UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
1600 E LAMAR BLVD
ARLINGTON, TX 76011-4511

May 9, 2014

EA 14-008

Jeremy Browning, Site Vice President
Arkansas Nuclear One
Entergy Operations, Inc.
1448 SR 333
Russellville, AR 72802-0967

SUBJECT: SUMMARY OF REGULATORY CONFERENCE TO DISCUSS SAFETY SIGNIFICANCE OF ARKANSAS NUCLEAR ONE UNIT 1 DROPPED STATOR

Dear Mr. Browning:

On May 1, 2014, members of the U.S. Nuclear Regulatory Commission (NRC) staff met with representatives of the Arkansas Nuclear One facility to discuss the apparent violation affecting both units related to the drop of the Unit 1 main generator stator as documented in NRC Inspection Report 05000313;368/2013012, issued on March 24, 2014 (ML14083A409). The focus of the regulatory conference was a discussion on the safety significance of the finding. The discussion included Unit 1 mitigating actions focusing on the use of temporary power to recover the electrical buses and Unit 2 procedural electrical power recovery actions.

For Unit 1, three non-proceduralized and non-engineered success paths associated with recovery of electrical power were discussed, with the variation of Success Path 1 being actually used, after the event, to restore power to the vital buses within 6 days. Your staff indicated that this power was available for use within 4.4 days and could have been used in an emergency. The delay on re-energizing the vital buses with offsite power was based on completing and approving the engineering, installation, and operating procedures documentation. The three success paths all had estimated times to being available to re-energize the electrical buses of 60 hours or less. This information was discussed during your presentation on Slides 15 – 35. Your staff also discussed other recovery actions. Based on credit for the recovery options, your staff estimated the conditional core damage probability of 5.5E-6.

For Unit 2, the focus was on procedurally directed electrical power recovery strategies. This information was discussed during your presentation on Slides 81 – 86. Based on these recovery options, your staff estimated the conditional core damage probability of 1.8E-6.

The NRC staff asked questions during the Regulatory Conference, with some questions requiring additional information that you indicated you would supply to us by Friday, May 9. The NRC will continue to review the information that you provided during the Regulatory Conference and the subsequent information that was requested in order to reach a final significance determination. We are developing our final risk significance and will issue a final significance determination letter in June.

A copy of your presentation slides is included as Enclosure 1. Copies of the NRC slides (Enclosure 2) and meeting attendance (Enclosures 3 and 4) are included.

This regulatory conference was transcribed, and a copy of the transcription will be made available and placed into the NRC's Agencywide Documents Access and Management System (ADAMS). This Category 1 public meeting was attended by 52 members of the public, both telephonically and in the Region IV office.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter and its enclosures will be available electronically for public inspection in the NRC's Public Document Room or from the Publicly Available Records (PARS) component of the NRC's ADAMS. ADAMS is accessible from the NRC web site at http://www.nrc.gov/reading-rm/adams.html (The Public Electronic Reading Room).

Sincerely,

***/RA/***

Gregory E. Werner, Chief
Project Branch E
Division of Reactor Projects

Docket Nos.: 50-313, 50-368
License Nos.: DPR-51, NPF-6

Enclosures:
1. ANO Presentation Slides
2. NRC Slides
3. Meeting Attendance at Region IV
4. Meeting Attendance by Phone

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| SUNSI Rev Compl. | ☑Yes ☐ No | ADAMS | ☑Yes ☐ No | Reviewer Initials | JFM1 |
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| 5/7/14 | 5/8/14 | | | | |

OFFICIAL RECORD COPY

# Arkansas Nuclear One Regulatory Conference Stator Drop

May 1, 2014



Enclosure 1

# Opening Comments

Jeremy Browning
ANO Site Vice-President



Enclosure 1

# Opening Comments

- ANO and Entergy recognize the significance of the event
- Plant personnel took appropriate actions and plant mitigating systems performed as designed to protect the health and safety of the public
- Entergy concurs with the performance deficiency
- Independent root cause evaluations performed
- Effective corrective actions to prevent re-occurrence were taken addressing the root causes, contributing causes, extent of condition and extent of cause
- Entergy understands its responsibility for the oversight of vendor performance
- We appreciate the opportunity to share additional information that improves the accuracy of the estimated risk following the event

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Enclosure 1

# Agenda

- Unit 1
  - Response
  - Recovery Actions
  - Significance Determinations
- Break
- Unit 2
  - Response
  - Recovery Actions
  - Significance Determinations
- Site Actions and Common Cause
- Fleet Learnings
- Closing Comments

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Enclosure 1

# Unit 1 Overview

- Focus on NRC event tree
  - 4160VAC power recovery
  - Inventory control recovery
- Provide a basis that the probability of failure to recover is not 1.0 as assumed by the NRC analysis
- Discuss three success paths for the reestablishment of 4160VAC power
- Discuss a separate success path for inventory makeup to the reactor coolant system
- Apply risk modeling techniques to provide best estimate of actual plant risk

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# ANO Unit 1 Response and Recovery

Gary Sullins
Unit 1 Manager – Shift Operations
David McKenney
Engineering Supervisor



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# Initial Conditions

- Day 7 of Refueling Outage
- Fuel transfer canal flooded
  - 12 hour time to boil
  - 115 hour (4.8 day) time to core uncovery
- Power distribution supplying vital switchgear is unavailable
  - Distribution from Startup Transformers (SU1 and SU2)
  - Supply from Alternate AC Diesel Generator (AACDG)
- Vital switchgear unaffected
- 480VAC Offsite Power remained available in Power Block throughout the event from local distribution (London Line)

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# Emergency Response

- Emergency Response Organization activated immediately following event
  - Outage Control Center organization transitions into Technical Support Center
  - Emergency Operations Facility (EOF) manned and focused on obtaining offsite support
    - Equipment
    - Resources

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# Human Resources

Approximate number of key departmental personnel (including contract personnel supporting a department) available on site on the day of the event:

| | |
|---|---|
| CRAFT | 295 (including 45 electrical craft) |
| ENGINEERING | 40 (not including contractors) |
| OPERATIONS | 60 |

*Per Shift Numbers*

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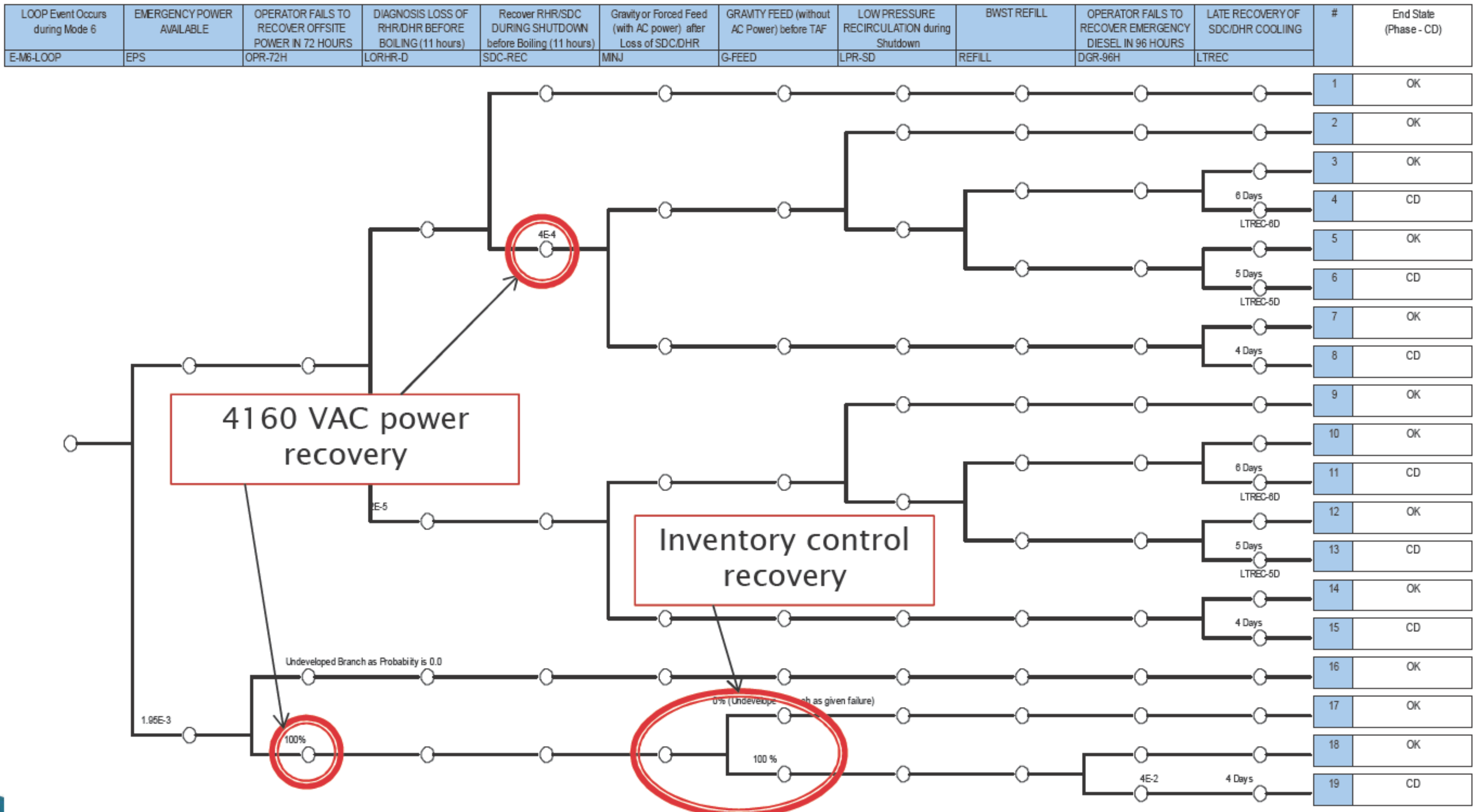
# NRC Event Tree – Unit 1



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# Basis for Unit 1 Recovery Actions

- Provide basis for core cooling success paths if emergency diesel generator (EDG) failed (dominant cut set)
  - Three success paths to recover 4160VAC Power Source(s) were developed as part of event response
    - Cable from Startup 1 Transformer (SU1)
    - Cable from Alternate AC Diesel Generator Breaker
    - Cable from Unit 2 Non-Vital Switchgear
  - One Success Path for 480VAC power cables for Reactor Coolant System (RCS) Makeup
- All actions consistent with and less complex than demonstrated recovery actions

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# Unit 1 Response

- Priorities Dictated by Actual Plant Conditions
  - Actual Plant Conditions
    - Unit 1 in a stable condition
    - Redundant trains available for decay heat removal
  - Priorities
    - Avoid challenges to available power sources
    - Protect Decay Heat Removal (DHR) and support systems
    - Protect Spent Fuel Pool (SFP) Cooling
    - Minimize potential for personnel injury
    - Optimize temporary configurations for future electrical recovery actions

# Unit 1 Post Event Response

- Restored DHR within 5 minutes
- Restored SFP cooling with less than 3 degree temperature rise
- Reliably operated both EDGs and both trains of DHR
- Recovery path chosen for 4160VAC offsite power recovery based on both vital trains in service and > 300,000 gallons of water in refueling canal
  - Provided offsite power capability to 4160VAC vital busses in 4.4 days
    - Design featured flexibility for operation and accommodations for turbine building repairs
  - Demonstrated source of offsite power placed in service in 6 days
- Additional simple contingency actions were being developed had power further degraded

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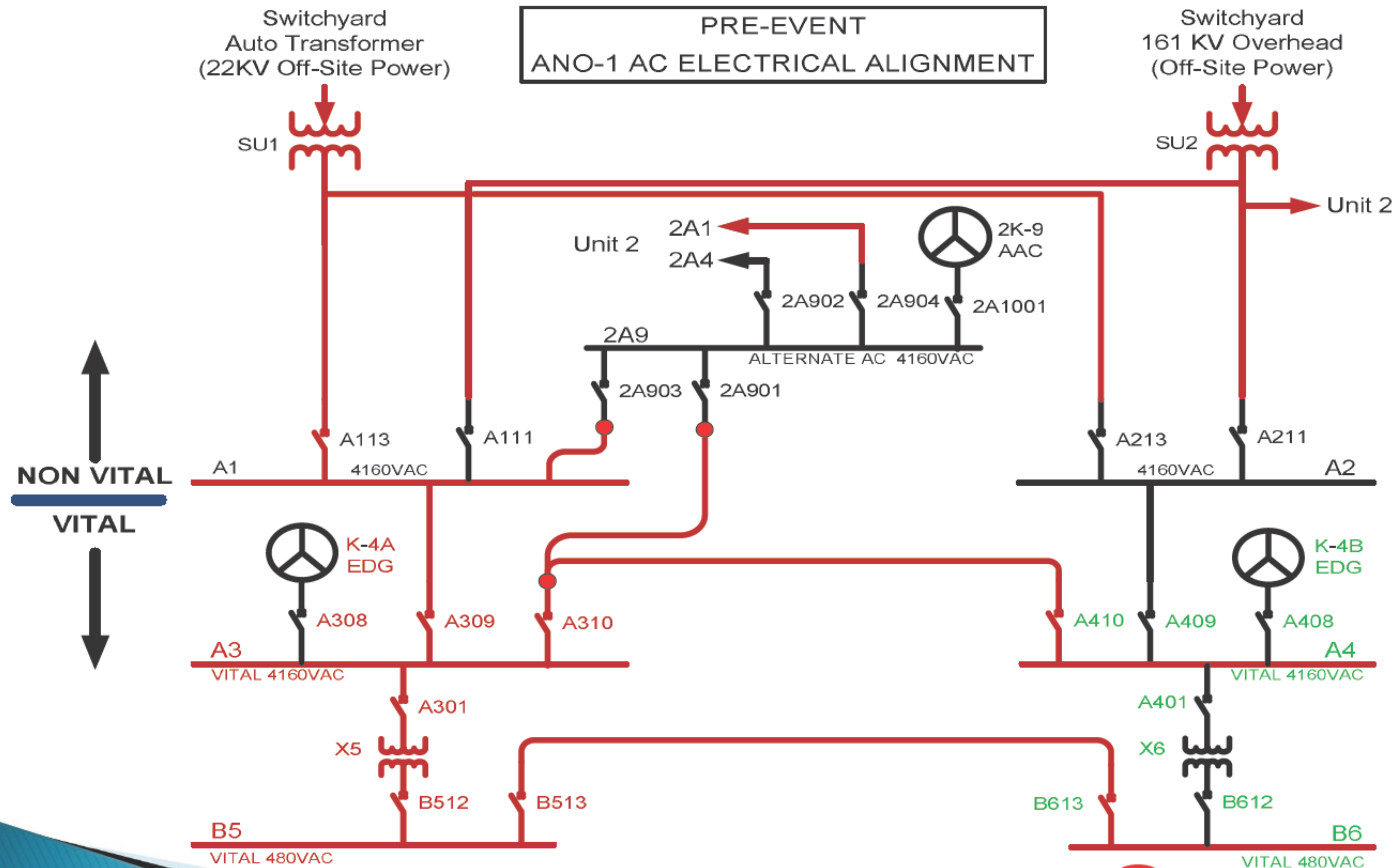
# Unit 1 Pre-Event Response



