Tab 3:

Module 2: Electrical Analysis

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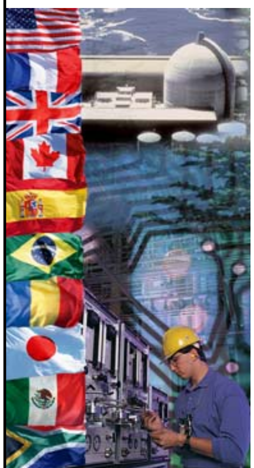
Tab 3.1:

Circuit Analysis Overview

ELECTRIC POWER RESEARCH INSTITUTE

Science Applications International Corporation



EPRI/NRC-RES FIRE PRA METHODOLOGY

Module 2: Fire PRA Circuit Analysis Overview

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F. Wyant - Sandia National Laboratories

Joint RES/EPRI Fire PRA Course
September and November 2008
Bethesda, MD

A Collaboration of U.S. NRC Office of Nuclear Regulatory Research (RES) & Electric Power Research Institute (EPRI)

CIRCUIT ANALYSIS
Presentation Road Map

- Circuit Analysis "Big Picture" Overview
- Circuit Analysis Strategy & Implementation
- Introduction to Key Considerations & Factors
- Review and Discussion of Tasks
- Relationship to Appendix R & NFPA 805
- Discussion of Relevant FAQs
- Examples

CIRCUIT ANALYSIS
Circuit Analysis Tasks

- Task 3 – Fire PRA Cable Selection
- Task 9 – Detailed Circuit Analysis
- Task 10 – Circuit Failure Mode Likelihood Analysis
- Support Task B – Fire PRA Database

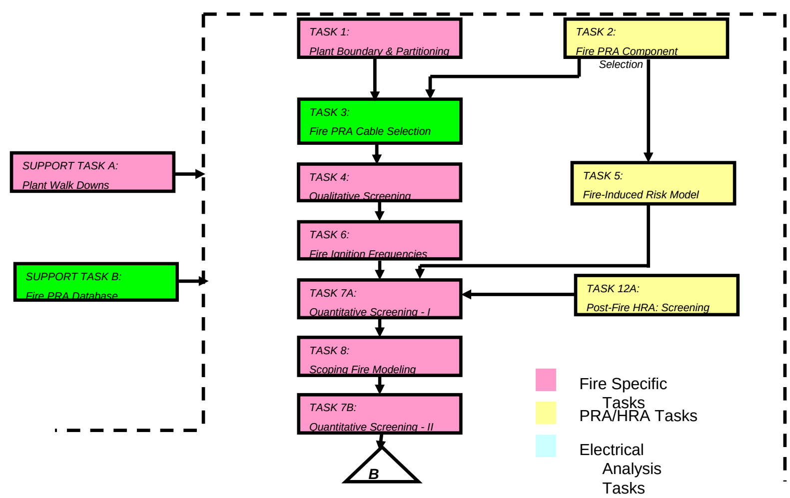
CIRCUIT ANALYSIS
Circuit Analysis Overview

- Substantial Technical and Process-Related Advances
  - Implication of these Advances: Circuit analysis is more complex and difficult than analyses performed under Appendix R
- Collective Awareness of Circuit Failure Implications Greatly Improved
- Knowledge Base Improvements
  - Fire Tests: EPRI, CAROLFIRE, Duke: Better but not perfect understanding of fire-Induced circuit failures
  - Practical experience from NFPA 805 transition projects
    - Important “Lessons Learned” from pilot plants
    - Significant insights from “in-progress” transition projects
  - Active FAQ Process
    - Interpretation of guidance
    - New guidance

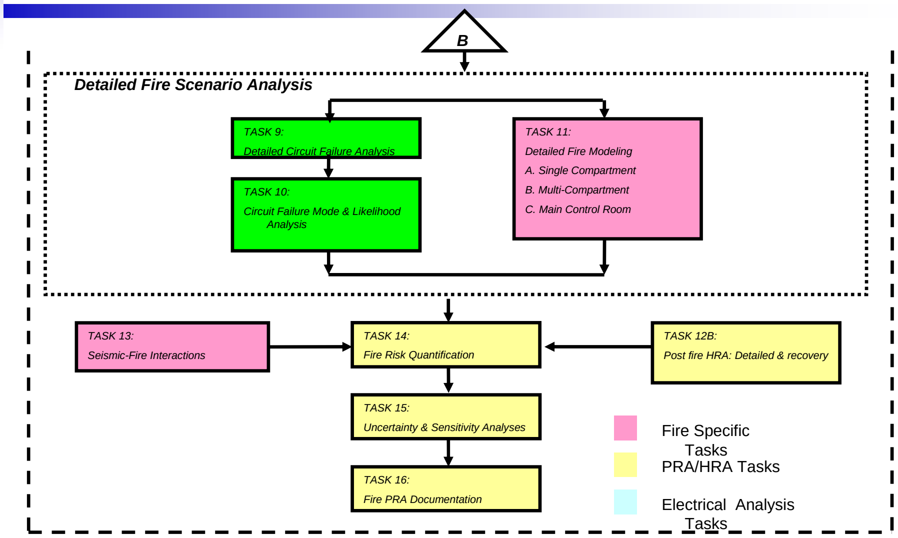
CIRCUIT ANALYSIS
Circuit Analysis Overview

- Circuit Analysis is Now an Integral and Formal Part of the Fire PRA Process
  - Rigorous and formal process for correlating cables-to-equipment-to-affected locations
  - Definitive data and criteria has replaced estimations and judgment
  - Essential that Fire PRA and NFPA-805 data be fully integrated
    - *Note: The subtleties of aligning Fire PRA and traditional Appendix R/NFPA-805 data is more complex than originally anticipated.* This primarily shows up in Component Selection (Task 2), but has major ramifications to the circuit analysis
  - Further Refinements to "State-of-the-Art" Techniques Realistic
  - Practical aspects of dealing with an integrated data set
  - Practical approach for dealing with MSOs

CIRCUIT ANALYSIS
PRA Task Flow Chart



CIRCUIT ANALYSIS
PRA Task Flow Chart (continued)



CIRCUIT ANALYSIS
Overall Strategy & Implementation

- Each Electrical Analysis Task Represents a Refined Level of Detail, i.e., Graded Approach
- Level-of-Effort for the Electrical Work is a Key Driver for Project Scope, Schedule, and Resources
  - High Programmatic Risk if Not Carefully Controlled
  - Analysis and Routing of all Cables can be a Large Resource Sink with Minimal Overall Benefit
  - Concerns Validated by Numerous Projects
- Detailed Analysis Driven by Quantitative Screening Results
  - Intelligence-Based Circuit Analysis
  - Iterative Process
  - Important to screen out obvious “Not Required” cables during the initial cable selection process, with refinement driven by quantitative screening

CIRCUIT ANALYSIS
Overall Strategy & Implementation, cont…

- Recommended Methods are Consistent with Industry Best Practices
- Use Risk Perspectives to Streamline and Focus Analysis
- Remains a Technically and Logistically Challenging Area
- Limitations to the State-of-the-Art:
  - Number of Multiple Hot Shorts/Spurious Actuations
  - Spurious Actuation Probabilities
  - Timing Considerations (being addressed by FAQ process)
- Existing Appendix R Circuit Analysis is NOT as Useful as Originally Envisioned

CIRCUIT ANALYSIS
Overall Strategy – Related FAQ

- FAQ 08-0051 Hot Short Duration (Status: Open)
  - Issue:
    - The guidance does not provide a method for estimating the duration of a hot short once formed
    - This could be a significant factor for certain types of plant equipment that will return to a "fail safe" position if the hot short is removed
  - General approach to resolution:
    - Analyze the existing cable failure modes and effects test data to determine if an adequate basis exists to establish hot short duration distributions
  - Status:
    - Initial data analysis has been completed and results are under team review
    - NRC staff and industry review pending

CIRCUIT ANALYSIS
Overall Strategy & Implementation, cont…

- Circuit Analysis (including cable tracing) Can Consume 40%-70% of Overall Budget
- Circuit Analysis Scope MUST be a Primary Consideration During Project Scoping
- Qualified and Experienced Electrical Analysts Must be Integral Member of PRA Team
- Coordination and Integration with Appendix R Must Occur Early and Must be Rigorous
- Coordination with Task 2 (Component Section) is Essential – MUST Understand the EXACT Functionality Credited for Each Component

CIRCUIT ANALYSIS
Key Considerations

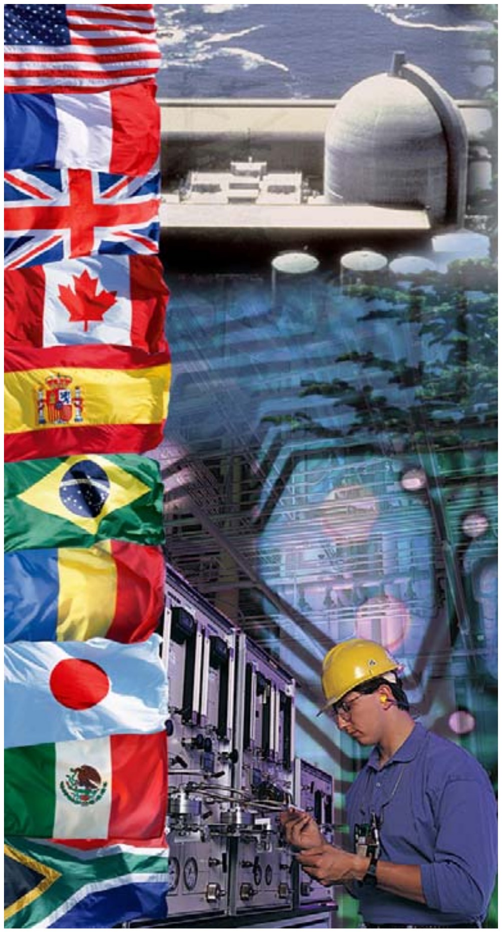
- Relationship with Appendix R/NFPA 805 Analysis
- Long-Term Strategy for Data Configuration Control – Especially if Shared Data with Appendix R/NFPA-805
- Availability, Quality, and Format of Cable Data
- Usability of Appendix R Circuit Analysis Data
  - Not as useful as originally envisioned
  - Automated tools are essential
  - Functional state analysis is critical – overly conservative cable selection will not work for Fire PRA
  - Many plants are finding that circuit analysis re-baseline is necessary to support upgraded Fire PRA and NFPA-805 projects
- User-Friendliness of Electrical Drawings
- Availability of Electrical Engineering Support
  - Circuit analysis is a developed expertise
  - Do not expect to be a proficient analyst based on a simple introductory course

CIRCUIT ANALYSIS
Summary

- Do Not Underestimate Scope
- Ensure Proper Resources are Committed to Project
- Doable but **MUST** Work Smart
- Do Not “Broad Brush” Interface with Appendix R – Have a Detailed Plan Before Starting
- Constant Interaction with Systems Analysts is Critical
- Develop Project Procedures – But Don’t Get Carried Away
- Compilation and Management of Large Volume of Data
  - Automated Tools Imperative for Efficient Process
  - Be Mindful of Long-Term Configuration Management

Tab 3.2:

Task 3 Cable Selection



EPRI/NRC-RES FIRE PRA METHODOLOGY

Module 2: Task 3 - Fire PRA Cable Selection

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FIRE PRA CABLE SELECTION
Purpose & Scope

- Identify Circuits/Cables Associated with Fire PRA Components
- Determine Routing/Location of the Identified Cables
- Use Component-to-Cable-to-Location Relationships to Determine What Components Could be Affected for Postulated Fire Scenarios

  Note: Scenario can be Fire Area, Room, Raceway, or Other Specific Location

- Identify Fire PRA Power Supplies

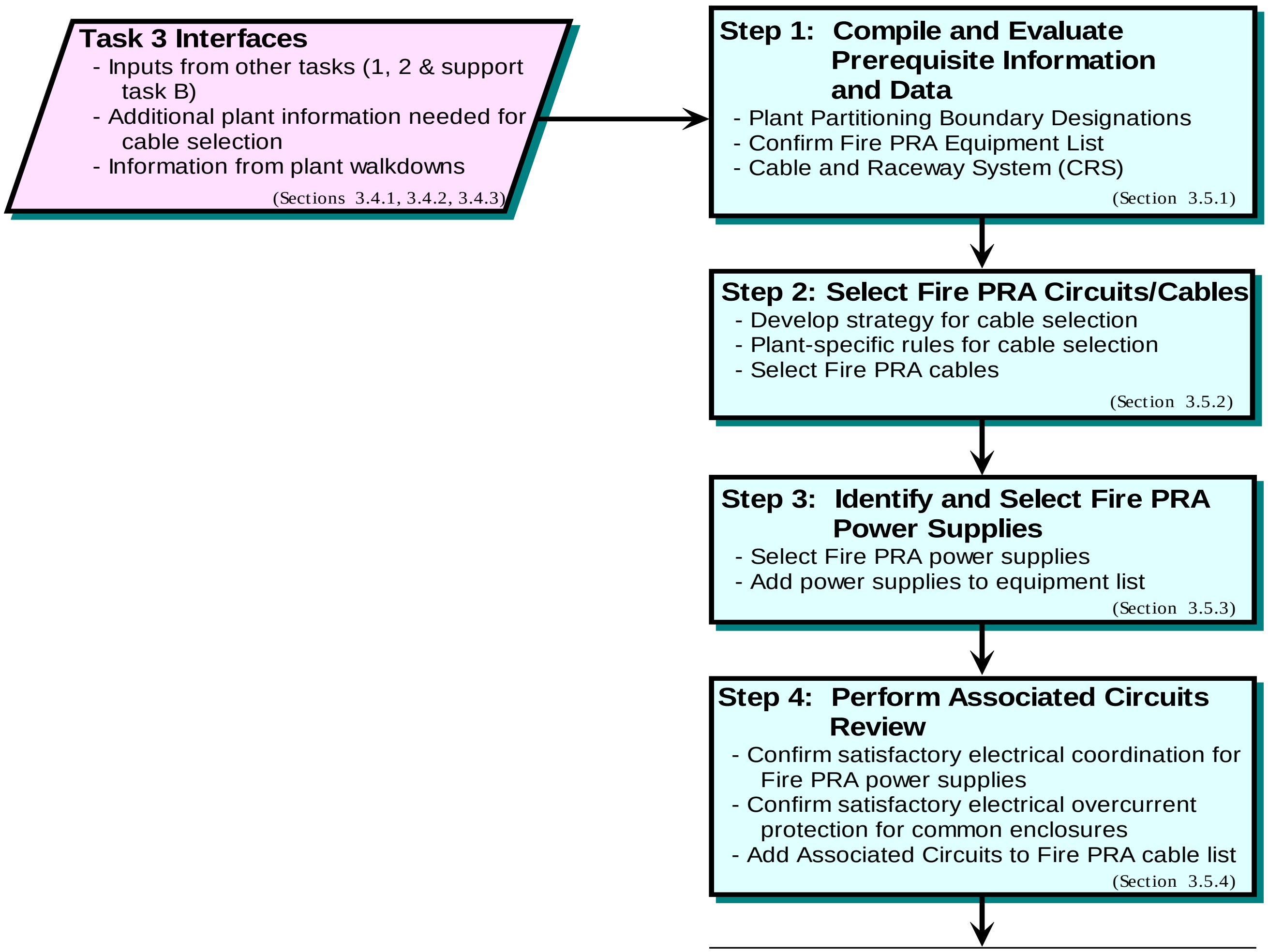
FIRE PRA CABLE SELECTION
Introduction

- Conducted for all Fire PRA Components

  Note: Exceptions do exist

- Deterministic Process
- Cables Associated to Components Based on Specified Functionality
  - Basic circuit analysis (Task 9) incorporated into Task 3 work to prevent overwhelming the PRA model with inconsequential cable failures
  - Final product is a listing of defined Basic Events (component and credited function) that could be impacted by a fire for a given location (Fire Area, Fire Compartment, Fire Scenario)
- Procedure subdivided into six (6) distinct steps

FIRE PRA CABLE SELECTION
Flowchart



FIRE PRA CABLE SELECTION
Flowchart

Step 5: Determine Cable Routing and Plant Locations
- Determine cable routing and end points
- Determine raceway and end point locations
- Determine raceway fire protection features

(Section 3.5.5)

Step 6: Fire PRA Cable List and Target Equipment Location Reports
- Assemble Fire PRA cable list
- Generate target equipment location reports

(Section 3.5.6)

Uncertainty
- Plant partitioning and cable location
- Plant-specific cable selection guidelines
- Cable selection process
- Cable location and routing accuracy
- Electrical coordination and protection

Task 3 Outputs
- Fire PRA Database
- Component work packages

(Input to Task 9)

(Section 3.4.4)

FIRE PRA CABLE SELECTION
Task Interfaces - Input

- Plant Boundary Partitions (Task 1)
- Fire PRA Component List (Task 2)
- Fire PRA Database (Support Task B)
- Appendix R Circuit Analysis
- Plant Cable & Raceway Database
- Plant Drawings

FIRE PRA CABLE SELECTION
Task Interfaces - Output

- Fire PRA Cable List
- Fire PRA Power Supply List
- Associated Circuits review
- Component Analysis Packages
- Target Equipment Loss Reports (Potential Equipment Functional Losses Broken Down by Location or Scenario)

FIRE PRA CABLE SELECTION
Step 1 – Prerequisite Information

- Confirm Plant Partitioning is Compatible
  - Do partitions align with cable location data?
  - What data is available and what is missing?
- Confirm PRA Equipment List is Final
  - Input into a formal and controlled database
  - For NFPA-805 transition projects a joint “consistency” review of NSP task and PRA component selection task is highly recommended
  - *Critical that electrical analysts understand what the Basic Events really mean*
- Evaluate Database Requirements
  - What currently exists?
  - What is needed to support work?
  - How is data to be managed and controlled?
  - This is a “Biggy”

FIRE PRA CABLE SELECTION
Step 2 – Select Fire PRA Cables

- Analysis Cases
  - Appendix R Component with Same Functional Requirements
    - Must consider which (if any) automatic features are included in the existing analysis
    - Aligning existing analyses to Fire PRA Basic Events is not straightforward
  - Appendix R Component with Different Functional Requirements
  - Non-Appendix R Component with Cable Location Data
  - Non-Appendix R Component without Cable Location Data

- Analysis Sub-Steps
  - Step 2.1 - Analysis Strategy
  - Step 2.2 - Plant Specific Rules
  - Step 2.3 - Select Cables

FIRE PRA CABLE SELECTION
Step 2.1 – Analysis Strategy

- Coordinate with Systems Analysts to Establish Functional Requirements and General Rules
  - Equipment functional states, basic events, initiators
  - Initial conditions and equipment lines (i.e., normal state)
  - Consistent conventions for equipment functions/state/position
  - Equipment-level dependencies and primary components
  - Multiple function components
  - Super components
- Evaluate Appendix R Component & Circuit Data
  - Ensure equipment list comparison conducted during Task 2
  - Review in detail the comparison list – ask questions!!!
  - Essential that comparison includes detailed review/comparison of “desired functional state(s)”

FIRE PRA CABLE SELECTION
Step 2.1 – Analysis Strategy (continued)

- Goal – Efficient and Accurate Process to Obtain Required Information
- Revisit Past Assumptions, Conventions, Approach
- Potential Trouble Areas
  - How is off-site power going to be handled?
  - Instrument circuits – understand exactly what is credited
  - ESAFA, Load-Shed, EDG Sequencer, other automatic functions
  - Medium-voltage switchgear control power
- Extent of Detailed Analysis to be Conducted Concurrently
- Determine How Analysis Will be Documented

FIRE PRA CABLE SELECTION
Step 2.2 – Plant Specific Cable Selection Rules

- Objective is Consistency
- Approach for Groups of Components
- Approach for Spurious Actuation Equipment
- Auxiliary Contacts – Critical Area for Completeness
- System-Wide Actuation Signals
- Bus or Breaker?
- Subcomponents & Primary Components
- Identification of Permanent Damage Scenarios
- Procedure - Develop Circuit Analysis Procedure/Guidelines

FIRE PRA CABLE SELECTION
Step 2.2 – Ready to Start?

- Develop Written Project Procedure/Guidelines
  - Consistency, Consistency, Consistency
  - Checking Process?
  - Data Entry
  - Problem Resolution
- Training for Analysts
  - Prior circuit analysis experience is a prerequisite for key team members
  - Familiarity with plant drawings and circuits is highly beneficial
  - A junior engineer with no prior circuit analysis experience will not be able to work independently

FIRE PRA CABLE SELECTION
Step 2.3 – Select Cables

- Case 1: Incorporate Existing Appendix R Analysis
  – Confirm adequacy of existing analyses IAW plan
  – Careful consideration of automatic functions
  – Exact alignment for credited functionality
- Cases 2 & 3: New Functional State/Component: w/ Cable Routing Data
  – Collect drawings and/or past analysis information
  – Identify/select cables IAW plant specific procedure/guidelines
  – Conduct detailed analysis to the extent decided upon
  – Formally document cable selection IAW established procedures/guidelines

FIRE PRA CABLE SELECTION
Step 2.3 – Select Cables (continued)

- Case 3: New Component: w/o Cable Routing Data Available
  - Same as Case 2 & 3, plus…
  - Determine cable routing and associate with plant locations, including cable end points
- Analysis Work Packages
  - Retrieve from Past Appendix R Analysis
  - Highly Recommended for New Components
  - Major time saver for future work

FIRE PRA CABLE SELECTION
Step 3 – Select Fire PRA Power Supplies

- Identify Power Supplies as Integral Part of Cable Selection
  - Make sure to differentiate between “Required” and “Not Required” power supplies
  - Switchgear and Instrument power supplies can be tricky
  - Useful to identify the applicable breaker/fuse
- Add Power Supplies to Fire PRA Component List
- Make sure Fire PRA model, equipment list, and electrical analysis are consistent
- Does Fire PRA model consider spurious circuit breaker operations?
  - Must understand how this is modeled to correctly select cables

FIRE PRA CABLE SELECTION
Step 4 – Associated Circuits Review

- Objective is to Confirm Existing Studies Adequate
- View the Process as a “Gap Analysis”
- Common Power Supply Circuits - Assess Plant Coordination Studies
- Common Enclosure Circuits - Assess Plant Electrical Protection
- Roll Up Results to Circuit Analysis or Model as Appropriate

  Note: Ensure Switchgear Internal Fusing Supports Analysis Assumptions

FIRE PRA CABLE SELECTION
Step 5 – Determine Cable Routing and Locations

- Correlate Cables-to-Raceways-to-Locations
- Conceptually Straightforward
- Logistically Challenging
  - Labor intensive
  - Manual review of layout drawings
  - Plant walkdowns often required
- Determine Cable Protective Features
  - Fire wraps
  - Embedded conduit

FIRE PRA CABLE SELECTION
Step 6 – Target Equipment Loss Reports

- Data Entered into Fire PRA Database
- Sorts and Queries to Generate Target Equipment Loss Reports

Perspective….Cable selection process should be viewed as providing "Design Input" to the Fire PRA. It does not, however, provide any risk-based results. In its simplest form it provides a list of equipment that could be affected by a fire at a specified location or for a specific scenario.

Tab 3.3:

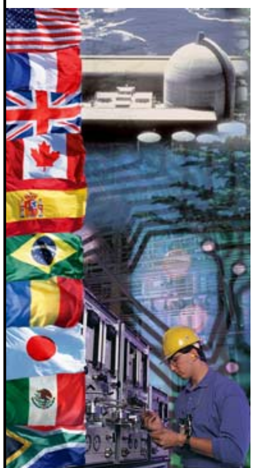
Task 9 Failure Modes Analysis

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

ELECTRIC POWER RESEARCH INSTITUTE

Sandia National Laboratories

SAIC Science Applications International Corporation



EPRI/NRC-RES FIRE PRA METHODOLOGY

Module 2: Task 9 - Detailed Circuit Failure Analysis

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September and November 2008
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DETAILED CIRCUIT FAILURE ANALYSIS
Purpose & Scope

The Detailed Circuit Failure Analysis Task is intended to:

- Identify the potential response of circuits and components to specific cable failure modes associated with fire-induced cable damage
- Screen out cables that do not impact the ability of a component to complete its credited function

DETAILED CIRCUIT FAILURE ANALYSIS
Introduction (1)

- Fundamentally a deterministic analysis
- Perform coincident with cable selection (Task 3) to the extent feasible and cost effective
- Difficult cases generally reserved for situations in which Quantitative Screening indicates a clear need and advantage for further analysis
- Detailed Failure Modes Analysis
  - Requires knowledge about desired functionality and component failure modes
  - Conductor-by-conductor evaluation (Hot Probe method recommended)
- Objective is to screen out all cables that CANNOT impact the ability of a component to fulfill the specific function of interest

DETAILED CIRCUIT FAILURE ANALYSIS
Introduction (2)

- Failure Modes Considered
  - Single Shorts-to-Ground (Reference Ground)
    - Grounded System
    - Ungrounded System
    - Resistance Grounded System
  - Single Hot Shorts
  - Compatible Polarity Multiple Hot Shorts for Ungrounded AC and DC Circuits
  - Coincident Independent Hot Shorts On Separate Cables
  - Multiple Intra-cable Hot Shorts
  - Cables Associated Through Common Power Supply

DETAILED CIRCUIT FAILURE ANALYSIS
Introduction (3)

- Failure Modes NOT Considered
  - 3-phase proper sequence hot shorts (except high consequence equipment with thermoplastic insulated conductor or ungrounded configuration)
  - Inter-cable hot shorts for armored cable and cable in dedicated conduit
  - Open circuit conductor failures
  - Multiple high-impedance faults

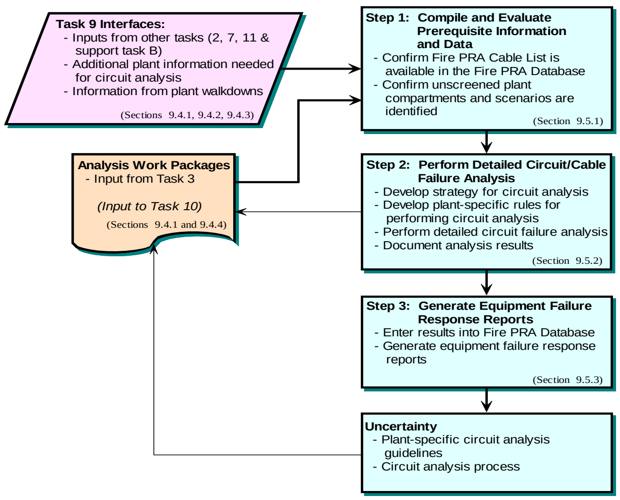
Note: if conducting a combined NFPA-805 and Fire PRA circuit analysis, NEI 00-01 suggests that open circuits be considered

DETAILED CIRCUIT FAILURE ANALYSIS
Assumptions

The Following Assumptions Form the Basis for Task 9:

- An Appendix R analysis for the plant has been completed and is available for identifying equipment failure responses to specific cable failure modes
- Component **Work Packages** have been assembled as part of the Task 3 activities or previous Appendix R analyses
- Equipment is assumed to be in its normal position or operating condition at the onset of the fire – the equipment state might be variable
- Users of this procedure are knowledgeable on and have experience with circuit design and analysis methods

DETAILED CIRCUIT FAILURE ANALYSIS
Flowchart



DETAILED CIRCUIT FAILURE ANALYSIS
Task Interfaces - Inputs

- Fire PRA Components List (Task 2)
- Fire PRA Cable List (Task 3)
- Fire PRA Database (Support Task B)
- Results of Quantitative Screenings (Task 7)
- Results of Detailed Fire Modeling (Task 11)
- Appendix R Circuit Analysis
- Plant Drawings
- CRS Database

DETAILED CIRCUIT FAILURE ANALYSIS
Task Interfaces - Outputs

- Equipment Failure Response Reports
- Component Analysis Packages (Updated)
- Revised Cable List
- Fire PRA Database & Model Updates

DETAILED CIRCUIT FAILURE ANALYSIS
Step 1 - Compile Prerequisite Information

- Ensure that prerequisite information and data is available and usable before beginning the analyses (ideally the necessary drawings are already in the Work Packages).
- Step 1.1: Confirm Fire PRA Cable List is Available in the Fire PRA Database
  - Component ⇒ Cable ⇒ Raceway ⇒ Compartment
- Step 1.2: Confirm Unscreened Plant Compartments and Scenarios are Identified
  - Target Equipment Loss Reports
  - Equipment ID, Normal Status, Functional Requirements, etc.

