to 12 h, 14 h to 15 h, 17 h to 18 h, 20 h to 21 h, 23 h to 24 h	Second pulses of 5 cycles of 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 (1)	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.

Notes : see p. c-10

Station	Location Latitude Latitude	Frequency (kHz)	Schedule (UTC)	Form of time signals
MSF	Rugby United Kingdom 52° 22'N 1° 11'W	60	continuous except for an interruption for maintenance from 10 h 0 m to 14 h 0 m on the first Tuesday in each month.	Interruptions of the carrier of 100 ms for the second pulses, of 500 ms for the minute pulses. The signal is given by the beginning of the interruption. BCD NRZ code, 100 bits/s (month, day of month, hour, minute), during minute interruption. 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.
OLB5	Liblice Czechoslovakia 50° 4'N 14° 53'E	3 170	continuous except from 9 h to 14 h on the first Wednesday of every month	A1 type, second pulses. No transmission of DUT1.
OMA (2)	Liblice Czechoslovakia 50° 4'N 14° 53'E	50	continuous (from 6 h to 12 h on the first Wednesday in each month, emitted from Podebrady with reduced power)	Interruption of the carrier of 100 ms at the beginning of every second, of 500 ms at the beginning of every minute. The precise time is given by the beginning of the interruption. Phase coded announcement of date, UT and local civil time. No DUT1 code.
OMA	Liblice Czechoslovakia 50° 4'N 14° 53'E	2 500	continuous except from 9 h to 14 h on the first Wednesday of every month	Pulses of 100 cycles of 1 kHz modulation (prolonged for the minutes) No DUT1 code.
PPE	Rio-de-Janeiro Brasil 22° 54'S 43° 13'W	8 721	0 h 30 m, 11 h 30 m, 13 h 30 m, 19 h 30 m, 20 h 30 m, 23 h 30 m	Second ticks, of A1 type, during the five minutes preceding the indicated times. The minute ticks are longer. DUT1 : CCIR code by double pulse.
PPR	Rio-de-Janeiro Brasil 22° 59'S 43° 11'W	435 4 244 8 634 13 105 17 194.4 22 603	1 h 30 m, 14 h 30 m, 21 h 30 m	Second ticks, of A1 type, during the five minutes preceding the indicated times. The minute ticks are longer.
RBU (3)	Moscow USSR 55° 48'N 38° 18'E	66 2/3	continuous	DXXXW type signals. The time of day in hours, minutes and seconds is transmitted in BCD code.
RCH (3)	Tashkent USSR 41° 19'N 69° 15'E	 2 500 5 000 10 000	between minutes 0 and 10, 30 and 40 0 h to 3 h 40 m 5 h to 23 h 40 m 0 h to 3 h 40 m 14 h to 23 h 40 m 5 h to 13 h 10 m	A1X type second pulses. The pulses at the beginning of the minute are prolonged to 0.5 s.
RID (3)	Irkutsk USSR 52° 26'N 104° 2'E	5 004 10 004 15 004	The station simultaneously operates on three frequencies between minutes 20 and 30, 50 and 60	A1X type second pulses. The pulses at the beginning of the minute are prolonged to 0.5 s.

Notes : see p. c-10

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of time signals
RTA (3)	Novosibirsk USSR 55° 4'N 82° 58'E	10 000 15 000	between minutes 0 and 10, 30 and 40, 0 h to 5 h 10 m, 14 h to 23 h 40 m, 6 h 30 m to 13 h 10 m	A1X type second pulses. The pulses at the beginning of the minute are prolonged to 0.5 s.
RWM (3)	Moscow USSR 55° 48'N 38° 18'E	4 996 9 996 14 996	The station simultaneously operates on three frequencies between 10 and 20, 40 and 50	A1X type second pulses. The pulses at the beginning of the minute are prolonged to 0.5 s.
RTZ (3)	Irkutsk USSR 52° 26'N 104° 2'E	50	between minutes 0 and 5 0 h to 20 h 05 m 22 h to 23 h 05 m in winter 0 h to 19 h 05 m 21 h to 23 h 05 m in summer	A1X type second pulses. The pulses at the beginning of the minute are prolonged to 0.5 s.
TDF	Allouis France 47° 10'N 2° 12'E	162	continuous except every Tuesday from 1 h to 5 h	Phase modulation of the carrier by + and - 1 radian in 0.1 s every second except the 59th second of each minute. This modulation is doubled to indicate binary 1. The numbers of the minute, hour, day of the month, day of the week, month and year are transmitted each minute from the 21st to the 58th second, in accordance with the French legal time scale. In addition a binary 1 at the 17th second indicates that the local time is 2 hours ahead of UTC(summer time), a binary 1 at the 18th second indicates when the local time is one hour ahead of UTC(winter time) ; a binary 1 at the 14th second indicates that the current day is a public holiday (Christmas, 14 July, etc...); a binary 1 at the 13th second indicates that the current day is a day before a public holiday.
UNW3	Molodechno USSR 54° 26'N 26° 48'E	25	7 h 43 m to 7 h 52 m 19 h 43 m to 19 h 52 m in winter 7 h 43 m to 7 h 52 m 20 h 43 m to 20 h 52 m in summer	A1N 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.
UPD8	Arkhangelsk USSR 64° 24'N 41° 32'E	25	8 h 43 m to 8 h 52 m 11 h 43 m to 11 h 52 m	A1N 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.
UQC3	Chabarovsk USSR 48° 30'N 134° 51'E	25	0 h 43 m to 0 h 52 m 6 h 43 m to 6 h 52 m 17 h 43 m to 17 h 52 m in winter 2 h 43 m to 2 h 52 m 6 h 43 m to 6 h 52 m 18 h 43 m to 18 h 52 m in summer	A1N 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.