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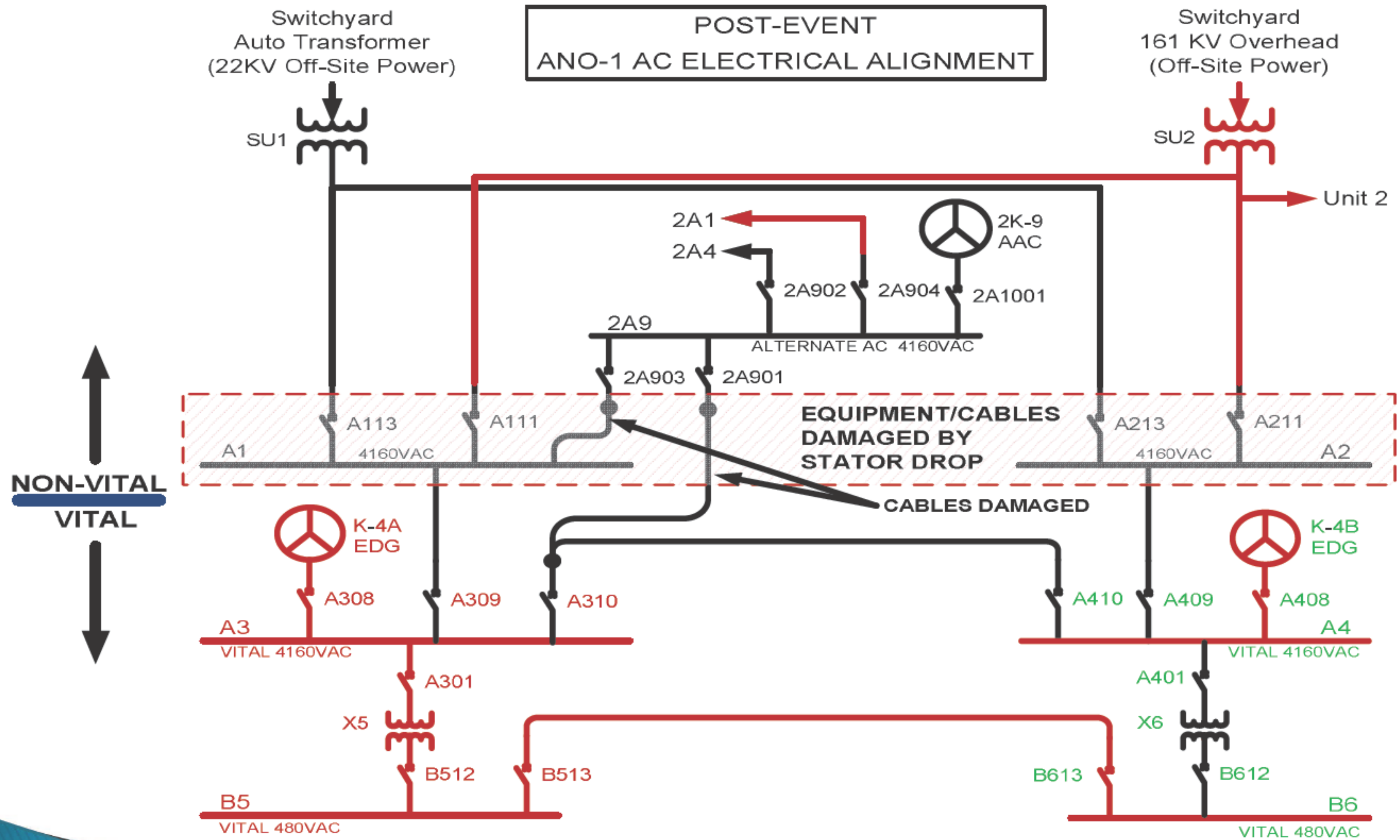
# Unit 1 Post Event Response

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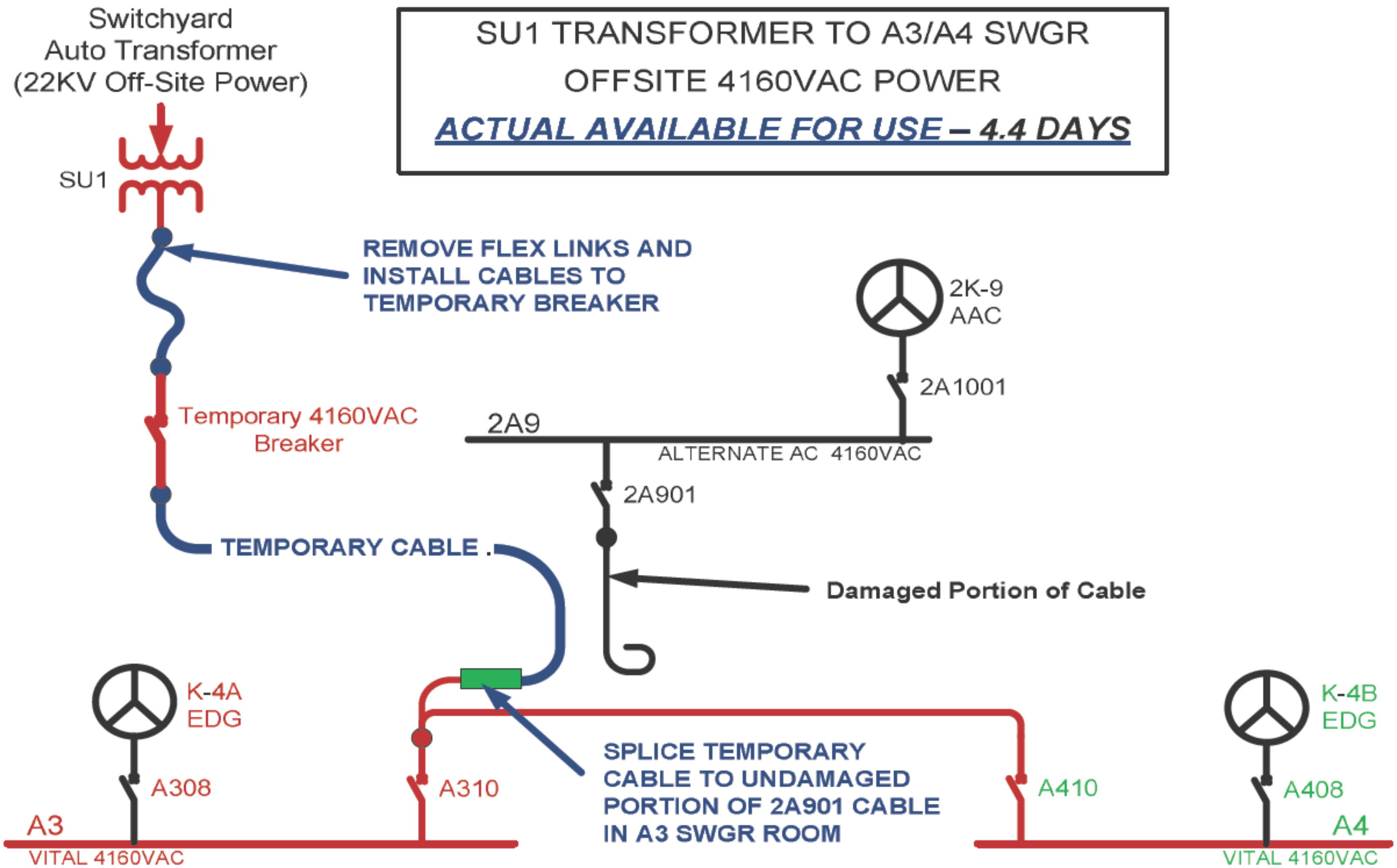
# Demonstrated Success –Provided 4160VAC From Offsite Unit 1 Transformer to Unit 1 Vital Switchgear

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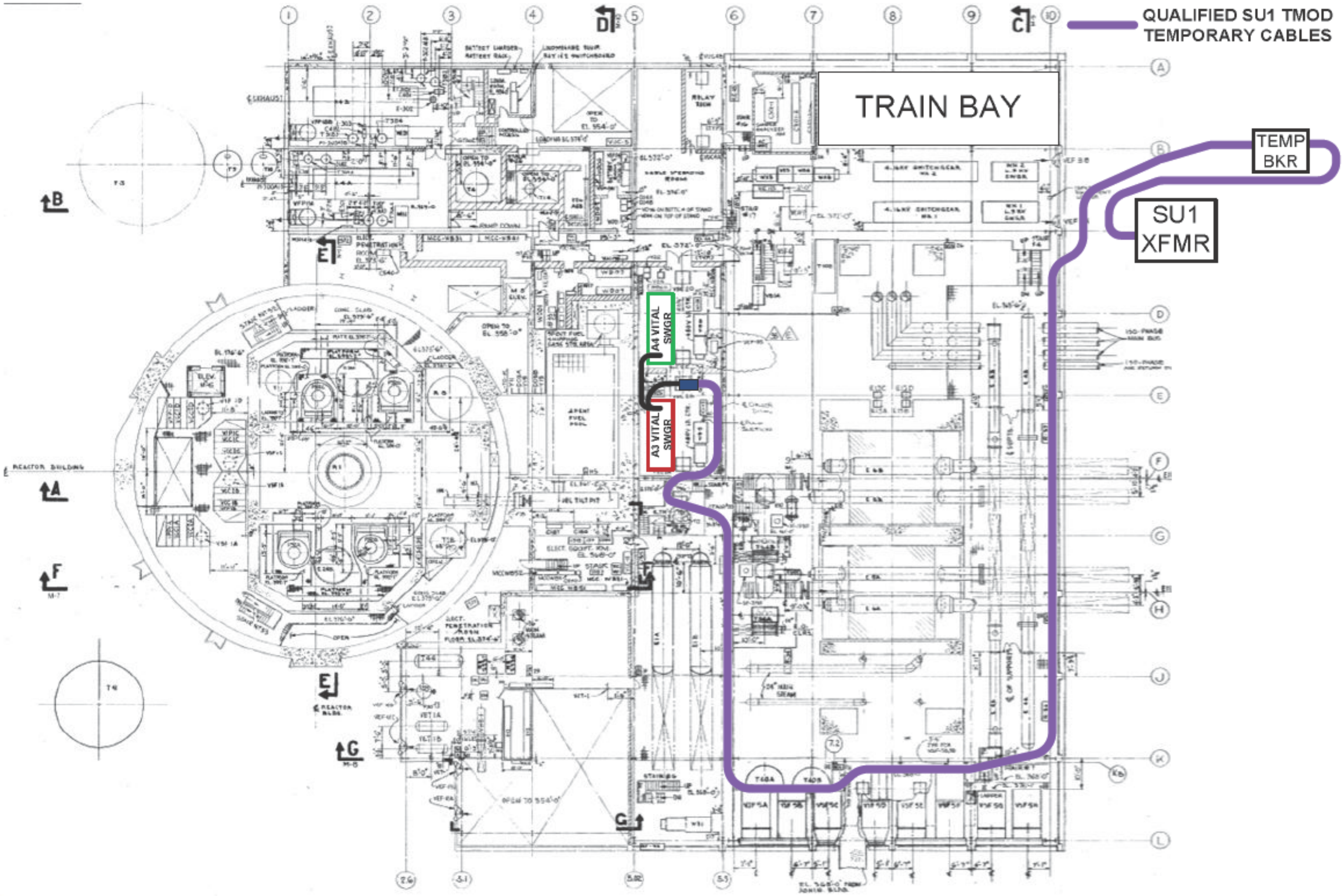
# Demonstrated Success –Provided 4160VAC From Offsite Unit 1 Transformer to Unit 1 Vital Switchgear

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# Demonstrated Success –Provided 4160VAC From Offsite Unit 1 Transformer to Unit 1 Vital Switchgear

- Temporary breaker supplying power to vital switchgear from SU1 transformer

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# Demonstrated Success –Provided 4160VAC From Offsite Unit 1 Transformer to Unit 1 Vital Switchgear

| | SU1 Source (Actual Installation Time) |
|---|---|
| | 7*50=350 feet of cable routing |
| | 7*500=3500 feet of cable routing |
| | 28 splices/terminations – 4160VAC |
| | Modify SWGR Room Door |
| | Seismic Cable Support |
| | Temporary 4160VAC Breaker |
| | DC control for Temp Breaker |
| | Temporary Breaker Setup & Testing |
| | |
| | 106 Hours (4.4 Days) |

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# Implementation Process

- Temporary Electrical Power
  - Recovery team was continuously investigating additional options
  - Additional on-site 4160VAC sources were considered and scope of work determined
  - Technical Support /Outage Control Center considered options
  - Additional technical support onsite
  - Implementation would have been controlled by
    - EN-DC-136 "Temporary Modifications"
    - EN-WM-102 "Work Implementation and Closeout"

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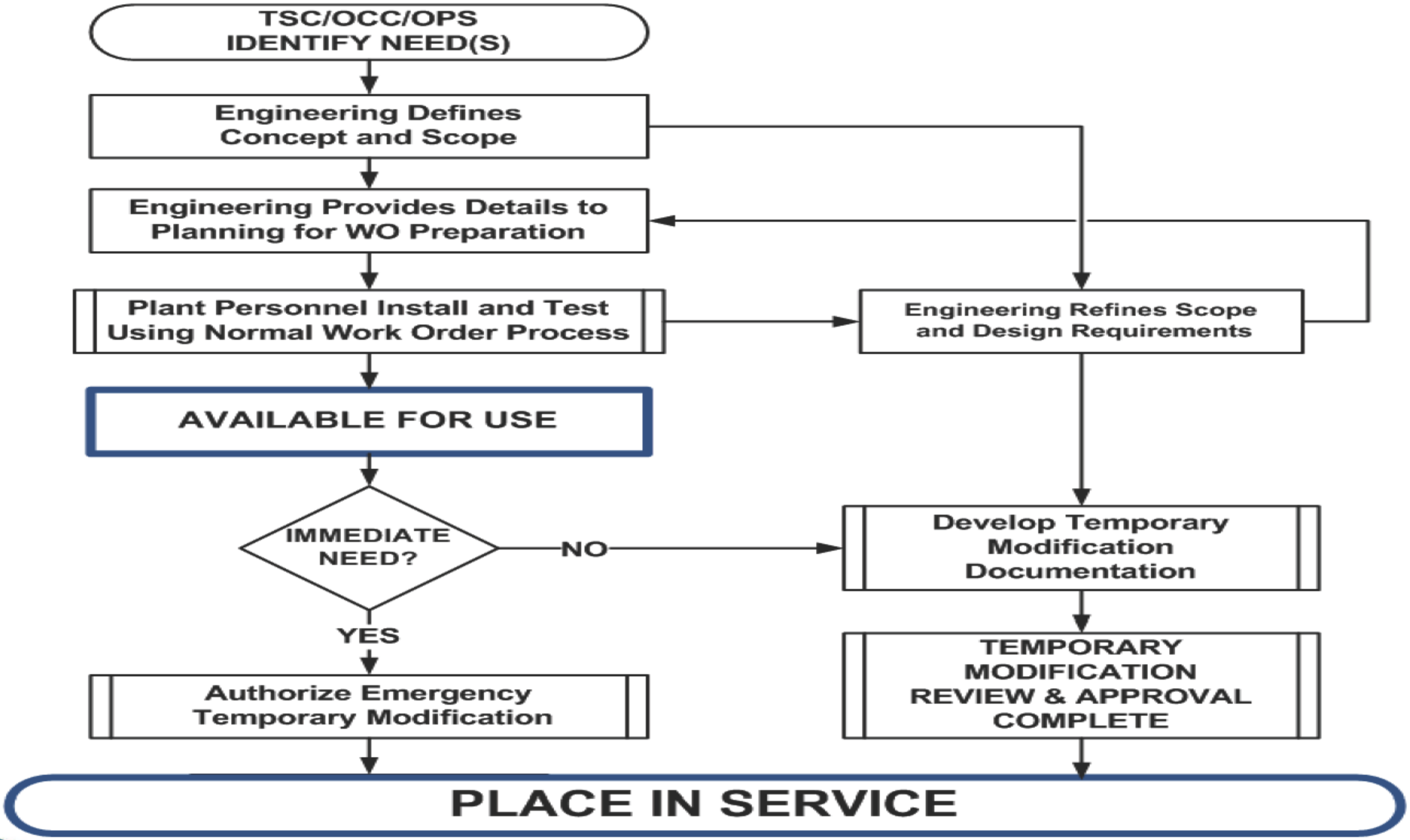
# Implementation Process

