IAEA Recommendations on Safety Assessment for Decommissioning of Facilities Using Radioactive Material

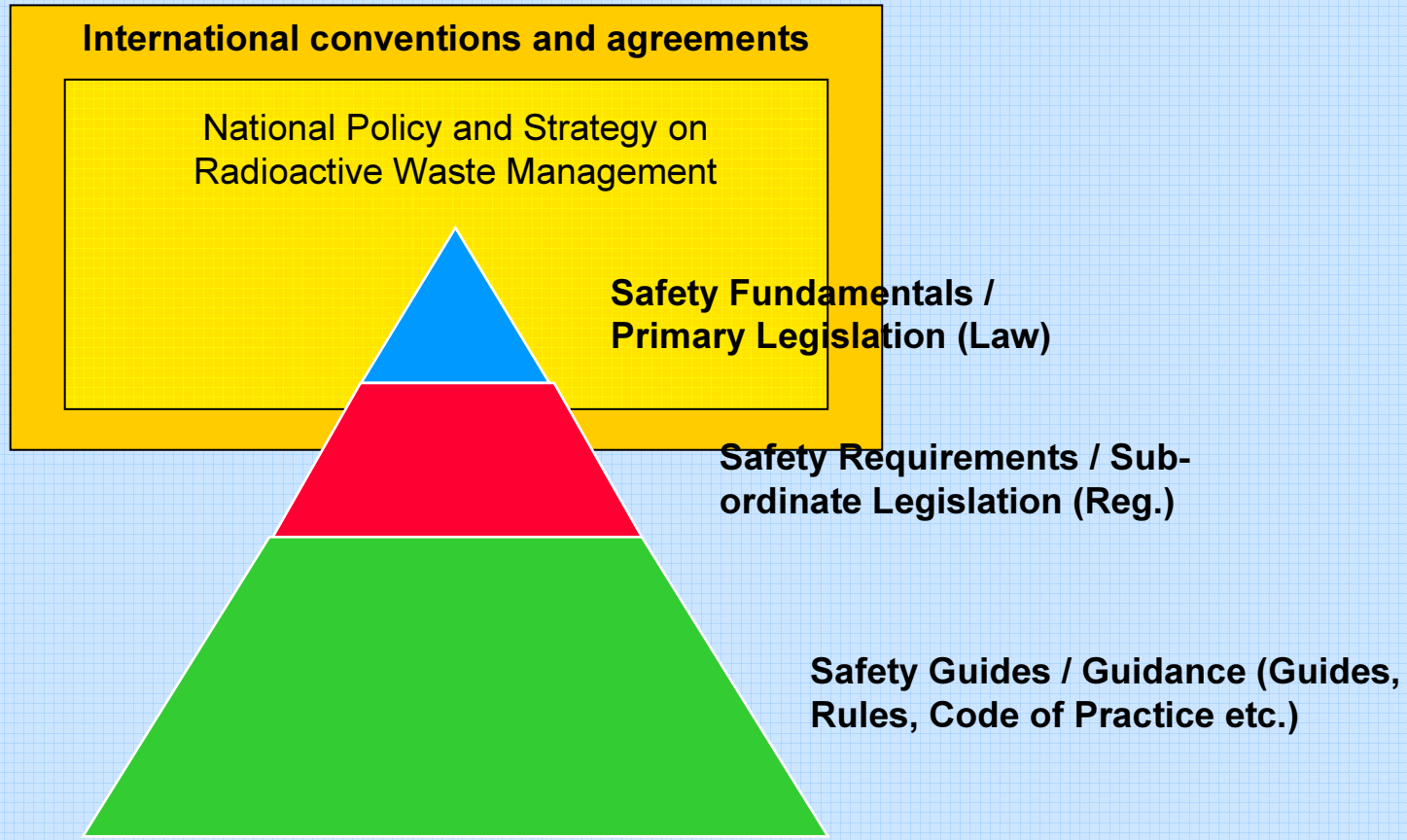
Ernst Warnecke, IAEA-NSRW

Research Reactors Decommissioning Demonstration Project (R^2D^2P)
Safety Assessment for Decommissioning of Research Reactors
Danish Decommissioning, Risø, Denmark; 04-08 October 2010

