[Form 2 (to be reported to Committee on Countermeasures for Contaminated Water Treatment and to be disclosed to public)

Technology Information	
Area	5 (Select the number from "Areas of Technologies Requested")
Title	Management measures to block groundwater from flowing into the site
Submitted by	EPRI

1. Overview of Technologies (features, specification, functions, owners, etc.)

Construction technologies for impervious walls: EPRI provided a presentation, at the July 2013 TEPCO/EPRI Decommissioning Workshop that described a number of technologies that have been successfully used at other locations to block the migration of groundwater (see Appendix 1; note that slides proprietary to Pacific Gas and Electric Company have been deleted; these slides were provided to TEPCO personnel during the workshop and may not be disseminated outside of TEPCO).

Also presented were advantages and disadvantages for the different technologies. The types of barrier technologies discussed in this presentation were:

- Slurry Walls
- Freeze Walls
- Conventional Shoring

Additional Details on these and other techniques are included in EPRI Report # 1021104, "*Groundwater and Soil Remediation Guidelines for Nuclear Power Plants*", 2010.

Concerning the use of these types of technologies at a site such as Fukushima Daiichi, there are certain key considerations that must be evaluated prior to implementation of a technology or a combination of techniques. Included in the key considerations are:

- Is there a high certainty that the technology will block groundwater migration as intended and be able to continue to perform this blocking function for the duration needed?
- Is there adequate data indicating that an impermeable layer is at the depth assumed and that it has adequate thickness for the whole area for which groundwater migration is to be blocked. If the blocking wall does not intersect the impermeable layer along its total length and the bottom of the enclosed area is not totally made up of an adequately impermeable layer, the effectiveness of blocking wall at preventing groundwater migration will be compromised.
- Are there obstacles such as underground structures or commodities that would make the installation of a blocking technique difficult or impractical to implement. The evaluation of alternative techniques needs to consider which obstacles need to be removed prior installation of the blocking technique.

Additional details on this subject are contained in the presentations given at the TEPCO/EPRI Decommissioning workshop mentioned above.

Concerning the options for the location of barriers at the plant 10 meter and/or 35 meter elevations, evaluation of these options should be based on information including the following:

- A fully developed Site Conceptual Model (SCM), describing source(s) of release, groundwater flow, nature and extent of contamination, fate and transport mechanisms. The SCM needs to describe in detail the hydrogeologic conditions that exist in the areas near to any proposed blocking walls and the areas where the lowering of groundwater level is intended.
- Sufficient field data should have been collected to support the SCM
- SCM is a “living” tool, and is updated when new data or findings are available
- Based on this Site Conceptual Model, a detailed numerical model should be used to predict the effectiveness of the blocking wall at preventing groundwater migration and whether the areas inside of the blocking wall can be adequately dewatered.

Technique for covering surfaces: Considering the large area of the hillside upgradient of the Fukushima Daiichi Units 1-4 plant area, recharge of groundwater due to rainwater is likely significant but may not be the largest source of groundwater under the plant. The Site Conceptual Model should include details of the contribution of this rainfall to the groundwater flow across the site along with any groundwater traveling from locations further upgradient of the 35 meter elevation of the Fukushima Daiichi site. A numerical model of the contributions to the groundwater flow across the site can help to determine the expected effectiveness in reducing groundwater flow.

Additionally, the evaluation of covering this hillside area to prevent groundwater infiltration needs to consider issues such as the following:

- Where will the rain water that collects on top of the covering be collected and directed? This is likely a substantial amount of runoff that will require a storm drain system.
- As leakage events have occurred in the areas where this covering would be installed, there is a potential that the runoff would become contaminated. In this case, the storm drain runoff would need to be treated as an effluent and the releases monitored, quantified and reported. EPRI presented information on some available monitoring devices at the July TEPCO/EPRI Workshop.