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# Demonstrated Success – SU1 Source

- Restored Off Site Power to Vital Switchgear
  - Craft personnel were qualified and scheduled to perform the same type activities in outage when replacing circulating water pump 4160VAC cables
  - Cable routed away from recovery zone
  - Provided option to tie either or both trains of vital power to SU1
  - Allowed the EDGs to remain available to feed their respective train
  - Available in 4.4 days

# Contingent Success Paths

- Three Alternate 4160VAC Power Source(s) Success Paths
  1. Cable from Startup 1 Transformer (SU1)
  2. Cable from Alternate AC Diesel Generator breaker
  3. Cable from Unit 2 Non-Vital Switchgear (Condensate Pump Supply)

- Estimated installation completion times for these success paths based on the actual installation of demonstrated 4160VAC power source
  - Adjustments made to reflect reduced work scope

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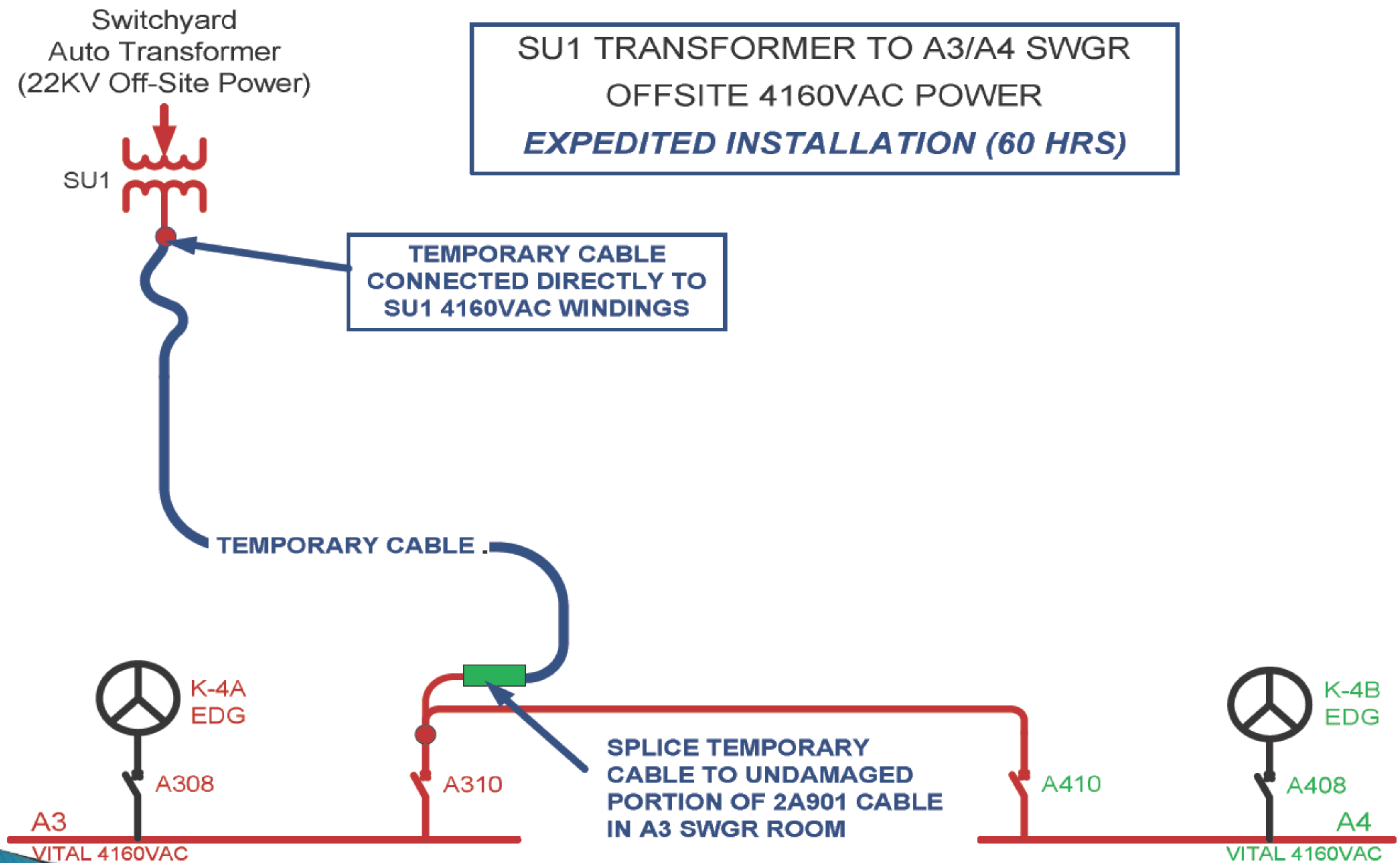
# Success Path 1 – Cable From Offsite SU1 Transformer

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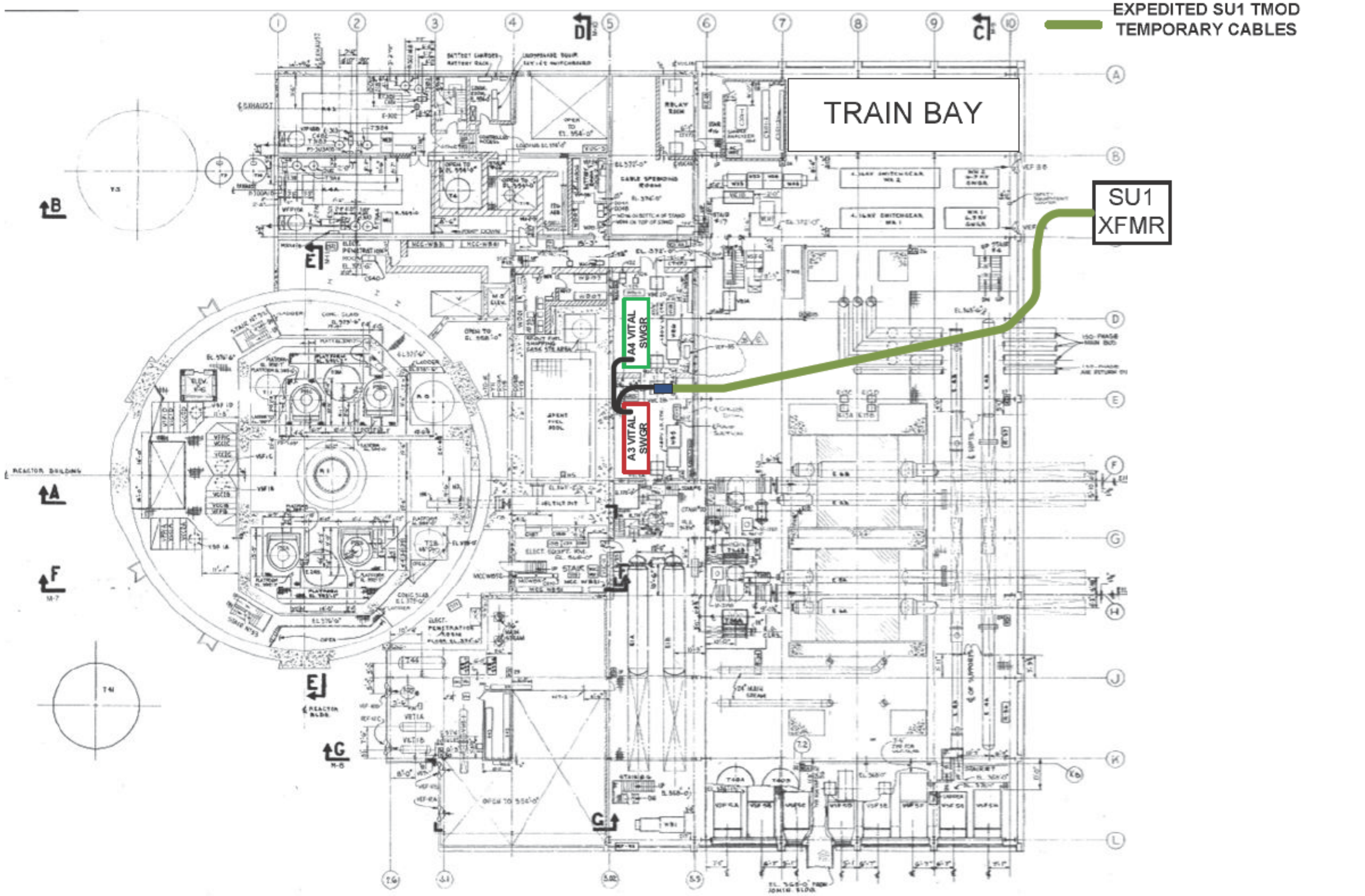
# Success Path 1 – Cable From Offsite SU1 Transformer

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# Success Path 1 – Cable From Offsite SU1 Transformer

SU1 Supply to Vital 4160 VAC – Expedited **vs.** Demonstrated Source

| SU1 Expedited Installation | SU1 Source (as installed) |
|---|---|
| 7*250=1750 feet of cable routing | 7*500=3500 feet of cable routing |
| | 7*50=350 feet of cable routing |
| 14 splices/terminations – 4160V | 28 splices/terminations – 4160V |
| | Modify SWGR Room Door |
| | Seismic Cable Support |
| | Temporary 4160 VAC Breaker |
| | DC control for Temp Breaker |
| | Temporary Breaker Setup & Testing |
| | |
| 60 Hours | 106 Hours |

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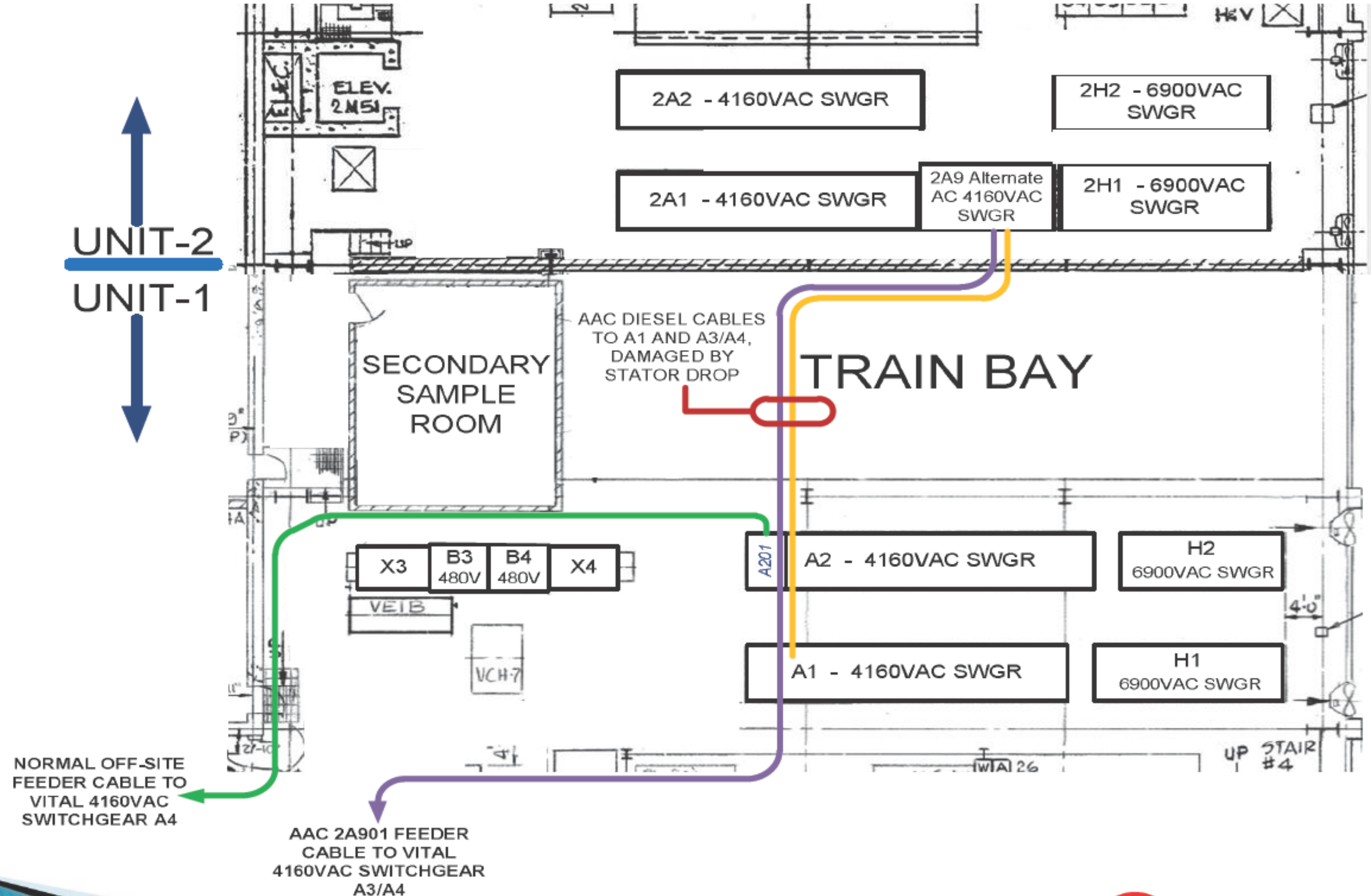
# Success Path 2 – Alternate AC Diesel Generator

