BUREAU INTERNATIONAL DES POIDS ET MESURES

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Practical information about the BIPM Time Section

The Time Section of the BIPM issues two periodic publications. These are the monthly *Circular T* and the *Annual Report of the BIPM Time Section*. The complete text of *Circular T* and most tables of the present Annual Report are available through the internet network.
La Section du temps du BIPM produit deux publications périodiques : la Circulaire T, *mensuelle, et le* Rapport annuel de la Section du temps du BIPM. *Les circulaires et la plupart des tableaux de ce rapport annuel sont disponibles par utilisation du réseau internet.*

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Access to the BIPM Time Section data via anonymous FTP

The BIPM Time section is making available several publications and data files via anonymous ftp.
You can access it via the BIPM Web site http://www.bipm.fr or with the following procedure :
ftp 145.238.2.2 user anonymous
system requests that you enter your identity as a password
cd [anonymous.tai] to access the [.tai] subdirectory and get the read.me file listed below.

Listing of the READ.ME file: last update : 19 January 1998

BUREAU INTERNATIONAL DES POIDS ET MESURES - TIME SECTION

The [.tai] subdirectory offers via anonymous ftp (node 145.238.2.2) informations of interest for the time and frequency community. This service presently contains 2 subdirectories:

[.tai.publication] The latest issues of the Time Section publications:

publication	filename
Circular T#XXX	cirt.XXX
GPS schedule #XX	schgps.XX
GLONASS schedule #XX	schglo.XX
Results of the computation of TAI over the two-month interval Z of year 19XY (Z = 1 for Jan-Feb, 2 for Mar-Apr, etc.) until Nov-Dec 1997	tai.XYZ
Weights and rates relative to TAI of clocks in the computation of TAI over the one-month interval ZT of year 19XY (ZT = 01 for Jan, 02 for Feb,..., 12 for Dec) starting Jan 1998	wXY.ZT rXY.ZT

[.tai.scale] Time scales data:

content	filename
TT(BIPMXY) computed in year 19XY	ttbipm.XY
• For 1993-19XY:	
Difference between the normalized frequencies of EAL and TAI	ealtaiXY.ar
TAI frequency	ftaiXY.ar (for 1993, 1994)
Measurements of the duration of The TAI scale interval	utaiXY.ar (starting 1995)
Mean duration of TAI scale interval	sitaiXY.ar
Independent local atomic time scales: values of [TAI-TA(lab)]	taiXY.ar
Local representations of UTC: values of [UTC-UTC(lab)]	utcXY.ar
[TAI-GPS time] and [UTC-GPS time]	utcgpsXY.ar
[TAI-GLONASS time] and [UTC-GLONASS time]	utcgloXY.ar
Rates of clocks contributing to TAI	rtaiXY.ar
Weights of clocks contributing to TAI	wtaiXY.ar
• For 19XY-1992:	
Local representations of UTC: Values of [UTC-UTC(lab)]	utc.XY
Local values of [TAI-TA(lab)]	ta.XY

For any comment or query send a message to : tai@bipm.fr

Leap seconds

Secondes intercalaires

Since 1 January 1988, the maintenance of International Atomic Time, TAI, and of Coordinated Universal Time, UTC (with the exception of decisions and announcements concerning leap seconds of UTC) has been the responsibility of the Bureau International des Poids et Mesures (BIPM) under the authority of the Comité International des Poids et Mesures (CIPM). The dates of leap seconds of UTC are decided and announced by the International Earth Rotation Service (IERS), which is responsible for the determination of Earth rotation parameters and for maintenance of the related celestial and terrestrial reference systems. The adjustments of UTC and the relationship between TAI and UTC are given in Tables 1 and 2 of this volume.

Depuis le 1er janvier 1988, l'établissement du Temps atomique international, TAI, et du Temps universel coordonné, UTC, (à l'exception de l'annonce des secondes intercalaires de l'UTC) est placé sous la responsabilité du Bureau international des poids et mesures (BIPM) et du Comité international des poids et mesures (CIPM). Le choix des dates et l'annonce des secondes intercalaires de l'UTC constituent quelques-unes des missions du Service international de la rotation terrestre (IERS), qui est responsable de la détermination des paramètres de la rotation terrestre et de la conservation des systèmes de référence terrestre et céleste associés. Les ajustements de l'UTC et la relation entre le TAI et l'UTC sont donnés dans les tableaux 1 et 2 de ce volume.

Information on IERS can be obtained from:

Des renseignements sur l'IERS peuvent être obtenus à l'adresse suivante:

Central Bureau of IERS
Dr. Daniel GAMBIS
Observatoire de Paris
61, avenue de l'Observatoire
75014 Paris, France

Telephone: + 33 1 40 51 22 26
Telefax: + 33 1 40 51 22 91
Electronic mail : iers@obspm.fr
World Wide Web : http://hpiers.obspm.fr/
Anonymous ftp : hpiers.obspm.fr or 145.238.100.28

Establishment of the International Atomic Time and of the Coordinated Universal Time

1. Data and computation

The International Atomic Time, TAI, and the Coordinated Universal Time, UTC, are obtained from a combination of data from some 230 atomic clocks kept by about 65 laboratories spread worldwide and regularly reported to the BIPM by about 50 timing centres maintaining a local UTC, UTC(k) (list in Table 3). This data is in the form of time differences [*UTC*(*k*) - *Clock*] taken at 5 day intervals for Modified Julian Dates (MJD) ending in 4 and 9, at 0h UTC, dates designated here as 'standard dates'. The equipment maintained by these timing centres is detailed in Table 4.

An iterative algorithm produces a free atomic time scale, EAL (Echelle atomique libre) defined as a weighted average of clock readings. The processing is done in deferred-time and treats as a whole one month blocks of data [1] (two month blocks were used before 1998). The weighting procedure and clock frequency prediction are chosen so that EAL is optimized for long-term stability. No attempt is made to ensure the conformity of the EAL scale interval with the second of the International System of Units.

2. Accuracy

The duration of the scale interval of EAL is evaluated by comparison with the data of primary caesium standards, correcting their proper frequency as needed to account for known effects (e.g. general relativity, blackbody radiation). The TAI is then derived from EAL by adding a linear function of time with a convenient slope to ensure the accuracy of the TAI scale interval. The frequency offset between TAI and EAL is changed when necessary to maintain accuracy, the magnitude of the changes being of the same order as the frequency fluctuations resulting from the instability of EAL. This operation is referred to as the 'steering of TAI'. Table 5 gives the normalized frequency offsets between EAL and TAI. Measurements of the duration of the TAI scale interval and estimates of its mean duration are reported in Tables 6 and 7.

3. Availability

The TAI and UTC are made available in the form of time differences with respect to the local time scales UTC(k), which approximate UTC, and TA(k), which are independent local atomic time scales. These differences, [*TAI* - *TA*(*k*)] and [*UTC* - *UTC*(*k*)], reported in Tables 8 and 9, are computed for the standard dates.

The computation of TAI is carried out every month and the results are published monthly in *Circular T*. When preparing the Annual Report, the results shown in

Circular T may be revised taking into account any improvement in the data made known after its publication.

4. Time links

In 1998, the network of time links used by the BIPM was non-redundant and mainly relied on the observation of GPS satellites in common views. For this purpose, international GPS tracking schedules are published by the BIPM about every six months. Tracking schedules for GLONASS are also established. The list of the schedules is reported in Table 10 and their content is available through the internet network.

Laboratories regularly send their GPS observations to the BIPM where they are processed following a unified procedure. Strict common views, synchronized to within 1 s, are used to remove the clock-dither noise brought about by the voluntary degradation, Selective Availability, of GPS signals.

The BIPM organizes the international GPS network which takes the form of local stars within a continent joined by two long-distance links, OP-CRL and OP-NIST, chosen because measured ionospheric delays are routinely available for these three sites. Precise GPS satellites ephemerides, produced by the International Geodynamics Service with a delay of a few days, are also routinely used for these long-distance links. The ultimate precision of one single measurement of [$UTC(k_1)$ - $UTC(k_2)$], obtained at the BIPM with these procedures, is about 2 ns for short distances and 4 ns for long distances. The BIPM also publishes an evaluation of [*UTC* - *GPS time*] which is reported in Table 11 of this volume.

The BIPM regularly publishes an evaluation of [*UTC* - *GLONASS time*], given here in Table 12, using current observations of the GLONASS system at the NMi Van Swinden Laboratorium, The Netherlands.

5. Time scales established in retrospect

For the most demanding applications, such as millisecond pulsar timing, the BIPM issues atomic time scales in retrospect. These are designated TT(BIPMxx) where 1900 + xx is the year of computation [2]. The successive versions of TT(BIPMxx) are both updates and revisions: they may differ for common dates. These time scales are available on request from the BIPM or via the internet network.

Notes

Tables 13 and 14 of this report give the rates relative to TAI and the weights of the contributing clocks to TAI in 1998.

The yellow pages, at the end of this volume, give indications about time signal emissions.

The report of the BIPM Time Section, for the year October 1997 - September 1998, to be published in 'Comité International des Poids et Mesures, Report of the 87th Meeting, 1998, Tome 66, BIPM Publications', is reproduced after the yellow pages. All the publications mentioned in this report are available on request from the BIPM.

References

[1] C. Thomas and J. Azoubib, TAI computation : study of an alternative choice for implementing an upper limit of clock weights, *Metrologia*, 1996, **33**, 227-240.

[2] B. Guinot, Atomic time scales for pulsar studies and other demanding applications, *Astron. Astrophys.*, 1988, **192**, 370-373.

Etablissement du Temps atomique international et du Temps universel coordonné

1. Données et mode de calcul

Le Temps atomique international (TAI) et le Temps universel coordonné (UTC) sont obtenus par une combinaison de données provenant de quelque 230 horloges atomiques conservées par environ 65 laboratoires répartis dans le monde entier, et fournies régulièrement au BIPM par environ 50 laboratoires de temps qui maintiennent un UTC local, UTC(k) (liste donnée dans le tableau 3). Ces données prennent la forme de differences de temps [UTC(k) - Horloge] *enregistrées de 5 jours en 5 jours pour les dates juliennes modifiées (MJD) se terminant par 4 et 9, à 0hUTC, 'dates normales'. L'équipement maintenu par ces laboratoires de temps est décrit dans le tableau 4.*

Un algorithme itératif qui traite en temps différé des blocs de 1 mois de données [1] produit une échelle atomique libre, EAL, définie comme étant une moyenne pondérée de lectures d'horloges (jusqu'en 1997 des blocs de deux mois étaient utilisés). Le choix de la pondération et du mode de prédiction de fréquence optimise la stabilité de l'EAL à long terme. Il n'est pas tenté d'assurer la conformité de l'intervalle unitaire de l'EAL avec la seconde du Système international d'unités.

2. Exactitude

La durée de l'intervalle unitaire de l'EAL est évaluée par comparaison aux données d'étalons de fréquence à césium primaires, après correction de leur fréquence propre pour tenir compte des effets connus (par exemple relativité générale, rayonnement du corps noir). Ensuite le TAI se déduit de l'EAL par l'addition d'une fonction linéaire du temps dont la pente est convenablement choisie pour assurer l'exactitude de l'intervalle unitaire du TAI. Le décalage de fréquence entre le TAI et l'EAL est changé quand c'est nécessaire pour maintenir l'exactitude, les changements ayant le même ordre de grandeur que les fluctuations de fréquence qui résultent de l'instabilité de l'EAL. Cette opération est désignée par l'expression 'pilotage du TAI'. Le tableau 5 donne les différences de fréquences normalisées entre l'EAL et le TAI. Des mesures de la durée de l'intervalle unitaire du TAI et des estimations de sa durée moyenne sont données dans les tableaux 6 et 7.

3. Disponibilité

Le TAI et l'UTC sont disponibles sous forme de différences de temps avec les échelles locales de temps UTC(k), approximation de l'UTC, et TA(k), temps atomique local indépendant. Ces différences, [TAI - TA(k)] *et* [UTC - UTC(k)], *calculées pour les dates normales sont reportées dans les tableaux 8 et 9.*

Le calcul du TAI est fait tous les mois et les résultats sont publiés mensuellement dans la Circulaire T *du BIPM. Quand le Rapport annuel est préparé, les résultats de la* Circulaire T *peuvent être révisés, compte-tenu des améliorations de données connues après la publication de la* Circulaire T.

4. Liaisons horaires

En 1998, le système des liaisons horaires utilisé par le BIPM était non-redondant et reposait principalement sur l'observation des satellites du GPS en vues simultanées. Dans ce but, le BIPM publie tous les six mois des programme de poursuite des satellites du GPS, ainsi que des programmes pour les satellites du GLONASS. La liste de ces programmes est reproduite dans le tableau 10 et leur contenu est disponible sur le réseau internet..

Les laboratoires envoient régulièrement leurs données au BIPM où les calculs sont effectués d'une manière unifiée. On utilise des observations en vues simultanées strictes, c'est-à-dire synchronisées à la seconde près, ceci afin de supprimer la dégradation des signaux des horloges embarquées, due à l'implantation de 'l'accés sélectif'.

Le BIPM organise le réseau international de comparaisons horaires utilisant le GPS selon un schéma en étoile au niveau des continents, et en deux liaisons à longue distance, OP-CRL et OP-NIST, choisies parce que des données de retards ionosphériques mesurés sont disponibles pour ces trois sites. Des éphémérides précises des satellites du GPS, produites par l'IGS et accessibles en quelques jours, sont aussi utilisées de manière courante pour ces deux liaisons. La précision ultime d'une mesure unique [UTC(k_1) - UTC(k_2)] *est alors d'environ 2 ns pour les liaisons à courte distance et d'environ 4 ns pour les liaisons à longue distance. Le BIPM publie aussi une évaluation de* [UTC - temps du GPS], *donnée dans le tableau 11 de ce volume.*

Le BIPM publie régulièrement une évaluation de [UTC - temps du GLONASS], *donnée dans le tableau 12 du présent volume et déduite des observations habituelles du système GLONASS, réalisées au NMi Van Swinden Laboratorium, Pays-Bas.*

5. Echelles de temps établies rétrospectivement

Pour les applications les plus exigeantes, comme le chronométrage des pulsars milliseconde, le BIPM produit des échelles de temps rétrospectivement, désignées par TT(BIPMxx), 1900 + xx étant l'année du calcul [2]. Les versions successives de TT(BIPMxx) ne sont pas seulement des mises à jour, mais aussi des révisions, de sorte qu'elles peuvent différer pour les dates communes. Ces échelles de temps sont disponibles sur demande faite au BIPM ou par utilisation du réseau internet.

Notes

Les tableaux 13 et 14 de ce rapport donnent les fréquences relatives au TAI et les poids des horloges qui ont contribué au calcul en 1998.

Les pages jaunes, à la fin de ce volume, concernent les émissions de signaux horaires.

Le rapport à un an (octobre 1997 - septembre 1998) de la section du temps du BIPM à paraître dans 'Comité international des poids et mesures, Procès-verbaux 87e session, 1998, Tome 66, Publications du BIPM', est reproduit après les pages jaunes. Toutes les publications qui y sont mentionnées sont disponibles sur demande au BIPM.

Les références sont données dans le texte anglais, page 11.

List of the Tables included in the Annual Report of the BIPM Time Section for 1998

Tables indicated with * are available through the internet network ftp 145.238.2.2 or http://www.bipm.fr.

TABLE 1. FREQUENCY OFFSETS AND STEP ADJUSTMENTS OF UTC, UNTIL 31 DECEMBER 1999

Date (at 0h UTC)	Offsets	Steps
1961 Jan. 1	-150×10^{-10}	
1961 Aug. 1	"	+0.050 s
1962 Jan. 1	-130×10^{-10}	
1963 Nov. 1	"	-0.100 s
1964 Jan. 1	-150×10^{-10}	
1964 Apr. 1	"	-0.100 s
1964 Sep. 1	"	-0.100 s
1965 Jan. 1	"	-0.100 s
1965 Mar. 1	"	-0.100 s
1965 Jul. 1	"	-0.100 s
1965 Sep. 1	"	-0.100 s
1966 Jan. 1	-300×10^{-10}	
1968 Feb. 1	"	+0.100 s
1972 Jan. 1	0	-0.107 7580 s
1972 Jul. 1	"	-1 s
1973 Jan. 1	"	-1 s
1974 Jan. 1	"	-1 s
1975 Jan. 1	"	-1 s
1976 Jan. 1	"	-1 s
1977 Jan. 1	"	-1 s
1978 Jan. 1	"	-1 s
1979 Jan. 1	"	-1 s
1980 Jan. 1	"	-1 s
1981 Jul. 1	"	-1 s
1982 Jul. 1	"	-1 s
1983 Jul. 1	"	-1 s
1985 Jul. 1	"	-1 s
1988 Jan. 1	"	-1 s
1990 Jan. 1	"	-1 s
1991 Jan. 1	"	-1 s
1992 Jul. 1	"	-1 s
1993 Jul. 1	"	-1 s
1994 Jul. 1	"	-1 s
1996 Jan. 1	"	-1 s
1997 Jul. 1	"	-1 s
1999 Jan. 1	"	-1 s

TABLE 2. RELATIONSHIP BETWEEN TAI AND UTC, UNTIL 31 DECEMBER 1999

LIMITS OF VALIDITY (AT 0h UTC)	*TAI - UTC* (IN SECONDS)
1961 Jan. 1 - 1961 Aug. 1	1.422 8180 + (MJD - 37300) x 0.001 296
1961 Aug. 1 - 1962 Jan. 1	1.372 8180 + " "
1962 Jan. 1 - 1963 Nov. 1	1.845 8580 + (MJD - 37665) x 0.001 1232
1963 Nov. 1 - 1964 Jan. 1	1.945 8580 + " "
1964 Jan. 1 - 1964 Apr. 1	3.240 1300 + (MJD - 38761) x 0.001 296
1964 Apr. 1 - 1964 Sep. 1	3.340 1300 + " "
1964 Sep. 1 - 1965 Jan. 1	3.440 1300 + " "
1965 Jan. 1 - 1965 Mar. 1	3.540 1300 + " "
1965 Mar. 1 - 1965 Jul. 1	3.640 1300 + " "
1965 Jul. 1 - 1965 Sep. 1	3.740 1300 + " "
1965 Sep. 1 - 1966 Jan. 1	3.840 1300 + " "
1966 Jan. 1 - 1968 Feb. 1	4.313 1700 + (MJD - 39126) x 0.002 592
1968 Feb. 1 - 1972 Jan. 1	4.213 1700 + " "
1972 Jan. 1 - 1972 Jul. 1	10 (integral number of seconds)
1972 Jul. 1 - 1973 Jan. 1	11
1973 Jan. 1 - 1974 Jan. 1	12
1974 Jan. 1 - 1975 Jan. 1	13
1975 Jan. 1 - 1976 Jan. 1	14
1976 Jan. 1 - 1977 Jan. 1	15
1977 Jan. 1 - 1978 Jan. 1	16
1978 Jan. 1 - 1979 Jan. 1	17
1979 Jan. 1 - 1980 Jan. 1	18
1980 Jan. 1 - 1981 Jul. 1	19
1981 Jul. 1 - 1982 Jul. 1	20
1982 Jul. 1 - 1983 Jul. 1	21
1983 Jul. 1 - 1985 Jul. 1	22
1985 Jul. 1 - 1988 Jan. 1	23
1988 Jan. 1 - 1990 Jan. 1	24
1990 Jan. 1 - 1991 Jan. 1	25
1991 Jan. 1 - 1992 Jul. 1	26
1992 Jul. 1 - 1993 Jul. 1	27
1993 Jul. 1 - 1994 Jul. 1	28
1994 Jul. 1 - 1996 Jan. 1	29
1996 Jan. 1 - 1997 Jul. 1	30
1997 Jul. 1 - 1999 Jan. 1	31
1999 Jan. 1 -	32

TABLE 3. ACRONYMS AND LOCATIONS OF THE TIMING CENTRES WHICH MAINTAIN A LOCAL APPROXIMATION OF UTC, UTC(K), OR/AND AN INDEPENDENT LOCAL TIME SCALE, TA(K)

AMC	Alternate Master Clock station, Colorado Springs, Colorado, USA
AOS	Astronomiczne Obserwatorium Szerokosciowe, Borowiec, Polska
APL	Applied Physics Laboratory, Laurel, MA, USA
AUS	Consortium of laboratories in Australia
BEV	Bundesamt für Eich - und Vermessungswesen, Wien, Oesterreich
BIRM	Beijing Institute of Radio Metrology and Measurement, Beijing, P. R. China
CAO	Cagliari Astronomical Observatory , Cagliari, Italia
CH	Consortium of laboratories in Switzerland
CNM	Centro Nacional de Metrologia, Queretaro, Mexico
CRL	Communications Research Laboratory, Tokyo, Japan
CSAO	Shaanxi Astronomical Observatory, Lintong, P.R. China
CSIR	Council for Scientific and Industrial Research, Pretoria, South Africa
DLR	Deutsche Forschungsanstalt fuer Luft-und Raumfahrt, Oberpfaffenhofen, Deutschland
DTAG	Deutsche Telecom AG, Darmstadt, Deutschland
F	Commission Nationale de l'Heure, Paris, France
GUM	Glówny Urzad Miar, Central Office of Measures, Warszawa, Polska
IEN	Istituto Elettrotecnico Nazionale Galileo Ferraris, Torino, Italia
IFAG	Bundesamt fuer Kartographie und Geodaesie, Fundamentalstation, Wettzell, Deutschland
IGMA	Instituto Geografico Militar, Buenos-Aires, Argentina
INPL	National Physical Laboratory, Jerusalem, Israel
IPQ	Institute Português da Qualidade (Portuguese Institute for Quality), Monte de Caparica, Portugal.
JATC	Joint Atomic Time Commission, Lintong, P.R. China
KRIS	Korea Research Institute of Standards and Science, Taejon, Rep. of Korea
LDS	The University of Leeds, Leeds, United Kingdom
MSL	Measurement Standards Laboratory, Lower Hutt, New Zealand
NAO	National Astronomical Observatory, Misuzawa, Japan
NIM	National Institute of Metrology, Beijing, P.R. China
NIST	National Institute of Standards and Technology, Boulder, CO, USA
NML	National Measurement Laboratory, Sydney, Australia
NPL	National Physical Laboratory, Teddington, United Kingdom
NPLI	National Physical Laboratory, New-Delhi, India
NRC	National Research Council of Canada, Ottawa, Canada
NRLM	National Research Laboratory of Metrology, Tsukuba, Japan
OMH	Orszagos Mérésügyi Hivatal, Budapest, Hungary
ONBA	Observatorio Naval, Buenos-Aires, Argentina

TABLE 3. ACRONYMS AND LOCATIONS OF THE TIMING CENTRES WHICH MAINTAIN A LOCAL APPROXIMATION OF UTC, UTC(K), OR/AND AN INDEPENDENT LOCAL TIME SCALE, TA(K) (CONT.)

ONRJ	Observatorio Nacional, Rio de Janeiro, Brazil
OP	Observatoire de Paris, Paris, France
ORB	Observatoire Royal de Belgique, Bruxelles, Belgique
PSB	National Measurement Center, Singapore Productivity and Standards Board, Singapore
PTB	Physikalisch-Technische Bundesanstalt, Braunschweig, Deutschland
ROA	Real Instituto y Observatorio de la Armada, San Fernando, Espana
SCL	Standards and Calibration Laboratory, Hong Kong
SMU	Slovak Institute of Metrology, Bratislava, Slovakia
SO	Shanghai Observatory, Shanghai, P.R. China
SP	Swedish National Testing and Research Institute, Boras, Sweden
SU	Institute of Metrology for Time and Space (IMVP), NPO "VNIIFTRI" Mendeleevo, Moscow Region, Russia
TL	Telecommunication Laboratories, Chung-Li, Taiwan
TP	Institute of Radio Engineering and Electronics, Academy of Sciences of Czech Republic - Czech Republic
TUG	Technische Universität, Graz, Oesterreich
UME	Ulusai Metroloji Enstitüsü, Marmara Research Centre, National Metrology Institute, Gebze-Kocaeli, Turkey
USNO	U.S. Naval Observatory, Washington D.C., USA
VSL	Van Swinden Laboratorium, Delft, Nederland

TABLE 4. EQUIPMENT AND SOURCE OF UTC(K) OF THE LABORATORIES CONTRIBUTING TO TAI IN 1998.

Ind. Cs : Industrial Cs standard

Lab. Cs : Laboratory Cs standard

H-maser : Hydrogen maser

* means 'yes'

Lab k	Equipment	Source of UTC(k) (1)	TA(k)	Time Links		
				GPS	GLONASS	Two-Way
AOS (a)	2 Ind. Cs	1 Cs + micro-phase-stepper		*		
APL (a)	2 Ind. Cs 3 H-masers	1 Cs	* (2)	*		*
AUS (3)	15 Ind. Cs 4 H-masers (4)	1 Cs	*	*	*	*
BEV	2 Ind. Cs 1 Ind. Rb	1 Cs		*		
BIRM	2 Ind. Cs 1 H-maser	1 Cs		*	*	
CAO	3 Ind. Cs	1 Cs		*		
CH	11 Ind. Cs (5)	all the Cs	*	*		
CNM	6 Ind. Cs	1 Cs		*		
CRL	13 Ind. Cs 1 Lab. Cs 4 H-masers	7 Cs	*	*	*	*
CSAO	6 Ind. Cs 2 H-masers	all the Cs	*	*		*
CSIR	2 Ind. Cs	1 Cs		*	*	
DLR	1 Ind. Cs 2 H-masers	1 H-maser		*	*	
DTAG	3 Ind. Cs	1 Cs		*		*
GUM	4 Ind. Cs	1 Cs		*		

TABLE 4. EQUIPMENT AND SOURCE OF UTC(K)... (CONT.)

Ind. Cs : Industrial Cs standard

Lab. Cs : Laboratory Cs standard

H-maser : Hydrogen maser

* means 'yes'

Lab k	Equipment	Source of UTC(k) (1)	TA(k)	Time Links		
				GPS	GLONASS	Two-Way
IEN	5 Ind. Cs	1 Cs + micro-phase-stepper	*	*	*	*
IFAG	5 Ind. Cs 3 H-masers	1 Cs + micro-phase-stepper		*		
IGMA	4 Ind. Cs	1 Cs + micro-phase-stepper		* (6)		
INPL	5 Ind. Cs	1 Cs	*	*		
IPQ	3 Ind. Cs	1 Cs		*		
JATC	6 Ind. Cs 3 H-masers (7)	1 Cs + micro-phase-stepper	*	*		*
KRIS	3 Ind. Cs 1 H-maser	1 Cs + micro-phase-stepper	*	*		
LDS	1 Ind. Cs	1 Cs		*	*	
MSL	3 Ind. Cs	1 Cs		*		
NAO	4 Ind. Cs 1 H-maser	1 Cs + micro-phase-stepper		*		
NIM (a)	3 Ind. Cs	1 Cs + micro-phase-stepper	*	*		
NIST	20 Ind. Cs 1 Lab. Cs 5 H-masers	11 Cs 5 H-maser	*	*	*	*

TABLE 4. EQUIPMENT AND SOURCE OF UTC(K)... (CONT.)

Ind. Cs : Industrial Cs standard

Lab. Cs : Laboratory Cs standard

H-maser : Hydrogen maser

* means 'yes'

Lab k	Equipment	Source of UTC(k) (1)	TA(k)	Time Links		
				GPS	GLONASS	Two-Way
NPL	6 Ind. Cs 2 H-maser	1 H-maser		*	*	*
NPLI	3 Ind. Cs	1 Cs		*	*	
NRC (a)	1 Ind. Cs 3 Lab. Cs 2 H-masers	1 Lab. Cs + micro-phase-stepper (8)	*	*		*
NRLM	4 Ind. Cs 1 Lab. Cs	1 Cs		*		
OMH	1 Ind. Cs	1 Cs		*		
ONBA (9)	2 Ind. Cs	1 Cs + micro-phase-stepper		*		
ONRJ	7 Ind. Cs 2 H-masers	1 Cs		*		
OP	5 Ind. Cs 2 Lab. Cs 1 H-maser	1 Cs + micro-phase-stepper	* (10)	*		
ORB	3 Ind. Cs 1 H-maser	1 Cs + micro-phase-stepper		*	*	
PSB	2 Ind. Cs	1 Cs		*		
PTB	4 Ind. Cs 3 Lab. Cs (11) 3 H-masers	1 Lab. Cs	* (12)	*		*
ROA	7 Ind. Cs	all the Cs		*		*

TABLE 4. EQUIPMENT AND SOURCE OF UTC(K)... (CONT.)

Ind. Cs : Industrial Cs standard

Lab. Cs : Laboratory Cs standard

H-maser : Hydrogen maser

* means 'yes'

Lab k	Equipment	Source of UTC(k) (1)	TA(k)	Time Links		
				GPS	GLONASS	Two-Way
SCL	3 Ind. Cs	1 Cs + micro-phase-stepper		*		
SMU (13)	1 Ind. Cs	1 Cs + micro-phase-stepper		*		
SO	1 Ind. Cs 3 H-masers	1 H-maser + micro-phase-stepper	*	* (6)		
SP	3 Ind. Cs	1 Cs + micro-phase-stepper		*		
SU	1 Lab. Cs 10 H-masers	6 H-masers	* (14)	*	*	
TL	5 Ind. Cs	1 Cs + micro-phase-stepper		*	*	
TP	4 Ind. Cs	1 Cs + output frequency steering		*		
TUG	3 Ind. Cs	1 Cs		*		*
UME	3 Ind. Cs	1 Cs		*		
USNO	59 Ind. Cs 15 H-masers	UTC(USNO,MC) is an H-maser + frequency synthesizer steered to UTC(USNO) (15)	* (15)	*	*	*
VSL	4 Ind. Cs	1 Cs + micro-phase-stepper		*	*	*

NOTES

(1) When several clocks are indicated as source of UTC(k), laboratory k computes a software clock, steered to UTC. Often a physical realization of UTC(k) is obtained using a Cs clock and a micro-phase-stepper.

(2) APL . *TA(APL)-UTC(APL)* = 30.999 998 537 s from 50814 to 51178

(3) AUS. From September 1, 1998, UTC(AUS) and TA(AUS) has been realized at the National Measurement Laboratory, Sydney, Australia.

(4) AUS. Some of the standards are located as follows (at the end of 1998):

* National Measurement Laboratory (NML, Sydney)	3 Cs, 2 H-masers,
* Camberra Deep Space Communication Complex (CDSCC, Camberra)	2 Cs, 2 H-masers,
* Philips Calibration Service (PHILIPS, Sydney)	1 Cs,
* Telstra Corporation Ltd (TELSTRA, Perth)	1 Cs,
* Telstra Corporation Ltd (TELSTRA, Melbourne)	5 Cs,
* Hewlett-Packard (HP, Melbourne)	1 Cs,
* TENIX Defence Systems Pty Ltd (TENIX, Williamstown)	1 Cs.

Australian laboratories are intercompared by GPS.

(5) CH . The standards are located as follows (at the end of 1998):

* Office Fédéral de Métrologie (OFMET, Bern)	7 Cs,
* Observatoire de Neuchâtel (ON, Neuchâtel)	3 Cs,
* Swisscom (PTT, Bern)	1 Cs,

this standard has been transferred to OFMET on December 1998.
They are intercompared by GPS (OFMET-ON) and the TV method (OFMET-PTT) and linked to the foreign laboratories through the Swiss Federal Office of Metrology.

(6) GPS link via local restitution of GPS time.

(7) JATC . The standards are located as follows :
* Shaanxi Astronomical Observatory (CSAO),
* Shanghai Astronomical Observatory (SO),
The link between UTC(JATC) and UTC(CSAO) is obtained by internal connection.

(8) NRC . In 1998, UTC(NRC) was derived from NRC Cs VI C.

(9) ONBA. Linked by TV to IGMA.

NOTES (CONT.)

(10) OP . The French atomic time scale TA(F) is computed by the BNM-LPTF with data from 16 industrial caesium clocks located as follows (at the end of 1998) :

* Centre Electronique de l'Armement (CELAR, Rennes)	1 Cs,
* Centre National d'Etudes Spatiales (CNES, Toulouse)	2 Cs,
* Observatoire de la Côte d'Azur (OCA, Grasse)	1 Cs,
* Hewlett-Packard (HP, Orsay)	2 Cs,
* Observatoire de Paris : Laboratoire Primaire du Temps et des Fréquences (BNM-LPTF, Paris)	4 Cs,
* Observatoire de Besançon (OB, Besançon)	2 Cs,
* Tekelec Technologies (TKL, Les Ulis, Paris)	1 Cs,
* Direction des Constructions Navales (DCN, Brest)	3 Cs.

Links by GPS : OP-OB, OP-OCA, OP-CNES, OP-CELAR, OP-HP, OP-TKL, OP-DCN.
Other national links by the TV method.

(11) PTB . The laboratory Cs, PTB CS1, PTB CS2 and PTB CS3, are operated continuously as clocks. Until further notice TA(PTB) is, as before, directly derived from PTB CS2.

(12) PTB . *TA(PTB)-UTC(PTB)* = 31.000 361 500 s from 50814 to 50904
Starting 50904, the rate difference between UTC(PTB) and TA(PTB) is published in the PTB Time Service Bulletin.

(13) SMU . Slovak Institute of Metrology, Bratislava, Slovakia.

(14) SU . *TA(SU)-UTC(SU)* = 28.172 759 000 s from 50814 to 51178

(15) USNO. The time scales A.1(MEAN) and UTC(USNO) are computed by USNO. They rely on a number of Cs clocks and H-masers. A.1(MEAN) is a free atomic time scale while UTC(USNO) is closely steered on UTC. In addition, a number of clocks are in operation at the Alternate Master Clock Station, Colorado Springs, Colorado; their data are used to compute TA(AMC).

(a) Information based on the Annual Report for 1997, not confirmed by the laboratory.

