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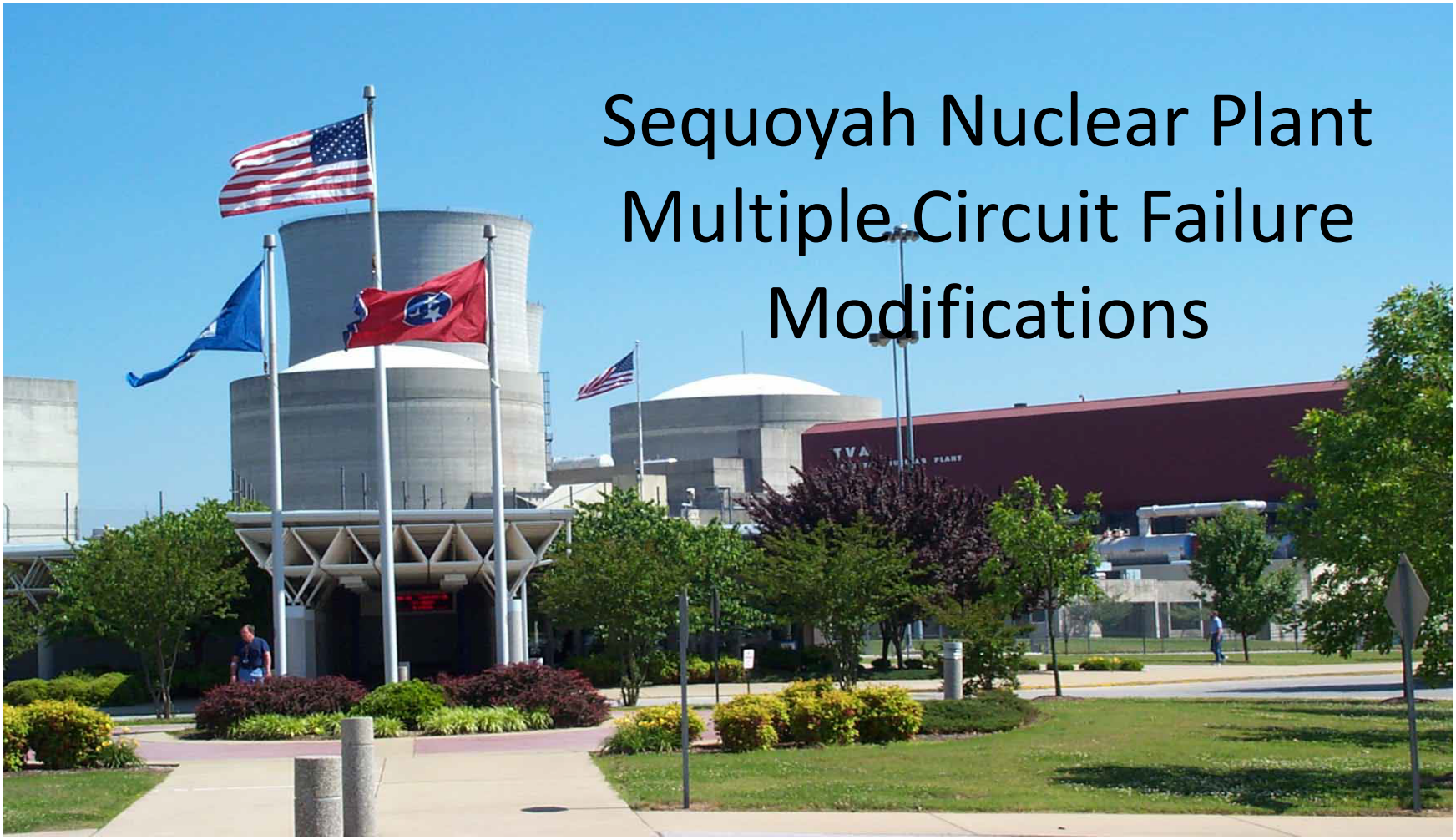


Sequoyah Nuclear Plant Multiple Circuit Failure Modifications

September 5, 2012

Agenda

• Introduction/Purpose	Joe Shea
• TVA Approach to Multiple Circuit Faults	Brenda Simril/ Joe Williams
• Resolution of Circuit Faults	Eddie Turner
• Plans Forward	Joe Shea

Purpose

- To advise the NRC of the status of TVA plans and actions to date to resolve multiple circuit fault concerns involving undesired operation of systems and components at Sequoyah Units 1 and 2.
- To advise the NRC of the timeline for completion of modifications associated with multiple circuit faults.