DETAILED CIRCUIT FAILURE ANALYSIS
Step 2 - Perform Circuit Failure Analysis

- Perform a *Deterministic-Based* detailed circuit analysis for the Fire PRA cables of interest that are located in the unscreened plant locations.
- Step 2.1: Develop Strategy/Plan for Circuit Analysis
- Step 2.2: Develop Plant-Specific Rules for Performing the Detailed Circuit Analysis
- Step 2.3: Perform Detailed Circuit Failure Analysis
- Document Analysis Results ⇒ Component Work Packages

DETAILED CIRCUIT FAILURE ANALYSIS
Step 3 - Generate Equipment Failure Response Reports

- Enter Results into Fire PRA Database
- Generate Equipment Failure Response Reports
  - A Listing by location (room, zone, area) of equipment and associated cables affected by fire
  - Provides specific equipment responses (cable failure consequences) that affect the credited function being analyzed
  - Equipment losses should be correlated to each Basic Event

DETAILED CIRCUIT FAILURE ANALYSIS
Caveats & Recommendations

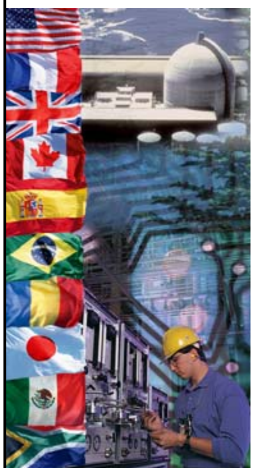
- This Detailed Circuit Failure Analysis Methodology is a Static Analysis (No Timing Issues are Considered)
- Be Aware of Possible Cable Logic Relationships
- Work Packages (Highly Recommended!)
- “Hot Probe” (Conductor-to-Conductor) Analysis Must be Rolled-Up to Cable/Component Level
- Outputs Need to Be Compatible with Fire PRA Database Format and Field Structure
- Coordinate with the Fire PRA Modelers/Analysts Early-On to Define the Fire PRA Component Failure Modes of Concern

Tab 3.4:

Task 10 Failure Mode Likelihood Analysis

Tab 3.4a:

Task 10 Presentation Materials



EPRI/NRC-RES FIRE PRA METHODOLOGY

Module 2: Task 10 - Circuit Failure Mode Likelihood Analysis

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CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS

Purpose & Scope

The Circuit Failure Mode Likelihood Analysis Task is Intended to:

- Establish First-Order Probability Estimates for the Circuit Failure Modes of Interest

AND

- Correlate Those Failure Mode Probabilities to Specific Components

CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS
Introduction (1)

- Probabilistic Based Analysis
- Two Methods Presented
  - Expert Panel Results (Look-Up Tables)
  - Computation-Based Analysis (Formulas)
- Requires Knowledge About Circuit Design, Cable Type and Construction, Installed Configuration, and Component Attributes
- Generally Reserved for Only Those Cases that Cannot be Resolved Through Other Means

CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS
Introduction (2)

- Caveats:
  - Our Knowledge is Greatly Improved but Uncertainties are Still High
    - Very limited data for many issues
  - For This Reason, Implementing Guidance is Conservative
  - Practical Implementation is Challenging
  - Further Analysis of Existing Test Data and Follow-On Tests Would be Beneficial:
    - Reduce Uncertainties, including conservatisms as appropriate
    - Solidify Key Influence Factors
    - Incorporate Time as a Factor (FAQ 007-051)
    - Incorporate “End-Device” Functional Attributes and States (e.g., latching circuits vs. drop-out design)
  - Computation-based method (formula) is an extrapolation of existing data; validation remains to be done. Conservatism has not been established.
- Probabilities of sufficient quality to move ahead

CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS
Introduction (3)

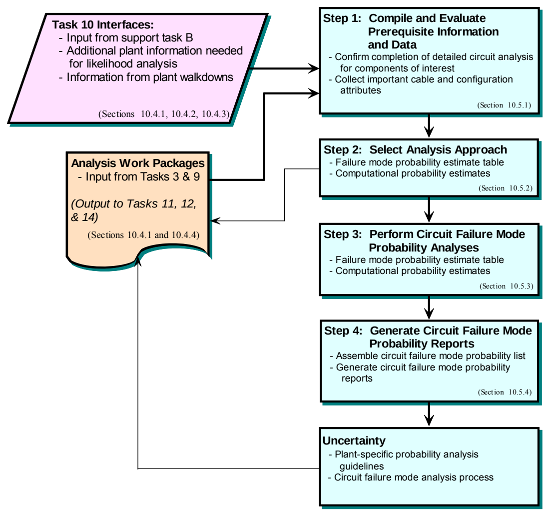
- Public and Peer Review Comments
  - Several Questions Involving Interpretation of the EPRI Test Data Lead to Extensive Discussions Regarding the Most Appropriate Way to Tally Spurious Actuation Probabilities (Many Subtleties for Implementation)
  - Team's Consensus is that Expert Panel Values are, in General, somewhat Conservative
  - Additional Independent Review of the Computational Method was Solicited as a Result of Peer and Public Comments
    - Review was Favorable, However the Team Acknowledges the Inevitable Limitations of the Methodology

CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS
Assumptions

The Following Assumptions Form the Basis for Task 10:

- Specific Cable/Circuit Configuration Attributes are Available or Can Be Determined
- The Equipment is in Its Normal Position or Operating Condition at the Onset of the Fire
- Users of This Procedure are Knowledgeable and Have Experience with Circuit Design and Analysis Methods and Probability Estimating Techniques
- This Analysis Method is Applied to Cables with No More than 15 Conductors

CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS
Flowchart



CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS
Task Interfaces - Inputs

- Fire PRA Cable List (Task 3)
- Fire PRA Database (Support Task B)
- Results of Detailed Circuit Failure Analysis (Task 9)
- Specific Scenarios Identifying Affected Cables (Tasks 11 & 14)
- Cable & Circuit Configuration Attributes
- Plant Drawings

CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS
Task Interfaces - Outputs

- Quantification of Fire Risk (Task 14)
- Post-Fire HRA (Task 12)
- Detailed Fire Scenario Quantification (Task 11)
- Circuit Failure Mode Probability Reports
- Component Work Packages (Finalized)
- Fire PRA Database & Model

CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS
Step 1 - Compile Prerequisite Information

Ensure that Prerequisite Information and Data is Available and Usable before Beginning the Analyses.

- Confirm Completion of Detailed Circuit Analysis for Components of Interest
- Collect Important Cable and Configuration Attributes
  - Insulation
  - Number of Conductors
  - Raceway Types
  - Power Source(s)
  - Number of Source & Target Conductors (for Option #2 Only)

CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS
Step 2 - Select Analysis Approach

Decide Which Analysis Option is Best Suited for Conducting the Evaluation.

1. Failure Mode Probability Estimate Tables
   - Grounded Circuit Design
   - Non-Complex Control Circuit
   - Single Component Service
   - Cable Configuration Matches Table Categories
   - Principal Failure Mode of Concern is Spurious Actuation
2. Computational Probability Estimate Formulas
   - Ungrounded or Resistance-Grounded Circuit Design
   - Complex Circuit or Component
   - Failure Potentially Affects Multiple Components
   - Cable Configuration Not Easily Categorized in Tables

CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS
Step 3 - Estimate Circuit Failure Mode Probabilities

Estimate Circuit Failure Mode Probabilities Employing the Selected Method

Option #1: Failure Mode Probability Estimate Tables

- Table 10-1, Thermoset Cables with CPTs
- Table 10-2, Thermoset Cables without CPTs
- Table 10-3, Thermoplastic Cables with CPTs
- Table 10-4, Thermoplastic Cables without CPTs
- Table 10-5, Armored or Shielded Cables

Option #2: Computational Probability Estimate Formulas

$$P_{CC} = (C_{Tot} - C_G) / [(C_{Tot} - C_G) + (2 \times C_G) + n]$$

$$CF = \{C_T \times [C_S + (0.5 / C_{Tot})]\} / C_{Tot}$$

$$P_{FM} = CF \times P_{CC}$$

CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS
Step 3 – Related FAQ

- FAQ 08-0047 Cable Dependency (Status: Open)
  - Issue:
    - Guidance (Vol. 2, Page 10-7, Bullet 3) states that when more than one cable can cause the same spurious actuation you combine probabilities using “exclusive or”
    - This assumes faults/effects are independent
  - General approach to resolution:
    - Consensus reached that “exclusive or” is not appropriate if faults are dependent (e.g., a common power supply for both cables)
    - Clarify treatment to determine and address dependency
  - Status:
    - Team draft has been completed
    - Staff and final industry review pending

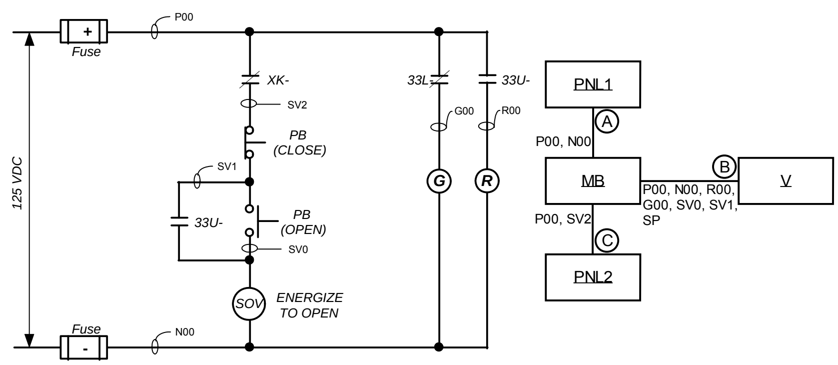
CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS
Step 4 - Generate Failure Mode Probability Reports

- Enter Results into Fire PRA Database

- Generate Circuit Failure Mode Probability Reports
  - Listing the Probability Estimates for the Circuit Failure Modes of Concern for Each Component of Interest by Plant Area (Compartment, Fire Area, Fire Zone, etc.)

CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS

Example - SOV Control Circuit



VALVE SHOWN CLOSED

QUESTION: What is the *probability* that damage to Cable B will result in spurious opening of the SOV?

See next slide→

CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS

Example – Step 1: Prerequisite Information

- Detailed circuit analysis completed & documented? ***Yes***

Cable	+125 VDC Hot Probe	-125 VDC Hot Probe
A	LOC	LOC
B	LOC, EI, SO - Open	LOC
C	NC	LOC

- Collect important cable and configuration data:
  - Cable insulation? ***Thermoset***
  - Number of conductors? ***Seven***
  - Raceway type? ***Tray***
  - Power source? ***Ungrounded DC bus (no CPT)***
  - Number of source & target conductors? ***3 sources, 1 target***

See next slide→

CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS
Example – Step 2: Select Analysis Approach

- Option #1: Failure Mode Probability Tables
  - Grounded circuit design? ***No***
  - Control circuit cable? ***Yes***
  - Single component circuit? ***Yes***
  - Known cable configuration? ***Yes***
  - Spurious operation concern? ***Yes***
- Option #2: Computational Probability Estimate
  - Ungrounded circuit? ***Yes***
  - Complex circuit/component? ***No***
  - Multiple component circuit? ***No***
  - Cable configuration not categorized? ***No***

For this example, we'll show both methods

See next slide →

CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS
Example – Step 3: Perform Analysis (1)

- Option #1:
  - Which Table to Use? ***Table 10-2, Thermoset Cable without CPT***

Raceway Type	Description of Hot Short	Best Estimate	High Confidence Range
Tray	M/C Intra-cable 1/C Inter-cable M/C → 1/C Inter-cable M/C → M/C Inter-cable	0.60 0.40 0.20 0.02 – 0.1	0.20 – 1.0 0.1 – 0.60 0.1 – 0.40
Conduit	M/C Intra-cable 1/C Inter-cable M/C → 1/C Inter-cable M/C → M/C Inter-cable	0.15 0.1 0.05 0.01 – 0.02	0.05 – 0.25 0.025 – 0.15 0.025 – 0.1

  - SO_{Open} Probability Estimate, **P** = <u>0.62</u> (0.60 + 0.06 – 0.60*0.06)

See next slide →

CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS

Example – Step 3: Perform Analysis (2)

- Option #2:
  - Calculate probability of a conductor-to-conductor short:

$$P_{CC} = (C_{Tot} - C_G) / [(C_{Tot} - C_G) + (2 * C_G)]$$

$$P_{CC} = (7 - 1) / [(7 - 1) + (2 * 1)]$$

$$P_{CC} = 6 / [6 + 2]$$

$$P_{CC} = 0.75$$

  - Determine cable configuration factor:

$$CF_{SO} = \{C_T * [C_S + (0.5 / C_{Tot})]\} / C_{Tot}$$

$$CF_{SO} = \{1 * [3 + (0.5 / 7)]\} / 7$$

$$CF_{SO} = 3.071 / 7$$

$$CF_{SO} = 0.44$$

  - Probability of spurious operation, $\mathbf{P}_{SO(Open)}$ = 0.75 * 0.44 = <u>0.33</u>

CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS

Example – Step 4: Failure Mode Probability Report

Failure Code	Estimated Probability (Calculated)	Estimated Probability (From Table 10-2)
SO (Open)	0.33	0.62

Tab 3.4b:

Task 10 Classroom Exercises

Task 10: Circuit Failure Mode Likelihood Analysis Methodology

This document summarizes the process for determining the probability, or likelihood, of a particular circuit failure mode occurrence. It includes the five Failure Mode Probability Estimate Tables employed under the Option #1 analysis approach, and the Option #2 Computational Probability Estimate formulas. **Important!** Please refer to the complete discussion of this methodology provided in NUREG/CR-6850, EPRI 1011989, "EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities; Volume 2: Detailed Methodology," Final Report, September 2005.

Selecting the Analysis Approach

1. Option #1: Failure Mode Probability Estimate Tables

   Tables of probability estimates would appropriately be used for cables that meet the following criteria:

   - The circuit is of a grounded design (including impedance grounded systems with ground fault trip capability),
   - The cable is part of the control circuit for a typical component (e.g., non-complex MOVs, SOVs, pumps),
   - The cable is associated with a single component,
   - The cable configuration is known and can be readily associated with one of the defined configurations in Tables 1 through 5, and
   - The principal hot short failure mode of concern is a spurious operation of the component.

2. Option #2: Computational Probability Estimates

   Use of the probability estimate formulas are recommended for cases where:

   - The circuit is ungrounded or is impedance grounded without ground fault trip capability,
   - The cable is part of a relatively complex circuit or component,
   - The cable is associated with or can influence the behavior of multiple components (e.g., safeguards actuation signal, bus shed scheme, etc.),
   - The cable configuration is not easily categorized into one of the defined configurations contained in Tables 1 through 5.

Performing the Circuit Failure Mode Probability Analyses

Option #1: Failure Mode Probability Estimate Tables

1. Categorize the circuit of interest based on its configuration attributes.

2. From the appropriate table (Tables 1 to 5), select the probability estimates for the failure modes of concern.
3. If the cable failure mode can occur due to different cable interactions, the probability estimate is taken as the simple sum of both estimates. For example, if a particular thermoset cable failure mode can be induced either by an intra-cable shorting event (P = 0.30) or by an inter-cable shorting event (P = 0.03; mid-range of 0.01–0.05), the overall probability of that failure mode is estimated to be 0.33.

Table-1
Failure Mode Probability Estimates Given Cable Damage
Thermoset Cable with Control Power Transformer (CPT)

Raceway Type	Description of Hot Short	Best Estimate	High Confidence Range
Tray	M/C Intra-cable	0.30	0.10 – 0.50
	1/C Inter-cable	0.20	0.05 – 0.30
	M/C → 1/C Inter-cable	0.10	0.05 – 0.20
	M/C → M/C Inter-cable	0.01 – 0.05	
Conduit	M/C Intra-cable	0.075	0.025 – 0.125
	1/C Inter-cable	0.05	0.0125 – 0.075
	M/C → 1/C Inter-cable	0.025	0.0125 – 0.05
	M/C → M/C Inter-cable	0.005 – 0.01	

M/C: Multi-conductor cable
1/C: Single conductor cable
Intra-cable: An internally generated hot short. The source conductor is part of the cable of interest
Inter-cable: An externally generated hot short. The source conductor is from a separate cable

Table-2
Failure Mode Probability Estimates Given Cable Damage
Thermoset Cable without CPT

Raceway Type	Description of Hot Short	Best Estimate	High Confidence Range
Tray	M/C Intra-cable	0.60	0.20 – 1.0
	1/C Inter-cable	0.40	0.1 – 0.60
	M/C → 1/C Inter-cable	0.20	0.1 – 0.40
	M/C → M/C Inter-cable	0.02 – 0.1	
Conduit	M/C Intra-cable	0.15	0.05 – 0.25
	1/C Inter-cable	0.1	0.025 – 0.15
	M/C → 1/C Inter-cable	0.05	0.025 – 0.1
	M/C → M/C Inter-cable	0.01 – 0.02	

Table-3
Failure Mode Probability Estimates Given Cable Damage
Thermoplastic Cable with CPT

Raceway Type	Description of Hot Short	Best Estimate	High Confidence Range
Tray	M/C Intra-cable 1/C Inter-cable M/C → 1/C Inter-cable M/C → M/C Inter-cable	0.30 0.20 0.10 0.01 – 0.05	0.10 – 0.50 0.05 – 0.30 0.05 – 0.20
Conduit	M/C Intra-cable 1/C Inter-cable M/C → 1/C Inter-cable M/C → M/C Inter-cable	0.075 0.05 0.025 0.005 – 0.01	0.025 – 0.125 0.0125 – 0.075 0.0125 – 0.05

Table-4
Failure Mode Probability Estimates Given Cable Damage
Thermoplastic Cable without CPT

Raceway Type	Description of Hot Short	Best Estimate	High Confidence Range
Tray	M/C Intra-cable 1/C Inter-cable M/C → 1/C Inter-cable M/C → M/C Inter-cable	0.60 0.40 0.20 0.02 – 0.1	0.20 – 1.0 0.1 – 0.60 0.1 – 0.40
Conduit	M/C Intra-cable 1/C Inter-cable M/C → 1/C Inter-cable M/C → M/C Inter-cable	0.15 0.1 0.05 0.01 – 0.02	0.05 – 0.25 0.025 – 0.15 0.025 – 0.1

Table-5
Failure Mode Probability Estimates Given Cable Damage
Armored or Shielded Cable

Raceway Type	Description of Hot Short	Best Estimate	High Confidence Range
With CPT	M/C Intra-cable	0.075	0.02 – 0.15
Without CPT	M/C Intra-cable	0.15	0.04 – 0.30

3. When more than one cable can cause the component failure mode of concern, and those cables are within the boundary of influence for the scenario under investigation, the

probability estimates associated with all affected cables should be considered when deriving a failure estimate for the component. In general, the probabilities should be combined as follows:

$$P_{\text{Component failure}} = (P_{\text{Failure Cable A}}) + (P_{\text{Failure Cable B}}) - (P_{\text{Failure Cable A}})(P_{\text{Failure Cable B}})$$

Option #2: Computational Probability Estimates

Application of this calculational method is more complex and is only recommended for cases where Option #1 cannot reasonably be applied. The intent is to give the analyst a means of refining the estimated circuit failure mode probabilities based on the most important characteristics of the cable/circuit under study.

This computational method involves applying circuit failure mode probability estimation formulas. The following discussions provide only the minimum definition of the failure mode likelihood estimation formulas and their terms. For a complete discussion of the technical basis, detailed explanations, and examples of usage, please refer to Appendices J and K in Volume 2 of EPRI 1011989, NUREG/CR-6850.

The probability of occurrence for a specific hot short failure mode (P_{FM}) is estimated by the formula:

$$P_{FM} = CF \times P_{CC},$$

Where:

P_{FM} = The probability that a specific hot short failure mode of interest will occur in a specific circuit given a fire of sufficient intensity to cause cable damage,

P_{CC} = The probability that a conductor-to-conductor short will occur prior to a short-to-ground or short to a grounded conductor, and

CF = A configuration factor applied to P_{CC} to account for the relative number of source conductors and target conductors. Target conductors are those conductors of a circuit that, if contacted by an electrical source of proper magnitude and voltage, will result in abnormal energization of the circuit, component or device of concern. Source conductors represent energized conductors that are a potential source of electrical energy.

1. Calculate P_{CC} as follows:

Cables in trays: $P_{CC} = (C_{Tot} - C_G) / [(C_{Tot} - C_G) + (2 \times C_G) + 1]$

Cables in conduit[1]: $P_{CC} = (C_{Tot} - C_G) / [(C_{Tot} - C_G) + (2 \times C_G) + 3]$

Ungrounded systems: $P_{CC} = (C_{Tot} - C_G) / [(C_{Tot} - C_G) + (2 \times C_G)]$

[1] Armored and shielded cable should use the equation for conduit.

Where:

C_{Tot} = The total number of conductors in the cable of interest (including spares), and

C_G = The number of grounded (or common) conductors in the cable of interest. The analyst should determine the number of grounded/common conductors based on the circuit configuration (contact positions, etc.) that represent the normal operating state of the component. If this information is unavailable or indeterminate, the worst-case conditions should be assumed.

Note: For ungrounded AC and DC systems, C_G represents the number of return conductors to the power source associated with the circuit of interest (e.g., the negative polarity conductors for an ungrounded 125 VDC circuit)

2. Calculate CF as follows.

Non-armored cables: $CF = \{C_T \times [C_S + (0.5 / C_{Tot})]\} / C_{Tot}$

Armored cables: $CF = (C_T \times C_S) / C_{Tot}$

Where:

C_S = The total number of source conductors in the cable under evaluation,

C_T = The total number of target conductors in the cable[2], and

C_{Tot} = The total number of conductors in the cable, as before.

Note: CF should be ≤ 1.0. If the calculated value of CF is greater than 1, then set CF = 1. In practical applications it is highly unlikely that the calculated value of CF will ever exceed 1. For this to occur, virtually all conductors in the cable would need to be either a source conductor or target conductor.

Note: The analyst should determine the number of target and source conductors based on the circuit configuration (contact positions, etc.) that represents the normal operating state of the component. If this information is unavailable or indeterminate, the worst-case conditions should be assumed.

3. Calculate P_{FM} as follows:

P_{FM} = $CF \times P_{CC}$,

where CF and P_{CC} are determined using the formulas discussed above.

4. When more than one cable can cause the component failure mode of concern, and those cables are within the boundary of influence for the scenario under investigation, the

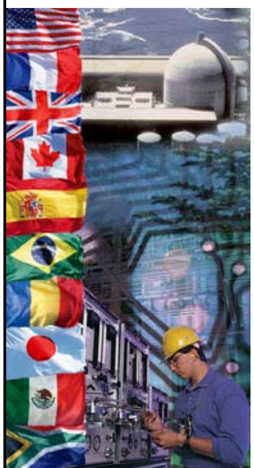
[2] Target conductors are only those cable conductors capable of forcing the component or circuit into the undesired state or condition of interest. For example, the target conductors associated with causing a spurious operation of the component will likely differ from target conductors associated with causing a loss of control condition.

probability estimates associated with all affected cables should be considered in deriving a failure estimate for the component. In general, the probabilities should be combined as follows:

$$P_{\text{Component failure}} = (P_{\text{Failure Cable A}}) + (P_{\text{Failure Cable B}}) - (P_{\text{Failure Cable A}})(P_{\text{Failure Cable B}})$$

Tab 3.5:

Task B FPRA Database



EPRI/NRC-RES FIRE PRA METHODOLOGY

Module 2: Support Task B - Fire PRA Database

D. Funk - Edan Engineering Corp.
F. Wyant - Sandia National Laboratories

Joint RES/EPRI Fire PRA Course
July and August 2007
Palo Alto, CA

A Collaboration of U.S. NRC Office of Nuclear Regulatory Research (RES) & Electric Power Research Institute (EPRI)

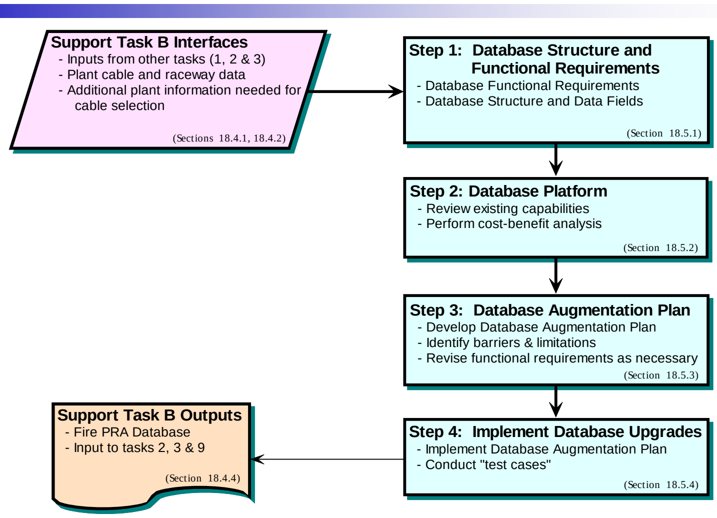
FIRE PRA DATABASE
Purpose & Scope

- Identify Required Database Functionality
- Assess Capability of Existing Systems
- Implement Structured Process to Obtain the Required Database Capability
- New Software and Data Management Tools are Finding Their Way Into the Market

FIRE PRA DATABASE
Introduction

- Task is Distinctly Different from Other Tasks
- Essential Element of PRA
  - Proposed Methods Require Manipulation and Correlation of Large Amounts of Data
  - Must be Efficient and User Friendly for Effective Implementation
  - Manual Analysis Not Practical

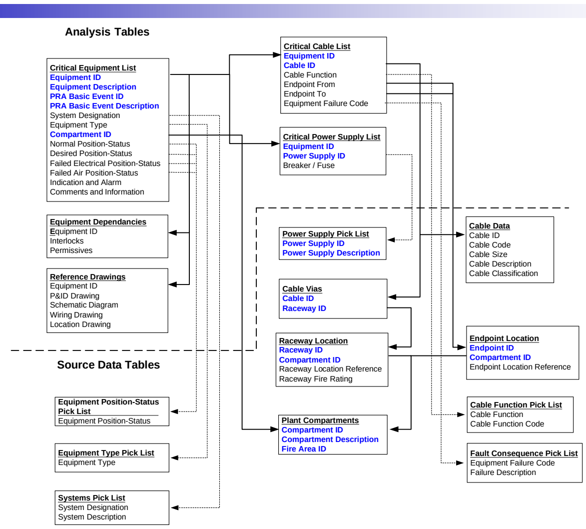
FIRE PRA DATABASE
Flowchart



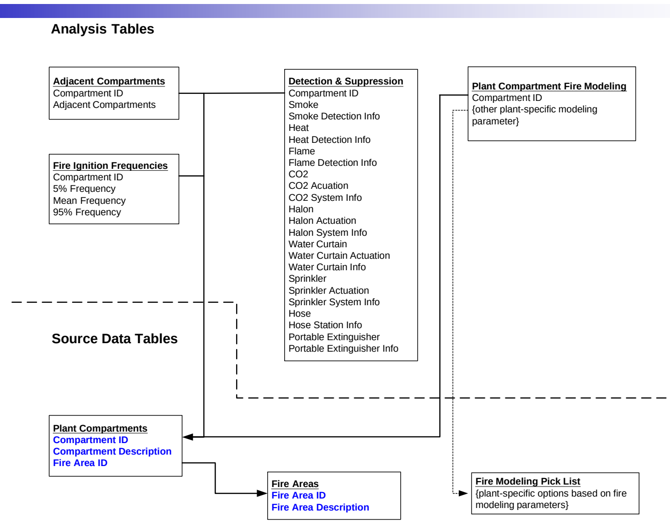
FIRE PRA DATABASE
Step 1.1 - Database Functional Criteria

- Data Input Criteria
  - In what shape and format is existing data?
  - How and who will entered and control data?
  - Will data be shared by separate groups? If so, who can change data?
- Data Output Criteria
  - Define Required Output Reports
  - Define Sort and Query Options

FIRE PRA DATABASE
Step 1.2 - Database Structure (Example A)



FIRE PRA DATABASE
Step 1.2 - Database Structure (Example A)



Joint Fire PRA Course, Sept. & Nov. 2008
Module 2: Support Task B - Fire PRA Database

Slide 7

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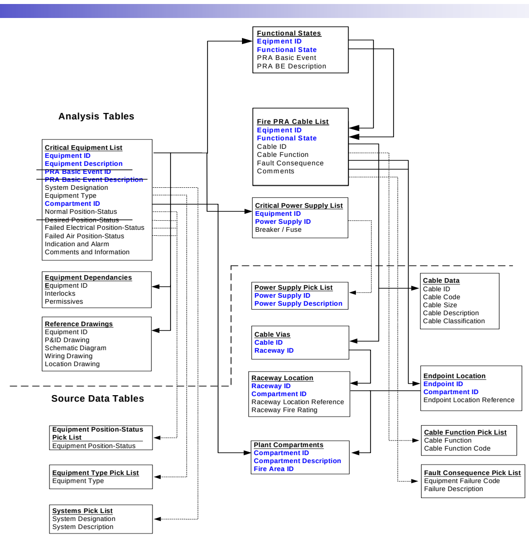
FIRE PRA DATABASE
Step 1.2 - Database Structure (Example B)



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Module 2: Support Task B - Fire PRA Database

Slide 8

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FIRE PRA DATABASE
Step 2 - Database Platform

- Decide on Platform for Database
  - Existing System
  - New Stand Alone System
  - Upgrade Existing System
  - Combination of Existing and New
- Vendors are Responding to the Call for New and Improved Software Functionality
  - Highly Integrated Solutions are Emerging as the Standard for NFPA 805 Plants
  - Seamless Link to Fire PRA Software is in the Works But Not Yet Available as Production Software

FIRE PRA DATABASE
Step 3 - Database Augmentation Plan

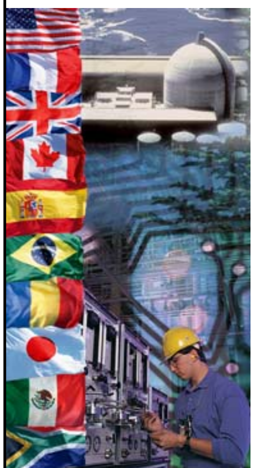
- Augmentation Plan is Based on the Results of Step 2
- Formalize Process for Upgrades/Changes
- Determine Necessary Resources
  - This Effort Can Innocently Affect Many Plant Organizations
  - The Cost, Resources, Schedule, Training, Procedural Changes and Overall Impact of Major Software Changes **ALWAYS** Seems to be Underestimated
- Involve IS/IT Department from the Beginning

FIRE PRA DATABASE
Step 4 – Implement Database Upgrades

- Have a Clear Plan BEFORE Beginning any Significant Work
- Consider Long-Term Maintainability
- Plan for De-bugging and Test Runs
- Do Not Overlook Data Integrity and Configuration Control Features
- Determine All Affected Users and Involve Then Early
- The Days of “Rouge” PRA Databases are Gone!

