Storage module options and selection of appropriate technical options for storage of small volumes of solid and liquid low level waste and disused radioactive sources

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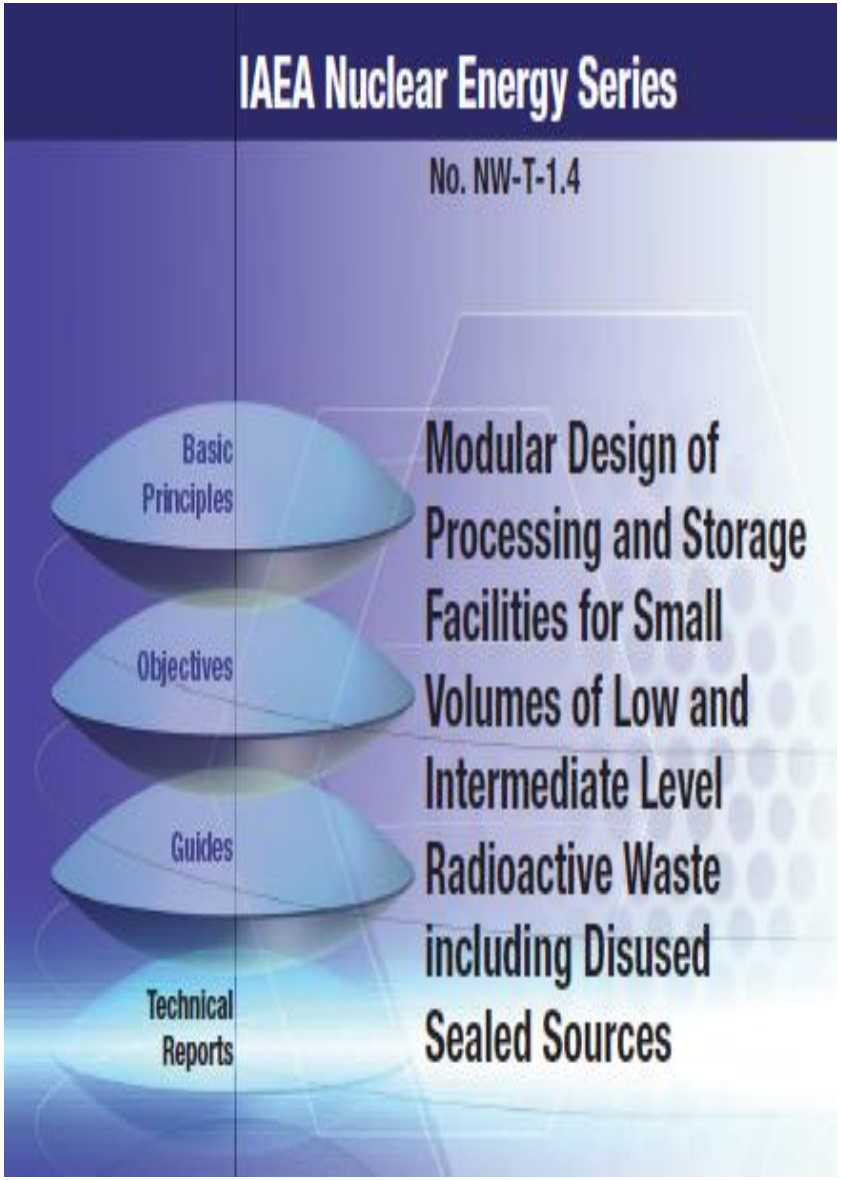
Modular design



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Modular Design of Processing and Storage Facilities for Small Volumes of Low and...

Modular design approach

- A number of IAEA Member States **generate relatively small quantities** of radioactive waste and/or disused sealed sources
- **Many** countries still **do not have adequate facilities for processing and storing** of their radioactive wastes – especially in **countries with small quantities** of generated radioactive wastes
- The existing waste processing and storage facilities (WPSF) have to be **upgraded** to address new waste streams, incorporate new waste processing technologies, or expand interim storage capacities
- **Fixed designs like the ones developed earlier may not be adequate** to very different needs as there are **wide variations** in the types and quantities of radioactive waste

Storage of RAW

- To **Isolate** RAW from people and environment
- To **prevent migration** of RN in ground water, atmosphere, environment
- Managing **time**
- Auxiliary systems- **monitoring, ventilation**
- **Record keeping**
- **Regulated** activity

Storage options

A wide **variety of storage options** are available:

- Shielded **cabinet**
- Dedicated **room**
- Concrete **container**
- ISO **freight container**
- Concrete **pipe**
- Concrete **bunker or trench**
- **Below ground tubes** or vaults
- **Caves, mines** and tunnels
- Purpose built **industrial building**

Shielded cabinet

- For **small waste packages** and small quantities of waste
- Located within an existing facility **where radioactive material is used** such as a hospital or research facility

- Cabinets are **lockable** and **provide** a degree of **security**
- Not suitable for larger waste packages

Source: IAEA NW-T-1.4

Concrete containers

- **Widely used** as transport, storage and disposal containers
- **Suitable for higher dose rate** waste packages, provide a degree of shielding

Source: IAEA NW-T-1.4

Concrete containers

- Able to **accommodate larger waste packages** (incl **200 L drums**)
- **Removable lid** for loading waste packages **from above**,
- **Requires a crane** for handling and positioning the waste packages

Source: www.dprao.bg

ISO freight containers

- ISO freight containers are **widely available** throughout the world.
- Used as radioactive **transport packages** and **storage modules**
- Portable, **flexible in location**

Source: IAEA NW-T-1.4

ISO freight containers

- Flexible, modular, low cost method of providing a weather proof enclosure for waste storage

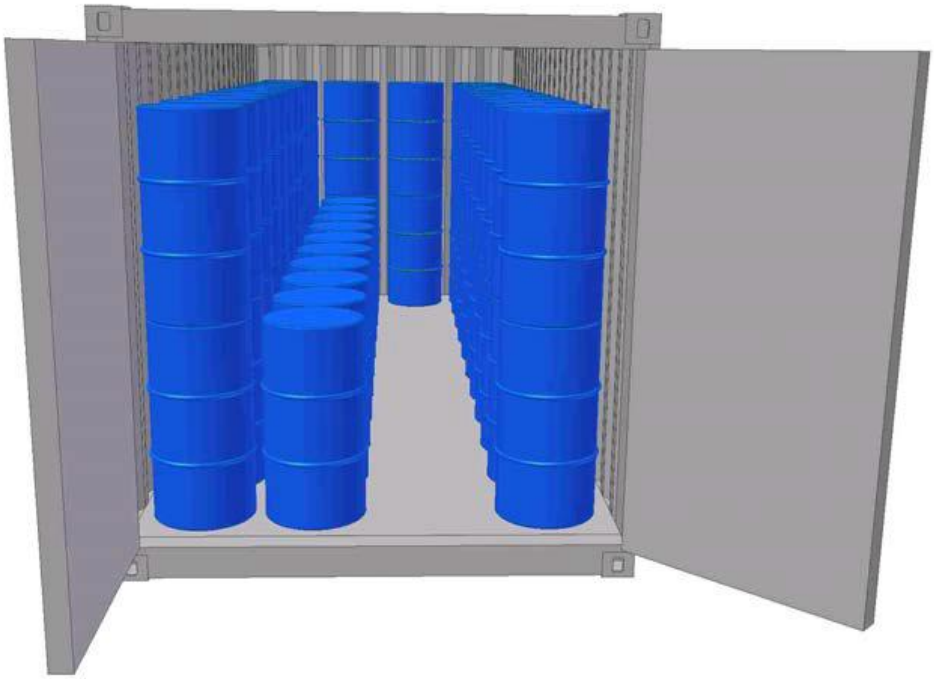
ISO containers at Novi han repository site

Source: www.dprao.bg

ISO freight containers

➢**Can ccommodate a wide range of waste package** sizes and weights, including 200 L drums

➢Metal construction → **corrosion** → **limited life-time**



➢**Internal shielding** if needed (by other drums or concrete blocks)

➢**ISO freight containers could be surrounded with an external shield** wall of interlocking concrete blocks

Concrete pipe

- **To store drums** in vertical stacks to reduce the floor footprint
- Suitable for higher level waste
- **Drums handled from above** with overhead cranes, adding **complexity and cost**
- **Inspection and monitoring are difficult**
- **Offer no significant benefits** for the storage of small volumes of waste and will **not be considered further**

