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Technical Meeting on Strategies and Opportunities for the Management of Spent Fuel from Power Reactors in Longer Timeframe
India, 25th to 29th November, 2019.
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Egyptian Atomic Energy Authority

The Nuclear Research Center (NRC)

Egyptian second Research Reactor (ETRR-2)

The National Center for Radiation Research and Technology (NCRRT)

The Hot Laboratories and Waste Management Center (HLWMC)
EGYPTIAN SECOND RESEARCH REACTOR (ETRR-2)

<table>
<thead>
<tr>
<th>Reactor type</th>
<th>Open pool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal power</td>
<td>22 MW</td>
</tr>
<tr>
<td>Enrichment</td>
<td>19.75%</td>
</tr>
<tr>
<td>Fuel type</td>
<td>Plate type</td>
</tr>
<tr>
<td>fuel</td>
<td>U3O8-Al</td>
</tr>
<tr>
<td><strong>No. of fuel plate</strong></td>
<td>19</td>
</tr>
<tr>
<td>-----------------------</td>
<td>----</td>
</tr>
<tr>
<td>Fuel element dimension (cm)</td>
<td>8 X 8</td>
</tr>
<tr>
<td>Active length (cm)</td>
<td>80</td>
</tr>
<tr>
<td>Meat dimension (cm)</td>
<td>6.4 X 0.07</td>
</tr>
<tr>
<td>Shape of fuel plate</td>
<td>Flat</td>
</tr>
<tr>
<td>Plate dimension (cm)</td>
<td>7.5 X 0.15</td>
</tr>
</tbody>
</table>
SPENT (OR USED) FUEL

- nuclear fuel that has been used and removed from the reactor core i.e. of a research reactor /nuclear power plant

- is one of the most hazardous substances created by humans. If not properly contained or shielded, the intense radioactivity of spent fuel can cause immediate deaths and environmental contamination and, in lower doses, cause long-term health hazards, such as cancer.

- Some radioactive components of spent fuel remain hazardous for tens of thousands of years

- Spent (or used) fuel can no longer efficiently generate power in a nuclear reactor. However, it is potentially a resource because it can be reprocessed to separate out uranium and plutonium to be used as fuel again in a reactor. Reprocessing, however, still results in nuclear waste that requires disposal.

- Some countries do not reprocess its spent fuel, and this fuel, when it is accepted for disposal, is considered to be high-level waste.
STORAGE OF SPENT FUEL

• The safety of a spent fuel storage facility, and the spent fuel stored within it, is ensured by: appropriate containment of the radionuclides involved, criticality safety, heat removal, radiation shielding and irretrievability. These functions are ensured by the proper siting, design, construction and commissioning of the storage facility, its proper management and safe operation. At the design stage, due consideration also needs to be given to the future decommissioning of the facility.

• Spent fuel is pools of some reactors have sufficient capacity to accommodate generated continually by operating nuclear reactors. It is stored in the reactor fuel storage pool for a period of time for cooling and then may be transferred to a designated wet or dry spent fuel storage facility, where it will await reprocessing or disposal (if it is considered to be radioactive waste). The 2 spent fuel storage lll the spent fuel that will be generated during the lifetime of the reactor.
ETRR-2 SPENT FUEL STORAGE

Figure 3: MPR layout

Interim Storage
ETRR-2 SPENT FUEL STORAGE
DEVELOPMENT FOR STORAGE OF SNF AT ETRR-2

INTERIM STORAGE

wet Storage
- AR
  - Reactor pool
    - Stored
      - Rod Consolidation
      - As It Is

Dry Storage
- AFR
  - Centralized pool
- Off Site
  - Vaults
  - casks
    - Metallic
    - Concrete
    - Mix
  - Silos
    - Horizontal
    - Vertical
DEVELOPMENT FOR STORAGE OF SNF

a) Vaults

A reinforced concrete building has cavities in the floor (vaults) which will have metallic cylinders that receive the SNF.

b) Silos

The silos are horizontal or vertical concrete cylinders with metallic canisters inside them, the canisters contain SNF. Heat is removed from SNF by natural air convection through special ducts.

c) Metallic Casks

generally are made from cast steel with one or two lids that are bolted or welded at the cask body. The steel cask provides a leak-tight containment of the spent fuel and provides shielding against gamma radiation. Inside the cask, there is a special resin (e.g., polyethylene) that shields neutrons. There are cooling fins on the external surface of the cask for better heat transfer with the environment. The external surface of the cask has trunnions which allow the cask to be lifted and displaced. Shock absorbers installed at bottom and cover of the cask assure its integrity in case of transport accident.
# ADVANTAGES OF DRY STORAGE OVER WET STORAGE

<table>
<thead>
<tr>
<th></th>
<th>Casks at dry storage</th>
<th>Wet storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility of spent fuel</td>
<td>Possible</td>
<td>No mobility</td>
</tr>
<tr>
<td>Cooling of spent fuel</td>
<td>Passive cooling</td>
<td>Forced cooling</td>
</tr>
<tr>
<td>Purification system</td>
<td>None</td>
<td>Necessary</td>
</tr>
<tr>
<td>Leakages</td>
<td>Easy to repair</td>
<td>Hard to repair</td>
</tr>
<tr>
<td>Inventory of spent fuel at accident</td>
<td>Only spent fuel in the cask</td>
<td>All spent fuel at the pool</td>
</tr>
<tr>
<td>Waste generation</td>
<td>None</td>
<td>Great amount of liquid waste</td>
</tr>
</tbody>
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CHALLENGES

• Experience
• Funding
• Siting
• Security
• Transportation (for reprocessing)
• Standardization
QUESTIONS?