Update on the Potential for and Challenges Facing Geologic Disposal of Spent Fuel in the ROK

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National Policy on Spent Fuel

- At its 253rd meeting in 2004, the Atomic Energy Committee (AEC) announced that national policy for spent fuel management would be decided later in consideration of progress of domestic and international technology development, and that spent fuel would be stored at a reactor site by 2016 under KHNP's responsibility.
- Since the ROK has not decided whether to directly dispose of or recycle spent fuel, currently, it has no national plan on geologic disposal of spent fuel either.

Status of Disposal System Development

- A long-term R&D program for spent fuel disposal was started in 1997.
- The Korean Reference spent fuel deep geological disposal System (KRS-V) for PWR spent fuels and CANDU spent fuel.
  - Developed at the end of 2006.
  - The depth of the repository is assumed to be 500 m.
  - The assumed amount of spent fuel from 24 PWRs and 4 CANDUs are 20,000 tHM and 16,000 tHM, respectively, assuming cooling times of 40 and 30 years for PWR and CANDU spent fuel, respectively.
  - The dimensions for the PWR and CANDU canisters.
    - The outer diameter of 1.02 m
    - The length of 4.83m
    - The weight of approximately 25 t, including the spent fuel
    - Including 4 assemblies for PWR spent fuel
    - Including 297 bundles for CANDU spent fuel
  - The distance between the parallel tunnels is 40 m, while the distance between two deposition holes for the PWR canisters is 6 m and for the CANDU canisters is 4 m.
  - Conclusion of a KAERI study: "Though no site for the underground repository has yet been specified in Korea, a generic site with a granitic rock is considered for the reference HLW repository design."

Status of Disposal System Development (cont)

