NUREG/CP-0194
Volume 2 of 3

EPRI 1020621
Final Report

Methods for Applying Risk Analysis to Fire Scenarios (MARIAFIRES)-2008

NRC-RES/EPRI Fire PRA Workshop

Volume 2

Module 2: Electrical Analysis

Based on the Joint
NRC-RES/EPRI Training Workshops
Conducted in 2008

September 28 – October 2, 2008, and
November 17-20, 2008, Bethesda, MD

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Methods for Applying Risk Analysis to Fire Scenarios (MARIAFIRES)-2008

NRC-RES/EPRI Fire PRA Workshop

Volume 2 - Module 2: Electrical Analysis

NUREG/CP-0194 **EPRI 1020621**

Final Report

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ABSTRACT

The U.S. Nuclear Regulatory Commission (NRC) approved the risk-informed and performance-based alternative regulation 10 CFR 50.48(c) in July 2004, which allows licensees the option of using fire protection requirements contained in the National Fire Protection Association (NFPA) Standard 805, "Performance Based Standard for Fire Protection for Light-Water Reactor Electric Generating Plants, 2001 Edition," with certain exceptions. To support licensees's use of that option, NRC and the Electric Power Research Institute (EPRI) jointly issued NUREG/CR-6850 (EPRI 1011989) "Fire PRA Methodology for Nuclear Power Facilities" in September 2005. That report documents the state-of-the art methods, tools, and data for conducting a fire probabilistic risk assessment (PRA) in a commercial nuclear power plant (NPP) application. The report is intended to serve the needs of a fire risk analysis team by providing a general framework for conduct of the overall analysis as well as specific recommended practices to address each key aspect of the analysis. Participants from the U.S. nuclear power industry supported demonstration analyses and provided peer review of the program. Methodological issues raised in past fire risk analyses, including the Individual Plant Examination of External Events fire analyses, are addressed to the extent allowed by the current state-of-the-art and the overall project scope. Although the primary objective of the report is to consolidate existing state-of-the-art methods, in many areas, the newly documented methods represent a significant advance over previous methods.

NUREG/CR-6850 does not constitute regulatory requirements, and NRC participation in this study neither constitutes nor implies regulatory approval of applications based on the analysis contained in this document. The analyses/methods documented in this report represent the combined efforts of individuals from RES and EPRI. Both organizations provided specialists in the use of fire PRA to support this work. The results from this combined effort do not constitute either a regulatory position or regulatory guidance.

In addition, NUREG/CR-6850 can be used for risk-informed, performance-based approaches and insights to support fire protection regulatory decision-making in general.

On 14–16 June 2005, NRC's Office of Nuclear Regulatory Research (RES) and EPRI conducted a joint public workshop for about 80 attendees at the EPRI NDE Center in Charlotte, NC. A second workshop was held the following year, on 24-26 May 2006, in NRC's Two White Flint North Auditorium in Rockville, MD. About 130 people attended the second workshop. Based on the positive public response to these two workshops, a more detailed training class was developed by the authors of NUREG/CR-6850. Two detailed training workshops were conducted in 2007: on 23-27 July, and again on 27-30 August, both at EPRI in Palo Alto, CA. About 100 people attended each of these workshops. In 2008, two more workshops were held from 29 September through 2 October, and again from 17-20 November, in Bethesda, MD near NRC Headquarters. The two workshops attracted about 170 participants including domestic representatives from NRC Headquarters and all four regional offices, U.S. Department of Energy, National Aeronautics and Space Administration, EPRI, NPP licensees/utilities, Nuclear Steam Supply System vendors, consulting engineering firms, and universities. Also in

attendance were international representatives from Belgium, Canada, France, Japan, South Korea, Spain, and Sweden.

The material in this NUREG/CP was recorded at the workshops in 2008, and adapted by RES Fire Research Branch members for use as an alternative training method for those who were unable to physically attend the training sessions. This report can also serve as a refresher for those who attended one or more training sessions and would be useful preparatory material for those planning to attend a session.

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Acknowledgements

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We also acknowledge the other Fire Research Branch members Kendra Hill, Aixa Belen-Ojeda, Jason Dreisbach, Jessica Kratchman, Gabriel Taylor, J. S. Hyslop, and Mark Henry Salley for their support and contributions during its development. Their input and encouragement facilitated its timely completion and greatly benefited the final product.

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LIST OF ACRONYMS

ACB	Air-cooled Circuit Breaker
ACRS	Advisory Committee on Reactor Safeguards
AEP	Abnormal Event Procedure
AFW	Auxiliary Feedwater
AGS	Assistance General Supervisor
AOP	Abnormal Operating Procedure
AOV	Air Operated Valve
ATHEANA	A Technique for Human Event Analysis
ATS	Automatic Transfer Switch
ATWS	Anticipated Transient Without Scram
BAT	Boric Acid Tank
BNL	Brookhaven National Laboratory
BWR	Boiling-Water Reactor
CBDT	Causal Based Decision Tree
CCDP	Conditional Core Damage Probability
CF	Cable (Configuration) Factors
CCPS	Center for Chemical Process Safety
CCW	Component Cooling Water
CDF	Core Damage Frequency
CFD	Computational Fluid Dynamics
CFR	Code of Federal Regulations
CLERP	Conditional Large Early Release Probability
CM	Corrective Maintenance
CR	Control Room
CRS	Cable and Raceway (Database) System
CST	Condensate Storage Tank
CVCS	Chemical and Volume Control System
CWP	Circulating Water Pump
DC	Direct Current
EDG	Emergency Diesel Generator
EDS	Electrical Distribution System
EF	Error Factor
EI	Erroneous Status Indicator
EOP	Emergency Operating Procedure
EPR	Ethylene-Propylene Rubber
EPRI	Electric Power Research Institute

FEDB	Fire Events Database
FEP	Fire Emergency Procedure
FHA	Fire Hazards Analysis
FIVE	Fire-Induced Vulnerability Evaluation (EPRI TR 100370)
FMRC	Factory Mutual Research Corporation
FPRAIG	Fire PRA Implementation Guide (EPRI TR 105928)
FRSS	Fire Risk Scoping Study (NUREG/CR-5088)
FSAR	Final Safety Analysis Report
HEAF	High Energy Arcing Fault
HEP	Human Error Probability
HFE	Human Failure Event
HPI	High-Pressure Injection
HPCI	High-Pressure Coolant Injection
HRA	Human Reliability Analysis
HRR	Heat Release Rate
HTGR	High Temperature Gas-cooled Reactor
HVAC	Heating, Ventilation, and Air Conditioning
ICDP	Incremental Core Damage Probability
ILERP	Incremental Large Early Release Probability
INPO	Institute for Nuclear Power Operations
IPE	Individual Plant Examination
IPEEE	Individual Plant Examination of External Events
IS	Ignition Source
ISLOCA	Interfacing Systems Loss of Coolant Accident
KS	Key Switch
LCO	Limiting Condition of Operation
LERF	Large Early Release Frequency
LFL	Lower Flammability Limit
LOC	Loss of Control
LOCA	Loss-of-Coolant Accident
LPG	Liquefied Petroleum Gas
LWGR	Light-Water-cooled Graphite Reactors (Russian design)
MCB	Main Control Board
MCC	Motor Control Center
MCR	Main Control Room
MG	Motor-Generator
MFW	Main Feedwater
MOV	Motor-Operated Valve
MQH	McCaffrey, Quintiere and Harkleroad's Method
MS	Main Steam
MSIV	Main Steam Isolation Valve
NC	No Consequence
NEI	Nuclear Energy Institute
NEIL	Nuclear Electric Insurance Limited
NFPA	National Fire Protection Association
NPP	Nuclear Power Plant

NPSH	Net Positive Suction Head
NQ cable	Non-Qualified (IEEE-383) cable
NRC	U.S. Nuclear Regulatory Commission
P&ID	Piping and Instrumentation Diagram
PE	Polyethylene
PM	Preventive Maintenance
PMMA	Polymethyl Methacrylate
PORV	Power-Operated Relief Valve
PRA	Probabilistic Risk Assessment
PSF	Performance Shaping Factor
PTS	Pressurized Thermal Shock
PVC	Polyvinyl Chloride
PWR	Pressurized-Water Reactor
Q cable	Qualified (IEEE-383) cable
RBMK	Reactor Bolshoy Moshchnosty Kanalny (high-power channel reactor)
RCIC	Reactor Core Isolation Cooling
RCP	Reactor Coolant Pump
RCS	Reactor Coolant System
RDAT	Computer program for Bayesian analysis
RES	Office of Nuclear Regulatory Research (at NRC)
RHR	Residual Heat Removal
RI/PB	Risk-Informed / Performance-Based
RPS	Reactor Protection System
RWST	Refueling Water Storage Tank
SCBA	Self-Contained Breathing Apparatus
SDP	Significance Determination Process
SGTR	Steam Generator Tube Rupture
SI	Safety Injection
SMA	Seismic Margin Assessment
SNPP	Simplified Nuclear Power Plant
SO	Spurious Operation
SOV	Solenoid Operated Valve
SRV	Safety Relief Valve
SSD	Safe Shutdown
SSEL	Safe Shutdown Equipment List
SST	Station Service Transformer
SUT	Start-up Transformer
SW	Service Water
SWGR	Switchgear
T/G	Turbine/Generator
THERP	Technique for Human Error Rate Prediction
TGB	Turbine-Generator Building
TSP	Transfer Switch Panel
UAT	Unit Auxiliary Transformer
VCT	Volume Control Tank
VTT	Valtion Teknillinen Tutkimuskeskus (Technical Research Centre of Finland)

VVER	The Soviet (and now, Russian Federation) designation for light-water pressurized reactor
XLPE	Cross-Linked Polyethylene
ZOI	Zone of Influence

1 INTRODUCTION - ELECTRICAL ANALYSIS OVERVIEW

The components that constitute the fire probabilistic risk assessment (PRA) model each have cables associated with them. These cables must be identified, traced, and analyzed. An electrical analysis is performed to determine the positions that a component could take given fire-induced cable failures. Because positions of components are critical to fire PRA to credit a train to mitigate core damage, the electrical analysis is critical to the PRA evaluation. These elements of the fire PRA are the topic of the Electrical Analysis module.

The first task of the Electrical Analysis module is to identify all cables associated with the components selected in fire PRA task 2. A PRA analyst can always assume the worst-case failure mode but must also consider the Appendix R failure mode for those components addressed by Appendix R. The worst-case failure mode may be dependent on the risk sequence entered, and care must be taken to ensure that the component failure modes are treated accordingly. Should a more realistic analysis be beneficial to the PRA sequence in question, then more detailed failure analysis can be done.

The Electrical Analysis module is divided into five sessions. Session 1 presents an overview of circuits relevant to nuclear power plants (NPPs) and a discussion of the importance of the electrical analysis within a fire PRA. Relevant technical specifications and requirements are discussed as well as an overall strategy for implementation of the electrical analysis within the fire PRA. Session 2 covers task 3 that addresses cable selection. This provides a method for choosing electrical cables and a guide for using the location of cables determined in plant walkdowns to generate reasonable outcomes of postulated fire scenarios. This deterministic process produces a list of basic events or electrical components and their associated functions and failure modes within a fire scenario.

Sessions 3 and 4 concern the failure modes of the electrical components as developed in Task 3. The first part of the failure mode analysis is a deterministic screening process to identify those cables with no critical effect on system elements. Only those cables that directly affect the ability of the system elements selected for PRA are further considered in the fourth session, which quantitatively establishes the likelihood of certain failure modes, including spurious actuations.

Session 5 of the Electrical Analysis module is actually not unique to the electrical segment of this course. The generation of a fire PRA database is a complex task that involves the compilation of all of the data and results collected in a fire PRA. Distinct from the rest of the electrical tasks, this is actually a database management task that occurs as a supporting function throughout the process of the assessment. Although elements from all three training modules are included, the fire PRA database tool is not repeated in either the Fire Analysis or the Systems Analysis modules, and so trainees in those modules may benefit from this section of the Electrical Analysis module.

1.1 EPRI Perspective

"Methods for Applying Risk Analysis to Fire Scenarios (MARIAFIRES)" is a collection of the materials that are presented at the Fire PRA course provided by EPRI and the U.S. Nuclear

Regulatory Commission's (NRC's) Office of Nuclear Regulatory Research (RES). The training and resulting presentation material is detailed and represents in excess of 60 hours of classroom instruction. The training focuses on the Fire PRA methods documented in the joint Electric Power Research Institute (EPRI)/RES publication 1011989 and NUREG/CR-6850 along with clarifications, enhancements, and additions provided via the Frequently Asked Question (FAQ) process for NFPA 805.

The intent of the publication is to provide to the public the training material used at the Fire PRA training. This material is not intended to be a substitute for direct interaction that is provided in the periodically offered fire PRA courses; rather, it is meant to augment that training and serve as a reference. Enthusiastic future students can use the material to become familiar with the general principles of fire PRA prior to arrival at the course. Students who have already taken the course can use the material for reference. The material consists of a series of reports that document the presentations including some speakers' notes and text. In addition, an edited version of a recorded training session is also available via a separate product number. This video version can be used in a similar manner to the documentation (e.g., for reference or in preparation for the course) and includes the actual recorded and edited course.

In providing this material, it is hoped that those who plan to attend the course can arrive more informed, those who have already attended can have a reference, and those who have been unable to attend have a resource to gain a more complete understanding of the intent and goals of EPRI 1011989 and NUREG/CR-6850.

2 ELECTRICAL ANALYSIS SLIDES

SESSION 1: Fire PRA Circuit Analysis Overview

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EPRI/NRC-RES FIRE PRA METHODOLOGY

Module 2: Fire PRA Circuit Analysis Overview

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

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September and November 2008
Bethesda, MD

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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

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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

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Notes:

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

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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

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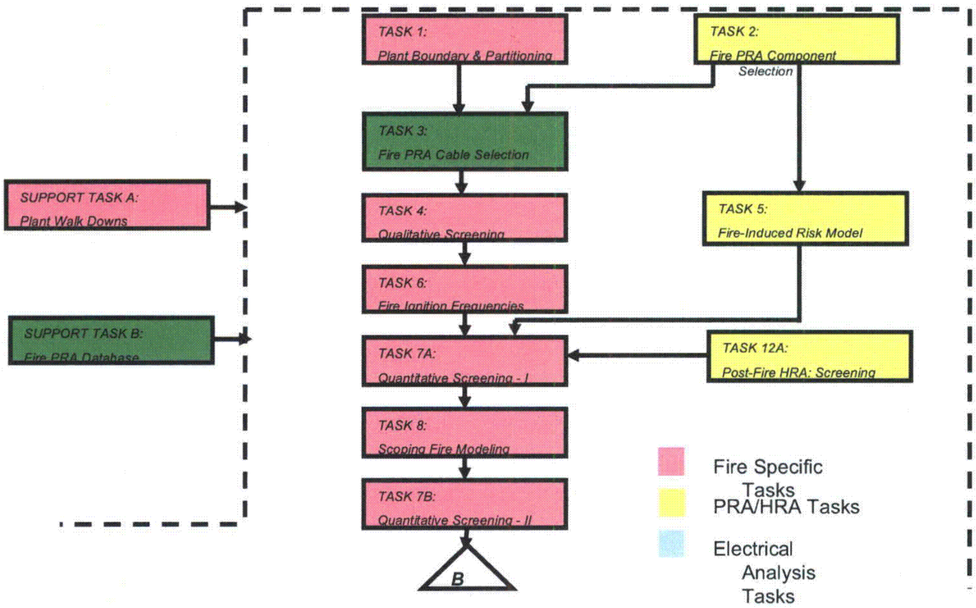
CIRCUIT ANALYSIS
PRA Task Flow Chart



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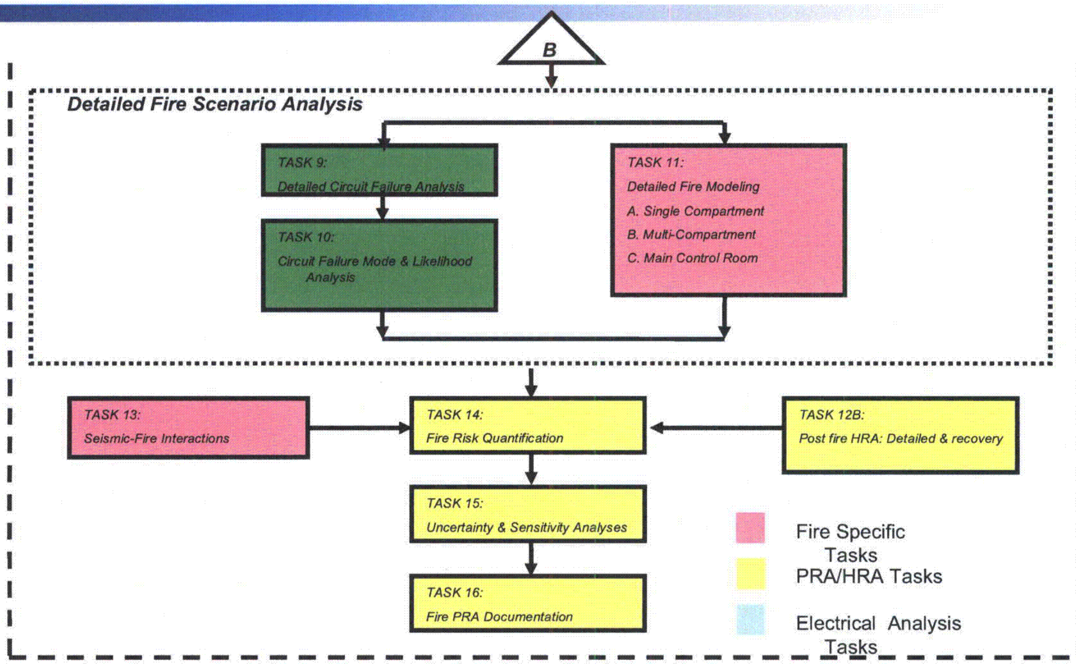
CIRCUIT ANALYSIS
PRA Task Flow Chart (continued)



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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

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CIRCUIT ANALYSIS
Overall Strategy & Implementation, cont...

- Recommended Methods are Consistent with Industry Best Practices
- Use Risk Perspectives to Streamline and Focus Analysis
- <u>Remains a Technically and Logistically Challenging Area</u>
- 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

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Notes:

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

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CIRCUIT ANALYSIS
Overall Strategy & Implementation, cont...

- Circuit Analysis (including cable tracing) Can Consume 40%-70% of Overall Budget
- <u>Circuit Analysis Scope MUST be a Primary Consideration During Project Scoping</u>
- 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
- <u>Coordination with Task 2 (Component Section) is Essential – MUST Understand the EXACT Functionality Credited for Each Component</u>

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Notes:

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

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Notes:

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

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SESSION 2: Task 3, Fire PRA Cable Selection

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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

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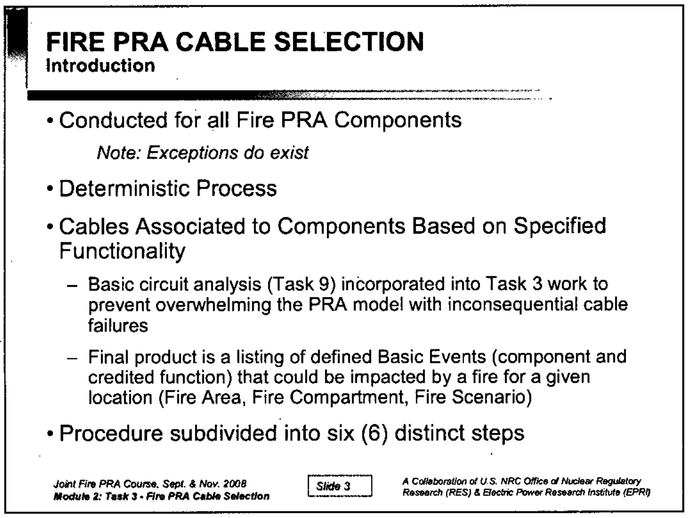

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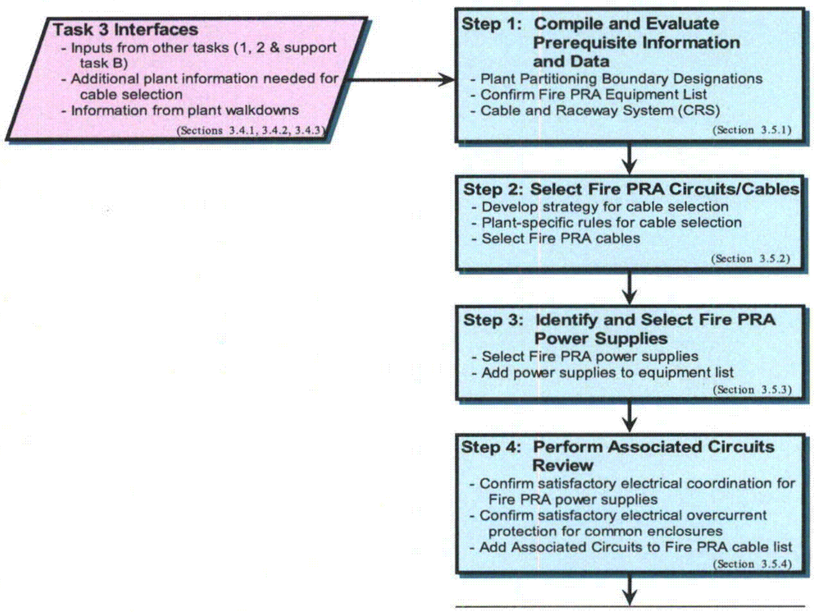
FIRE PRA CABLE SELECTION
Flowchart



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Module 2: Task 3 - Fire PRA Cable Selection

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Notes:

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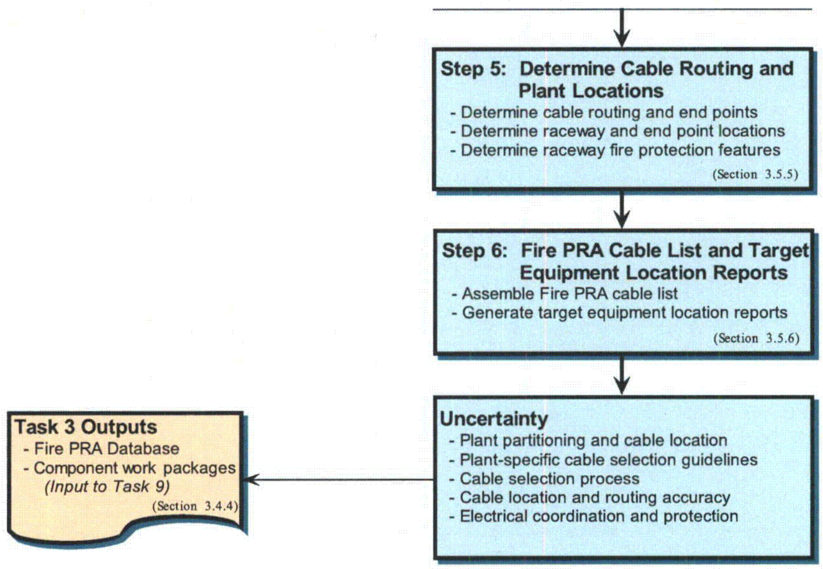
FIRE PRA CABLE SELECTION
Flowchart



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Notes:

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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

Notes:

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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)

Notes:

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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"

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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

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Notes:

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)"

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Notes:

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

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Notes:

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

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Notes:

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

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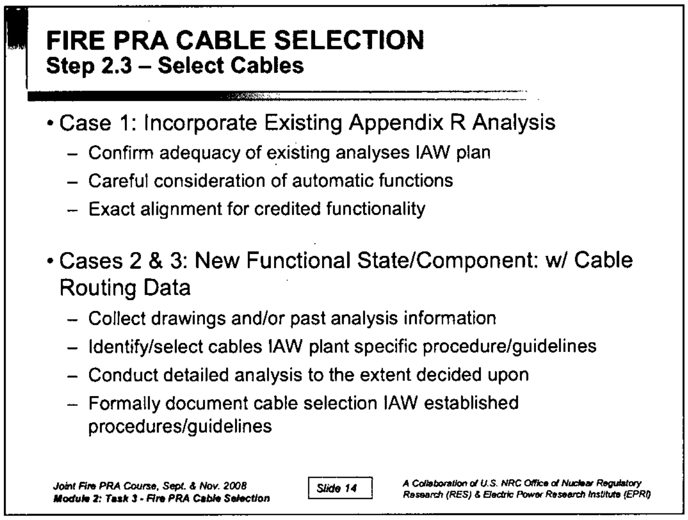

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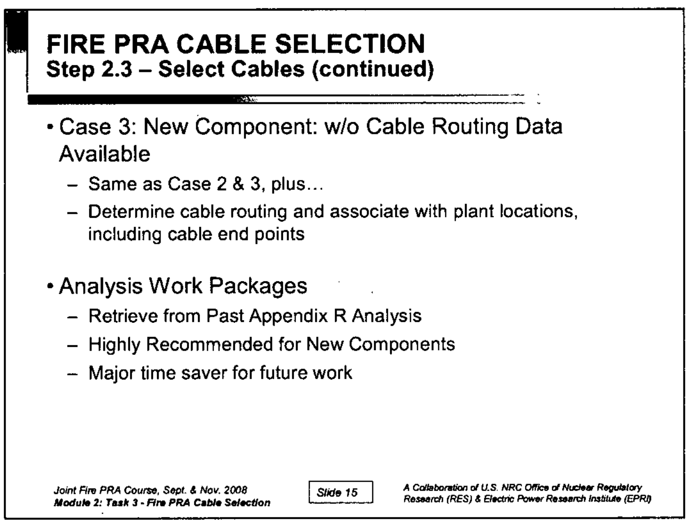

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FIRE PRA CABLE SELECTION
Step 3 – Select Fire PRA Power Supplies

- 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

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Notes:

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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

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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

Notes:

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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.

Notes:

SESSION 3: Task 9, Detailed Circuit Failure Analysis

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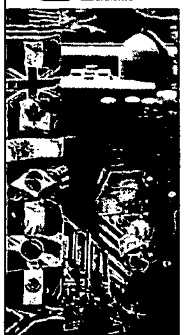

EPRI/NRC-RES FIRE PRA METHODOLOGY

Module 2: Task 9 - Detailed Circuit Failure Analysis

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

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September and November 2008
Bethesda, MD

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Notes:

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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

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Module 2: Task 9 - Detailed Circuit Failure Analysis

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Notes:

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Notes:

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

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Notes:

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

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Notes:

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

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Notes:

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

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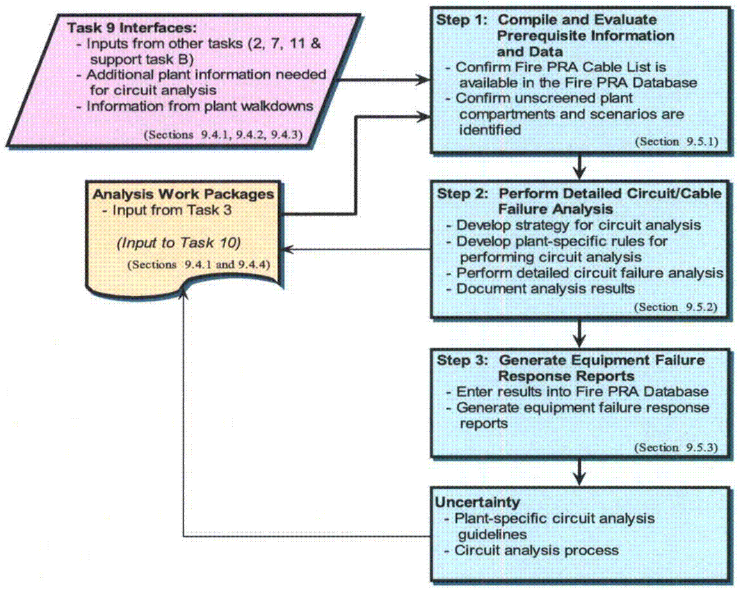
DETAILED CIRCUIT FAILURE ANALYSIS
Flowchart



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Notes:

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Notes:

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

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Notes:

DETAILED CIRCUIT FAILURE ANALYSIS
Task Interfaces - Outputs

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

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Notes:

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.

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Notes:

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

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Notes:

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

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Notes:

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

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SESSION 4: Task 10, Circuit Failure Likelihood Analysis

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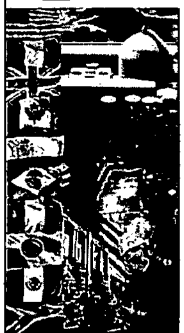

EPRI/NRC-RES FIRE PRA METHODOLOGY

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

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Module 2: Task 10 - Circuit Failure Mode Likelihood Analysis

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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

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CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS
Introduction (2)

- Caveats:
  - Our Knowledge is Greatly Improved but <u>Uncertainties are Still High</u>
    - 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

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Notes:

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

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Notes:

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

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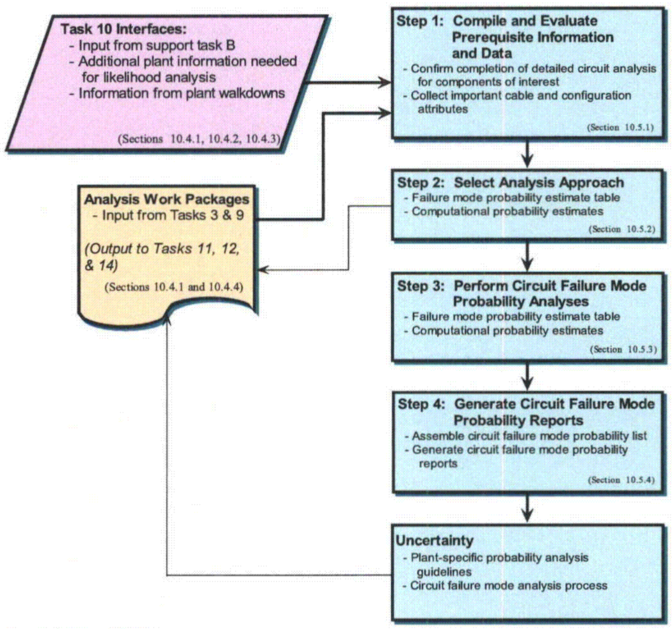
CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS

Flowchart



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Notes:

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

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Notes:

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

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Notes:

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)

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Notes:

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

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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

$$P_{CC} = (C_{Tot} - C_G) / [(C_{Tot} - C_G) + (2 \times C_G) + n]$$
$$CF = \{C_T \times [C_S + (0.5 / C_{Tot})]\} / C_{Tot}$$
$$P_{FM} = CF \times P_{CC}$$

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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

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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.)

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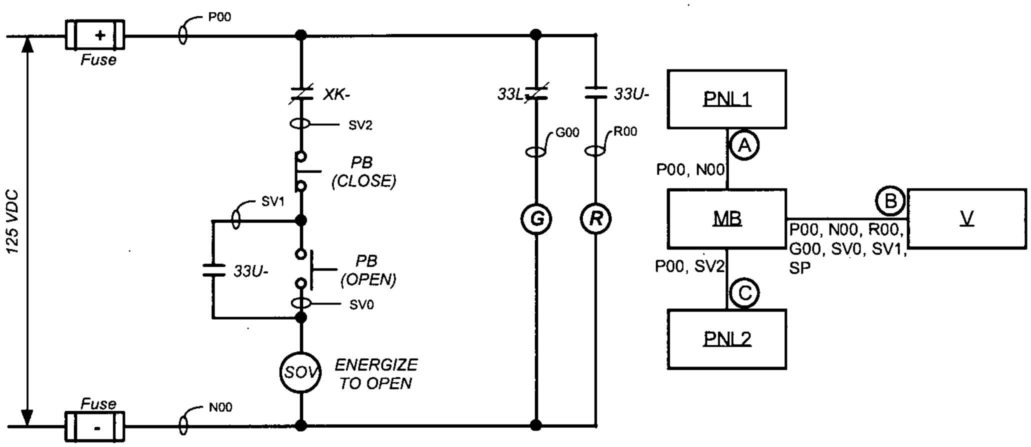
CIRCUIT FAILURE MODE LIKELIHOOD ANALYSIS

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→

Notes:

Slide 16

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 →

Notes:

Slide 17

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 →

Notes:

Slide 18

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→

Notes:

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, $\mathbf{P}_{SO(Open)} = 0.75 * 0.44 = \underline{0.33}$

Notes:

Slide 20

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

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Module 2: Task 10 - Circuit Failure Mode Likelihood Analysis

Slide 20

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Notes:

SESSION 5: Support Task B, Fire PRA Database

Slide 1

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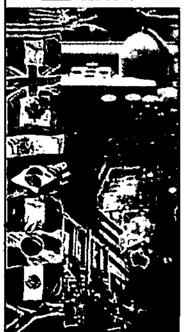
SAIC Science Applications International Corporation



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

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Notes:

Slide 2

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

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Module 2: Support Task B - Fire PRA Database

Slide 2

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Notes:

Slide 3

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

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Slide 3

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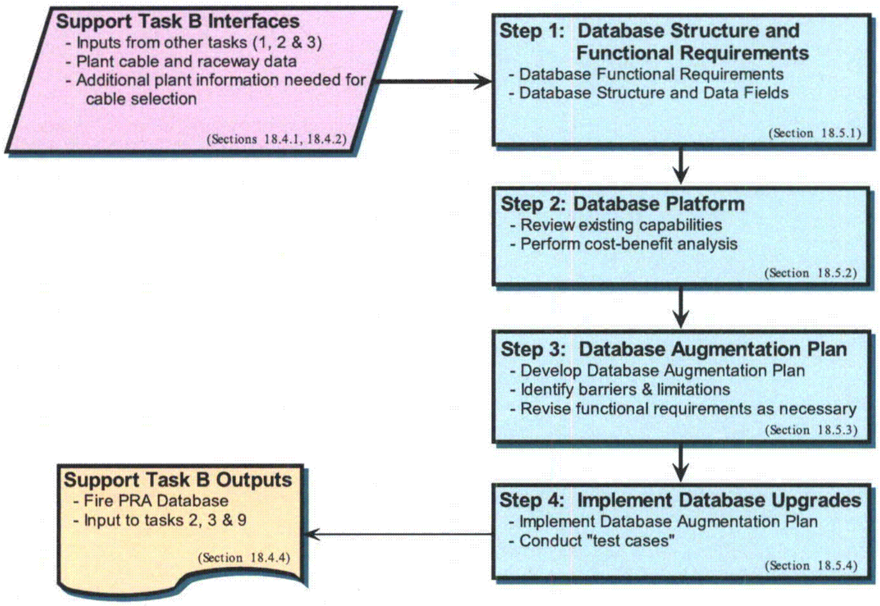
Notes:

Slide 4

FIRE PRA DATABASE
Flowchart



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Slide 4

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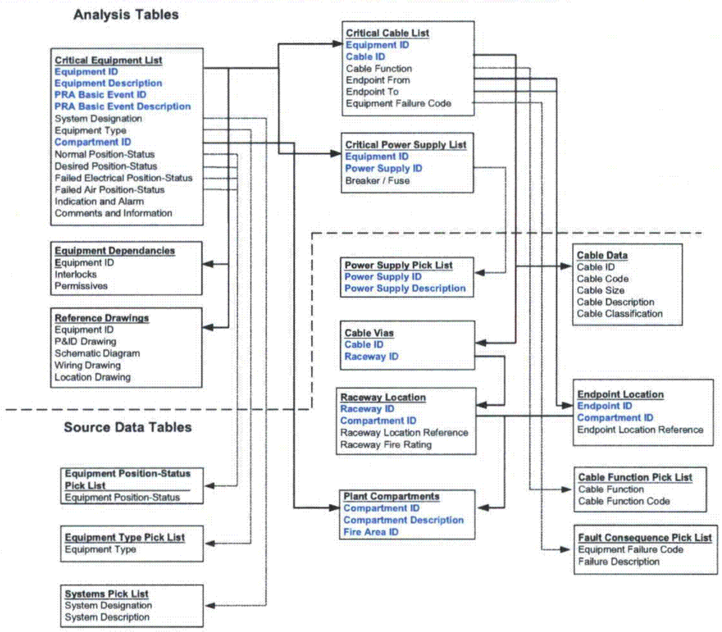
Notes:

Slide 5

Notes:

Slide 6

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



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Slide 6

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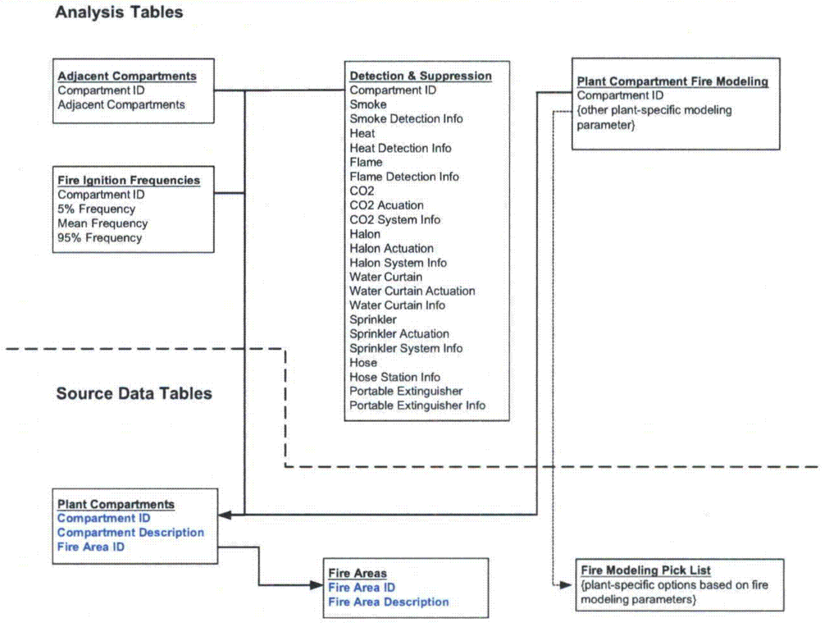
Notes:

Slide 7

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



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Slide 7

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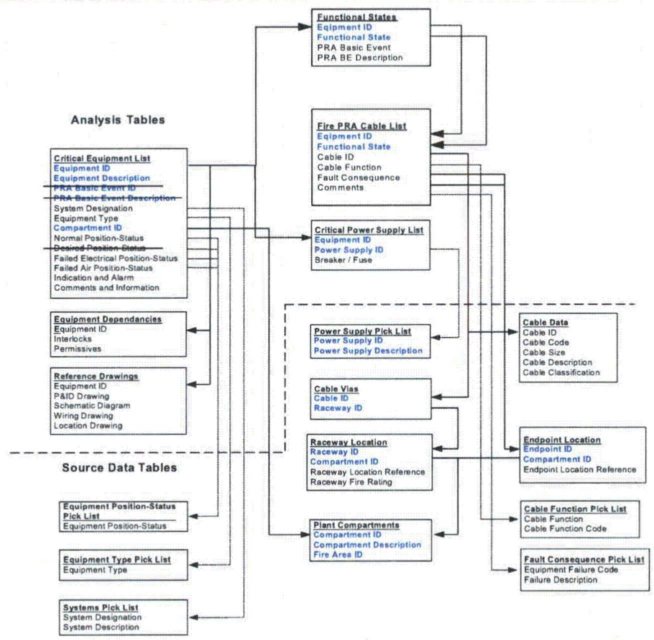
Notes:

Slide 8

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



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Slide 8

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Notes:

Slide 9

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

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Slide 9

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Notes:

Slide 10

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

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Module 2: Support Task B - Fire PRA Database

Slide 10

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Notes:

Slide 11

Notes:

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 "Rogue" PRA Databases are Gone!

SESSION 6: Electrical Exercises Overview

Slide 1

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EPRI/NRC-RES FIRE PRA METHODOLOGY

Module 2: Electrical Examples

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

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

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Notes:

Slide 2

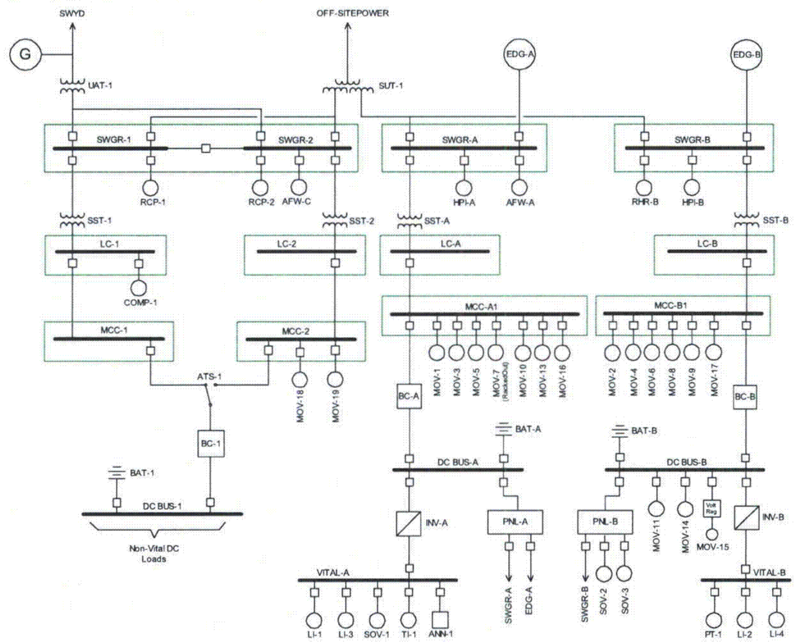
OVERVIEW OF EXAMPLES

- 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"

Notes:

Slide 3

SNPP ONE-LINE DIAGRAM



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Module 2: Electrical Examples

Slide 3

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Notes:

Slide 4

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

Notes:

Slide 5

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 ☐

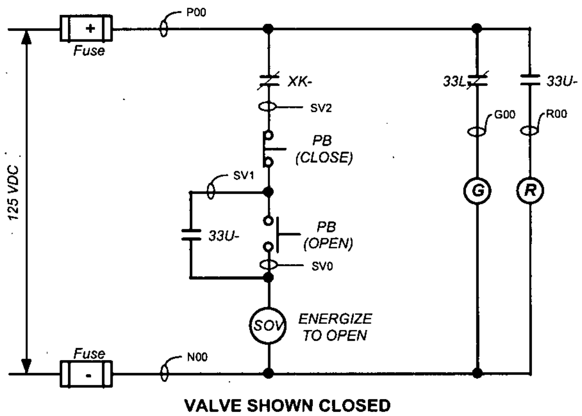
Power Supplies: __________ Breaker__________

__________ Breaker__________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:



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Notes:

3 EXAMPLE EXERCISES

CIRCUIT ANALYSIS WORKSHEET

Exercise 1 (first part)

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 Consequences	Comments

Comments:

____

____

____

____

CIRCUIT ANALYSIS WORKSHEET

Exercise 1 (second part)

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 Consequences	Comments

Comments:

CIRCUIT ANALYSIS WORKSHEET

Exercise 2

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 Consequences	Comments

Comments:

CIRCUIT ANALYSIS WORKSHEET

Exercise 3

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 Consequences	Comments

Comments:

CIRCUIT ANALYSIS WORKSHEET

Exercise 4

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 Consequences	Comments

Comments:

CIRCUIT ANALYSIS WORKSHEET

Exercise 5

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 Consequences	Comments

Comments:

CIRCUIT ANALYSIS WORKSHEET

Exercise 6

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 Consequences	Comments

Comments:

CIRCUIT ANALYSIS WORKSHEET

Exercise 7

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 Consequences	Comments

Comments:

CIRCUIT ANALYSIS WORKSHEET

Exercise 8

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 Consequences	Comments

Comments:

CIRCUIT ANALYSIS WORKSHEET

Exercise 9

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 Consequences	Comments

Comments:

CIRCUIT ANALYSIS WORKSHEET

Exercise 10

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 Consequences	Comments

Comments:

CIRCUIT ANALYSIS WORKSHEET

Exercise 11

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 Consequences	Comments

Comments:

____

____

____

CIRCUIT ANALYSIS WORKSHEET

Exercise 12

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 Consequences	Comments

Comments:

____

____

____

____

CIRCUIT ANALYSIS WORKSHEET

Exercise 13

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 Consequences	Comments

Comments:

____

____

____

____

CIRCUIT ANALYSIS WORKSHEET

Not a numbered exercise – Exercise 14 is similar, but its BE Code is PNL-B EPS-4VBUSBF-2 (not BF-1) and its Required Position: Functional State is Energized from EDG-B (not SUT-1)

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 Consequences	Comments

Comments:

CIRCUIT ANALYSIS WORKSHEET

Exercise 14

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 Consequences	Comments

Comments:

CIRCUIT ANALYSIS WORKSHEET

Exercise 15

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 Consequences	Comments

Comments:

CIRCUIT ANALYSIS WORKSHEET

Exercise 16

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 Consequences	Comments

Comments:

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:__________________ 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:

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CIRCUIT ANALYSIS WORKSHEET

Component ID:________________ Continuation Sheet (___ of ___)

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Appendices

Appendix A: Questions Asked in Module 2 Sessions

NRC Disclaimer: Appendix A is intended solely for use as part of a training tool. No portion represents NRC Conclusions or Regulatory Positions, and should not be interpreted as such.

Session 1:

QUESTION

How do the probability values assigned to certain events differ between Appendix R standpoints and probabilistic risk assessment (PRA)?

RESPONSE

If I had a motor-operated valve and Appendix R did an analysis in which it picked up a certain set of cables that were related to the desired function of that valve, which would generate a cable list. Historically, the guidelines there have been as such: if a valve was closed and an operator could open it and he could walk over and put the valve in the desired position, that was how we went for it. That's how the analysis was made. Of course, if there were contacts or portions of the circuit that could prevent you from doing that, by the rules of Appendix R, those were identified. The difference in PRA is that if a valve is normally closed and you wanted it open, there may be three or four ways that that valve could be opened. For example, an operator could go to a control switch or a safeguard signal could actuate, and each of these might have a contact within the circuit that could cause the valve to open. In addition, even regular interlocks could cause that valve to open. A PRA analysis would go in and determine that any type of operation that could open those valves, even by way of contacts, also affects the operation of this circuit. The failure of any of these mechanisms would not prevent the operator from opening the valve. Now, however, all of these other circuits must be evaluated to determine their effects on this component. The integrated nature of these circuits makes this evaluation quite a challenge.

QUESTION

The Appendix R analysis didn't account for necessary operator action; we were concerned mostly with the successful operation of warning signs. Is this similar for the PRA?

RESPONSE

From a PRA point of view, though, if the SI came on and they wanted that valve to reposition, they count on the SI actually repositioning that valve. They don't rely on the operator. Every time you have to rely on an operator, they have to credit the operator with diagnosing the problem, in the midst of all the commotion, and then going over and taking that action. A probability number, discussed in the Human Factors Analysis portion of this presentation, must be applied. Even though no circuit capacity has been lost, and the valve can still be opened, in the PRA world, it's very different. On-demand, that valve needs to be opened when given the signal by SI. So the key to this analysis is that if a valid SI signal is realized, then the valve must be opened on demand.

QUESTION

Are the analysts for task 3 and task 9 the same people?

RESPONSE

The people who do task 3 and task 9 are the same people.

QUESTION

Could we screen out certain aspects based on our knowledge of their importance in PRA?

RESPONSE

No. The ways tasks 3 and 9 are set up are meant to be deterministic. No screening is allowed based on importance at that stage. When we get into how important a cable is to the PRA model, a different group does that. What we did not want was for the electrical analysts to make a decision on what is important in the PRA model. No screening other than what can be screened deterministically by the actual circuit design.

Session 2:

QUESTION

Slide 3: Does fire PRA use alternate power supplies to switch power sources when analyzing events?

RESPONSE

Yes, they do. In fact, even more so than in Appendix R. If you take your appendix R analysis and multiply it by 5, you'll get the number of cross-ties in PRA. PRA solves the problem by having lots of different ways to accomplish the same thing. Where they have diverse options (like a bus that has multiple power supplies), that's a big win for them, whereas in Appendix R it may mean nothing. Diversity really works in their favor for reducing the core damage frequency numbers or conditional core damage probabilities. That same windfall doesn't exist in Appendix R.

QUESTION

Slide 5: But what if you take too many cables for a given component? How does this affect the conservatism of your answer?

RESPONSE

There would be no uncertainty with that. The cables you picked don't provide an uncertainty; in this case, the analysis would simply be too conservative for what you needed.

This is also a good question from a different angle. If I do a very conservative analysis from an electrical perspective and I pick all these cables and I do that for every component out there, I have this highly conservative electrical analysis. You may think, "Well, that'll make your overall answer conservative, right?" Wrong. This is because if by the nature that you picked cables too conservatively and for expediency associated particular cables with equipment rather than dispositioning them and therefore need them, it's a "required" cable. If I do that for all my components, as I mentioned, you'll have a very conservative analysis. Keep in mind that this circuit analysis feeds into the model. The problem is that if you're too conservative in a systematic point of view, you could skew the results of the PRA to suggest that one particular area is highly risk-significant in comparison to another. Being too conservative in the circuit analysis could mislead the results of the PRA.