TVA Approach to Multiple Circuit Fault Resolution

- Performed Expert Panel Review to Identify Multiple Circuit Failure Spurious Operation (MSO) Non-Compliance Scenarios
  - Conducted in January 2010
  - Used NEI 00-01, Revision 2
  - Used Regulatory Guide 1.189, Revision 2
- Implemented Compensatory Measures
- Entered Non-Compliances Into Corrective Action Program by May 2, 2010
  - Consistent With Enforcement Guidance Memorandum 09-002

TVA Approach to Multiple Circuit Failure Resolution

- Developed Modifications to Resolve multiple circuit failure related non-compliances to:
  - Comply with Appendix R, Section III.G or current licensing basis
  - Resolve Undesired Operation of One or More Systems Or Components required for Hot Shutdown Due to Multiple Circuit Faults
  - Resolve Undesired Operation of One or More Systems Or Components important to Safe Shutdown Due to Multiple Circuit Faults
  - Reduce Non-MSO Related Operator Manual Actions

TVA Approach to Multiple Circuit Failure Resolution

- Modifications will be completed:
  - By November 2, 2012 for Unit 1
    - Two AFW valves will remain as discussed later in the presentation
  - Prior to startup from steam generator replacement outage for Unit 2. Outage begins October 15, 2012 with startup projected late December 2012

TVA Approach to Multiple Circuit Failure Resolution -Expert Panel Process

- **Step 1: MSO Expert Panel Prep**

  SQN – Complete

- **Step 2: Conduct MSO Expert Panel**

  SQN – Complete

  - Generic PWR MSO List per NEI 00-01 App G
  - Plant Specific SSD Analysis Review
  - Documentation
  - Action Item List

- **Step 3: Document Non-Compliances**

  SQN – Complete (prior to May 2, 2010)

  - Developed comprehensive plant-specific MSO list
  - Performed MSO categorization
  - Documented Expert Panel Reviews