Tab 3.6:

Electrical Analysis Examples



EPRI/NRC-RES FIRE PRA METHODOLOGY

Module 2: Electrical Examples

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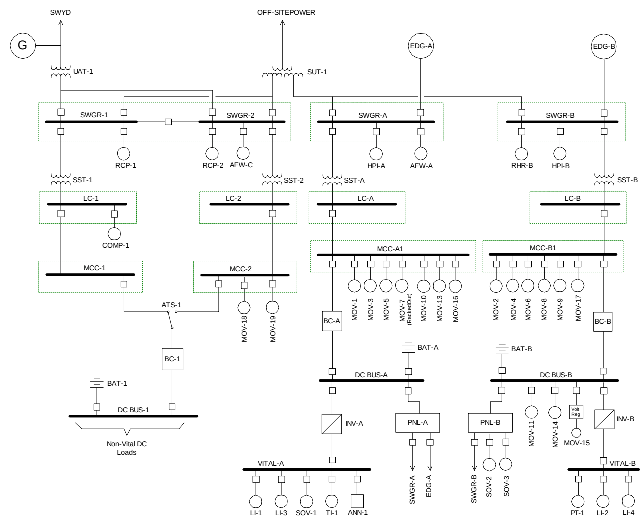
Joint RES/EPRI Fire PRA Course
September and November 2008
Bethesda, MD

A Collaboration of U.S. NRC Office of Nuclear Regulatory Research (RES) & Electric Power Research Institute (EPRI)

OVERVIEW OF EXAMPLES

- Provide Hands-On Practical Experience
- Cover Many (But Not All) Typical Cases
- Exposure to Typical Problems and Decisions
- Appreciation for Challenges and Trade-Offs
- A Worn Out Expression, Yes…But for Circuit Analysis the "Devil is in the Details"

SNPP ONE-LINE DIAGRAM



EXAMPLE PROBLEMS

Example No.	Component	Description of Analysis	NUREG/CR-6850	Comments
1	AOV-1 (SOV-1)	Std AC Solenoid Control Circuit	No	Multi-function component - analyzed for open and close
2	AOV-3 (SOV-3)	Std DC Solenoid Control Circuit	Yes - Figure I-2	Spurious only analysis
3	MOV-9	Typical MOV Control Circuit	Yes - Figure I-4	Functional analysis - change of position required
4	MOV-15	Double Pole DC Motor Control Circuit	Yes - Figure I-6	Functional analysis - change of position required
5	MOV-13	Ungnd AC, Inverted MOV Control Circuit	Yes - Figure I-8	Functional analysis - change of position required
6	MOV-10	Ungnd AC MOV Control Circuit	Yes - Figure I-10	Functional analysis - change of position required
7	MOV-8	MOV Control Circuit w/ Dual Controls	Yes - Figure I-12	Spurious only, classified as high consequence component
8	MOV-11	Typical DC MOV Control Circuit	No	Functional analysis - change of position required
9	MOV-16	Typical MOV Control Circuit	Yes - Figure I-4	Spurious Only
10	PI-1	Instrument Circuit	No	Indication only
11	ANN-1	Annunciator Circuit	No	No false indication
12	HPI-B	4.16 kV Motor	No	Functional analysis
13	COMP-1	480 V Motor	No	Functional analysis
14	SWGR-B	4.16 kV Bus	No	Multiple source options
15	LC-B	480V LC	No	Functional analysis
16	MCC-1B	480V MCC	No	Functional analysis

HANDS ON WORK

CIRCUIT ANALYSIS WORKSHEET

Component ID: ______________ Component Type: ______________

Component Description: ______________

BE Code: ______________

Required Position
Functional State: ______________

Normal Position: ______________

Failed Electrical Position: ______________

Failed Air Position: ______________

High Consequence Component: Yes ☐ No ☐

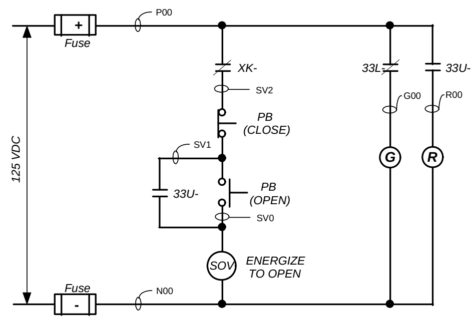
Power Supplies: ______________ Breaker: ______________

______________ Breaker: ______________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:



VALVE SHOWN CLOSED

Tab 3.7:

Electrical Examples Summary and Loss Report

Circuit Analysis Example Summary

Example No.	Component	Description of Analysis	NUREG/CR-6850	Comments
1	AOV-1 (SOV-1)	Std AC Solenoid Control Circuit	No	Multi-function component - analyzed for open and close
2	AOV-3 (SOV-3)	Std DC Solenoid Control Circuit	Yes - Figure I-2	Spurious only analysis
3	MOV-9	Typical MOV Control Circuit	Yes - Figure I-4	Functional analysis - change of position required
4	MOV-15	Double Pole DC Motor Control Circuit	Yes - Figure I-6	Functional analysis - change of position required
5	MOV-13	Ungnd AC, Inverted MOV Control Circuit	Yes - Figure I-8	Functional analysis - change of position required
6	MOV-10	Ungnd AC MOV Control Circuit	Yes - Figure I-10	Functional analysis - change of position required
7	MOV-8	MOV Control Circuit w/ Dual Controls	Yes - Figure I-12	Spurious only, classified as high consequence component
8	MOV-11	Typical DC MOV Control Circuit	No	Functional analysis - change of position required
9	MOV-16	Typical MOV Control Circuit	Yes - Figure I-4	Spurious Only
10	PI-1	Instrument Circuit	No	Indication only
11	ANN-1	Annunciator Circuit	No	No false indication
12	HPI-B	4.16 kV Motor	No	Functional analysis
13	COMP-1	480 V Motor	No	Functional analysis
14	SWGR-B	4.16 kV Bus	No	Multiple source options
15	LC-B	480V LC	No	Functional analysis
16	MCC-1B	480V MCC	No	Functional analysis

CIRCUIT ANALYSIS WORKSHEET

Component ID:__________________ Continuation Sheet (___ of ___)

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

CIRCUIT ANALYSIS WORKSHEET

Component ID:___________________ Component Type:______________________________

Component Description:_____________________________________

BE Code: _________________________________

Required Position: _________________________________
Functional State

Normal Position: _________________________________

Failed Electrical Position: _________________________________

Failed Air Position: _________________________________

High Consequence Component Yes ☐ No ☐

Power Supplies: __________________________ Breaker: __________________________

__________________________ Breaker: __________________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Commments

Comments:

____

____

____

Table 1: Target Equipment Loss Report

Equipment ID	Equipment Description	Equipment Type	Location	Desired Position/ Status	Target Loss Locations
HPI-A	High pressure safety injection pump A	Pump	Aux Bldg. El. 0 Ft	On	1, 2, 3, 10
				On	1, 2, 3, 10
HPI-B	High pressure safety injection pump B	Pump	Aux Bldg. El. 0 Ft	On	1, 2, 3, 11
				On	1, 2, 3, 11
RHR-B	Residual heat removal pump B	Pump	Aux Bldg. El. -20 Ft	Off	1, 2, 3, 4A, 9, 11
AFW-A	Motor driven AFW pump A	Pump	Aux Bldg. EL. 0 Ft	On	1, 3, 4B, 9, 10
AFW-B	Steam driven AFW pump B	Pump	Aux Bldg. EL. 0 Ft	On	1, 3, 4B, 9, 11
AFW-C	Motor driven AFW pump C	Pump	Turbine Bldg. El. 0 Ft	On	1, 3, 12
RCP-1	Reactor coolant pump 1	Pump	Containment	Off	1, 2, 3, 7, 12
RCP-2	Reactor coolant pump 2	Pump	Containment	Off	1, 2, 3, 7, 12
COMP-1	Instrument air compressor	Compressor	Turbine Bldg. El. 0 Ft	Cycle	12
AOV-1 (SOV-1)	Power operated relief valve	AOV	Containment	Closed	1, 3, 7, 9
				Open	1, 3, 7, 9, 10
AOV-2 (SOV-2)	Letdown isolation valve	AOV	Aux Bldg. El. 0 Ft	Closed	1, 2, 3, 9
AOV-3 (SOV-3)	Charging pump injection valve	AOV	Aux Bldg. El. 0 Ft	Closed	1, 2, 3, 9
MOV-1	HPI discharge valve	MOV	Aux Bldg. El. 0 Ft	Open	1, 2, 3, 9, 10
MOV-2	VCT isolation valve	MOV	Aux Bldg. El. 0 Ft	Closed	1, 2, 3, 9, 11
MOV-3	Cont. sump recirc valve	MOV	Aux Bldg. El. -20 Ft	Open/ Closed[2]	1, 2, 3, 4A, 9, 10
MOV-4	Cont. sump recirc valve	MOV	Aux Bldg. El. -20 Ft	Open/ Closed	1, 2, 3, 4A, 9, 11
MOV-5	RWST isolation valve	MOV	Aux Bldg. El. 0 Ft	Open	1, 2, 3, 12
MOV-6	RWST isolation valve	MOV	Aux Bldg. El. 0 Ft	Open	1, 2, 3, 12
MOV-7	RHR inboard suction valve	MOV	Containment	Closed	4A,7,9,12
MOV-8	RHR outboard suction valve	MOV	Aux Bldg. El. -20 Ft	Closed	4A,9,12
MOV-9	HPI discharge valve	MOV	Aux Bldg. El. 0 Ft	Open	1,2,3,,9
MOV-10	AFW pump A discharge valve	MOV	Aux Bldg. EL. 0 Ft	Open	1,3,4B,9,12
MOV-11	AFW pump B discharge valve	MOV	Aux Bldg. EL. 0 Ft	Open	1,3,4B,9,11,12
MOV-13	PORV block valve	MOV	Containment	Open/ Closed[1]	1, 3, 7, 9
MOV-14	AFW pump B turbine steam line isolation valve	MOV	Turbine Bldg. El. 0 Ft	Open	1, 3, 4B, 12

Equipment ID	Equipment Description	Equipment Type	Location	Desired Position/ Status	Target Loss Locations
MOV-15	AFW pump B steam inlet throttle valve	MOV	Turbine Bldg. El. 0 Ft	Throttled	1, 3, 4B, 12
MOV-16	AFW pump A test line isolation valve	MOV	Turbine Bldg. El. 0 Ft	Closed	2, 4B, 9
MOV-17	AFW pump B test line isolation valve	MOV	Turbine Bldg. El. 0 Ft	Closed	2, 4B, 9
MOV-18	AFW pump C discharge valve	MOV	Turbine Bldg. El. 0 Ft	Open	1, 3, 12
MOV-19	AFW pump C test line isolation valve	MOV	Turbine Bldg. El. 0 Ft	Closed	1, 3, 12
V-12	CST isolation valve	MOV	Turbine Bldg. El. 0 Ft	Open	12
LI-1	RWST level	Instrument	Yard	Available	1, 3, 12, 13
LI-2	RWST level	Instrument	Yard	Available	1, 3, 12, 13
LI-3	Cont. sump level	Instrument	Containment	Available	1, 3, 7, 12
LI-4	Cont. sump level	Instrument	Containment	Available	1, 3, 7, 12
TI-1	Letdown heat exchanger outlet temperature	Instrument	Aux Bldg El. 0 Ft	Available	1, 2, 3, 9
PT-1	RCS pressure	Instrument	Containment	Available	1, 3, 7
ANN-1	AFW motor high temperature	Annunciator	SWG Access Room	Non spurious	1, 2, 3, 9, 4B
SWGR-A	Train A 4160 V switchgear	Switchgear	Switchgear Room A	Energized from SUT-1	1, 3, 10, 12, 13
				Energized from EDG-A	1, 3, 8A, 10, 12
SWGR-B	Train B 4160 V switchgear	Switchgear	Switchgear Room B	Energized from SUT-1	1, 3, 9, 11, 12, 13
				Energized from EDG-A	1, 3, 8B, 9, 11, 12
SWGR-1	Non-safety 4160 V switchgear	Switchgear	Turbine Bldg. El. 0ft	Energized	1, 3, 12, 13
SWGR-2	Non-safety 4160 V switchgear	Switchgear	Turbine Bldg. El. 0ft	Energized	1, 3, 12, 13
SUT-1	Startup transformer	Transformer	Yard	Energized	1, 3, 12, 13
EDG-A	Train A emergency diesel generator	Diesel Generator	DG Bldg.	On	1, 3, 8A, 10, 12
EDG-B	Train B emergency diesel generator	Diesel Generator	DG Bldg.	On	1, 3, 8B, 10, 12
LC-1	Non-safety 480 V load center	Load Center	Turbine Bldg. El. 0 ft	Energized	1, 3, 12
LC-2	Non-safety 480 V load center	Load Center	Turbine Bldg. El. 0 ft	Energized	1, 3, 12
LC-A	Train A 480 V load center	Load Center	Switchgear Room A	Energized	1, 3,10
LC-B	Train B 480 V load center	Load Center	Switchgear Room B	Energized	1, 3, 11
SST-1	Non-safety station service transformer	Transformer	Turbine Bldg. El. 0 F	Energized	12

Equipment ID	Equipment Description	Equipment Type	Location	Desired Position/ Status	Target Loss Locations
SST-2	Non-safety station service transformer	Transformer	Turbine Bldg. El. 0 F	Energized	12
SST-A	Train A station service transformer	Transformer	Switchgear Room A	Energized	10
SST-B	Train B station service transformer	Transformer	Switchgear Room B	Energized	11
MCC-1	Non-safety 480 V motor control center	Motor Control Center	Turbine Bldg El. 0 Ft	Energized	12
MCC-2	Non-safety 480 V motor control center	Motor Control Center	Turbine Bldg El. 0 Ft	Energized	12
MCC-A1	Train A 480 V motor control center	Motor Control Center	SWG Access Room	Energized	9, 10
MCC-B1	Train B 480 V motor control center	Motor Control Center	SWG Access Room	Energized	9, 11
ATS-1	Automatic transfer switch	ATS	SWG Access Room	Energized from MCC-1	12
BC-1	Non-safety swing battery charger	Battery Charger	Turbine Bldg El. 0 Ft	Energized	12
BC-A	Train A battery charger	Battery Charger	Switchgear Room A	Energized	9, 10
BC-B	Train B battery charger	Battery Charger	Switchgear Room B	Energized	9, 11
BAT-1	Non-safety battery	Battery	Turbine Bldg El. 0 Ft	Available	12, 15
BAT-A	Train A battery	Battery	Battery Room A	Available	5, 10
BAT-B	Train B battery	Battery	Battery Room B	Available	6, 11
DC BUS-1	Non-safety 250 VDC bus	DC Bus	Turbine Bldg El. 0 Ft	Energized	12
DC BUS-A	Train A 125 VDC bus	DC Bus	Switchgear Room A	Energized	10
DC BUS-B	Train B 125 VDC bus	DC Bus	Switchgear Room B	Energized	11
PNL-A	Train A 125 VDC panel	Panelboard	Switchgear Room A	Energized	10
PNL-B	Train B 125 VDC panel	Panelboard	Switchgear Room B	Energized	11
INV-A	Train A inverter	Inverter	Switchgear Room A	Energized	3, 9, 10
INV-B	Train B inverter	Inverter	Switchgear Room B	Energized	3, 9, 11
VITAL-A	Train A 120 VAC vital bus	120VAC Bus	SWG Access Room	Energized	9, 10
VITAL-B	Train B 120 VAC vital bus	120VAC Bus	SWG Access Room	Energized	9, 11

Tab 3.8:

Circuit Analysis Worksheets

CIRCUIT ANALYSIS WORKSHEET

Component ID: **LC-B** Component Type: **Load Center**

Component Description: **Train B 480 V Load Center**

BE Code: **EPS-480VLCBF** **(480V LOAD CENTER B FAULT)**

Required Position: Functional State **ENERGIZED**

Normal Position: **ENERGIZED**

Failed Electrical Position: **Off**

Failed Air Position: **N/A**

High Consequence Component Yes ☐ No ☒

Power Supplies: ______________________ Breaker: ______________________

______________________ Breaker: ______________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:

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CIRCUIT ANALYSIS WORKSHEET

Component ID: **SWGR-B** Component Type: **Switchgear**

Component Description: **Train B 4160V Switchgear**

BE Code: **PNL-B EPS-4VBUSBF-2 (4KV BUS B FAULT)**

Required Position:
Functional State **ENERGIZED FROM EDG-B**

Normal Position: **ENERGIZED FROM SUT-1**

Failed Electrical Position: **Off**

Failed Air Position: **N/A**

High Consequence Component Yes ☐ No ☒

Power Supplies: ______________________ Breaker: ______________________

______________________ Breaker: ______________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:

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CIRCUIT ANALYSIS WORKSHEET

Component ID: **SWGR-B** Component Type: **Switchgear**

Component Description: **Train B 4160V Switchgear**

BE Code: **PNL-B EPS-4VBUSBF-1 (4KV BUS B FAULT)**

Required Position: Functional State **ENERGIZED FROM SUT-1**

Normal Position: **ENERGIZED FROM SUT-1**

Failed Electrical Position: **Off**

Failed Air Position: **N/A**

High Consequence Component Yes ☐ No ☒

Power Supplies: ______________________ Breaker: ______________________

______________________ Breaker: ______________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:

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CIRCUIT ANALYSIS WORKSHEET

Component ID: **COMP-1** Component Type: **Compressor**

Component Description: **Instrument Air Compressor**

BE Code: **COMP-1_FTR (COMP-1 Fails to Run)**

Required Position: Functional State **CYCLE**

Normal Position: **CYCLE**

Failed Electrical Position: **Off**

Failed Air Position: **N/A**

High Consequence Component Yes ☐ No ☒

Power Supplies: ____________________ Breaker: ____________________

____________________ Breaker: ____________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:

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CIRCUIT ANALYSIS WORKSHEET

Component ID: **HPI-B** Component Type: **Pump**

Component Description: **High Pressure Injection Pump B**

BE Code: **HPIA_FTS (HPI-A Fails to Start)**
HPIA_FTR (HPI-A Fails to Run)

Required Position: Functional State **ON**

Normal Position: **STANDBY / ON**

Failed Electrical Position: **Off**

Failed Air Position: **N/A**

High Consequence Component Yes ☐ No ☒

Power Supplies: ______________________ Breaker: ______________________

______________________ Breaker: ______________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:

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CIRCUIT ANALYSIS WORKSHEET

Component ID: **ANN-1** Component Type: **Annunciator**

Component Description: **AFW Motor High Temperature**

BE Code: **ANN-1_FH (AFW Pump Motor Spurious High Ann)**

Required Position: Functional State **NON-SPURIOUS**

Normal Position: **AVAILABLE**

Failed Electrical Position: **UNAVAILABLE**

Failed Air Position: **N/A**

High Consequence Component Yes ☐ No ☒

Power Supplies: ____________________ Breaker: ____________________

____________________ Breaker: ____________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:

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CIRCUIT ANALYSIS WORKSHEET

Component ID: **PI-1** Component Type: **Instrument**

Component Description: RCS Pressure

BE Code: **PI-1_FL** **(RCS Pressure Indication Fails High)**

Required Position: Functional State **AVAILABLE**

Normal Position: **AVAILABLE**

Failed Electrical Position: **LOW**

Failed Air Position: **N/A**

High Consequence Component Yes ☐ No ☒

Power Supplies: ______________________ Breaker: ______________________

______________________ Breaker: ______________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:

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CIRCUIT ANALYSIS WORKSHEET

Component ID: **MOV-16** Component Type: **MOV**

Component Description: **AFW Test Line Isolation Valve**

BE Code: **MOV-16_TO (MOV-16 TRANSFERS OPEN)**

Required Position: Functional State **CLOSED**

Normal Position: **CLOSED**

Failed Electrical Position: **AS-IS**

Failed Air Position: **N/A**

High Consequence Component Yes ☐ No ☒

Power Supplies: ______________________ Breaker: ______________________

______________________ Breaker: ______________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:

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CIRCUIT ANALYSIS WORKSHEET

Component ID: **MOV-11** Component Type: **MOV**

Component Description: **AFW Discharge Isolation Valve**

BE Code: **MOV-11_FTO** **(MOV-11 FAILS TO OPEN)**

Required Position: Functional State **OPEN**

Normal Position: **CLOSED**

Failed Electrical Position: **AS-IS**

Failed Air Position: **N/A**

High Consequence Component Yes ☐ No ☒

Power Supplies: ______________________ Breaker: ______________________

______________________ Breaker: ______________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:

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CIRCUIT ANALYSIS WORKSHEET

Component ID: **MOV-8** Component Type: **MOV**

Component Description: **RHR Outboard Suction Valve**

BE Code: **MOV-8_TO** **(MOV-8 TRANSFERS OPEN)**

Required Position: Functional State **CLOSED**

Normal Position: **CLOSED**

Failed Electrical Position: **AS-IS**

Failed Air Position: **N/A**

High Consequence Component Yes ☒ No ☐

Power Supplies: ______________________ Breaker: ______________________

______________________ Breaker: ______________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:

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CIRCUIT ANALYSIS WORKSHEET

Component ID: **MOV-10** Component Type: **MOV**

Component Description: **AFW Discharge Isolation Valve**

BE Code: **MOV-10_FTO (MOV-10 FAILS TO OPEN)**

Required Position: Functional State **OPEN**

Normal Position: **CLOSED**

Failed Electrical Position: **AS-IS**

Failed Air Position: **N/A**

High Consequence Component Yes ☐ No ☒

Power Supplies: ____________________ Breaker: ____________________

____________________ Breaker: ____________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:

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CIRCUIT ANALYSIS WORKSHEET

Component ID: **MOV-13** Component Type: **MOV**

Component Description: **PORV Block Valve**

BE Code: **MOV-13_FTC (MOV-13 FAILS TO CLOSE)**

Required Position:
Functional State **OPEN / CLOSED**

Normal Position: **OPEN**

Failed Electrical Position: **AS-IS**

Failed Air Position: **N/A**

High Consequence Component Yes ☐ No ☒

Power Supplies: ______________________ Breaker: ______________________

______________________ Breaker: ______________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:

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CIRCUIT ANALYSIS WORKSHEET

Component ID: **MOV-15** Component Type: **MOV**

Component Description: **AFW Steam Inlet Throttle Valve**

BE Code: **MOV-15_FTO (MOV-15 FAILS TO OPEN)**

Required Position: Functional State **THROTTLED**

Normal Position: **CLOSED**

Failed Electrical Position: **AS-IS**

Failed Air Position: **N/A**

High Consequence Component Yes ☐ No ☒

Power Supplies: ______________________ Breaker: ______________________

______________________ Breaker: ______________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:

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CIRCUIT ANALYSIS WORKSHEET

Component ID: **MOV-9** Component Type: **MOV**

Component Description: **High Pressure Injection Valve**

BE Code: **MOV-9_FTO (MOV-9 FAILS TO OPEN)**

Required Position: Functional State **OPEN**

Normal Position: **CLOSED**

Failed Electrical Position: **AS-IS**

Failed Air Position: **N/A**

High Consequence Component Yes ☐ No ☒

Power Supplies: ____________________ Breaker: ____________________

____________________ Breaker: ____________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:

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CIRCUIT ANALYSIS WORKSHEET

Component ID: **AOV-3 (SOV-3)** Component Type: **AOV**

Component Description: **Charging Pump Injection Valve**

BE Code: **AOV-3_FTC (AOV-3 FAILS TO CLOSE)**

Required Position: Functional State **CLOSED**

Normal Position: **OPEN**

Failed Electrical Position: **CLOSED**

Failed Air Position: **CLOSED**

High Consequence Component Yes ☐ No ☒

Power Supplies: ______________________ Breaker: ______________________

______________________ Breaker: ______________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:

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CIRCUIT ANALYSIS WORKSHEET

Component ID: **AOV-1 (SOV-1)** Component Type: **AOV**

Component Description: **Power Operated Relief Valve**

BE Code: **AOV-1_FTO (PORV AOV-1 FAILS TO OPEN)**

Required Position: Functional State **OPEN**

Normal Position: **CLOSED**

Failed Electrical Position: **CLOSED**

Failed Air Position: **CLOSED**

High Consequence Component Yes ☐ No ☒

Power Supplies: ______________________ Breaker: ______________________

______________________ Breaker: ______________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:

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CIRCUIT ANALYSIS WORKSHEET

Component ID: **AOV-1 (SOV-1)** Component Type: **AOV**

Component Description: **Power Operated Relief Valve**

BE Code: **AOV-1_TO (PORV AOV-1 TRANSFERS OPEN)**

Required Position: Functional State **CLOSED**

Normal Position: **CLOSED**

Failed Electrical Position: **CLOSED**

Failed Air Position: **CLOSED**

High Consequence Component Yes ☐ No ☒

Power Supplies: ______________________ Breaker: ______________________

______________________ Breaker: ______________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:

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CIRCUIT ANALYSIS WORKSHEET

Component ID: **MCC-1B**

Component Type: **MCC**

Component Description: **Train B 480 V Motor Control Center**

BE Code: **EPS-480MCCB1F** **(480V MCC B1 FAULT)**

Required Position: Functional State **ENERGIZED**

Normal Position: **ENERGIZED**

Failed Electrical Position: **Off**

Failed Air Position: **N/A**

High Consequence Component Yes ☐ No ☒

Power Supplies: ____________________ Breaker: ____________________

____________________ Breaker: ____________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:

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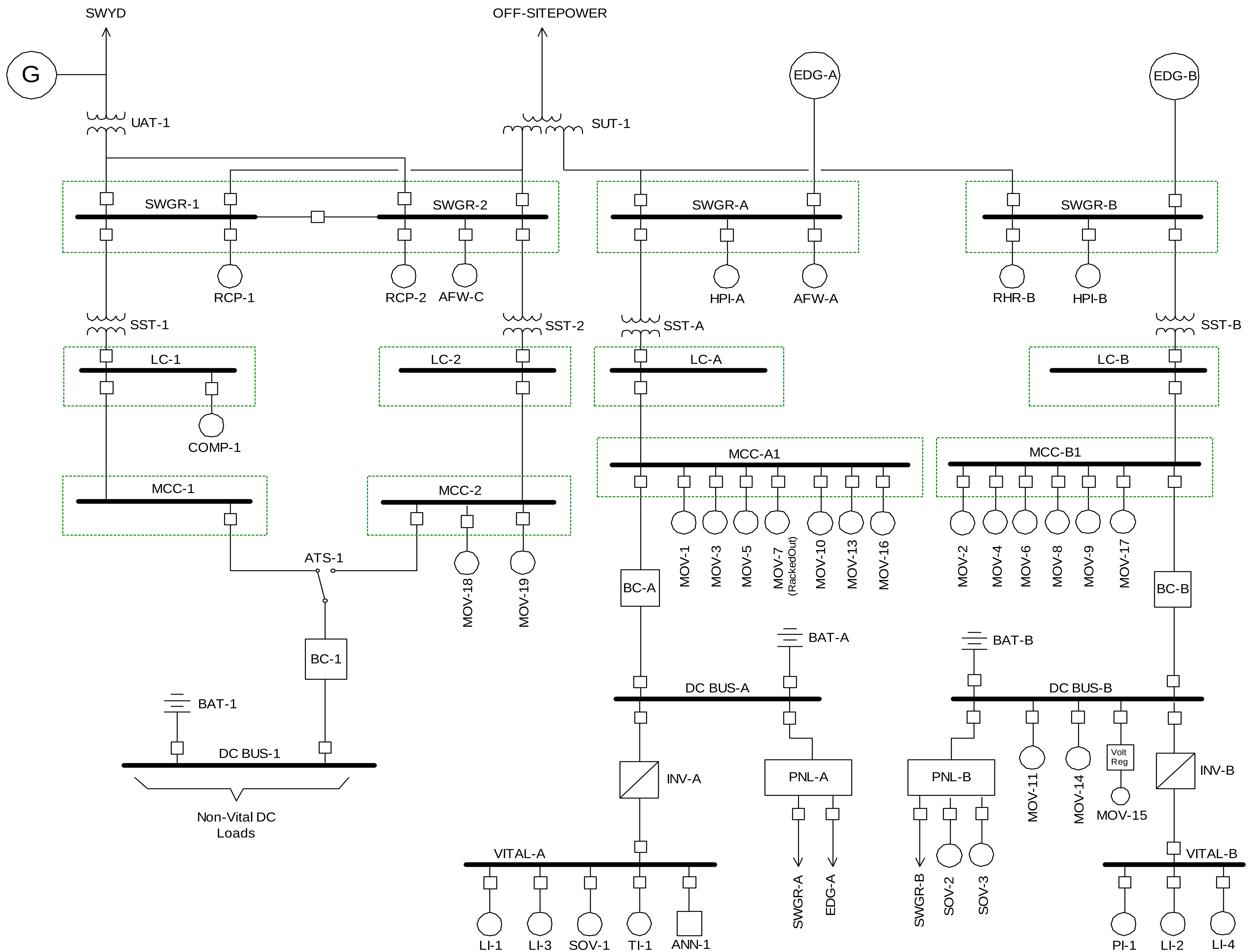
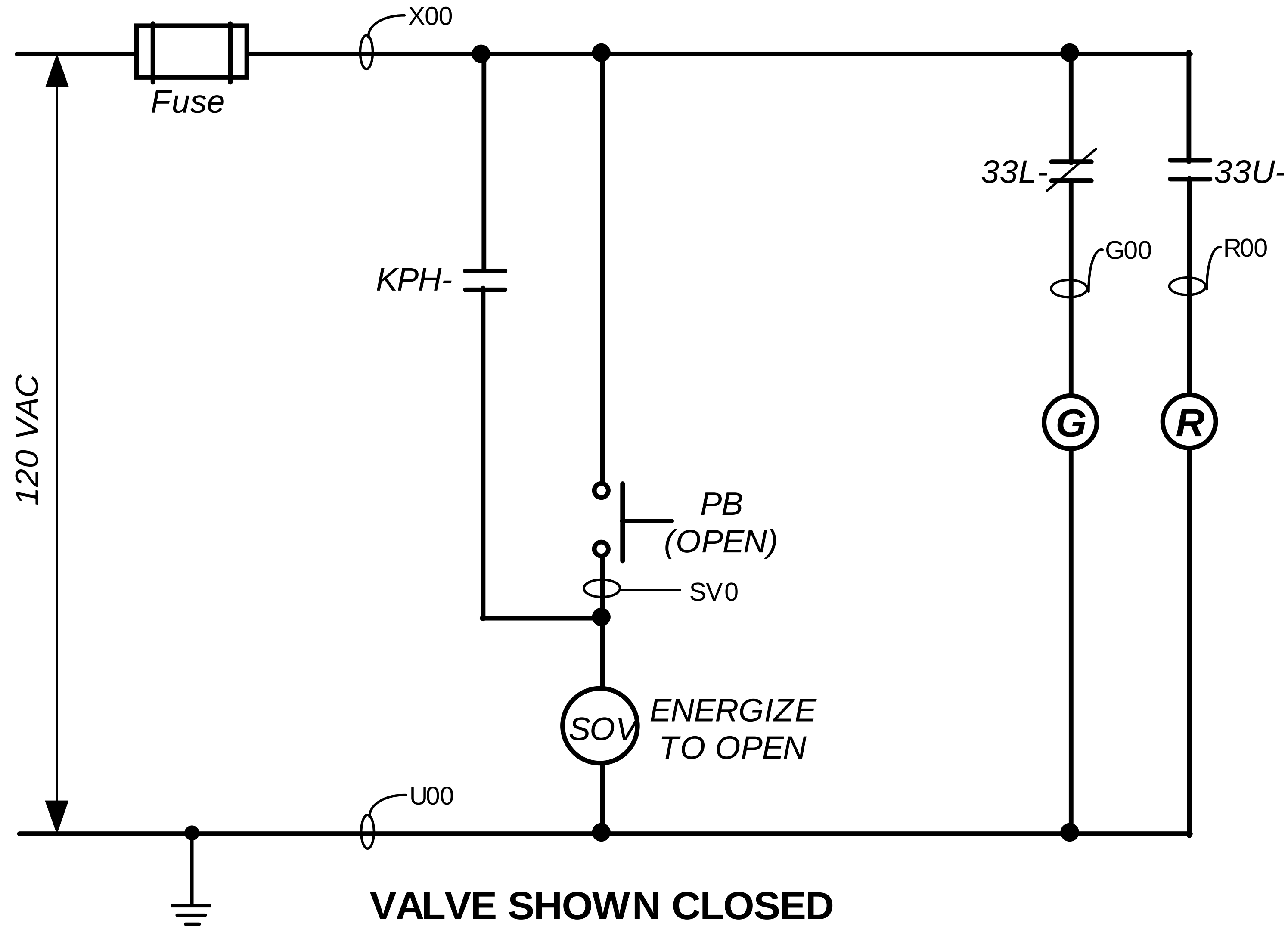
Tab 3.9:

