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Feasibility Analysis for Using Halogen Lights in Reactor Containment Building

Chungsuh Ku[a], Inchul Ryu[a], Heedo Lee[a], Hyungwon Lee[a]
a Korea Power Engineering Co., 360-9 Mabuk-dong, Giheung-gu, Yongin-si, Gyeonggi-do, 446-713, Korea
Joon Cho[b]
b Shaw Stone & Webster, 100 Technology Center Drive Stougton, MA 02072, USA

1. Introduction

As a part of a Shinkori 1&2 NPP project, we at KOPEC and SS&W conducted the feasibility study for using halogen lights in the reactor containment building to replace current incandescent lights.

The items of feasibility evaluation are the RCB atmosphere and its effects on equipment, personnel, and sump pH in case that all lights break simultaneously.

2. Methodology and Calculation

For RCB global volume concentration of halide gas, the ideal gas law is used. The accident temperature is used for the pressure and temperature added by gases. For the pH, the hypalon cable insulation is used for the comparison. For the maximum RCB sump water bromide/chloride ion concentration, it is considered the total released halogen gas mass and minimum sump water volume of normal operating condition.

Base data used for the calculation are follows.

Halogen gas of the lamp in RCB	
Bromine (CH_3Br)	0.11 mg / lamp,
Chlorine (CH_2Cl_2)	0.099 mg / lamp,
Total Number of Lamp	42 / Unit,
RCB minimum free volume	2.727 x 10^6 ft^3,
RCB minimum sump water	
Volume	1,918.4 ft^3,
Mass	111,697 lbm,
Temperature	270 ^oF

3. Result

3.1 Maximum RCB Halogen Gas Concentration

The calculated maximum RCB global volume halogen gas concentrations are $1.542x10^{-5}$ ppm for the methyl bromide (CH_3Br) and 1.552 $x10^{-5}$ ppm for the methylene chloride (CH_2Cl_2)

The calculated maximum RDT Room halogen gas concentrations are $4.682x10^{-4}$ ppm for the methyl bromide (CH_3Br) and $4.713x10^{-4}$ ppm for the methylene chloride (CH_2Cl_2).

Since the calculated halogen concentrations are far less than the OSHA permissible exposure limit (PEL), which are 20 ppm for the methyl bromide and 25 ppm for the methylene chloride, there is no concern for the RCB atmosphere, RDT room and control room habitability.

3.2 Maximum RCB Pressure Increase

The calculated maximum RCB pressure increase is $3.483x10^{-10}$ psia. Since the pressure increase is far less than the margin (i.e., 10% of gauge) applied to the containment DBA pressure profile (Figure 1), there are no concern for the RCB pressurization and equipment qualification.

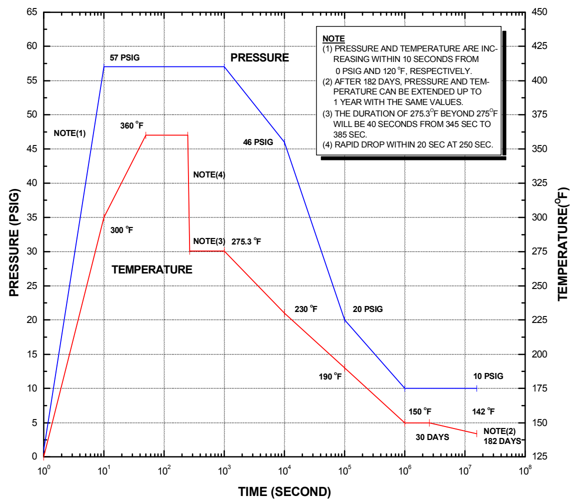

Figure 1 Containment DBA Pressure & Temperature profile

3.3 Maximum RCB Temperature Increase

The calculated maximum RCB temperature increase is 0.00897^oF. Since the pressure increase is far less than the margin applied to the containment DBA temperature profile (i.e., +15 ^oF) (Figure 1), there is no concern for the equipment qualification.

3.4 Containment Sump pH Following a LOCA

Comparing the maximum calculated acid addition to the sump from broken light fixtures to the acid addition from radiation degradation of cable jacketing inside containment indicated that the quantity of HCl from the halogen lighting would be a minimum of 6 orders of magnitude below that of the cabling. This would be well within the error margin of the sump pH calculation and deemed insignificant in consequence.

3.5 Charcoal Filter Capacity

The calculated maximum loss of capacity if only a single Type II charcoal filter were used in an effluent path is < 0.1 %. This impact is deemed to be insignificant.

3.6 Maximum RCB Sump Water Bromide/Chloride Ion Concentration

The calculated maximum RCB sump water bromide/chloride ion concentration is 0.00462 ppm. Since the ion concentration is far less than 10 ppm which is the maximum allowable limit to avoid halide corrosion for stainless steel, there is no concern for the corrosion of metals.

4. Conclusion

Based on each conclusion for each key item, it is concluded that there are no adverse effects for using halogen lights in the reactor containment building (RCB) to replace current incandescent lights as long as the prohibited substances such as mercury or lead are not introduced into the RCB.

REFERENCES

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[3] OSHA Regulation (Standards 29CFR), Standard Number 1910.1000 Table Z-1, "Table Z-1 Limits for Air Contaminants," Occupational Safety & Health Administration

[4] OSHA Regulation (Standards 29CFR), Standard Number 1910.1052, "Methylene Chloride," Occupational Safety & Health Administration

[5] CRC Handbook, 2nd Edition, CRC Press, Inc

[6] NUREG/CR-5950, "Iodine Evolution and pH Control"