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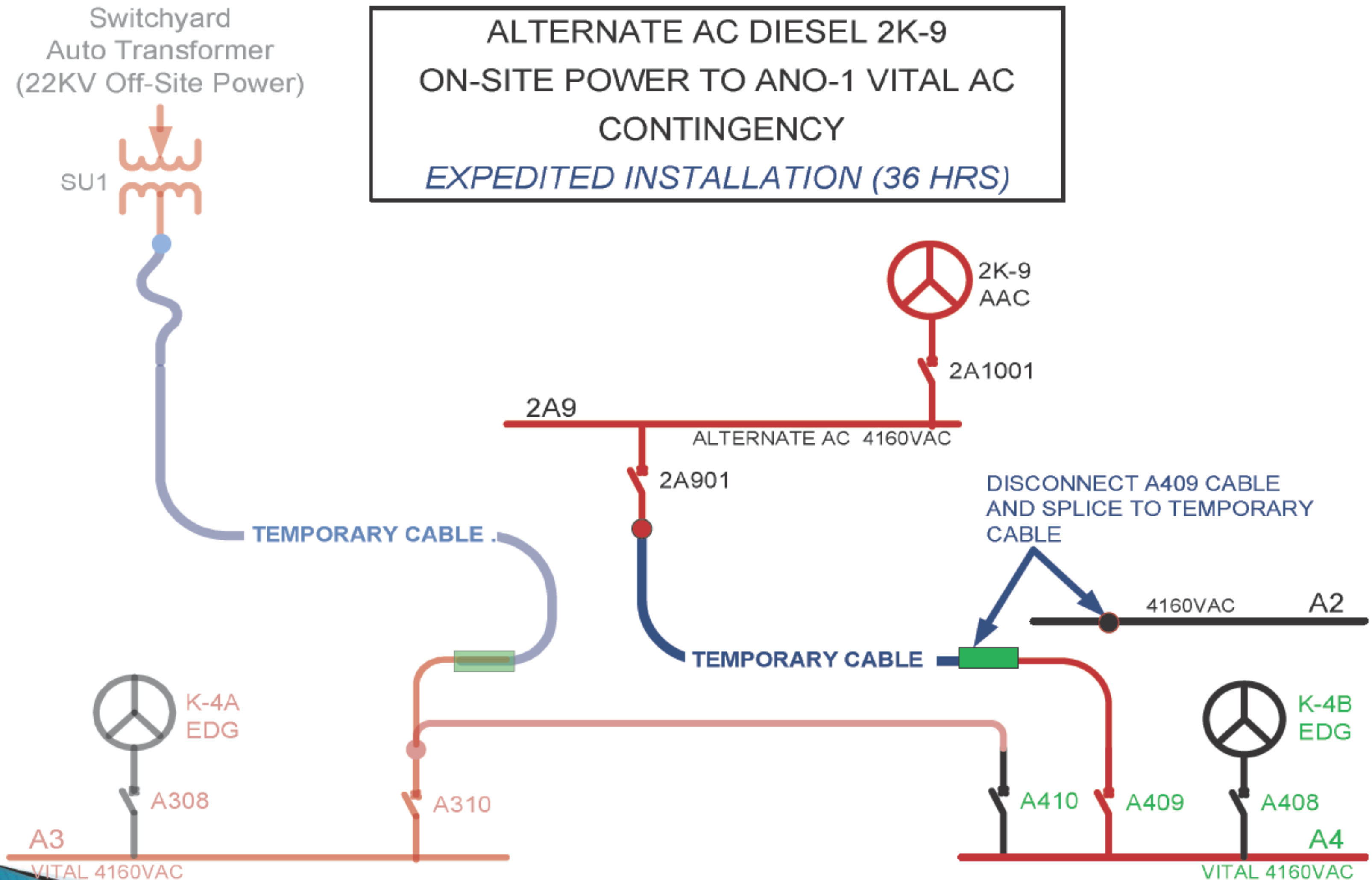
# Success Path 2 – Alternate AC Diesel Generator



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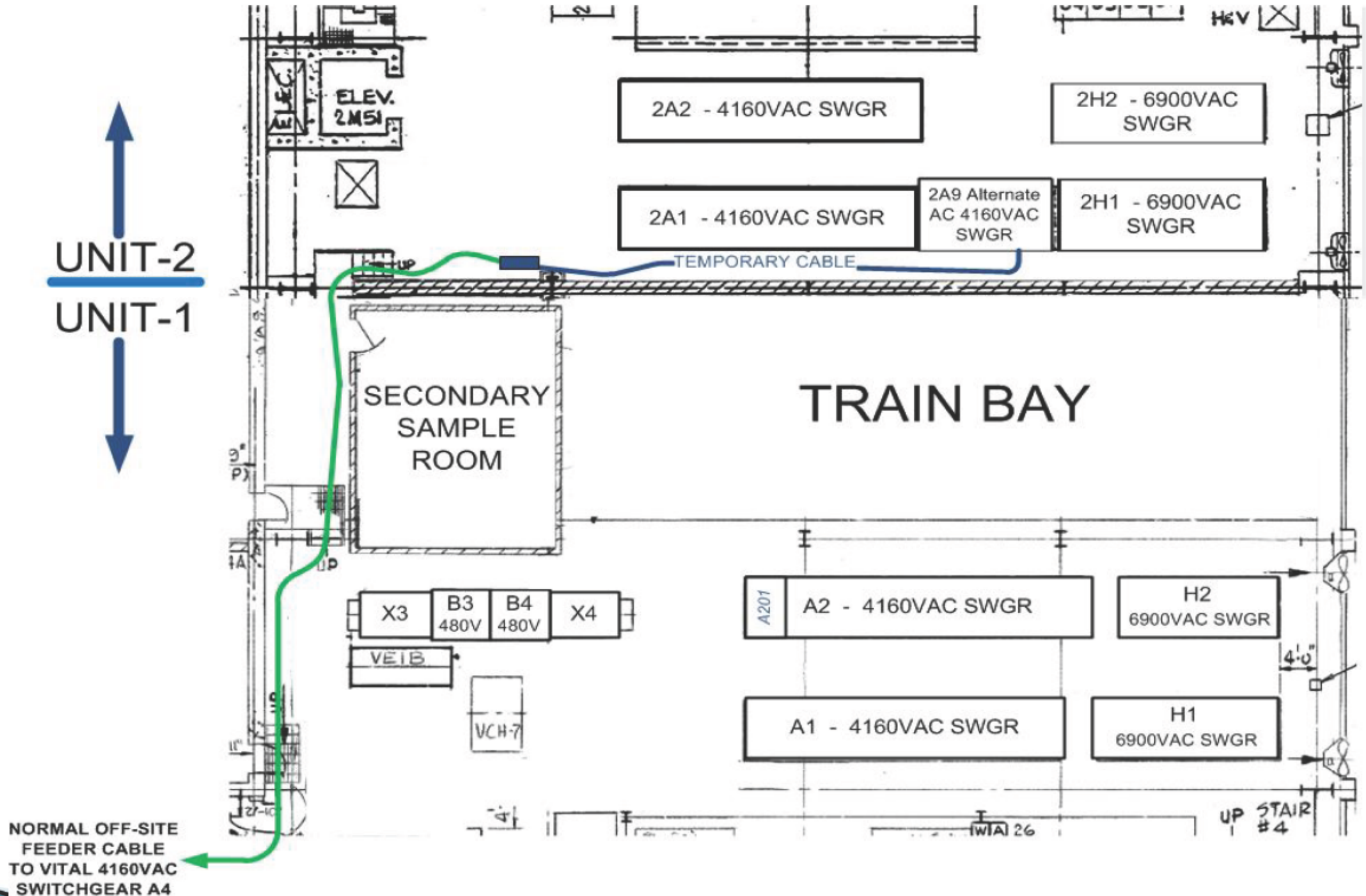
# Success Path 2 – Alternate AC Diesel Generator

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# Success Path 2 – Alternate AC Diesel Generator

AAC DG to Vital 4160VAC <u>vs</u>. SU1 to Vital 4160VAC Demonstrated Source

| AAC DG to ANO-1 Vital 4160 VAC | SU1 Source (as installed) |
|---|---|
| 7*100=700 feet of cable routing | 7*500=3500 feet of cable routing |
| | 7*50=350 feet of cable routing |
| 14 splices/terminations – 4160V | 28 splices/terminations – 4160V |
| | Modify SWGR Room Door |
| | Seismic Cable Support |
| | Temporary 4160 VAC Breaker |
| | DC control for Temp Breaker |
| | Temporary Breaker Setup & Testing |
| Minor 2A901 Term Point Repairs | |
| **36 Hours** | **106 Hours** |

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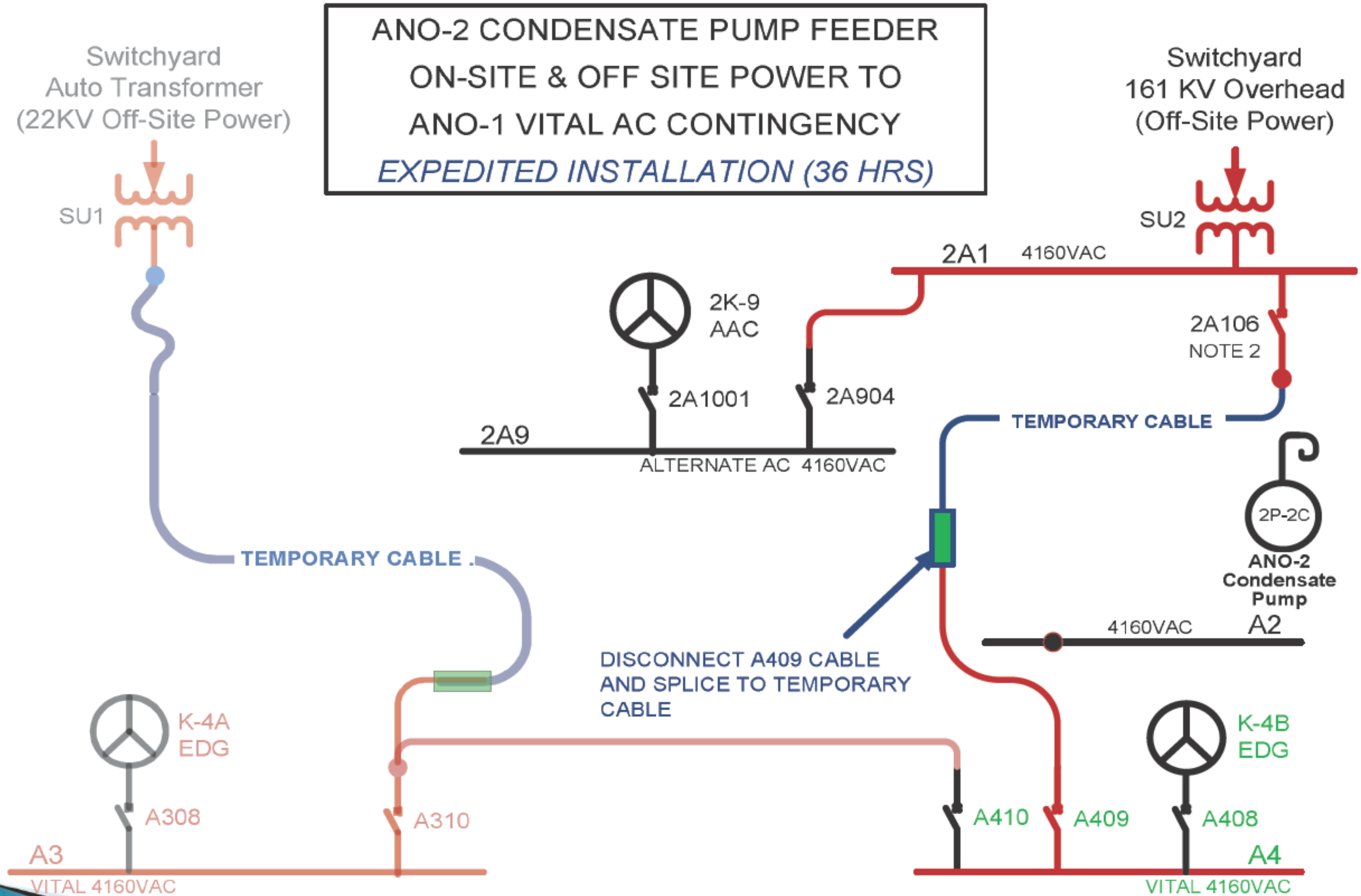
# Success Path 3 – Cable From Unit 2 Non-Vital Switchgear

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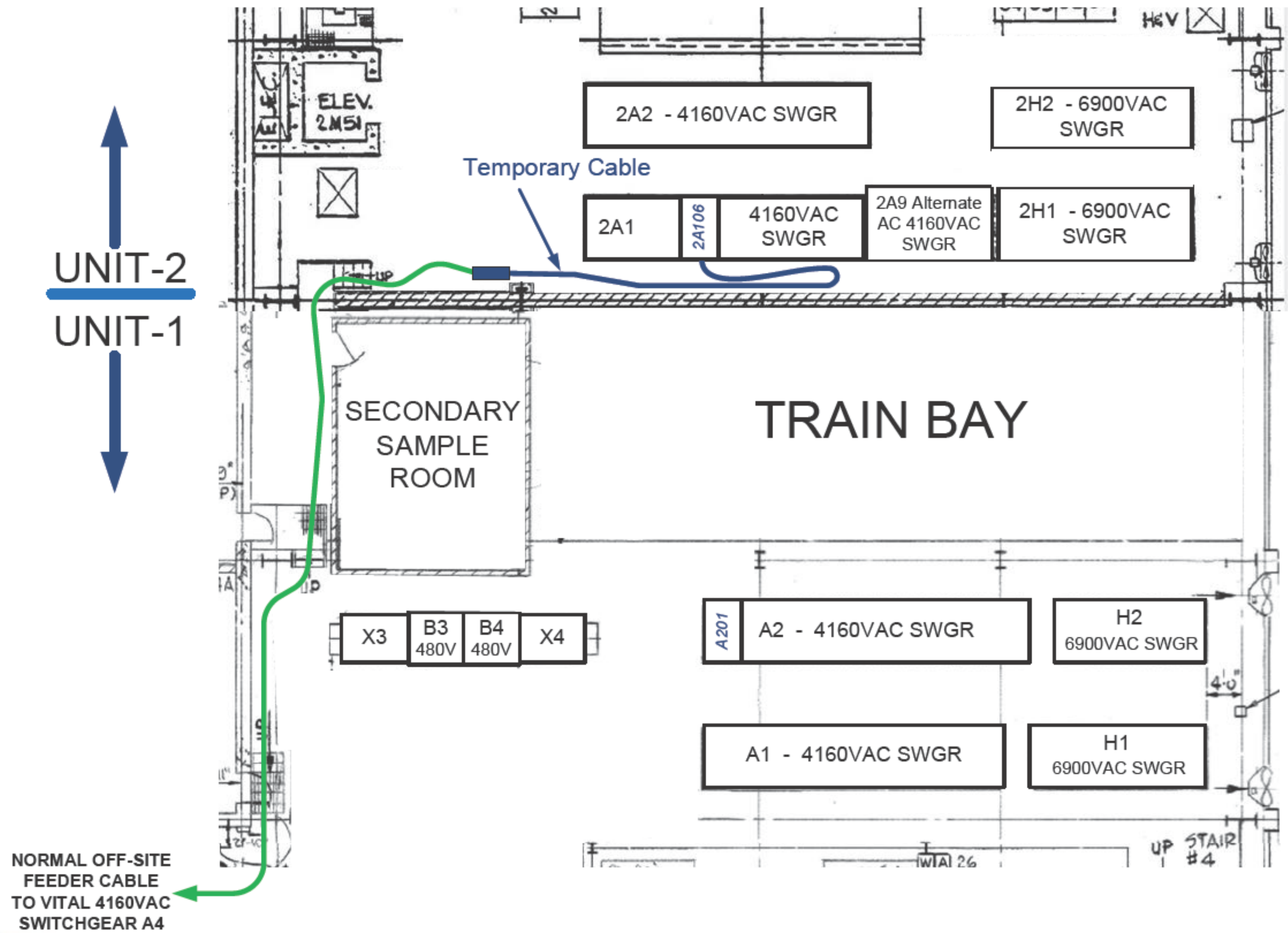
# Success Path 3 – Cable From Unit 2 Non-Vital Switchgear