TABLE 5. DIFFERENCES BETWEEN THE NORMALIZED FREQUENCIES OF EAL AND TAI, UNTIL FEBRUARY 1999

(File available on http://www.bipm.fr under the name EALTAI98.AR)

Date	MJD	f(EAL) - f(TAI) in 10^{-13}
until 1977 Jan 1	until 43144	0
1977 Jan 1 - 1977 Apr 26	43144 - 43259	10.0
1977 Apr 26 - 1977 Jun 25	43259 - 43319	9.8
1977 Jun 25 - 1977 Aug 24	43319 - 43379	9.6
1977 Aug 24 - 1977 Oct 23	43379 - 43439	9.4
1977 Oct 23 - 1978 Oct 28	43439 - 43809	9.2
1978 Oct 28 - 1979 Jun 25	43809 - 44049	9.0
1979 Jun 25 - 1979 Aug 24	44049 - 44109	8.8
1979 Aug 24 - 1979 Oct 23	44109 - 44169	8.6
1979 Oct 23 - 1982 Apr 30	44169 - 45089	8.4
1982 Apr 30 - 1982 Jun 29	45089 - 45149	8.2
1982 Jun 29 - 1982 Aug 28	45149 - 45209	8.0
1982 Aug 28 - 1984 Feb 29	45209 - 45759	7.8
1984 Feb 29 - 1987 Apr 24	45759 - 46909	8.0
1987 Apr 24 - 1987 Dec 30	46909 - 47159	8.0125
1987 Dec 30 - 1989 Jun 22	47159 - 47699	8.0
1989 Jun 22 - 1989 Dec 29	47699 - 47889	7.95
1989 Dec 29 - 1990 Feb 27	47889 - 47949	7.90
1990 Feb 27 - 1990 Apr 28	47949 - 48009	7.85
1990 Apr 28 - 1990 Jun 27	48009 - 48069	7.80
1990 Jun 27 - 1990 Aug 26	48069 - 48129	7.75
1990 Aug 26 - 1991 Feb 22	48129 - 48309	7.70
1991 Feb 22 - 1991 Apr 23	48309 - 48369	7.625
1991 Apr 23 - 1991 Aug 31	48369 - 48499	7.55
1991 Aug 31 - 1991 Oct 30	48499 - 48559	7.50
1991 Oct 30 - 1992 Apr 27	48559 - 48739	7.45
1992 Apr 27 - 1992 Jun 26	48739 - 48799	7.40
1992 Jun 26 - 1993 Apr 22	48799 - 49099	7.35
1993 Apr 22 - 1995 Feb 21	49099 - 49769	7.40
1995 Feb 21 - 1995 Apr 22	49769 - 49829	7.39
1995 Apr 22 - 1995 Jun 21	49829 - 49889	7.38
1995 Jun 21 - 1995 Aug 30	49889 - 49959	7.37
1995 Aug 30 - 1995 Oct 29	49959 - 50019	7.36
1995 Oct 29 - 1995 Dec 28	50019 - 50079	7.35
1995 Dec 28 - 1996 Feb 26	50079 - 50139	7.34
1996 Feb 26 - 1996 Apr 26	50139 - 50199	7.33
1996 Apr 26 - 1996 Jun 30	50199 - 50264	7.32
1996 Jun 30 - 1996 Aug 29	50264 - 50324	7.31
1996 Aug 29 - 1996 Oct 28	50324 - 50384	7.295
1996 Oct 28 - 1996 Dec 27	50384 - 50444	7.280
1996 Dec 27 - 1997 Feb 25	50444 - 50504	7.265
1997 Feb 25 - 1997 Apr 26	50504 - 50564	7.250
1997 Apr 26 - 1997 Jun 30	50564 - 50629	7.230
1997 Jun 30 - 1997 Aug 29	50629 - 50689	7.210
1997 Aug 29 - 1997 Oct 28	50689 - 50749	7.190
1997 Oct 28 - 1997 Dec 27	50749 - 50809	7.170
1997 Dec 27 - 1998 Jan 31	50809 - 50844	7.160
1998 Jan 31 - 1998 Feb 25	50844 - 50869	7.150
1998 Feb 25 - 1998 Mar 27	50869 - 50899	7.140
1998 Mar 27 - 1999 Feb 25	50899 - 51234	7.130

As the time scales UTC and TAI differ by an integral number of seconds (see Tables 1 and 2), UTC is necessarily subjected to the same intentional frequency adjustment as TAI.

TABLE 6. MEASUREMENTS OF THE DURATION OF THE TAI SCALE INTERVAL

(File available on http://www.bipm.fr under the name UTAI98.AR)

The following table gives the difference *d* between the duration of the TAI scale interval and the SI second as produced by the primary standards CRL-01, LPTF-JPO, LPTF-F01, NIST-7, NRC CsVI A and C, NRLM-4, PTB CS1, PTB CS2, PTB CS3 and SU MCsR 102 for the period 1993-1998. Previous calibrations are available in the successive annual reports of the BIPM Time Section volumes 1 to 10.

The frequencies of the primary frequency standards are corrected for the gravitational shift (of about $1\text{x}10^{-13}$ for an altitude of 1000 m), and for the black-body radiation shift (of about $2\text{x}10^{-14}$ for a temperature of 40 °C) when available (standards tagged with a *).

The characteristics of the calibrations of the TAI frequency provided by the different primary standards are as follows:

Standard	Unc. (1 σ)	Operation	Comparison with	Transfer to TAI
CRL-01*	$1.0\text{x}10^{-14}$	Discontinuous	H maser	25 d
LPTF-JPO*	$1.1\text{x}10^{-13}$	Discontinuous	UTC(OP)	10 d
LPTF-F01*	$2.2\text{x}10^{-15}$	Discontinuous	H maser	5 d, 10 d or 30d
NIST-7*	0.7 or $1.0\text{x}10^{-14}$	Discontinuous	H maser	5 d or 10 d
NRC CsVI A	$\approx 1\text{x}10^{-13}$	Continuous	TAI	60 d
NRC CsVI C	$\approx 1\text{x}10^{-13}$	Continuous	TAI	60 d
NRLM-4*	$2.9\text{x}10^{-14}$	Discontinuous	TAI	5 d or 10 d
PTB CS1*(1)	3.0 or $0.7\text{x}10^{-14}$	Continuous	TAI	60 d
PTB CS2*	$1.5\text{x}10^{-14}$	Continuous	TAI	60 d
PTB CS3*	$1.4\text{x}10^{-14}$	Continuous	TAI	60 d
SU MCsR 102*	$5\text{x}10^{-14}$	Discontinuous	UTC(SU)	60 d

(1) Until MJD = 49889, 1 $\sigma = 3.0\text{x}10^{-14}$. From MJD = 50994, 1 $\sigma = 0.7\text{x}10^{-14}$

Note :

The uncertainty quoted in this table is the type B standard uncertainty of the primary frequency standard, as declared to the BIPM by the laboratory. It does not include any additional uncertainty due to frequency transfer from the primary frequency standard to TAI.

TABLE 6. (CONT.)

d in 10^{-14} s

Interval for transfer to TAI	Central date of the calibration	CRL CRL-01*	LPTF JPO*	NIST NIST-7*	NRLM NRLM-4*	SU MCsR 102*	LPTF F01*
48979-49039	1993 Jan 30					+4.0	
49039-49099	1993 Mar 31					-2.0	
49119-49129	1993 May 17		+11.6				
49099-49159	1993 May 30					-1.9	
49159-49229	1993 Jul 30					-1.3	
49229-49289	1993 Sep 30					+0.6	
49289-49349	1993 Nov 30					+5.2	
49469-49529	1994 May 30					+0.6	
49529-49589	1994 Jul 31					-0.5	
49589-49649	1994 Sep 30					-3.5	
49649-49709	1994 Nov 30					+0.3	
49789-49799	1995 Mar 16			+2.0			
49809-49819	1995 Apr 5			+3.0			
49819-49829	1995 Apr 15			+2.9			
49829-49839	1995 Apr 25			+2.0			
49839-49849	1995 May 8			+2.2			
49899-49909	1995 Jul 7			+2.2			
49959-49969	1995 Sep 3			+3.3			
49959-50019	1995 Sep 30					+3.5	
49969-49979	1995 Sep 14						+1.4
49979-49989	1995 Sep 24						+1.6
49989-49999	1995 Oct 4						+1.8
49999-50009	1995 Oct 14						+2.2
50009-50019	1995 Oct 24						+1.4
50029-50039	1995 Nov 13						+1.3
50039-50049	1995 Nov 23						+1.1
50049-50059	1995 Dec 3						+0.6
50059-50069	1995 Dec 13						+1.1
50069-50079	1995 Dec 23						+1.6
50019-50029	1995 Nov 7			+2.2			
50019-50079	1995 Nov 30					+4.3	
50079-50084	1995 Dec 30			+2.5			
50094-50124	1996 Jan 27					+8.4	
50124-50154	1996 Feb 26					+2.4	
50144-50149	1996 Mar 4			+2.1			
50154-50184	1996 Mar 27					+1.9	
50199-50209	1996 May 1			+2.5			
50209-50214	1996 May 8						+1.8
50214-50219	1996 May 13						+2.3
50219-50224	1996 May 18						+2.2
50439-50449	1996 Dec 27			+2.7			
50619-50629	1997 Jun 25			+1.7			
50739-50749	1997 Oct 23			-0.3			
50754-50784	1997 Nov 17						+0.99

TABLE 6. (CONT.)

d in 10^{-14} s

Interval for transfer to TAI	Central date of the calibration	CRL CRL-01*	LPTF JPO*	NIST NIST-7*	NRLM NRLM-4*	SU MCsR 102*	LPTF FO1*
50869-50874	1998 Feb 27				-2.4		
50879-50889	1998 Mar 12			-0.9			
50889-50894	1998 Mar 19				-0.3		
50929-50964	1998 May 13			+1.2			
50934-50939	1998 May 3				-1.0		
50969-50979	1998 Jun 10				-0.7		
51014-51024	1998 Jul 25				-0.9		
51009-51039	1998 Jul 30			-1.1			
51019-51044	1998 Aug 6	-1.2					
51034-51044	1998 Aug 14				-1.9		
51099-51129	1998 Oct 28			-0.3			
51124-51134	1998 Nov 12				-3.9		
51144-51174	1998 Dec 12			-0.1			

TABLE 6. (CONT.)

Interval for transfer to TAI	Central date of the calibration	NRC CsVIA	NRC CsVIC	PTB CS1*	PTB CS2*	PTB CS3*
			d in 10^{-14} s			
48979-49039	1993 Jan 22		-19.0	+2.0	+1.4	
49039-49099	1993 Mar 23		-11.8	+2.8	+0.6	
49099-49159	1993 May 22		-13.1	+0.8	+2.4	
49159-49229	1993 Jul 26		-9.0	+1.3	+2.1	
49229-49289	1993 Sep 29		-9.4	+2.3	+2.9	
49289-49349	1993 Nov 28		-12.6	-0.7	+2.3	
49349-49409	1994 Jan 27		-10.2	+0.6	+1.4	
49409-49469	1994 Mar 28		-11.6	+1.4	+1.3	
49469-49529	1994 May 27		-11.4	+1.2	+2.9	
49529-49589	1994 Jul 26		-10.8	+2.1	+3.3	
49589-49649	1994 Sep 24		-10.8	+1.0	+2.4	
49649-49709	1994 Nov 23		-10.4	+0.6	+1.9	
49709-49769	1995 Jan 22			+2.5	+2.7	
49769-49829	1995 Mar 23	-7.5	-1.7	-0.1	+3.0	
49829-49889	1995 May 22	-10.7	-6.1	+3.5	+2.0	
49889-49959	1995 Jul 26	-11.6	-5.0		+3.5	
49959-50019	1995 Sep 29	-11.1	-5.8		+2.7	+4.9
50019-50079	1995 Nov 28	-9.2	-6.3		+2.5	+4.3
50079-50139	1996 Jan 27	-15.7	-8.2		+3.1	
50139-50199	1996 Mar 27	-17.6	-7.2		+2.8	
50199-50264	1996 May 28	-15.5	-5.9		+2.6	
50264-50324	1996 Jul 30	-15.6	-7.7		+2.9	+5.6
50324-50384	1996 Sep 28	-13.7	-2.5		+2.2	+2.6
50384-50444	1996 Nov 27	-12.5	-5.3		+2.9	+5.0
50444-50504	1997 Jan 26	-10.9	+1.7		+2.8	+5.6
50504-50564	1997 Mar 27	-11.0	+2.4		+2.8	+4.5
50564-50629	1997 May 28	-11.0	-0.5		+2.6	+4.9
50629-50689	1997 Jul 30	-11.2	+0.7		+0.4	+3.4
50689-50749	1997 Sep 28	-12.1	+0.7		+1.4	+3.8
50749-50809	1997 Nov 27	-12.3	+0.5		+0.5	+2.5
50809-50844	1998 Jan 13	-12.6	+0.6		+0.6	+1.6
50844-50869	1998 Feb 12	-13.6	-0.4		+0.6	+0.8
50869-50899	1998 Mar 12	-13.1	+0.2		+0.2	+3.3
50899-50929	1998 Apr 11	-13.5	-0.1		-0.1	+0.5
50929-50964	1998 May 13	-12.2	+0.3		+0.4	+0.1
50964-50994	1998 Jun 15	-13.4	-0.4		-0.3	+0.8
50994-51024	1998 Jul 15	-13.4	+0.1	-0.3	+0.2	+0.5
51024-51054	1998 Aug 14	-15.1	+0.2	-0.7	+0.5	+1.7
51054-51084	1998 Sep 13		+1.5	-0.8	+0.2	+2.4
51084-51114	1998 Oct 13		+0.4	-0.2	-0.6	+2.6
51114-51144	1998 Nov 12		+0.2	-1.0	-0.1	+4.0
51144-51174	1998 Dec 12		-0.1	-0.4	+0.1	+1.7

TABLE 7. MEAN DURATION OF THE TAI SCALE INTERVAL IN SI SECOND ON THE ROTATING GEOID

(File available on http://www.bipm.fr under the name SITAI98.AR)

The estimate of the mean duration of the TAI scale interval in SI second on the rotating geoid, and its relative uncertainty are computed by the BIPM according to the method described in 'Azoubib J., Granveaud M., Guinot B., *Metrologia* 13, 1977, pp. 87-93', using all available measurements from the most accurate primary frequency standards CRL-01, LPTF-FO1, NIST-7, NRLM-4, PTB CS1, PTB CS2, PTB CS3 and SU MCsR 102, consistently corrected for the black-body radiation shift.

For the months	Mean duration in s	Relative uncertainty
1993 Jan - Feb	$1 + 1.7\times10^{-14}$	0.9×10^{-14}
1993 Mar - Apr	+ 1.3	0.9
1993 May - Jun	+ 1.8	0.9
1993 Jul - Aug	+ 1.9	0.9
1993 Sep - Oct	+ 2.1	0.9
1993 Nov - Dec	+ 1.9	0.9
1994 Jan - Feb	$1 + 1.7\times10^{-14}$	0.9×10^{-14}
1994 Mar - Apr	+ 1.8	0.9
1994 May - Jun	+ 2.1	0.9
1994 Jul - Aug	+ 2.3	0.9
1994 Sep - Oct	+ 2.0	0.8
1994 Nov - Dec	+ 2.0	0.8
1995 Jan - Feb	$1 + 2.3\times10^{-14}$	0.7×10^{-14}
1995 Mar - Apr	+ 2.4	0.5
1995 May - Jun	+ 2.4	0.5
1995 Jul - Aug	+ 2.4	0.6
1995 Sep - Oct	+ 2.1	0.4
1995 Nov - Dec	+ 1.7	0.4
1996 Jan - Feb	$1 + 2.2\times10^{-14}$	0.6×10^{-14}
1996 Mar - Apr	+ 2.3	0.6
1996 May - Jun	+ 2.4	0.5
1996 Jul - Aug	+ 2.6	0.7
1996 Sep - Oct	+ 2.5	0.8
1996 Nov - Dec	+ 2.6	0.7
1997 Jan - Feb	$1 + 2.6\times10^{-14}$	0.7×10^{-14}
1997 Mar - Apr	+ 2.4	0.8
1997 May - Jun	+ 2.1	0.7
1997 Jul - Aug	+ 1.6	0.8
1997 Sep - Oct	+ 1.1	0.7
1997 Nov - Dec	+ 0.9	0.4
1998 Jan - Feb	$1 + 0.5\times10^{-14}$	0.5×10^{-14}
1998 Mar - Apr	+ 0.1	0.5
1998 May - Jun	- 0.1	0.5
1998 Jul - Aug	- 0.4	0.4
1998 Sep - Oct	- 0.4	0.4
1998 Nov - Dec	- 0.4	0.4

TABLE 8 - INDEPENDENT LOCAL ATOMIC TIME SCALES

(File available on http://www.bipm.fr under the name TAI98.AR)

The following table gives the values of [*TAI* - *TA*(*k*)], where TA(k) denotes the independant time scale established by the laboratory k.

Unit is one nanosecond.

Date 1998 0h UTC	MJD	TAI - TA(k) AMC	APL	AUS (*)	CH	CRL
Jan 1	50814	-365142	-	-83090	-39699	94306
Jan 6	50819	-365147	-	-83177	-39512	94512
Jan 11	50824	-365151	6387	-83273	-39326	94735
Jan 16	50829	-365157	6436	-83346	-39145	94953
Jan 21	50834	-365159	6493	-83474	-38979	95156
Jan 26	50839	-365164	6542	-83587	-38782	95365
Jan 31	50844	-365171	6590	-83669	-38577	95573
Feb 5	50849	-365181	6646	-83717	-38383	95779
Feb 10	50854	-365183	6690	-83826	-38198	95992
Feb 15	50859	-365188	6739	-83934	-38009	96200
Feb 20	50864	-365191	6800	-84049	-37811	96411
Feb 25	50869	-365193	6846	-84145	-37633	96622
Mar 2	50874	-365198	6896	-84252	-37447	96824
Mar 7	50879	-365203	6939	-84343	-37277	97040
Mar 12	50884	-365205	6989	-84446	-37099	97246
Mar 17	50889	-365211	7039	-84559	-36905	97457
Mar 22	50894	-365213	7098	-84645	-36717	97667
Mar 27	50899	-365220	7148	-84768	-36510	97878
Apr 1	50904	-365213	7198	-84884	-36341	98087
Apr 6	50909	-365216	7243	-84986	-36166	98303
Apr 11	50914	-365218	7301	-85064	-35995	98511
Apr 16	50919	-365224	7353	-85164	-35830	98726
Apr 21	50924	-365227	7400	-85277	-35658	98939
Apr 26	50929	-365232	-	-85384	-35484	99146
May 1	50934	-365238	6452	-85496	-35309	99357
May 6	50939	-365242	6387	-85600	-35135	99568
May 11	50944	-365242	6417	-85722	-34963	99774
May 16	50949	-365245	-	-85821	-34791	99984
May 21	50954	-365248	1723	-85955	-34617	100196
May 26	50959	-365254	1779	-86063	-34455	100413
May 31	50964	-365259	1831	-86160	-34281	100621
Jun 5	50969	-365258	1888	-86287	-34115	100828
Jun 10	50974	-365261	1922	-86357	-33947	101044
Jun 15	50979	-365266	1961	-86462	-33783	101258
Jun 20	50984	-365270	1995	-86579	-33614	101468
Jun 25	50989	-365275	-	-86660	-33443	101673
Jun 30	50994	-365277	-	-86750	-33280	101880

(*) From September 1, 1998, TA(AUS) has been realized at NML.

TABLE 8. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	TAI - TA(k) AMC	APL	AUS	CH	CRL
Jul 5	50999	-365283	-	-86884	-33099	102094
Jul 10	51004	-365288	-	-86971	-32924	102304
Jul 15	51009	-365294	-	-87094	-32756	102515
Jul 20	51014	-365296	-	-87202	-32580	102731
Jul 25	51019	-365302	-	-87247	-32401	102941
Jul 30	51024	-365305	-	-87397	-32227	103156
Aug 4	51029	-365310	-	-87487	-32054	103377
Aug 9	51034	-365309	-	-87595	-31879	103570
Aug 14	51039	-365313	2370	-87711	-31691	103782
Aug 19	51044	-365318	2419	-87849	-31517	103992
Aug 24	51049	-365325	2471	-87930	-31335	104207
Aug 29	51054	-365330	2521	-88037	-31167	104427
Sep 3	51059	-365335	2566	-88176	-30986	104642
Sep 8	51064	-365339	2621	-88307	-30798	104847
Sep 13	51069	-365345	2675	-88383	-30622	105065
Sep 18	51074	-365349	2729	-88489	-30450	105276
Sep 23	51079	-365356	2772	-88600	-30269	105489
Sep 28	51084	-365359	2310	-88682	-30091	105702
Oct 3	51089	-365363	2403	-88823	-29911	105920
Oct 8	51094	-365368	2276	-88914	-29726	106135
Oct 13	51099	-365374	2214	-88992	-29537	106350
Oct 18	51104	-365378	2112	-89127	-29360	106556
Oct 23	51109	-365383	2094	-89241	-29190	106770
Oct 28	51114	-365387	1982	-89355	-29001	106981
Nov 2	51119	-365397	1987	-89472	-28812	107194
Nov 7	51124	-365400	1902	-89579	-28626	107408
Nov 12	51129	-365406	1819	-89694	-28431	107617
Nov 17	51134	-365411	1843	-89777	-28246	107830
Nov 22	51139	-365421	1830	-89803	-28057	108039
Nov 27	51144	-365428	1807	-89934	-27860	108250
Dec 2	51149	-365430	-	-90113	-27666	108463
Dec 7	51154	-365437	1796	-90196	-27477	108675
Dec 12	51159	-365439	1835	-	-27280	108891
Dec 17	51164	-365448	1794	-90354	-27087	109109
Dec 22	51169	-365454	1747	-90511	-26897	109326
Dec 27	51174	-365460	1776	-90625	-26718	109536

TABLE 8. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	TAI - TA(k) CSAO (*)	F	IEN	INPL	JATC
Jan 1	50814	259	162764	5233	-	11269
Jan 6	50819	263	162759	5280	-	11113
Jan 11	50824	253	162748	5325	-	11013
Jan 16	50829	269	162740	5373	-	10923
Jan 21	50834	238	162735	5426	-	10826
Jan 26	50839	236	162728	5473	-	10705
Jan 31	50844	212	162723	5527	-	10583
Feb 5	50849	178	162714	5574	-	10468
Feb 10	50854	183	162715	5619	-	10385
Feb 15	50859	187	162712	5670	-	10252
Feb 20	50864	213	162709	5715	-	10190
Feb 25	50869	207	162708	5763	-65	10071
Mar 2	50874	165	162702	5816	-89	10021
Mar 7	50879	209	162701	5862	-119	9943
Mar 12	50884	176	162701	5907	-151	9857
Mar 17	50889	174	162697	5949	-188	9748
Mar 22	50894	126	162692	5980	-221	9670
Mar 27	50899	161	162687	6023	-253	9590
Apr 1	50904	139	162684	6068	-285	9611
Apr 6	50909	142	162681	6141	-311	9525
Apr 11	50914	123	162676	6211	-333	9450
Apr 16	50919	136	162673	6272	-370	9376
Apr 21	50924	121	162670	6335	-399	9325
Apr 26	50929	136	162666	6388	-431	9249
May 1	50934	128	162667	6426	-456	9173
May 6	50939	140	162668	6455	-492	9103
May 11	50944	145	162663	6493	-525	9034
May 16	50949	122	162662	6538	-551	8942
May 21	50954	121	162657	6583	-577	8883
May 26	50959	113	162654	6612	-607	8817
May 31	50964	93	162652	6665	-634	8735
Jun 5	50969	91	162650	6720	-665	8652
Jun 10	50974	105	162652	6793	-689	8562
Jun 15	50979	97	162649	6850	-721	8465
Jun 20	50984	89	162650	6893	-749	8393
Jun 25	50989	92	162648	6951	-761	8300
Jun 30	50994	66	162645	7012	-758	8207

(*) CSAO. Starting on MJD = 50814, TA(CSAO) is a new independent local atomic time scale.

TABLE 8. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	*TAI - TA(k)* CSAO	F	IEN	INPL	JATC
Jul 5	50999	74	162642	7070	-743	8105
Jul 10	51004	81	162641	7126	-727	8003
Jul 15	51009	39	162637	7185	-708	7895
Jul 20	51014	61	162636	7239	-693	7762
Jul 25	51019	63	162637	7300	-683	7686
Jul 30	51024	43	162633	7361	-669	7593
Aug 4	51029	39	162631	7415	-654	7523
Aug 9	51034	42	162634	7475	-637	7389
Aug 14	51039	43	162637	7531	-612	7253
Aug 19	51044	19	162638	7586	-598	7133
Aug 24	51049	23	162641	7646	-586	7049
Aug 29	51054	26	162631	7698	-572	6963
Sep 3	51059	26	162631	7747	-555	6273
Sep 8	51064	24	162632	7800	-543	6154
Sep 13	51069	27	162631	7848	-532	6040
Sep 18	51074	1	162629	7898	-511	5912
Sep 23	51079	-17	162629	7945	-495	5808
Sep 28	51084	-17	162629	7999	-475	5700
Oct 3	51089	-17	162627	8056	-458	5608
Oct 8	51094	-37	162626	8116	-437	5500
Oct 13	51099	-29	162623	8147	-420	5416
Oct 18	51104	-37	162621	8187	-406	5319
Oct 23	51109	-24	162618	8236	-393	5240
Oct 28	51114	-37	162621	8270	-372	5137
Nov 2	51119	-31	162622	8304	-354	5068
Nov 7	51124	-48	162624	8332	-354	4959
Nov 12	51129	-50	162624	8359	-343	4906
Nov 17	51134	-57	162627	8386	-322	4832
Nov 22	51139	-78	162626	8405	-305	4743
Nov 27	51144	-79	162630	8433	-291	4672
Dec 2	51149	-95	162632	8448	-278	4588
Dec 7	51154	-107	162630	8462	-269	4518
Dec 12	51159	-122	162629	8476	-252	4450
Dec 17	51164	-133	162631	8500	-237	4397
Dec 22	51169	-134	162635	8519	-228	4336
Dec 27	51174	-163	162633	8541	-215	4257

TABLE 8. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	TAI - TA(k) KRIS	NIST	NML	NRC
Jan 1	50814	5379	-45170255	926	27000
Jan 6	50819	5397	-45170465	945	26999
Jan 11	50824	5414	-45170676	967	26998
Jan 16	50829	5448	-45170890	971	26999
Jan 21	50834	5457	-45171100	977	26997
Jan 26	50839	5473	-45171312	981	27000
Jan 31	50844	5484	-45171525	991	27000
Feb 5	50849	5500	-45171735	1007	27004
Feb 10	50854	5514	-45171945	1018	27006
Feb 15	50859	5536	-45172156	1021	27008
Feb 20	50864	5552	-45172366	1014	27013
Feb 25	50869	5588	-45172577	1012	27009
Mar 2	50874	5619	-45172789	1026	27007
Mar 7	50879	5648	-45172999	1047	27001
Mar 12	50884	5659	-45173208	1067	26999
Mar 17	50889	5688	-45173420	1094	26998
Mar 22	50894	5705	-45173631	1124	27006
Mar 27	50899	5729	-45173843	1159	27003
Apr 1	50904	5769	-45174054	1173	26995
Apr 6	50909	5788	-45174266	1186	26984
Apr 11	50914	5809	-45174476	1194	26998
Apr 16	50919	5866	-45174686	1228	26996
Apr 21	50924	5902	-45174896	1249	27000
Apr 26	50929	5932	-45175104	1264	26999
May 1	50934	5965	-45175314	1248	27008
May 6	50939	5984	-45175524	1232	27002
May 11	50944	6010	-45175733	1240	27000
May 16	50949	6050	-45175942	1238	26997
May 21	50954	6064	-45176152	1256	27002
May 26	50959	6094	-45176364	1266	26997
May 31	50964	6120	-45176571	1270	26996
Jun 5	50969	6116	-45176778	1288	26993
Jun 10	50974	6115	-45176987	1265	26996
Jun 15	50979	6115	-45177196	1258	26998
Jun 20	50984	6107	-45177402	1258	27003
Jun 25	50989	6117	-45177612	1250	27002
Jun 30	50994	6113	-45177820	1280	27007

TABLE 8. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	TAI - TA(k) KRIS	NIST	NML	NRC
Jul 5	50999	6135	-45178029	1296	27009
Jul 10	51004	6126	-45178237	1321	27004
Jul 15	51009	6115	-45178445	1312	27006
Jul 20	51014	6106	-45178652	1316	27003
Jul 25	51019	6103	-45178861	1330	27003
Jul 30	51024	6086	-45179068	1353	27010
Aug 4	51029	6088	-45179281	1379	27000
Aug 9	51034	6070	-45179486	1380	27007
Aug 14	51039	6077	-45179690	1382	27014
Aug 19	51044	6081	-45179898	1373	27006
Aug 24	51049	6089	-45180106	1373	27004
Aug 29	51054	6101	-45180313	1392	27002
Sep 3	51059	6109	-45180520	-	27000
Sep 8	51064	6099	-45180729	-	26991
Sep 13	51069	6106	-45180935	-	26986
Sep 18	51074	6095	-45181143	-	26981
Sep 23	51079	6100	-45181350	-	26970
Sep 28	51084	6097	-45181557	-	26964
Oct 3	51089	6096	-45181764	-	26967
Oct 8	51094	6102	-45181971	-	26963
Oct 13	51099	6102	-45182177	-	26958
Oct 18	51104	6079	-45182383	-	26959
Oct 23	51109	6090	-45182590	-	26956
Oct 28	51114	6088	-45182797	-	26956
Nov 2	51119	6091	-45183005	-	26953
Nov 7	51124	6093	-45183211	-	26952
Nov 12	51129	6094	-45183418	-	26955
Nov 17	51134	6106	-45183623	-	26957
Nov 22	51139	6111	-45183833	-	26954
Nov 27	51144	6112	-45184040	-	26945
Dec 2	51149	6117	-45184244	-	26950
Dec 7	51154	6116	-45184451	-	26947
Dec 12	51159	6114	-45184660	-	26949
Dec 17	51164	6135	-45184864	-	26948
Dec 22	51169	6131	-45185067	-	26952
Dec 27	51174	6134	-45185276	-	26948

TABLE 8. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	TAI - TA(k) PTB	SO	SU (*)	USNO
Jan 1	50814	-361531	-46770	27241366	-34786294
Jan 6	50819	-361527	-46777	27241357	-34786614
Jan 11	50824	-361521	-46777	27241348	-34786931
Jan 16	50829	-361517	-46764	27241343	-34787249
Jan 21	50834	-361511	-46799	27241345	-34787565
Jan 26	50839	-361509	-46786	27241339	-34787882
Jan 31	50844	-361507	-46780	27241323	-34788200
Feb 5	50849	-361508	-46771	27241321	-34788516
Feb 10	50854	-361499	-46783	27241316	-34788833
Feb 15	50859	-361498	-46770	27241307	-34789149
Feb 20	50864	-361487	-46784	27241307	-34789463
Feb 25	50869	-361485	-46779	27241292	-34789778
Mar 2	50874	-361482	-	27241288	-34790092
Mar 7	50879	-361472	-	27241282	-34790409
Mar 12	50884	-361461	-	27241284	-34790722
Mar 17	50889	-361458	-	27241266	-34791037
Mar 22	50894	-361454	-	27241269	-34791350
Mar 27	50899	-361449	-	27241262	-34791669
Apr 1	50904	-361445	-	27241258	-34791983
Apr 6	50909	-361439	-	27241251	-34792297
Apr 11	50914	-361432	-	27241250	-34792610
Apr 16	50919	-361420	-	27241244	-34792925
Apr 21	50924	-361413	-	27241245	-34793238
Apr 26	50929	-361403	-	27241246	-34793552
May 1	50934	-361392	-	27241237	-34793867
May 6	50939	-361387	-	27241240	-34794181
May 11	50944	-361384	-	27241235	-34794493
May 16	50949	-361378	-	27241228	-34794806
May 21	50954	-361373	-	27241222	-34795120
May 26	50959	-361367	-	27241238	-34795434
May 31	50964	-361360	-	27241228	-34795749
Jun 5	50969	-361356	-	27241214	-34796059
Jun 10	50974	-361351	-	27241215	-34796373
Jun 15	50979	-361342	-	27241208	-34796685
Jun 20	50984	-361330	-	27241209	-34796998
Jun 25	50989	-361318	-	27241209	-34797311
Jun 30	50994	-361311	-	27241204	-34797622

(*) SU . Listed values are TAI-TA(SU) - 2.80 seconds.

TABLE 8. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	TAI - TA(k) PTB	SO	SU	USNO
Jul 5	50999	-361305	-	27241199	-34797937
Jul 10	51004	-361298	-	27241200	-34798250
Jul 15	51009	-361295	-	27241194	-34798562
Jul 20	51014	-361288	-	27241193	-34798873
Jul 25	51019	-361279	-	27241186	-34799186
Jul 30	51024	-361271	-	27241184	-34799497
Aug 4	51029	-361266	-	27241179	-34799816
Aug 9	51034	-361261	-	27241184	-34800123
Aug 14	51039	-361255	-	27241186	-34800437
Aug 19	51044	-361250	-	27241179	-34800750
Aug 24	51049	-361246	-	27241182	-34801063
Aug 29	51054	-361239	-	27241183	-34801377
Sep 3	51059	-361229	-	27241180	-34801692
Sep 8	51064	-361225	-	27241174	-34802005
Sep 13	51069	-361222	-	27241175	-34802318
Sep 18	51074	-361214	-	27241173	-34802629
Sep 23	51079	-361209	-	27241176	-34802945
Sep 28	51084	-361198	-	27241171	-34803256
Oct 3	51089	-361191	-	27241174	-34803569
Oct 8	51094	-361178	-	27241172	-34803883
Oct 13	51099	-361169	-	27241171	-34804196
Oct 18	51104	-361159	-	27241170	-34804505
Oct 23	51109	-361148	-	27241164	-34804818
Oct 28	51114	-361141	-	27241162	-34805129
Nov 2	51119	-361133	-	27241162	-34805446
Nov 7	51124	-361123	-	27241163	-34805758
Nov 12	51129	-361114	-	27241160	-34806071
Nov 17	51134	-361105	-	27241157	-34806382
Nov 22	51139	-361105	-	27241154	-34806701
Nov 27	51144	-361096	-	27241156	-34807016
Dec 2	51149	-361092	-	27241166	-34807329
Dec 7	51154	-361083	-	-	-34807643
Dec 12	51159	-361080	-	-	-34807954
Dec 17	51164	-361068	-	-	-34808270
Dec 22	51169	-361059	-	-	-34808584
Dec 27	51174	-361057	-	-	-34808898

TABLE 9. LOCAL REPRESENTATIONS OF UTC : VALUES OF [*UTC - UTC(K)*]

(File available on http://www.bipm.fr under the name UTC98.AR)

The following table gives the values of [*UTC-UTC(k)*], where UTC(k) denotes the approximation to UTC kept by laboratory k.