QUESTION

Slide 6: Is there a systematic framework for establishing the task 1 boundaries?

RESPONSE

The first task in the PRA, Task 3, is already available and done. When you do Task 1, setting up the boundaries for the fire PRA, ensure that what you're doing aligns with the preexisting data in the PRA database. If the electrical analysts establish partitions that do not align with the data in the database, it is too expensive to try to retroactively develop the database to align with the electrical analysts.

QUESTION

Slide 8: How do you deal with PRA analysts and electrical analysts viewing the same components different ways?

RESPONSE

This is a typical case for plants that are trying to establish a correlation up-front. Plants that fail to do this will find out on the back end of Task 9 that they'll have to pay for their indolence. One thing that we've started doing, which has proven to be extremely effective, is to arrange a meeting between the PRA analysts, the fire modelers, and the electrical analysts after the PRA equipment list is done. They must sit together and process every system component and every functional state. It sounds horribly detailed, but you would be amazed at how much comes out in those meetings. When you try to reconcile Appendix R and PRA and you see the same valve and both groups are trying to demonstrate that the plant runs safely and one group wants the valve open and the other wants it closed, it begs the question: "How can you both be right here?" The answer is that sometimes they are both right and you figure out what the reason for that was. In most cases, however, one group will admit that they had it wrong. One recommendation is that when completing task 2, build into your schedule time to have face-to-face interactions where you process every component and every functional state in great detail.

QUESTION

Slide 9: How should auxiliary components be included?

RESPONSE

Deterministically decide if the components can affect the desired functional state of the component in question.

QUESTION

Slide 10: What is a supercomponent and how is it employed in this context?

RESPONSE

Some components aren't actually components. Instead, they're systems of subcomponents that are better defined as a component. A perfect example is the load sequencer. One does not simply walk and touch the load sequencer. Instead, the sequencer is made of sundry subcomponents. Even though it's not a component proper, everyone thinks of it as a component.

Session 3:

QUESTION

Slide 5: what's the difference between thermoset and thermoplastic cables?

RESPONSE

The difference is largely in the insulation that protects the conductor, not necessarily the cable jacket.

QUESTION

Slide 5: When specifying a fire-resistant cable, does this imply a certain configuration?

RESPONSE

In a sense, it does imply the thermoset—only because those are the types of cable that are survivable under those conditions. However, it does not *a priori* define them as one particular type or another. Another very rugged material is a silicon rubber insulation. We tried several times to fail those during the CAROLFIRE tests and were not successful until we hit it with water.

QUESTION

Slide 5: When you talked about the cable, you spoke little about the jacket. Is that because the jackets on most of these cables are the same materials?

RESPONSE

The jacket's intent is not an electrical insulation. Instead, its purpose is to provide physical protection for the electrical insulators that surround the individual conductors. When you're pulling it through a conduit, sometimes that conduit has burrs or sticky things that will score the jacket and hopefully protect the insulation. It's a sacrificial material. It also binds the conductors together, making it easier to deal with a multi-conductor cable. Usually a binding tape will be inside the jacket, just a plastic wrap to bind the strands together. Filler is also used to help maintain the roundness of the cable.

QUESTION

Slide 5: Is the shielding considered part of the jacket?

RESPONSE

This can be both ways. There are a few insulators where people will have a shield around the inside of the jacket, surrounding the thing. This is rare. Most cables, especially for instrumentation wire, shield twisted wire pairs with an aluminized mylar. This has minimal structural strength and is actually intended to provide protection against radio frequencies and other electromagnetic interference.

Just as an aside, if your cables are stacked in a tray, the uppermost cables will generally be the power cables, the next lower group would be control cables, and finally near the bottom are your instrumentation cables. The whole idea there is that the power cables tend to give off much more heat, and would likely be more prone to spontaneous combustion if a fault occurs.

QUESTION

Slide 5: Are cables generally given any sort of systematic designation on cables to specify their function?

RESPONSE

When doing a plant walkdown, generally your cable tray identifiers will have a letter or number within the identifier that indicates its service function, whether it's power, control, or instrumentation. Sometimes they use a variety of letters, not necessarily P, but maybe AB or M for power. C generally is used to designate control. Instrumentation is designated X or I or some other designator.

QUESTION

Slide 5: I'm told there are few spurious actuations in power cables.

RESPONSE

This is true. We will elaborate more as we cover the three-phase proper sequence hot short. The only other possibility would be for DC-powered circuits; since they're ungrounded, the possibility exists for a polarity conflict that would result in a short.

QUESTION

Slide 5: When do you have to consider inter-cable shorts?

RESPONSE

It doesn't matter what insulation type is in either cable, we don't consider it credible that an external short will be observed through the robust armor to interact with another protected cable. The same is true for a cable in dedicated conduit sitting by itself. An interaction through the conduit by an outside source is, again, not credible. However, for both cases, you must still consider the intra-cable events.

QUESTION

But is inter-cable shorting still possible with thermoset cables?

RESPONSE

This is still credible. We did find one or two cases during CAROLFIRE where this happened.

QUESTION

But you said that thermoset cables only have issues with conductors and not with the jacket.

RESPONSE

The issue is with a cable-to-cable interaction between two thermoset cables.

QUESTION

And does it matter whether it's thermoplastic or thermoset?

RESPONSE

The existing guidelines indicate no difference between the two. However, we hope that with additional research we will show that the probability for interaction between the two cables is much less for thermoset than it is for thermoplastic.

QUESTION

What causes high-impedance faults?

RESPONSE

Fire damage. Again, it's somewhat of an artificial assumption that the cable will sit and short with long arcs. The arcing tends to suppress the current. It is actually a resistance to flow pathway.

QUESTION

Do we normally ground power cables?

RESPONSE

Yes. Through the equipment, it does see a ground. But these aren't normally grounded; instead, they run with the ground. This is a grounded electrical *system* because the alternative (ungrounded) cases are about the same.

Yes. I have a compressor motor here, and it needs to have the proper sequence (A-A, B-B, C-C) in order to operate. If it's an MOV, then in order to reverse direction, you have to reverse two of the phases.

QUESTION

Slide 9: Earlier you talked about using tasks 3 and 9 together, thus removing a lot of cables from the appendix R safe shutdown list. On your first pass, about how much of the cables are you able to get rid of by looking at functional states?

RESPONSE

It depends on the failure mode of interest to the fire modelers who generated the component list, or what functional state is important, and then the circuit design plays a major role in which cables can be thrown out.

QUESTION

Slide 10: What does a screened compartment look like?

RESPONSE

That's where your interaction with the fire modelers comes from. They will break down the plant into a variety of compartments and affirm that certain ones are devoid of combustible materials or ignition sources where others are not. A screened compartment is one where the fire modelers have decided that there is no way a fire can occur in that compartment.

QUESTION

Slide 10: How do you define the "normal" state of the plant?

RESPONSE

One of the underlying assumptions of the whole PRA is that all events take place at-power.

QUESTION

Slide 11: We know that the analysis has to be done on a conductor basis. You've only identified the cable as far as the documentation goes, though.

RESPONSE

It will take different conductor actions to cause each of these possible events within the cables. However, for a particular cable, multiple events are listed as possible outcomes.

QUESTION

Slide 11: When looking at a particular consequence, can you work backwards to determine the possible initiating events?

RESPONSE

Fire damage to the cable can cause some event. For a particular cable, we want to diagnose it by looking at the overall list of events and discerning what the cable can cause a component to do. If it gives an erroneous indication by misleading the operator, is that important from a human factors standpoint? Perhaps. Therefore, it must be identified as a possible failure mode of this cable. If not, and if the operators plan to use procedures to verify the operating status of a particular component, then you'll probably only be looking for the spurious operation case, if that's a possibility. This will be determined by inspecting individual cables.

QUESTION

11: If you're done with the fire analysis on a cable and know which ones cause spurious operation, how do you make the final determination of what is risk-significant?

RESPONSE

It's not the decision of the electrical analysts, it's the systems analysts who make the determination about what should finally be included in the PRA and decide how risky a fire can be to their plant. They will have made a set of component selections that they believe are key to successfully operating their plant. All the electrical engineers do is identify those cables which could be affected by the fire in such a way as to result in unsuccessful operation of the plant.

QUESTION

So do the PRA analysts simply disregard the Appendix R analysis and form their component lists independently?

RESPONSE

When they form their component lists, they too go through the Appendix R components. If they fail to include an Appendix R component, they justify why. They, too, depend on previous analyses. However, they have a completely different rationale for their component selection.

QUESTION

How are inter-cable shorts affected by using the raceway system as the ground path?

RESPONSE

Based on experience, there may be intra-cable shorting long before one element shorts to ground, but by the time you have cables shorting across one another, we have generally seen a short to ground occur prior to that. So even if there isn't a ground conductor within the cable itself, and you're using your raceway as the ground path, it still applies.

Session 4:

QUESTION

What do you mean by a 50-percent margin of safety for the CPT?

RESPONSE

If this CPT is rated for no more than 150 percent of the normal power requirements for the circuit, including surge current, and the CPT is not overly sized, then you can credit the reduction in the probability of a spurious actuation. You'll see that reduction when we get to the tables. However, if you start getting a number of leakage current paths because the fire damages the cable, you'll start drawing down on the CPT to the point where it won't support a spurious actuation.

QUESTION

What happens when the CPT margin is greater than 150 percent? Do we analyze it without further consideration?

RESPONSE

Yeah, we don't formalize that as part of our process, but that's really the right way to do it. For example, if your normal power requirement is on the order of 100 V-A, and you've got a 300 V-A CPT out there, that violates the 150-percent rule. You really shouldn't take credit for the CPT. However, we don't deal with that in the decisionmaking process.

QUESTION

When are you able to allow the internal event risk contribution to be zero?

RESPONSE

If you can justify it by saying that there is no possibility of an internal shorting event and there is no way to get an intra-cable portion of that event, note it and use your external event (one only). But it is incumbent upon you to justify why you didn't use the primary shorting event.

QUESTION

What source do you use for the fire scenario when you have multiple neighboring compartments?

RESPONSE

If, in your plant, you have four neighboring compartments and only have fire concerns in two compartments; if you have a cable in a tray running through one fire hazard compartment into the other, but only the conduit exists in the second; then you would have had to do the Task 9 circuit analysis for that particular cable no matter where it ran, now the neighboring compartment issue does become important. Now, in the tray compartment, you would use the tray case. If, on the other hand, they wanted you to analyze the fire impact from the conduit compartment on spurious operation, then you go to the conduit.

QUESTION

What if you have a cable in a tray that extends partway into the room and the rest of the cable remains in conduit?

RESPONSE

You must then ask the modelers about their postulated fire scenario. Is the fire scenario more likely to affect the conduit, or is it more likely to affect the cable tray portion of it? If they say "both," then my suggestion would be to only investigate the one with the higher probability value.

QUESTION

Why would you use the table method at all to get probability values if it is so inaccurate?

RESPONSE

It changes the approach so that when you use the table method, you just go with the numbers that you have. Again, the differences in number of targets and sources and grounds play a role in the formula there. The table method has one nice aspect in that it is quick and dirty. We think it is overly conservative. However, it gives you a number, and you don't spend days working it out. You instead just go to the cable, write it down, and go to the next cable.

QUESTION

Where do you get the inputs for the PRA model (probability of ignition, severity, duration)?

RESPONSE

The basic probability number is used in the PRA model as whether or not a certain component will experience an operation and what impact that will have on the plant. There is no means right now of determining the duration, other than what the fire modelers predict for how long it will take to damage the cable. This turns around, then, and becomes an HRA issue, which is something rather alien to me.

QUESTION

What type of cable should we assume for PRA applications if we can't get in to look at them?

RESPONSE

For Appendix R and safety-related applications, my best guess would be that the great majority of cables are thermoset. But, because this fire PRA will also bring in balance-of-plant-type components and systems, the ratio for the fire PRA may bring the number of thermoplastic cables a little closer to the number of thermoset. Again, you need to consider whether or not you're talking about an older plant, where a lot of thermoplastic cables were used (i.e., pre Browns Ferry), or are you talking about a later version, like a Watts-Barr—something that uses almost exclusively thermoset. In any case, it's still a plant-specific issue.

Session 5:

QUESTION

Are the functional states of the cables in question described in the PRA database?

RESPONSE

We'd say that the answer to that is "yes" in the sense that it is clearly the intent of the database where the functional requirements of the database are defined to include the functional requirements of the critical cable elements that are required. It is the intent of the database to house the information developed through the circuit analysis project. The cable raceway information does not typically have that.

My experience to date is that some of the traditional stuff would always be in there—you know, the worksheet stuff. If you noticed, the worksheet didn't really cover that. I think what you'll see is that when Frank gets into the Task 10, as far as inter-cable, intra-cable, and all the subtleties and mechanistic things that go into Task 10, those tend to be more of a "here's a comment field, write down what you did" rather than one or the other. I think that part could be matured a little bit, certainly, but to this point, my experience or exposure hasn't been in instances where it was as rigorous as the task-end type of data that you're discussing, that I've seen for the other circuit analysis data. But, your point's still very valid that when all is said and done, you want to have some way to capture that in a fairly automated sense. We're trying to avoid going back and having volumes and volumes of paperwork that don't work with the database.

QUESTION

Rather than using the default position of all valves as "open, full power" because this results in inadequate results, could you use three conditions in your PRA: open, closed, and operating?

RESPONSE

You could. You could define your operating conditions to cover all cases. That's where, when you sit down to develop your strategy, you'll sit down with these guys and know how their basic events are done. It can become amazingly complicated, based upon how basic events are captured. At the onset, the way basic events were first presented in the model just seemed silly. I didn't get it. After a while, though, when I got really familiar with what the PRA is trying to do, it makes more sense. Let me give you an example. If the initial state of a motor-operated valve is closed and the desired position is open, there may be two basic events for this event. I can't change their model every time I don't like the way it works for me electrically. If they have a basic event, called BE-1, where the valve fails to close, and BE-2, where the valve transfers open, then they split into two events the functioning of the valve. This becomes an embedded spurious actuation concern of a functional state. You may have to do two separate analyses for this valve every time you see that. If BE-2 is mapped under a different gate in the model, you may want to, because it will encompass a smaller subset of cables than BE-1. But when you consider 400 or 500 valves, it would cost a great deal of money to do this. Is that money well spent? It depends. If both events are mapped under the same gate in the electrical model, the dominant basic event will dominate and the other one will become meaningless. If you didn't understand that you could do circuit analysis for 300-400 valves, it would be a lot of money and time for absolutely zero value. You really need to understand how the basic events line up. It's okay to map BE-2 to the circuit analysis for BE-1 for one functional state because the functional state encompasses the second one. You have case after case where it's just necessary to drive it down to a detailed level when doing the circuit analysis and making sure it gets mapped into the PRA and basic events. What seems to be simple is not. If you do your database correctly, it should be able to accommodate all the different iterations of the functional state. If you can't come to terms in an 805 project on the issue of what a functional state means, you just create another one, which checks 805, not PRA.

Appendix B: Exercise Problems and Solutions

Exercises with Reference Figures

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 ☒

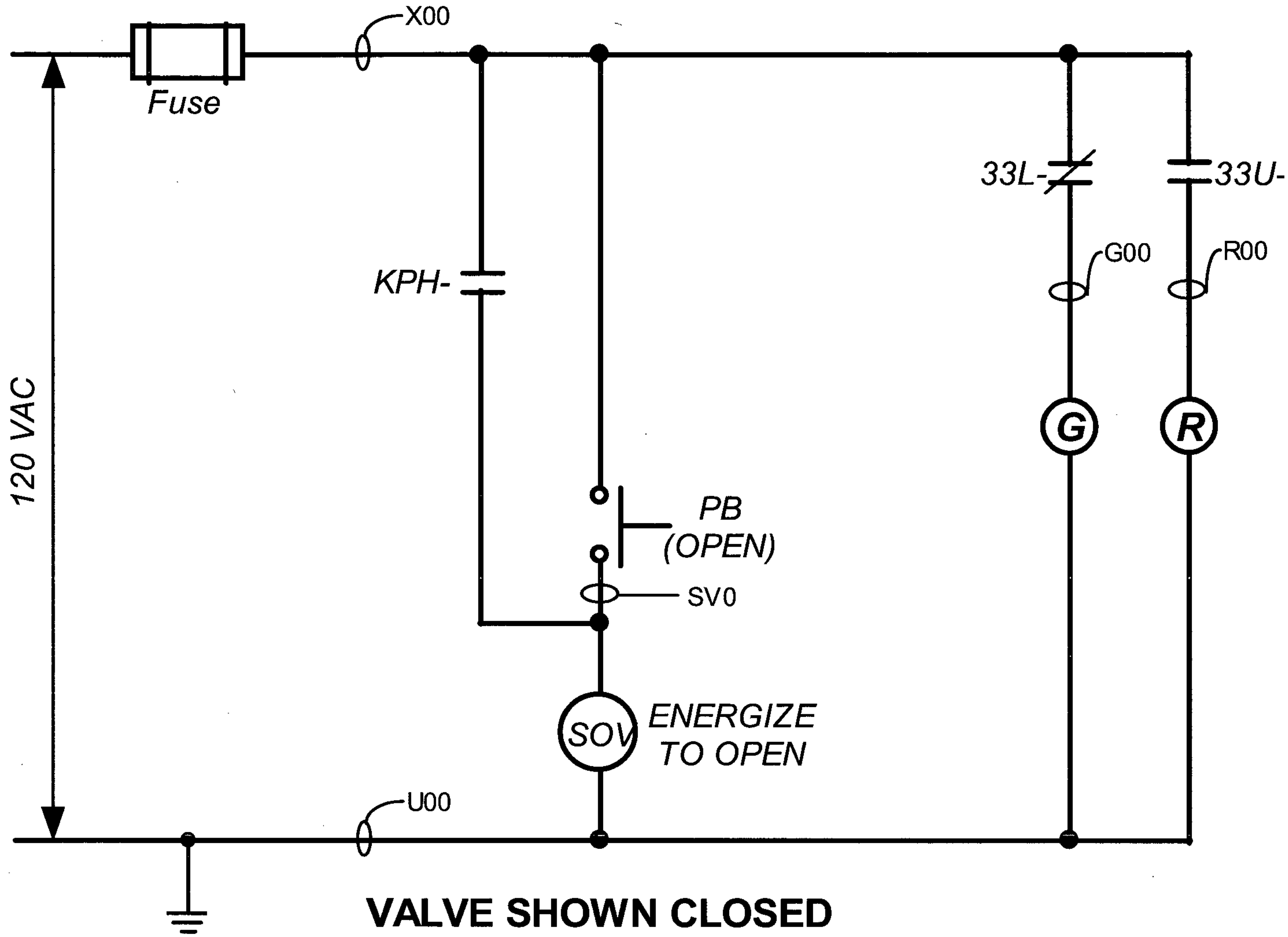
Power Supplies: ____________________ Breaker: ____________________

____________________ Breaker: ____________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

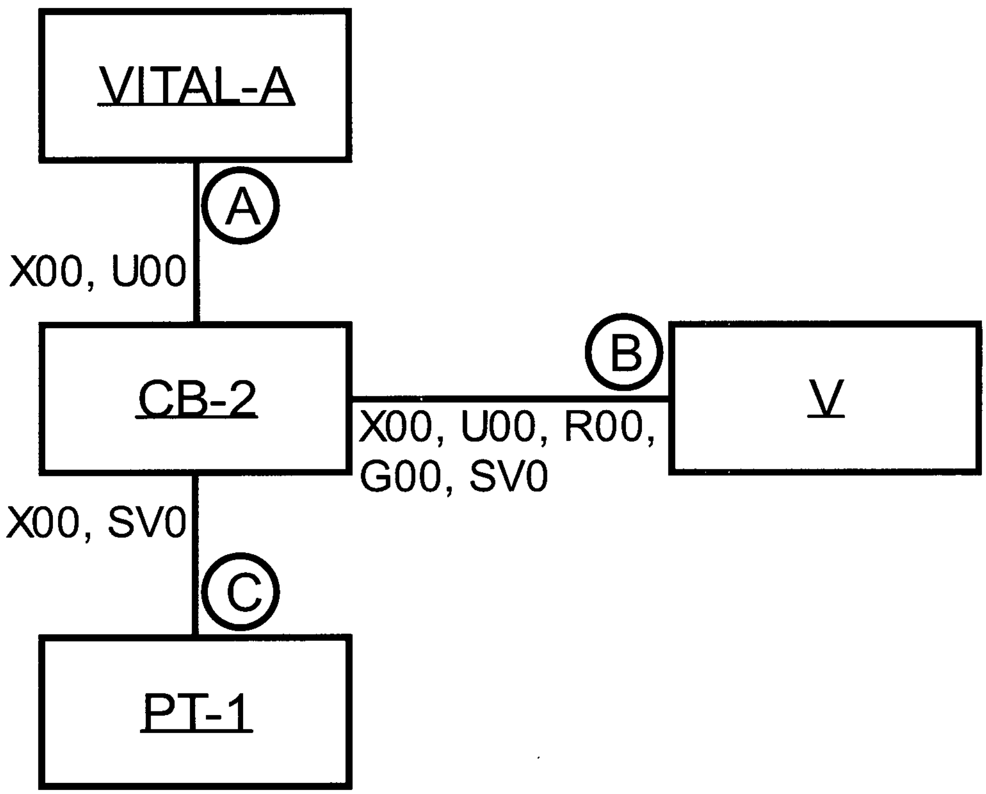
Comments:



SCHEME VA3

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

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



SOV-1, SCHEME VA3

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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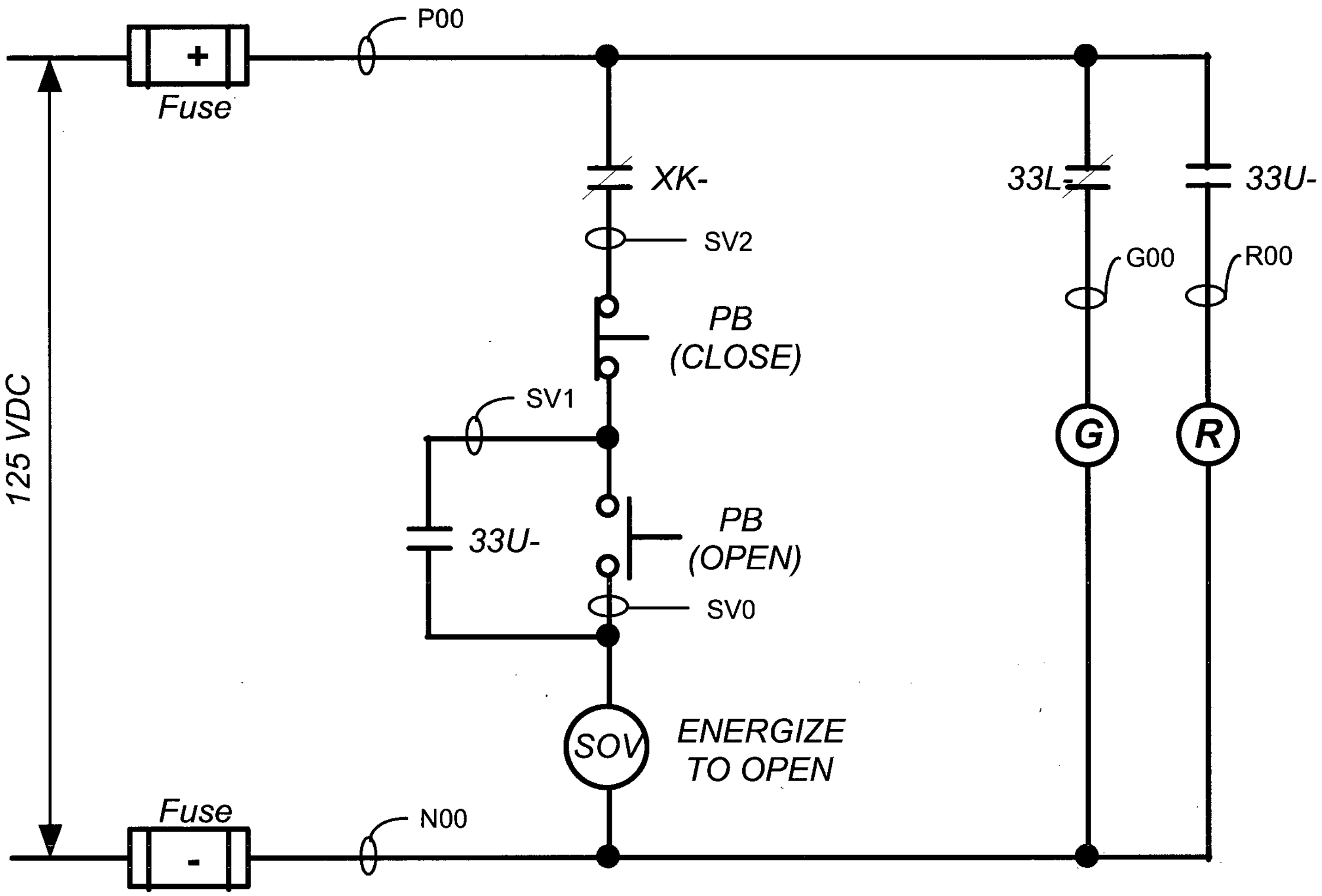


VALVE SHOWN CLOSED

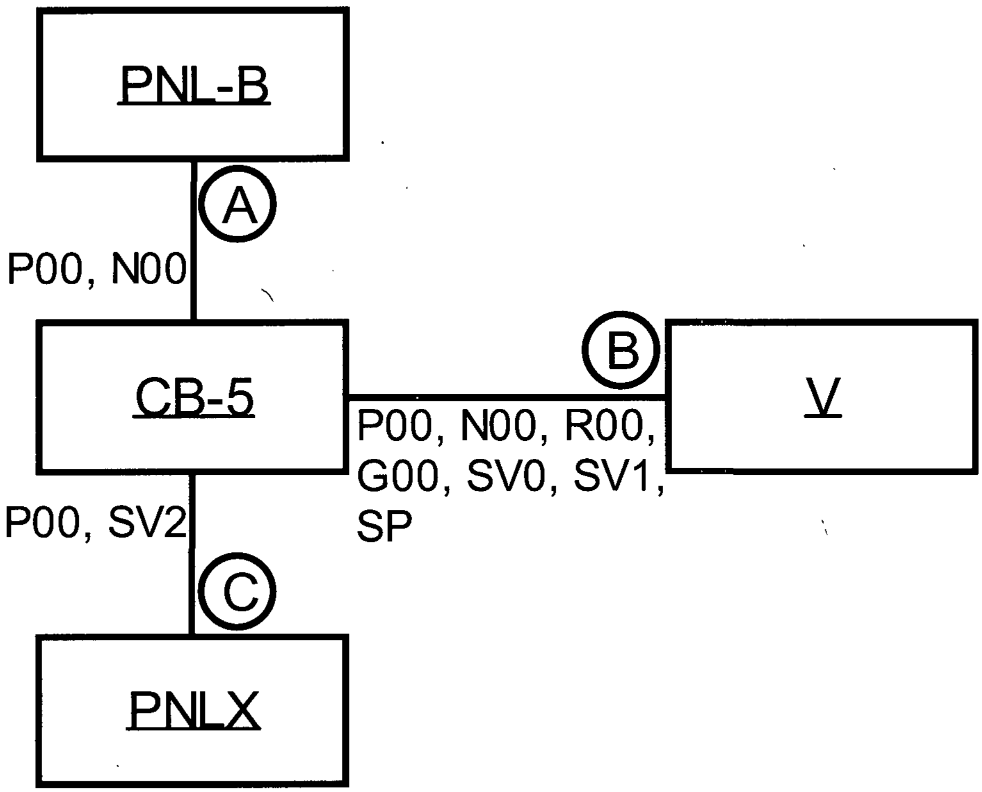
VALVE	DESCRIPTION	SCHEME	SWITCH ID
SOV-2	LETDOWN ISOLATION	PB2	AOV-2
SOV-3	CHARGING PUMP INJECTION	PB3	AOV-3

SNPP

SCHEMATIC DIAGRAM -- PRIMARY MAKEUP SYSTEM SOLENOID VALVES SOV-2 & SOV-3

Drawing No.:	E-02
Date:	07/25/2008
Revision No.:	1

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



SOV-3, SCHEME PB3

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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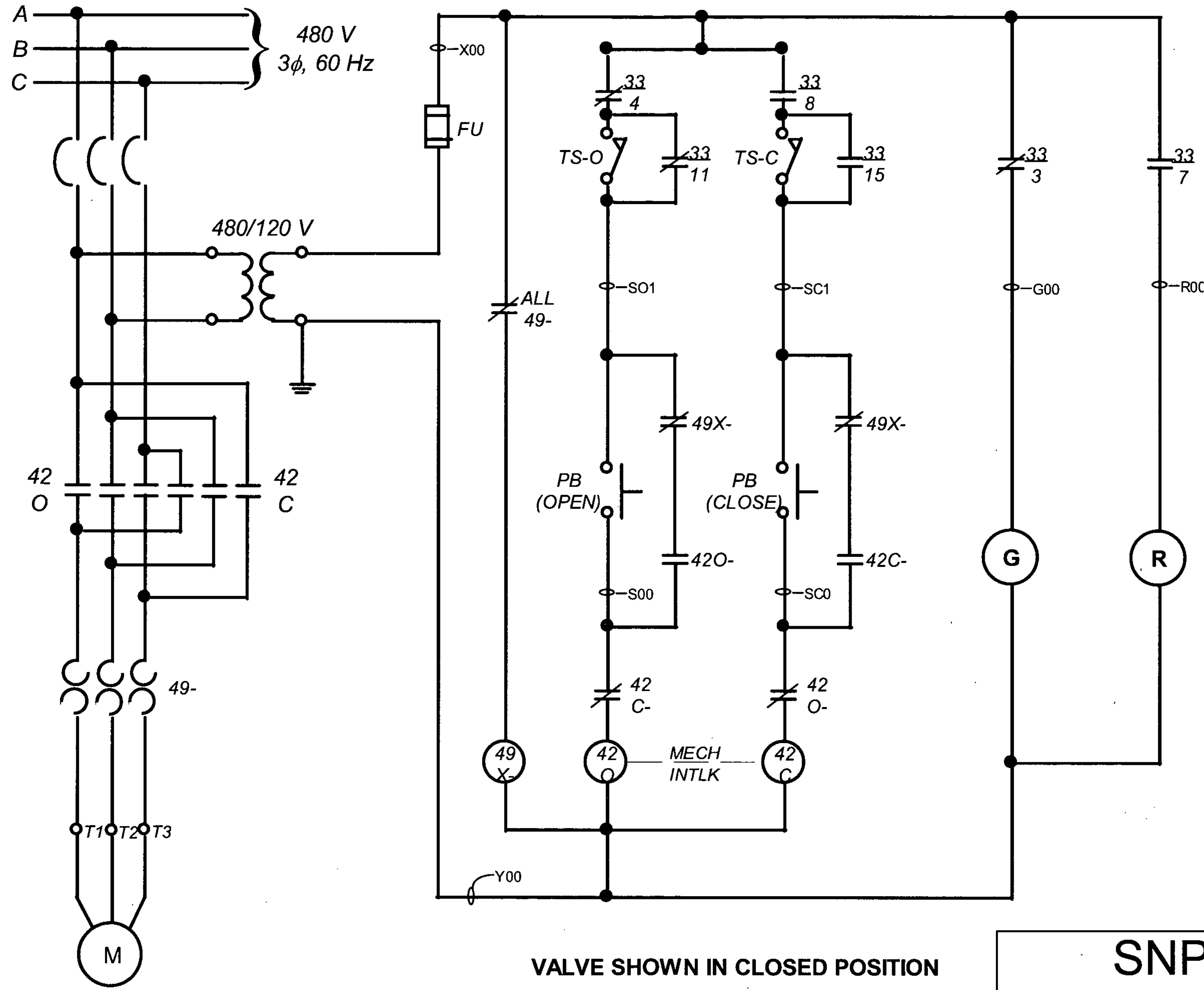
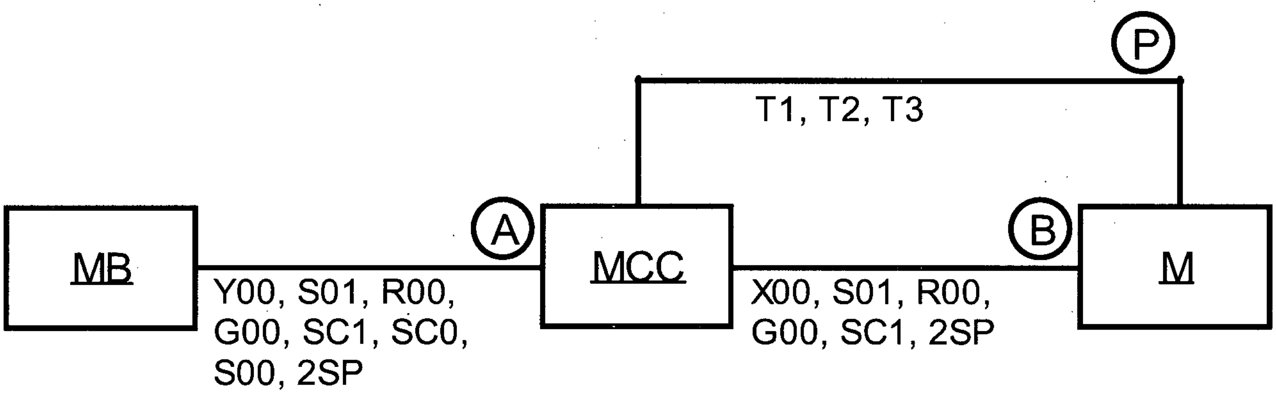


VALVE	DESCRIPTION	SCHEME	SWITCH ID
MOV-1	HIGH PRESS INJECTION-A	MA12	MOV-1
MOV-9	HIGH PRESS INJECTION-B	MB15	MOV-9

SNPP SCHEMATIC DIAGRAM – HIGH PRESSURE INJECTION MOTOR OPERATED VALVES MOV-1 & MOV-9	Drawing No.: E-04
	Date: 05/01/2007
	Revision No.: 0



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

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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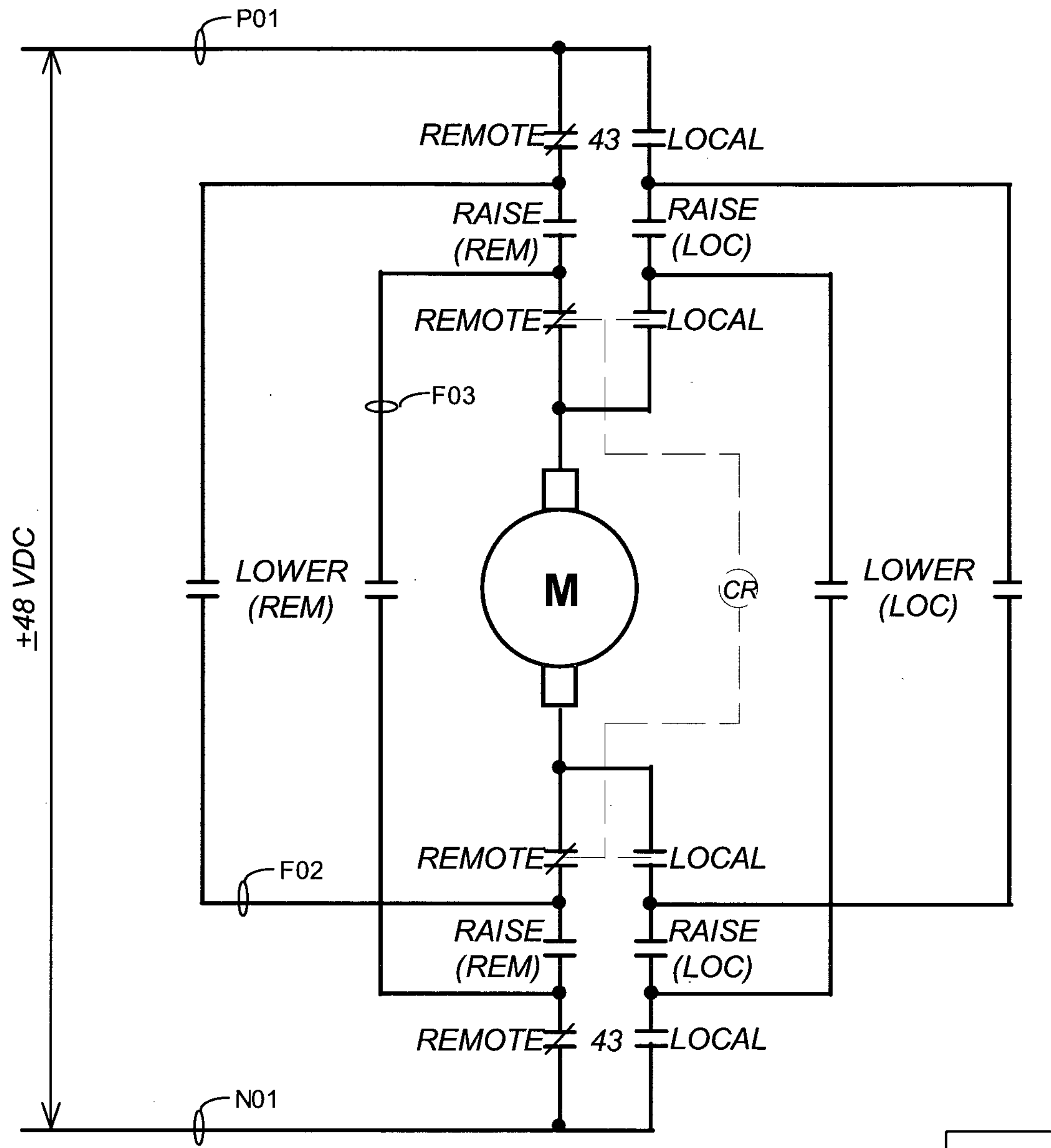
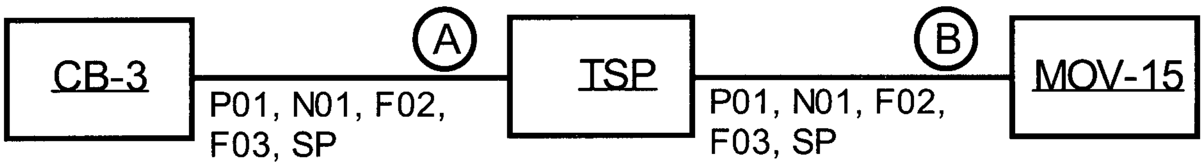


Motor Shown in Remote Operating Mode

MOV-15, SCHEME DB4 B-13

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



MOV-15, SCHEME DB4

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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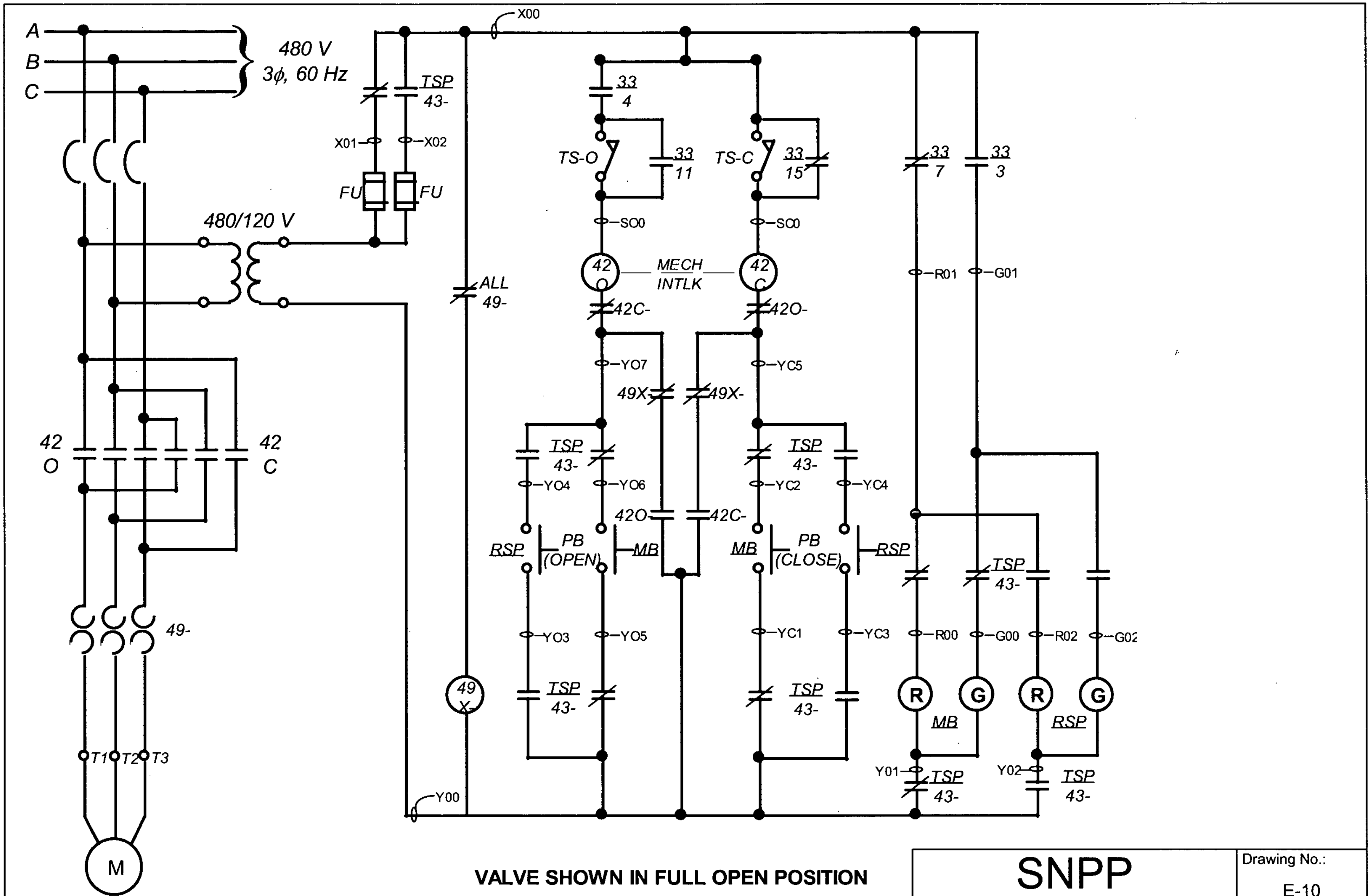
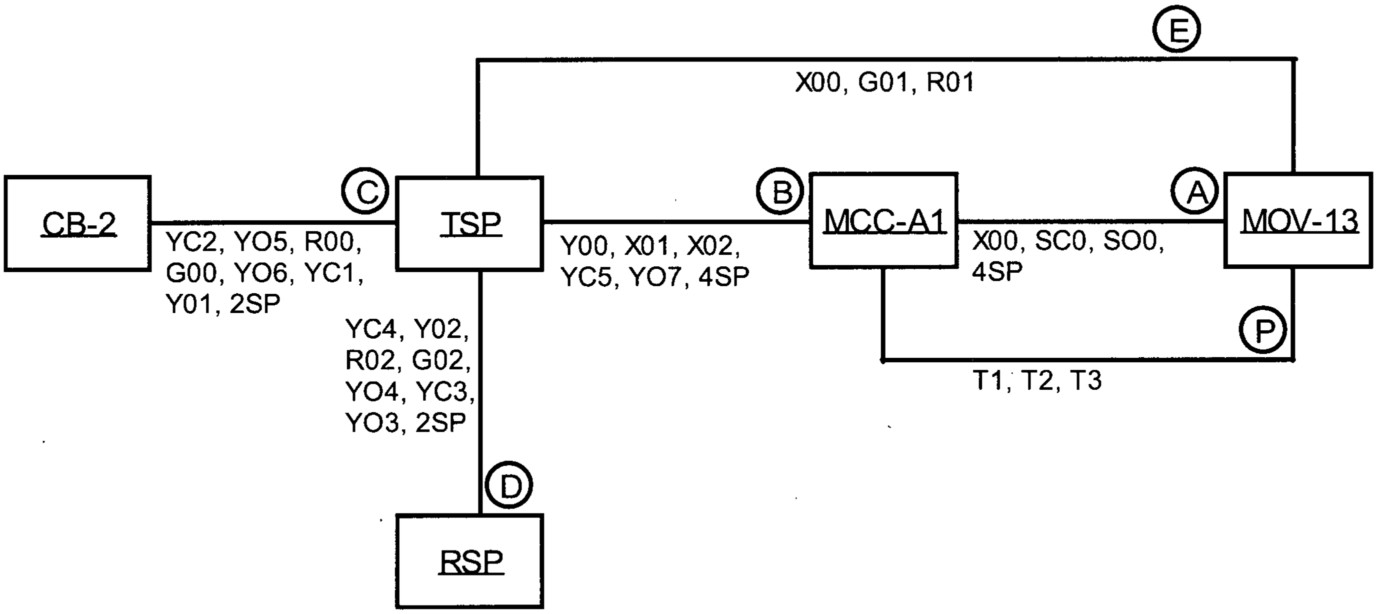


VALVE SHOWN IN FULL OPEN POSITION

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



MOV-13, SCHEME MA17

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 ☒

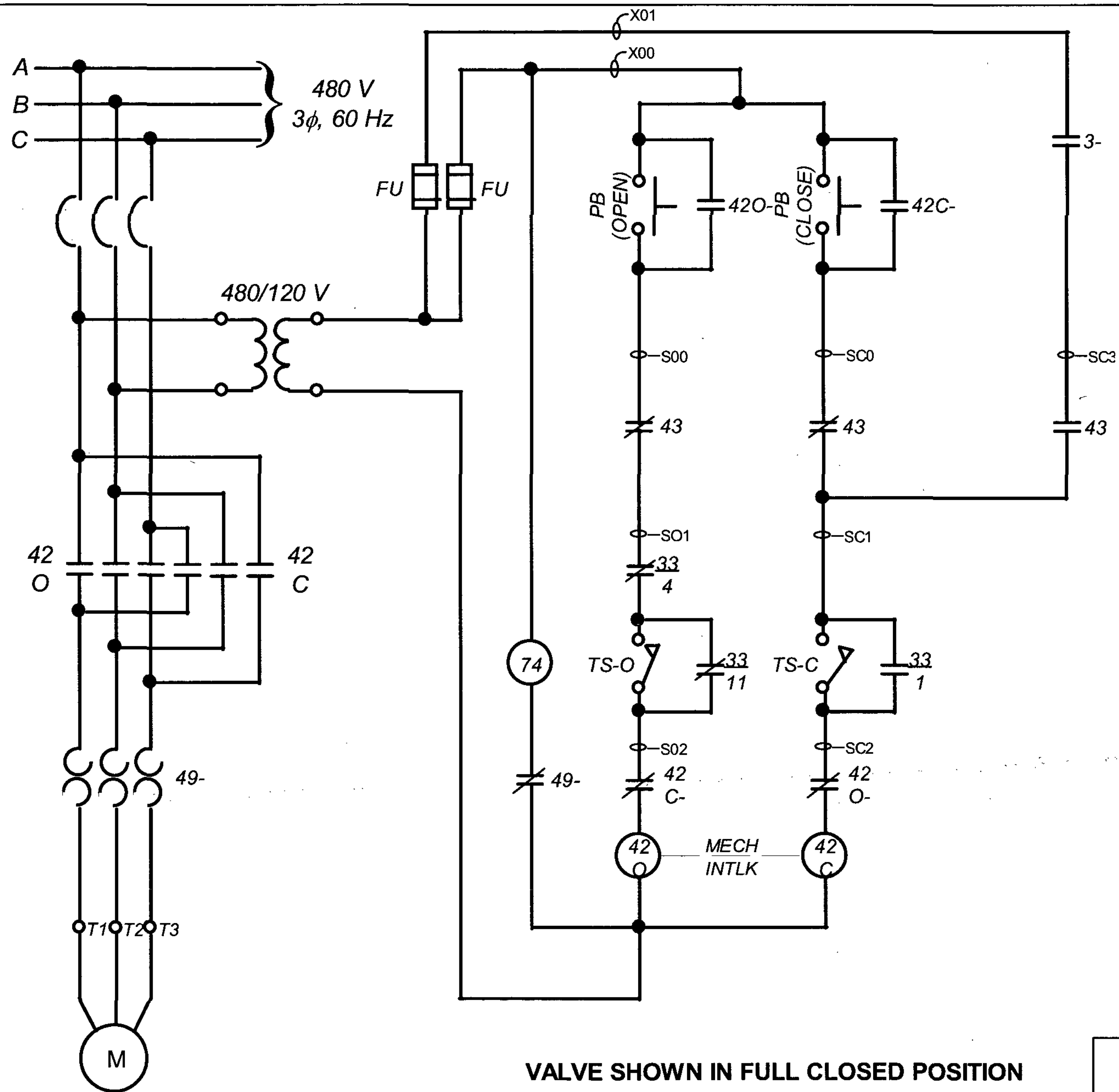
Power Supplies: ______________ Breaker: ______________