Source: IAEA NW-T-1.4

Concrete bunker or trench

- Used for **unconditioned wastes**
- **Difficulties in the retrieval** of this waste.
- Suited to **high dose rate wastes** as they do not require additional shielding

Source: IAEA NW-T-1.4

Below ground tubes or vaults

- Suitable for high activity disused **sealed sources- shielding** and **improved security**
- **Lower activity waste can be stored above ground**, adding shielding and security

Source: IAEA NW-T-1.4

Purpose built industrial building

- The **most common storage** solution
- **Realistic and practical option** for the most countries
- Represents a **shell of reinforced concrete** with vehicle **access doors for a fork lift truck** for the waste and **personnel entrance**

Source: IAEA NW-T-1.4

Purpose built industrial building

- Illuminated by **electric lighting**
- **Easily decontaminated floor paint**

- **Ventilation** system
- **Air conditioning** for humidity
- **Temperature control**
- **Overhead crane**

Source: www.dprao.bg

SELECTION OF APPROPRIATE STORAGE MODULES

To consider:

- Storage **strategy**
- ✓ **Facility type relevant to the waste inventory**
- ✓ Need of **ventilation**
- ✓ **Need for shielding**
- ✓ Mechanical **handling requirements**
- ✓ **Overall implementation of a storage facility** project

STORAGE STRATEGY CONSIDERATIONS

➢The product - **conditioned** and **packaged waste suitable for storage**

How and where to store the waste packages?

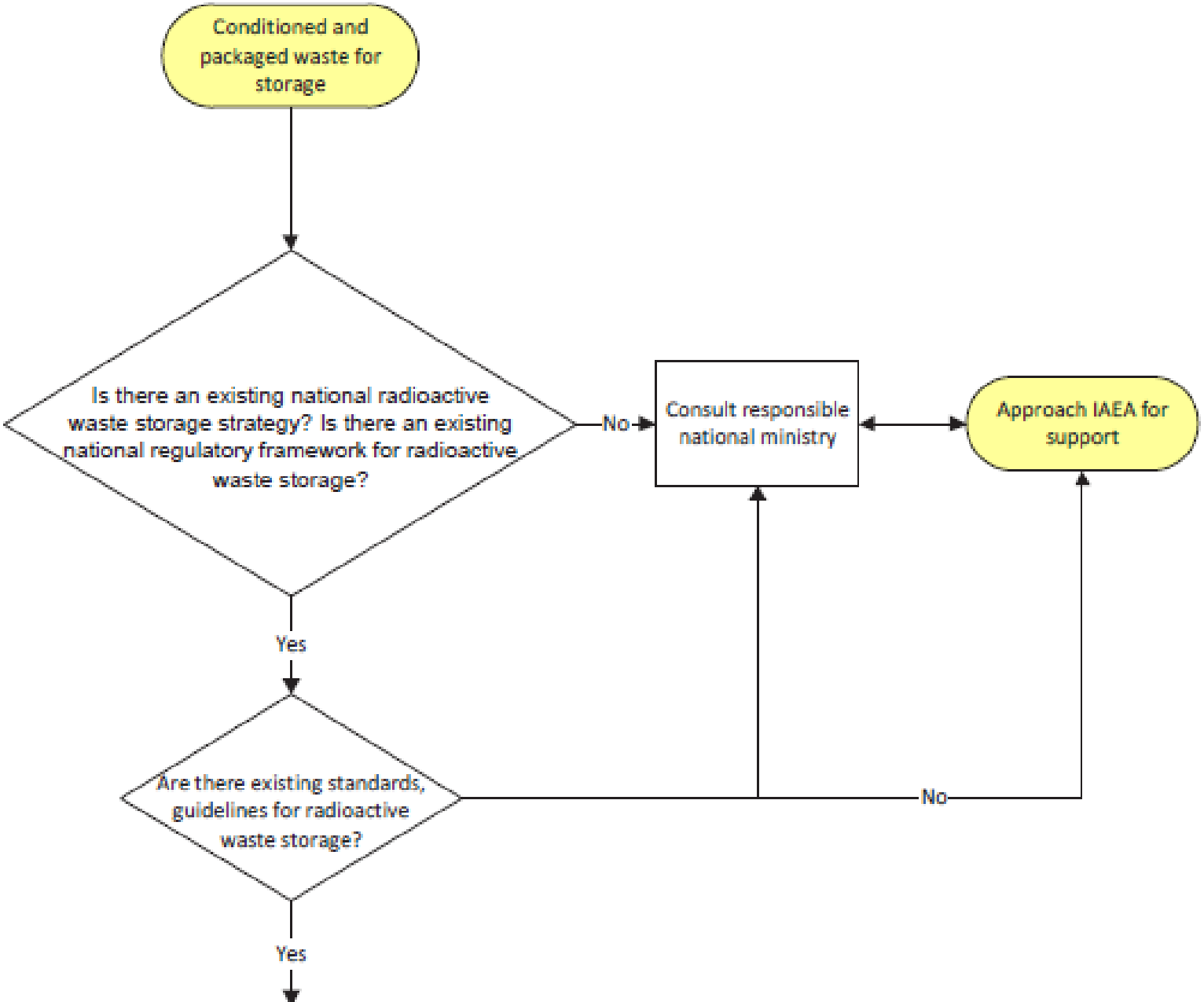
✓ N**ational strategy** for radioactive waste storage

✓**Regulatory framework**

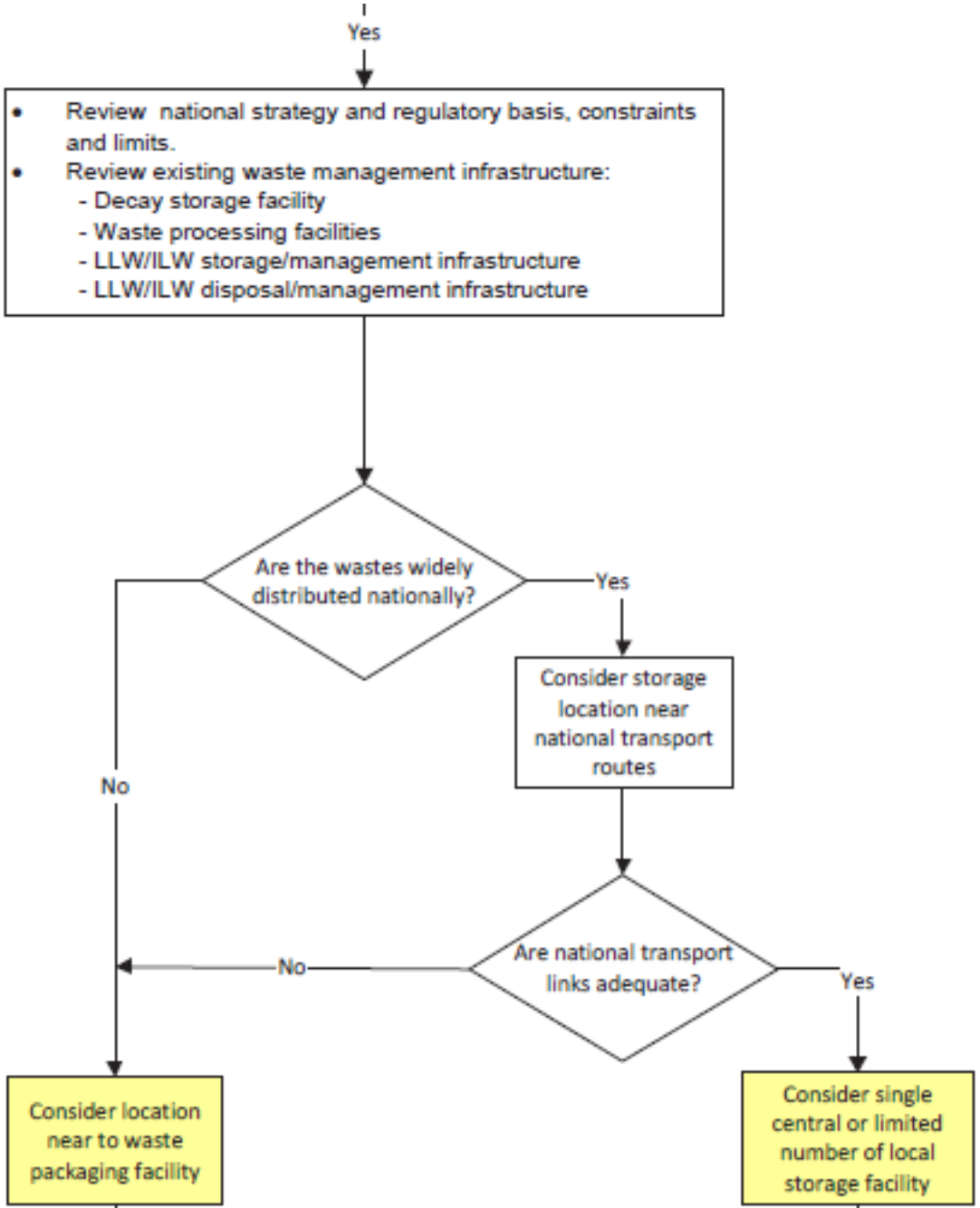
✓Supporting **standards and guidelines**

