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Considerations Related to Human Intrusion in the Context of Disposal of Radioactive Waste – Results of the IAEA HIDRA Project

Roger Seitz
Senior Advisory Scientist

Acknowledge Members of Leadership Team
Yumiko Kumano (IAEA), Lucy Bailey (UK NDA), Chris Markley (US NRC),
Eva Andersson (SKB Sweden), and Thomas Beuth (GRS Germany)

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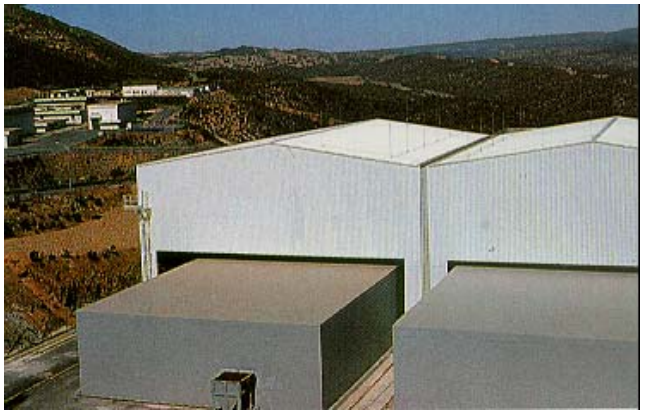
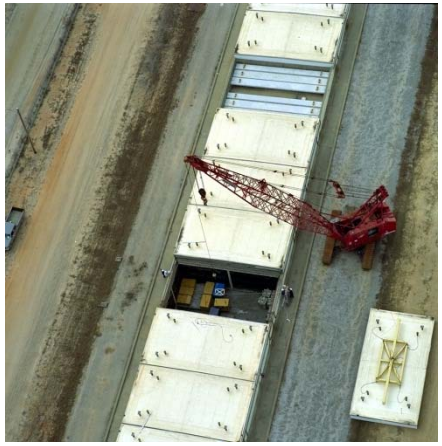
Outline

- Background
- Requirements and Expectations
- Project Development and Structure
- Example Suggestions
- Conclusions

Background

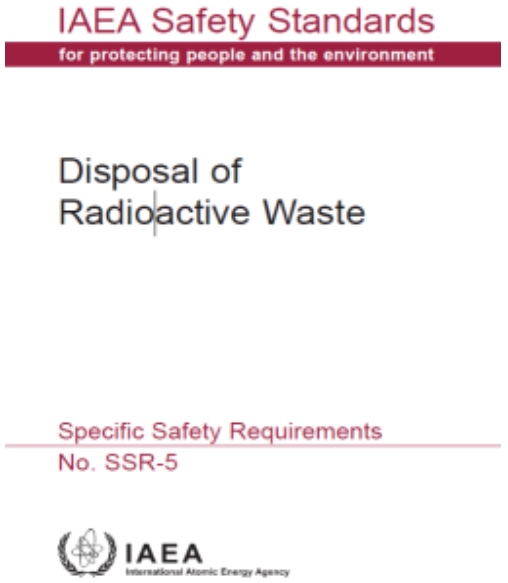
- “Concentrate and contain” is considered the best alternative, but potential risk increases should someone inadvertently disrupt facility
- General consensus that the possibility of inadvertent human intrusion must be addressed to build confidence in the safety of waste disposal
- Concern that intrusion on its own should not disqualify a good facility and site
- Lack of consistent implementation





