

# Traceability of Calibration facility

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**Fuji Electric Systems Co.,Ltd.  
Tokyo Factory**

# FES Calibration Facility

Fuji Electric Systems Co.,Ltd deals with radiation measurement devices for radiation management to be used in the facility where deal with radioactive materials or nuclear fuel materials.

These devices are required to have high-reliable measurement accuracy, and appropriate calibration have to be performed to achieve it.

Fuji Electric Systems owns and operates 4 type calibrators to be applied to various needs for instruments calibration.

1) Gamma calibrator (High-level dose calibration room)

Device : Survey meter, Area monitor, spherical chamber  
 Source :  $^{137}\text{Cs}$ ,  $^{60}\text{Co}$ ,  $^{226}\text{Ra}$

2) Gamma calibrator (Middle-level dose calibration room)

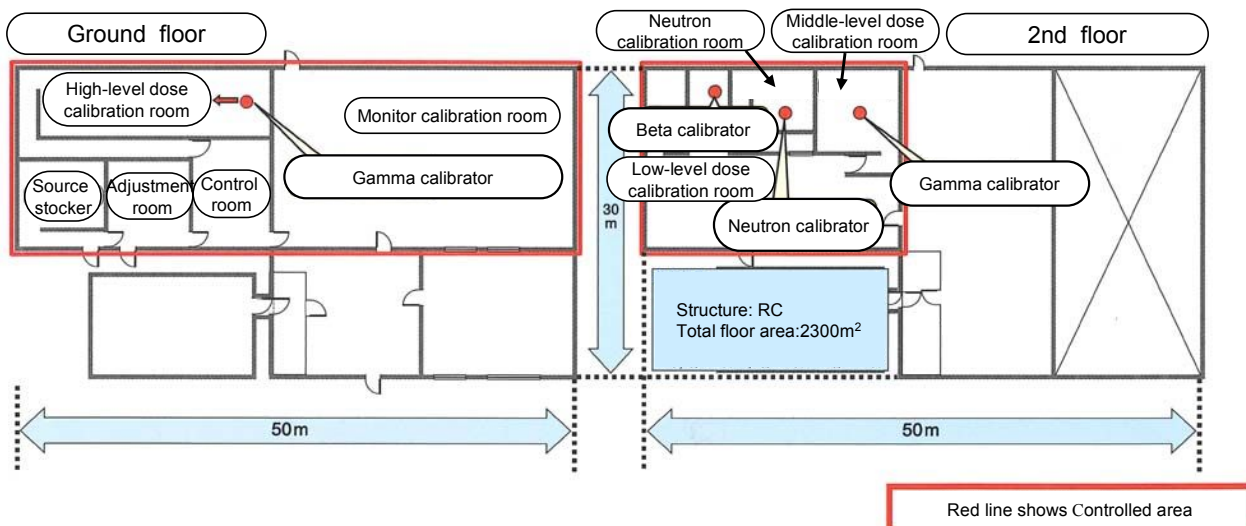
Device : Personal dosimeter, Environmental dosimeter  
 Source :  $^{137}\text{Cs}$

3) Neutron calibrator (Neutron calibration room)

Device : Neutron area monitor, Rem counter, Personal dosimeter  
 Source :  $^{252}\text{Cf}$