- **Step 4: Resolve Non-Compliances**

  - SSD Analysis Revision
  - Plant Modifications

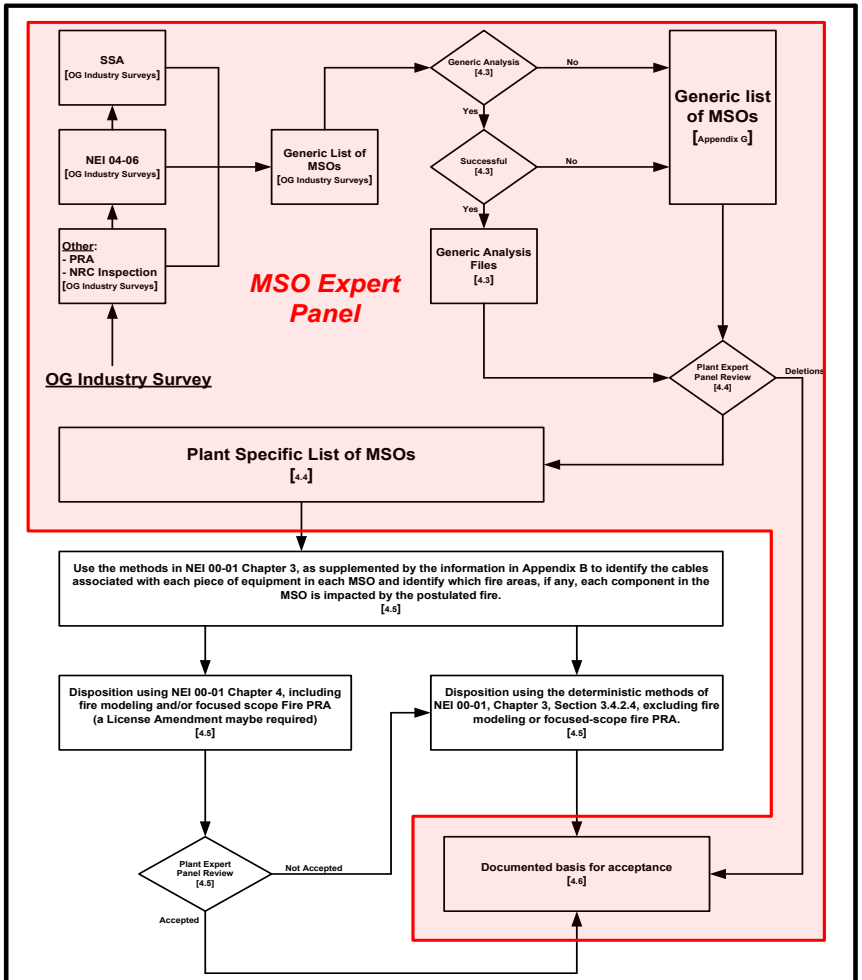


Figure 4.1 - Resolution Methodology

TVA Approach to Multiple Circuit Failure Resolution -Expert Panel Process

		SQN
Date		*Jan 5-7, 2010*
Regulatory Basis		*RG 1.189*
Team Lead TVA Corporate Fire Protection Program Manager		Brenda Simril
Industry Expert Panel Lead		Kleinsorg Group Risk Services
Industry Expert Technical Support		EPM
PRA Support TVA Corporate PRA Program Managers		Anne Robinson Mike Walker
Fire Protection Site FP Program Owner		Robert Egli
SSD Analysis Site Appendix R Analysis Expert / Electrical Support		Eddie Turner Rebecca Travis Denise Smith
SSD Procedures Site Ops Procedure Writer		Dave Porter

Resolution of Circuit Faults

Scenario 2 of Table G-2, NEI 00-01, Revision 3 (RCS Inventory Control/RCS Integrity)

- Sequoyah Specific Issue:
  - Multiple circuit failures result in spurious operation (opening) of Centrifugal Charging Pump injection tank (CCPIT) flow control valves 1,2-FCV-63-25, 26, 39, 40
    - CCPIT Valve control circuitry
    - SI signal concerns
  - Effect: Diversion of injection path results in loss of cooling to Reactor Coolant Pump (RCP) seals and possible Pressurizer (PZR) overfill
  - Affected Unit: Units 1 and 2
- Resolution:
  - Redesign control circuitry (prevent CCPIT valves from spuriously opening from control circuitry)
  - Reroute control cables and protect cables with Thermo Lag (prevent spurious Safety Injection (SI) signal from opening CCPIT valves)
  - Fuses permanently removed for Aux PZR spray valves (prevents pressure generated SI signal from occurring)
  - Reroute valve control cables and separate target conductor inside dedicated conduit (prevent spurious operation of PZR Power Operated Relief Valves (PORVs), Steam Generator (S/G) Atmospheric Relief Valves (ARVs), and Reactor Head Vent Valves (RHVVs)
  - Eliminate OMAs: Opening CCPIT valve breakers; Closing CCPIT valves from handwheel (1,2-FCV-63-39 and -40 only); Stopping Emergency Core Cooling System (ECCS) pumps

Scenario 10/11 of Table G-2, NEI 00-01, Revision 3 (RCS Inventory Control/RCS Integrity)

- Sequoyah Specific Issue:
  - Circuit failures result in spurious isolation of a single Volume Control Tank (VCT) outlet valve (LCV-062-132, 133) concurrent with spurious isolation, or failure to open, of both suction valves to the Refueling Water Storage Tank (RWST), (LCV-062-135, 136).
  - Effect: Damage to the running CCP (due to loss of suction), resulting in loss of Reactor Coolant System (RCS) make-up
  - Affected Unit: Unit 2 only
- Resolution:
  - Reroute and protect power cables using Thermo Lag which prevents multiple 480V board failures.
  - Eliminate OMAs: De-energizing RWST valve breaker; Opening RWST valve (LCV-62-136) from handwheel

Scenario 12 of Table G-2, NEI 00-01, Revision 3 (RCS Inventory Control/RCS Integrity)

- Sequoyah Specific Issue:
  - Spurious opening (or failure to close) of one or both VCT outlet valves
  - Effect : Hydrogen binding of CCP resulting in loss of CCP.
  - Affected Unit: Units 1 and 2
- Resolution:
  - Reroute cables and protect cables with Thermo Lag to ensure one VCT valve can be closed from MCR for all Fire Areas except VCT Room

