A Day at the BIPM

Richard Fertell
Proteus Industries

The Meter Convention (Convention du Mètre) is a treaty signed in 1875 that created the International Bureau of Weights and Measures (BIPM), an international organization under the authority of the General Conference on Weights and Measures (CGPM) and the supervision of the International Committee for Weights and Measures (CIPM). The BIPM's mandate is to provide the basis for a single, coherent system of measurements throughout the world, traceable to the International System of Units (SI). This task takes many forms, from direct dissemination of units to coordination through international comparisons of national measurement standards I had what is perhaps a metrologist's greatest dream — the opportunity to visit the BIPM and tour some of their prestigious laboratories.

Le Bureau International des Poids et Mesures — The International Bureau of Weights and Measures (BIPM) is situated on a hill within a public park in Sévres, France. The setting is magnificent – an historic French building (the Pavillon de Breteuil, 1672) surrounded by beautiful gardens with a view of the Eiffel Tower. At the time of the signing of the Convention du Mètre and the foundation of the BIPM in 1875, the Pavillon de Breteuil was already more than two hundred years old.

In 1875, the French government offered the site to the Comité International des Poids et Mesures (CIPM) for the establishment of the BIPM. The state-of-the-art laboratories are in separate buildings. In addition to modern metrology laboratories they also house historic measurement equipment.

In 1795, long before the Meter Convention was signed, the French National Assembly defined the meter and kilogram. In 1799, the first prototype standards were deposited in the Archives of the French Republic and dedicated "to all nations" and "to all times."

Just after the Franco-Prussian War ended in 1875, delegations from 17 countries met in Paris and signed the Meter Convention. (*Convention du Métre),* a treaty that created the International Bureau of Weights and Measures (BIPM), an intergovernmental organization under the authority of the General Conference on Weights and Measures (CGPM) and the supervision of the CIPM. The BIPM is an intergovernmental organization financed by those countries who are signatories of the Metre Convention, and operates under the supervision of the CIPM.

The BIPM has a mandate to provide the basis for a single, coherent system of measurements throughout the world which is traceable to the International System of Units (SI). This responsibility includes many functions from direct dissemination of units (as in the case of mass and time) to international comparisons to validate the consistency of national standards (as in electricity, ionizing radiation and chemistry).

The BIPM also conducts scientific research at the highest level on physical and chemical quantities. The major task of the BIPM is the worldwide coordination of metrology in collaboration with the national metrology institutes (NMIs) which continue to disseminate the chain of traceability to the SI into national accredited laboratories and finally to industry.

The BIPM is not exactly a tourist stop. It is the center of the measurement science world. As such, there are no road signs indicating the location or even the existence of BIPM. So after a few wrong turns, my wife and I passed through the entrance gate to the BIPM and were instructed at the entrance how to reach our rendezvous with Dr. Michael Stock. The honor and privilege

Pavillion de Breteuil in Sevres, France has housed the BIPM since 1875. Photo courtesy of BIPM. (copyright BIPM)

of a private tour with the Head of the Electrical Measuring Department of BIPM has not been lost with me. Besides being brilliant, Dr. Stock is a man of intense focus. He has to be. He is in charge of electrical reference calibrations for the world and the Watt Balance Experiment at BIPM.

The Watt Balance Experiment is a method to replace the present definition of the unit of mass, based on the international kilogram prototype of 1875 by linking mass to the Planck constant, using electrical quantum effects. (www.bipm.org/en/scientific/elec/watt_balance/wb_principle.html).

To reach the Watt Balance Experiment, one travels down several flights of stairs and through two pass-code doors into the temperature and humidity controlled lab. The simple elegance of the Watt Balance Experiment catches the eye and imagination. This measurement device is for the 21st century, where every influence imaginable is accounted for: all electro-magnetic influences are considered and shielded from interference, if possible. An induction coil moves nearly perfectly vertically through a magnetic field. All other velocity components are carefully measured and corrected. Resistance changes of the main coil due to temperature changes are tracked by using a second coil. Humidity and condensation on the mass under test are determined. Frictional force on moving parts is minimized by flexure strips. This project is where science, engineering, mathematics, precision machining and a whole lot of brain-power come together.

Another highlight of our tour in the electrical laboratory was seeing the BIPM Josephson array. The Josephson array at BIPM serves as a reference to verify the performance of many national Josephson standards.

We also toured the international atomic time laboratory. Dr. Wlodzimierz Lewandowski showed us the equipment used to record and process the reports from atomic clocks of many different countries and regions. The time data are pooled and calculated to create a Standard Time that is sent back to each contributing laboratory with a report showing the deviation of each clock and clock group from the Universal Coordinated Time.

To fulfill their mission to advance measurement around the world, in 2008 BIPM organized a two-week summer school for staff from national metrology laboratories. We left Dr. Stock as he prepared presentations for the CPEM and BIPM summer school, and we continued our vacation in Paris.

Richard Fertell, richard_ncsli_1410@mac.com.

BIPM Watt Balance Experiment.

Imagine the pleasure of visiting BIPM, then having dinner with Parisian friends only to discover their daughter is an engineering student and the night's conversation is all about engineering and measurement. It was a fantastic day, even better than the day that Tommy Lee Jones was standing in line behind me at the Paris airport.

Coincidently, the topic of measurements and porcelain appeared in an unrelated tourist destination - the Musée National de Céramique – one press on the tour guide button of a beautiful dish display and the history of ceramics in Sévres was presented the day before my visit to BIPM. To make excellent "true" porcelain, one must know how to measure the process time and temperature, weight of the materials and dimensions. The Museum of Ceramics is in Sévres: www.musee-ceramique-sevres.fr.)

You can find more information about the BIPM online at www.bipm.org.