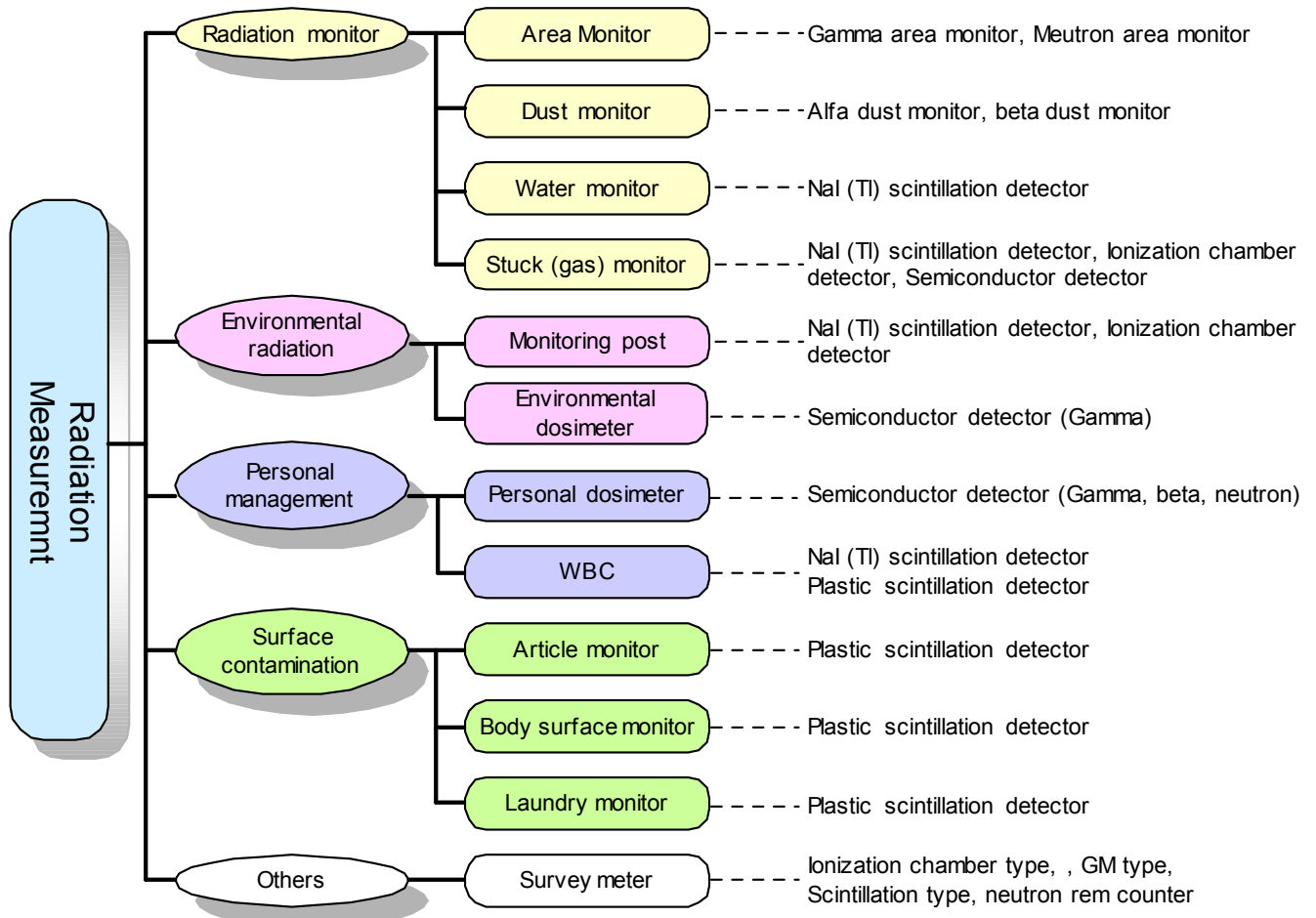
4) Beta calibrator (Low-level dose calibration room)

Device : Personal dosimeter  
 Source :  $^{90}\text{Sr}$



Red line shows Controlled area

# FES Radiation measurement devices



## Main Radiation Instruments



**Gamma area monitor (NEL)**

Si semiconductor detector  
 Measurement from  $10^{-1}$  to  $10^4 \mu\text{Sv/h}$   
 Energy range from 55 keV to 3 MeV



