IAEA Safety Standards for the release of sites and buildings

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"International Training Course on the Release of Sites and Building Structures"

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IAEA STATUTE

- Article III.A.6

  The Agency is authorised to **establish … standards of safety** for protection of health and the danger to life and property, … and to **provide for the application of these standards** … at the request of a state … .

- Article VIII.C

  [The Agency] shall take positive steps to encourage the **exchange** amongst its members **of information** relating to the nature and peaceful uses of atomic energy and shall **serve as an intermediary** among its members for this purpose.

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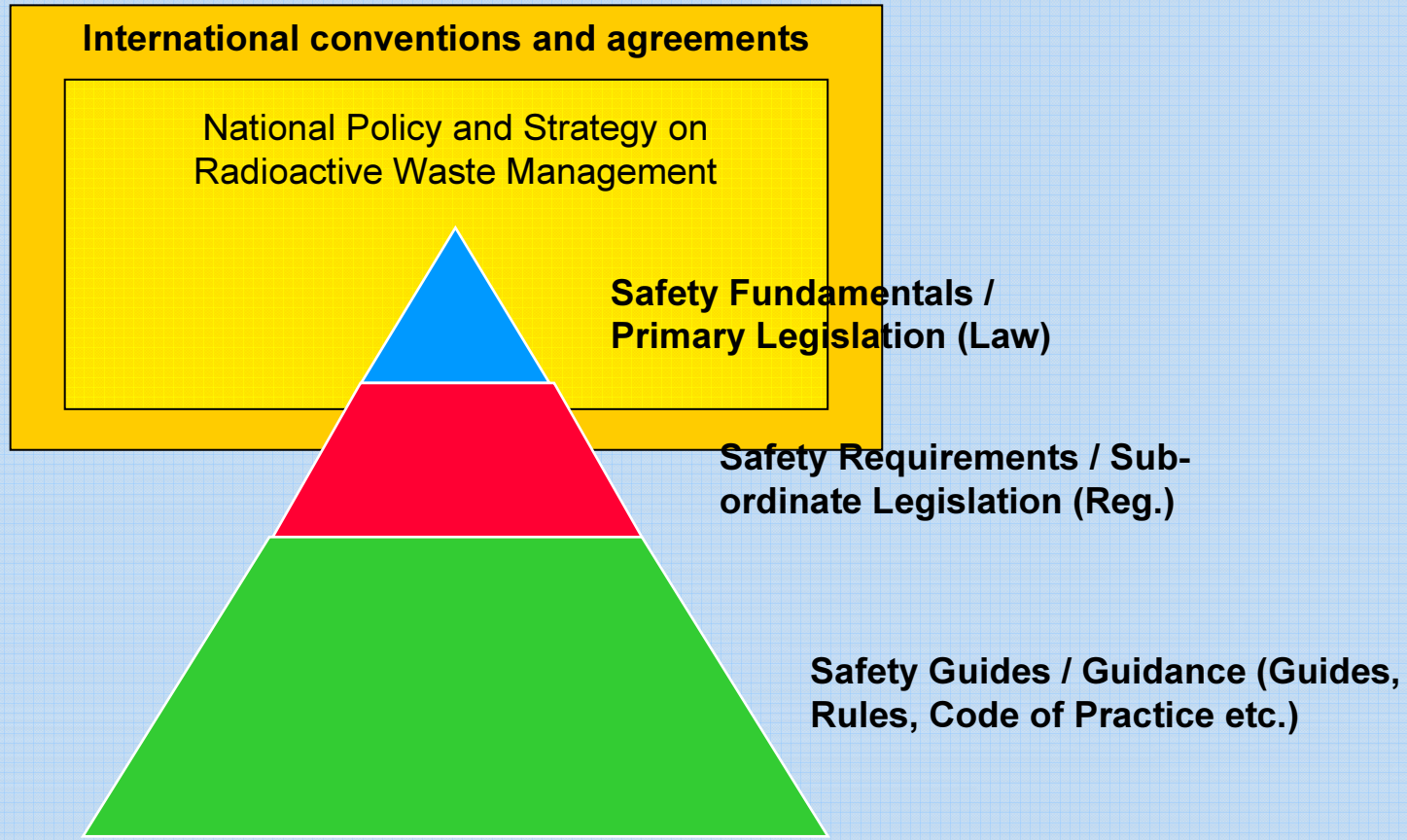
Hierarchy of Legal Framework