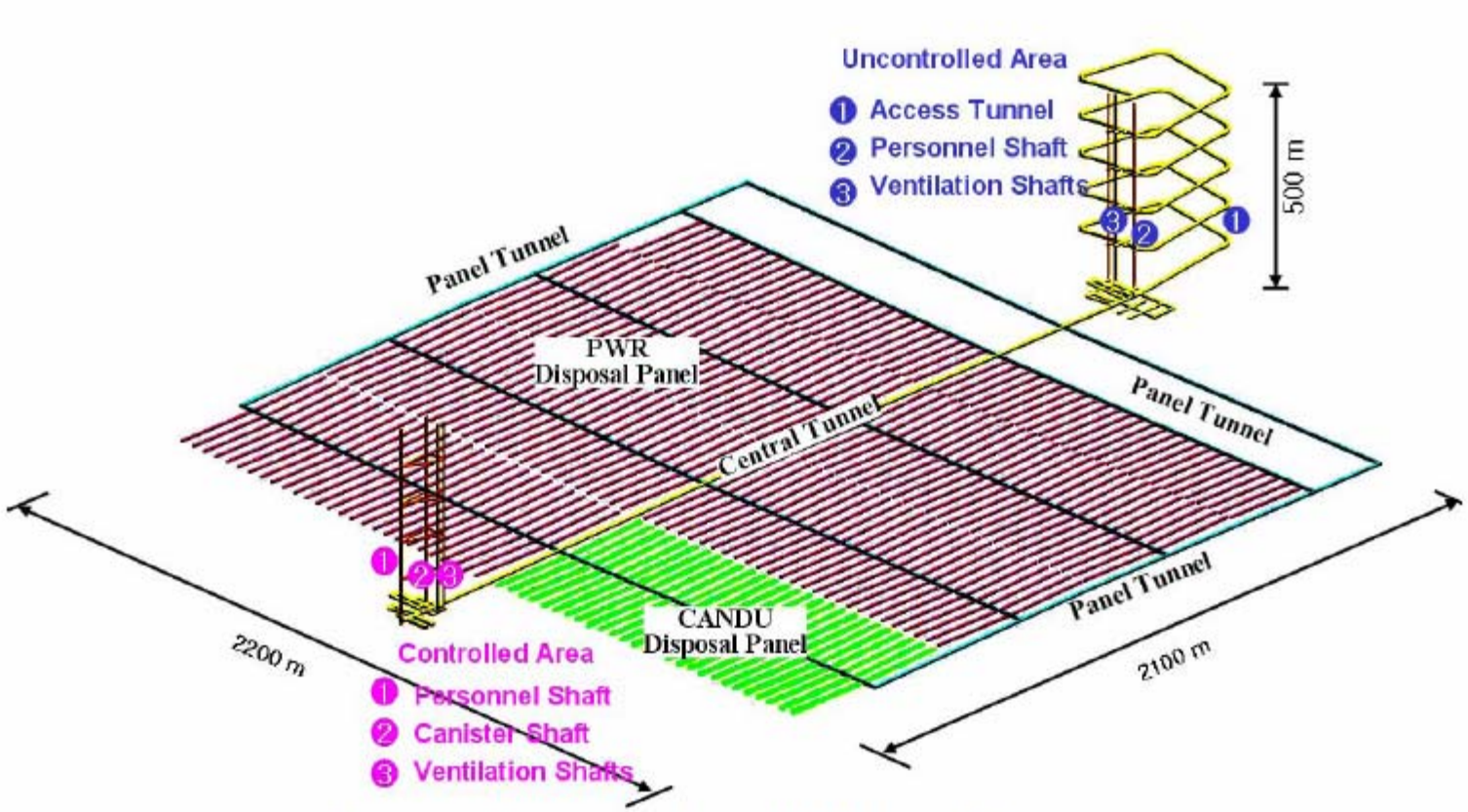
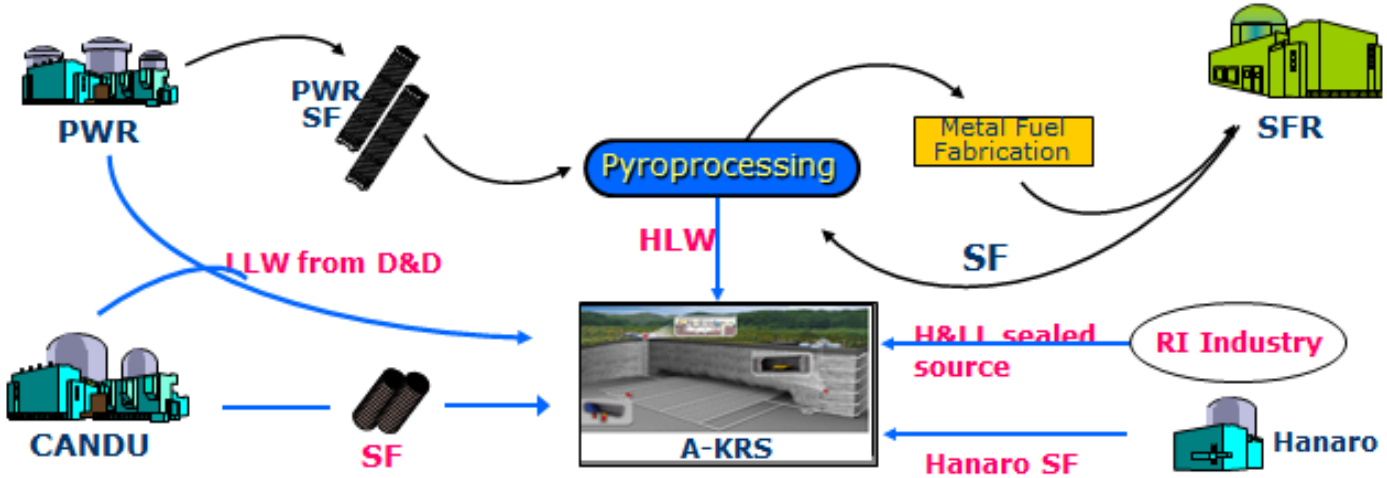


Figure 1. Layout of the Korean reference HLW Vertical disposal system.
(Green panel is for CANDU canisters.)

(Quoted from a reference)

Status of Disposal System Development (cont)

- Advanced Korean Reference disposal System (A-KRS)
  - Integrated disposal system to accept various HLW/LLW generated from pyroprocessing;
  - Pre-conceptual design of A-KRS for 2007-2011.



