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Environmental Sampling Technique

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“Environmental Radiation Monitoring During Decommissioning of Nuclear Facilities”

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Biography

- Name : Teguh Permana
- Education : Bachelor of Nuclear Engineering, Gadjah Mada University, Yogyakarta.
- Occupation : Personnel Dose and Environmental Monitoring Laboratory Serpong
  Environmental Safety – Radioactive Waste Management Facility
  Directorate of Nuclear Facility Management
  National Research and Innovation Agency (BRIN)
- Training Courses :

*) Advanced Instructor Training Course on Environmental Radioactivity Monitoring, Japan (2024)

*) Regional Workshop on Development of National Radiation Emergency Plan (NREP) (Including Hazard Assessment), Thailand (2024)

*) Monitoring Training of Terrestrial Radioactivity in the Nuclear Emergency System, Ukraine (2021)

*) Advanced Instructor Training Course on Nuclear / Radiological Emergency Preparedness (Online Training Course), JAEA (2021)

*) Instructor Training Course on Environmental Radioactivity Monitoring, Japan (2019)

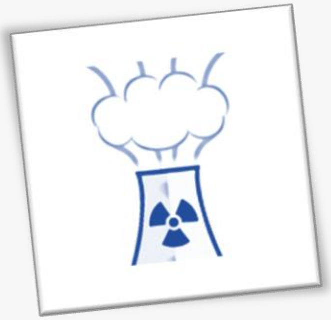
Background

Nuclear Facility

Discharge and Release of Radioactive Materials into environment

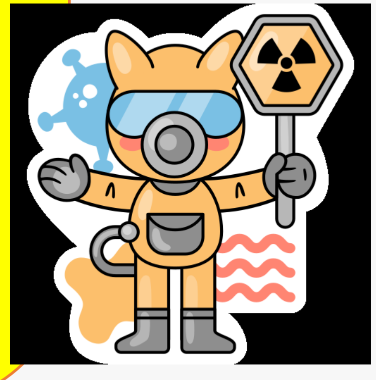
Radiation protection

Environmental sampling is important



Benefit

Participants can understand how to take environmental samples



Basic Competency

Participants are expected to explain **environmental sampling techniques**

Success Indicators

- To brief the overview of environmental sampling
- To explain the techniques of environmental sampling

Contents

Environmental Radioactivity Sampling ?

Environmental radioactivity sampling involves collecting samples from air, water, soil, and biota to measure natural and artificial radionuclides.

Purpose :

- To assess environmental radiation levels
- To evaluate exposure to the public and biota
- To detect contamination from nuclear facilities or fallout
- To provide baseline and trend data

Objectives of Sampling

- Obtain representative samples
  The sample should truly reflect the environmental conditions of the site. It must capture spatial and temporal variations of radionuclide concentrations. Use proper sampling design (random, grid, or composite) to avoid bias.

- Minimize contamination and loss
  Prevent outside materials (dust, residues, hands, tools) from contaminating the sample.Use clean, dedicated, or disposable equipment. Avoid spilling or evaporating volatile radionuclides (e.g., tritium).

- Maintain sample integrity
  Keep samples in their original physical and chemical state. Use appropriate containers and preservatives (e.g., cooling, acidifying water samples).Record date, location, and handling steps to ensure traceability.

- Ensure accurate and reproducible results
  Follow standardized procedures for sampling and analysis. Calibrate instruments regularly. Collect duplicates or blanks to verify precision and consistency.

Principles of Sampling (1/3)

1. **Representativeness**

- The sample must **accurately reflect the true environmental conditions** at the sampling site.
- Representative sampling ensures that the measured radioactivity corresponds to the actual contamination level of the medium (air, water, soil, etc.).
- Achieved by proper **sampling design**, **adequate sample size**, and **consistent procedures**.

2. **Homogeneity**

- Before subsampling, the sample should be **uniformly mixed or homogenized** to ensure even distribution of radionuclides.
- This minimizes variability between portions taken for analysis.
- Especially important for **soil, sediment, and biological samples**, where particle size or moisture can affect radionuclide distribution.

Principles of Sampling (2/3)

3. Contamination Control

- Prevent introduction of **foreign radioactive or non-radioactive materials** during collection, handling, or storage.
- Use **clean, dedicated equipment** and wear gloves.
- Clean sampling tools between sites and avoid contact with surfaces that may carry contaminants.
- Contamination control ensures **data accuracy and reliability**.

4. Preservation

- Maintain the **physical and chemical integrity** of the sample until laboratory analysis.
- Use proper **temperature, sealing, and storage conditions** to prevent radionuclide loss, leaching, or transformation.
- For example, water samples are kept refrigerated, and soil samples are air-dried or frozen as required.

Principles of Sampling (3/3)

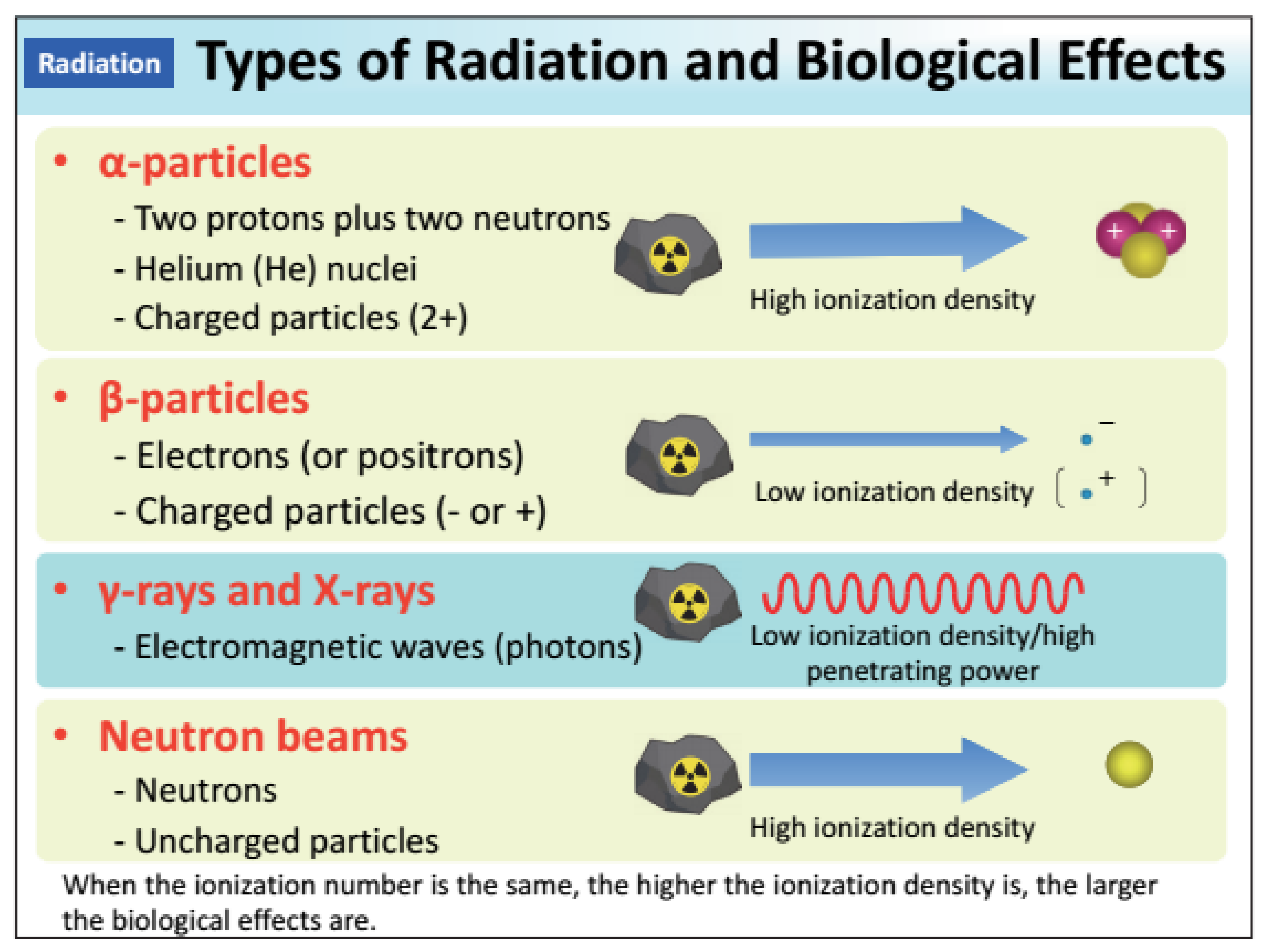
5. Documentation

- Every step in sampling must be **well-documented** to maintain traceability and quality assurance.
- Includes:
  - **Chain of custody** – records transfer of samples between handlers.
  - **Field logbook** – records environmental conditions, equipment, and procedures used.
  - **Labeling** – ensures correct sample identification.
- Proper documentation supports **data integrity, verification, and regulatory compliance**.