Concepts of Exclusion + Exemption

- **Exclusion** - ***any exposure whose magnitude or likelihood is essentially not amenable to regulatory control and is deemed to be excluded from standards / legal framework***
  - Naturally occurring radionuclides (e.g. K^{40}, natural U / Th and decay products)
  - Cosmic and terrestrial radiation
  - Fallout from atmospheric weapons testing
- **Exemption** - ***Practices and sources within a practice may be, a priori, exempted from the requirements of standards (not from legal framework) if exposures or risks will be sufficiently small (trivial)***
  - Specify quantitative criteria (small amounts of material)
  - Justify practice (more overall benefit than detriment)

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Concept of Clearance

- **Clearance** - ***Removal of radioactive materials or objects from within authorised practices without any further control by the regulatory authority***
  - Trivial amounts of radionuclide / trivial exposures
  - Clearance levels shall not be higher than exemption levels
  - Clearance of bulk amounts of material may require particular regulatory consideration
  - **Summary:**
  - Excluded and exempt materials do not enter the nuclear regime. They remain outside of regulated practices
  - Cleared materials are released from within the nuclear regime to outside of regulated practices

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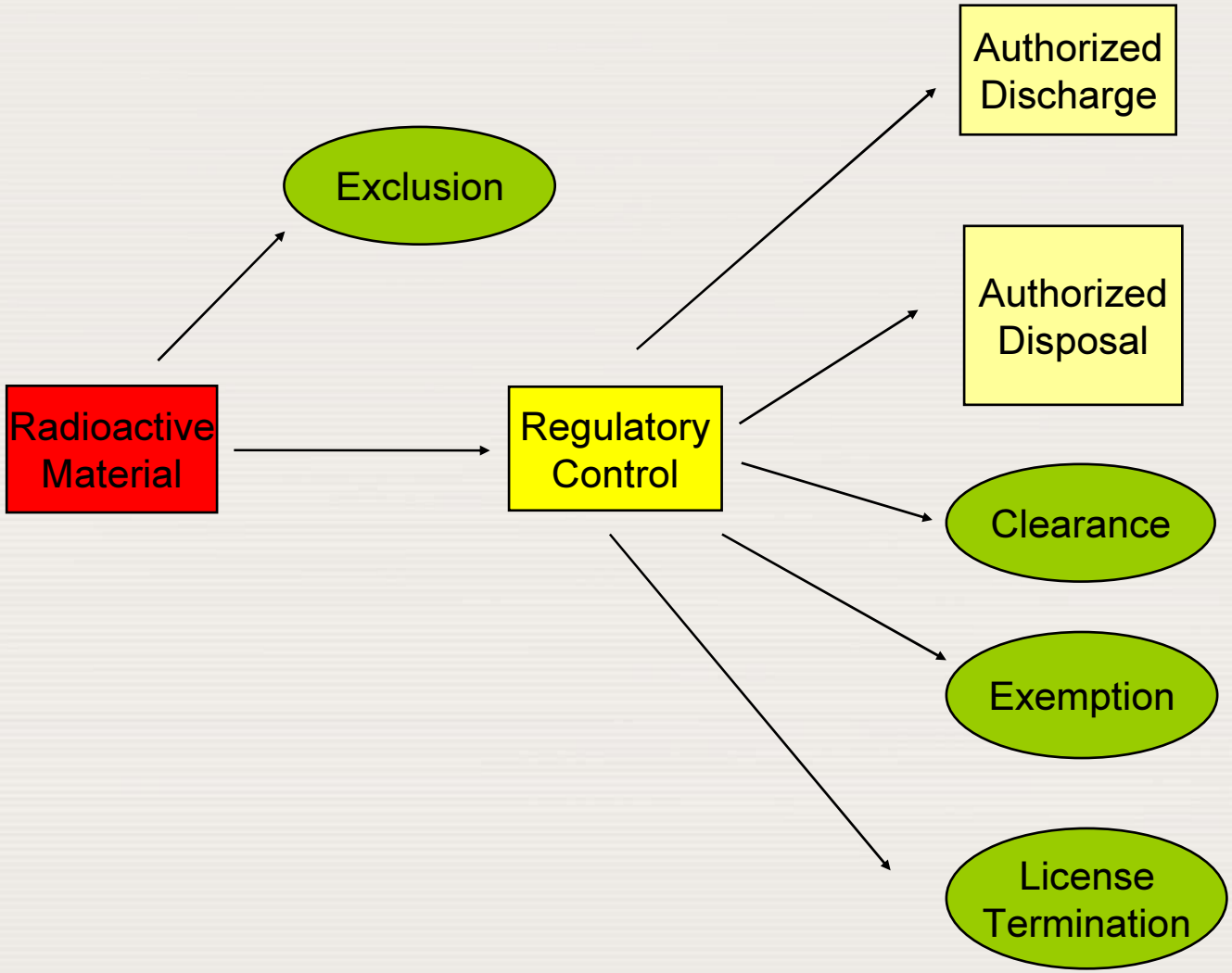
Options for the Control of Radioactive Material and the Release of a Site



