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Study on the Operating Strategy of HVAC Systems for Nuclear Decommissioning Plant

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1. Introduction

According as Kori nuclear power plant unit 1 was determined to be defueled in 2017, various studies on nuclear plant decommissioning have been performed. In nuclear decommissioning plant, HVAC systems with large fan and electric coil have to be operated for long periods of time to support various types of work from defueled phase to final dismantling phase. So, in view of safety and utility costs, their overall operating strategy need to be established prior to defueled phase. This study presents HVAC system operating strategy at each decommissioning phase, that is, defueled plant operating phase, SSCs(systems, structures, components) decontamination and dismantling phases.

2. HVAC Design Considerations for Nuclear Decommissioning Plant

In defueled plant operating phase, all fuel assemblies in reactor vessel are transferred to spent fuel pool(SFP) permanently. Therefore, areas that require the same HVAC conditions as those of power operating plant, are limited to the areas functioning SF storage and cooling, SFP water cleanup, radwaste treatment and so on. Other areas irrespective of above functioning areas can be considered as radwaste storage areas or general access areas. In decontamination phase, according to the types of decontamination work, HVAC system design bases such as temperature, humidity or air change rate and so on, for corresponding areas should be re-established. This process will be also applied to dismantling phase of components and pipings. In structure dismantling phase, HVAC system will be used only for ventilation purpose. At each phase, HVAC design bases can be re-established in consideration of design temperature ranges (Table I) and wet bulb temperature thresholds (Fig. 1) in Utility Requirements Document. Required air quantities for each area can be calculated shown as Fig. 2. In fact, required air quantities in most areas except main control room in decommissioning plant will be determined by the necessity of ALARA flow or general ventilation not by cooling or heating load in Fig. 2. Infiltration or exfiltration is considered in need of making somewhere negative or positive HVAC zone

3. HVAC System Operating Strategy for Nuclear Decommissioning Plant

During defueled plant operation more than 5 years, necessity of HVAC for reactor containment building, safety related component rooms in auxiliary building, turbine building except for SFP and related areas is very low, because most heat generating components such as reactor, steam generator and safety related pumps and heat exchangers are not in-service.

Table I: Design inside temperature ranges

Building	Design inside temp. (RH)
Occupied areas : light work(MCR, office, laboratories etc.) without special electronic equipment	73~78° F (Recommended) 65~80° F (Designed) (40~60%)
Occupied area : moderate work (shop, maintenance facilities)	65~85° F (35~60%)
Inaccessible areas (without sensitive equipment)	50~131° F (-)
Areas with infrequent inspections or maintenance activities(without sensitive electronic equipment)	According to the guideline in Fig. 1
Areas with frequent inspection or maintenance(without sensitive electronic equipment)	50~104° F (-)
Areas with electronic equipment	65~85° F (manufacturer requirements)

Therefore, HVAC operating strategy in this period is necessary to be established in view of economy. But, though the required air quantity is drastically reduced, introduction of new HVAC components with reduced capacity has little advantages because of its cost and difficulty in adjusting air quantity at each HVAC ductwork. Therefore, reduction of the operating system trains is worthy of reviewing as a practical option.

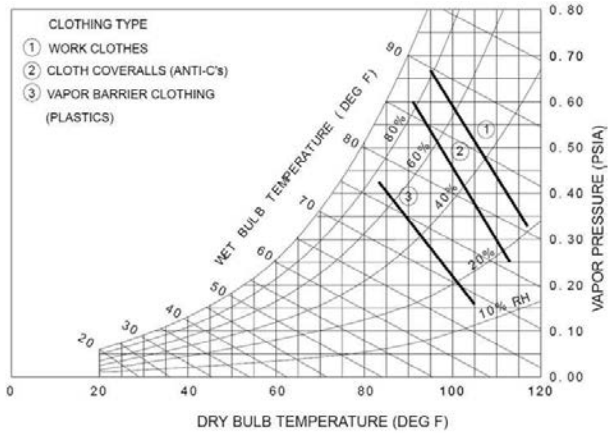

Fig. 1. Wet bulb globe temperature thresholds

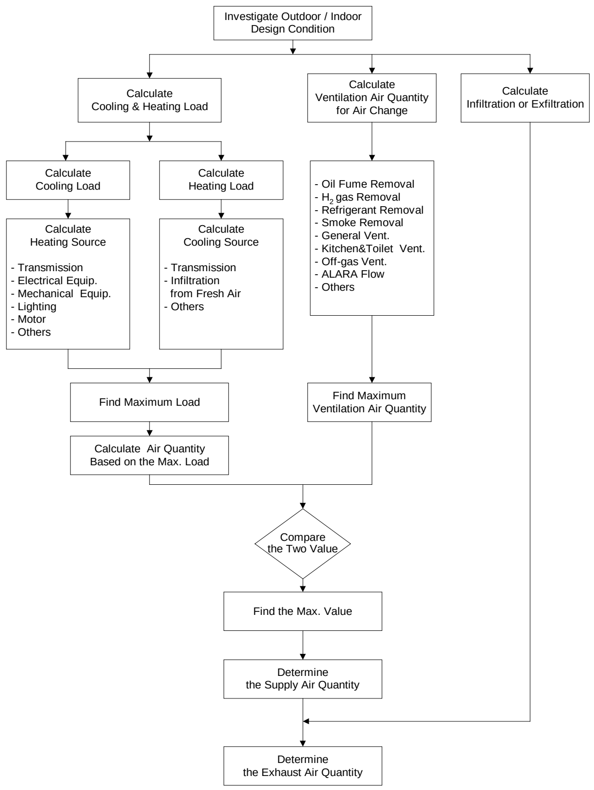

Fig. 2. Determination process of required air quantity in nuclear facility

And, based on the result of accident analyses for defueled plant such as spent fuel handling accident and so on, the radiation control requirements of 10 CFR 50 Appendix A, criterion 19, to permit access and occupancy of the control room following accident conditions may not be required. According to theses results, MCR environmental conditions can be mitigated to the level of general office. And, MCR sub-systems preparing for emergency condition such as emergency charcoal recirculation system may not be necessary and associated SSCs can be downgraded. In similar approach, design bases for other areas should be also changed in comparison with those of normal operation. In decontamination or dismantling phases, according to the types of decontamination(or dismantling) work, HVAC systems not in-service in defueled period may be re-operated, if necessary, temporary HVAC systems may be provided according to the revised design bases.

4. Conclusion

In defueled plant operation phase, reduction of the operating system trains is more practicable than the introduction of new HVAC components with reduced capacity. And, based on the result of the accident analyses for this phase, HVAC design bases such as MCR habitability requirement can be mitigated. According to these results, associated SSCs also can be downgraded. In similar approach, at each phase of plant decommissioning, proper inside design conditions and operating strategies should be re-established. Furthermore, from the design phase for new nuclear plant, design concept in preparation of plant decommissioning need to be incorporated in its design such as constitution of independent SFP area HVAC system or general arrangement of related equipment.

REFERENCES

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