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# Success Path 3 – Cable From Unit 2 Non-Vital Switchgear

2A106 to Vital ANO-1 4160VAC <u>vs</u>. SU1 to Vital 4160VAC Demonstrated Source

| 2A106 to ANO-1 Vital 4160 VAC | SU1 Source (as installed) |
|---|---|
| 7*100=700 feet of cable routing | 7*500=3500 feet of cable routing |
| | 7*50=350 feet of cable routing |
| 14 splices/terminations – 4160V | 28 splices/terminations – 4160V |
| | Modify SWGR Room Door |
| | Seismic Cable Support |
| | Temporary 4160 VAC Breaker |
| | DC control for Temp Breaker |
| | Temporary Breaker Setup & Testing |
| Minor 2A106 Interlock Defeats | |
| 36 Hours | 106 Hours |

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# Other 4160 VAC Success Paths

- Additional success paths for 4160VAC Power to vital busses were considered and scoped
  - Portable Diesel Generator (4160VAC)
  - Unit Aux Transformer backfeed from offsite 500KV line (Variation of SU1 temporary modification)
  - Restoration of A1 Non-Vital Switchgear fed from SU2 offsite transformer

# Summary – 4160 VAC Success Paths

- Simple design concepts (typical of normal outage activities)
- Simple to implement (typical of normal outage activities)
- Craft personnel were qualified and scheduled to perform the same type activities in outage when replacing circulating water pump 4160VAC cables
- Cables would have been routed away from damaged turbine building areas
- Success paths spatially and electrically independent
- Success paths could be implemented in parallel
  - Sufficient time to implement other success paths sequentially if one of the success paths failed
- Alternate 4160VAC Success Paths are less complex than the demonstrated source of offsite power which was actually installed and available in 4.4 days

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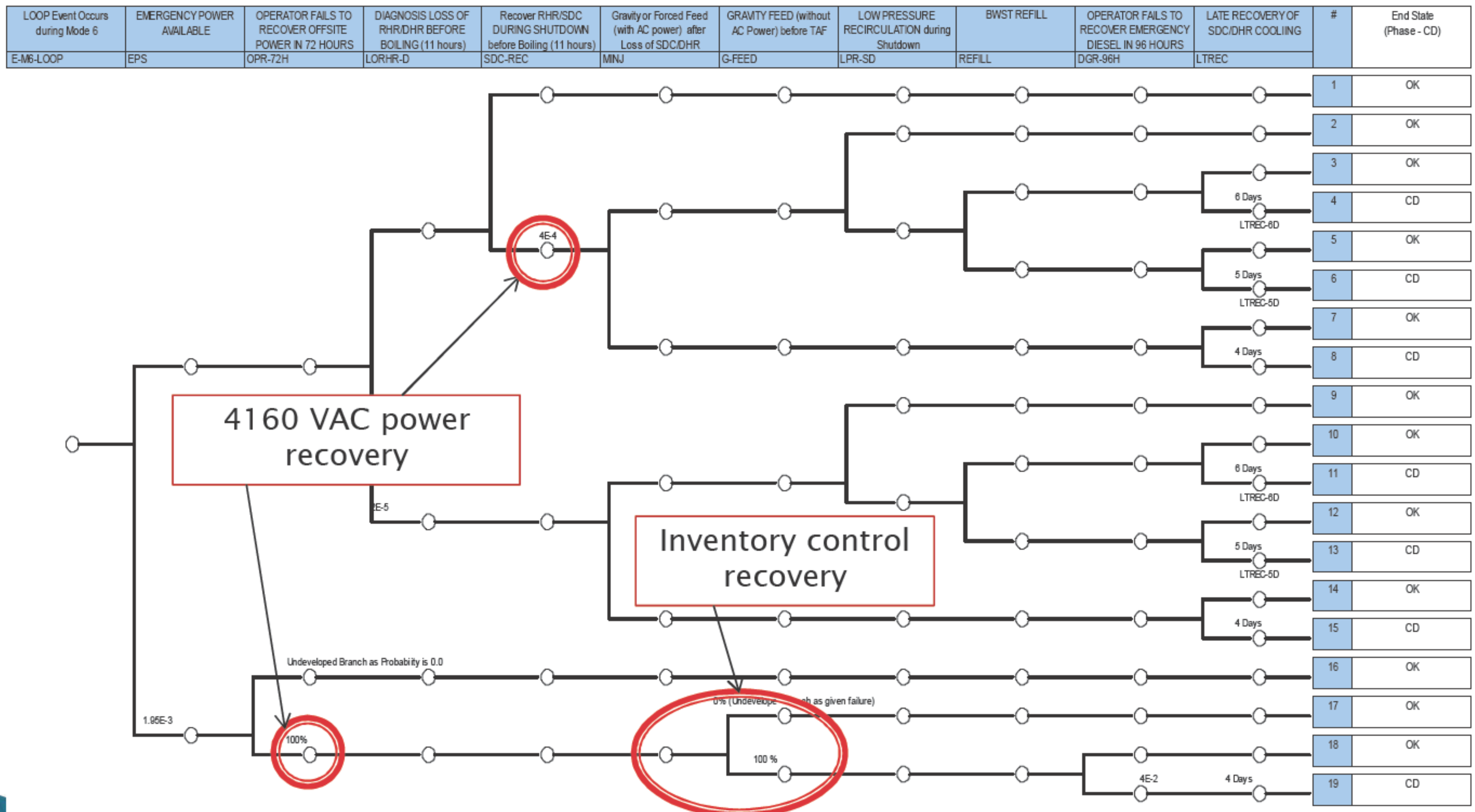
# NRC Event Tree – Unit 1

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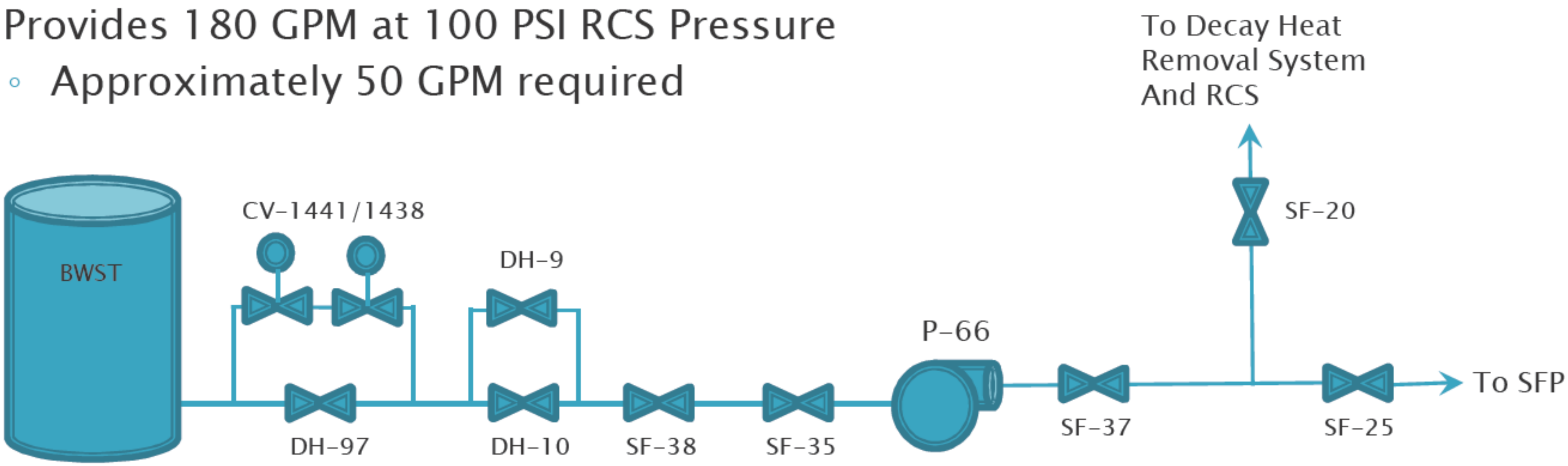
# Success Path 4 – Forced Flow Makeup

- Forced flow makeup to RCS via Borated Water Recirculation Pump
- One of six methods directed by Loss of Decay Heat Removal procedure
- Support actions
  - Provide temporary 480VAC power to Borated Water Recirculation Pump
    - 480VAC local distribution unaffected and available in Unit 1 power block
  - Establish makeup to Borated Water Storage Tank (BWST) per procedure
- 20 hours to implement
- Provides 180 GPM at 100 PSI RCS Pressure
  - Approximately 50 GPM required

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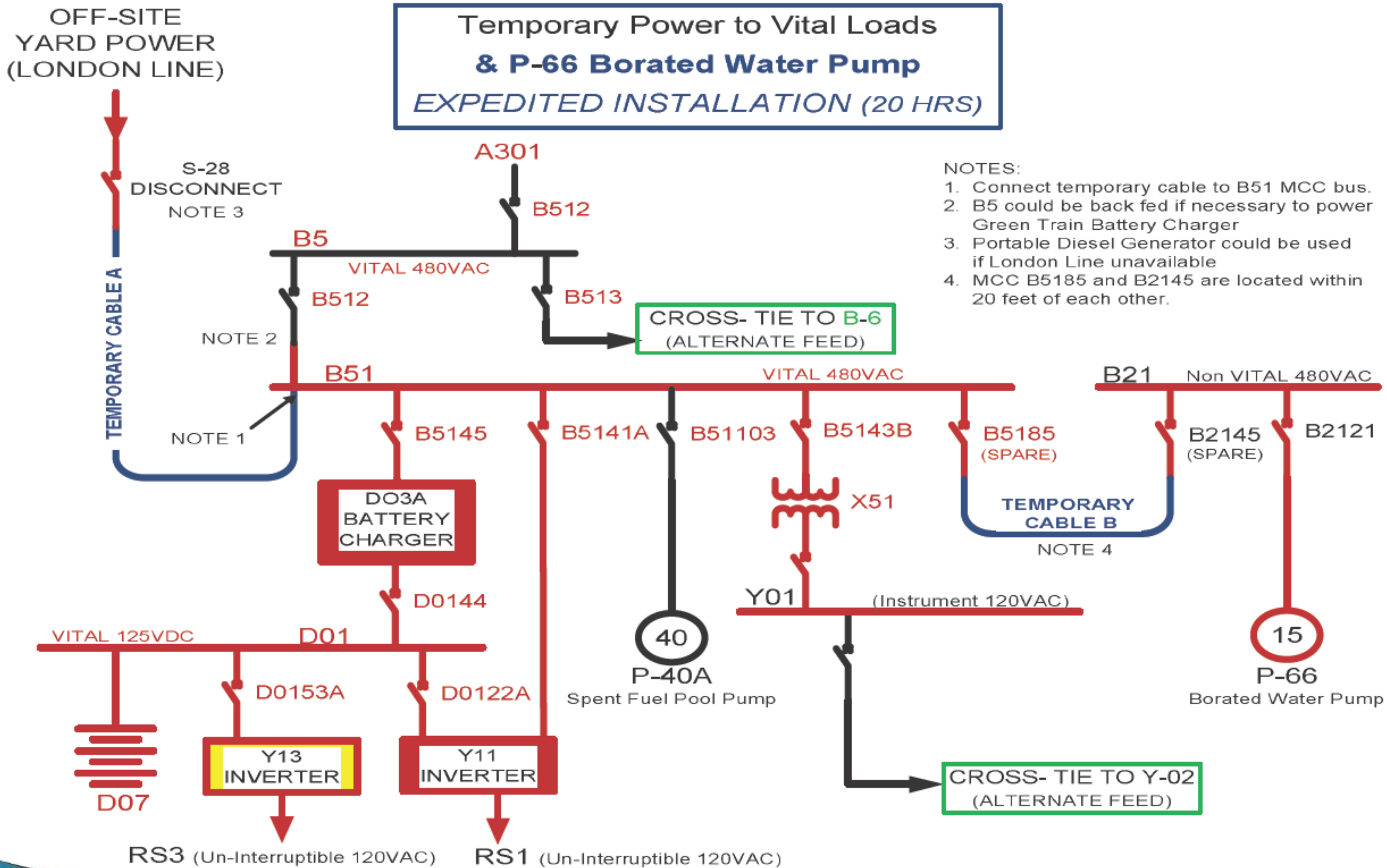
# Success Path 4 – Forced Flow Makeup




NOTES:
1. Connect temporary cable to B51 MCC bus.
2. B5 could be back fed if necessary to power Green Train Battery Charger
3. Portable Diesel Generator could be used if London Line unavailable
4. MCC B5185 and B2145 are located within 20 feet of each other.