Drawing Package #1

ELECTRICAL DISTRIBUTION SYSTEM - SIMPLIFIED ONE-LINE DIAGRAM

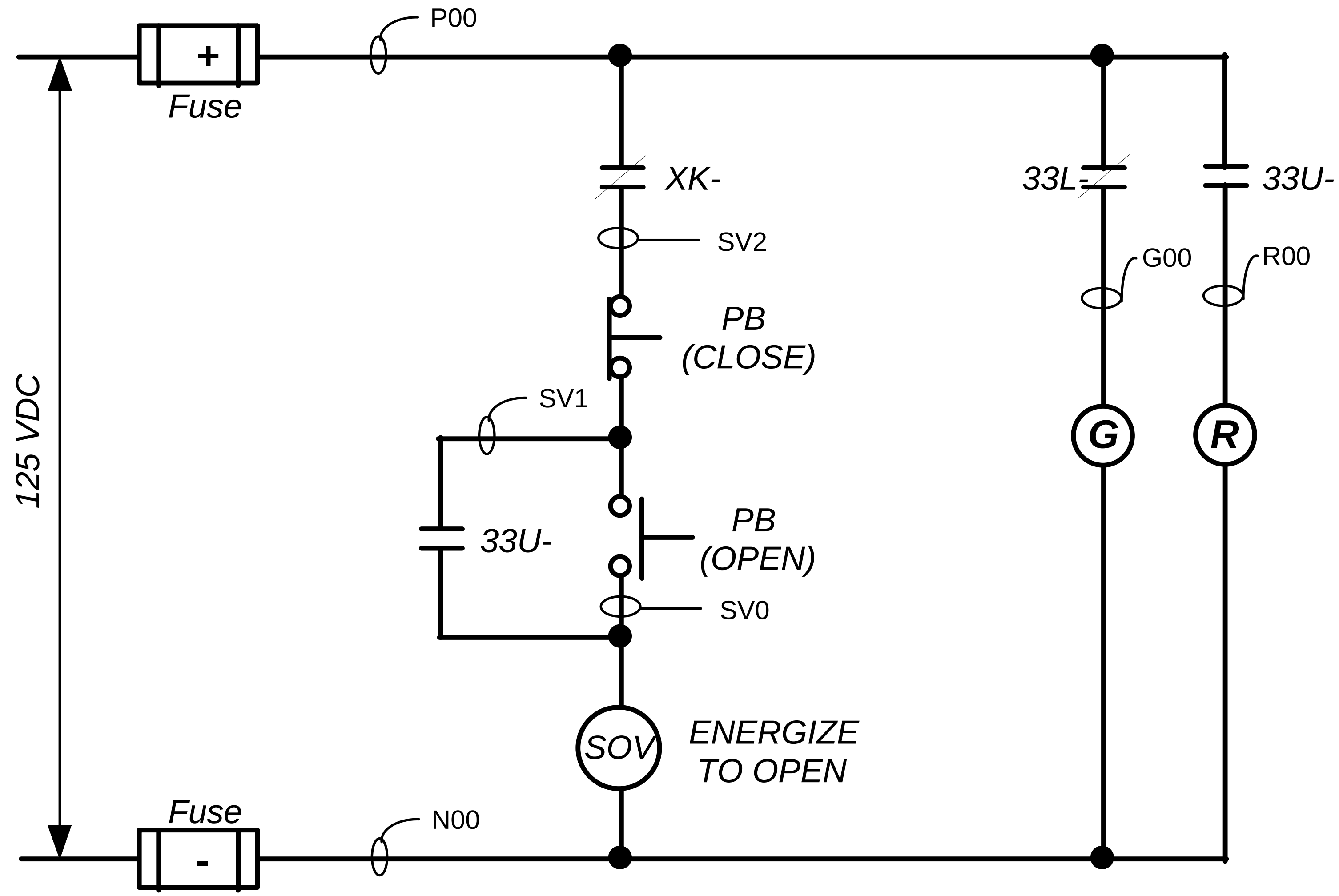




VALVE SHOWN CLOSED

SCHEME VA3

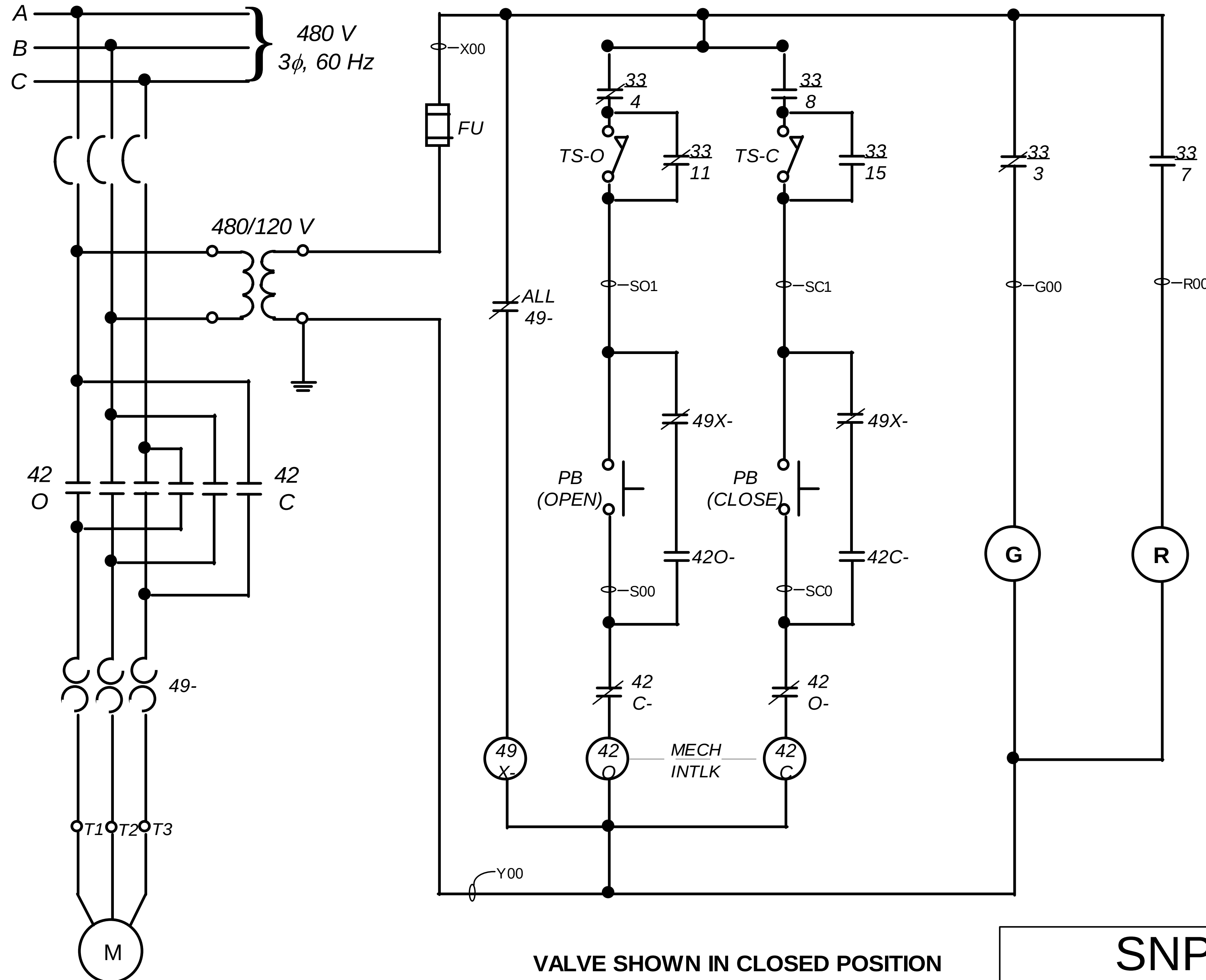
SNPP SCHEMATIC DIAGRAM – PRESSURE OPERATED RELIEF SOLENOID VALVE SOV-1	Drawing No.: E-03
	Date: 05/04/2007
	Revision No.: 1



VALVE SHOWN CLOSED

VALVE	DESCRIPTION	SCHEME	SWITCH ID
SOV-2	LETDOWN ISOLATION	PB2	AOV-2
SOV-3	CHARGING PUMP INJECTION	PB3	AOV-3

SNPP SCHEMATIC DIAGRAM -- PRIMARY MAKEUP SYSTEM SOLENOID VALVES SOV-2 & SOV-3	Drawing No.: E-02
	Date: 07/25/2008
	Revision No.: 1

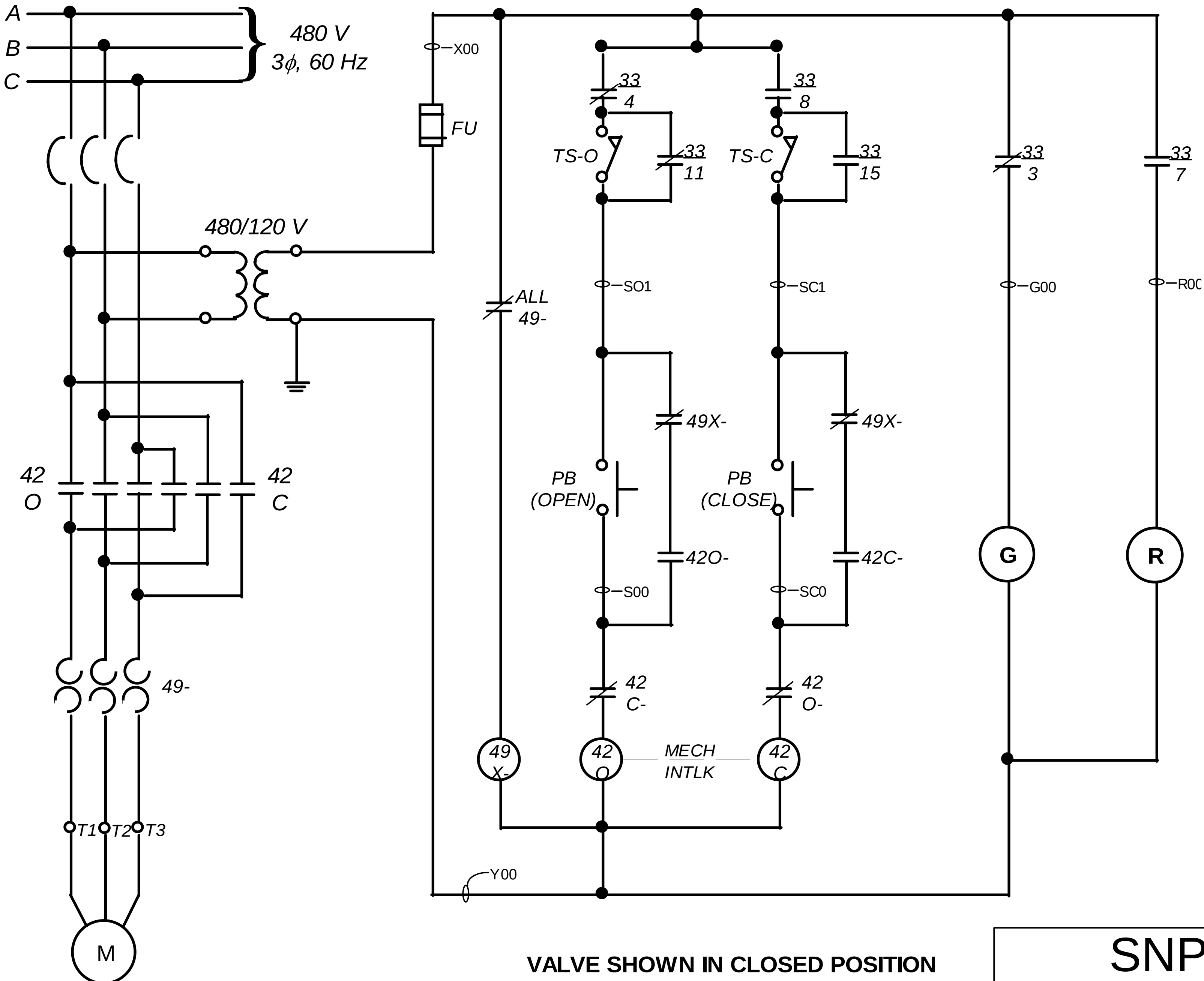


VALVE	DESCRIPTION	SCHEME	SWITCH ID
MOV-1	HIGH PRESS INJECTION-A	MA12	MOV-1
MOV-9	HIGH PRESS INJECTION-B	MB15	MOV-9

SNPP

SCHEMATIC DIAGRAM – HIGH PRESSURE INJECTION MOTOR OPERATED VALVES MOV-1 & MOV-9

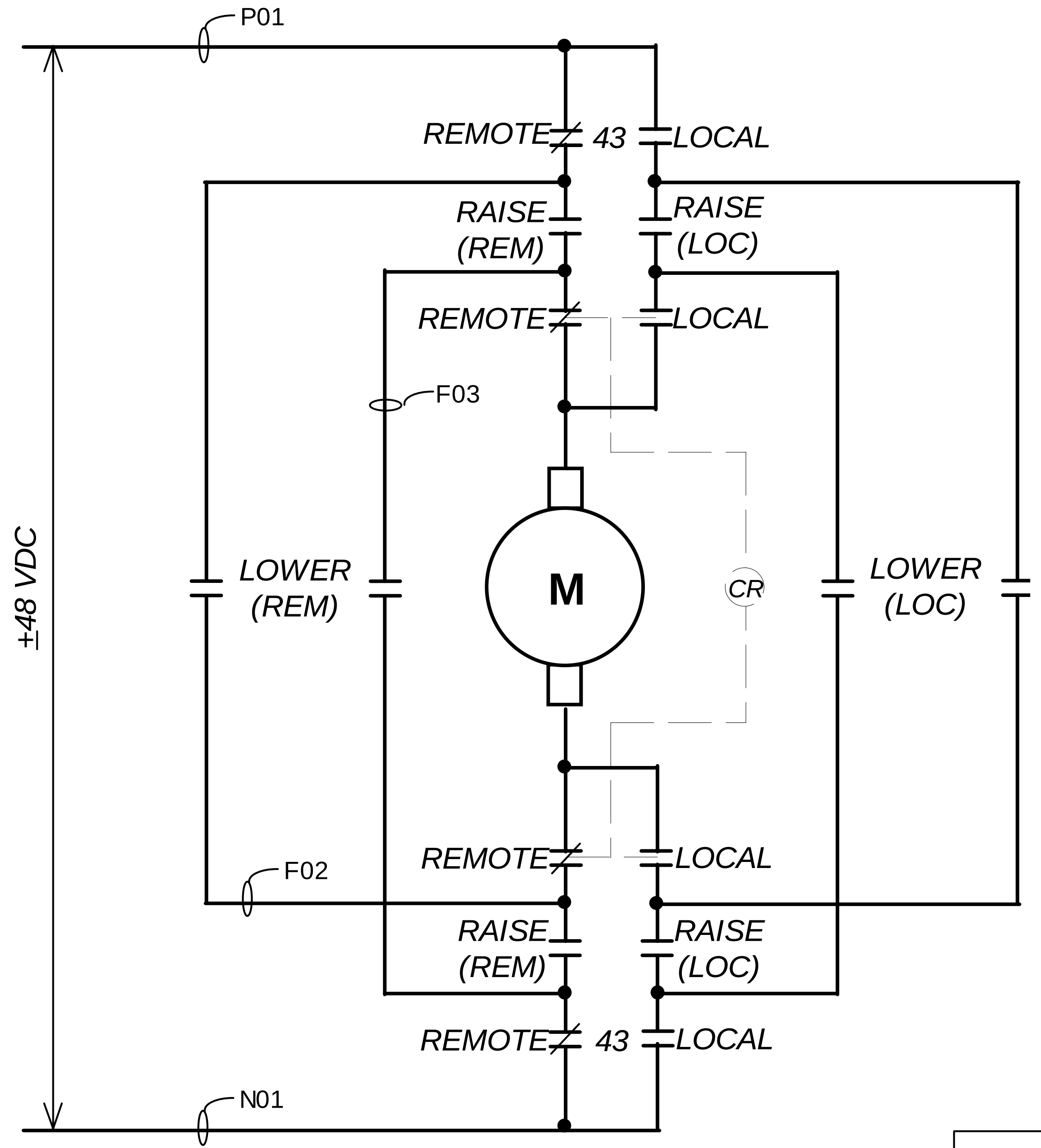
Drawing No.:	E-04
Date:	05/01/2007
Revision No.:	0



VALVE SHOWN IN CLOSED POSITION

VALVE	DESCRIPTION	SCHEME	SWITCH ID
MOV-16	AFW TEST LINE ISOLATION	MA18	MOV-16
MOV-17	AFW TEST LINE ISOLATION	MB16	MOV-17

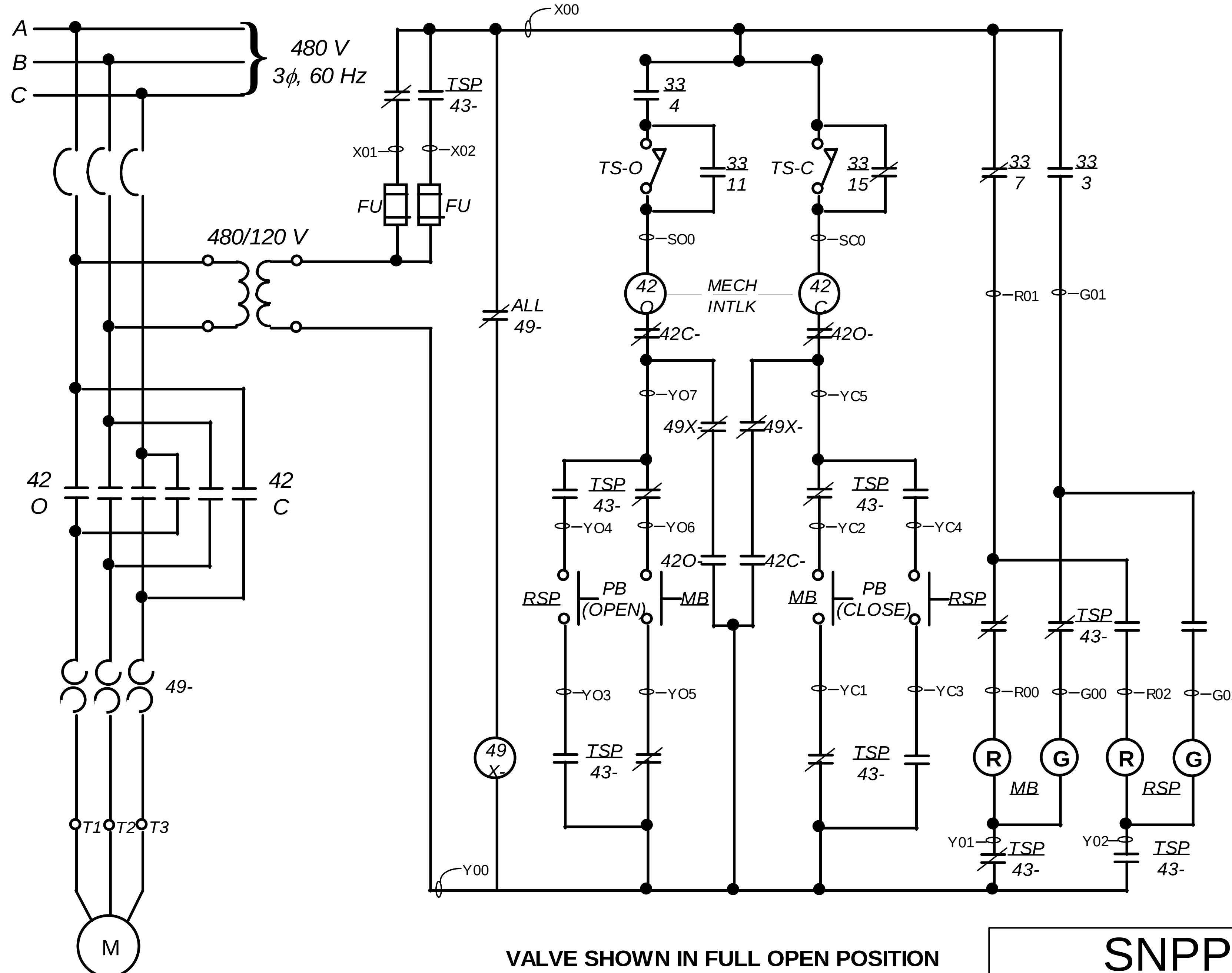
SNPP SCHEMATIC DIAGRAM – AFW TEST LINE ISOLATION MOTOR OPERATED VALVES MOV-16 & MOV-17	Drawing No.: E-08
	Date: 05/01/2007
	Revision No.: 0



Motor Shown in Remote Operating Mode

MOV-15, SCHEME DB4

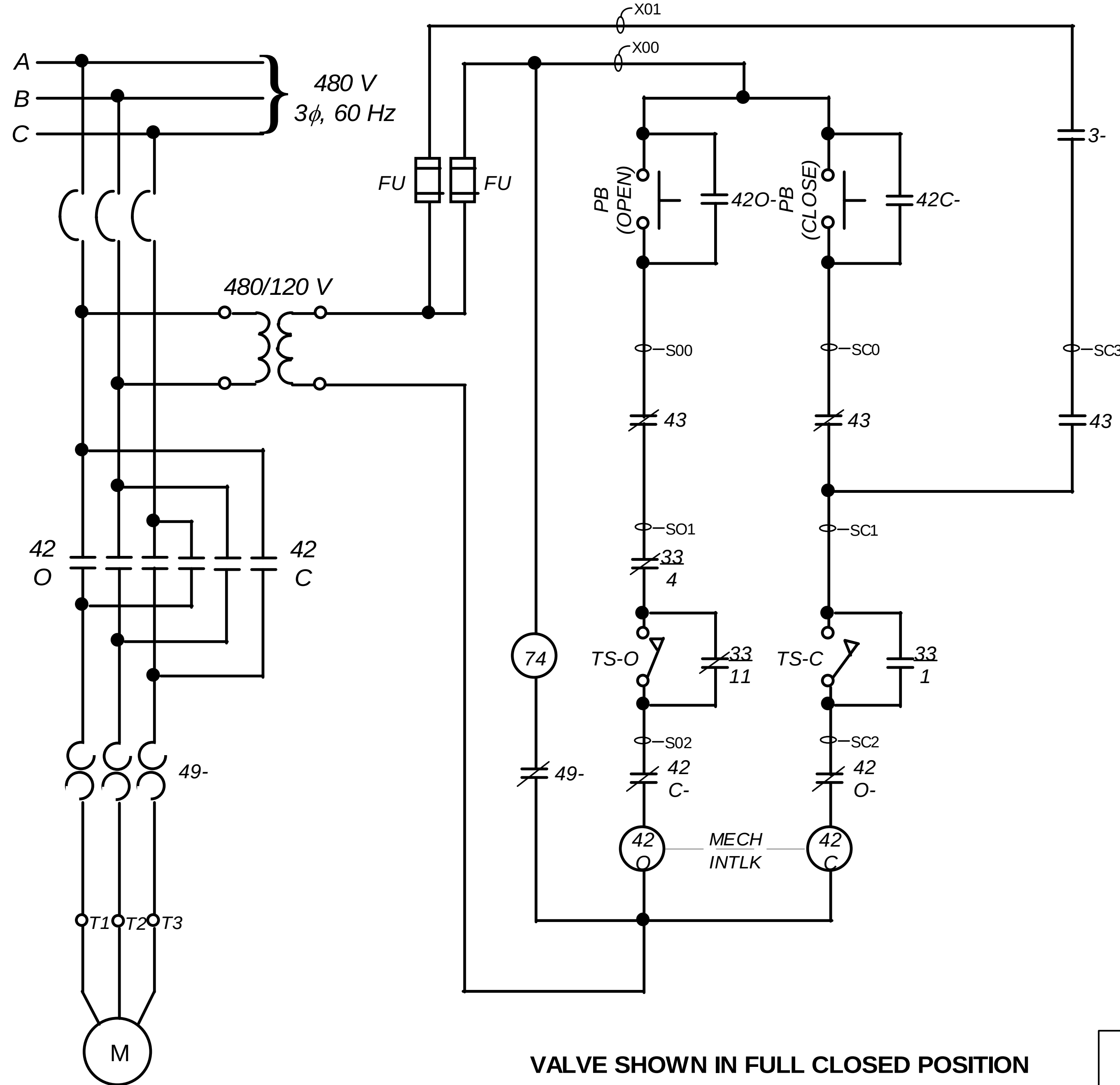
SNPP	Drawing No.: E-09
SCHEMATIC DIAGRAM – AFW- B STEAM THROTTLE MOTOR OPERATED VALVE MOV-15	Date: 05/01/2007
	Revision No.: 0



VALVE SHOWN IN FULL OPEN POSITION

MOV-13, SCHEME MA17

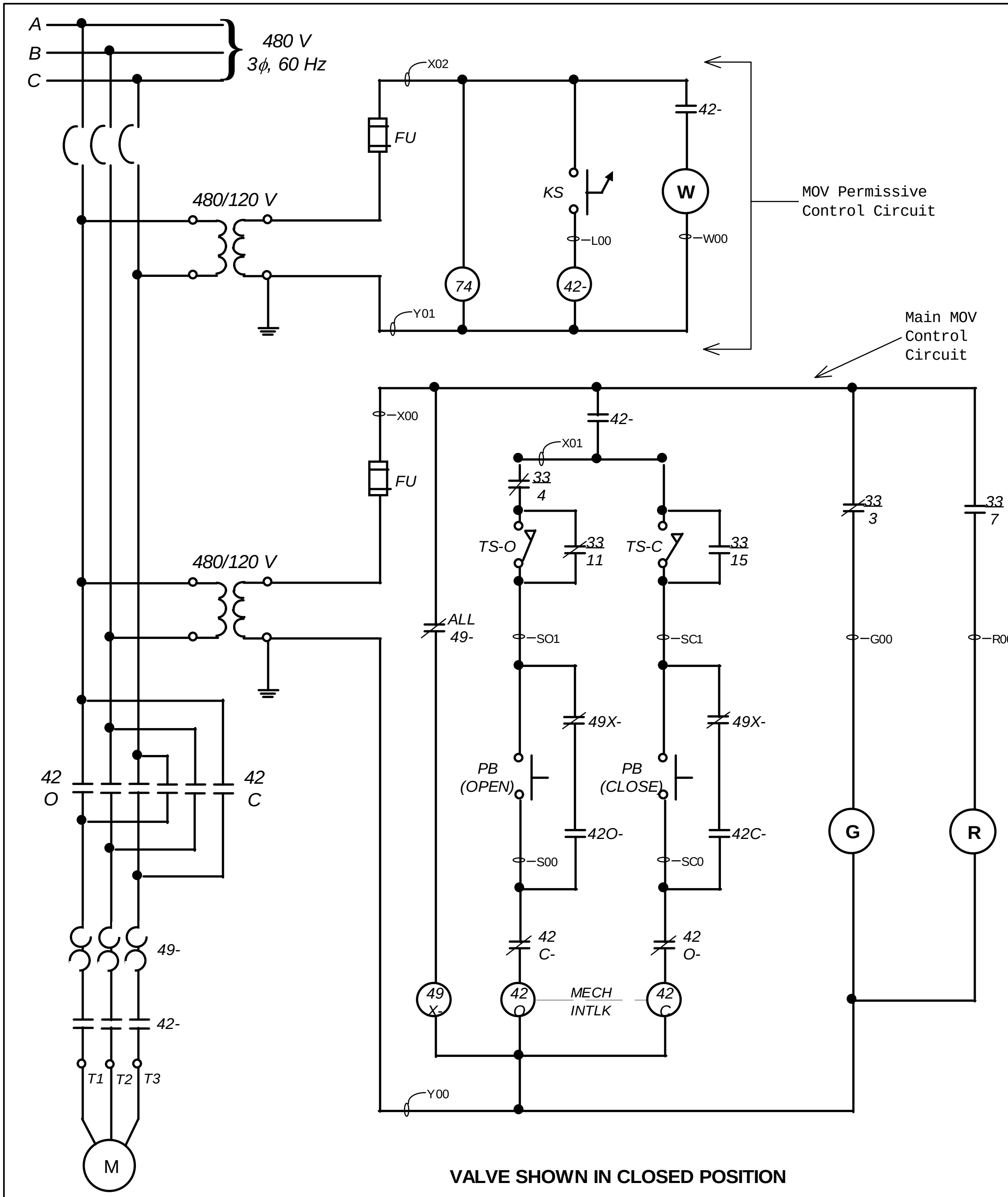
SNPP	Drawing No.: E-10
SCHEMATIC DIAGRAM – PORV BLOCK MOTOR OPERATED VALVE MOV-13	Date: 05/01/2007
	Revision No.: 0



VALVE SHOWN IN FULL CLOSED POSITION

MOV-10, SCHEME MA16

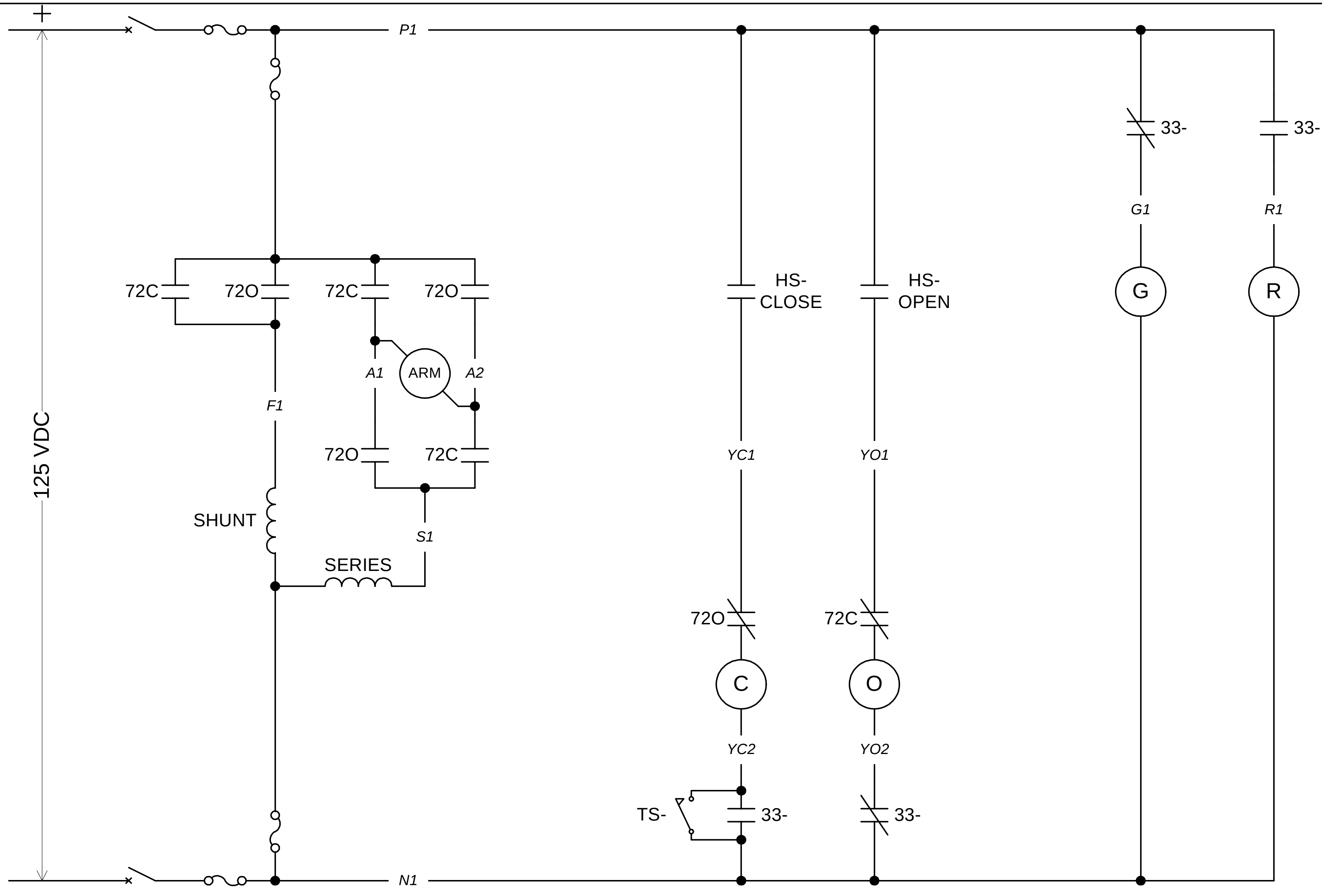
SNPP	Drawing No.: E-11
SCHEMATIC DIAGRAM – AFW-A DISCHARGE MOTOR OPERATED VALVE MOV-10	Date: 05/04/2007
	Revision No.: 0