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Radiological Situations

- Practices

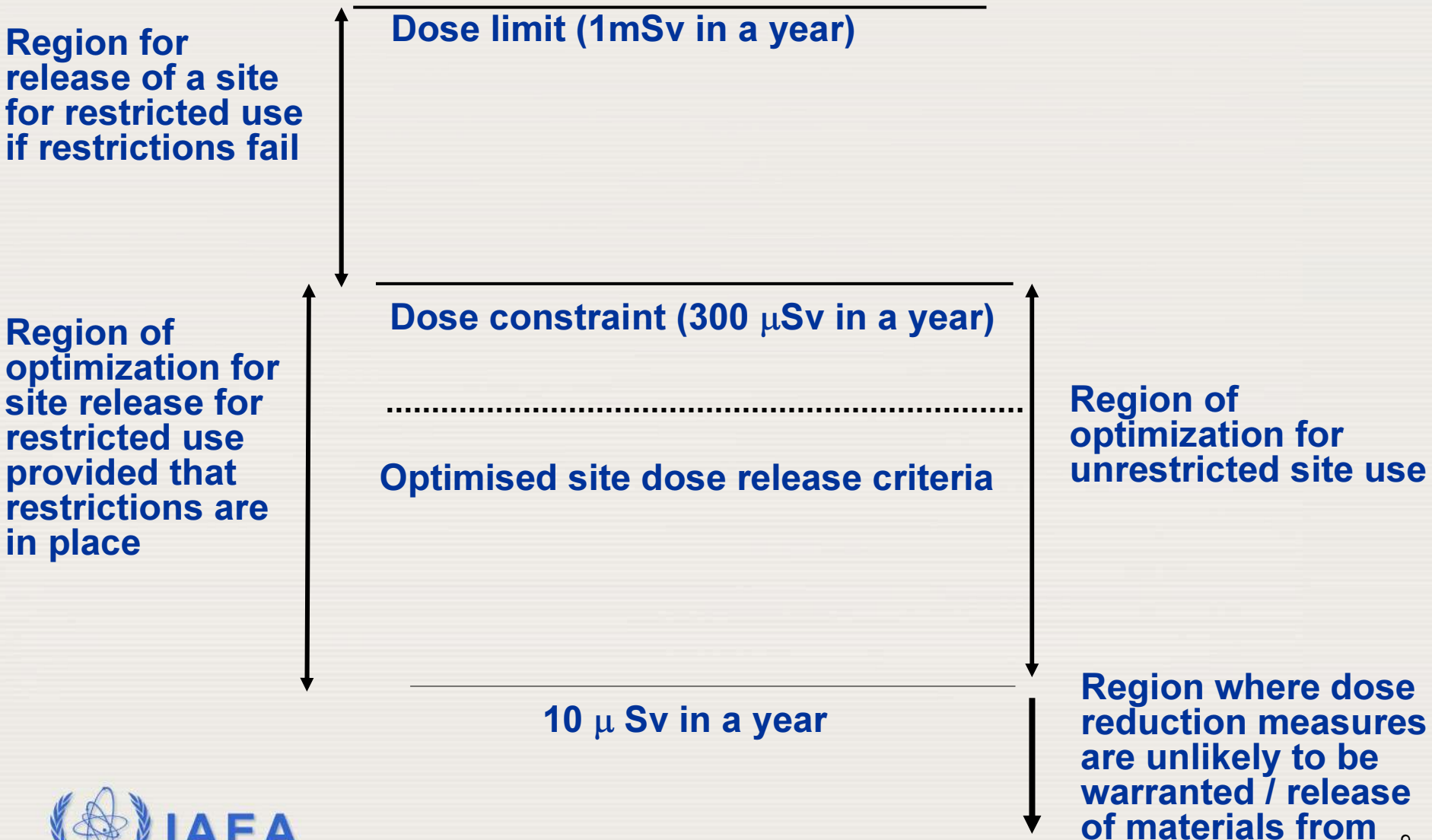
  Deliberate human activities resulting in an increase of (potential) radiation exposure; e.g. operation of nuclear power plants, use of radionuclides in medicine + industry

