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Dear Ed:

Enclosed, in accordance with your request, is information concerning HVAC for electrical equipment rooms and treatment of instrument air loss as an initiating event in the Zion IPE. Information regarding the flooding analysis will be forthcoming.

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**HVAC for Electrical Equipment Rooms**

The attached pages (Attachment A) from the electric power notebook show that room ventilation was considered, and a decision was made to exclude such failures from fault trees. Engineering judgment was used to justify this decision. Beyond what was written in the notebook, the following reasoning was employed:

1. The principal heat source in switchgear rooms is the 4kV/480V transformer, and each room is fairly large. It was judged that the pump rooms have a larger heat source (pump motor and piping) in a much smaller room. This thinking is supported by the fact that large self-contained recirculation cooling units were provided in ECCS pump cubicles, but that flow of fresh air is all that is installed in switchgear rooms. A heat-up analysis for the most limiting pump cubicle showed that temperatures remained acceptably low without room cooling. Therefore, it was judged that all other pump cubicles would not require room cooling. With their larger size and smaller heat load, it was expected that switchgear rooms would be even less of a problem.

2. Switchgear room ventilation has been very, very reliable at Zion. The only such room that has periodic problems is the rod-drive MG set room. (On those hot days, the problems is easily solved by opening the doors to the room.) Therefore, component failure due to loss of ventilation was judged to be a small contributor compared to other causes of failure, such as spurious opening of breakers.

3. Switchgear for each of the three safety-related divisions is in its own room, with its own ventilation system.

4. The Equipment Attendant, as part of his rounds, goes in each switchgear room at least once per shift, so that ventilation failures prior to an initiator would be detected. Furthermore, temperature alarms are available in the control room for each room.

5. After any initiator, standard practice is for Equipment Attendants and Equipment Operators to be dispatched to periodically monitor their respective equipment, if it is operating. Upon detection of high temperatures, the room doors could be propped open. Portable fans could also be installed. In the event of loss of offsite power, the fire birigade's smoke exhaust fans, which do not require external AC power, could be used.

6. Loss of ventilation to an essential switchgear room during normal operation would not cause a plant trip, because breakers and respective buses for such equipment as reactor coolant pumps are located in the non-essential switchgear room. Problems with switchgear room ventilation have not caused plant trips at Zion.

Rather than spending considerable resources attempting to quantify what was expected to be a negligible contibutor, it was decided to omit ventilation failures from the electric power fault trees.

Loss of Instrument Air, as an Initiating Event

This elimination was based on some engineering judgments that could have been better recorded in the Initiating Events Notebook. The first issue is whether loss of IA should be a special initiator--one that would cause a plant trip and would also disable important plant equipment. Page 23 (attached, and labeled as Attachment B) of the Initiating Events Notebook discusses some reasons why Loss of IA was not included as a special initiator. A more thorough examination was done than is suggested by those words. Specifically, system descriptions and Abnormal Operating Procedure AOP-3.3 were reviewed, and this revealed that, besides causing a plant trip, the significant effects on the reactor are to isolate letdown, isolate the normal charging path, and isolate pressurizer spray. Charging through the seal injection lines continues, but this results in a slow increase in pressurizer level. The AOP directs charging pumps to be turned on and off, as necessary, to control pressurizer level. Similarly, normal operation of pressurizer heaters, coupled with pressurizer PORV operation only as a backup, can be used to control pressurizer pressure, despite the loss of pressurizer spray. This is described well in the procedure and it is a simple operation. Therefore, it was concluded that loss of instrument air did not merit inclusion as a special initiator. The second issue concerns frequency of Loss of Instrument Air. Zion has no history of trips due to loss of instrument air, and so it was felt that inclusion of instrument air losses could not significantly affect the transient event frequency. Finally, instrument air pressure can be easily recovered via local operation of a manual cross-tie valve to the independent (and diverse) service air system. Instrument air problems are dominated by compressor trips and air dryer problems. For these events, a trip would occur only if there was delay in opening the cross-tie valve. While such a delay might cause a trip, it would not result in sustained loss of instrument air header pressure. For all of these reasons, it was judged that not modeling loss-of-instrument-air scenarios would make essentially no difference in the results of the PRA.

ATTACHMENT A

terminals to the primary windings of the main transformer, it is not used for cooling the plant 4 KV and 480 V ESF buses.

Room Cooling and Ventilation

Room ventilation and HVAC systems also support electric power system operation by removing the heat produced by the systems in the room and by providing the ambient temperature needed by the systems and their controls for reliable operation. Ventilation fans and air handling units typically require 480V power for operation. The dedicated rooms for the electric power system are the auxiliary electric equipment rooms, ESF and non-ESF switchgear rooms, diesel generator rooms, diesel fuel oil storage tank rooms, and battery rooms.

