ML16092A029

Technical Paper on Loss of AC Bus Initiator for RBS

Background

The NRC has sent RBS an Inspection Report (EA-15-140 dated February 16, 2016). This inspection report refers to use of a SPAR model for RBS used by the NRC in performing their risk analysis. This SPAR model has a Loss of 4KV Bus initiating event whereas the RBS plant specific PRA model does not have this Loss of 4KV Bus as an initiator. The objective of this paper is to investigate this difference and develop and provide a basis for Entergy's position on this issue as part of the HVC/HVK regulatory conference scheduled with the NRC on April 3, 2016.

Discussion

RBS IPE

Attachment 1 has the Table of initiators modeled in the RBS IPE model. Per the Report EA-RA-91-0004-MP, rev 0, Pages 63 and 64, the Loss of AC Bus initiator was considered but not included in the model as a review of bus loads indicated that it does not cause a plant scram. However, the plant would have to proceed to a manual shutdown either on loss of drywell cooling or Tech Spec LCO entry within 8 hours.

RBS Latest Model (Rev 5)

The RBS PRA model does not model the loss of 4KV bus event as an initiator because a review of the loads impacted by the loss of these buses has been found to not cause a plant scram. This detailed review is available in Attachment 11 of the RBS Rev 4 PRA Initiating Event calculation and is reproduced in Attachment 2.

Given that GGNS has it in their Rev 4 model, a review was performed for the basis for inclusion of that event at GGNS. The loss of AC power procedure at GGNS provides clear direction to proceed to shutdown should there be a loss of a 4 KV bus. The equivalent RBS procedure does not have a similar procedural direction. This combined with the fact that at RBS a loss of 4 KV bus does not cause a plant scram is used to base the RBS PRA position that the loss of 4KV AC bus event need not be included in the RBS PRA model as a special initiator.

Other BWR/6 Info

GGNS

NUREG/CR-4550 (GGNS)

The Loss of AC bus was screened out. Basis: no plant scram found to be caused by loss of the 4KV bus initiator.

IPE

The Loss of AC bus was included based on Instrument Air isolation caused by failing the AC bus. (Since then the GGNS Instrument Air/Plant Air design has been modified so that this isolation will not occur).

Latest Model (Rev 4 Draft)

The loss of AC bus initiator is conservatively included in the model even though it no longer causes a loss of instrument air and an automatic plant scram. This is based on GGNS Procedure for "Loss of AC Power", Section 3.1 for Loss of Div 1 OR Div 2 ESF Buses (15AA OR 16AB de-energized). Step 3.1.3 in this procedure states: " IF it is obvious the affected bus CANNOT be immediately energized, THEN INITIATE a manual scram." Therefore, this event is considered conservatively to be an initiator in the GGNS Rev 4 draft PRA model (note that this model is currently undergoing closure of F&Os from the recent BWROG RG 1.200 Peer Review).

Perry

Loss of 4KV AC Bus is not in the Perry model, as it does not cause a plant scram.

Clinton

The Clinton PRA model does not have a Loss of 4KV AC Bus initiator. They do have an impact on Instrument Air from such a loss of bus as was evident from a recent plant event and they are planning to add this initiator to the model at the next periodic model revision to address this issue.

Conclusions

The RBS Plant Specific PRA Rev 5 does not model the loss of 4 KV. This is based on a detailed review of plant loads fed by the 4KV AC buses as well as the procedural directions in the AOP-0004 (loss of Offsite Power). No other procedures were found that deal with the loss of a 4KV Bus. Therefore, it is believed that the RBS PRA model appropriately treats the loss of 4KV bus event without a special initiator for it.

Attachment 1: Table with List of Initiators in RBS IPE Calculation

A	Large Loss of Coolant Accident (LOCA)	1.00E-4
S1	Intermediate LOCA	3.00E-4
S2	Small LOCA	3.00E-3
S3	Small-Small LOCA (Recirc pump seal LOCA)	3.00E-2
T1	Loss of Offsite Power Transient	0.1
T2	Transient With Loss of PCS	1.66
$T3_A$	Transient With PCS Available	4.5
$T3_B$	Loss of Feedwater Transient	0.76
$T3_C$	Inadvertent SRV Opening Transient	0.14
TB	Station Blackout - Not a Separate Initiator but a Sequence of Concern That Could Result From Other Initiators	
TDCI	Loss of DC Division I Transient	5.0E-3
TDCII	Loss of DC Division II Transient	5.0E-3
TNSW	Loss of Normal Service Water Transient	2.0E-3
TCCS	Loss of Turbine Plant Component Cooling Water Transient	2.0E-3
TCCP	Loss of Reactor Plant Component Cooling Water Transient	2.0E-3
TIAS	Loss of Instrument Air Transient	8.0E-4

