• Safety Requirements and design criteria for near surface disposal

• Waste disposal strategy in Italy

• National repository preliminary design

• Siting process
SAFETY REQUIREMENTS AND DESIGN CRITERIA FOR NEAR SURFACE DISPOSAL
Classification of radioactive waste

For disposal purposes, radioactive waste can be classified in two broad categories:

**SHORT LIVED WASTE**
Wastes containing mainly short-lived isotopes, i.e. with half-lives up to around 30 years; typically Sr-90 and Cs-137

**LONG LIVED WASTE**
Wastes with significant content of long-lived radionuclides, i.e. with half-lives up to thousands of years
Aims of disposal

1.10 The specific aims of disposal are:

(a) To contain the waste;

(b) To isolate the waste from the accessible biosphere and to reduce substantially the likelihood of, and all possible consequences of, inadvertent human intrusion into the waste;

(c) To inhibit, reduce and delay the migration of radionuclides at any time from the waste to the accessible biosphere;

(d) To ensure that the amounts of radionuclides reaching the accessible biosphere due to any migration from the disposal facility are such that possible radiological consequences are acceptably low at all times.

1.16. ... the ability of the chosen disposal system to provide containment of the waste and to isolate it from people and the environment will be commensurate with the hazard potential of the waste
Requirement 5: The operator shall evaluate the site and shall design, construct, operate and close the disposal facility in such a way that safety is ensured by passive means to the fullest extent possible and the need for actions to be taken after closure of the facility is minimized.

Requirement 7: Containment and isolation of the waste shall be provided by means of a number of physical barriers...The performance of these physical barriers shall be achieved by means of diverse physical and chemical processes together with various operational controls. The capability of the individual barriers and controls together with that of the overall disposal system to perform as assumed in the safety case shall be demonstrated.

Requirement 8: The engineered barriers...shall be designed, and the host environment shall be selected, so as to provide containment of the radionuclides...until radioactive decay has significantly reduced the hazard posed by the waste.
Requirement 9: The disposal facility shall be sited, designed and operated to provide features that are aimed at isolation of the radioactive waste from ...the accessible biosphere...for several hundreds of years for short lived waste...

Requirement 10: An appropriate level of surveillance and control shall be applied to protect and preserve the passive safety features

Requirement 12: A safety case and supporting safety assessment shall be prepared and updated by the operator...at each step in the development of a disposal facility
Life phases of a near surface repository

IAEA SSG 29

Phase of activities
- Pre-construction activities
- Construction activities
- Operational activities
- Closure activities

Decision points
- Decision to investigate
- Regulatory Decision to construct
- Regulatory Decision to emplace
- Regulatory Decision to close
- Facility closed

Safety Case for construction
Safety Case for emplacement
Safety Case for closure

Timeline
- Pre-operational period
  - Tens of years
- Operational period
  - Several hundreds of years
- Post-closure period
4.6. ...long term safety is to be ensured by (1) the capability of the features of the disposal facility to contain the waste and isolate it from the biosphere; (2) the capability of the features of the site to contribute to containment and isolation of the waste; (3) the limitations...on the radiological inventory, mainly the long lived radionuclides...; (4) the measures for surveillance and control of the disposal facility ...to prevent or restrict any human activities that could disturb the facility barriers...

4.7. Near surface disposal ...is appropriate only for VLLW and LLW; ... the location of a near surface disposal facility ...makes it susceptible to processes and events that will degrade its containment and isolation capacity over periods of time up to several hundreds of years. ...The possibility of human intrusion into a near surface disposal facility after the period of institutional control is considerably higher than in the case of geological disposal. Therefore...the limitations placed on the radioactive inventory should be...principally in terms of allowable quantities of long lived radionuclides.

4.29. The isolation capability of near surface disposal facilities should be ensured for periods up to several hundreds of years...mainly through passive means, in order neither to impose an excessive burden on future generations nor to rely on active measures to ensure safety
Safety approach for near surface disposal

- Limiting the overall inventory to be disposed of to ‘short lived’ waste (i.e. Half-life max 30 y) with small quantities of ‘long lived’ radionuclides (i.e.< 370 Bq/g)
- 300 y = 10 half-lives $\rightarrow 1/2^{10} \approx 1/1000$ of the initial ‘short-lived’ waste activity while long lived radionuclides keep the same initial activity

Institutional control (period of $\approx$ 300 y) prevents human intrusions
- Multiple barriers in series contain waste and protect from unintentional intrusion after the institutional control period (passive protection)
- Monitoring and treating possible water infiltrations/releases (active protection)
WASTE DISPOSAL STRATEGY
IN ITALY
Waste volumes to be managed

- Waste to be managed in the Italian National Repository derive from the past nuclear energy generation, from NPP’s and fuel cycle installations decommissioning and from medical, industrial and research activities.
- The latter will continue produce waste in the future with foreseen annual quantities even higher than the current ones.