(Quoted from a reference)

Suitability of the ROK for DBD

- Geology of the Korean Peninsula

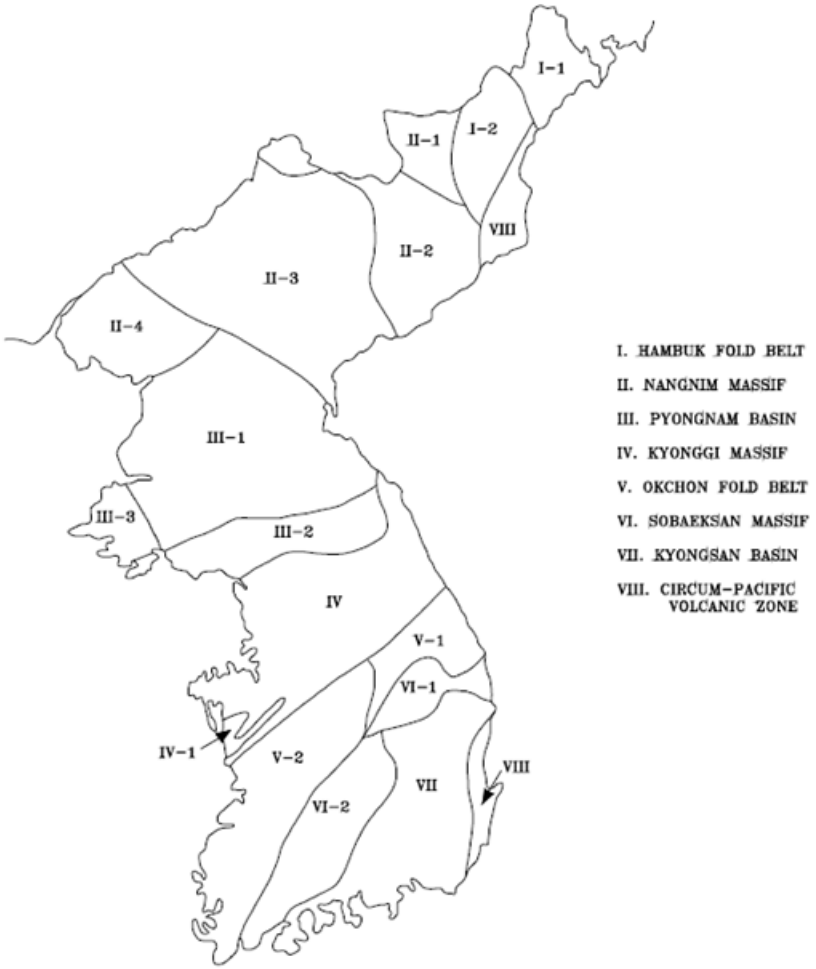


Figure 3: Tectonic Provinces in Korean Peninsula

(Quoted from a reference)

Suitability of the ROK for DBD (cont)