Scenario 13 of Table G-2, NEI 00-01, Revision 3 (RCS Inventory Control/RCS Integrity)

- Sequoyah Specific Issue:
  - Circuit failures results in failure to close normal RCS letdown (with failure of CCS HX) and failure to close VCT isolation valves. Affected components: 1,2-FCV-062-069, -070, -072, -073, -074; 1-FCV-032-110; 2-FCV-032-111; 1,2-LCV-062-132, -133
  - Effect: Loss of RCS inventory and overheating of CCPs
  - Affected Unit: Units 1 and 2
- Resolution:
  - Reroute cables and protect cables with Thermo Lag for the VCT isolation valves (prevent CCP overheating).
  - Maintain OMA to isolate control air to normal letdown valves (to close RCS Letdown valves) to maintain RCS inventory.

Scenario 14 of Table G-2, NEI 00-01, Revision 3 (RCS Inventory Control/RCS Integrity)

- Sequoyah Specific Issue:
  - Spurious opening of Cont Sump isolation valves, including RHR and Cont Spray suction valves, (1,2-FCV-063-072, -073; 1,2-FCV-074-003, -021; 1,2-FCV-072-020, -023).
  - Effect: Loss of inventory
  - Affected Unit: Units 1 and 2
- Resolution:
  - Relocate power for FCV-74-3, -21 and FCV-72-20, -23 to 480V C&A Vent Board.
  - Redesign the valve control circuits for FCV-63-72, -73; FCV-74-3, -21; and FCV-72-20, -23.
  - Separate target conductors (MCC to MCR cable) into dedicated conduit from the other conductors going to the Control Bldg.

Scenario 15 of Table G-2, NEI 00-01, Revision 3 (RCS Inventory Control/RCS Integrity)

- Sequoyah Specific Issue:
  - Spurious start of Containment Spray Pump(s) concurrent with spurious opening of associated pump discharge valve results in transferring Refueling Water (borated water) Storage Tank (RWST/BWST) inventory to the Containment Sump
  - Effect: Loss of inventory.
  - Affected Unit: Units 1 and 2
- Resolution:
  - Remove the Diesel Generator Emergency Stop circuits from FAA-067 and FAA-081 to ensure circuit will function for fire inside 6.9KV Shutdown Board Rooms.
  - Protect Diesel Generator Emergency Stop circuits with Thermo Lag to ensure circuit will function for a fire in Fire Area FAA-054, Sections 1 & 2.
  - Protect Containment Pressure Transmitter cables with Thermo Lag.
  - After completion of the above modifications, MCR Operators will be able to de-energize the associated non-credited boards and associated D/G (i.e. MCR Operators can stop the spuriously started Containment Spray pumps).
  - Eliminate OMAs: Locally de-energizing Containment Spray Pump and closing pump discharge valves from handwheel

Scenario 16 of Table G-2, NEI 00-01, Revision 3 (RCS Inventory Control/RCS Integrity)

- Sequoyah Specific Issue:
  - Spurious start of Containment Spray Pump(s) concurrent with spurious opening of associated pump discharge valve results in transferring RWST inventory to the Containment Sump
  - Spurious start of RHR concurrent with spurious opening of RHR Spray header valve(s) results in transferring RWST inventory to the Containment Sump
  - Effect: Loss of RWST inventory
  - Affected Unit: Units 1 and 2
- Resolution:
  - See resolution of Scenario #15
  - Eliminate OMAs: in addition to OMAs resolved in Scenario #15, eliminates locally de-energizing Residual Heat Removal Pumps at the Shutdown Boards

Scenario 18/20 of Table G-2, NEI 00-01, Revision 3 (RCS Inventory Control/RCS Integrity)

- Sequoyah Specific Issue:
  - Spurious operation of PZR PORV(s) / PORV Block Valve(s) given that the associated PORV Block Valve is open
  - Spurious operation of RHVV
  - Effect: Loss of inventory
  - Affected Unit: Units 1 and 2
- Resolution:
  - Reroute valve control cables and separated target conductor inside dedicated conduit
  - Eliminate OMAs: remove RHVV fuses at Vital Battery Boards and then re-install fuses, as necessary; Place Block Valve Transfer Switch in AUX and ensure valves are Open using Handswitch at breaker

