China’s nuclear waste: management and disposal

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Talk outline

Section 1: Current status of post-Fukushima activities and implications

Section 2: China’s current and future nuclear waste management

Section 3: Challenges of geological disposal of nuclear waste in China
Current status of post-Fukushima activities

- National Nuclear Safety Administration’s nuclear safety plan called for higher safety standards and pushed on Gen III technologies.
- The 2012 safety inspection report required 16 areas to improve by 2015.
Implications of post-Fukushima activities

- Only few Gen II+ projects which either were under construction or paired with existed units moved forward.

- Planned units switched to Gen III designs

- The Chinese nuclear industry already appears the urgency to develop domestic next generation technologies (ACPR1000, ACP1000, CAP1400)

- The main nuclear utilities are actively seeking overseas investment opportunities to make use of their financial resources
Potential impacts on spent fuel management

- The slower development pace of nuclear power program will decrease spent fuel generation

- R&D programs on on-site spent fuel storage safety
  - Deploying extra backup emergency power systems and portable pumps
  - Emergency coolant makeup system (passive coolant tank) and continuous water level monitoring system
Section 2: China’s current and future nuclear waste management
Low and Intermediate Level Waste

- Two existed LILW facilities
  - Beilong facility located in Guangdong
    - ~205,00 M^3 in total and 80,000 M^3 waste
  - Above ground
Cont’d

- Two existed LILW facilities
  - Yumen facility located in Gansu
    - ~200,000 M^3 in total and 60,000 M^3 waste
    - Under ground (10~20 meter)

- Three future facilities in plan
  - East coast area
  - Northeast area
  - Central area
High Level Nuclear Waste (HLW)

- China has a long-term reprocessing policy for its fuel cycle program and proposed a deep geological disposal method for high level nuclear waste since 1985.
- Since China’s nuclear industry is relatively young, China hasn’t experienced any pressure from spent fuel and HLW storage.
- R&D program is still at the early stage.
Conceptual design

- The preliminary repository concept is a shaft-tunnel system, located in saturated zones in granite.
- The granite is considered as the most suitable host rock and bentonite is proposed as buffer and backfill material.
HLW R&D program

- The China Atomic Energy Authority (CAEA) is in charge of developing plans and projects for HLW disposal
- China National Nuclear Corporation (CNNC) is in charge of implementing R&D activities
- Beijing Research Institute of Uranium Geology (BRIUG) implements core research projects
The three-step plan in progress

- It is expected that China will finish the siting selection and build up an underground laboratory around 2020;
- On-site research activities at the underground laboratory should take place between 2020 and 2040;
- The actual HLW repository will be constructed around 2050.
Major research activities: 2006-2020

- Strategies, planning and management
- Site selection and site characterization
- Engineering Design
- Radiochemical studies for disposal
- Safety assessment
Current status

- The early projects include studies of regional geological setting, seismic safety, geological and hydrogeological features, rock mass quality investigation, geophysical survey, borehole drilling and borehole tests.

- China has not finalized the permanent location and is still conducting researches in Xinjiang and Inner Mongolia areas.

- Five potential sites are chosen, studied and compared and the most promising one is the Beishan area.
Current status (Cont’d)

- 16 boreholes were drilled at three sub-areas in the Beishan area during the period of 2000–2011.
- Designs of the underground laboratory and the repository passed the expert panel evaluation
Major activities: Site selection and site characterization

NW China: Beishan

Inner Mongolia

SW China

E China

S China

5 Pre-selected regions for China’s HLW repository since 1986
drilling sites at BS01, BS02, BS03, BS04 boreholes
Section 3 : China’s nuclear waste disposal: Future scenarios and Challenges
Future spent fuel management

- 60 GW Scenario
- A 500 ton off-site spent fuel storage capacity
- A 1000 ton off-site spent fuel storage capacity
- A 3000 ton off-site spent fuel storage capacity
China will experience very little pressure to reduce the burden of storing spent fuel.

<table>
<thead>
<tr>
<th>Offsite storage space (tons)</th>
<th>Estimate of when the storage will reach full capacity</th>
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<tbody>
<tr>
<td>500</td>
<td>2017</td>
</tr>
<tr>
<td>1000</td>
<td>2025</td>
</tr>
<tr>
<td>3000</td>
<td>2035</td>
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China’s current fuel cycle program

- The reprocessing pilot site will be in operation after safety modifications (50 tons/year)
- The China’s experimental fast reactor connected to the grid (20 MWe)
- A potential commercial reprocessing site is under plan (Areva tech or domestic tech)
- A 200 tons/year demo project is under development
- A MOX pilot site is under construction
Future scenarios

- Due to less pressure from spent fuel storage and China’s ongoing R&D program on reprocessing, China will not view the deep geological disposal as a spent fuel storage tool in the near term.
- China will continue to generate HLW from its reprocessing R&D activities
- The potential commercial reprocessing site might not be in operation in the next 15 years.
Potential deep borehole disposal

- In China, deep borehole disposal was not considered as an option for HLW management and has not been studied closely
  - China has reprocessing policy for spent fuel
  - High level nuclear waste will be disposed next to the reprocessing site

- Commercial drilling technologies in China allow a 4km depth and mainly focus on mining exploration

- In 2005, China’s national drilling R&D project fulfilled a 5km deep borehole
Problems & Challenges

- An Incomplete regulatory system to regulate all nuclear activities
  - China needs an Atomic Energy Law to regulate all nuclear related activities
  - Currently, there is not any law to regulate nuclear waste management, disposal and spent fuel disposal fund imposition
Cont’d

- Insufficient attentions and financial supports on nuclear waste disposal R&D activities.
  - The budget on HLW R&D activities was relatively low comparing to other national energy projects
  - The HLW R&D program never been listed as a key national R&D program
  - An independent and specialized agency needed to plan and manage the program
Cont’d

- Insufficient public participation
  - the Chinese public seems to accept and embrace nuclear technologies before Fukushima for several reasons.
  - In the past, the Chinese public has not been an integral part of nuclear energy decision-making. This situation is changing.
  - The Chinese government will have to improve public participation to make the decision making system more transparent and enforce the regulatory system more effectively.
Cont’d

- Limited international cooperation on nuclear waste management and disposal
  - Participating international R&D projects
  - Communicating and collaborating with other nuclear states on geological disposal R&D