Type of Sampling

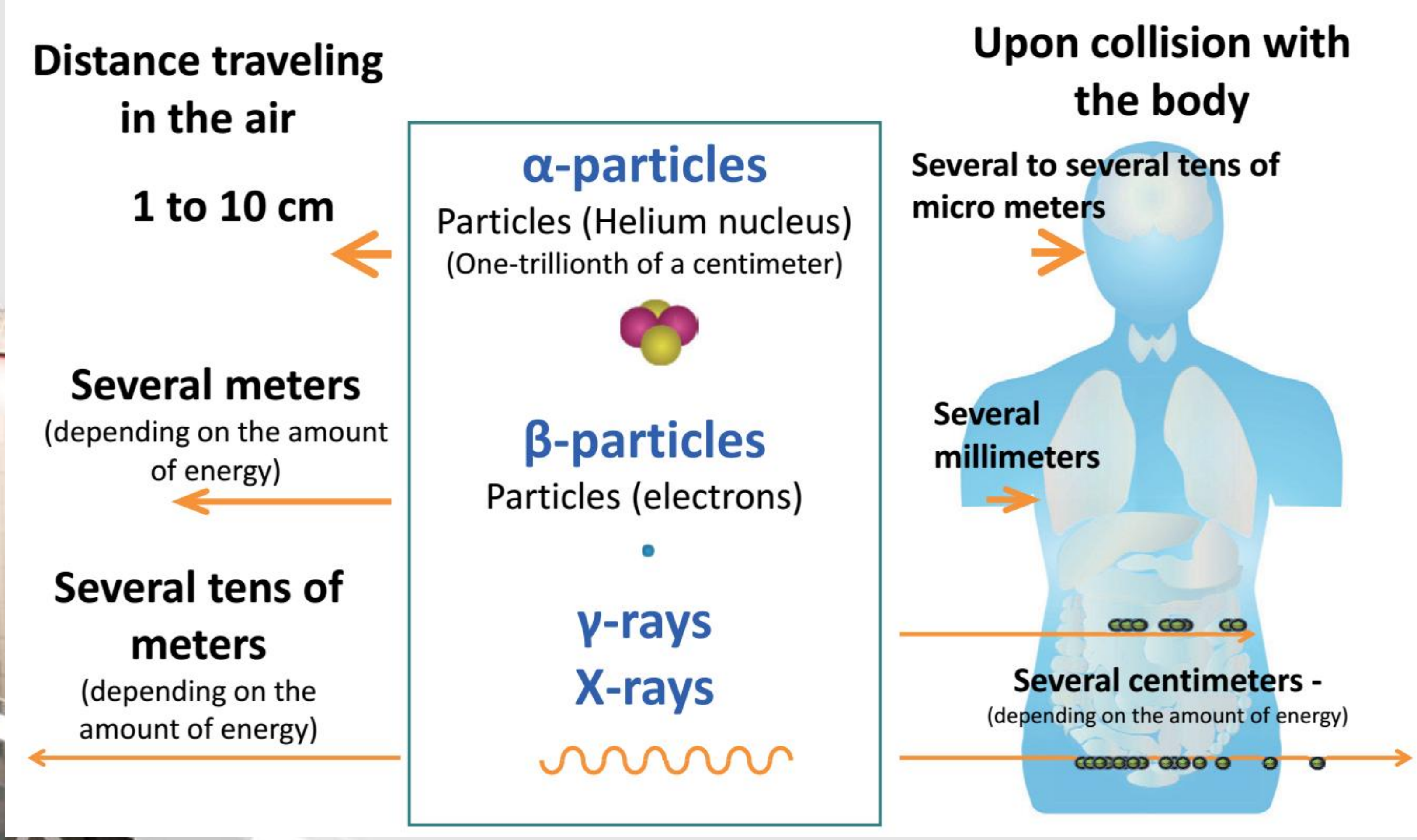
Type	Description	Explanation
Routine Monitoring	Regular surveillance to detect trends	Conducted periodically (e.g., weekly, monthly, or annually) to observe long-term changes in environmental radioactivity. It helps identify gradual increases or decreases in radiation levels and ensures compliance with safety standards.
Emergency Sampling	After nuclear accident or release	Performed immediately after an accidental or unplanned release of radioactive material (e.g., from a reactor, laboratory, or transport accident). The goal is to quickly assess contamination levels, determine affected areas, and support emergency response actions.
Research Sampling	For environmental or radioecological studies	Carried out for scientific investigation, such as studying radionuclide behavior, transfer in ecosystems, or validating models of radioactive dispersion and dose assessment. Often involves specialized designs and multiple sample types.

Introduction



Introduction

Penetrating Power of Radiation



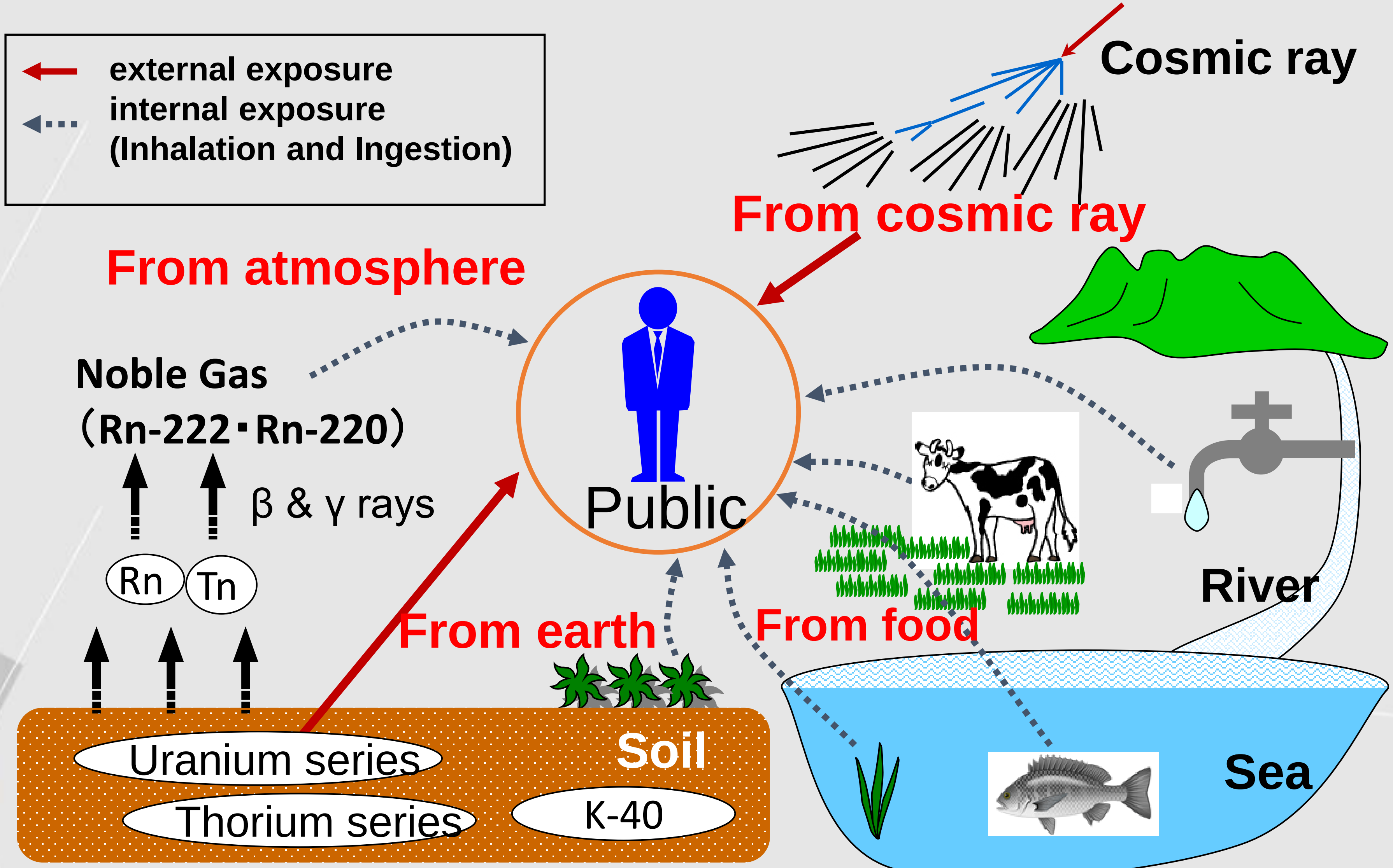
Introduction

Type of Exposure

- Exposure
  - External Exposure
    - Direct from radiation sources
    - Radiation from plume, contaminated ground surface and water
  - Internal Exposure
    - Inhalation of contaminated air
    - Ingestion (Intake of contaminated water & foodstuffs)
    - Absorption (breaks in the skin)

