Reliability and Traceability in Radiation Calibration

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1. Introduction

Fuji Electric has a successful history of delivering radiation measuring equipment used in the controlled areas of facilities that handle radioactive matter and nuclear fuel materials. Radiation measuring equipment is required to have high measuring accuracy, and proper calibration, using a calibrator that provides traceability to national standards, is essential in order to ensure that accuracy.

In order to calibrate radiation measuring equipment for various uses, Fuji Electric maintains and operates calibrator having different nuclides and irradiation strengths.

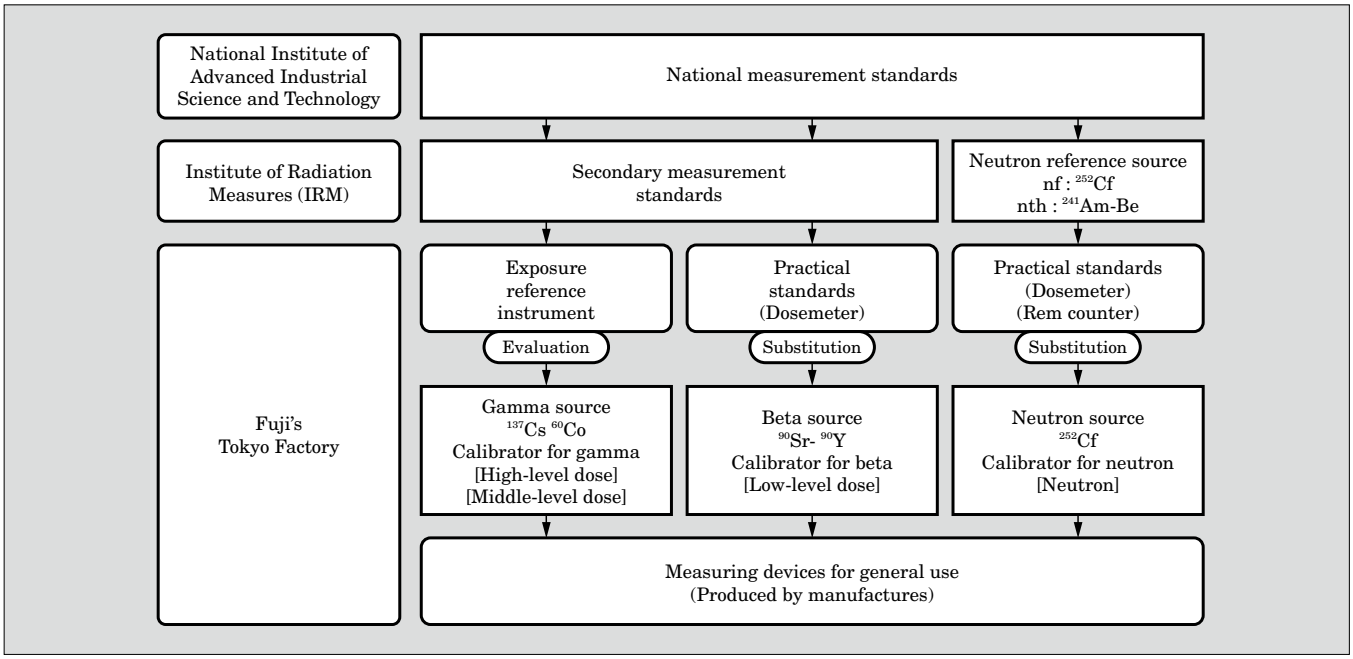
2. Traceability

For radiation measuring equipment, establishing traceability linking the national standards to products, and maintaining the calibration accuracy are extremely important. Fuji Electric's calibration equipment for radiation measurement devices is based on Japanese domestic laws and standards, and is traceable to the national standards shown in Fig. 1.