Contents

- Background
- Hierarchy of legal framework / IAEA Safety Standards
- Safety assessment: Relevant aspects (WS-G-5.2)
- Safety assessment methodology (WS-G-5.2)
- Applications
  - DeSa project
  - FaSa project
- Summary
- References

Hierarchy of Legal Framework / IAEA Safety Standards



Overall Approach to Safety Assessment 1

- Avoid accidents / incidents
- Mitigate consequences should accidents happen
- Demonstrate compliance with safety requirements
- Derive limits, conditions, requirements (outcome)
- Start with screening assessments
- Identify and assess in detail critical / most relevant scenarios

Reminder:

- Safety assessment is an essential part of a decommissioning plan, i.e. an overall plan or the plan for an individual decommissioning step/stage
- Essential prerequisite for a license application

Overall Approach to Safety Assessment 2

- Safety assessment is necessary BEFORE an activity is carried out; it does not need a full set of real / factual data → work with best estimates → revise when new data become available
- Safety assessment includes nuclear and non-nuclear hazards
- Nuclear hazards have the potential of doing harm
- Non-nuclear hazards do harm (e.g. injuries, death)
- The presentation is focused on nuclear hazards

→ If necessary, request help and support from IAEA

Safety Assessment Objectives

WS-G-5.2 „Safety Assessment for Decommissioning“

- To support
  - The selection of a decommissioning strategy
  - The development of a decommissioning plan

    → Safety assessment is part of a decommissioning plan
  - Associated specific decommissioning activities
- Determine whether:
  - Exposures to the public and to workers are below limits and ALARA -as low as reasonably achievable
  - Risks due to accidents and / or normal operations are reduced accordingly
  - Radioactive waste generation is minimised

Safety Assessment for Decommissioning 1

WS-G-5.2 „Safety Assessment for Decommissioning“

- Overall assessments for the whole facility / activity
- Assessments for a decommissioning step / stage
- At facilities with a phased (step-by-step) approach
  - Define the phases, the nature of the decommissioning activities and the associated hazards which may differ between phases / step / stage
  - A graded approach should be applied to each decommissioning phase
- Give consideration to both: individual doses (occupational and public) and the collective dose

Safety Assessment for Decommissioning 2

WS-G-5.2 „Safety Assessment for Decommissioning“

- Use a systematic methodology
  - To demonstrate compliance with criteria
  - To build confidence with ‘stakeholders’ (regulatory body, public etc.)
- Review of assessment
  - Operator internal (independent)
  - Regulatory body; for approval according to the national legal framework
- Review and revise to keep it up-to-date, e.g.
  - When new data become available
  - If surprises have been found
  - If modifications of the plan are suggested

Safety Assessment for Decommissioning 3

WS-G-5.2 „Safety Assessment for Decommissioning“

- In the absence of national requirements for the release of sites develop such requirements by safety assessment
- Demonstrate that exposures after site release will be below 0.3 mSv per year and ALARA
- Materials management should be addressed
  - Radioactive waste
  - Cleared material
  - Destination for waste and materials
  - Other hazardous material

Graded Approach

WS-G-5.2 „Safety Assessment for Decommissioning“

- Grading shall not compromise safety
- Commensurate with:
  - Complexity of type of facility
  - Decommissioning activities/associated hazards
  - Inventory
  - Physical state of the facility
  - Quality of data
  - Resources (human, financial) etc.
- All phases / steps of decommissioning
  - Need a safety assessment
  - Regulators review the safety assessment

Safety Functions and SSCs 1

WS-G-5.2 „Safety Assessment for Decommissioning“

- Safety functions and associated SSCs (Systems Structures and Components) should be identified for:
  - Planned decommissioning activities
  - Accident conditions
- Safety functions
  - Existing and temporary situations
  - Change of safety functions
  - Identification and justification

Safety Functions and SSCs 2

WS-G-5.2 „Safety Assessment for Decommissioning“

- Safety assessment should be used to evaluate
  - Suitability
  - Sufficiency
  - Reliability

of these safety functions (e.g. containment) for the duration of decommissioning, including deferrals

- Deferred dismantling strategy
  - Preference to passive systems, devices and approaches
  - Minimal reliance on active systems, human intervention or monitoring