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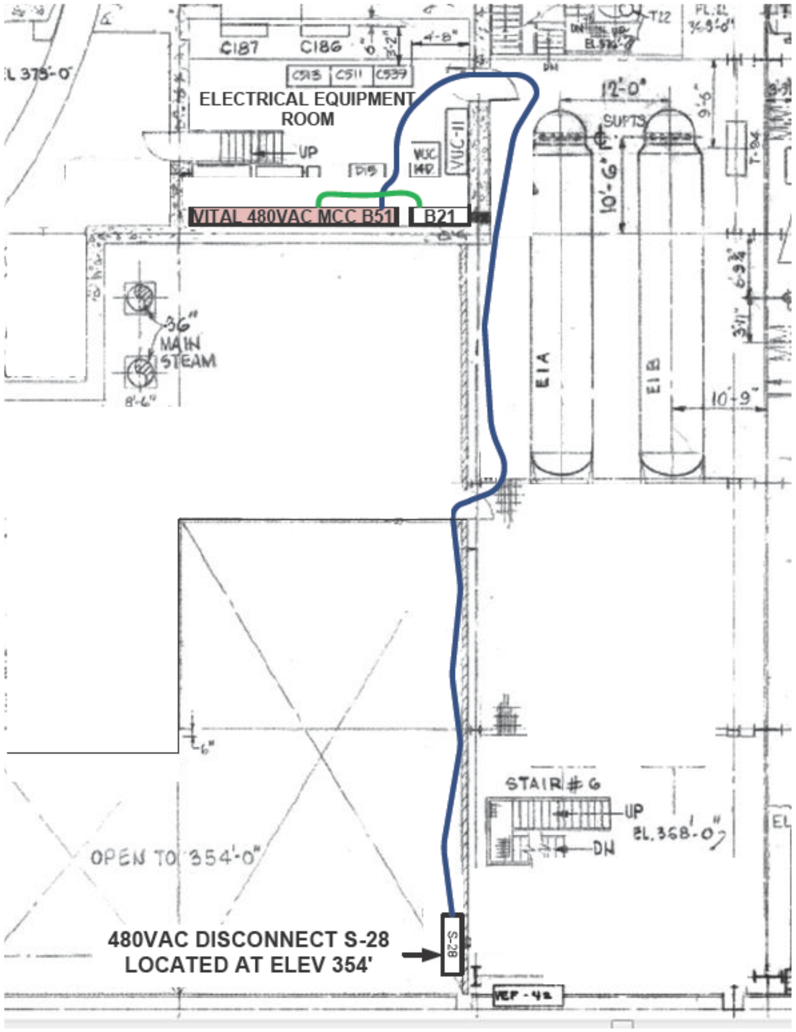
# Success Path 4 – Forced Flow Makeup

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# Success Path 4 – Forced Flow Makeup


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# Success Path 4 – Forced Flow Makeup

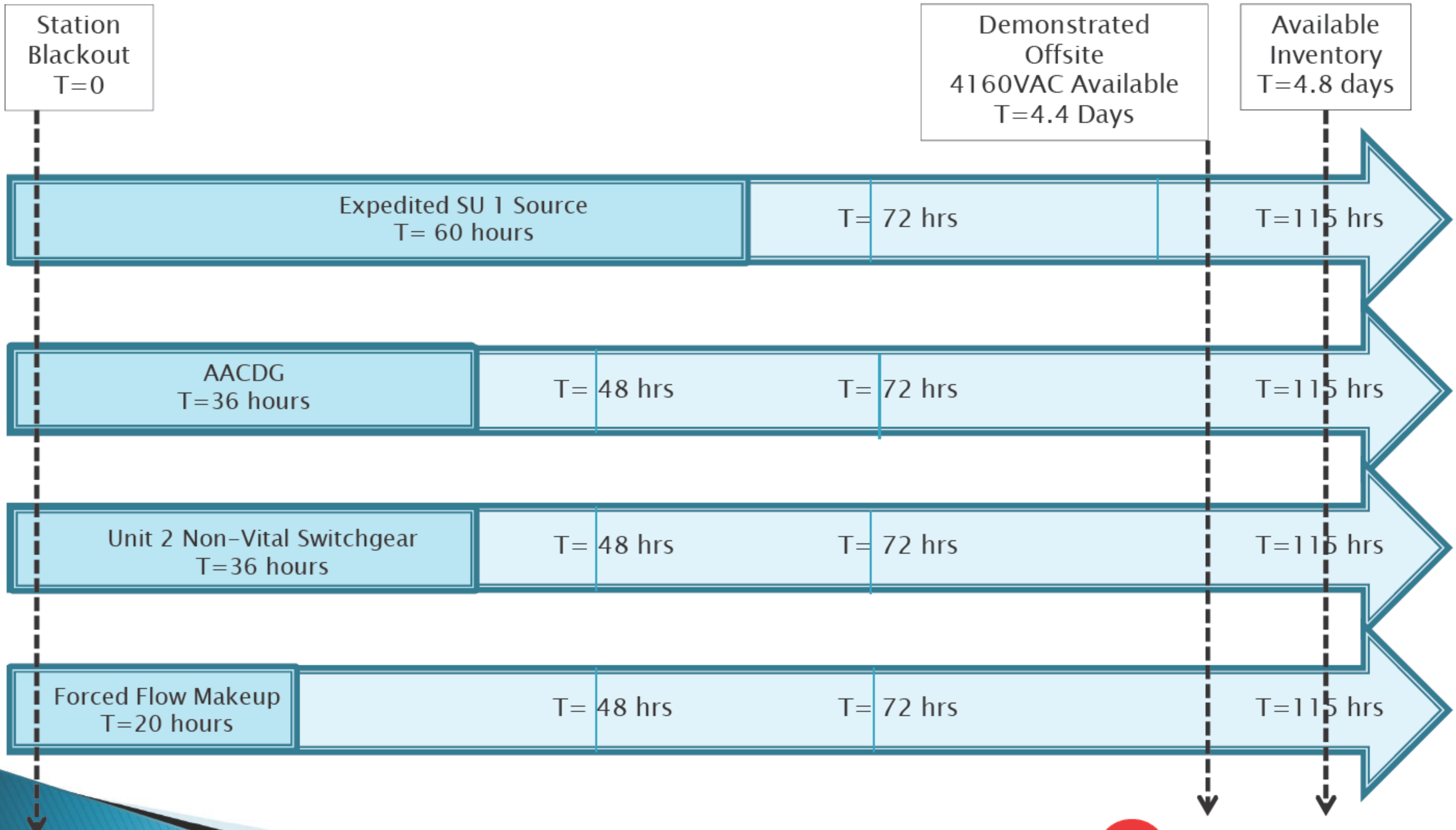
# Success Path 4 – Forced Flow Makeup

- Summary
  - Simple design concepts (standard electrical connections)
  - Simple to implement (typical outage temporary modification)
  - 480VAC temporary power typical of normal outage activities
  - 480VAC local distribution unaffected by event and available in power block at a disconnect switch
  - Success path spatially and electrically independent from 4160VAC Success Paths
  - Multiple variations of temporary power connection points are available
  - If one of the success paths or connection points failed, there was sufficient time to implement another path sequentially

# Additional Benefits of Success Path 4

- Powering B51 provides additional makeup options
  - SFP Cooling Pump
  - Gravity Feed
    - Requires BWST makeup and Reactor Building (RB) vent
    - Vent path available via RB Purge exhaust
- Also energizes battery chargers and inverters for instrumentation

# Timeline for Success Paths



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# Confidence in Success

- Substantial margin in response time (4.8 days available inventory)
- Refueling outage resources immediately available
  - Stator lift would only occur during major outages
  - Fleet resources available
- Simple and straightforward installations
  - Installed utilizing existing processes
  - Consistent with typical outage activities
  - Required materials onsite
  - Response time available to inspect and test success paths prior to energization
- Defense in Depth – multiple success paths
- Successfully demonstrated response by actually installing and making 4160VAC power available in 4.4 days

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# Significance Determination Unit 1

Richard Harris
Manager, Emergency Planning



Enclosure 1

# Key Objectives

- Realistic estimate of risk utilizing best available information
  - Review key assumptions in the NRC risk assessment
  - Identify applicable ANO success paths
  - Assess impact of ANO success paths on the NRC analysis
- Present ANO Risk significant results

# Significance Determination – Unit 1

- Desired result is a safe and stable end state
- NRC Event Tree model was reviewed to understand method and results
- Event tree dominant sequences were reviewed
- No credit in the NRC event tree for potential recovery actions associated with 4160VAC and inventory control
- Assumption is not realistic based on the actual recovery of offsite power and the potential for other success paths

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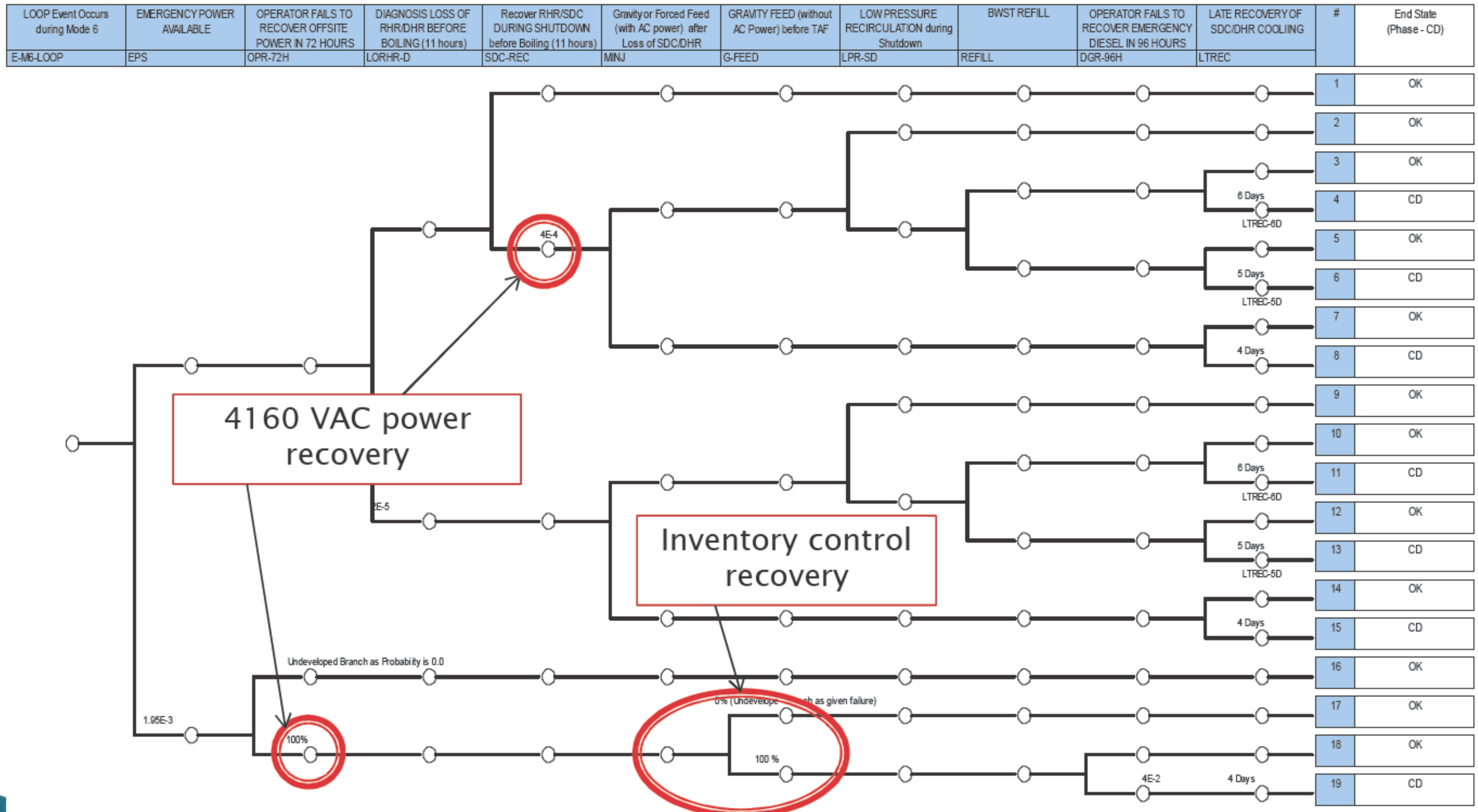
# NRC Event Tree – Unit 1



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# Methodology

- Consulted available resources for determining an acceptable method of calculating recovery factors
- No definitive standard was identified for calculating recovery factors for shutdown conditions
- A realistic risk assessment must include recovery potential that was present
- Ultimate goal is to determine best estimate recovery factor

# Methodology Development

- Assembled expert team
  - Risk analyst
  - Operations
  - Outside consultants
- Different methods and options considered
- Modeling methods ultimately selected
  - HRA Calculator
  - EPRI's "Human Action Reliability Procedure", TR-101711

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# Recovery Elements Considered

- Cognitive/Decision Making
- Design Development
- Execution

# Cognitive/Decision Making Factors

- Cognitive elements that are important to success were developed
  - Examples
    - Cues
    - Assessment against safety functions
    - Contingency plan development
    - Outage resources immediately available
    - Simplicity of temporary modifications
- HRA Calculator was reviewed for applicability
- It was determined that the Cognitive portion of the HRA Calculator is applicable for this element

# Design Development Factor

- Examples of design development issues that were considered
  - Resource limitations and dynamics
  - Affect on existing systems
  - Operating Crew/Staff interaction
  - Temporary Modification development
- Concluded that the HRA Calculator does not adequately address Design Development Factor
- Alternative approaches were considered
  - Determined that the recovery event tree from EPRI's Human Action Reliability Procedure was applicable

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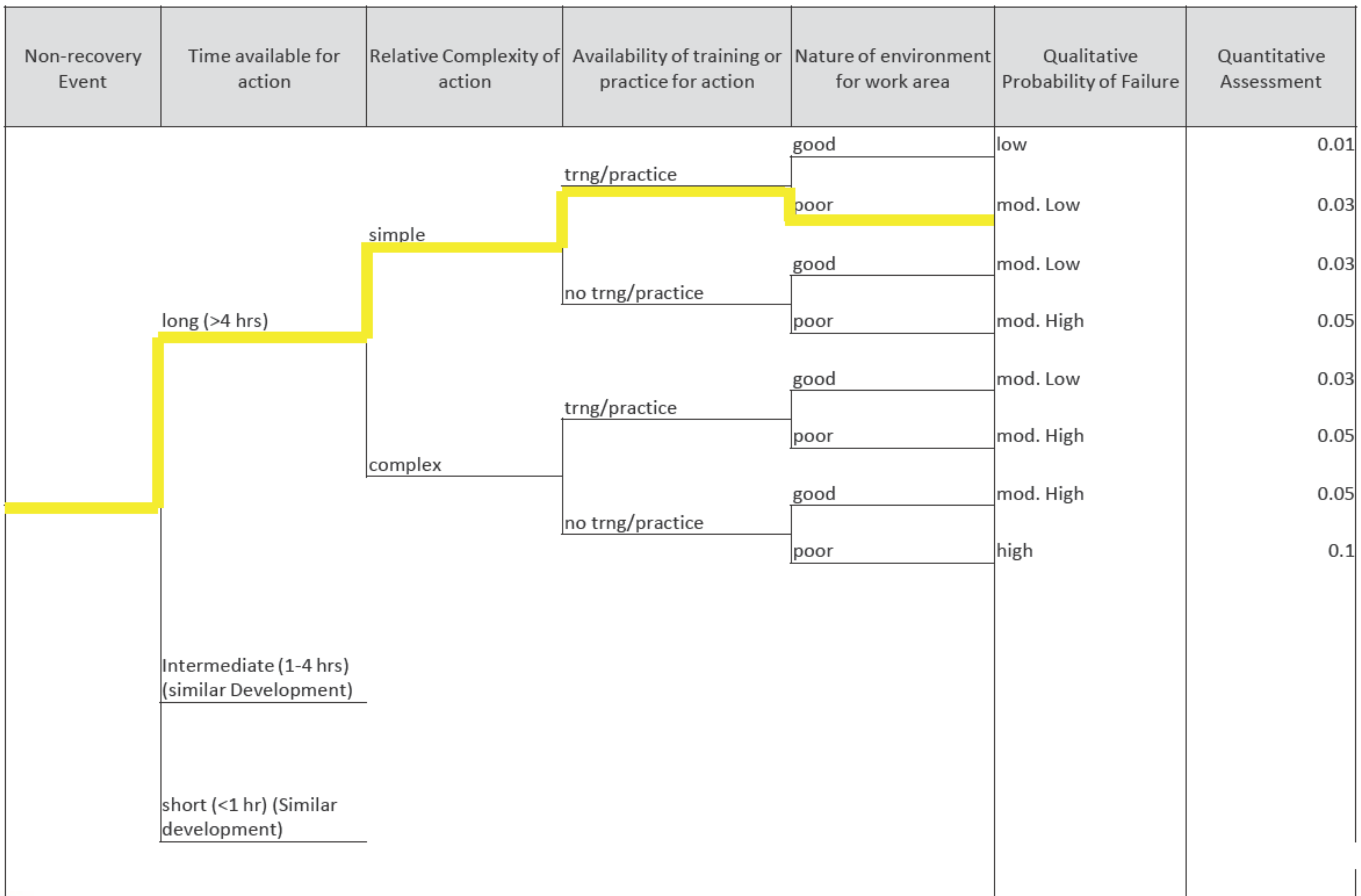
# Recovery Event Tree from EPRI