Introduction

Natural Radioactive Sources



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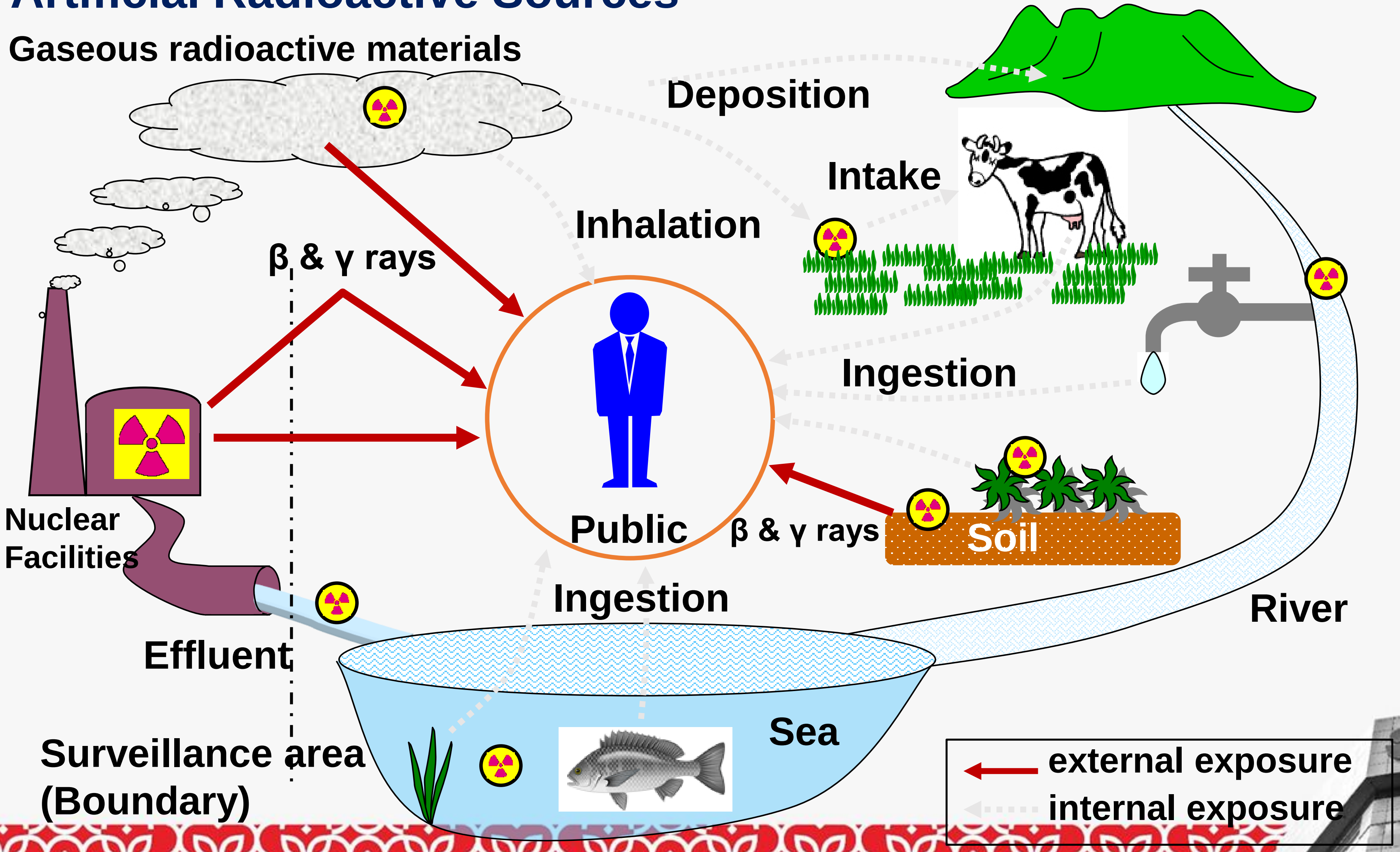
Artificial Radioactive Sources



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FISSION AND ACTIVATION PRODUCTS WHICH MAY BE OF CONCERN IN HUMAN EXPOSURE

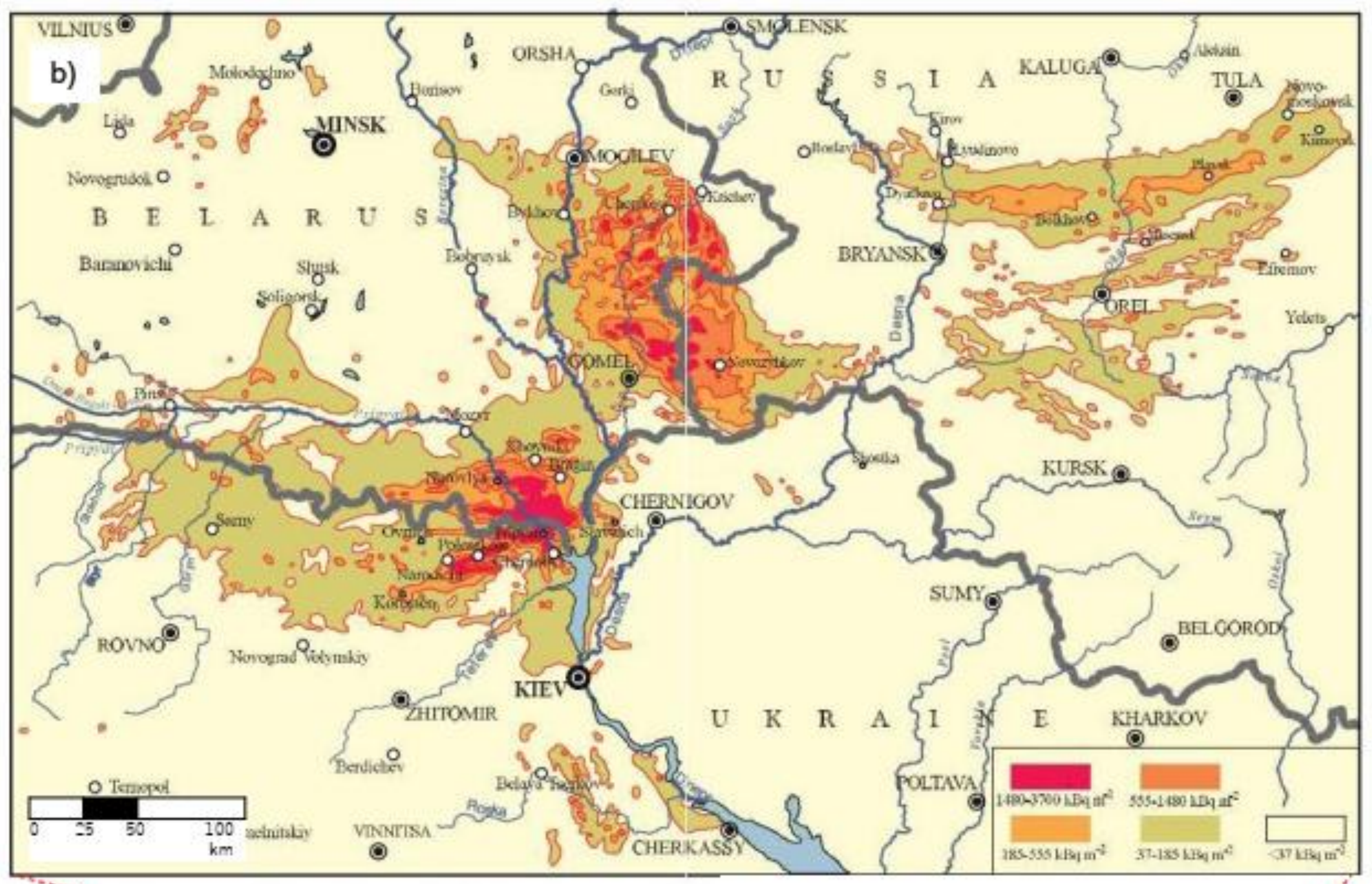
	Nuclide[a]	Half-life[b]	Fission yield %	Major decay
Fission products	Sr-89	50.5 d	4.77	β^-
	Sr-90*, Y-90	28.7 a, 64.1 h	5.76	β^-, β^-
	Zr-95, Nb-95	64.09 d, 35.0 d	6.51	$\beta^-\gamma$, $\beta^-\gamma$
	Mo-99*, Tc-99m*	2.747 d, 6.006 h	6.09	$\beta^-\gamma$, $\beta^-\gamma$
	Ru-103*, Rh-103m*	39.272 d, 56, 116 min	3.03	$\beta^-\gamma$, $\beta^-\gamma$
	Ru-106, Rh-106*	372.6 d, 29.92 s	0.4	β^-, $\beta^-\gamma$
	Te-129m	33.6 d	0.661	$\beta^-\gamma$
	I-131*	8.021 d	2.875	$\beta^-\gamma$
	Te-132*, I-132	76.856 h, 2.3 h	4.282	$\beta^-\gamma$, $\beta^-\gamma$
	Cs-137, Ba-137m	30.0 a, 2.55 min	6.136	β^-, γ
	Ba-140*, La-140*	12.751 d, 1.6779 d	6.134	$\beta^-\gamma$, $\beta^-\gamma$
	Ce-144*, Pr-144	284.45 d, 17.28 d	5.443	$\beta^-\gamma$, $\beta^-\gamma$
Activation products	H-3*	12.35 a		β^-
	C-14	5730 a		β^-
	Fe-55*	2.75 a		EC
	Fe-59*	44.53 d		$\beta^-\gamma$
	Mn-54	312.5 d		EC, γ
	Co-60	5.27 a		$\beta^-\gamma$
	Zn-65*	243.9 d		EC, γ
	Cs-134*	754.2 d		$\beta^-\gamma$
	Np-239*	2.355 d		$\beta^-\gamma$
	Pu-241, Am-241*	14.35 a, 432.0 a		β^-, $\alpha\gamma$
	Cm-242*	162.94 d		α
	Pu-238*	87.7 a		α
	Pu-239*	2.411×10^4 a		α
	Pu-240*	6.563×10^3 a		α
	Pu-242*	3.735×10^5 a		α