➢The **lack of national strategy should not prevent** safe radioactive waste **storage facilities from being developed**. Additional advice- relevant national bodies, IAEA

STORAGE STRATEGY CONSIDERATIONS

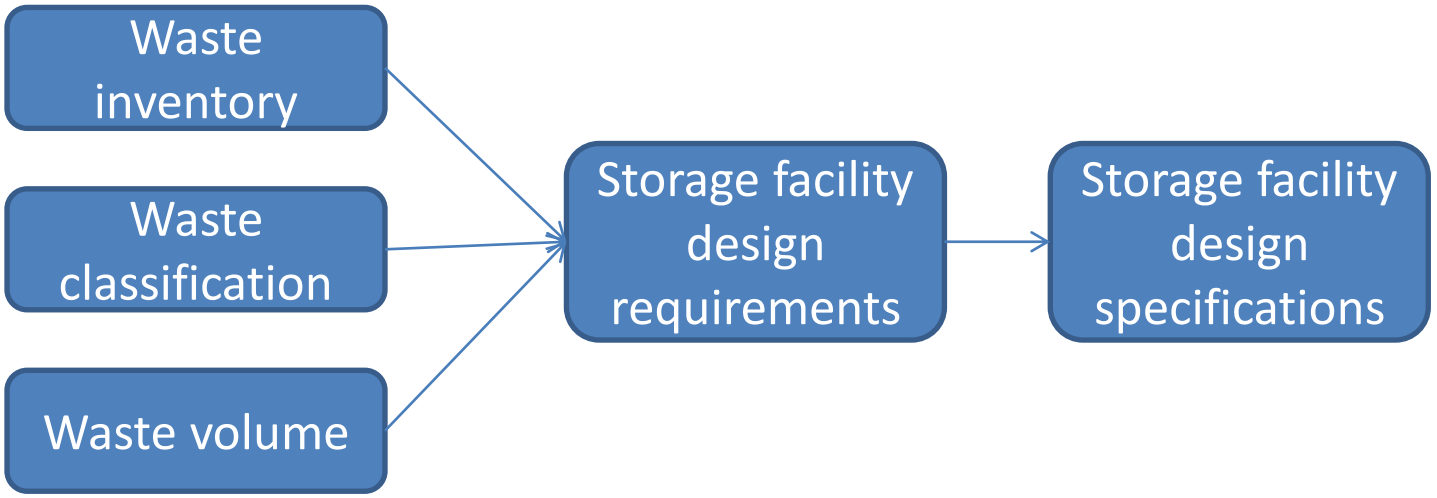


STORAGE STRATEGY CONSIDERATIONS

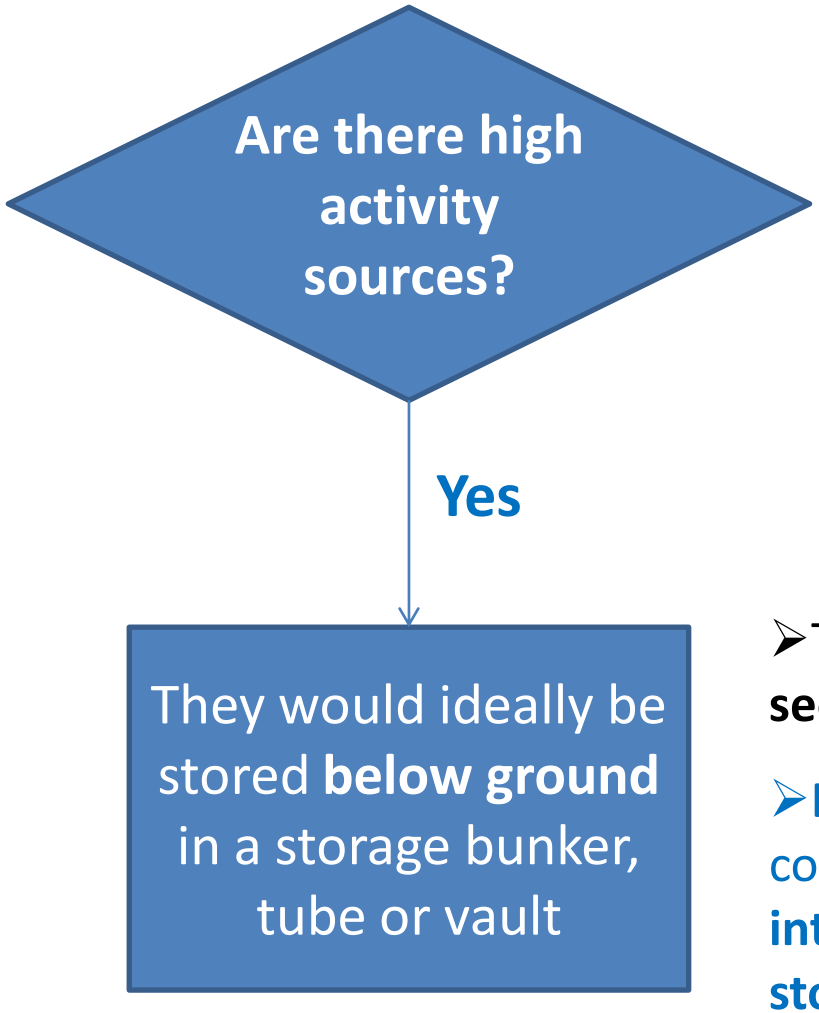


STORAGE FACILITY TYPE SELECTION

- The total **waste inventory and classification**

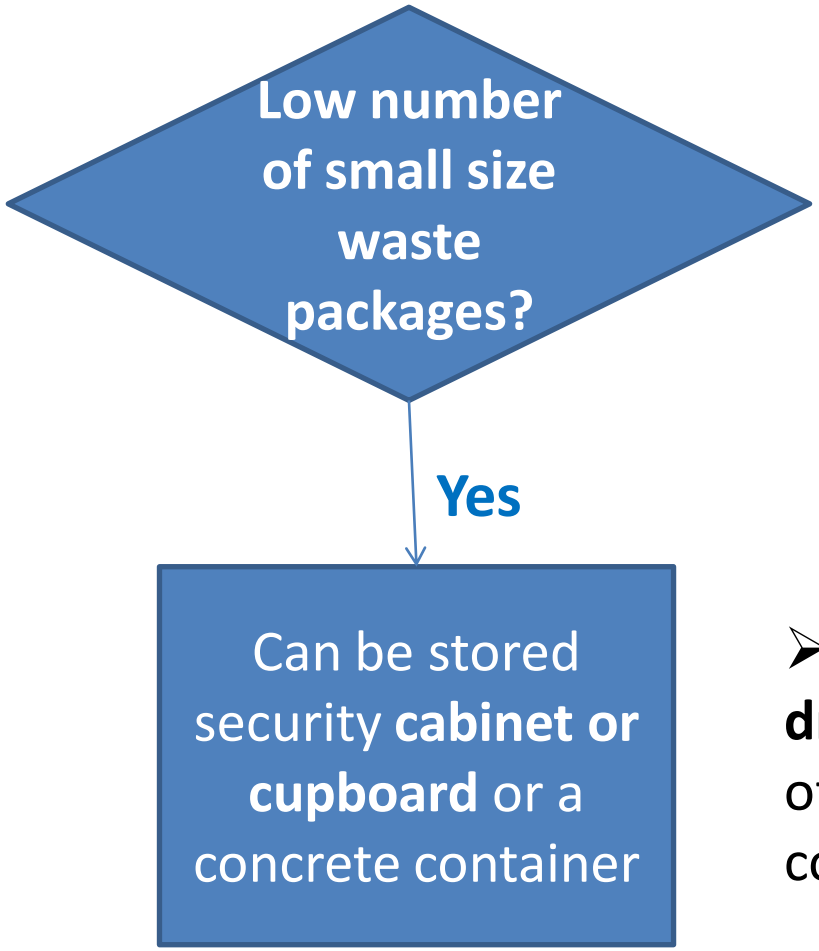


Activity of the sources



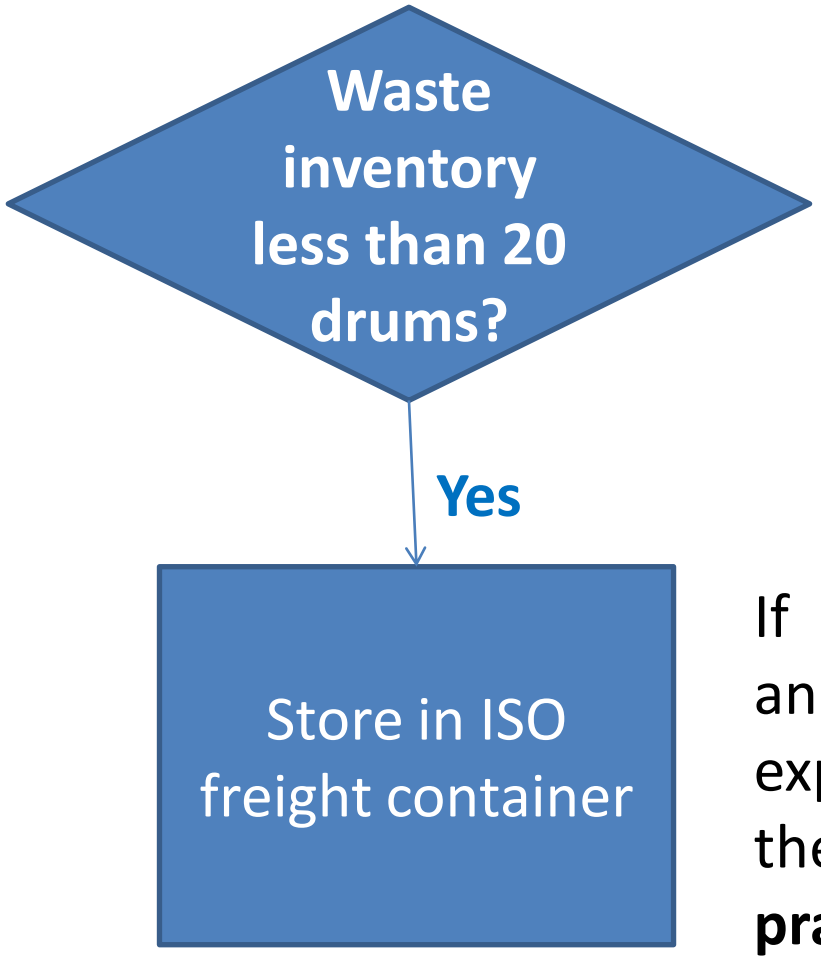
