

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

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# Outline

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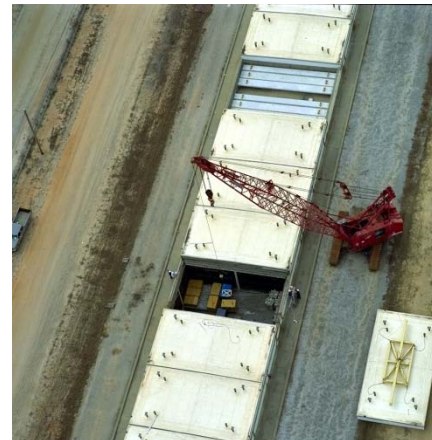
- Background
- Requirements and Expectations
- Project Development and Structure
- Example Suggestions
- Conclusions



# Background

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- “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

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- 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 Safety Standards  
for protecting people and the environment

Disposal of  
Radioactive Waste

Specific Safety Requirements  
No. SSR-5



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# IAEA, ICRP, and OECD/NEA General Expectations

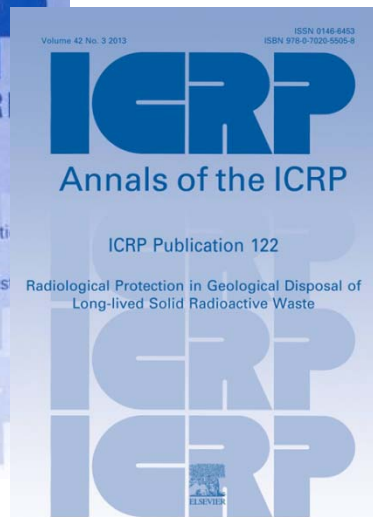
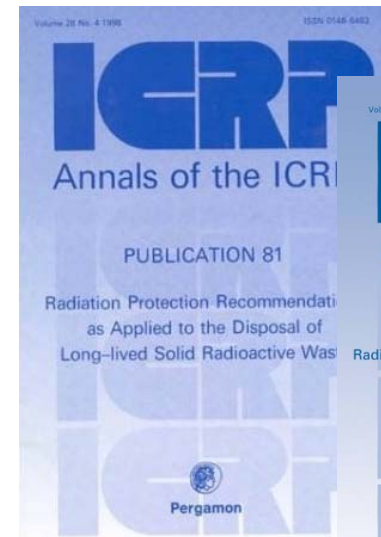
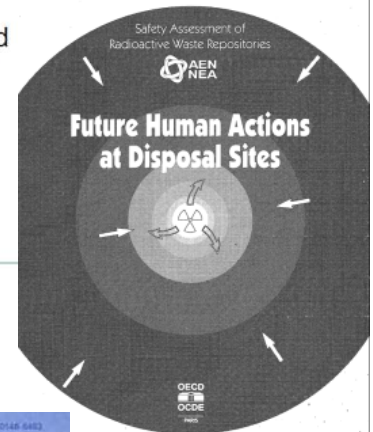
- Protect inadvertent intruder, not someone knowingly intruding into a disposal facility
- One or more stylized scenarios with current habits, not intended to be speculative
- Considered separately from the normal evolution scenario and viewed in the context of optimization, not a dose limit
- Specifics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

## IAEA Safety Standards

for protecting people and the environment

The Safety Case and  
Safety Assessment  
for the Disposal of  
Radioactive Waste

Specific Safety Guide  
No. SSG-23



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# HIDRA Project

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- 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

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- 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*