Introduction

RADIONUCLIDES OF SPECIFIC INTEREST IN FOODS AND THE ENVIRONMENT

Air	^{131}I, ^{134}Cs, ^{137}Cs
Water	^{3}H, ^{89}Sr, ^{90}Sr, ^{131}I, ^{134}Cs, ^{137}Cs
Milk	^{89}Sr, ^{90}Sr, ^{131}I, ^{134}Cs, ^{137}Cs
Meat	^{134}Cs, ^{137}Cs
Other foods	^{89}Sr, ^{90}Sr, ^{134}Cs, ^{137}Cs
Vegetation	^{89}Sr, ^{90}Sr, ^{95}Zr, ^{95}Nb, ^{103}Ru, ^{106}Ru, ^{131}I, ^{134}Cs, ^{137}Cs, ^{141}Ce, ^{144}Ce
Soil	^{90}Sr, ^{134}Cs, ^{137}Cs, ^{238}Pu, $^{239+240}Pu$, ^{241}Am, ^{242}Cm

Surface Ground Deposition in Belarus, 1998.



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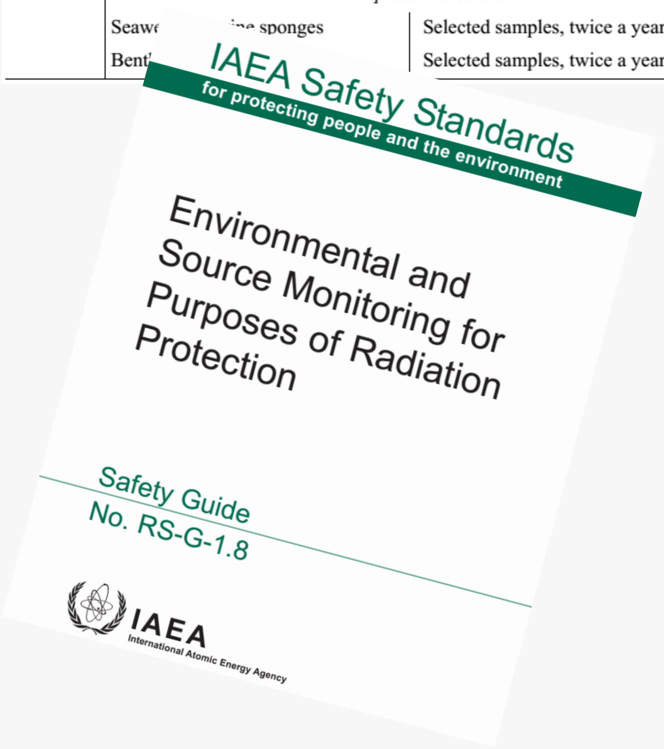
Environmental Monitoring (IAEA RS-G-1.8)

TABLE 3. ENVIRONMENTALLY MONITORED CONSTITUENTS AND FREQUENCIES OF SAMPLING AND MEASUREMENT FOR NORMAL DISCHARGES OF RADIONUCLIDES TO THE ENVIRONMENT

Discharge	Monitored constituents	Frequency
	External radiation	
Airborne	Gamma dose rate	Continuously
	Gamma dose — integrated	Twice a year
	Neutron dose rate (if neutron radiation is foreseen)	Continuously
	Neutron integrated (if neutron radiation is foreseen)	Twice a year
	Air, deposition	
	Air	Continuous collection, weekly to monthly measurement
	Rain	Continuous collection, monthly measurement
	Deposition	Continuous collection, monthly measurement
	Soil	Once a year
	Foodstuff and/or ingestion	
	Leafy vegetables	Each month during growing season
	Other vegetables and fruits	Selected samples, at harvest
	Grain	Selected samples, at harvest
	Milk	Each month when cows are on pasture
	Meat	Selected samples, twice a year
	Drinking water and/or groundwater	Twice a year
	Terrestrial indicators	
	Grass	Each month when cattle are on pasture
	Lichen, mosses, mushrooms	Selected samples, once a year
	Aquatic dispersion	
Liquid	Surface water	Continuous sampling, monthly measurement
	Sediment	Once a year

TABLE 3. ENVIRONMENTALLY MONITORED CONSTITUENTS AND FREQUENCIES OF SAMPLING AND MEASUREMENT FOR NORMAL DISCHARGES OF RADIONUCLIDES TO THE ENVIRONMENT (cont.)

Discharge	Monitored constituents	Frequency
	Aquatic foodstuffs	
	Fish	Selected samples, once a year
	Shellfish	Selected samples, once a year
	Aquatic indicators	
	Seawe[illegible]ine sponges	Selected samples, twice a year
	Bent[illegible]	Selected samples, twice a year



ENVIRONMENTAL MONITORING

Air samples, 4 points / month

Sediment samples, 9 points / 6 month

Surface water samples, 12 points / month

Grass samples, 24 points / year

Soil samples, 24 points / 6 month

Drinking water samples, 16 points / 6 month

ENVIRONMENTAL MONITORING PROGRAM IN Ibaraki Prefecture

Table 2-1 Environmental samples of monitoring program in Ibaraki Pref. (1/2)

Items	Frequency (times / year)	Radionuclides
Dust	Every week [4]	Multi γ-RI, [$^{239, 240}$Pu]
Fallout	12	Multi γ-RI
Milk	2 [4]	Multi γ-RI, ^{90}Sr, [^{131}I]
Vegetable	2	Multi γ-RI, ^{90}Sr, ^{131}I
Polished rice	1	Multi γ-RI, ^{90}Sr, ^{14}C
Soil	2	Multi γ-RI
River bed Soil	2	Multi γ-RI

Multi γ-RI：^{54}Mn, ^{60}Co, ^{95}Zr, ^{95}Nb, ^{106}Ru, ^{137}Cs, ^{144}Ce

Table 2-2 Environmental samples of monitoring program in Ibaraki Pref. (2/2)

Items	Frequency (times / year)	Radionuclides
Beach sand	2	Multi γ-RI
River water	2	Multi γ-RI, ^{3}H
Marsh water	2	Multi γ-RI, ^{3}H
Drinking water	2	Multi γ-RI, ^{3}H, U
Sea water	2 [4]	Multi γ-RI, ^{90}Sr, [^{3}H]
Sea soil	4	Multi γ-RI, ^{90}Sr, $^{239, 240}$Pu
Marine products	2	Multi γ-RI, ^{90}Sr, $^{239, 240}$Pu
Sand at outlet drain	2	Facility characteristic nuclide

	Sample
Terrestrial Environment Monitoring	Ambient dose rate (Monitoring Post: 8 systems, Monitoring Station 5 systems) Cumulative dose (TLD: in-site 15 points, off-site 25 points) Radioactivity in air (Particulates, Iodine, Rare Gas, Atmospheric Water (humidity)) Rain water, Fallout Plants (Polished Rice, Leafy Vegetables, Milk) Water (Drinking Water, River Water) Soil (Surface Soil, River Bed Sediment)
Marine Environment Monitoring	Water (Seawater: 8 points, Beachwater: 3 points) Soil (Seabed Sediment: 8 points, Beachsand: 3 points) Marine Products (Fish (Whitebait, Flatfish), Seaweed, Shellfish) Dose rate (Fishing Net, Boat Beck)

	Radionuclides
Terrestrial Environment Monitoring	**Gross alpha, Gross beta** **Gaseous beta radioactivity (Kr-85)** **H-3, C-14** **Sr-90, I-131, Cs-137, Pu-239,240**
Marine Environment Monitoring	**Gross beta** **H-3** **Sr-90, Ru-106, Cs-134,** **Cs-137, Ce-144, Pu-239,240**

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JAEA Normal Monitoring

➢ Considering factors for the monitoring design

(i) Types of facilities and its potential hazard.

- Types of Nuclear Facilities -

- Nuclear Reactor Facilities
- Reprocessing Facilities
- Fuel Fabrication Facilities
- Fuel Use Facilities
- Radioisotope Use Facilities
- Radioactive Waste Disposal Facilities

(ii) Nuclides to be released, their activity, their physical and chemical form, how to release and its route.