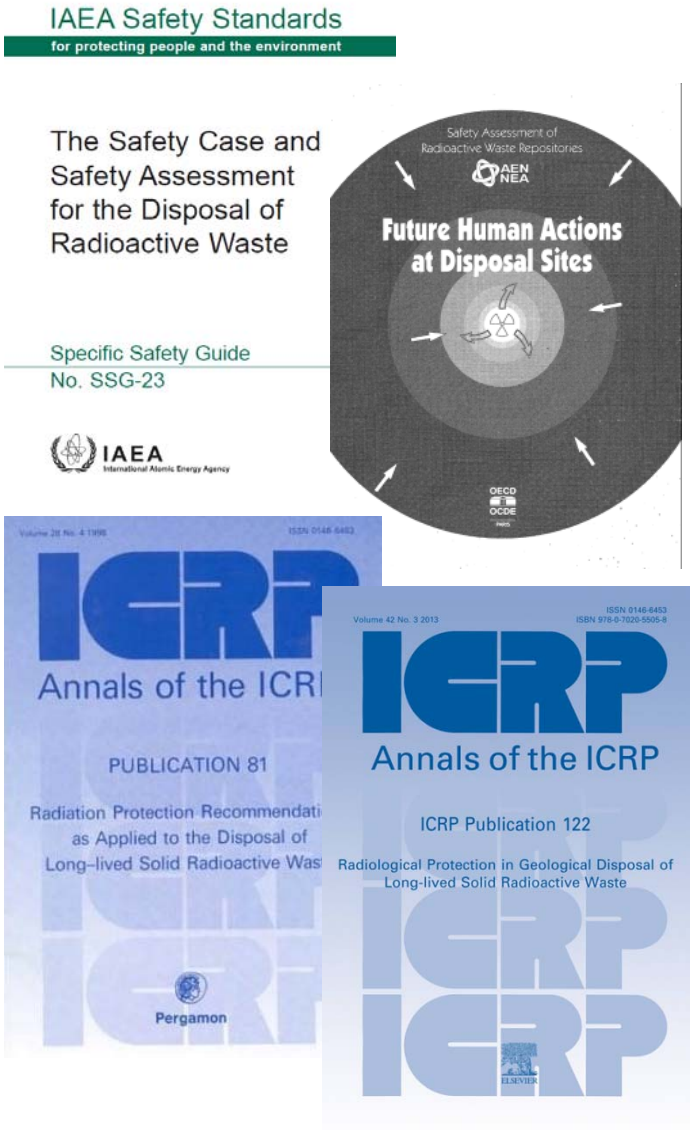
IAEA Safety Requirements

- Potential inadvertent intrusion must be addressed (geologic and near-surface disposal interpreted differently)
- Criteria (Optimization rather than a dose constraint)
  - Less than 1 mSv/yr, efforts to *reduce probability or limit consequences* not warranted
  - Between 1 and 20 mSv/yr, reasonable efforts are warranted to *reduce probability or limit consequences* by means of *optimization* of facility design
  - Greater than 20 mSv/yr, alternative options for disposal should be considered



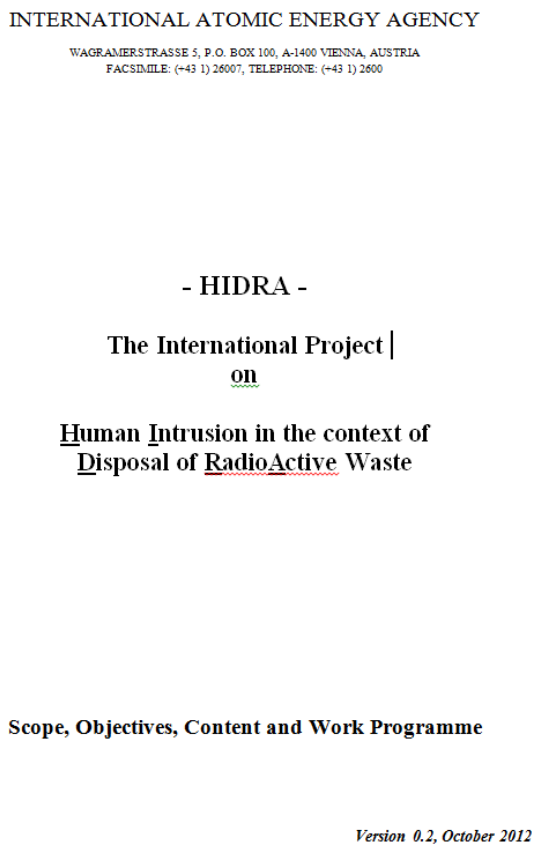
IAEA, ICRP, and OECD/NEA General Expectations