Notes : see p. C-10

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of time signals
USB2	Frunze USSR 43° 04'N 73° 39'E	25	4 h 43 m to 4 h 52 m 9 h 43 m to 9 h 52 m 21 h 43 m to 21 h 52 m in winter 4 h 43 m to 4 h 52 m 10 h 43 m to 10 h 52 m 22 h 43 m to 22 h 52 m in summer	A1N 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	Gorki USSR 56° 11'N 43° 58'E	25	5 h 43 m to 5 h 52 m 13 h 43 m to 13 h 52 m 18 h 43 m to 18 h 52 m in winter 7 h 43 m to 7 h 52 m 14 h 43 m to 14 h 52 m 19 h 43 m to 19 h 52 m in summer	A1N 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.
WWV	Fort-Collins, CO USA 40° 41'N 105° 2'W	2 500 5 000 10 000 15 000 20 000	continuous	Pulses of 5 cycles of 1 kHz modulation. 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, CO USA 40° 40'N 105° 3'W	60	continuous	Second pulses given by reduction of the amplitude of the carrier. Coded announcement of the date, time, correction to obtain UT1, daylight savings time in effect and leap year. No CCIR code.
WWVH	Kauai, HI USA 21° 59'N 159° 46'W	2 500 5 000 10 000 15 000	continuous	Pulses of 6 cycles of 1 200 Hz modulation. 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 (4)	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 40 and 50 of each minute, voice announcement of the identification of the station. Between seconds 52 and 57 of each minute, voice announcement of hour, minute and second.
Y3S (5)	Nauen Germ. Dem. Rep. 52° 39'N 12° 55'E	4 525	continuous except from 8 h 15 m to 9 h 45 m 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.
ZUO	Olifantsfontein South Africa 25° 58'S 28° 14'E	2 500 5 000	18 h to 4 h continuous	Pulses of 5 cycles of 1 kHz modulation. Second 0 is prolonged.
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.

Notes : see p. C-10

NOTES ON THE CHARACTERISTICS OF THE SIGNALS

(1) No recent information on these time signals.

(2) OMA, 50 kHz

a. The main transmitter in Liblice radiates approx. 7 kW and the stand-by transmitter in Podebrady (50° 9'N, 15° 9'E) approx. 50 W.

b. The details of the time code were published in Nomenclature des stations de radiorepérage et des stations effectuant des services spéciaux - Liste VI, Volume I, édition 7 de U.I.T. in Geneva in July 1980.

(3) The radiostations of the USSR emit DUT1 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 an 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.

(4) YVTO. The frequency may change to 5000 kHz during 1988.

(5) 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 doubling a number (p) of consecutive seconds markers from second marker 21 to second 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 doubling a number (q) of consecutive seconds markers following the minute marker from second marker 31 to second marker (30 + q) inclusive ; (q) being an integer from 1 to 5 inclusive.

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

The second 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.

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
BPM	0.1
BSF	0.2
CHU	0.05
DCF77	0.005
EBC	0.1
HBG	0.005
HLA	0.1
IAM	0.5
IBF	0.1
JJY, JG2AS	0.1
LOL1	0.1
MSF	0.02
OMA (all frequencies)	0.5
RBU, RTZ	0.05
RCH, RID, RTA, RWM	0.5
TDF	0.02
UNW3, UPD8, UQC3, USB2, UTR3	0.05
WWV	0.1
WWVB	0.1
WWVH	0.1
ZUO	0.1

TIME OF EMISSION OF THE TIME SIGNALS IN THE UTC SYSTEM, IN 1987

The following deviations of the time of emission of the time signals, from UTC, have been reported to the BIH, or observed.

ATA	UTC-ATA = -0.0500 s
BPM	UTC-BPM = -0.0200 s
OLB5	UTC-OLB5= 0.0008 s