GEOLOGICAL FACTORS OF DISPOSAL SITE SELECTION FOR LOW- AND INTERMEDIATE-LEVEL SOLID RADWASTES IN CHINA

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With development of the modern science and technology and utilization of nuclear energy, a large amount of radioactive wastes are being generated, particularly low- and intermediate-level solid radioactive wastes generated from the nuclear power plants. Those wastes, causing harm to human health and impact on environment, have to be disposed of safely. Therefore, radioactive waste management has become one of the most pressing problems facing the world today.

As compared with other options for disposal of low- and intermediate-level solid wastes, geological disposal can be easily accepted by the public and authorities in charge of waste management. Shallow-ground disposal can provide adequate isolation of wastes from human for a fairly long period of time. The objective of disposal site selection is to ensure that the natural properties of the site together with the engineered barriers shall provide adequate isolation of radionuclides from the human beings and environment so that the whole disposal system can keep the radiological impact within an acceptable level.

Selecting a disposal site within an appropriate geological environment, regardless of the waste type or disposal option, is to a great extent based on the geological factors. In this context, there is a need to evaluate the entire geological background, comprising the lithology, stratigraphy, hydrogeology, geochemistry, geotectonics, and potential mineral resources.

In 1980s, two national standards, i.e. "Regulations for Shallow-Ground Disposal of Solid Low- and Intermediate-Level Radioactive Wastes" and "Regulations for Disposal of Solid Low- and Intermediate-Level Radioactive Wastes in Rock Cavities", were issued, and a suggestion to establish regional disposal sites for local waste has been put forward by the experts in nuclear waste management.

Since the early 1980s, complying with the national standards and the expert's conception as well as the related IAEA criteria, geological selection of disposal sites for low- and intermediate-level solid radwastes has been carried out in East China, South China, Northwest China, and Southwest China separately.

In 1970s, technology for disposal of intermediate- level liquid waste using the hydraulic fracturing was studied. The Cambrain strata which consist of sandy shale and shale have been chosen as host rocks for this kind of disposal option, where the strata are horizontal as a whole; the inclination is about 10°~15°. No faults appear in the area for hydraulic fracturing test. The main test well located at hill-side is about 500 m in depth. The findings prove the feasibility of hydraulic fracturing for disposal of intermediate-level liquid wastes in this area.

Since 1988 a program on east disposal site selection for low- and intermediate- level solid radioactive wastes has been performed by the CNNC. Based on 17 areas suitable for the disposal site, which were found in geological maps, 21 potential sites were investigated in the field.

Finally, 5 candidate sites were recommended to the CNNC.

The following criteria have been taken into account in siting:

1. Population Distribution

The potential impact of radioactivity to be released from disposal site on the general public should be considered, and the distribution and characteristics of the population in the region at present and in the future should be evaluated.

Zhejiang Province is one of the densely-populated provinces in China. Its average population density is approximately 400 persons/km^2. In this case, disposal site for low- and intermediate-level solid radwastes arising from Qinshan Nuclear Power Plant has to be selected in the region where population density is relatively low. In any case, cities and their surroundings, like Hangjiahu area with high population density, areas with major junctures of traffic lines, railway stations, harbours, and their neighbouring areas should be excluded from building up a disposal site.

2. Development of Economy and Perspectives

As specified, the management and control period of the low- and intermediate-level wastes disposal site is generally in the range of 300 to 500 years. By then, radionuclides in the wastes can be decayed to an acceptable level before they migrate to human environment, and the land for the disposal site can be used again.

During the control period, any other activities irrelevant to waste disposal are not allowed within the site and its buffer areas.

Such areas shall be excluded from building up the disposal site for low- and intermediate-level solid radioactive waste, i. e. mineral resources areas, nature preserve zones, scenic spots, and developed economic regions.

Therefore, Tianmushan Nature Preserve Zone, Yandangshan Scenic Spot, Xin'anjiang Reservoir and its surroundings, and Hangjiahu developed economic region in Zhejiang Province are not suitable for building up the disposal site for low- and intermediate-level solid radioactive wastes.

