Shielding Performance Evaluation of the Alternative Design for a Concrete Plug of Calandria Vault in the Wolsong Units 3 and 4

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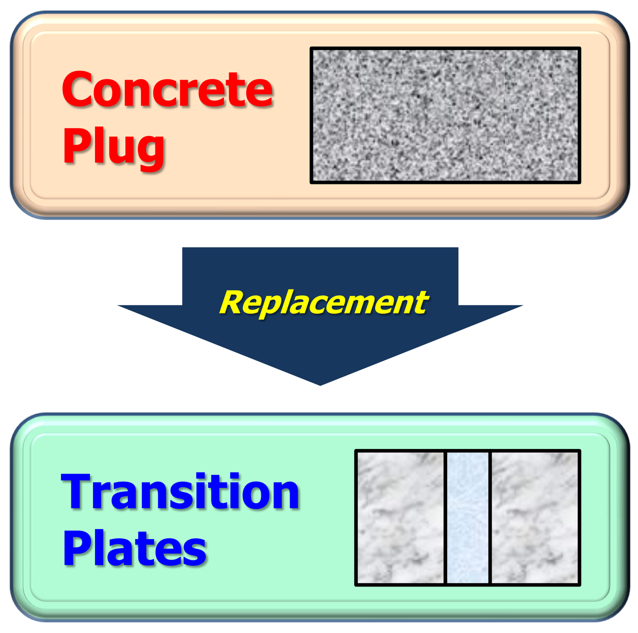
Introduction

- Calandria Vault Water Makeup (CVWM)
  - The flow-path for supplying emergency cooling water to the calandria vault
  - Utilized in case that loss of cooling function for the reactor is lasted over a long period of time due to beyond DBAs
- Alternative design for the calandria vault is currently under review.
  - Replacement of a concrete plug by the transition plate (made of two steel plates)
  - Should be designed to provide at least an equivalent shielding effectiveness compared with a concrete plug
- The shielding analysis for each design
  - Carried out for confirming feasibility of the replacement
  - Comparing the shielding performance between a concrete plug and the alternative design (i.e. transition plates)

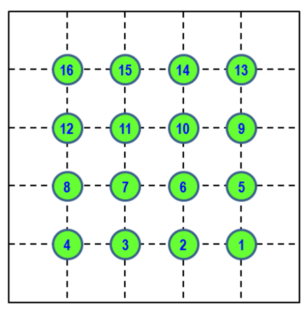


Methods

- Computer Code: MicroShield v9.05 (Point Kernel Method)
- Input Data and Assumptions
  - Dimensions: Inputted referring to drawings for each design
    - ※ Some values are reasonably determined by the engineering judgment.
  - Material and Density