Scenario 21 of Table G-2, NEI 00-01, Revision 3 (RCS Inventory Control/RCS Integrity)

- Sequoyah Specific Issue:
  - Spurious operation of high head charging pumps and spurious opening of additional RCS make-up flowpaths
  - Effect: Loss of Inventory (water solid PZR PORV/safeties opening)
  - Affected Unit: Units 1 and 2
- Resolution:
  - See Scenario #2 for CCPIT flowpath
  - Reroute 480V cable for normal charging valve (FCV-062-090, -091). Protect a portion of control circuit for normal charging valve with Thermo Lag. Fire model survival of normal charging valve in one Fire Area (with support of cable reroute away from floor)
  - For Unit 1, the fire modeling and cable reroute will be accomplished in the next unit 1 refueling outage. The existing OMA eliminated below will be maintained until the cable reroute modification is complete.
  - Eliminate OMA: Closing Normal Charging flowpath from manual valve handwheel

Scenario 23 of Table G-2, NEI 00-01, Revision 3 (Decay Heat Removal)

- Sequoyah Specific Issue:
  - Spurious opening of Atmospheric Relief Valves (ARVs) upstream of the Main Steam Isolation Valves (MSIVs)
  - Effect: Decay heat removal – RCS overcooling
  - Affected Unit: Units 1 and 2
- Resolution:
  - Redesign and reroute cable for S/G ARV solenoid, Pressure Indicating Switch (PIS), controller control circuits to prevent spurious operation of ARVs.
  - Reroute solenoid target cables in dedicated conduit. Reroute PIS and controller cables in Fire Areas such that they will not impact Fire Safe Shutdown strategy for SI signal (e.g., CCPIT Valves and ECCS Pumps)

Scenario 27 of Table G-2, NEI 00-01, Revision 3 (Decay Heat Removal)