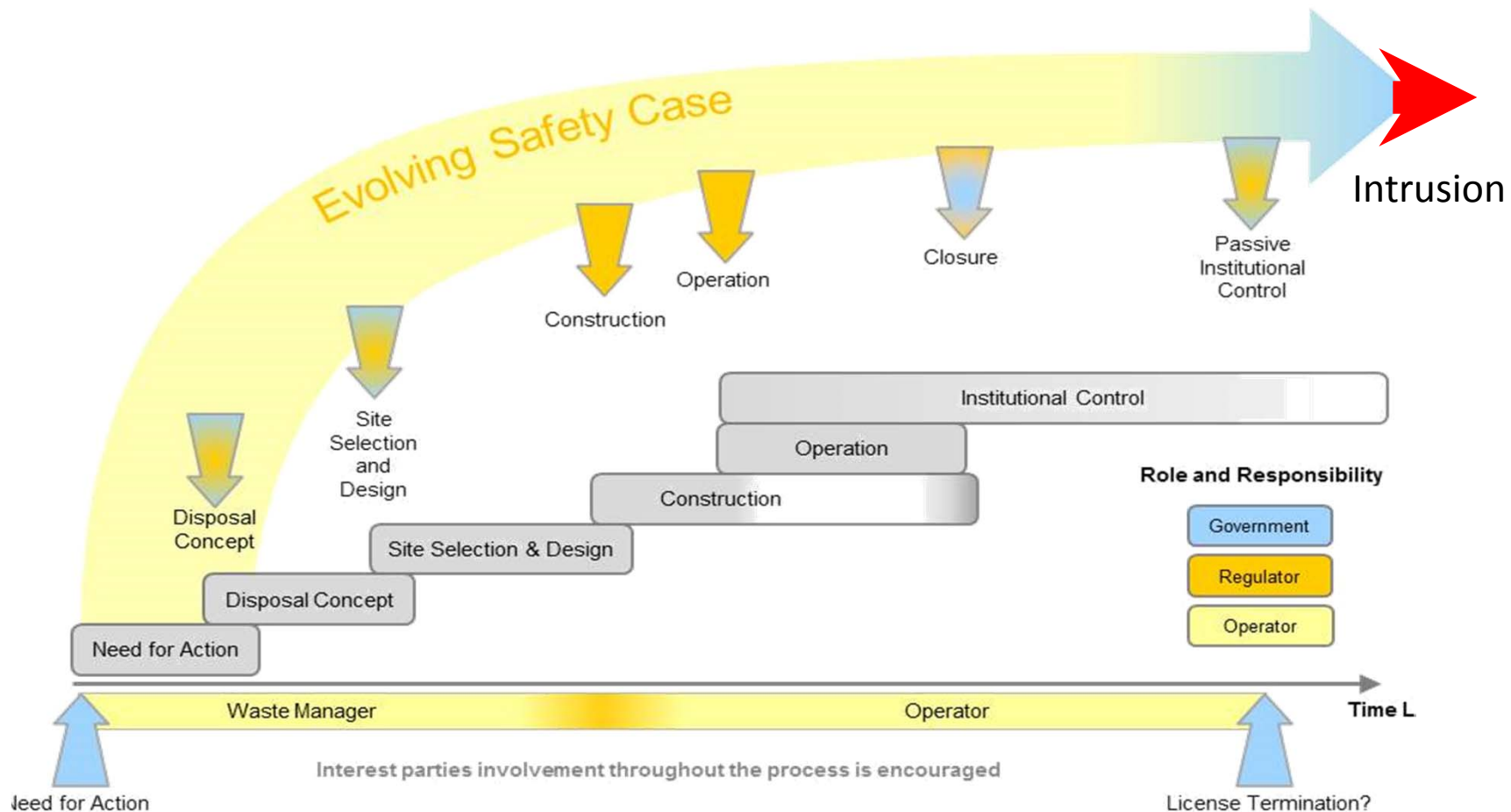


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# Safety Case and Lifecycle Considerations



