**Integration Group for the Safety Case (IGSC) Symposium 2024***MOVING TOWARDS THE CONSTRUCTION OF A SAFE DGR – GETTING REAL*

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| **Abstract Title:**  Application of machine learning for a systematic simplification process of realistic 3D radionuclide migration model for post-closure safety assessment | |
| **Abstract (300-500 words):**  The models used in safety assessment of a repository can generally be classified as two levels of models, process-level models and integrated or system-level models to balance the complexity of the model with the available data and understanding (Ref. 1). Advances in high-performance computing and process understanding are recently enabling more complex 3D nuclide migration analyses over wider ranges of time and spaces. However, the use of complex models makes it more difficult to understand the modelling approach, including the justification of model simplifications to develop a system-level model for safety assessment, which leads to challenges in building confidence in the assessment results. It should be clearly demonstrated that the simplification process is implemented systematically to provide a reasonably conservative system-level model. For this purpose, it is essential to identify key factors to calculation results of complex 3D nuclide migration model through analysis of the effects of model parameters and boundary conditions to the model output under large computational load, processing a huge amount of data.  This study aims to develop a method for the analysis of key factors to the results of 3D nuclide migration analysis by applying machine learning, which makes the simplification process more systematic and efficient.  Nuclear Waste Management of Japan (NUMO) has established a methodology to develop a reasonably simplified 1D nuclide migration model of the entire repository system based on 3D particle tracking simulation with the random walk method by PARTRIDGE (Ref. 2) and applied this methodology to post-closure safety assessments in the Pre-siting SDM-based Safety Case (Ref. 3). This 3D model was used for the machine learning study. The particle tracking simulation with the model including 1,000 canisters of HLW was performed to obtain training, validation, and test data sets. Cluster analysis using unsupervised machine learning with density-based spatial clustering of applications with noise (DBSCAN) was attempted for the migration pathways of particles to understand the migration data by classifying the pathways. As a result, the main factors affecting the differences in migration behavior, such as high permeability fractures and panel surrounding tunnels, are identified.  Supervised machine learning with neural network method was applied to develop a surrogate model, using the relationship between fracture information (e.g. distribution of fracture frequency and size) and particle fluxes at the downstream model boundary at each time step. The surrogate model based on 30 training data sets successfully predicted the particle flux of several HLW canisters which are not used for training.  These approaches would be more useful in the phase of building site-specific models, where the data and the spatial resolution will increase along with the stepwise process of site investigation. Iterative application of these approaches can improve the reliability of the surrogate model as a system-level model to be applied for safety assessment.  Reference   1. OECD/NEA (2012): Methods for Safety Assessment of Geological Disposal Facilities for Radioactive Waste, Outcomes of the NEA MeSA Initiative, NEA No. 6923. 2. Ishida, K., Fujisaki, K., Saegusa, H., Onoe, H. and Mitsuyama, K. (2024): Development of an integrated realistic radionuclide migration model for the entire geological disposal system, IGSC Symposium 2024 (submitted). 3. Nuclear Waste Management Organization of Japan (2021): The NUMO Pre-siting SDM-based Safety Case, NUMO-TR-21-01. | |