- Interventions

  Actions to reduce dose in existing situations; e.g. badly managed closed sites, fallout from atmospheric weapons tests, radon at home, contamination from a nuclear accident

- Practices will be the subject of this presentation

Radiological approach to the release from Nuclear Regulatory Control



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Release from nuclear regulatory control 1

- Large amounts of materials are generated during decommissioning
  - Some materials may be released from regulatory control (clearance), e.g. after decontamination or radioactive decay
  - Clearance drastically reduces radioactive waste amounts to be stored + disposed of (by up to 95%)
  - Guidance is needed on acceptable release levels and their derivation
- A decision is to be made on the termination of a site license and the further use of a site
  - Guidance is needed on the release of sites from regulatory control

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Release from nuclear regulatory control 2

- Release levels define the boundary of what is regarded “radioactive” and what is regarded “non-radioactive”
- Natural radionuclides (if unaffected by a “practice”) are excluded
- Avoid re-contamination of clean materials or cleaned surfaces / sites etc.

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Release from nuclear regulatory control 3

- Exclusion concept for radionuclides of natural origin (RS-G-1.7):
  - Based on upper end radionuclide distribution in soil worldwide
  - Activity concentration for
    - K-40: 10 Bq/g
    - All other radionuclides of natural origin: 1 Bq/g
  - U-238, U-235, Th-232: parents of decay chains; secular equilibrium
  - Ra-226: Is a decay product in the chain or is the head of a subset of the chain

Release from nuclear regulatory control 4

- How to deal with natural radionuclides in the release from practices?
  - Establish a baseline concentration of natural radionuclides in soil, concrete or any respective other material
  - Attribute concentrations above natural contamination to a practice
  - Take radionuclides from a practice into account in the clearance process

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Release of Materials from Nuclear Regulatory Control (Clearance)

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Release of Materials: Basics 1