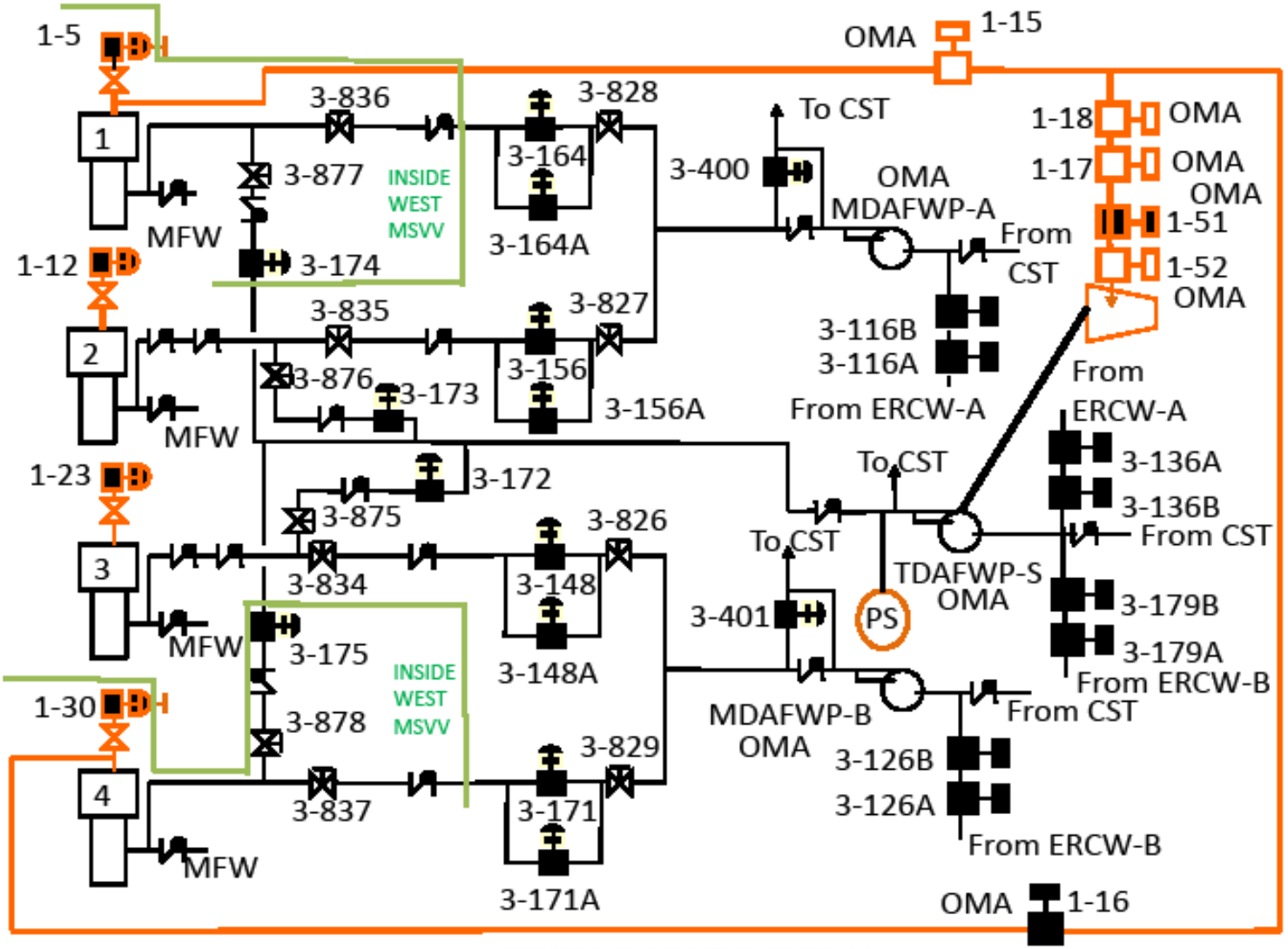
- Sequoyah Specific Issue:
  - Spurious operation/failure to operate active steam supply valves which fail the Turbine Driven (TD) Auxiliary Feedwater (AFW) Pump
  - Effect: TDAFW Pump fails (Challenges secondary side heat removal)
  - Affected Unit: Units 1 and 2
- Resolution:
  - Currently, only S/G 1 and 4 allow local control of the ARV. Thus both Motor Driven (MD) AFW Pumps must be credited in all fire scenarios crediting the MDAFW Pumps.
  - Modifications to utilize Station Blackout compressed air bottles and install air controlled station with 3-way pneumatic valve to allow local control of ARV on S/Gs #2 and #3 (1,2-PCV-1-12, -23). This provides flexibility by only requiring a single MDAFW Pump to be credited for secondary side decay heat removal for most Fire Areas.
  - Eliminated numerous OMAs associated with steam supply valves for TDAFW Pump (1,2-FCV-1-15, -16, -17, -18, -51).
  - Reroute affected cables to ensure the TDAFW Pump, when credited in Fire Hazards Analysis (FHA) (i.e. when MDAFW Pumps are in Fire Area), can be operated from the Main Control Room (MCR).

Scenario 28 of Table G-2, NEI 00-01, Revision 3 (Decay Heat Removal)