3. Calibrator

The calibrator is measured at a location an arbitrary distance from the radiation supply, with a reference measuring device traceable to national standards, and is assigned a value. The device to be calibrated is placed in the same place with the calibrator, and the calibration is performed by comparing the measured values obtained with the values measured by the reference measuring device. The calibration of the device to be calibrated is performed using a radiation source of the same nuclide, also by changing the irradiated dose equivalent rate. Moreover, the energy calibration is performed using a radiation source of different nuclide to irradiate at the same dose equivalent rate.

Fig.1 Traceability system chart



3.1 Gamma-ray calibrator

(1) Gamma-ray calibrator (high dose)

This calibrator is used for calibrating survey meters, area monitors, ionization chambers and the like. ^{137}Cs, ^{60}Co and ^{226}Ra radiation sources are used for the calibration and for energy calibration. This calibrator is configured from an irradiator that houses the radiation source, a calibration truck in which the device to be calibrated is placed, and a controller that controls the operation of these apparatuses. When an irradiated dose equivalent rate is set by the controller, the type of radiation source and distance are computed, the calibration truck moves automatically to a predetermined location, the radiation source is selected, irradiation by the radiation source is implemented, and so on. Figure 2 shows the external appearance, Fig. 3 shows the system configuration and Fig. 4 shows the calibration range of this gamma-ray calibrator.

(2) Gamma-ray calibrator (medium dose)

This calibrator uses a ^{137}Cs radiation source to calibrate personal dosemeters and environmental dosemeters. The calibrator is configured from an irradiator and a controller. This calibrator varies the strength of the radiation source and the time duration of the irradiation to change the irradiated dose and to perform the calibration. The devices to be calibrated are arranged in a circle around the radiation source, and 50 devices can be calibrated simultaneously. Figure 5

Fig.2 Photograph of gamma-ray calibrator (high range)

Fig.4 Calibration range of gamma-ray calibrator (high level)