______________ Breaker: ______________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

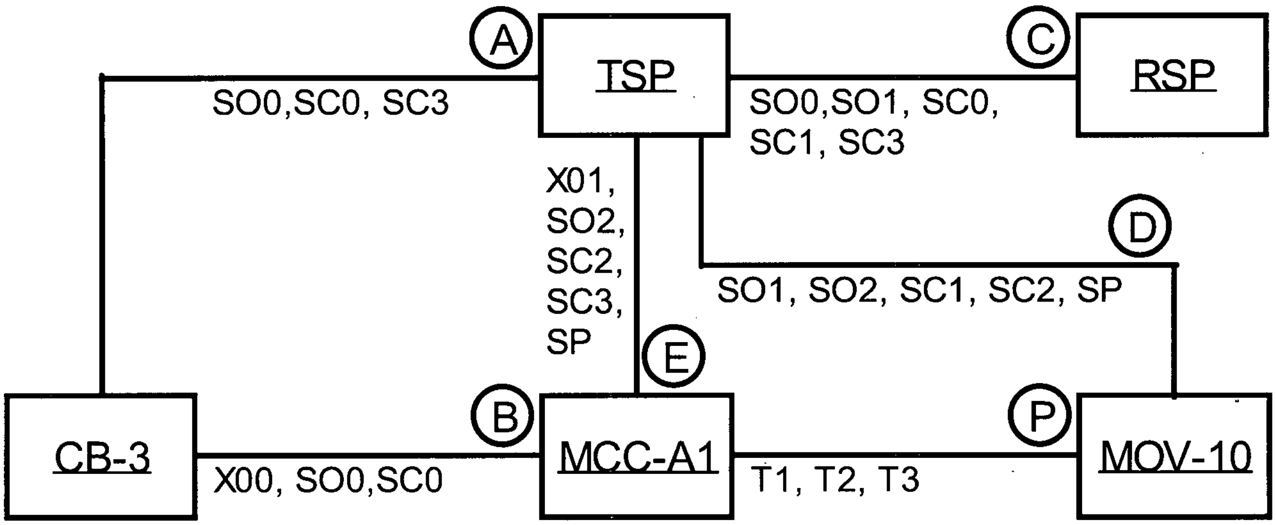
Comments:



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



MOV-10, SCHEME MA16

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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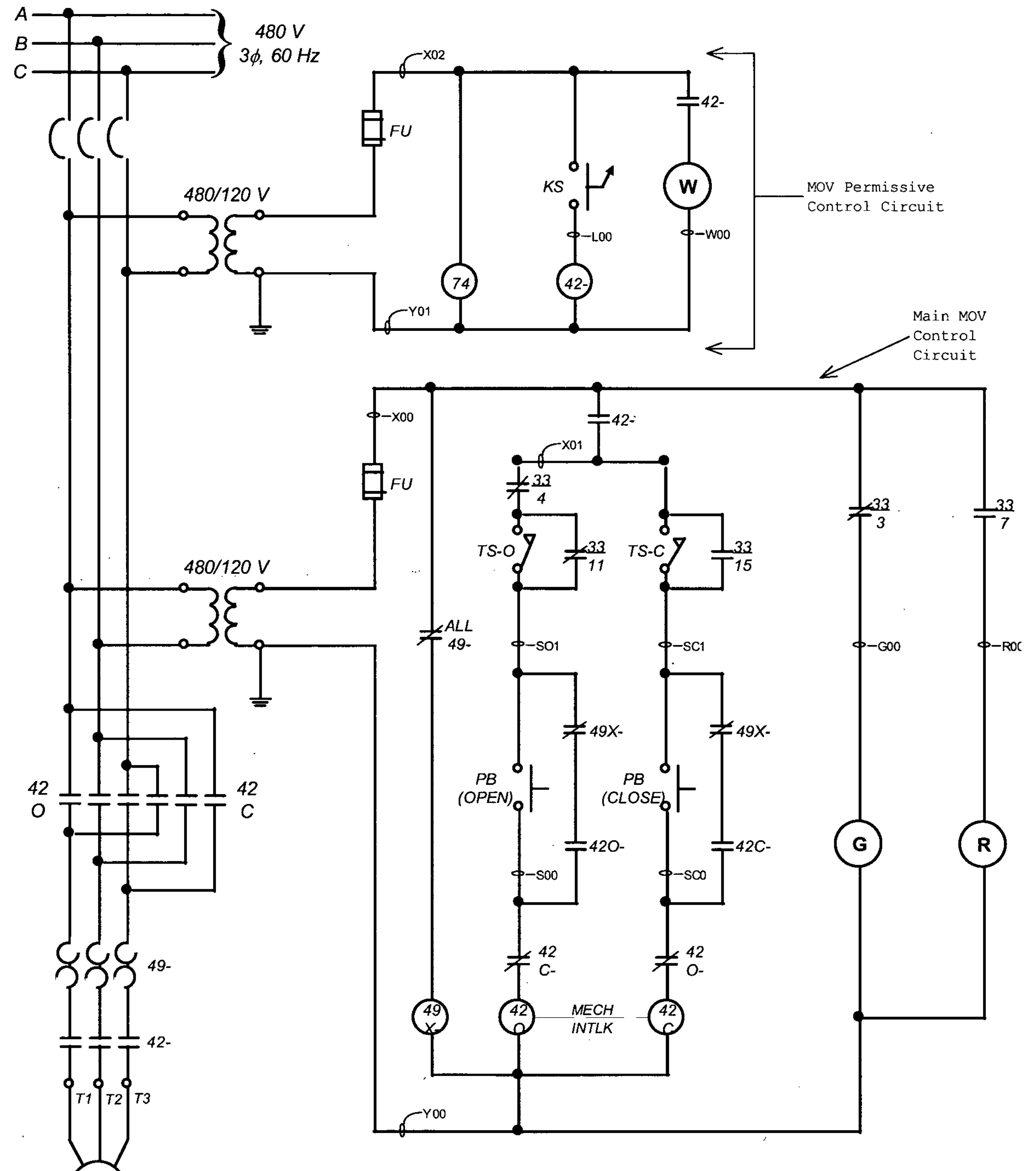
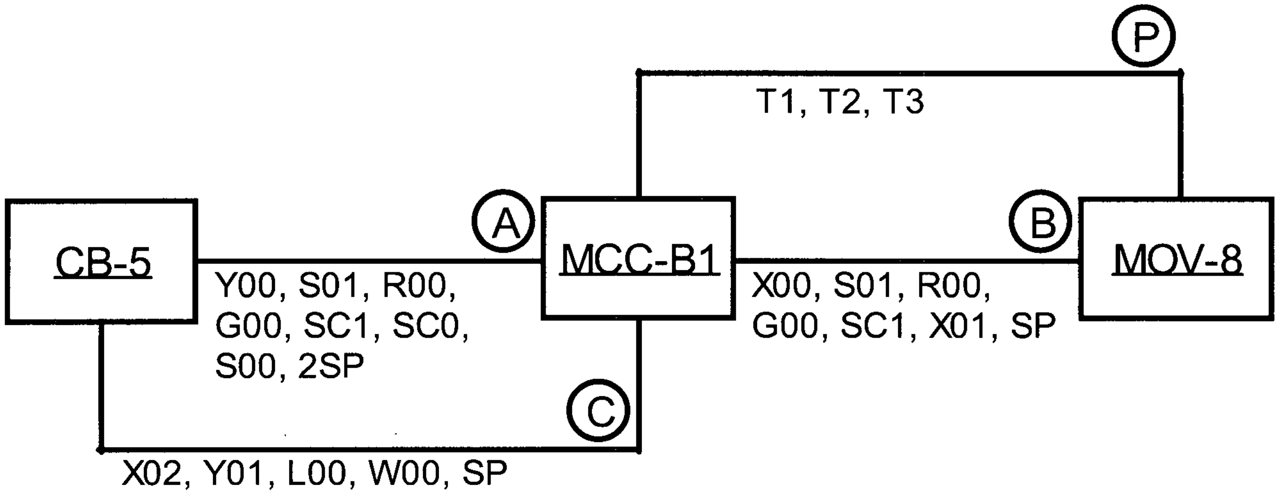


VALVE SHOWN IN CLOSED POSITION

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

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



MOV-8, SCHEME MB14

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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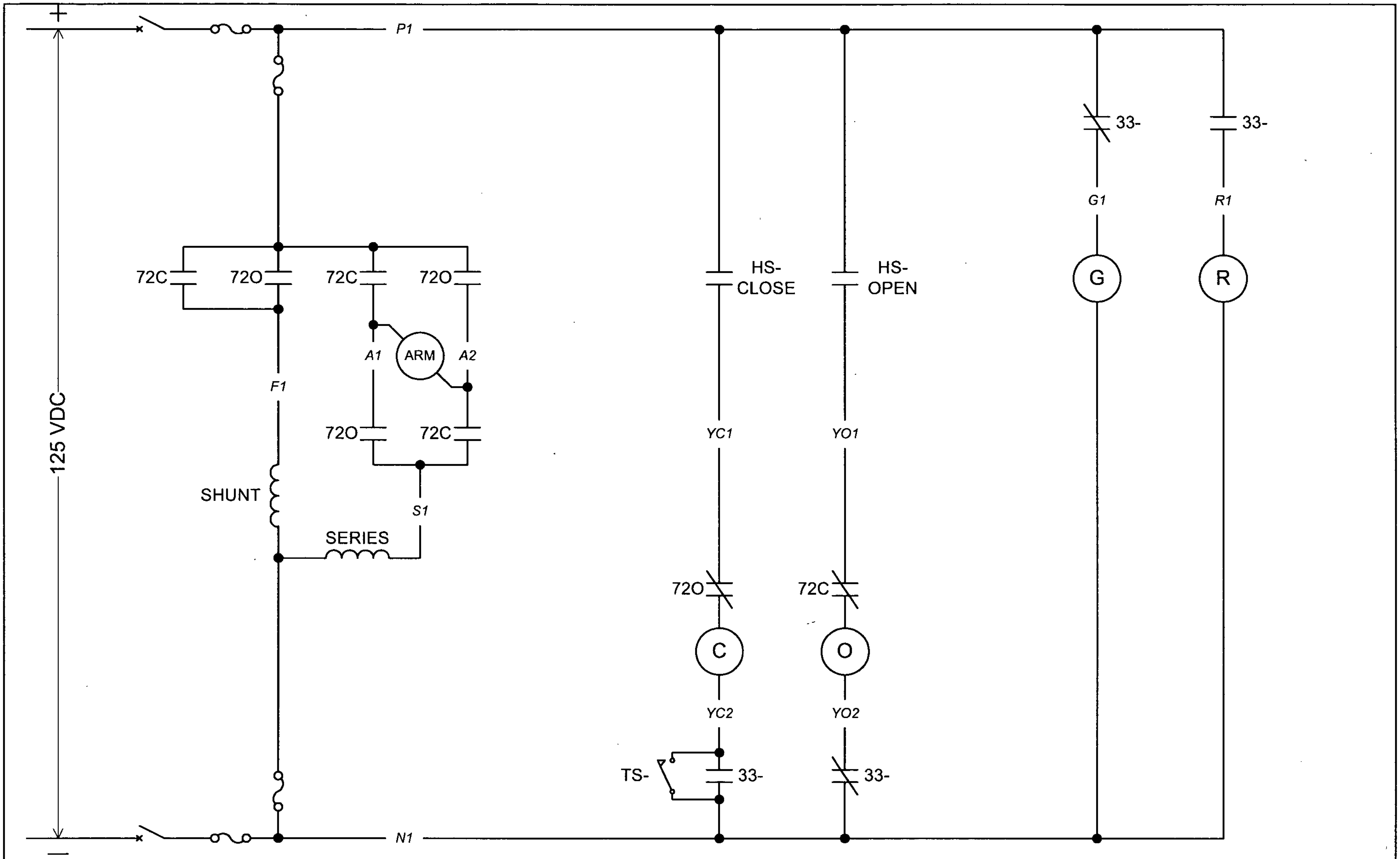
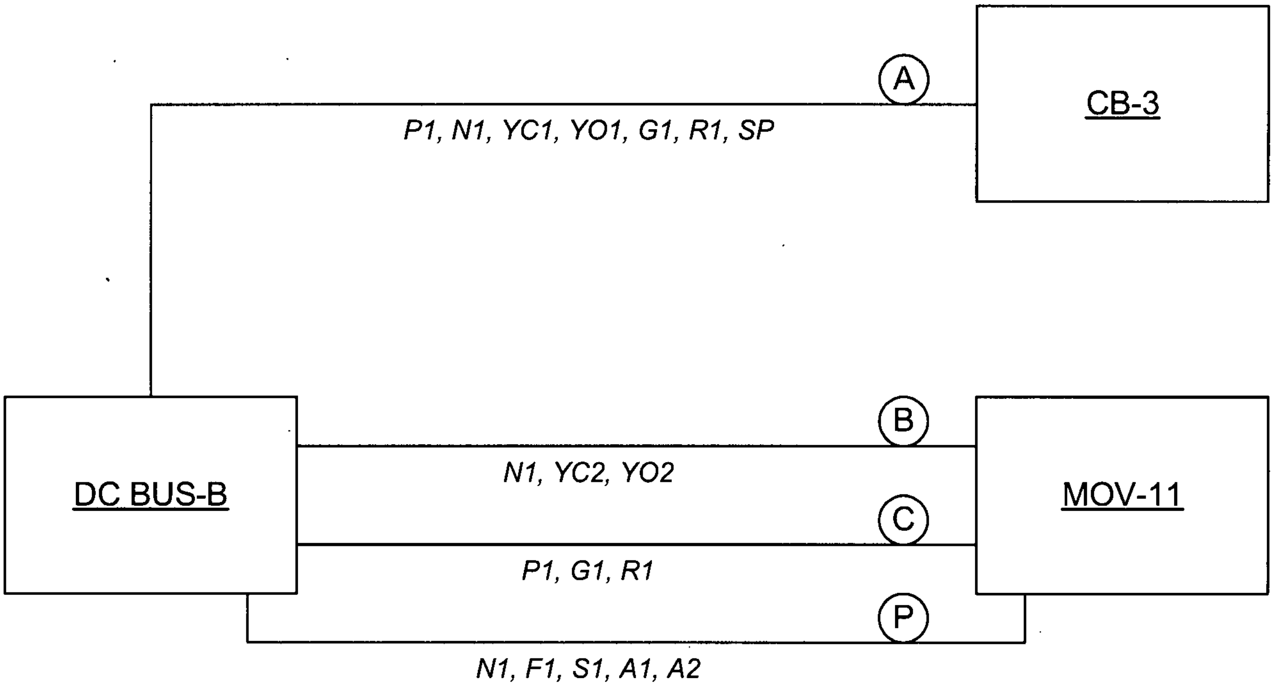


VALVE SHOWN IN CLOSED POSITION

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



MOV-11, SCHEME DB3

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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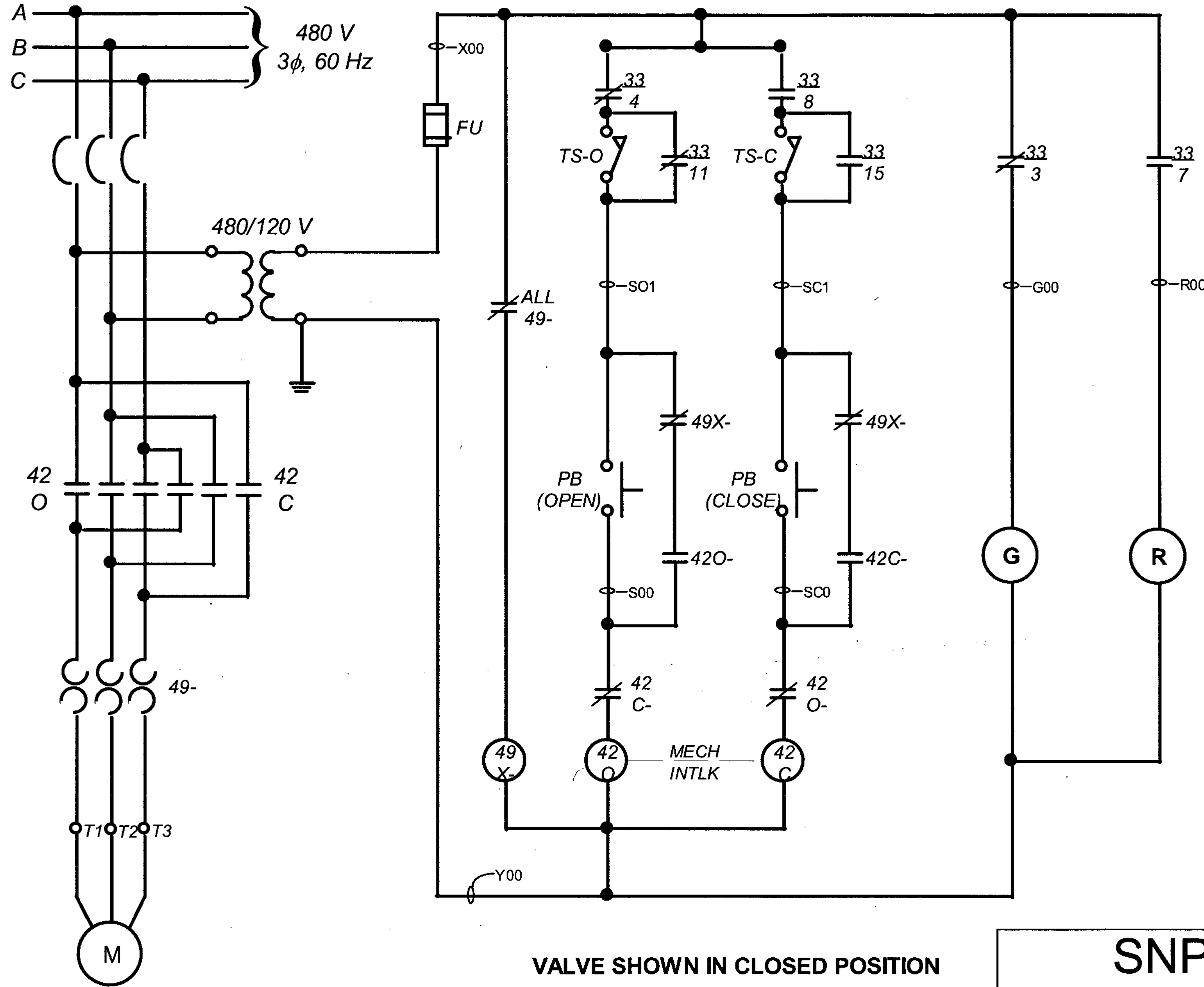
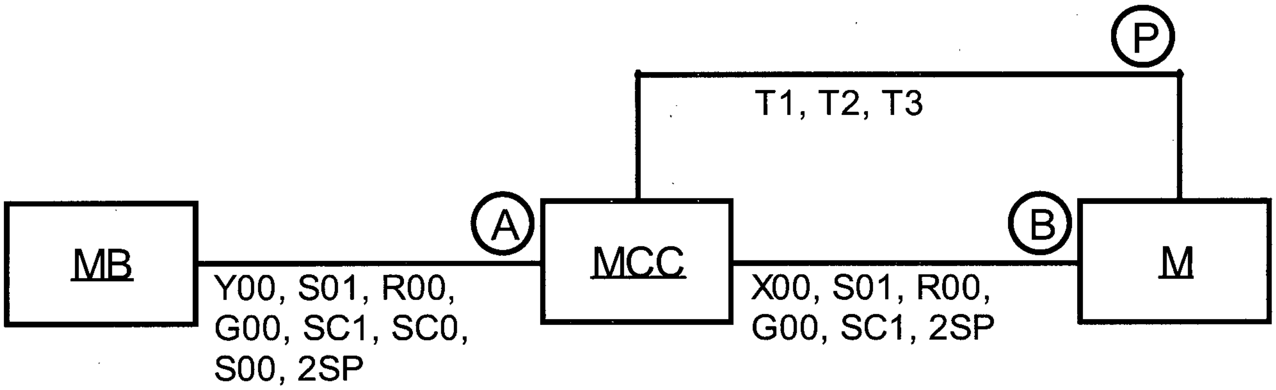


VALVE SHOWN IN CLOSED POSITION

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

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

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 ☒

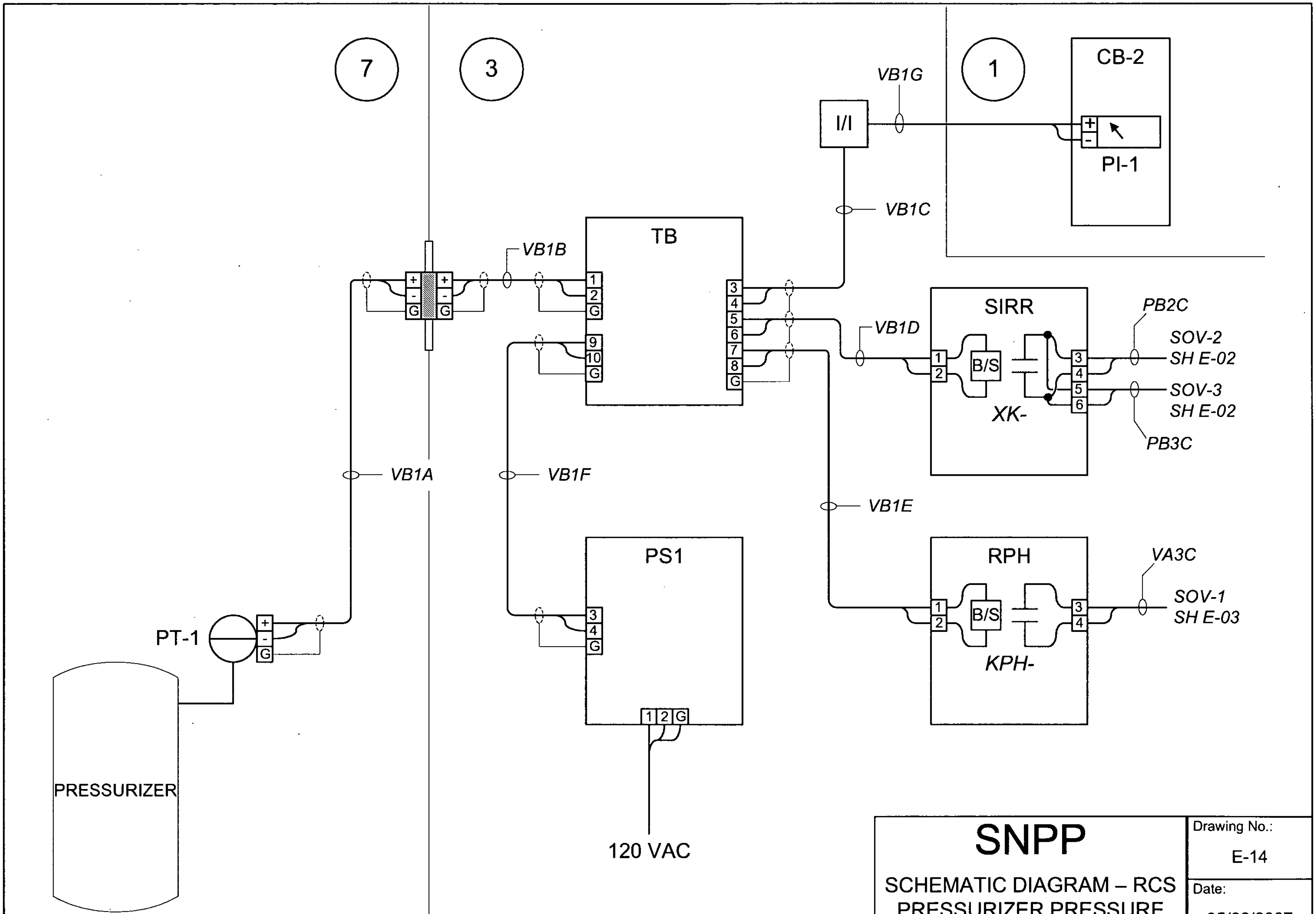
Power Supplies: ____________ Breaker: ____________

____________ Breaker: ____________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:



SNPP

SCHEMATIC DIAGRAM – RCS PRESSURIZER PRESSURE TRANSMITTER PT-1

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

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 ☒

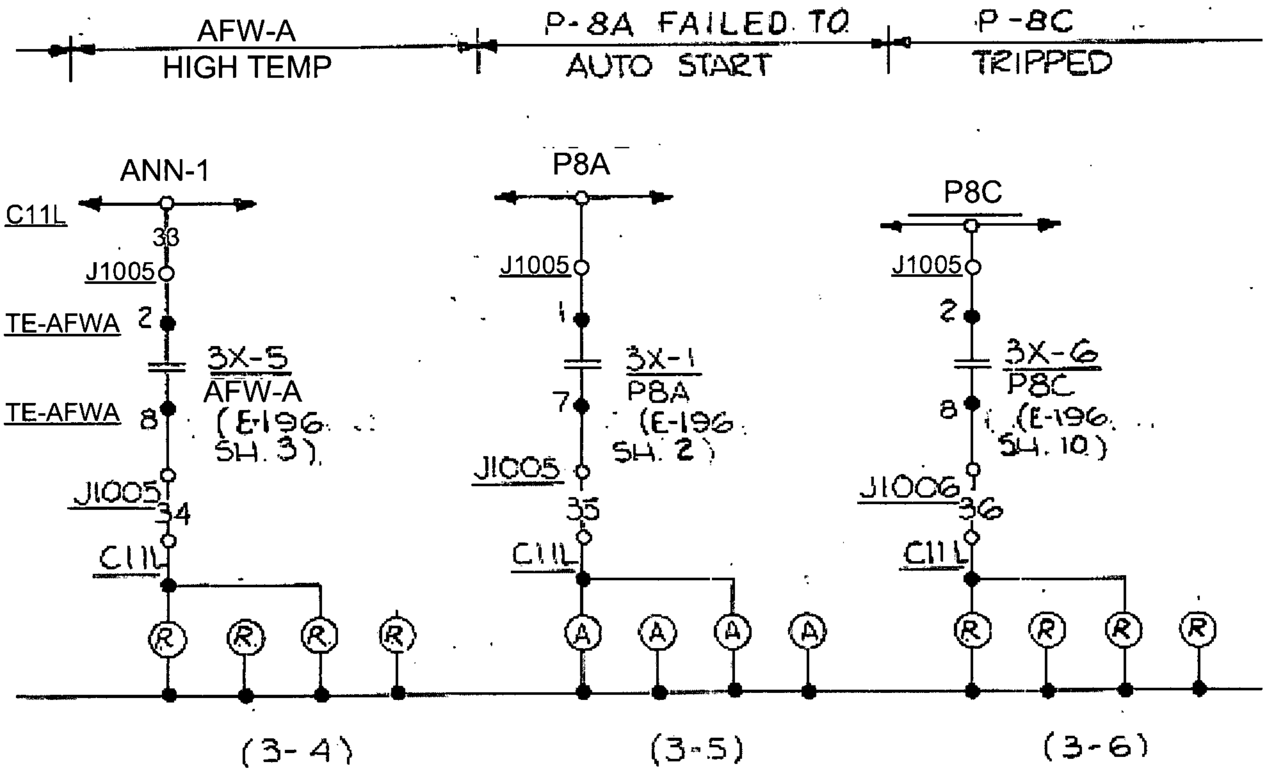
Power Supplies: ______________ Breaker: ______________

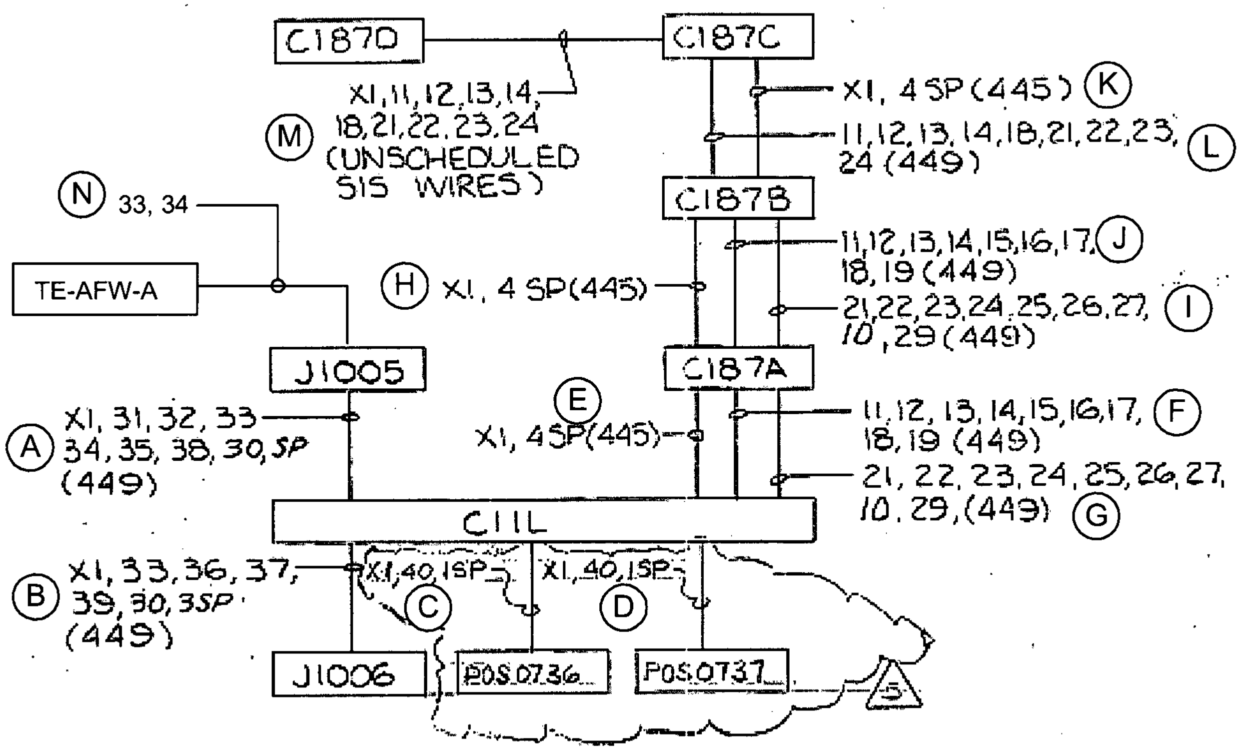
______________ Breaker: ______________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:





BLOCK DIAGRAM
SCHEME K16

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

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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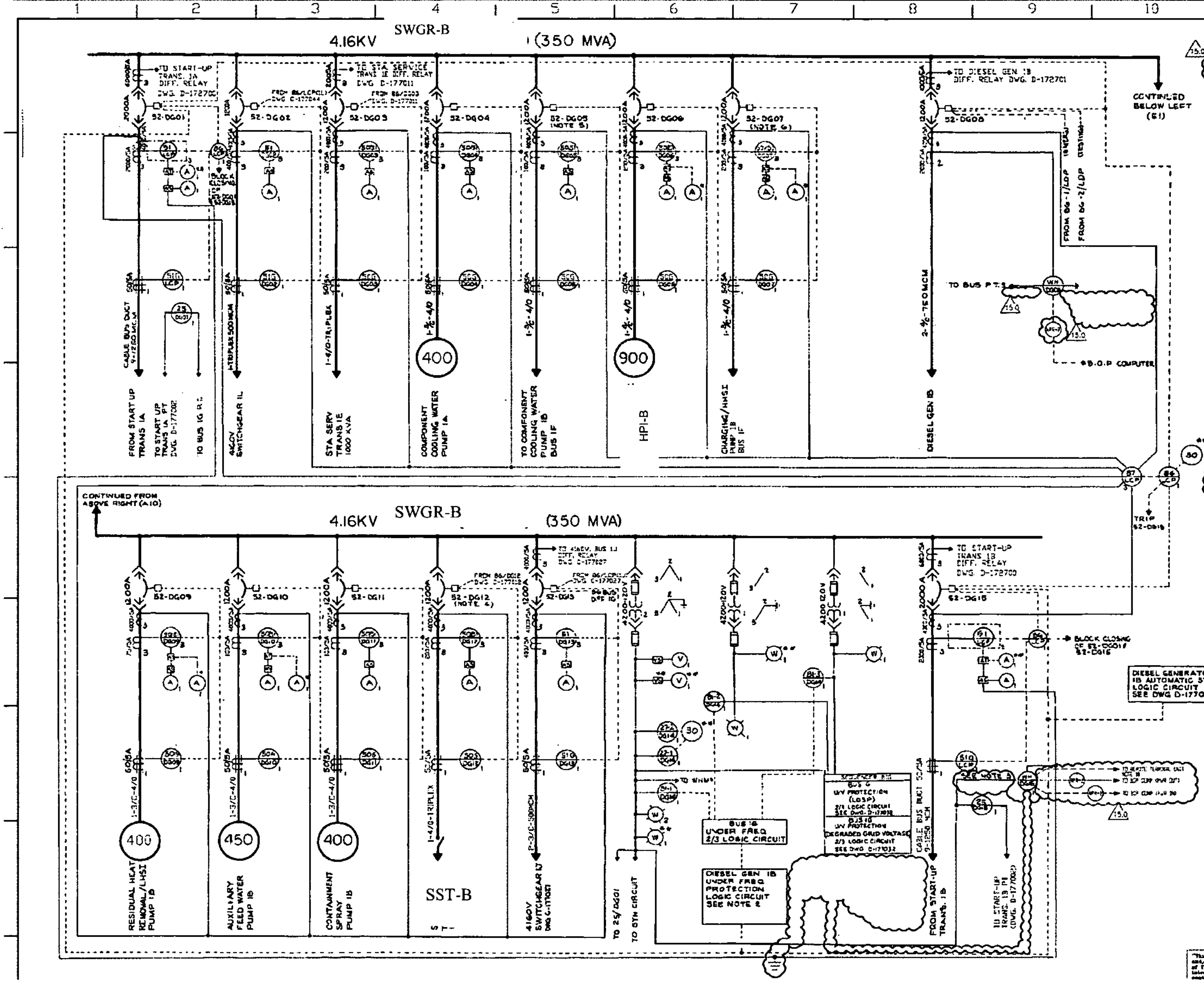


DEVICE	DESCRIPTION	MFR/TYPE	REMARKS
51 / LCP	START UP TRANS 1A OVER CURRENT RELAY	GE/IAC53B	
WH / DG08	DIESEL GEN 1B WATT HOUR METER	JEMSTAR JS05R6010 -85-DNP	
25 / SEE REMARKS	BUS 1G SYNCHRONISM CHECK RELAY	GE/IJS51A	APPLICABLE TO CELLS DG01 & DG15
51 / DG02	4160V SWITCHGEAR 1L OVER CURRENT RELAY	GE/IAC53B	
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 DG08 & DG16
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/IAC53	
86 / LCP	BUS DIFFERENTIAL LOCKOUT RELAY	GE/HEA	
87 / LCP	BUS 1G DIFF. PROTECTIVE RELAY	GE/PVD11C	
RPR-2	REPEATING PULSE RELAY	SOLID STATE INSTRUMENTS	LOC. IN MN. CONT. RM. METER & RELAY PNL.
27-1,2 / DG14	BUS 1G UNDER VOLTAGE RELAY	GE/IAV	
WH / DG15	START-UP TRANS 1B WATT HOUR METER	JEMSTAR JS05R6010 -85-DNP	
81-(1,2/3) / DG16	BUS 1G UNDER FREQUENCY RELAY	GE/SFF201B	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-177031 SINGLE LINE ELEC AUX. SYSTEM (EMERG 4160V & 600V)

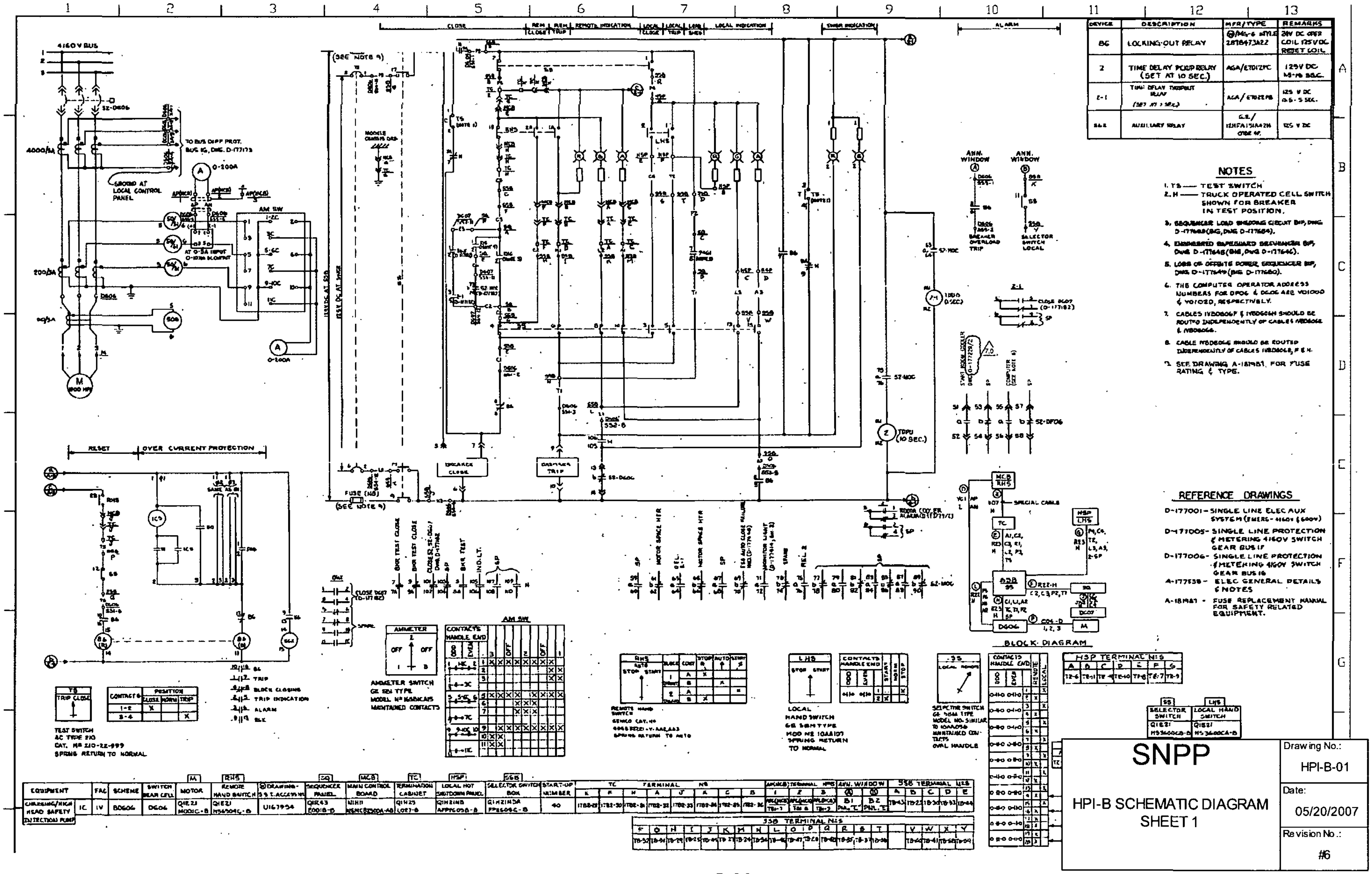
SNPP

4.16 KV SWGR-B ONE-LINE DIAGRAM

Drawing No.: SWGR-B-01

Date: 05/20/2007

Revision No.: #6



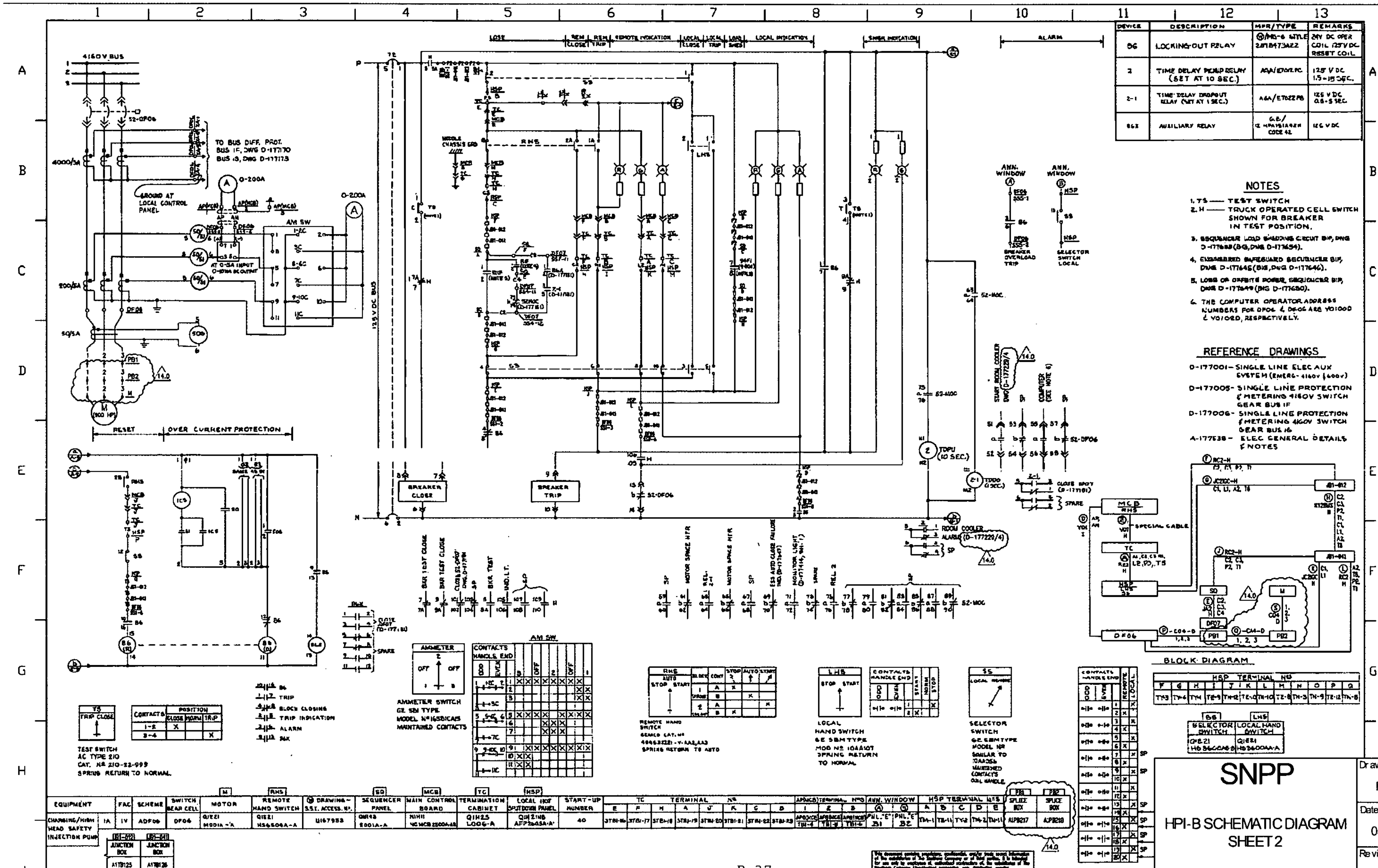
SNPP

HPI-B SCHEMATIC DIAGRAM
SHEET 1

Drawing No.: HPI-B-01

Date: 05/20/2007

Revision No.: #6



SNPP

HPI-B SCHEMATIC DIAGRAM
SHEET 2

Drawing No.: HPI-B-02

Date: 05/20/2007

Revision No.: #6

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 ☒

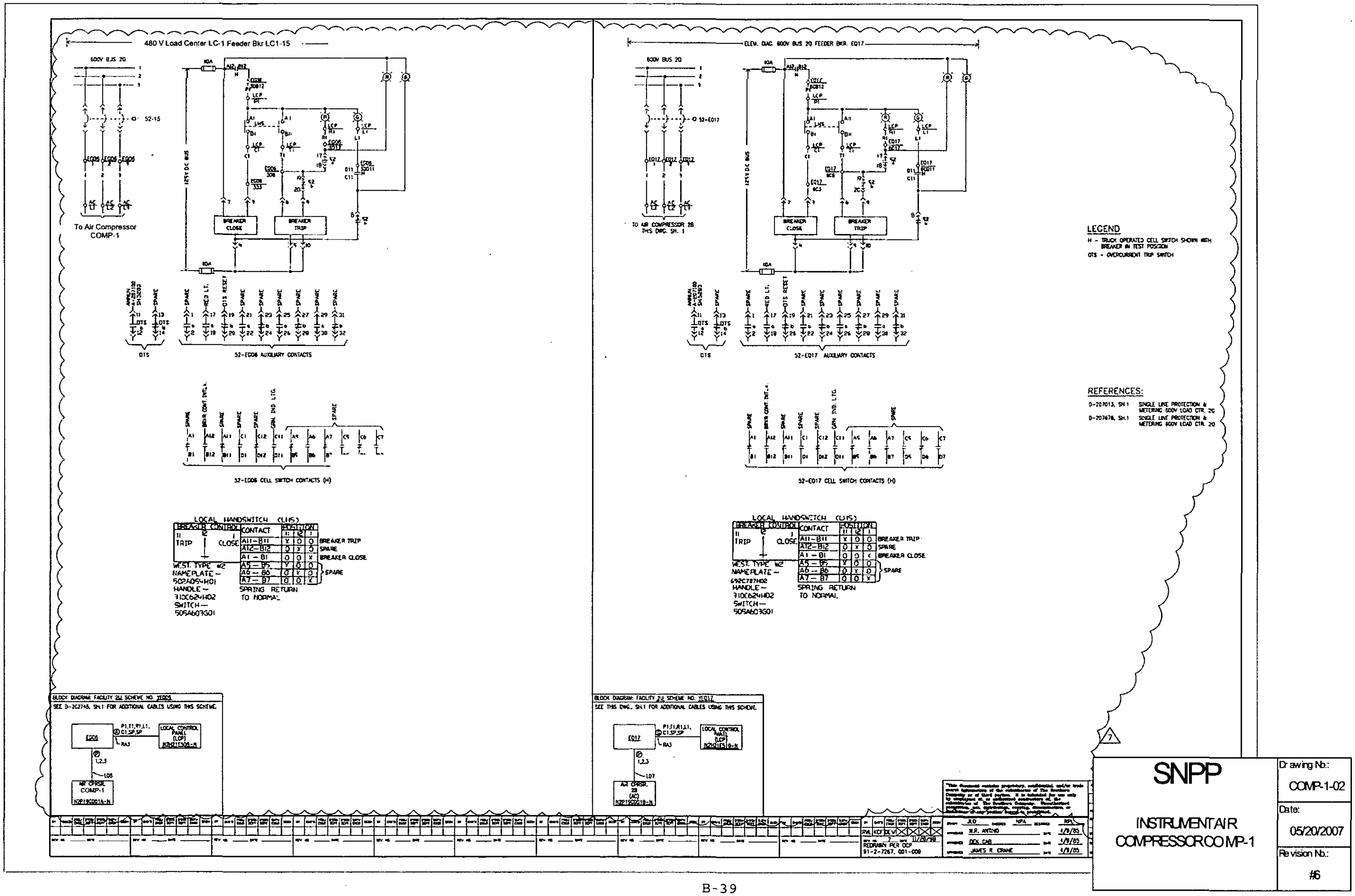
Power Supplies: ______________________ Breaker: ______________________

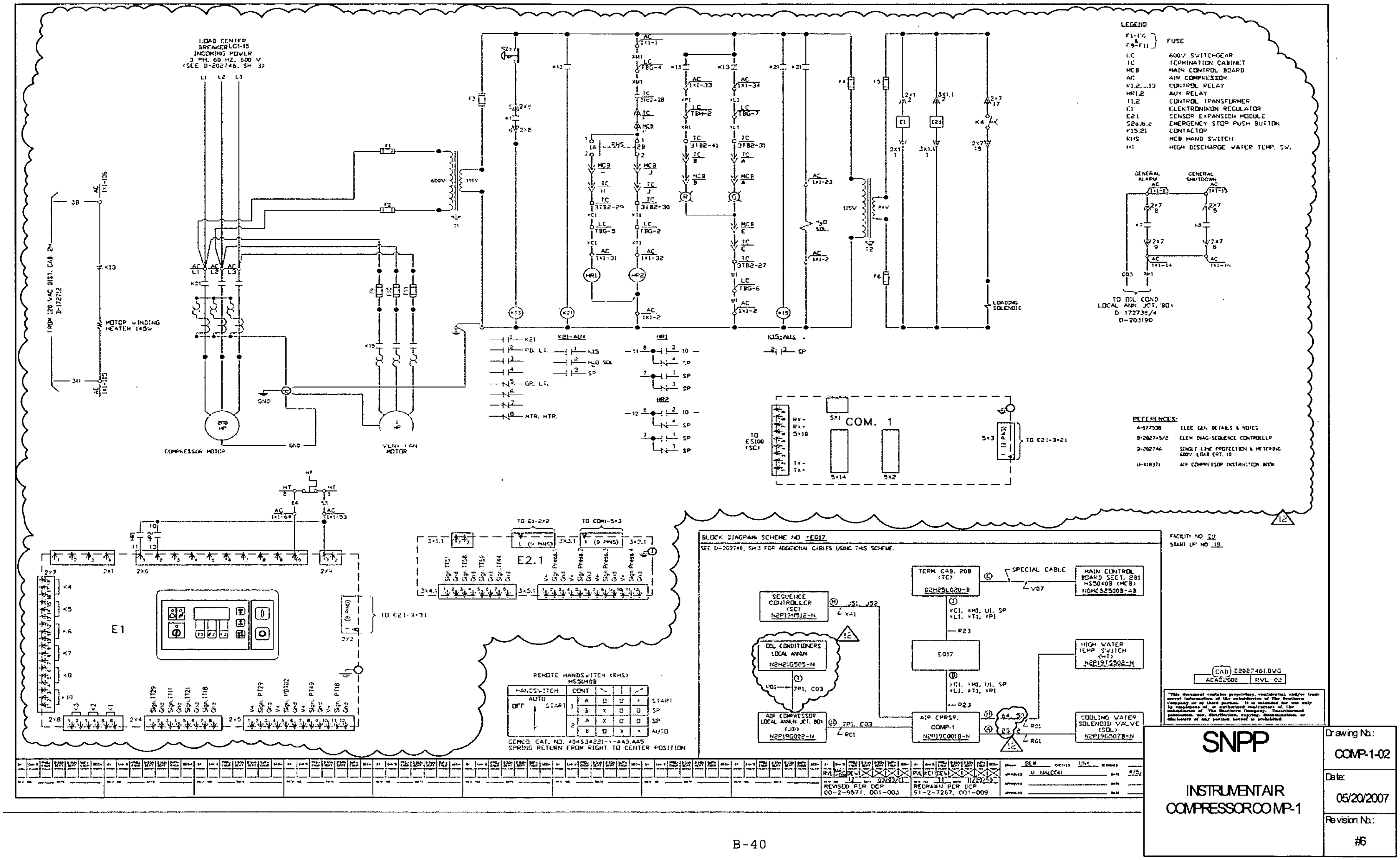
______________________ Breaker: ______________________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:


480 V Load Center LC-1 Feeder Bkr LC1-15
To Air Compressor COMP-1
LEGEND
REFERENCES:
LOCAL HANDSWITCH (LHS)
BREAKER TRIP
SPARE
BREAKER CLOSE
SPRING RETURN TO NORMAL
SNPP
INSTRUMENT AIR COMPRESSOR COMP-1
Drawing No.:
COMP-1-02
Date:
05/20/2007
Revision No.:
#6


LOAD CENTER BREAKER LC1-15 INCOMING POWER 3 PH, 60 HZ, 600 V (SEE D-202746, SH 3)
COMPRESSOR MOTOR
VENT FAN MOTOR
MOTOR WINDING HEATER 145W
FROM 120 VAC DIST. CAB. 2H D-172712
LEGEND
F1-F6 & F9-F11 FUSE
LC 600V SWITCHGEAR
TC TERMINATION CABINET
MCB MAIN CONTROL BOARD
AC AIR COMPRESSOR
K1,2,...13 CONTROL RELAY
HR1,2 AUX RELAY
T1,2 CONTROL TRANSFORMER
E1 ELEKTRONIKON REGULATOR
E21 SENSOR EXPANSION MODULE
S2a,b,c EMERGENCY STOP PUSH BUTTON
K15,21 CONTACTOR
RHS MCB HAND SWITCH
HT HIGH DISCHARGE WATER TEMP. SW.
GENERAL ALARM
GENERAL SHUTDOWN
TO OIL COND. LOCAL ANN. JCT. BOX D-172738/4 D-203190
LOADING SOLENOID
COM. 1
TO ES100 (SC)
TO E21-3X21
REFERENCES:
E1
E2.1
TO E21-3X31
REMOTE HANDSWITCH (RHS) MS50408
GEMCO CAT. NO. 4045342 21-Y-AA3,AA5 SPRING RETURN FROM RIGHT TO CENTER POSITION
BLOCK DIAGRAM: SCHEME NO. YC017
SEE D-202746, SH 3 FOR ADDITIONAL CABLES USING THIS SCHEME.
SEQUENCE CONTROLLER (SC) N2P19N512-N
TERM. CAB. 208 (TC) 02H25L020-B
SPECIAL CABLE
MAIN CONTROL BOARD SECT. 281 MS50408 (MCB) N0MCB2500B-AB
OIL CONDITIONERS LOCAL ANNUN. N2H21G505-N
E017
HIGH WATER TEMP SWITCH (HT) N2P19T2502-N
AIR COMPRESSOR LOCAL ANNUN JCT. BOX (JB) N2P19G002-N
AIR CPRSR. COMP-1 N2P19C001B-N
COOLING WATER SOLENOID VALVE (SOL) N2P19G007B-N
REVISED PER DCP 00-2-9571, 001-003
REDRAWN PER DCP 91-2-7267, 001-009
CAD D2027461.DWG
SNPP
INSTRUMENT AIR COMPRESSOR COMP-1
Drawing No.: COMP-1-02
Date: 05/20/2007
Revision No.: #6

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:

Note: This page was erroneously included in the available set of exercises in the proper location for Exercise 14, but is instead a duplicate of Exercise 4. A later section of this Volume 2 has a solution for Exercise 4, but not for Exercise 14.