Unit is one nanosecond.

Date 1998 0h UTC	MJD	*UTC - UTC (k)* AOS (1)	APL (2)	AUS (3)	BEV	BIRM	CAO
Jan 1	50814	-245	-	254	-	-8229	-2084
Jan 6	50819	-221	-	259	-	-8273	-2088
Jan 11	50824	-176	4924	276	-	-8330	-2121
Jan 16	50829	-91	4973	289	-	-8384	-2163
Jan 21	50834	-353	5030	298	-	-8413	-2184
Jan 26	50839	-216	5079	289	-	-8452	-2196
Jan 31	50844	-192	5127	308	-	-8508	-2226
Feb 5	50849	-166	5183	310	-	-8563	-2250
Feb 10	50854	-199	5227	302	-	-8608	-2273
Feb 15	50859	-242	5276	302	-	-8654	-2287
Feb 20	50864	-367	5337	291	-	-	-2309
Feb 25	50869	-375	5383	285	-	-8754	-2321
Mar 2	50874	-418	5433	291	-	-8794	-2338
Mar 7	50879	-418	5476	291	-	-8793	-2362
Mar 12	50884	-398	5526	311	-	-8918	-2382
Mar 17	50889	-334	5576	306	-	-	-2405
Mar 22	50894	-280	5635	326	-	-	-2436
Mar 27	50899	-190	5685	319	-	-9056	-2463
Apr 1	50904	-119	5735	311	-	-9102	-2479
Apr 6	50909	-192	5780	310	2293	-9192	-2504
Apr 11	50914	-271	5838	297	2432	-9214	-2509
Apr 16	50919	-348	5890	322	2560	-9318	-2529
Apr 21	50924	-444	5937	322	2694	-9382	-2560
Apr 26	50929	-527	4940	331	2821	-9372	-2582
May 1	50934	-474	4989	357	-	-9443	-2596
May 6	50939	-469	4924	372	-	-9470	-2607
May 11	50944	-481	4954	377	-	-9498	-2638
May 16	50949	-585	208	373	-	-9525	-2666
May 21	50954	-634	260	391	-	-9550	-2678
May 26	50959	-597	316	424	-	-9576	-2699
May 31	50964	-616	368	437	-	-9560	-2709
Jun 5	50969	-814	425	461	-	-9592	-2753
Jun 10	50974	-1046	459	487	-	-9660	-2777
Jun 15	50979	-1259	498	509	-	-9648	-2795
Jun 20	50984	-1407	532	524	-	-9704	-2806
Jun 25	50989	-1566	-	577	244	-9786	-2832
Jun 30	50994	-1764	-	612	350	-9803	-2844

TABLE 9. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	UTC - UTC (k) AOS (1)	APL (2)	AUS (3)	BEV	BIRM	CAO
Jul 5	50999	-1988	-	638	549	-9794	-2865
Jul 10	51004	-2137	-	652	728	-9904	-2893
Jul 15	51009	-2243	-	682	861	-9921	-2907
Jul 20	51014	-2371	-	727	988	-9946	-2940
Jul 25	51019	-2586	-	742	1116	-10018	-2954
Jul 30	51024	-2812	-	764	1247	-10066	-2953
Aug 4	51029	-3036	-	785	1376	-10096	-3001
Aug 9	51034	-3211	-	787	1512	-10138	-3012
Aug 14	51039	-3427	907	812	1660	-10170	-3036
Aug 19	51044	-3659	956	830	1814	-10227	-3079
Aug 24	51049	-3891	1008	859	1951	-10235	-3121
Aug 29	51054	-4082	1058	901	2087	-10280	-3151
Sep 3	51059	-4101	1103	726	2227	-10284	-3175
Sep 8	51064	-3660	1158	742	2375	-10358	-3198
Sep 13	51069	-3977	1212	769	2511	-10388	-3229
Sep 18	51074	-4356	1266	784	2629	-10466	-3252
Sep 23	51079	-4580	1309	792	2755	-10498	-3272
Sep 28	51084	-4937	847	824	2907	-10572	-3273
Oct 3	51089	-5255	940	864	2970	-	-3306
Oct 8	51094	-5632	813	887	3186	-10628	-3328
Oct 13	51099	-6037	751	910	3410	-10625	-3332
Oct 18	51104	-6437	649	937	3568	-10641	-3363
Oct 23	51109	-6879	631	964	3721	-	-3391
Oct 28	51114	-7274	519	974	3859	-	-3406
Nov 2	51119	-7661	524	998	3953	-10914	-3432
Nov 7	51124	-8077	439	1021	4096	-10980	-3450
Nov 12	51129	-8445	356	1035	4238	-10988	-3471
Nov 17	51134	-8718	380	1050	4375	-11127	-3494
Nov 22	51139	-8969	367	1077	4521	-11087	-3499
Nov 27	51144	-9184	344	1090	4681	-11167	-3538
Dec 2	51149	-9400	-	1100	4813	-11234	-3565
Dec 7	51154	-9560	333	1099	4956	-11277	-3609
Dec 12	51159	-9787	372	1077	5100	-11314	-3645
Dec 17	51164	-9978	331	1052	5260	-11331	-3661
Dec 22	51169	-10348	284	1062	5618	-11404	-3685
Dec 27	51174	-10353	313	1067	5776	-11451	-3710

TABLE 9. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	*UTC - UTC (k)* CH (4)	CNM (5)	CRL (6)	CSAO	CSIR (7)	DLR
Jan 1	50814	91	-608	-73	55	-2180	-1805
Jan 6	50819	90	-552	-70	58	-2260	-1846
Jan 11	50824	89	-479	-82	50	-2345	-
Jan 16	50829	82	-421	-78	62	-2424	-
Jan 21	50834	61	-361	-85	32	-2481	-
Jan 26	50839	70	-291	-89	32	-2560	-2044
Jan 31	50844	87	-241	-92	17	-2638	-2090
Feb 5	50849	94	-186	-98	-13	-2724	-2139
Feb 10	50854	91	-118	-101	-1	-2780	-2181
Feb 15	50859	89	-63	-106	6	-2872	-2232
Feb 20	50864	96	-36	-105	31	-2964	-2277
Feb 25	50869	83	-20	-101	23	-3059	-2325
Mar 2	50874	78	-5	-111	-12	-3127	-2370
Mar 7	50879	57	20	-105	35	-3220	-2419
Mar 12	50884	44	46	-107	6	-3313	-2463
Mar 17	50889	47	66	-110	12	-3382	-2510
Mar 22	50894	44	83	-110	-32	-3451	-2559
Mar 27	50899	60	95	-113	7	-3543	-2608
Apr 1	50904	38	112	-114	-11	-3627	-2654
Apr 6	50909	22	142	-108	-10	-3709	-
Apr 11	50914	2	159	-109	-24	-3786	-2637
Apr 16	50919	-25	185	-105	-7	-3862	-2686
Apr 21	50924	-44	198	-103	-22	-3931	-2735
Apr 26	50929	-61	220	-104	-6	-4027	-2779
May 1	50934	-77	236	-111	-9	-4120	-2823
May 6	50939	-95	260	-103	1	-4217	-2876
May 11	50944	-114	280	-100	4	-4313	-2923
May 16	50949	-133	305	-90	-19	-4425	-2969
May 21	50954	-150	326	-84	-12	-4520	-3019
May 26	50959	-179	355	-82	-21	-4600	-3072
May 31	50964	-197	373	-76	-31	-4716	-3120
Jun 5	50969	-222	400	-76	-26	-4802	-3172
Jun 10	50974	-239	428	-68	-1	-4906	-3221
Jun 15	50979	-235	446	-58	2	-4983	-3273
Jun 20	50984	-227	462	-55	-2	-5048	-3322
Jun 25	50989	-216	477	-52	5	-5096	-3373
Jun 30	50994	-214	490	-50	-10	-5152	-3424

TABLE 9. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	UTC - UTC (k) CH (4)	CNM (5)	CRL (6)	CSAO	CSIR (7)	DLR
Jul 5	50999	-193	512	-44	4	-5222	-3478
Jul 10	51004	-179	524	-42	21	-5304	-3531
Jul 15	51009	-171	562	-36	-18	-5390	-3589
Jul 20	51014	-156	581	-27	8	-5457	-3640
Jul 25	51019	-137	613	-16	16	-5545	-3693
Jul 30	51024	-124	641	-10	-2	-5616	-3748
Aug 4	51029	-111	658	-1	5	-5682	-3804
Aug 9	51034	-97	667	3	12	-5742	-3853
Aug 14	51039	-69	700	4	16	-5819	-3900
Aug 19	51044	-55	718	6	-2	-5897	-3957
Aug 24	51049	-33	739	13	3	-5963	-4016
Aug 29	51054	-25	765	23	6	-6066	-4083
Sep 3	51059	-4	781	29	14	-6137	-4133
Sep 8	51064	24	802	32	18	-6184	-4188
Sep 13	51069	40	826	40	28	-6278	-4268
Sep 18	51074	52	859	34	8	-6361	-4326
Sep 23	51079	73	886	42	-3	-6460	-4387
Sep 28	51084	91	912	39	3	-6540	-4450
Oct 3	51089	111	926	54	13	-6613	-4516
Oct 8	51094	132	954	55	0	8317	-4579
Oct 13	51099	138	981	65	14	8283	-4647
Oct 18	51104	133	1003	62	13	8237	-4716
Oct 23	51109	120	1026	60	32	8181	-4786
Oct 28	51114	126	1053	64	26	8173	-4858
Nov 2	51119	133	1072	68	38	7988	-4932
Nov 7	51124	136	1096	67	27	7890	-5019
Nov 12	51129	148	1122	71	32	7827	-5092
Nov 17	51134	151	1152	74	31	7757	-5171
Nov 22	51139	157	1174	72	17	7685	-5261
Nov 27	51144	171	1197	61	22	7604	-5349
Dec 2	51149	183	1217	55	12	7534	-5436
Dec 7	51154	188	1246	55	7	7466	-5520
Dec 12	51159	199	1260	57	-2	7390	-5608
Dec 17	51164	206	1288	62	-6	7294	-5683
Dec 22	51169	209	1319	59	-1	7219	-5756
Dec 27	51174	202	1336	51	-24	7135	-5834

TABLE 9. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	UTC - UTC (k)					
		DTAG (8)	GUM	IEN (9)	IFAG (10)	IGMA (11)	INPL (12)
Jan 1	50814	-327	987	95	-1656	86	-3
Jan 6	50819	-416	993	102	-1729	94	-4
Jan 11	50824	-417	999	102	-1788	79	8
Jan 16	50829	-394	982	99	-1852	95	6
Jan 21	50834	-364	987	99	-1914	84	-
Jan 26	50839	-331	984	93	-1970	85	-
Jan 31	50844	-306	986	95	-2019	85	-
Feb 5	50849	-300	974	90	-2063	117	-
Feb 10	50854	-278	970	87	-2079	101	-
Feb 15	50859	-262	965	84	-2110	101	-
Feb 20	50864	-237	965	77	-2121	94	-
Feb 25	50869	-223	968	71	-2132	97	-65
Mar 2	50874	-222	974	72	-2137	115	-89
Mar 7	50879	-204	994	66	-2128	106	-119
Mar 12	50884	-196	999	61	-2144	104	-151
Mar 17	50889	-177	996	53	-2140	110	-188
Mar 22	50894	-168	997	32	-2152	106	-221
Mar 27	50899	-111	998	26	-2186	112	-253
Apr 1	50904	-102	1007	23	-2217	133	-285
Apr 6	50909	-77	1016	10	-2226	135	-311
Apr 11	50914	-79	1012	-5	-2187	130	-333
Apr 16	50919	-70	1011	-14	-2193	133	-370
Apr 21	50924	-51	1009	-33	-2203	138	-399
Apr 26	50929	-41	1001	-60	-2219	146	-431
May 1	50934	-20	1006	-67	-2228	146	-456
May 6	50939	-4	1000	-83	-2241	159	-492
May 11	50944	10	1003	-94	-2230	168	-525
May 16	50949	37	1007	-108	-2240	162	-551
May 21	50954	52	1009	-118	-2238	166	-577
May 26	50959	58	1010	-136	-2243	174	-607
May 31	50964	74	1019	-138	-2244	175	-634
Jun 5	50969	89	1023	-134	-2229	180	-665
Jun 10	50974	120	1028	-121	-2257	194	-689
Jun 15	50979	141	1016	-111	-2246	178	-721
Jun 20	50984	147	1015	-101	-2229	181	-749
Jun 25	50989	158	1016	-93	-2230	193	-761
Jun 30	50994	160	1018	-75	-2262	184	-758

TABLE 9. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	UTC - UTC (k) DTAG (8)	GUM	IEN (9)	IFAG (10)	IGMA (11)	INPL (12)
Jul 5	50999	164	1024	-63	-2277	184	-743
Jul 10	51004	184	1037	-59	-2286	177	-727
Jul 15	51009	191	1046	-61	-2298	184	-708
Jul 20	51014	219	1046	-62	-2315	190	-693
Jul 25	51019	216	1050	-58	-2358	168	-683
Jul 30	51024	219	1062	-56	-2383	165	-669
Aug 4	51029	211	1066	-49	-2419	176	-654
Aug 9	51034	210	1070	-41	-2396	177	-637
Aug 14	51039	217	1074	-38	-2405	165	-612
Aug 19	51044	251	1080	-42	-2439	168	-598
Aug 24	51049	261	1082	-34	-2454	173	-586
Aug 29	51054	270	1086	-36	-2483	175	-572
Sep 3	51059	274	1098	-41	-2480	164	-555
Sep 8	51064	288	1114	-32	-2473	160	-543
Sep 13	51069	275	1124	-28	-2491	168	-532
Sep 18	51074	271	1122	-20	-2474	182	-511
Sep 23	51079	268	1138	-15	-2452	173	-495
Sep 28	51084	271	1154	-3	-2475	179	-475
Oct 3	51089	270	1154	1	-2494	171	-458
Oct 8	51094	280	1168	10	-2446	179	-437
Oct 13	51099	273	1175	9	-2434	194	-420
Oct 18	51104	269	1180	11	-2447	184	-406
Oct 23	51109	260	1190	28	-2450	160	-393
Oct 28	51114	255	1195	31	-2507	165	-372
Nov 2	51119	240	1205	40	-2486	178	-354
Nov 7	51124	225	1211	49	-2453	189	-354
Nov 12	51129	224	1220	47	-2423	194	-343
Nov 17	51134	224	1231	48	-2398	191	-322
Nov 22	51139	207	1240	37	-2384	204	-305
Nov 27	51144	207	1254	35	-2373	181	-291
Dec 2	51149	201	1263	24	-2393	190	-278
Dec 7	51154	207	1278	19	-2404	200	-269
Dec 12	51159	191	1287	8	-2373	187	-252
Dec 17	51164	185	1300	12	-2364	163	-237
Dec 22	51169	168	1308	11	-2380	163	-228
Dec 27	51174	166	1322	8	-2358	176	-215

TABLE 9. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	UTC - UTC (k) IPQ (13)	JATC (14)	KRIS (15)	LDS	MSL	NAO (16)
Jan 1	50814	1051	3386	44	81	-6073	56
Jan 6	50819	1069	3353	49	109	-6021	119
Jan 11	50824	1090	3364	50	100	-5948	185
Jan 16	50829	1111	3382	78	119	-5857	228
Jan 21	50834	1125	3388	76	119	-5806	281
Jan 26	50839	1136	3376	80	125	-5772	354
Jan 31	50844	1141	3360	82	138	-5717	408
Feb 5	50849	57	3354	86	146	-5663	472
Feb 10	50854	69	3380	80	138	-5672	543
Feb 15	50859	91	3362	87	152	-5587	605
Feb 20	50864	105	3398	88	143	-5509	673
Feb 25	50869	121	3371	109	152	-5482	753
Mar 2	50874	139	3405	123	162	-5415	823
Mar 7	50879	156	3398	134	160	-5352	878
Mar 12	50884	176	3389	132	159	-5336	942
Mar 17	50889	200	3396	140	171	-5289	999
Mar 22	50894	218	3404	140	182	-5242	1068
Mar 27	50899	245	3377	149	175	-5206	1121
Apr 1	50904	262	3412	173	192	-	1184
Apr 6	50909	275	3403	172	185	-	1250
Apr 11	50914	287	3413	180	186	-	1303
Apr 16	50919	313	3416	224	199	-	1732
Apr 21	50924	342	3437	245	210	-	1710
Apr 26	50929	359	3429	257	210	-	1691
May 1	50934	371	3427	271	208	-	1679
May 6	50939	388	3436	267	220	-	1659
May 11	50944	406	3442	275	223	-	1645
May 16	50949	425	3425	292	234	-4736	1628
May 21	50954	441	3445	284	259	-4734	1606
May 26	50959	459	3455	291	261	-4597	1594
May 31	50964	478	3449	297	260	-4622	1574
Jun 5	50969	492	3440	291	277	-4626	1549
Jun 10	50974	517	3425	299	283	-4628	1524
Jun 15	50979	551	3412	301	280	-4567	1518
Jun 20	50984	563	3421	293	293	-4479	1497
Jun 25	50989	582	3406	316	327	-4390	1483
Jun 30	50994	604	3398	313	345	-4304	1454

TABLE 9. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	UTC - UTC (k)					
		IPQ (13)	JATC (14)	KRIS (15)	LDS	MSL	NAO (16)
Jul 5	50999	632	3387	335	351	-4269	1426
Jul 10	51004	654	3370	328	358	-4236	1405
Jul 15	51009	677	3351	323	366	-4228	1401
Jul 20	51014	702	3306	314	380	-4218	1365
Jul 25	51019	728	3320	317	396	-4206	1333
Jul 30	51024	749	3315	302	413	-4101	1308
Aug 4	51029	759	3321	307	437	-4048	1311
Aug 9	51034	776	3276	295	448	-3956	1285
Aug 14	51039	784	3231	298	460	-3921	1265
Aug 19	51044	805	3205	303	481	-3870	1239
Aug 24	51049	827	3212	301	511	-3903	1231
Aug 29	51054	847	3216	307	523	-3863	1204
Sep 3	51059	-	2623	315	532	-3783	1185
Sep 8	51064	-	2594	310	540	-3667	1161
Sep 13	51069	-	2561	318	552	-3593	1126
Sep 18	51074	-	2518	309	571	-3528	1100
Sep 23	51079	-	2489	310	581	-3399	1077
Sep 28	51084	-	2465	306	603	-3379	1046
Oct 3	51089	-	2459	296	623	-3248	1031
Oct 8	51094	-	2434	296	632	-3136	1011
Oct 13	51099	-	2434	292	661	-3045	987
Oct 18	51104	-	2419	260	662	-2906	958
Oct 23	51109	-	2426	272	678	-2814	930
Oct 28	51114	-	2407	263	688	-2745	906
Nov 2	51119	-	2420	266	703	-2651	886
Nov 7	51124	-	2395	260	707	-2593	865
Nov 12	51129	-	2413	246	726	-2498	836
Nov 17	51134	-	2418	250	729	-2383	809
Nov 22	51139	-	2414	255	732	-2244	769
Nov 27	51144	-	2423	249	738	-2152	729
Dec 2	51149	-	2430	250	738	-2111	702
Dec 7	51154	-	2445	249	749	-1876	677
Dec 12	51159	-	2461	250	753	-1818	659
Dec 17	51164	-	2484	275	757	-1672	650
Dec 22	51169	-	2500	251	759	-1620	632
Dec 27	51174	-	2498	256	766	-1502	603

TABLE 9. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	UTC - UTC (k) NIM	NIST	NML	NPL (17)	NPLI	NRC (18)
Jan 1	50814	-2569	0	889	80	-	9
Jan 6	50819	-2576	2	907	79	-	54
Jan 11	50824	-2604	4	929	77	-	117
Jan 16	50829	-2616	2	933	74	-	13
Jan 21	50834	-2638	5	939	76	-	14
Jan 26	50839	-2642	5	943	76	-	17
Jan 31	50844	-2635	5	952	75	-	17
Feb 5	50849	-2653	7	969	73	-	20
Feb 10	50854	-2664	10	979	72	-	22
Feb 15	50859	-2652	11	980	72	-	24
Feb 20	50864	-2658	14	975	69	-	29
Feb 25	50869	-2657	15	974	71	-	26
Mar 2	50874	-2672	16	988	76	-	24
Mar 7	50879	-2691	18	1009	77	-	18
Mar 12	50884	-2678	22	1029	81	-	16
Mar 17	50889	-2690	22	1057	84	-	14
Mar 22	50894	-2689	24	1086	85	-	22
Mar 27	50899	-2678	24	1121	87	-	19
Apr 1	50904	-2702	26	1135	87	-	13
Apr 6	50909	-2757	24	1148	90	-	1
Apr 11	50914	-2761	24	1156	90	-	15
Apr 16	50919	-2776	24	1190	92	-	13
Apr 21	50924	-2779	24	1211	92	-	17
Apr 26	50929	-2823	26	1226	91	-	16
May 1	50934	-2849	26	1210	92	-	25
May 6	50939	-2868	26	1194	90	-	19
May 11	50944	-2883	27	1202	83	-	18
May 16	50949	-2916	28	1200	81	-	14
May 21	50954	-2923	28	1218	78	-	19
May 26	50959	-2929	26	1228	70	-	9
May 31	50964	-2932	29	1232	65	-	8
Jun 5	50969	-2948	30	1251	55	-	6
Jun 10	50974	-2940	28	1229	51	-	9
Jun 15	50979	-2932	27	1221	50	-	11
Jun 20	50984	-2945	28	1222	46	-	15
Jun 25	50989	-2896	26	1214	42	-	14
Jun 30	50994	-2916	25	1244	35	-	19

TABLE 9. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	UTC - UTC (k) NIM	NIST	NML	NPL (17)	NPLI	NRC (18)
Jul 5	50999	-2922	24	1260	32	-	21
Jul 10	51004	-2928	23	1284	29	-	17
Jul 15	51009	-2944	23	1275	29	-	19
Jul 20	51014	-2958	23	1279	28	-	16
Jul 25	51019	-2962	22	1294	32	-	18
Jul 30	51024	-2987	22	1316	32	-	25
Aug 4	51029	-2988	15	1344	30	-	15
Aug 9	51034	-3007	15	1344	33	-	22
Aug 14	51039	-3040	16	1346	36	-	29
Aug 19	51044	-3039	13	1337	38	-	21
Aug 24	51049	-3030	11	1337	39	-	19
Aug 29	51054	-3018	8	1356	39	-	17
Sep 3	51059	-3023	6	-	38	-	15
Sep 8	51064	-3027	2	-	41	-	6
Sep 13	51069	-3019	1	-	46	-	1
Sep 18	51074	-3011	-1	-	47	-	-3
Sep 23	51079	-3025	-4	-	47	-	-14
Sep 28	51084	-3030	-6	-	51	-	-21
Oct 3	51089	-3028	-7	-	54	-	-18
Oct 8	51094	-3025	-6	-	58	-	-22
Oct 13	51099	-3021	-5	-	62	-	-27
Oct 18	51104	-3010	-3	-	62	-	-25
Oct 23	51109	-3016	-3	-	59	-	-28
Oct 28	51114	-3022	-2	-	58	-	-29
Nov 2	51119	-3025	-3	-	59	-	-28
Nov 7	51124	-3049	-1	-	56	-	-25
Nov 12	51129	-3039	-1	-	55	-	-17
Nov 17	51134	-3050	2	-	58	-	-11
Nov 22	51139	-3059	-1	-	53	-	-9
Nov 27	51144	-3064	0	-	53	-	-13
Dec 2	51149	-3067	3	-	52	1112	-4
Dec 7	51154	-3070	4	-	49	1183	-6
Dec 12	51159	-3082	2	-	45	1188	-5
Dec 17	51164	-3072	6	-	47	1213	-6
Dec 22	51169	-3083	10	-	46	1266	-2
Dec 27	51174	-3082	9	-	45	1317	-5

TABLE 9. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	UTC - UTC (k) NRLM	OMH	ONBA (19)	ONRJ	OP (20)	ORB
Jan 1	50814	315	1419	-511	270	27	188
Jan 6	50819	328	1448	-450	289	27	211
Jan 11	50824	334	1458	-376	293	20	222
Jan 16	50829	337	1497	-345	311	16	230
Jan 21	50834	339	1515	-224	332	13	231
Jan 26	50839	347	1530	-34	349	13	211
Jan 31	50844	356	1553	203	353	15	233
Feb 5	50849	367	1573	519	362	9	229
Feb 10	50854	377	1581	937	374	12	246
Feb 15	50859	387	1606	1256	385	13	255
Feb 20	50864	382	1621	1548	403	7	241
Feb 25	50869	385	1623	1800	419	11	245
Mar 2	50874	391	1645	2106	450	7	277
Mar 7	50879	401	1640	2354	471	17	265
Mar 12	50884	410	1664	2638	497	28	262
Mar 17	50889	421	1680	2885	523	22	255
Mar 22	50894	426	1690	3163	538	21	246
Mar 27	50899	436	1697	3323	563	14	241
Apr 1	50904	438	1724	3489	566	14	240
Apr 6	50909	452	1738	3794	594	11	249
Apr 11	50914	459	1766	4169	607	13	253
Apr 16	50919	466	1778	4568	628	11	291
Apr 21	50924	476	1786	4979	641	10	308
Apr 26	50929	481	1807	5363	658	11	286
May 1	50934	496	1816	5858	676	16	264
May 6	50939	507	1817	6328	690	29	257
May 11	50944	518	1831	6852	720	15	269
May 16	50949	530	1840	7304	735	-3	284
May 21	50954	536	1864	7843	762	-4	275
May 26	50959	544	1886	8433	774	-6	280
May 31	50964	559	1897	9013	770	-5	281
Jun 5	50969	569	1909	105	789	-2	283
Jun 10	50974	588	1921	78	810	4	265
Jun 15	50979	597	1935	231	830	-1	267
Jun 20	50984	603	1952	307	845	4	267
Jun 25	50989	608	1971	410	853	16	297
Jun 30	50994	618	2006	388	869	18	325

TABLE 9. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	NRLM	OMH	ONBA (19)	ONRJ	OP (20)	ORB
		UTC - UTC (k)					
Jul 5	50999	625	2019	416	894	26	333
Jul 10	51004	639	2043	427	905	29	350
Jul 15	51009	646	2063	473	920	36	362
Jul 20	51014	660	2065	559	935	40	362
Jul 25	51019	668	2103	669	949	40	378
Jul 30	51024	671	2119	764	976	47	381
Aug 4	51029	696	2143	987	986	54	385
Aug 9	51034	692	2161	1127	1008	56	396
Aug 14	51039	695	2197	1167	1028	59	374
Aug 19	51044	708	2214	1116	1044	62	375
Aug 24	51049	717	2240	1150	1066	68	395
Aug 29	51054	729	2268	1209	1067	48	389
Sep 3	51059	733	2274	1212	1092	45	403
Sep 8	51064	742	2303	1135	1106	39	389
Sep 13	51069	761	2335	965	1114	38	404
Sep 18	51074	767	2343	845	1122	36	407
Sep 23	51079	785	2348	1002	1136	33	416
Sep 28	51084	798	2365	931	1146	28	435
Oct 3	51089	819	2366	876	1165	26	402
Oct 8	51094	837	2388	609	1186	26	395
Oct 13	51099	831	2419	449	1186	18	365
Oct 18	51104	836	2433	181	1206	14	365
Oct 23	51109	869	2440	-168	1221	10	358
Oct 28	51114	879	2471	-486	1235	12	359
Nov 2	51119	896	2478	-534	1244	6	376
Nov 7	51124	908	2502	-247	1259	8	360
Nov 12	51129	916	2506	-120	1292	9	389
Nov 17	51134	932	2519	-82	1308	13	405
Nov 22	51139	941	2519	-51	1319	12	371
Nov 27	51144	961	2540	-91	1328	10	384
Dec 2	51149	965	2555	23	1358	15	359
Dec 7	51154	983	2572	32	1372	7	389
Dec 12	51159	994	2591	17	1390	2	409
Dec 17	51164	1006	2612	-64	1401	2	408
Dec 22	51169	1015	2631	-144	1434	3	396
Dec 27	51174	1027	2645	-68	1448	-1	420

TABLE 9. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	PSB	PTB (21)	ROA (22)	SCL (23)	SMU (24)	SO (25)
		UTC - UTC (k)					
Jan 1	50814	964	-31	55	-152	-	797
Jan 6	50819	994	-27	46	-196	-	792
Jan 11	50824	1021	-21	49	-238	-	791
Jan 16	50829	1049	-17	40	-270	-	802
Jan 21	50834	1078	-11	46	-296	-	769
Jan 26	50839	1106	-9	44	-312	-	784
Jan 31	50844	1130	-7	35	-319	-	789
Feb 5	50849	1156	-8	31	-347	-	797
Feb 10	50854	1180	1	29	-337	-	784
Feb 15	50859	1207	2	31	-342	-	795
Feb 20	50864	1235	13	29	-356	-	782
Feb 25	50869	1257	15	28	-327	-	781
Mar 2	50874	1282	18	31	-326	-	781
Mar 7	50879	1308	28	26	-288	-	751
Mar 12	50884	1334	39	16	-261	-	758
Mar 17	50889	1353	42	13	-235	-	751
Mar 22	50894	-	46	9	-192	-	752
Mar 27	50899	200	51	7	-160	-	745
Apr 1	50904	233	55	9	-122	-	750
Apr 6	50909	264	58	4	-111	-	720
Apr 11	50914	289	63	-6	-100	-	719
Apr 16	50919	310	72	-11	-86	-	706
Apr 21	50924	332	77	-10	-66	-	726
Apr 26	50929	356	85	-12	-47	-	732
May 1	50934	387	90	-14	-44	-	716
May 6	50939	402	90	-19	-45	-	693
May 11	50944	437	88	-30	-52	-	690
May 16	50949	458	89	-41	-51	-	696
May 21	50954	474	89	-59	-44	-	703
May 26	50959	505	90	-70	-35	-	689
May 31	50964	530	92	-68	-39	-	687
Jun 5	50969	557	89	-83	-	-	692
Jun 10	50974	583	87	-82	-62	-	685
Jun 15	50979	614	88	-91	-42	-	689
Jun 20	50984	650	93	-82	-92	-	690
Jun 25	50989	671	97	-76	-	-	671
Jun 30	50994	696	96	-73	-	-	666

TABLE 9. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	UTC - UTC (k) PSB	PTB (21)	ROA (22)	SCL (23)	SMU (24)	SO (25)
Jul 5	50999	722	95	-70	-	-	664
Jul 10	51004	745	95	-72	-	-	640
Jul 15	51009	782	90	-75	-	-	638
Jul 20	51014	816	90	-73	-	-	652
Jul 25	51019	836	91	-72	-	-	610
Jul 30	51024	864	92	-77	-	-	616
Aug 4	51029	917	87	-87	-	-1224	623
Aug 9	51034	922	81	-81	-	-1235	617
Aug 14	51039	945	77	-71	-	-1061	595
Aug 19	51044	964	72	-66	-	-1098	601
Aug 24	51049	979	66	-64	-	-1130	602
Aug 29	51054	1004	63	-72	-	-1150	585
Sep 3	51059	1034	63	-68	-97	-1179	572
Sep 8	51064	1055	57	-61	-96	-1197	562
Sep 13	51069	1050	51	-56	-95	-1226	562
Sep 18	51074	1115	48	-58	-115	-1232	547
Sep 23	51079	1153	44	-67	-120	-1250	546
Sep 28	51084	1156	44	-65	-130	-1277	530
Oct 3	51089	1182	41	-68	-122	-1292	523
Oct 8	51094	1214	44	-59	-124	-1305	523
Oct 13	51099	-	43	-56	-108	-1310	542
Oct 18	51104	-	43	-63	-105	-1327	545
Oct 23	51109	504	44	-62	-97	-1351	537
Oct 28	51114	540	41	-64	-89	-1371	552
Nov 2	51119	576	39	-74	-83	-1382	571
Nov 7	51124	601	42	-80	-91	-1380	563
Nov 12	51129	647	43	-84	-90	-1387	577
Nov 17	51134	691	45	-86	-79	-1389	589
Nov 22	51139	727	37	-96	-62	-1399	600
Nov 27	51144	761	39	-90	-70	-1404	612
Dec 2	51149	793	35	-84	-76	-1422	596
Dec 7	51154	833	33	-81	-69	-1454	612
Dec 12	51159	871	27	-83	-43	-1478	612
Dec 17	51164	917	29	-74	-45	-1479	632
Dec 22	51169	946	28	-74	-38	-1485	634
Dec 27	51174	970	20	-65	-46	-1480	632

TABLE 9. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	SP (26)	SU (27)	TL	TP (28)	TUG (29)	UME (30)
		UTC - UTC (k)					
Jan 1	50814	650	366	476	195	4046	971
Jan 6	50819	655	357	470	194	4092	977
Jan 11	50824	652	348	469	182	4140	978
Jan 16	50829	649	343	468	191	4194	983
Jan 21	50834	-	345	454	209	4245	999
Jan 26	50839	-	339	450	201	4293	1008
Jan 31	50844	-	323	447	206	4340	1018
Feb 5	50849	655	321	440	208	4388	1030
Feb 10	50854	660	316	422	214	4422	1051
Feb 15	50859	667	307	416	206	4466	1057
Feb 20	50864	671	307	400	204	4519	1066
Feb 25	50869	673	292	396	210	4563	1077
Mar 2	50874	674	288	389	207	4621	1094
Mar 7	50879	677	282	389	200	4669	1100
Mar 12	50884	683	284	355	204	4727	1110
Mar 17	50889	678	266	350	209	4781	1128
Mar 22	50894	723	269	345	200	4832	1135
Mar 27	50899	725	262	341	212	4878	1142
Apr 1	50904	722	258	331	216	-4066	1152
Apr 6	50909	723	251	330	215	-4017	1157
Apr 11	50914	721	250	328	223	-3959	1164
Apr 16	50919	721	244	322	232	-3913	1166
Apr 21	50924	723	245	322	233	-3858	1177
Apr 26	50929	726	246	320	248	-3819	1184
May 1	50934	729	237	309	247	-3773	1198
May 6	50939	735	240	317	248	-3722	1198
May 11	50944	734	235	306	245	-3676	1204
May 16	50949	737	228	306	234	-3628	1212
May 21	50954	742	222	316	205	-3585	1216
May 26	50959	740	238	296	164	-3536	1228
May 31	50964	741	228	294	167	-3474	1235
Jun 5	50969	734	214	282	166	-3433	1240
Jun 10	50974	737	215	271	165	-3380	1450
Jun 15	50979	743	208	275	160	-3339	1457
Jun 20	50984	746	209	281	179	-3287	1468
Jun 25	50989	762	209	270	187	-3242	1469
Jun 30	50994	769	204	261	196	-3198	1478

TABLE 9. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	UTC - UTC (k) SP (26)	SU (27)	TL	TP (28)	TUG (29)	UME (30)
Jul 5	50999	775	199	263	204	-3144	1484
Jul 10	51004	781	200	256	215	-3089	1499
Jul 15	51009	780	194	251	214	-3029	1509
Jul 20	51014	785	193	250	209	-2985	1524
Jul 25	51019	795	186	244	231	-2915	1532
Jul 30	51024	803	184	247	232	-2874	1542
Aug 4	51029	813	179	265	228	-2836	1547
Aug 9	51034	827	184	249	227	-2789	1556
Aug 14	51039	830	186	246	234	-2744	1565
Aug 19	51044	846	179	255	242	-2693	1569
Aug 24	51049	861	182	256	246	-2645	1582
Aug 29	51054	854	183	250	242	-2605	1591
Sep 3	51059	843	180	243	247	-2550	1598
Sep 8	51064	826	174	246	259	-2507	1604
Sep 13	51069	812	175	247	262	-2459	1609
Sep 18	51074	799	173	239	257	-2413	1615
Sep 23	51079	778	176	227	262	-2361	1629
Sep 28	51084	767	171	177	259	-2315	1640
Oct 3	51089	756	174	155	261	-2271	1638
Oct 8	51094	748	172	154	248	-2225	1650
Oct 13	51099	734	171	158	247	-2174	1661
Oct 18	51104	721	170	159	245	-2130	1665
Oct 23	51109	718	164	176	232	-2079	1667
Oct 28	51114	712	162	164	225	-2029	1676
Nov 2	51119	690	162	209	234	-1979	1682
Nov 7	51124	675	163	206	232	-4047	1691
Nov 12	51129	663	160	206	230	-4104	1698
Nov 17	51134	662	157	178	230	-4174	1711
Nov 22	51139	649	154	214	225	-4235	1716
Nov 27	51144	642	156	210	223	-4300	1727
Dec 2	51149	629	166	216	212	-4366	1736
Dec 7	51154	611	-	229	213	-4430	1738
Dec 12	51159	606	-	234	215	-4499	1741
Dec 17	51164	593	-	239	217	-4574	1751
Dec 22	51169	591	-	233	225	-4641	1758
Dec 27	51174	582	-	259	216	-50	1766

TABLE 9. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	UTC - UTC(k) USNO	VSL (31)
Jan 1	50814	-3	-10
Jan 6	50819	-5	-5
Jan 11	50824	-4	-20
Jan 16	50829	-5	-19
Jan 21	50834	-3	-20
Jan 26	50839	-2	-9
Jan 31	50844	-3	-8
Feb 5	50849	-2	-17
Feb 10	50854	2	-26
Feb 15	50859	4	-32
Feb 20	50864	7	-40
Feb 25	50869	10	-35
Mar 2	50874	12	-35
Mar 7	50879	12	-34
Mar 12	50884	16	-30
Mar 17	50889	17	-33
Mar 22	50894	19	-18
Mar 27	50899	17	-7
Apr 1	50904	19	8
Apr 6	50909	20	18
Apr 11	50914	23	24
Apr 16	50919	22	35
Apr 21	50924	24	47
Apr 26	50929	24	60
May 1	50934	24	75
May 6	50939	23	81
May 11	50944	24	103
May 16	50949	23	101
May 21	50954	23	105
May 26	50959	21	113
May 31	50964	19	115
Jun 5	50969	22	116
Jun 10	50974	22	123
Jun 15	50979	23	128
Jun 20	50984	23	128
Jun 25	50989	23	127
Jun 30	50994	25	119

TABLE 9. (CONT.)