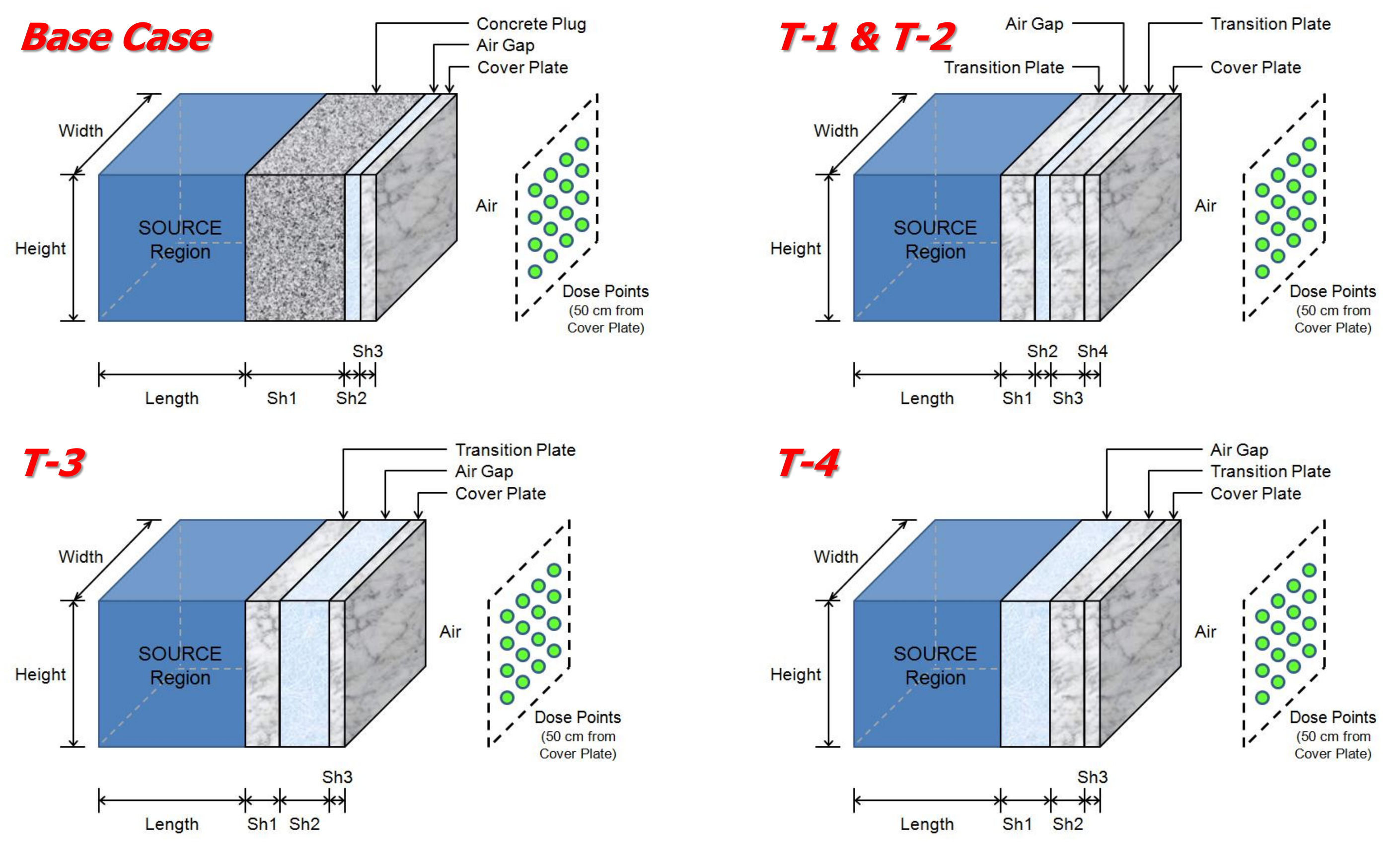
Region		Material	Density [g/cc]
Source		Air	0.00122
Concrete Plug		Concrete	2.35
Transition Plate	T-1	Iron	6.67
	T-2	Iron	5.49
	T-3 & T-4	Iron	7.86
Air Gap		Air	0.00122
Cover Plate		Iron	7.86

  - Source Terms
    - ✓ Assumed that 1 Ci of ^{16}N is uniformly distributed in the source region filled with air
    - ✓ Gamma-rays are sorted into energy groups using standard indices.
  - Nuclide Library: ICRP-107
  - Flux-to-Dose Conversion Factors: ICRP-74 (Based on ICRP-60)
  - Dose Points
    - ✓ A total of 16 intersections of imaginary lines which divide width and height into 5 equal parts, respectively.
    - ✓ 50 cm above the cover plate