- Motivation for clearance
  - No repository for radioactive waste; storage of radioactive waste for many years before disposal
  - High disposal costs for radioactive waste
  - Saving of resources (re-use and recycling)
- Re-use and recycling options (examples)
  - Melting of metals and fabrication of containers for storage and disposal of radioactive waste
  - Concrete recycling in road construction
- Option: Disposal as non-radioactive waste
  - Disposal of cleared waste in a disposal facility for non-radioactive waste, e.g. chemo-toxic waste

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Release of Materials: Basics 2

- Effective dose to a member of a critical group in the order of 10μSv/a (trivial hazards)
- 10μSv/a concept is widely accepted
- Radionuclide specific levels are generated by safety assessment (multiple scenarios)
  - Direct radiation from the use of recycled material
  - Ingestion of radionuclides from released material
  - Take accumulation of radionuclides into account
- Levels for unrestricted release are given in RS-G-1.7 for individual radionuclides in bulk
- Higher levels may be accepted for defined destinations of materials, e.g. for metal melting

Release of Materials: Basics 3

- Clearance of materials is normally irreversible!
- Great care necessary: No unintentional release of contaminated materials
- Strict regulatory control: licensing of release measurement equipment and supervision of operation
- No release of material without regulatory permission

Release of Materials: Application 1

- Clearance levels are very low
- Consequence: Requirements for clearance measurements are very high
- An ‘intelligent’ approach is necessary
- Elements of a ‘intelligent’ approach
  - Sophisticated characterisation, including the measurement of a complete radionuclide inventory
  - Try to characterise materials in such a way as to be able to declare, as a goal, concentrations of about 1% of clearance levels
  - Develop conservative scaling factors between easily measurable and other radionuclides

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Release of Materials: Application 2

- These scaling factors are also called correlation factors or fingerprints
- easily measurable radionuclides (key radionuclides) are typically Cs-137, Co-60
- Scaling factors will differ within a facility
- Develop a reasonable number of scaling factor sets
- Check the key radionuclides in release measurements and develop the full radionuclide inventory through the respective scaling factors

- A similar approach applies to the determination of radionuclide inventories in waste packages and their declaration, e.g. for disposal!

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Release of Materials: Application 3

- Release measurement
  - Develop / buy / rent appropriate equipment to measure the key radionuclides
  - Demonstrate to the regulator that the equipment works as required (low detection levels, shielding effects, inhomogeneities …)
  - Develop a measurement procedure, including regulatory reviews, agreements and measurements independent of the operator
  - Find approval / agreement of the regulator

Release of Materials: Application 4

- Measure key radionulides in each batch of material
  - Low level measurements may need time
- Develop the full radionuclide inventory through the appropriate scaling factors
- Check whether the batch can be released
- The documentation of all measurement results have to be checked by the regulator
- The regulator decides on the release and may carry out independent measurements
- Never release a batch before approval / agreement is given by the regulator

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Clearance of materials: Release Measurement

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Clearance of materials: Release Measurement

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Release of Buildings from Nuclear Regulatory Control

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Release of Buildings 1

- How to deal with inactive buildings (e.g. office) on a licensed nuclear complex?
  - A reasonable approach may target at giving evidence of clean buildings
    - Provide evidence that radionuclides were never used
    - Provide evidence that contaminations did never occur
    - Provide factual evidence by random / designated measurement on the structures and by sampling
- In general: A building can be released from regulatory control when all radioactive materials have been removed to the required level

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Release of Buildings 2

- The following activities are typically carried out:
  - Decontaminate walls, ceilings, floors, as necessary
  - Remove (deep) contaminated equipment and materials, also along fissures, cracks, joints etc.
  - Prevent re-contamination after decontamination! (Protect surfaces)
  - Clearance measurements on the existing structure
    - If the building will be re-used; or
    - Before demolition of the building
  - Clearance of the rubble of a demolished building is conceivable, but not the typical approach

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Summary: Release of Materials and Buildings 1