Attachment 2 – Review of Loads Impacted by a Loss of 4 KV Bus Event at RBS

Table 1: Normally Running Class 1E Loads and Non-Class 1E Equipment Supplied from Class 1E Buses			
Load	Description	Class 1E Bus	Impact to Scram due to Loss of Associated Emergency AC Bus
ENB-CHGR1A	Emergency battery charger (Battery ENB-BAT01A)	ENS-SWG1A	ENB-CHGR1A is used to power safety related 125 VDC bus ENB-SWG1A and charge ENB-BAT01A. Failure of the charger would not result in an automatic scram, but would result in 2 hour shutdown LCO. If the charger is not restored within 2 hours, the plant must be in Mode 3 within 12 hours and Mode 4 within 24 hours.
ENB-CHGR1B	Emergency battery charger (Battery ENB-BAT01B)	ENS-SWG1B	ENB-CHGR1B is used to power safety related 125 VDC bus ENB-SWG1B and charge ENB-BAT01B. Failure of the charger would not result in an automatic scram, but would result in 2 hour shutdown LCO. If the charger is not restored within 2 hours, the plant must be in Mode 3 within 12 hours and Mode 4 within 24 hours.
E22-S001CGR	Emergency battery charger (Battery E22-S001BAT)	E22-S002	E22-S001CGR is used to power safety relater 125 VDC bus E22-S001 and charge E22-S001BAT. Failure of the charger would not result in an automatic scram.
HVR-UC1A	Containment Unit Cooler	ENS-SWG2A	Each containment unit cooler can remove 50% of rated heat load during normal operation. If division I power is lost, HVR-UC1C would be needed to remove the heat generated and maintain containment temperatures below 90^{o}F. If containment temperature cannot be maintained below 90^{o}F, the plant would enter an 8-hour shutdown LCO. If the temperature is not restored within 8 hours, the plant must be in Mode 3 within 12 hours and Mode 4 within 36 hours.
HVR-UC1B, HVR-UC1C	Containment Unit Coolers	ENS-SWG2B	Each containment unit cooler can remove 50% of rated heat load during normal operation. If division II power is lost, two of the three containment unit coolers would be inoperable. Therefore, the plant would enter an 8-hour LCO. If one of the two unit coolers is not restored within 8 hours, the plant must be in Mode 3 within 12 hours and Mode 4 within 36 hours.
Division I Control Building HVAC components (ACUs, Fans, AODs, Chillers)	Various equipment required to run to provide cooling to the Control Room, Switchgear Rooms, Battery Rooms, etc.	ENS-SWG1A, EHS-MCC14A	Each Control building HVAC subsystem can remove 100% of the rated heat load during normal operation. Each HVK Chiller can remove 100% of rated heat load. Therefore, failure of the Division I HVC/HVK system would not impact power operation as long as the area temperatures remain below the setpoints in TR 3.7.10.
Division II Control Building HVAC components (ACUs, Fans,	Various equipment required to run to provide cooling to the Control Room, Switchgear Rooms, Battery Rooms, etc.	EJS-SWG1B, EHS-MCC14B	Each Control building HVAC subsystem can remove 100% of the rated heat load during normal operation. Each HVK Chiller can remove 100% of rated heat load. Therefore, failure of the Division II HVC/HVK system would not impact power operation as long as the area temperatures remain below