- This **adds shielding and security**
- **Below ground vaults** could be **incorporated into the design of a storage building for other waste**

Number and size of the packages



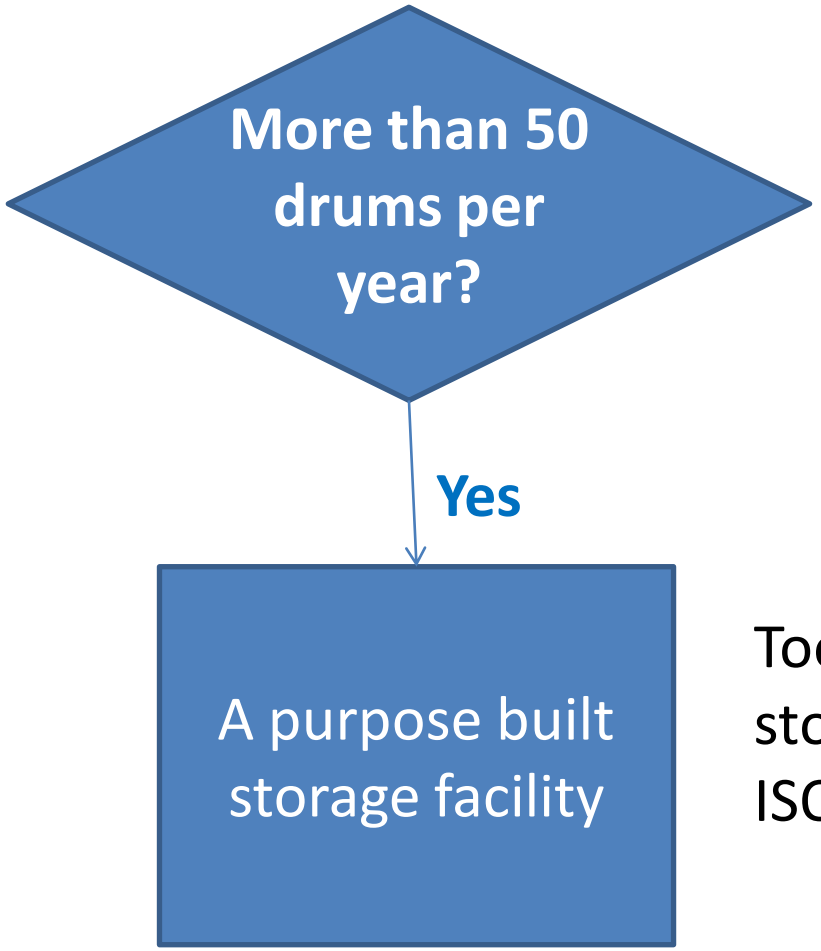
➢**Consider 200L drums** (main type of processed and conditioned waste)

Low number of waste packages



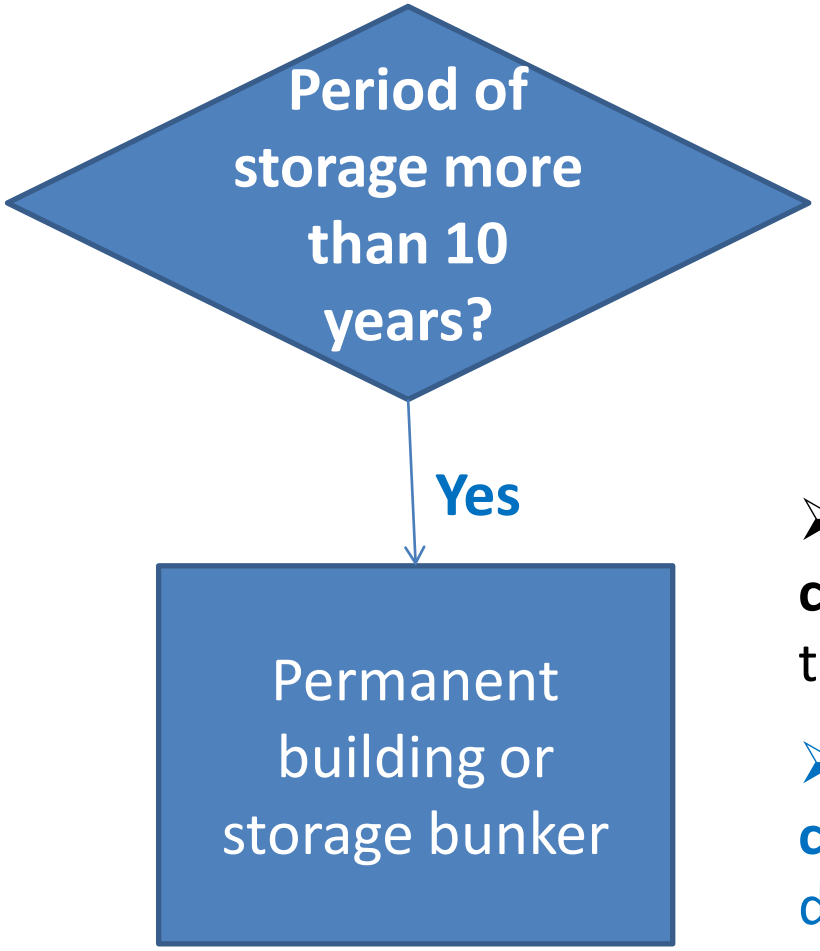
If the waste volumes and **numbers of drums** expected are **larger**, then this is **not a practical solution**

