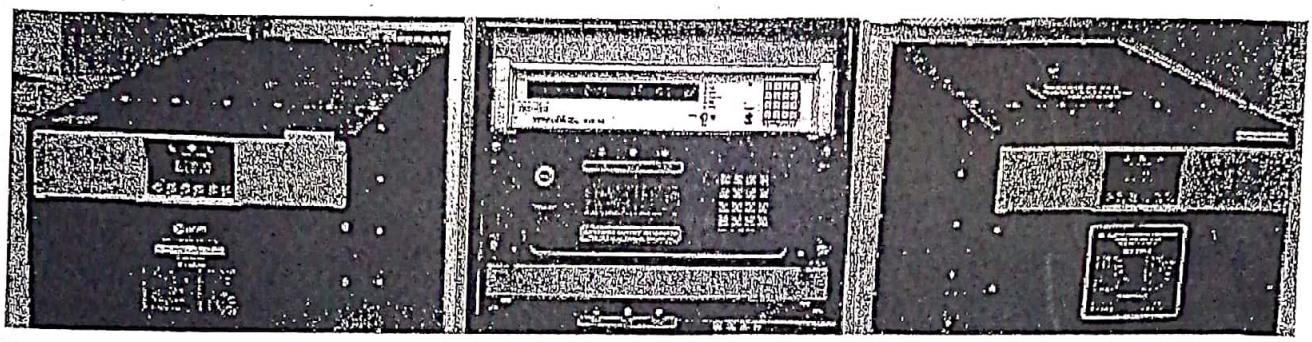
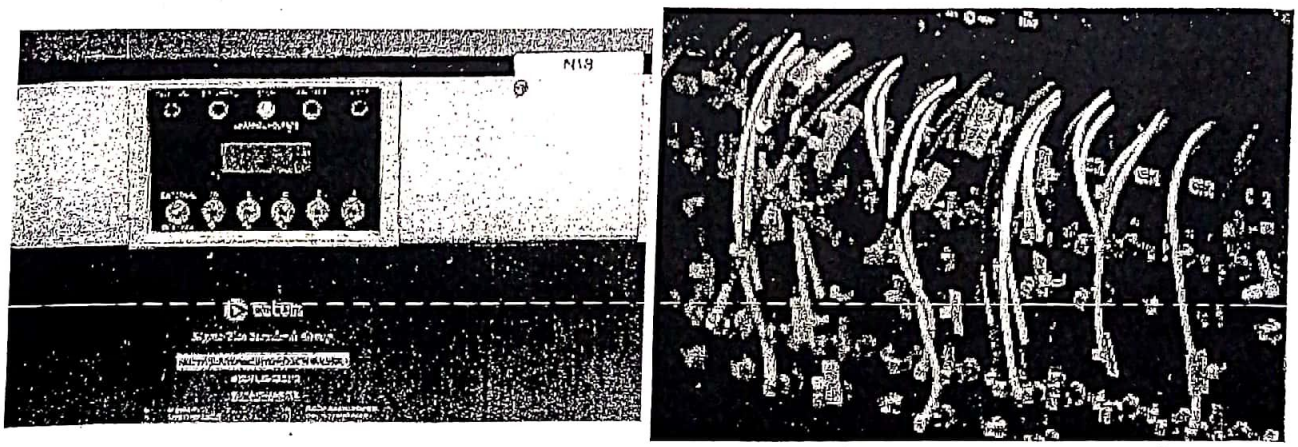
USNO Master Clock Description



"Time and the hour runs through the roughest day."
-- W. S.

The U.S. Naval Observatory (USNO) is charged with the responsibility for precise time determination and management of **time dissemination**. Modern electronic systems, such as electronic navigation or communications systems, depend increasingly on precise time and time interval (PTTI). Examples would be the ground-based LORAN-C navigation system and the satellite-based Global Positioning System (GPS). These systems are based on the travel time of the electromagnetic signals: an accuracy of 10 nanoseconds (10 one-billionths of a second) corresponds to a position accuracy of 10 feet. In fast communications, time synchronization is equally important. All of these official systems are referenced to the **USNO Master Clock**.

