Preliminary Safety Evaluation on PRIDE Facility

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I. Introduction

The PRIDE facility comprises the capabilities necessary to develop and test high-temperature molten salts technology with the stringent inert atmosphere control, remote operation features, and safety issues, etc. So far, the design technology on large scale inert atmosphere cell is not yet a mature technology in Korea for handling the high-temperature molten salts, but by our efforts is it possible to design essential equipments for large scale inert cell and the control system to maintain the inert atmosphere. And safety evaluation is also performed to ensure the safety issues.

II. PRIDE Facility Description

The PRIDE facility is that of contiguous argon-atmosphere and air-atmosphere cells that have carbon steel frame with stainless lining plates and are surrounded by operating area. The inner dimension of the air cell is 9.3m × 4.75m × 6.45m, and argon cell is 30.05m × 4.75m × 6.45m.

III. Safety Evaluation for PRIDE Facility

All significant processes and operations in PRIDE facility would take place behind stainless steel walls in confined cells. Both the air and the argon atmosphere would be released through 2nd stage HEPA filters. Therefore, it is to be expected that many types of accident conditions could occur with little effect on the public, the worker, and the environment. Several accidents are analyzed to show that the operation of PRIDE facility presents no harmful to the public, the worker, and the environment. The preliminary accident analyses consist of developing a scenario for each accident considered, estimating radiological dose at the site boundary.

The calculated effective dose due to external exposure and equivalent dose to the thyroid received by inhalation are summarized in table 1. The dose rate limit for unlikely accidents are 0.25 Sv of effective dose rate to the whole body or 3 Sv of equivalent dose rate to the thyroid which is embodied in 10 CFR 100.11. Table 1 shows that even in the firing case of the all uranium metal in argon cell dose rates are negligible comparing to dose rate limit values.

Table 1. Summary of MAR/ARF/RF/LPF Values

Condition	Effective dose (Sv)			Equivalent dose for thyroid(Sv)		
	I[a)]	E[b)]	Tot.	I	E	Tot.
Free-fall spill, powder	7.9e-5	3.8e-11	7.9e-5	1.4e-7	4.2e-12	1.4e-7
Fire, Be heated or ignited, metal	6.6e-4	3.2e-11	6.6e-4	1.2e-6	3.5e-11	1.2e-6
Process Equipment eruption	6.5e-5	3.2e-12	6.5e-5	1.2e-7	3.5e-12	1.2e-7

a) Internal exposure from inhalation
b) External exposure from radioactive cloud

The performance of indoor argon flow for the argon cell has been investigated by means of CFD analysis. The aims of this analysis are to investigate the influence of the process apparatus layout and argon cooling system with varying argon flow rate. To operate argon cell safely, the all generated heat in the argon cell should be removed effectively by circulating argon gas and there are no abnormally higher temperature regions via ambient argon cell room temperature. The argon is supplied to the argon cell at 15 °C with total argon exchange rate of 4,000 m^3/h and inlet argon velocity is 0.6 m/sec. The k-ε turbulence model has been used to calculate the argon flow velocity profile, temperature profile in argon cell, and heat transfer characteristics between process apparatus and argon gas. The temperature of all the walls of process apparatus has been defined constant temperature as 100 °C, which would be the bounding value of process apparatus wall temperature constraint. Because detail design of process apparatus is progressing until now, the size and shape of the apparatus is assumed with conceptual information.

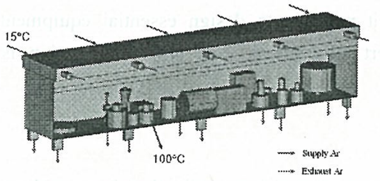

Fig. 1. CFD model showing the layout of the argon cell and process apparatus.

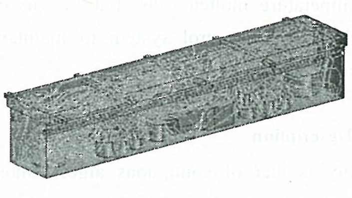

Fig. 2. Streamline plot for the argon cell.

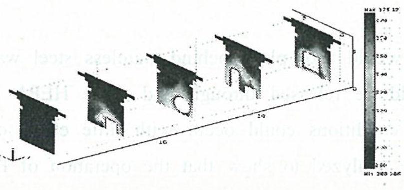

Fig. 3. Plot demonstrating temperature profile at the supply duct section.

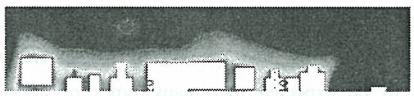

Fig. 4. Plot demonstrating temperature profile in the center of argon cell.

IV. Conclusion

In the worst accident case, even in the firing of the all uranium metal in argon cell, dose rates are negligible values compared to 0.25 Sv of effective dose rate to whole body or 3 Sv of equivalent dose rate to the thyroid. CFD techniques allow visualization of argon flow, temperature distributions of PRIDE facility. With CFD analysis, the more detail review is possible for the specifications of the argon system and this study will support to the improvements of argon flow and temperature distributions. It may contain the resize of the argon cooling system, rearray of the supply and exhaust duct, and relocate the process unit.

Acknowledgments

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