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# Execution Factor

- Evaluated the list of execution steps for successful implementation
- HRA Calculator was reviewed for applicability
- It was concluded that this element can be properly modeled by the HRA Calculator
- Individual steps from the implementing instructions for the Temporary Modification that was actually implemented were evaluated for this portion of the analysis

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# Quantification of Recovery Factor

- Using processes discussed above
  - HRA Calculator was used to determine the Cognitive and Execution results
  - A screening factor assigned to the recovery event tree from EPRI was used to estimate the Design Implementation results
    - Screening factor dominates results and provides some conservatism
  - Results were included in a fault tree logic for determining the failure probability

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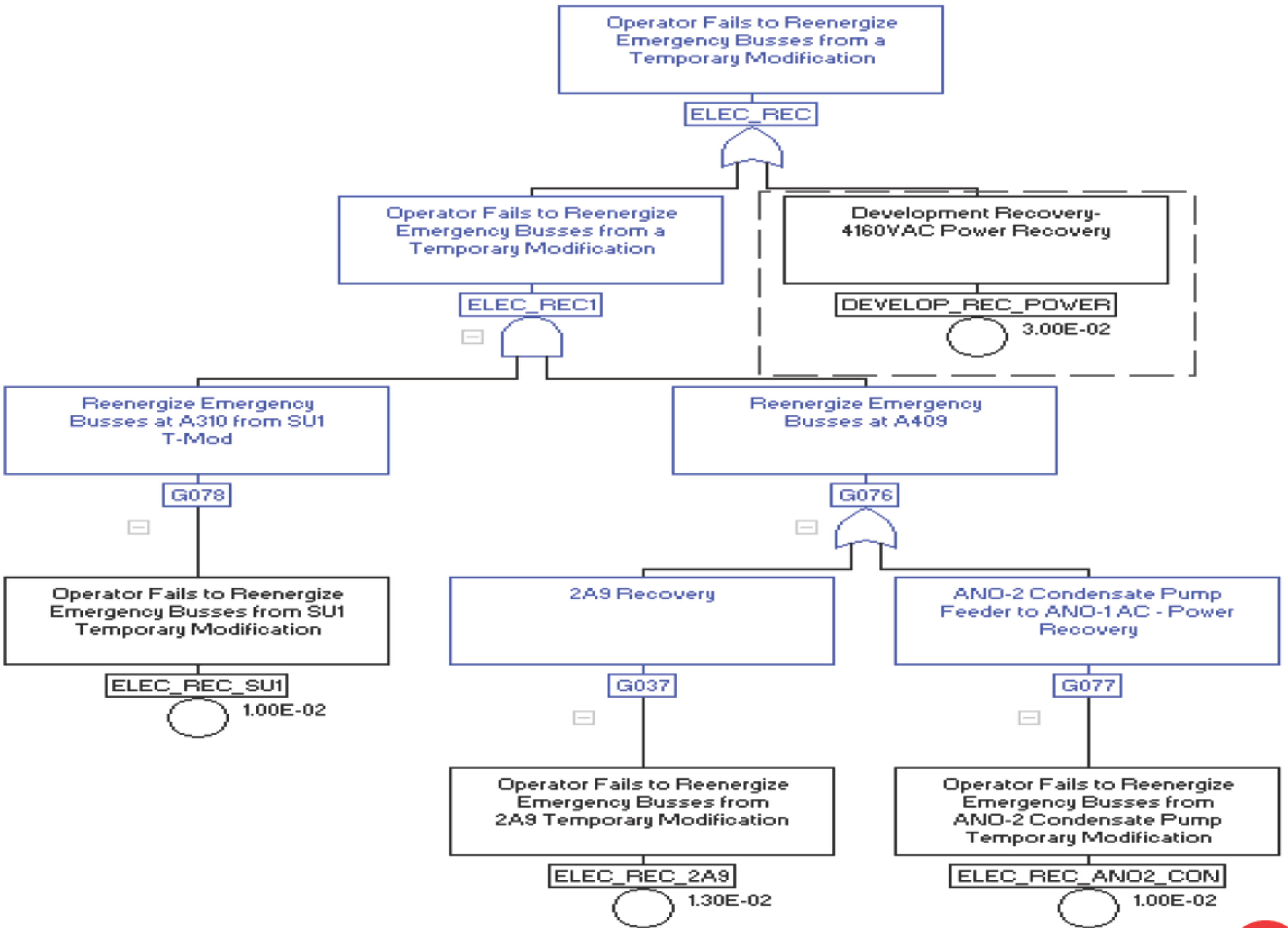
# 4160VAC Recovery Fault Tree

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# Modeling Method Results

The resulting point estimate for 4160VAC recovery fault tree is 3.1E-02

# 4160VAC Recovery Evaluation – Alternate 1

- Using a normal distribution, performed a statistical assessment for Mean Time To Repair (MTTR) vs. available time
- Assumed best estimate completion times as the mean (60 hours)
- Used a standard deviation of 20 hours
- Results in a probability of failure = 2.6E-3

# 4160VAC Recovery Evaluation – Alternate 2

- Actual offsite power was restored before the calculated time to core uncovery
  - Calculated a recovery factor using HRA Calculator for the time between recovery of power and core uncovery
  - Night orders were in place
  - Operator actions were not complicated
- Results in a probability of failure = 2.0E-03

# NRC Assumptions for Inventory Recovery

- NRC model did not give credit for this recovery action
- Success Path 4 – Forced Flow Makeup

# Recovery Dependencies

- Reviewed dependencies between the 4160VAC recoveries and inventory recoveries
- Each of the recovery options would be worked independently
  - Sufficient persons available to work multiple success paths
  - No spatial conflicts between the two main recoveries
- Conclusion: No dependency between 4160VAC and inventory control recoveries

# Inventory Control Recovery Factor

- Same approach applied to inventory recovery as was applied in determining the 4160VAC recovery factor
- These results were included in a fault tree logic for determining the failure probability

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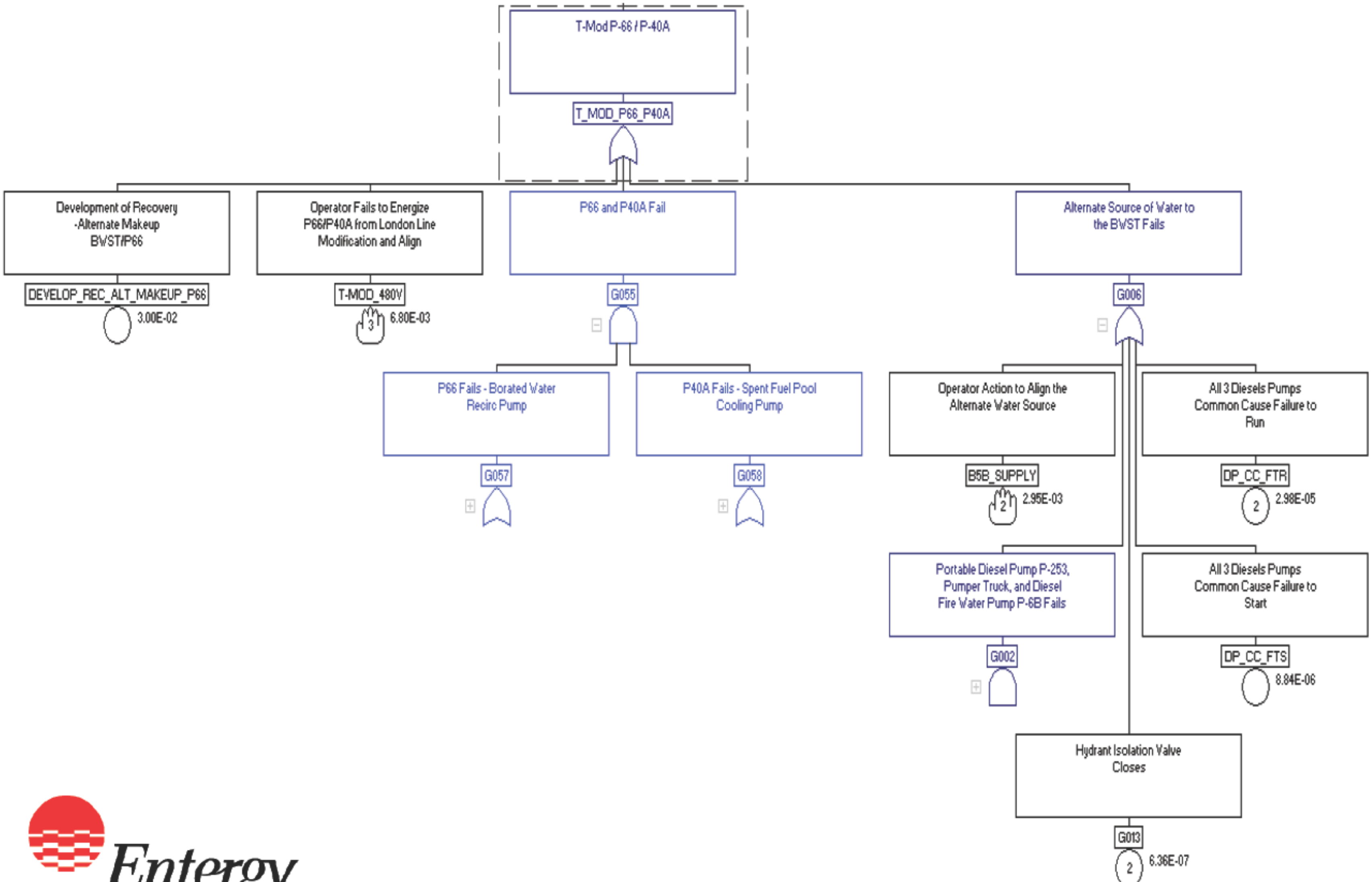
# Recovery Fault Tree for Inventory Control

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Enclosure 1

# Modeling Method Results

The resulting point estimate for inventory recovery fault tree is 4.0E-02

# Results

- When these recoveries are applied to the NRC's event tree model, the results are estimated to be 5.5E-06 CCDP

# Results to Include Sensitivities

Estimated NRC CCDP Results with Recoveries

| | | | | | |
|---|---|---|---|---|---|
| | ***4kV recovery*** | | | | |
| | 5.00E-03 | **4.88E-06** | **4.77E-06** | **4.71E-06** | |
| *mean* | 3.12E-02 | **6.14E-06** | **5.45E-06** | **5.07E-06** | |
| | 1.00E-01 | **9.44E-06** | **7.25E-06** | **6.01E-06** | |
| | | 1.00E-01 | 3.95E-02 | 5.00E-03 | ***Inventory Control*** |

*mean*

# ANO Shutdown PRA Risk Significant Results

- ANO developed event tree for Unit 1
- Utilized industry experts
- Quantifying this event tree has resulted in a core damage probability to be 4.8E-06

# Conclusion

- ANO's demonstrated response to the loss of offsite power provides overwhelming evidence that the probability of failure is not 1.0 as assumed by the NRC analysis

- ANO has instituted a reasonable method for assessing the risk of recovery

- ANO calculated the risk associated with the stator drop to be in the mid E-6 range

# Break

# ANO Unit 2
# Opening Comments

Jeremy Browning
ANO Site Vice-President



Enclosure 1

# Opening Comments

- Plant personnel took appropriate actions
- Plant mitigating systems performed as designed
- Priorities for system alignment and restoration of plant systems were based on actual plant conditions
- Procedurally directed and available success paths not credited in NRC risk model
- Available Success Paths would have been driven and implemented by existing procedures and processes
- Available Success Paths are trained on and are not complex and can be implemented in a timely manner
- Success Paths are modeled in existing PRA models
- Additional modeling improves the accuracy of the estimated risk

# ANO Unit 2 Response & Recovery

John Hathcote
Unit 2 Manager – Shift Operations



Enclosure 1

# Objectives

- Provide detail of procedurally directed electrical power recovery strategies using immediately available power sources
  - Offsite SU2 transformer available to power non-vital 4160VAC switchgear (2A2)
  - Alternate AC Diesel Generator
  - Cross tie vital 4160VAC busses 2A3/2A4

# Unit 2 Response

- Unit 2 100% power
- 'B' Reactor Coolant Pump (RCP) tripped due to breaker vibration
- Reactor tripped as a result of RCP trip
- Uncomplicated post trip response
- Off-site source auto-transferred from UAT to SU3
- Diagnosed Reactor Trip Recovery

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Enclosure 1

# Unit 2 Response

- SU3 lock out occurred ~90 minutes post trip
  - Water migration into the bottom of the RED train non-vital 4160VAC switchgear cubical 2A113
- SU2 automatically aligned to RED train
  - 2A1 and 2A3 energized from SU2
- GREEN train initially de-energized
  - GREEN train 2A2 and 2A4 de-energized based on selected configuration (2A2 feed from SU2 in PTL)
    - 2A2 remained de-energized
    - GREEN Train 4160VAC Vital Bus (2A4) energized by #2EDG on Bus undervoltage condition

