Current Trends in Radiation Monitoring Systems

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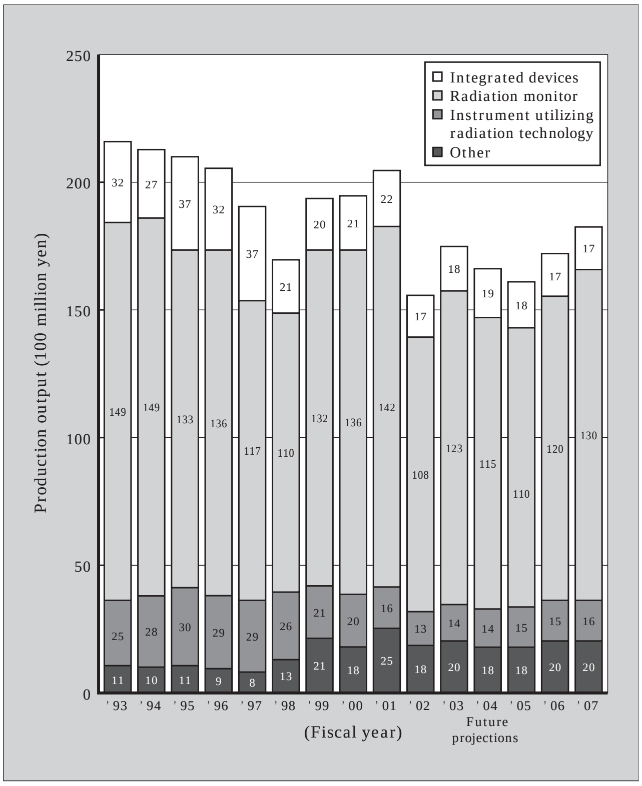
1. Introduction

During the more than 100 years since the discovery of X-rays in 1895 by the German scientist Roentgen, the use of radiation has been advanced in scientific, engineering and medical fields. The radiation measurement technology applied in industrial applications mainly utilizes the material penetration capability of radiation rays and is incorporated into production lines for iron and steel, paper, film, etc., where the technology is used in thickness gauges or cast-iron level gauges to measure the thickness or fluid level of an object rapidly, with high precision and without contact. In recent years, due to the overseas migration of iron/steel and chemical fiber production and the absence of an increase in production quantities, including the portion produced overseas, demand for measuring instruments that utilize radiation technology has continued on a downward trend.

On the other hand, radiation monitors are being shipped to facilities that use radioisotopes such as nuclear power plants, nuclear-related research organizations and universities, hospitals and pharmaceutical companies. When nuclear power facilities first began to be constructed, there was an increase in demand for radiation monitoring equipment, which gradually became the largest sector of the market for radiation equipment. Hospitals promoted the installation of diagnostic radiology equipment, and accompanying the use and control of medical isotopes that are administered to patients, radioactive wastewater treatment facilities and radiation monitoring equipment were also promoted.

Figure 1 shows the historical and future estimated production of radiation measuring instruments made by the Japan Electric Measuring Instruments Manufacturers' Association (JEMIMA). Demand for radiation monitors is largely dependent upon plans for the new construction of nuclear power plants, and the delay in construction planning effects the size of the market.

Fig.1 Production of radiation measuring instruments: historical output and future projections



2. Current Status of Radiation Monitoring Systems

Radiation monitors fall into the categories of environmental radiation monitoring, personal dose monitoring, surface contamination monitoring, radioactive material monitoring and area process monitoring.

Environmental radiation monitoring measures the spatial gamma-ray dose rate, the concentration of gaseous radioactive material, and the concentration of airborne radioactive material. Measurement of the spatial gamma-ray dose rate is implemented with a low range (background dose rate to 10 μSv/h range) monitor and a high range (10 μSv/h to 10 mSv/h range) monitor. NaI (Tl) scintillation detectors and spherical pressurized ionization chambers are used as radiation detectors. Radioisotope diagnostic radiology equipment is increasingly being used for in-hospital screenings, and monitor readings have a greater chance to fluctuate when, for example, a patient who has been internally administered a radioisotope approaches the environmental monitoring equipment or when a cart that transports radioactive elements passes nearby. Recently, low range monitors are being provided with the capability to measure spectral energy, and spatial gamma-ray equipment is increasingly being used to enable identification of the radiation source in cases when there is an unexpected change in the reading under normal measurement conditions. In combination with this function, energy characteristic compensation is being implemented with a digital method of energy load correction having good counting accuracy.

For the environmental dosimetry performed both on-site and off-site by fixed-point continuous gamma-ray monitoring, a transition is underway from passive dosemeters, such as a thermoluminescence dosemeter in which measuring-related processing such as the heating of an element is required, to electronic dosemeters capable of recording the history of dosage changes over time.

For personal dose monitoring, electronic dosemeters capable of measuring gamma-rays, beta-rays and neutrons are utilized in practical applications for measuring external exposure to radiation and are being used to record the doses. In particular, gamma-ray and beta-ray dosimetry will changeover to electronic dosemeters in the near future. Communication between the dosemeter and dose reader is gradually transitioning from infrared communication to wireless communication, and short-range communications technology is enabling data communication to be implemented with a dosemeter carried in a work clothes pocket or the like.

Surface contamination monitoring of a physical object is implemented by whole body surface monitors, article monitors, laundry monitors and the like. Plastic scintillation detectors for detecting beta-rays are used as radiation detectors because they are capable of measuring a large area within a short time interval.

For the dust monitors used in area process monitoring, a single radiation detector capable of detecting both beta-rays and alpha-rays, simultaneously and individually, is being used, making it possible to lessen the influence of radiation emitted from natural radioisotopes such as radon/thoron daughters. In facilities that handle nuclear fuel, large-area semiconductor detectors capable of discriminating alpha-ray energy are used, and dust monitors capable of measuring plutonium separation are being installed.

3. Technical Trends

Radiation monitoring equipment must be highly reliable. Technical development for the future is targeting smaller sizes, lighter weight, lower cost, longer useful life and even higher reliability.

Passive radiation detectors and finite-life radiation detectors such gas-filled counters and the like will be replaced with smaller-size and lighter weight semiconductor detectors. Because the silicon semiconductor material in a semiconductor element operates stably at room temperature and possess components similar to human body tissue, semiconductor elements are suitable for dosimetry and will continue to be used as the main element in future radiation detectors.

Construction of nuclear fuel reprocessing facilities and accelerator facilities is advancing and neutron dosimetry is crucially important at these facilities. Because at accelerator facilities, in particular, the neutron energy to be measured exceeds 10 MeV, development work is progressing for a new type of neutron detector, such as one in which material that boosts sensitivity of the neutron detector, which otherwise tends to decrease at high energy levels, is added to a conventional moderator.

4. Conclusion

Fuji Electric intends to develop commercial radiation monitoring equipment that uses mainly semiconductor radiation detectors and is optimally suited for various measurement conditions.