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➤ Radionuclides for Dose Evaluation of Public

Type of facility	Radionuclides
Nuclear reactor facilities	Gas : radioactive noble gas, radioactive iodine Liquid : ^{3}H, ^{51}Cr, ^{54}Mn, ^{59}Fe, ^{58}Co, ^{60}Co, ^{89}Sr, ^{90}Sr, ^{131}I, ^{134}Cs, ^{137}Cs
Reprocessing facilities	Gas : ^{3}H, ^{14}C, ^{60}Co, ^{90}Sr, ^{106}Ru, ^{137}Cs, ^{239}Pu, ^{240}Pu, radioactive noble gas, radioactive iodine Liquid : ^{3}H, ^{60}Co, ^{90}Sr, ^{106}Ru, ^{129}I, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{241}Am, ^{244}Cm
Fuel fabrication facilities	Gas : U Liquid : U
Radioactive waste facilities	Gas : ^{3}H, ^{14}C, ^{60}Co, ^{59}Ni, ^{63}Ni, ^{90}Sr, ^{94}Nb, ^{99}Tc, ^{129}I, ^{137}Cs, gross alpha Liquid : ^{3}H, ^{14}C, ^{60}Co, ^{59}Ni, ^{63}Ni, ^{90}Sr, ^{94}Nb, ^{99}Tc, ^{129}I, ^{137}Cs, gross alpha

Source: Application of license
Kansai Electric Power Co., Inc. / Tohoku Electric Power Co., Inc.
Japan Nuclear Fuel Limited / Global Nuclear Fuel - Japan Co., Ltd.

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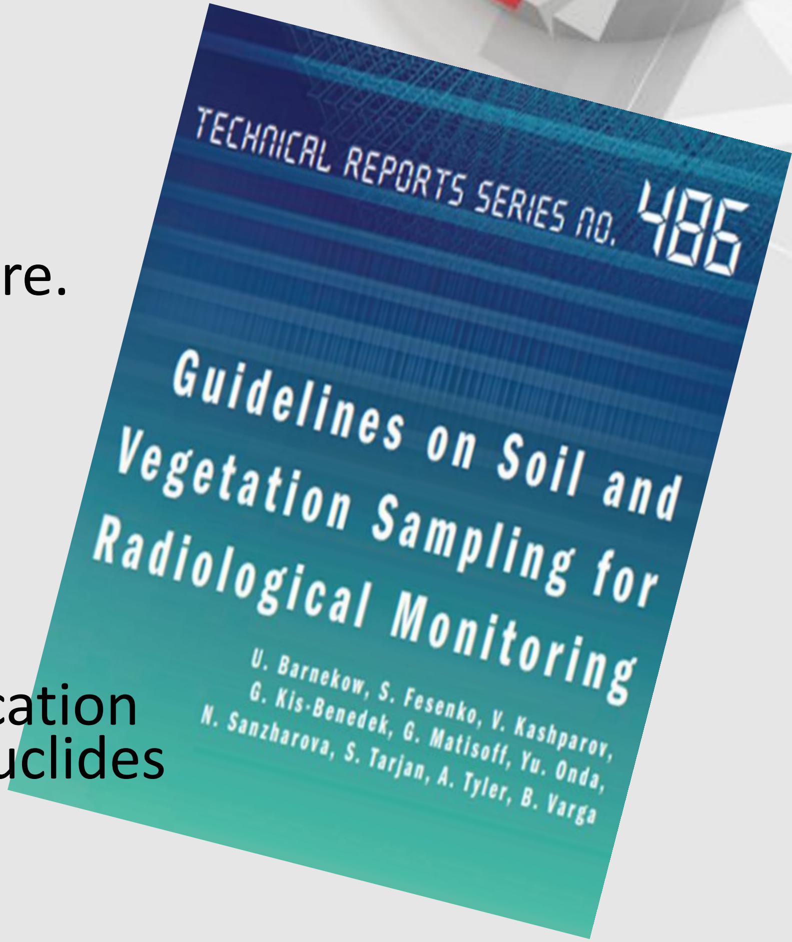
Essential key words to make a sampling plan

1. Radiation transfer pathway

Radiation transfer pathway determined from lifestyle habit indicates items which cause be able to the radiation exposure.

2. Critical radionuclide
Characteristic nuclides that produced during operation of nuclear facilities can distinguish artificial products from natural existence.

• The main purpose of the analysis should be quick identification of the most critical samples and the most important radionuclides so that the necessary rapid actions can be carried out.



Sampling

Measurement of trace amount of radioactivity

Procedure of analysis of environmental sample

Sampling → Pre-treatment → Measurement → Evaluation

Choice of appropriate Samples

Sampling frequency

Depending on such as
Type of facilities, its potential hazard,
Pathways of Radioactive Materials,
critical group

Sampling method

Depending on such as
Types of samples, target radiation, chemical form, etc.

Amount of each sample

Close relationship with detection limit

General Procedure

Preparation

Sample location identification

Sampling

Sample packaging and labeling

Contamination control

Sample delivery

Sample Handling and Preservation (1/2)

- **Use clean, labeled containers**

- Containers must be **pre-cleaned and made of suitable materials** (e.g., polyethylene, glass, or stainless steel) to avoid contamination or adsorption of radionuclides.
- Each container should be **clearly labeled** with:
  - Sample IDE
  - Sampling date and time
  - Location or GPS coordinates
  - Type of sample (e.g., soil, water, air filter)
- Proper labeling ensures traceability and prevents mix-ups during analysis.

- **Avoid cross-contamination**

- Use **separate tools and gloves** for each sample.
- Clean all sampling equipment between sites using **distilled water or decontamination solutions**.
- Keep samples **sealed and isolated** from other materials or potential contaminants.
- Cross-contamination can cause **false readings** of radioactivity, leading to inaccurate conclusions.

Sample Handling and Preservation (2/2)

- **Keep at appropriate temperature**

➢ Temperature control prevents **chemical or biological changes** that could affect radionuclide concentration.
➢ For **water or biological samples**, store at **4°C (refrigerated)** until analysis.
➢ Soil and sediment samples should be air-dried or kept at ambient conditions if drying is not possible immediately.
➢ Avoid direct sunlight and excessive heat during transport.

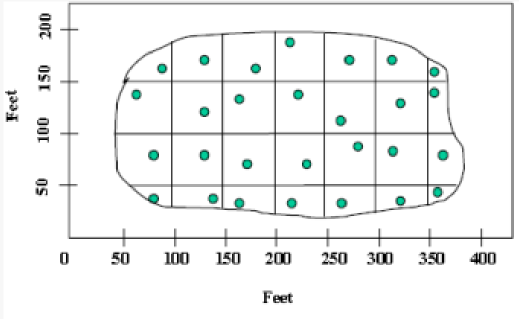
- **Record sample ID, date, GPS, collector name**

➢ Maintain **detailed field records** for traceability and quality assurance.
➢ Essential information includes:
  ❖ **Sample ID:** Unique code for each sample
  ❖ **Date & Time:** To track temporal variation
  ❖ **GPS Coordinates:** Exact sampling location
  ❖ **Collector Name:** Person responsible for sampling
➢ This data ensures **accountability**, supports **QA/QC**, and enables **accurate data mapping** during environmental assessments.

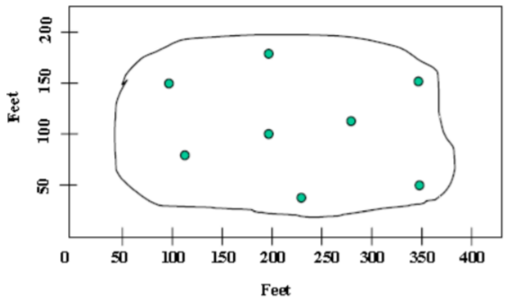
Sampling Design

TABLE 5. SAMPLING TECHNIQUES FOR ENVIRONMENTAL MONITORING

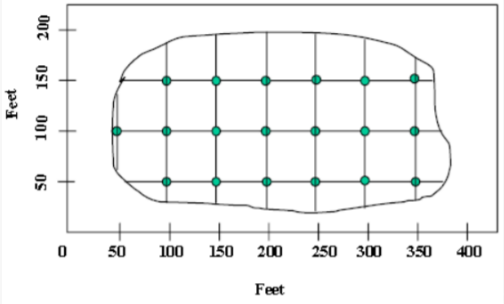
Sampling technique	Description	Comment
Judgemental sampling	Sample is taken on the judgement of the sampling person	Increased probability of biased sampling; representativeness cannot be quantified; accuracy cannot be quantified
Simple random sampling	Any sample has the same probability of being included	Provides representativeness; problems may arise with inhomogeneous terrain
Stratified sampling	The sample in its entirety is divided into parts that are known to be more homogeneous; simple random sampling is then applied to the remaining subdivisions	Requires knowledge of the inhomogeneity of the entire sample; may lead to bias if the fractions of the samples are not properly estimated
Systematic sampling	Starting from a randomly selected point, sampling follows a strict predefined sampling grid	In comparison with random sampling, easier to implement in practice; spatial contamination patterns may be overlooked