Large number of waste packages



Too large number to be stored in a room or in ISO freight containers

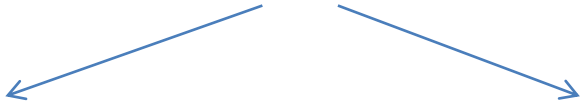
Period of storage



- ISO containers **suffer from corrosion** which in long term can affect the integrity.
- The **lifetime of a freight container is about 10 y**, depending on the climate

VENTILATION REQUIREMENTS

- **High relative humidity → corrosion**
- **Painted mild steel 200 L drums** – 10y **storage life**, provided the drums are stored in a suitable environment, i.e. kept dry.
- **Periodic inspections** of the drums, remediation e.g. **repainting**, or over packing
- If environmental conditions are **likely to lead to corrosion** of mild steel drums, **two options** are possible:



Use **stainless steel drums**

Control the storage conditions- **ventilation and humidity control**

VENTILATION REQUIREMENTS

- **Are volatile nuclides or hazardous gases likely to be released?**
- Some waste packages **may gradually release gaseous contaminants** such as ^{222}Rn, ^{3}H, ^{14}C and ^{131}I.
- **Ra sources - sealed into gas-tight containers before over-packing**
- N**o significant gas release - watherproof closure** with sufficient **natural ventilation (passive ventilation)**

SHIELDING REQUIREMENTS

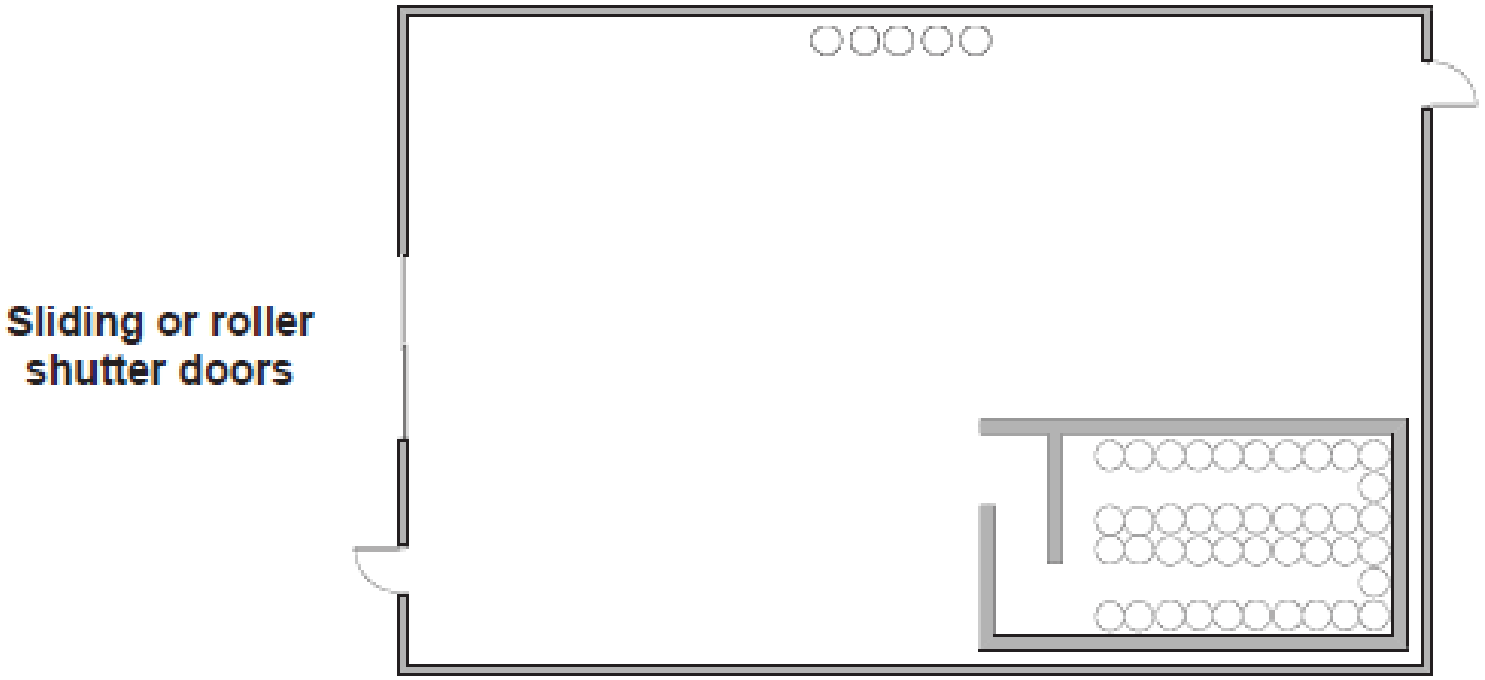
- **Each waste package** should meets the normal **transport** of radioactive material **limits** of **<2 mSv/h at contact** and **<0.1 mSv/h at 1 m**, if individual package **dose rates are greater** than **additional shielding is required**

- Usually the size and weight of packages **requires fork lift trucks** for transferring and positioning drums **which provide distance** from the source.

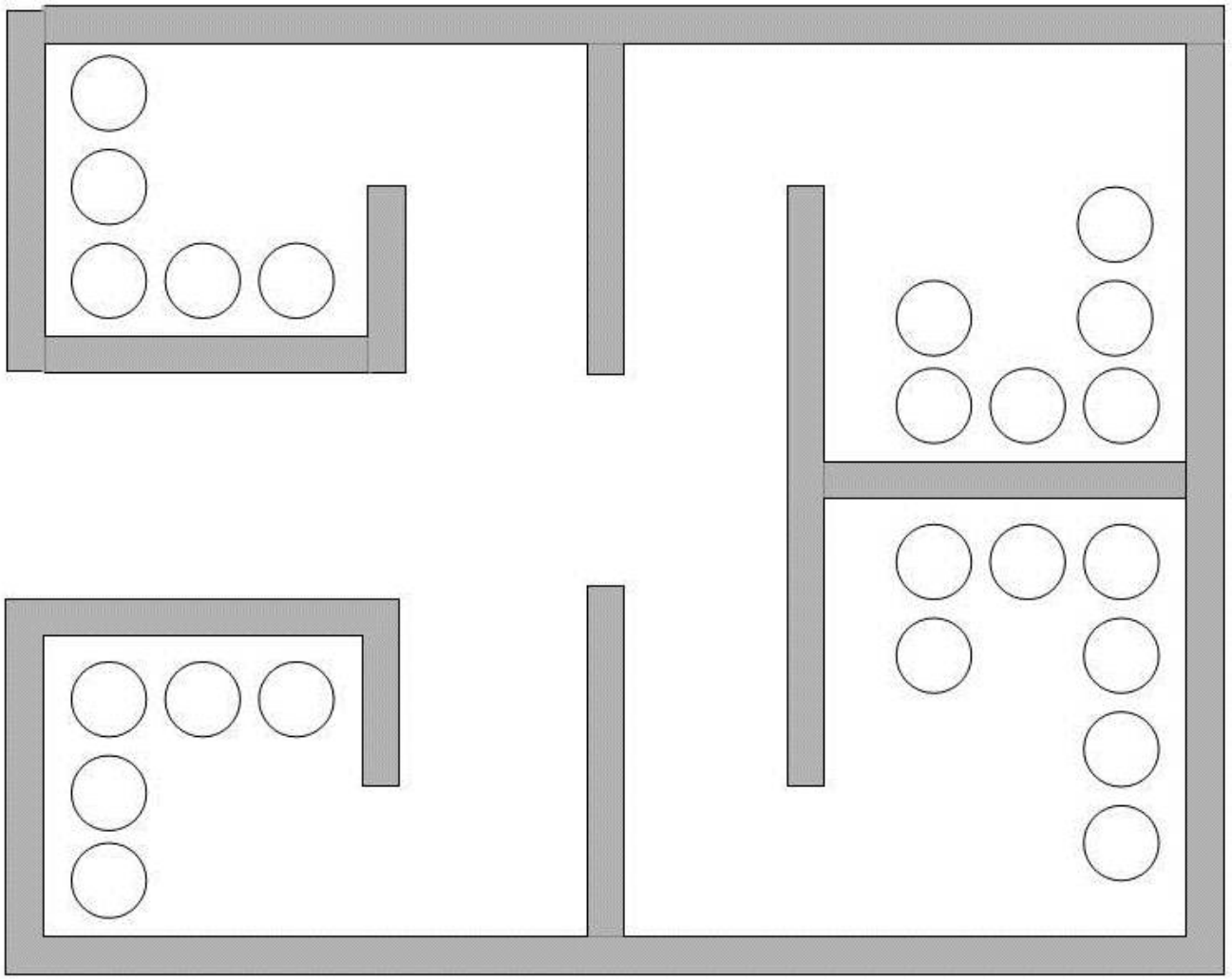
- **A labyrinth entrance** should be provided shielding