Unit is one nanosecond.

Date 1998 0h UTC	MJD	*UTC - UTC(k)* USNO	VSL (31)
Jul 5	50999	23	129
Jul 10	51004	23	138
Jul 15	51009	24	143
Jul 20	51014	26	150
Jul 25	51019	24	152
Jul 30	51024	24	153
Aug 4	51029	18	160
Aug 9	51034	23	168
Aug 14	51039	21	170
Aug 19	51044	20	177
Aug 24	51049	18	176
Aug 29	51054	15	174
Sep 3	51059	11	174
Sep 8	51064	8	182
Sep 13	51069	6	188
Sep 18	51074	6	187
Sep 23	51079	2	196
Sep 28	51084	2	199
Oct 3	51089	2	206
Oct 8	51094	0	205
Oct 13	51099	-1	210
Oct 18	51104	1	209
Oct 23	51109	1	208
Oct 28	51114	2	211
Nov 2	51119	-1	216
Nov 7	51124	2	220
Nov 12	51129	3	221
Nov 17	51134	7	218
Nov 22	51139	2	205
Nov 27	51144	-2	195
Dec 2	51149	-2	190
Dec 7	51154	-3	184
Dec 12	51159	-2	176
Dec 17	51164	-5	169
Dec 22	51169	-6	160
Dec 27	51174	-7	147

TABLE 9. (CONT.)

NOTES

(1) AOS . Time step of UTC(AOS) of + 400 ns on MJD = 50832.34
Time step of UTC(AOS) of - 500 ns on MJD = 51063.30

(2) APL . Apparent time step of UTC-UTC(APL) of -1050 ns between MJD = 50924 and MJD = 50929.
Apparent time step of UTC-UTC(APL) of about - 4750 ns between MJD = 50944 and MJD = 50949.
Apparent time step of UTC-UTC(APL) between MJD = 51079 and MJD = 51084.

(3) AUS . From September 1, 1998, UTC(AUS) has been realized at the National Measurement Laboratory, Sydney, Australia.
Change of master clock on MJD = 51162.0

(4) CH . Time step of UTC-UTC(CH) of + 14 ns between MJD = 50994 and MJD = 50999 due to GPS link calibration.
Frequency steps of UTC(CH) in ns/d :

MJD	Freq. step
50853	+0.67
50913	+0.05
50973	-6.15
51033	-0.09
51093	+4.53
51153	+0.75

(5) CNM . Frequency step of UTC(CNM) of + 8.813 ns/d on MJD = 50859.

(6) CRL . Frequency steps of UTC(CRL) in ns/d :

MJD	Freq. step
50864.0	-0.432
50934.0	+1.296
51038.0	+0.432

(7) CSIR. Time step of UTC(CSIR) of - 14700 ns on MJD = 51091.3021

(8) DTAG. Apparent time step of UTC-UTC(DTAG) of - 100 ns between MJD = 50814 and MJD = 50819.
Apparent time step of UTC-UTC(DTAG) of + 85 ns between MJD = 50894 and MJD = 50899.
Frequency step of UTC(DTAG) of + 2.765 ns/d on MJD = 51057.

(9) IEN. Frequency steps of UTC(IEN) in ns/d :

MJD	Freq. step
50822.4	+2.188
50962.5	-4.924
51126.4	+1.644

TABLE 9. (CONT.)

(10) IFAG. Frequency step of UTC(IFAG) of +10.0 ns/d on MJD = 50850.75

(11) IGMA. Frequency step of UTC(IGMA) of - 0.969 ns/d on MJD 50959.0

(12) INPL. Frequency steps of UTC(INPL) in ns/d :

50986.15	-6.05
50993.42	-2.59

(13) IPQ . Time step of UTC(IPQ) of + 1100 ns on MJD = 50847.76
Apparent time step of UTC-UTC(IPQ) of - 22 ns on MJD = 51036.44
due to calibration of a cable delay.

(14) JATC. Apparent time step of UTC-UTC(JATC) between MJD = 51054 and MJD = 51059.

(15) KRIS. Frequency step of UTC(KRIS) of +0.864 ns/d on MJD = 51086.0 and on MJD = 50933.0

(16) NAO . Apparent time step of UTC-UTC(NAO) of + 400 ns between MJD = 50914 and MJD = 50919.

(17) NPL . Change of master clock between MJD = 51004 and MJD 51009.
Frequency steps of UTC(NPL) in ns/d :

MJD	Freq. step
51008.73	-0.7
51101.60	+0.8

(18) NRC . Time step of UTC(NRC) of + 145 ns on MJD = 50827.66
Frequency steps of UTC(NRC) in ns/d :

MJD	Freq. step
50834.00	+0.432
51114.00	-0.864
51149.00	+0.864

(19) ONBA. Time step of UTC(ONBA) of + 9450 ns on MJD = 50968.0

(20) OP . Frequency steps of UTC(OP) in ns/d :

MJD	Freq. step
50813.56	+0.432
50964.56	-0.432
51028.56	+1.296

TABLE 9. (CONT.)

(21) PTB . Time step of UTC(PTB) of + 1900 ns on MJD = 50814.0
Frequency steps of UTC(PTB) in ns/d :

MJD	Freq. step
50904	+0.5
50929	+0.5
50964	+0.5
51024	+0.5
51119	-0.5
51148	+0.5

(22) ROA . Frequency steps of UTC(ROA) in ns/d :

MJD	Freq. step
50981.42	-2.2
51137.39	-1.1

(23) SCL . Frequency steps of UTC(SCL) in ns/d :

MJD	Freq. step
50834.3	-4.320
50849.3	-3.456
50864.3	-3.456
50879.2	-3.456
50904.2	+3.456
50934.2	+3.456

(24) SMU . Slovak Institute of Metrology, Bratislava, Slovakia.
Apparent time step of UTC-UTC(SMU) of about + 170 ns between MJD = 51034 and MJD = 51039.

(25) SO . Change of master clock on MJD = 51091.

(26) SP . Time step of UTC-UTC(SP) of + 43 ns between MJD = 50889 and MJD = 50894 due to GPS link calibration.
Frequency step of UTC(SP) of + 4.32 ns/d on MJD = 51051.28

(27) SU . Apparent time step of UTC-UTC(SU) between MJD = 50954 and MJD = 50959 due to change of GPS receiver.

(28) TP . Change of master clock between MJD = 51024 and MJD = 51029.

(29) TUG . Time step of UTC(TUG) of + 9000 ns on MJD = 50903.5
Change of master clock on MJD = 51123.0
Time step of UTC(TUG) of - 4614 ns on MJD = 51170.25
Frequency step of UTC(TUG) of - 12.58 ns/d on MJD = 51170.25

(30) UME . Apparent time step of UTC-UTC(UME) of about + 200 ns between MJD = 50969 and MJD = 50974 .

(31) VSL . Frequency steps of UTC(VSL) in ns/d :

MJD	Freq. step
50814.6	+1.728
50876.4	-0.864
50946.4	+0.864
51131.4	+2.592

TABLE 10. LIST OF INTERNATIONAL GPS AND GLONASS TRACKING SCHEDULES

(Files available on http://www.bipm.fr)

GPS Schedule no 30 File SCHGPS.30	implemented on MJD = 50902 (1998 March 30) at 0h UTC	Reference date MJD = 50722 (1997 October 1)
GPS Schedule no 31 File SCHGPS.31	implemented on MJD = 51087 (1998 October 1) at 0h UTC	Reference date MJD = 50722 (1997 October 1)
GLONASS Schedule no 5 File SCHGLO.05	implemented on MJD = 50902 (1998 March 30) at 0h UTC	Reference date MJD = 50722 (1997 October 1)
GLONASS Schedule no 6 File SCHGLO.06	implemented on MJD = 51087 (1998 October 1) at 0h UTC	Reference date MJD = 50722 (1997 October 1)

TABLE 11. [*TAI - GPS time*] AND [*UTC - GPS time*]

(File available on http://www.bipm.fr under the name UTCGPS98.AR)

The GPS satellites disseminate a common time scale designated as 'GPS time'. The relation between GPS time and TAI is :

$$[TAI - GPS\ time] = 19\ \text{s} + C_0,$$

where the time difference of 19 seconds is kept constant and C_0 is a quantity of order tens of nanoseconds, varying with time.

The relation between GPS time and UTC involves a variable number of seconds as a consequence of the leap seconds of the UTC system and is as follows :

from 1997 July 1, 0h UTC, until 1999 January 1, 0h UTC :

$$[UTC - GPS\ time] = -12\ \text{s} + C_0.$$

from 1999 January 1, 0h UTC, until further notice :

$$[UTC - GPS\ time] = -13\ \text{s} + C_0.$$

Here C_0 is given at 0h UTC every day.

C_0 is computed as follows: the GPS data taken at the Paris Observatory, from satellites with highest elevation, are first corrected for precise satellite ephemerides and for measured ionospheric delays, and then smoothed to obtain daily values of [*UTC(OP) - GPS time*] at 0h UTC. Daily values of C_0 are derived from them using linear interpolation of [*UTC - UTC(OP)*] from Table 9. The global uncertainty of daily C_0 values is of order 10 ns.

In the following tables, the standard deviation σ characterizes the dispersion of individual measurements, and N is the number of measurements used on a given day for estimation of the corresponding daily C_0 value.

Table 11. (Cont.)

Date 1998 0h UTC	MJD	C_0 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Jan 1	50814	-4	41	6
Jan 2	50815	-7	46	7
Jan 3	50816	-8	46	7
Jan 4	50817	-5	41	6
Jan 5	50818	-3	42	6
Jan 6	50819	-6	49	7
Jan 7	50820	-11	39	6
Jan 8	50821	-12	42	6
Jan 9	50822	-7	50	7
Jan 10	50823	-8	51	8
Jan 11	50824	-13	38	6
Jan 12	50825	-15	44	7
Jan 13	50826	-15	43	7
Jan 14	50827	-14	46	7
Jan 15	50828	-11	34	5
Jan 16	50829	-10	41	7
Jan 17	50830	-11	47	7
Jan 18	50831	-8	44	7
Jan 19	50832	-4	36	5
Jan 20	50833	-3	38	6
Jan 21	50834	-6	43	7
Jan 22	50835	-5	47	7
Jan 23	50836	-2	47	7
Jan 24	50837	-3	49	7
Jan 25	50838	-8	52	8
Jan 26	50839	-10	51	8
Jan 27	50840	-9	38	6
Jan 28	50841	-7	40	6
Jan 29	50842	-4	44	7
Jan 30	50843	-1	44	7
Jan 31	50844	-3	44	7

Table 11. (Cont.)

Date 1998 0h UTC	MJD	C_0 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Feb 1	50845	-6	35	5
Feb 2	50846	-6	44	7
Feb 3	50847	-5	41	6
Feb 4	50848	-6	48	7
Feb 5	50849	-11	49	7
Feb 6	50850	-10	37	6
Feb 7	50851	-5	43	6
Feb 8	50852	-1	27	11
Feb 9	50853	-1	43	8
Feb 10	50854	-4	49	7
Feb 11	50855	-8	46	7
Feb 12	50856	-9	42	6
Feb 13	50857	-5	51	8
Feb 14	50858	0	42	6
Feb 15	50859	3	29	4
Feb 16	50860	2	40	6
Feb 17	50861	-1	53	8
Feb 18	50862	-2	47	7
Feb 19	50863	3	47	7
Feb 20	50864	5	41	7
Feb 21	50865	3	38	6
Feb 22	50866	0	38	6
Feb 23	50867	0	34	5
Feb 24	50868	2	35	5
Feb 25	50869	-1	43	6
Feb 26	50870	-3	46	7
Feb 27	50871	5	41	6
Feb 28	50872	10	44	7

TABLE 11. (CONT.)

Date 1998 0h UTC	MJD	C_0 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Mar 1	50873	9	36	5
Mar 2	50874	4	52	8
Mar 3	50875	4	56	9
Mar 4	50876	5	38	6
Mar 5	50877	5	47	7
Mar 6	50878	6	45	7
Mar 7	50879	12	51	8
Mar 8	50880	19	34	6
Mar 9	50881	16	39	6
Mar 10	50882	11	42	7
Mar 11	50883	12	43	6
Mar 12	50884	14	38	6
Mar 13	50885	12	27	6
Mar 14	50886	10	39	6
Mar 15	50887	10	53	8
Mar 16	50888	10	43	13
Mar 17	50889	7	36	8
Mar 18	50890	6	53	13
Mar 19	50891	12	36	6
Mar 20	50892	21	43	12
Mar 21	50893	26	38	8
Mar 22	50894	20	38	7
Mar 23	50895	8	41	15
Mar 24	50896	-1	44	8
Mar 25	50897	5	51	12
Mar 26	50898	11	46	8
Mar 27	50899	15	49	12
Mar 28	50900	10	34	6
Mar 29	50901	8	39	7
Mar 30	50902	22	51	23
Mar 31	50903	26	47	7

TABLE 11. (CONT.)

Date 1998 0h UTC	MJD	C_0 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Apr 1	50904	15	52	8
Apr 2	50905	10	40	6
Apr 3	50906	13	48	7
Apr 4	50907	16	40	6
Apr 5	50908	17	46	7
Apr 6	50909	15	47	7
Apr 7	50910	16	46	7
Apr 8	50911	16	47	7
Apr 9	50912	11	45	7
Apr 10	50913	6	37	6
Apr 11	50914	8	66	10
Apr 12	50915	13	34	5
Apr 13	50916	18	44	7
Apr 14	50917	21	49	7
Apr 15	50918	18	47	7
Apr 16	50919	16	46	7
Apr 17	50920	19	44	7
Apr 18	50921	21	44	7
Apr 19	50922	17	49	7
Apr 20	50923	14	43	6
Apr 21	50924	16	45	7
Apr 22	50925	19	42	6
Apr 23	50926	18	49	7
Apr 24	50927	14	36	5
Apr 25	50928	15	48	7
Apr 26	50929	22	48	7
Apr 27	50930	31	44	7
Apr 28	50931	33	59	9
Apr 29	50932	28	36	5
Apr 30	50933	22	39	6

TABLE 11. (CONT.)

Date 1998 0h UTC	MJD	C_0 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
May 1	50934	20	49	7
May 2	50935	24	42	6
May 3	50936	27	41	6
May 4	50937	29	46	7
May 5	50938	27	33	5
May 6	50939	24	52	8
May 7	50940	15	46	7
May 8	50941	9	42	6
May 9	50942	13	34	5
May 10	50943	18	41	6
May 11	50944	16	47	7
May 12	50945	11	42	6
May 13	50946	15	48	7
May 14	50947	23	39	6
May 15	50948	25	48	7
May 16	50949	16	39	6
May 17	50950	8	49	7
May 18	50951	9	53	8
May 19	50952	12	49	7
May 20	50953	13	45	7
May 21	50954	16	42	6
May 22	50955	21	35	5
May 23	50956	23	46	7
May 24	50957	24	45	7
May 25	50958	22	44	7
May 26	50959	17	41	6
May 27	50960	9	40	6
May 28	50961	7	44	7
May 29	50962	12	42	6
May 30	50963	17	48	7
May 31	50964	17	36	6

TABLE 11. (CONT.)

Date 1998 0h UTC	MJD	C_0 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Jun 1	50965	16	45	7
Jun 2	50966	16	37	6
Jun 3	50967	16	53	8
Jun 4	50968	14	50	8
Jun 5	50969	16	41	6
Jun 6	50970	18	40	6
Jun 7	50971	17	54	8
Jun 8	50972	14	41	6
Jun 9	50973	9	42	7
Jun 10	50974	10	37	6
Jun 11	50975	17	46	7
Jun 12	50976	24	40	6
Jun 13	50977	20	39	6
Jun 14	50978	13	46	7
Jun 15	50979	10	46	7
Jun 16	50980	10	48	7
Jun 17	50981	8	40	6
Jun 18	50982	6	47	7
Jun 19	50983	7	44	7
Jun 20	50984	11	50	8
Jun 21	50985	13	40	6
Jun 22	50986	13	46	7
Jun 23	50987	18	38	6
Jun 24	50988	23	47	7
Jun 25	50989	22	48	7
Jun 26	50990	19	47	7
Jun 27	50991	21	37	6
Jun 28	50992	23	41	6
Jun 29	50993	24	53	8
Jun 30	50994	25	33	5

TABLE 11. (CONT.)

Date 1998 0h UTC	MJD	C_0 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Jul 1	50995	29	42	6
Jul 2	50996	26	46	7
Jul 3	50997	24	40	6
Jul 4	50998	21	50	8
Jul 5	50999	21	46	7
Jul 6	51000	22	51	8
Jul 7	51001	24	50	8
Jul 8	51002	27	45	7
Jul 9	51003	29	47	7
Jul 10	51004	27	35	5
Jul 11	51005	21	41	6
Jul 12	51006	15	36	5
Jul 13	51007	12	39	6
Jul 14	51008	14	44	7
Jul 15	51009	19	57	9
Jul 16	51010	21	41	6
Jul 17	51011	19	41	6
Jul 18	51012	17	48	7
Jul 19	51013	20	38	6
Jul 20	51014	23	48	7
Jul 21	51015	22	39	6
Jul 22	51016	18	49	8
Jul 23	51017	13	47	7
Jul 24	51018	12	37	6
Jul 25	51019	14	37	6
Jul 26	51020	17	50	8
Jul 27	51021	18	48	7
Jul 28	51022	18	49	8
Jul 29	51023	19	45	7
Jul 30	51024	17	46	7
Jul 31	51025	13	41	6

TABLE 11. (CONT.)

Date 1998 0h UTC	MJD	C_0 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Aug 1	51026	15	45	7
Aug 2	51027	18	41	7
Aug 3	51028	18	44	7
Aug 4	51029	15	76	11
Aug 5	51030	13	41	6
Aug 6	51031	12	49	7
Aug 7	51032	13	37	6
Aug 8	51033	13	46	7
Aug 9	51034	10	40	6
Aug 10	51035	12	48	7
Aug 11	51036	12	50	8
Aug 12	51037	11	60	10
Aug 13	51038	10	40	6
Aug 14	51039	9	51	8
Aug 15	51040	6	44	7
Aug 16	51041	2	32	5
Aug 17	51042	5	47	7
Aug 18	51043	9	47	7
Aug 19	51044	12	43	7
Aug 20	51045	13	42	6
Aug 21	51046	15	42	6
Aug 22	51047	16	40	6
Aug 23	51048	14	43	6
Aug 24	51049	11	49	8
Aug 25	51050	9	50	8
Aug 26	51051	12	47	7
Aug 27	51052	11	53	8
Aug 28	51053	8	42	6
Aug 29	51054	5	52	8
Aug 30	51055	4	41	6
Aug 31	51056	6	45	7

TABLE 11. (CONT.)

Date 1998 0h UTC	MJD	C_0 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Sep 1	51057	8	40	6
Sep 2	51058	7	44	7
Sep 3	51059	6	42	6
Sep 4	51060	5	45	7
Sep 5	51061	6	39	6
Sep 6	51062	5	39	6
Sep 7	51063	4	42	6
Sep 8	51064	5	38	6
Sep 9	51065	5	44	7
Sep 10	51066	3	40	6
Sep 11	51067	-1	49	7
Sep 12	51068	-1	49	7
Sep 13	51069	3	45	7
Sep 14	51070	1	42	6
Sep 15	51071	-3	49	7
Sep 16	51072	-3	63	10
Sep 17	51073	-4	40	6
Sep 18	51074	-1	48	7
Sep 19	51075	-1	48	7
Sep 20	51076	-2	45	7
Sep 21	51077	-6	50	8
Sep 22	51078	-8	43	7
Sep 23	51079	-8	41	6
Sep 24	51080	-10	45	7
Sep 25	51081	-10	42	6
Sep 26	51082	-6	48	7
Sep 27	51083	-5	44	7
Sep 28	51084	-8	25	5
Sep 29	51085	-9	49	9
Sep 30	51086	-3	44	7

TABLE 11. (CONT.)

Date 1998 0h UTC	MJD	C_0 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Oct 1	51087	-8	34	7
Oct 2	51088	-8	52	8
Oct 3	51089	-13	49	7
Oct 4	51090	-20	49	8
Oct 5	51091	-20	37	6
Oct 6	51092	-12	47	9
Oct 7	51093	0	41	7
Oct 8	51094	2	45	8
Oct 9	51095	-3	43	8
Oct 10	51096	-4	37	7
Oct 11	51097	-3	40	8
Oct 12	51098	-1	59	12
Oct 13	51099	-2	49	10
Oct 14	51100	-4	52	10
Oct 15	51101	-11	42	8
Oct 16	51102	-12	56	11
Oct 17	51103	-8	49	10
Oct 18	51104	-6	40	8
Oct 19	51105	-7	41	8
Oct 20	51106	-7	46	10
Oct 21	51107	-3	36	7
Oct 22	51108	-2	44	8
Oct 23	51109	-3	38	8
Oct 24	51110	-7	47	8
Oct 25	51111	-12	42	8
Oct 26	51112	-14	45	9
Oct 27	51113	-8	45	9
Oct 28	51114	-6	52	9
Oct 29	51115	-8	44	8
Oct 30	51116	-10	37	8
Oct 31	51117	-6	47	8

TABLE 11. (CONT.)

Date 1998 0h UTC	MJD	C_0 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Nov 1	51118	-3	51	8
Nov 2	51119	-6	47	8
Nov 3	51120	-12	33	6
Nov 4	51121	-12	42	8
Nov 5	51122	-3	43	8
Nov 6	51123	4	53	11
Nov 7	51124	-8	38	6
Nov 8	51125	-17	35	5
Nov 9	51126	-12	40	6
Nov 10	51127	-5	42	6
Nov 11	51128	-6	42	6
Nov 12	51129	-5	44	7
Nov 13	51130	-1	37	6
Nov 14	51131	0	43	7
Nov 15	51132	-4	40	6
Nov 16	51133	-4	42	6
Nov 17	51134	-2	46	7
Nov 18	51135	-1	47	7
Nov 19	51136	-4	52	8
Nov 20	51137	-13	47	7
Nov 21	51138	-17	51	8
Nov 22	51139	-18	50	8
Nov 23	51140	-17	59	9
Nov 24	51141	-17	37	6
Nov 25	51142	-13	44	7
Nov 26	51143	-10	48	7
Nov 27	51144	-12	41	6
Nov 28	51145	-13	40	6
Nov 29	51146	-15	40	6
Nov 30	51147	-18	37	6

TABLE 11. (CONT.)

Date 1998 0h UTC	MJD	C_0 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Dec 1	51148	-16	48	7
Dec 2	51149	-10	44	7
Dec 3	51150	-8	43	7
Dec 4	51151	-9	38	6
Dec 5	51152	-11	45	7
Dec 6	51153	-13	48	7
Dec 7	51154	-14	47	7
Dec 8	51155	-13	43	7
Dec 9	51156	-14	48	7
Dec 10	51157	-14	41	6
Dec 11	51158	-14	50	8
Dec 12	51159	-16	39	6
Dec 13	51160	-16	39	6
Dec 14	51161	-17	53	8
Dec 15	51162	-18	53	8
Dec 16	51163	-18	45	7
Dec 17	51164	-14	50	8
Dec 18	51165	-10	52	8
Dec 19	51166	-14	44	7
Dec 20	51167	-19	46	7
Dec 21	51168	-21	42	6
Dec 22	51169	-20	51	13
Dec 23	51170	-23	41	9
Dec 24	51171	-27	40	6
Dec 25	51172	-23	49	8
Dec 26	51173	-19	48	7
Dec 27	51174	-20	44	7
Dec 28	51175	-21	40	6
Dec 29	51176	-16	43	7
Dec 30	51177	-10	39	6
Dec 31	51178	-6	50	8

TABLE 12. [*TAI - GLONASS time*] AND [*UTC - GLONASS time*]

(File available on http://www.bipm.fr under the name UTCGLO98.AR)

The GLONASS satellites disseminate a common time scale designated as 'GLONASS time'. The relation between GLONASS time and UTC is :

$$[UTC - GLONASS\ time] = 0\ s + C_1,$$

where the time difference 0 s is kept constant as a consequence of the leap seconds applied to GLONASS time in order to follow the UTC system, and C_1 is a quantity of order several hundreds of nanoseconds (tens of microseconds until 1997 July 1) which varies with time.

The relation between GLONASS time and TAI involves a variable number of seconds and is as follows :

from 1997 July 1, 0h UTC, until 1999 January 1, 0h UTC :

$$[TAI - GLONASS\ time] = 31\ s + C_1,$$

from 1999 January 1, 0h UTC, until further notice :

$$[TAI - GLONASS\ time] = 32\ s + C_1.$$

Here C_1 is given at 0h UTC every day.

C_1 is computed as follows: the GLONASS data taken at the NMi Van Swinden Laboratorium, Delft, The Netherlands, for highest elevation, are smoothed to obtain daily values of [*UTC*(*VSL*)-*GLONASS time*] at 0h UTC. Daily values of C_1 are then derived from them using linear interpolation of [*UTC - UTC*(*VSL*)] from Table 9.

A time correction of + 1285 ns is also applied in order to ensure continuity of C_1 estimates on 1997, January 1 (MJD = 50449). The global uncertainty of daily C_1 values is of order several hundreds nanoseconds.

In the following tables, the standard deviation σ characterizes the dispersion of individual measurements, and N is the number of measurements used on a given day for estimation of the corresponding daily C_1 value.

TABLE 12. (CONT.)

Date 1998 0h UTC	MJD	C_1 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Jan 1	50814	370	28	5
Jan 2	50815	366	30	5
Jan 3	50816	362	21	3
Jan 4	50817	362	21	3
Jan 5	50818	365	26	5
Jan 6	50819	369	20	3
Jan 7	50820	367	23	4
Jan 8	50821	374	30	6
Jan 9	50822	390	31	5
Jan 10	50823	399	22	4
Jan 11	50824	390	22	4
Jan 12	50825	379	20	3
Jan 13	50826	367	22	4
Jan 14	50827	359	21	3
Jan 15	50828	358	22	4
Jan 16	50829	363	28	5
Jan 17	50830	372	26	4
Jan 18	50831	383	20	4
Jan 19	50832	385	19	3
Jan 20	50833	375	-	-
Jan 21	50834	364	15	3
Jan 22	50835	363	18	3
Jan 23	50836	364	19	3
Jan 24	50837	365	18	3
Jan 25	50838	365	24	4
Jan 26	50839	368	19	3
Jan 27	50840	373	-	-
Jan 28	50841	381	19	3
Jan 29	50842	384	20	4
Jan 30	50843	375	20	3
Jan 31	50844	370	17	3

TABLE 12. (CONT.)

Date 1998 0h UTC	MJD	C_1 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Feb 1	50845	376	18	3
Feb 2	50846	389	25	4
Feb 3	50847	391	12	3
Feb 4	50848	385	32	7
Feb 5	50849	381	18	4
Feb 6	50850	373	19	4
Feb 7	50851	365	21	3
Feb 8	50852	368	17	3
Feb 9	50853	375	16	3
Feb 10	50854	385	25	4
Feb 11	50855	393	15	3
Feb 12	50856	393	20	3
Feb 13	50857	390	25	4
Feb 14	50858	392	27	5
Feb 15	50859	389	23	4
Feb 16	50860	377	14	2
Feb 17	50861	371	20	3
Feb 18	50862	374	12	3
Feb 19	50863	381	27	5
Feb 20	50864	384	19	3
Feb 21	50865	389	16	3
Feb 22	50866	396	23	4
Feb 23	50867	396	21	4
Feb 24	50868	393	25	5
Feb 25	50869	394	24	6
Feb 26	50870	397	15	4
Feb 27	50871	389	18	5
Feb 28	50872	387	24	4

TABLE 12. (CONT.)

Date 1998 0h UTC	MJD	C_1 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Mar 1	50873	393	20	3
Mar 2	50874	393	19	3
Mar 3	50875	381	20	3
Mar 4	50876	372	16	3
Mar 5	50877	376	19	3
Mar 6	50878	382	23	4
Mar 7	50879	384	26	5
Mar 8	50880	385	23	4
Mar 9	50881	382	21	3
Mar 10	50882	375	19	3
Mar 11	50883	371	29	5
Mar 12	50884	370	19	3
Mar 13	50885	372	18	3
Mar 14	50886	383	17	3
Mar 15	50887	390	18	3
Mar 16	50888	389	22	4
Mar 17	50889	378	16	2
Mar 18	50890	371	19	3
Mar 19	50891	367	22	4
Mar 20	50892	375	21	3
Mar 21	50893	389	18	3
Mar 22	50894	395	17	3
Mar 23	50895	389	24	4
Mar 24	50896	386	24	4
Mar 25	50897	388	19	3
Mar 26	50898	387	22	4
Mar 27	50899	385	16	3
Mar 28	50900	393	19	3
Mar 29	50901	397	19	4
Mar 30	50902	386	21	6
Mar 31	50903	376	15	3

TABLE 12. (CONT.)