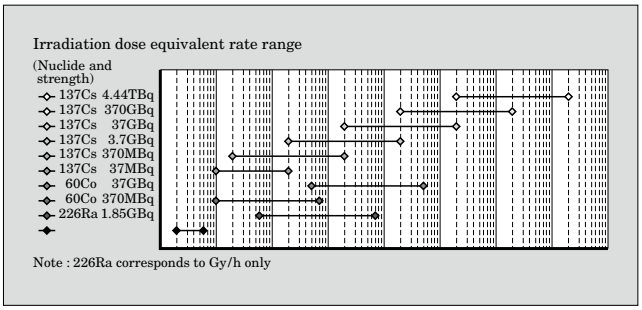
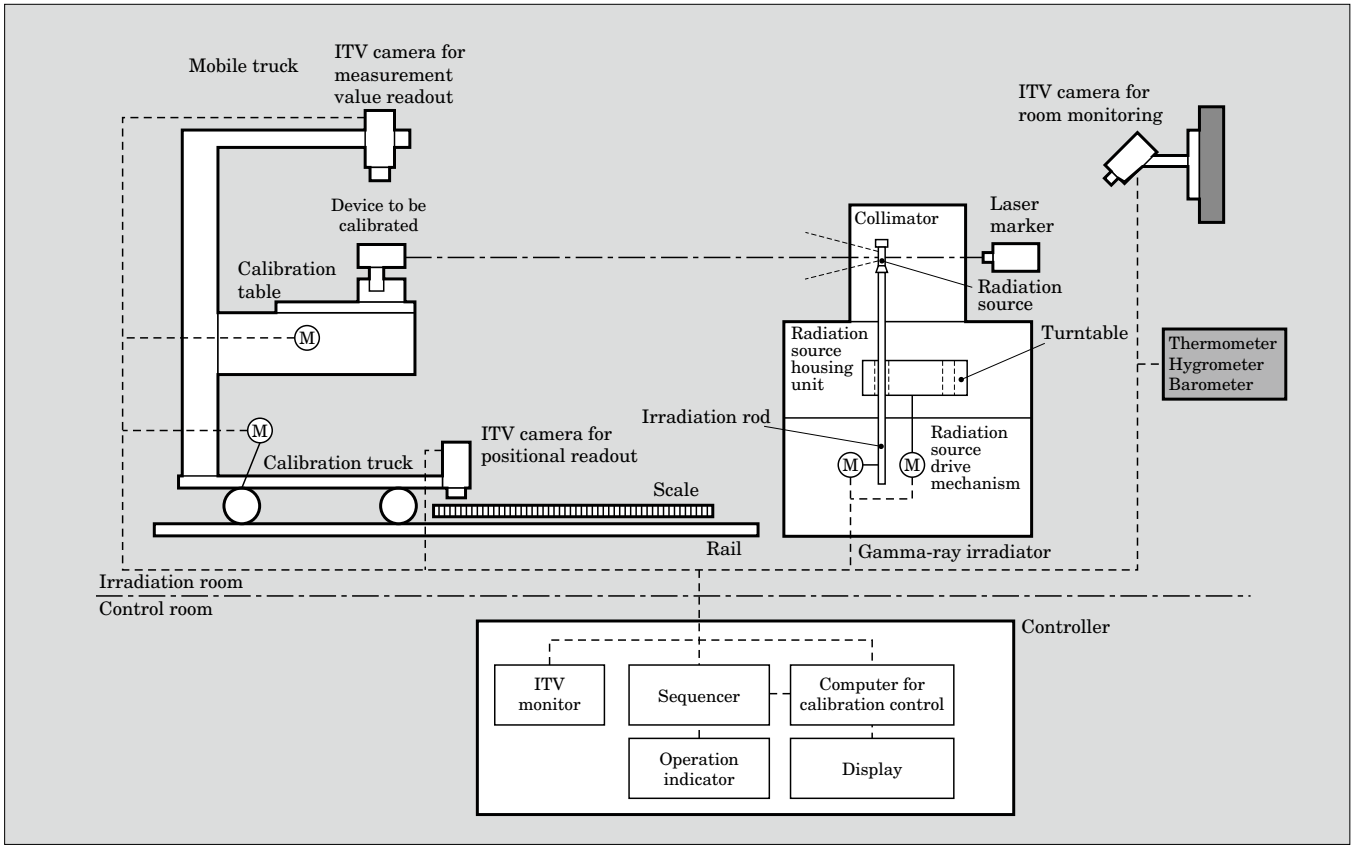


Fig.3 System configuration of gamma-ray calibrator (high level)



shows the external appearance, Fig. 6 shows the system configuration and Fig. 7 shows the calibration range of this gamma-ray calibrator.

3.2 Neutron calibrator

This calibrator uses a ^{252}Cf radiation source to calibrate neutron area monitors, rem counters, personal dosemeters and the like. This calibrator is configured from an irradiator and an apparatus (automatic conveyor) in which the device to be calibrated is placed, and calibrates with the dose equivalent of fast neutrons and thermal neutrons. Personal dosemeters are conveyed automatically by an automatic conveyor to the calibration location, and 24 personal dosemeters may be calibrated consecutively. Figure 8 shows the external appearance, Fig. 9 shows the system configuration and Fig. 10 shows the calibration range of this neutron calibrator. The apparatus shown in the front in Fig. 8 is the automatic conveyor and the rear apparatus is the irradiator that houses the radiation source.

Fig.5 Photograph of gamma-ray calibrator (middle level)

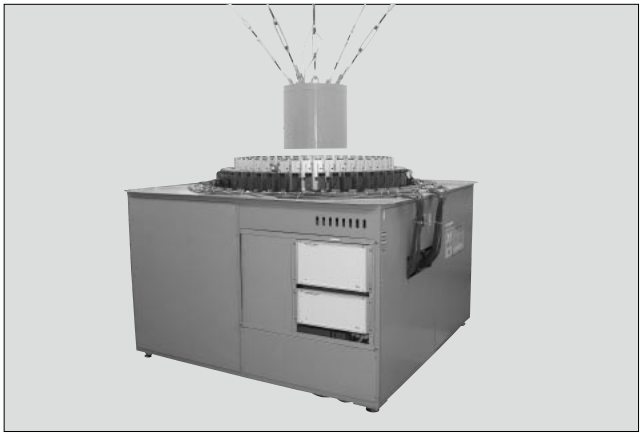


Fig.6 System configuration of gamma-ray calibrator (middle level)