Shielding

- **Individual drums can be shielded by other waste drums** or by concrete blocks
- If **larger numbers of drums** require shielding, then a **shielded area within a dedicated storage building with a labyrinth entrance** can be provided

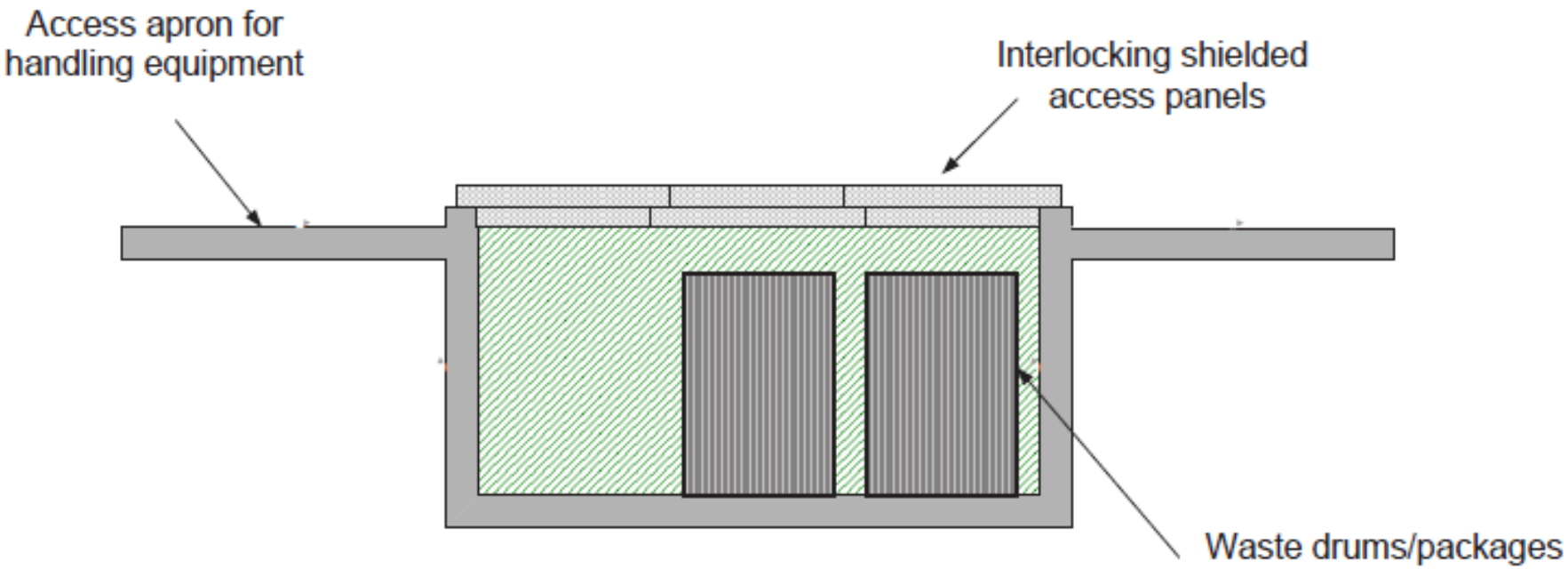


Shielding



Storage building divided into four shielded labyrinths

Shielding

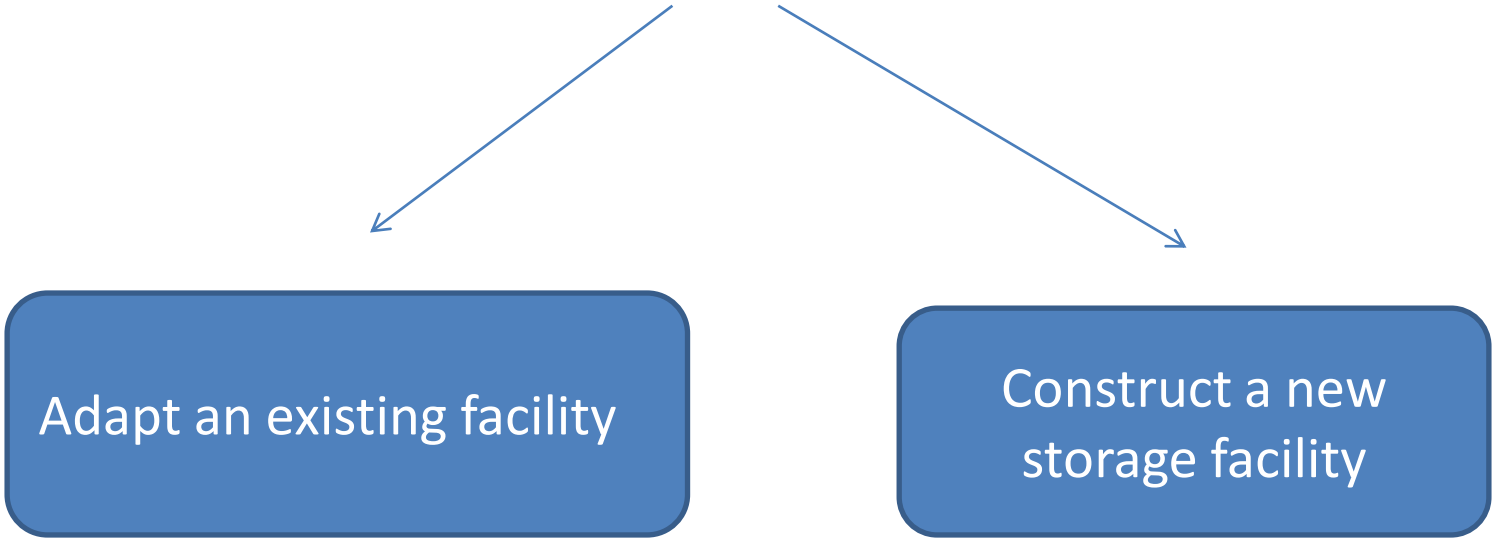


Below ground bunker within storage building

IMPLEMENTATION OF STORAGE FACILITY PROJECT

New or existing storage facility

Having identified the storage facility design requirements (size, capacity design requirements, shielding, ventilation) a decision can be taken



IMPLEMENTATION OF STORAGE FACILITY PROJECT

The **location** of the storage facility will depend on a number of factors:

- The **location and distribution of the waste**
- The availability of suitably **qualified personnel in the area**
- The **security of the area**
- The **accessibility of the site**
- **Population density and traffic** in the area (both should be low)
- Local **environmental conditions** – **temperature** fluctuations, **humidity**, snow loadings, **geological** and hydro-geological conditions, **flooding probability etc**