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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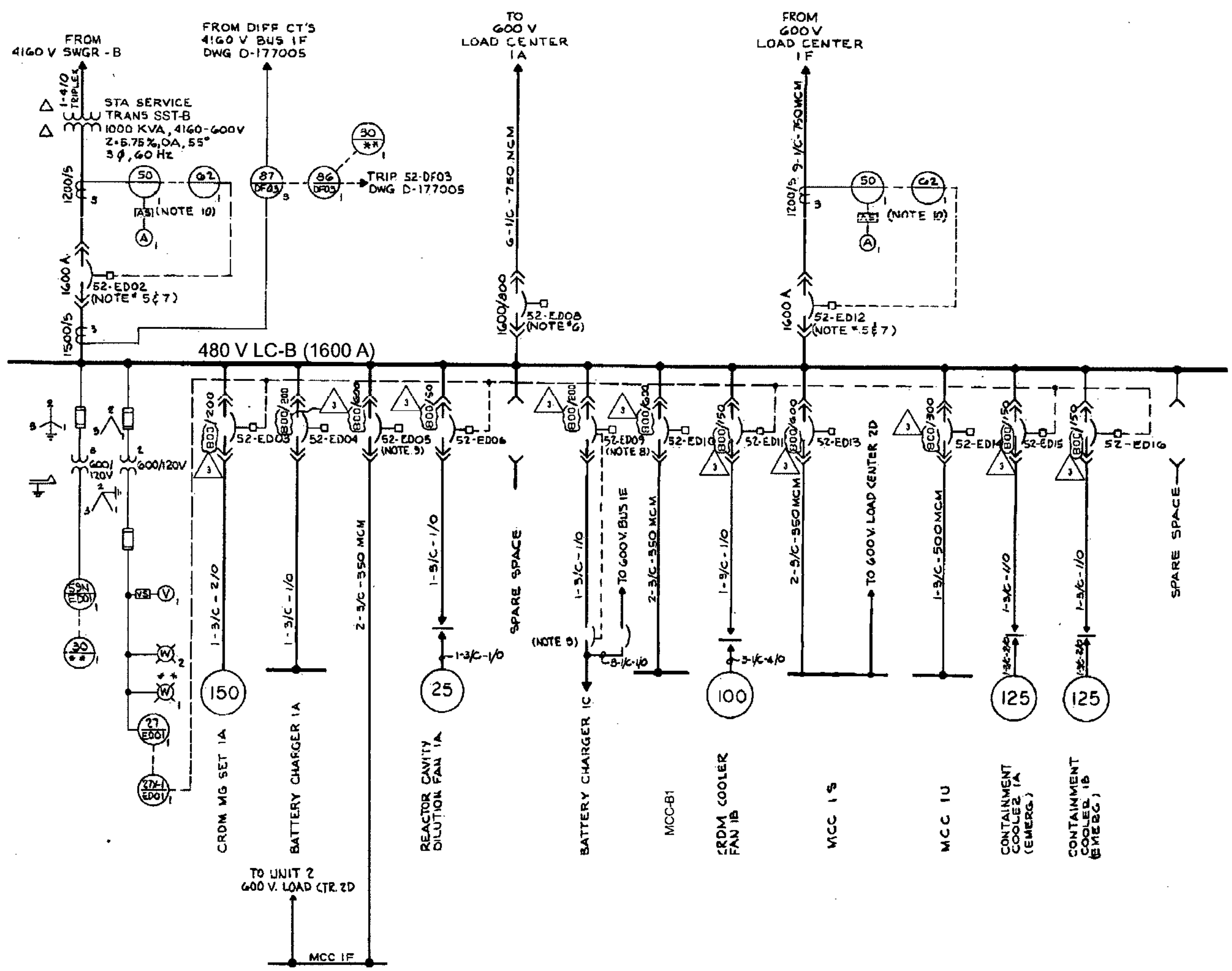


DEVICE	DESCRIPTION	MFR/TYPE	REMARKS
50 / NOTE 10	STA. SERVICE TRANSF. 1D OVER CURRENT RELAY, 3ø	GE/PJC82G	
62 / NOTE 10	TIME DELAY RELAY	AGASTAT/ E7012PA	
50 / NOTE 10	OVER CURRENT RELAY, 3ø, FOR INC FOR FROM LOAD CTR 1F	GE/PJC82G	
62 / NOTE 10	TIME DELAY RELAY	AGASTAT/ E7012PA	
87 / DF03	STA. SERVICE 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	

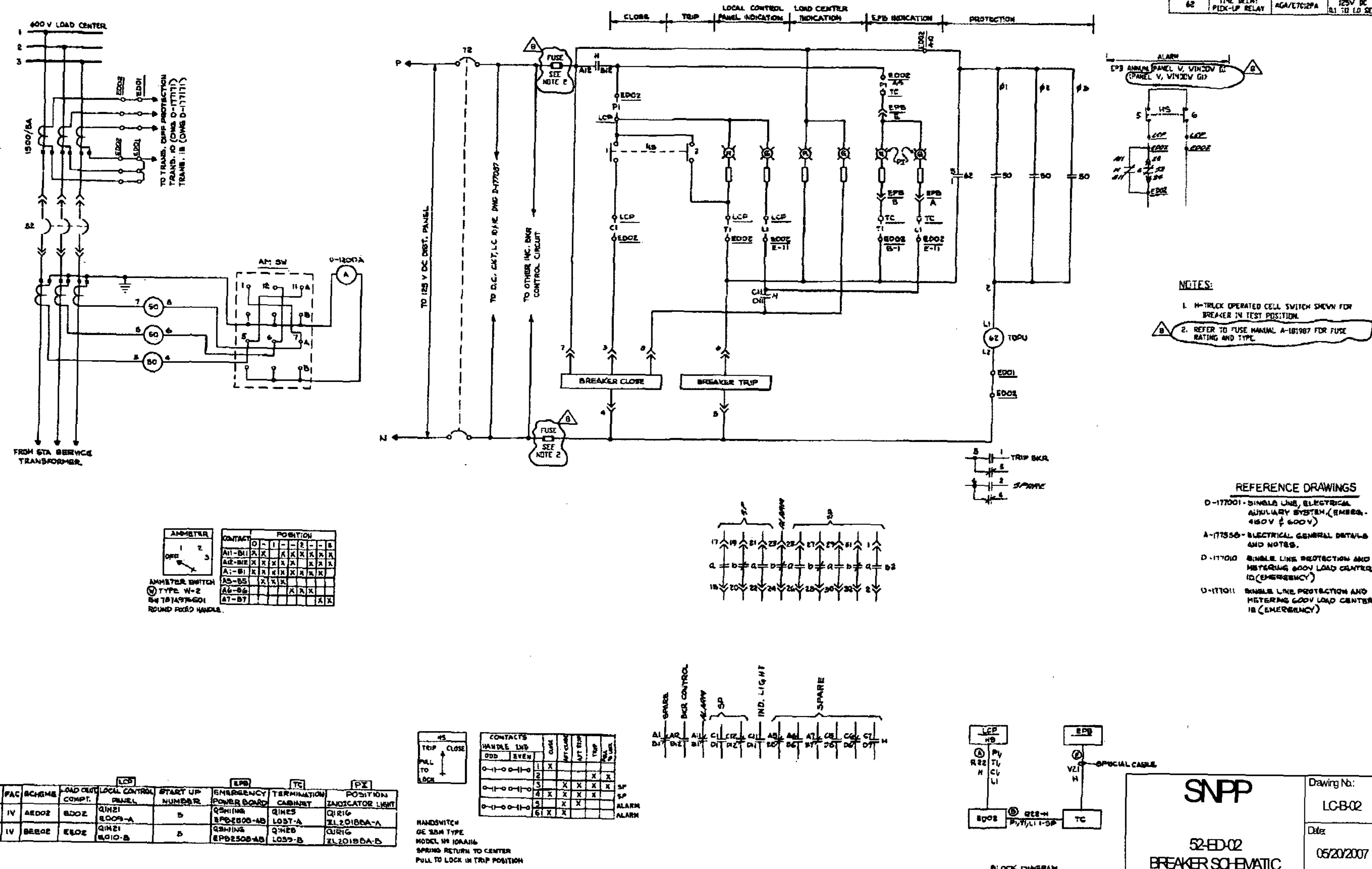
NOTES

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-EA03 (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-177153).
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



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-177556 - ELECTRICAL GENERAL DETAILS AND NOTES.

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

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

AMMETER

AMMETER SWITCH
(W) TYPE W-2
SN 7914976601
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

HS: TRIP / CLOSE / PULL TO LOCK

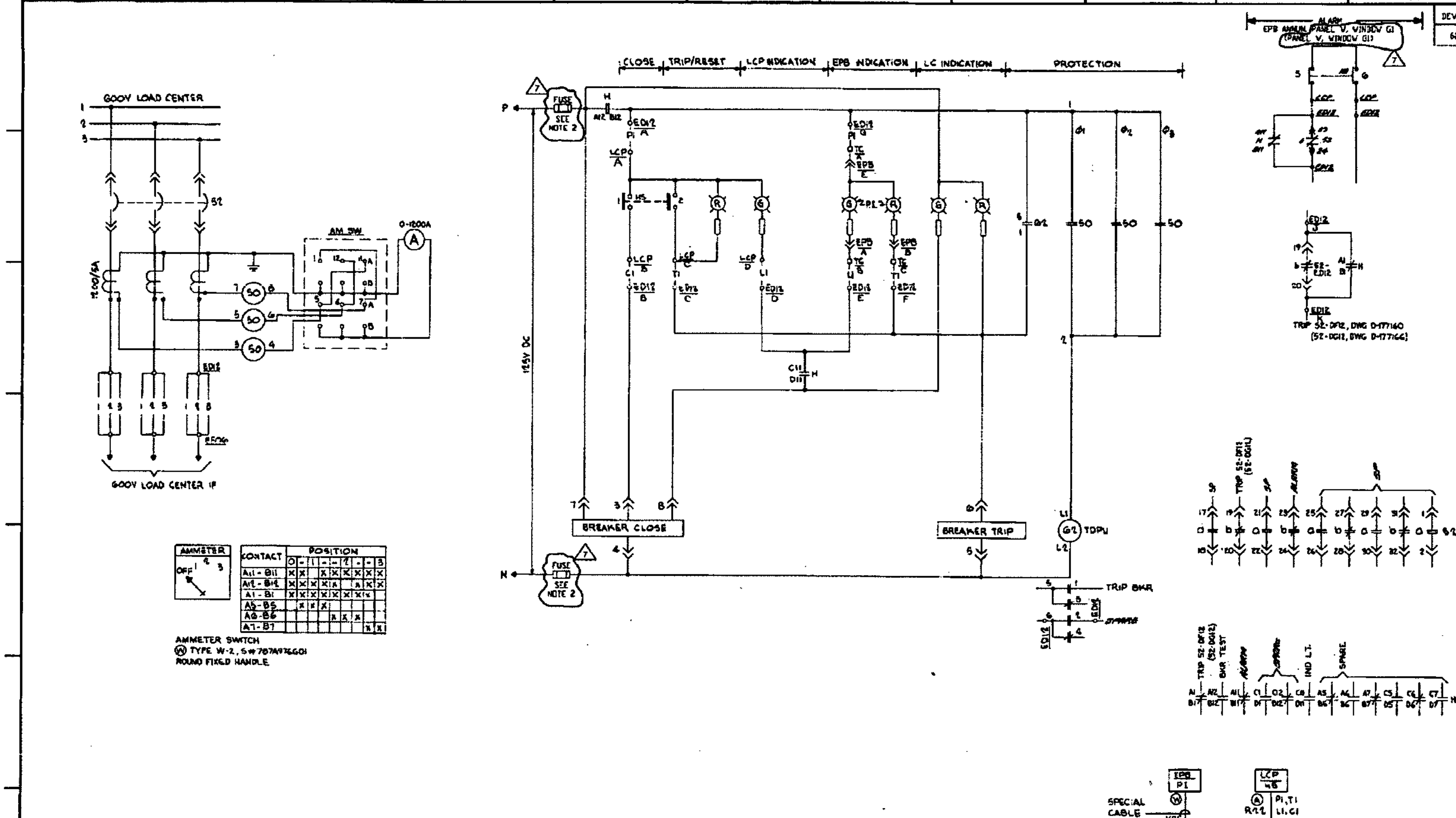
CONTACTS HANDLE END ODD	EVEN		CLOSE	AFT CLOSE	AFT TRIP	TRIP	PULL TO LOCK	
o-||-o	o-||-o	1	X					
		2				X	X	
o-||-o	o-||-o	3		X	X	X	X	SP
		4	X	X	X	X		SP
o-||-o	o-||-o	5		X	X			ALARM
		6	X	X				ALARM

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

EQUIPMENT		FAC	SCHEME	LOAD CENTER COMPT.	LOCAL CONTROL PANEL (LCP)	START UP NUMBER	EMERGENCY POWER BOARD (EPB)	TERMINATION CABINET (TC)	POSITION INDICATOR LIGHT (PX)
INCOMING BREAKER TO 600V LOAD CENTER	ID	IV	AED02	ED02	Q1H21 ED09-A	8	Q5HING EPB2508-AB	Q1HES L057-A	Q1RIG ZL2018BA-A
	IB	IV	BEE02	EE02	Q1H21 ED10-B	8	Q5HING EPB2508-AB	Q1HEB L059-B	Q1RIG ZL2018BA-B

SNPP	Drawing No: LC-B-02
52-ED-02 BREAKER SCHEMATIC	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

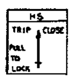
A-177538 – ELECTRICAL GENERAL DETAILS AND NOTES
D-177001 – SINGLE LINE ELECTRICAL AUX SYSTEM (EMERG – 4160V & 600V)
D-177010 – SINGLE LINE PROTECTION AND METERING 600V L.C. 1D (EMERG)
D-177011 – SINGLE LINE PROTECTION AND METERING 600V L.C.1E (EMERG)
C-177012 – SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER 1F

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	Q5H11NG EPB260B-AB	Q1H25 L037-A	Q1R16 ZL2018MA-A	5	EF06
	1E	IV	BEE12	EE12	Q1H21 E010-B	Q5H11NG EPB260B-AB	Q1H25 L039-B	Q1R16 ZL2019MA-B	5	EF08

LOAD CENTER COMPARTMENT	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

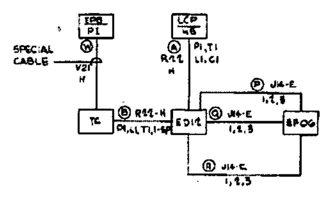
LOCAL CONTROL PNL	A	B	C	D
ED12	TB7-5	TB7-11	TB7-16	TB7-12
EE12	TB10-5	TB10-6	TB10-7	TB10-8

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



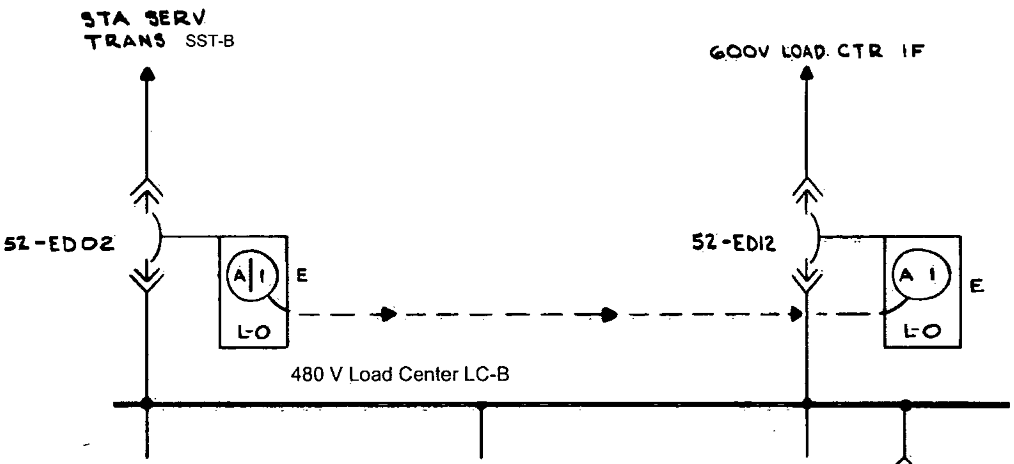
CONTACTS HANDLE END		CLOSE	AFT CLOSE	AFT TRIP	TRIP	PULL TO LOCK	
	1	X					
	2				X	X	
	3		X	X	X	X	SP
	4	X	X	X	X		SP
	5		X	X			ALARM
	6	X	X				ALARM

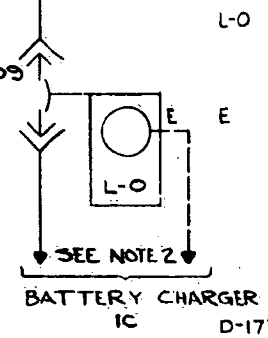
HANDSWITCH
GE SBM TYPE
MODEL NO 10AA116
SPRING RETURN TO CENTER
PULL TO LOCK IN TRIP POSITION.



BLOCK DIAGRAM

SNPP	Drawing No.: LC-B-03
52-ED-12 SCHEMATIC	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.

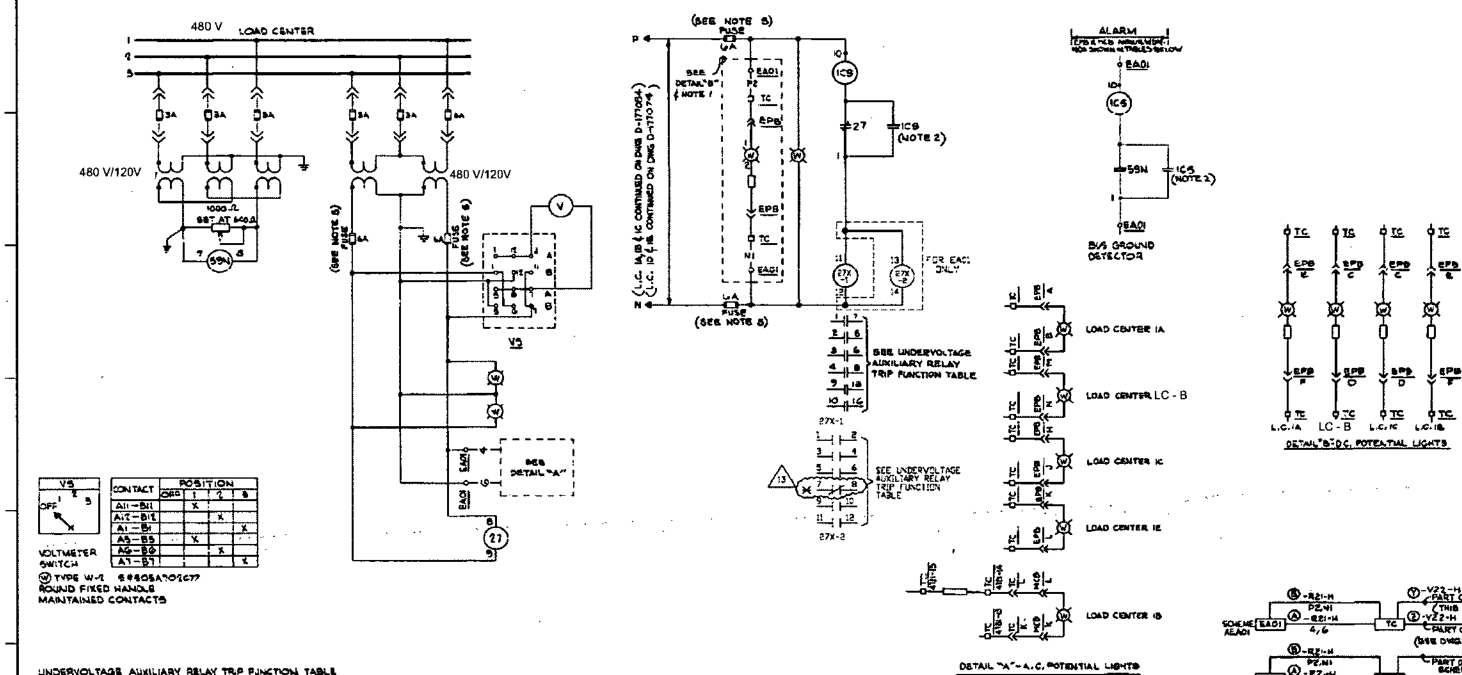
D-177001 - SINGLE LINE ELEC AUX SYSTEM (4160V & 600V)

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

A-177538 - ELEC GEN DETAILS & NOTES

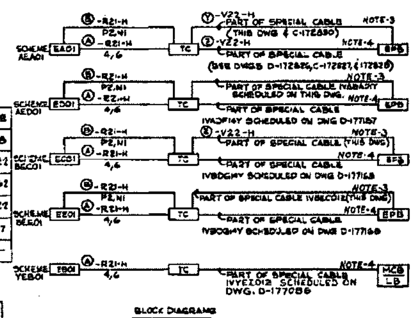
SNPP	Drawing No.: LC-B-04
LC-B INCOMING BREAKER INTERLOCKS	Date: 05/20/2007
	Revision No.: #6

DEVICE	DESCRIPTION	MFR / TYPE	REMARKS
27X-1	UNDERVOLTAGE AUXILIARY RELAY	Ⓦ/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 EAC1, EC01, ED01, AND EE01 ONLY).



REFERENCE DRAWINGS:

- A-177536 — 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 IA
- C-177008 — SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER IB
- C-177009 — SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER IC
- D-177010 — SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER ID (EMERG)
- D-177011 — SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER IE (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 NO	27X-1 EB01	LC BKR COMPT	TRIP FUNCTION	DWG NO	27X-1 EC01	LC BKR COMPT	TRIP FUNCTION	DWG NO
9-15	EA13	600-480/277V LIGHTING TRANS 1A	D-177050	4-8	EB05	CTMT COOLER IB (NORMAL)	D-177221	2-8	EC09	SPENT FUEL POOL PUMP IA	D-177106
2-5	EA06	CTMT PURGE AHU FAN STARTER PANEL	D-177242	3-6	EB06	CTMT COOLER IC (NORMAL)	D-177221	1-7	EC12	CTMT COOLER ID (NORMAL)	D-177221
3-6	EA10	CTMT COOLER IA (NORMAL)	D-177221	2-5	EB10	HYDRO TEST PUMP	D-177241	9-15	—	SPARE	—
4-8	EA12	SPENT FUEL POOL PUMP IB	D-177106	9-15	—	SPARE	—	4-8	EC05	AUX BLDG MAIN EXHAUST FAN IA	D-177257
1-7	EA05	CTMT PURGE EXH. FAN STARTER PANEL	D-177242	1-7	EB11	AUX BLDG MAIN EXHAUST FAN IB	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 NO	27X-1 EE01	LC BKR COMPT	TRIP FUNCTION	DWG NO
4-8	ED05	CRDM MG SET IA	D-177198	4-8	EE05	CRDM MG SET IB	D-177198
1-7	ED15	CTMT COOLER IA (EMERG)	D-177222	2-5	EE08	CTMT COOLER IC (EMERG)	D-177222
3-6	ED11	CRDM COOLER FAN IB	D-177262	1-7	EE13	CRDM COOLER FAN IA	D-177262
10-16	ED16	CTMT COOLER IB (EMERG)	D-177222	10-16	EE16	CTMT COOLER ID (EMERG)	D-177222
2-5	ED06	REACTOR CAVITY H2 DIL. SYSTEM AIR COMP. IA	D-177277	3-6	EE09	REACTOR CAVITY H2 DIL. SYSTEM AIR COMP. IB	D-177277
9-15	—	SPARE	—	9-15	—	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	

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

EMERGENCY POWER BOARD (EPB)	TERMINATION CABINET (TC)	FAC	SWGR CELL	SCHEME	START-UP NUMBER	ANN. WDW. NO. (EPB)
0SHIING EP82508-A8	01H25L037-A	IV	EAC1	AEA01	5	PANEL "V" 02
0SHIING EP82508-A8	01H25L039-B	IV	EC01	BEC01	5	PANEL "V" 02
0SHIING EP82508-A8	01H25L037-A	IV	ED01	AED01	5	PANEL "V" 02
0SHIING EP82508-A8	01H25L039-B	IV	EE01	BEE01	5	PANEL "V" 02

MAIN CONTROL BOARD (MCB)	TERMINATION CABINET (TC)	FAC	SWGR CELL	SCHEME	START-UP NUMBER	BUS POTENTIAL LIGHT BOX (LB)	ANNUNCIATOR WINDOW NO. (MCB)
01-IING MCB25303-A8	01H25L016-B	IV	EB01	YEB01	5	NI-01E12111F-N	PANEL "L" 33

SNPP	Drawing No.: LC-B-05
LOAD CENTER UNDERVOLTAGE SCHEME	Date: 05/20/2007
	Revision No.: #6

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 ☒

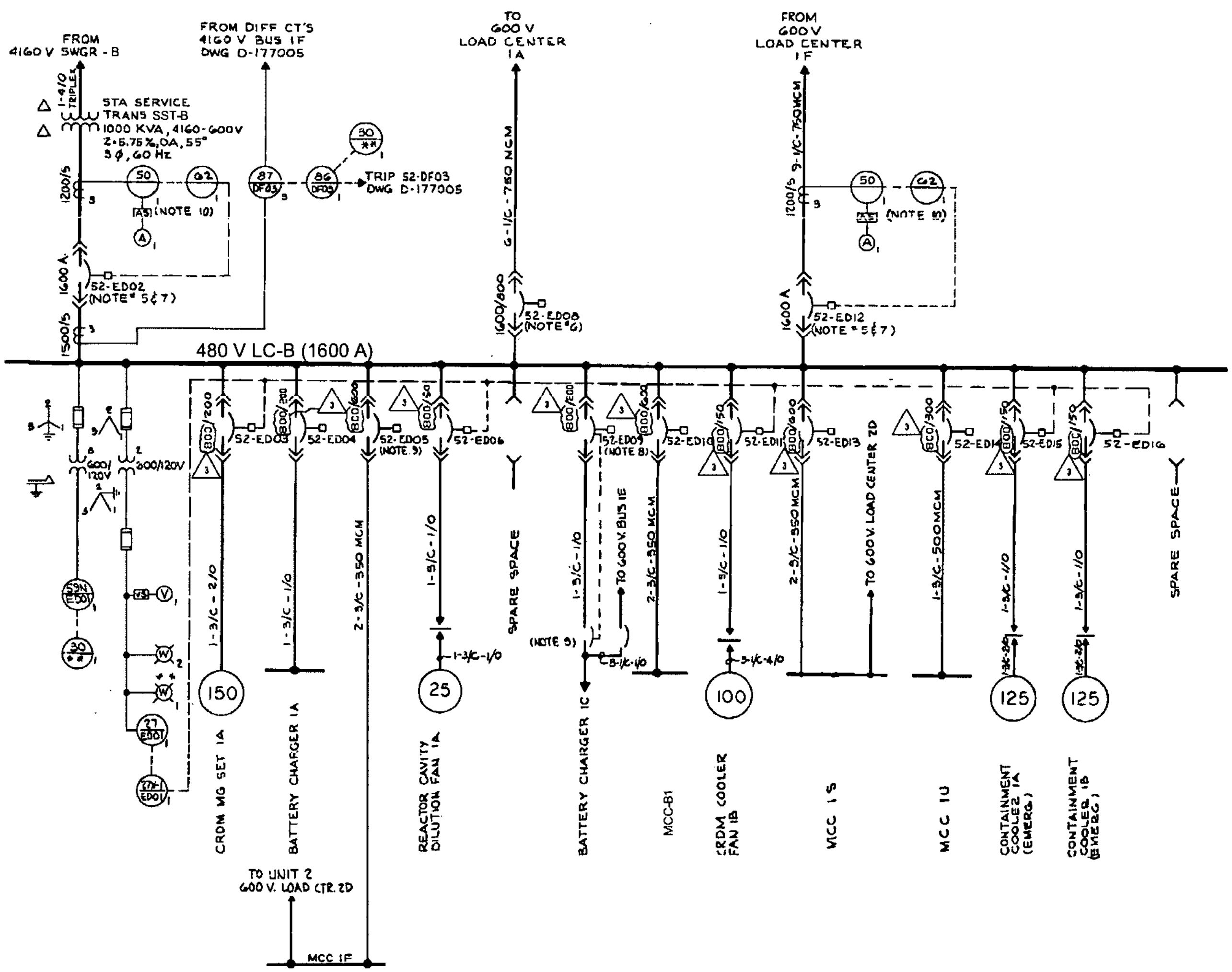
Power Supplies: ______________ Breaker: ______________

______________ Breaker: ______________

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments

Comments:



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 / DF05	STA. SERVICE TRANSF. 1D DIFFERENTIAL RELAY	GE/12STD15C5A	
86 / DF08	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	

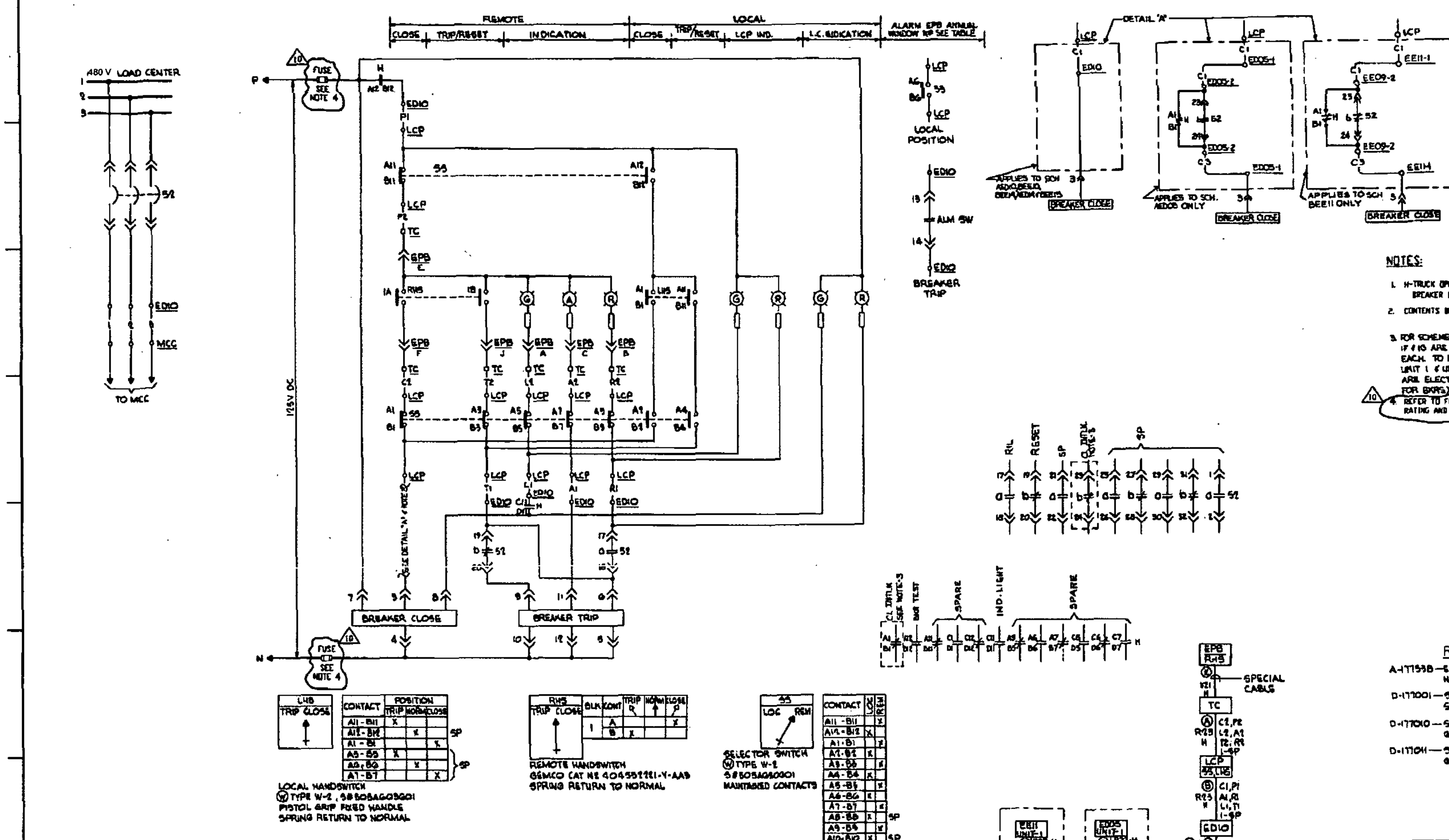
NOTES

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-177123)
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 ED06 IS ELECTRICALLY INTERLOCKED WITH UNIT 2 BREAKER ED06 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



NOTES:

1. H-TRUCK OPERATED CELL SWITCH SHOWN FOR BREAKER IN TEST POSITION.
2. CONTENTS DELETED.
3. FOR SCHEMES AEDO5, AND BEE11 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 1D (EMERG)
D-177011 — SINGLE LINE PROTECTION & METERING 600V LOAD CENTER 1G (EMERG)

EQUIPMENT		FAC	SCHEME	L.C. COMPT.	LOCAL CONTROL PANEL (LCP)	EMERGENCY POWER BOARD (EPB)	TERMINATION CABINET (TC)	START-UP NUMBER	POWER CABLE CODE	MOTOR CONT CENTER (MCC)	CONDUCTOR NOS. CABLE P	CABLE Q	REMOTE HANDSWITCH (RHS)	EPB ANNUNCIATOR WINDOW NO. BKR ON LOCAL CONTROL	BKR TRIP	LC COMPT
600V LOAD CENTER BARS TO MOTOR CONTROL CENTER	1A	IV	AED10	ED10	Q1H21E009-A	Q5H11NGEPB1508-A	Q1H25L037-A	6	L09-F	FA-A2	1,2,3	1,2,3	[illegible]	PANEL V, WINDOW G2	PANEL V, WINDOW G1	
	1B	IV	BEE10	EE10	Q1H21E010-B		Q1H25L039-B	6	L09-F	FB-A2	1,2,3		[illegible]	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	[illegible]	PANEL V, WINDOW G2	PANEL V, WINDOW G1	ED05-2
	1G	IV	BEE11	EE11	Q1H21E010-B		Q1H25L039-B	6	L09-F	FG-A2	1,2,3	1,2,3	[illegible]	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	[illegible]	PANEL V, WINDOW G2	PANEL V, WINDOW G1	
	1U	IV	AED14	ED14	Q1H21E009-A		Q1H25L037-A	6	L10-F	FU-A1	1,2,3		[illegible]	PANEL V, WINDOW G2	PANEL V, WINDOW G1	
	1V	IV	BEE15	EE15	Q1H21E010-B		Q1H25L039-B	6	L10-F	FV-A1	1,2,3		[illegible]	PANEL V, WINDOW G2	PANEL V, WINDOW G1	

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

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

Instructors' Exercise Solutions

CIRCUIT ANALYSIS WORKSHEET

Exercise 1

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: Vital-A Breaker: ____

Breaker: ____

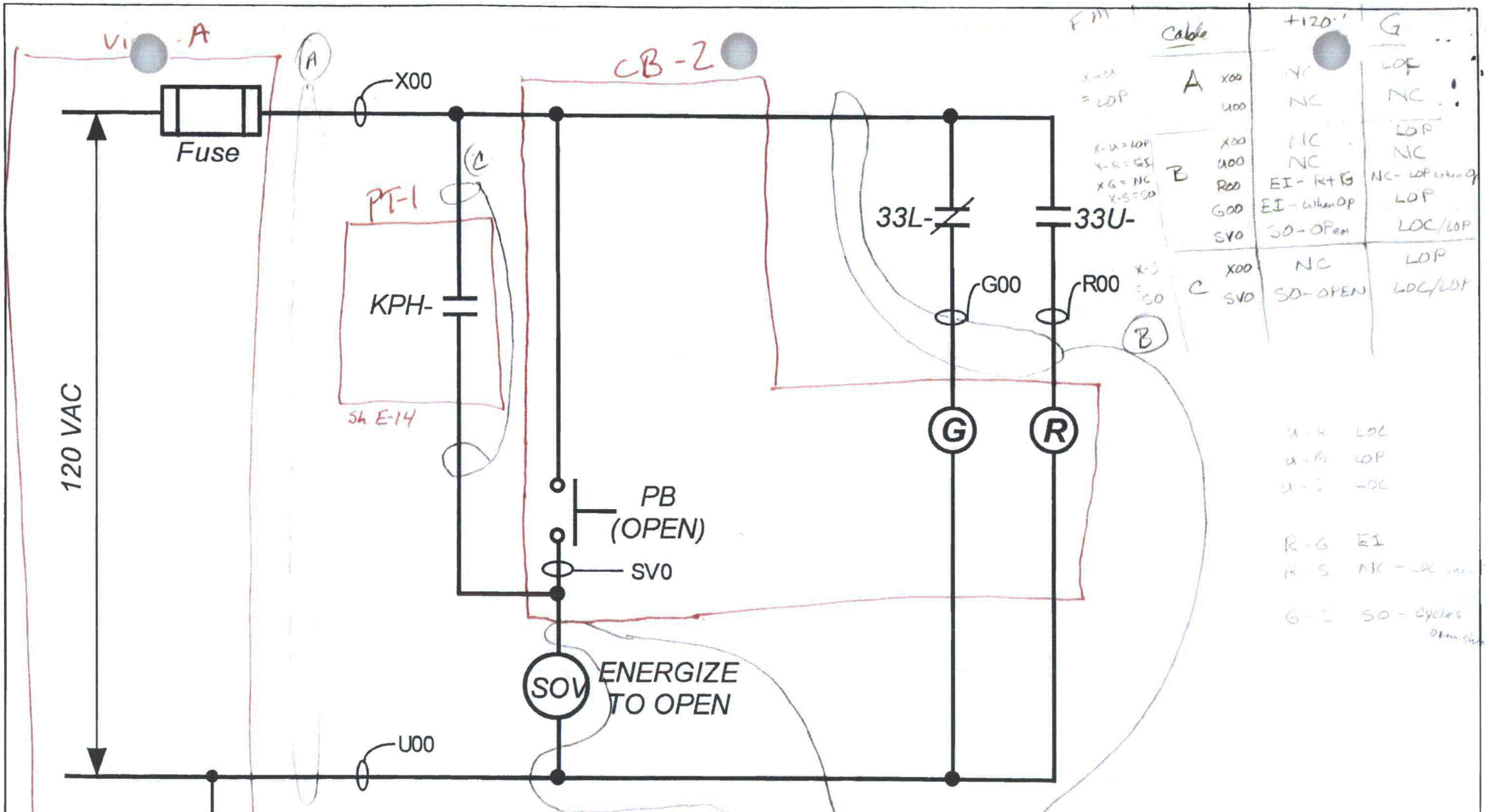
Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments
VA3A	No	Power	LOP	
VA3B	Yes	Control	SO-Open	Hot Short between conductors G00 and SVC can cause valve to cycle open-shut repeatedly
VA3C	Yes	Control	SO-Open	

Comments: Table Formula

P(SO, B) = 0.60+ 0.06 – (0.6*0.06) = 0.62 P(SO, B)= 0.57*0.42= 0.24

P(SO, C) = 0.60+ 0.06 – (.6*0.06) = 0.62 P(SO, C)= 0.67*0.63= 0.42

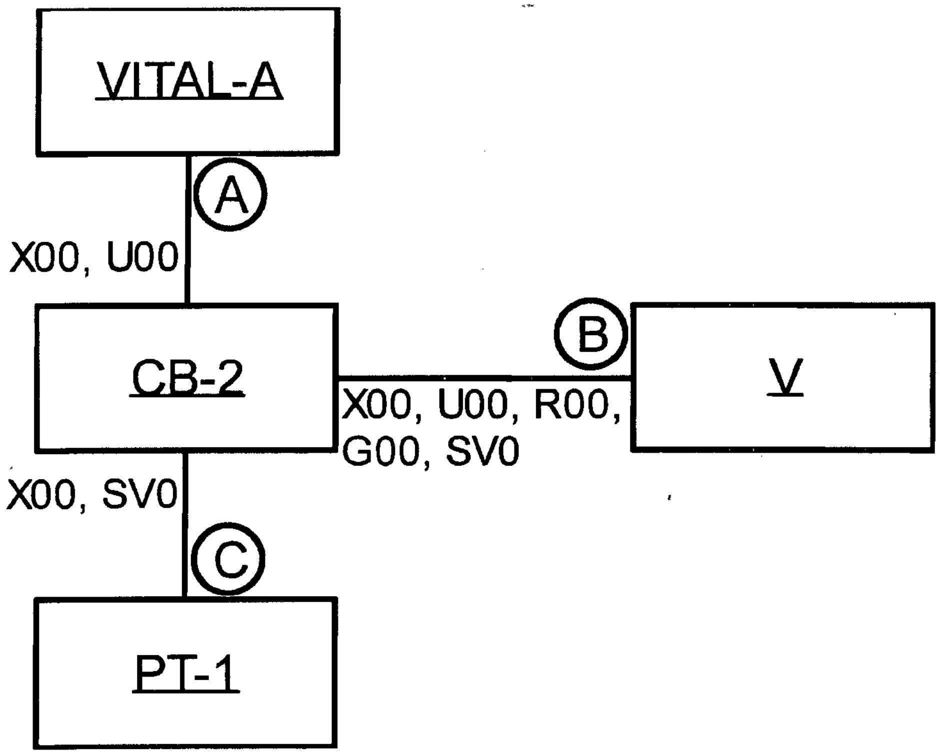


VALVE SHOWN CLOSED

SCHEME VA3

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

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



SOV-1 SCHEME VA3

CIRCUIT ANALYSIS WORKSHEET

Exercise 2

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: Panel B Breaker: 3

Breaker:

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments
PB3A	No	Power	LOP	
PB3B	Yes	Control	SO-Open	Energize SVO (Also EI, LOP, LOC)
PB3C	No	Control	LOP	

