Screening Criteria for a Room Cooling Failure of the AFW MDP Room

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1. Introduction

In this paper, we performed a heat up calculation for the Auxiliary Feedwater Motor Operated Pump (AFW MDP) room, PAB-077-11A with CFX-10[1] and RATT[2] when the HVAC (Heating, Ventilation, and Air Condition) system is failed. We also reviewed the operability of the components under a loss of the HVAC.

Room cooling failure does not need to be modeled if the components maintain their operability after a loss of a room cooling function during the mission time.

ASME Standard [3] describes that a recovery action can be credited if the related recovery action is included in the procedure or there are similar recovery experiences in the plant. However, there is no description about the recovery action of the HVAC in the EOP (Emergency Operation Procedure) of the UCN3, 4 under the situation of a loss of the HVAC[4].

However, if we consider the HVAC failure in the PSA FT model, the problem is that the unavailability induced from a loss of the HVAC is unrealistically high. From a viewpoint of the PSA, it is not true that the related system always fails even if the HVAC system fails [4]. Therefore, we reviewed the necessity of the HVAC model through two cases of a room heat up calculation under the situation of a loss of the HVAC system with conservative and realistic input data respectively.

2. Review of the Operable Temperature of the Components

We reviewed references [5, 6, and 7] for an identification of the operable temperature of the components under a loss of the HVAC.

Table 1 shows the operability condition by the equipment category [4]. Table 2 shows the estimated operability condition for the AFW MDP room [4].

3. Heat up Calculation for the AFW MDP Room in the Case of a Loss of the HVAC

We calculated the change of the temperature in the AFW MDP room after a loss of the HVAC by using RATT[5] and CFX-10. Input data for RATT is conservative. Otherwise, input data for CFX-10 is realistic.

3.1 Estimation Result by Using RATT with Conservative Data

The initial and boundary conditions, and the basic assumptions are as follows:

- The initial temperature of the air: 40°C
- Inside a pump room, a natural convection is induced by a heating from a pump's surface.
- The shapes of a room and a pump are hexahedral and the pump occupies 35% of the room volume.
- The total heat load from the pump is 157,000 Btu/hr.

The RATT cannot handle the configuration of the room in detail. Therefore, we estimated the room temperature under a conservative condition which the room is tightly shut. Table 3 shows the room temperature after 24 hours under a loss of the HVAC. Figure 1 shows the temperature change for 24 hours.

3.2 Estimation Result by Using CFX-10 with Realistic Data

The initial and boundary conditions, and the basic assumptions are as follows.

- Room Volume : 11.7348 x 6.4008 x 6.4008 m^3
- Motor volume : 1.5 x 1.6 x 1.5 m^3
- Heat source : 8327.4 W/m^3 (102,360 Btu/hr)
- Initial temperature : 35°C
- Piping, tray, Compressor, & other small structures omitted. (occupy less than 10% of total volume)
- The door is closed
- The small gaps for the penetration of the pipes and electric lines are ignored.
- Balancing windows are closed.
- Cubicle Cooler is not working.
- No light on.

Room heat up calculation by using CFX-10 was performed to consider a realistic condition of the pump room because of the RATT's limitation.

The computation has been performed for over 2 hours so far and will be continued until 24 hours after the event. Figure 2 shows the change of the volume-averaged temperature of the AFW MDP room.

4. Conclusions

The results of the AFW MDP room heat up calculation show that a loss of the HVAC can bring about a function failure of the components in the case of using the RATT with the conservative input data. Moreover, the time for the operable temperature of the components is very short.

Therefore, we performed a room heat up calculation with realistic data obtained through a plant-walkdown. The result of the comparison shows that the effect is remarkable. About 2 hours later, the averaged temperature of the pump room was almost saturated to 122°F. Therefore, if we accept these evaluation results, we can screen out the HVAC model in the PSA FT model for UCN 3&4.

Thus, we understand that it is necessary to estimate the change of the temperature of the pump rooms by considering in more detail the pump shape and condition of the pump room.

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Table 1 Operability Conditions by Category [2]

Equipment		Operable Temp. (for 4hours)
Mechanical Equipment	Pumps (Bearing, Seal)	180 °F (82.2°C) (180 °F, 200 °F)
	Valves	200 °F (93.3°C)
MOV Actuators	Limitorque	200 °F (93.3°C)
	Other	180 °F (82.2°C)
Electrical and Electronic Equipment	Cables	185 °F (85°C)
	Switches and Relays	185 °F (85°C)
Turbine Governor		160 °F (71.1°C)

Table 2 Operability Condition of the Pump Room

Pump Room	Operable temp. of comp. NUMARC87-00[2]
AFW MDP	180°F (71.1°C)
AFW TDP	160 °F (71.1°C)

Table 3 Temperature of the Rooms After 24 hours

Pump Room	Temp. of the room after 24 hour(°F) - RATT	Temp. of the room after 2 hour(°F) – CFX-10
AFW MDP (077-A11A)	205.12 (97.22°C)	122 (50 °C)

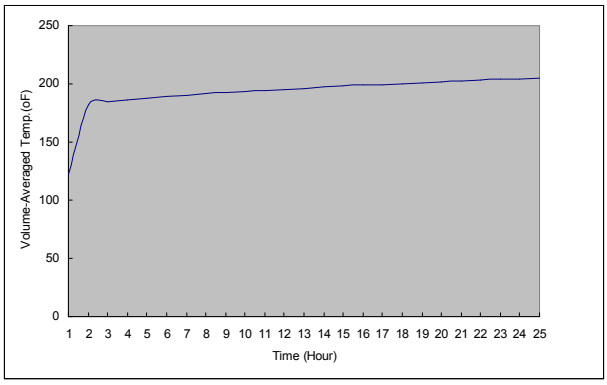

Figure 1. Temperature of the AFW MDP Room w/o HVAC Estimated with RATT (Closed-Door Case)

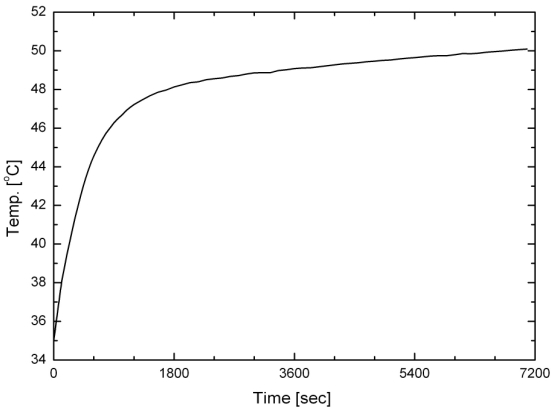

Figure 2. Temperature of the AFW MDP Room w/o HVAC Estimated with CFX-10

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