**Neutron area monitor (NDN)**

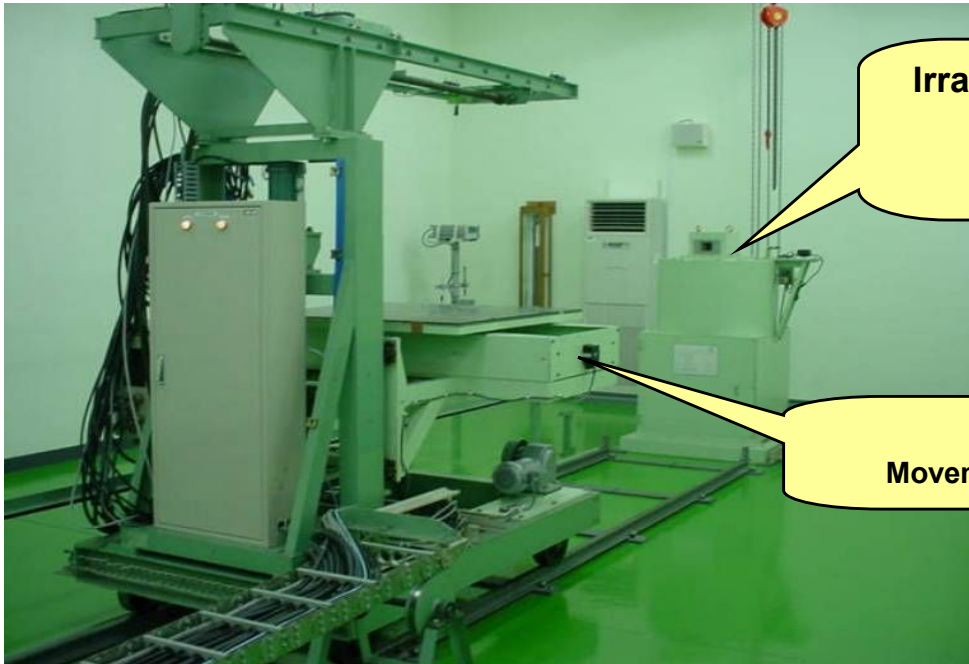
$^3\text{He}$  Proportional counter (2")  
 • Measurement from  $10^{-2}$  to  $10^3 \mu\text{Sv/h}$   
 • Energy range from 0.025 eV to 14 MeV



**Personal dosimeter (NRN)**

• Si semiconductor detector  
 • Radiation detected: Gamma, beta, neutron

# Gamma Calibrator (Type: N92-27) [High-level dose calibration room]



## Irradiator & Source vessel

<sup>137</sup>Cs: 6 sources  
<sup>60</sup>Co: 2 sources  
<sup>226</sup>Ra: 1 source

## Mobile truck

Movement from 0.8m to 8m

## Main devices to be calibrated



Survey meter



Area monitor



Spherical chamber

## Application

### Calibration with gamma source

Environ.BG to 100XmSv/h

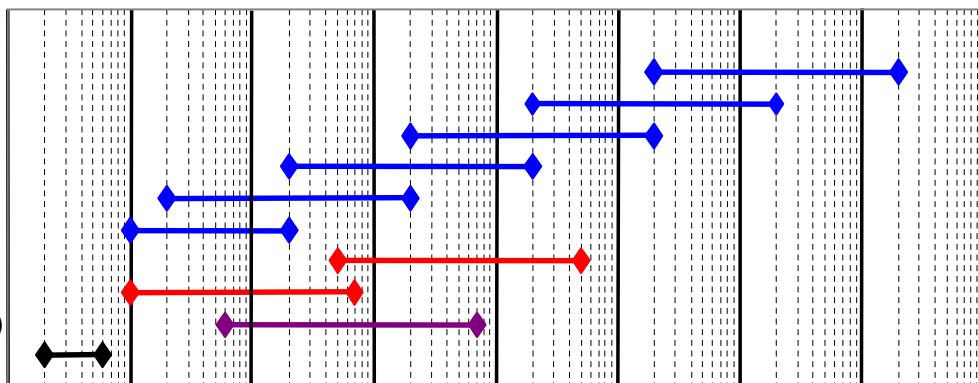
Calibrate area monitors, etc

- Dose rate linearity
- Energy response (3 nuclides)