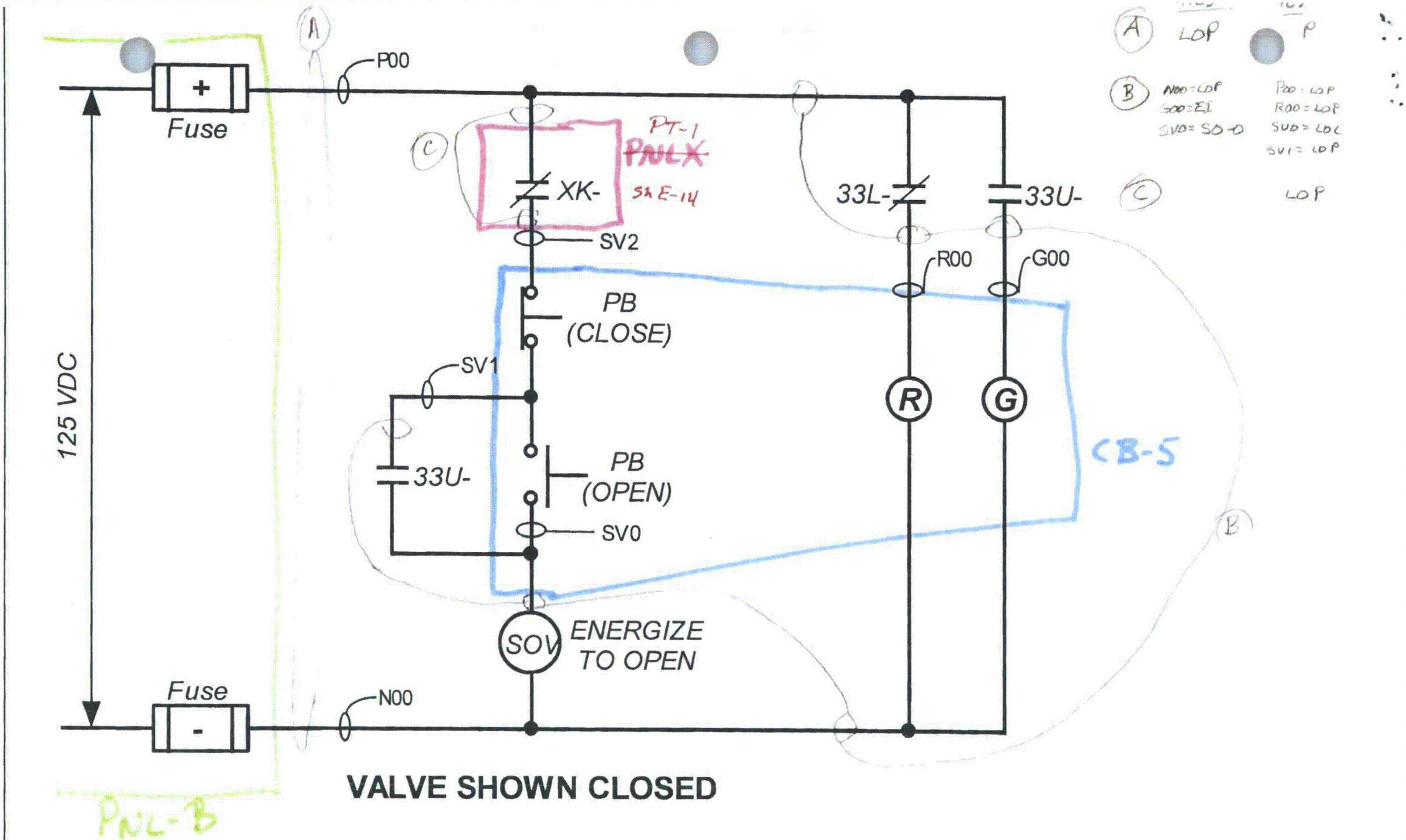
Comments: Table Formula

P(SO, B)= 0.60 + 0.06 – (0.60*0.06)= 0.62

$P_{CC} = \frac{(7-1)}{(7-1)+(2*1)} = \frac{6}{6+2} = \frac{6}{8} = 0.75$

CF= {1*[3+(0.5/7)]}/7= 3.07/7= 0.44

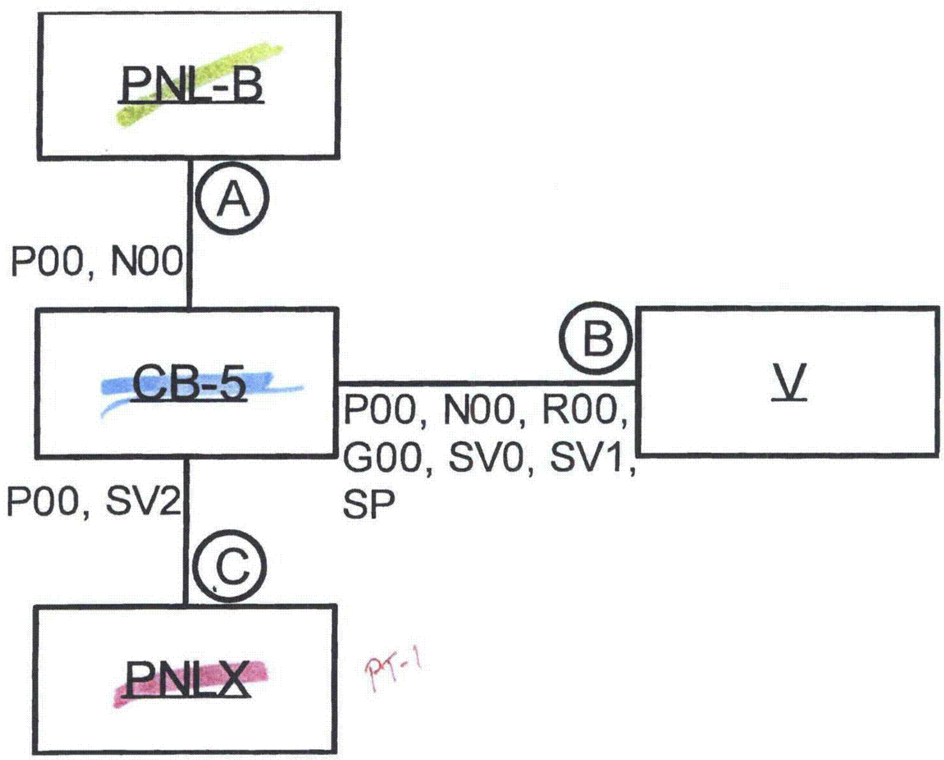
P(SO, B)= 0.75* 0.44= 0.33



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

SNPP	Drawing No.: E-02
SCHEMATIC DIAGRAM -- PRIMARY MAKEUP SYSTEM SOLENOID VALVES	Date: 5/4/07 ~~04/27/2007~~
SOV-2 & SOV-3	Revision No.: 0

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



SOV-3, SCHEME PB3

CIRCUIT ANALYSIS WORKSHEET

Exercise 3

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: MCC–B1 Breaker: 5

Breaker:

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments
MB15A	Yes	Control	EI, SO-C, SO-O, LOP, LOC	9-C, 1 ground, 1 target, 2 sources
MB15B	Yes	Control	EI, LOP, LOC	
MB15P	Yes	Power	LOP	

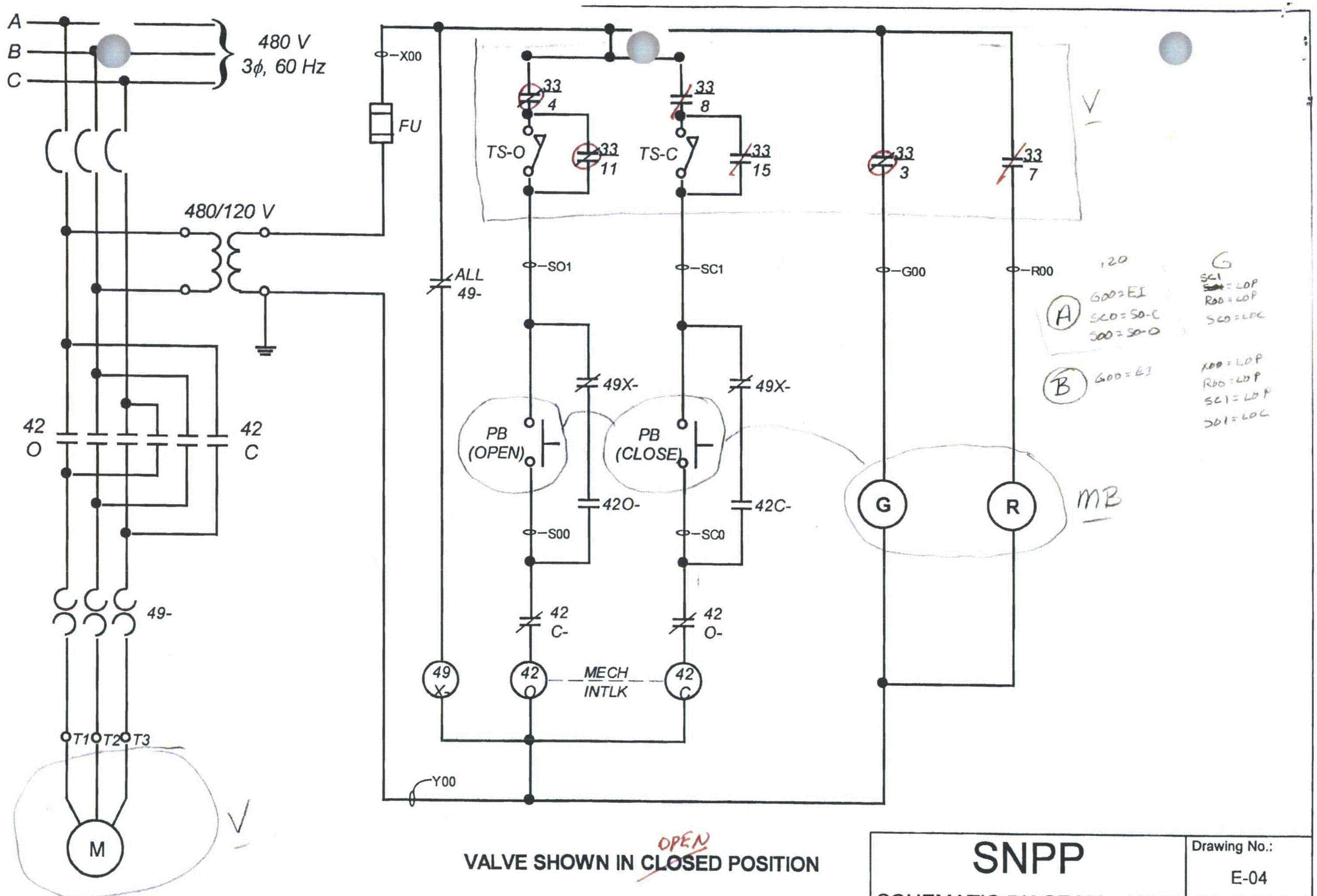
Comments:

P Table 10-1= 0.3+0.03= 0.33

$P_{CC} = \frac{(9-1)}{(9-1)+(2*1)+1} = 0.727$

Pcalc= 0.727*0.228= 0.17

CF= 1x[2+ (0.5/9)]/9= 0.228



VALVE SHOWN IN CLOSED POSITION

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

B-62

SNPP

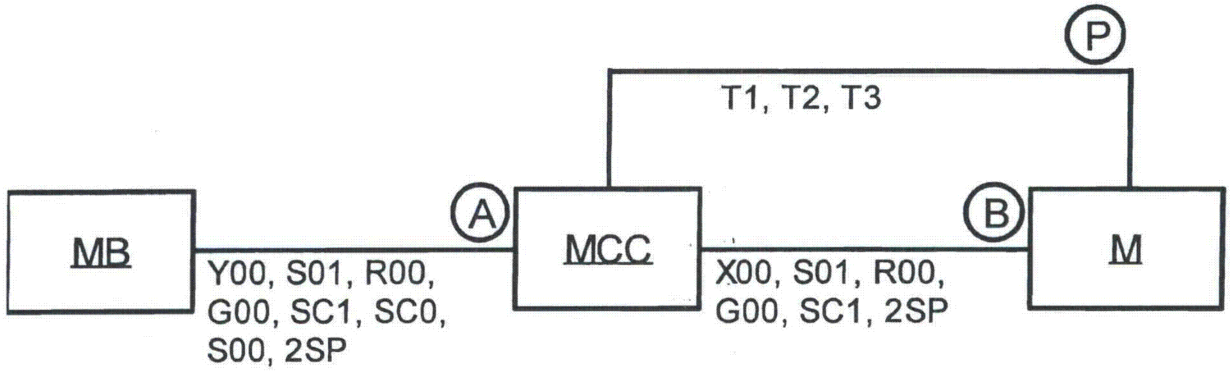
SCHEMATIC DIAGRAM – HIGH PRESSURE INJECTION MOTOR OPERATED VALVES MOV-1 & MOV-9

Drawing No.: E-04

Date: 05/01/2007

Revision No.: 0

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

CIRCUIT ANALYSIS WORKSHEET

Exercise 4

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: DC Bus-B Breaker: 4

Breaker:

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments
DB4A	Yes	Control	LOP	SO possible only with dual hot shorts P01-F03 (F02) and N01-F02 (F03)
DB4B	Yes	Control	LOP	

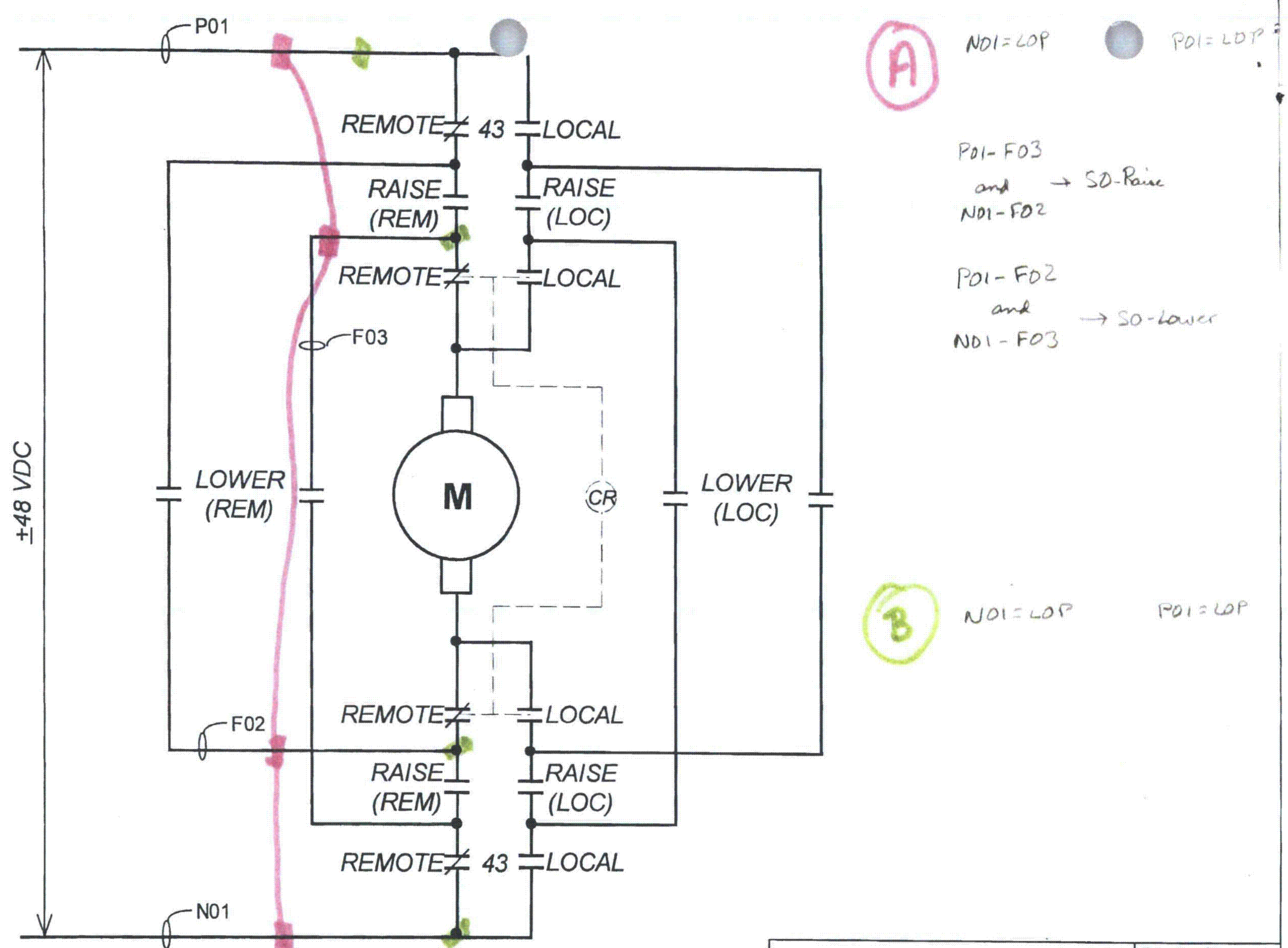
Comments:

P(SO) = 0.60+0.06-(0.60*0.06)= 0.62

$P_{CC} = \frac{5-0}{(5-0)+0} = 1$

CF_1= (1*(1+(0.5/5)))/5= .22 CF_2= (1*(1+(0.05/3)))/3= 0.39

P(SO)= P_{CC}*CF_1*CF_2= 1*.22*.39= 0.09

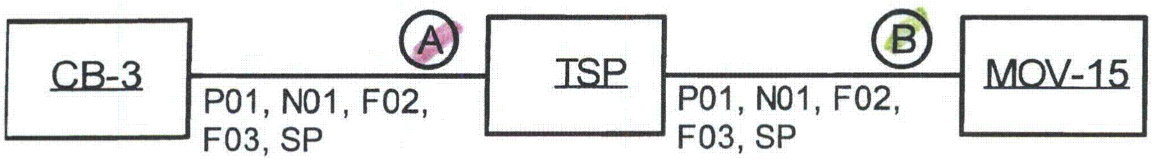


Motor Shown in Remote Operating Mode

MOV-15, SCHEME DB4 B-65

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

SNPP	MOV BLOCK DIAGRAM - 2	5/1/07



MOV-15, SCHEME DB4

CIRCUIT ANALYSIS WORKSHEET

Exercise 5

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: MCC-A1 Breaker: 7

Breaker:

Cable Analysis:

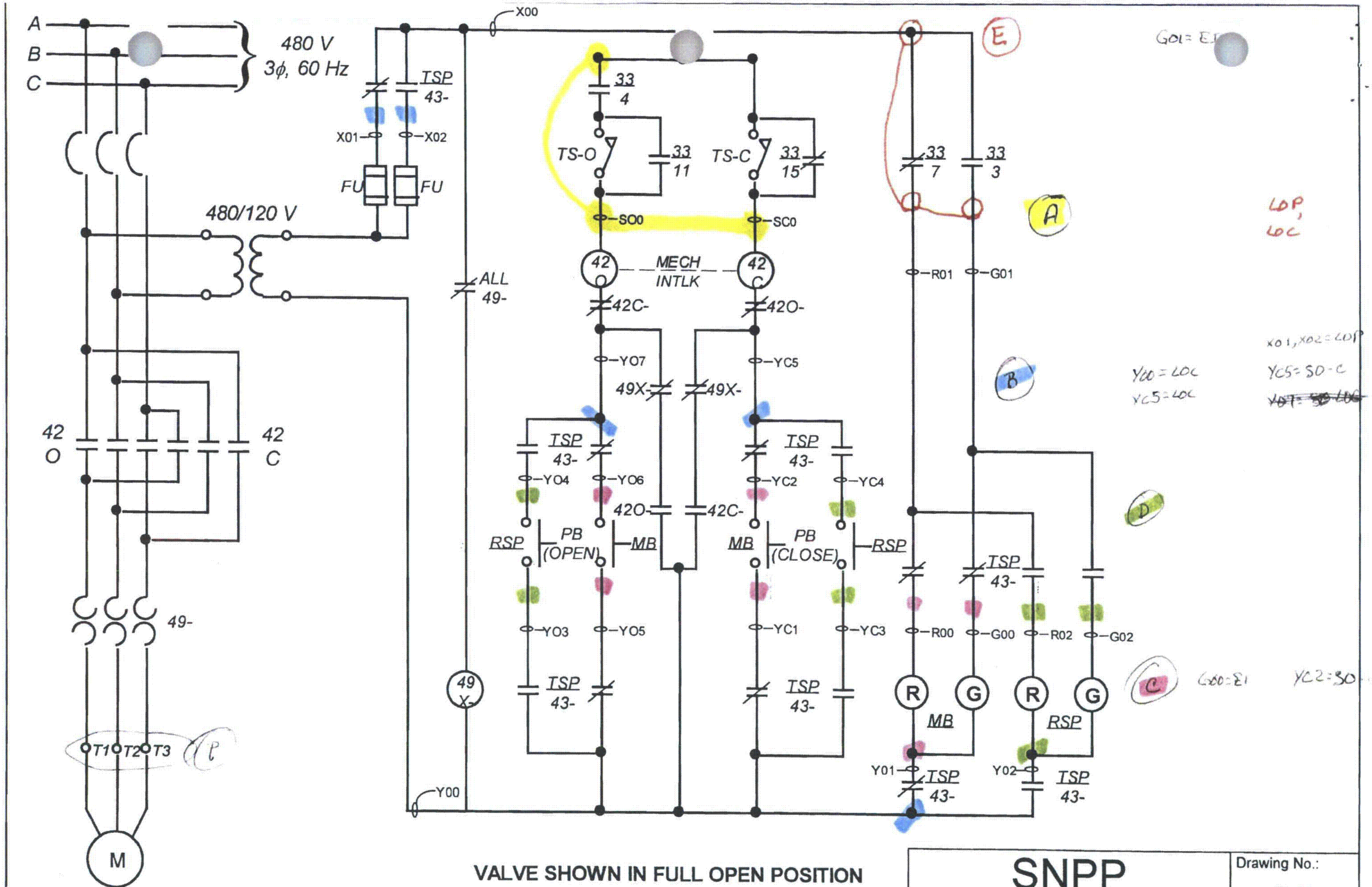
Cable ID	Required?	Function	Fault Consequence	Comments
MA17A	Yes	Control	LOP, LOC	
MA17B	Yes	Control	SO-C, LOP, LOC	
MA17C	Yes	Control	SO-C, EI, LOC	
MA17D	Yes	Control	EI, LOP	RSP
MA17P	Yes	Power	LOP	

Comments:

Case for both B/C P(SO)= 0.30+0.03-(.3*.03)= 0.32

B: $P_{CC} = \frac{(9-1)}{(9-1)+(2*1)} = 0.8$ CF= {1*[1+5/9]}/9= 0.12 P(SO)= 0.8*0.12= 0.10

C: $P_{CC} = \frac{(9-3)}{(9-3)+(2*3)} = 0.5$ CF= {1*[3+5/9]}/9= 0.34 P(SO)= 0.5*0.34= 0.17

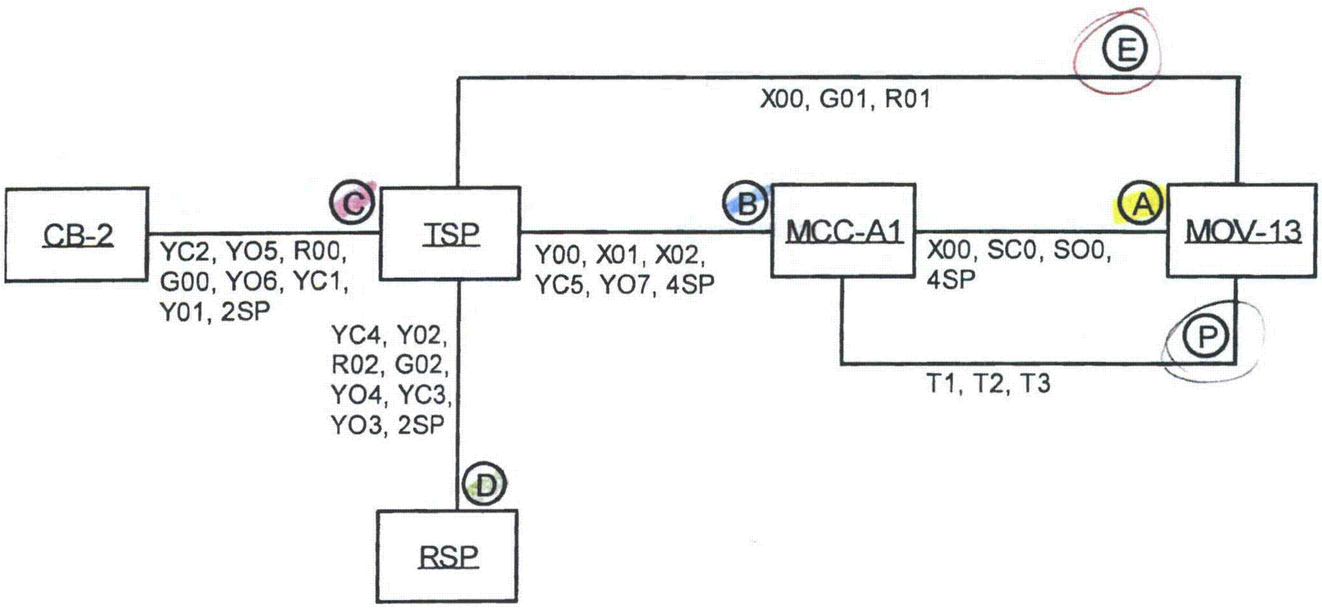


VALVE SHOWN IN FULL OPEN POSITION

MOV-13, SCHEME MA17

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

SNPP	MOV BLOCK DIAGRAM - 3	5/1/07



MOV-13, SCHEME MA17

CIRCUIT ANALYSIS WORKSHEET

Exercise 6

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: MCC-A1 Breaker: 6

Breaker:

Cable Analysis:

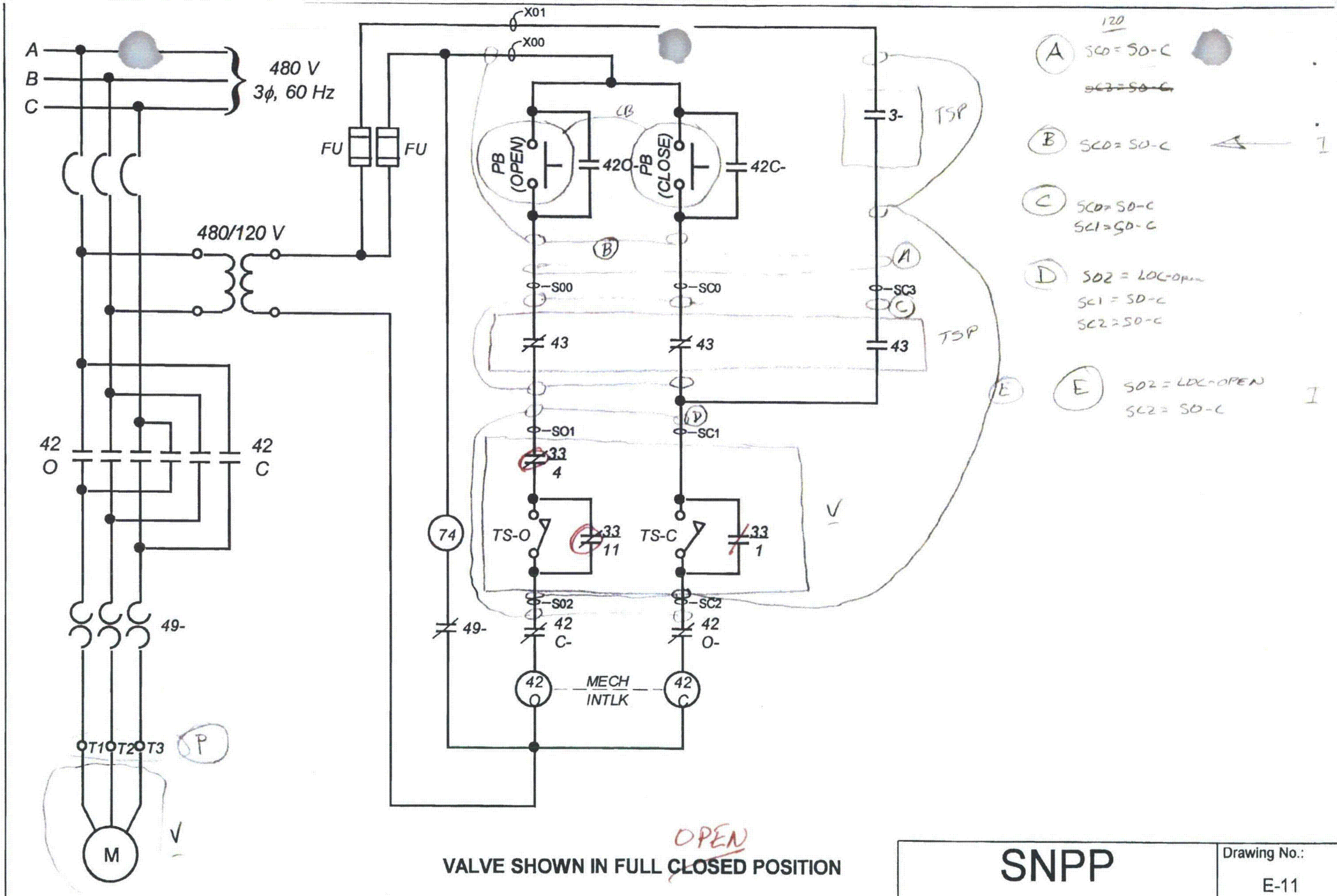
Cable ID	Required?	Function	Fault Consequence	Comments
MA16A	Yes	Control	SO-Close	
MA16B	Yes	Control	SO-Close	3-C, 0 ground, 1 target, 1 source
MA16C	Yes	Control	SO-Close	RSP
MA16D	Yes	Control	SO-Close, LOC-Open	
MA16E	Yes	Control	SO-Close, LOC-Open	
MA16P	Yes	Power	LOP	

Comments: Note- MOV-10 is an ungrounded control circuit

Ptable= 0.3+0.03= 0.33 $P_{CC}= \frac{(3-0)}{(3-0)+(2*0)} = 1$

Pcalc= 1.0*0.39= 0.39 CF= 1*[1+(.5/3)]/3= 0.39

Note: only cables B and E have energized conductors

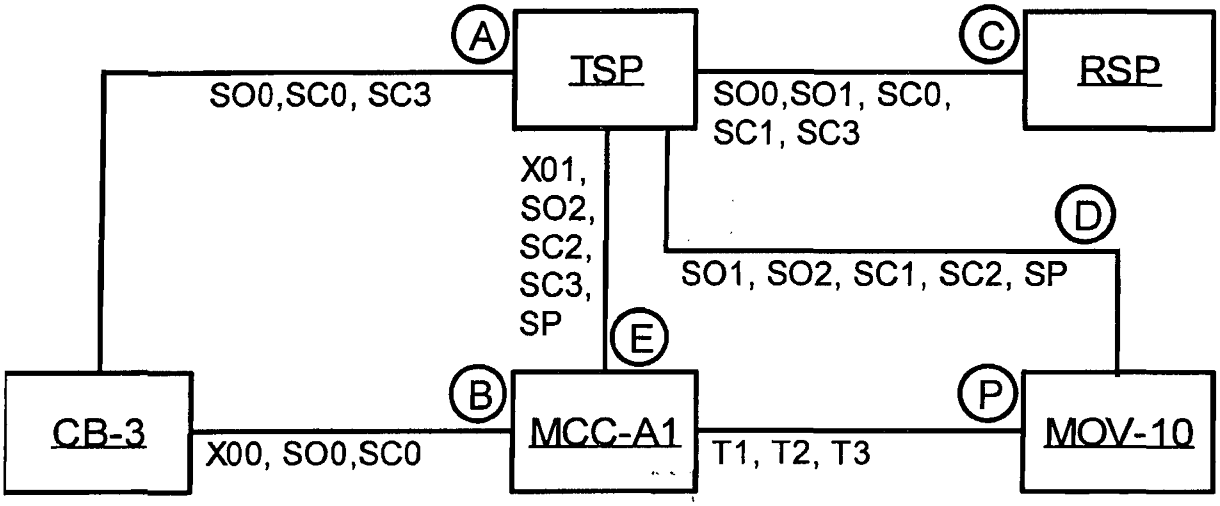


VALVE SHOWN IN FULL ~~CLOSED~~ OPEN POSITION

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

SNPP	MOV BLOCK DIAGRAM - 4	5/4/07



MOV-10, SCHEME MA16

CIRCUIT ANALYSIS WORKSHEET

Exercise 7

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: MCC-B1 Breaker: 4

Breaker:

Cable Analysis:

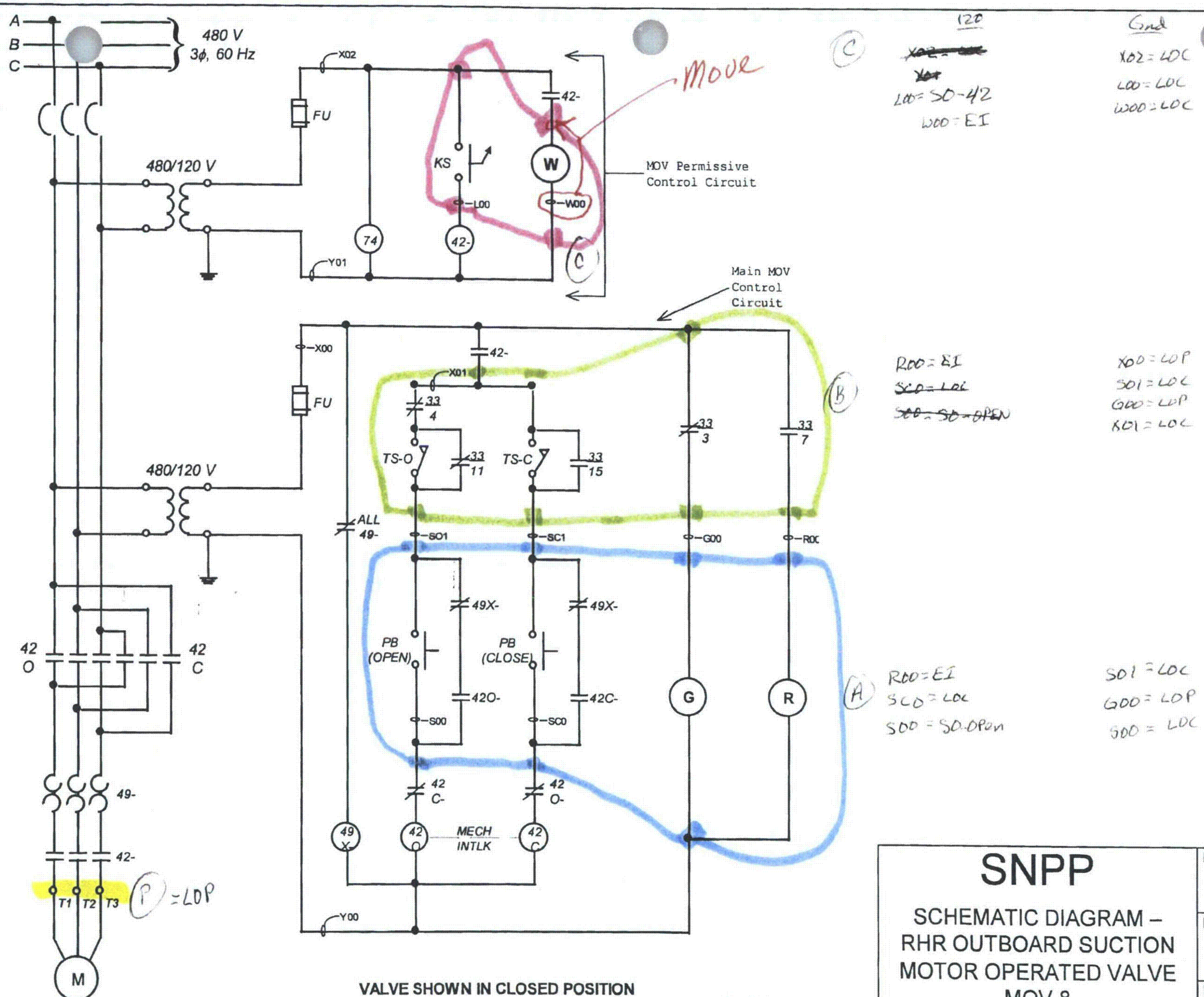
Cable ID	Required?	Function	Fault Consequence	Comments
MB14A	Yes	Control	SO-Open	Energize S00 (Also EI, LOC, LOP)
MB14B	No	Control	EI, LOC, LOP	
MB14C	Yes	Control	SO-42	Energize L00 (Also EI, LOC)
MB14P	Yes	Power	SO-Open	3Φ "smart short"

Comments:

P(SO, A)= 0.3+ 0.03= 0.33

$P_{CC} = \frac{(9-1)}{(9-1)+(2*1)+1}$ = 0.73 CF={1*[1+5/9]}/9= 0.12

P(SO, A)= 0.73*0.12= 0.09



VALVE SHOWN IN CLOSED POSITION

MOV-8, SCHEME MB14

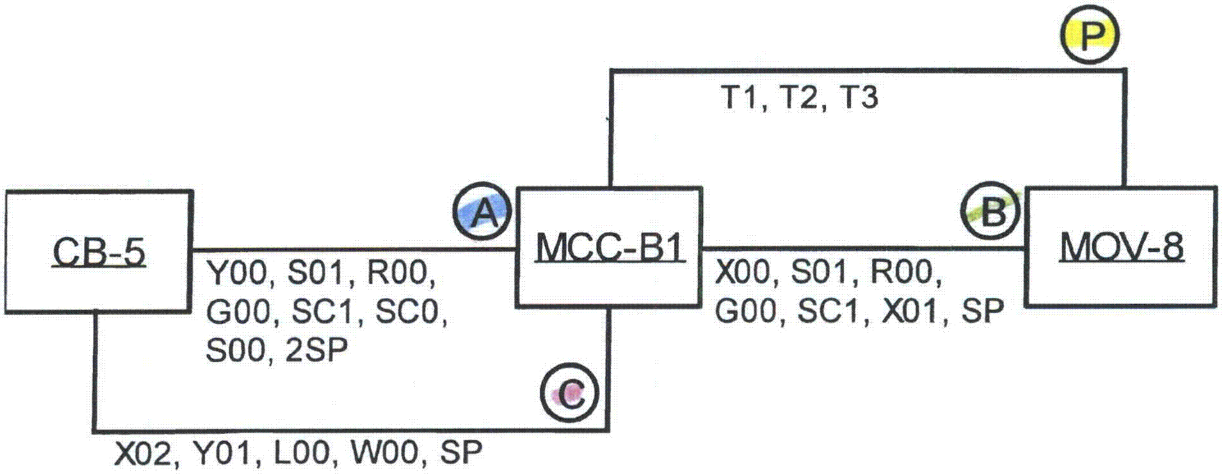
B-74

SNPP

SCHEMATIC DIAGRAM – RHR OUTBOARD SUCTION MOTOR OPERATED VALVE MOV-8

Drawing No.:	E-12
Date:	05/04/2007
Revision No.:	0

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



MOV-8, SCHEME MB14

CIRCUIT ANALYSIS WORKSHEET

Exercise 8

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: DC Bus-B Breaker: 3

Breaker:

Cable Analysis:

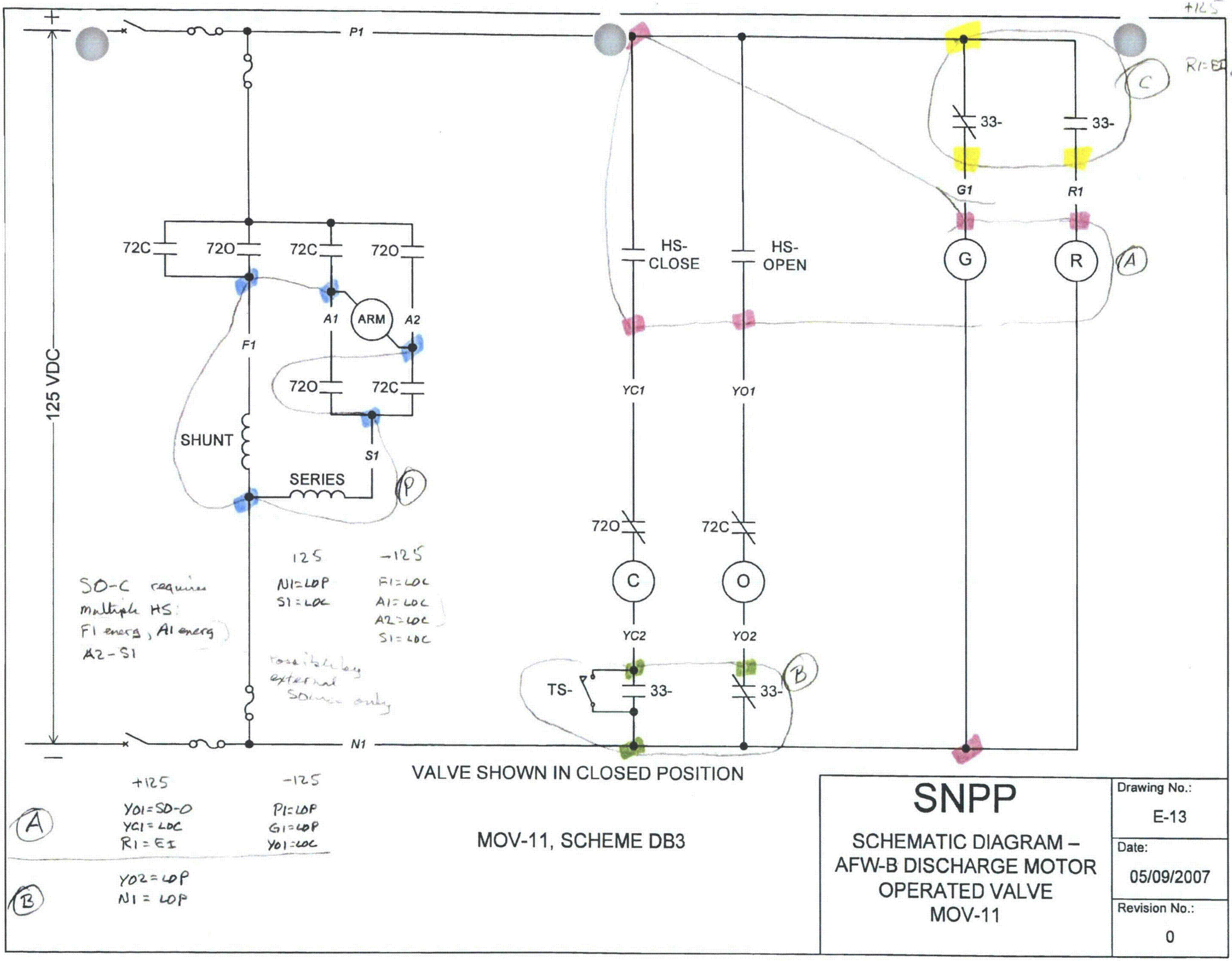
Cable ID	Required?	Function	Fault Consequence	Comments
DB3A	Yes	Control	SO-C, EI, LOC, LOP	
DB3B	Yes	Control	LOP	
DB3C	Yes	Control	EI, LOP	
DB3P	Yes	Power	LOC, LOP	

Comments:

P(SO, A)= 0.60+0.06 – (0.6*0.06)= 0.62

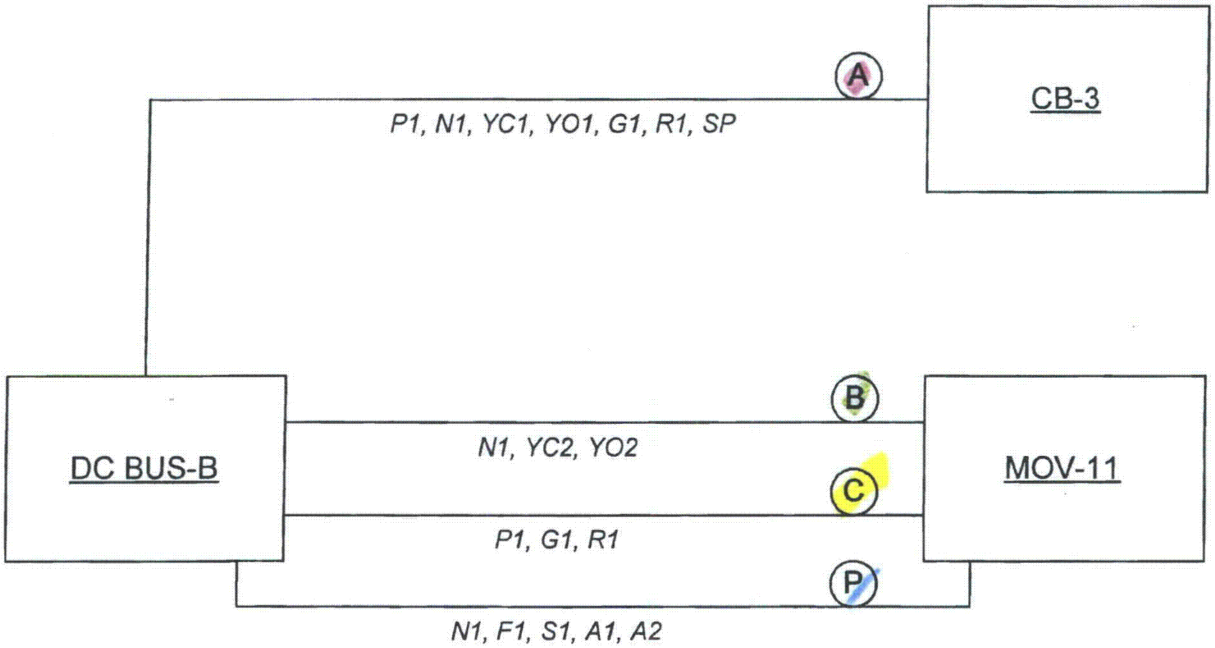
$P_{CC} = \frac{7-1}{(7-1)+(2*1)} = 0.75$ CF= {1*[2+5/7]}/7= 0.30

P(SO, A)= 0.75*0.30= 0.23



125 VDC
P1
N1
72C
72O
A1
ARM
A2
F1
S1
SHUNT
SERIES
HS-
CLOSE
HS-
OPEN
YC1
YO1
YC2
YO2
C
O
G
R
G1
R1
33-
TS-
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
SO-C requires multiple HS:
F1 energ, A1 energ
A2 - S1
N1 = LOP
S1 = LOC
F1 = LOC
A1 = LOC
A2 = LOC
S1 = LOC
YO1 = SO-O
YC1 = LOC
R1 = EI
P1 = LOP
G1 = LOP
YO1 = LOC
YO2 = LOP
N1 = LOP

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



MOV-11, SCHEME DB3

CIRCUIT ANALYSIS WORKSHEET

Exercise 9

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: MCC-A1 Breaker: 8

Breaker:

Cable Analysis:

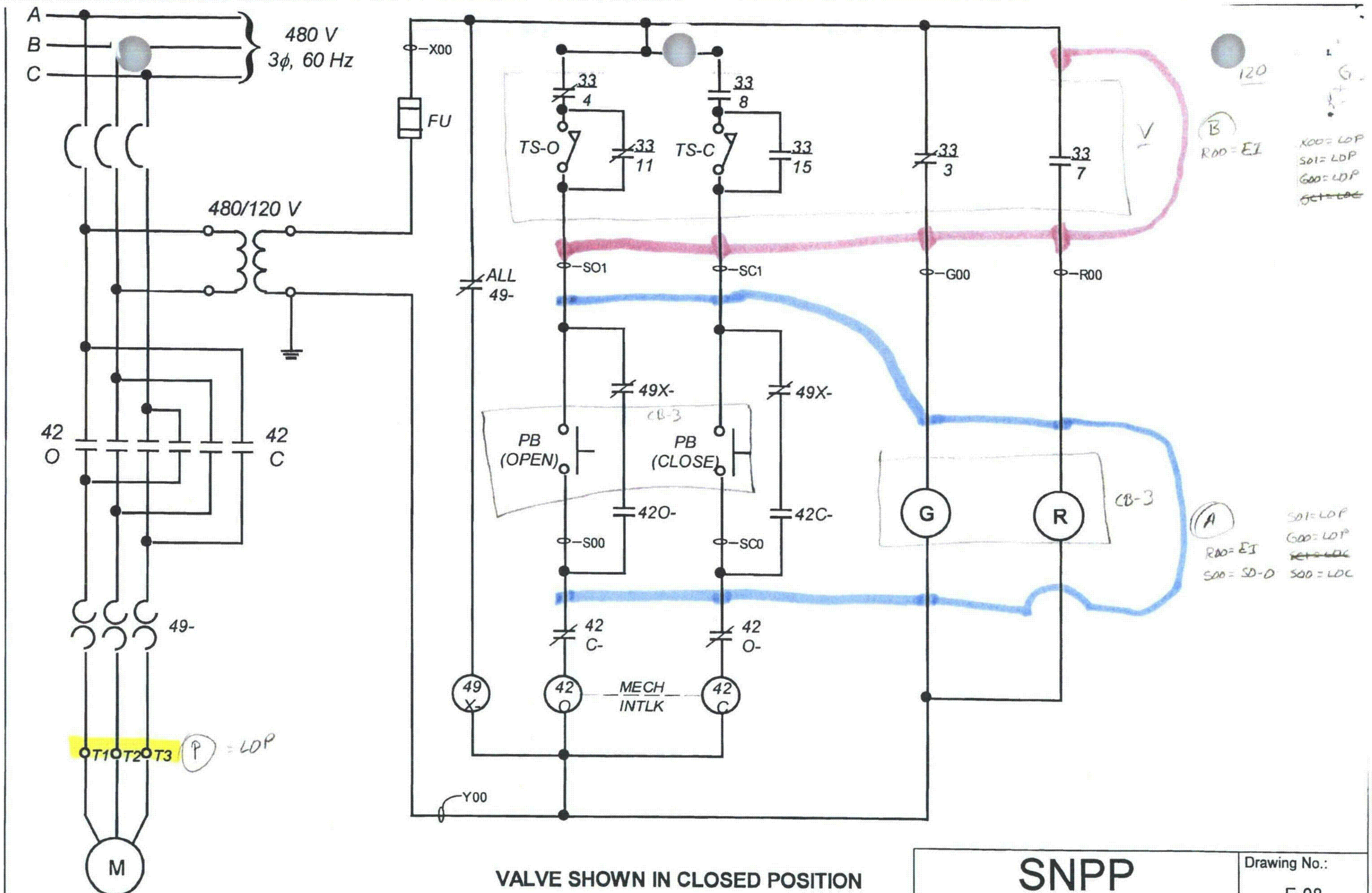
Cable ID	Required?	Function	Fault Consequence	Comments
MA18A	Yes	Control	SO-Open	Energize S00 (Also EI, LOP, LOC)
MA18B	No	Control	EI, LOP	
MA18P	No	Power	LOP	

Comments:

P(SO, A)= 0.30+0.03= 0.33

$P_{CC} = \frac{9-1}{(9-1)+(2*1)+1} = 0.73$ CF= {1*[2+5/9]}/9= 0.23

P(SO, A)= 0.73*0.23= 0.17



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

B-80

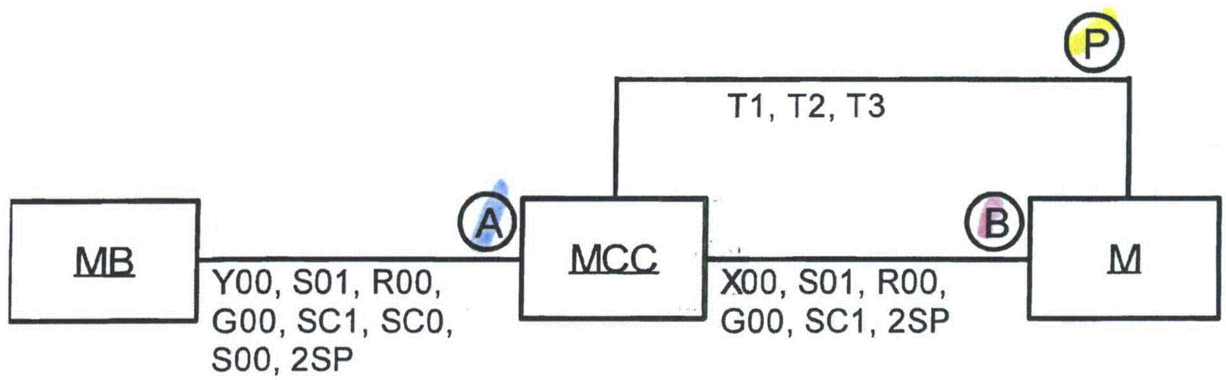
SNPP

SCHEMATIC DIAGRAM – AFW TEST LINE ISOLATION MOTOR OPERATED VALVES MOV-16 & MOV-17

Drawing No.: E-08

Date: 05/01/2007

Revision No.: 0



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

CIRCUIT ANALYSIS WORKSHEET

Exercise 10

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: Vital-B Breaker: 8

Breaker:

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments
VB1A	Yes	Indication	FH, Error-H	
VB1B	Yes	Indication	FH, Error-H	
VB1C	Yes	Indication	FL, Error-L	
VB1D	Yes	Indication	FL, Error-L	
VB1E	Yes	Indication	FL, Error-L	
VB1F	Yes	Indication	FL, Error-L	
VB1G	Yes	Indication	FL, Error-L	
VA3C	No	Indication	None	Cannot affect indication

Comments:

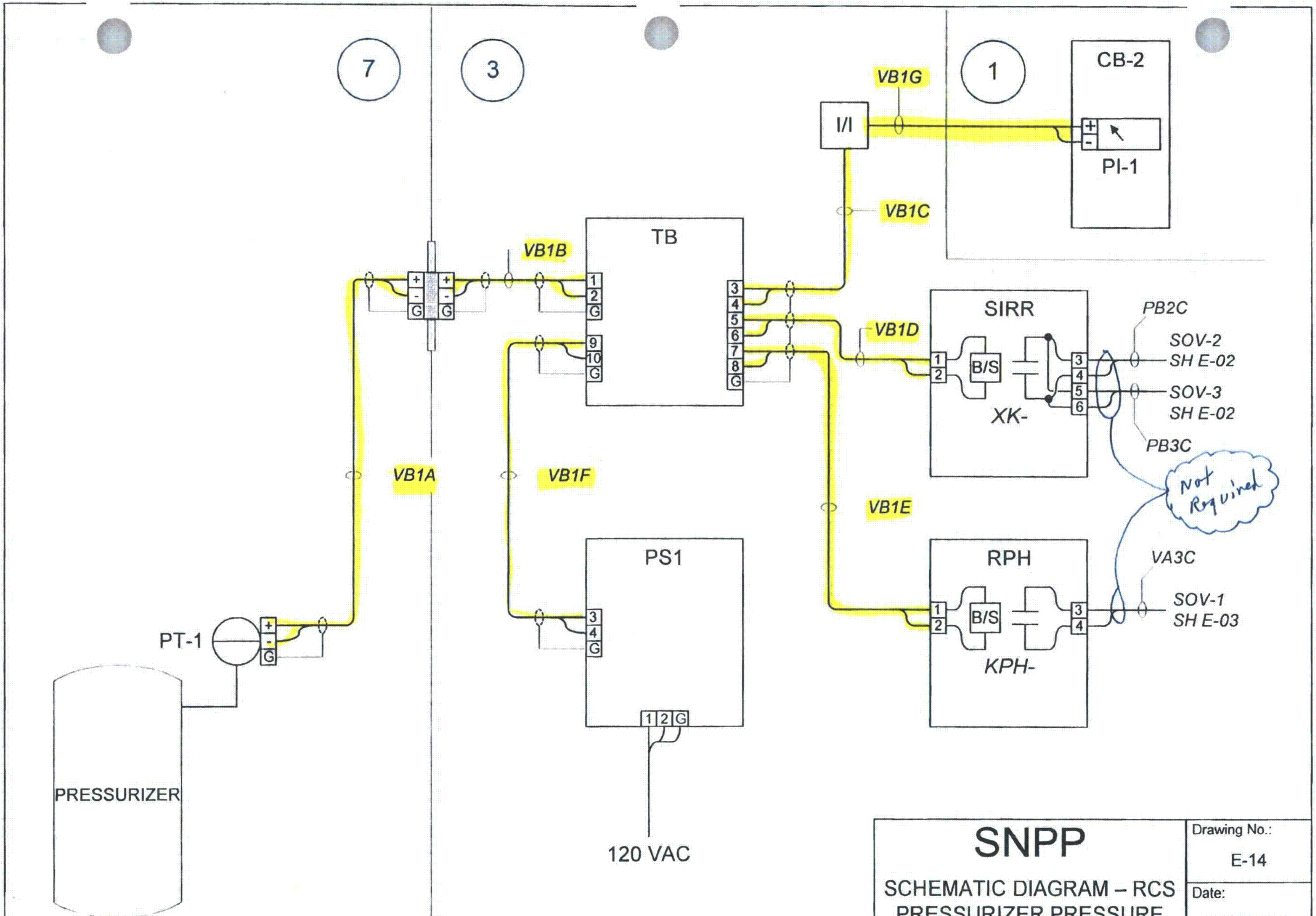
1. Shielded Instrument Cable- External hot shorts not considered credible.