<table>
<thead>
<tr>
<th>VLLW - LLW</th>
<th>ILW - HLW</th>
<th>SPENT FUEL AND REPROCESSING RESIDUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>m3</td>
<td>m3</td>
<td>m3</td>
</tr>
<tr>
<td>75000</td>
<td>15000</td>
<td>1000</td>
</tr>
</tbody>
</table>

Foreseen overall volume of waste to be managed at the Nat. Repository
Waste management strategy in Italy

Main references and constraints

• The actual volume of waste from energy production is consolidated, while the production of waste from medicine, industry, research (mainly VLLW and LLW) will be continuing in the future

• Spent fuel is being reprocessed abroad (UK, France); residues (vitrified waste and compacted waste) will be returned to Italy from 2019 to 2025

• Experimental irradiated fuel is not suitable for reprocessing

• Waste are currently temporarily stored in more than 20 interim storage facilities all over Italy, most of which with limited residual capacity or design life

• Italy has recently endorsed the European Directive 2011/70 which requires that each Member State shall propose within August 2015 a National Programme for the safe management of all the categories of waste and spent fuel

• Directive 2011/70 indicates the surface disposal as the typical disposal concept for VLLW and LLW
Waste management strategy in Italy

- About 75,000 m³ of VLLW and LLW (II category according to GT26) will be disposed of in the National Repository, a surface disposal facility to be realised in the area of a Technology Park dedicated to research activities on decommissioning and waste management.

- The National Repository will receive only already conditioned waste packages; limited treatment capacity will be foreseen in the National Repository for solid waste deriving from small producers.

- The final disposal solution for about 15,000 m³ of ILW and HLW and 1000 m³ of spent fuel and reprocessing residues (III category) is the geologic disposal (to be searched on a dual track approach, i.e. both on a national basis and on a European basis).

- While waiting for the availability of a geologic repository, ILW and HLW will be temporarily stored in an engineered Interim Storage Facility (CSA) to be realised on the same site of the National Repository.

- Spent fuel and reprocessing residues will be dry-stored in the CSA in dual purpose casks (qualified both for transport and storage).
NATIONAL REPOSITORY
PRELIMINARY DESIGN
• Sogin is currently developing the Preliminary Design of the Technology Park and National Repository based on its own expertise and current norms and rules

• The design solutions take into account the best international practices

• The preliminary design is independent from the yet unknown site characteristics and shall be kept ‘flexible’ in order to be aligned to such characteristics and to possible comments raised by the stakeholders during the consultation phase
Concept lay-out

- Technology Park Area
- National Repository Area
- VLLW-LLW FINAL REPOSITORY
- TEMPORARY STORAGE FOR ILW-HLW

~1000 m

~1600 m
The waste is conditioned with a cement-based matrix in steel containers (FIRST BARRIER).

Waste packages are inserted and grouted in special concrete modules 3 m x 2 m x 1.7 m qualified for 350 design life (SECOND BARRIER).

Once completely filled, the cells are sealed and covered with a suitable multilayer cover qualified for 350 design life.

Modules are inserted in reinforced concrete vaults 27m x 15.5 m x 10 m (THIRD BARRIER), qualified for 350 design life.
Module loading

Prima barriera
MANUFATTO
Vault loading
The phases of the National Repository

Siting, licensing and realization Phase – about 10 years

Operations Phase – about 40 years

- Operations: the repository receives VLLW/LLW packages to be disposed of in the surface repository and ILW/HLW packages/casks to be temporarily stored in the Interim Storage Facility
- Closure: the repository is closed and sealed, ready for the institutional control period

Post Closure Phase – 200 - 300 years

- Institutional control period: the repository is monitored to guarantee the actual isolation of the waste from the environment
- Site release: at the end of the institutional control period, the possible release of the repository from radiological constraints will be agreed with the Regulator
After final closing, the waste isolation from biosphere is assured by periodic controls aimed at verifying possible water infiltrations and/or releases through a drainage system under each cell. In case of unexpected releases, the infiltration water is checked for contamination and eventually treated. Possible damages to the final cover are fixed.
Safety Assessment

With the Safety Assessment the potential radiological impact on human health and environment is evaluated for all the expected scenarios, both normal evolution and accidental ones. The impact from the normal evolution is associated with the transport of the residual radionuclides (mainly long lived) to the biosphere after the institutional control period, when the artificial barriers can no longer assure the containment and the migration is delayed by the site geology.
REPOSITORY SYSTEM

INVENTORY
Co60, Sr90, Tc99, Cs137, U238,......