VALVE SHOWN IN CLOSED POSITION

MOV-8, SCHEME MB14

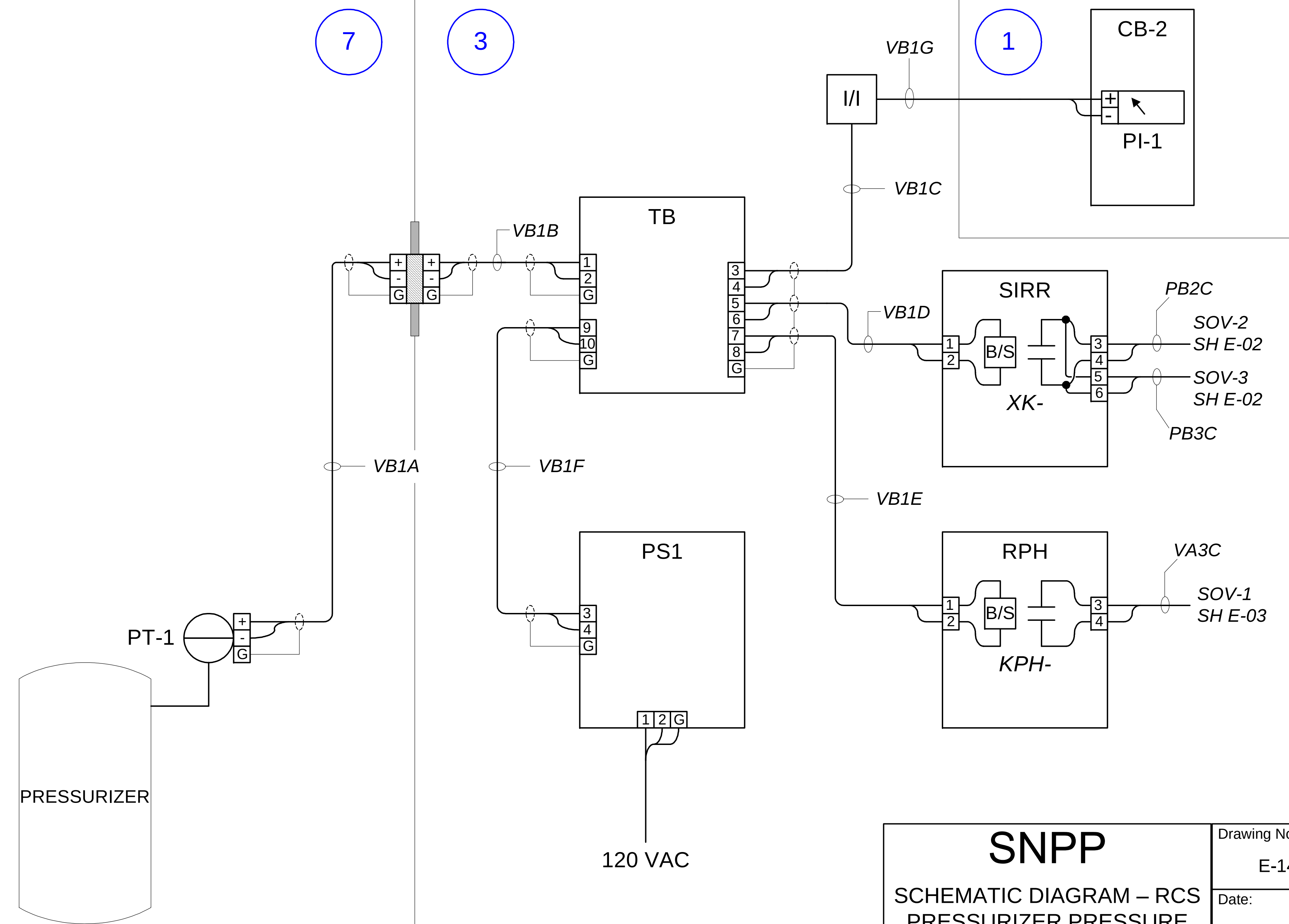
SNPP SCHEMATIC DIAGRAM – RHR OUTBOARD SUCTION MOTOR OPERATED VALVE MOV-8	Drawing No.: E-12
	Date: 05/04/2007
	Revision No.: 0



VALVE SHOWN IN CLOSED POSITION

MOV-11, SCHEME DB3

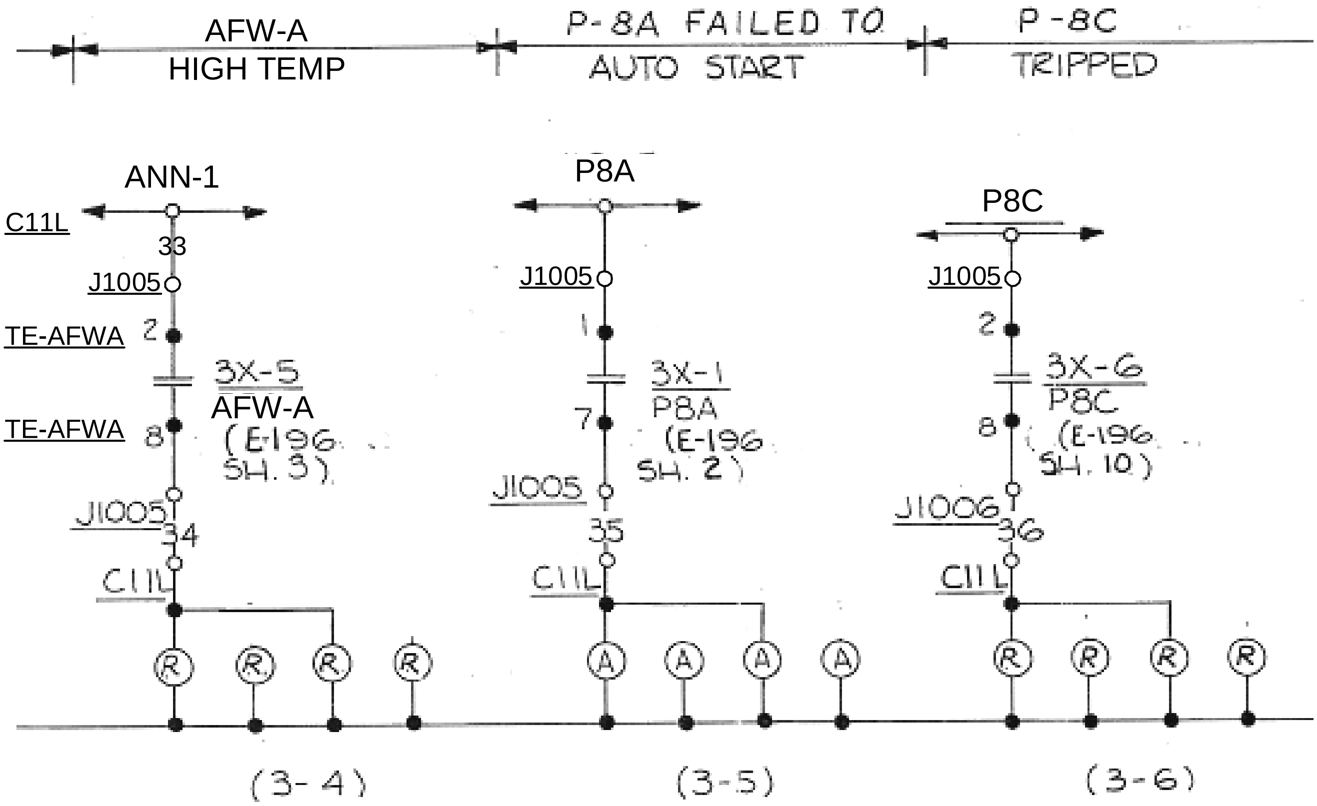
SNPP SCHEMATIC DIAGRAM – AFW-B DISCHARGE MOTOR OPERATED VALVE MOV-11	Drawing No.: E-13
	Date: 05/09/2007
	Revision No.: 0

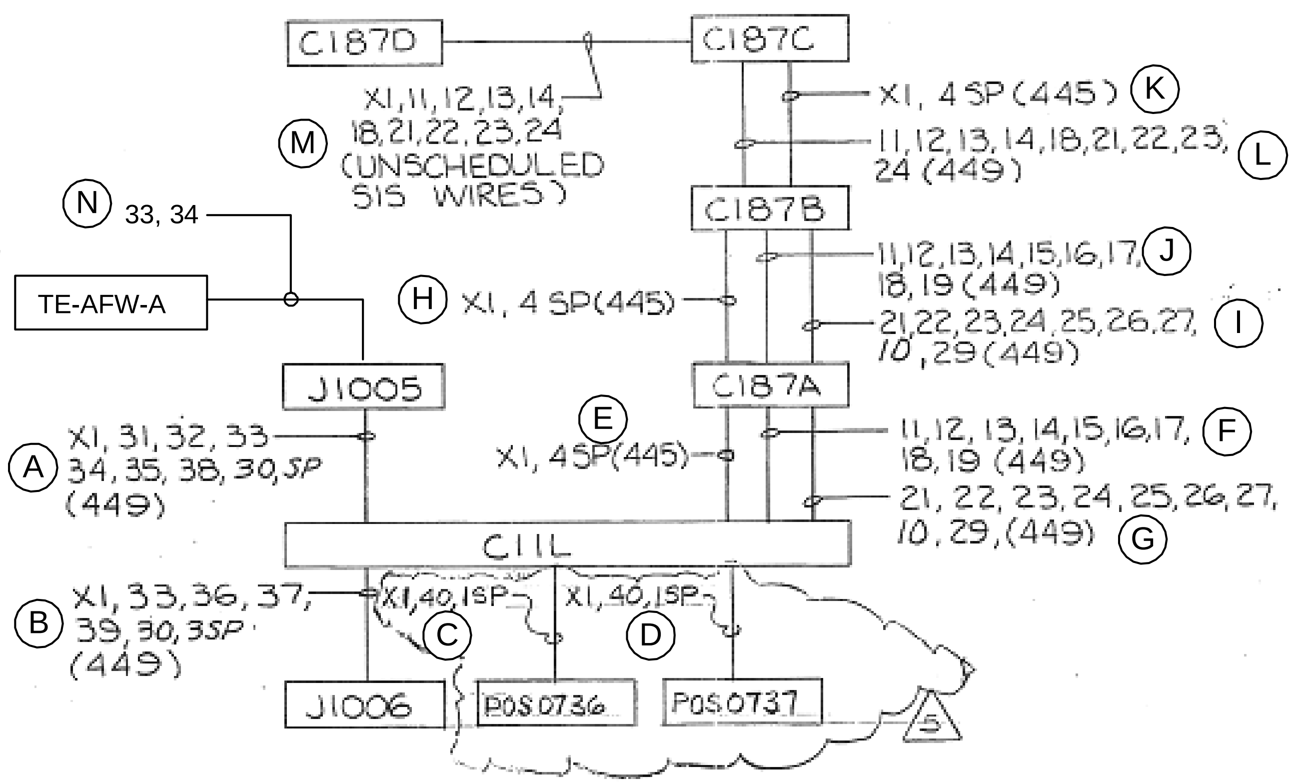


SNPP

SCHEMATIC DIAGRAM – RCS PRESSURIZER PRESSURE TRANSMITTER PT-1

Drawing No.:	E-14
Date:	05/22/2007
Revision No.:	1





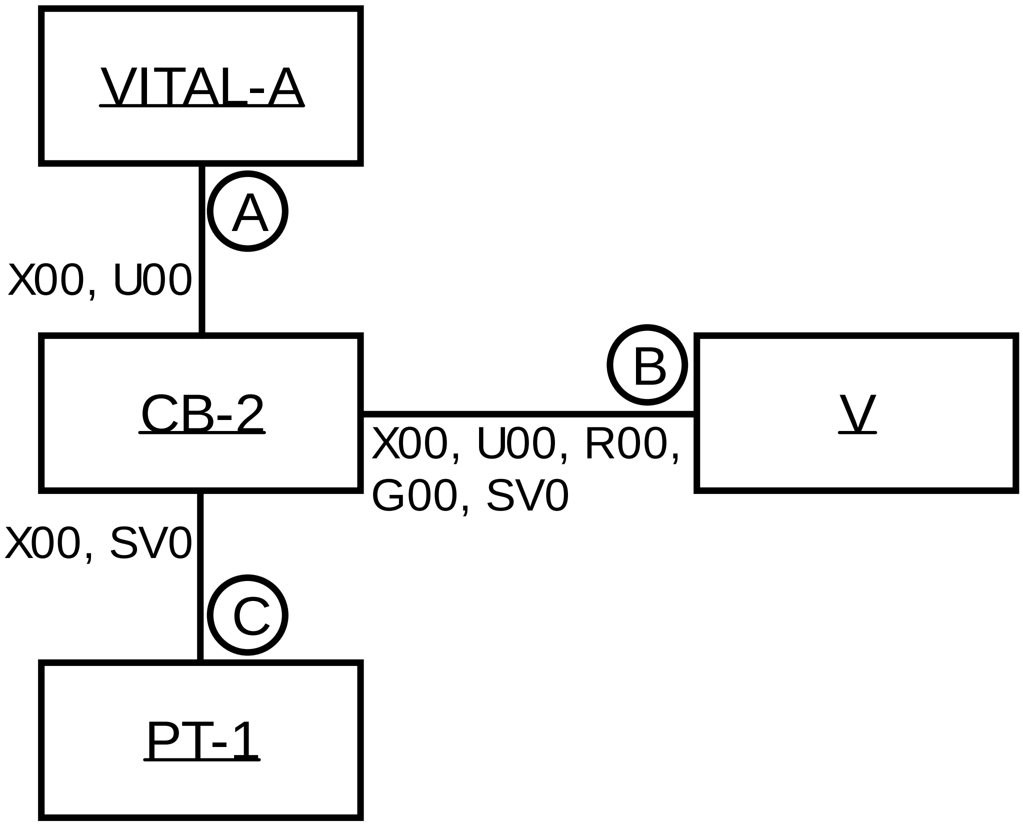
BLOCK DIAGRAM
SCHEME K16

SNPP	Drawing No.: ANN-1	
ANNUNCIATOR SCHEME K16	Date: 05/20/2007	
	Revision No.: #8	

Tab 3.10:

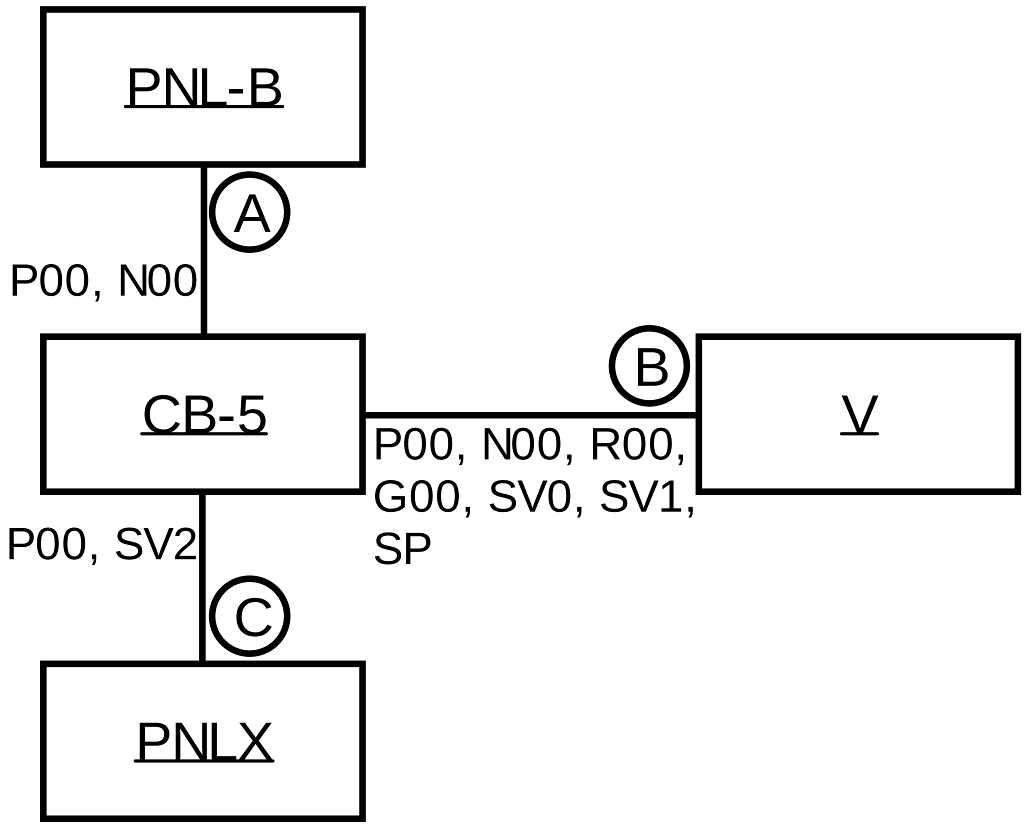
Drawing Package #2

SNPP	TITLE: AOV-1 BLOCK DIAGRAM	DATE: 4/27/07



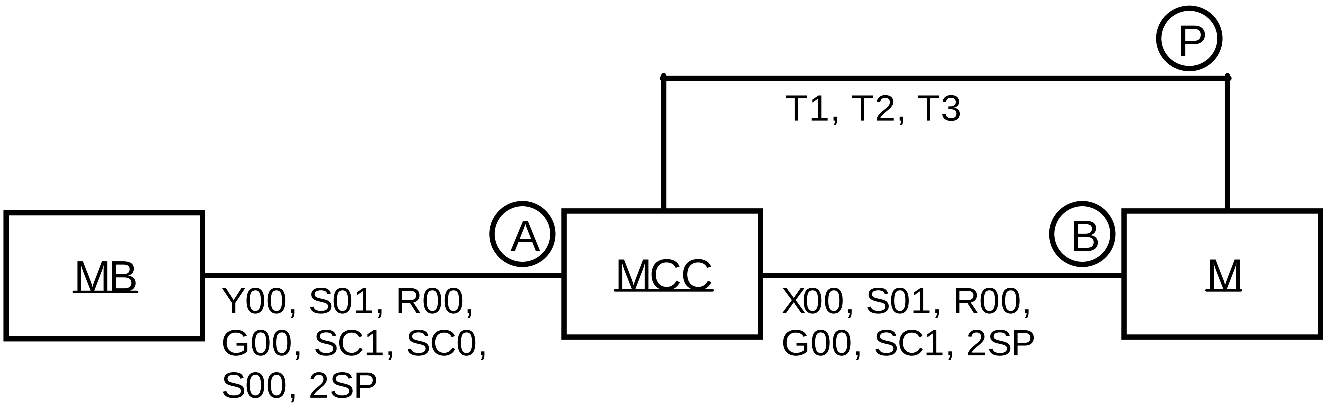
SOV-1, SCHEME VA3

SNPP	TITLE: AOV-3 BLOCK DIAGRAM	DATE: 4/27/07

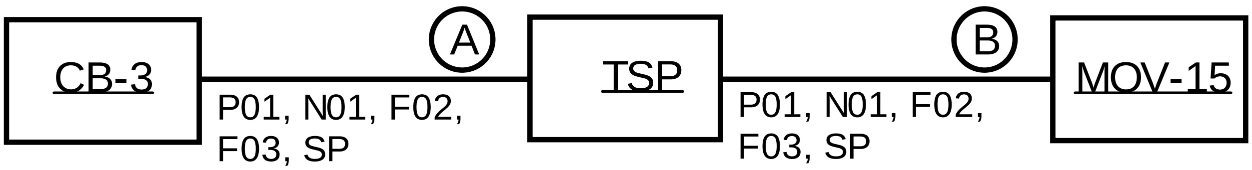


SOV-3, SCHEME PB3

SNPP	MOV BLOCK DIAGRAM - 1	5/4/07

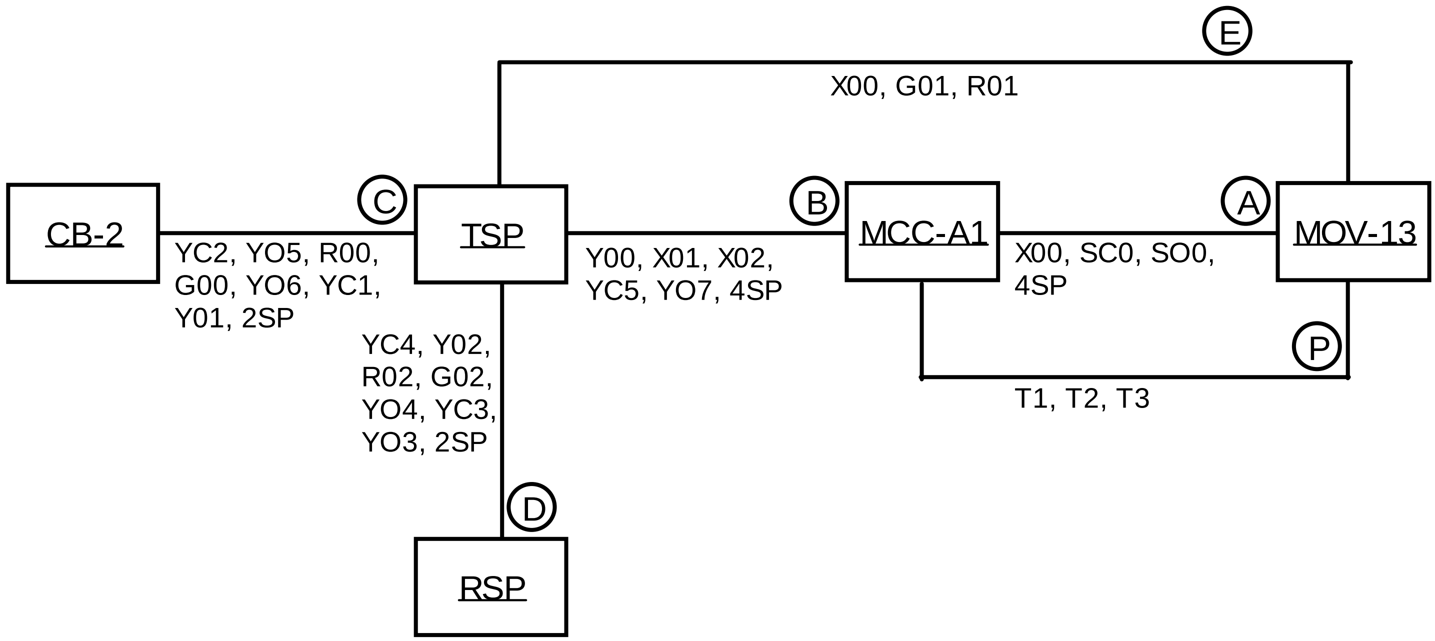


M	MCC	CUBICLE	MB	SCHEME
MOV-1	MCC-A1	2	CB-5	MA12
MOV-3	MCC-A1	3	CB-5	MA13
MOV-4	MCC-B1	2	CB-5	MB12
MOV-5	MCC-A1	4	CB-5	MA14
MOV-6	MCC-B1	3	CB-5	MB13
MOV-7	MCC-A1	5	CB-5	MA15
MOV-9	MCC-B1	5	CB-5	MB15
MOV-16	MCC-A1	8	CB-3	MA18
MOV-17	MCC-B1	6	CB-3	MB16