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AODs, Chillers)			the setpoints in TR 3.7.10.
BYS-CHGR1A	Normal battery charger (Battery BYS-BAT01A)	EJS-SWG1A	BYS-CHGR1A is used to power non-safety related 125 VDC bus BYS-SWG1A and charge BYS-BAT01A. The batteries have a 2550 amp-hour rating and can supply to the bus for at least 2 hours. Backup charger BYS-CHGR1D can be used to supply power to the bus if this charger failed. No scram would occur due to loss of the normal battery charger
BYS-CHGR1B	Normal battery charger (Battery BYS-BAT01B)	ENS-SWG1B	BYS-CHGR1B is used to power non-safety related 125 VDC bus BYS-SWG1B and charge BYS-BAT01B The batteries have a 2550 amp-hour rating and can supply to the bus for at least 2 hours. Backup charger BYS-CHGR1D can be used to supply power to the bus if this charger failed. No scram would occur due to loss of the normal battery charger
IHS-CHGR1D	Information handling system battery charger (battery IHS-BAT01D)	EJS-SWG2B	IHS-CHGR1D is used to power non-safety related 125 VDC bus IHS-SWG01D and charge IHS-BAT01D. The batteries have a 2550 amp-hour rating. IHS-SWG01D supplies power to IHS-INV01 which is used to power security and information handling. The primary source of power to the inverter is not lost due to loss of the emergency AC bus. Therefore, there is no impact to plant operation.
NHS-MCC101	Normal motor control center for turbine mezzanine level and auxiliary building	ENS-SWG1B	See impact due to failure of the loads listed below.
LPM-1-LPM-6 TGOP MSOP SOVP VXM MSP TGM PBM SCA-PNL101	Bearing Lift Pumps Turning gear oil pump motor H2 main seal oil pump motor H2 seal oil vacuum pump motor Vapor Extraction Tank motor Motor oil suction pump motor Turning gear motor Turning gear piggyback motor Turbine building distribution panel	NHS-MCC101	Most of these pumps are only required for startup and shutdown operations. Therefore, there is no impact due to these pump motors. The main seal oil pump would receive backup from the Emergency Booster Oil Pump (DC Driven). The EBOP is not impacted by loss of ENS-SWG1B. If H2 Seal Oil Vacuum Pump is lost, no vacuum pretreatment is available. Therefore, the generator must be supplied with clean hydrogen to maintain purity. Plant shutdown is not required.
NHS-MCC102A	Normal motor control center for auxiliary and turbine buildings	ENS-SWG2A	See impact due to failure of the loads listed below.
DRS-UC1A,C,E SLP-1	Drywell unit coolers Surveillance light	NHS-MCC102A	Drywell UCs are used for drywell heat removal during operation. Each of the drywell UCs are sized for 25% capacity. Two from each division are normally running. A total loss of one division of AC power would reduce the capacity to 50% and a low flow alarm would annunciate in the control

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			room. The operator could start the standby unit on the available division, resulting in 75% capacity. A slow heatup and pressurization of the drywell could occur. Power reduction might be needed to reduce the heat load in the drywell. However, Technical Specifications requirements for high drywell containment differential pressure (+1.2 psid) and high drywell temperature (145°F) would ultimately force a controlled shutdown before a scram would occur.
NHS-MCC102B	Normal motor control center for auxiliary and turbine buildings	ENS-SWG2B	See impact due to failure of the loads listed below.
DRS-UC1B,D,F CPP-FN1 SLP-2	Drywell unit coolers Hydrogen purge fan Surveillance light	NHS-MCC102B	Drywell UCs are used for drywell heat removal during operation. Each of the drywell UCs are sized for 25% capacity. Two from each division are normally running. A total loss of one division of AC power would reduce the capacity to 50% and a low flow alarm would annunciate in the control room. The operator could start the standby unit on the available division, resulting in 75% capacity. A slow heatup and pressurization of the drywell could occur. Power reduction might be needed to reduce the heat load in the drywell. However, Technical Specifications requirements for high drywell containment differential pressure (+1.2 psid) and high drywell temperature (145°F) would ultimately force a controlled shutdown before a scram would occur. The hydrogen purge fan is not required to operate during normal operation.
Various	Unqualified heaters furnished with Class 1E MOVs	Various 120V	MOV heaters are not required to function for the Class 1E MOVs to function.
C71-P001	RPS bus	RPS-XRC10A1	Loss of power to a RPS bus will result in a half scram and a half MSIV isolation. However, loss of a RPS bus will not result in an automatic scram unless test or maintenance activities on the other division is in process which would cause a half scram on the other division.
C71-P002	RPS bus	RPS-XRC10B1	Loss of power to a RPS bus will result in a half scram and a half MSIV isolation. However, loss of a RPS bus will not result in an automatic scram unless test or maintenance activities on the other division is in process which would cause a half scram on the other division.
IHA-PNL1	Control Building data acquisition system	EHS-MCC8A	Loss of this panel causes loss of monitoring to status of HVK chilled water pumps (A,C) and HVK flow switches (A). This would not result in a plant trip.
IHA-PNL1	Control Building data acquisition system	EHS-MCC8B	Loss of this panel causes loss of monitoring to status of HVK chilled water