Gambar 5 *Systematic Random Sampling*



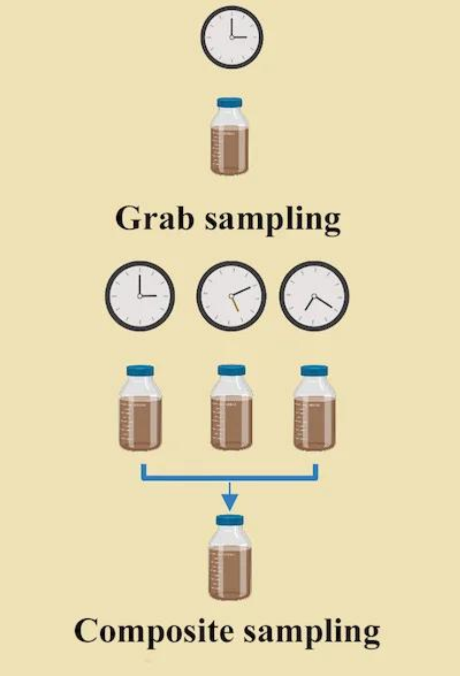
Gambar 2 *Random Sampling*



Gambar 4 *Systematic Grid Sampling*

Sampling Technique / Timing

Sampling Type	Main Feature	Brief Explanation	Weakness
Grab Sampling	Single-time, single-place sampling	Sample collected at one specific time to represent that condition.	May not reflect temporal variation; snapshot only.
Composite Sampling	Combination of several samples	Samples from various times or places are mixed for average analysis.	Loss of individual sample variability; may mask extremes.
Sequential Sampling	Stepwise sampling	Samples collected sequentially; decision made after each stage.	Time-consuming; requires interim analysis at each step.
Continuous Sampling	Continuous monitoring	Samples continuously collected to observe changes over time.	Expensive; high data volume; requires continuous equipment.



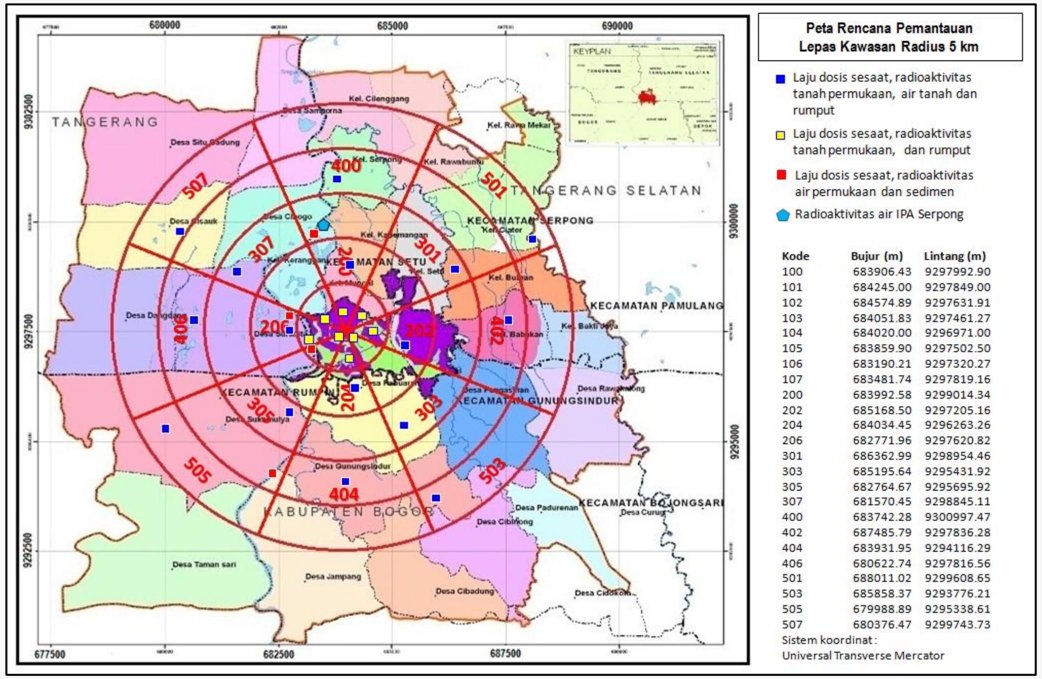
Sample items

1. Dust
2. Fallout
3. Rain water
4. Milk and Grass
5. Vegetable
6. Polished rice
7. Soil
8. Beach sand
9. River, lake and marsh water
10. Drinking water
11. Sea water
12. Seabed sand
13. Marine Products
14. Sand at the outlet drain

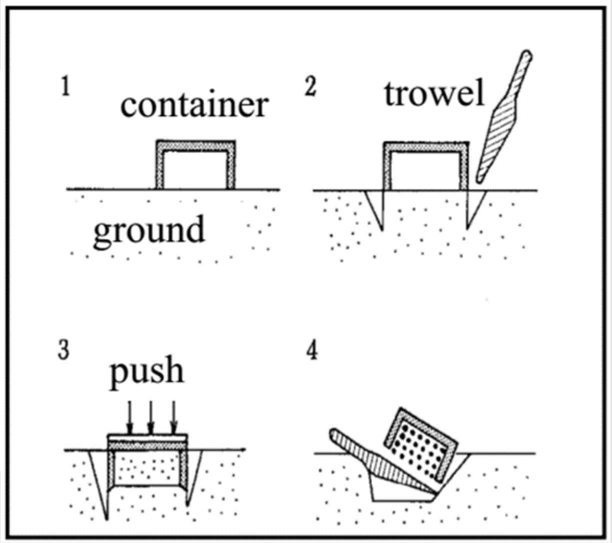
Soil Sampling

1. Sampling point
   - Take into consideration local geography such as vegetation, flat land, utilization of land, and others
   - At the same point that decided beforehand, because periodic sampling allow to determine the accumulation of radioactivity

2. Sampling tools
   - Trowel and polyethylene container
   - Stainless steel top soil cutter (5×10×10cm)
   - Hoe

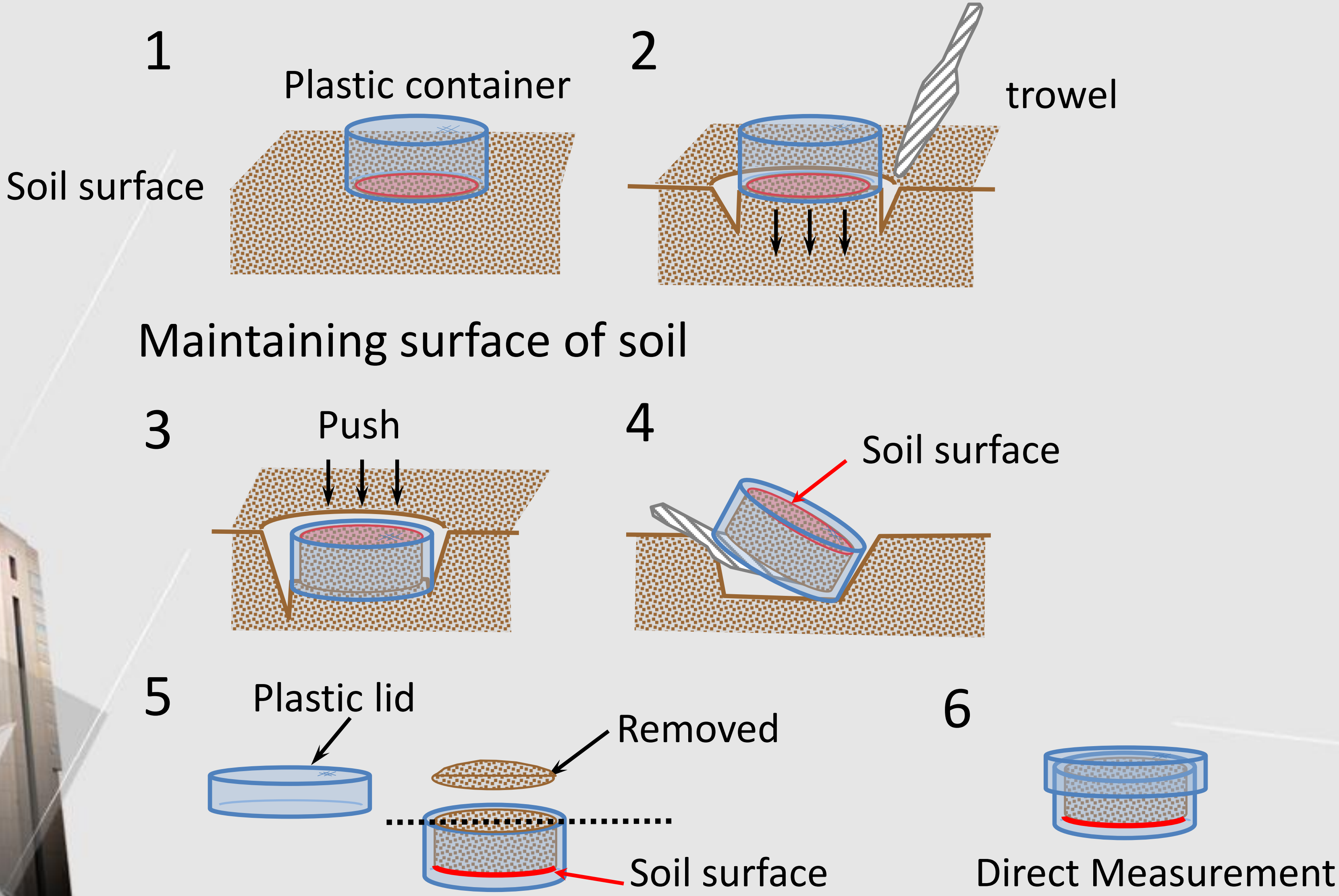


3. Collecting method
    - Collecting soil from the surface to 5cm depth with a top soil cutter and trowel
    - For each sampling point, take 3~5 samples from the same area, and mix them well to form one representative sample
4. Sampling volume
    - About 2 kg / sampling point