## Irradiated dose

equivalent rate 0.01  $\mu$ Sv/h 0.1  $\mu$ Sv/h 1  $\mu$ Sv/h 10  $\mu$ Sv/h 100  $\mu$ Sv/h 1mSv/h 10mSv/h 100mSv/h 1000mSv/h

- ◆ <sup>137</sup>Cs (4.44TBq)
  - ◆ <sup>137</sup>Cs (370GBq)
  - ◆ <sup>137</sup>Cs (37GBq)
  - ◆ <sup>137</sup>Cs (3.7GBq)
  - ◆ <sup>137</sup>Cs (370MBq)
  - ◆ <sup>137</sup>Cs (37MBq)
  - ◆ <sup>60</sup>Co (37GBq)
  - ◆ <sup>60</sup>Co (370MBq)
  - ◆ <sup>226</sup>Ra (1.85GBq)
  - ◆ BG
- Gy/h only for <sup>226</sup>Ra



# Gamma Calibrator (Type: N92-53) [Middle-level dose calibration room]



Simultaneous irradiation of 50 units

Source vessel  
<sup>137</sup>Cs / 4 sources

## Main devices to be calibrated



**NRY series**  
(Gamma)



**NRN series**  
(Gamma+Beta, etc.)



**NSD**  
(Environmental)

## Application

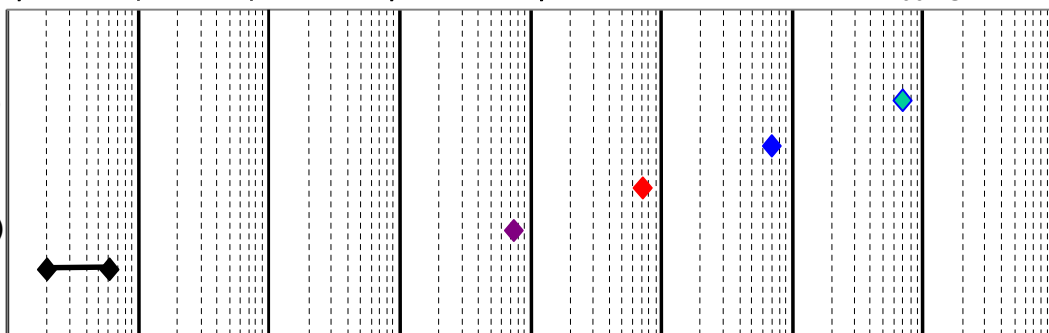
### Dosimeter calibration with gamma source

- Dedicated irradiator for dosimeter
- Simultaneous irradiation of 50 units

## Irradiated dose equivalent rate

0.01  $\mu$  Sv/h 0.1  $\mu$  Sv/h 1  $\mu$  Sv/h 10  $\mu$  Sv/h 100  $\mu$  Sv/h 1mSv/h 10mSv/h 100mSv/h 1000mSv/h

- ◆ <sup>137</sup>Cs (370GBq)
- ◆ <sup>137</sup>Cs (37GBq)
- ◆ <sup>137</sup>Cs (3.7GBq)
- ◆ <sup>137</sup>Cs (370MBq)
- ↔ BG



# Neutron Calibrator (Type:N92-52) [Neutron calibration room]



Source vessel  
 $^{252}\text{Cf}$

Dosimeter auto-carrying  
equipment

## Main devices to be calibrated



NRN series  
( $\gamma+\beta+n$ )



NRN series  
( $\gamma+n$ )