- Protect inadvertent intruder, not someone knowingly intruding into a disposal facility
- One or more stylized scenarios with current habits, not intended to be speculative
- Considered separately from the normal evolution scenario and viewed in the context of optimization, not a dose limit
- Specifics of implementation not addressed in detail



HIDRA Project

- Formal project plan was developed at a Plenary Meeting in 2012
- First Project Plenary was held in November 2013
- Final Plenary in December 2014
- Some general guidelines were identified:
  - Focus on implementation in a safety case
  - Expect final product to be a report that could inform future updates to Safety Standards
  - Identify areas where consensus is possible
  - Provide information for countries developing new disposal capacity
  - Discuss differences between geologic and near-surface disposal



INTERNATIONAL ATOMIC ENERGY AGENCY

WAGRAMERSTRASSE 5, P.O. BOX 100, A-1400 VIENNA, AUSTRIA
FACSIMILE: (+43 1) 26007, TELEPHONE: (+43 1) 2600

- HIDRA -

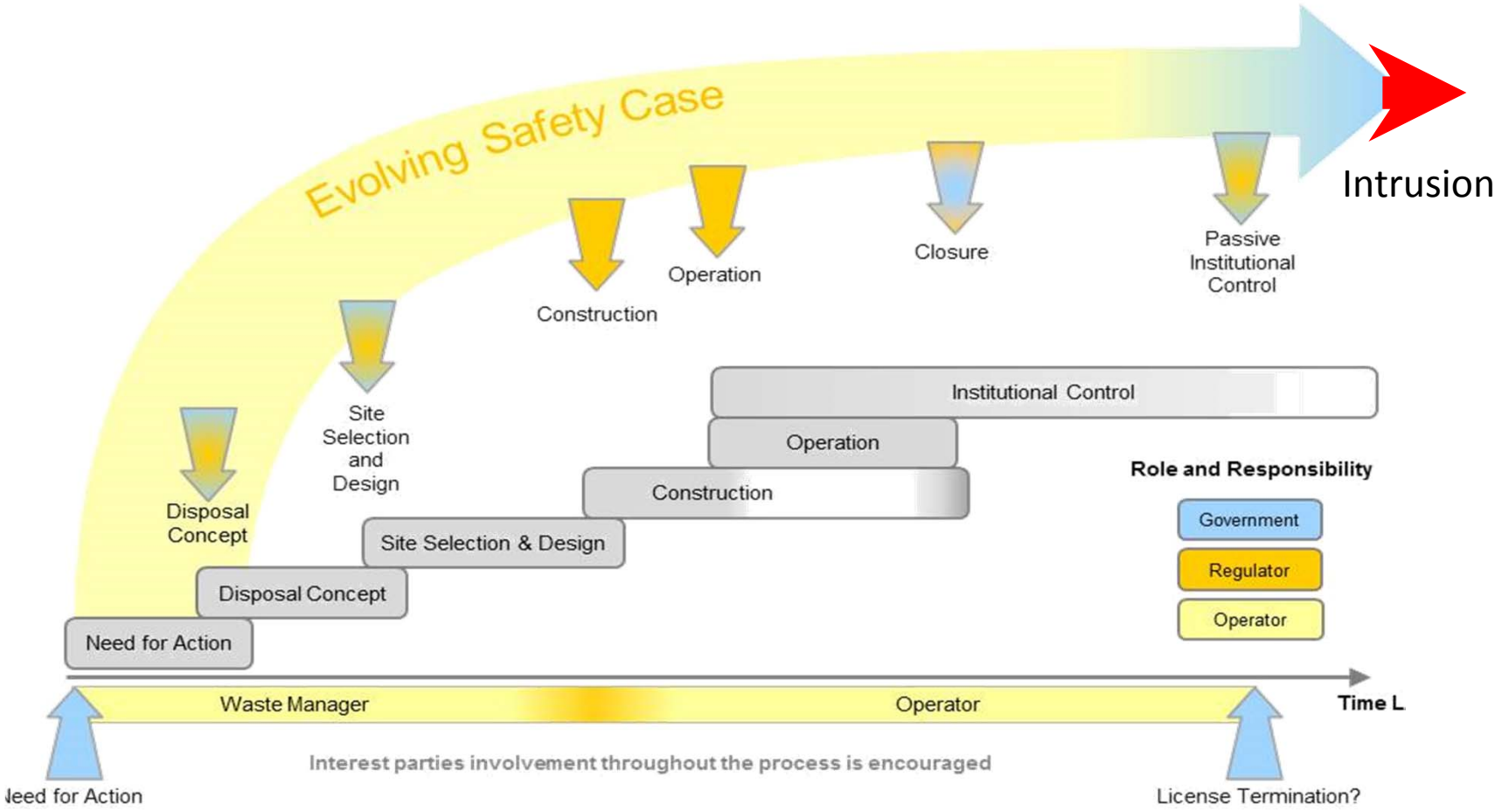
The International Project on

Human Intrusion in the context of Disposal of RadioActive Waste

Scope, Objectives, Content and Work Programme

Version 0.2, October 2012

Safety Case and Lifecycle Considerations

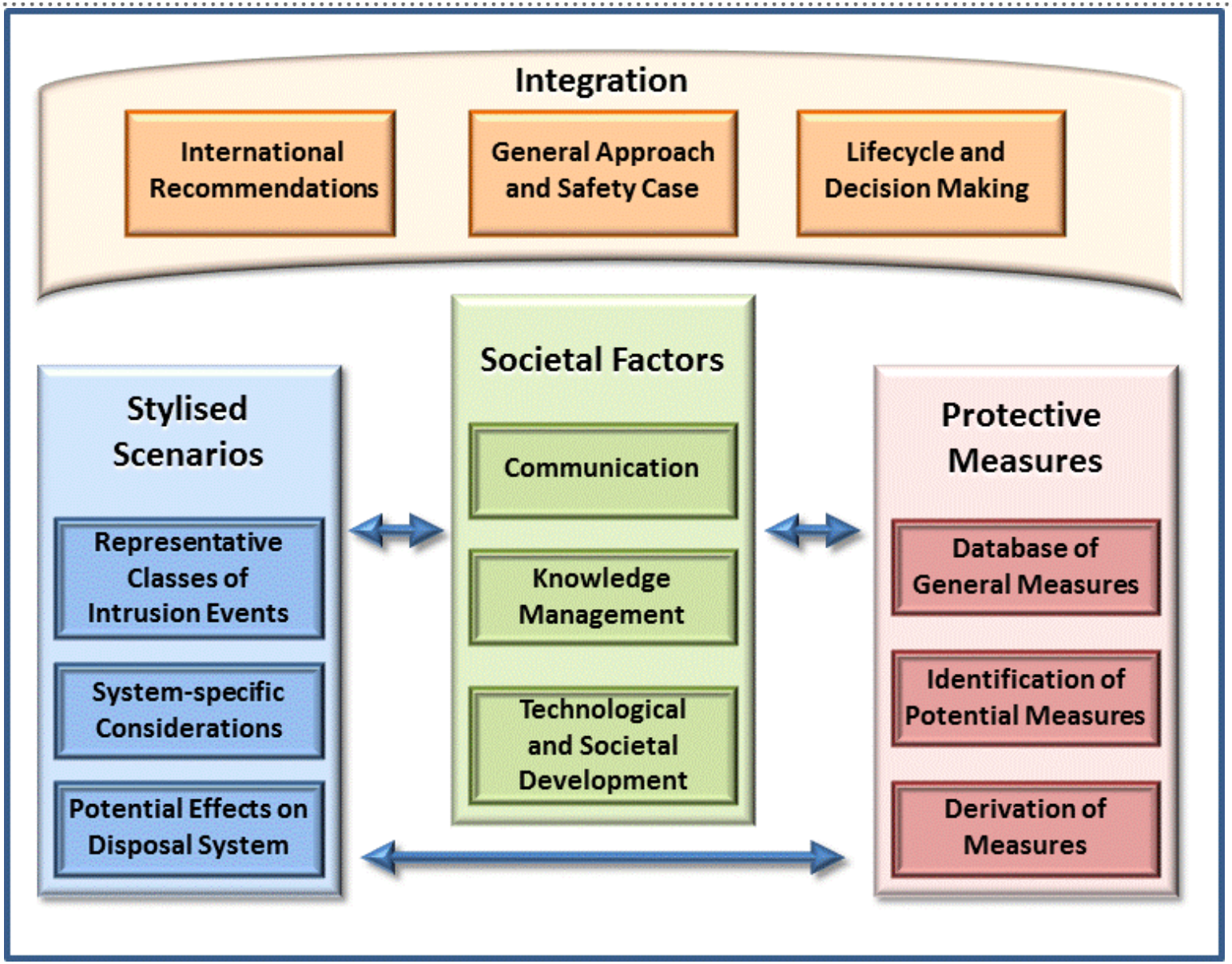


- Intruder considerations during the lifecycle (siting, design, operations…)
- Implementation of intrusion within the general construct of the safety case

Challenging Areas

- Distinction between geologic and near-surface facilities (geologic disposal is selected in order to significantly reduce any potential for intrusion)
- “Inadvertent” intrusion, when does it become knowingly disrupting waste
- Timing of intrusion
  - Effectiveness of passive controls (“major public works” or individual actions)
  - Effectiveness of design/engineered barriers
- Likelihood, possibility, probability (scenarios, hitting waste, etc.)
- Choice of scenarios (avoiding speculation)
- Optimization or dose limit/constraint
- How to reduce potential for and/or consequences of intrusion (ICRP 122)
- Communication (over-conservatism, interpretation of results, perception of intrusion)
- Maintaining knowledge of the disposal facility