- Population density of the ROK

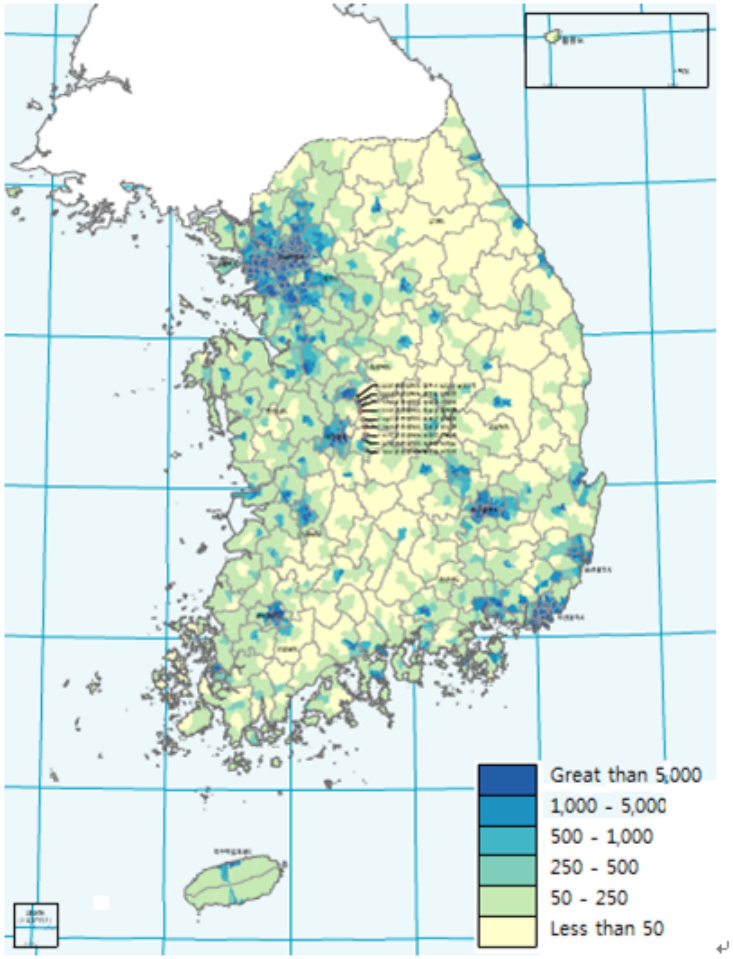


Figure 4: Population Density Map of South Korea in 2005 (Legend: persons per sq. km)

(Quoted from a reference)

Suitability of the ROK for DBD (cont)

- Regional Fractures in the ROK

I. Kyonggi Massif
II. Chungnam Trough
III. Gonju Trough
IV. Okchon Fold Belt
  IVa. Paleogeosyncline Zone
  IVb. Neogeosyncline Zone
V. Yongdong-Kwangju Trough
VI.Soaeksan Massif
  VIa. Sobaeksan Block
  VIb. Jirisan Block
VII. Kyongsang Basin

Figure 5: Fracture Map Superimposed on Tectonic Provinces in South Korea

(Quoted from a reference)

Suitability of the ROK for DBD (cont)

- Seismicity in the Korean Peninsula

Table 4: Statistics of Magnitude >4.75 Historical Earthquakes on the Korean Peninsula

Century	4.7~4.9	5~5.9	6~6.9	≥7	Total
1~10	2	11	1	0	14
11~14	1	13	2	0	16
15	11	13	4	0	28
16	10	30	5	0	45
17	0	14	5	1	20
18	5	8	0	0	13
19	0	0	0	1	1
20	8	15(1)	1(2)	(2)	24(5)
Total	37	104(1)	18(2)	2(2)	161(5)

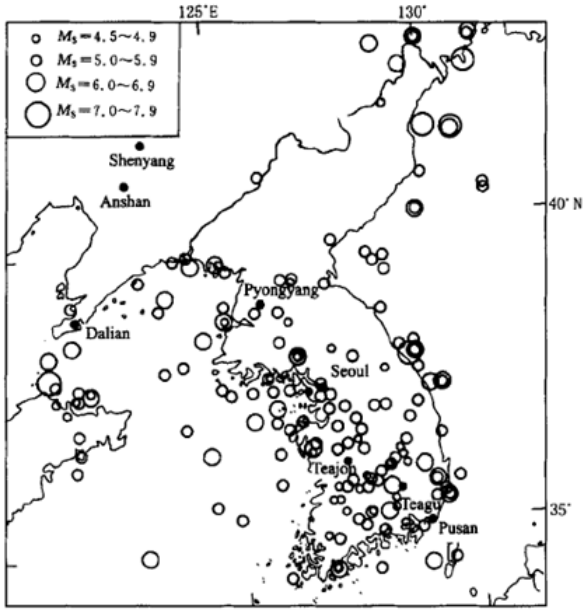


Figure 6: Epicentral Distribution of Historical Earthquakes in the Korean Peninsula

(Quoted from a reference)