REPOSITORY

SITE GEOLOGY

Safety Assessment
SITE
SUITABLE
YES / NO
The radiological impact evaluations are performed by means of computer codes which use radionuclide transport models to check that the overall dose to man is lower than the dose objective established by the Control Authority (usually a fraction of the natural background dose).
Interim Storage Facility for ILW - HLW

- The complex is composed of three similar buildings with separate storage vaults. An access aisle connects the vaults through dedicated transit and control cells.

- The handling systems are conceived to allow both remote operations (for more radioactive packages) and contact handling.
The Technology Park is a centre of excellence for advanced R&D on nuclear matters and possibly on sustainable development with structures dedicated to information and training. It will support the local communities bringing added value to the territory.

**Foreseen research laboratories and infrastructures:**

- Technologies for ‘challenging’ decommissioning activities and waste management
- Laboratories for Environmental Analyses
- Training School and visitors centre
- Additional research laboratories to be agreed with local authorities during the site selection phase
SITING PROCESS
The Italian control Authority has recently published Technical Guide n.29 with the siting criteria for a near surface disposal facility, based on IAEA Safety Guide SG29. Two categories of criteria are defined:

- **Exclusion criteria**
  
  In the first phase of the siting process and on a national scale they lead to the exclusion of the areas whose characteristics do not comply with the IAEA principles

- **Investigation criteria**
  
  Investigation criteria can be applied to the not excluded areas by means of data on a local scale for further exclusion of unsuitable areas and/or for ranking the remaining areas on the basis of their suitability to host the repository (techno-economic realization aspects)
Exclusion criteria

Areas to be excluded:
1. Active or quiescent volcanic
2. High seismicity areas (≥ 0.25 PGA; return time 2475 y)
3. Interested by superficial faulting
4. Geomorphologically and hydraulically endangered areas
5. With Holocene alluvial deposits
6. Located above 700 m a.s.l.
7. With average slope > 10 %
8. Within 5 km from coasts and under 20 m a.s.l.
9. Interested by morphogenetic karst processes or sinkholes
10. With near surface piezometric levels or interfering with the repository foundations
11. Naturalistic protected areas
12. At an unsuitable distance from residential zones
13. Distant < 1 km from highways, principal suburban roads and railways
14. With known presence of underground resources
15. With industrial activities involving major accident hazards
Main Investigation Criteria

The not excluded areas shall be evaluated for:

- Presence of secondary volcanic activities
- Presence of significant vertical movements
- Presence of accelerated erosion
- Weather and climatic conditions
- Physical and mechanical parameters of the soil
- Hydrogeological parameters
- Habitats, animal and plant species of conservation importance
- Agricultural production of outstanding quality and archaeologic and historical interest
- Availability of primary transport infrastructures
National Repository - Siting time frame

Phase 1
- Map of the Potentially Suitable Areas (CNAPI)
- Preliminary Design

Phase 2
- Expressions of interest
- Agreement with Local Entities

Phase 3
- Site qualification and selection

Phase 4
- Detailed Design
- Safety Analysis
- EIA, License

Authority issues siting criteria

17 months

~ 5 years

CNAPI approval

Formal Agreement

Ministerial Decree for Site identification

Design License

SOGIN
Siting process

Phase 1 steps

GT29: Siting Criteria

C. Authority

SOGIN

Start

4.6.2014

Issue and delivery of CNAPI to C.A.

C. Authority

Preliminary Design

CNAPI validation and OK to publication

C. Authority/ Min. of Economic Development

Publication of CNAPI and Preliminary Design

SOGIN

National Workshop

Integration of comments, review and delivery to Min. Econ. Dev.

SOGIN

Final verification

ISPRA

Ministerial Decree for approval of CNAPI
Thank you!

Questions?