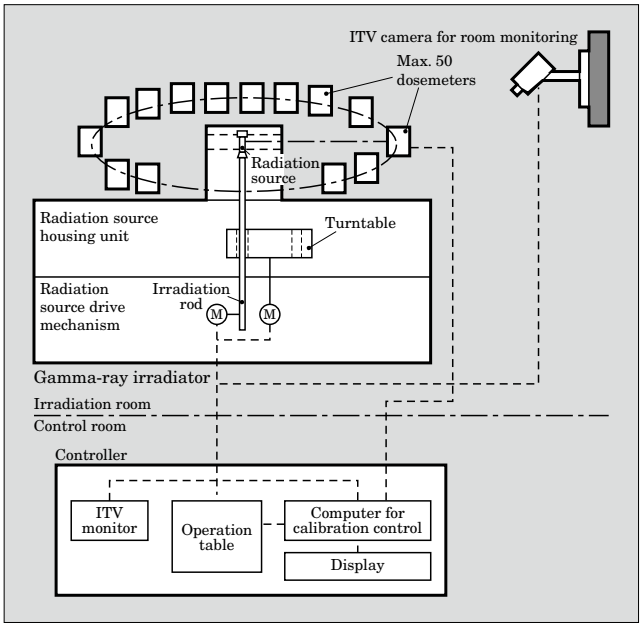


Fig.7 Calibration range of gamma-ray calibrator (middle level)

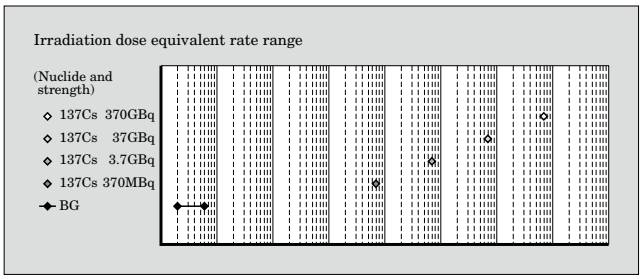


Fig.8 Photograph of neutron calibrator

Fig.9 System configuration of neutron calibrator (middle level)

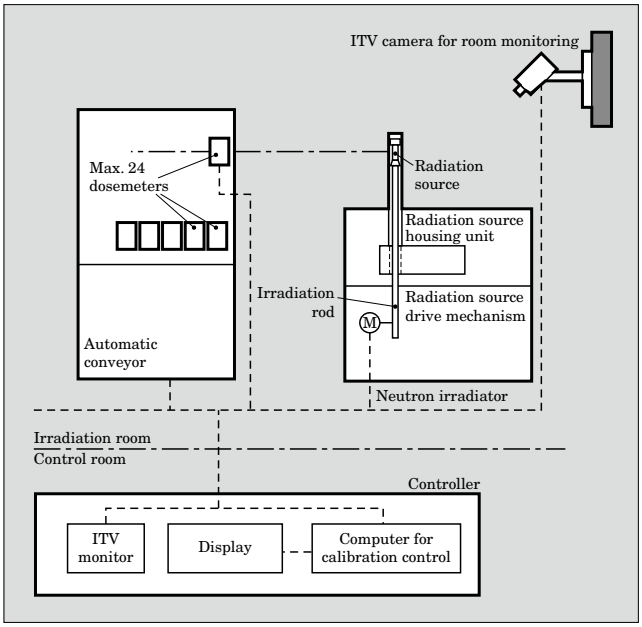


Fig.10 Calibration range of neutron calibrator (middle level)

