HEALTH PHYSICS INSTRUMENTATION
A PROGRESS REPORT

R. Maushart

Laboratorium Prof.Dr.Berthold GmbH & Co.
Wildbad, Germany

ABSTRACT

Health Physics Instruments have changed rather dramatically in the past decade. On the one hand, technological innovations like Microprocessors, data storage facilities and imaging displays have altered shape, size and appearance of the classical devices, particularly the hand-held ones. On the other hand, instruments are increasingly being considered as an integral part of Radiation Protection procedures and organisations, supporting a smooth and reliable implementation of all necessary measures. This implies ease of operation, and extensive self-checking and performance control features.

Since there are different categories of users with quite different degrees of motivation and training, the measuring instruments of the future will have to be adapted to specific types of users. Instruments for "professional" radiation protection - for example in nuclear power plants and nuclear technology - will differ from instruments used in the radionuclide laboratory, where radiation protection will necessarily have to be done as a "side-job".

TODAY'S STATE OF THE ART IN THE DEVELOPMENT OF MEASURING INSTRUMENTS

The present state of the art in measuring technique can be illustrated by means of several types of instruments which are employed for important tasks in radiation protection in the medical field.

A large variety of <u>portable doserate measuring instruments</u> with digital microprocessor systems is available on the market. Their detector is usually a built-in miniature GM counter tube, and a more or less great assortment of external probes may be connected in addition.

Strangely enough, instruments with scintillation detectors have hardly been improved since they were introduced into the market one and a half decades ago; the technology change in electronics seems to have passed by these instruments.

Portable instruments using an ionization chamber as a detector are mainly supplied by US manufacturers. German manufacturers offer only two instruments, both rather obsolete.

Still hardly available - probably due to the low demand - are instruments capable of measuring the beta doserate.

Stationary doserate measuring systems used, for example, for the monitoring of accelerators are worlds apart from the first generation of analog ratemeters.

Usually, they operate, like the portable instruments, almost exclusively with digital result display. Moreover, they incorporate a significant intelligence, such as sliding time constants, dose integration, result storage over longer time periods, and autonomous programs for data transfer to a printer or computer, with data transfer option via bus lines.

The different energy and doserate ranges for specific applications are covered by a broad assortment of GM, proportional and ionization chamber probes.

Rem counters - which actually should be called Sievert counters - with BF_3 or ^3He counter tubes or even LiI scintillation counters as detectors in combination with large moderator spheres are still employed for the measurement of the **neutron doserate.** Alternative systems such as the "Dineutron" made by a French company, or tissue-equivalent proportional counter tubes (TEPC), whose development has been reported a number of years ago, have not been very successful so far.

Xenon large-area counter tubes in combination with preselectable nuclide-specific calibration factors for Bq/cm^2 display are fairly common in portable contamination monitors. Wall holding devices allow their application as semi-stationary units for exit control. Sophisticated calculation methods for determining the measured value have largely eliminated the slow reaction of the display of older ratemeter units. Background storage is a standard feature with most instruments.

Self-monitoring and test routines are also fairly common. However, some instruments appear to be "over-refined"; simple handling, an essential factor for the every-day use in the laboratory, is sacrificed to a large number or parameters which can be selected and edited by the user.

In the aftermath of accidents involving person contaminations one usually has to perform measurements under difficult conditions, such as high humidity or bad visibility. Many of our modern contamination monitors do justice to these requirements.

The external design of personal contamination monitors reflects the modern technology they incorporate. Detector contaminations are monitored, external radiation fields compensated, measurement times adapted to the statistics. Monitors for graphic, location-related result display are fairly common. Highly advanced data processing allows the build-up of a network of recording systems comprising contamination monitors, access control and a PC-based central evaluation station.

In the medical field, the measurement of gaseous radioactivity is required particularly in two areas: for the diagnostic use of the radioactive noble gases ^{85}Kr and ^{133}Xe, on the one hand, and for the room and waste air monitoring of accelerators, on the other hand. The monitoring systems used for this purpose usually still operate with large-area proportional counter tubes, occasionally also with surface layer semiconductors as detectors. The progress becomes obvious largely in the subsequently connected "smart" electronics.

Detectors used for **iodine measurement** which is more and more required and employed in room air monitoring on therapy stations did not change much over the last years. The noise reduction was improved, however. Specially designed low-noise instruments are capable of reaching sound levels around 50 db.

FUTURE TRENDS IN THE DEVELOPMENT OF MEASURING INSTRUMENTS

With regard to the measuring electronics the change in technology is largely completed. Microelectronics, surface mounting and hybrid technique, and the use of solid-state data memory affect the appearance and performance of the instruments.

With regard to the detectors, however, the technology has hardly changed in recent years, leaving aside the introduction of highest grade germanium detectors for high resolution gamma spectrometry. This will change in the years ahead.

Geiger-Müller counter tubes are still preferred for doserate measurement, particularly in portable instruments. Their weak points are the limited service life, in particular with high doserates, the measuring range which is limited to a maximum of 5 decades, and the inadequate sensitivity in the energy range below 40 keV.

These detectors will be replaced by very small proportional counter tubes in ceramic technology which can be employed in particular in the low energy range required in radiology.

Silicium-PIN-detectors offer another alternative to the GM counter tube, especially for low-priced instruments.

Large-area proportional counter tubes for contamination measurement will be constructed in plastic technology. This allows the simple electrical division of very large detector areas into small, separate counting elements.

Thus, position-resolution detectors for scanning extensive contaminated areas can be realized, for example as one square meter large mosaic of one hundred individual detectors with 100 cm^2 window area each.

The detectors will incorporate an integrated microelectronics including the HV supply. The counts will thus be stored in the detector unit itself and then transferred to the measuring electronics as a data package. Thick, shielded HV and pulse cables between detector and evaluation electronics will become obsolete.

Now that the instruments have become rather similar in performance, future improvements will mainly be concerned with the outer design, an aspect which indeed has often been somewhat neglected. Occasionally one can even notice quite "fashionable" trends which have not much to do with any progress in measuring technique.

All instruments, even the portable ones, will include computer interfaces, Thus, one can output data and analyze and display it on a PC; on the other hand, parameters in the instrument can be edited and test routines can be run via the PC. Complete programs may also be entered via a barcode reader.

The portable instruments show a distinct trend toward a universal electronics suitable for a variety of applications when using different detectors. Thus, the circle becomes complete, with the disadvantages apparent in the very first instruments, especially of American origin, being completely eliminated today. Set-up routines by the user have become redundant. The modern electronics identifies the respective detector and automatically defines all pertinent parameters, such as calibration factors and display units.

The performance test, the automatic comparison of current reference values with stored standard values via so-called utility programs, will become more common. The constant storage of data, for example background rates or the detector efficiency, and the presentation of time curves permits the user to assess the stability of the system and to recognize drifts or aging effects in time.

Modern data storage technology, the versatile combination and presentation offer nearly unlimited opportunities. Unfortunately, this has led to a trend to overload the instruments with fancy electronic features and thus to overtax the user's abilities by manifold operation options and program ramifications. Finding a reasonable compromise will be the goal of the development for the years to come.

Today we are in an integrative phase of radiation protection measuring technique development. The measuring task, i.e. the safe and reliable radiation protection, must determine the appearance and performance features of the measuring instruments. They will have to be more and more integrated into the process of operative radiation protection. The user interface, the interaction of instrument and user, will play therefore a dominant role in future Health Physics Instrumentation.