Project Organization



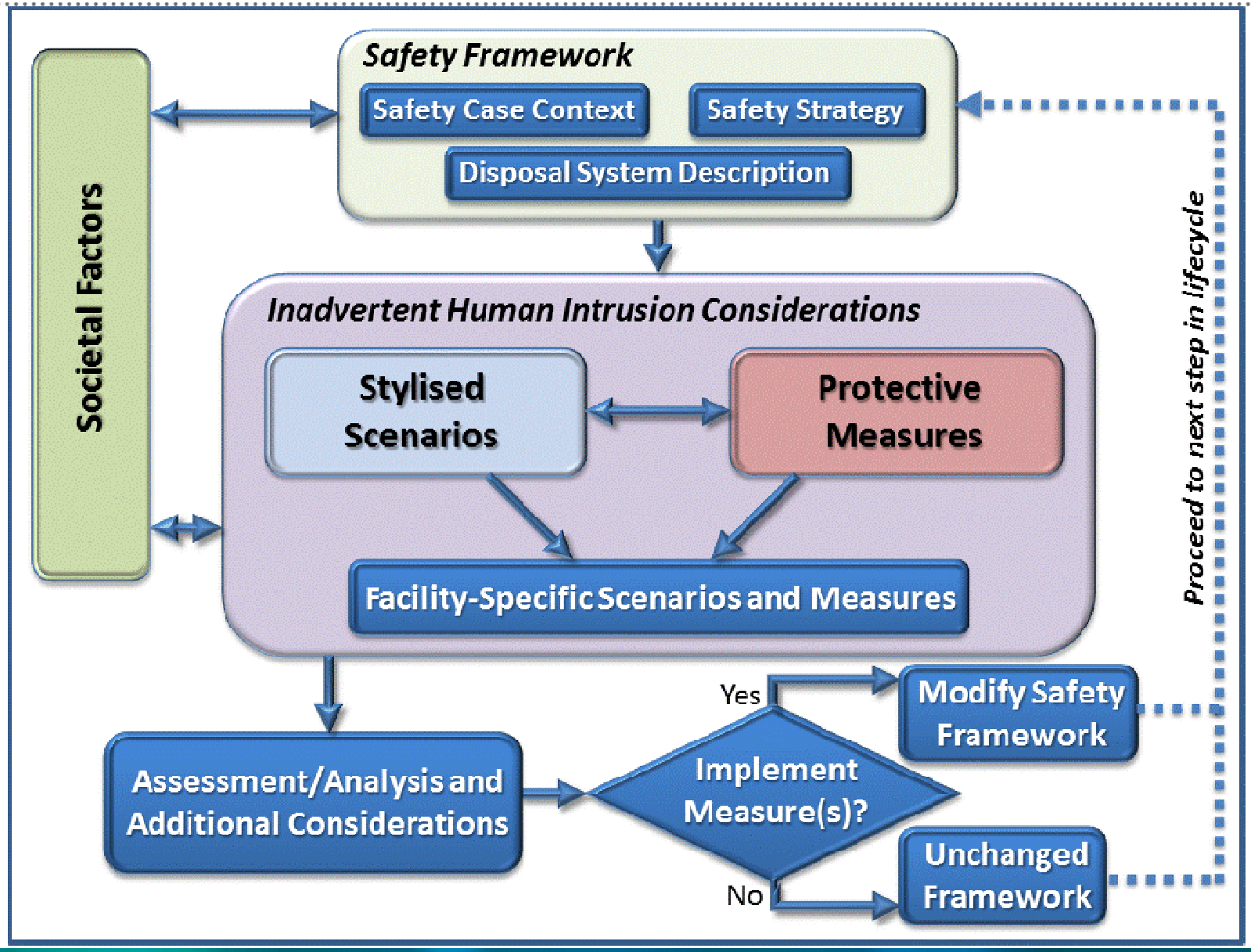
Communication (What has to happen for scenario to occur?)

- Assumed loss of knowledge of the repository
- Assumption that intrusion occurs (even in a rural site with low human activities)
- Assumed intrusion occurs immediately following the end of active control period (to minimise the effect of radioactive decay)
- Assumed intrusion occurs within the disposal facility footprint rather than outside its footprint
- Assumed direct contact by intruders with radioactive waste?
- Assumed contact with the highest activity waste?
- Assumed the drill will not deflect around barriers, containers or waste forms
- Assumed the driller/construction worker will not recognise that something is wrong and stop
- Assumed drilling and use of a well for water without considering water quality
- Assumed residents establishing home/garden specifically on the drill cuttings
- Assumption that some of the cuttings are respirable
- Assumption that cuttings will behave like soil with respect to uptake in plants;
- Conservative bias for exposure assumptions for occupancy and local food production and consumption, rather than those relevant to typical situations.

