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

Technology Information	
Area	1,2,3 (Select the number from “Areas of Technologies Requested”)
Title	Use of systems modelling approaches to understand radiological risks from Fukushima site in perspective
Submitted by	Quintessa Ltd

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

The accident at the Fukushima Dai-ichi site has resulted in significant quantities of environmental contamination in and around the site. The primary concern is to minimize the spread of this contamination through groundwater management. However, these efforts have resulted in the storage of large quantities of contaminated water. There also exists significant (and in some cases, unknown) amounts of radioactive contamination in ground and the marine environment.

Managing the environmental contamination and the stored wastes is the major challenge faced at Fukushima, and there is a need to understand the radiological does and risks from all the different sources of contamination in context. For example:

- What are the comparative risks from the discharge of tritium to seawater compared with the potential for future leaks or spills of stored water on the site; or
- How do the risks from contaminated sediment in the harbour contrast with the radiological effects if it were to be retrieved and disposed of?

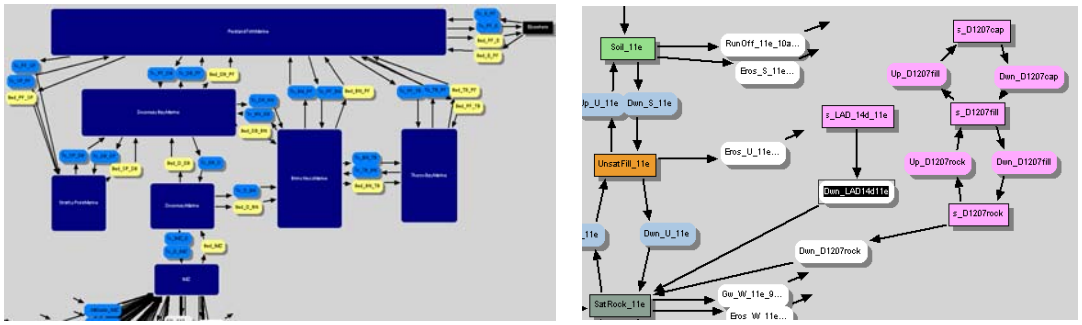
Understanding the level of risk from all the sources of radioactive contamination, and waste, on a common basis provides a highly valuable input into decisions on the environmental management of the site. Furthermore, risk assessment methods can be used to project these risk estimates into the future, enabling all the potential radiation impacts to be understood – in the present day and on future generations.

Systems assessment offers a way in which all of the potential sources of radioactive contamination can be represented together, along with the surrounding environment and the processes that move contamination in groundwater, soils and the marine environment. Such an approach can highlight the relative risks from different aspects. For example, it may indicate that relatively high subsurface concentrations of Cs-137 are of less importance than, say, suspended dust from relatively local and low-levels surface contamination. Such information provides the basis for radiological protection actions to be well targeted and effective.

Systems models also provide a “predictive” capability which can allow decision-makers to explore alternative ways of dealing with contaminated material when remediating the site, and examining alternative “scenarios”. For example, the radiological risks of grouting contamination in-situ can be compared with the risks from excavating the contamination, packaging it, and disposing of it elsewhere in a dedicated radioactive waste facility. Insights into the relative radiological impacts of different options are highly valuable in deciding what the best strategy is, particularly where there are large amounts of contamination involved. They provide a way of asking “what if ?” and using the knowledge gained to make better decisions on how to manage the radiological risks in an optimized way. It has been widely applied to, for example, designing radioactive waste disposal facilities.

These goals can be achieved by systems assessment models that represent whole sites and their environment. A systems assessment model of the Fukushima site and its environment would provide insights into the critical issues concerned with the environmental radioactivity, the overall levels of risk now and in the future, and also the benefits – in terms of reducing risks – from different remediation actions.

Figure: Example of a Parts of a Systems Model for a Nuclear Site



The fundamental modelling methods have been developed over many years and are well founded. Systems assessment is therefore a well-established method for evaluating radiological impacts from actual or proposed radioactive waste disposal facilities, but, with some exceptions, it has not been applied to large nuclear sites in which significant amounts of radioactive contamination is present. However, the technology is now sufficiently mature that suitably powerful and flexible computer codes are available for modelling the environment in this way. It is also sufficiently mature that the skills required to build whole-site systems models are available and there is already some experience with such an approach.

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

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

Whilst systems modelling has largely been focused on assessing radioactive waste disposal facilities, there are examples of whole-site systems modelling dating back more than a decade. For example, in the 1990s a number of major “dose reconstruction” studies were undertaken in US to inform the restoration of historic defence sites. These were major projects, requiring a considerable investment in mathematical modelling and data collection.

Since this time, considerable progress has been made in the capabilities of modelling software. Modern environmental modelling codes like AMBER and GoldSim have been used to represent complex environmental systems including geological, surface, marine and climate-change aspects. A good case study is the environmental system model for this purpose is the Integrated Performance Assessment Tool for the Dounreay site in Scotland. As such, the modelling capability is presently available and there is a track record of applications to cases like this.

- Challenges

The primary challenge will be gathering sufficient information concerning the environmental characteristics at Fukushima and in particular the patterns of environmental radioactivity in the soil, rock, and water. This information will nevertheless be required as part of the broader actions to understand the situation at the site. There is also considerable experience with developing system models in the context of uncertainties, and using the models themselves to constrain the uncertainties. For example, models can be used to estimate the amount of contamination in the ground by comparing model results with measurements.

- Others (referential information on patent if any)

The modelling tools, and model building skills, are currently available in the supply chain. Suitable software applications such as AMBER and GoldSim are commercially available, and bespoke modelling tools are unlikely to be required. Models that describe the site and its environment that are developed would usually become the property of the client.

【Areas of Technologies Requested】

(1) Accumulation of contaminated water (Storage Tanks, etc.)
(2) Treatment of contaminated water (Tritium, etc.)
(3) Removal of radioactive materials from the seawater in the harbor
(4) Management of contaminated water inside the buildings
(5) Management measures to block groundwater from flowing into the site
(6) Understanding the groundwater flow