Nuclear Power Plants Deployment Scenarios

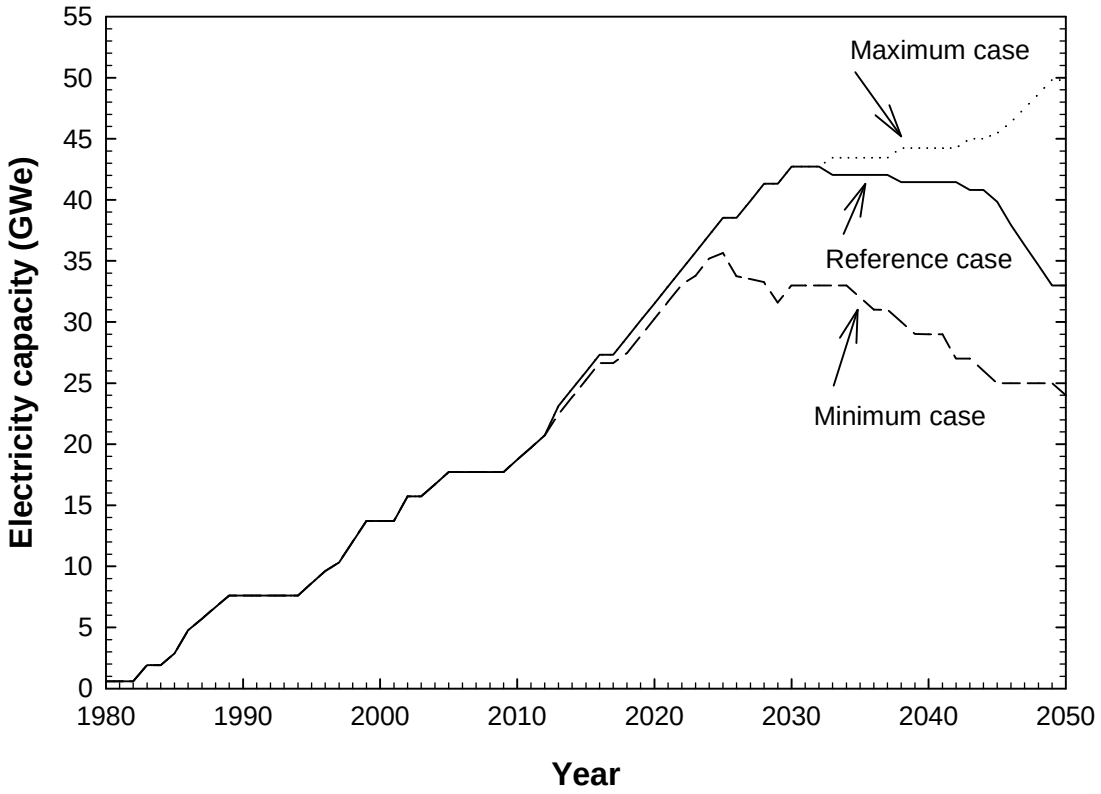


Figure. Installed nuclear capacity in South Korea (1980-2050)

Nuclear Power Plants Deployment Scenarios
(cont)