IMPLEMENTATION OF STORAGE FACILITY PROJECT

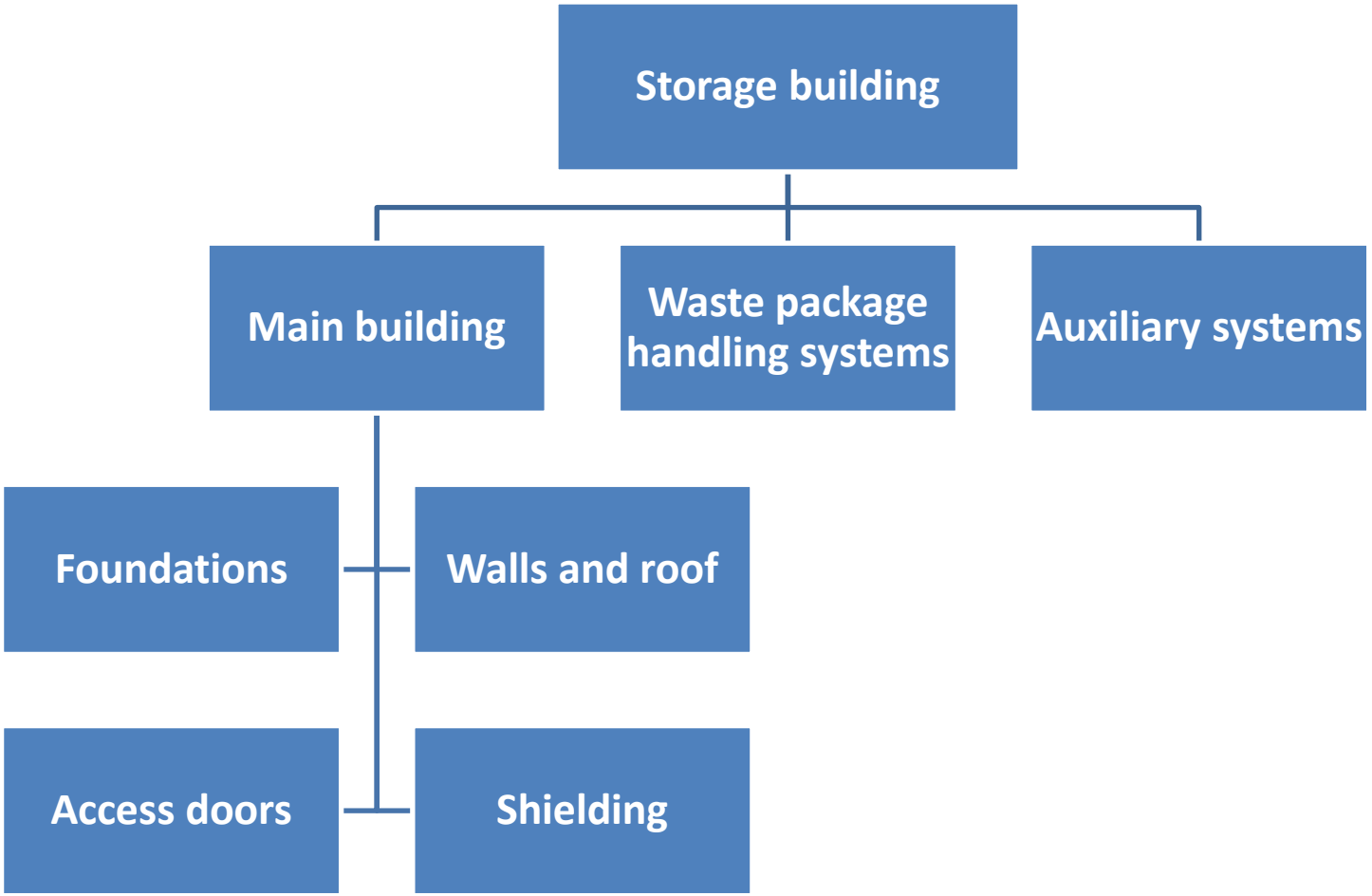
Regulatory approval will be required for permission to site a storage facility for radioactive waste.

Operator to demonstrate:

- ✓ **security and safety of the storage facility** with respect to the protection of human health and the environment
- ✓ **compliance with the regulations and the legislation**

Public acceptance!

DESIGN AND SPECIFICATION INFORMATION FOR STORAGE MODULES



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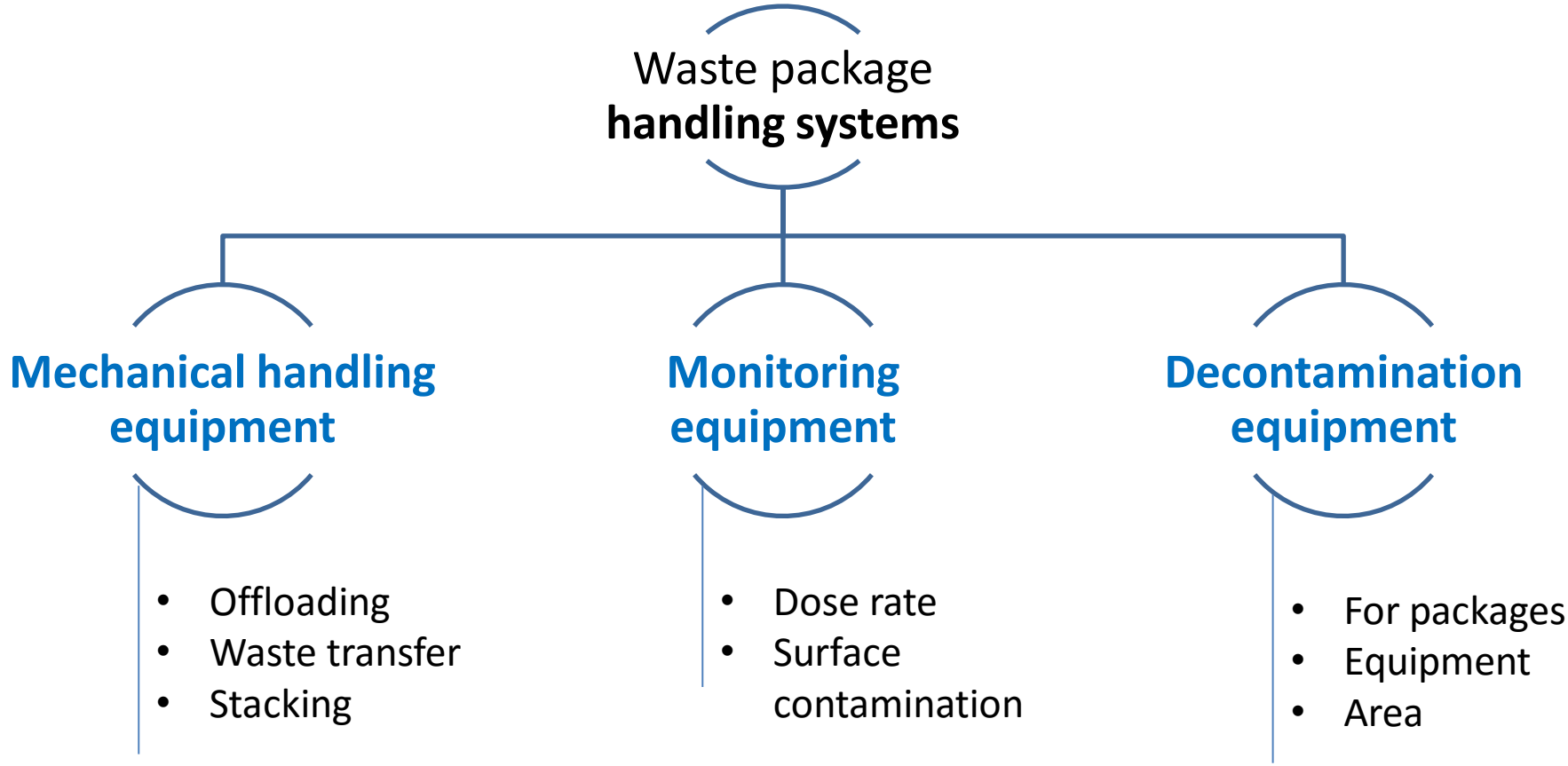