➢ *Sampling Method of Surface Soil (For emergency)*

(an Example of Using Plastic Container)



Soil Sampling

Core sampler

- To determine the depth of penetration of a radionuclide or contaminant or to establish a detailed depth profile
- A depth profile is useful for finding the relative vertical distribution of the radionuclide

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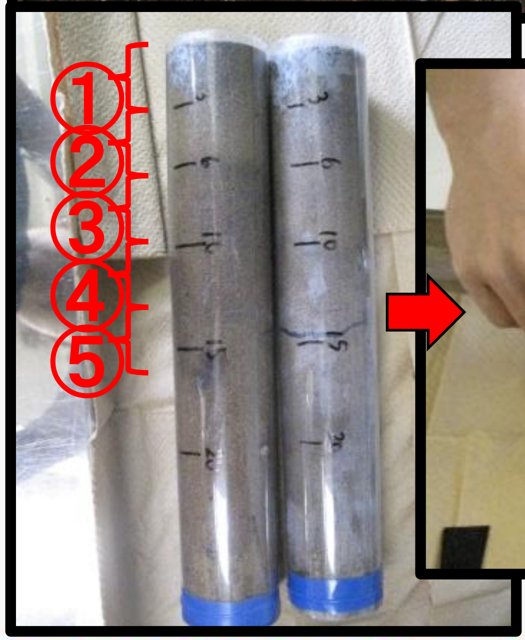
Soil Sampling

BerAKHLAK
#banggamelayanibangsa

Core sampler



Air Sampling / Dust Sampling

1. Sampling point
   - Local atmosphere whose conditions are well understood (air temperature, humidity, rainfall, and so on)
   - Avoid place which are directly influenced buildings or trees
2. Sampling tools
   - Capacity to sample air-dust at flow rate of 50~100 L/min
   - Glass-cellulose-filter is equipped with this tool.
   - Activated charcoal cartridge can be fit to the tool

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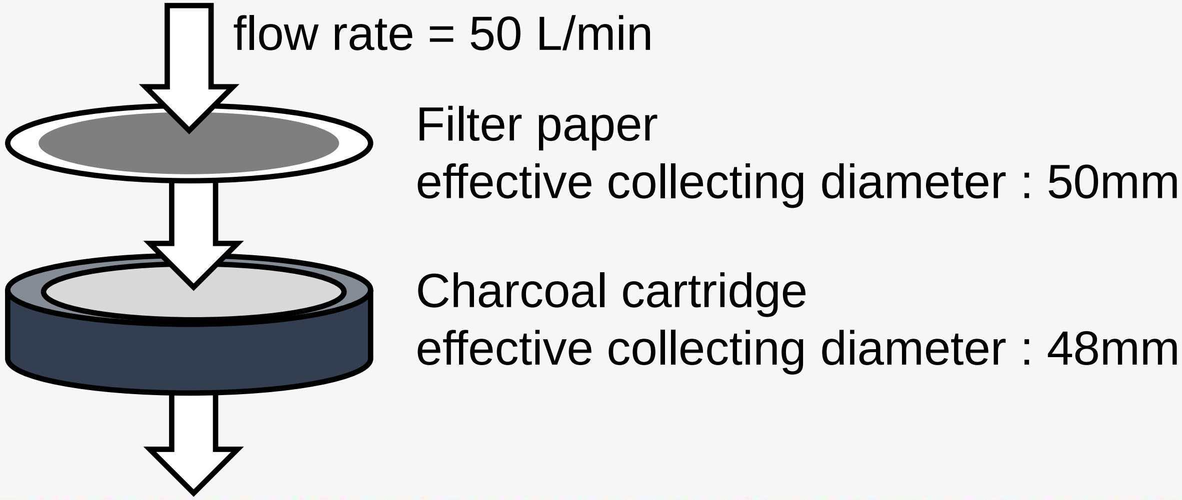
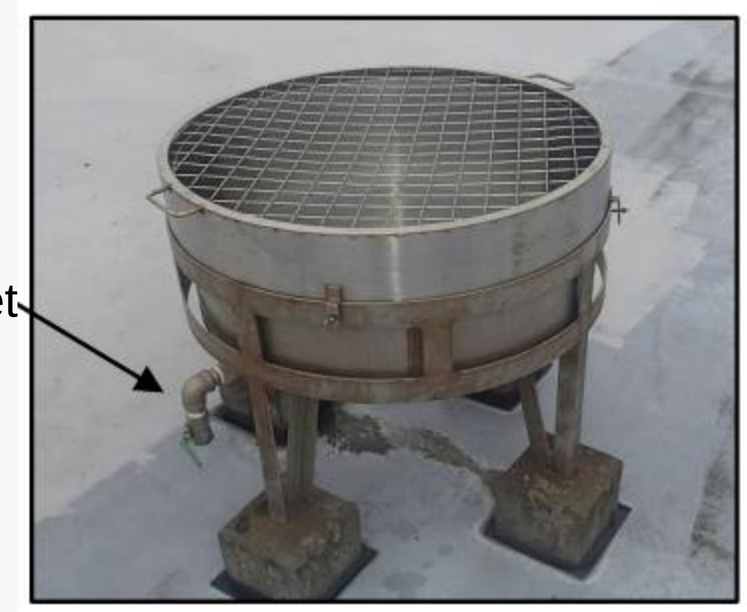


Fallout

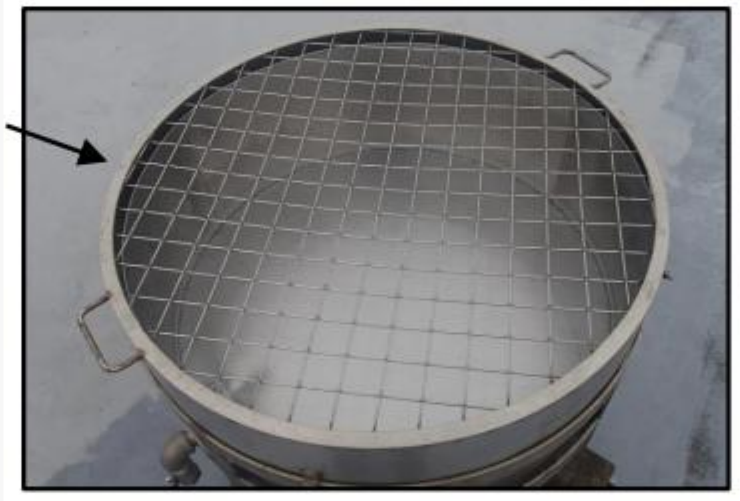
1. Sampling point
   - Plane and open place which are not directly influenced by ventilation caused of buildings or trees
   - Feet of the basin are fixed in direct to floor
   - The height of the upper peripheral of the basin should be about
     1m away from ground

2. Sampling tools
   - Large stainless steel basin
     diameter : 80cm
     depth : 30cm

Water outlet



Bird repelling tool



Fallout

3. Collecting Method

1) Pour the pure water into a basin before collecting fallout-dust and keep its depth at least about 1 cm.
2) Collect the water together with rain and the dust a month. And wash remaining dust on the inner surface of the basin with pure water and collect the sample and rinse water from a bottom valve of the basin
3) After sampling, measure the total volume, and add 1 mL of nitric acid or hydrochloric acid per 1L of water sample

Water Sampling

1. Sampling point
   River water
   - Collect at the center flow of a river
   - Avoid collecting muddy water (e.g. after heavy rain)
   - Avoid collecting at the mouth of a river, because tides sometimes mix sea water with river water
   - Avoid mixing soil, sand, or sediment with the water sample

   Lake and marsh water
   - Collect at the center of the lake or marsh

3. Collecting method

- Wash the sample container 3~4 times with water taken from the sampling point before sampling
- Collect the water from surface to about 5 cm depth, and check the water temperature
- After sampling, add 1mL of HNO3 or HCl per 1 L of water, except the sample for analyzing 3H, 14C, or measuring salinity

4. Sampling volume

- 40 L for Co-precipitation pretreatment
- 5 L for analyzing γ-spectrometry and Gross β
- 500 mL for analyzing 3H by using Liquid Scintillation Counter

Drinking Water

1. Sampling point
   - Top of water pipe in general home / drinking water source
2. Collecting method
   - Discharge the water for few minutes before sampling, and wash the bottle 3~4 times with drinking water
   - Collect the water directly from tap
   - After sampling, add 1mL of HNO3 or HCl per 1L of water, except the sample for analyzing 3H, 14C, or measuring salinity