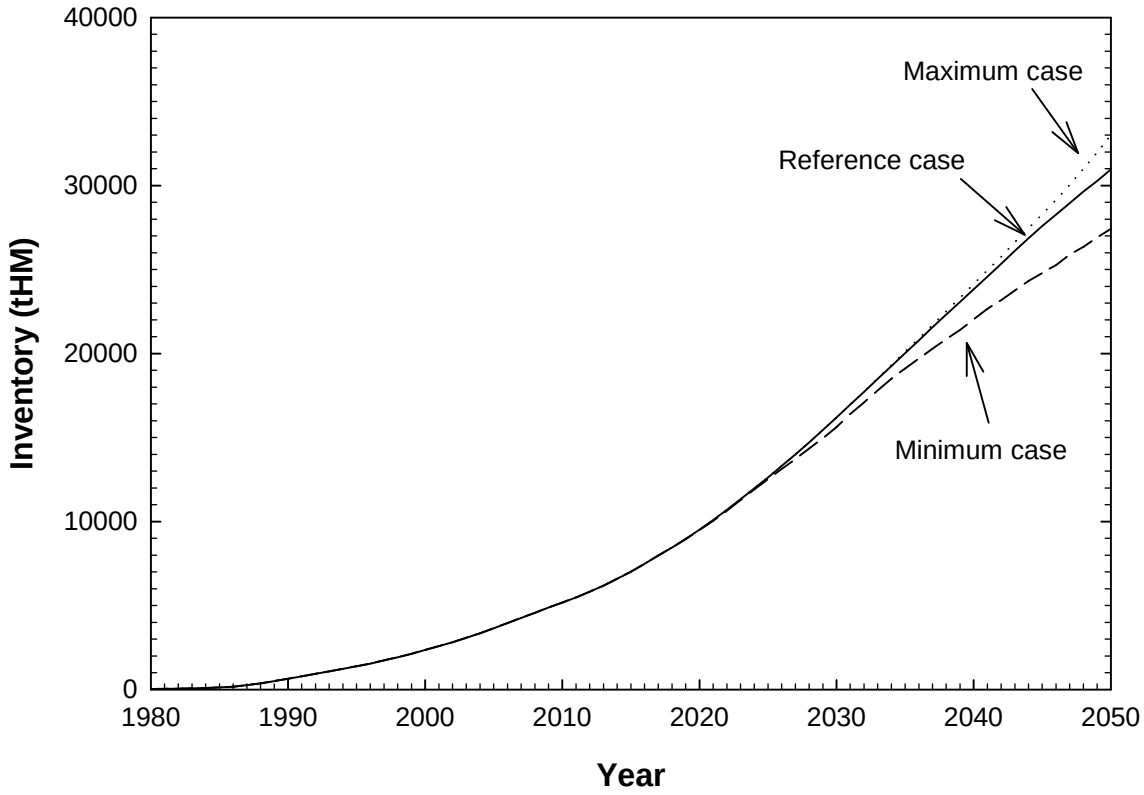


Figure. Cumulative inventory of PWR spent fuel in South Korea (1980-2050)

Nuclear Power Plants Deployment Scenarios
(cont)

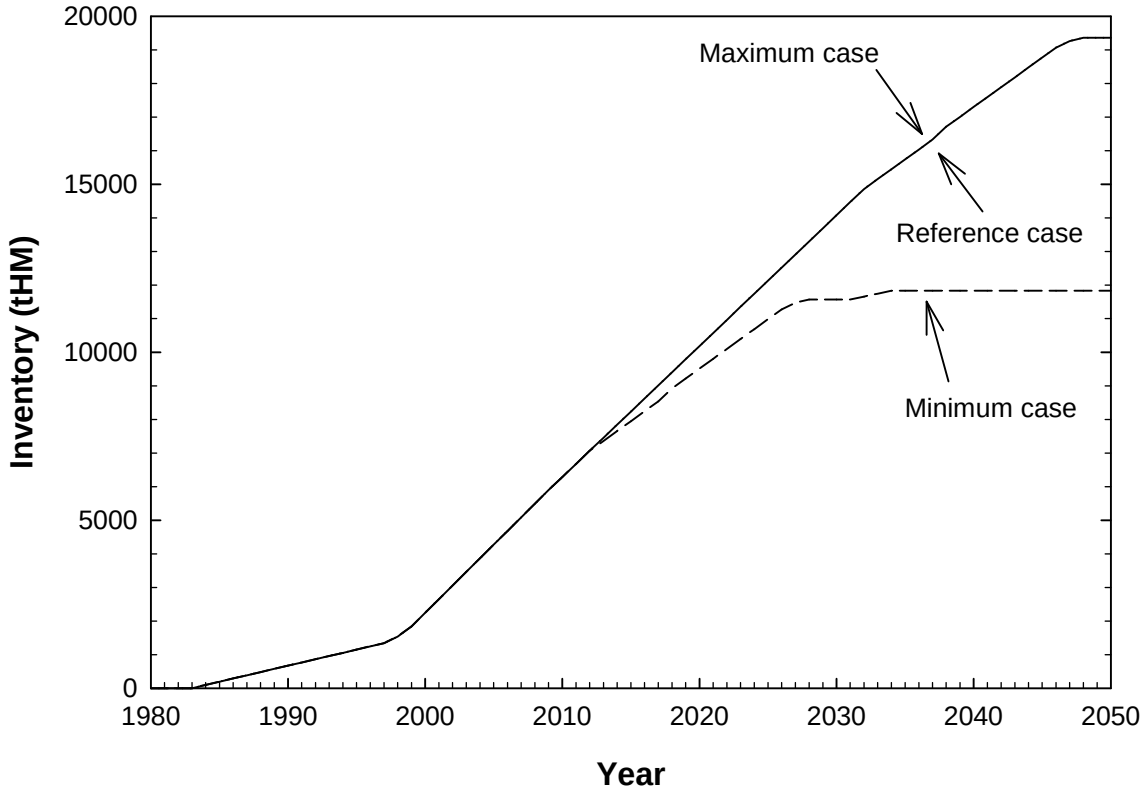


Figure. Cumulative inventory of CANDU spent fuel in South Korea (1980-2050)