CIRCUIT ANALYSIS WORKSHEET

Component ID: PI-1 Continuation Sheet (2 of 2)

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments
PB2C	N	I	NONE	CANNOT AFEECT INDICATION
PB3C	N	I	NONE	CANNOT AFFECT INDICATION



SNPP	Drawing No.:	E-14
SCHEMATIC DIAGRAM – RCS PRESSURIZER PRESSURE TRANSMITTER PT-1	Date:	05/22/2007
	Revision No.:	1

CIRCUIT ANALYSIS WORKSHEET

Exercise 11

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 ☒

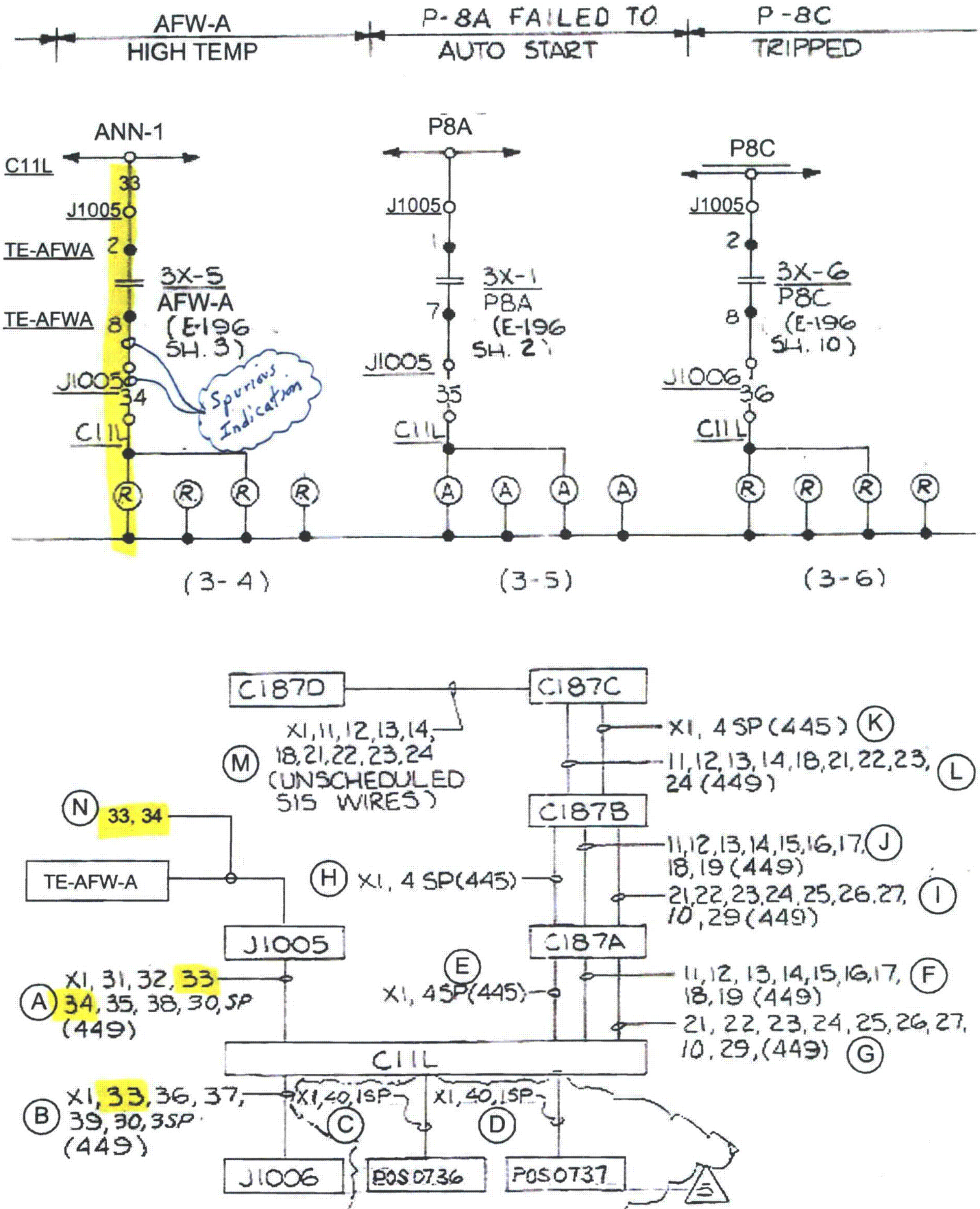
Power Supplies: Vital-A Breaker: 4

Breaker:

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments
K16A	Yes	Indication	LOI, SP-ALM	
K16N	Yes	Indication	LOI, SP-ALM	
K16B-K16M	No	Indication	LOI	

Comments:



BLOCK DIAGRAM
SCHEME K16

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

CIRCUIT ANALYSIS WORKSHEET

Exercise 12

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:

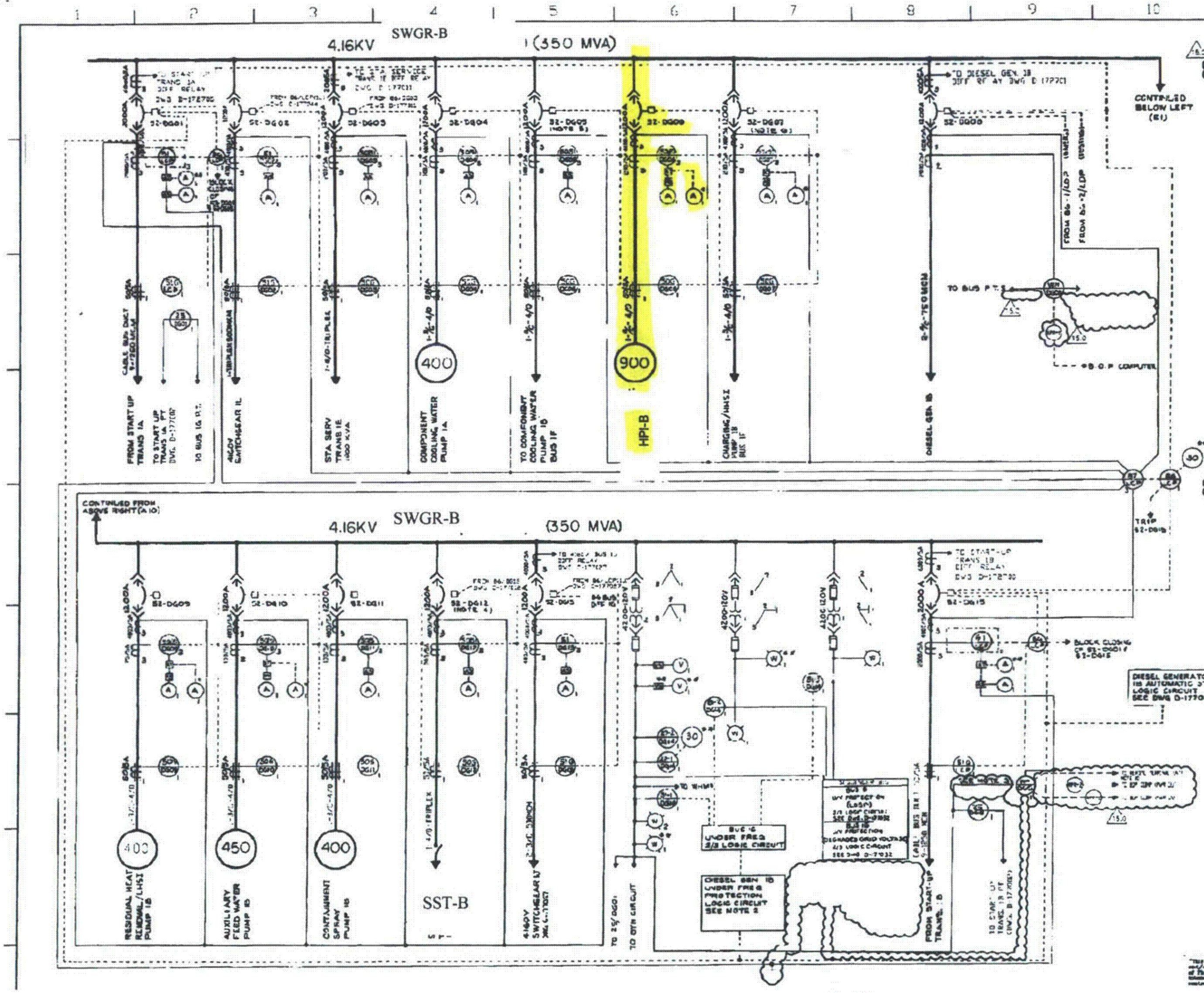
Cable ID	Required?	Function	Fault Consequence	Comments
BDG06-P	Yes	Power	LOP	
BDG06-N	Yes	Control		
BDG06-D	No	Indication	None	Isolated by I/I
BDG06-G	No	Control	None	Isolated by SCB/SS
BDG06-E	Yes	Control		
BDG06-Z	Yes	Control		
BDG06-L	Yes			DC Control Power

Comments:

____

____

____



DEVICE	DESCRIPTION	MFR/TYPE	REMARKS
51 / LCP	START UP TRANS 1A OVER CURRENT RELAY	GE/IAC53B	
WH / 5308	DIESEL GEN 1B WATT HOUR METER	JEMSTAR JS33R6010 BS CNP	
25	BUS 1G SYNCHRONISM CHECK RELAY	GE/IJS51A	APPLICABLE TO CELLS DG01 & DG15
51 / DG02	4160V SWITCHGEAR 1L OVER CURRENT RELAY	GE/IAC53B	
50G	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	VERY INVERSE TIME GROUND RELAY	GE/IAC54A	APPLICABLE TO CELLS DG01 & 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 MAIN CONT. BRD METER & RELAY PNL
27-1,2 / DG14	BUS 1G UNDER VOLTAGE RELAY	GE/IAV54E	
WH / DG15	START UP TRANS 1B WATT HOUR METER	JEMSTAR JS33R6010 -BS-CNP	
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-DG01 (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

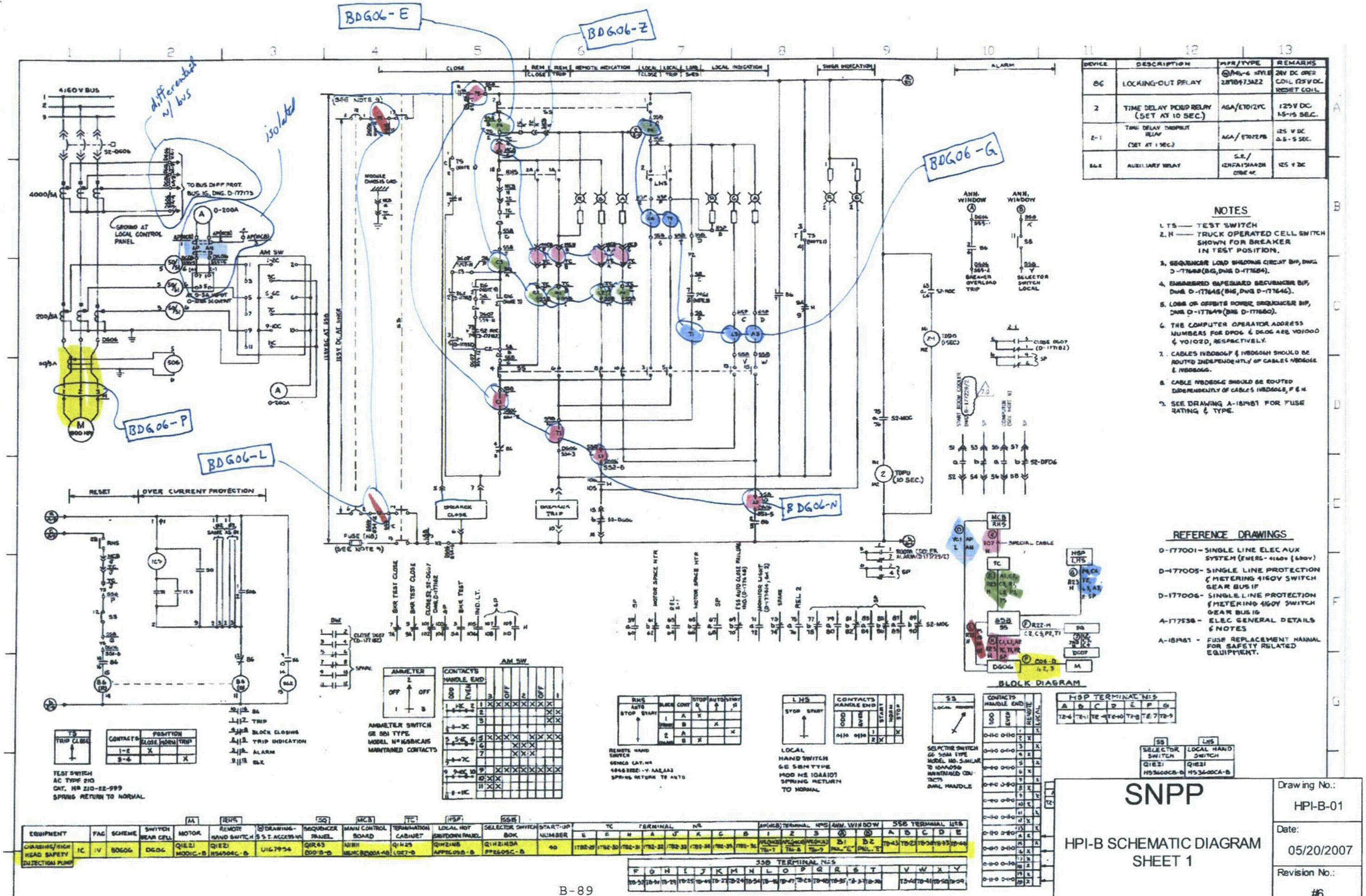
REFERENCE DRAWINGS

E 177031 SINGLE LINE ELEC AUX SYSTEM (EMERG 4160V & 480V)

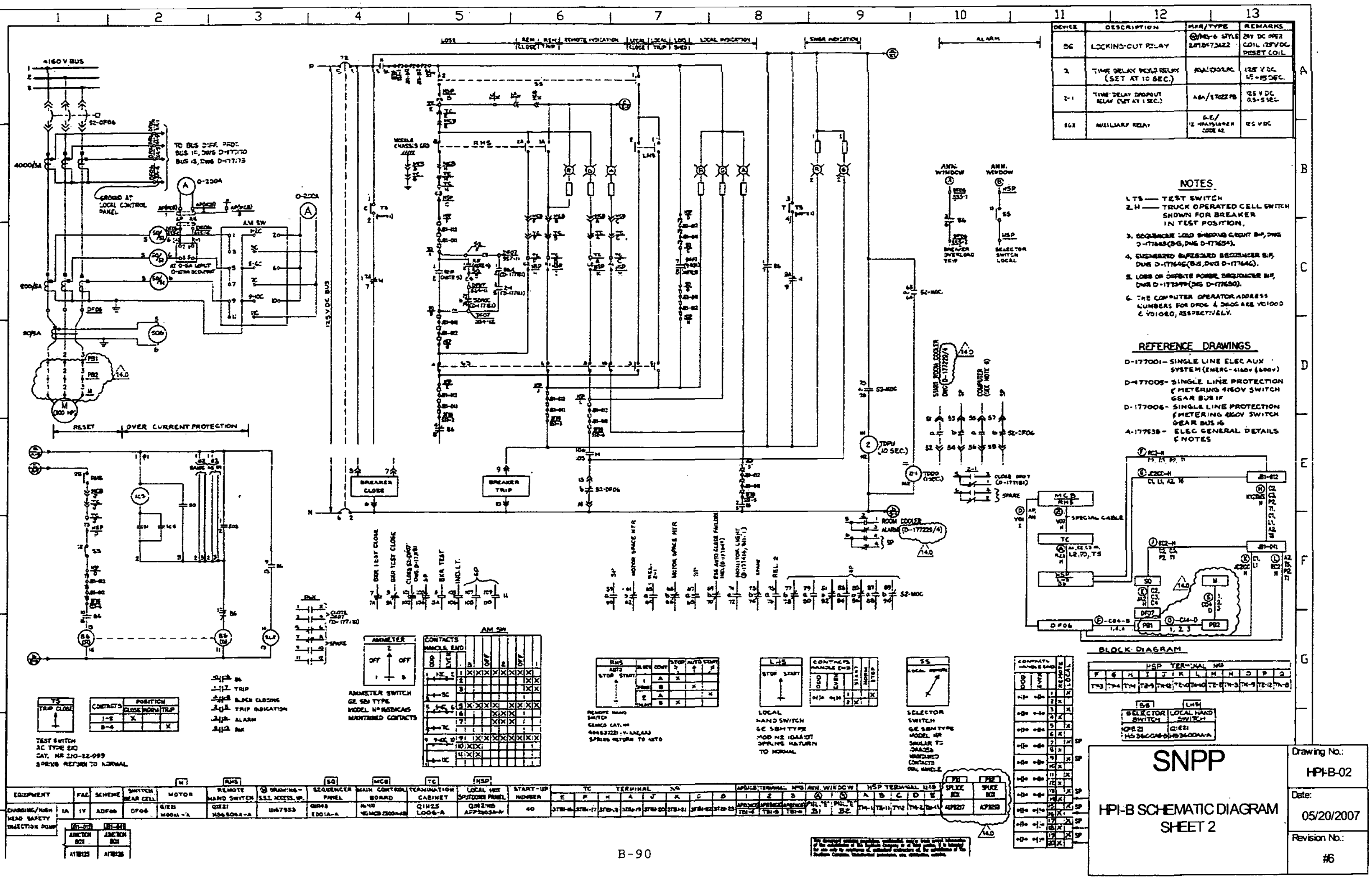
SNPP

4.16 KV SWGR-B ONE-LINE DIAGRAM

Drawing No.:	SWGR-B-01
Date:	05/20/2007
Revision No.:	#6



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



4160 V BUS
NOTES
1. TS — TEST SWITCH
2. H — TRUCK OPERATED CELL SWITCH SHOWN FOR BREAKER IN TEST POSITION.
REFERENCE DRAWINGS
D-177001 - SINGLE LINE ELEC AUX SYSTEM
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
DEVICE
DESCRIPTION
MFR/TYPE
REMARKS
LOCKING-OUT RELAY
TIME DELAY PICKUP RELAY (SET AT 10 SEC.)
TIME DELAY DROPOUT RELAY (SET AT 1 SEC.)
AUXILIARY RELAY
RESET
OVER CURRENT PROTECTION
BREAKER CLOSE
BREAKER TRIP
125 V DC BUS
AM SW
BLOCK DIAGRAM
HSP TERMINAL NO
AMMETER SWITCH
TEST SWITCH
LOCAL HAND SWITCH
SELECTOR SWITCH
EQUIPMENT
MOTOR
SNPP
HPI-B SCHEMATIC DIAGRAM
SHEET 2
Drawing No.:
HPI-B-02
Date:
05/20/2007
Revision No.:
#6

CIRCUIT ANALYSIS WORKSHEET

Exercise 13

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: LC-1 Breaker: LC1-15

Breaker:

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments
YEG06-P	Yes	Power	LOP	
YEG06-A	Yes	Control	LOP	Faults could cause LOP to Air Compressor Skid
YEQ17-A	Yes	Control	Loss of Cooling H_2O, LOC	
YEQ17-B	Yes	Control	LOC	
YEQ17-E	Yes	Control	LOC	
YEQ17-I	Yes	Control	LOC	
YEQ17-H	Yes	Control	Fail off	
YEQ17-M	Yes	Control	LOC, fail off	

Comments:

1. Air Compressor Sequence Control Mounted on COMP-1 skid

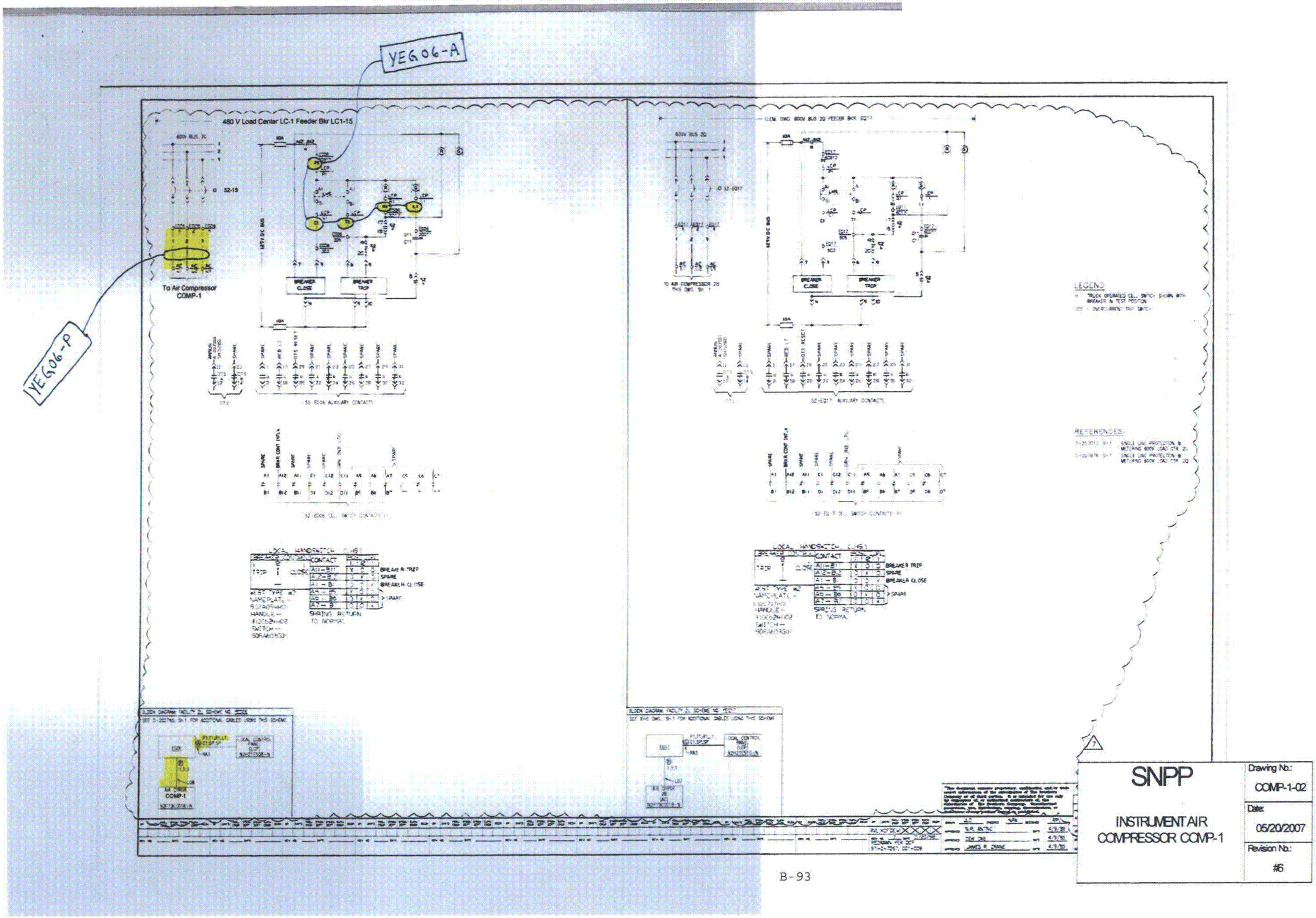
2. Motor winding heater not required

CIRCUIT ANALYSIS WORKSHEET

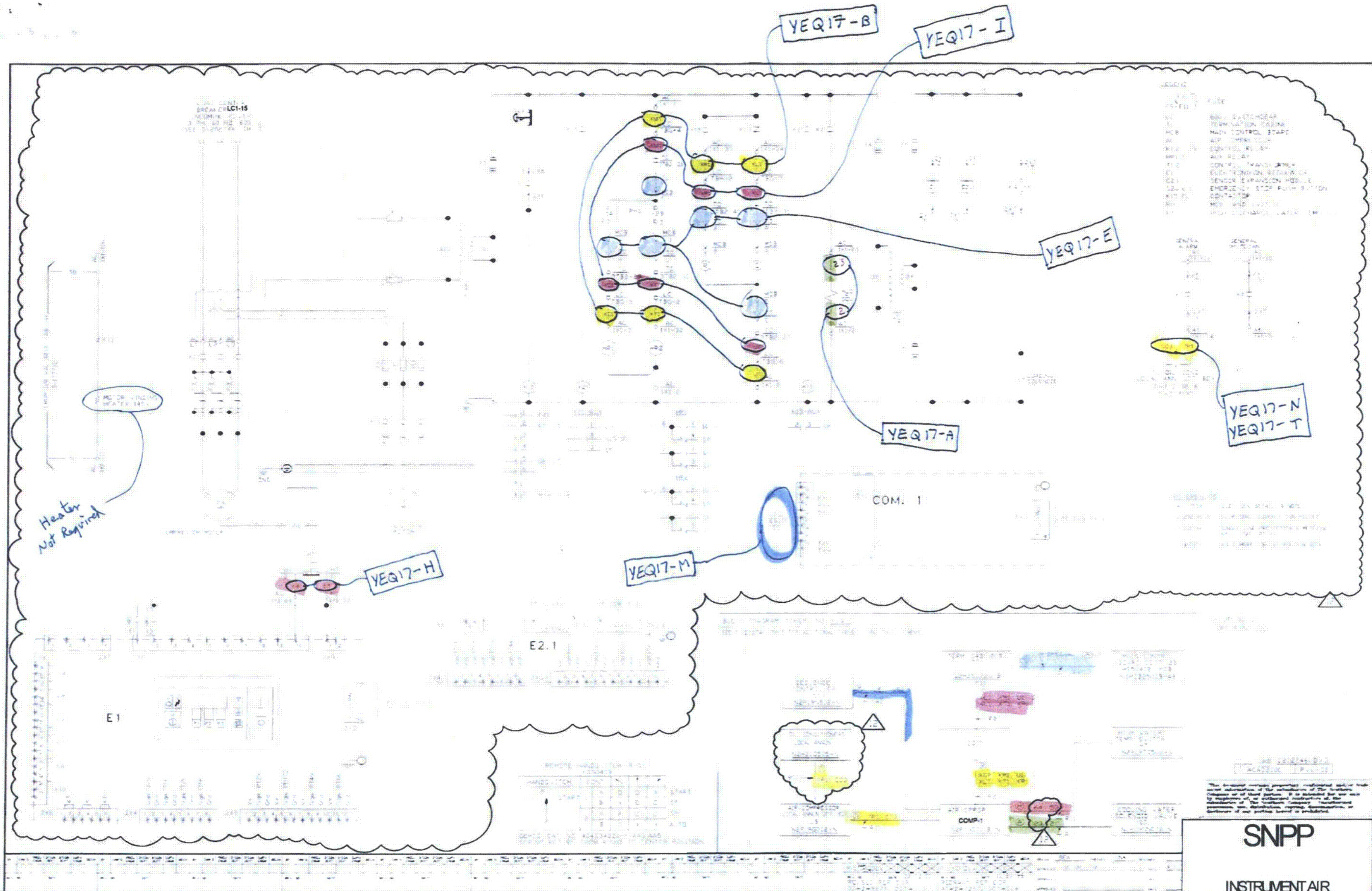
Component ID: COMP-1 Continuation Sheet (2 of 2)

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments
YEQ17-N	N	IND	NONE	ANNUNCIATION ONLY
YEQ17-T	N	IND	NONE	ANNUNCIATION ONLY



YEG06-A
YEG06-P
480 V Load Center LC-1 Feeder Bkr LC1-15
52-15
To Air Compressor COMP-1
BREAKER CLOSE
BREAKER TRIP
LOCAL HANDSWITCH (LHS)
CONTACT
BREAKER TRIP
SPARE
BREAKER CLOSE
SPRING RETURN TO NORMAL
LEGEND
REFERENCES
SNPP
INSTRUMENT AIR COMPRESSOR COMP-1
Drawing No.:
COMP-1-02
Date:
05/20/2007
Revision No.:
#6



SNPP

INSTRUMENT AIR COMPRESSOR COMP-1

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

Example 14

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:

CIRCUIT ANALYSIS WORKSHEET

Exercise 15 (Note: No detailed description, nor solution, of Exercise 14 on prev. pg. is available.)

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: SST-B Breaker: N/A

PNL-B Breaker: 11

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments
AED02-A	Yes	Control	LOC, Loss-Protection	
AED02-B	Yes	Control	LOC, Loss-Protection	
AED02-Z	Yes	Control	LOC, Loss-Protection	
AED12-A	No	Control	None	Kirk-Key Interlock
AED12-B	No	Control	None	Kirk-Key Interlock
AED12-P	No	Power	None	LOP from LC-1F
AED12-Q	No	Power	None	LOP from LC-1F
AED12-R	No	Power	None	LOP from LC-1F

Comments:

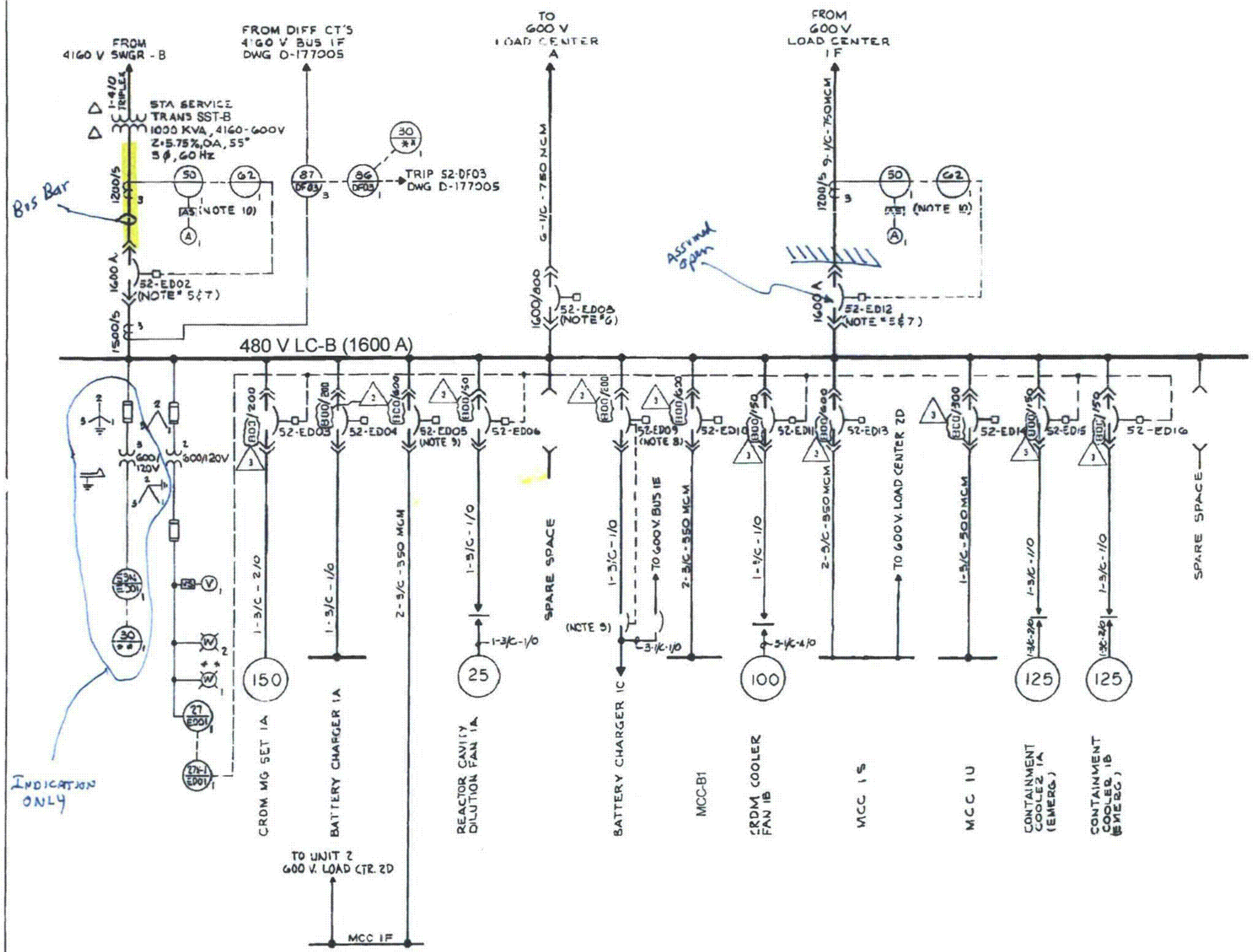
CIRCUIT ANALYSIS WORKSHEET

Component ID: LC-B　　　　Continuation Sheet (2 of 2)

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments
AED12-W	N	C	NONE	KIRK-KEY INTERLOCK
ALIB06-A	Y	P	Loss of Control Pwr	Supply Breakers
ALIB06-B	Y	P	Loss of Control Pwr	Feeder Breakers
ADF14-Y	Y	C	Fail Load Shed	
AEA01-Y	Y	C	Fail Load Shed	
AED01-A	Y	C	Fail Load Shed	
AED01-B	Y	C	Fail Load Shed	

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	[illegible]	
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	



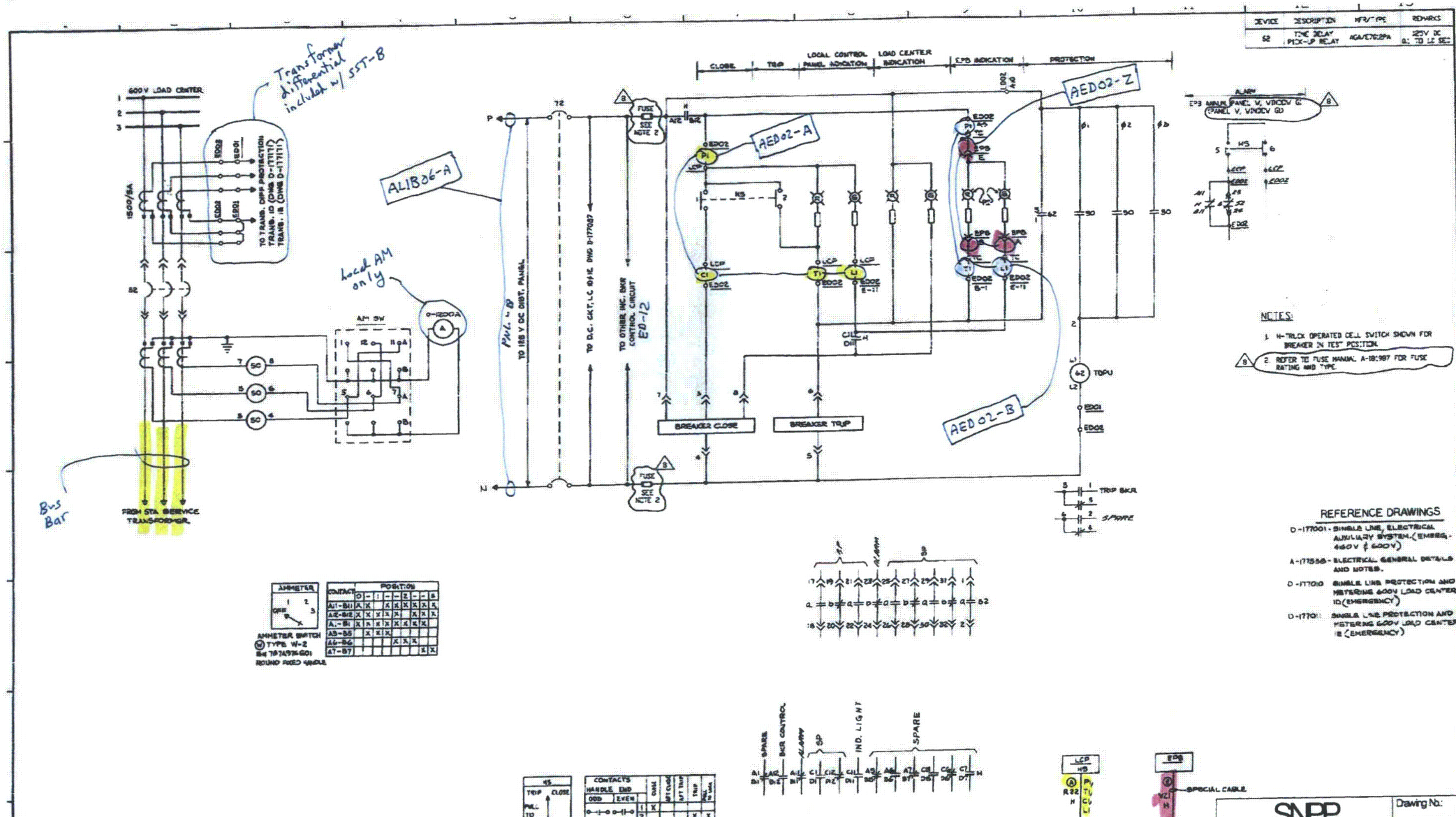
NOTES

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 ED06 IS ELECTRICALLY INTERLOCKED WITH UNIT 2 BREAKER ED06 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 8590, 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

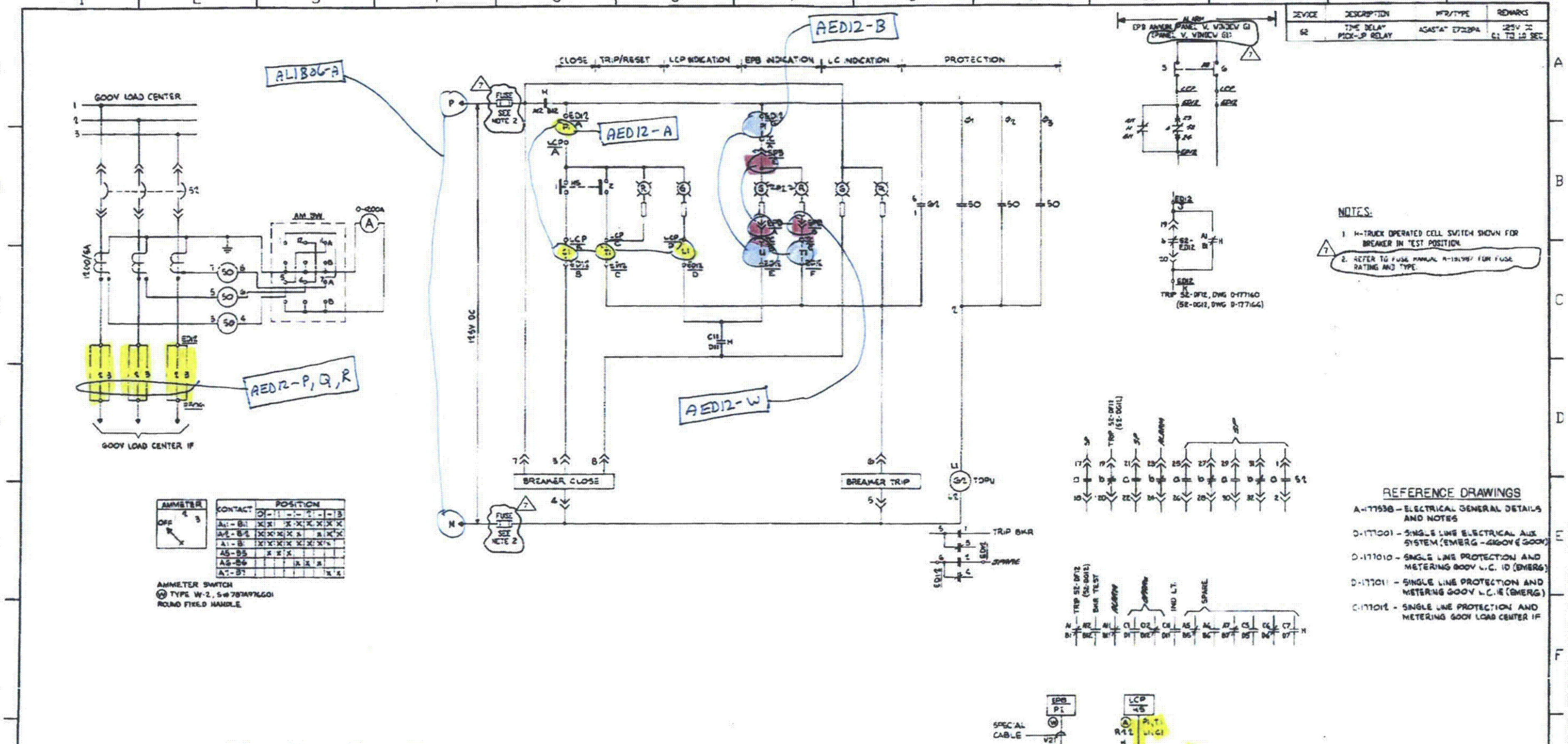


EQUIPMENT		FAC	SCHEME	LOAD CENT COMPT.	LOCAL CONTROL PANEL (LCP)	START UP NUMBER	EMERGENCY POWER BOARD (EPB)	TERMINATION CABINET (TC)	POSITION INDICATOR LIGHT (PI)
INCOMING BREAKER TO 600V LOAD CENTER	1D	IV	AED02	ED02	Q1H21 E009-A	5	Q5H1NG EPB2508-AB	Q1H25 L037-A	Q:216 ZL20158A-A
	1E	IV	BEE02	EE02	Q1H21 E010-B	5	Q5H1NG EPB2508-AB	Q1H25 L039-B	Q:216 ZL20158A-B

SNPP

52-ED-02
BREAKER SCHEMATIC

Drawing No.: LC-B-02
Date: 05/20/2007
Revision No.: #6



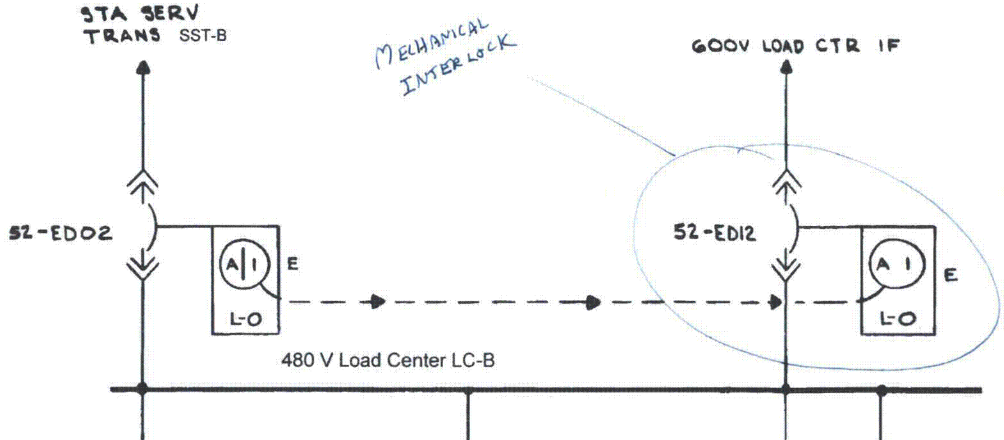
EQUIPMENT		FAC	SCHEME	L.C. COMPT.	LOCAL CONTROL PANEL (LCP)	EMERG POWER BOARD (EPB)	TERMINATION CABINET (TC)	POSITION IND. LIGHTS (PI)	START-UP NUMBER	L.C. COMPT
INCOMING 600V LOAD CENTER BREAKER	ID	IV	AED12	ED12	QH21 EC09-A	QSHING EPB1508-AB	QH25 L037-A	QIR6 ZL2018MA-A	5	EF06
	IE	V	BEE12	EE12	QH42 E010-B	QSHING EPB1508-AB	QH13 L039-B	QIR6 ZL2019MA-B	5	EF08

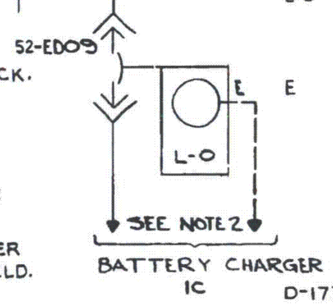
LOAD CENTER COMPARTMENT	A	B	C	D	E	F	G	H	I	J	K
ED12	A-5	A-7	B-1	E-1	E-11	B-2	A-6	B-5	B-4	C-11	C-12
EE12	A-5	A-7	B-1	E-11	E-11	B-2	A-4	B-5	B-4	C-11	C-12

LOCAL CONTROL PNL	A	B	C	D
ED12	TB7-5	TB7-11	TB7-14	TB7-12
EE12	TB10-5	TB10-6	TB10-7	TB10-8

TERMINATION CABINET	A	B	C
QH25L037-A	1TB2-38	1TB2-36	1TB2-37
QH25L039-B	3TB1-33	3TB1-31	3TB1-32

SNPP	Drawing No.: LC-B-03
52-ED-12 SCHEMATIC	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

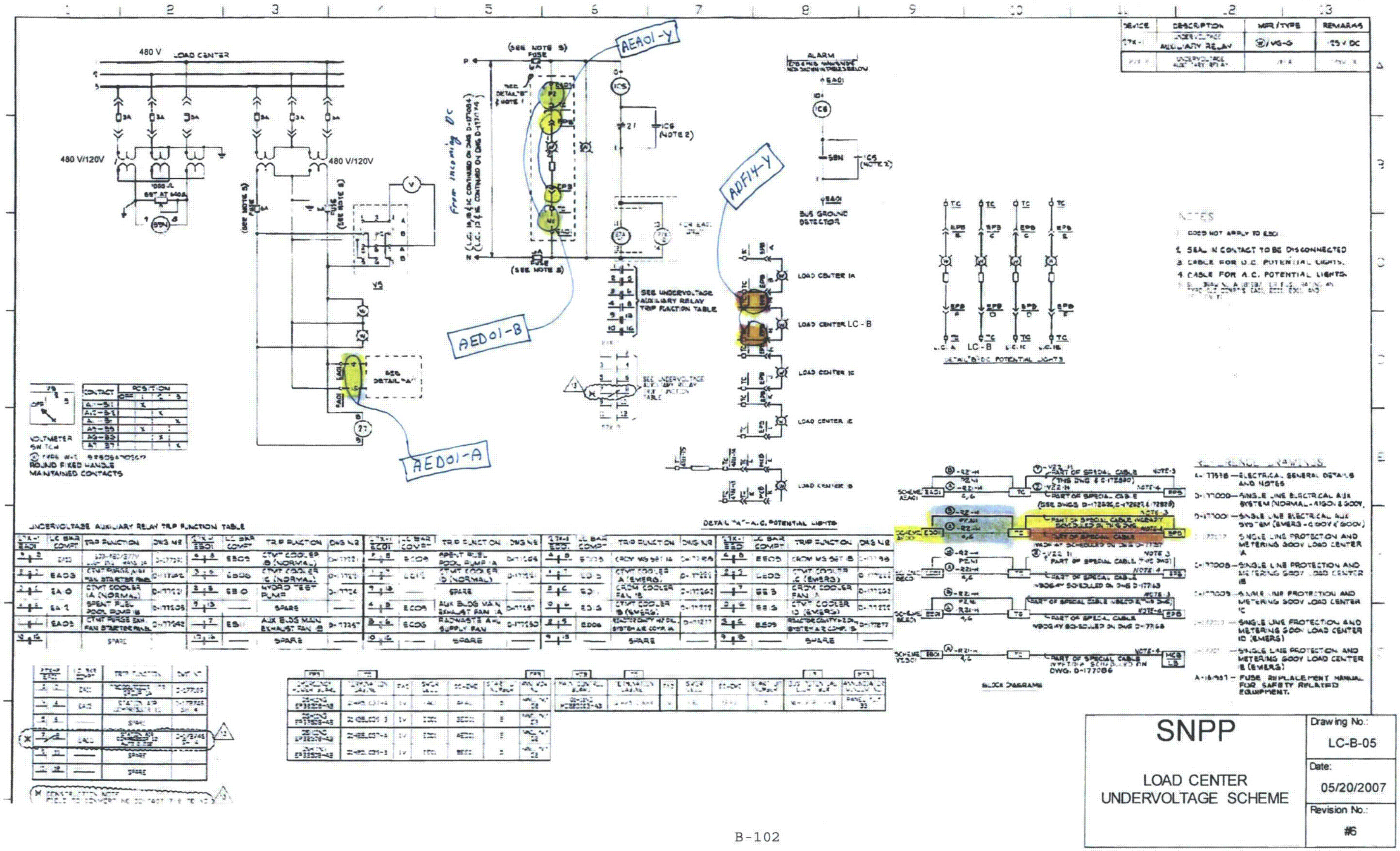
REFERENCE DWG.