Rem-counter



Neutron area

## Application

### Calibration with neutron source

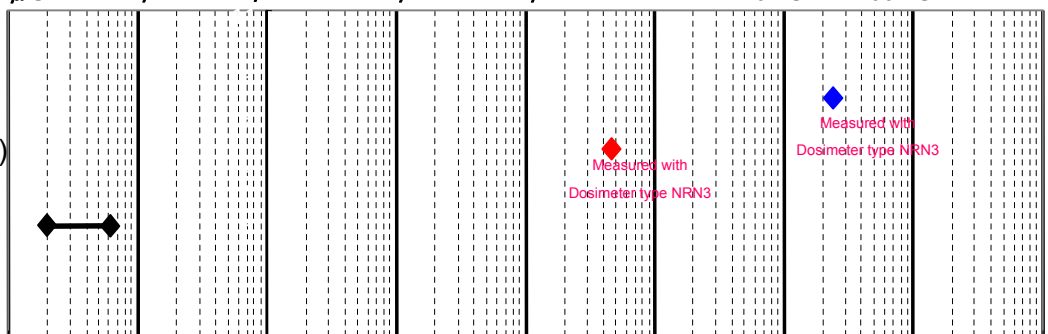
#### (substitution method)

- Continuous irradiation of 23 units
- Calibrate neutron area monitor and rem counter

Irradiated dose  
equivalent rate

0.01  $\mu\text{Sv/h}$    0.1  $\mu\text{Sv/h}$    1  $\mu\text{Sv/h}$    10  $\mu\text{Sv/h}$    100  $\mu\text{Sv/h}$    1mSv/h   10mSv/h   100mSv/h   1000mSv/h

- ◆  $^{252}\text{Cf}$  (200MBq:nf)
- ◆  $^{252}\text{Cf}$  (200MBq:nth)
- ← BG



# Beta Calibrator (Type: N92-62) [Low-level dose calibration room]



Source vessel  
 $^{90}\text{Sr}$ - $^{90}\text{Y}$

Dosimeter inlet

## Main devices to be calibrated



NRN series  
(Gamma + beta)



NRN series  
(Gamma + beta + n)

## Application

Calibration with neutron source  
(substitution method)