Date 1998 0h UTC	MJD	C_1 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Apr 1	50904	376	23	5
Apr 2	50905	375	17	3
Apr 3	50906	359	18	5
Apr 4	50907	333	17	4
Apr 5	50908	327	21	4
Apr 6	50909	330	12	3
Apr 7	50910	339	29	6
Apr 8	50911	351	28	6
Apr 9	50912	337	18	4
Apr 10	50913	313	31	10
Apr 11	50914	318	24	6
Apr 12	50915	329	16	3
Apr 13	50916	333	27	7
Apr 14	50917	333	23	6
Apr 15	50918	323	16	3
Apr 16	50919	311	16	3
Apr 17	50920	308	18	3
Apr 18	50921	309	17	3
Apr 19	50922	308	18	4
Apr 20	50923	308	22	4
Apr 21	50924	309	20	3
Apr 22	50925	309	17	3
Apr 23	50926	308	22	3
Apr 24	50927	310	22	4
Apr 25	50928	310	21	4
Apr 26	50929	310	21	3
Apr 27	50930	314	21	4
Apr 28	50931	316	22	4
Apr 29	50932	316	25	4
Apr 30	50933	319	21	4

TABLE 12. (CONT.)

Date 1998 0h UTC	MJD	C_1 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
May 1	50934	325	30	4
May 2	50935	331	27	5
May 3	50936	332	31	6
May 4	50937	324	19	3
May 5	50938	314	21	3
May 6	50939	310	23	4
May 7	50940	316	18	3
May 8	50941	322	24	4
May 9	50942	326	14	2
May 10	50943	329	27	4
May 11	50944	326	20	4
May 12	50945	317	16	2
May 13	50946	313	23	4
May 14	50947	313	14	2
May 15	50948	308	22	3
May 16	50949	304	20	3
May 17	50950	307	17	2
May 18	50951	310	24	4
May 19	50952	312	23	4
May 20	50953	315	23	4
May 21	50954	314	18	3
May 22	50955	311	26	5
May 23	50956	309	20	3
May 24	50957	317	36	6
May 25	50958	325	28	4
May 26	50959	319	24	4
May 27	50960	308	23	4
May 28	50961	302	33	5
May 29	50962	295	18	3
May 30	50963	293	16	3
May 31	50964	298	22	3

TABLE 12. (CONT.)

Date 1998 0h UTC	MJD	C_1 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Jun 1	50965	306	25	5
Jun 2	50966	306	26	4
Jun 3	50967	303	24	4
Jun 4	50968	304	28	5
Jun 5	50969	311	31	6
Jun 6	50970	305	32	6
Jun 7	50971	286	31	6
Jun 8	50972	270	30	5
Jun 9	50973	266	20	3
Jun 10	50974	270	21	3
Jun 11	50975	278	27	4
Jun 12	50976	282	23	4
Jun 13	50977	282	18	3
Jun 14	50978	283	15	3
Jun 15	50979	291	35	6
Jun 16	50980	304	33	5
Jun 17	50981	322	20	3
Jun 18	50982	336	19	3
Jun 19	50983	338	19	3
Jun 20	50984	332	25	4
Jun 21	50985	332	22	4
Jun 22	50986	341	24	4
Jun 23	50987	347	22	4
Jun 24	50988	344	32	5
Jun 25	50989	337	29	5
Jun 26	50990	336	30	4
Jun 27	50991	347	21	4
Jun 28	50992	356	26	5
Jun 29	50993	347	31	6
Jun 30	50994	328	38	9

TABLE 12. (CONT.)

Date 1998 0h UTC	MJD	C_1 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Jul 1	50995	330	23	5
Jul 2	50996	339	29	4
Jul 3	50997	343	25	4
Jul 4	50998	346	30	4
Jul 5	50999	355	29	5
Jul 6	51000	357	34	5
Jul 7	51001	348	27	5
Jul 8	51002	335	-	-
Jul 9	51003	324	-	-
Jul 10	51004	314	29	5
Jul 11	51005	304	30	5
Jul 12	51006	309	19	3
Jul 13	51007	321	33	6
Jul 14	51008	328	27	4
Jul 15	51009	328	35	6
Jul 16	51010	316	32	8
Jul 17	51011	304	28	5
Jul 18	51012	307	25	5
Jul 19	51013	312	24	4
Jul 20	51014	300	31	5
Jul 21	51015	288	22	4
Jul 22	51016	285	13	3
Jul 23	51017	284	32	5
Jul 24	51018	283	-	-
Jul 25	51019	276	-	-
Jul 26	51020	269	-	-
Jul 27	51021	268	39	7
Jul 28	51022	278	24	3
Jul 29	51023	283	27	5
Jul 30	51024	274	18	3
Jul 31	51025	272	21	3

TABLE 12. (CONT.)

Date 1998 0h UTC	MJD	C_1 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Aug 1	51026	283	29	5
Aug 2	51027	285	31	5
Aug 3	51028	277	23	3
Aug 4	51029	272	-	-
Aug 5	51030	270	-	-
Aug 6	51031	268	-	-
Aug 7	51032	269	23	4
Aug 8	51033	272	28	4
Aug 9	51034	274	14	2
Aug 10	51035	276	26	4
Aug 11	51036	275	20	3
Aug 12	51037	265	25	4
Aug 13	51038	264	28	4
Aug 14	51039	271	33	6
Aug 15	51040	278	27	4
Aug 16	51041	271	19	3
Aug 17	51042	251	26	5
Aug 18	51043	243	23	4
Aug 19	51044	256	30	5
Aug 20	51045	264	18	3
Aug 21	51046	265	17	2
Aug 22	51047	264	20	3
Aug 23	51048	262	21	3
Aug 24	51049	266	21	6
Aug 25	51050	279	23	5
Aug 26	51051	290	-	-
Aug 27	51052	297	-	-
Aug 28	51053	298	23	4
Aug 29	51054	294	25	4
Aug 30	51055	292	21	4
Aug 31	51056	294	13	3

TABLE 12. (CONT.)

Date 1998 0h UTC	MJD	C_1 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Sep 1	51057	294	17	3
Sep 2	51058	289	15	3
Sep 3	51059	293	20	3
Sep 4	51060	310	22	3
Sep 5	51061	320	19	3
Sep 6	51062	318	24	3
Sep 7	51063	313	17	3
Sep 8	51064	308	22	4
Sep 9	51065	311	21	3
Sep 10	51066	313	14	2
Sep 11	51067	306	25	4
Sep 12	51068	306	-	-
Sep 13	51069	316	-	-
Sep 14	51070	322	22	5
Sep 15	51071	318	14	2
Sep 16	51072	308	20	3
Sep 17	51073	304	23	5
Sep 18	51074	300	-	-
Sep 19	51075	295	-	-
Sep 20	51076	289	-	-
Sep 21	51077	283	-	-
Sep 22	51078	282	22	16
Sep 23	51079	285	19	3
Sep 24	51080	289	25	4
Sep 25	51081	286	16	2
Sep 26	51082	284	21	3
Sep 27	51083	285	20	3
Sep 28	51084	285	18	3
Sep 29	51085	287	-	-
Sep 30	51086	289	-	-

TABLE 12. (CONT.)

Date 1998 0h UTC	MJD	C_1 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Oct 1	51087	293	16	3
Oct 2	51088	286	-	-
Oct 3	51089	267	-	-
Oct 4	51090	262	-	-
Oct 5	51091	269	9	2
Oct 6	51092	283	-	-
Oct 7	51093	278	15	4
Oct 8	51094	265	14	3
Oct 9	51095	265	17	2
Oct 10	51096	269	20	4
Oct 11	51097	266	15	3
Oct 12	51098	261	21	3
Oct 13	51099	258	17	6
Oct 14	51100	253	20	6
Oct 15	51101	264	20	5
Oct 16	51102	296	16	3
Oct 17	51103	287	15	2
Oct 18	51104	282	12	3
Oct 19	51105	280	15	3
Oct 20	51106	272	16	3
Oct 21	51107	267	23	6
Oct 22	51108	274	22	6
Oct 23	51109	287	19	4
Oct 24	51110	290	14	3
Oct 25	51111	284	16	2
Oct 26	51112	284	19	4
Oct 27	51113	285	-	-
Oct 28	51114	289	15	3
Oct 29	51115	292	18	4
Oct 30	51116	307	-	-
Oct 31	51117	318	-	-

TABLE 12. (CONT.)

Date 1998 0h UTC	MJD	C_1 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Nov 1	51118	312	12	2
Nov 2	51119	299	18	3
Nov 3	51120	293	13	3
Nov 4	51121	291	15	4
Nov 5	51122	293	20	4
Nov 6	51123	300	8	2
Nov 7	51124	298	18	5
Nov 8	51125	282	17	3
Nov 9	51126	273	15	4
Nov 10	51127	270	27	5
Nov 11	51128	256	18	5
Nov 12	51129	263	20	6
Nov 13	51130	270	18	7
Nov 14	51131	268	19	6
Nov 15	51132	264	16	4
Nov 16	51133	261	17	4
Nov 17	51134	255	19	4
Nov 18	51135	253	13	2
Nov 19	51136	259	11	6
Nov 20	51137	262	10	2
Nov 21	51138	274	14	3
Nov 22	51139	284	14	4
Nov 23	51140	281	24	6
Nov 24	51141	272	20	4
Nov 25	51142	266	16	3
Nov 26	51143	265	29	20
Nov 27	51144	266	20	4
Nov 28	51145	266	16	4
Nov 29	51146	267	27	6
Nov 30	51147	271	32	8

TABLE 12. (CONT.)

Date 1998 0h UTC	MJD	C_1 (ns)	σ (ns)	$\sigma/\sqrt{N}$ (ns)
Dec 1	51148	263	27	9
Dec 2	51149	235	20	4
Dec 3	51150	221	25	7
Dec 4	51151	232	17	3
Dec 5	51152	244	-	-
Dec 6	51153	255	12	3
Dec 7	51154	261	21	6
Dec 8	51155	266	32	8
Dec 9	51156	281	17	5
Dec 10	51157	297	20	5
Dec 11	51158	303	16	4
Dec 12	51159	298	22	4
Dec 13	51160	298	-	-
Dec 14	51161	300	18	4
Dec 15	51162	299	15	4
Dec 16	51163	301	20	7
Dec 17	51164	304	12	3
Dec 18	51165	291	24	6
Dec 19	51166	275	27	5
Dec 20	51167	280	20	3
Dec 21	51168	301	19	3
Dec 22	51169	315	17	3
Dec 23	51170	305	21	4
Dec 24	51171	303	9	2
Dec 25	51172	308	19	4
Dec 26	51173	312	15	4
Dec 27	51174	309	-	-
Dec 28	51175	297	-	-
Dec 29	51176	285	22	5
Dec 30	51177	284	15	3
Dec 31	51178	290	10	2

TABLE 13A. RATES RELATIVE TO TAI OF CONTRIBUTING CLOCKS IN 1998

(File available on http://www.bipm.fr under the name RTAI98.AR)

Mean clock rates relative to TAI are computed for one-month intervals ending at the dates given in the table.
When an intentional frequency adjustment has been applied to a clock, the data prior to this adjustment are corrected, so that Table 14A gives homogeneous rates for the whole year 1998. For studies including the clock rates of previous years, corrections must be brought to the data published in the Annual Reports for 1988 to 1997, and in the BIH Annual Reports for the previous years. These corrections are given in Table 14B.
Unit is ns/day, *** denotes that the clock was not used.

LAB.	CLOCK		50844	50869	50899	50929	50964	50994
AMC	35	173	-17.27	-17.13	-17.75	-17.37	-17.53	-17.27
AMC	35	231	8.58	9.22	9.64	9.20	9.04	10.31
AMC	35	266	-14.63	-14.87	-14.25	-14.16	-14.05	-14.67
AMC	35	268	-19.72	-19.50	-19.46	-19.49	-19.20	-19.69
AMC	35	389	-30.20	-30.31	-30.41	-30.58	-30.39	-30.32
AMC	35	416	-16.59	-16.31	-16.04	-15.78	-15.45	-16.60
AMC	35	703	-6.84	-6.85	-6.73	-6.75	-6.00	-6.32
AMC	35	717	7.40	8.51	8.05	7.69	7.84	7.87
AMC	35	762	-22.71	-23.74	-22.84	-22.20	-23.41	-22.88
AMC	35	763	-6.64	-6.86	-6.24	-7.25	-7.83	-8.01
AMC	35	765	-6.56	-5.97	-6.80	-6.41	-6.20	-6.18
AMC	40	713	-17.29	-16.94	-16.78	-16.55	-16.45	-16.13
AMC	40	714	-40.12	-39.87	-39.75	-39.72	-39.92	-39.73
AOS	23	67	14.10	-8.94	6.55	-12.97	-4.38	-37.93
APL	14	793	***	2.17	7.25	1.96	0.02	***
APL	35	904	***	10.21	10.09	10.21	4.50	***
APL	40	3102	***	9.97	11.72	8.88	4.88	***
APL	40	3106	***	10.23	11.18	9.40	4.29	***
AUS	35	299	***	***	***	***	***	***
AUS	36	207	2.23	-1.01	1.35	0.50	2.69	5.67
AUS	36	249	-3.80	-3.62	-3.87	-3.47	-2.96	-3.74
AUS	36	340	***	***	***	***	***	***
AUS	36	379	14.92	9.70	11.90	14.96	***	***
AUS	36	424	-0.12	0.15	2.02	0.74	1.58	5.36
AUS	36	1035	4.42	4.65	7.42	6.21	6.16	10.24
AUS	36	1141	***	***	***	***	***	***
AUS	40	5403	***	***	6.63	0.20	-4.51	-8.13
AUS	40	7501	***	***	***	***	***	***
AUS	40	7502	***	***	***	***	***	***
BEV	35	1065	***	***	***	***	***	***
CAO	35	939	-4.90	-3.83	-4.73	-3.88	-3.92	-4.23
CH	16	77	-154.26	-153.84	-151.48	-157.02	-159.13	-164.28
CH	17	206	-1.34	2.89	2.79	0.26	3.50	-0.13
CH	21	179	-8.83	-5.18	-6.33	-8.35	-8.59	-5.06
CH	21	194	-55.68	-56.75	-59.11	-65.32	-63.65	-65.88

TABLE 13A. (CONT.)

LAB.	CLOCK		51024	51054	51084	51114	51144	51174
AMC	35	173	-17.69	-16.75	-17.07	-17.20	-17.90	-16.79
AMC	35	231	9.63	9.09	9.99	9.37	7.88	6.82
AMC	35	266	-15.12	-13.85	-14.73	-14.03	-14.28	-15.20
AMC	35	268	-19.01	-19.75	-20.32	-18.32	-16.77	-16.80
AMC	35	389	-30.34	-29.53	-30.08	-30.34	-30.60	-30.02
AMC	35	416	-16.48	-17.33	-17.72	-16.67	-16.90	-17.26
AMC	35	703	-6.97	-7.64	-7.47	-7.17	-7.31	-8.17
AMC	35	717	7.70	7.77	7.94	7.01	8.44	7.58
AMC	35	762	-22.97	-24.54	-23.85	-24.81	-25.53	-24.98
AMC	35	763	-9.04	-9.63	***	***	***	***
AMC	35	765	-7.19	-6.39	-6.57	-6.75	-7.24	-7.05
AMC	40	713	-16.07	-15.87	-15.70	-15.61	-15.76	-15.37
AMC	40	714	-39.86	-39.83	-39.79	-40.97	-40.06	-39.94
AOS	23	67	-32.68	-42.63	-47.99	-79.03	-64.15	-41.59
APL	14	793	***	***	***	***	***	***
APL	35	904	***	***	9.91	-12.62	-6.37	***
APL	40	3102	***	***	***	***	***	***
APL	40	3106	***	***	***	***	***	***
AUS	35	299	***	***	1.24	***	2.14	***
AUS	36	207	5.27	4.30	1.23	***	***	***
AUS	36	249	0.03	***	***	***	1.37	***
AUS	36	340	***	***	2.88	2.26	1.37	***
AUS	36	379	***	***	***	***	***	***
AUS	36	424	5.36	3.91	1.45	***	***	***
AUS	36	1035	6.82	***	-7.02	***	***	***
AUS	36	1141	***	***	3.58	4.99	3.86	***
AUS	40	5403	-10.40	***	***	***	9.73	***
AUS	40	7501	***	***	24.85	26.08	23.91	***
AUS	40	7502	***	***	***	***	12.88	***
BEV	35	1065	29.17	28.37	26.93	33.85	27.77	37.13
CAO	35	939	-3.95	-6.43	-4.38	-4.32	-4.06	-5.78
CH	16	77	-164.42	-157.73	-149.50	-145.30	-146.16	-138.05
CH	17	206	5.49	3.14	1.48	-3.22	-2.41	-5.83
CH	21	179	-8.17	-5.04	-3.71	-0.91	-0.08	3.13
CH	21	194	-61.49	-61.83	-58.96	-62.87	-59.45	-51.30

TABLE 13A. (CONT.)

LAB.	CLOCK		50844	50869	50899	50929	50964	50994
CH	21	217	98.92	101.89	98.63	88.24	91.53	86.84
CH	21	243	55.20	47.66	42.78	54.54	35.60	27.33
CH	21	265	39.89	41.66	23.00	48.97	31.19	23.40
CH	31	403	-36.80	***	***	***	***	-71.80
CH	35	413	15.24	16.42	15.71	15.43	16.64	19.66
CH	35	771	18.70	18.29	17.14	12.90	13.48	13.47
CH	36	354	44.56	45.75	47.10	46.09	46.36	47.72
CNM	35	237	-14.93	-14.84	-13.90	-14.42	***	3.65
CNM	35	238	12.38	9.18	4.07	4.22	4.50	3.85
CNM	35	378	-21.48	-21.70	-21.27	-24.52	-22.53	-22.90
CNM	35	381	-17.88	-17.92	-15.21	-18.02	-17.69	-17.63
CNM	35	382	-28.99	-28.81	-26.78	-28.63	-28.09	-28.36
CRL	35	112	12.08	13.26	13.62	14.42	15.28	15.93
CRL	35	144	***	***	***	15.55	14.62	15.04
CRL	35	332	27.31	26.98	28.18	27.68	27.38	27.72
CRL	35	342	13.67	12.54	13.96	13.20	12.62	12.70
CRL	35	343	11.43	11.57	10.50	11.55	11.92	11.53
CRL	35	715	11.90	11.91	11.16	10.95	9.35	8.31
CRL	35	732	-14.37	-14.35	-16.02	-15.16	-15.30	-15.60
CRL	35	907	20.10	19.15	20.18	20.30	20.67	20.82
CRL	35	908	11.44	11.25	10.83	12.28	11.91	11.72
CSAO	12	1648	66.87	***	***	***	***	***
CSAO	30	152	555.90	***	***	***	***	***
CSAO	35	1007	-1.12	-0.41	0.01	2.59	-0.31	-3.54
CSAO	35	1008	***	4.78	5.18	6.82	6.02	3.12
CSAO	35	1011	-5.27	-5.43	-5.34	-1.79	-2.41	-4.07
CSAO	35	1016	***	-3.42	-3.60	0.09	-1.77	-3.68
CSAO	35	1017	-0.70	-0.35	0.66	2.53	0.72	-0.02
CSAO	35	1018	***	-7.04	-6.45	-4.47	-6.71	-7.50
DLR	40	7416	***	-10.14	-9.52	***	-9.95	***
DLR	40	7424	***	-9.39	-9.39	***	-9.78	-10.11
DTAG	36	136	14.76	13.85	16.16	39.22	90.72	***
DTAG	36	345	1.17	0.59	0.66	-0.51	0.56	0.35
DTAG	36	465	-2.02	-1.14	1.07	0.35	0.39	0.68
F	14	51	-115.79	-111.18	-113.07	-110.07	-109.32	-109.92
F	14	134	67.77	43.37	***	***	***	***
F	14	1120	-59.40	-61.12	-59.20	-56.93	-55.58	-54.02
F	14	1645	72.87	***	***	***	***	***
F	16	106	-21.96	-19.00	-24.52	-21.12	-23.04	-21.16
F	35	122	-16.39	-16.50	-15.18	-16.13	-15.58	-15.58
F	35	124	-3.55	-3.07	-2.91	-2.79	-2.67	-2.98
F	35	131	11.21	11.57	10.33	11.08	10.58	9.17
F	35	158	12.59	13.42	13.85	12.77	12.48	13.19
F	35	172	1.67	2.25	1.28	1.95	2.19	2.49
F	35	198	2.37	2.83	3.09	3.48	3.50	4.12

TABLE 13A. (CONT.)

LAB.	CLOCK		51024	51054	51084	51114	51144	51174
CH	21	217	86.73	93.61	98.53	96.22	102.73	115.18
CH	21	243	16.86	23.65	38.91	45.56	53.96	83.58
CH	21	265	40.01	30.79	13.70	10.56	18.82	98.51
CH	31	403	-71.37	-70.49	-70.52	-71.07	-69.69	-71.57
CH	35	413	17.33	18.73	19.05	16.14	16.77	14.13
CH	35	771	14.01	14.29	14.27	16.20	17.67	16.94
CH	36	354	46.63	45.69	46.32	43.80	47.63	***
CNM	35	237	3.45	***	***	***	***	***
CNM	35	238	5.08	4.18	5.06	4.80	4.99	4.73
CNM	35	378	-23.27	-22.57	-23.06	-22.43	-23.50	-23.03
CNM	35	381	***	***	***	***	***	***
CNM	35	382	-26.98	-30.38	-26.48	-26.32	-26.41	-26.53
CRL	35	112	16.23	16.47	17.19	17.60	18.50	19.20
CRL	35	144	15.21	14.63	14.95	15.20	14.89	15.64
CRL	35	332	27.67	27.42	27.60	28.15	28.08	28.58
CRL	35	342	12.16	12.47	12.43	12.38	12.06	12.10
CRL	35	343	11.73	11.62	11.60	11.89	11.21	11.79
CRL	35	715	8.16	6.87	6.61	6.94	5.89	6.28
CRL	35	732	-15.62	-17.29	-16.82	-18.06	-18.63	-18.89
CRL	35	907	20.13	20.57	21.34	20.18	20.44	20.57
CRL	35	908	11.86	12.49	11.07	12.58	12.82	13.00
CSAO	12	1648	***	***	***	***	***	***
CSAO	30	152	***	***	***	***	***	***
CSAO	35	1007	-3.64	-4.21	***	-4.22	-6.11	-6.98
CSAO	35	1008	4.42	3.91	***	3.10	3.32	2.57
CSAO	35	1011	-5.02	-5.54	***	-5.54	-6.79	-8.91
CSAO	35	1016	-2.80	-3.43	***	-3.55	-5.08	-6.55
CSAO	35	1017	-0.43	-1.24	***	-1.14	-2.47	-2.19
CSAO	35	1018	-7.92	-8.04	***	-10.22	-10.23	-11.82
DLR	40	7416	***	-11.51	***	***	***	***
DLR	40	7424	-10.80	-10.95	-12.47	-13.58	-16.26	-16.14
DTAG	36	136	***	***	***	10.91	9.87	12.31
DTAG	36	345	-0.75	-0.66	-0.47	-0.52	-1.48	-1.32
DTAG	36	465	0.01	1.28	-0.15	1.70	-0.28	-0.31
F	14	51	-113.76	-115.58	-103.61	***	***	***
F	14	134	***	***	***	***	***	***
F	14	1120	-51.30	-46.29	-44.56	***	***	***
F	14	1645	***	***	***	***	***	***
F	16	106	-22.41	-24.67	-17.49	-21.51	-10.57	-18.76
F	35	122	-16.12	-15.73	-15.02	-14.50	-14.04	-14.01
F	35	124	-3.00	***	***	***	***	***
F	35	131	9.28	8.72	9.08	7.88	8.22	7.13
F	35	158	13.17	12.74	13.18	12.13	11.57	11.50
F	35	172	2.57	1.90	2.20	2.03	2.03	2.73
F	35	198	4.12	4.59	4.21	3.95	4.24	4.43

TABLE 13A. (CONT.)

LAB.	CLOCK	50844	50869	50899	50929	50964	50994
F	35 355	***	***	***	***	***	***
F	35 385	2.30	2.89	2.68	3.17	2.61	3.46
F	35 396	7.25	5.93	6.22	6.25	5.87	6.07
F	35 536	-7.47	-7.09	-6.54	-7.05	-6.79	-6.45
F	35 609	16.37	18.51	18.18	18.20	18.92	18.30
F	35 770	12.42	12.61	13.09	12.68	12.73	13.12
F	35 781	-22.04	-21.00	-22.61	-21.14	-21.20	-21.60
F	35 819	18.67	18.30	19.07	18.76	19.25	18.57
F	35 859	16.26	18.34	17.35	19.08	18.73	19.32
F	40 816	6.60	6.59	6.06	***	***	***
GUM	14 1144	-8.42	-0.33	0.03	-30.77	-24.58	-25.75
GUM	31 652	-0.63	-9.81	1.77	-1.16	-37.13	4.37
GUM	35 441	-0.15	-0.72	1.00	0.06	0.42	-0.22
GUM	35 502	3.70	2.48	2.18	0.37	1.62	4.50
IEN	14 1230	***	59.44	53.24	43.85	46.34	***
IEN	31 659	-29.95	-31.49	-31.10	-20.51	-37.26	-31.13
IEN	35 219	21.05	20.85	21.70	22.40	23.45	23.70
IEN	35 505	4.35	3.94	3.31	2.07	2.40	2.07
IEN	35 1115	***	-7.20	-5.76	-1.72	-9.55	-9.68
IFAG	14 1105	-61.35	-63.58	***	***	***	***
IFAG	16 131	18.44	22.38	21.04	30.50	24.58	***
IFAG	16 173	189.90	193.76	172.25	173.11	153.74	***
IFAG	16 274	54.82	43.33	44.92	50.82	55.70	***
IFAG	36 1034	-12.14	-12.59	-11.17	-10.95	-10.65	***
IFAG	36 1176	***	***	***	***	***	***
IFAG	40 4401	60.77	76.15	***	***	91.55	***
IFAG	40 4413	-9.40	-17.50	-24.38	-35.80	-58.10	***
IGMA	14 2403	-1.10	9.41	2.09	-0.58	-4.13	-9.02
IGMA	16 112	42.85	41.75	42.53	42.14	46.96	42.02
IGMA	35 631	***	***	***	***	***	***
IGMA	35 645	11.30	11.20	11.50	12.07	12.18	12.52
IGMA	35 647	18.30	17.91	18.57	18.94	18.35	18.45
INPL	35 1021	***	***	2.25	2.78	2.79	2.88
IPQ	35 125	3.29	3.21	4.12	3.86	3.45	4.31
IPQ	35 615	6.48	5.84	6.50	6.94	6.59	6.05
IPQ	35 1030	2.35	2.67	3.40	3.50	3.25	3.45
KRIS	36 321	4.86	4.50	4.62	7.03	5.21	4.89
KRIS	36 739	-11.45	-14.07	-14.67	-13.55	-12.89	-13.60
KRIS	36 1135	1.12	2.24	2.12	6.18	5.67	8.74
KRIS	40 5623	20.03	19.19	20.58	20.63	23.17	24.61
LDS	35 289	2.08	0.41	0.88	1.11	1.77	2.60
MSL	12 933	11.31	9.82	8.86	***	***	11.25
MSL	35 1025	***	***	***	***	***	-6.25
MSL	36 274	6.07	2.92	3.65	***	***	13.87
NAO	14 1315	-81.68	-63.48	-62.95	-62.31	-62.46	-60.58

TABLE 13A. (CONT.)

LAB.	CLOCK		51024	51054	51084	51114	51144	51174
F	35	355	***	***	3.81	3.06	2.45	3.03
F	35	385	3.38	3.89	3.93	3.19	7.24	6.23
F	35	396	6.66	6.13	6.08	5.73	5.49	5.62
F	35	536	-7.29	-7.20	-6.57	-6.41	-6.37	-6.69
F	35	609	17.88	18.52	18.49	18.46	19.02	19.45
F	35	770	13.23	13.80	13.03	13.00	13.79	13.22
F	35	781	-20.77	-23.20	-22.38	-22.66	-22.43	-22.48
F	35	819	18.20	18.80	19.69	18.88	18.39	18.24
F	35	859	17.86	18.90	19.20	***	***	***
F	40	816	3.04	2.55	1.91	1.58	1.59	1.22
GUM	14	1144	-16.35	-9.55	1.77	-12.00	1.54	-17.11
GUM	31	652	9.32	-5.45	10.54	***	-21.94	-24.03
GUM	35	441	1.37	0.82	2.09	1.48	1.95	2.25
GUM	35	502	4.48	4.46	5.33	5.78	6.34	5.47
IEN	14	1230	***	***	***	***	***	***
IEN	31	659	-24.92	-23.63	-29.58	-35.92	-48.94	***
IEN	35	219	22.28	22.10	23.30	24.23	24.70	23.95
IEN	35	505	0.53	0.64	1.19	1.08	0.08	-0.78
IEN	35	1115	-0.23	-0.13	-6.55	-6.84	-8.16	-7.87
IFAG	36	1173	***	0.40	0.01	-2.58	-6.37	-4.66
IFAG	16	131	***	27.08	25.81	24.12	35.07	39.22
IFAG	16	173	***	120.24	127.25	138.63	160.19	207.38
IFAG	16	274	***	***	***	***	***	***
IFAG	36	1034	***	-12.97	-9.42	-10.09	-5.21	-9.22
IFAG	36	1176	***	-12.45	-11.07	-11.62	-11.81	-13.41
IFAG	40	4401	***	118.44	141.67	181.54	155.75	120.53
IFAG	40	4413	***	-86.71	***	-95.20	-105.08	-109.57
IGMA	14	2403	-13.54	-9.79	-16.77	-2.65	-10.83	-21.07
IGMA	16	112	49.09	45.30	47.20	46.98	44.33	43.80
IGMA	35	631	***	15.47	16.82	14.99	17.77	16.35
IGMA	35	645	11.69	12.38	12.55	11.84	13.02	11.49
IGMA	35	647	***	***	***	***	***	***
INPL	35	1021	3.00	3.33	3.17	3.35	2.71	2.56
IPQ	35	125	4.81	4.22	***	***	***	***
IPQ	35	615	6.07	5.72	***	***	***	***
IPQ	35	1030	3.97	2.93	***	***	***	***
KRIS	36	321	3.75	4.56	4.29	3.56	4.53	5.50
KRIS	36	739	-12.05	-13.98	-12.12	-12.01	-13.45	-14.37
KRIS	36	1135	9.07	9.75	10.13	7.95	7.35	9.10
KRIS	40	5623	24.58	25.27	25.35	23.01	20.55	22.25
LDS	35	289	2.25	3.65	2.64	2.82	1.69	0.95
MSL	12	933	5.37	7.79	16.85	21.43	20.07	22.39
MSL	35	1025	-8.97	-9.05	-8.90	-9.96	-8.18	-7.72
MSL	36	274	7.58	9.40	8.02	9.35	7.36	8.50
NAO	14	1315	-63.41	***	***	***	***	***

TABLE 13A. (CONT.)

LAB.	CLOCK	50844	50869	50899	50929	50964	50994
NAO	34 2146	***	***	-39.29	-33.71	-26.51	-23.10
NAO	35 779	20.27	22.33	20.93	20.96	21.58	21.27
NAO	35 1214	***	***	***	2.35	2.02	0.78
NIM	12 614	27.23	18.22	44.65	23.25	13.74	20.75
NIM	30 277	373.93	366.55	390.69	392.97	410.07	429.62
NIM	35 479	7.64	8.64	10.48	5.54	6.96	10.93
NIM	35 1239	***	***	***	***	***	***
NIST	14 1316	-24.66	-25.73	-25.08	***	***	***
NIST	35 132	-7.82	-7.83	-7.68	-8.65	-7.89	-7.75
NIST	35 182	-7.48	-6.10	-6.71	-6.52	-7.02	-5.99
NIST	35 408	-11.72	-11.33	-11.57	-11.35	-11.34	-11.14
NIST	35 1074	-10.37	-10.39	-10.37	-9.82	-10.01	-9.95
NIST	40 201	***	17.67	17.80	18.02	18.20	18.53
NIST	40 203	9.41	9.13	8.31	7.45	***	***
NIST	40 204	-7.70	-7.54	-6.74	-6.11	-5.95	-5.48
NIST	40 222	-738.90	-738.64	-738.53	-738.59	-738.69	-738.59
NIST	50 2008	-53.51	-53.71	-52.71	-56.02	-59.02	-61.86
NML	36 340	2.02	0.71	4.91	3.64	0.48	-0.33
NML	36 1141	***	***	***	***	***	***
NML	40 7501	***	***	24.67	24.91	25.02	24.38
NML	40 7502	61.44	63.51	63.56	64.72	***	***
NPL	14 1334	-82.63	-84.68	-83.49	-84.73	-82.87	-82.30
NPL	14 1813	-28.63	-31.74	-29.77	-30.12	-29.44	-21.48
NPL	35 123	3.12	3.99	3.40	3.49	3.46	3.70
NPL	35 784	4.35	5.56	5.45	6.13	5.96	5.45
NPL	35 1275	***	***	***	***	***	***
NPL	36 404	0.69	1.54	-0.52	0.15	-1.13	-1.82
NPL	40 1701	-1.89	-1.79	-1.04	-0.77	-0.90	-0.92
NPL	40 1708	-0.70	-0.72	0.03	-0.15	-0.79	-0.87
NRC	35 234	7.07	7.21	6.66	7.12	7.95	8.48
NRC	35 372	15.64	16.30	29.95	5.35	8.34	10.13
NRC	40 304	3.85	5.01	4.10	4.32	3.80	4.87
NRC	90 61	9.93	10.83	10.33	10.70	9.58	10.60
NRC	90 63	-1.49	-0.57	-1.15	-0.90	-1.17	-0.57
NRLM	35 224	12.50	12.21	12.09	11.45	10.95	9.74
NRLM	35 459	1.27	1.12	1.75	1.61	2.11	1.92
NRLM	35 523	1.18	1.29	2.01	2.18	2.26	1.56
OMH	12 1067	4.35	2.94	2.53	3.53	2.69	3.44
ONRJ	35 903	2.78	2.63	4.73	3.35	3.58	3.28
ORB	35 201	1.22	-0.23	-0.34	0.68	1.91	-0.26
ORB	35 202	5.85	5.87	4.53	7.37	5.41	6.30
ORB	35 593	28.85	29.89	28.33	28.87	30.24	28.88
ORB	40 2601	-170.38	-177.05	-186.07	-192.58	-196.72	-190.58
PSB	35 267	17.25	17.75	***	18.42	18.67	18.75
PSB	35 277	5.48	5.12	***	5.09	4.87	5.66

TABLE 13A. (CONT.)