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

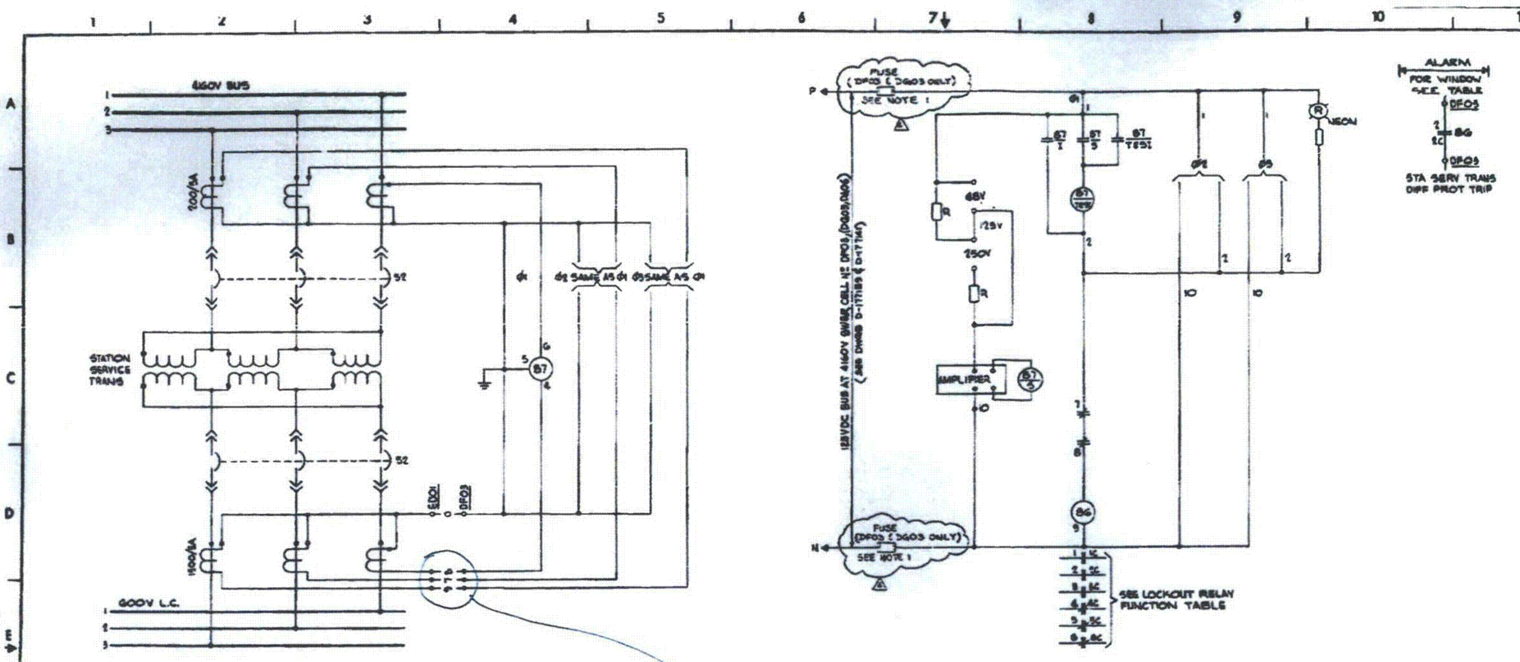
C-177010 - SINGLE LINE PROTECTION & METERING 600V LOAD CENTER 1D

A-177538 - ELEC GEN DETAILS & NOTES

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

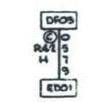

480 V LOAD CENTER
480 V/120V
480 V/120V
AEA01-Y
ADF14-Y
AED01-B
AED01-A
From incoming DC
SEE UNDERVOLTAGE AUXILIARY RELAY TRIP FUNCTION TABLE
ALARM
BUS GROUND DETECTOR
LOAD CENTER 1A
LOAD CENTER LC-B
LOAD CENTER 1C
LOAD CENTER 1E
LOAD CENTER 1B
DETAIL "A" - A.C. POTENTIAL LIGHTS
NOTES
VOLTMETER SWITCH
ROUND FIXED HANDLE
MAINTAINED CONTACTS
UNDERVOLTAGE AUXILIARY RELAY TRIP FUNCTION TABLE
DEVICE
DESCRIPTION
MFR./TYPE
REMARKS
UNDERVOLTAGE AUXILIARY RELAY
125 V DC
REFERENCE DRAWINGS
BLOCK DIAGRAMS
SNPP
LOAD CENTER
UNDERVOLTAGE SCHEME
Drawing No.:
LC-B-05
Date:
05/20/2007
Revision No.:
#6

DEVICE	DESCRIPTION	MFR/TYPE	REMARKS
86	LOCKOUT RELAY	GE/HEA61A223	125V DC



ED01-C

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



BLOCK DIAGRAM

LOCKOUT RELAY FUNCTION TABLE

86 DF03	FUNCTION	DWG No	86 DG03	FUNCTION	DWG No	86 DA06	FUNCTION	DWG No
1-1C	TRIP BKR 52-DF03	C-177159	1-1C	TRIP BKR 52-DG03	C-177159	1-1C	TRIP BKR 52-DA06	D-177141
2-2C	ALARM	TRS DWG	2-2C	ALARM	TRS DWG	2-2C	ALARM	TRS DWG
3-3C	SPARE	—	3-3C	SPARE	—	3-3C	SPARE	—
4-4C	SPARE	—	4-4C	SPARE	—	4-4C	BLOCK CLOSING BKR 52-DA06	D-177141
5-5C	BLOCK CLOSING BKR 52-DF03	C-177159	5-5C	BLOCK CLOSING BKR 52-DG03	C-177159	5-5C	SPARE	—
6-6C	SPARE	—	6-6C	SPARE	—	6-6C	SPARE	—

EQUIPMENT		FAC	SCHEME	SWGR CELL	LOAD CENTER COMPARTMENT	START-UP NUMBER	ANNUNCIATOR WINDOW No
DIFFERENTIAL RELAY FOR STATION SERV TRANSFORMER	1D	IV	ADF03	DF03	ED01	5	EPS PANEL "X" C-
	1G	IV	BDG03	DG03	EE01	5	EPS PANEL "Y" C-
	1I	IV	XDA06	DA06	EI01	5	MCB PANEL "L" E2

REFERENCE DRAWINGS

A-177536 — 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.

SNPP STATION SERVICE TRANSFORMER DIFFERENTIAL PROTECTION SCHEME	Drawing No.: LC-B-06
	Date: 05/20/2007
	Revision No.: #6

CIRCUIT ANALYSIS WORKSHEET

Exercise 16

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: LC-B

Breaker: ED-10

Breaker:

Cable Analysis:

Cable ID	Required?	Function	Fault Consequence	Comments
BEE10-P	Yes	Power	LOP	
BEE10-A	Yes	Control	LOC, SO	
BEE10-B	Yes	Control	LOC, SO	
BEE10-Z	Yes	Control	LOC, SO	

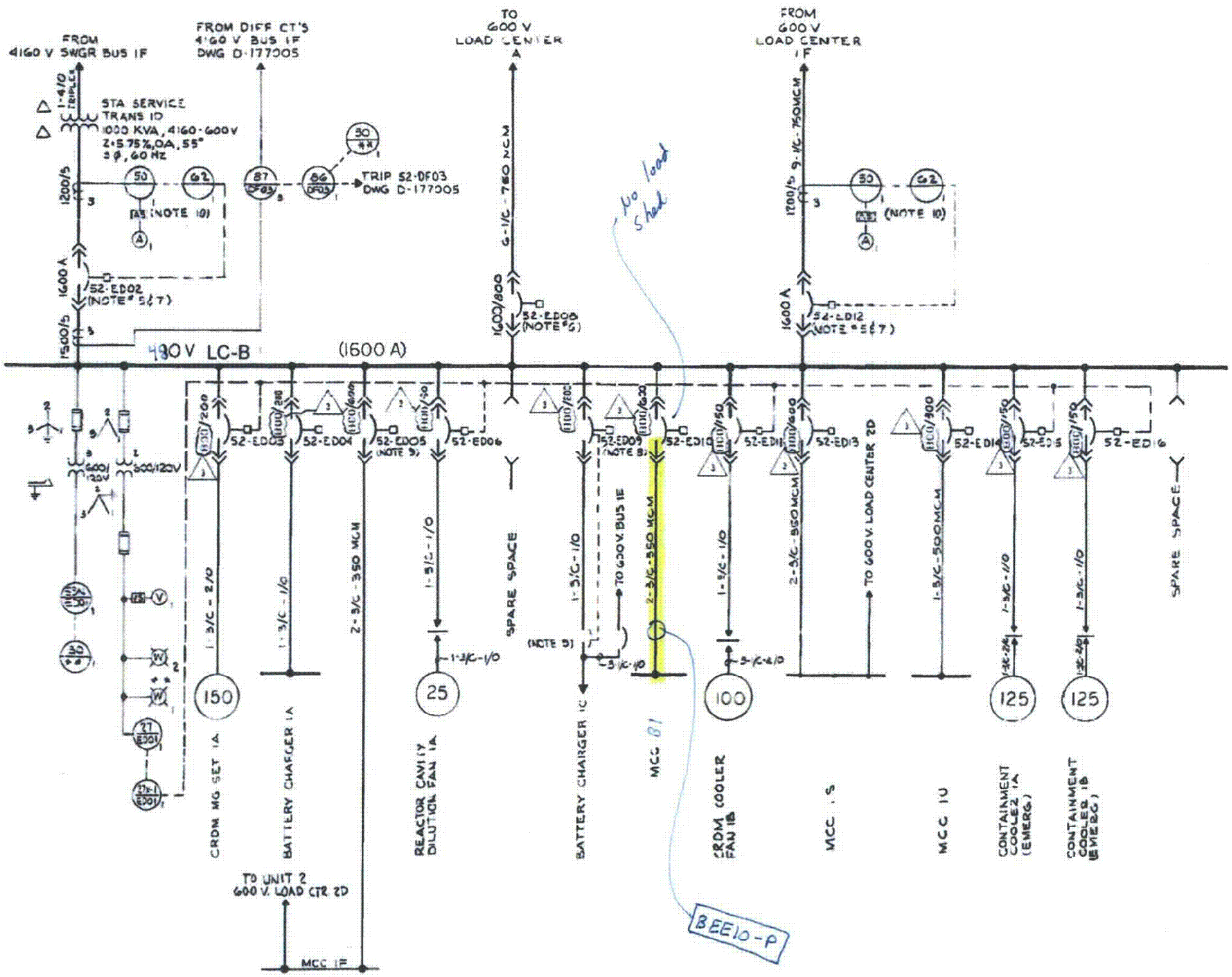
Comments:

1. Breaker control power included in analysis for LC-B.

2. MCC-1B has no main breaker. Power cables connected directly to bus.

3. Annunciation circuits not required for functionality.

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	



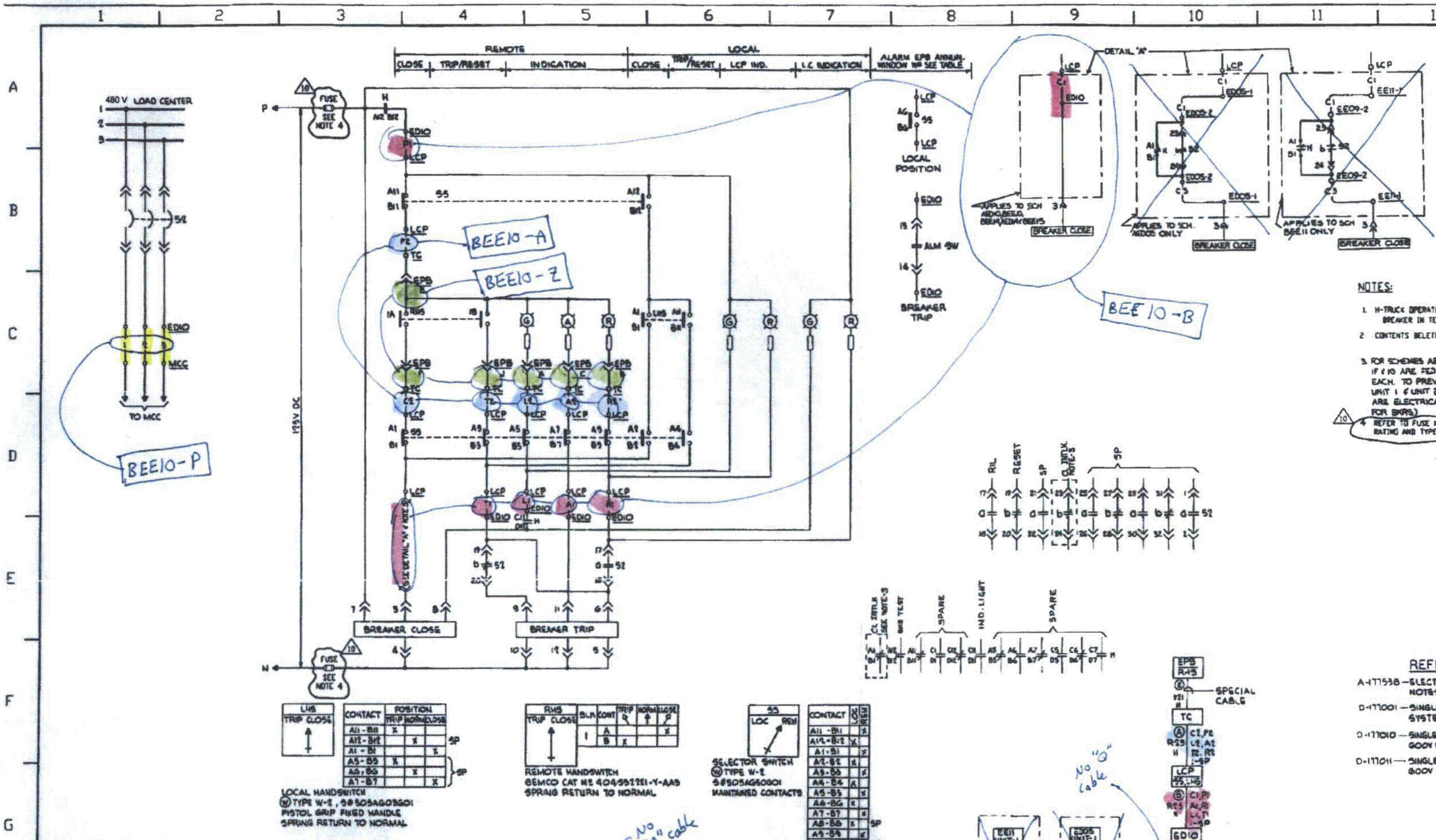
NOTES

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-177153).
9. UNIT 1 BREAKER ED06 IS ELECTRICALLY INTERLOCKED WITH UNIT 2 BREAKER ED06 TO PREVENT SIMULTANEOUS CLOSING OF BOTH BREAKERS
10. LOCATED IN TERMINAL BLOCK COMPARTMENT ABOVE ASSOCIATED BREAKER.
11. THIS DRAWING SUPERSEDES DRAWING [illegible]

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



NOTES:

1. H-TRUCK OPERATED CELL SWITCH SHOWN FOR BREAKER IN TEST POSITION.
2. CONTENTS DELETED
3. FOR SCHEMES AEDOS, AND BEE11 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. (10) 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-4IGOV & GOOV)

D-177010 — SINGLE LINE PROTECTION & METERING GOOV LOAD CENTER ID (EMERG)

D-177011 — SINGLE LINE PROTECTION & METERING GOOV LOAD CENTER IG (EMERG)

EQUIPMENT		FAC	SCHEME	L.C. COMPT.	LOCAL CONTROL PANEL (LCP)	EMERGENCY POWER BOARD (EPB)	TERMINATION CABINET (TC)	START-UP NUMBER	POWER CABLE CODE	MOTOR CONT CENTER (MCC)	CONDUCTOR NOS CABLE P	CONDUCTOR NOS CABLE Q	REMOTE HANDSWITCH (RHS)	EPB ANNUNCIATOR WINDOW NO. BKR ON LOCAL CONTROL	EPB ANNUNCIATOR WINDOW NO. BKR TRIP	LC COMPT
GOOV LOAD CENTER BKR'S TO MOTOR CONTROL CENTER	IA	IV	AEDIO	EDIO	QIH21EOO9-A	[illegible]	QIH25LO37-A	6	LO9-F	FA-AZ	1,2,3	1,2,3	[illegible]	PANEL V, WINDOW G2	PANEL V, WINDOW G1	
	IB	IV	BEEIO	EEIO	QIH21EO1O-B		QIH25LO39-B	6	LO9-F	FB-AZ	1,2,3	X	[illegible]	PANEL V, WINDOW G2	PANEL V, WINDOW G1	
	IF	IV	AEDO5	EDO5	QIH21EOO9-A		QIH25LO37-A	6	LO9-F	FF-AZ	1,2,3	1,2,3	[illegible]	PANEL V, WINDOW G2	PANEL V, WINDOW G1	EDO5-2
	IG	IV	BEE11	EE11	QIH21EO1O-B		QIH25LO39-B	6	LO9-F	FG-AZ	1,2,3	1,2,3	[illegible]	PANEL V, WINDOW G2	PANEL V, WINDOW G1	EEO9-2
	IT	IV	BEE14	EE14	QIH21EO1O-B		QIH25LO39-B	6	LO9-F	FT-A1	1,2,3	1,2,3	[illegible]	PANEL V, WINDOW G2	PANEL V, WINDOW G1	
	IU	IV	AEDI4	ED14	QIH21EOO9-A		QIH25LO37-A	6	L1O-F	FU-A1	1,2,3	X	[illegible]	PANEL V, WINDOW G2	PANEL V, WINDOW G1	
	IV	IV	BEE15	EE15	QIH21EO1O-B		QIH25LO39-B	6	L1O-F	FY-A1	1,2,3	X	[illegible]	PANEL V, WINDOW G2	PANEL V, WINDOW G1	

No "Q" cable

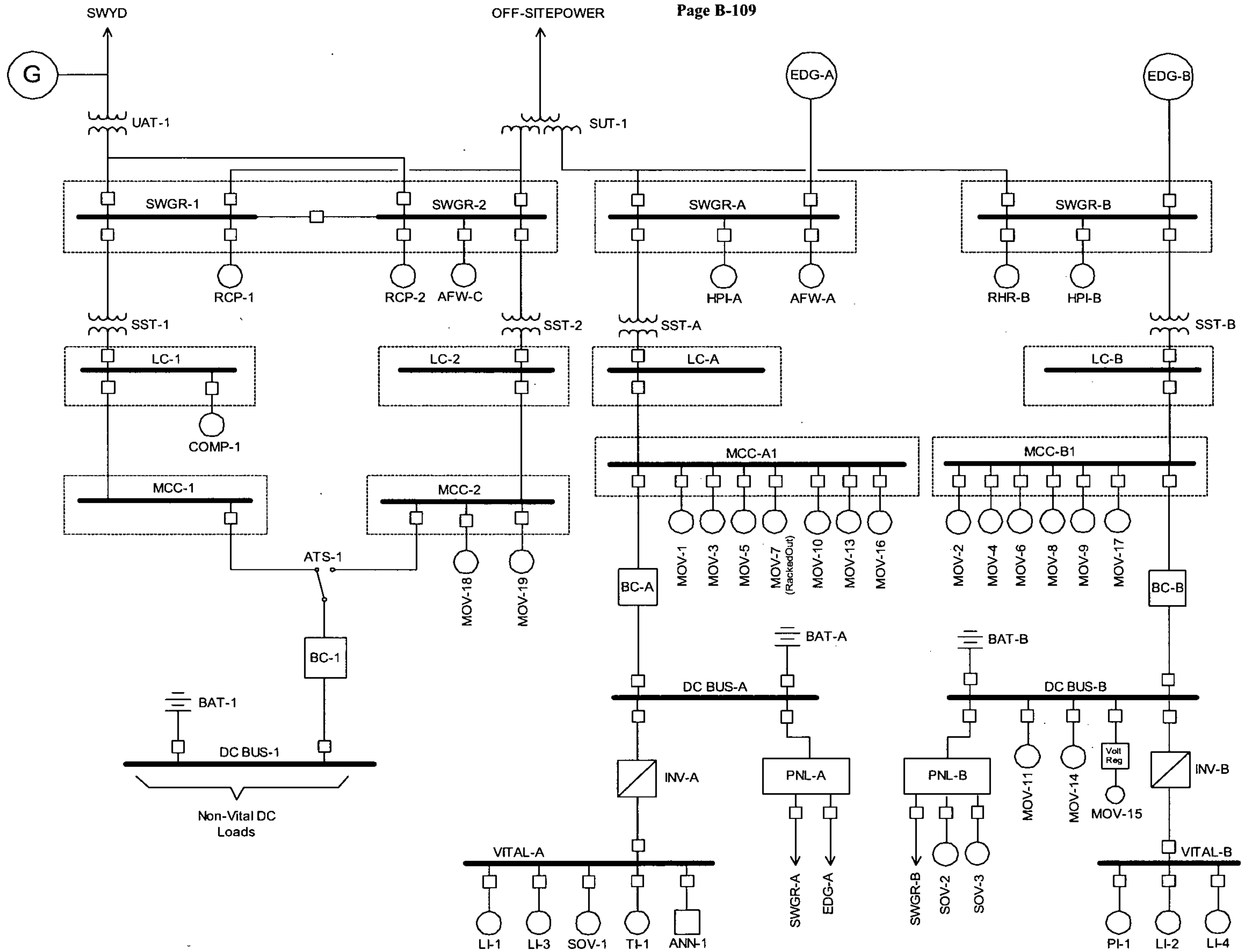
SNPP	Drawing No.: MCC-B1-01
MOTOR CONTROL CENTER MCC-1B	Date: 05/20/2007
	Revision No.: #6

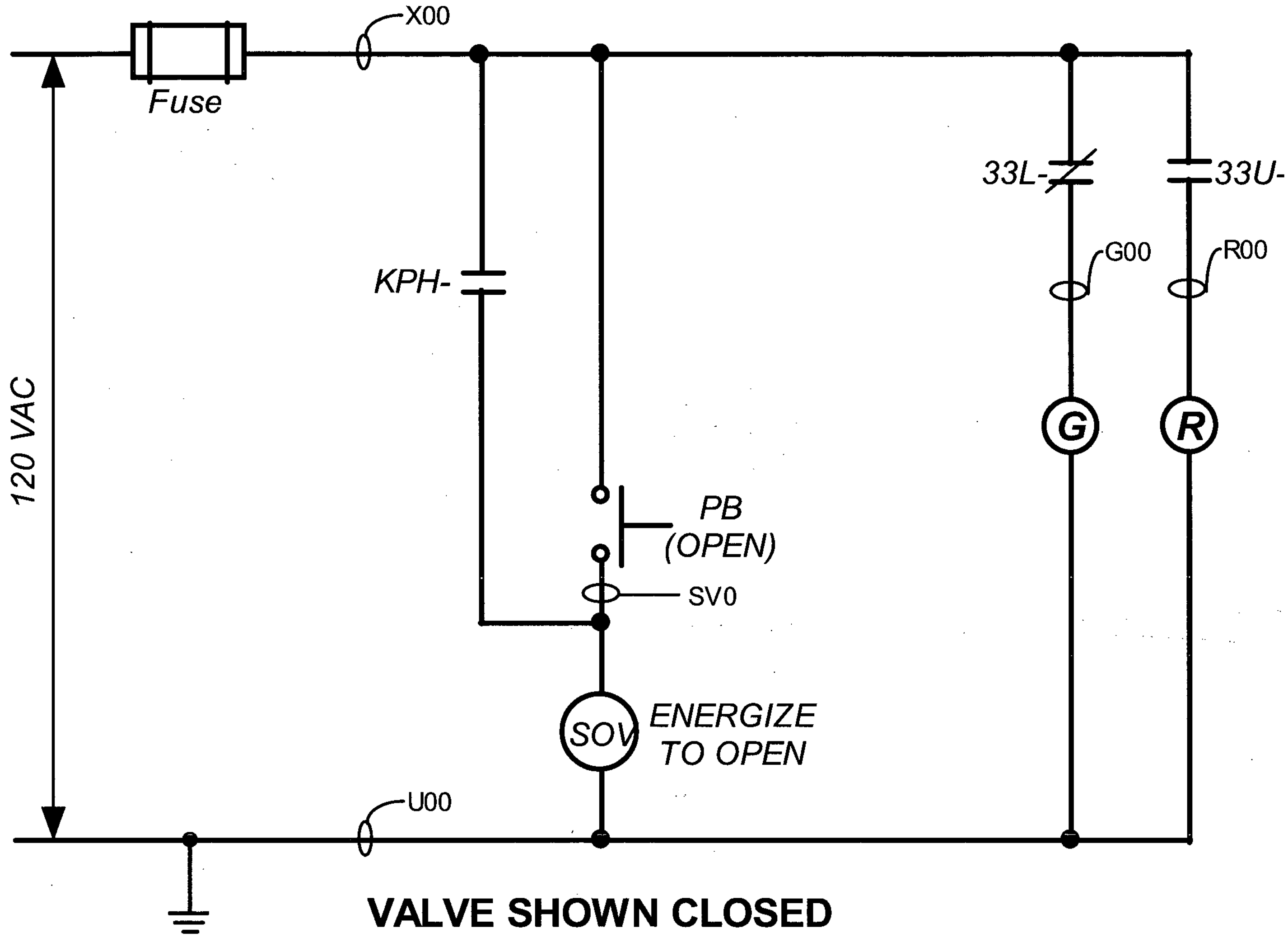
Drawings Needed in the Exercises

Drawing Pack 1 - Electrical Schematic Diagrams

ELECTRICAL DISTRIBUTION SYSTEM - SIMPLIFIED ONE-LINE DIAGRAM

Page B-109



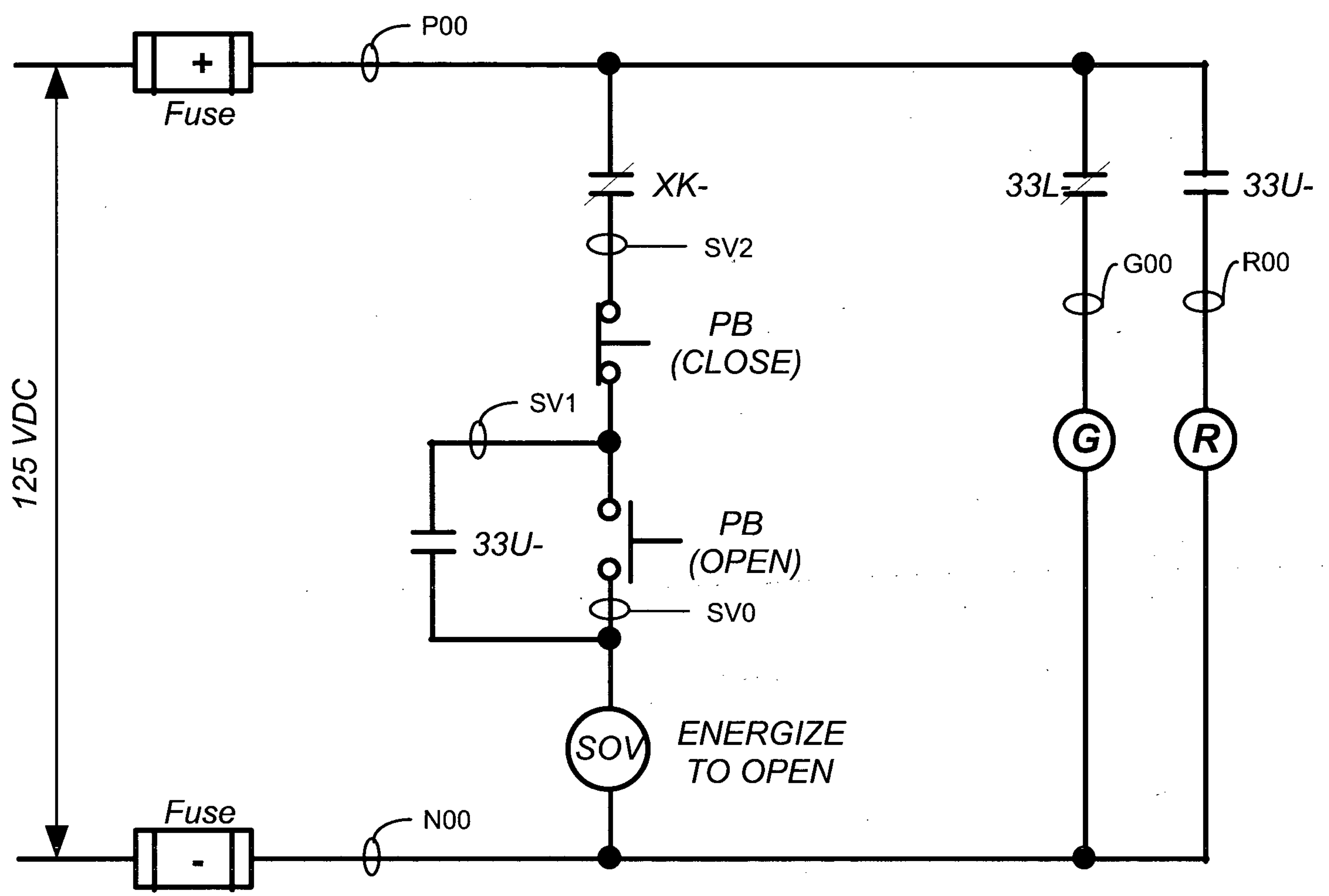


VALVE SHOWN CLOSED

SCHEME VA3

B-110

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



VALVE SHOWN CLOSED

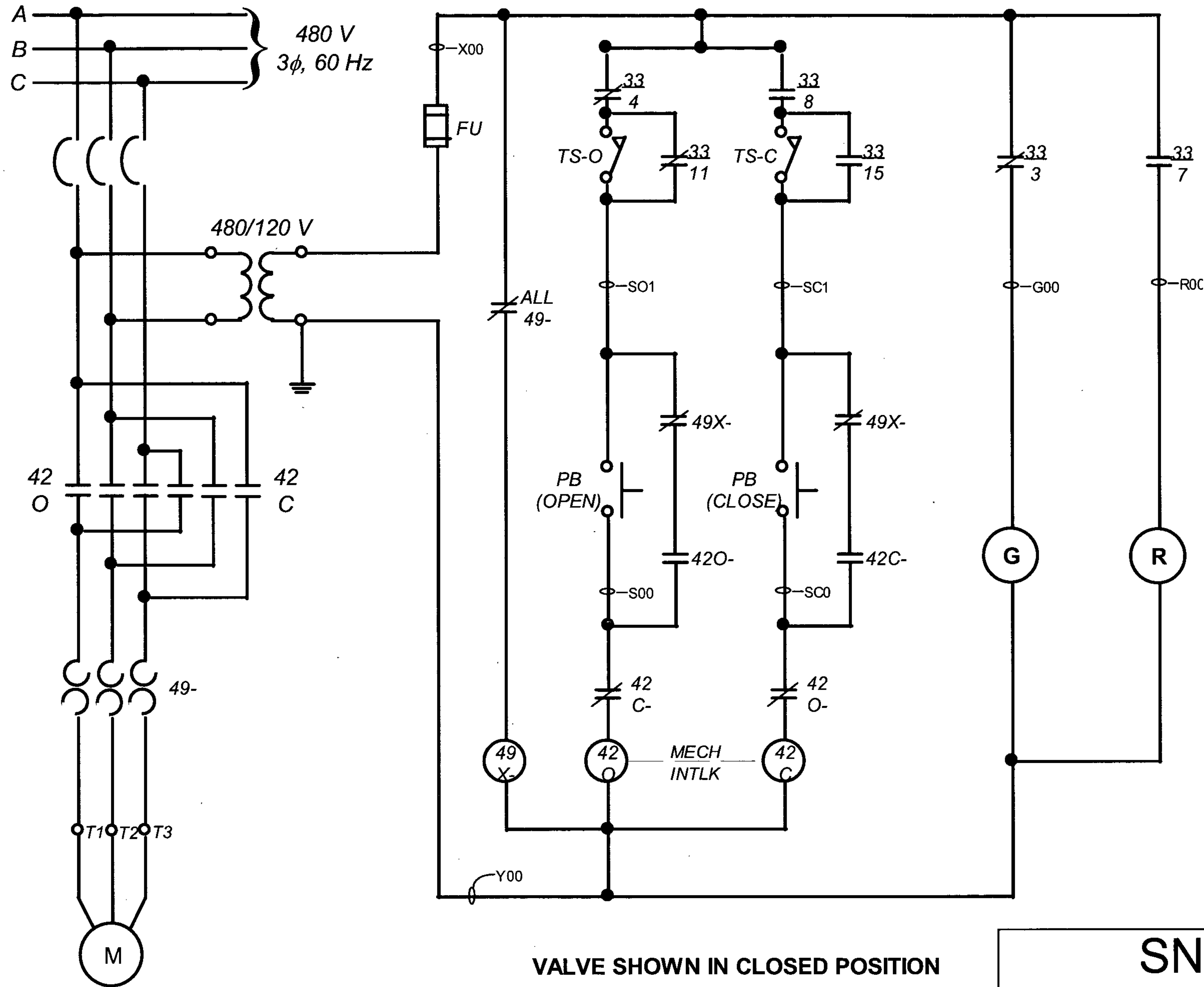
VALVE	DESCRIPTION	SCHEME	SWITCH ID
SOV-2	LETDOWN ISOLATION	PB2	AOV-2
SOV-3	CHARGING PUMP INJECTION	PB3	AOV-3