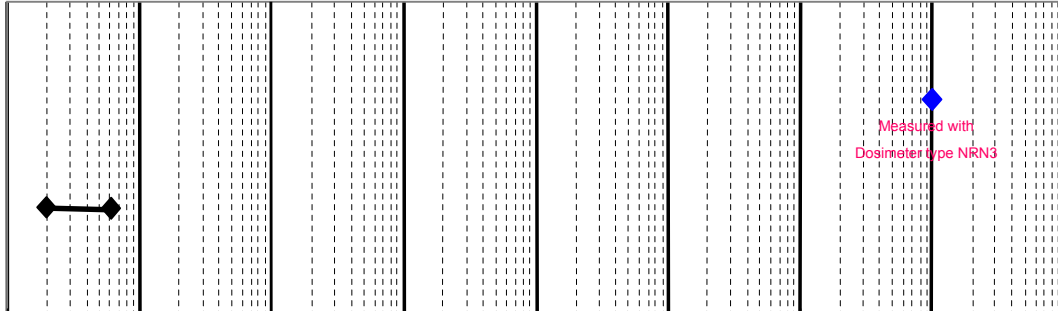
\* Dedicated for personal dosimeter

Irradiated dose equivalent rate

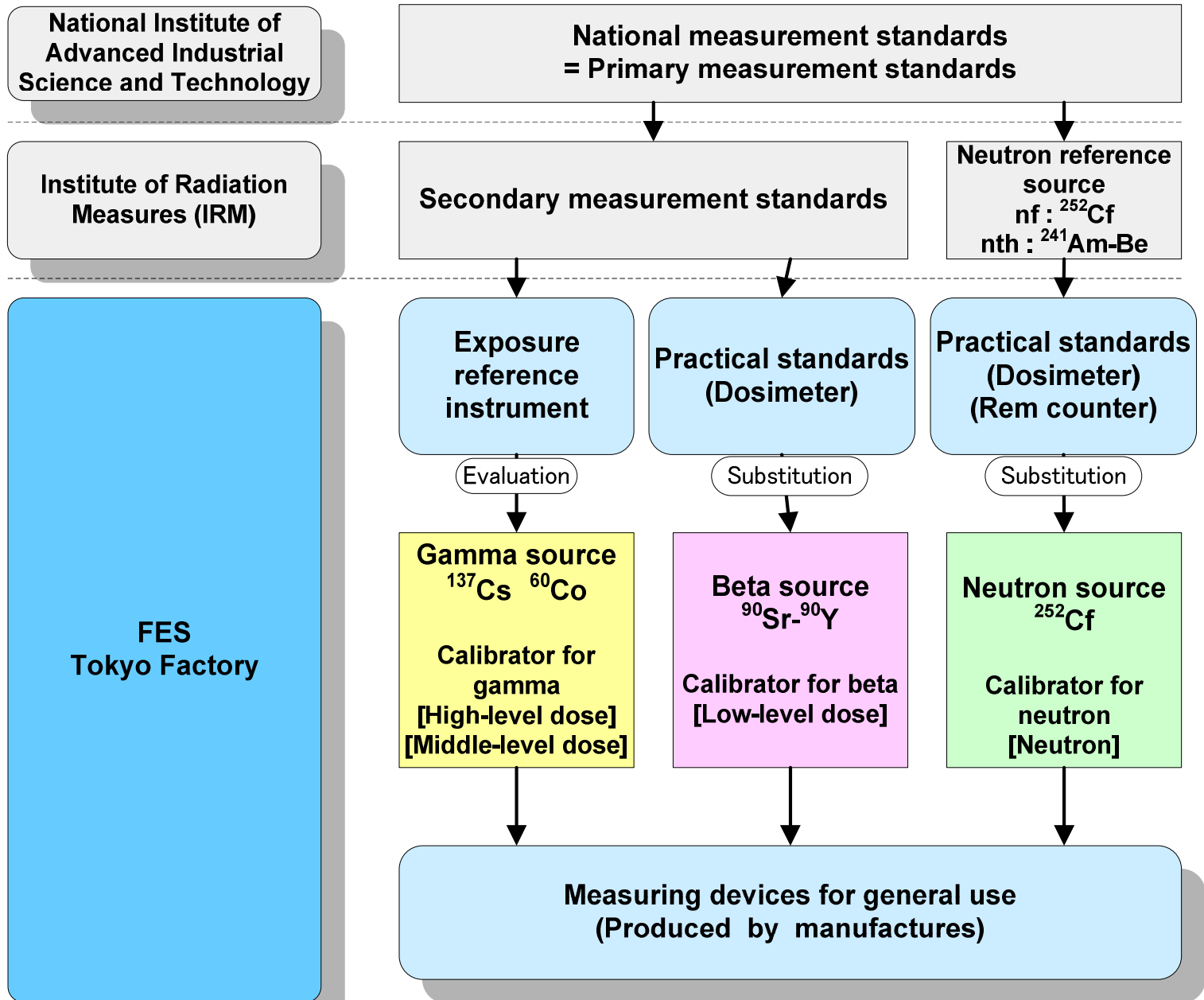
0.01  $\mu\text{Sv/h}$  0.1  $\mu\text{Sv/h}$  1  $\mu\text{Sv/h}$  10  $\mu\text{Sv/h}$  100  $\mu\text{Sv/h}$  1mSv/h 10mSv/h 100mSv/h 1000mSv/h

◆  $^{90}\text{Sr}$  (74MBq)

↔ BG



# Dissemination system of measurement standards



## Exposure reference instrument & Practical standards

### 1. Irradiated dose of gamma

[Ion-chamber type exposure meter]

A6-type (detector) / EXTRADIN

TN32002 (detector) / PTW

RAMTEC1000D (Measuring assembly) / Toyo medic

### 2. Practical standards for beta

[Dosimeter] NRN0, NRN1, NRN3, NRN6 / Fuji Electric Systems

### 3. Practical standards for neutron

[Dosimeter] NRN0, NRN3, NRN5 / Fuji Electric Systems

[Rem counter] NSN10001 / Fuji Electric Systems