- Applicable to trivial radionuclide concentrations in decommissioning materials
- Maybe after decontamination and / or decay
- Motivation: Waste minimisation; recycling/reuse
- Elaborate clearance process
- Sophisticated release measurements: low radionuclide concentration levels
- Application of scaling factors derived from a detailed characterisation programme
- Irreversible process, i.e. releases beyond acceptable levels should never happen

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Summary: Release of Materials and Buildings 2

- Give special attention to natural radionuclides
- Receive equipment from another project or pass it to a next project
- Apply an appropriate approach to inactive buildings with a nuclear license
- Clearance measurements are typically carried out on the existing structure of a building

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Release of Sites from Nuclear Regulatory Control

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Release of sites: Basics 1

- Release of sites is an authorised practice
- Aim: Termination of the license and use of the site for other (non-nuclear) purpose
- Decommissioning of the nuclear facilities and site cleanup are prerequisites
- The definition of an endpoint is important
- Release from regulatory control
  - May be unrestricted or restricted, often termed ‘green field’ or ‘brown field’
  - Radiological and non-radiological hazards must be taken into account

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Release of Sites: Basics 2

- Natural radionuclides are excluded, i.e. they are not amenable to regulatory control
  - This is a difficult situation; situations are even more complicated if natural radionuclides are involved in a practice, e.g. in U / Th fuel fabrication facilities
- Intervention, i.e. cleanup after a nuclear accident, is different from the normal site release
  - Intervention sites often remain under institutional control for given time periods
  - Responsibilities are to be assigned for relevant time
  - This paper does not address intervention situations

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Release of Sites: Basics 3

- The remaining contamination determines the endpoint of the release of a site
  - Non-nuclear use
    - ‘Green field’: Unrestricted release, normal public use of the site, e.g. presence of humans (children) for 24 h/d
    - ‘Brown field’: Industrial use, limited use of the site, e.g. presence of humans for ~8 h/d (no children)
  - Nuclear use (site remains under nuclear regulatory control)
  - Restricted or closed area

Release of Sites: Radiology 1

- Dose limit of 1 mSv/a for a member of the public is an upper bound for the sum of all doses arising from practices
- Optimisation of long term exposure of the public from residual site contamination is necessary
- Dose constraint for multiple pathways of exposure: < 300 μSv/a above background (in accordance with viewgraph 9)
- Some countries apply a 10 μSv/a concept also for the release of sites

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Release of Sites: Radiology 2

- IAEA does not provide radionuclide specific release levels
  - The regulator should provide generic release levels
  - Or: The operator proposes and uses site specific release levels with regulatory approval
- Corrective actions are possible on a site at a later point in time

Cleanup Activities - Overview

- Development of the cleanup activities
  - Site characterisation (planning and execution)
  - Definition of release levels; no radionuclide specific IAEA guidance available
  - Definition of endpoints (often free release)
  - Develop a cleanup plan
- Approval of the cleanup activities before their implementation
- Management of radioactive waste and materials resulting from the cleanup activities
- Surveillance and monitoring of the cleanup activities
- Release of the site from regulatory control

Site Characterisation 1

- General site conditions, e.g. radiological and chemical conditions
- Current use and history of the site
- Identification of radiological contaminants and concentrations
  - Three-dimensional radionuclide distribution
    - Type and concentration of radionuclides
    - Homogeneity / heterogeneity
    - Contamination from leaks in tanks and pipes
    - Contamination below buildings
    - Other hidden and buried contaminated structures
  - Check potential for re-suspension of contaminants

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Site Characterisation 2

- Soil contamination (surface / subsurface)
- Groundwater contamination
- Non-radiological contamination requiring cleanup under non-nuclear legal framework
- Conventional hazards

- Search for existing data / information
- Retrieve information from (former) staff
- Define data information needs and prepare characterisation plan