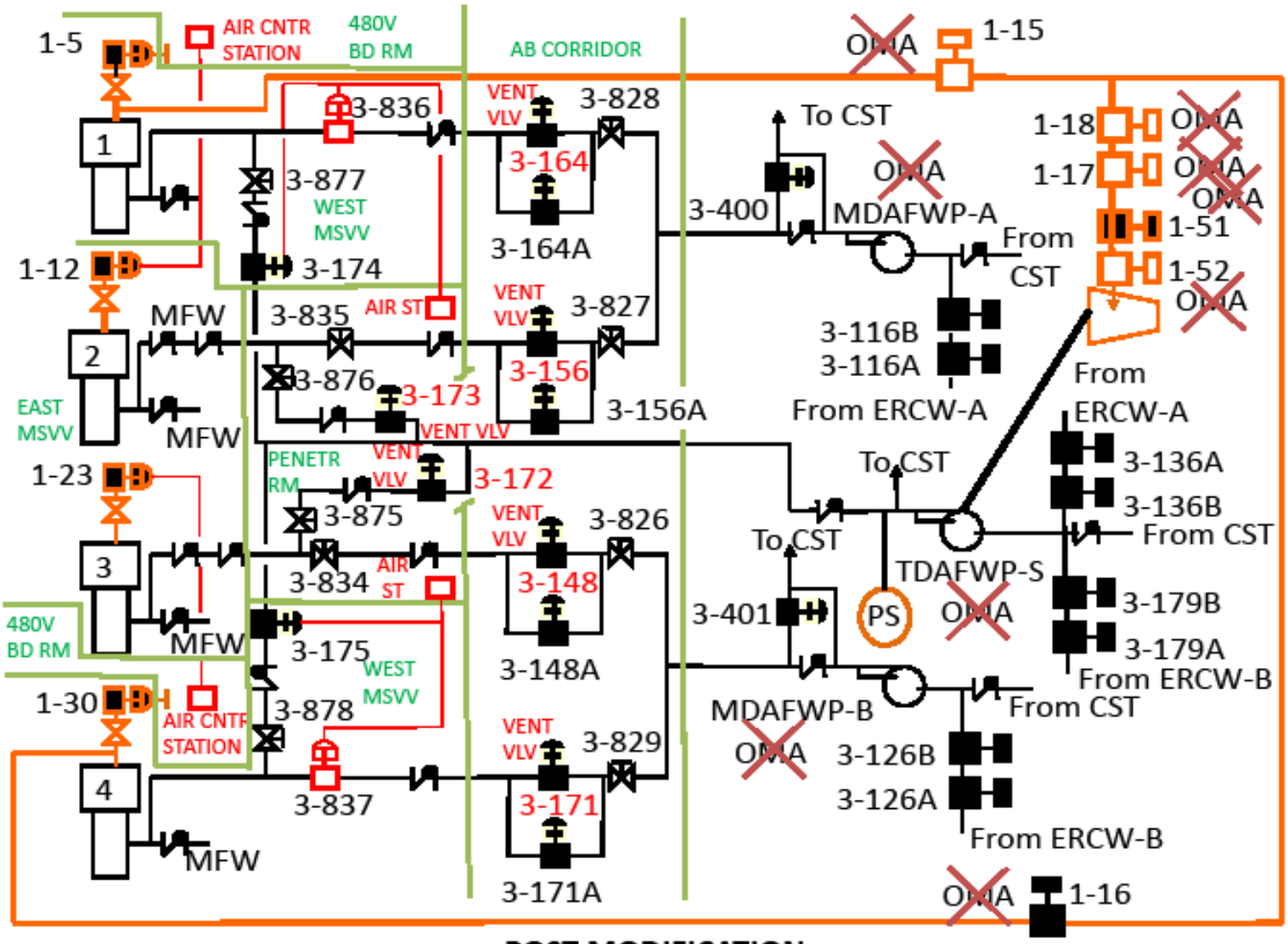
- Sequoyah Specific Issue:
  - Multiple circuit failures result in spurious closure of multiple valves in AFW pump discharge flow path.
  - Effect: Flow is lost to multiple S/Gs resulting in a challenge to decay heat removal
  - Affected Unit: Units 1 and 2
- Resolution:
  - Reroute cables to ensure at least one of the three AFW pumps can be operated from the MCR for a fire in every Fire Area outside the Control Bldg.
  - Install air control stations and 3-way vent valves (for 1,2-LCV-3-174, -175) to provide a local means of throttling TDAFW flow to S/G 1 and 4 without entering the Main Steam Valve Vault (eliminates OMAs on manual valves 1,2-VLV-3-877, -878 which are in the Main Steam Valve Vault).
  - Install air control stations and replace manual valve (1,2-VLV-3-836, -837) with air operated valve to provide a local means of throttling MDAFW flow to S/G 1 and 4 without entering the Main Steam Valve Vault.

Scenario 29 of Table G-2, NEI 00-01, Revision 3 (Decay Heat Removal)

- Sequoyah Specific Issue:
  - Multiple circuit failures result in spurious closure of steam supply valves to TDAFW Pump and spurious isolation of AFW Pump discharge flow path
  - Effect: Flow is lost to multiple S/Gs resulting in a challenge to decay heat removal
  - Affected Unit: Units 1 and 2
- Resolution:
  - See Scenario #27 for steam supply valves.
  - See Scenario #28 for AFW Pump discharge valves.