LAB.	CLOCK		51024	51054	51084	51114	51144	51174
NAO	34	2146	***	***	***	***	***	***
NAO	35	779	20.25	21.28	19.56	20.18	19.14	21.08
NAO	35	1214	1.16	1.67	1.93	2.68	1.82	4.36
NIM	12	614	18.31	23.57	26.85	33.47	32.48	40.50
NIM	30	277	433.11	446.60	447.93	***	***	***
NIM	35	479	8.27	9.22	9.88	10.75	9.84	9.73
NIM	35	1239	***	***	***	***	***	10.05
NIST	14	1316	***	***	***	***	***	***
NIST	35	132	-7.95	-7.69	-8.85	-7.93	-8.69	-9.82
NIST	35	182	-6.61	-6.60	-6.68	-6.84	-7.36	-7.10
NIST	35	408	-11.33	-11.00	-11.44	-10.88	-10.83	-10.75
NIST	35	1074	-10.44	-9.99	-10.08	-10.12	-10.63	-10.19
NIST	40	201	18.73	19.01	19.10	19.28	19.39	19.62
NIST	40	203	6.53	6.35	5.88	5.71	5.39	5.45
NIST	40	204	-5.40	-4.91	-4.92	-4.55	-4.54	-4.19
NIST	40	222	-738.57	-738.51	-738.70	-738.70	-738.88	-739.00
NIST	50	2008	-63.94	***	***	-68.37	-68.36	-73.25
NML	36	340	1.98	0.71	***	***	***	***
NML	36	1141	***	2.21	***	***	***	***
NML	40	7501	26.00	25.41	***	***	***	***
NML	40	7502	2.76	3.76	***	***	***	***
NPL	14	1334	***	***	***	***	***	***
NPL	14	1813	***	***	***	***	***	***
NPL	35	123	4.08	3.74	4.13	4.70	4.91	4.23
NPL	35	784	6.34	4.47	4.80	5.73	5.72	5.73
NPL	35	1275	***	***	***	***	***	3.74
NPL	36	404	-1.10	0.03	1.61	-1.88	-1.70	-0.62
NPL	40	1701	-0.63	-0.48	-0.37	-0.24	-0.13	-0.28
NPL	40	1708	***	***	***	-1.40	-1.43	-1.50
NRC	35	234	8.35	8.40	8.30	8.26	9.11	9.55
NRC	35	372	10.43	10.54	10.56	10.28	10.96	11.80
NRC	40	304	5.73	6.32	6.39	6.56	6.07	7.30
NRC	90	61	10.61	12.07	***	***	***	***
NRC	90	63	-1.00	-1.08	-2.27	-1.32	-1.11	-0.89
NRLM	35	224	10.18	9.86	9.73	9.82	10.01	10.54
NRLM	35	459	1.89	1.66	2.40	2.44	2.62	2.28
NRLM	35	523	1.76	1.57	2.07	2.18	2.26	2.02
OMH	12	1067	3.77	4.96	3.43	3.65	2.23	3.61
ONRJ	35	903	3.28	3.35	2.44	2.85	3.46	3.85
ORB	35	201	0.84	-2.58	-1.53	-1.82	1.81	1.36
ORB	35	202	7.10	5.31	6.48	2.76	6.03	6.58
ORB	35	593	28.80	29.84	28.71	28.83	30.45	30.60
ORB	40	2601	-189.18	-190.25	-191.55	-195.25	-197.83	-198.14
PSB	35	267	18.44	17.78	16.79	***	17.74	18.47
PSB	35	277	5.73	4.19	5.39	***	7.58	7.25

TABLE 13A. (CONT.)

LAB.	CLOCK		50844	50869	50899	50929	50964	50994
PTB	35	128	14.48	14.78	14.88	14.95	14.57	14.04
PTB	35	271	8.15	6.95	8.67	8.92	7.96	7.91
PTB	35	415	-0.60	-0.44	-0.05	1.10	0.54	0.83
PTB	35	1072	4.16	3.33	4.06	4.54	4.12	4.25
PTB	40	502	-32.46	-32.38	-32.15	-31.77	***	***
PTB	40	505	-5.98	-5.48	-4.96	-4.62	-4.09	-3.02
PTB	40	537	13.98	15.39	16.04	16.03	17.29	18.14
PTB	92	1	1.80	1.65	2.38	2.27	1.88	2.07
PTB	92	2	0.93	0.97	1.29	1.58	1.11	1.76
PTB	92	3	0.22	0.93	-1.23	1.18	1.54	0.87
ROA	12	1223	-114.65	-103.72	-120.75	-116.31	-94.47	-97.48
ROA	14	896	19.21	13.43	26.65	28.16	28.18	30.50
ROA	14	1569	8.02	9.21	5.01	6.05	7.85	5.95
ROA	16	113	13.58	6.78	***	***	***	***
ROA	31	422	0.72	3.86	6.45	6.18	1.54	6.23
ROA	35	583	-1.69	-1.27	-1.96	-1.87	-3.03	-0.25
ROA	35	718	6.94	7.11	7.19	6.75	6.90	6.38
SCL	14	2127	66.00	72.12	95.29	84.20	87.64	***
SCL	31	838	-146.37	-153.01	-152.17	-150.15	-148.35	***
SCL	35	764	-1.81	-2.91	-2.62	-3.04	-2.65	***
SMU	36	1063	***	***	***	***	***	***
SO	40	5101	-69.77	-69.99	-72.33	-72.32	-73.10	-73.98
SO	40	5102	***	***	***	***	***	***
SP	16	137	***	***	89.56	90.06	80.54	80.65
SP	35	641	***	***	-17.48	-17.77	-17.33	-16.78
SP	35	1188	***	***	18.26	17.34	17.82	17.85
SU	40	3802	8.74	9.19	9.09	9.30	9.75	9.44
SU	40	3806	3.00	3.18	3.40	3.78	4.13	4.68
SU	40	3807	***	-6.34	***	***	***	***
SU	40	3808	-40.88	-41.45	***	***	***	***
SU	40	3809	***	***	***	***	***	***
SU	40	3811	-17.13	-16.70	-16.65	-16.29	-16.17	-16.61
SU	40	3812	-23.80	-24.57	-24.81	-25.81	-26.25	-27.10
TL	34	438	187.69	230.25	252.53	215.87	222.47	269.10
TL	35	300	13.63	12.47	12.62	14.05	14.08	13.89
TL	35	474	-1.30	-1.39	-1.16	-0.13	-0.38	-0.83
TL	35	809	-7.95	-7.77	-7.11	-7.62	-7.38	-8.63
TL	35	1012	-18.97	-15.25	-14.02	-14.02	-16.63	-14.09
TP	35	1227	***	***	***	***	***	***
TP	36	154	13.30	14.67	11.89	12.45	11.85	11.52
TP	36	163	0.37	-0.30	-0.20	-1.33	-1.64	-1.43
TP	36	326	-7.35	-7.70	-7.64	-6.50	-6.59	-6.65
TUG	14	1654	30.84	31.24	27.23	30.85	27.07	28.77
TUG	35	107	10.00	8.85	10.58	10.21	9.66	9.30
TUG	35	247	3.85	3.72	3.23	3.05	2.38	1.44

TABLE 13A. (CONT.)

LAB.	CLOCK	51024	51054	51084	51114	51144	51174
PTB	35 128	***	***	10.80	10.50	11.21	15.08
PTB	35 271	7.96	9.10	8.66	8.90	8.12	8.43
PTB	35 415	1.25	0.94	0.67	2.03	0.33	0.65
PTB	35 1072	4.87	5.38	4.92	6.10	6.42	6.13
PTB	40 502	***	***	***	***	***	***
PTB	40 505	-2.35	-2.25	-1.84	-0.82	-0.36	-0.87
PTB	40 537	20.78	22.26	22.41	17.64	18.94	13.56
PTB	92 1	1.74	2.06	2.09	1.60	2.29	1.77
PTB	92 2	1.29	1.05	1.25	1.97	1.54	1.39
PTB	92 3	1.19	0.08	-0.50	-0.62	-1.89	0.10
ROA	12 1223	-103.82	-91.01	-45.80	-69.46	***	***
ROA	14 896	31.51	32.15	37.50	38.97	39.27	38.14
ROA	14 1569	6.60	12.88	17.02	13.57	13.06	-0.10
ROA	16 113	***	***	***	***	***	***
ROA	31 422	8.60	6.05	7.50	4.35	4.94	6.65
ROA	35 583	1.01	1.63	1.30	1.20	0.04	0.73
ROA	35 718	6.61	7.06	6.37	6.93	6.74	7.86
SCL	14 2127	***	***	***	86.52	69.27	90.64
SCL	31 838	***	***	***	***	***	***
SCL	35 764	***	***	***	-5.00	-6.08	-5.68
SMU	36 1063	***	***	-3.98	-3.02	-0.97	-2.72
SO	40 5101	-77.07	-77.74	-76.62	***	***	***
SO	40 5102	***	***	***	***	-13.36	-11.95
SP	16 137	72.98	72.74	72.80	85.88	92.74	94.62
SP	35 641	-16.77	-15.67	-16.42	-15.40	-15.62	-15.46
SP	35 1188	17.91	***	***	***	***	***
SU	40 3802	8.92	9.28	9.19	9.15	9.32	***
SU	40 3806	4.15	5.37	4.43	4.55	5.32	***
SU	40 3807	***	***	***	***	***	***
SU	40 3808	***	***	***	***	-16.32	***
SU	40 3809	***	***	***	***	0.21	***
SU	40 3811	-16.43	-15.98	-16.28	***	***	***
SU	40 3812	-27.34	-27.02	-27.54	-27.62	-28.14	***
TL	34 438	267.03	267.37	272.28	268.28	257.46	268.76
TL	35 300	14.08	14.65	12.02	13.89	14.72	15.15
TL	35 474	0.18	-1.04	-2.70	-0.91	-0.03	0.34
TL	35 809	-8.03	-8.23	-9.46	-8.30	-7.73	-7.73
TL	35 1012	-15.66	-16.06	-15.55	-15.05	-13.82	-14.54
TP	35 1227	***	-3.47	-1.94	-3.37	-2.32	-2.15
TP	36 154	11.92	10.74	12.88	13.06	13.55	13.33
TP	36 163	0.56	-1.01	-5.86	-1.87	-2.60	-4.63
TP	36 326	-6.55	-4.75	-5.34	***	-6.39	-5.14
TUG	14 1654	29.64	27.90	24.20	24.67	27.90	27.35
TUG	35 107	10.95	9.18	9.59	9.54	***	***
TUG	35 247	1.28	1.73	1.06	0.78	-0.12	-1.20

TABLE 13A. (CONT.)

LAB.	CLOCK	50844	50869	50899	50929	50964	50994
UME	35 251	17.23	17.39	17.35	17.25	17.40	16.43
UME	35 252	1.68	2.31	2.20	1.33	1.35	1.46
USNO	35 101	17.29	17.85	17.69	16.85	16.35	15.88
USNO	35 104	13.80	14.90	14.60	14.11	14.60	14.39
USNO	35 106	-14.57	-14.66	-14.62	-14.96	-15.18	-14.60
USNO	35 108	17.77	17.72	17.93	17.80	18.06	***
USNO	35 114	18.69	17.20	16.93	16.59	15.16	14.82
USNO	35 120	4.69	5.56	4.27	4.04	3.83	3.53
USNO	35 142	7.14	6.76	7.42	7.98	7.83	8.34
USNO	35 146	4.49	3.29	4.75	4.34	4.95	***
USNO	35 148	-28.38	-28.33	-27.37	-27.75	***	***
USNO	35 150	22.02	22.28	24.00	22.70	22.00	22.55
USNO	35 152	-1.15	-0.43	-0.68	0.19	-0.55	-0.23
USNO	35 153	***	***	13.10	13.39	13.18	13.26
USNO	35 156	41.12	40.78	41.29	38.48	38.50	***
USNO	35 161	4.33	3.66	3.85	4.83	4.06	4.08
USNO	35 164	4.61	4.38	4.23	4.10	3.68	4.54
USNO	35 165	18.35	***	***	7.58	7.68	7.05
USNO	35 166	7.69	9.00	8.95	9.74	10.44	9.78
USNO	35 167	9.32	9.82	7.76	7.26	6.93	7.22
USNO	35 169	***	***	13.05	13.16	13.72	14.82
USNO	35 171	23.30	22.32	23.48	22.21	21.74	***
USNO	35 213	-6.16	-5.75	-6.35	-5.14	-5.71	-5.08
USNO	35 217	-6.85	-6.65	-7.41	-7.27	-7.68	-7.46
USNO	35 225	10.05	9.95	10.16	10.06	10.42	11.09
USNO	35 226	3.61	2.90	3.53	1.73	4.10	3.28
USNO	35 227	12.96	14.08	13.00	13.25	13.84	13.95
USNO	35 229	22.68	22.82	23.48	23.49	23.76	25.27
USNO	35 233	5.36	5.21	5.23	5.62	5.59	5.45
USNO	35 242	15.80	17.23	16.43	17.20	16.74	17.30
USNO	35 244	14.82	15.65	14.78	15.48	15.59	14.95
USNO	35 249	-2.07	-2.00	-1.98	-2.42	-1.84	-1.35
USNO	35 253	-7.48	-7.41	-8.06	-7.10	-7.22	-7.21
USNO	35 254	-1.04	0.85	-0.25	-0.49	-0.09	-0.45
USNO	35 255	-13.01	-12.63	-14.54	-13.68	-12.68	-11.49
USNO	35 256	***	***	***	-12.89	-13.47	-14.38
USNO	35 260	6.56	7.86	7.12	7.88	7.69	7.89
USNO	35 270	5.95	6.53	7.06	6.33	***	***
USNO	35 279	-10.86	-11.06	-9.69	-9.91	-9.28	-9.70
USNO	35 392	2.85	2.98	4.02	4.11	4.34	5.11
USNO	35 394	12.71	13.02	13.23	13.22	14.39	15.06
USNO	35 417	12.02	14.31	13.75	13.70	13.74	13.81
USNO	35 496	-16.27	-15.60	-16.19	-14.94	***	***
USNO	35 1096	10.98	10.05	10.40	11.14	10.90	***
USNO	35 1097	7.69	8.03	7.84	9.00	8.74	8.15

TABLE 13A. (CONT.)

LAB.	CLOCK	51024	51054	51084	51114	51144	51174
UME	35 251	14.91	19.15	16.50	17.10	17.92	17.53
UME	35 252	2.23	1.65	1.58	1.29	1.77	1.23
USNO	35 101	16.06	16.40	16.38	15.18	15.77	15.38
USNO	35 104	14.73	13.67	14.00	13.60	13.00	13.75
USNO	35 106	-14.77	-14.50	-14.07	-14.82	-14.41	-14.14
USNO	35 108	***	***	3.36	3.75	4.37	4.09
USNO	35 114	13.43	12.33	11.35	10.59	8.92	9.29
USNO	35 120	4.31	4.79	4.17	3.86	3.23	4.15
USNO	35 142	8.89	9.12	7.78	10.40	9.82	10.19
USNO	35 146	***	***	4.35	4.80	4.50	4.78
USNO	35 148	***	-5.05	-5.45	-4.25	-4.48	-3.99
USNO	35 150	22.23	22.27	22.68	22.05	22.30	21.52
USNO	35 152	-1.24	-1.70	-1.42	-1.23	-1.47	***
USNO	35 153	13.21	13.40	12.73	13.28	13.22	13.38
USNO	35 156	***	***	13.26	14.03	12.75	13.32
USNO	35 161	4.06	***	***	***	-13.43	-14.06
USNO	35 164	4.16	4.27	4.34	3.72	3.67	3.98
USNO	35 165	6.88	7.18	7.17	6.60	7.38	6.89
USNO	35 166	9.69	11.07	9.73	10.43	10.04	9.77
USNO	35 167	7.24	7.30	6.60	6.80	6.52	6.30
USNO	35 169	14.13	13.70	14.14	14.62	13.97	14.55
USNO	35 171	***	21.56	21.54	21.45	21.28	21.52
USNO	35 213	-6.01	-5.74	-5.79	-5.14	***	***
USNO	35 217	-7.52	-7.99	***	***	-8.74	-8.36
USNO	35 225	10.68	10.20	10.80	10.70	10.33	9.99
USNO	35 226	3.73	3.27	4.08	3.52	2.80	2.76
USNO	35 227	14.22	13.46	13.98	14.46	14.59	14.10
USNO	35 229	24.38	24.82	24.86	24.64	25.37	25.03
USNO	35 233	4.94	5.06	5.65	5.00	4.55	5.08
USNO	35 242	16.41	17.32	17.49	17.56	17.22	16.20
USNO	35 244	15.98	15.69	15.32	15.57	15.34	15.28
USNO	35 249	-1.74	-1.93	-2.16	-2.11	-2.66	-1.96
USNO	35 253	-7.56	-6.80	-6.72	-6.47	-7.35	-6.99
USNO	35 254	-0.68	-0.71	-0.36	-0.46	-0.86	-0.67
USNO	35 255	-11.68	***	***	-11.07	-11.68	-11.16
USNO	35 256	-13.06	-13.12	-13.13	-12.88	-13.35	-13.69
USNO	35 260	7.84	8.30	8.45	7.80	8.09	8.10
USNO	35 270	***	9.44	10.25	10.05	10.20	9.89
USNO	35 279	-9.57	-9.46	-8.94	-9.47	-8.93	-8.69
USNO	35 392	6.04	5.92	7.05	7.59	8.48	9.73
USNO	35 394	14.51	14.84	15.10	15.33	14.09	14.75
USNO	35 417	14.11	13.93	13.74	13.89	13.70	***
USNO	35 496	***	***	***	***	***	***
USNO	35 1096	***	***	***	***	***	***
USNO	35 1097	8.66	9.15	7.58	8.89	7.75	8.10

TABLE 13A. (CONT.)

LAB.	CLOCK	50844	50869	50899	50929	50964	50994
USNO	35 1125	23.99	24.60	24.28	24.61	24.84	24.50
USNO	40 701	-27.60	-27.59	-27.52	-27.40	-27.54	***
USNO	40 702	-6.02	-5.80	-5.88	-5.80	-6.04	-5.99
USNO	40 703	-2.11	-2.04	-2.15	-2.05	-2.23	-1.89
USNO	40 704	***	-51.11	-51.20	-53.74	-53.75	***
USNO	40 705	-30.24	-29.95	-30.04	-30.32	-30.41	***
USNO	40 708	0.40	0.70	0.77	1.08	1.05	1.14
USNO	40 709	-47.34	-46.58	-46.12	-45.66	***	***
USNO	40 710	2.56	7.74	13.46	14.23	14.72	15.56
USNO	40 711	42.32	43.90	45.08	46.52	47.80	49.43
USNO	40 712	-8.04	-7.81	-7.90	-7.84	-8.09	-8.03
USNO	40 715	-19.16	-19.28	-19.47	-19.60	-19.90	-19.93
USNO	40 718	***	***	***	152.70	150.85	147.27
USNO	40 722	***	***	***	-64.37	***	***
USNO	40 723	***	***	***	-104.20	-103.96	-104.05
VSL	35 179	16.14	15.09	16.49	17.55	17.38	16.59
VSL	35 456	26.29	25.92	26.18	26.55	27.08	26.40
VSL	35 548	3.49	1.94	3.09	3.29	3.85	3.10
VSL	35 731	13.45	13.19	14.21	15.10	14.81	14.12

TABLE 13A. (CONT.)

LAB.	CLOCK	51024	51054	51084	51114	51144	51174
USNO	35 1125	24.61	25.11	24.66	24.55	24.53	24.43
USNO	40 701	***	-27.18	-27.17	-27.05	-27.34	-27.29
USNO	40 702	-6.28	-6.31	-6.38	-6.31	-5.63	***
USNO	40 703	-2.09	-1.97	-2.05	-1.90	-2.46	-2.32
USNO	40 704	***	***	-54.19	-53.90	-54.06	-53.83
USNO	40 705	***	-30.55	-31.04	-30.70	-30.98	-31.03
USNO	40 708	1.08	1.21	1.66	1.95	1.78	1.95
USNO	40 709	-44.42	-44.99	-44.76	-44.24	-44.06	-43.50
USNO	40 710	16.08	16.51	16.62	16.81	17.09	17.55
USNO	40 711	50.68	52.09	53.36	54.83	55.96	57.43
USNO	40 712	-8.25	-8.25	-8.36	-8.31	-8.61	-8.52
USNO	40 715	-20.12	-20.15	-20.32	-20.27	-20.54	-20.41
USNO	40 718	147.36	143.92	145.36	144.78	143.50	142.54
USNO	40 722	-75.59	-78.63	-81.82	-84.70	-84.47	-90.75
USNO	40 723	-104.24	-104.71	-106.12	-106.74	-108.85	-109.59
VSL	35 179	17.41	17.00	17.13	16.55	16.82	17.28
VSL	35 456	26.58	27.41	26.78	27.15	25.82	26.28
VSL	35 548	3.66	3.51	3.28	2.17	4.09	3.23
VSL	35 731	14.66	14.17	15.05	14.54	14.35	14.91

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

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
4x HYDROGEN MASERS
9x PRIMARY CLOCKS AND PROTOTYPES
21 OSCILLOQUARTZ 3210
23 OSCILLOQUARTZ EUDICS 3020
30 HEWLETT-PACKARD 5061B
31 HEWLETT-PACKARD 5061B OPT. 4
34 H-P 5061A/B with 5071A tube
35 HEWLETT-PACKARD 5071A High perf.
36 HEWLETT-PACKARD 5071A Low perf.
50 FREQ. AND TIME SYSTEMS INC. 4065A

TABLE 13B. CORRECTIONS FOR AN HOMOGENEOUS USE OF THE CLOCK RATES PUBLISHED IN THE CURRENT AND PREVIOUS ANNUAL REPORTS.

Each line refers to the same clock working without interruption.

	1998	1997		1996		1995	
	clock nø	clock nø	corr. (ns/d)	clock nø	corr. (ns/d)	clock nø	corr. (ns/d)
CH	17 206	17 206		17 206		17 206(1)	
CSAO	12 1648	12 1648		12 1648		12 1648(2)	
	35 1007	35 1007	+24.50				
	35 1011	35 1011	-2.84				
	35 1017	35 1017	-8.67				
DTAG	36 345	36 345	-2.76	36 345	-2.76		
GUM	35 441	35 441		35 441	+5.53	35 441	+5.53
IEN	35 505	35 505	+2.73	35 505	+2.73	35 505	-1.10
NIST	14 1316	14 1316		14 136		14 1316(3)	
NPL	14 1334	14 1334		14 1334	+47.00	14 1334(4)	+76.00
	14 1813	14 1813		14 1813		14 1813(5)	+19.20
	36 404	36 404	-1.60	36 404	-1.60	35 404(6)	-15.30
	35 123	35 123		35 123		35 123(7)	-3.30
	40 1701	40 1701	-2.80	40 1701	-4.00	40 1701(8)	-0.35
	40 1708	40 1708	-0.50	40 1708	+1.90		
NRC	40 304	40 304		40 304	-17.28	40 304	-17.28
NRLM	35 523	35 523		35 523		35 523	+2.76
PTB	40 0505	40 0505	-12.96				
ROA	12 1223	12 1223		35 1223		12 1223(9)	
	14 896	14 896		14 896		14 896(10)	
	14 1569	14 1569		14 1569		14 1569(11)	
	16 113	16 113		16 113	-79.00	16 113(12)	-79.00
	35 583	35 583	-1.10	35 583	+1.60	35 583	+1.60
SU	40 3802	40 3802		40 3802(13)	+9.00		
	40 3806	40 3806	+1.00	40 3806(14)	+1.00		
TUG	35 247	35 247	+12.58				

Notes

(1) A correction of +78.00 ns/d has to be applied in 1994, 1993 and in 1992.

(2) A correction of +98.60 ns/d has to be applied in 1986 and 1985.

(3) A correction of +10.70 ns/d has to be applied in 1990. A correction of +27.63 ns/d has to be applied in 1989, 1988, 1987, 1986, 1985 and for the last three two-month intervals of 1984.

Notes (Cont.)

(4) A correction of +76.00 ns/d has to be applied in 1994, 1993, 1992, 1991, 1990, 1989, 1988 and 1987.

(5) A correction of + 19.20 ns/d has to be applied in 1994. A correction of -20.80 ns/d has to be applied in 1993, 1992, 1991, 1990 and for the last four two-month intervals of 1989.

(6) A correction of -15.30 ns/d has to be applied in 1994.

(7) A correction of -3.30 ns/d has to be applied in 1994 and 1993.

(8) A correction of -0.35 ns/d has to be applied in 1994, 1993 and 1992, and a correction of +26.65 ns/d has to be applied in 1991.

(9) A correction of + 124.00 ns/d has to be applied in 1994.

(10) A correction of - 31.00 ns/d has to be applied in 1994.

(11) A correction of - 6.00 ns/d has to be applied in 1994.

(12) A correction of -79.00 ns/d has to be applied in 1994, 1993, 1992, 1991 and 1990.

(13) A correction of +9.00 ns/d has to be applied for the last three two-month intervals of 1996.

(14) A correction of +1.00 ns/d has to be applied for the last three two-month intervals of 1996.

TABLE 14A. RELATIVE WEIGHTS (IN PERCENT) OF CONTRIBUTING CLOCKS IN 1998

(File available on http://www.bipm.fr under the name WTAI98.AR)

Clock weights are computed for one-month intervals ending at the dates given in the table. Since 1998 January 1, the maximum relative weight of a given clock cannot exceed 0.7 % .

***** denotes that the clock was not used

LAB.	CLOCK		50844	50869	50899	50929	50964	50994
AMC	35	173	0.000	0.000	0.000	0.700	0.700	0.700
AMC	35	231	0.363	0.290	0.381	0.279	0.330	0.609
AMC	35	266	0.700	0.700	0.700	0.700	0.700	0.700
AMC	35	268	0.700	0.700	0.700	0.700	0.700	0.700
AMC	35	389	0.000	0.000	0.000	0.700	0.700	0.700
AMC	35	416	0.700	0.700	0.700	0.700	0.700	0.700
AMC	35	703	0.700	0.700	0.700	0.700	0.700	0.700
AMC	35	717	0.700	0.700	0.700	0.700	0.700	0.700
AMC	35	762	0.700	0.561	0.700	0.627	0.655	0.700
AMC	35	763	0.629	0.428	0.569	0.343	0.328	0.464
AMC	35	765	0.700	0.700	0.700	0.700	0.700	0.700
AMC	40	713	0.700	0.700	0.700	0.700	0.700	0.700
AMC	40	714	0.700	0.700	0.700	0.700	0.700	0.700
AOS	23	67	0.006	0.004	0.005	0.003	0.004	0.004
APL	14	793	*****	0.000	0.000	0.000	0.000	*****
APL	35	904	*****	0.000	0.000	0.000	0.000	*****
APL	40	3102	*****	0.000	0.000	0.000	0.000	*****
APL	40	3106	*****	0.000	0.000	0.000	0.000	*****
AUS	35	299	*****	*****	*****	*****	*****	*****
AUS	36	207	0.285	0.220	0.317	0.465	0.449	0.000
AUS	36	249	0.700	0.700	0.700	0.700	0.700	0.700
AUS	36	340	*****	*****	*****	****	*****	*****
AUS	36	379	0.163	0.074	0.071	0.048	*****	*****
AUS	36	424	0.700	0.700	0.700	0.589	0.700	0.000
AUS	36	1035	0.000	0.000	0.000	0.082	0.136	0.135
AUS	36	1141	*****	*****	*****	*****	*****	*****
AUS	40	5403	*****	*****	0.000	0.000	0.000	0.000
AUS	40	7501	*****	*****	*****	*****	*****	*****
AUS	40	7502	*****	*****	*****	*****	*****	*****
BEV	35	1065	*****	*****	*****	*****	*****	*****
CAO	35	939	0.700	0.700	0.700	0.700	0.700	0.700
CH	16	77	0.035	0.039	0.055	0.051	0.057	0.064
CH	17	206	0.131	0.108	0.113	0.078	0.083	0.197
CH	21	179	0.000	0.015	0.021	0.019	0.028	0.047
CH	21	194	0.000	0.045	0.037	0.012	0.013	0.019

TABLE 14A. (CONT.)

LAB.	CLOCK		51024	51054	51084	51114	51144	51174
AMC	35	173	0.700	0.700	0.700	0.700	0.700	0.700
AMC	35	231	0.611	0.685	0.700	0.700	0.700	0.700
AMC	35	266	0.700	0.700	0.700	0.700	0.700	0.700
AMC	35	268	0.700	0.700	0.700	0.700	0.700	0.700
AMC	35	389	0.700	0.700	0.700	0.700	0.700	0.700
AMC	35	416	0.700	0.700	0.700	0.700	0.700	0.700
AMC	35	703	0.700	0.700	0.700	0.700	0.700	0.700
AMC	35	717	0.700	0.700	0.700	0.700	0.700	0.700
AMC	35	762	0.700	0.700	0.700	0.700	0.700	0.700
AMC	35	763	0.334	0.290	*****	*****	*****	*****
AMC	35	765	0.700	0.700	0.700	0.700	0.700	0.700
AMC	40	713	0.700	0.700	0.700	0.700	0.700	0.700
AMC	40	714	0.700	0.700	0.700	0.700	0.700	0.700
AOS	23	67	0.002	0.002	0.002	0.002	0.001	0.002
APL	14	793	*****	*****	*****	*****	*****	*****
APL	35	904	*****	*****	0.000	0.000	0.000	*****
APL	40	3102	*****	*****	*****	*****	*****	*****
APL	40	3106	*****	*****	*****	*****	*****	*****
AUS	35	299	*****	*****	0.000	*****	0.000	*****
AUS	36	207	0.175	0.151	0.246	*****	*****	*****
AUS	36	249	0.000	*****	*****	*****	0.000	*****
AUS	36	340	*****	*****	0.484	0.664	0.655	*****
AUS	36	379	*****	*****	*****	*****	*****	*****
AUS	36	424	0.273	0.246	0.366	*****	*****	*****
AUS	36	1035	0.156	*****	0.000	*****	*****	*****
AUS	36	1141	*****	*****	0.000	0.000	0.000	*****
AUS	40	5403	0.007	*****	*****	*****	0.000	*****
AUS	40	7501	*****	*****	0.700	0.700	0.700	*****
AUS	40	7502	*****	*****	*****	*****	0.000	*****
BEV	35	1065	0.000	0.000	0.000	0.000	0.079	0.045
CAO	35	939	0.700	0.700	0.700	0.700	0.700	0.700
CH	16	77	0.045	0.043	0.051	0.046	0.037	0.024
CH	17	206	0.125	0.110	0.179	0.210	0.197	0.134
CH	21	179	0.051	0.053	0.082	0.152	0.158	0.103
CH	21	194	0.020	0.022	0.040	0.060	0.081	0.080

TABLE 14A. (CONT.)

LAB.	CLOCK		50844	50869	50899	50929	50964	50994
CH	21	217	0.025	0.018	0.020	0.012	0.015	0.031
CH	21	243	0.006	0.004	0.004	0.003	0.003	0.005
CH	21	265	0.012	0.012	0.013	0.006	0.007	0.010
CH	31	403	0.000	*****	*****	*****	*****	0.000
CH	35	413	0.700	0.700	0.700	0.700	0.700	0.000
CH	35	771	0.420	0.320	0.364	0.175	0.165	0.226
CH	36	354	0.700	0.700	0.700	0.536	0.570	0.667
CNM	35	237	0.250	0.227	0.276	0.510	*****	0.000
CNM	35	238	0.700	0.700	0.000	0.059	0.050	0.062
CNM	35	378	0.700	0.700	0.700	0.000	0.691	0.700
CNM	35	381	0.392	0.345	0.285	0.192	0.209	0.318
CNM	35	382	0.462	0.428	0.434	0.470	0.700	0.700
CRL	35	112	0.000	0.000	0.000	0.000	0.218	0.280
CRL	35	144	*****	*****	*****	0.000	0.000	0.000
CRL	35	332	0.700	0.700	0.700	0.700	0.700	0.700
CRL	35	342	0.700	0.700	0.700	0.700	0.700	0.700
CRL	35	343	0.700	0.700	0.700	0.700	0.700	0.700
CRL	35	715	0.403	0.308	0.337	0.258	0.234	0.262
CRL	35	732	0.513	0.337	0.263	0.180	0.202	0.305
CRL	35	907	0.700	0.700	0.700	0.700	0.700	0.700
CRL	35	908	0.700	0.551	0.677	0.370	0.411	0.624
CSAO	12	1648	0.196	*****	*****	*****	*****	*****
CSAO	30	152	0.077	*****	*****	*****	*****	*****
CSAO	35	1007	0.000	0.000	0.000	0.000	0.215	0.170
CSAO	35	1008	*****	0.000	0.000	0.000	0.000	0.207
CSAO	35	1011	0.000	0.000	0.000	0.009	0.015	0.031
CSAO	35	1016	*****	0.000	0.000	0.000	0.000	0.156
CSAO	35	1017	0.000	0.000	0.000	0.174	0.285	0.568
CSAO	35	1018	*****	0.000	0.000	0.000	0.000	0.303
DLR	40	7416	*****	0.000	0.000	*****	0.000	*****
DLR	40	7424	*****	0.000	0.000	*****	0.000	0.000
DTAG	36	136	0.000	0.256	0.175	0.000	0.000	*****
DTAG	36	345	0.614	0.492	0.628	0.623	0.700	0.700
DTAG	36	465	0.700	0.700	0.700	0.700	0.700	0.700
F	14	51	0.000	0.000	0.000	0.000	0.042	0.085
F	14	134	0.023	0.012	*****	*****	*****	*****
F	14	1120	0.000	0.035	0.032	0.021	0.022	0.035
F	14	1645	0.028	*****	*****	*****	*****	*****
F	16	106	0.159	0.125	0.176	0.126	0.161	0.281
F	35	122	0.700	0.700	0.700	0.700	0.700	0.700
F	35	124	0.700	0.700	0.700	0.700	0.700	0.700
F	35	131	0.000	0.700	0.700	0.700	0.700	0.700
F	35	158	0.700	0.700	0.700	0.700	0.700	0.700
F	35	172	0.700	0.700	0.700	0.700	0.700	0.700
F	35	198	0.700	0.700	0.700	0.700	0.669	0.700

TABLE 14A. (CONT.)