Defence in Depth

WS-G-5.2 „Safety Assessment for Decommissioning“

- Sometimes called ‘Multi-barrier’ approach
- Safety assessment should:
  - (a) Identify necessary
    - Preventative
    - Protective
    - Mitigating measures
  - (b) Justify that these measures will be suitable and sufficient to ensure safety during decommissioning

Management System

WS-G-5.2 „Safety Assessment for Decommissioning“

- **Management system for decommissioning safety assessment:**
  - **Performance of assessment**
  - **Interface with other related facilities and activities**
  - **Graded approach**
  - **Responsibilities**
  - **Qualification**
  - **Contractors**
  - **Training**
  - **Procedures (e.g. independent review)**
  - **Record and archiving**
  - **Involvement of Regulatory Body etc.**

Staffing and Training 1

WS-G-5.2 „Safety Assessment for Decommissioning“

- Be reflected in the safety assessment e.g.:
  - Through consideration of increased initiating events due to human errors
  - Need for measures to prevent or mitigate the associated consequences
- Balance between human-based and engineered measures
- Rigour of training commensurate with complexity of decommissioning project

Staffing and Training 2

WS-G-5.2 „Safety Assessment for Decommissioning“

- Decommissioning safety assessment needs a qualified and experienced multi-disciplinary expert team with expertise covering all relevant areas:
  - Knowledge of the facility (operational history)
  - Decommissioning technologies
  - Waste management
  - Radiation protection
  - Industrial safety
  - Hazard analysis
  - Engineering analysis
  - Specific areas: criticality, hydrogeology, modelling

Safety Assessment Outcome 1

WS-G-5.2 „Safety Assessment for Decommissioning“

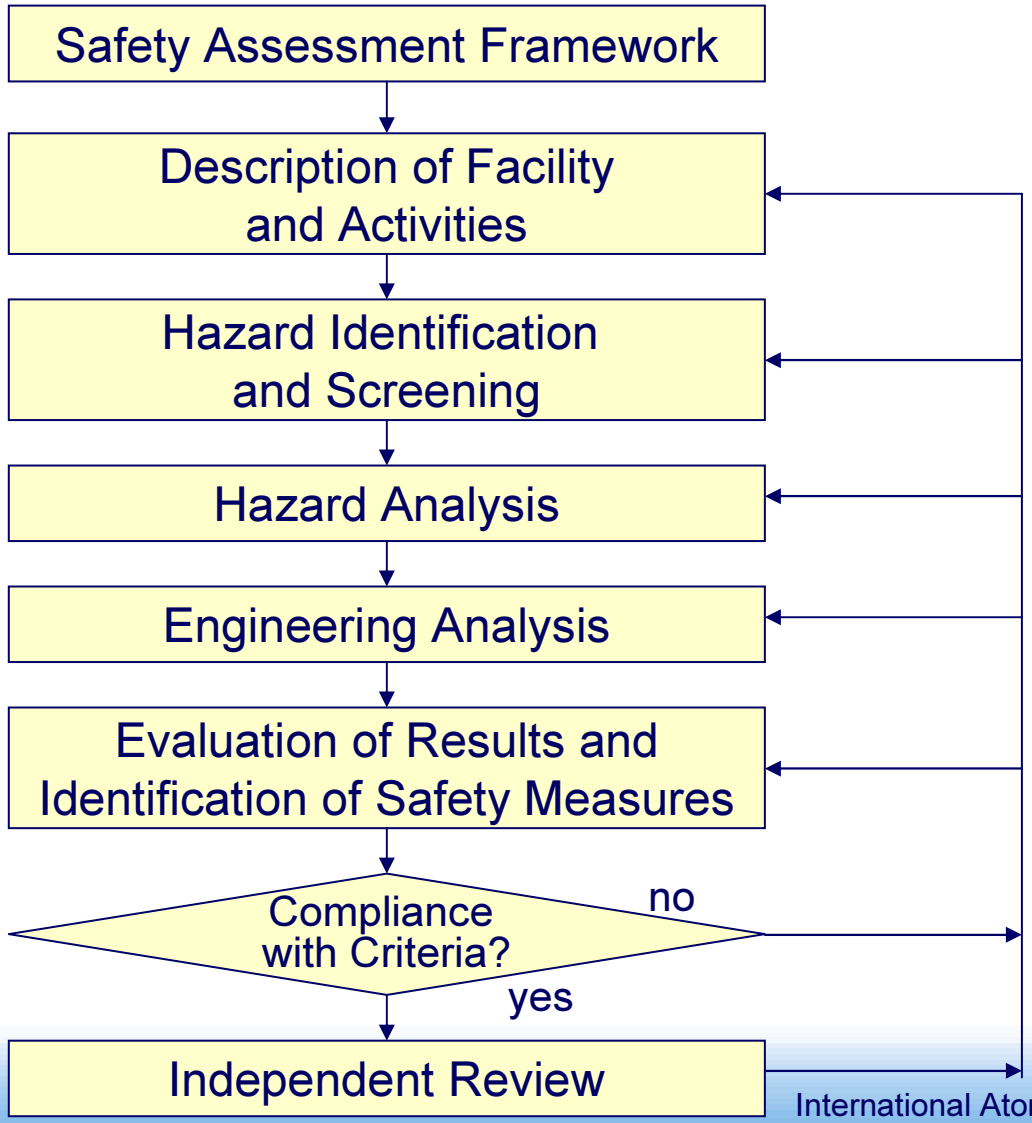
- Document how regulatory requirements / criteria are met
- Evaluate the nature, magnitude and likelihood of hazards and their radiological consequences to workers, public and the environment under normal conditions and during accidents
- Quantify the systematic and progressive reduction in radiological hazards
- Identify the safety measures, limits, conditions, requirements ...
- Demonstrate safety after license termination
- Demonstrate that any institutional control will not impose undue burdens on future generations