Technique for collecting radioactive Sr: EPRI provided TEPCO with information on two potential methods for the immobilization of Sr-90 and Cs-137 in soil during a conference call on September 3, 2013. The techniques mentioned on that call were:

- Use of Calcium Apatite in a Permeable Reactive Barrier for the capture of Sr-90
- Replacement of current granular material in the groundwater flow path with material that has a high affinity for Sr-90 and/or Cs-137 at the Savannah River Site (This approach was also used in choosing post remediation backfill material to retain Sr-90 at the Connecticut Yankee power plant site).
- Hanford Site Study: Investigated the in-situ immobilization of radionuclides such as Sr-90 in groundwater by their facilitated co-precipitation with calcium carbonate

Additional techniques and details on the above mentioned techniques are contained in EPRI Report # 1016763, "*Advanced Technologies for Groundwater Monitoring and Remediation at Nuclear Power Plants*", 2008. There are likely other immobilization techniques that could be usable at the Fukushima Daiichi site. EPRI can research to find other potential techniques at the request of TEPCO.

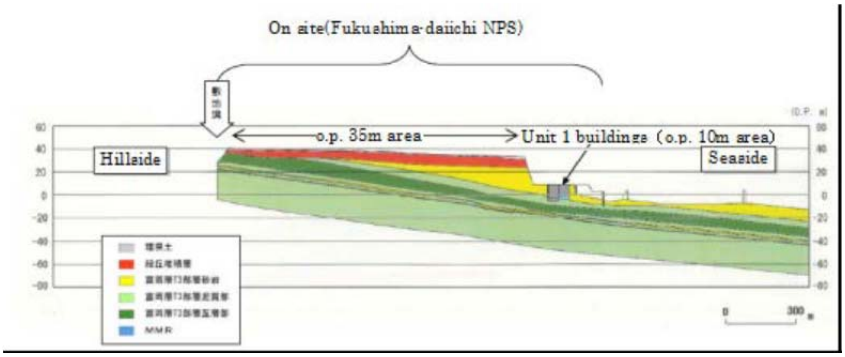
Techniques needed to remove the trapped radioactive Sr from the ground soil: EPRI discussed methods such as groundwater pump and treat as a technique for the removal of Sr-90 from soil during the July TEPCO/EPRI Decommissioning Workshop (Presentation name. "*Operating Experiences*"). EPRI is aware of techniques that can be used to improve the efficiency of groundwater pump and treat through the injection of chemicals that increase the mobility of Sr-90 in soil, thereby increasing the removal rate. There are likely other Sr-90 removal techniques that could be usable at the Fukushima Daiichi site. EPRI can research this topic to find other potential techniques and/or more details on those mentioned above if requested by TEPCO.

Additional Details on groundwater remediation using Pump and Treat techniques are included in EPRI Report # 1021104, "*Groundwater and Soil Remediation Guidelines for Nuclear Power Plants*", 2010.

Techniques needed to collect the radioactive Sr without affecting groundwater flow: EPRI discussed Permeable Reactive Barriers as a method of removing Sr-90 from groundwater without affecting groundwater flow during the July TEPCO/EPRI Decommissioning Workshop (Presentation name, "*Operating Experiences*").. There may be other Sr-90 removal techniques that do not affect groundwater flow that could be usable at the Fukushima Daiichi site. EPRI can research this topic to find other potential techniques and/or provide more details on Permeable Reactive Barriers mentioned above.

Concerning all the items discussed for IRID Subject Area 5, it is recommended that the effect of any of these techniques on site groundwater flow conditions and radionuclide mobility be carefully evaluated and/or tested prior to field deployment.

Figure □-1 Schematic Layout of Unit Building and Ground Layer



Summary of EPRI Reply to TEPCO on IRID Subject Area 5

As discussed above, EPRI has prepared reports that discuss techniques that could address a number of the technology needs identified in IRID Subject Area #5. On request, EPRI could provide detailed summaries of the relevant information in these reports as well as information on additional technologies that can be gathered by performing additional research.

2. Notes (Please provide following information if possible.)

- Technology readiness level (including cases of application, not limited to nuclear industry, time line for application)

- Challenges

- Others (referential information on patent if any)