LAB.	CLOCK		51024	51054	51084	51114	51144	51174
CH	21	217	0.025	0.023	0.034	0.042	0.038	0.000
CH	21	243	0.004	0.004	0.006	0.008	0.007	0.000
CH	21	265	0.009	0.008	0.010	0.010	0.009	0.000
CH	31	403	0.000	0.000	0.000	0.700	0.700	0.700
CH	35	413	0.593	0.452	0.548	0.660	0.660	0.544
CH	35	771	0.185	0.168	0.247	0.312	0.285	0.315
CH	36	354	0.562	0.534	0.700	0.700	0.700	*****
CNM	35	237	0.000	*****	*****	*****	*****	*****
CNM	35	238	0.051	0.046	0.074	0.105	0.132	0.210
CNM	35	378	0.700	0.700	0.700	0.700	0.700	0.700
CNM	35	381	*****	*****	*****	*****	*****	*****
CNM	35	382	0.700	0.700	0.700	0.700	0.700	0.700
CRL	35	112	0.238	0.232	0.333	0.398	0.353	0.329
CRL	35	144	0.000	0.700	0.700	0.700	0.700	0.700
CRL	35	332	0.700	0.700	0.700	0.700	0.700	0.700
CRL	35	342	0.700	0.700	0.700	0.700	0.700	0.700
CRL	35	343	0.700	0.700	0.700	0.700	0.700	0.700
CRL	35	715	0.191	0.139	0.182	0.222	0.217	0.265
CRL	35	732	0.283	0.243	0.409	0.533	0.524	0.549
CRL	35	907	0.700	0.700	0.700	0.700	0.700	0.700
CRL	35	908	0.585	0.611	0.700	0.700	0.700	0.700
CSAO	12	1648	*****	*****	*****	*****	*****	*****
CSAO	30	152	*****	*****	*****	*****	*****	*****
CSAO	35	1007	0.130	0.115	*****	0.000	0.000	0.000
CSAO	35	1008	0.250	0.287	*****	0.000	0.000	0.000
CSAO	35	1011	0.034	0.039	*****	0.000	0.000	0.000
CSAO	35	1016	0.201	0.246	*****	0.000	0.000	0.000
CSAO	35	1017	0.578	0.513	*****	0.000	0.000	0.000
CSAO	35	1018	0.285	0.305	*****	0.000	0.000	0.000
DLR	40	7416	*****	0.000	*****	*****	*****	*****
DLR	40	7424	0.000	0.000	0.447	0.336	0.154	0.145
DTAG	36	136	*****	*****	*****	0.000	0.000	0.000
DTAG	36	345	0.700	0.700	0.700	0.700	0.700	0.700
DTAG	36	465	0.700	0.700	0.700	0.700	0.700	0.700
F	14	51	0.089	0.080	0.062	*****	*****	*****
F	14	134	*****	*****	*****	*****	*****	*****
F	14	1120	0.033	0.032	0.042	*****	*****	*****
F	14	1645	*****	*****	*****	*****	*****	*****
F	16	106	0.300	0.274	0.269	0.340	0.000	0.100
F	35	122	0.700	0.700	0.700	0.700	0.700	0.700
F	35	124	0.700	*****	*****	*****	*****	*****
F	35	131	0.665	0.529	0.700	0.700	0.660	0.663
F	35	158	0.700	0.700	0.700	0.700	0.700	0.700
F	35	172	0.700	0.700	0.700	0.700	0.700	0.700
F	35	198	0.561	0.473	0.700	0.700	0.700	0.700

TABLE 14A. (CONT.)

LAB.	CLOCK		50844	50869	50899	50929	50964	50994
F	35	355	*****	*****	*****	*****	*****	*****
F	35	385	0.000	0.700	0.700	0.700	0.700	0.700
F	35	396	0.700	0.700	0.700	0.700	0.700	0.700
F	35	536	0.700	0.700	0.700	0.700	0.700	0.700
F	35	609	0.592	0.000	0.276	0.182	0.186	0.298
F	35	770	0.700	0.700	0.700	0.700	0.700	0.700
F	35	781	0.000	0.252	0.204	0.134	0.142	0.200
F	35	819	0.700	0.700	0.700	0.700	0.700	0.700
F	35	859	0.432	0.595	0.700	0.581	0.520	0.640
F	40	816	0.114	0.184	0.423	*****	*****	*****
GUM	14	1144	0.032	0.021	0.020	0.000	0.006	0.009
GUM	31	652	0.090	0.000	0.062	0.041	0.000	0.007
GUM	35	441	0.700	0.700	0.700	0.700	0.700	0.700
GUM	35	502	0.700	0.700	0.624	0.235	0.238	0.377
IEN	14	1230	*****	0.000	0.000	0.000	0.000	*****
IEN	31	659	0.039	0.035	0.055	0.000	0.000	0.058
IEN	35	219	0.000	0.000	0.000	0.000	0.282	0.386
IEN	35	505	0.700	0.700	0.700	0.700	0.700	0.700
IEN	35	1115	*****	0.000	0.000	0.000	0.000	0.037
IFAG	14	1105	0.003	0.002	*****	*****	*****	*****
IFAG	16	131	0.209	0.000	0.063	0.000	0.018	*****
IFAG	16	173	0.001	0.001	0.001	0.001	0.001	*****
IFAG	16	274	0.004	0.003	0.005	0.004	0.005	*****
IFAG	36	1034	0.000	0.000	0.000	0.167	0.267	*****
IFAG	36	1176	*****	*****	*****	*****	*****	*****
IFAG	40	4401	0.000	0.000	*****	*****	0.000	*****
IFAG	40	4413	0.000	0.000	0.000	0.000	0.000	*****
IGMA	14	2403	0.000	0.000	0.005	0.003	0.003	0.005
IGMA	16	112	0.413	0.249	0.260	0.156	0.168	0.248
IGMA	35	631	*****	*****	*****	*****	*****	*****
IGMA	35	645	0.700	0.700	0.700	0.700	0.700	0.700
IGMA	35	647	0.700	0.700	0.700	0.700	0.700	0.700
INPL	35	1021	*****	*****	0.000	0.000	0.000	0.000
IPQ	35	125	0.700	0.700	0.700	0.700	0.700	0.700
IPQ	35	615	0.700	0.700	0.700	0.700	0.700	0.700
IPQ	35	1030	0.000	0.000	0.000	0.700	0.700	0.700
KRIS	36	321	0.700	0.700	0.700	0.700	0.700	0.700
KRIS	36	739	0.700	0.700	0.700	0.561	0.564	0.700
KRIS	36	1135	0.000	0.000	0.000	0.000	0.055	0.057
KRIS	40	5623	0.123	0.143	0.244	0.304	0.000	0.000
LDS	35	289	0.700	0.700	0.700	0.700	0.700	0.700
MSL	12	933	0.000	0.029	0.027	*****	*****	0.000
MSL	35	1025	*****	*****	*****	*****	*****	0.000
MSL	36	274	0.000	0.000	0.000	*****	*****	0.000
NAO	14	1315	0.000	0.004	0.006	0.005	0.008	0.014

TABLE 14A. (CONT.)

LAB.	CLOCK		51024	51054	51084	51114	51144	51174
F	35	355	*****	*****	0.000	0.000	0.000	0.000
F	35	385	0.700	0.700	0.700	0.700	0.700	0.686
F	35	396	0.700	0.700	0.700	0.700	0.700	0.700
F	35	536	0.700	0.700	0.700	0.700	0.700	0.700
F	35	609	0.296	0.318	0.633	0.700	0.700	0.700
F	35	770	0.700	0.700	0.700	0.700	0.700	0.700
F	35	781	0.186	0.179	0.327	0.524	0.700	0.700
F	35	819	0.700	0.700	0.700	0.700	0.700	0.700
F	35	859	0.612	0.616	0.700	*****	*****	*****
F	40	816	0.000	0.000	0.000	0.000	0.700	0.700
GUM	14	1144	0.007	0.007	0.009	0.011	0.010	0.011
GUM	31	652	0.006	0.005	0.007	*****	0.000	0.000
GUM	35	441	0.700	0.700	0.700	0.700	0.700	0.700
GUM	35	502	0.320	0.291	0.398	0.440	0.381	0.435
IEN	14	1230	*****	*****	*****	*****	*****	*****
IEN	31	659	0.047	0.041	0.062	0.062	0.000	*****
IEN	35	219	0.468	0.582	0.700	0.700	0.700	0.700
IEN	35	505	0.566	0.399	0.547	0.625	0.551	0.538
IEN	35	1115	0.026	0.026	0.051	0.079	0.090	0.110
IFAG	36	1173	*****	0.000	0.000	0.000	0.000	0.071
IFAG	16	131	*****	0.000	0.000	0.000	0.000	0.014
IFAG	16	173	*****	0.000	0.000	0.000	0.000	0.000
IFAG	16	274	*****	*****	*****	*****	*****	*****
IFAG	36	1034	*****	0.000	0.000	0.000	0.000	0.079
IFAG	36	1176	*****	0.000	0.000	0.000	0.000	0.700
IFAG	40	4401	*****	0.000	0.000	0.000	0.000	0.001
IFAG	40	4413	*****	0.000	*****	0.000	0.000	0.000
IGMA	14	2403	0.004	0.004	0.007	0.012	0.017	0.019
IGMA	16	112	0.153	0.152	0.210	0.241	0.236	0.246
IGMA	35	631	*****	0.000	0.000	0.000	0.000	0.502
IGMA	35	645	0.700	0.700	0.700	0.700	0.700	0.700
IGMA	35	647	*****	*****	*****	*****	*****	*****
INPL	35	1021	0.700	0.700	0.700	0.700	0.700	0.700
IPQ	35	125	0.700	0.700	*****	*****	*****	*****
IPQ	35	615	0.700	0.700	*****	*****	*****	*****
IPQ	35	1030	0.700	0.700	*****	*****	*****	*****
KRIS	36	321	0.700	0.700	0.700	0.700	0.700	0.700
KRIS	36	739	0.644	0.601	0.700	0.700	0.700	0.700
KRIS	36	1135	0.048	0.046	0.072	0.108	0.129	0.150
KRIS	40	5623	0.155	0.113	0.149	0.202	0.229	0.316
LDS	35	289	0.700	0.700	0.700	0.700	0.700	0.700
MSL	12	933	0.000	0.000	0.000	0.014	0.016	0.018
MSL	35	1025	0.000	0.000	0.000	0.307	0.442	0.596
MSL	36	274	0.000	0.000	0.000	0.096	0.120	0.171
NAO	14	1315	0.015	*****	*****	*****	*****	*****

TABLE 14A. (CONT.)

LAB.	CLOCK		50844	50869	50899	50929	50964	50994
NAO	34	2146	*****	*****	0.000	0.000	0.000	0.000
NAO	35	779	0.700	0.647	0.700	0.700	0.700	0.700
NAO	35	1214	*****	*****	*****	0.000	0.000	0.000
NIM	12	614	0.024	0.023	0.000	0.006	0.007	0.010
NIM	30	277	0.002	0.002	0.003	0.003	0.003	0.003
NIM	35	479	0.700	0.700	0.000	0.276	0.301	0.309
NIM	35	1239	*****	*****	*****	*****	*****	*****
NIST	14	1316	0.274	0.207	0.225	*****	*****	*****
NIST	35	132	0.700	0.700	0.700	0.700	0.700	0.700
NIST	35	182	0.700	0.700	0.700	0.700	0.700	0.700
NIST	35	408	0.700	0.700	0.700	0.700	0.700	0.700
NIST	35	1074	0.000	0.700	0.700	0.700	0.700	0.700
NIST	40	201	*****	0.000	0.000	0.000	0.000	0.700
NIST	40	203	0.000	0.000	0.000	0.000	*****	*****
NIST	40	204	0.700	0.700	0.700	0.700	0.700	0.700
NIST	40	222	0.700	0.700	0.700	0.700	0.700	0.700
NIST	50	2008	0.036	0.037	0.047	0.035	0.039	0.051
NML	36	340	0.700	0.512	0.353	0.289	0.281	0.355
NML	36	1141	*****	*****	*****	*****	*****	*****
NML	40	7501	*****	*****	0.000	0.000	0.000	0.000
NML	40	7502	0.000	0.000	0.000	0.000	*****	*****
NPL	14	1334	0.022	0.032	0.065	0.056	0.066	0.097
NPL	14	1813	0.032	0.024	0.026	0.016	0.017	0.025
NPL	35	123	0.700	0.700	0.700	0.700	0.700	0.700
NPL	35	784	0.700	0.700	0.700	0.700	0.700	0.700
NPL	35	1275	*****	*****	*****	*****	*****	*****
NPL	36	404	0.700	0.700	0.700	0.700	0.700	0.700
NPL	40	1701	0.700	0.700	0.700	0.700	0.700	0.700
NPL	40	1708	0.700	0.700	0.700	0.700	0.700	0.700
NRC	35	234	0.700	0.700	0.700	0.700	0.700	0.700
NRC	35	372	0.000	0.000	0.000	0.000	0.003	0.006
NRC	40	304	0.215	0.134	0.152	0.112	0.144	0.238
NRC	90	61	0.700	0.700	0.700	0.700	0.700	0.700
NRC	90	63	0.700	0.700	0.700	0.700	0.700	0.700
NRLM	35	224	0.700	0.700	0.700	0.700	0.700	0.700
NRLM	35	459	0.700	0.700	0.700	0.700	0.700	0.700
NRLM	35	523	0.700	0.700	0.700	0.700	0.700	0.700
OMH	12	1067	0.700	0.700	0.700	0.700	0.700	0.700
ONRJ	35	903	0.000	0.700	0.700	0.700	0.700	0.700
ORB	35	201	0.700	0.700	0.700	0.603	0.579	0.700
ORB	35	202	0.700	0.700	0.700	0.480	0.542	0.700
ORB	35	593	0.700	0.700	0.700	0.700	0.700	0.700
ORB	40	2601	0.027	0.021	0.022	0.011	0.009	0.012
PSB	35	267	0.000	0.000	*****	0.000	0.000	0.000
PSB	35	277	0.000	0.000	*****	0.000	0.000	0.000

TABLE 14A. (CONT.)

LAB.	CLOCK	51024	51054	51084	51114	51144	51174
NAO	34 2146	*****	*****	*****	*****	*****	*****
NAO	35 779	0.700	0.700	0.700	0.700	0.700	0.700
NAO	35 1214	0.000	0.700	0.700	0.700	0.700	0.700
NIM	12 614	0.010	0.010	0.017	0.022	0.020	0.017
NIM	30 277	0.002	0.001	0.002	*****	*****	*****
NIM	35 479	0.270	0.246	0.373	0.518	0.539	0.548
NIM	35 1239	*****	*****	*****	*****	*****	0.000
NIST	14 1316	*****	*****	*****	*****	*****	*****
NIST	35 132	0.700	0.700	0.700	0.700	0.700	0.700
NIST	35 182	0.700	0.700	0.700	0.700	0.700	0.700
NIST	35 408	0.700	0.700	0.700	0.700	0.700	0.700
NIST	35 1074	0.700	0.700	0.700	0.700	0.700	0.700
NIST	40 201	0.700	0.700	0.700	0.700	0.700	0.700
NIST	40 203	0.000	0.000	0.000	0.000	0.700	0.700
NIST	40 204	0.700	0.642	0.700	0.700	0.700	0.700
NIST	40 222	0.700	0.700	0.700	0.700	0.700	0.700
NIST	50 2008	0.036	*****	*****	0.000	0.000	0.000
NML	36 340	0.367	0.317	*****	*****	*****	*****
NML	36 1141	*****	0.000	*****	*****	*****	*****
NML	40 7501	0.700	0.700	*****	*****	*****	*****
NML	40 7502	0.000	0.000	*****	*****	*****	*****
NPL	14 1334	*****	*****	*****	*****	*****	*****
NPL	14 1813	*****	*****	*****	*****	*****	*****
NPL	35 123	0.700	0.700	0.700	0.700	0.700	0.700
NPL	35 784	0.700	0.700	0.700	0.700	0.700	0.700
NPL	35 1275	*****	*****	*****	*****	*****	0.000
NPL	36 404	0.605	0.577	0.700	0.700	0.700	0.700
NPL	40 1701	0.700	0.700	0.700	0.700	0.700	0.700
NPL	40 1708	*****	*****	*****	0.000	0.000	0.000
NRC	35 234	0.700	0.700	0.700	0.700	0.700	0.700
NRC	35 372	0.007	0.009	0.017	0.025	0.030	0.037
NRC	40 304	0.228	0.256	0.465	0.671	0.700	0.700
NRC	90 61	0.700	0.700	*****	*****	*****	*****
NRC	90 63	0.700	0.700	0.700	0.700	0.700	0.700
NRLM	35 224	0.580	0.442	0.598	0.700	0.700	0.700
NRLM	35 459	0.700	0.700	0.700	0.700	0.700	0.700
NRLM	35 523	0.700	0.700	0.700	0.700	0.700	0.700
OMH	12 1067	0.700	0.700	0.700	0.700	0.700	0.700
ONRJ	35 903	0.700	0.700	0.700	0.700	0.700	0.700
ORB	35 201	0.700	0.000	0.553	0.592	0.576	0.658
ORB	35 202	0.568	0.532	0.700	0.648	0.668	0.700
ORB	35 593	0.700	0.700	0.700	0.700	0.700	0.700
ORB	40 2601	0.010	0.008	0.012	0.014	0.014	0.020
PSB	35 267	0.000	0.700	0.700	*****	0.000	0.000
PSB	35 277	0.000	0.700	0.700	*****	0.000	0.000

TABLE 14A. (CONT.)

LAB.	CLOCK		50844	50869	50899	50929	50964	50994
PTB	35	128	0.700	0.700	0.700	0.700	0.700	0.700
PTB	35	271	0.700	0.700	0.700	0.700	0.700	0.700
PTB	35	415	0.700	0.700	0.700	0.700	0.700	0.700
PTB	35	1072	0.000	0.538	0.700	0.700	0.700	0.700
PTB	40	502	0.700	0.700	0.700	0.700	*****	*****
PTB	40	505	0.078	0.053	0.055	0.039	0.046	0.074
PTB	40	537	0.060	0.051	0.064	0.053	0.072	0.140
PTB	92	1	0.000	0.000	0.000	0.700	0.700	0.700
PTB	92	2	0.700	0.700	0.700	0.700	0.700	0.700
PTB	92	3	0.700	0.700	0.700	0.584	0.516	0.700
ROA	12	1223	0.002	0.002	0.002	0.001	0.001	0.001
ROA	14	896	0.056	0.038	0.041	0.027	0.030	0.044
ROA	14	1569	0.016	0.016	0.020	0.014	0.018	0.033
ROA	16	113	0.028	0.020	*****	*****	*****	*****
ROA	31	422	0.119	0.089	0.087	0.069	0.080	0.105
ROA	35	583	0.700	0.700	0.700	0.700	0.700	0.700
ROA	35	718	0.700	0.700	0.700	0.700	0.700	0.700
SCL	14	2127	0.000	0.000	0.000	0.000	0.002	*****
SCL	31	838	0.000	0.000	0.000	0.000	0.035	*****
SCL	35	764	0.000	0.000	0.000	0.000	0.700	*****
SMU	36	1063	*****	*****	*****	*****	*****	*****
SO	40	5101	0.174	0.133	0.152	0.123	0.169	0.332
SO	40	5102	*****	*****	*****	*****	*****	*****
SP	16	137	*****	*****	0.000	0.000	0.000	0.000
SP	35	641	*****	*****	0.000	0.000	0.000	0.000
SP	35	1188	*****	*****	0.000	0.000	0.000	0.000
SU	40	3802	0.700	0.700	0.700	0.700	0.700	0.700
SU	40	3806	0.700	0.700	0.700	0.700	0.700	0.700
SU	40	3807	*****	0.000	*****	*****	*****	*****
SU	40	3808	0.467	0.401	*****	*****	*****	*****
SU	40	3809	*****	*****	*****	*****	*****	*****
SU	40	3811	0.700	0.700	0.700	0.700	0.700	0.700
SU	40	3812	0.700	0.700	0.700	0.700	0.700	0.700
TL	34	438	0.001	0.000	0.000	0.000	0.000	0.000
TL	35	300	0.700	0.700	0.700	0.700	0.700	0.700
TL	35	474	0.700	0.700	0.700	0.700	0.700	0.700
TL	35	809	0.700	0.700	0.700	0.700	0.700	0.700
TL	35	1012	0.000	0.069	0.108	0.100	0.127	0.239
TP	35	1227	*****	*****	*****	*****	*****	*****
TP	36	154	0.700	0.700	0.700	0.610	0.506	0.624
TP	36	163	0.600	0.443	0.550	0.525	0.565	0.700
TP	36	326	0.700	0.700	0.700	0.700	0.700	0.700
TUG	14	1654	0.657	0.577	0.422	0.307	0.225	0.318
TUG	35	107	0.700	0.700	0.700	0.700	0.700	0.700
TUG	35	247	0.130	0.101	0.111	0.090	0.119	0.205

TABLE 14A. (CONT.)

LAB.	CLOCK		51024	51054	51084	51114	51144	51174
PTB	35	128	*****	*****	0.000	0.000	0.000	0.000
PTB	35	271	0.700	0.700	0.700	0.700	0.700	0.700
PTB	35	415	0.700	0.700	0.700	0.700	0.700	0.700
PTB	35	1072	0.700	0.700	0.700	0.700	0.700	0.700
PTB	40	502	*****	*****	*****	*****	*****	*****
PTB	40	505	0.070	0.075	0.138	0.227	0.291	0.415
PTB	40	537	0.107	0.076	0.097	0.135	0.155	0.172
PTB	92	1	0.700	0.700	0.700	0.700	0.700	0.700
PTB	92	2	0.700	0.700	0.700	0.700	0.700	0.700
PTB	92	3	0.700	0.700	0.700	0.700	0.700	0.700
ROA	12	1223	0.001	0.002	0.002	0.003	*****	*****
ROA	14	896	0.034	0.029	0.031	0.030	0.025	0.023
ROA	14	1569	0.027	0.028	0.044	0.077	0.092	0.067
ROA	16	113	*****	*****	*****	*****	*****	*****
ROA	31	422	0.067	0.075	0.115	0.149	0.171	0.283
ROA	35	583	0.700	0.490	0.583	0.628	0.618	0.624
ROA	35	718	0.700	0.700	0.700	0.700	0.700	0.700
SCL	14	2127	*****	*****	*****	0.000	0.000	0.000
SCL	31	838	*****	*****	*****	*****	*****	*****
SCL	35	764	*****	*****	*****	0.000	0.000	0.000
SMU	36	1063	*****	*****	0.000	0.000	0.000	0.000
SO	40	5101	0.194	0.125	0.164	*****	*****	*****
SO	40	5102	*****	*****	*****	*****	0.000	0.000
SP	16	137	0.007	0.007	0.012	0.018	0.017	0.017
SP	35	641	0.700	0.700	0.700	0.700	0.700	0.700
SP	35	1188	0.700	*****	*****	*****	*****	*****
SU	40	3802	0.700	0.700	0.700	0.700	0.700	*****
SU	40	3806	0.700	0.700	0.700	0.700	0.700	*****
SU	40	3807	*****	*****	*****	*****	*****	*****
SU	40	3808	*****	*****	*****	*****	0.000	*****
SU	40	3809	*****	*****	*****	*****	0.000	*****
SU	40	3811	0.700	0.700	0.700	*****	*****	*****
SU	40	3812	0.445	0.364	0.481	0.569	0.546	*****
TL	34	438	0.000	0.000	0.001	0.001	0.001	0.002
TL	35	300	0.700	0.700	0.700	0.700	0.700	0.700
TL	35	474	0.700	0.700	0.700	0.700	0.700	0.700
TL	35	809	0.700	0.700	0.700	0.700	0.700	0.700
TL	35	1012	0.252	0.277	0.494	0.684	0.676	0.700
TP	35	1227	*****	0.000	0.000	0.000	0.000	0.700
TP	36	154	0.546	0.468	0.700	0.700	0.700	0.700
TP	36	163	0.679	0.700	0.000	0.407	0.384	0.374
TP	36	326	0.700	0.700	0.700	*****	0.000	0.000
TUG	14	1654	0.286	0.285	0.000	0.257	0.262	0.269
TUG	35	107	0.700	0.700	0.700	0.700	*****	*****
TUG	35	247	0.205	0.240	0.420	0.571	0.580	0.560

TABLE 14A. (CONT.)

LAB.	CLOCK		50844	50869	50899	50929	50964	50994
UME	35	251	0.700	0.700	0.700	0.700	0.700	0.700
UME	35	252	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	101	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	104	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	106	0.000	0.000	0.000	0.000	0.700	0.700
USNO	35	108	0.700	0.700	0.700	0.700	0.700	*****
USNO	35	114	0.450	0.237	0.203	0.113	0.096	0.124
USNO	35	120	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	142	0.401	0.329	0.378	0.263	0.327	0.553
USNO	35	146	0.700	0.700	0.700	0.700	0.700	*****
USNO	35	148	0.504	0.370	0.474	0.375	*****	*****
USNO	35	150	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	152	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	153	*****	*****	0.000	0.000	0.000	0.000
USNO	35	156	0.000	0.000	0.000	0.141	0.165	*****
USNO	35	161	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	164	0.700	0.700	0.700	0.660	0.653	0.700
USNO	35	165	0.700	*****	*****	0.000	0.000	0.000
USNO	35	166	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	167	0.700	0.700	0.700	0.546	0.413	0.559
USNO	35	169	*****	*****	0.000	0.000	0.000	0.000
USNO	35	171	0.700	0.700	0.700	0.606	0.476	*****
USNO	35	213	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	217	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	225	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	226	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	227	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	229	0.163	0.121	0.137	0.108	0.147	0.250
USNO	35	233	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	242	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	244	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	249	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	253	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	254	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	255	0.000	0.000	0.000	0.356	0.537	0.631
USNO	35	256	*****	*****	*****	0.000	0.000	0.000
USNO	35	260	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	270	0.700	0.700	0.700	0.700	*****	*****
USNO	35	279	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	392	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	394	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	417	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	496	0.700	0.700	0.700	0.700	*****	*****
USNO	35	1096	0.000	0.062	0.089	0.081	0.115	*****
USNO	35	1097	0.000	0.700	0.700	0.700	0.700	0.700

TABLE 14A. (CONT.)

LAB.	CLOCK		51024	51054	51084	51114	51144	51174
UME	35	251	0.700	0.700	0.700	0.700	0.700	0.700
UME	35	252	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	101	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	104	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	106	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	108	*****	*****	0.000	0.000	0.000	0.000
USNO	35	114	0.093	0.081	0.113	0.131	0.117	0.130
USNO	35	120	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	142	0.548	0.678	0.700	0.700	0.700	0.700
USNO	35	146	*****	*****	0.000	0.000	0.000	0.000
USNO	35	148	*****	0.000	0.000	0.000	0.000	0.700
USNO	35	150	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	152	0.700	0.700	0.700	0.700	0.700	*****
USNO	35	153	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	156	*****	*****	0.000	0.000	0.000	0.000
USNO	35	161	0.700	*****	*****	*****	0.000	0.000
USNO	35	164	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	165	0.000	0.700	0.700	0.700	0.700	0.700
USNO	35	166	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	167	0.462	0.431	0.608	0.700	0.700	0.700
USNO	35	169	0.679	0.700	0.700	0.700	0.700	0.700
USNO	35	171	*****	0.000	0.000	0.000	0.000	0.700
USNO	35	213	0.700	0.700	0.700	0.700	*****	*****
USNO	35	217	0.700	0.700	*****	*****	0.000	0.000
USNO	35	225	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	226	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	227	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	229	0.275	0.300	0.534	0.700	0.700	0.700
USNO	35	233	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	242	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	244	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	249	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	253	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	254	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	255	0.584	*****	*****	0.000	0.000	0.000
USNO	35	256	0.000	0.700	0.700	0.700	0.700	0.700
USNO	35	260	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	270	*****	0.000	0.000	0.000	0.000	0.700
USNO	35	279	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	392	0.700	0.619	0.612	0.556	0.413	0.321
USNO	35	394	0.700	0.700	0.700	0.700	0.700	0.700
USNO	35	417	0.700	0.700	0.700	0.700	0.700	*****
USNO	35	496	*****	*****	*****	*****	*****	*****
USNO	35	1096	*****	*****	*****	*****	*****	*****
USNO	35	1097	0.700	0.700	0.700	0.700	0.700	0.700

TABLE 14A. (CONT.)

LAB.	CLOCK	50844	50869	50899	50929	50964	50994
USNO	35 1125	0.000	0.000	0.000	0.700	0.700	0.700
USNO	40 701	0.534	0.399	0.449	0.368	0.495	*****
USNO	40 702	0.700	0.700	0.700	0.700	0.700	0.700
USNO	40 703	0.700	0.700	0.700	0.700	0.700	0.700
USNO	40 704	*****	0.000	0.000	0.000	0.000	*****
USNO	40 705	0.700	0.700	0.700	0.700	0.700	*****
USNO	40 708	0.700	0.700	0.700	0.700	0.700	0.700
USNO	40 709	0.700	0.700	0.700	0.618	*****	*****
USNO	40 710	0.123	0.000	0.000	0.016	0.015	0.020
USNO	40 711	0.059	0.040	0.040	0.026	0.028	0.041
USNO	40 712	0.700	0.700	0.700	0.700	0.700	0.700
USNO	40 715	0.000	0.000	0.000	0.700	0.700	0.700
USNO	40 718	*****	*****	*****	0.000	0.000	0.000
USNO	40 722	*****	*****	*****	0.000	*****	*****
USNO	40 723	*****	*****	*****	0.000	0.000	0.000
VSL	35 179	0.700	0.700	0.700	0.700	0.700	0.700
VSL	35 456	0.700	0.700	0.700	0.700	0.700	0.700
VSL	35 548	0.700	0.700	0.700	0.700	0.700	0.700
VSL	35 731	0.700	0.700	0.700	0.700	0.700	0.700

TABLE 14A. (CONT.)

LAB.	CLOCK	51024	51054	51084	51114	51144	51174
USNO	35 1125	0.700	0.700	0.700	0.700	0.700	0.700
USNO	40 701	*****	0.000	0.000	0.000	0.000	0.700
USNO	40 702	0.700	0.700	0.700	0.700	0.700	*****
USNO	40 703	0.700	0.700	0.700	0.700	0.700	0.700
USNO	40 704	*****	*****	0.000	0.000	0.000	0.000
USNO	40 705	*****	0.000	0.000	0.000	0.000	0.700
USNO	40 708	0.700	0.700	0.700	0.700	0.700	0.700
USNO	40 709	0.000	0.000	0.000	0.000	0.700	0.700
USNO	40 710	0.017	0.016	0.026	0.037	0.047	0.075
USNO	40 711	0.035	0.032	0.047	0.058	0.058	0.061
USNO	40 712	0.700	0.700	0.700	0.700	0.700	0.700
USNO	40 715	0.700	0.700	0.700	0.700	0.700	0.700
USNO	40 718	0.000	0.027	0.053	0.080	0.085	0.093
USNO	40 722	0.000	0.000	0.000	0.000	0.038	0.026
USNO	40 723	0.000	0.700	0.700	0.675	0.307	0.235
VSL	35 179	0.700	0.700	0.700	0.700	0.700	0.700
VSL	35 456	0.700	0.700	0.700	0.700	0.700	0.700
VSL	35 548	0.700	0.700	0.700	0.700	0.700	0.700
VSL	35 731	0.700	0.700	0.700	0.700	0.700	0.700

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

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
4x HYDROGEN MASERS
9x PRIMARY CLOCKS AND PROTOTYPES
21 OSCILLOQUARTZ 3210
23 OSCILLOQUARTZ EUDICS 3020
30 HEWLETT-PACKARD 5061B
31 HEWLETT-PACKARD 5061B OPT. 4
34 H-P 5061A/B with 5071A tube
35 HEWLETT-PACKARD 5071A High perf.
36 HEWLETT-PACKARD 5071A Low perf.
50 FREQ. AND TIME SYSTEMS INC. 4065A

TABLE 14B. STATISTICAL DATA ON THE WEIGHTS ATTRIBUTED TO THE CLOCKS IN 1998

Interval	Number of clocks			Number of clock with a given weight								
				0* weight			0** weight			maximum weight		
1998	HM	5071A	total	HM	5071A	total	HM	5071A	total	HM	5071A	total
Jan.	33	133	233	2	24	36	2	1	9	17	93	125
Feb	40	137	242	10	21	41	3	1	8	17	94	125
Mar.	39	140	243	11	21	43	2	5	10	17	95	126
Apr.	39	146	246	11	21	40	1	2	8	17	91	118
May	37	142	239	11	15	31	2	0	6	16	91	119
June	29	137	220	5	13	23	1	1	5	16	93	123
July	33	135	219	8	9	20	0	0	2	15	90	115
Aug.	37	135	225	11	7	27	0	1	2	15	91	117
Sep.	35	131	220	8	14	33	0	0	2	16	95	124
Oct.	35	135	219	10	20	40	0	0	0	14	95	122
Nov.	40	137	229	11	24	48	0	0	2	18	94	124
Dec.	31	136	213	4	19	29	0	0	4	16	96	125

* A priori null weight (test interval of new clocks).
** Null weight resulting from the statistics.
HM designates hydrogen masers and 5071A designates Hewlett-Packard 5071A units with high performance tube.
Clocks with missing data during a one-month interval of computation are excluded.

TIME SIGNALS

The time signal emissions reported here follow the UTC system, in accordance with the Recommendation 460-4 of the Radiocommunication Bureau (RB) of the International Telecommunication Union (ITU) unless otherwise stated.

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

The following tables are based on information received at the BIPM in January and February 1999.