The auxiliary electric equipment rooms are served by a two train HVAC system which operates on a year round basis to maintain an environment suitable for personnel comfort, health, and safety. This system also serves the computer room, offices, cold and process laboratories, battery rooms, the cable room, and the decontamination room. The two-train system includes two return air fans, two air handling units, two refrigeration units, and mixing boxes for outside air and temperature control. Each air handling unit is equipped with supply filters, cooling and heating coils, a humidifier, and a vane axial fan. The system maintains a constant temperature of 75°F in the rooms at a relative humidity of approximately 40 percent. Normally, only one air handling unit operates. In the event of loss of offsite power, or high radiation, rooms other than the auxiliary electric equipment room are shut off from the supply of conditioned air, and the system shifts to operating on a 100 percent recirculation basis.

Each ESF switchgear room at the 617 ft level has its own ventilation supply fan rated at 10,500 cfm. Each non-ESF switchgear room at the 642 ft level is provided with two 50 percent capacity ventilation supply fans rated at 6,000 cfm. The supply fans provide outside air to the rooms, and the air intakes for the fans are equipped with fire dampers. The air is discharged from the rooms into the turbine building after passing through fire dampers. Each switchgear room ventilation system is designed to limit the maximum room ambient temperature to 105°F.

The ESF switchgear rooms contain four of the twelve motor control centers for each unit. The remaining eight motor control centers are located in the auxiliary building and the crib house, as described in Section 2.5 of this notebook. The motor control centers are cooled by natural convection.

Each diesel generator room has a dedicated ventilation supply fan rated at 70,000 cfm and driven by a 50 HP motor. The fans take suction from the common outside air plenum that also serves the switchgear room ventilation fans. The suction line to each fan is equipped with an inlet modulating damper which automatically adjusts the flow of air in response to a signal provided by the room thermostat. (The switchgear rooms have similar temperature control systems.) When a diesel is started, the ventilation fan starts automatically and the inlet and outlet dampers both open. The outlet damper exhausts the room air to the turbine building. If the fire protection system activates in either the diesel generator room or in the ESF switchgear room which houses the bus that the diesel supplies, both ventilation systems will automatically shut down. The diesel generator room ventilation systems are designed to limit the maximum room ambient temperature to 115°F.

Each diesel oil storage tank room has two 100 percent capacity room exhaust fans rated at 6,000 cfm. The system is designed to prevent the accumulation of flammable or toxic fumes. One fan normally operates with the other fan in standby. The fan draws air through an intake equipped with a fire damper and exhausts the air to the outside. A relief damper admits ambient air from the turbine building into the diesel oil storage tank room.

The auxiliary building HVAC system serves all areas of the building, including the areas where the auxiliary building motor control centers are located. The system is common for both units and consists of a supply system and an exhaust system. The supply system is equipped with three 50 percent capacity fans, each having a rated flow of 300,000 cfm. Air is drawn in from the outside by the supply fans, is passed through filter banks, a heating coil, and a cooling coil, and is distributed to the main areas of the auxiliary building. Six auxiliary building exhaust fans send the filtered auxiliary building exhaust air to two vent stacks for discharge to the outside.

The crib house room where four motor control centers are located is ventilated by the service water pump area ventilation system. This system consists of a north train and a south train, each equipped with three 25 percent capacity ventilation fans rated at 37,500 cfm. Outside air is drawn in, mixed with recirculated air, and discharged by the ventilation fans to the service water pump motor area.

Table 2 describes the support systems for each major component of the electrical power systems. The term "supply" in this table is used in a general sense to denote a source of cooling water supply or an electric power supply. For each entry in the table involving electrical support, the table indicates the particular bus or motor control center where the circuit breaker feeding the component is located.

Support Systems for Diesel Generators

The diesel generators require cooling from the service water system, DC power for control, operation, and loading of the diesels, and 480 VAC power for the operation of auxiliary motors and pumps. Two service water lines provide cooling water for buses to the opposite unit. The manual connection of the Unit 1 ESF buses to Unit 2 Bus 241 is considered in the case of loss of offsite power at Unit 1. A human error probability for failure to perform the manual restoration is included in the fault trees.

11. A proposed modification of the cross tie system which adds a cross tie to be used when the common diesel generator is being overhauled is not considered in the electric power system fault trees.

12. A total loss of offsite power is assumed to be a simultaneous occurrence at both units. For this event, the analysis assumes that the common diesel automatically connects to Bus 147. Although the common diesel might be equally likely to automatically connect to Unit 2 Bus 247, it is assumed that the diesel would be manually reconnected to Bus 147 if an accident sequence was occurring in Unit 1. A Unit 1 SI signal would automatically reconnect the common diesel to Bus 147.

13. It is assumed that the loss of the room ventilation system for a diesel generator or fuel storage tank has no impact on the operation of the system during the required mission time, and therefore failures of the ventilation system are not included in the fault trees. The diesel itself can operate in high ambient temperatures as it has its own cooling water system. The diesel controls are designed to operate in ambient temperatures up to 115°F. If the diesel room ventilation system does not start when the diesel starts and loads, plant personnel can use portable ventilation equipment in the room while the ventilation fan is being repaired. Due to this ability to manage and control the temperature excursion in the room, a failed ventilation fan is not included in the fault tree and is not treated as a contributor to diesel failure. The determination

that diesel room ventilation failure need not be modeled is further supported by past experience in which a diesel at the Zion site operated successfully for 24 hours with the ventilation system dampers closed.