EXISTING CONFIGURATION



POST MODIFICATION

Scenario 36 of Table G-2, NEI 00-01, Revision 3 (RCS Pressure Control)

- Sequoyah Specific Issue:
  - Spurious operation of the Auxiliary PZR spray valve concurrent with spurious closure of normal charging air operated valve.
  - Effect: Loss of pressure control
  - Affected Unit: Units 1 and 2
- Resolution:
  - Permanently remove fuses for Auxiliary PZR spray valves

Scenario 37 of Table G-2, NEI 00-01, Revision 3 (RCS Pressure Control)

- Sequoyah Specific Issue:
  - Spurious operation of multiple PZR heaters and failure of PZR Spray (or Auxiliary Spray)
  - Effect: Loss of pressure control
  - Affected Unit: Units 1 and 2
- Resolution:
  - Modify the Diesel Generator Emergency Stop circuit to ensure circuit can be credited inside 6.9KV Shutdown Board Rooms and Fire Area FAA-054, Sections 1 & 2
  - Trip RCPs from MCR during spurious operation of normal PZR spray valve
  - Permanently remove fuses for Auxiliary PZR spray valves
  - Eliminate OMAs: De-energize PZR Heater breakers from the Shutdown Boards and Distribution Panels

Scenario 38 of Table G-2, NEI 00-01, Revision 3 (Reactivity Control)

- Sequoyah Specific Issue:
  - Inadvertent injection of undiluted makeup water / inadvertent injection of makeup water with very low boron concentration to VCT
  - Effect: Reactivity control
  - Affected Unit: Units 1 and 2
- Resolution:
  - Performed evaluation that showed that reactivity change due to injection of unborated water is insignificant during the first 5 minutes, and VCT valves can be isolated from the MCR within this duration.
  - Reroute cable and protect cable with Thermo Lag to ensure VCT valves can be closed from the MCR for Fire Areas where VCT blender valve can be spurious actuated

Scenario 41 of Table G-2, NEI 00-01, Revision 3 (Support Functions)

- Sequoyah Specific Issue:
  - Spurious loss of Component Cooling Water (CCS) to individual critical loads
  - Effect: Failure of cooling to Safe Shutdown (SSD) loads
  - Affected Unit: Units 1 and 2
- Resolution:
  - Redesign circuit and reroute cables to prevent spurious operation (closure) of FCV-67-146 (ERCW to CCS HX) to prevent loss of CCS to individual critical loads
  - Redesign circuit and reroute cable of CCS pumps to ensure CCS Train A Header is always available to Seal Water HX
  - Reroute cable of 1-FCV-062-61 to allow seal return line to be isolated from the MCR when ERCW is not available to Train A CCS HX

Scenario 49 of Table G-2, NEI 00-01, Revision 3 (Support Functions)

- Sequoyah Specific Issue:
  - Non-synchronous paralleling of emergency D/Gs (EDGs) with onsite and offsite sources through spurious circuit breaker operations
  - Effect: Loss of EDG, Loss of Offsite Power
  - Affected Unit: Units 1 and 2
- Resolution:
  - Redesign feeder breaker circuitry in the auxiliary control room to eliminate spurious potential.
  - Eliminates 4 OMAs associated with restoring offsite power to 6.9kV Shutdown Boards.

Scenario 55 of Table G-2, NEI 00-01, Revision 3 (Other Scenarios)

- Sequoyah Specific Issue:
  - Single spurious motor operated valve (MOV) with fire induced failure of torque and/or limit switches.
  - Effect: Valve damage resulting in inability to operate (or valve failure), Loss of AFW suction
  - Affected Unit: Units 1 and 2
- Resolution:
  - Redesign valve circuit to prevent stall condition such that operation by handwheel is possible when required (2-FCV-3-116A, -116B; 1-FCV-3-126A, -126B; 1,2-FCV-3-136A, -136B).

Scenario 56f of Table G-2, NEI 00-01, Revision 3 (Other Scenarios)

- Sequoyah Specific Issue:
  - Spurious Recirculation Actuation Signal (RAS) starting and aligning RHR and Containment Spray pumps to a dry Containment Sump.
  - Effect: Pump damage
  - Affected Unit: Units 1 and 2
- Resolution:
  - Protect SI signal cables with Thermo Lag where RWST and Containment Sump Level instrumentation cables are located inside same Fire Area that could cause a spurious automatic swap to Sump valve suction

Path Forward

- Complete modifications for Unit 1 by November 2, 2012 with two AFW valves remaining as discussed previously in the presentation
- Complete modifications for Unit 2 prior to startup from steam generator outage (projected late December 2012)
- Perform confirmatory review/evaluation of Fire Protection Program Change Regulatory Reviews