

## Report to the 19<sup>th</sup> Session of the CCTF

### Working Group on Primary Frequency Standards

Thomas E. Parker, Chair

August 30, 2012

#### Introduction

The Working Group on Primary Frequency Standards (WGPFS) was organized in 2005. The membership includes 21 individual from 13 metrology organizations, including the Time, Frequency and Gravimetry Section of the Bureau International des Poids et Mesures (BIPM). The current Chairman is Thomas Parker from the National Institute of Standards and Technology (NIST) in Boulder, USA. Dr. Parker's term expires in September of 2012. A list of current members is included in Appendix A.

There are now seven laboratories that are, more or less, regularly reporting to the BIPM the results of formal evaluations from ten Cs fountains and two thermal beam standards. For the last few years an average of between 3 and 4 fountains have been reported in each Circular T. The large number of regularly reporting primary standards reflects a very healthy community.

#### Terms of Reference

The terms of reference for the WGPFS are given in Appendix B.

#### Primary Objectives of the WGPFS

- Encourage and support the development of new primary frequency standards (PFS) and to promote high quality in PFS operations.
- Serve as a group of experts on PFS that the Time, Frequency and Gravimetry Section of the BIPM can consult with, particularly with regard to new standards.

#### Activities of the WGPFS

According to the CCTF Recommendation CCTF/06-08, the first report(s) of a new primary frequency standard (PFS), as well as those from frequency standards whose uncertainties have changed appreciably will be circulated to the WGPFS for comments before the report is accepted by the BIPM. Lately, the primary activity of the WG has been to review new or significantly modified primary frequency standards that are reporting to the BIPM for publication in Circular T.

Overall, the WG has reviewed the first reports from a total of 6 new or modified primary frequency standards and one secondary frequency standard (see next section). This includes 4 standards reviewed since the last CCTF meeting in June, 2009. The first

reports for one new standard were withdrawn due to frequency transfer problems. The Chairman would like to thank all of the WG members who helped with reviews.

### Secondary Frequency Standards

The first reports of a Secondary Frequency Standard (SFS) were presented to the BIPM in February, 2012 for publication in Circular T. The secondary standard was the LNE-SYRTE FO2-Rb fountain. The reports were treated the same as if from a PFS for review purposes and therefore the WG was asked to review the reports. This review was carried out in a normal fashion.

However, there was some discussion on how to use reports from secondary standards in steering TAI, since an SFS has an addition bias and associated uncertainty from the original calibration of the SFS relative to the SI second. As uncertainties are gradually reduced over time it may become clear that the defined frequency of an SFS needs to be changed. As long as the SFS error is within its stated uncertainty, and there are also a sufficient number of PFS actively reporting, this has no practical significance if the SFS frequency is used in the calculation of the rate of TAI. However, it is not inconceivable that a situation could arise when, in a particular issues of Circular T, there were no significant PFS reports, but only an SFS report (before the frequency could be redefined) which had a known bias error. Should the BIPM correct for this before using the information in the calculation of the rate of TAI? This issue has not yet been resolved.

With the presence of reports from SFS's now being published in Circular T it has become clear that the WGPFS needs to be reorganized to include members from the SFS community.

### Upcoming Changes

It has been proposed that the WGPFS will become the Working Group on Primary and Secondary Frequency Standards (WGPSFS). Also, the membership should be expanded to include experts on secondary frequency standards. Dr. Steve Jefferts will be the new WG chairman.

Appendix A

**Members of the Working Group on Primary Frequency Standards**

Chair: T. Parker (NIST)

BIPM	G. Petit, F. Arias
LNE-SYRTE	A. Clairon, S. Bize
INRIM	A. Godone, F. Levi
KRISS	Ho Seong Lee, Taeg Yong Kwon
METAS	Jacques Morel, Laurent-Guy Bernier
NICT	M. Hosokawa, Motohiro Kumagai
NIM	Tianchu LI
NIST	S. Jefferts
NMIJ/AIST	T. Ikegami, Shinichi Ohshima
NPL	Krzysztof Szymaniec
NRC	Louis Marmet
PTB	A. Bauch, R. Wynands
VNIIFTRI	Y. Domnin

## Appendix B

### **Working Group on Primary Frequency Standards Terms of Reference**

#### Members

The working group is made up of:

- representatives of all National Metrology Institutes (NMIs) that operate Primary Frequency Standards (PFSs) reporting to TAI,
- representatives of NMIs that are planning to operate at least one PFS reporting to TAI,
- representatives of the BIPM.

#### Chairperson

The chairperson is a member of the Working Group on Primary Frequency Standards representing an NMI operating a PFS appointed by the CCTF for the term of two consecutive CCTF meetings.

#### Objectives

(1) Develop and propose standards for the documentation of frequency biases and uncertainties, operational details, and frequency transfer uncertainties for a PFS. Develop and propose standards for the reporting of the results of a PFS evaluation to the BIPM.

(2) Provide a forum to evaluate and discuss the consistency among primary frequency standards.

(3) Provide a forum to discuss and assess the overall knowledge of the accuracy of the SI second for use in establishing the frequencies of secondary standards (microwave and optical) and possibly an eventual redefinition of the second.

(4) Interact with the BIPM on issues related to PFS contributions to the accuracy of TAI, particularly in the process of integration of the first reports of a standard.

(5) Encourage and facilitate direct comparisons between primary frequency standards.

(6) Encourage and support laboratories with new standards under construction.