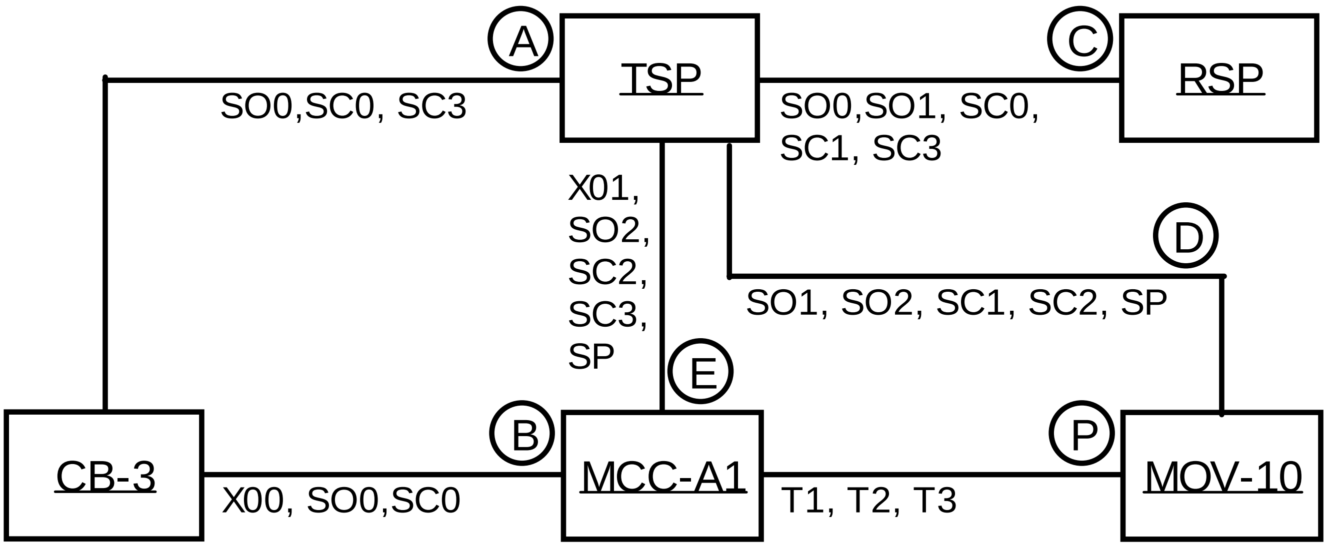
MOV-15, SCHEME DB4

SNPP	MOV BLOCK DIAGRAM - 3	5/1/07



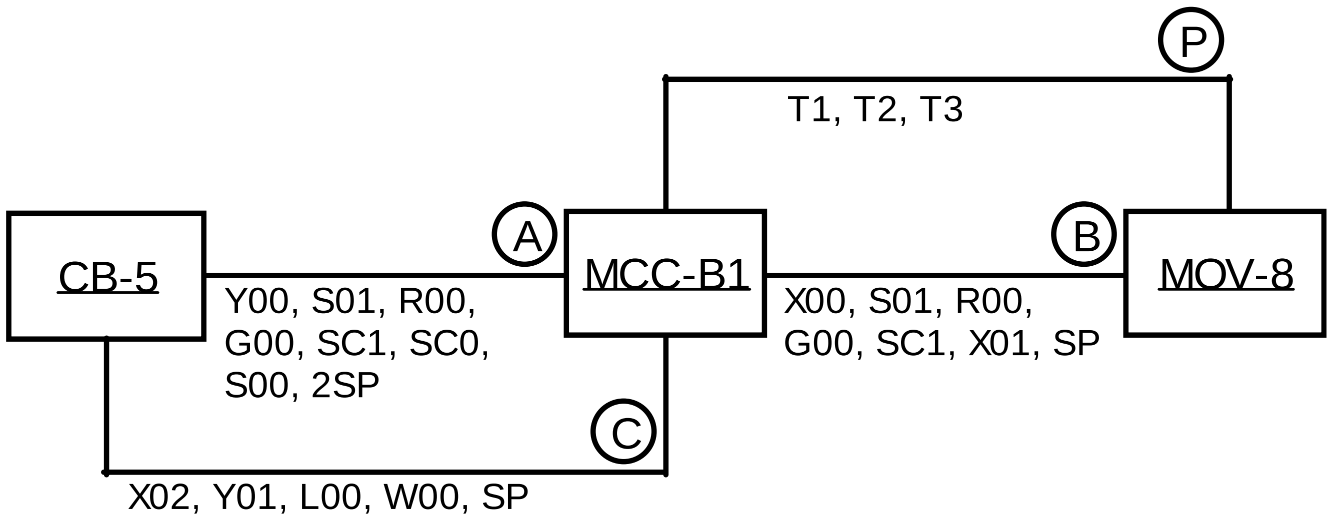
MOV-13, SCHEME MA17

SNPP	MOV BLOCK DIAGRAM - 4	5/4/07



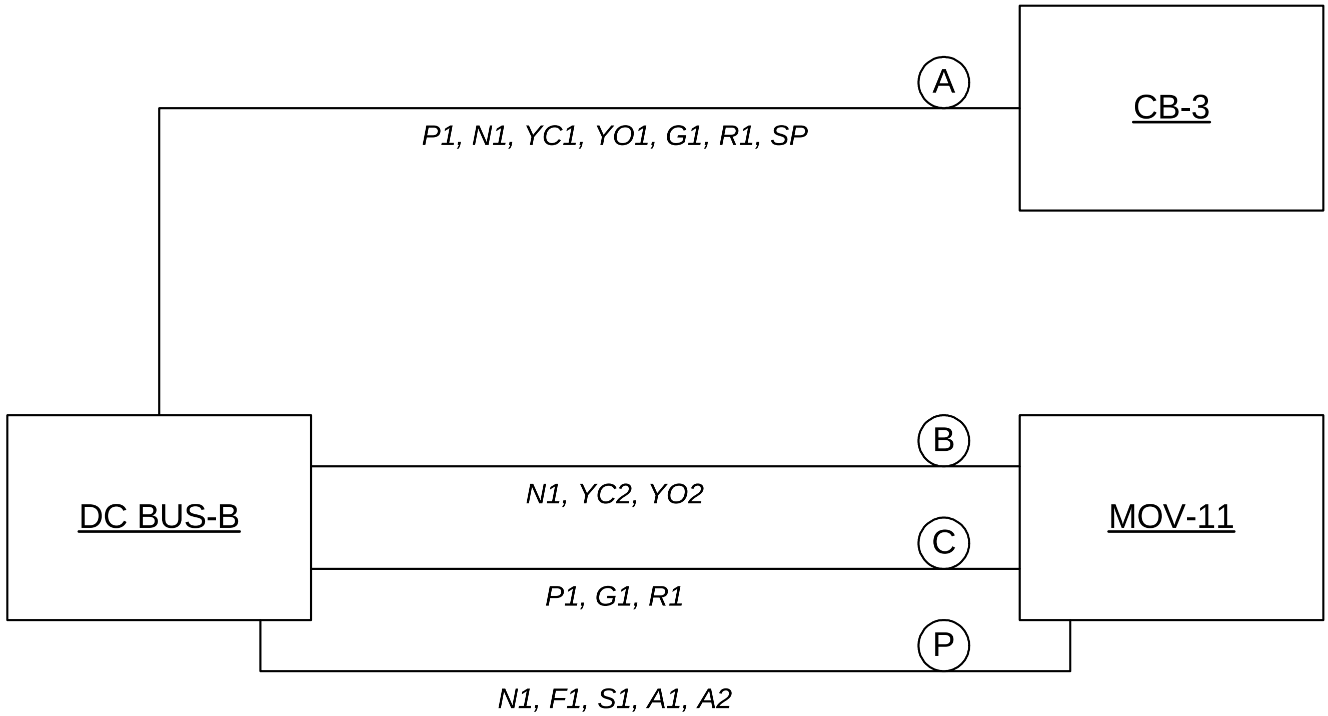
MOV-10, SCHEME MA16

SNPP	TITLE: MOV BLOCK DIAGRAM - 5	DATE: 5/4/07



MOV-8, SCHEME MB14

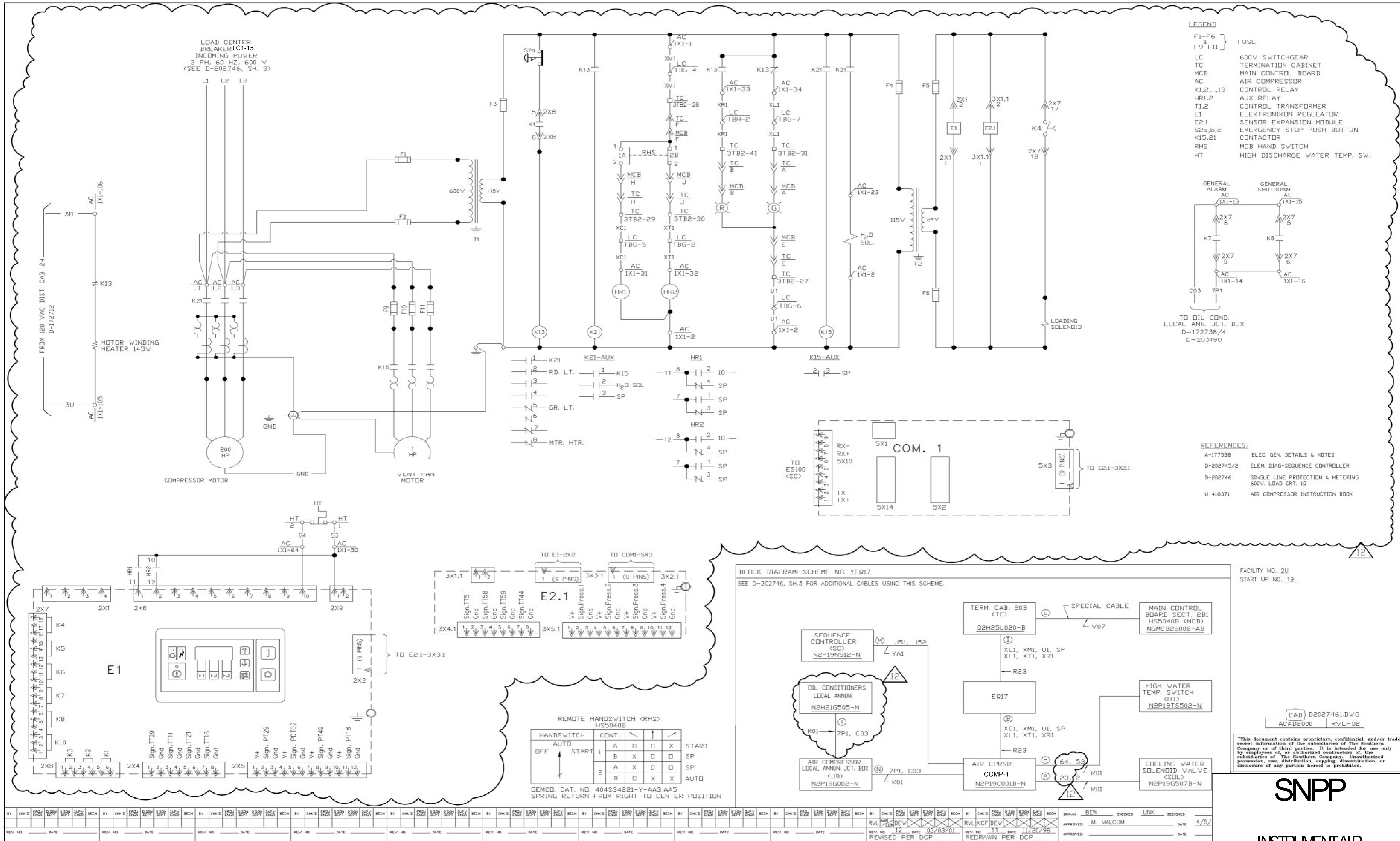
SNPP	TITLE: MOV BLOCK DIAGRAM - 6	DATE: 5/9/07



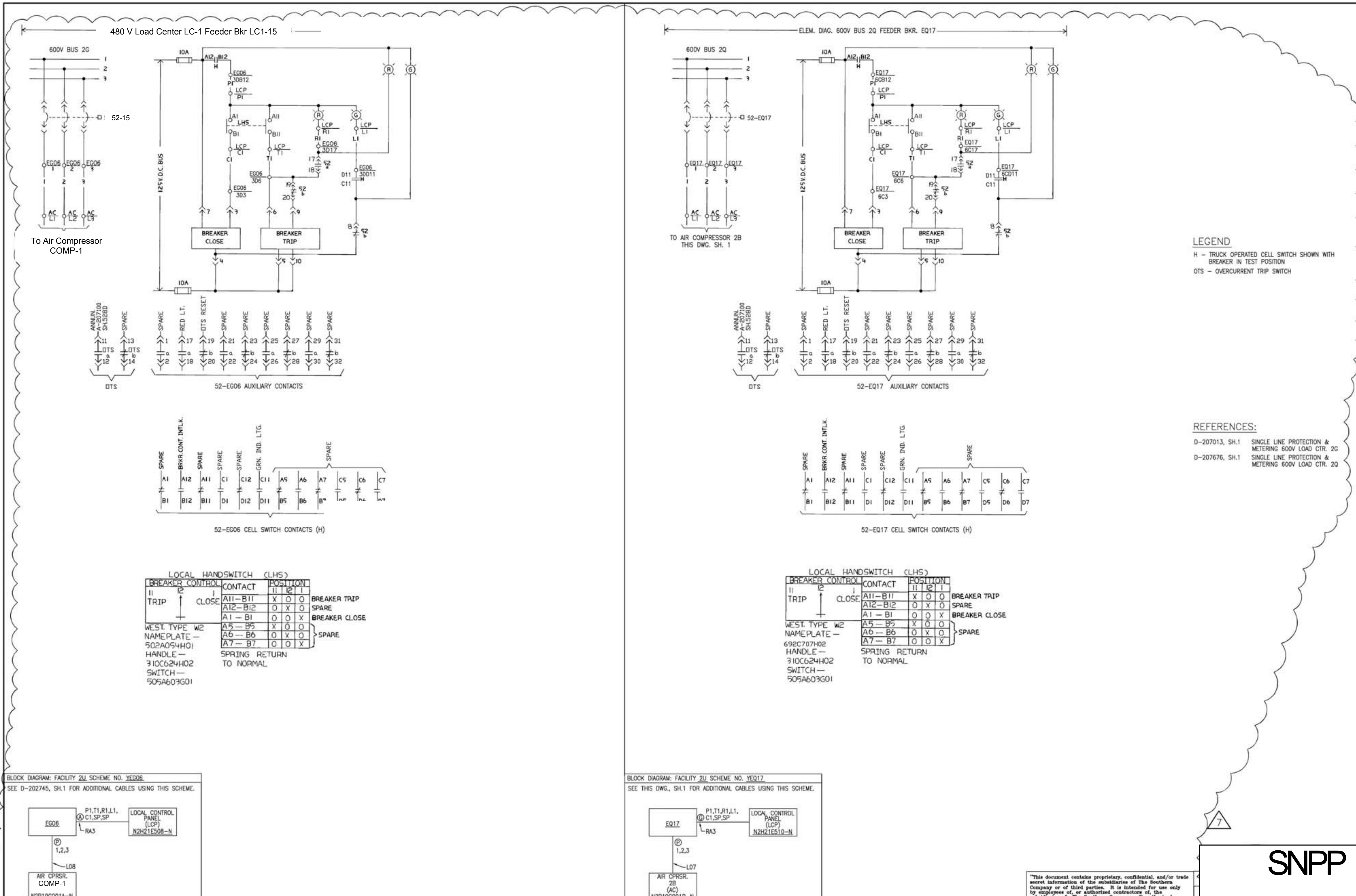
MOV-11, SCHEME DB3

Tab 3.11 Part 1:

Drawing Package #3 Part 1



SNPP	Drawing No.: COMP-1-02
	Date: 05/20/2007
INSTRUMENT AIR COMPRESSOR COMP-1	Revision No.: #6



LOCAL HANDSWITCH (LHS)

BREAKER CONTROL: 11 TRIP — 12 — 1 CLOSE

CONTACT	11	12	1	
A11—B11	X	O	O	BREAKER TRIP
A12—B12	O	X	O	SPARE
A1—B1	O	O	X	BREAKER CLOSE
A5—B5	X	O	O	SPARE
A6—B6	O	X	O	SPARE
A7—B7	O	O	X	SPARE

WEST. TYPE W2
NAMEPLATE — 502A054H01
HANDLE — 310C624H02
SWITCH — 505A603G01
SPRING RETURN TO NORMAL

LOCAL HANDSWITCH (LHS)

BREAKER CONTROL: 11 TRIP — 12 — 1 CLOSE

CONTACT	11	12	1	
A11—B11	X	O	O	BREAKER TRIP
A12—B12	O	X	O	SPARE
A1—B1	O	O	X	BREAKER CLOSE
A5—B5	X	O	O	SPARE
A6—B6	O	X	O	SPARE
A7—B7	O	O	X	SPARE

WEST. TYPE W2
NAMEPLATE — 692C707H02
HANDLE — 310C624H02
SWITCH — 505A603G01
SPRING RETURN TO NORMAL

LEGEND

H – TRUCK OPERATED CELL SWITCH SHOWN WITH BREAKER IN TEST POSITION

OTS – OVERCURRENT TRIP SWITCH

REFERENCES:

D-207013, SH.1 SINGLE LINE PROTECTION & METERING 600V LOAD CTR. 2G

D-207676, SH.1 SINGLE LINE PROTECTION & METERING 600V LOAD CTR. 2Q

REV. NO. 7 DATE 11/20/98 REDRAWN PER DCP 91-2-7267, 001-009 RVL KCF DEW

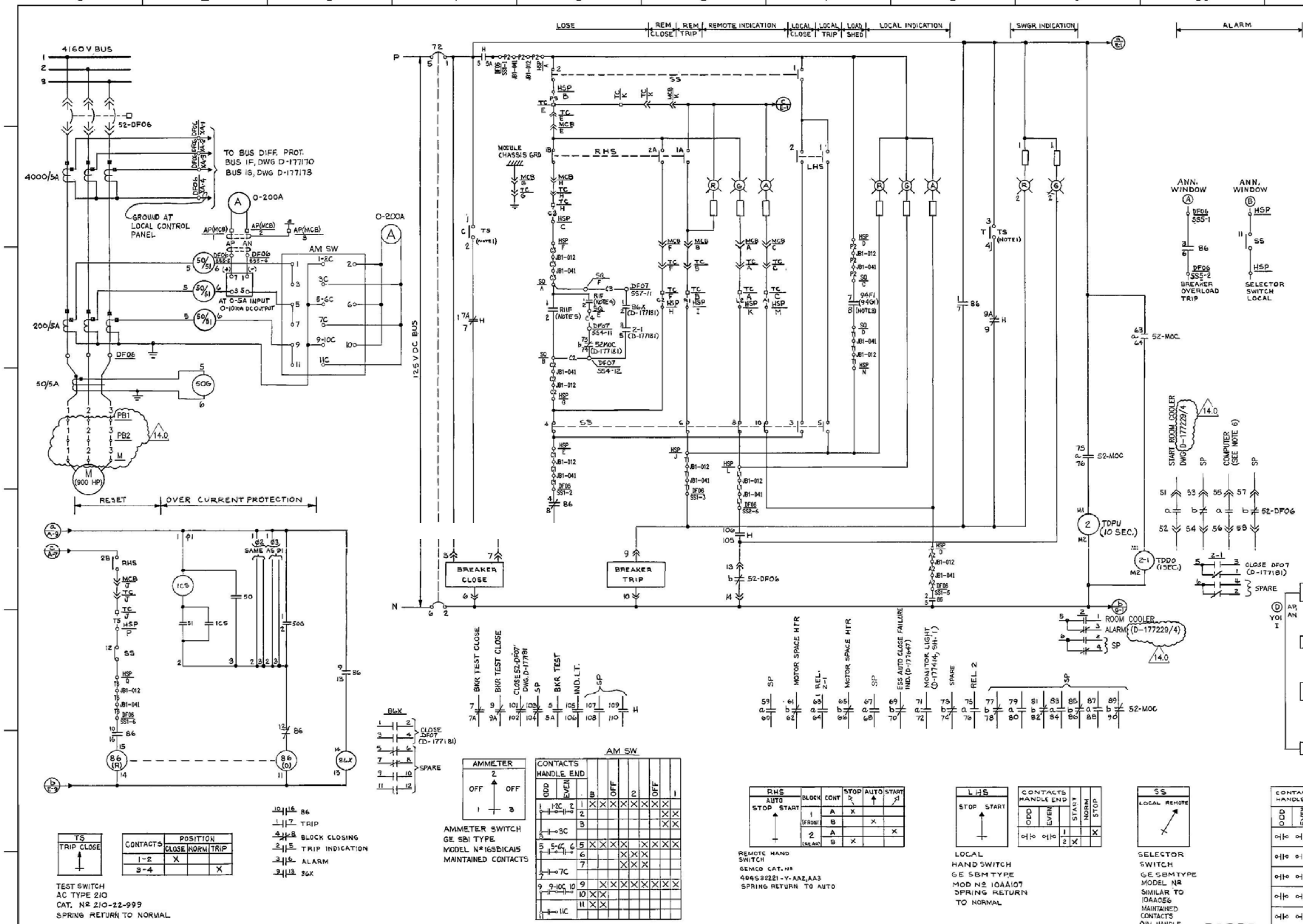
DRAWN JLO CHECKED NPA DESIGNED RPL

APPROVED N.R. ANTINO DATE 4/9/85

APPROVED DEK CAB DATE 4/9/85

APPROVED JAMES R. CRANE DATE 4/9/85

SNPP	Drawing No.: COMP-1-02
INSTRUMENT AIR COMPRESSOR COMP-1	Date: 05/20/2007
	Revision No.: #6



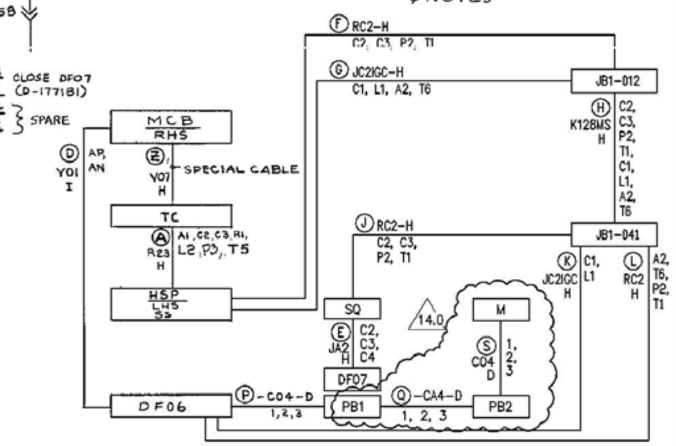
DEVICE	DESCRIPTION	MFR/TYPE	REMARKS
86	LOCKING-OUT RELAY	Ⓦ/MG-6 STYLE 289B473A22	24V DC OPER COIL 125V DC RESET COIL
2	TIME DELAY PICKUP RELAY (SET AT 10 SEC.)	AGA/E7012PC	125 V DC 1.5-15 SEC.
2-1	TIME DELAY DROPOUT RELAY (SET AT 1 SEC.)	AGA/E7022PB	125 V DC 0.5-5 SEC.
86X	AUXILIARY RELAY	G.E./ 12 HFA151A42H CODE 42	125 V DC

NOTES

1. TS —— TEST SWITCH
2. H —— TRUCK OPERATED CELL SWITCH SHOWN FOR BREAKER IN TEST POSITION.
3. SEQUENCER LOAD SHEDDING CIRCUIT B/F, DWG D-177653 (B/G, DWG D-177654).
4. ENGINEERED SAFEGUARD SEQUENCER B/F, DWG D-177645 (B/G, DWG D-177646).
5. LOSS OF OFFSITE POWER SEQUENCER B/F, DWG D-177649 (B/G D-177650).
6. THE COMPUTER OPERATOR ADDRESS NUMBERS FOR DF06 & DG06 ARE Y0100D & Y0102D, RESPECTIVELY.

REFERENCE DRAWINGS

D-177001 – SINGLE LINE ELEC AUX SYSTEM (EMERG - 4160V & 600V)
D-177005 – SINGLE LINE PROTECTION & METERING 4160V SWITCH GEAR BUS IF
D-177006 – SINGLE LINE PROTECTION & METERING 4160V SWITCH GEAR BUS IG
A-177538 – ELEC GENERAL DETAILS & NOTES



EQUIPMENT	FAC	SCHEME	SWITCH GEAR CELL	MOTOR (M)	REMOTE HAND SWITCH (RHS)	Ⓦ DRAWING – S.S.I. ACCESS. Nº.	SEQUENCER PANEL (SQ)	MAIN CONTROL BOARD (MCB)	TERMINATION CABINET (TC)	LOCAL HOT SHUTDOWN PANEL (HSP)	START-UP NUMBER	TC TERMINAL Nº E	F	H	A	J	K	C	B	AP(MCB) TERMINAL Nº 1	2	3	ANN. WINDOW Ⓐ	Ⓑ	HSP TERMINAL Nº A	B	C	D	E	PB1 SPLICE BOX	PB2 SPLICE BOX
CHARGING/HIGH HEAD SAFETY INJECTION PUMP	1A	1V	ADF06	DF06	Q1E21 M001A-'A	Q1E21 HS6504A-A	U167953	Q1R43 E001A-A	N1H11 NGMCB2500A-AB	Q1H25 L006-A	Q1H21NB AFP2605A-A'	40	3TB1-16	3TB1-17	3TB1-18	3TB1-19	3TB1-20	3TB1-21	3TB1-22	3TB1-23	AP8(MCB) TB1-4	AP8(MCB) TB1-5	AP8(MCB) TB1-6	PNL."E" B1	PNL."E" B2	TM-1	TZ-11	TY-2	TM-2	TN-11	A1PB217	A1PB218

JB1-012 JUNCTION BOX	JB1-041 JUNCTION BOX
A1TB125	A1TB126

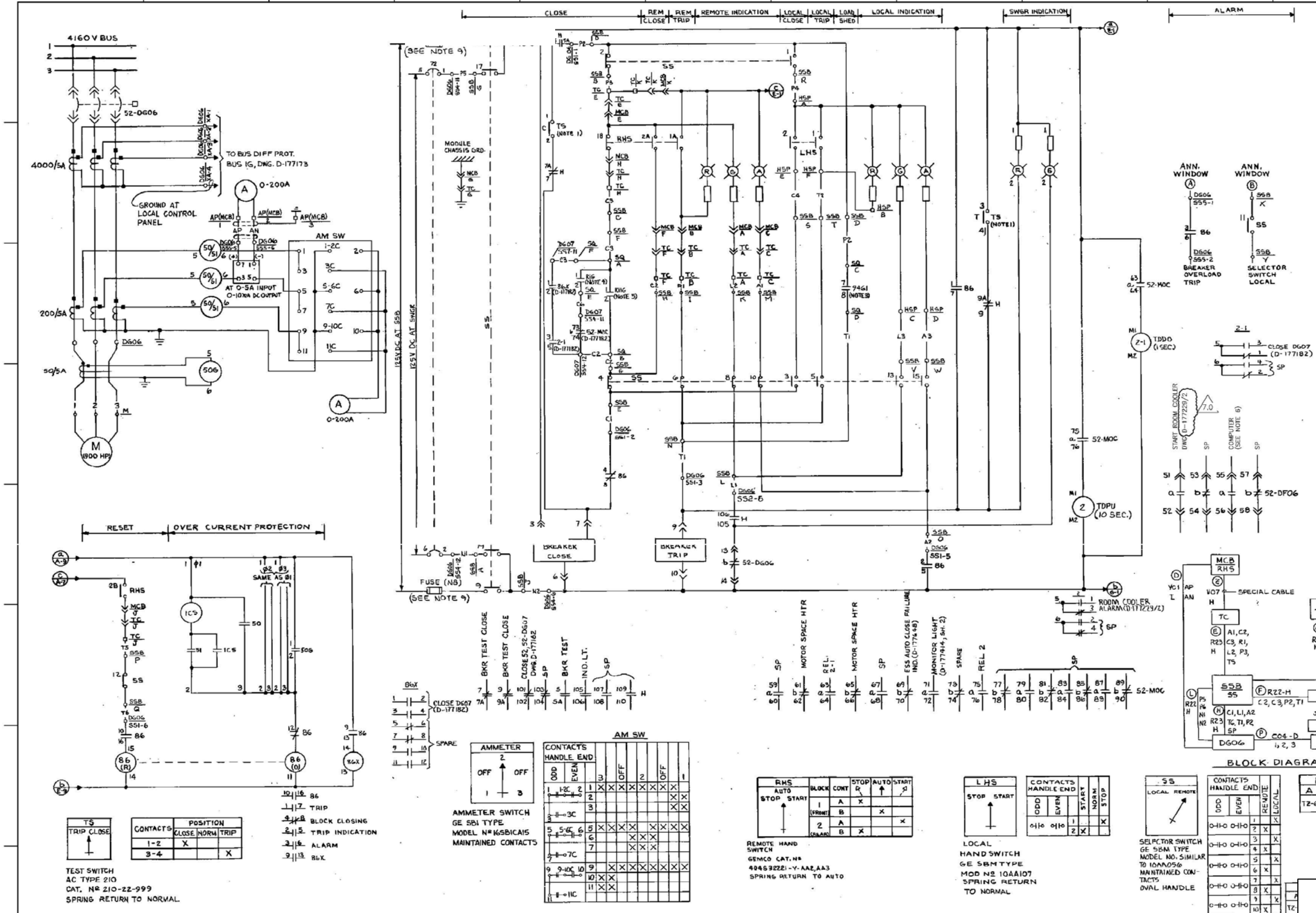
SNPP

HPI-B SCHEMATIC DIAGRAM
SHEET 2

Drawing No.: HPI-B-02

Date: 05/20/2007

Revision No.: #6



DEVICE	DESCRIPTION	MFR/TYPE	REMARKS
86	LOCKING-OUT RELAY	Ⓦ/MG-6 STYLE 2878473A22	24V DC OPER COIL 125V DC RESET COIL
2	TIME DELAY PICKUP RELAY (SET AT 10 SEC.)	AGA/E7012PC	125V DC 1.5-15 SEC.
Z-1	TIME DELAY DROPOUT RELAY (SET AT 1 SEC.)	AGA/E7022PB	125 V DC 0.5-5 SEC.
86X	AUXILIARY RELAY	G.E./ 12HFA151A42H CODE 42	125 V DC

NOTES

1. TS — TEST SWITCH
2. H — TRUCK OPERATED CELL SWITCH SHOWN FOR BREAKER IN TEST POSITION.
3. SEQUENCER LOAD SHEDDING CIRCUIT BIF, DWG D-177683 (BIG, DWG D-177654).
4. ENGINEERED SAFEGUARD SEQUENCER BIF, DWG D-177645 (BIG, DWG D-177646).
5. LOSS OF OFFSITE POWER SEQUENCER BIF, DWG D-177649 (BIG D-177650).
6. THE COMPUTER OPERATOR ADDRESS NUMBERS FOR DF06 & DG06 ARE Y0100D & Y0102D, RESPECTIVELY.
7. CABLES 1VBDG06F & 1VBDG06H SHOULD BE ROUTED INDEPENDENTLY OF CABLES 1VBDG06E & 1VBDG06G.
8. CABLE 1VBDG06G SHOULD BE ROUTED INDEPENDENTLY OF CABLES 1VBDG06E, F & H.
9. SEE DRAWING A-181987 FOR FUSE RATING & TYPE.

REFERENCE DRAWINGS

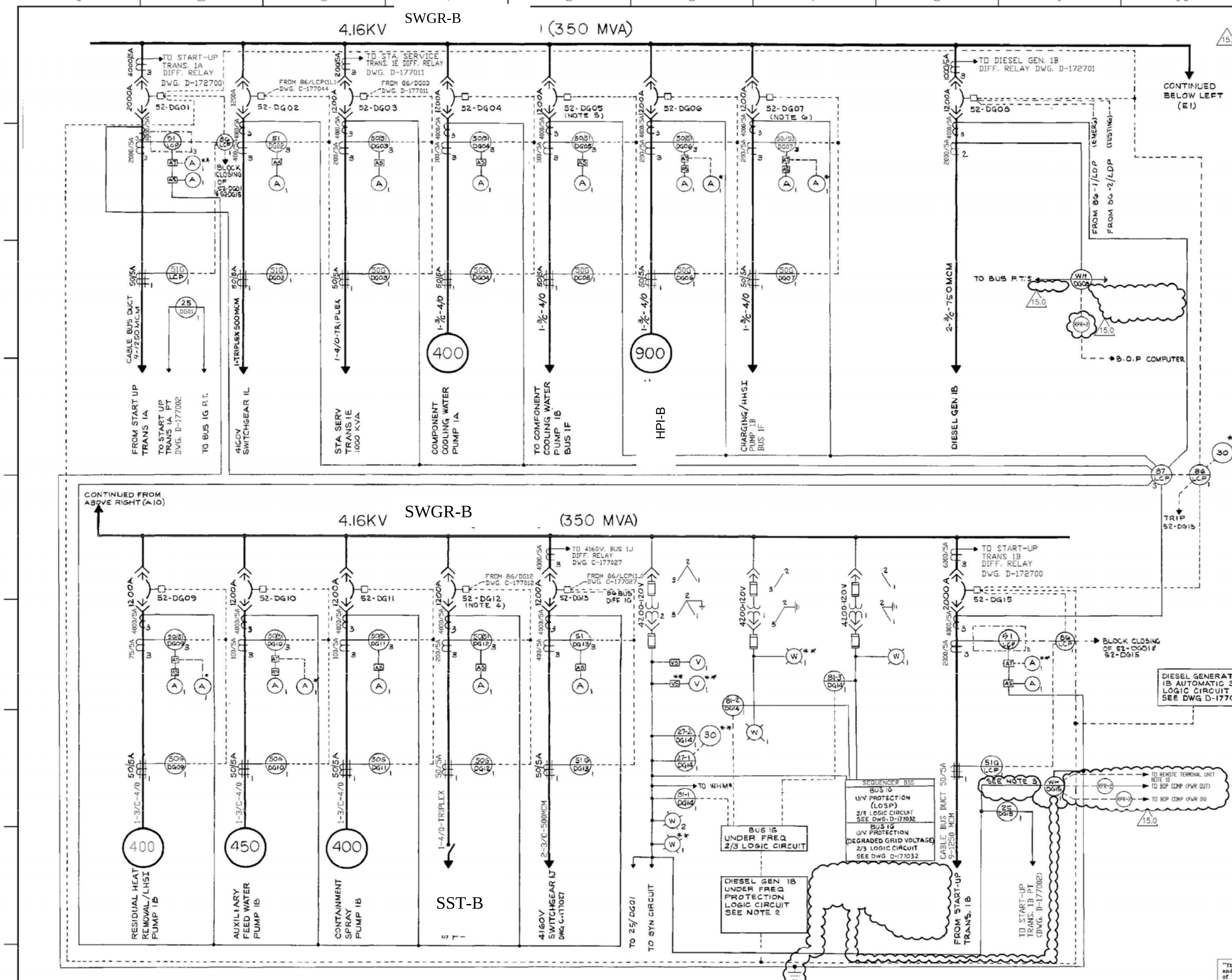
D-177001 – SINGLE LINE ELEC AUX SYSTEM (EMERG - 4160V & 600V)
D-177005 – SINGLE LINE PROTECTION & METERING 4160V SWITCH GEAR BUS 1F
D-177006 – SINGLE LINE PROTECTION & METERING 4160V SWITCH GEAR BUS 1G
A-177538 – ELEC GENERAL DETAILS & NOTES
A-181987 – FUSE REPLACEMENT MANUAL FOR SAFETY RELATED EQUIPMENT.

