Radwaste Management in the Republic of Slovenia


5th Review Meeting, Vienna, May 2015
Main Radioactive Waste Generators in Slovenia

- Krško nuclear power-plant
- Žirovski vrh uranium mine
- Research reactor
- Hot cell
- Central interim storage for radioactive waste
- Proposed repository

Countries:
- Austria
- Italy
- Croatia
- Hungary

Locations:
- Krško: Central interim storage for radioactive waste
- Žirovski vrh: Uranium mine
- LJUBLJANA: Hot cell

Countries:
- Austria
- Croatia
- Hungary
The Krško NPP

- Major producer of radioactive waste in Slovenia
  - PWR, two loops, Westinghouse design
  - 700 MWₑ
  - Joint project of Slovenia and Croatia
  - Commercial operation: 1983
  - Design life time 40 years, could be extended from 2023 to 2043, pending the successful conclusion of Periodic Safety Reviews in 2023 and 2033.
LILW in Krško NPP

In total (end of 2014): 3,726 drums, 2,258 m³, 1.85x10^{13} Bq
Spent Fuel Management - Krško NPP

- Spent fuel pool for 1694 fuel assemblies, made of reinforced concrete, covered with SS liner, leak detection system
- Water purification system, $< 18.4 \times 10^4$ Bq/cm$^3$
- Criticality analysis design basis criterion, $k_{eff} + 3\sigma < 0.95$
- Average burn-up 45.9 GWd/MTU
- Re-racked in 2003
Spent Fuel – Krško NPP

- Dry storage for SF (according to currently long term policy)
  - construction 2024 - 2037
  - operation 2037 – 2070
  - closure 2075
- After Fukushima: long term policy is under revision
  - dry storage operational already in 2018
  - long term storage (up to 100 years)
- Looking for regional or global solutions for disposal
- Disposal of SF in Slovenia
  - beginning of site characterization 2035
  - beginning of construction 2055
- After storage period disposal in Slovenia/Croatia or export
Spent Fuel Elements in Krško NPP

In total 1098 assemblies (end of 2014)
Implications after Fukushima

- Stress tests at NPP Krško:
  - More restrictive requirements for storage of SF in the spent fuel pool under potential beyond design bases accidents
  - Therefore the storage capacity is sufficient only until 2018
  - A dry storage option should be operational by 2018,
  - The National Programme for Managing Radioactive Waste and Spent Nuclear Fuel will be revised
  - Safety Upgrade Programme includes:
    - Permanent sprays around the spent fuel pool
    - Mobile heat exchanger that can be connected to the spent fuel pool.
TRIGA Mark II Research Reactor

- Part of Jožef Stefan Institute Reactor Centre
  - 250 kWt General Atomic open pool type
  - Start in 1966
  - In 1991 re-licensed for pulse mode operation
- No spent fuel on site (return of spent fuel to U.S. in 1999)
- Minor amount of LILW
- Hot laboratory as an integral part since early 2008 (licensed for treatment of RW from small producers)
TRIGA: Spent Fuel Management

- All irradiated fuel is stored in the reactor pool
- Two spent fuel pools, both empty
- At present there are no plans to shut down this reactor in the near future,
- The option to finish its operation in 2016 and return SF to U.S. by 2019 is still open
- In case of extension of operation, SF will be arranged jointly with the SF disposal for the Krško NPP
Central Storage for Radioactive Waste in Brinje (CSF)

- Storage of low and intermediate level radioactive waste from medical, industrial and research applications
- Constructed in 1984
- Operational since 1986
- Refurbished in 2004
- New revision of SAR is being prepared
Central Storage Inventory

- **End of 2014:**
  - 194 packages of smoke detectors ($^{241}\text{Am}$, $^{226}\text{Ra}$)
  - 189 packages of spent sealed sources ($^{60}\text{Co}$, $^{137}\text{Cs}$, $^{85}\text{Kr}$, $^{90}\text{Sr}$, $^{226}\text{Ra}$, $^{152}\text{Eu}$, $^{241}\text{Am/Be}$, $^{133}\text{Ba}$)
  - 440 packages of solid, non/compressible, non/c Combustible RAW
  - In total 823 packages
  - Total activity app. 3 TBq
Small Producers

- **Jožef Stefan Institute:**
  - Solid radwaste transferred to Central Storage for Radwaste

- **Industry and Research:**
  - ~80 different organisations
  - ~800 sealed radioactive sources
  - Spent and disused sources shipped back to the supplier or to the Central Storage for Radwaste

- **Medicine:**
  - 7 hospitals
  - Decay storage tanks at Institute of Oncology
  - Short lived radioactive waste stored at users’ locations
  - After decay transferred to the municipal disposal site
Disused Sealed Sources

- **Storage:**
  - Central Storage Facility
  - "Polluter pays" principle

- **Re-manufacturing and re-entry**
  - No manufacturing of sealed sources in Slovenia
  - Some sources are re-exported

- **A lot of effort was put into establishment of regulatory control over ionization smoke detectors**

- **Prevention of Illicit Trafficking of Radioactive Materials in Scrap Metal**
  - 24-hour on duty officer
  - Scrap metal collectors and recyclers properly equipped
Žirovski Vrh Uranium Mine