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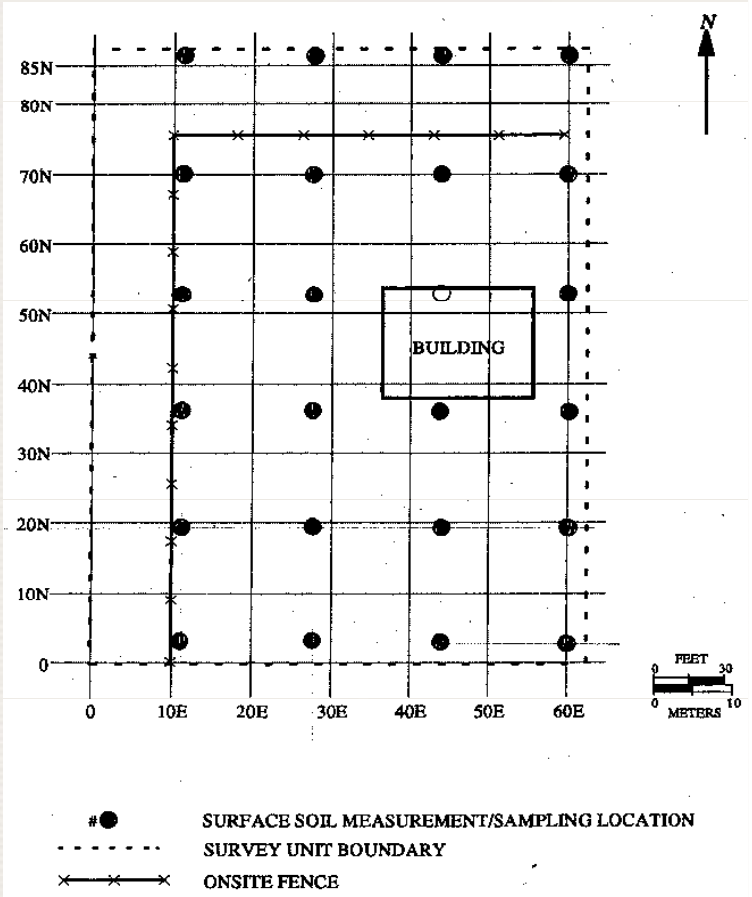
Sampling / Monitoring for Compliance

- Radionuclides of concern
- Acceptable site release levels
- Categorization of areas based on information on spills / contamination
- Determination of boundaries of survey and survey units
- Selection of background areas, if needed
- Reference coordinate system
- Direct measurements versus sampling
- Determination of sampling locations
  - Sampling equipment
  - Sampling technique / Sample size
  - Analysis / Measurement
- In case of contamination: increase density of grid / additional samples



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Cleanup Activities

- Excavation of contaminated soil
  - Equipment / technology
  - Avoid any re-contamination!
  - Measurement to a predetermined gamma level (exclusion of natural radionuclides)
  - Clearance decision on excavated soil
  - Release of soil or management as radioactive waste
  - Identify a destination for the waste
- Backfill of excavations with uncontaminated soil (check!)
- Take, maintain and store samples and records of cleanup activities
- Have cleanup levels been achieved?
- Is unconditional release possible?

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Decision on the Release of Sites

- Regulatory body is responsible for a release decision
- Basis: Demonstration by the operator of compliance with release levels (final radiological survey)
- Regulator may decide to make independent reviews, inspections, analysis etc.
- If compliance is not demonstrated: further proof or cleanup is required
- Acceptance of a final decommissioning report by the regulator
- Storage and maintenance of required documentation (Who, Where, How, How long etc.)
- Enforce restrictions on release of site, if necessary

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Summary – Release of Site

- Release of a site is the final step in decommissioning processes and aims at termination of the license
- A site can be released if all contamination has been removed and the site has been cleaned to acceptable levels
- Compliance has to be demonstrated by the operator
- The regulator may review, check or otherwise act on data of the operator
- A site can be released for unrestricted / restricted use
- A final decommissioning report has to be prepared
- The details of storage and maintenance of the decommissioning documentation have to be specified
- Any restrictions on the site have to be documented and enforced for the pre-determined period of time

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