- Cases Evaluated

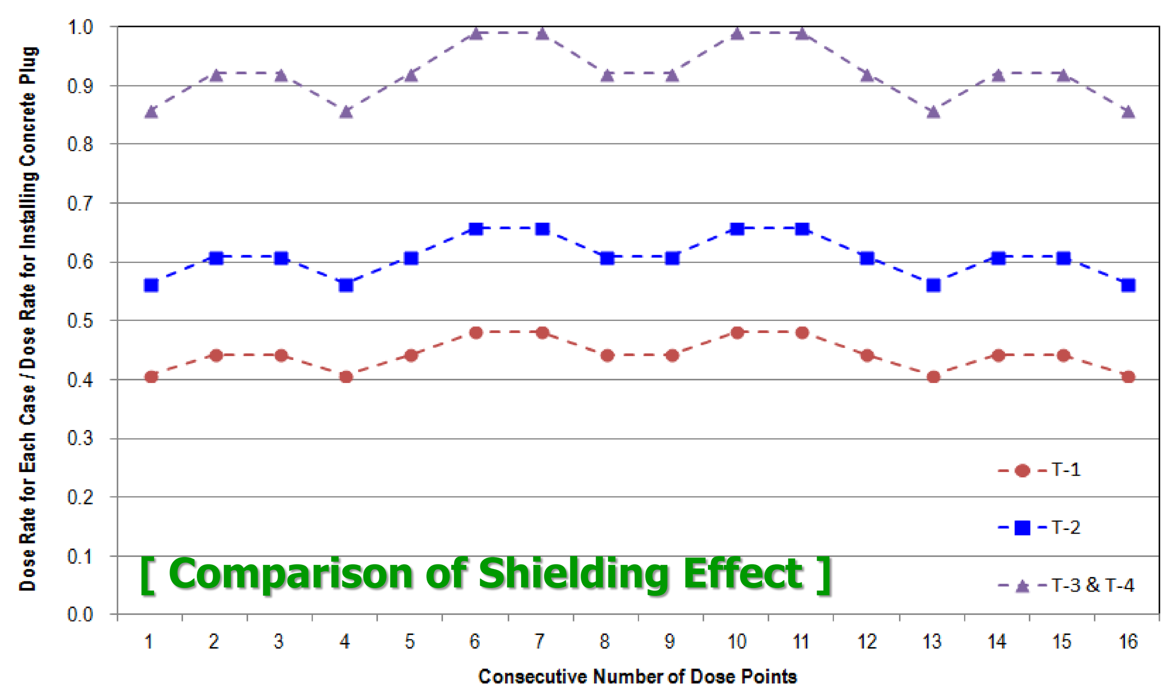
Case	Description
Base	● A concrete plug is installed.
T-1	● A concrete plug is replaced by the transition plate made of 2 plates of steel, which are separated from each other by an air gap. ● It is assumed that steel and 8 cylindrical openings are homogeneously mixed in the transition plate. ● A density of the plate is adjusted considering the total volume of openings.
T-2	● Very similar to case "T-1" ● The homogenized density for half space of the plate is applied as that for the whole plate referring to configuration of the transition plate.
T-3 T-4	● Since there may be the radiation streaming through openings, a single plate (i.e. the lower or upper part) is only considered in each case. ● A plate excluded from the calculation is assumed to be an air gap.



Results and Discussion

- For each case,
  - the effective dose rate by dose point are evaluated, and
  - the value obtained with a concrete plug is considered as the reference value (i.e. 100%) for each point.
- The fraction of dose rate can be calculated through dividing the value for the transition plate by that for a concrete plug.

The alternative design provides a better shielding than a concrete plug, even if only a single plate is considered in the calculation.



Conclusions

- Ratio of Dose Rate for Each Case to that for Base Case

Cases	Minimum	Maximum
T-1	0.408	0.482
T-2	0.563	0.659
T-3	0.857	0.989
T-4	0.857	0.989

- Based on these results,
  - The feasibility of replacement of a concrete plug by two (2) steel plates is confirmed.
  - In the aspect of the gamma-ray shielding, it is judged that the transition plate is designed to provide an equivalent or up to about 50% better performance in comparison with the original design using a concrete plug.
- These results will be updated by the additional information, if necessary, and could be applied to the installation design for CVWM.

Acknowledgments

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