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



# Challenging Areas

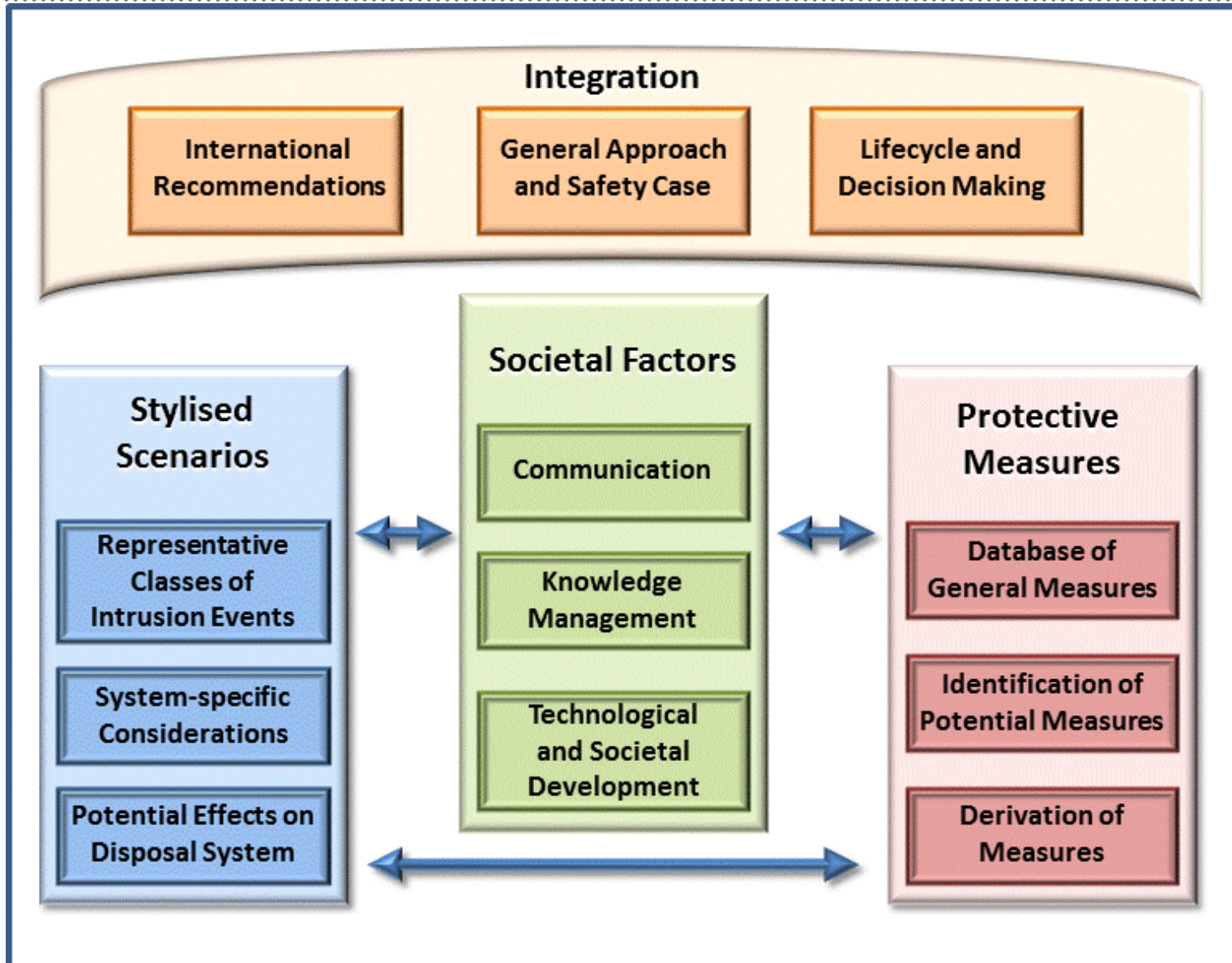
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- Distinction between geologic and near-surface facilities (geologic disposal is selected in order to significantly reduce any potential for intrusion)
- “Inadvertent” intrusion, when does it become knowingly disrupting waste
- Timing of intrusion
  - 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?)

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- 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.

