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Application of Thermal Dimensioning Tools to Consider Different Strategies for the Disposal of High-Heat-Generating Waste

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Abstract : The principle of geological disposal is to isolate higher-activity radioactive wastes deep inside a suitable rock formation to ensure that no harmful quantities of radioactivity reach the surface environment. To achieve this, wastes will be placed in an engineered underground containment facility – the geological disposal facility (GDF) – which will be designed so that natural and man-made barriers work together to minimise the escape of radioactivity. Internationally, various multi-barrier concepts have been developed for the disposal of higher-activity radioactive wastes. High-heat-generating wastes (HLW, spent fuel and Pu) provide a number of different technical challenges to those associated with the disposal of low-heat-generating waste. Thermal management of the disposal system must be taken into consideration in GDF design; temperature constraints might apply to the wasteform, container, buffer and host rock. Of these, the temperature limit placed on the buffer component of the engineered barrier system (EBS) can be the most constraining factor. The heat must therefore be managed such that the properties of the buffer are not compromised to the extent that it cannot deliver the required level of safety. The maximum temperature of a buffer surrounding a container at the centre of a fixed array of heat-generating sources, arises due to heat diffusing from neighbouring heat-generating wastes, incrementally contributing to the temperature of the EBS. A range of strategies can be employed for managing heat in a GDF, including the spatial arrangements or patterns of those containers; different geometrical configurations can influence the overall thermal density in a disposal facility (or area within a facility) and therefore the maximum buffer temperature. A semi-analytical thermal dimensioning tool and methodology have been applied at a generic stage to explore a range of strategies to manage the disposal of high-heat-generating waste. A number of examples, including different geometrical layouts and chequer-boarding, have been illustrated to demonstrate how these tools can be used to consider safety margins and inform strategic disposal options when faced with uncertainty, at a generic stage of the development of a GDF.

Keywords : buffer, geological disposal facility, high-heat-generating waste, spent fuel
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