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Sea Water

1. Sampling point
   - Near the outlet drain of nuclear facilities
2. Sampling volume
   - About 60 L / sampling point
3. Collecting method
   - Collect the surface water in a bucket or directly in container by means of suction pomp installed in the ship
   - Check the water temperature, the latitude and longitude of sampling points
   - After sampling, add 1mL of HNO3 or HCl per 1L of water, except the sample for analyzing 3H, 14C, or measuring salinity

Rain Water

1. Sampling point
   - Avoid place which are directly influenced buildings or trees
   - The height of the upper peripheral of the receiving part should be about 1m away from ground
2. Sampling tools

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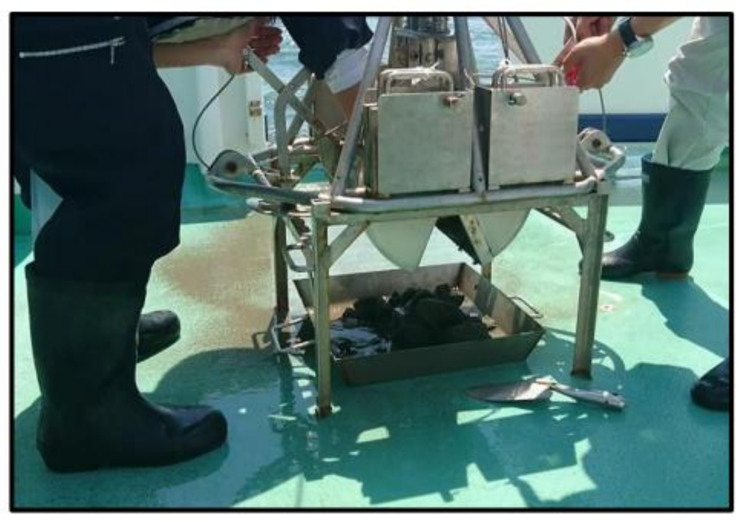
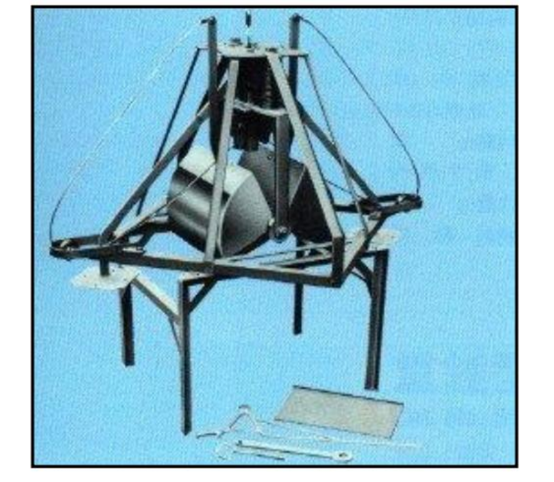
Sediment Sampling / Seabed Sand

1. Sampling point
   - Near the outlet drain of nuclear facilities, at the same point of sea water / river sediment
2. Collecting method
   - Collect the sand with the sediment sampler on the monitoring ship
3. Sampling volume
   - About 2 kg / sampling point





Smith-Mcintyre sediment sampler

Ekman-Birge sediment sampler

Marine Product Sampling

1. Sampling point
   - Near the outlet drain of nuclear facilities
2. Collecting method
   - Purchase from fisherman's associations or fish dealer
3. Sampling volume
   - Fish : 15 kg
   - Shell : 30 kg
   - Sea weed : 12 kg

Agricultural Product Sampling

1. Sampling point
   - Near the nuclear facilities within about 2-3 km
2. Collecting method
   - Polyethylene bag
   - Purchase from farmhouse (Spinach and Cabbage)
3. Sampling volume
   - About 15 kg (Spinach)
   - About 20 kg (Cabbage)
   - About 10 kg (Polished Rice)
   - After sampling, cut the part of stem

Milk and Grass

1. Sampling point
   - Near the nuclear facilities within about 2~3km
2. Collecting method
   - Polyethylene container (14L)
   - Purchase from stockbreeder
3. Sampling volume
   - About 14 L(Milk) and 5 kg(Grass)

Sampling Volume

Table 4-1 Sample volumes for requested precision in Oarai, JAEA (1/3)

Monitoring items		Detector	Pretreatment method	Sample volume (collecting)	Sample volume (for measuring)
Dust	Multi γ-RI	γ-PHA	Direct measurement	5.0×10^3 m^3	measure all
Fallout	Multi γ-RI	γ-PHA	Evaporation to dryness	collect all	measure all
Rain water	^{137}Cs	γ-PHA	Direct measurement	collect all	2 L
Milk	^{131}I	γ-PHA	Direct measurement	14 L	2 L
	Multi γ-RI		Ashing		10 L (fresh) ⇒ 80 g (ash)

ai, JAEA (2/3)

Monitoring items		Detector	Pretreatment method	Sample volume (collecting)	Sample volume (for measuring)
Vegetable	^{131}I	γ-PHA	Direct measurement (Vegetable Juice)	20 kg	2 kg (fresh)
	Multi γ-RI		Ashing		16 kg (fresh) ⇒ 100 g (ash)
Polished rice	Multi γ-RI	γ-PHA	Ashing	12 kg	10 kg (fresh) ⇒ 70 g (ash)
Soil	Multi γ-RI	γ-PHA	Drying and Sieving	2 kg	2 kg ⇒ 300 g (dry)
River water (Lake, Marsh)	^3H	LSC	Distillation	85L	100 mL
	Multi γ-RI	γ-PHA	Co-precipitation		40 L ⇒ measurement dish
Sea water	^3H	LSC	Distillation	120 L	100 mL
	Multi γ-RI	γ-PHA	Co-precipitation		40 L ⇒ measurement dish

Table 4-3 Sample volumes for requested precision in Oarai, JAEA (3/3)

Monitoring items		Detector	Pretreatment method	Sample volume (collecting)	Sample volume (for measuring)
Sea soil	Multi γ-RI	γ-PHA	Drying and Sieving	2 kg	2 kg ⇒ 50 g (dry)
Shell	Multi γ-RI	γ-PHA	Ashing	30 kg	10 kg (fresh) ⇒ 250 g (ash)
Fish	Multi γ-RI	γ-PHA	Ashing	15 kg	10 kg (fresh) ⇒ 130 g (ash)
Sea weed	^{131}I	γ-PHA	Direct measurement	12kg	1.5 kg (fresh)
	Multi γ-RI	γ-PHA	Ashing		10 kg (fresh) ⇒ 460 g (ash)
Sand outlet drain	Multi γ-RI	γ-PHA	Drying and Sieving	2 kg	2 kg ⇒ 50 g (dry)

Safety and Radiation Protection

Aspect	Description	Key Practices
Follow ALARA (As Low As Reasonably Achievable)	Keep radiation exposure as low as reasonably possible.	• Minimize **time** near sources• Increase **distance** from radiation• Use **shielding** materials (lead, concrete, etc.)
Wear Protective Gear	Prevent direct contact and reduce exposure.	• Lab coats, gloves, goggles• **Dosimeters** to monitor dose• **Lead aprons/shields** for X-ray or gamma work
Use Contamination Monitors	Detect and control radioactive contamination.	• Regular area surveys• Check **hands, clothes, and equipment**• Maintain exposure within **safe limits**
Follow Waste Disposal Regulations	Handle radioactive waste safely and legally.	• **Segregate** and **label** waste• **Store** securely until safe• **Dispose** via licensed facilities

Summary

- Purpose : to assess and monitor radioactivity in air, water, soil, and biota.
- Sampling Design : Judgmental, Random, Systematic, Stratified.
- Sampling Technique : Grab, Composite, Sequential, Continuous.
- Sampling Media : Air/Dust, Water, Soil/Sediment, Biota/Vegetation.
- Reliable sampling : accurate radioactivity assessment

Reference

1. Environmental an Measurement Of Radionuclides In Food And The Environment, IAEA Technical Report Series No. 295
2. Environmental and Source MonitoringSource Monitoring for Purposes of Radiation Protection, IAEA Safety Standards, Safety Guide No. RS-G-1.8
3. SB 014-BATAN : 2013, Standar BATAN tentang Analisis sampel radioaktivitas lingkungan
4. Basic Knowledge and Health Effects of Radiation, Radiation Health Management Division, Ministry of the Environment, Government of Japan
5. Environmental Radioactivity Monitoring in JAEA, Hiroya Yokoyama, Training on Meteorology and Radiation Monitoring System at Nuclear Facilities (FTC in Indonesia), 2017.
6. Collecting methods and pretreatment of environmental samples in JAEA, Eita Maeda, Instructor Training Course on Environmental Radioactivity Monitoring, JAEA, 2019.
7. Environmental Sampling Techniques During Emergency, Arif Yuniarto, Training On Radiation Protection & Environmental Monitoring During a Nuclear Emergency (FTC in Indonesia), 2016
8. Environmental Radiation Monitoring, Takehisa Ohkura, Instructor Training Course on Environmental Radioactivity Monitoring, JAEA, 2019.
9. Guidelines on Soil and Vegetation Sampling for Radiological Monitoring, IAEA Technical Report Series No. 486

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