3. Geological Stability

The safety of a disposal site is highly dependent upon the engineered barriers and the geological formations which act as a natural barrier to prevent the migration of radionuclides. Favourable geological environment can minimize the contact of groundwater with the underground wastes and absorb radionuclides and retard the movement of radionuclides.

Tectonic stability constitutes a favourable condition for shallow-ground disposal sites. The area of high seismicity or in the immediate vicinity of active faults is excluded from consideration in selecting a shallow-ground disposal site.

Any active earthquake area and active fault zone as well as the area where natural disaster happens frequently shall be avoided in siting. Hangjiahu area, Zhenhai-Dinghai, Hexi-Qingyuan and Leqing-Wenzhou located in earthquake zones shall be excluded in selecting

disposal site for low- and intermediate-level solid radioactive wastes.

4. Characteristics of Hydrology and Hydrogeology

The main approach of the migration of radionuclides from the disposal site into the envrionment is water flow, either the surface water or the groundwater. Thus, study on the characteristics of the surface water and groundwater in the disposal site and its surrounding areas aims at assessing the confining ability of the site. The potential migration approach of radionuclides and the interaction between the groundwater and rock materials can only be predicted on the basis of detailed information of the hydrogeology.

East China disposal site

Since the low- and intermediate-level wastes arising from Qinshan Nuclear Power Plant will be first disposed of at East China disposal site, it is suitable to select the site in Zhejiang Province. Zhejiang Province is situated in the humid subtropic zone, the rainfall is an unfavourable factor for shallow-ground disposal of low- and intermediate-level solid radioactive wastes. Hence, engineered barriers shall be strengthened to compensante for this factor.

Five candidate sites have been recommended, i.e. one shallow-ground disposal site, two abandoned zinc-lead mines, one abandoned uranium mine, and one artificial cavity at Qinshan.

The shallow-ground disposal site is preferably introduced as follows:
Bajiaotang shallow-ground disposal site is located about 200 km northwest of Qinshan Nuclear Power Plant in Anji County, Zhejiang Province .

The average population density of the township, where the site is located, is about 230 persons/km^2, but the population density within or near the site is far less than that figure. Since the land is rather barren, no important crops grow there.

The topography is relatively even with an elevation of about 50～70 m above the sea level.

The lithology at the site has been found to consist of conglomerate, sandstone, and tuff with arrested occurrence. Thickness of the weathered layer is about 3～5 m. No apparent faults are discovered at the site. Earthquakes of 3～4 degree on the Richter scale are recorded. Average annual rainfall is about 1300 mm. The groundwater tabie is over 10 m.

In addition, bentonite and weathered tuff as backfill materials occur near the site.

Northwest China disposal site

In Northwest China, 6 disposal sites have been proposed in the preliminary selection, and two of them are chosen as candidate sites for characterization assessment. Both are located in stable geological units without any active faults. Lithology at the sites has been found to consist of a thick sedimentary deposit in different compositions of sand, gravels, and clay. The groundwater table is over 18 m. Average annual rainfall is below 70 mm. Population density is 10 persons/km^2.

Southwest China disposal site

In Southwest China, 38 preliminary disposal sites have been proposed on the geological maps, 10 of them were investigated in the field; at last 3 candidate sites were selected for further investigation. They are situated in a relatively stable region, where the earthquake intensity is

below 6 ~ 7 degree on the Richter scale. The Jurassic strata, which consist of mudstone, sandstone, and siltstone, crop out at the sites.

South China disposal site

A disposal site for low- and intermediate-level solid radioactive wastes, arising from the Daya Bay Nuclear Power Plant in Guangdong Province, has been selected. 30 preliminary disposal sites were chosen on the geological maps, 20 of them were investigated in the field, 2 candidate sites, 2 km north of the Plant, have been determined. The Devonian sandy shale appears around the site. The area near Dapeng town, where the disposal site is located, is of stable geological formation suitable for construction of a disposal site for low- and intermediate-level solid radioactive wastes.

Much work and the support from the general public and the local authority are required to build up a disposal site for low- and intermediate-level solid radioactive wastes.