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			pumps (B,D) and HVK flow switches (B).). This would not result in a plant trip.
IHA-PNL1	Control Building data acquisition system	SCV-PNL8A1	Loss of this panel causes loss of monitoring to status of HVK chilled water pumps (A,C) and HVK flow switches (A). This would not result in a plant trip.
IHA-PNL1	Control Building data acquisition system	SCV-PNL8B1	Loss of this panel causes loss of monitoring to status of HVK chilled water pumps (B,D) and HVK flow switches (B).). This would not result in a plant trip.
LAC-XLC9	Main Control Room lighting system transformer	EHS-MCC14A	To furnish 20% lighting in the main control room upon loss of non-Class 1E sources of power to remaining 80%. No impact on plant operation.
LAC-XLC9	Main Control Room lighting system transformer	EHS-MCC14B	To furnish 20% lighting in the main control room upon loss of non-Class 1E sources of power to remaining 80%. No impact on plant operation.
MHR-CRN1	Polar crane - Reactor Building	EJS-LDC2A	Used for maintenance. No impact on plant operation.
MHW-CRN2A	Monorail – Standby Cooling Tower	EHS-MCC16A	Used for maintenance. No impact on plant operation.
MHW-CRN2B	Monorail – Standby Cooling Tower	EHS-MCC16B	Used for maintenance. No impact on plant operation.
Various	Non-Class 1E slide wire transducers	Various control circuits	Valve position indication on selected RHR valves. No impact on plant operation.
Various	Non-Class 1E limit switches	Various control circuits	Valve position indication. No impact on plant operation.
SWP-P2AH	Non-Class 1E motor heater	SCV-PNL14A1	Humidity control. No impact on plant operation.
SWP-P2BH	Non-Class 1E motor heater	SCV-PNL14B1	Humidity control. No impact on plant operation.
SWP-P2CH	Non-Class 1E motor heater	SCV-PNLS002	Humidity control. No impact on plant operation.
SWP-P2DH	Non-Class 1E motor heater	SCV-PNL14B1	Humidity control. No impact on plant operation.
SWP-SOV600A	Control solenoid for SWP-AOV599	VBS-PNL01A	Energize to close valve SWP-AOV599. SWP-AOV599 closed during power operation. Valve open logic is not made.
SWP-SOV600B	Control solenoid for SWP-AOV599	VBS-PNL01A	Energize to close valve SWP-AOV599. See SWP-SOV600A
SWP-SOV601	Control solenoid for SWP-AOV599	VBS-PNL01A	Energize to open valve SWP-AOV599. See SWP-SOV600A
SWP-SOV602A	Control solenoid for SWP-AOV599	EHS-MCC16A	De-energize when Division I is not available to auto open valve SWP-AOV599. See SWP-SOV600A
SWP-SOV602B	Control solenoid for SWP-AOV599	EHS-MCC16B	De-energize when Division II is not available to auto open valve SWP-AOV599. See SWP-SOV600A
SWP-SOV602C	Control solenoid for SWP-AOV599	E22-S002	Energize when valve SWP-MOV40C is open to auto open valve SWP-AOV599. See SWP-SOV600A
RPS-PNL2B	RPS-EPA Monitoring	EHS-MCC14B	Monitoring voltage and frequency. No impact on plant scram.

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E31-TDSR608	Leak detection area ambient temperature recorder	VBS-PNL01A	Records ambient temperature in various areas of the plant and provides a high temperature alarm. No impact on plant scram.
E31-TDSR611	Leak detection area differential temperature recorder	VBS-PNL01A	Records the temperature difference between the inlet and outlet air temperature of various areas of the plant and provides an alarm on high differential temperature. No impact on plant scram.
C11-TRR018	CRD Temperature recorder	VBS-PNL01A	Records CRD temperatures and provides common high temperature alarm in the main control room. No impact on plant scram..
JRB-DRA1	Upper containment airlock	EHS-MCC2K	Access to containment. No impact to plant operation.
JRB-DRA2	Lower containment airlock	EHS-MCC8B	Access to containment. No impact to plant operation.
E31-FYN021-1 and E31-FTN021	Drywell cooler condensate drain flow transmitter	SCV-PNL2B1	Power drywell cooler condensate flow element E31-FYN021-1 and E31-FTN021. No impact on plant scram.