Safety Assessment Outcome 2

WS-G-5.2 „Safety Assessment for Decommissioning“

- Provide input to on-site and off-site emergency planning and safety management arrangements
- Provide input to the training needs for decommissioning and qualification of staff

Safety Assessment Methodology



Assessment Framework

WS-G-5.2 „Safety Assessment for Decommissioning“

- Context and relation to decommissioning plan
  - Scope
  - Objectives
  - Requirements and criteria
  - Timeframes
  - End state of decommissioning
  - End states of decommissioning phases/steps …
  - Assessment outputs
  - Safety assessment approach
  - Existing safety assessments and experience
  - Involvement of interested parties
- Include normal operation and incidents / accidents

Description of Facility and Activities

WS-G-5.2 „Safety Assessment for Decommissioning“

- Facility and associated buildings: existing hazards
  - Site description and local infrastructure
  - Structures, systems and components
- Radioactive inventory, mechanical, physical, and chemical characteristics
- Existing and planned safety measures (as input)
- Common systems with other facilities
- Operational history
- Decommissioning plan (activities, sequence and techniques)
- Supporting facilities
- Before, during phases and after decommissioning

Hazard Identification and Screening 1

WS-G-5.2 „Safety Assessment for Decommissioning“

- Hazards
  - Radiological
  - Chemically toxic
  - Dangerous (e.g. asbestos)
  - Industrial / non-radiological hazards
  - Combined and additive effect
  - Initiating events, scenarios following such an event, (potential) consequences (radiological and non-radiological)

Hazard Identification and Screening 2

WS-G-5.2 „Safety Assessment for Decommissioning“

- Existing and potential hazards
- Induced:
  - External
  - Internal
  - Human
- Identification of hazards
    - To workers, public and environment