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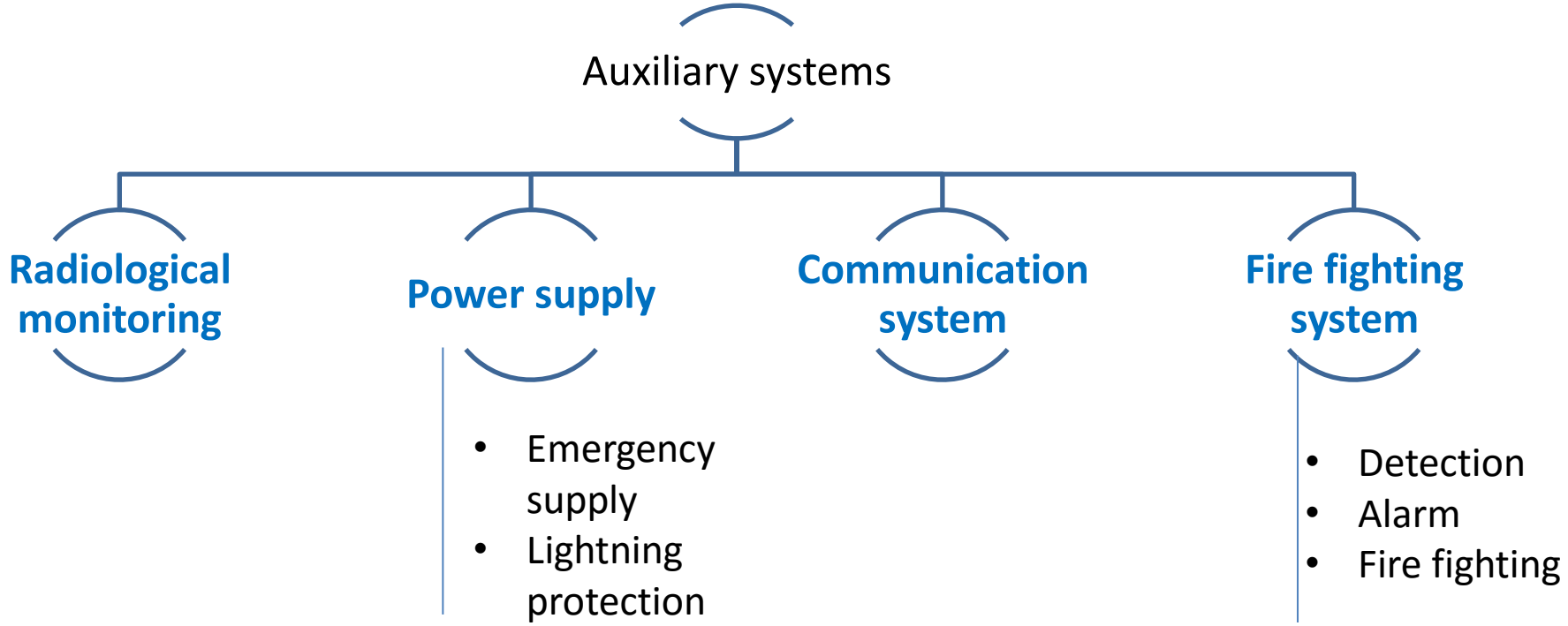

Operational Requirements

- **Receipt of vehicles** carrying waste packages
- **Radiation and contamination monitoring** of the transport vehicle and the waste packages
- **Quarantining and subsequent decontamination**
- **Off-loading of the waste packages** from the transport vehicle, cceptance and **transfer of the waste packages**
- **Storage** of the waste drums/packages for the total storage time
- **Record keeping**

Operational Requirements

- Periodic **inspection** and radiological **monitoring** of the **storage building and waste packages**
- **Quarantining of waste** packages within the storage building **if contamination is discovered**
- Wrapping/bagging of the quarantined waste packages and transfer for **decontamination**
- **Maintenance of the storage building** and all associated equipment
- **Physical protection of the storage building**
- Operator **radiation safety**, e.g. possible monitoring of operating and maintenance staff on exit from the storage building
- The design intent is that the storage building should **be available to perform** these operational requirements **for 250 days of operation per year**

Radiological monitoring of the storage facility

Main aim of the radiological monitoring:

- To ensure that **radiation levels are acceptable**
- To **identify that drums/packages may need to be relocated** or placed behind shielding if **levels are not acceptable**
- To **monitor airborne and surface contamination** levels **to minimize any spread** of contamination **and dose to operators**

For these reasons, the **waste packages should be easy to access** and visually inspect

Facility personnel

Qualified and trained personnel should manage and operate the storage facility:

Operations manager: An experienced **radiochemist or a radiophysicist trained to university degree level** with experience in radioactive waste management;

Radiation protection supervisor: A person **experienced in radiological protection procedures** and regulations;

Supervisor: Someone who has **practical experience with the handling of radioactive materials** and quality control to supervise day to day operations

Skilled operators: Persons with **experience in mechanical handling** operations

Information and records

- Waste package **unique identification number**
- **Position of waste package** in storage facility
- **Description of waste** package contents:
  - -**Physical** characteristics
  - -**Chemical** characteristics
  - -**Biological** characteristics
  - -**Radionuclide content**
  - -Origin of waste, **generator name and address**
  - -Results and date of the **last waste package inspection**
  - -Measured **dose rate** (usually at 1 m distance and on contact)

Building floor

- **Resistance to water penetration from the ground** should be provided **by a waterproof membrane** to the underside of the floor
- **Internal floor drain system** with a collection tank, **inspection and sampling of accumulated liquid**
- **The risk of any liquids leaking out of the building is minimized**

Building structure

- Take into account data for **extreme environmental events** with a return frequency higher than 1 in 50 years- **floodings, earthquakes, extreme temperatures, strong winds** etc.
- The **foundations, columns, walls and roof** - to support all structural loads as well as all applicable additional loads
- The structure should be **designed to withstand extreme loads**- i.e. earthquake, wind and snow.
- The **floor** should be able to **support loads of the waste containers**, **accidental dropping of waste containers** as well as live **loads of vehicles** used to load the waste
- **Rainwater should be prevented from entering** any radiologically designated secondary containment areas of the storage building

Access

- **Vehicle access** for access **by fork lift truck carrying a waste package**
- A **separate personnel door**
- E**mergency personnel exits,** only be able to be **opened from the inside (security)**
- **No windows**- both a **shielding and a security weakness**
- N**o penetrations in the roof**, it **should be designed for minimum inspection and maintenance** over the lifetime of the facility
- S**pace and power supply at the main entrance** to the building for **personnel radiation monitoring equipment**

Waste package stacking

- Waste packages shall be stacked in a manner such **that packages do not contact the interior surface** of the building walls.
- The **design should allow** the operator, either directly or remotely, to **visually inspect wall surfaces for water leakages**
- Drums can be stacked **up to two high**
- Stacking of **drums of different heights is not recommended** as the **stacked drums may not be stable** and represent a hazard to the operator.

Mechanical handling requirements

- **Complex crane installations should be avoided**.
- A simple **fork lift truck fitted with a jib crane** attachment should be adequate

Radiation safety requirements

Radiation exposure of personnel should be optimized – time and distance

All **radiation levels quoted here are for illustrative purposes only**, in order to provide an idea about the magnitudes.

The **figures should be reviewed and revised** in accordance Member States own radiological protection requirements

- The **interior of the storage building is classified as a controlled area** - govern access control, contamination control, hazard detection, monitoring and alarms

Radiation safety requirements

- Dose rate **at contact at the exterior building surface walls ≤ 25 µSv/h**
- A**t the fenced boundary of the storage site** ≤ 0.5 µSv/h
- At **1 m above the building roof** after 15 years of service ≤ 0.1 mSv/h
- **Operational controls have to be in place** and to comply with the dose rates noted above
- Building **inspection and maintenance designed to minimize exposure** of workers
- **Hand and foot contamination monitors** at the building access points.

Physical protection/security requirements

Access control should be in place.

Security measures should prevent any intrusion risks by :

- **Deterring unauthorized access** to sources or source location
- **Detecting** intrusion (e.g. **motion sensors, CCTV, guards**)
- **Assessing** intrusion (e.g. cameras, guards)
- **Delaying** perpetrators (e.g. cages, tie downs) until appropriate forces can respond
- Providing **response capabilities** (security or law enforcement units)
- Security **management over time** (i.e. adequate resources, procedures)

IAEA
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Thank you.
Any questions?

National Measurement System

The National Measurement System delivers world-class measurement science & technology through these organisations

NPL National Physical Laboratory
LGC Setting standards in analytical science
nel
National Measurement Office

The National Measurement System is the UK's national infrastructure of measurement laboratories, which deliver world-class measurement science and technology through four National Measurement Institutes (NMIs): LGC, NPL, the National Physical laboratory, TUV NEL the former National Engineering Laboratory, and the National Measurement Office (NMO).