Rough Cost Estimation of DBD Implementation

Table. Estimated Annual Cost of DBD Construction from 2030 through 2050 to Accommodate ROK Spent Nuclear Fuel

Year	PWRs			CANDUs		
	Spent Fuel (tHM)	# of Boreholes	M$	Spent Fuel (tHM)	# of Boreholes	M$
2030	2352	11.8 – 23.5	235 – 470	2243	35.0 – 70.1	701 – 1402
2031	229	1.1 – 2.3	23 – 46	406	6.3 – 12.7	127 – 254
2032	229	1.1 – 2.3	23 – 46	406	6.3 – 12.7	127 – 254
2033	269	1.3 – 2.7	27 – 54	406	6.3 – 12.7	127 – 254
2034	269	1.3 – 2.7	27 – 54	406	6.3 – 12.7	127 – 254
2035	289	1.4 – 2.9	29 – 58	406	6.3 – 12.7	127 – 254
2036	309	1.5 – 3.1	31 – 62	406	6.3 – 12.7	127 – 254
2037	309	1.5 – 3.1	31 – 62	406	6.3 – 12.7	127 – 254
2038	309	1.5 – 3.1	31 – 62	406	6.3 – 12.7	127 – 254
2039	309	1.5 – 3.1	31 – 62	406	6.3 – 12.7	127 – 254
2040	297	1.5 – 3.0	30 – 59	390	6.1 – 12.2	122 – 244
2041	317	1.6 – 3.2	32 – 64	390	6.1 – 12.2	122 – 244
2042	337	1.7 – 3.4	34 – 67	390	6.1 – 12.2	122 – 244
2043	357	1.8 – 3.6	36 – 71	390	6.1 – 12.2	122 – 244
2044	405	2.0 – 4.1	41 – 81	390	6.1 – 12.2	122 – 244
2045	433	2.2 – 4.3	43 – 87	390	6.1 – 12.2	122 – 244
2046	461	2.3 – 4.6	46 – 92	390	6.1 – 12.2	122 – 244
2047	489	2.4 – 4.9	49 – 98	390	6.1 – 12.2	122 – 244
2048	488	2.4 – 4.9	49 – 98	390	6.1 – 12.2	122 – 244
2049	516	2.6 – 5.2	52 – 103	390	6.1 – 12.2	122 – 244
2050	544	2.7 – 5.4	54 – 109	390	6.1 – 12.2	122 – 244
Total	9,515	47.6 – 95.2	952 – 1,903	10,180	159.1 – 318.1	3,181 – 6,363

(A borehole is assumed to accommodate 200-400 canisters containing a total of about 100-200 tHM of spent PWR fuel, while about 1,600-3,200 canisters containing about 32-64 tHM spent HWR fuel. Cost estimation is based on a cost of about $20 million for construction of each 5 km-depth borehole.)

Political and Legal Issues

- Whether or not local communities in the ROK would oppose to site for deep borehole disposal of spent fuel/HLW remains to be seen.
- There are no current legal issues that might affect the practicality of deep borehole disposal of spent fuel in the ROK.

Concluding Remarks

- Since spent fuels would be buried at a depth of deeper than 3 km underground, surrounding geologic conditions at any places in the Korean peninsula might be suitable for deep borehole disposal.
- Considering its potential safety superiority when compared with normal geologic disposal, deep borehole disposal could be an alternative, which might be more acceptable to local communities, for the eventual disposal of spent fuel and/or HLW in the ROK.
- Public consultation process of spent fuel management would start in the ROK soon, which will critically affect nuclear fuel cycle activities and development, including deep borehole disposal, in the ROK in the coming years.