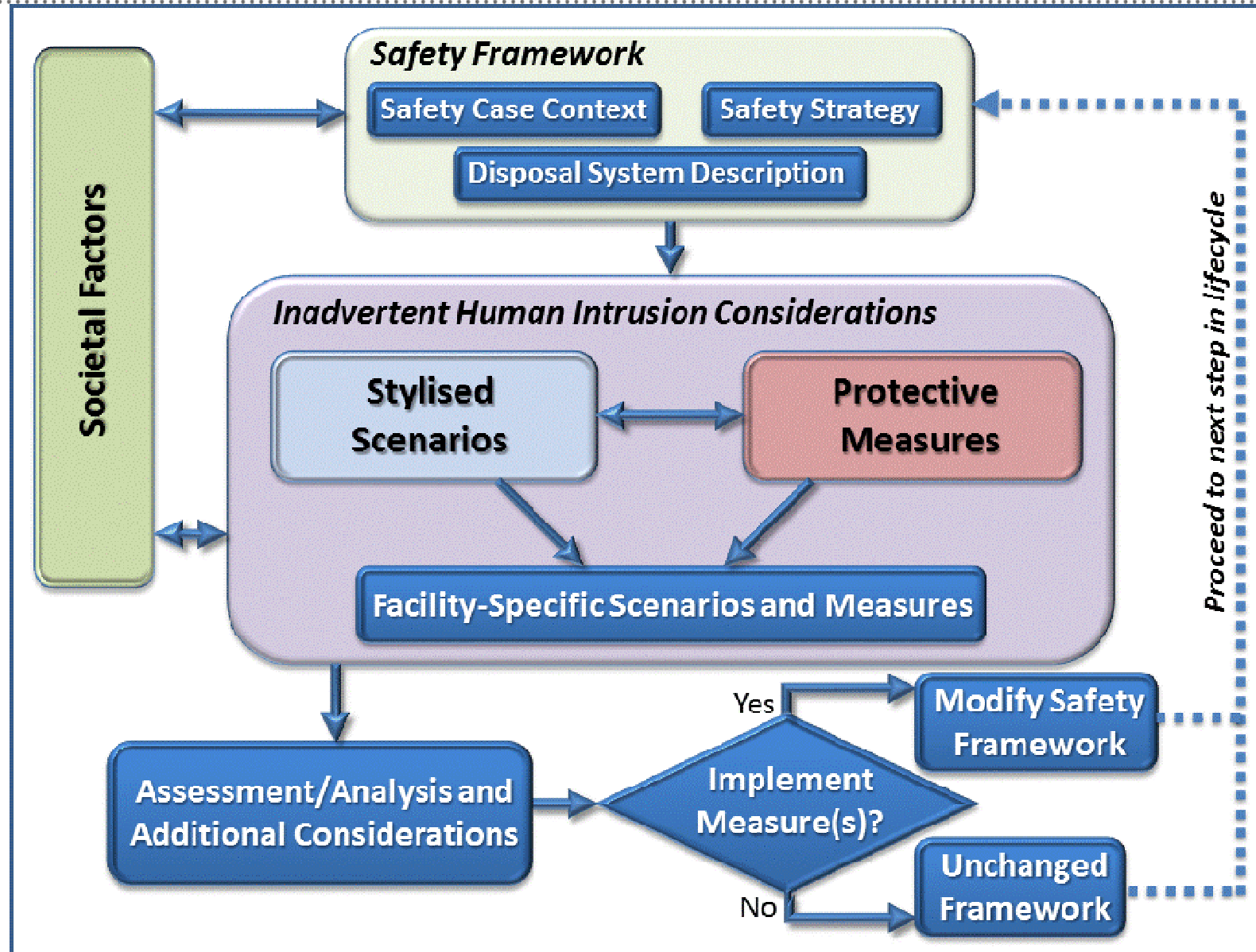


# Concept of Protective Measures

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 hundred years up to a few thousand 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 measure 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
<b>Societal control</b>	Physical security at site, knowledge management, records, site markers	Knowledge management, records, site markers	No knowledge of hazardous nature of site
<b>Design safety features</b>	Depth of disposal, multi-barriers	Depth of disposal, multi-barriers	Depth of disposal, multi-barriers may be degrading
<b>Implications for potential for HI</b>	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
<b>Hazard of facility</b>	Disposal inventory	Decaying inventory	Decay may be significant for near-surface, low-level waste facilities



# Conclusions

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- 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

The screenshot displays the IAEA.org website. At the top, the IAEA logo and name are visible, along with navigation links like 'Contact IAEA', 'IAEA site Index', and 'News Feeds'. A search bar is also present. Below the header, a main navigation bar includes 'About Us', 'Our Work', 'News Center', 'Publications', and 'Nucleus'. The 'Nuclear Safety & Security' section is highlighted, with sub-links for 'Nuclear Energy', 'Nuclear Applications', 'Safeguards', and 'Technical Cooperation'. On the left, a sidebar lists various projects under 'Special projects', including Chernobyl, CRAFT, EBP Asia, EBP Bulgaria, EBP ISSC, EBP Romania, EBP Ukraine, EMRAS II, FaSa, GEOSAF, HIDRA, IGALL, IGSCC, Iraq decommissioning project, and MODARTA. The main content area features the title 'HIDRA: Human Intrusion in the context of Disposal of Radioactive Waste' in red. Below the title is a group photo of meeting participants. To the right of the photo, text describes the launch of the project, mentioning a technical meeting at the IAEA headquarters on September 24-28, 2012, attended by 34 participants from 21 Member States. Further down, the 'Objective' section explains the meeting's goal to explore means for addressing future human actions and intrusion in the safety case and safety assessment of radioactive waste disposal facilities. On the far right, there are sections for 'Resources' (Safety of Radioactive Waste and Spent Fuel Management, Radioactive Waste Management publications), 'Page links' (Meeting presentations, First plenary meeting), and 'Related projects' (PRISM, GEOSAF).

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## HIDRA: Human Intrusion in the context of Disposal of Radioactive Waste



**Human Intrusion and Future Human Actions in relation to Disposal of Radioactive Waste - Launch of new project**

A Technical Meeting was held at the IAEA headquarters on 24-28 September 2012 to discuss Human Intrusion and Future Human Actions in relation to Disposal of Radioactive Waste. The meeting was attended by 34 participants from 21 Member States representing regulators, operators and technical support organizations.

### Objective

The objective of the meeting was to explore a means of effectively addressing future human actions and human intrusion in the safety case and safety assessment of radioactive waste disposal facilities, including both geological and near-surface disposal facilities.

The discussions focused on various issues such as the difference and commonality of human intrusion scenarios for geological and near-surface disposal facilities. Three groups were established to address specific issues related to Technical, Social and Design aspects.

As a result of the these discussions, a new international project was launched: "HIDRA - Human Intrusion in the context of Disposal of

### Resources

- Safety of Radioactive Waste and Spent Fuel Management
- Radioactive Waste Management publications

### Page links

- Meeting presentations
- First plenary meeting

### Related projects

- PRISM
- GEOSAF

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



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# Questions

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