

## Allied post war investigations

The Allies showed considerable interest in the German technical and scientific achievements. Groups of specialists were arriving, sometimes a few hours after the Germans had surrendered (or after they had withdrawn at particular sites) to investigate places of interest. Their aim being to capture as much valuable apparatus and documents as possible and to interrogate the leading members of staff.

One of the reports (31) which was published concerning these interrogations dealt with the use of the quartz-clocks which were maintained by the major time controlling institution Deutsche Seewarte in Hamburg. This institution maintained clocks which were produced by both PTR and R&S.

The second party, on behalf of the U.S. Technical Industrial Intelligence Committee, investigated (in June 1945) the PTR clocks which were employed in Heidelberg (after this institution had been moved from a site which was, until recently, under Russian control). (32)

According to Jucker's additional information (33): *On pressure of members of the U.S. Technical Industrial Intelligence Committee (Melville Eastham, President of General Radio and Dr. Don Sinclair, Vicepresident of General Radio) the PTR site Zeulenroda/Thuringa was moved out of the Russian occupied zone into the US zone at Heidelberg.*

I would add, that it is most likely that this would have been managed before the Russians could lay their hands on the possessions of the PTR. All the Allies tried to keep, for themselves, what ever they could lay their hands on. Not even all U.S. investigation reports, concerning German technology, were shared with their closest ally Britain!

If we remember that the pre-war General Radio quartz-clocks were of more or less similar design to those of the PTR in Berlin, it is no wonder that they were showing distinct interest in the state of the art of the PTR clocks.

The Americans allowed the remaining PTR body to continue operation after the surrender of the Third Reich. According to one of the reports they recommended: *"It is believed that this group is an important potential aid to rehabilitating the German equivalent of the Bureau of Standards, and should be tied in to whatever Government Institution is established to look towards the economic technical rehabilitation of Germany".* (32)

On 10 September 1946 the U.S. Department of Commerce issued its final FIAT Report No. 895, called: *"Progress in time and radio frequency measurements at the PTR Heidelberg"*. This report describes extensively several aspects of time and frequency measurements which were employed by the German Bureau of Standards prior to 1945. (In the meantime, **all** the PTR quartz-clock apparatus had been removed from the Heidelberg site and had been sent to Greenwich (UK) and to the U.S. for investigation thus leaving no remaining quartz-clock in Heidelberg!)

## Evaluation

We have learned that quartz-clocks, in the 1930s and early 1940s, were becoming quite accurate time and frequency generating instruments. That the short term stability could be estimated for  $\approx 1 \times 10^{-9}$ , for some good clocks even up to  $10^{-10}$ . Longer running (good) quartz-

clocks could reach values of  $10^{-9}$  a day. This latter figure was mainly due to the typical aging of the quartz resonators. For quartz controlled oscillators, even for today, this is a reasonable value. According to Rohde (34) the long term frequency accuracy of the PTR clocks, in the early 1940s, was estimated at  $1 \times 10^{-9}$ .

According to Hans Jucker's additional information which he recently passed on to me: - the typical deviation of a clock, controlled by means of a BVA quartz oscillator (Swiss brand name which is very well known for its excellent products), **with no offset** after 90 days can be observed as follows:-

- Aging drift  $90 \times 2 \times 10^{-11} = 1.8 \times 10^{-9}$
- Accumulated time deviation  $\frac{1}{2} \times 90 \times 86400 \times (1.8 \times 10^{-9}) = 7 \text{ ms}$

The typical deviation of a clock controlled by an atomic frequency (Rubidium) standard **with no offset** after 90 days has, for comparison figures of the order:-

- Aging drift  $90 \times 10^{-13} = 9 \times 10^{-12}$
- Accumulated time deviation:  $\frac{1}{2} \times 90 \times 86400 \times (9 \times 10^{-12}) = 35 \text{ } \mu\text{s}$

The specifications of modern frequency standards are much better than those which were achieved by the early quartz controlled clocks and frequency standards. But, the technology has been improved tremendously over the years. However, comparing today's technology with that of the early days of the quartz-clocks, their parameters weren't too bad, but the early, bulky, quartz-clock systems required much effort to maintain those devices. In contrast the time standards of today are very handsome devices which are very easy to operate.