The present **USNO Master Clock** is based on a system of dozens of independently operating **cesium atomic clocks** and a dozen **hydrogen maser clocks**.



"A man with a watch knows what time it is. A man with two watches is never sure."
-- Segal's Law

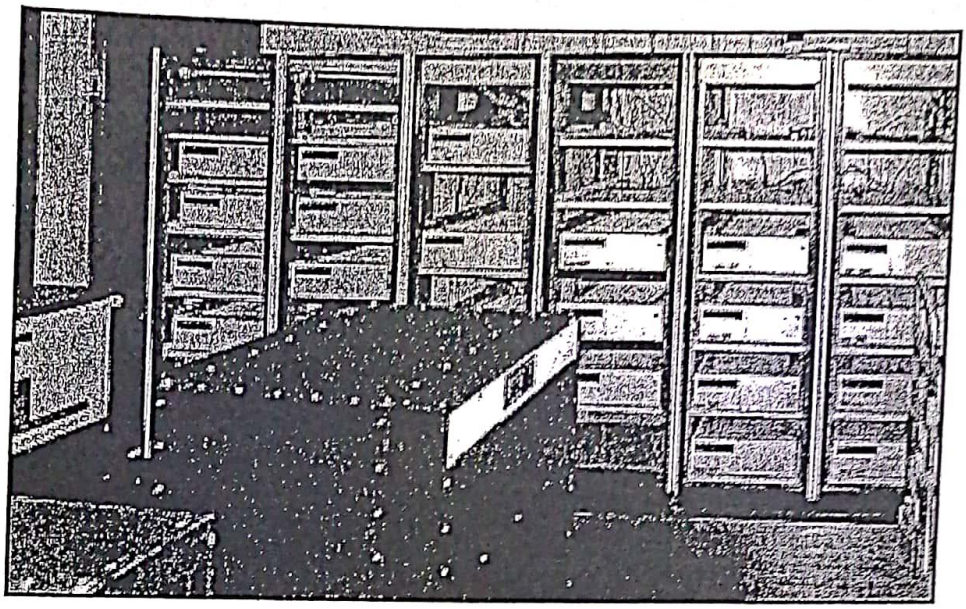
To find out how many cesiums and H-masers are currently in the USNO mean timescale, click:

How Many Clocks?

These clocks are distributed over 20 environmentally controlled clock vaults, to ensure their stability. By automatic intercomparison of all clocks *every 100 seconds*, the USNO time scale can be computed which is not only reliable but also extremely stable. Its rate does not change by more than about 100 *picoseconds* (0.000 000 000 1 seconds) per day from day to day.

On the basis of this computed time a clock reference system can be steered to produce clock signals which serve as the USNO Master Clock. The clock reference system is driven by a hydrogen maser atomic clock. Hydrogen masers are extremely stable clocks over short time periods (less than one week). They provide the stability, reliability and accessibility needed to maintain the accuracy of the Master Clock system.

USNO Master Clock



A USNO clock vault. Masers in the foreground, cesium beam clocks in the background.

The USNO Master Clock is the underlying product for all of our precise time and time interval products. The timing reference produced by this timing ensemble is called UTC(USNO). This timing reference is mandated to be the precise time reference for all of the DoD.

- **USNO Master Clock Description**

  Technical information about the physical components that make up our timing ensemble.

- **USNO Time Scales**

  Descriptions of the time scales determined at USNO and their relationships.

- **International Time Scales and the BIPM**

  Information about the relationship between international time scales and the USNO products. This section includes data files and plots of these time scales.

- **Definitions of Systems of Time**

Definitions of systems for determining and referencing times. These range from atomic time scales to the rotation of the earth.