EQUIPMENT		FAC	SCHEME	SWITCH GEAR CELL	MOTOR (M)	REMOTE HAND SWITCH (RHS)	Ⓦ DRAWING - S.S.I. ACCESS Nº	SEQUENCER PANEL (SQ)	MAIN CONTROL BOARD (MCB)	TERMINATION CABINET (TC)	LOCAL HOT SHUTDOWN PANEL (HSP)	SELECTOR SWITCH BOX (SSB)	START-UP NUMBER
CHARGING/HIGH HEAD SAFETY INJECTION PUMP	1C	IV	BDG06	DG06	Q1E21 M001C-B	Q1E21 HS6504C-B	U167954	Q1R43 E001B-B	N1H11 N6MCB2500A-AB	Q1H25 L027-B	Q1H21NB AFP2605B-B	Q1H21NBA FP2605C-B	40

START-UP NUMBER	TC TERMINAL Nº E	F	H	A	J	K	C	B	AP(MCB) TERMINAL NºS 1	2	3	ANN. WINDOW Ⓐ	Ⓑ	SSB TERMINAL NºS A	B	C	D	E
40	1TB2-29	1TB2-30	1TB2-31	1TB2-32	1TB2-33	1TB2-34	1TB2-35	1TB2-36	AP6(MCB) TB1-7	AP6(MCB) TB1-8	AP6(MCB) TB1-9	B1 PNL."E"	B2 PNL."E"	TB-43	TB-23	TB-30	TB-33	TB-44

SSB TERMINAL NºS F	G	H	I	J	K	M	N	L	O	P	Q	R	S	T		V	W	X	Y
TB-32	TB-31	TB-29	TB-25	TB-45	TB-27	TB-24	TB-34	TB-46	TB-47	TB-28	TB-48	TB-35	TB-37	TB-36		TB-40	TB-41	TB-58	TB-59

SNPP	Drawing No.: HPI-B-01
HPI-B SCHEMATIC DIAGRAM SHEET 1	Date: 05/20/2007
	Revision No.: #6



DEVICE	DESCRIPTION	MFR/TYPE	REMARKS
51 / LCP	START UP TRANS 1A OVER CURRENT RELAY	GE/IAC53B	
WH / DG08	DIESEL GEN 1B WATT HOUR METER	JEMSTAR JS05R6010 -B6-DNP	
25 / SEE REMARKS	BUS 1G SYNCHRONISM CHECK RELAY	GE/IJS52A	APPLICABLE TO CELLS DG01 & DG15
51 / DG02	4160V SWITCHGEAR 1L OVER CURRENT RELAY	GE/IAC53B	
50G / SEE REMARKS	GROUND SENSOR RELAY	GE/PJC11AV	APPLICABLE TO CELLS DG03 TO DG07, DG09 TO DG12
50/51 / DG03	STA SERV TRANS 1E OVER CURRENT RELAY	GE/IAC53B	
50/51 / DG04	COMP COOLING WATER PUMP 1A OVER CURRENT RELAY	GE/IAC66B	
50/51 / DG05	COMP COOLING WATER PUMP 1B OVER CURRENT RELAY	GE/IAC66B	
50/51 / DG06	CHARGING/HHSI PUMP 1C OVER CURRENT RELAY	GE/IAC66B	
50/51 / DG07	CHARGING/HHSI PUMP 1B OVER CURRENT RELAY	GE/IAC66B	
51G / SEE REMARKS	VERY INVERSE TIME GROUND RELAY	GE/IAC54A	APPLICABLE TO CELLS DG02 & DG15
50/51 / DG09	RHR/LHSI PUMP 1A OVER CURRENT RELAY	GE/IAC66B	
50/51 / DG10	AUX FEED WATER PUMP 1B OVER CURRENT RELAY	GE/IAC66B	
50/51 / DG11	CTMT SPRAY PUMP 1B OVER CURRENT RELAY	GE/IAC66B	
50/51 / DG12	STA SERV TRANS 1F OVER CURRENT RELAY	GE/IAC53B	
51 / DG13	4160V SWITCHGEAR 1J OVER CURRENT RELAY	GE/IAC53B	
86 / LCP	BUS DIFFERENTIAL LOCKOUT RELAY	GE/HEA	
87 / LCP	BUS 1G DIFF. PROTECTIVE RELAY	GE/PVD11C	
RPR-2	REPEATING PULSE RELAY	SOLID STATE INSTRUMENT	LOC. IN MN. CONT. RM. METER & RELAY PNL.
27-1, 2 / DG14	BUS 1G UNDER VOLTAGE RELAY	GE/IAV54E	
WH / DG15	START-UP TRANS 1B WATT HOUR METER	JEMSTAR JS05R6010 -B6-DNP	
81-(1,2,&3) / DG14	BUS 1G UNDER FREQUENCY RELAY	GE/SFF201B1A	DIESEL GENERATOR 1B 2/3 LOGIC CIRCUIT
51 / LCP	START UP TRANS 1B OVER CURRENT RELAY	GE/IAC53B	
86 / LCP	START UP TRANS 1B LOCKOUT RELAY	GE/HEA	
86 / LCP	START UP TRANS 1A LOCKOUT RELAY	GE/HEA	
51G / LCP	VERY INVERSE TIME GROUND RELAY	GE/IAC54A	APPLICABLE TO CELLS DG01 & DG15

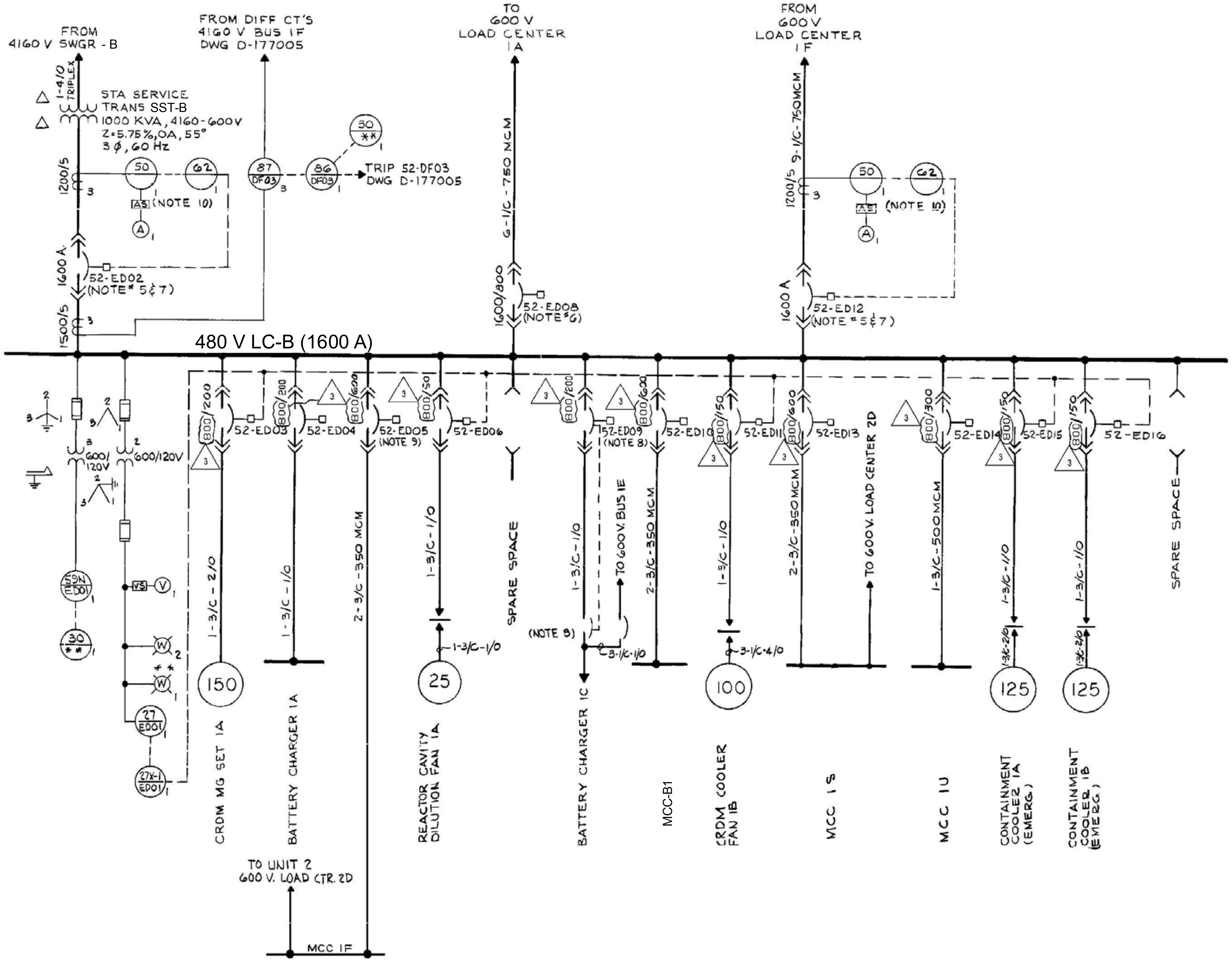
NOTES:

1. * - DENOTES MAIN CONTROL BOARD IN MAIN CONTROL ROOM.
2. DIESEL GENERATOR UNDER FREQUENCY PROTECTION FUNCTIONS ONLY WHEN DIESEL 1B IS OPERATING IN PARALLEL WITH SYSTEM.
3. WH METER IS BI-DIRECTIONAL.
4. FOR KEY INTERLOCKING OF BKR 52-DG12 (SEE DWG. C-177118)
5. FOR KEY INTERLOCKING OF BKR. 52-DG05 (SEE DWG. C-177119)
6. FOR KEY INTERLOCKING OF BKR. 52-DG07 (SEE DWG. C-177120
7. LCP - DENOTES LOCAL CONTROL PANEL.
8. ** - DENOTES EMERG. POWER BOARD IN MAIN CONTROL ROOM
9. LDP - DENOTES LOCAL DIESEL PANEL.
10. REMOTE TERMINAL UNIT IN MAIN CONTROL ROOM.

REFERENCE DRAWINGS:

D-177001 SINGLE LINE ELEC. AUX. SYSTEM (EMERG. 4160V & 600V).

SNPP	Drawing No.: SWGR-B-01
4.16 KV SWGR-B ONE-LINE DIAGRAM	Date: 05/20/2007
	Revision No.: #6



DEVICE	DESCRIPTION	MFR/TYPE	REMARKS
50 / NOTE 10	STA. SERVICE TRANSF. 1D OVER CURRENT RELAY, 3Ø	GE/PJC32G	
62 / NOTE 10	TIME DELAY RELAY	AGASTAT/ E7012PA	
50 / NOTE 10	OVER CURRENT RELAY, 3Ø, FOR INC FDR FROM LOAD CTR 1F	GE/PJC32G	
62 / NOTE 10	TIME DELAY RELAY	AGASTAT/ E7012PA	
87 / DF03	STA. SERVICE TRANSF. 1D DIFFERENTIAL RELAY	GE/12STD15C5A	
86 / DF03	STA. SERVICE TRANSF. 1D LOCKING OUT RELAY	G.E/HEA	
59N / ED01	BUS 1D OVER VOLTAGE RELAY (GROUND DETECTION)	WEST/CV-8	
27 / ED01	BUS 1D UNDER VOLTAGE RELAY	WEST/CV-2	
27X-1 / ED01	BUS 1D UNDER VOLTAGE AUXILIARY RELAY.	WEST/MG-6	

NOTES

1. ** -DENOTES EMERG. POWER BOARD IN MAIN CONT. RM.
2. INTERRUPTING RATING OF ACB'S IS 22,000 AMPS RMS SYMMETRICAL (MIN.)
3. BUS SHORT CIRCUIT RATING 22,000 AMPS SYMMETRICAL.
4. STATION SERVICE TRANSFORMER "ASKAREL" TYPE.
5. BREAKERS 52-ED02 AND 52-ED12 ARE KEY INTERLOCKED SO THAT ONLY ONE CAN BE CLOSED AT ANY TIME (DWG. B-177125)
6. BREAKERS 52-ED08 AND 52-EA09 (ON 600V. BUS 1A) ARE OPERATED BY A SINGLE CONTROL SWITCH IN THE MAIN CONTROL ROOM.
7. ALL BKR'S EXCEPT 52-ED02 & 52-ED12 HAVE SOLID STATE TRIP UNITS WITH FOLLOWING DESIGNATIONS (BREAKER FRAME/SENSOR RATING-AMPERES)
8. BREAKERS 52-ED09, 52-EE06 AND MOLDED CASE BKRS. TO BATTERY CHARGER 1C ARE KEY INTERLOCKED SO THAT ONLY ONE BREAKER AND CORRESPONDING MOLDED CASE BKRS CAN BE CLOSED AT ANY TIME (DWG-C-177133).
9. UNIT 1 BREAKER ED05 IS ELECTRICALLY INTERLOCKED WITH UNIT 2 BREAKER ED05 TO PREVENT SIMULTANEOUS CLOSING OF BOTH BREAKERS.
10. LOCATED IN TERMINAL BLOCK COMPARTMENT ABOVE ASSOCIATED BREAKER.
11. THIS DRAWING SUPERSEDES DRAWING C-177010, SHT 1 OF 1. REV. 14, DATED 11-15-90, PER PCN S-93-1-8690, REV. 0.

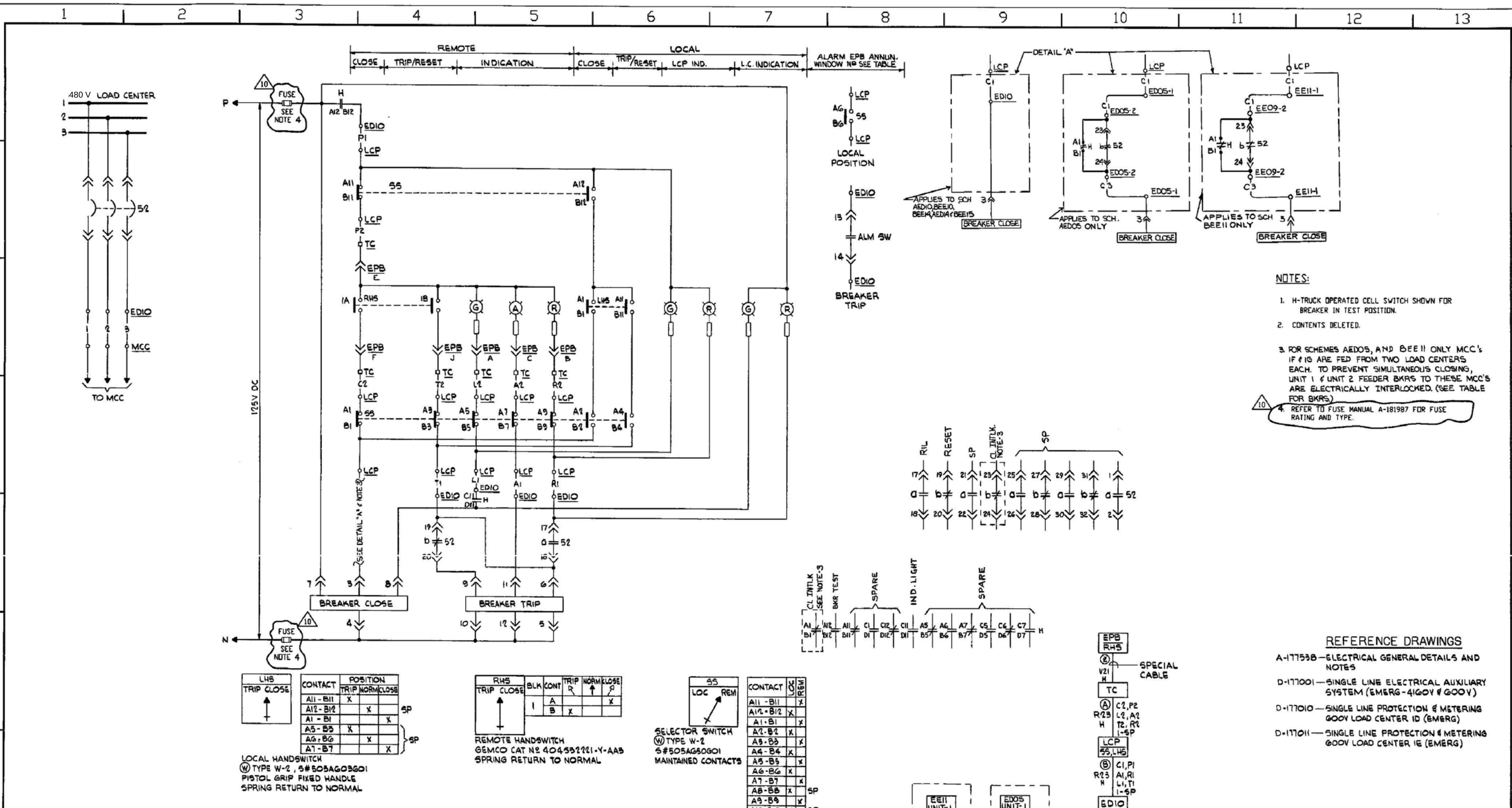
REFERENCE DRAWINGS

A-177538 - ELECTRICAL GENERAL DETAILS & NOTES
D-177001 - SINGLE LINE ELEC. AUX. SYSTEM (4160 & 600V)

SNPP	Drawing No.: LC-B-01
LOAD CENTER B (LC-B) ONE-LINE DIAGRAM	Date: 05/20/2007
	Revision No.: #6

Tab 3.11 Part 2:

Drawing Package #3 Part 2



NOTES:

1. H-TRUCK OPERATED CELL SWITCH SHOWN FOR BREAKER IN TEST POSITION.
2. CONTENTS DELETED.
3. FOR SCHEMES AEDO5, AND BEE II ONLY MCC's IF & IG ARE FED FROM TWO LOAD CENTERS EACH. TO PREVENT SIMULTANEOUS CLOSING, UNIT 1 & UNIT 2 FEEDER BKRS TO THESE MCC'S ARE ELECTRICALLY INTERLOCKED. (SEE TABLE FOR BKRS)
4. REFER TO FUSE MANUAL A-181987 FOR FUSE RATING AND TYPE.

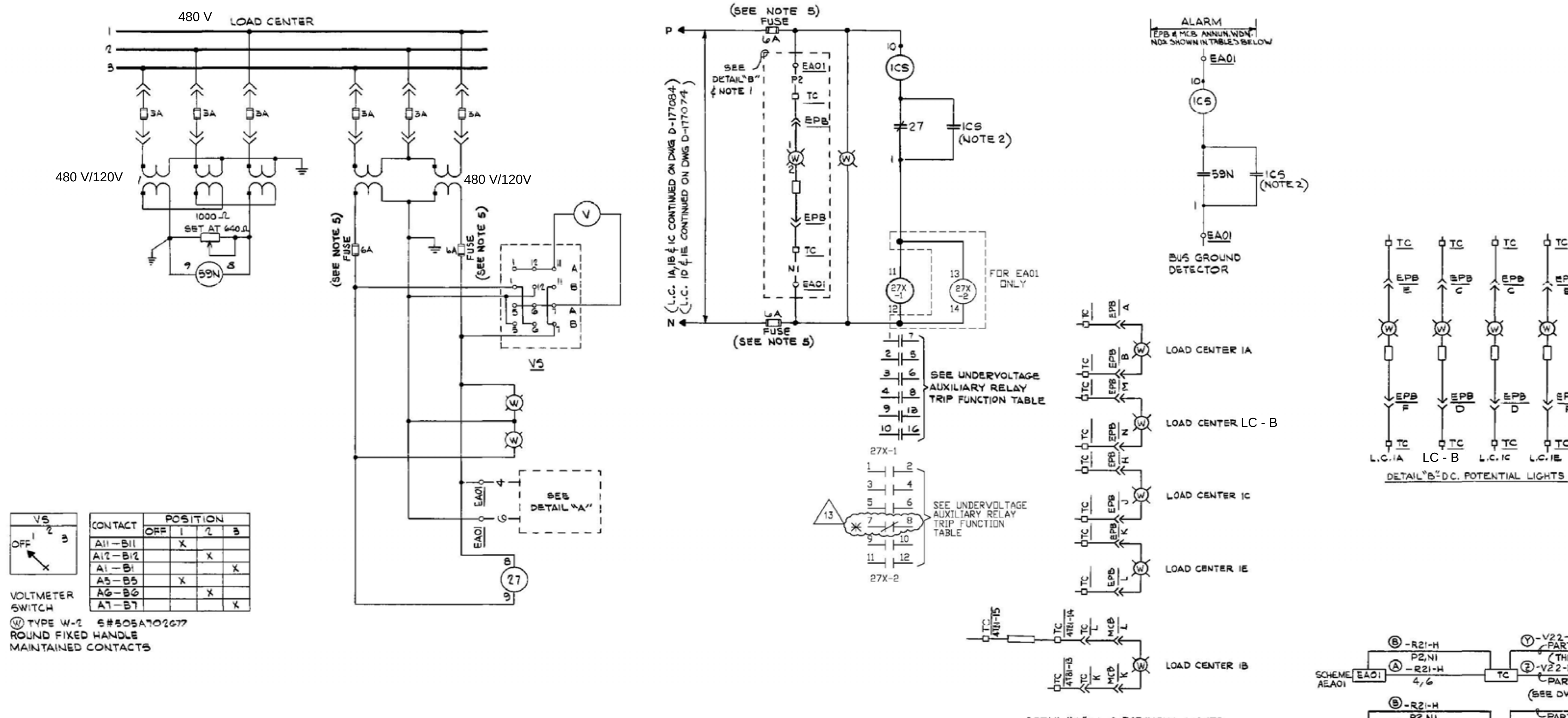
REFERENCE DRAWINGS

A-177538 — ELECTRICAL GENERAL DETAILS AND NOTES
D-177001 — SINGLE LINE ELECTRICAL AUXILIARY SYSTEM (EMERG-4160V & 600V)
D-177010 — SINGLE LINE PROTECTION & METERING 600V LOAD CENTER ID (EMERG)
D-177011 — SINGLE LINE PROTECTION & METERING 600V LOAD CENTER IE (EMERG)

EQUIPMENT		FAC	SCHEME	L.C. COMPT.	LCP LOCAL CONTROL PANEL	EPB EMERGENCY POWER BOARD	TC TERMINATION CABINET	START-UP NUMBER	POWER CABLE CODE	MCC MOTOR CONT CENTER	CONDUCTOR NOS CABLE P	CONDUCTOR NOS CABLE Q	RHS REMOTE HANDSWITCH	EPB ANNUNCIATOR WINDOW NO. BKR ON LOCAL CONTROL	EPB ANNUNCIATOR WINDOW NO. BKR TRIP	LC COMPT
600V LOAD CENTER BKR'S TO MOTOR CONTROL CENTER	1A	IV	AED10	ED10	Q1H21E009-A	QSH1INGEPB250B-AB	Q1H25L037-A	6	L09-F	FA-A2	1,2,3	1,2,3	Q1R16HS2018KA-A	PANEL W, WINDOW G2	PANEL W, WINDOW G1	
	1B	IV	BEE10	EE10	Q1H21E010-B		Q1H25L039-B	6	L09-F	FB-A2	1,2,3		Q1R16HS2019KA-B	PANEL V, WINDOW G2	PANEL V, WINDOW G1	
	1F	IV	AED05	ED05	Q1H21E009-A		Q1H25L037-A	6	L09-F	FF-A2	1,2,3	1,2,3	Q1R16HS2018EA-A	PANEL W, WINDOW G2	PANEL W, WINDOW G1	ED05-2
	1G	IV	BEE11	EE11	Q1H21E010-B		Q1H25L039-B	6	L09-F	FG-A2	1,2,3	1,2,3	Q1R16HS2019LA-B	PANEL V, WINDOW G2	PANEL V, WINDOW G1	EE09-2
	1T	IV	BEE14	EE14	Q1H21E010-B		Q1H25L039-B	6	L09-F	FT-A1	1,2,3	1,2,3	Q1R16HS2019PA-B	PANEL V, WINDOW G2	PANEL V, WINDOW G1	
	1U	IV	AED14	ED14	Q1H21E009-A		Q1H25L037-A	6	L10-F	FU-A1	1,2,3		Q1R16HS2018PA-A	PANEL W, WINDOW G2	PANEL W, WINDOW G1	
	1V	IV	BEE15	EE15	Q1H21E010-B		Q1H25L039-B	6	L10-F	FV-A1	1,2,3		Q1R16HS2019QA-B	PANEL V, WINDOW G2	PANEL V, WINDOW G1	

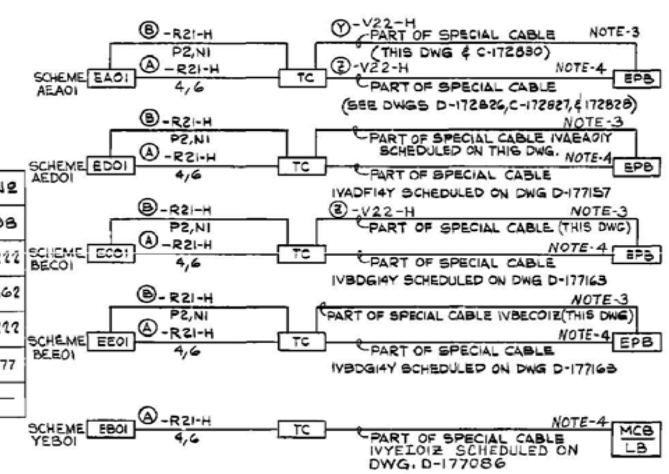
SNPP	Drawing No.: MCC-B1-01
MOTOR CONTROL CENTER MCC-1B	Date: 05/20/2007
	Revision No.: #6

DEVICE	DESCRIPTION	MFR / TYPE	REMARKS
27X-1	UNDERVOLTAGE AUXILIARY RELAY	(W)/MG-6	125V DC
27X-2	UNDERVOLTAGE AUXILIARY RELAY	GE/HFA	125V DC



NOTES:

1. DOES NOT APPLY TO EB01.
2. SEAL IN CONTACT TO BE DISCONNECTED
3. CABLE FOR D.C. POTENTIAL LIGHTS.
4. CABLE FOR A.C. POTENTIAL LIGHTS.
5. SEE DRAWING A-181987 FOR FUSE RATING AND TYPE (LC COMPT'S EA01, EC01, ED01, AND EE01 ONLY).



BLOCK DIAGRAMS

REFERENCE DRAWINGS:

A-177538 — ELECTRICAL GENERAL DETAILS AND NOTES
D-177000 — SINGLE LINE ELECTRICAL AUX SYSTEM (NORMAL - 4160V & 600V)
D-177001 — SINGLE LINE ELECTRICAL AUX SYSTEM (EMERG - 4160V & 600V)
D-177007 — SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER 1A
C-177008 — SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER 1B
C-177009 — SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER 1C
D-177010 — SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER 1D (EMERG)
D-177011 — SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER 1E (EMERG)
A-181987 — FUSE REPLACEMENT MANUAL FOR SAFETY RELATED EQUIPMENT.

UNDERVOLTAGE AUXILIARY RELAY TRIP FUNCTION TABLE

27X-1 EA01	LC BKR COMPT	TRIP FUNCTION	DWG №	27X-1 EB01	LC BKR COMPT	TRIP FUNCTION	DWG №	27X-1 EC01	LC BKR COMPT	TRIP FUNCTION	DWG №
9-13	EA13	600-480/277V LIGHTING TRANS 1A	D-177090	4-8	EB05	CTMT COOLER 1B (NORMAL)	D-177221	2-5	EC09	SPENT FUEL POOL PUMP 1A	D-177205
2-5	EA06	CTMT PURGE AHU FAN STARTER PANEL	D-177242	3-6	EB06	CTMT COOLER 1C (NORMAL)	D-177221	1-7	EC12	CTMT COOLER 1D (NORMAL)	D-177221
3-6	EA10	CTMT COOLER 1A (NORMAL)	D-177221	2-5	EB10	HYDRO TEST PUMP	D-177241	9-13	—	SPARE	—
4-8	EA12	SPENT FUEL POOL PUMP 1B	D-177205	9-13	—	SPARE	—	4-8	EC05	AUX BLDG MAIN EXHAUST FAN 1A	D-177257
1-7	EA03	CTMT PURGE EXH. FAN STARTER PANEL	D-177242	1-7	EB11	AUX BLDG MAIN EXHAUST FAN 1B	D-177257	3-6	EC06	RADWASTE AHU SUPPLY FAN	D-177250
10-16	—	SPARE		10-16	—	SPARE	—	10-16	—	SPARE	—

27X-1 ED01	LC BKR COMPT	TRIP FUNCTION	DWG №	27X-1 EE01	LC BKR COMPT	TRIP FUNCTION	DWG №
4-8	ED03	CRDM MG SET 1A	D-177198	4-8	EE03	CRDM MG SET 1B	D-177198
1-7	ED15	CTMT COOLER 1A (EMERG)	D-177222	2-5	EE08	CTMT COOLER 1C (EMERG)	D-177222
3-6	ED11	CRDM COOLER FAN 1B	D-177262	1-7	EE13	CRDM COOLER FAN 1A	D-177262
10-16	ED16	CTMT COOLER 1B (EMERG)	D-177222	10-16	EE16	CTMT COOLER 1D (EMERG)	D-177222
2-5	ED06	REACTOR CAVITY H2 DIL. SYSTEM AIR COMP. 1A	D-177277	3-6	EE09	REACTOR CAVITY H2 DIL. SYSTEM AIR COMP. 1B	D-177277
9-13	—	SPARE	—	9-13	—	SPARE	—

27X-2 EA01	LC BKR COMPT	TRIP FUNCTION	DWG NO.
1-2	EA11	PRESSURIZER HTR GROUP 1A	D-177109
3-4	EA15	STATION AIR COMPRESSOR 1C	D-172746 SH. 4
5-6	—	SPARE	
* 7-8	EA15	STATION AIR COMPRESSOR 1C AUTO CLOSE	D-172746 SH. 4
9-10	—	SPARE	
11-12	—	SPARE	

13

* CONSTRUCTION NOTE: FIELD TO CONVERT NO CONTACT 7-8 TO NC. 13

EMERGENCY POWER BOARD (EPB)	TERMINATION CABINET (TC)	FAC	SWGR CELL	SCHEME	START-UP NUMBER	ANN. WDW. NO. (EPB)
QSH11NG EPB2508-AB	Q1H25L037-A	1V	EA01	AEA01	5	PANEL "V," G2
QSH11NG EPB2508-AB	Q1H25L039-B	1V	EC01	BEC01	5	PANEL "V," G2
QSH11NG EPB2508-AB	Q1H25L037-A	1V	ED01	AED01	5	PANEL "V," G2
QSH11NG EPB2508-AB	Q1H25L039-B	1V	EE01	BEE01	5	PANEL "V," G2

MAIN CONTROL BOARD (MCB)	TERMINATION CABINET (TC)	FAC	SWGR CELL	SCHEME	START-UP NUMBER	BUS POTENTIAL LIGHT BOX (LB)	ANNUNCIATOR WINDOW NO. (MCB)
Q1H11NG MCB2500B-AB	Q1H25L016-B	1V	EB01	YEB01	5	N1H11EI2111F-N	PANEL "L," B3

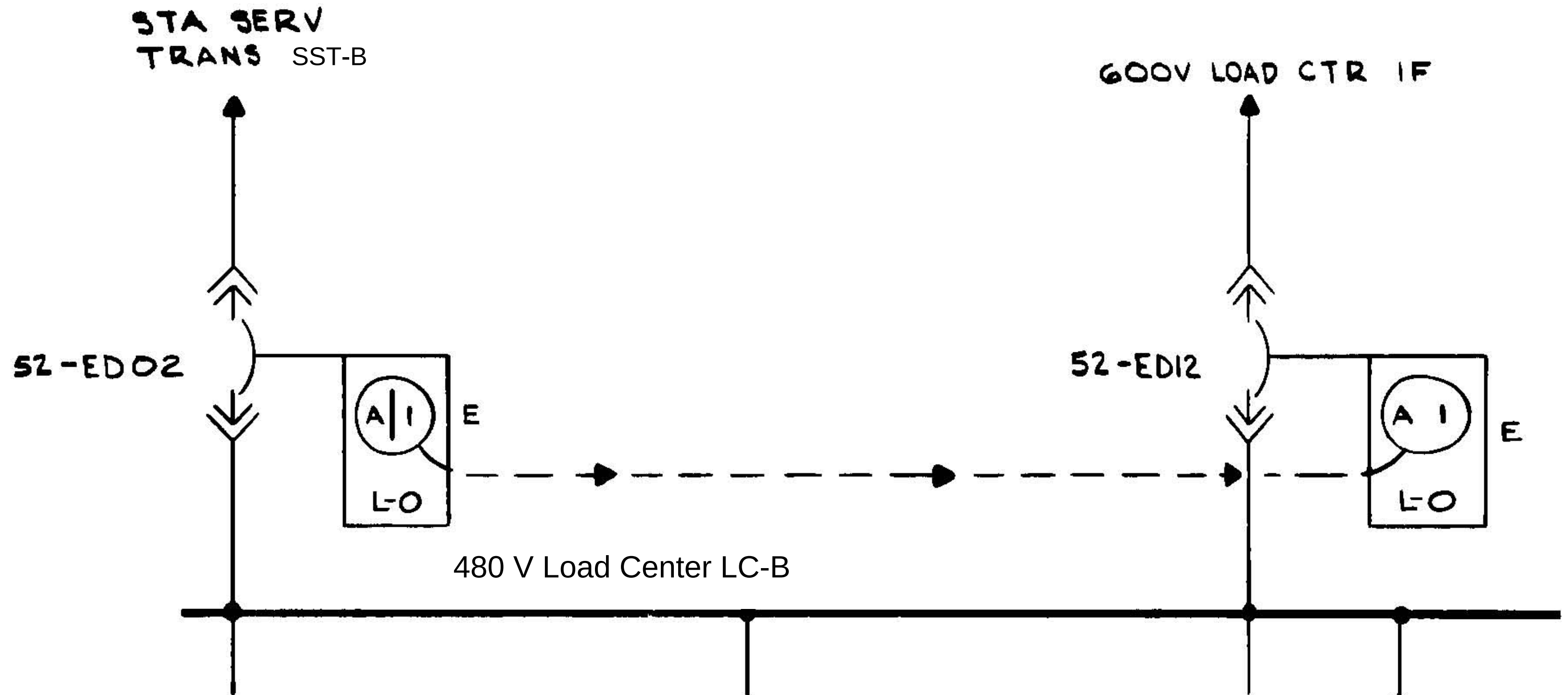
SNPP

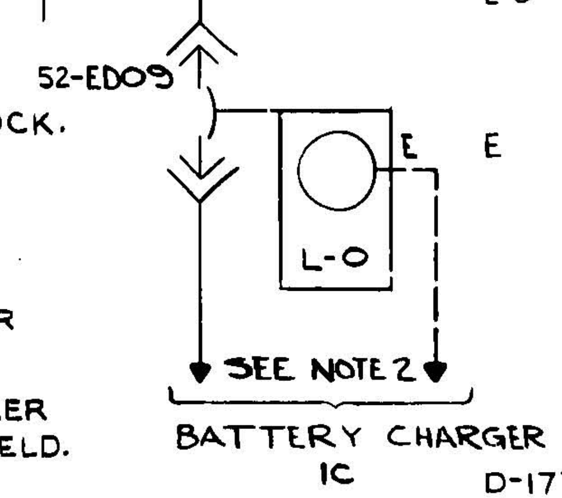
LOAD CENTER UNDERVOLTAGE SCHEME

Drawing No.: LC-B-05

Date: 05/20/2007

Revision No.: #6





OPERATION SEQUENCE

KEY IS HELD IN CIRCUIT BREAKER 52-ED02 INTERLOCK.