Hazard Identification and Screening 3

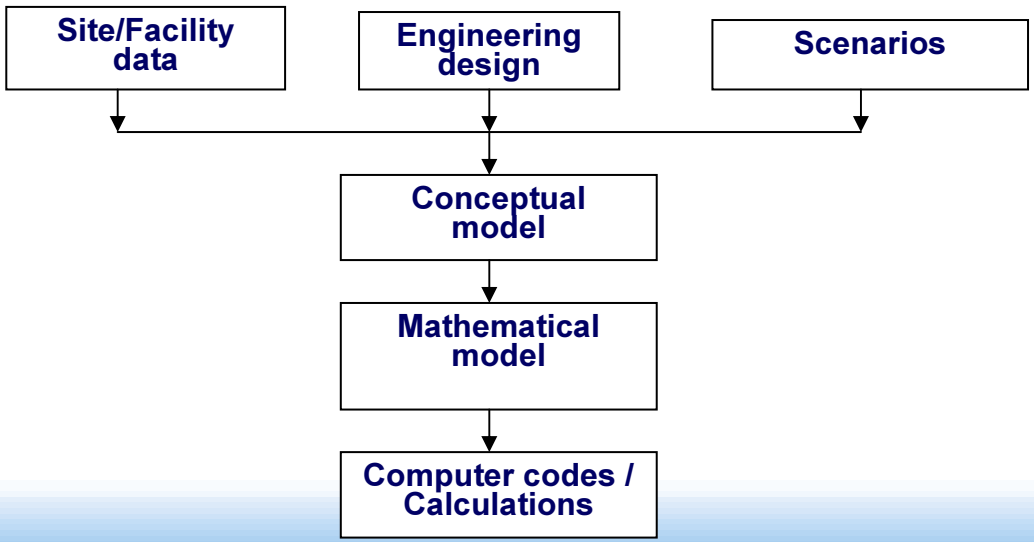
WS-G-5.2 „Safety Assessment for Decommissioning“

- Main steps:
  - Hazards and initiating event identification
  - Screening
  - Selection of critical / more relevant scenarios
    - Normal conditions (as planned)
    - Accidental conditions
- Various techniques
    - Check lists
    - Expert judgement, etc.
- Graded approach
  - Facility complexity, decommissioning phases…

Hazard Analysis 1

WS-G-5.2 „Safety Assessment for Decommissioning“

- Identify sources for radiological hazards
- Assess the magnitude of such hazards
- Check for scenarios that could lead to hazards
- Calculation of consequences (doses and risk)
- Verify and validate methods and models



Hazard Analysis 2

WS-G-5.2 „Safety Assessment for Decommissioning“

- Assumptions should be clearly justified
- Uncertainties should be assessed / determined
- Approach to the analysis should be selected
- Measures should be identified and put in place that would prevent or protect against accidents or mitigate their consequences

Engineering Analysis

WS-G-5.2 „Safety Assessment for Decommissioning“

- Physical, chemical, mechanical and radiological state of the facility after shutdown
- Extent of ageing of facility and safety systems
- Reliability of any existing engineered SSCs need to be in compliance with relevant current codes and standards
- Need for additional engineered SSCs to deliver safety functions
  - Necessary because existing SSCs are inadequate
  - Necessary as a result of proposed specific activities

Evaluation of Results and Identification of Safety Measures 1

Ws-G-5.2 „Safety Assessment for Decommissioning“

- Comparison of results with safety criteria (dose or risk etc.), including uncertainties
- Uncertainty analysis should take due account of all known uncertainties, e.g.
  - quality, reliability information, e.g. assumptions real data
  - precision in the planning of cleanup activities
  - later stages / steps in a phased approach
- Sensitivity analysis
- Adequacy of safety measures
  - Engineering
  - Procedural

Evaluation of Results and Identification of Safety Measures 2

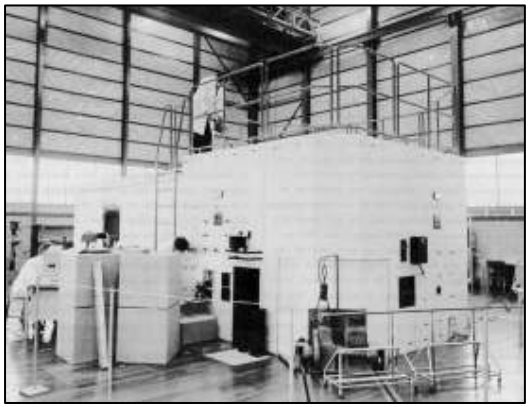
WS-G-5.2 „Safety Assessment for Decommissioning“

- Level of confidence
- Safety margins
- Confidence building in assessment and results
  - Management system / procedures, etc.
  - Qualified and trained staff
  - Independent review carried out by operator
  - Involvement of ‘stakeholders’
  - Dialogue with regulators etc.
- Independent review of safety assessment with independent means by regulator

DeSa Project (2004-2007) 1

- **DeSa: Evaluation and Demonstration of Safety for Decommissioning of Facilities Using Radioactive Material**