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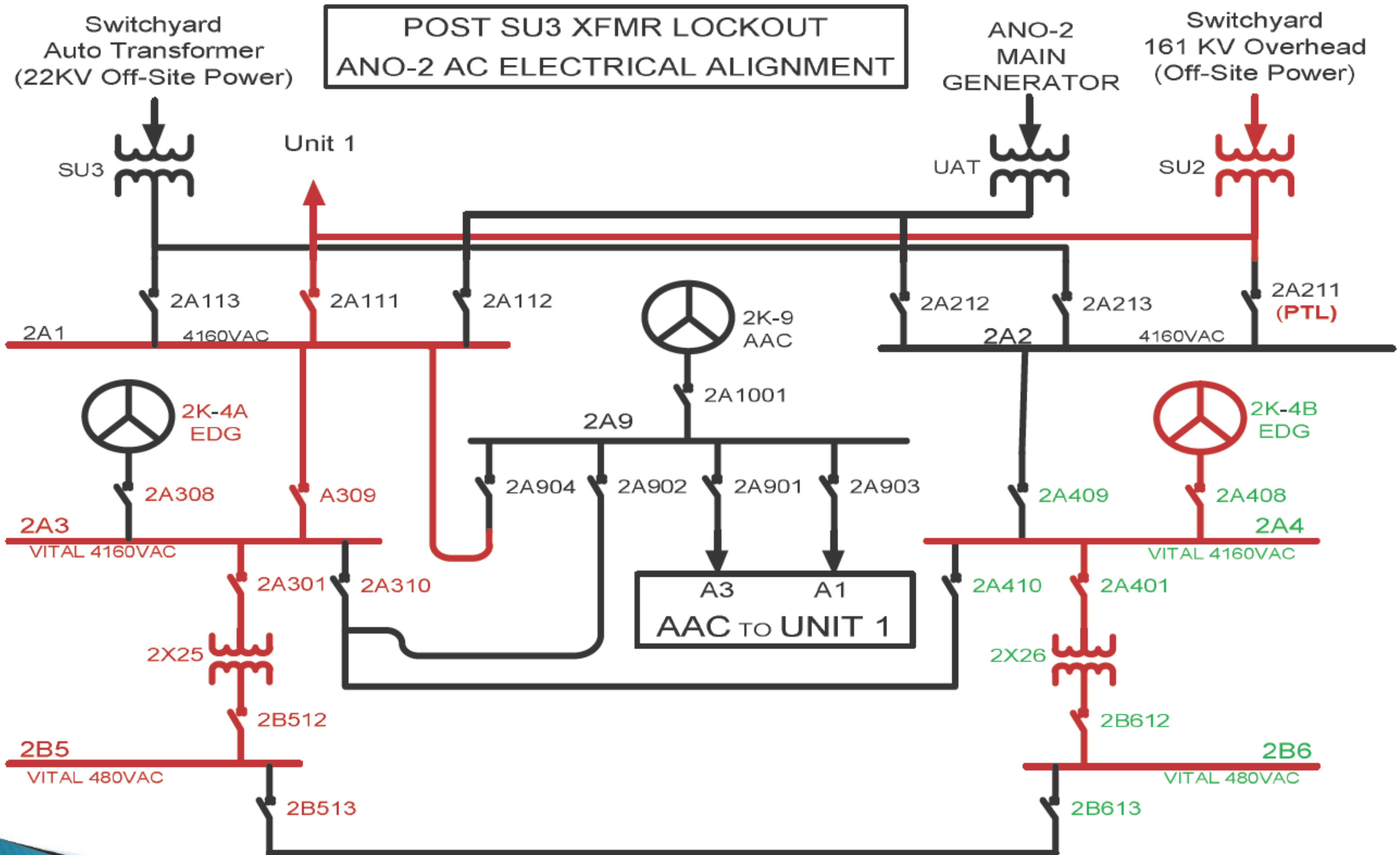
# Unit 2 Response






Enclosure 1

# Unit 2 Response

- SU2 Offsite Transformer Design
  - Capable of supplying both Units
  - Operating procedures limit the number of busses on both units that can be auto-transferred to SU2
    - 2A2 breaker hand switch in Control Room in pull to lock to control auto loading in SU2
  - Capable of manual loading both busses to SU2

- SU2 Offsite Transformer remained available for use on the GREEN (2A2/2A4) Train
  - Procedural guidance to manually energize 2A2 from SU2
  - Power was stable and SU2 to 2A2 was not needed
  - Later transferred power from SU2 to 2A2

# Unit 2 Response

- Unit 2 in a stable condition with power to all safety equipment
- Redundant systems available for decay heat removal
- Alternate AC Diesel Generator and 2A9 to Unit 2 busses were not damaged and were available
  - Initially declared unavailable
  - Not needed to support Unit 2
    - SU2 to both RED and GREEN Trains
    - #1 and #2 EDGs operable

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# Unit 2 Recovery

- Priorities dictated by circumstances
  - If additional power challenges were to occur
    - Unit 2 Control Room would re-diagnose
      - LOOP, SBO, Functional Recovery
    - Pursue procedurally directed action for recovery of available power
      - Feed to 2A2 from SU2
      - Alternate AC Diesel Generator
      - Cross tie 4160VAC busses 2A3 and 2A4

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# Unit 2 Recovery

- Feed for 2A2 from SU2
  - Proceduralized
  - Control Room staff trained on this action
  - In Control Room activity
  - Available resources

# Unit 2 Recovery

- Alternate AC Diesel Generator (AACDG) available to Unit 2
  - AACDG and 2A9 feeds to Unit 2 not affected
  - Only visible damage was associated with 2A9 feed to Unit 1 load side connections to A1 and A3
    - Fully capable of supplying Unit 2 loads if required
    - Confirmed later by Electrical Maintenance and Engineering through inspection and testing
  - 2A9 status verification was not given a high priority based on the stable condition of the units

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# Unit 2 Recovery

- AACDG available for Unit 2
  - Emergency Use
    - In a black out condition, EOPs instruct operations to utilize the AACDG
    - AACDG would have been used by the Control Room to power a vital 4160VAC bus and satisfy a safety function
      - Available in ~15 minutes
      - Adequate time available to establish feed in SBO
        - 6 hours until transition to manual operations on Unit 2 EFW pump

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# Unit 2 Recovery

- Ability to cross-tie 4160VAC Busses was available to the Operators
  - Proceduralized
  - Operations staff is trained on this action
  - Resources available

# Conclusion

- Available success paths not credited in NRC risk model
  - 2A2 availability from SU2
  - AACDG
  - Cross tie 4160VAC busses 2A3/2A4
- Four of five possible power sources available
- Resources
- Training
- Procedures

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# Significance Determination Unit 2

Richard Harris

Manager, Emergency Planning

# Key Objectives

- Best estimate of risk utilizing available information
  - Review key assumptions in the NRC risk assessment
  - Identify applicable ANO success paths
  - Discuss ANO risk significant results

# NRC Assumptions Affecting Dominant Sequences

- Review of the NRC results for the Unit 2 SDP
  - Dominant cutsets are driven by a loss of vital power
    - 2A2 unavailable
    - AACDG unavailable
    - No credit to cross tie 4160VAC busses 2A3/2A4

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# 4160 VAC Power Recovery

- 2A2 was available from SU2
- Operations guidance and procedures available for offsite power feed to 2A2
- ANO PRA existing recovery for aligning SU2 to 2A2 is 8.0E-4

# 4160 VAC Power Recovery

- Operations guidance and procedures available for AACDG alignment if needed for loss of vital power
- AACDG was available and would have successfully provided power to the vital loads
- ANO has increased PRA unavailability by a factor of 0.1 for AACDG (unavailability assumed to be 0.17)

# 4160 VAC Power Recovery

- 2A3 / 2A4 cross tie capability was available
- Per Operations guidance and procedures, 4160VAC busses 2A3/2A4 would have been cross tied if needed for loss of vital power
- ANO PRA existing recovery of the 2A3/2A4 cross tie is 2.0E-4

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# Results

- These new results present a risk that is categorized as 1.8E-6 CCDP

- A sensitivity analysis reflects the following
  - 3.9E-07 CCDP – lower bound
  - 5.3E-06 CCDP – upper bound

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# Site Actions & Common Cause

Dale James
ANO Regulatory & Performance Improvement Director

# Corrective Actions

- Lift plan for refurbished stator incorporated Root Cause findings
  - Developed Detail Engineering Change Package
  - Computer modeling
  - Load test
  - Third Party Independent Review
- Revised Entergy Fleet procedure EN-MA-119, Material Handling Program, to require a documented engineering response to evaluate specially designed temporary lifting devices
  - Owner review in accordance with EN-DC-149, Acceptance of Vendor Documents
  - Verification of a third party independent review of vendor calculations
  - Verification of load test

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# Corrective Actions

- Revised Entergy Fleet procedure EN-DC-114, Project Management
  - Guidance for contract language to ensure necessary design documentation provided
  - Guidance for Project Management team expertise for high consequence evolutions
- Reinforced standards for vendor oversight plans
- Established structured tool for project management oversight
- Subsequent directive issued requiring manager level validation of mitigating actions
- Industry wide web cast hosted by ANO Site VP discussing the event and lessons learned

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# Common Cause Review

- Review of 2013 conditions including stator drop for common causal factors
  - Seven plant conditions included in the review
    - Interviews conducted to provide additional insights
  - Trend Code and Keyword review of Category A and B Condition Reports from 2012-Present for further refinement
  - External agency and assessment report reviewed
  - Review performed by team consisting of independent analysis, fleet and ANO personnel
- Specifically charged with assessing oversight as a common causal factor

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# Fleet Learnings

Joe Kowalewski
Senior Vice President and COO – Southern Regional Operations

# Fleet Learnings

- Entergy depends on contractors to perform work to improve the reliability and improve the safety of the plant
- Entergy must have robust processes and oversight in place to detect and correct errors before they cause significant consequences

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# Actions Completed

- EN-MA-119 Material Handling and EN-DC-114 have been revised to incorporate lessons learned from the ANO Stator Event
- Communication of lessons learned to the Fleet and assessment of ongoing projects with heavy lifts
- Organizational changes to provide additional oversight of engineering activities for major project and additional oversight of site project management
- Improvements in the skill assessment of supplemental personnel supervision, including Entergy presence at oral boards and evaluated practical exercises

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# Actions In-Progress

- Common cause evaluation of contractor performance issues
- Participation in industry committee supporting assessment and lessons learned of industry wide high consequence vendor/contractor performance issues
- Evaluation of Fleet process and oversight improvements based on industry wide lessons learned
- Implementation of improvements in the validation of completed actions for the mitigation of identified high project risks

# Closing Comments

Jeremy Browning
ANO Site Vice-President

U.S.NRC
United States Nuclear Regulatory Commission
*Protecting People and the Environment*

# *Arkansas Nuclear One Regulatory Conference*

**Nuclear Regulatory Commission - Region IV**

**Arlington, TX**

**May 1, 2014**



Enclosure 2

# Agenda

- Introduction of Participants
- NRC Opening Remarks
- Licensee Presentation
- NRC Caucus
- Final Questions
- Closing Remarks
- Conference Adjournment
- Questions and Comments from Members of the Public

| PUBLIC MEETING ATTENDANCE LIST | |
|---|---|
| **LICENSEE/FACILITY** | Entergy/Arkansas Nuclear One |
| **DATE/TIME** | May 1, 2014 / 1:00 p.m. (CDT) |
| **LOCATION** | Region IV, Arlington, TX |

| NAME (PLEASE PRINT) | ORGANIZATION |
|---|---|
| John McCann | Entergy |
| Bryan Ford | Entergy |
| JOHN HATHCOTE | ENTERGY / ANO |
| Gary Sullins | Entergy / ANO |
| DAVID MCKERNEY | ENTERGY / ANO |
| Dale James | Entergy / ANO |
| Jeremy Browning | Entergy / ANO |
| STEPHENIE PYLE | ENTERGY / ANO |
| Joseph Kowalewski | ENTERGY |
| Mike Shannon | QGTB / ANO |
| Jason Hall | Entergy |
| Richard Harris | Entergy / ANO |
| | |
| | |

| PUBLIC MEETING ATTENDANCE LIST | |
|---|---|
| LICENSEE/FACILITY | Entergy/Arkansas Nuclear One |
| DATE/TIME | May 1, 2014 / 1:00 p.m. (CDT) |
| LOCATION | Region IV, Arlington, TX |

| NAME (PLEASE PRINT) | ORGANIZATION |
|---|---|
| JAMES, WILLIAM J. | ENTERGY |
| ALUISE, JOSEPH A. | ENTERGY |
| Neil O'Keefe | NRC |
| Vikram Shukla | Bigge |
| Sanjay Mirpuria | Bigge |
| Jamie Weiss | Siemens / EWLLP |
| Dave Duerr | Siemens |
| Michael Langelier | NRC |
| | |
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| | |
| | |

NWX-US NUCLEAR REGULATORY COM Conference Call

Mr. James Melfi - Conference Leader

May 1 2014 @ 12:00 PM CT

Confirmation # 4934859

| Speakers: | | |
|---|---|---|
| Dori | Willis | NRC |
| Greg | Werner | Mike Bloodgood |
| Joseph | Giitter | NRC |
| Sunil | Weerakkody | NRC |
| Michael | Markley | NRC HQ |
| Eric | Towell | NRC |
| Kamishan | Martin | NRC HQ |
| Lauren | Casey | NRC |
| Geoff | Miller | NRC |
| Abin | Fairbanks | NRC |
| Paul | Nizonv | NRC Region 4 |

| | First Name | Last Name | Affiliation |
|---|---|---|---|
| 1 | Kenneth | Baldwin | Private Citizen |
| 2 | Bernie | Bevill | AK Dept of Health |
| 4 | Alan | Blind | Public |
| 5 | Thomas | Bostrom | Bigge Crane & Rigging |
| 7 | Mike | Bowling | Entergy |
| 8 | Justin | Brittler | Pope County Office of Emergency Management |
| 9 | David | Condi | ABZ Inc. |
| 10 | Mike | Cooper | Certrec Corporation |
| 11 | Dan | Cunnard | Seimans |
| 12 | Jeff | Dail | Duke Energy |
| 15 | Carla | Fuller | Nuclear Regulatory Commission Region 4 |
| 16 | Kelly | Gamble | Vincent and Elkins |
| 17 | Darla | Gardner | Finance MGR for Nuclear Fleet |
| 18 | Joshep | Gitter | NRC |
| 19 | Mike | Guerrero | Siemens |
| 20 | David | Gullott | Exelon |
| 21 | Greg | Halnon | First Energy Corp |
| 22 | Mark | Hollander | Siemens |
| 23 | Cet | Jackson | Siemens |
| 24 | Jeff | Julius | Scientech |
| 27 | Dan | Kaunnard | Siemens |
| 28 | Fred | Laber | Siemens |
| 29 | David | Lochbaum | Union of Concerned Scientists |
| 30 | William | Maier | NRC |
| 31 | Jim | Melfi | NRC |
| 32 | Sarah | Millard | Communication Specialist |
| 34 | Sanjay | Minocha | Kane Russell Omen Logan |

| | First Name | Last Name | Affiliation |
|---|---|---|---|
| 35 | Robert | Myer | PROS |
| 36 | Paul | Nizov | NRC |
| 37 | Roosevelt | Shavers | OSHA |
| 38 | Deborah | Shurberg | Human Performance Analysis Corporation |
| 39 | Lisa | Simpson | Exelon |
| 40 | Brian | Smith | Siemens |
| 41 | David | Smith | Arkansaw Democrat Gazette |
| 42 | Whitney | Snipes | River Valley Leader |
| 43 | Guy | Thompson | Siemens |
| 44 | David | Tondi | ABZ |
| 45 | Russell | Voight | Siemens |
| 46 | Shelton | Voigt | Siemens Energy |
| 47 | Seno | Weerakkody | NRC |
| 48 | Sunil | Weerkkoy | NRC |
| 49 | Gregory | Werner | NRC |
| 50 | Michael | Wilder | Duke Energy |
| 52 | Carrie | Wilson | Duke Energy |
| 54 | Peter | Wilson | TN Valley Authority |