AUTHORITIES RESPONSIBLE FOR THE TIME SIGNAL EMISSIONS

Signal	Authority
ATA	National Physical Laboratory Dr. K.S. Krishnan Road New Delhi - 110012, India
BPM	Shaanxi Astronomical Observatory Chinese Academy of Sciences P.O. Box 18 - Lintong Shaanxi, China
BSF	National Standard Time and Frequency Laboratory Telecommunication Laboratories Chunghwa Telecom. Co., Ltd. No. 12, Ln.551, Ming-Tsu Road Sec. 5 Yang-Mei, Taoyuan, 326 Taiwan, Rep. of China
CHU	National Research Council of Canada Institute for National Measurement Standards - Time Standards Ottawa, Ontario, K1A OR6, Canada
DCF77	Physikalisch-Technische Bundesanstalt Lab. Zeit-und Frequenzuebertragung Bundesallee 100 D-38116 Braunschweig Germany
EBC	Real Instituto y Observatorio de la Armada 11100 San Fernando Cadiz, Spain
HBG	Service horaire HBG Observatoire Cantonal CH - 2000 Neuchâtel, Suisse
HLA	Time and Frequency Laboratory Korea Research Institute of Standards and Science Yusong P.O. Box 102, Taejon 305-600 Republic of Korea

Signal	Authority
IAM	Istituto Superiore delle Comunicazioni e delle Tecnologie dell'Informazione Viale America, 201 00144 - Roma, Italia
JG2AS, JJY	Standards and Measurements Division Communications Research Laboratory 2-1, Nukui-kitamachi 4-chome Koganei-shi, Tokyo 184-8795 Japan
LOL	Servicio de Hidrografia Naval Observatorio Naval Av. España 2099 1107 - Buenos-Aires, Argentina
MSF	National Physical Laboratory Centre for Time Metrology Teddington, Middlesex TW11 OLW United Kingdom
PPR	Departamento Serviço da hora Observatorio Nacional (CNPq) Rua General Bruce, 586, Sao Cristovao 20921-030 - Rio de Janeiro, Brasil
RAB-99, RBU, RJH-63, RJH-69, RJH-77, RJH-86, RJH-90,RTZ, RWM, ULA-4	Institute of Metrology for Time and Space (IMVP), GP "VNIIFTRI" Mendeleevo, Moscow Region 141570 Russia
TDF	France Telecom Centre National d'Etudes des Télécommunications DTD/EDT Synchronisation Temps Fréquence 2, avenue Pierre Marzin 22307 - Lannion Cedex, France

Signal	Authority
VNG	National Standards Commission P.O. Box 282 North Ryde NSW 2113 Australia
WWV, WWVB, WWVH	Time and Frequency Division, 847.00 National Institute of Standards and Technology - 325 Broadway Boulder, Colorado 80303, U.S.A.
YVTO	Direccion de Hidrografia y Navegacion Observatorio Cagigal Apartado Postal No 6745 Caracas, Venezuela

TIME SIGNALS EMITTED IN THE UTC SYSTEM

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
ATA	Greater Kailash New Delhi India 28° 34'N 77° 19'E	10 000	continuous	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	Signals emitted in advance on UTC by 20 ms. Second pulses of 10 ms duration with 1 kHz modulation. Minute pulses of 300 ms duration with 1 kHz modulation. UTC time signals are emitted from minute 0 to 10, 15 to 25, 30 to 40, 45 to 55. UT1 time signals are emitted from minute 25 to 29, 55 to 59.
BSF	Chung-Li Taiwan Rep. of China 24° 57'N 121° 09'E	5 000 15 000	continuous except interruption between minutes 35 and 40	From minute 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. From minute 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. Minute pulses are extended to 300 ms duration. DUT1: ITU-R code by pulse lengthening.
CHU	Ottawa Canada 45° 18'N 75° 45'W	3 330 7 335 14 670	continuous	Second pulses of 300 cycles of a 1 kHz modulation, 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) is made each minute following the 50th second pulse. FSK code (300 bps, Bell 103) after 10 cycles of 1 kHz on seconds 31 to 39. Year, DUT1, leap second information, TAI-UTC and Canadian summer time format on 31, and time code on 32-39. Broadcast is single sideband; upper sideband with carrier reinsert. DUT1 : ITU-R code by double pulse.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
DCF77	Mainflingen Germany 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 Germany and second markers 17 and 18 indicate if the transmitted time refers to UTC(PTB) + 2 h (summer time) or UTC(PTB) + 1 h (winter time). 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.
EBC	San Fernando Spain 36° 28'N 6° 12'W	15006 4998	10 h 00 m to 10 h 25 m 10 h 30 m to 10 h 55 m except Saturday, Sunday and national holidays.	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: ITU-R code by double pulse.
HBG	Prangins Switzerland 46° 24'N 6° 15'E	75	continuous	Interruption of the carrier at the beginning of each second during 100 ms or 200 ms. The minutes are identified by a double pulse (from sec 0.0 to 0.1 and 0.2 to 0.3). Coded transmission of year, month, day, hour, minute and day of week from sec n° 21 to n° 58 (similar to DCF 77). During summer time (UTC +2), sec n° 17 interruption is 200 ms long while during winter time (UTC +1) sec n° 18 is 200 ms long.
HLA	Taedok Science Town Rep. of Korea 36° 23'N 127° 22'E	5 000	continuous	Pulses of 9 cycles of 1 800 Hz modulation. 29th and 59th second pulses omitted. Hour identified by 0.8 s long 1 500 Hz tone. Beginning of each minute identified by a 0.8 s long 1 800 Hz tone. Voice announcement of hours and minutes each minute following the 52nd second pulse. BCD time code given on 100 Hz subcarrier. DUT1: ITU-R code by double pulse.
IAM	Roma Italy 41° 47'N 12° 27'E	5 000	7 h 30 m to 8 h 30 m 10h 30 m to 11 h 30 m except Sunday and national holidays. Advanced by 1 hour in summer.	Second pulses of 5 cycles of 1 kHz modulation. Minute pulses of 20 cycles. Voice announcements every 15 minutes beginning at 0 h 0 m. DUT1: ITU-R code by double pulse.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
JG2AS	Sanwa Ibaraki Japan 36° 11'N 139° 51'E	40	continuous, except interruption during communications.	During experimental coded transmission of the total day, hour, minute and DUT1, second pulses are 0.2 s, 0.5 s and 0.8 s long. In case of no coded transmission, A1A type second pulses of 0.5 s duration.
JJY	Sanwa Ibaraki Japan 36° 11'N 139° 51'E	5 000 8 000 10 000	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: ITU-R code by lengthening.
LOL1	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 ms of 1 000 Hz or 440 Hz modulation. DUT1: ITU-R code by lengthening.
MSF	Rugby United Kingdom 52° 22'N 1° 11'W	60	continuous, except interruption for maintenance from 10 h 0 m to 14 h 0 m on the first Tuesday of each month. A longer period of maintenance during summer is announced annually.	Interruptions of the carrier of 100 ms for the second pulses and of 500 ms for the minute pulses. The signal is given by the beginning of the interruption. BCD NRZ code, 1 bit/s (year, month, day of the month, day of the week, hour, minute) from second 17 to 59 in each minute, following the seconds interruption. DUT1: ITU-R code by double pulse.
PPR	Rio de Janeiro Brazil 22° 59'S 43° 11'W	435 4 244 8 634 13 105 17 194.4	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.
RAB-99	Khabarovsk Russia 48° 30'N 134° 50'E	25	Winter schedule 02 h 06 m to 02 h 22 m 06 h 06 m to 06 h 22 m Summer schedule 01 h 06 m to 01 h 22 m 05 h 06 m to 05 h 22 m	A1N type signals are transmitted between 10 and 22: 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13 ; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms duration and minute pulses of 10 s duration are transmitted between minutes 13 and 22.

Station	Location Latitude Longitude	Frequency (KHz)	Schedule (UTC)	Form of the signal
RBU	Moscow Russia 55° 30'N 38° 12'E	200/3	Continuous	DXXXW type 0.1 s signals. The numbers of the minute, hour, day of the month, day of the week, month, year of the century, difference between the universal time and the local time, TJD and DUT1+dUT1 are transmitted each minute from the 1st to the 59 th second. DUT1+dUT1 : by double pulse.
RJH-63	Krasnodar Russia 44° 46'N 39° 34'E	25	Winter schedule 11 h 06 m to 11 h 20 m Summer schedule 10 h 06 m to 10 h 20 m	A1N type signals are transmitted between minutes 9 and 20 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 9 and 11 ; 0.1 second pulses of 25 ms duration, 10 second pulses of 1 s duration and minute pulses of 10 s duration are transmitted between minutes 11 and 20.
RJH-69	Molodechno Belarus 54° 28'N 26° 47'E	25	Winter schedule 07 h 06 m to 07 h 22 m Summer schedule 06 h 06 m to 6 h 22 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RJH-77	Arkhangelsk Russia 64° 22'N 41° 35'E	25	Winter schedule 09 h 06 m to 09 h 22 m Summer schedule 08 h 06 m to 08 h 22 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RJH-86	Bishkek Kirgizstan 43° 03'N 73° 37'E	25	Winter schedule 04 h 06 m to 04 h 22 m 10 h 06 m to 10 h 22 m Summer schedule 03 h 06 m to 03 h 22 m 09 h 06 m to 09 h 22 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.
RJH-90	Nizhni Novgorod Russia 56° 11'N 43° 57'E	25	Winter schedule 05 h 06 m to 05 h 22 m Summer schedule 04 h 06 m to 04 h 22 m	A1N type signals are transmitted between minutes 10 and 22 : 0.025 second pulses of 12.5 ms duration are transmitted between minutes 10 and 13; second pulses of 0.1 s duration, 10 second pulses of 1 s duration, 0.1 second pulses of 25 ms and minute pulses of 10 s duration are transmitted between minutes 13 and 22.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
RTZ (1)	Irkutzk Russia 52° 32'N 103° 52'E	50	0 h to 21 h 05 m 23 h to 23 h 05 m	A1X type second pulses of 0.1 s duration are transmitted between minutes 0 and 5. The pulses at the beginning of the minute prolonged to 0.5 s. A1N type 0.1 second pulses of 0.02 s duration are transmitted at 59 th minute. The pulses at the beginning of the second are prolonged to 40 ms and of the minute to 0.5 s. DUT1+dUT1: by double pulse.
RWM (1)	Moscow Russia 55° 44'N 38° 12'E	4 996 9 996 14 996	The station operates simultaneously on the three frequencies.	A1X type second pulses od 0.1 s duration are transmitted between minutes 10 and 20, 40 and 50. The pulses at the beginning of the minute are prolonged to 0.5 s. A1N type 0.1 s second pulses of 0.02 s duration are transmitted between minutes 20 and 30. The pulses at the beginning of the second are prolonged to 40 ms and of the minute to 0.5 ms. DUT1+dUT1: by double pulse.
ULA-4 (1)	Tashkent Uzbekistan 41° 19'N 69° 15'E	2 500 5 000 10 000	0 h to 3 h 50 m 5 h to 23 h 50 m 0 h to 3 h 50 m 14 h to 23 h 50 m 5 h to 13 h 20 m	A1X type second pulses of 0.1 s duration are transmitted between minutes 0 and 10, 30 and 40. The pulses at the beginning of the minute are prolonged to 0.5 s. A1N type 0.1 second pulses of 0.02 s duration are transmitted between minutes 10 and 20, 40 and 50. The pulses at the beginning of the second are prolonged to 40 ms and of the minute to 0.5 s. DUT1+dUT1: by double pulse.
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 +1 and -1 rd 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 that the local time is 1 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.

(1) RTZ, RMW, ULA-4. CIS radiostation emitting DUT1 information in accordance with the ITU-R code and also giving an additional information, dUT1, which specifies 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 21st and 24th second so that dUT1 = +px0.02 s.
Negative values of dUT1 are transmitted by the marking of q second markers within the range between the 31st and 34th second, so that dUT1 = -qx0.02 s.

Station	Location Latitude Longitude	Frequency (kHz)	Schedule (UTC)	Form of the signal
VNG	Llandilo New South Wales Australia 33° 43'S 150° 48'E	2 500 5 000 8 638 12 984 16 000	continuous continuous continuous continuous 22 h to 10 h	Second pulses of 50 ms of 1 kHz modulation. Second pulses 55 to 58 of 5 ms of 1 kHz modulation. Minute pulses of 0.5 s of 1 kHz modulation. During minutes 5, 10, 15, ..., second pulses 50 to 58 are 5 ms long with 1 kHz modulation. BCD time code giving day of the year, hour and minute at the next minute is given between seconds 20 and 46. Voice announcement on 2 500, 5 000 and 16 000 kHz during minutes 15, 30, 45 and 60. Morse station identification on 8 638 and 12 984 kHz during minutes 15, 30, 45 and 60. DUT1: ITU-R code by double pulse.
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. 29th and 59th 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: ITU-R 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, DUT1 correction, daylight saving time in effect, leap year and leap second.
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. 29th and 59 th 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 1 200 Hz tone. DUT1: ITU-R code by double pulse. BCD time code given on 100 Hz subcarrier, includes DUT1 correction.
YVTO	Caracas Venezuela 10° 30'N 66° 56'W	5 000	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.

ACCURACY OF THE CARRIER FREQUENCY

Station	Relative uncertainty of the carrier frequency in 10^{-10}
ATA	0.1
BPM	0.1
BSF	0.1
CHU	0.05
DCF77	0.005 (10d-mean)
EBC	0.1
HBG	0.1
HLA	0.1
IAM	0.5
JG2AS, JJY	0.1
LOL	0.1
MSF	0.02
RAB-99, RBU	0.05
RWM, ULA-4	0.5
RJH-63, RTZ	0.05
RJH-69, RJH-77	0.05
RJH-86, RJH-90	0.05
TDF	0.02
VNG	0.1
WWV	0.01
WWVB	0.01
WWVH	0.01

December 1998

Comité International des Poids et Mesures

Report of the 87th Meeting, 1998, Tome 66

(BIPM Publications)

Director's Report on the scientific work of the BIPM

October 1997 – September 1998

TIME

1 International Atomic Time (TAI) and Co-ordinated Universal Time (UTC)

Reference time scales TAI and UTC have been computed regularly and have been published in the monthly *Circular T*. Definitive results for 1997 have been available, in the form of computer-readable files in the BIPM home-page, since 23 February 1998 and printed volumes of the *Annual Report of the BIPM Time Section* for 1997 (Volume 10) were distributed in April 1998.

2 Algorithms for time scales (J. Azoubib, C. Thomas, assisted by H. Konaté)

Research concerning time scale algorithms includes studies which aim to improve the long-term stability of the free atomic time scale EAL and the accuracy of TAI.

2.1 EAL stability

Since January 1996, access to TAI and UTC has been provided for the Modified Julian Days (MJDs) ending in 4 and 9, which corresponds to an update period of 5 days instead of the 10 days used previously. The replacement of clocks of older design by new ones of type HP 5071A continues with consequent improvement in the stability of EAL, the first step in the calculation of TAI. The medium-term stability of EAL, expressed in terms of the Allan deviation, σ_y, is estimated to be 1.0×10^{-15} for averaging times of about 40 days. This improves the predictability of UTC for averaging times of between one and two months, a scale attribute of fundamental importance for institutions charged with the dissemination of real-time time scales.

To improve the stability of EAL further, the algorithm which produces it may need to be revised. With this in view, experiments have been carried out on real clock data collected at the BIPM. These show the advantage of simultaneously using an upper limit on relative weights, as opposed to one on absolute weights, and a basic interval of computation of one, rather than two, months. The BIPM reported on these studies to the CCTF working group on TAI [2, 17] which gave its agreement, on 31 October 1997, to the implementation of consequent changes. Since 1 January 1998, the upper limit of relative weight attributed to clocks contributing to TAI has been fixed at the value 0.7 %, and each monthly *Circular T* has given definitive results for access to the reference time scales TAI and UTC.

2.2 TAI accuracy

To characterize the accuracy of TAI, estimates are made of the relative departure, and its uncertainty, of the duration of the TAI scale interval from the SI second as produced on the rotating geoid by primary frequency standards. Since October 1997, individual measurements of the TAI frequency have been provided by seven primary frequency standards:

- LPTF-FO1, which is the caesium fountain developed at the BNM-LPTF, Paris (France). In the period covered by this report, it provided one measurement covering a 30-day period in November 1997. For this measurement the type B uncertainty of LPTF-FO1 is 0.22×10^{-14} ($1\ \sigma$).
- NIST-7, which is the optically pumped primary frequency standard developed at the NIST, Boulder (Colorado, United States). In the period covered by this report, it provided four measurements. These cover two 10-day periods in October 1997 and March 1998, one 35-day period in April-May 1998 and one 30-day period in July-August 1998. The type B uncertainty of NIST-7 is 1×10^{-14} ($1\ \sigma$).
- NRLM-4, which is the newly optically pumped primary frequency standard developed at the NRLM, Tsukuba (Japan). Its first measurements cover three 5-day periods in February, March and May 1998. Two other 10-day measurements were also provided for June and July 1998. The type B uncertainty of NRLM-4 is 2.9×10^{-14} ($1\ \sigma$).
- PTB CS2 and PTB CS3, which are classical primary frequency standards operating continuously as clocks at the PTB, Braunschweig (Germany). Frequency measurements have been taken over successive one-month periods since 1 January 1998 and their type B uncertainties ($1\ \sigma$) are 1.5×10^{-14} and 1.4×10^{-14}, respectively.
- PTB CS1, which is a classical primary frequency standard, rebuilt at the PTB from the old CS1 in continuous operation from 1976 to 1995. The type B uncertainty ($1\ \sigma$) of PTB CS1 is 0.7×10^{-15} and one-month measurements have been regularly reported at the BIPM since July 1998.
- CRL-01, which is an optically pumped primary frequency standard jointly developed by the NIST and the CRL at the NIST. Its first measurement covers a 25-day period in July-August 1998, and its type B uncertainty is 1×10^{-14} ($1\ \sigma$).

The global treatment of individual measurements [3] led to a relative departure of the duration of the TAI scale unit from the SI second on the geoid, for March-April 1998, of 0.1×10^{-14} with an uncertainty of 0.5×10^{-14}. This result suggests that the procedure for compensating the discrepancy consecutive to uniform application of the correction for the black-body radiation frequency shift in 1995 (cumulative frequency steering corrections, each of relative amplitude 1×10^{-15} and applied on dates separated by 60-day intervals) should now be abandoned. The relationship between the frequencies of EAL and TAI has thus been fixed since March 1998. It may be changed in future if the frequency of EAL drifts relative to TAI by an amount large enough to threaten the long-term stability and the accuracy of TAI.

The CCTF working group on the expression of uncertainties in primary frequency standards [4] continues its work; this committee asked the BIPM to prepare a report on the weighting factors attributed to measurements of primary frequency standards in estimating the accuracy of TAI [18]. This and other topics will be discussed at the third meeting of the working group, scheduled for early 1999.

3 **Time links** (J. Azoubib, Z. Jiang, W. Lewandowski, G. Petit, C. Thomas, P. Wolf, assisted by H. Konaté, P. Moussay and M. Thomas)

Since the beginning of 1995, the sole means of time transfer used for TAI computation has been the 'classical' GPS common-view technique based on C/A code measurements obtained from one-channel receivers. The global uncertainty of one 13-minute comparison between remote clocks is about 3 ns (1 σ) for continental distances and 5 ns (1 σ) for intercontinental distances, provided that the GPS receivers involved are differentially calibrated. The commercial availability of newly developed receivers has stimulated interest in extending the 'classical' common-view technique for use of multichannel dual-code dual-system (GPS and GLONASS) observations, with the aim of improving the accuracy of time transfer. In addition, the BIPM Time section is interested in other time and frequency comparison methods, among them phase measurements and two-way time transfer via geostationary satellites.

3.1 Global Positioning System (GPS) and Global Navigation Satellite System (GLONASS)

i) Current work

The BIPM issues, twice a year, GPS and GLONASS international common-view schedules. GPS Schedule No. 29 and GLONASS Schedule No. 4 were implemented in time receivers on 1 ctober 1997; GPS Schedule No. 30 and GLONASS Schedule No. 5 on 30 March 1998.

Rough GPS data are collected and treated regularly following well-known procedures. Only strict common-views are used in order to overcome effects related to the implementation of Selective Availability on satellite signals. The international network of GPS time links used by the BIPM is organized to follow a pattern of local stars within a continent, together with two long-distance links, NIST-OP and CRL-OP, for which data are corrected to take account of on-site ionospheric measurements and post-processed precise satellite ephemerides. A study has shown the advantage of applying the same treatment for the North-South clock comparison between the SP and the OP, though the baseline is only 1200 km long [5]. Rough GLONASS data taken by ten time laboratories are collected and studied at the BIPM, but are not currently used in the TAI computation.

The BIPM publishes an evaluation of the daily time differences [*UTC – GPS time*] and [*UTC - GLONASS time*] in its monthly *Circular T*. These differences are obtained by smoothing GPS data, taken at the OP, and GLONASS data, taken at the NMi-VSL, from a selection of satellites at high elevation. The standard deviations characteristic of daily GPS and GLONASS results are respectively about 8 ns and 3 ns, the poorer performance of the GPS resulting from intentional degradation of the signal by Selective Availability of GPS. The combined standard uncertainty of the daily GLONASS values is, however, not better than several hundred nanoseconds, compared to 10 ns for GPS, because no absolutely calibrated GLONASS time receivers are available.

ii) Determination of differential delays of GPS and GLONASS receivers

An important part of our work is to check the differential delays between GPS receivers which operate on a regular basis in collaborating timing centres. A series of differential calibrations of GPS equipment, involving the OP and European time laboratories equipped with two-way time transfer stations, began in June-August 1997. Since then two other calibration trips have been conducted: from October 1997 to January 1998 and from February to April 1998 [19, 20]. A fourth calibration trip, involving two additional time laboratories in the United States, began in May 1998 but, unfortunately, was stopped in July 1998 due to the losts of the portable equipment during shipment between the two laboratories. The results of these successive calibration trips are consistent with the stated uncertainties (a few nanoseconds) for most of the laboratories visited. In some cases, however, larger discrepancies were observed. These are probably linked to unrecorded changes in the experimental set-up maintained by the host laboratories.

The first differential calibration of GPS/GLONASS multichannel dual-code receivers was carried out in the period from August to November 1997 [21]. This involves 3S Navigation, the NMi-VSL and the BIPM. The second part of this exercise began in February 1998. Results for the parts of the receivers involving GPS and GLONASS C/A code are similar to those usually obtained with 'classical' single-channel C/A code GPS receivers, and preliminary results for GLONASS P code seem to indicate an improvement in stability for averaging times of a few days. This should be confirmed by further investigation.

iii) Standards for GPS and GLONASS receivers

The staff of the BIPM Time section is actively involved in the work of the CCTF sub-group on GPS and GLONASS time transfer standards, and several decisions made by the sub-group have their origins in studies initiated at the BIPM.

The *Technical Directives*, agreed by the sub-group in 1993 for the standardization of 'classical' GPS time receiver software, are now widely implemented. In May 1998, nearly all the timing centres contributing to TAI provided data according to this new format.

The BIPM played a key role in the adaptation of the standard GPS data format for use in dual-system, dual-frequency, dual-code observation. The suggestions made by the BIPM on this topic were officially adopted at the open forum organized by the sub-group on 1 December 1997 in Long Beach (California, United States).

The BIPM has also sought ways to reduce the sensitivity to outside temperature of some types of GPS and GLONASS receivers currently in operation. After building three temperature-controlled prototype ovens to protect GPS and GLONASS antennas, with resulting improvement in time transfer, the BIPM is now equipped with three commercial temperature-stabilized antennas, model TSA 100 from 3S Navigation. Their use with 3S Navigation and

Ashtech Z12T receivers clearly demonstrates a reduction of systematic effects in experiments of time and frequency transfer [9, 14].

The BIPM is also concerned with the problem of the so-called 'GPS week roll-over' which will occur on 22 August 1999 when the GPS week number will pass from 1023 to 1024. Since the week number as broadcast by the satellites is a 10 bit word, the week number will appear to be zero for week 1024. Nearly all the GPS time receivers used for TAI computation use a software which is not prepared for treating this roll-over and will misunderstand the current date by more than nineteen years. A test was carried out at the CNES, Toulouse (France), using their GPS signal simulator. In this, a classical GPS time receiver observed a fictitious GPS constellation for the period 21-22 August 1999. This test shows that such receivers do not stop when the roll-over occurs, but, since they detect an error in the date, they stop using it and refer subsequent observations to dates given by their internal oscillators. It follows that common-view tracks are referenced to a time scale which drifts with respect to UTC, thus undermining the computation of strict common views. New EPROMS fixing up this software problem will be distributed in due time by the receiver makers. The additional problem of the year 2000, entered in the receivers as 00, will also be taken into account in this software release.

iv) Simultaneous common views

Several studies have been carried out with a view to extending the 'classical' GPS common-view time transfer technique to multichannel dual-system (GPS and GLONASS) observations. The idea is to take advantage of 'all-in-view' observations from each site for computing as many common views as possible between two sites. The number of GPS and GLONASS satellites now in orbit is such that for short-distance links (<1000 km) 5 GPS and 3 GLONASS common views may be obtained simultaneously for each 16-minute interval. This increases the number of daily common views by a factor 20 relative to the 'classical case', and thus to a possible gain of about 4.5 in the precision of daily clock comparisons. For these receivers equipped with additional GLONASS P code boards, the number of simultaneous common views is still further increased. In addition, the P code common-view results are potentially of higher quality than corresponding C/A code results.

The BIPM is currently equipped with three GPS/GLONASS or GLONASS-only time receivers from the 3S Navigation Company:

- one two-channel P code single-frequency GLONASS unit;
- one multichannel dual-code GPS/GLONASS receiver with twelve channels for C/A code single-frequency GPS or GLONASS observation, and two P code channels for double-frequency GLONASS observation (receivers of the same type are in operation in some timing centres, in particular at the NMi-VSL);
- one multichannel dual-code GPS/GLONASS receiver with twelve channels for C/A code single-frequency GPS or GLONASS observation, and eight P code channels for double-frequency GLONASS observation.

The two multichannel receivers are equipped with temperature-stabilized antennas. They were extensively compared on site during a 7-day period in April 1998. Individual common views between the two are characterized by standard deviations of respectively 1.4 ns and 2.2 ns for GPS C/A code and GLONASS C/A code observations. (The results obtained with GLONASS C/A code could be improved by removing the biases due to the different frequencies of the GLONASS signals.) These noise levels fall to about 130 ps and 220 ps for an averaging time of one day.

A similar one-site study carried out in November 1997 with GLONASS P-code single-channel data shows a noise reduction by a factor 5 relative to GPS C/A-code single-channel data performance [6]. Further improvement is expected when using GLONASS P-code in a multi-channel mode.

Data obtained in a time transfer experiment, between the NMi-VSL and the BIPM, demonstrates a stability gain of 4 between single-channel GPS C/A-code common views and multichannel GPS and GLONASS C/A-code common views for averaging times of less than 10^4 seconds [9]. The additional systematic effects observed for longer averaging times are partially reduced by the use of TSA antennas.

The Allen Osborne Associates TTR-4P receiver in operation at the BIPM also provides multichannel C/A code GPS observations. The results of remote clock comparisons have been somewhat disappointing, however, because of the erratic behaviour of the receiver and the high sensitivity of the hardware to environmental variations [12, 13].

The BIPM is also conducting studies involving cheap pocket-sized multichannel GPS C/A code receivers: software which fulfils all standards agreed for accurate time transfer is being developed for one of these, the Motorola Oncore 8-channel receiver [8, 10].

3.2 Phase measurements

GPS time and frequency transfer may also be carried out using dual-frequency carrier-phase measurements rather than code measurements. This technique, already in common use in the geodetic community, can be adapted to the needs of time transfer: it is expected that an uncertainty of one part in 10^{15} in frequency transfer may be obtained over a period of one day. An Ashtech Z12T receiver has been acquired for this purpose and has been in operation at the BIPM since December 1997. In close collaboration with the BNM-LPTF, which owns a similar receiver, a detailed study of the two receivers placed side by side is being undertaken. Preliminary experiments show:

- In the zero-baseline configuration (comparison of two receivers linked to the same local clock and to the same antenna) the observed noise is characterized by a standard deviation of 1.2 ps for averaging times of 30 s. Peak amplitudes of 10 ps to 20 ps have been detected for longer averaging times [14]. They are caused by mechanical effects or temperature sensitivity of the main units.
- In the short-baseline configuration (comparison of two receivers linked to the same local clock, their antennas between distant by several metres) the observed noise is characterized by a standard deviation of 3.4 ps for averaging times of 30 s. Variations in delay caused by the temperature sensitivity of the antennas, typically about 2 ps/°C, may be reduced by the use of a TSA antenna. Antenna cables also show a temperature sensitivity of about 1 ps/(m × °C), leading to variations in the receiver comparison of about 120 ps when cables are placed in full sunshine [14]. The use of low-temperature coefficient cables and of high quality connectors reduced this effect in an experiment carried out in August 1998. In this frequency comparison experiment corresponding to a baseline of 1.7 metres, a modified Allan deviation of 4×10^{-17} was obtained for an averaging time of 60 000 s [15].

Our principal objective is now to assess the performance of this technique for frequency comparisons over baselines of several hundreds of kilometres with averaging times of about 1day, in order to apply it to the comparison of ultra-accurate primary frequency standards. In addition, when absolute calibration of the receiver delays is available, the technique may also be used for time transfer. These studies are being conducted in the framework of the newly created IGS/BIPM Pilot Project to study accurate time and frequency comparisons using GPS phase and code measurements, which organized its first meeting at the BIPM on 22 and 23 June 1998.

The dual-frequency capability of the Ashtech Z12T receiver allows its use for measurements of the ionospheric delay of GPS signals. Such measurements were used to complement and recalibrate (after a failure in March 1998) ionospheric delay measurements obtained from an older Nitzuki 7633 unit which is routinely used at the BIPM to obtain the on-site ionospheric corrections for OP.

The 3S Navigation receivers in operation at the BIPM have the capability to provide GLONASS phase measurements but require software enhancements to allow automatic data retrieval. When such data become available we intend to participate in the International GLONASS Experiment, IGEX'98, organized by the IAG, the IGS and the ION, and scheduled for October-December 1998. The objective of this project is, among others, to produce post-processed precise GLONASS satellite ephemerides as has been done for several years for GPS satellites.

3.3 Two-way time transfer

The CCTF working group on two-way satellite time transfer met for the fifth time in Boulder (Colorado, United States) on 8-9 December 1997. More technical meetings of representatives of the participating two-way stations were held on 9, 10 and 11 March 1998 in Warsaw (Poland), during the 12th EFTF, and on 30 June and 1 July 1998 in Graz (Austria). At these meetings the main topics discussed were the comparisons of two-way and GPS common-view time transfer and preparations for routine operation. Since May 1998, the BIPM has embarked on the collection of two-way data from seven operational stations and undertaken treatment of some two-way links. A staff member of the BIPM chairs the secretariat of the working group and the BIPM is also involved in the calibration of two-way time transfer links by comparison with GPS [19, 20].

4 **Pulsars** (G. Petit, B. Rougeaux*)

Millisecond pulsars can be used as stable clocks to realize a time scale by means of a stability algorithm. Collaboration is maintained with a number of radio-astronomy groups observing pulsars and analysing pulsar data. The Time section provided these groups with the latest version of its post-processed realization of Terrestrial Time TT (BIPM98) in January 1998. This collaboration also continues through the working group on pulsar timing of the IAU Commission 31 (Time), which is chaired by G. Petit.

A new technique to obtain pulsar data for use at radio observatories has been developed with the collaboration of the CNES. The implementation of this technique to search for new pulsars in a sky survey is the subject of the doctoral work undertaken by B. Rougeaux at the BIPM, in collaboration with the CNES, the Observatoire Midi-Pyrénées, Toulouse (France), and the OP.

The main steps and the present status of this experiment are as follows. The acquisition system bought by the CNES was installed at the Radio Observatory in Nançay (France) in November 1996 and test observations of known pulsars were carried out. The ensemble of hardware and

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* Research student (partly supported through a contract with CNES).

software necessary to process the data was realized in 1997. Some parts of the hardware designed by the CNES were built at the BIPM and the software was developed at the BIPM by B. Rougeaux as the main part of her doctoral work. Starting March 1998, the efficacity of the system was validated by the successful detection of two pulsars known to be present in the test observations. In the meantime, a programme of survey observations, initially covering a solid angle of 1.5 msr, has been started at Nançay. The processing of these observations is presently under way at the BIPM. This calls for very important computer resources and, in the present set-up, is implemented as a two-step procedure. First, the data is treated by a network of Pentium processors located in the different BIPM sections and operated at nights and during week-ends. Results are then sent by Intranet to the central BIPM computer facility (SUN work-station) where the second step is performed. In the future, the processing will be carried out on a parallel computer developed by the CNES.

5 **Space-time references** (G. Petit, P. Wolf)

In 1997 the CIPM and the IAU created the BIPM/IAU Joint Committee on general relativity for space-time reference systems and metrology, with the objective of unifying the work on space-time references previously undertaken within the CCDS working group on the application of relativity to metrology and in different working groups within the IAU, the IUGG and the IERS. The membership of the Joint Committee is now established with G. Petit acting as the Chairman. The Joint Committee has already issued three circulars. After the initial work of specifying the tasks, notably with the IAU working group on relativity in celestial mechanics and astrometry, the first issues raised concern the realization of barycentric and geocentric co-ordinate times at current and foreseeable levels of uncertainty. A Web site has been established (http://www.bipm.fr/WG/CCTF/JCR/welcome.html) that provides general information on the Joint Committee and outlines the main features of its work.

One important study undertaken at the BIPM concerns the extension of the relativistic framework for the realization of barycentric co-ordinate time. In 1991 the IAU defined a number of co-ordinate time scales (including barycentric co-ordinate time, TCB) together with transformations and parameters relating them one to another. These definitions are valid up to terms of order c^{-2} in the post-Newtonian expansions used, but could lead to ambiguities when used at the next order of the expansion c^{-4}. Terms of this order describe effects that may amount to parts in 10^{16} in relative frequency for a clock in the solar system, so future studies will have to take them into account. This implies the need to adopt new conventions, for example concerning the gauge used.

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