NPP



Research reactor

Pu - laboratory

- **Objectives**
  - **Safety assessments for real facilities**
  - **Develop harmonized approach on safety assessment**
  - **Investigate practical applicability**
  - **Demonstrate and illustrate application of approaches**
  - **Investigate approaches for review**

DeSa Project (2004-2007) 2

- **Scope**
  - **Safety assessment for decommissioning of facilities using radioactive material**
  - **Not in the focus:**
    - **development of the Safety Assessment for decommissioning during life time of a facility and during progress of decommissioning work**
    - **Implementation of Safety Assessment results**
    - **These are some of the main issues for the new FaSa project**
- **Outcome**
  - **Important input to the finalization of WS-G-5.2**
  - **Safety Report with 4 volumes to illustrate safety assessment and review methodology**
  - **Network of experts in decommissioning**
- **Website:**

  http://www-ns.iaea.org/tech-areas/waste-safety/desa/start.asp?s=8&l=59

FaSa Project (2008-2011) 1

- Use of safety assessment in planning and implementation of decommissioning of facilities using radioactive material (FaSa)
- Objectives of FaSa (based on DeSa experiences)
- Provide practical and useful recommendations on the evolution and use of safety assessment in planning and execution of decommissioning with the aim of ensuring safe termination of practices
- More detailed recommendations on
  - Use of safety assessment methodology and safety assessment results and their evolution
  - Use of safety assessments in identification and practical implementation of safety control measures and of their evolution

FaSa Project (2008-2011) 2

- Application of the graded approach
- Further recommendations on methodologies and approaches for independent reviews for the operator and regulatory reviews of safety assessments and the implementation of their results

- **Scope of FaSa**
  - Focus on immediate and deferred dismantling of a large range of facilities with different complexities and hazards, endpoints and end states
  - Explore interfaces between safety assessments for decommissioning and for waste management
- **Website:**

http://www-ns.iaea.org/tech-areas/waste-safety/fasa/default.asp?s=8&l=64

Summary

- Systematic analysis of the safety of a facility / activity
- Relevant input data (factual data or assumptions) are needed
- The better the data the better the safety assessm.
- Qualified, experienced, skilled experts are needed
- Important aspect of a license application as part of the decommissioning plan
- IAEA recommendations on safety assessment (see References)
- DeSa and FaSa Projects apply safety assessment and foster international co-operation
- IAEA provides continued assistance to Member States on the application of safety standards and the exchange of information

References 1

- Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1, 2006
  http://www-pub.iaea.org/MTCD/publications/PubDetails.asp?pubId=7592
- International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources, IAEA Safety Series No.115, 1996
  http://www-pub.iaea.org/MTCD/publications/PDF/Pub996_EN.pdf
  - Draft BSS Revision of January 2010:
    http://www-ns.iaea.org/downloads/standards/drafts/ds379.pdf
- Decommissioning of Nuclear Facilities Using Radioactive Material, IAEA Safety Standards Series No. WS-R-5, 2006
  http://www-pub.iaea.org/MTCD/publications/PDF/Pub1274_web.pdf
- Decommissioning of Nuclear Power Plants and Research Reactors, IAEA Safety Standards Series No. WS-G-2.1,1999
  http://www-pub.iaea.org/MTCD/publications/PDF/P079_scr.pdf

References 2

- **Safety Assessment for Facilities and Activities, IAEA Safety Standards Series No. GSR-4, 2009**
  http://www-pub.iaea.org/MTCD/publications/PDF/Pub1375_web.pdf
- **Safety Assessment for the Decommissioning of Facilities Using Radioactive Material, IAEA Safety Standards Series No. WS-G-5.2, 2008**
  http://www-pub.iaea.org/MTCD/publications/PDF/Pub1372_web.pdf
- **Standard Format and Content for Safety Related Decommissioning Documents, IAEA Safety Reports Series No. 45, 2005**
  http://www-pub.iaea.org/MTCD/publications/PDF/Pub1214_web.pdf
- **Safety considerations in the transition from Operation to Decommissioning of Nuclear Facilities, IAEA Safety Reports Series No. 36, 2004**
  http://www-pub.iaea.org/MTCD/publications/PDF/Pub1184_web.pdf
- **DeSa Project Reports (Password protected)**
  http://www-ns.iaea.org/tech-areas/waste-safety/desa/login.asp?s=8&l=59