14. Failures of room cooling or ventilation systems in switchgear rooms where 4 KV buses, 480 V buses,and motor control centers are located are not included in the fault trees in accordance with Guideline b for electrical system random faults. It is assumed that the impact of loss of the switchgear room ventilation systems can be managed and controlled by the use of portable ventilation equipment.

15. Modeling of the dependence of motor control centers in the auxiliary building on ventilation system operation is not included in the electrical power system models. These motor control centers are located in large open areas which are ventilated by a system having three 50 percent capacity ESF-powered supply fans and numerous exhaust fans. The loss of the three intake fans for any appreciable length of time is considered a very low probability scenario. Furthermore, common cause failure of these MCCs, to be modeled in the fault trees, covers environmentally induced failures of this type.

16. Modeling of the dependence of motor control centers in the crib house on ventilation system operation is not included in the electrical power system models. The ventilation system that serves the crib house where the service water pumps are located consists of six 25 percent capacity fans arranged in two trains of three fans each. The fans of the North train are powered by three Unit 1 MCCs and the fans of the South train are powered by three Unit 2 MCCs. Given the redundancy and diversity of the ventilation system and the large open area in which the motor control

of power available at the 4 KV ESF support bus times the unavailability contributed by the system that feeds the power from the 4 KV bus to the 480 V bus. The 480 V ESF fault trees are developed as modules (small fault trees) which are designed to be consistent with the 4 KV ESF bus trees and the support state model. These modules contain the component failures downstream of the 4 KV ESF bus, including transformer failure, circuit breaker spurious opening, and 480 V bus failure.

2. Unavailability of power at the critical motor control centers is modeled in module form. These modules have a basic form similar to the modules constructed for the 480 V ESF Buses (Assumption 1 above) except that additional component failures (downstream of the 480 V bus) are included.

3. Failures of room cooling or ventilation systems in switchgear rooms where 480 V substation transformers and ESF buses are located are not included in the fault trees in accordance with Guideline b for electrical system random faults. Assumption No. 14 for the 4160 V AC system gives the justification of this assumption.

4. In accordance with the Zion Station Technical Specifications, component maintenance outages are credible events during normal plant operation for the following 480 V system components:

   a) 480 V Substation Transformers
   b) 480 V ESF Buses and Breakers
   c) 480 V Motor Control Centers and Breakers

8. Equalization of the DC batteries is assumed to be performed or initiated only when offsite power is available.

9. It is assumed that the loss of the ventilation system in the battery room has no impact on the operation of the system during the required mission time. This is based on the facts that the batteries themselves produce little heat and the ventilation system is intended primarily to remove hydrogen. According to the Zion site, the main effect of elevated room temperatures is to accelerate aging of the batteries. However, a short term loss of ventilation is assumed to have a minimal effect on aging and therefore is not a concern. The fault trees include common cause failure of batteries which accounts for environmentally induced failures of this type.

10. It is assumed that the loss of the ventilation and air conditioning system in the aux. electric equipment rooms has no impact on the operation of the battery chargers or other DC components during the required mission time.

    This assumption is based on the fact that if the ventilation system is lost, the temperature excursion in the room can be managed and controlled by portable ventilation equipment. The DC fault trees account for environmentally-induced failures of this type by including common cause failures of the battery chargers and DC distribution panel circuit breakers.

11. Maintenance of a DC battery charger or battery can occur during plant operation. Equalization of a battery is a regular preventive maintenance act performed four times per year. Other battery or charger maintenances are assumed to be infrequent corrective events caused by failure or

ATTACHMENT B

In order to identify the special initiating events for Zion, the system drawings, abnormal operating procedures, and FSAR were reviewed. The special initiators identified for Zion are: loss of component cooling water, loss of service water, and loss of a DC bus. The special initiators are discussed below and quantified in Section 4.5.

Loss of heating, ventilation, and air conditioning (HVAC) systems and loss of instrument air have not been included as initiating events. The HVAC systems at Zion are independent systems, serving one component, each with their own power supply connections and cooling system connections. Loss of HVAC systems at Zion were investigated in the Equipment Survivability Notebook (Reference 21). Where HVAC was found to be important to specific equipment, it was analyzed in the system model. Loss of instrument air has been found to cause no serious degradation of the Zion safety systems. The air operator on the pressurizer PORVs are each supplied by a dedicated air accumulator which permits the valve to cycle several times after loss of air pressure in the supply header. The ARVs are air-operated valves with a manual override and are to be manually operated if air is lost to their air operator. Other air operated valves on safety systems fail safe (in support of safe shutdown) in the event of instrument air failure.

Losses of vital AC and DC buses were reviewed for applicability as special initiators. The Loss of One 125 VDC Bus 111 is identified as a special initiator. The impact of loss of a vital AC bus was reviewed and no events could be identified which would result in a reactor trip or LOCA and disable or degrade the performance of the accident prevention systems. This is attributed to the three separate AC buses at Zion which are utilized during accident prevention.