Concept of Protective Measures

Reference		Explanation	Example
Objective	Reduction of the possibility of intrusion	Measures with focus on a specific objective	Institutional control
	Reduction of the radiological consequences		Waste separation, compartmentalisation, encapsulation
Position	External measures	reference on measures outside the disposal system or be applied	Restriction of use, development freeze
	Internal measures	reference on measures inside the disposal system or be activated	Inserting of resistances against tunnelling/mining techniques
Action	Passive measures	reference on measures which need no further actions and maintenance if they are once	Labelling and marking
	Active measures	reference on measures which need sometimes or continued updates and maintenance	Preservation of information and knowledge
Type	Regulative measures	mandatory measures provided by authorities	Surveillance (site inspection, satellite-based)
	Constructive measures	measures which require a design layout	Inserting of a reinforced concrete slab near surface
	Planning measures	measures which require a planning realisation regarding implementation and place of installation	Usage of difficultly soluble fixtures
	Conceptual measures	measures which have to be considered in the disposal concept	Placement of the repository (repository depth)
Characteristic	Delaying	measures which can have a respective effect	Inserting of rubber mats in the emplacement drifts
	Deterring, preventing, restricting		Designation as prohibited zone
	Indicating, informing, warning		Optical indicators (fluorescent colours, phosphorescent materials
	Aggravating, hindering, defending		Increase of the cask wall thickness
	Controlling, guarding		Safeguards
Dependence	Depending on the spec. human action	measures which are connected to a specific human action	Construction of a borehole top seal, borehole plug made of robust material
	Independent of the spec. human action	measures which are not connected to a specific human action	Archiving and documentation (local, regional, national, global)
Basic action	Borehole drilling	reference to a specific basic action	Repository dimensions (reduction of spatial expansion)
	Creation of a cavern		Usage of difficultly soluble fixtures
	Construction of a mine		Inserting of resistances against tunnelling/mining techniques
	Excavation/ Blasting/ Others		Inserting of a reinforced concrete slab near surface
	General	no reference to a specific basic action	Adoption of the issue in the education programme
Assessment: benefit/ cost	High	evaluation of the effectiveness of respective measures	Institutional control
	Medium		Labelling and marking
	Low		Alteration of the landscape (difficult to develop)
Assessment: effort	Great	evaluation of the expected effort in conjunction with respective measures	Usage of difficultly soluble fixtures
	Medium		Construction of a drift backfilled with robust material/rock
	Little		Colour indicators that react upon contact with a liquid and cause e.g. colouring of the fluid, uranine
Assessment: availability	Long-term	evaluation of the temporal availability of respective measures (for deep geological disposal e.g. from few thousand years to the demonstration period and longer)	Placement of the repository (repository depth)
	Medium-term	evaluation of the temporal availability of respective measures (depending of the disposal facility e.g. from loss of the memory to several hunderd years up to a few thounsand years)	Inserting of rubber mats in the emplacement drifts
	Short-term	evaluation of the temporal availability of respective measures (from closure to the loss of memory e.g. few hundred years)	Monitoring of the environment
Optimisation conflict	Existing	assessment of the measure regarding optimisation conflicts (e.g. the meausre might compromise the safety of the disposal system)	If an optimisation conflict exists depends primarily on the criteria regarding conflicts, respective national regulations, site conditions and disposal concepts.
	Explanation	explanation of the reasons in case of an optimisation conflict	

Proposed Structure for Approach



Considerations over Time (ICRP uses term “Oversight”)

	Active Control	Passive Control	Loss of Memory
Societal control	Physical security at site, knowledge management, records, site markers	Knowledge management, records, site markers	No knowledge of hazardous nature of site
Design safety features	Depth of disposal, multi-barriers	Depth of disposal, multi-barriers	Depth of disposal, multi-barriers may be degrading
Implications for potential for HI	No inadvertent HI	Inadvertent HI extremely unlikely – safety case can justify exclusion of major HI scenarios	Inadvertent HI a possibility, may still be mitigated by enduring design features
Hazard of facility	Disposal inventory	Decaying inventory	Decay may be significant for near-surface, low-level waste facilities

Conclusions

- IAEA established the HIDRA project to provide suggestions for a more consistent approach to address human intrusion in a safety case
- General international agreement that “inadvertent” human intrusion needs to be considered …, in the context of optimization rather than a dose limit
- Geologic disposal is inherently protective of intruders, assessment is more quantitative for near surface disposal
- Identification of a standard set of stylized scenarios based on current practices/technology is seen as important to limit excessive speculation
- Timing influenced by design and institutional factors (delay is important)
- Concept of measures that can reduce the potential for and/or consequences of intrusion is seen as very useful
- Effective communication of the purpose and meaning of results from human intrusion assessments is critical

HIDRA

http://www-ns.iaea.org/projects/hidra/default.asp?s=8

Questions

For further information, please contact:
Roger Seitz
Savannah River National Laboratory
Roger.Seitz@srnl.doe.gov