- Operation from 1984 to 1990
- Lifetime production 610,000 tons
- 452.5 tons $\text{U}_3\text{O}_8$ equivalent of yellow cake
- In 1990 the decision to close
- Mine and Mill decommissioned
- Mine waste pile remediation completed in 2008 (Jazbec)
- Mill tailings remediation completed in 2010 (Boršt)
Žirovski Vrh Uranium Mine

Jazbec:
- 1,198,900 m³, 21.7 TBq
- License for closure (2014)
- Transfer of responsibility to Agency for RW
  management is being finalized

Boršt:
- 415,543 m³, 48.8 TBq
- remediation completed
- reactivation of landslide requires revision of
  SAR, additional studies are being prepared
Future Repository of LILW

- After significant delay generated in last years the activities on the project intensified in the last year

- LILW repository site approved in December 2009
- Site investigation finished in 2014
- Investment programme approved in 2014
- Licensing process:
  - Project documentation for construction license is being prepared
  - Environmental Impact Assessment Report is being prepared
  - Safety Analysis Report as the key licensing documents is also under preparation
Future Repository of LILW

- Silo type:
  - Waste packages placed 15 to 50 m beneath the surface
  - Covered by 5 m thick clay layer
  - 27.3 m in diameter
  - 700 concrete containers in 10 levels
  - 2 silos with an overall capacity of 9,400 m³ are foreseen in the preliminary design
Transboundary Movement

- Two transits of nuclear material took place in October and November 2012
  - irradiated highly enriched uranium for TRIGA research reactor in Vienna
  - return of spent low and highly enriched uranium from the same reactor to the country of origin (USA), Pu/Be source in the same shipment.
Governmental Organizations

- Slovenian Nuclear Safety Administration (1987)
  - established in 1987
  - director appointed and released by the Government
  - 41 employees
  - SNSA management system complies with ISO 9001:2008
  - IRRS – Follow-up Mission in 2014

- Slovenian Radiation Protection Administration (2003)

- Agency for Radwaste Management (1991)

- Public Enterprise Žirovski vrh Mine (1992)

- Fund for the decommissioning of the Krško NPP (1995)
Governmental Policy related to RW

- Resolution on the National Energy Programme
- Resolution on the National Programme for Radioactive Waste and Spent Fuel Management (2006-2015), revision is being prepared
- Agreement between Slovenia and Croatia on Krško NPP
- Decommissioning Plan for the Krško NPP
## Summary of basic information - matrix

<table>
<thead>
<tr>
<th>Type</th>
<th>Long Term Management Policy</th>
<th>Funding</th>
<th>Current Practice / Facilities</th>
<th>Planned Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spent Fuel</strong></td>
<td>Geological disposal, as a reference scenario, multinational option kept open</td>
<td>Decommissioning Fund (Levy from kWh)</td>
<td>On site wet storage at NPP</td>
<td>Dry storage, then geological disposal or export</td>
</tr>
<tr>
<td><strong>Nuclear Fuel Cycle Waste</strong></td>
<td>LILW repository HLW together with SF</td>
<td>Decommissioning Fund (Levy from kWh)</td>
<td>On site storage</td>
<td>LILW repository HLW in geological repository</td>
</tr>
<tr>
<td><strong>Application Wastes</strong></td>
<td>Central Storage for Radioactive Waste, then transfer to LILW repository (short-lived)</td>
<td>Users and state</td>
<td>Central Storage for Radioactive waste</td>
<td>LILW repository</td>
</tr>
<tr>
<td><strong>Decommissioning Liabilities</strong></td>
<td>National programme for RW and SF management, Bilateral agreement with Croatia</td>
<td>Decommissioning Fund (Levy from kWh)</td>
<td>Periodical review of Decommissioning Plan</td>
<td>LILW repository HLW&amp;SF repository in 2065 at earliest</td>
</tr>
<tr>
<td><strong>Disused Sealed Sources</strong></td>
<td>Central Storage for Radioactive Waste then transfer to LILW repository</td>
<td>Users and state</td>
<td>Central Storage for Radioactive Waste</td>
<td>LILW repository or together with high level waste</td>
</tr>
</tbody>
</table>
Issues raised at the 4th Review Meeting

• LILW repository licensing, construction and operation
  – Investment programme approved in 2014, field investigation finished, licensing documents are being prepared

• Agreement with Croatia about solution for Krško NPP waste disposal
  – The question is still open

• Approval of Krško NPP Decommissioning plan
  – No major progress, old decommissioning plan is still valid

• De-licensing and institutional monitoring for Mill tailing pile of former uranium mine
  – De-licensing is pending due to reactivation of the landslide which requires revision of the SAR, SA studies are being prepared

• Preparation of revised National Radwaste Managements Programme
  – Draft revision is prepared and should be approved by the end of 2015
Challenges

- LILW repository licensing, construction and operation
- Dry storage for spent fuel licensing, construction and operation
- Approval of the Krško NPP Decommissioning plan
- Approval of the revised National Programme for RW and SF management
- Long term surveillance and maintenance of the Jazbec disposal site performed by ARAO
- De-licensing of the Boršt disposal site
CONCLUSIONS

- Amount of radwaste in Slovenia is relatively small, but magnitude of problems is similar as in countries with big nuclear programmes
- Current situation is well under control
- Slovenia fulfils provisions of Joint Convention