TO ESTABLISH SERVICE THROUGH CIRCUIT BREAKER 52-ED12

1. TRIP CIRCUIT BREAKER 52-ED02
2. TURN KEY A1 IN L-O INTERLOCK ON CIRCUIT BREAKER 52-ED02 TO LOCK OPEN. KEY A1 IS NOW FREE.
3. INSERT KEY A1 IN L-O INTERLOCK ON CIRCUIT BREAKER 52-ED12 AND TURN TO UNLOCK. KEY A1 IS NOW HELD.
4. CLOSE CIRCUIT BREAKER 52-ED12.

REVERSE SEQUENCE TO RESTORE SERVICE THROUGH CIRCUIT BREAKER 52-ED02.

NOTE : AS AN EXCEPTION FOR MAINTENANCE WORK PER A PLANT PROCEDURE, TWO KEYS MAY BE USED TO OVERRIDE THE NORMAL CIRCUIT BREAKER INTERLOCK FEATURE. 4

NOTES

1. ALL INTERLOCKS ARE KIRK TYPE
2. CIRCUIT BREAKERS 52-ED09, 52-EE06 & MOLDED CASE BREAKERS TO BATTERY CHARGER 1C ARE KEY INTERLOCKED SO THAT ONLY ONE BREAKER AND CORRESPONDING BATTERY CHARGER MOLDED CASE BREAKER CAN BE CLOSED AT ANY TIME (SEE DWG C-177133)

LEGEND

A1 L-O — INTERLOCK WITH KEY HELD.

A1 L-O — INTERLOCK WITH KEY REMOVED.

L-O — (LOCKED OPEN) INDICATES THAT THE KEY IS REMOVABLE WHEN THE CIRCUIT BREAKER IS LOCKED IN THE OPEN POSITION.

E — INDICATES KEY REMOVABLE ONLY WHEN BOLT EXTENDED.

INTERLOCK KEY TABLE

INTERLOCK	KEY NUMBER
A1	RE-14204

REFERENCE DWG.

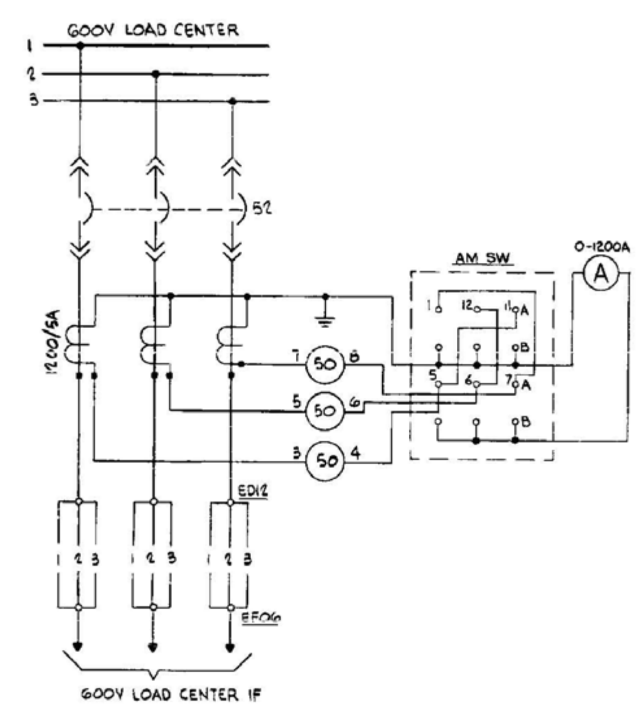
D-177001 - SINGLE LINE ELEC AUX SYSTEM (4160V & 600V)

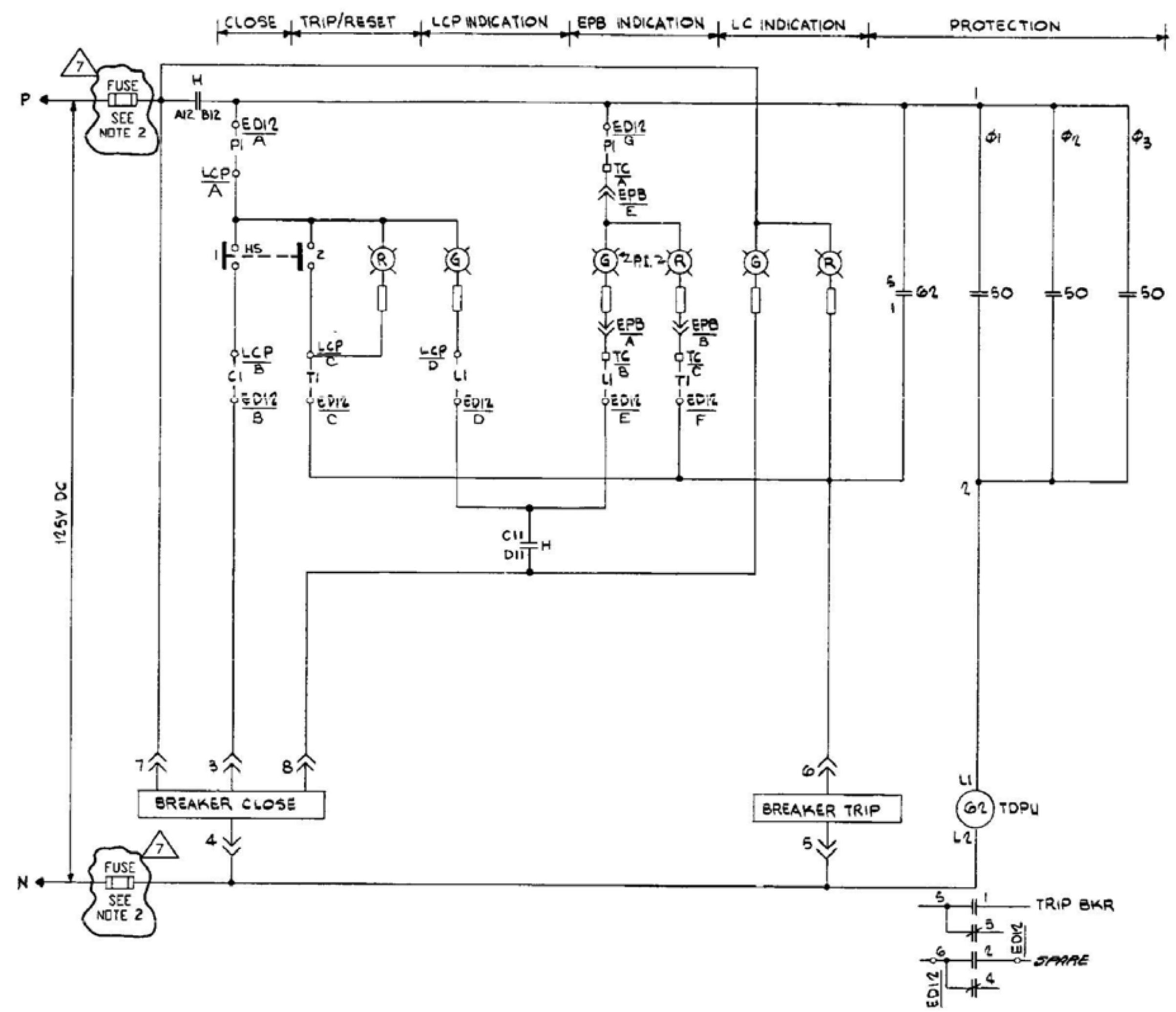
C-177010 - SINGLE LINE PROTECTION & METERING 600V LOAD CENTER 1D

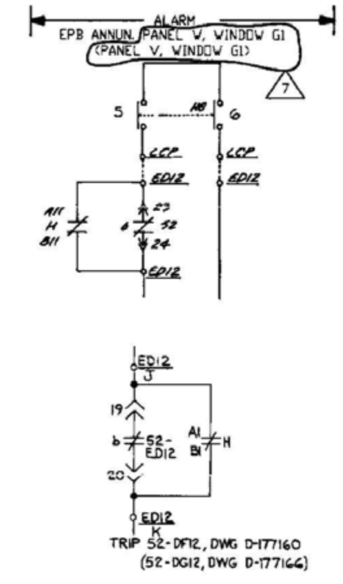
A-177538 - ELEC GEN DETAILS & NOTES

SNPP	Drawing No.: LC-B-04
LC-B INCOMING BREAKER INTERLOCKS	Date: 05/20/2007
	Revision No.: #6

DEVICE	DESCRIPTION	MFR/TYPE	REMARKS
62	TIME DELAY PICK-UP RELAY	AGASTAT E7012PA	125V DC 0.1 TO 1.0 SEC

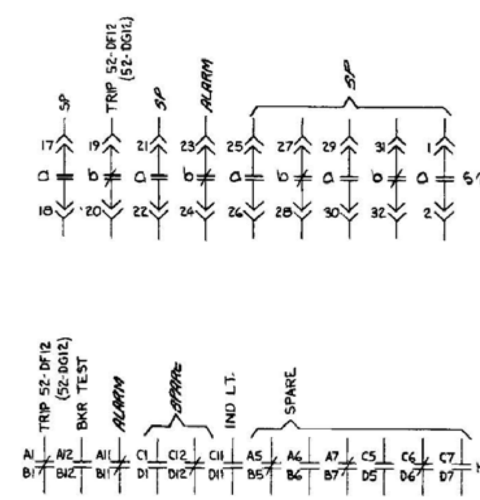






NOTES:

1. H-TRUCK OPERATED CELL SWITCH SHOWN FOR BREAKER IN TEST POSITION.
2. REFER TO FUSE MANUAL A-181987 FOR FUSE RATING AND TYPE.



REFERENCE DRAWINGS

A-177538 – ELECTRICAL GENERAL DETAILS AND NOTES

D-177001 – SINGLE LINE ELECTRICAL AUX SYSTEM (EMERG – 4160V & 600V)

D-177010 – SINGLE LINE PROTECTION AND METERING 600V L.C. 1D (EMERG)

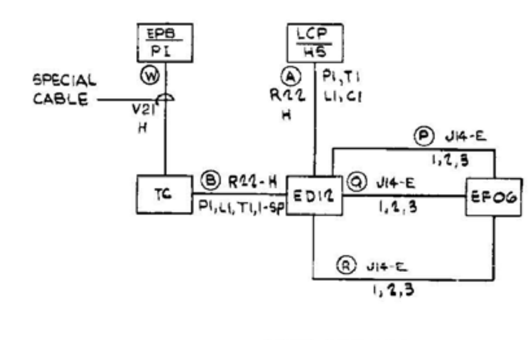
D-177011 – SINGLE LINE PROTECTION AND METERING 600V L.C. 1E (EMERG)

C-177012 – SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER 1F

AMMETER
OFF 1 2 3

CONTACT	POSITION 0	-	1	-	-	2	-	-	3
A11 - B11	X	X		X	X	X	X	X	X
A12 - B12	X	X	X	X	X		X	X	X
A1 - B1	X	X	X	X	X	X	X	X	
A5 - B5		X	X	X					
A6 - B6					X	X	X		
A7 - B7								X	X

AMMETER SWITCH
(W) TYPE W-2, S#787A976G01
ROUND FIXED HANDLE



EQUIPMENT		FAC	SCHEME	L.C. COMPT.	LCP LOCAL CONTROL PANEL	EPB EMERG POWER BOARD	TC TERMINATION CABINET	PI POSITION IND. LIGHTS	START-UP NUMBER	L C COMPT
INCOMING 600V LOAD CENTER BREAKER	1D	IV	AED12	ED12	Q1H21 E009-A	QSH11NG EPB2508-AB	Q1H25 L037-A	Q1R16 ZL2018MA-A	5	EF06
	1E	IV	BEE12	EE12	Q1H21 E010-B	QSH11NG EPB2508-AB	Q1H25 L039-B	Q1R16 ZL2019MA-B	5	EF08

LOAD CENTER COMPARTMENT	TERMINAL BLOCK NUMBERS A	B	C	D	E	F	G	H	I	J	K
ED12	A-5	A-7	B-1	E-11	E-11	B-2	A-6	B-5	B-4	C-11	C-12
EE12	A-5	A-7	B-1	E-11	E-11	B-2	A-4	B-5	B-4	C-11	C-12

LOCAL CONTROL PNL	TERMINAL BLOCK NUMBERS A	B	C	D
ED12	TB7-9	TB7-11	TB7-10	TB7-12
EE12	TB10-5	TB10-6	TB10-7	TB10-8

TERMINATION CABINET	TERMINAL BLOCK NUMBERS A	B	C
Q1H25L037-A	1TB2-38	1TB2-36	1TB2-37
Q1H25L039-B	3TB1-33	3TB1-31	3TB1-32

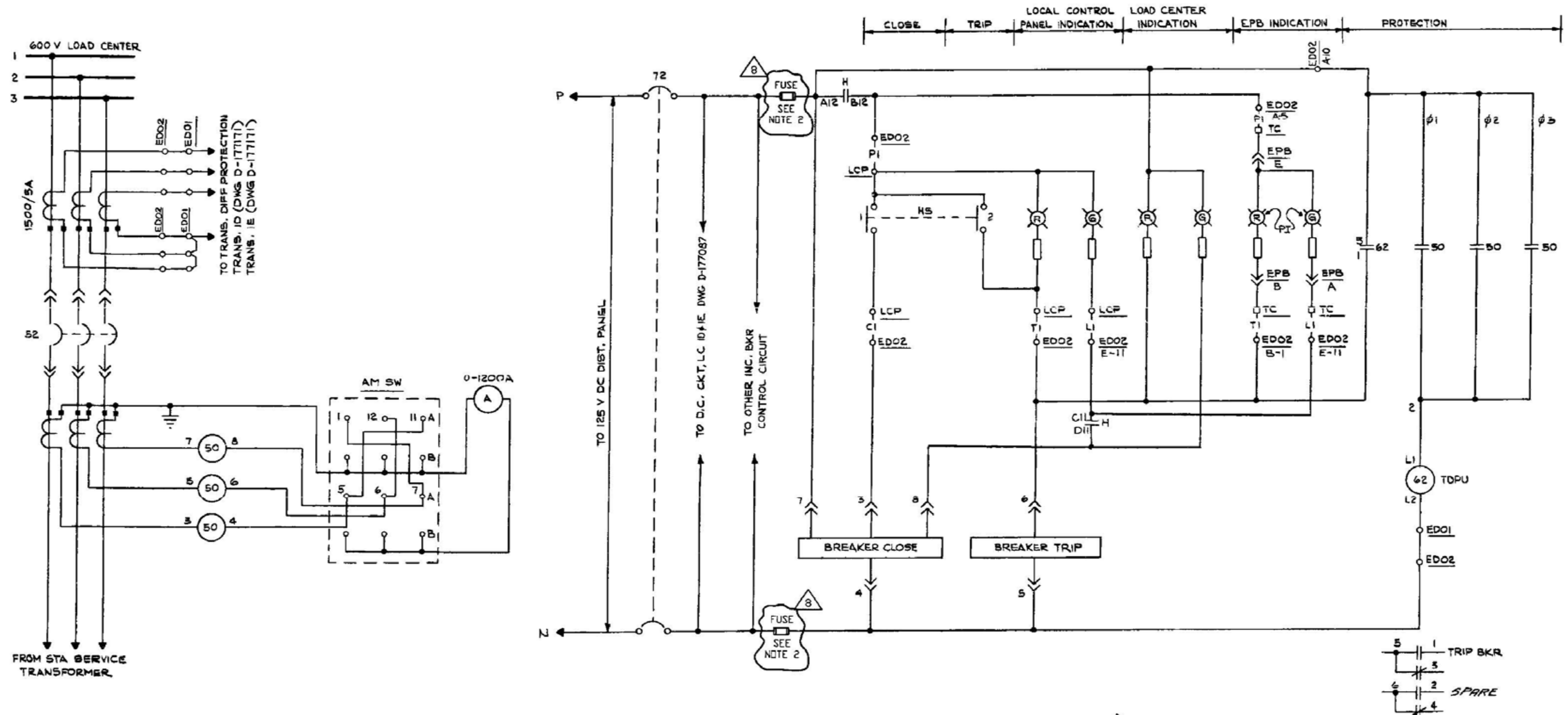
HS
TRIP CLOSE
PULL TO LOCK

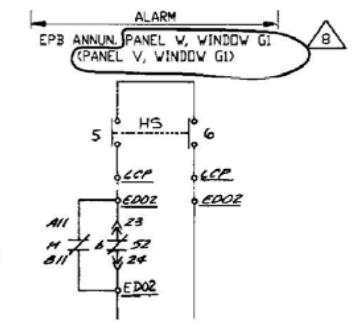
CONTACTS HANDLE END ODD	EVEN		CLOSE	AFT CLOSE	AFT TRIP	TRIP	PULL TO LOCK	
o-||-o	o-||-o	1	X					
		2				X	X	
o-||-o	o-||-o	3		X	X	X	X	SP
		4	X	X	X	X		SP
o-||-o	o-||-o	5		X	X			ALARM
		6	X	X				ALARM

HANDSWITCH
GE SBM TYPE
MODEL Nº 10AA116
SPRING RETURN TO CENTER
PULL TO LOCK IN TRIP POSITION.

SNPP	Drawing No.: LC-B-03
52-ED-12 SCHEMATIC	Date: 05/20/2007
	Revision No.: #6

DEVICE	DESCRIPTION	MFR/TYPE	REMARKS
62	TIME DELAY PICK-UP RELAY	AGA/E7012PA	125V DC 0.1 TO 1.0 SEC





NOTES:

1. H-TRUCK OPERATED CELL SWITCH SHOWN FOR BREAKER IN TEST POSITION.
2. REFER TO FUSE MANUAL A-181987 FOR FUSE RATING AND TYPE.

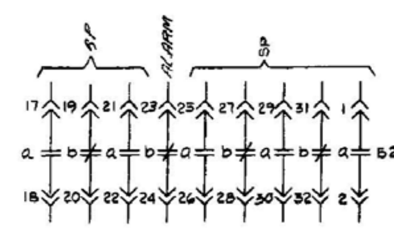
REFERENCE DRAWINGS

D-177001 - SINGLE LINE, ELECTRICAL AUXILIARY SYSTEM. (EMERG. - 4160V & 600V)

A-177538 - ELECTRICAL GENERAL DETAILS AND NOTES.

D-177010 SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER 1D (EMERGENCY)

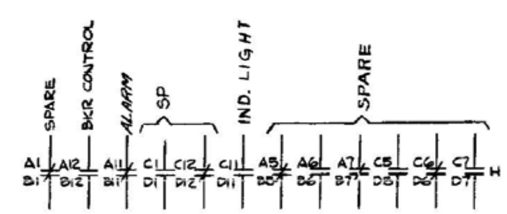
D-177011 SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER 1E (EMERGENCY)



AMMETER

AMMETER SWITCH
(W) TYPE W-2
S# 787A976G01
ROUND FIXED HANDLE

CONTACT	POSITION 0	-	1	-	-	2	-	-	3
A11-B11	X	X		X	X	X	X	X	X
A12-B12	X	X	X	X	X		X	X	X
A1-B1	X	X	X	X	X	X	X	X	
A5-B5		X	X	X					
A6-B6					X	X	X		
A7-B7								X	X



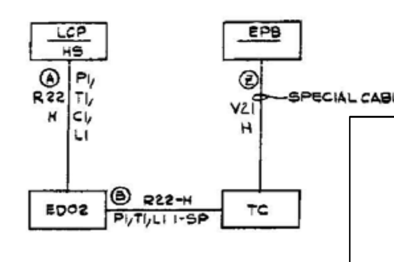
EQUIPMENT		FAC	SCHEME	LOAD CENT. COMPT.	LCP LOCAL CONTROL PANEL	START UP NUMBER	EPB EMERGENCY POWER BOARD	TC TERMINATION CABINET	PI POSITION INDICATOR LIGHT
INCOMING BREAKER TO 600V LOAD CENTER	1D	IV	AED02	ED02	Q1H21 E009-A	5	Q5H11NG EPB2508-AB	Q1H25 L037-A	Q1R16 ZL2018BA-A
	1E	IV	BEE02	EE02	Q1H21 E010-B	5	Q5H11NG EPB2508-AB	Q1H25 L039-B	Q1R16 ZL2019BA-B

HS

TRIP CLOSE
PULL TO LOCK

CONTACTS HANDLE END ODD	EVEN		CLOSE	AFT CLOSE	AFT TRIP	TRIP	PULL TO LOCK	
		1	X					
		2				X	X	
		3		X	X	X	X	SP
		4	X	X	X	X		SP
		5		X	X			ALARM
		6	X	X				ALARM

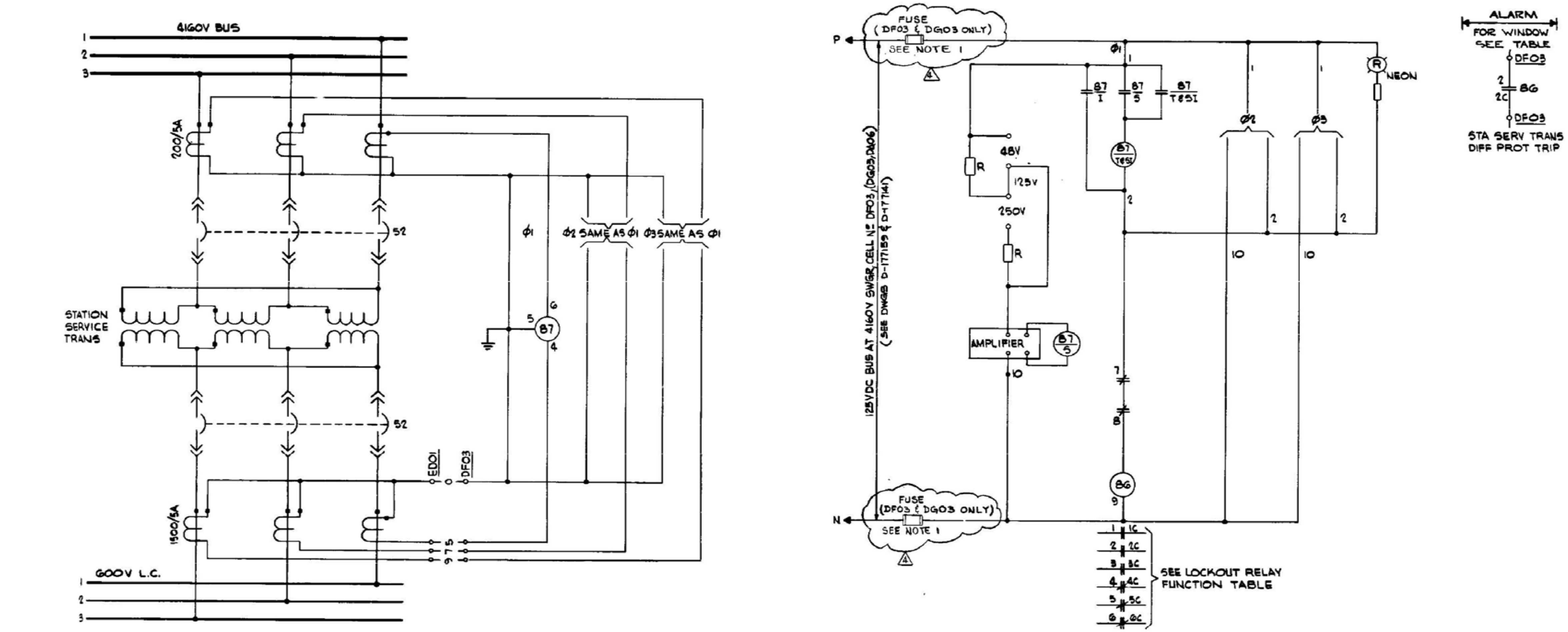
HANDSWITCH
GE SBM TYPE
MODEL No 10AA116
SPRING RETURN TO CENTER
PULL TO LOCK IN TRIP POSITION



BLOCK DIAGRAM

SNPP	Drawing No.: LC-B-02
	Date: 05/20/2007
52-ED-02 BREAKER SCHEMATIC	Revision No.: #6

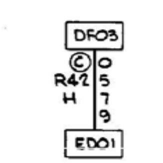
DEVICE	DESCRIPTION	MFR/TYPE	REMARKS
86	LOCKOUT RELAY	GE/HEAGIA223	125V DC



NOTES:
1. SEE DRAWING A-181987 FOR FUSE RATING & TYPE.

LOCKOUT RELAY FUNCTION TABLE

86 DFO3	FUNCTION	DWG Nº	86 DGO3	FUNCTION	DWG Nº	86 DAO6	FUNCTION	DWG Nº
1 1C	TRIP BKR 52-DFO3	C-177159	1 1C	TRIP BKR 52-DGO3	C-177159	1 1C	TRIP BKR 52-DAO6	D-177141
2 2C	ALARM	THIS DWG	2 2C	ALARM	THIS DWG	2 2C	ALARM	THIS DWG
3 3C	SPARE	—	3 3C	SPARE	—	3 3C	SPARE	—
4 4C	SPARE	—	4 4C	SPARE	—	4 4C	BLOCK CLOSING BKR 52-DAO6	D-177141
5 5C	BLOCK CLOSING BKR 52-DFO3	C-177159	5 5C	BLOCK CLOSING BKR 52-DGO3	C-177159	5 5C	SPARE	—
6 6C	SPARE	—	6 6C	SPARE	—	6 6C	SPARE	—



BLOCK DIAGRAM

REFERENCE DRAWINGS

- A-177538 — ELECTRICAL GENERAL DETAILS AND NOTES
- D-177001 — SINGLE LINE ELECTRICAL AUX SYSTEM (EMERG - 4160V & 600V)
- D-177002 — SINGLE LINE PROTECTION AND METERING 4160V SWITCHGEAR. BUS 1A
- D-177005 — SINGLE LINE PROTECTION AND METERING 4160V SWITCHGEAR BUS 1F (EMERG)
- D-177006 — SINGLE LINE PROTECTION AND METERING 4160V SWITCHGEAR BUS 1G (EMERG)
- C-177010 — SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER 1D (EMERG)
- C-177011 — SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER 1E (EMERG)
- C-177674 — SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER 1I
- A-181987 — FUSE REPLACEMENT MANUAL FOR SAFETY RELATED EQUIPMENT.

EQUIPMENT		FAC	SCHEME	SWGR CELL	LOAD CENTER COMPARTMENT	START-UP NUMBER	ANNUNCIATOR WINDOW Nº
DIFFERENTIAL RELAY FOR STATION SERV TRANSFORMER	1D	IV	ADFO3	DFO3	EDO1	5	EPB PANEL "W" D4
	1E	IV	BDGO3	DGO3	EEO1	5	EPB PANEL "V" D4
	1I	IV	XDAO6	DAO6	EIO1	5	MCB PANEL "L" E2

SNPP

STATION SERVICE TRANSFORMER DIFFERENTIAL PROTECTION SCHEME

Drawing No.: LC-B-06

Date: 05/20/2007

Revision No.: #6