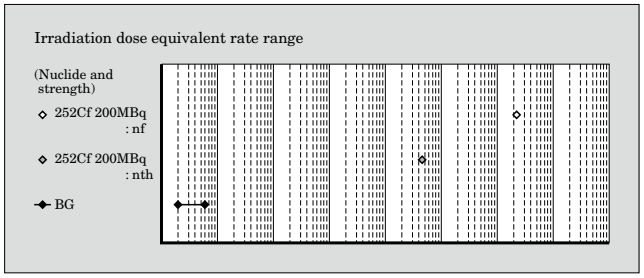


Fig.11 Photograph of beta-ray calibrator

3.3 Beta-ray calibrator

This calibrator uses a ^{90}Sr radiation source and this calibrator is dedicated for use with personal dosemeters (beta-rays). This calibrator is configured from a radiation source housing unit, a part on which to mount the device to be calibrated, an operation part and a computer. The radiation source is housed in the radiation source housing unit and the dosemeter is inserted through an inlet to the mounting part. Then, by setting the irradiation time duration from the operation part or from the computer and starting the calibration, the shutter will open and the calibration begins. After the preset irradiation time duration has elapsed, the shutter closes automatically and the calibration is completed, and personal dosemeter measurements are verified with the computer. Figure 11 shows the external appearance, Fig. 12 shows the system configuration and Fig. 13 shows the calibration range of this beta-ray calibrator.

Fig.12 System configuration of beta-ray calibrator (middle level)

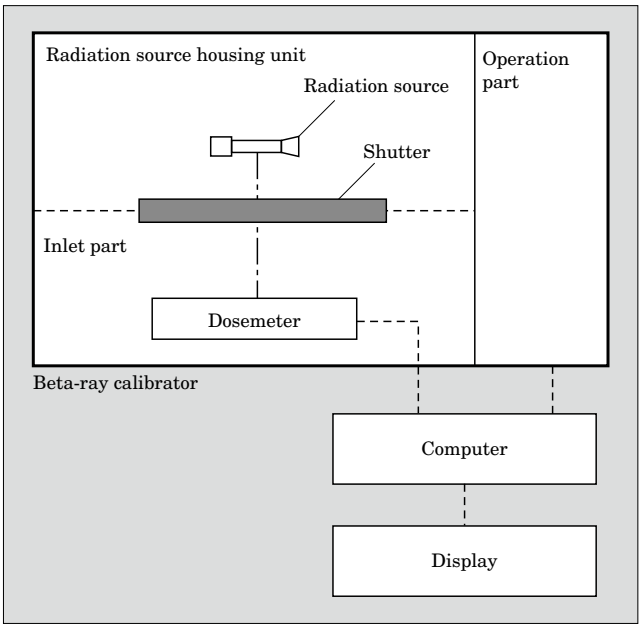
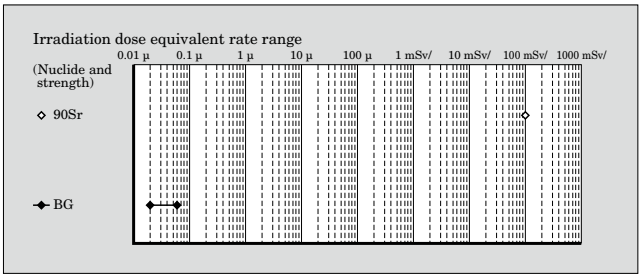


Fig.13 Calibration range of beta-ray calibrator



4. Postscript

This paper has introduced Fuji Electric's calibrators.

Monitoring by radiation measurement devices is of critical importance for ensuring the radiation safety in nuclear power plant facilities and surrounding areas, and the calibration of these devices ensures the reliability of the abovementioned monitoring and is an indispensable part of maintenance. To complement efforts to design, manufacture and sell radiation measurement devices, Fuji Electric intends to continue to maintain and improve the reliability of calibration equipment that is traceable to national standards.