B-111

SNPP

SCHEMATIC DIAGRAM --
PRIMARY MAKEUP SYSTEM
SOLENOID VALVES
SOV-2 & SOV-3

Drawing No.:	E-02
Date:	07/25/2008
Revision No.:	1



VALVE SHOWN IN CLOSED POSITION

SNPP

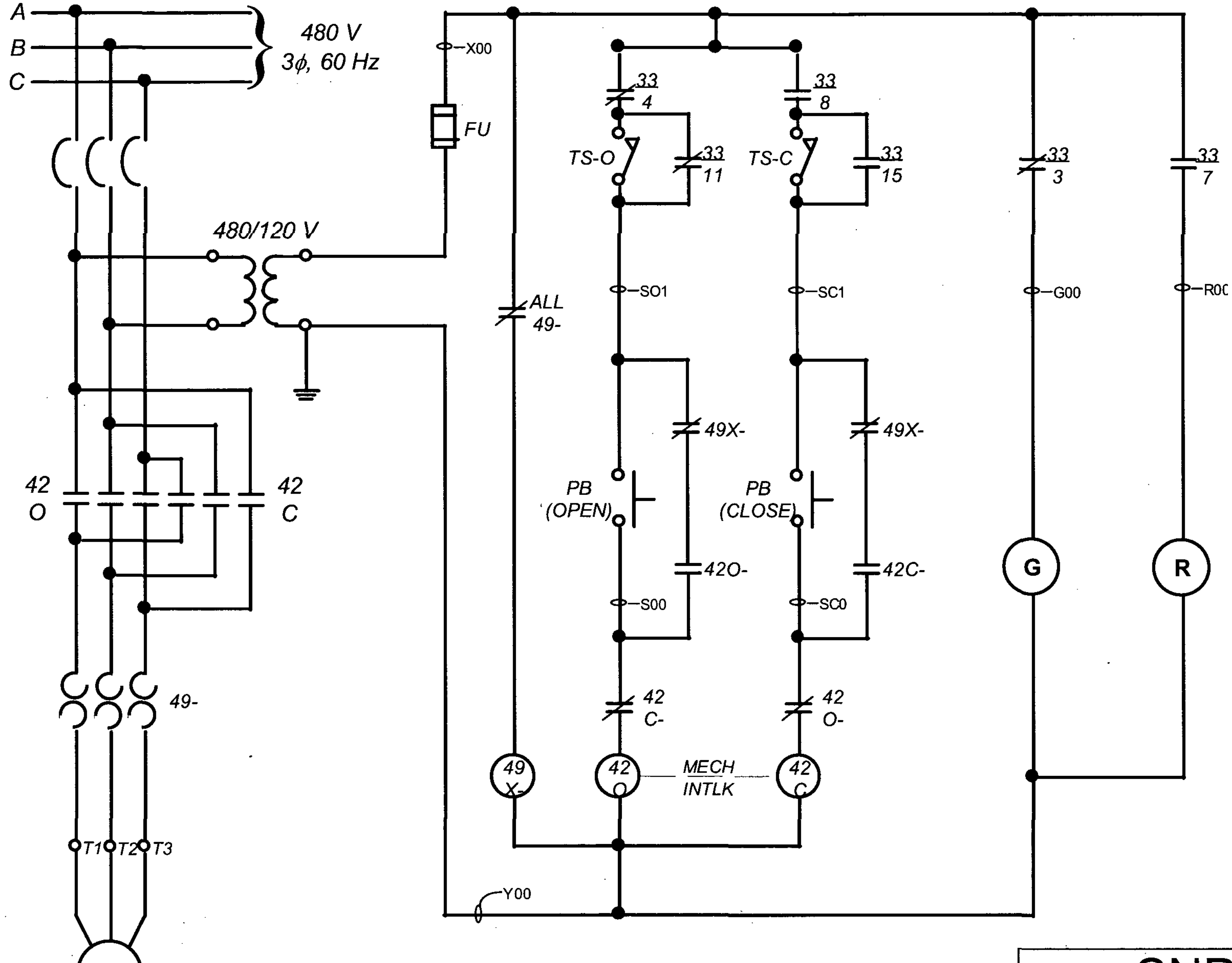
SCHEMATIC DIAGRAM – HIGH PRESSURE INJECTION MOTOR OPERATED VALVES MOV-1 & MOV-9

Drawing No.: E-04

Date: 05/01/2007

Revision No.: 0

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



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

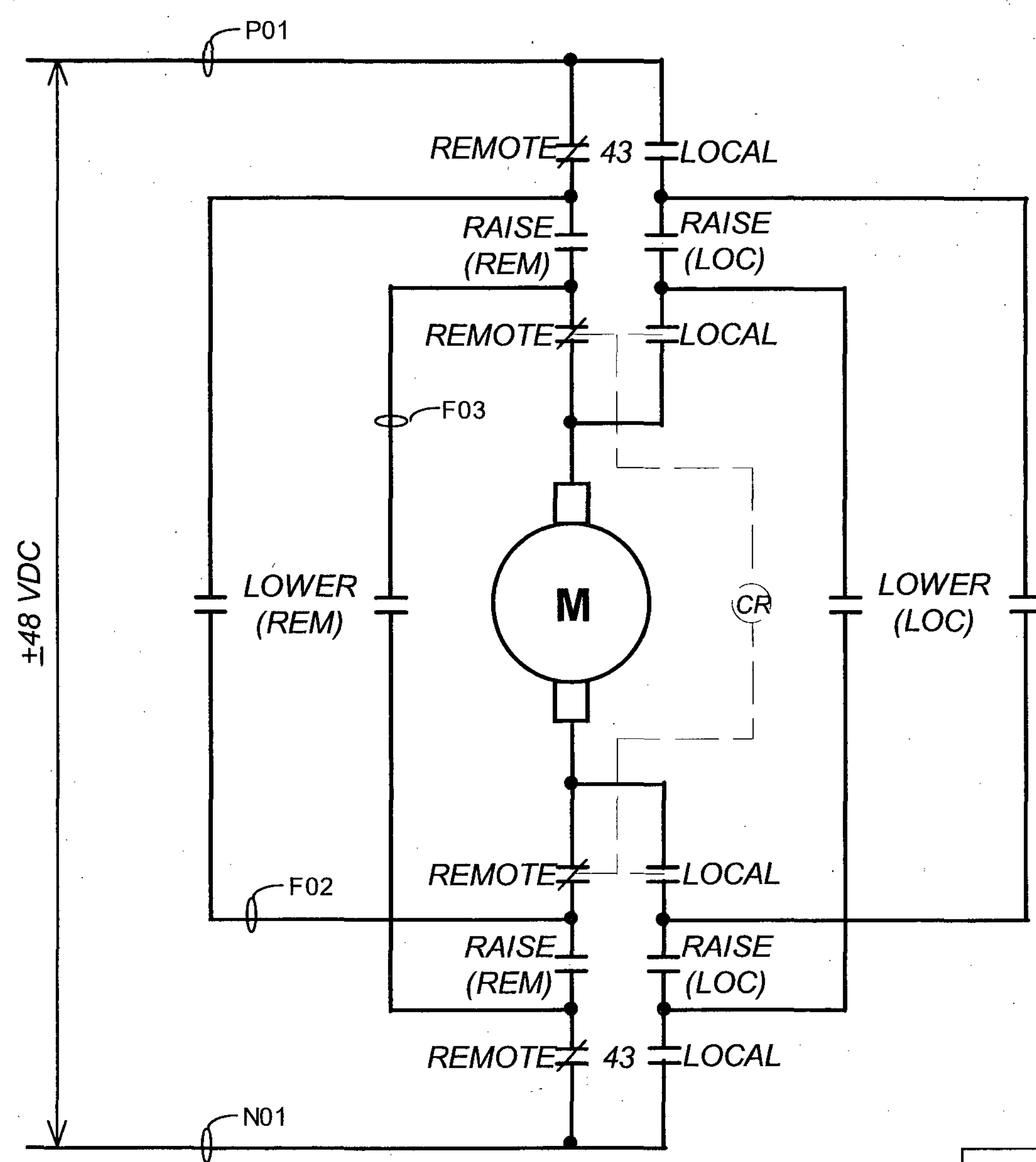
SNPP

SCHEMATIC DIAGRAM – AFW TEST LINE ISOLATION MOTOR OPERATED VALVES MOV-16 & MOV-17

Drawing No.: E-08

Date: 05/01/2007

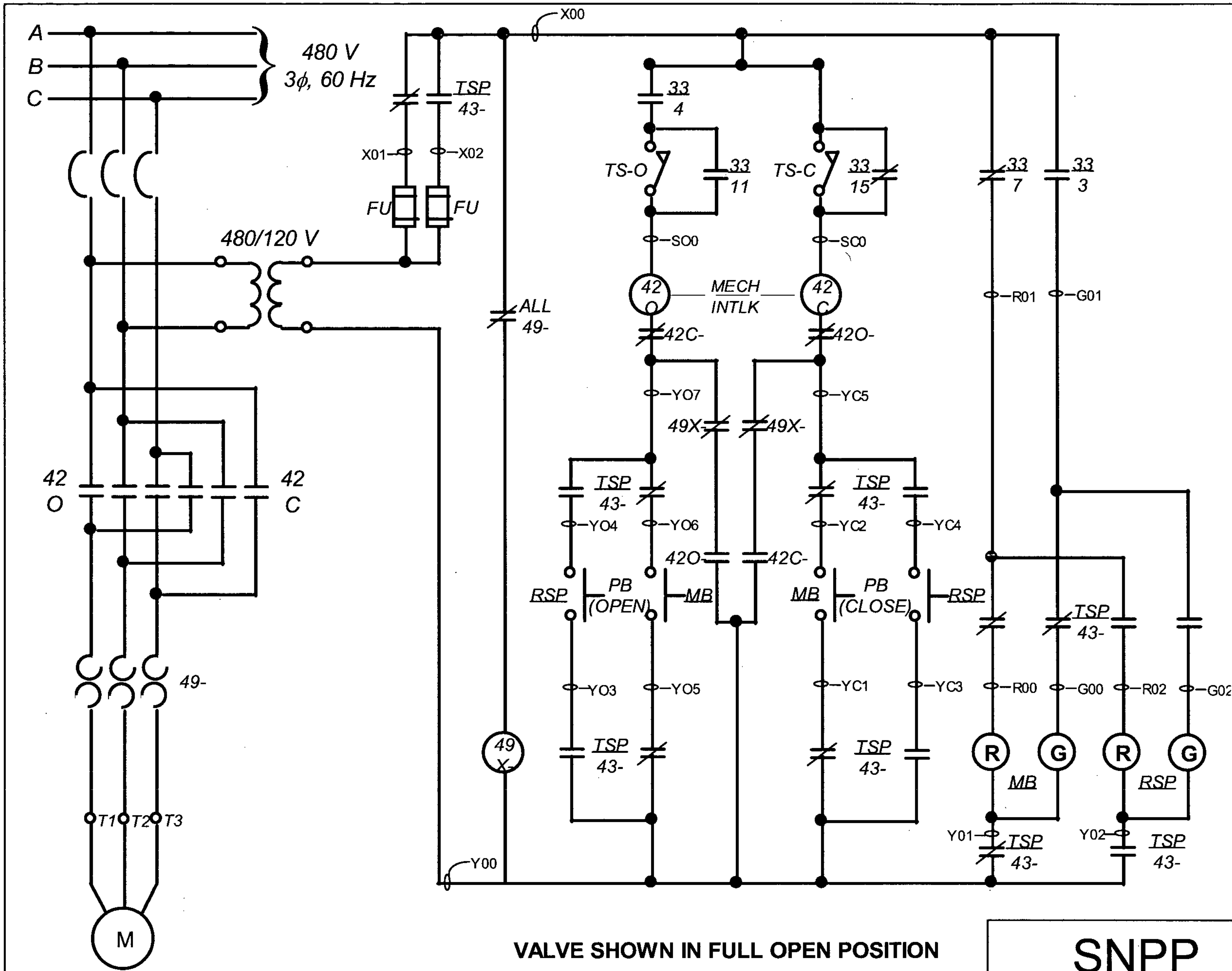
Revision No.: 0



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

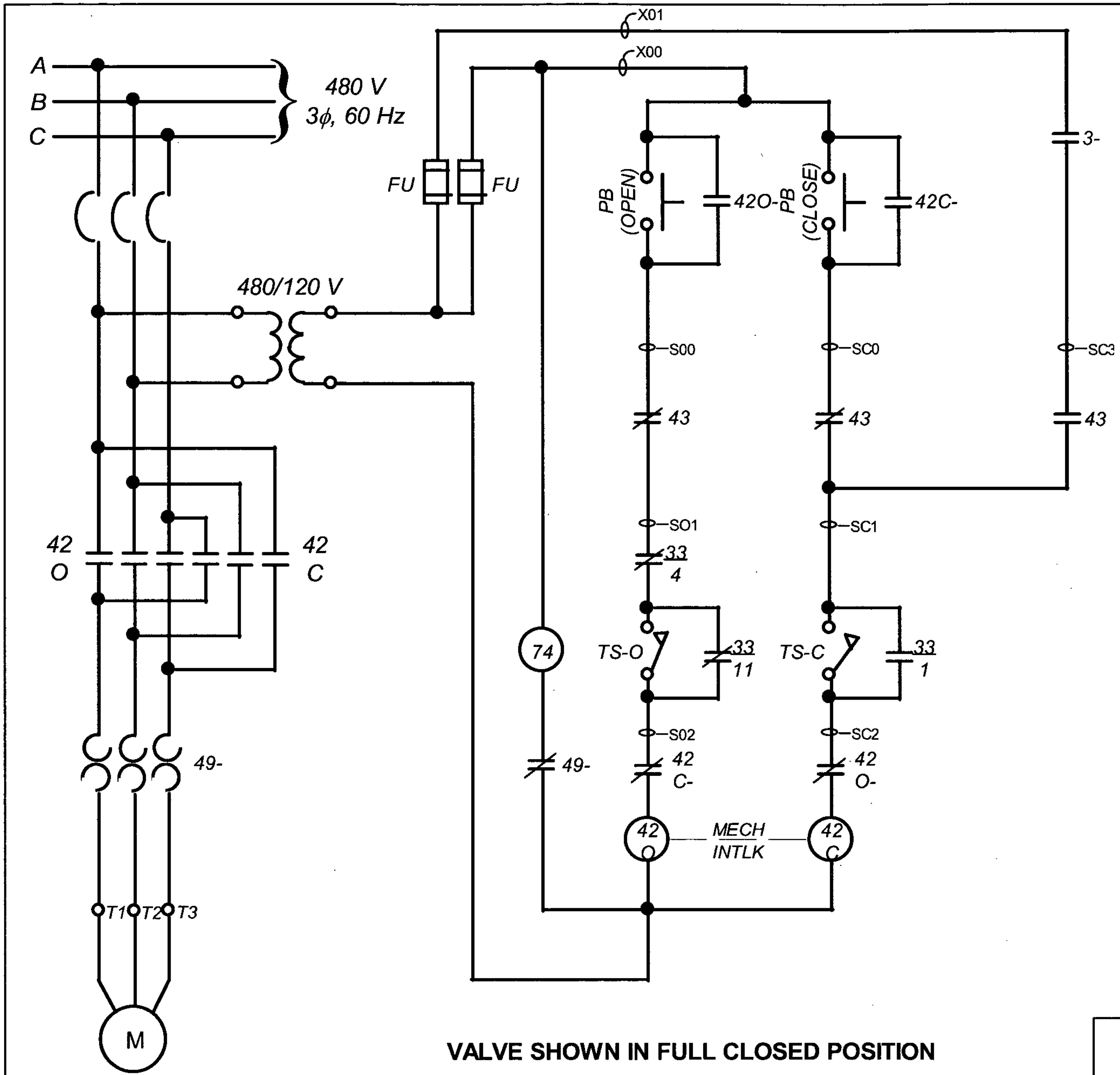


VALVE SHOWN IN FULL OPEN POSITION

MOV-13, SCHEME MA17

B-115

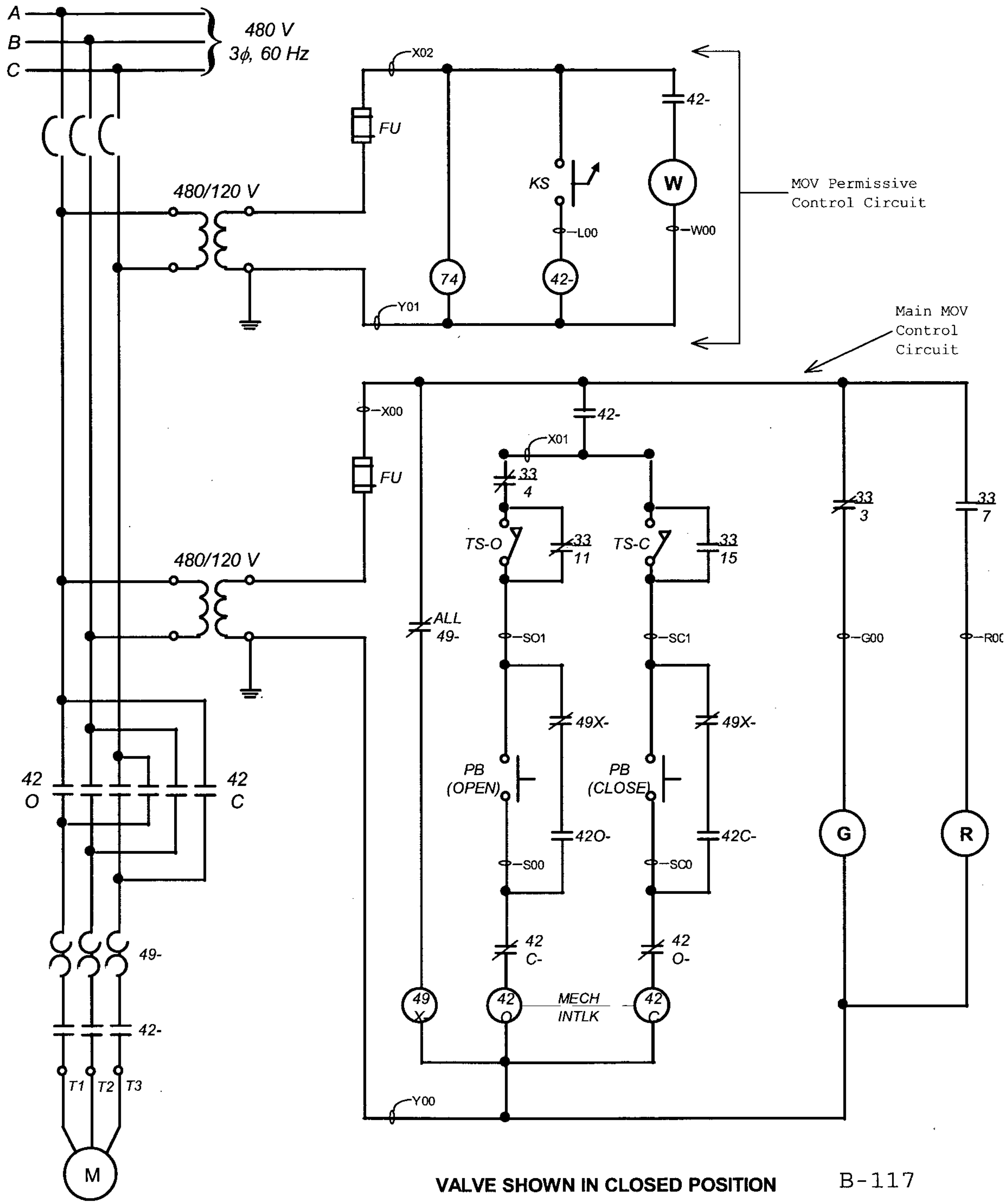
SNPP	Drawing No.: E-10
SCHEMATIC DIAGRAM – PORV BLOCK MOTOR OPERATED VALVE MOV-13	Date: 05/01/2007
	Revision No.: 0



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

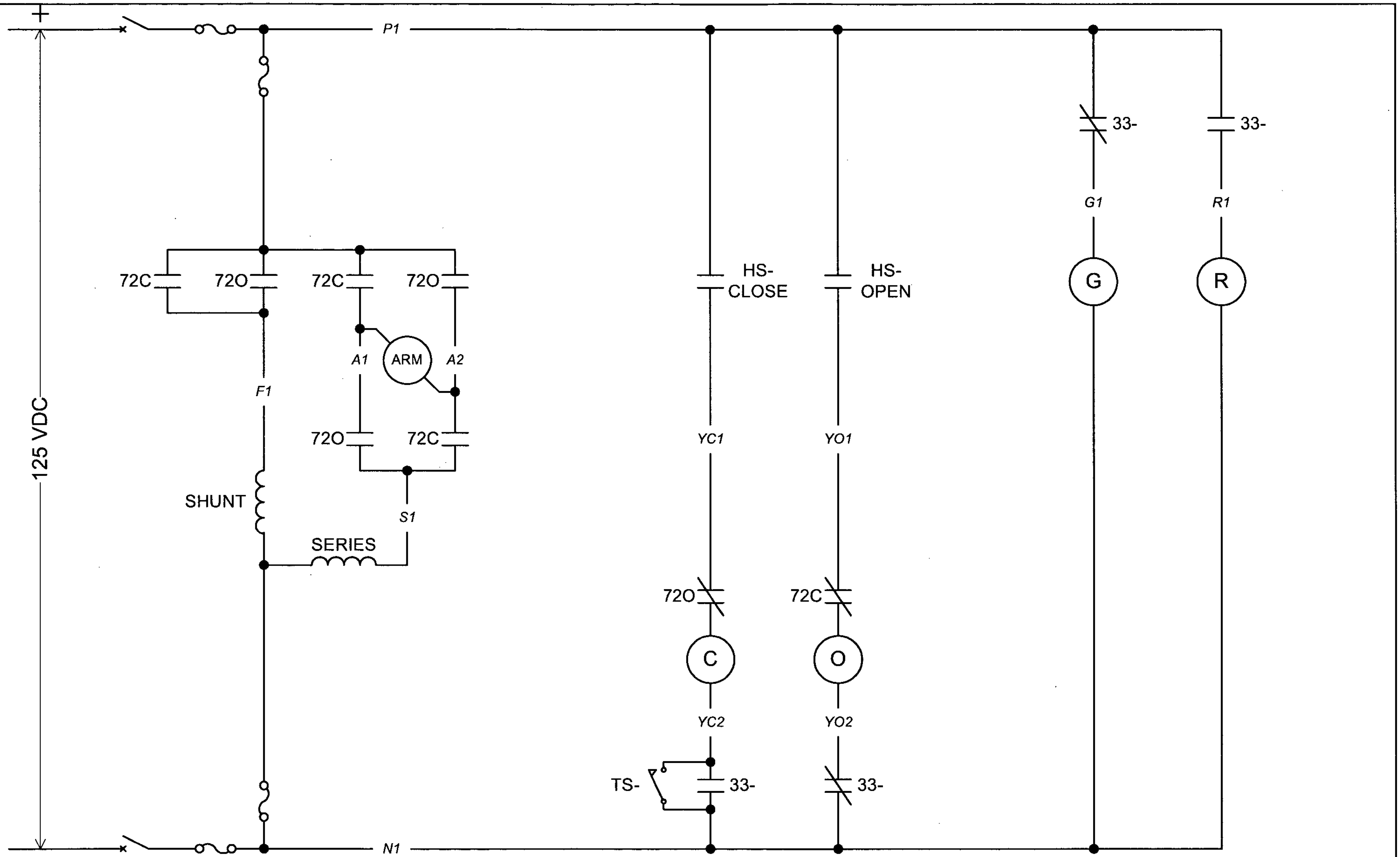
MOV-8, SCHEME MB14

B-117

SNPP

SCHEMATIC DIAGRAM – RHR OUTBOARD SUCTION MOTOR OPERATED VALVE MOV-8

Drawing No.:	E-12
Date:	05/04/2007
Revision No.:	0

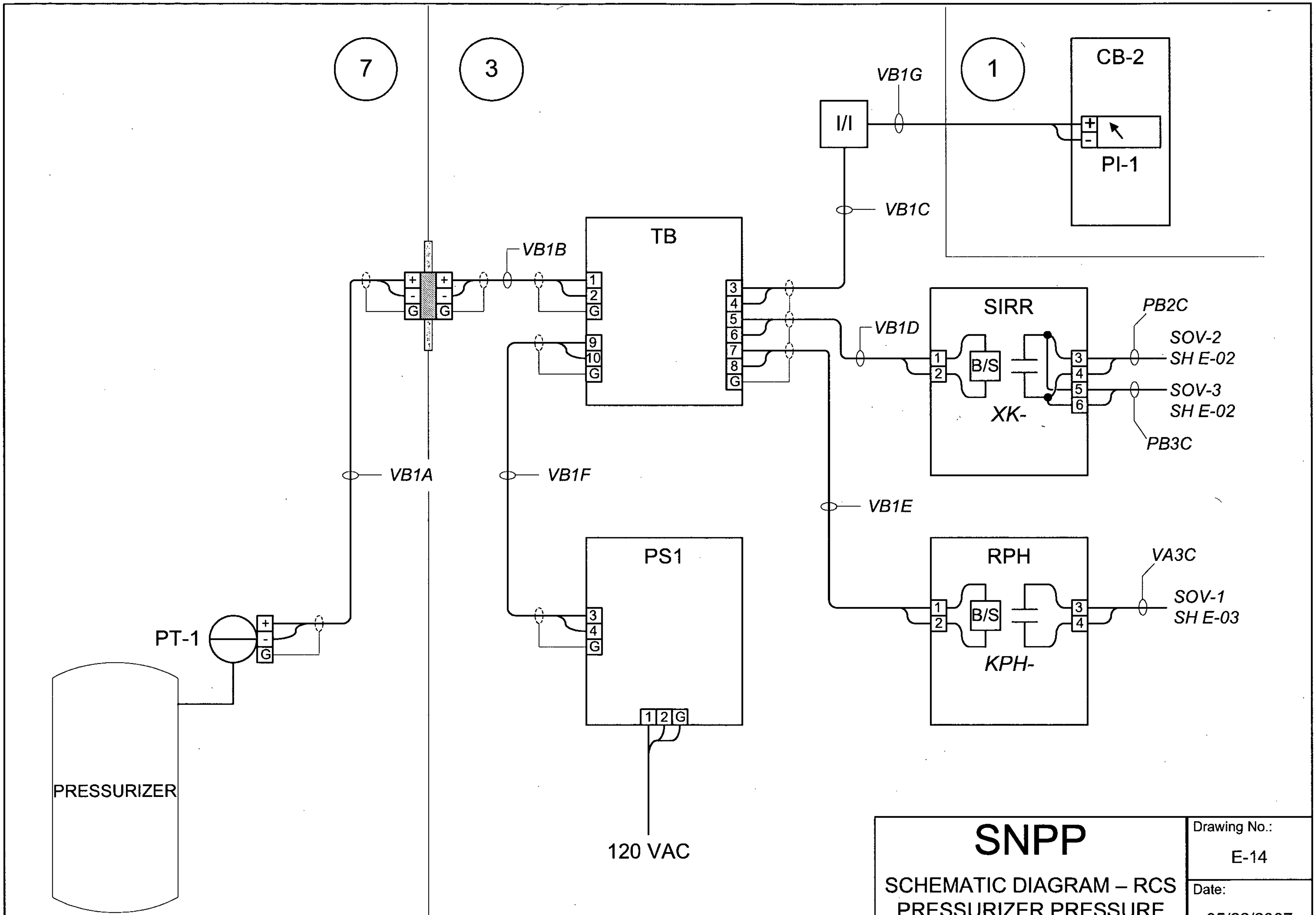


VALVE SHOWN IN CLOSED POSITION

MOV-11, SCHEME DB3

B-118

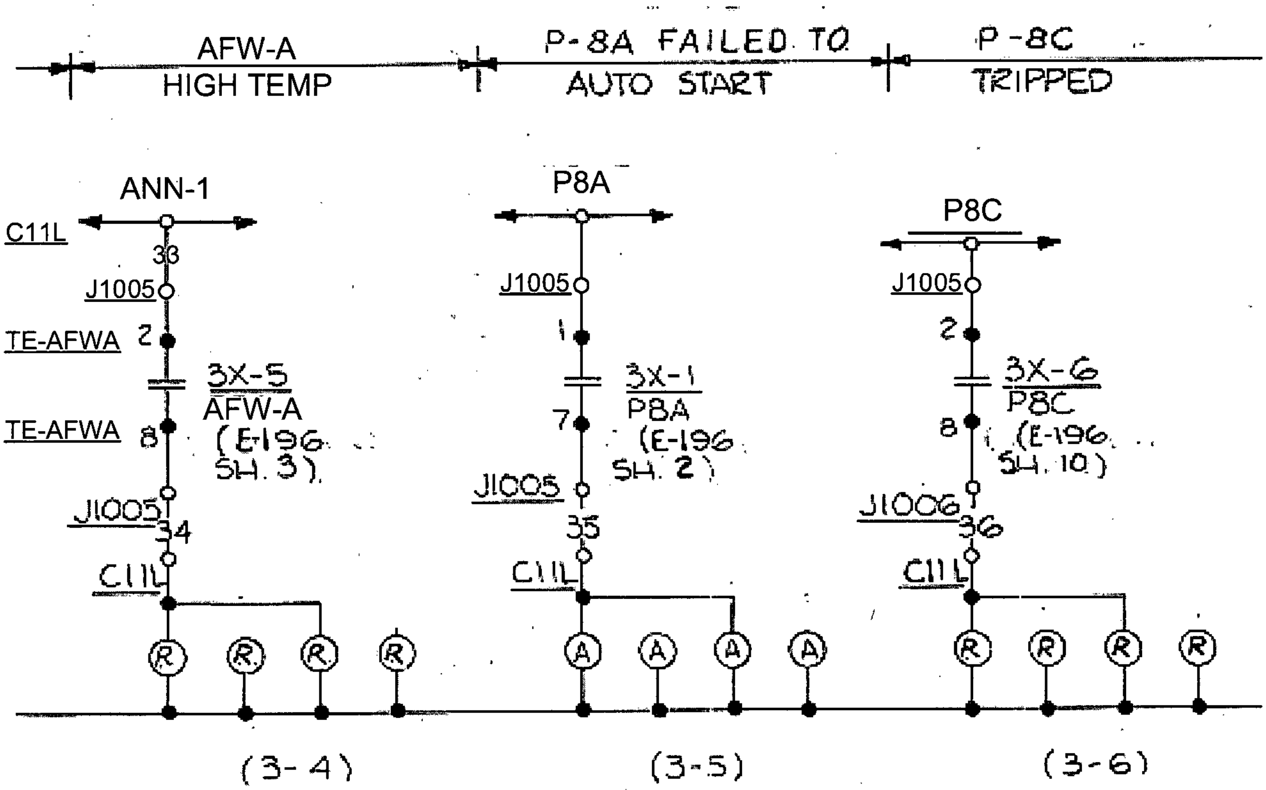
SNPP SCHEMATIC DIAGRAM – AFW-B DISCHARGE MOTOR OPERATED VALVE MOV-11	Drawing No.: E-13
	Date: 05/09/2007
	Revision No.: 0

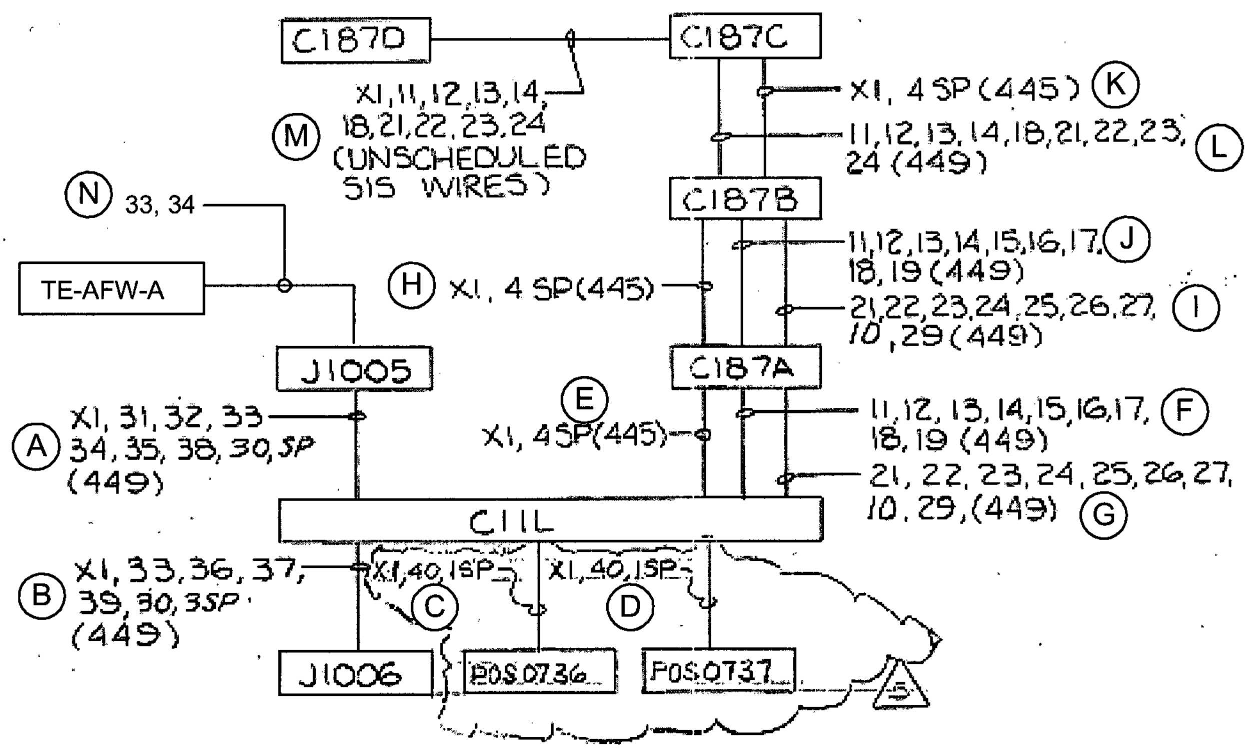


SNPP

SCHEMATIC DIAGRAM – RCS
PRESSURIZER PRESSURE
TRANSMITTER
PT-1

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



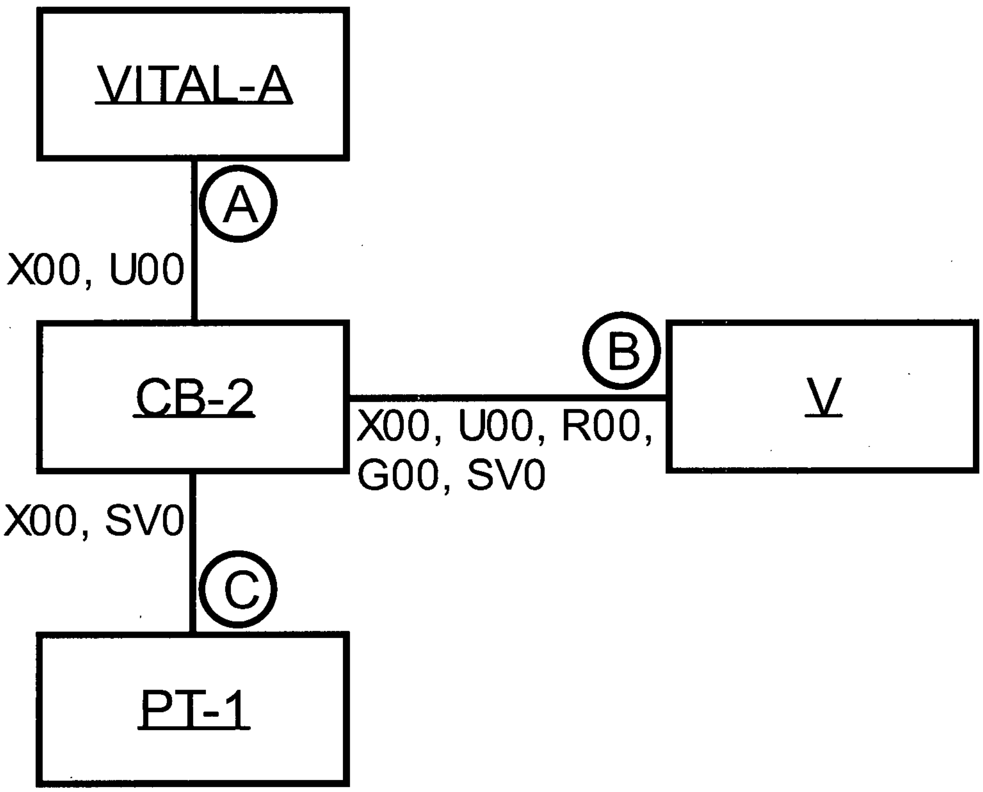


BLOCK DIAGRAM
SCHEME K16

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

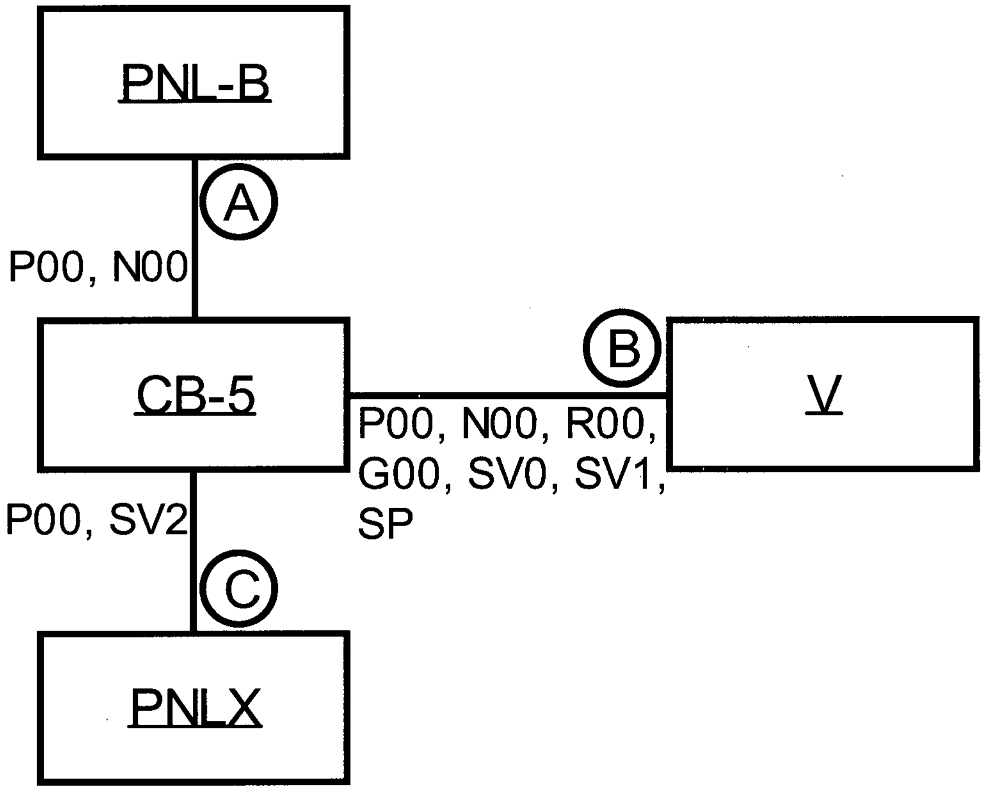
Drawing Pack 2 - AOV and MOV Block Diagrams

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

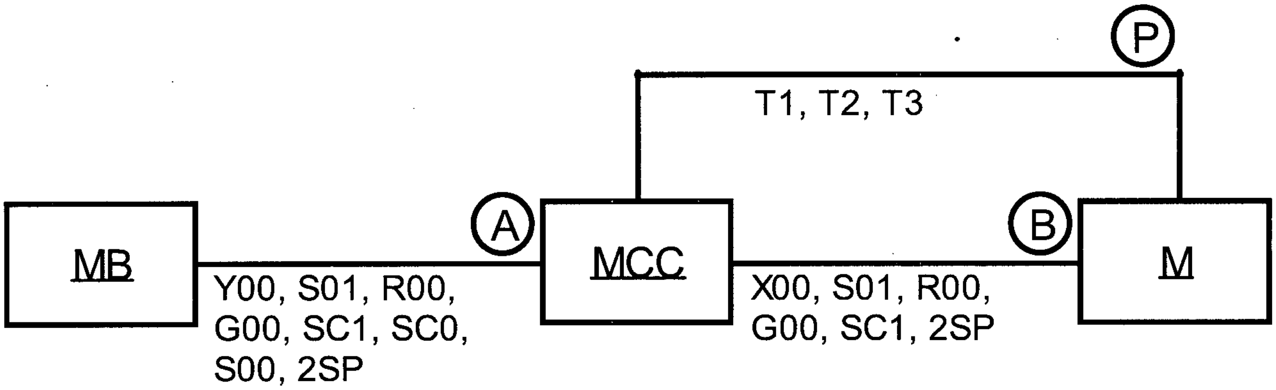


SOV-1, SCHEME VA3

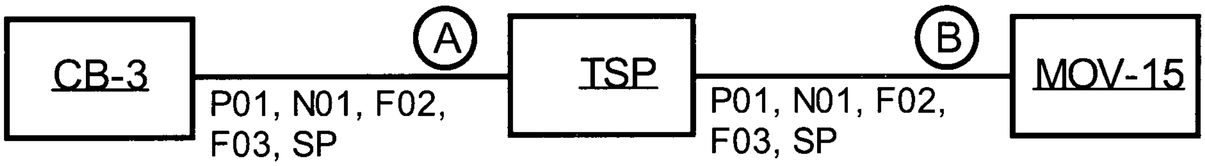
SNPP	TITLE: AOV-3 BLOCK DIAGRAM	DATE: 4/27/07



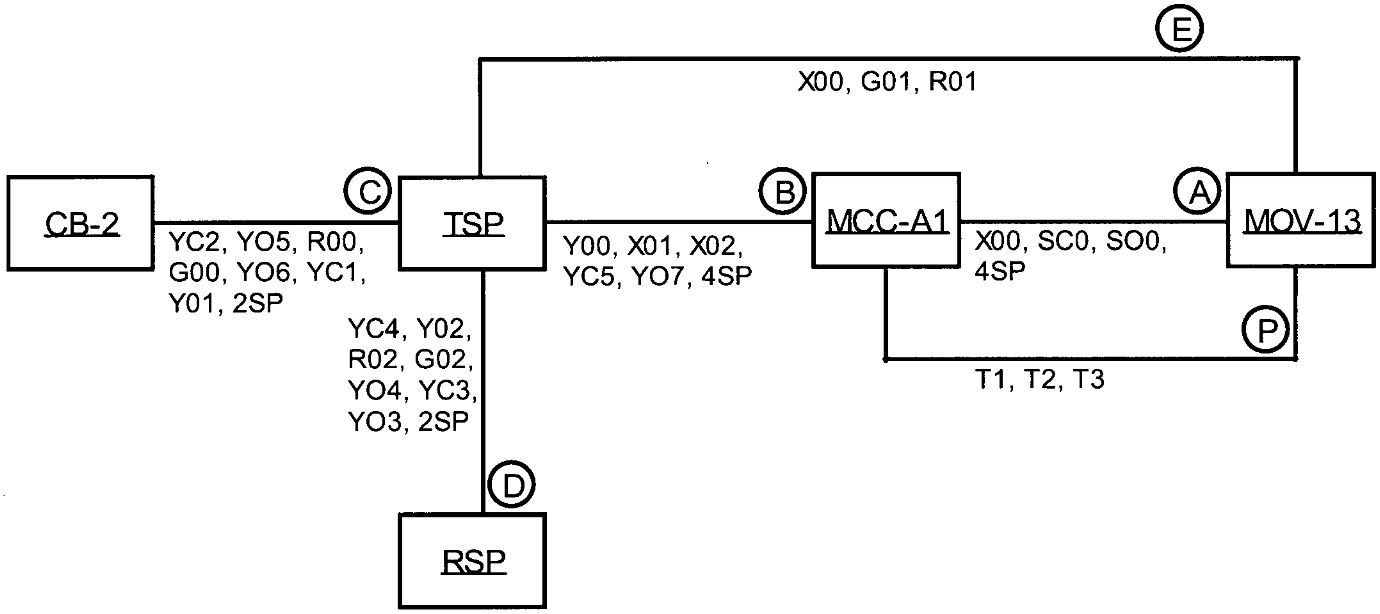
SOV-3, SCHEME PB3



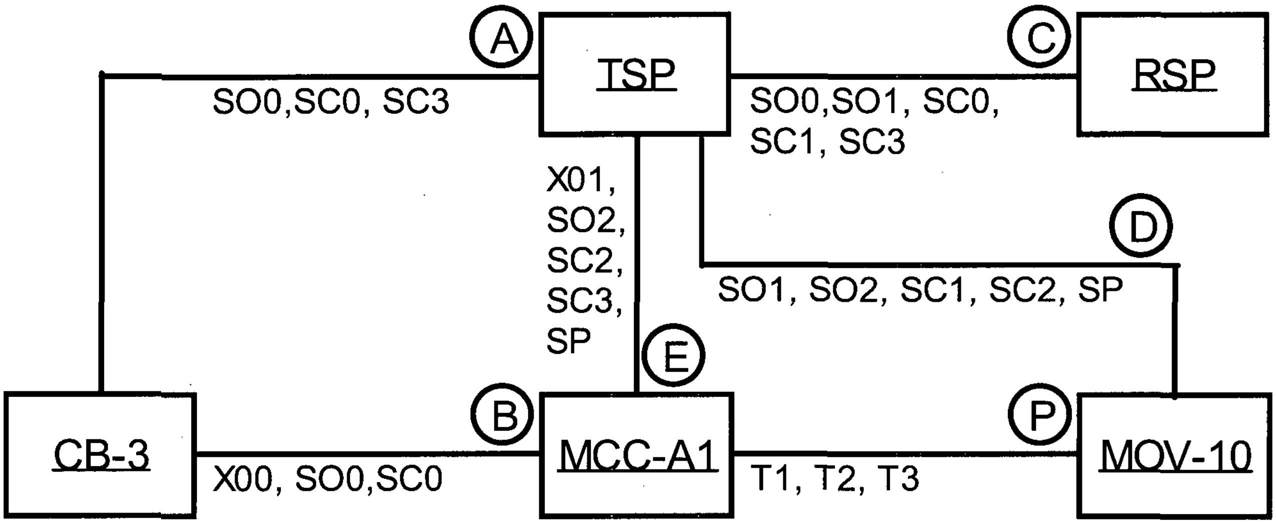
M	MCC	CUBICLE	MB	SCHEME
MOV-1	MCC-A1	2	CB-5	MA12
MOV-3	MCC-A1	3	CB-5	MA13
MOV-4	MCC-B1	2	CB-5	MB12
MOV-5	MCC-A1	4	CB-5	MA14
MOV-6	MCC-B1	3	CB-5	MB13
MOV-7	MCC-A1	5	CB-5	MA15
MOV-9	MCC-B1	5	CB-5	MB15
MOV-16	MCC-A1	8	CB-3	MA18
MOV-17	MCC-B1	6	CB-3	MB16



MOV-15, SCHEME DB4

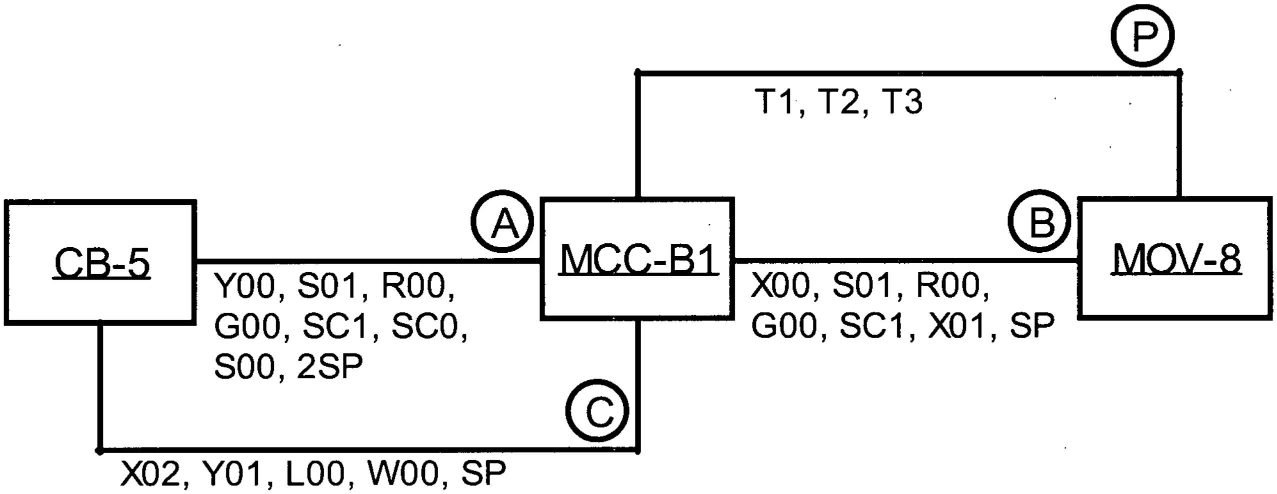


MOV-13, SCHEME MA17



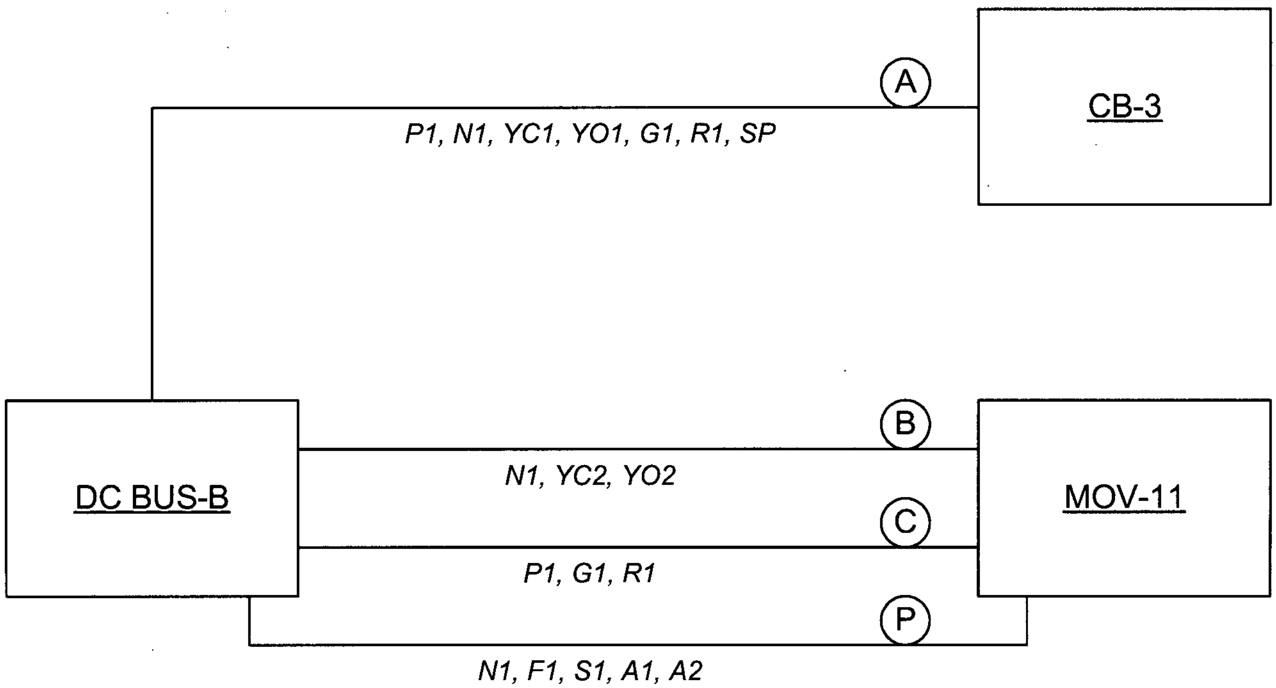
MOV-10, SCHEME MA16

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



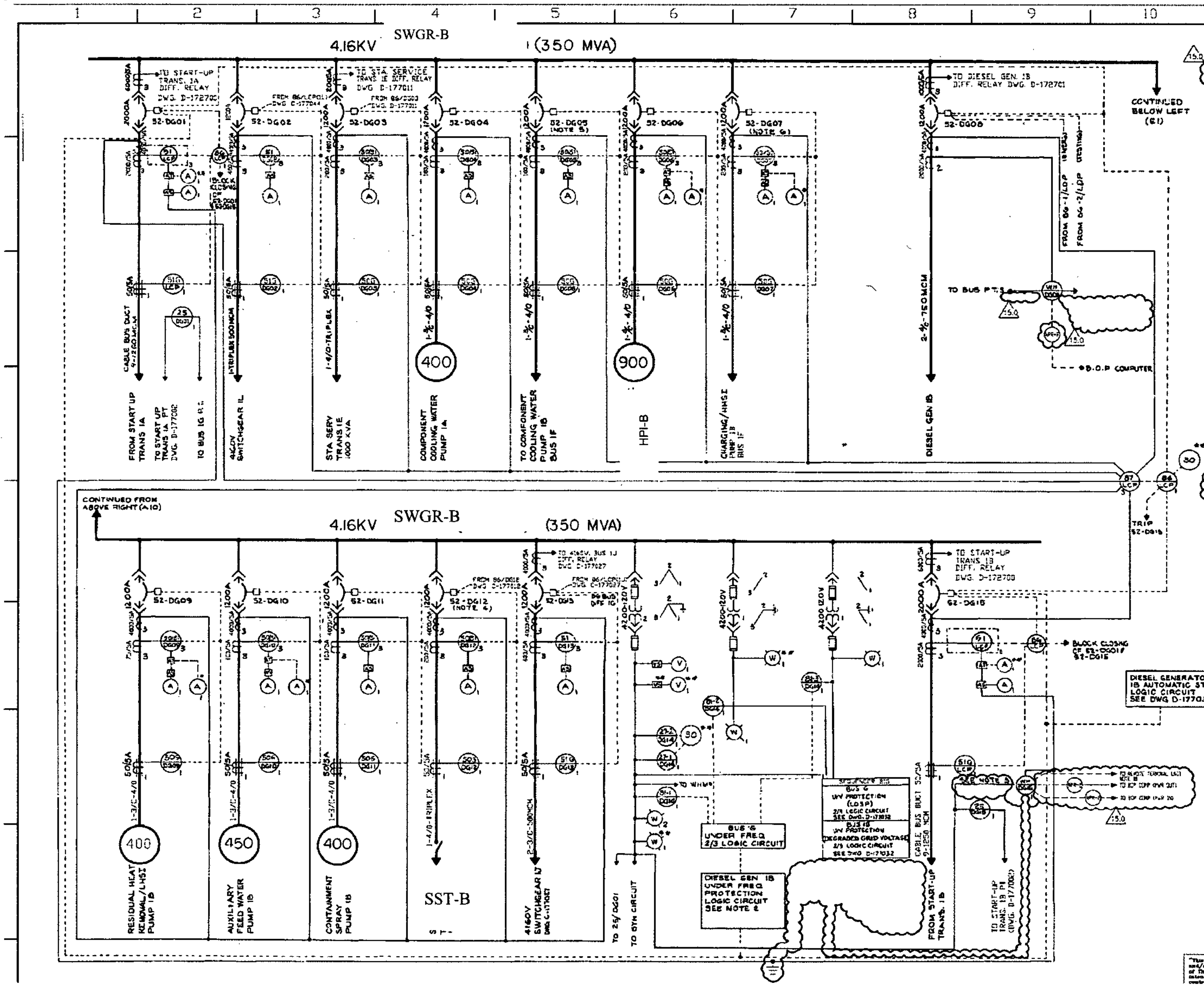
MOV-8, SCHEME MB14

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



MOV-11, SCHEME DB3

Drawing Pack 3 - More Detailed Electrical Schematics



DEVICE	DESCRIPTION	MFR/TYPE	REMARKS
51 / LCP	START UP TRANS IA OVER CURRENT RELAY	GE/IAC53B	
WH / DG08	DIESEL GEN IB WATT HOUR METER	JEMSTAR JS05R6010 -B6-DNP	
25 (SEE REMARKS)	BUS IG SYNCHRONISM CHECK RELAY	GE/IJS51A	APPLICABLE TO CELLS DG01 & DG15
51 / DG02	4160V SWITCHGEAR IL 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 IE OVER CURRENT RELAY	GE/IAC53B	
50/51 / DG04	COMP COOLING WATER PUMP IA OVER CURRENT RELAY	GE/IAC66B	
50/51 / DG05	COMP COOLING WATER PUMP IB OVER CURRENT RELAY	GE/IAC66B	
50/51 / DG06	CHARGING/HHSI PUMP IC OVER CURRENT RELAY	GE/IAC66B	
50/51 / DG07	CHARGING/HHSI PUMP IB OVER CURRENT RELAY	GE/IAC66B	
51G (SEE REMARKS)	VERY INVERSE TIME GROUND RELAY	GE/IAC54A	APPLICABLE TO CELLS DG02 & DG16
50/51 / DG09	RHR/LHSI PUMP IA OVER CURRENT RELAY	GE/IAC66B	
50/51 / DG10	AUX FEED WATER PUMP IB OVER CURRENT RELAY	GE/IAC66B	
50/51 / DG11	CTMT SPRAY PUMP IB OVER CURRENT RELAY	GE/IAC66B	
50/51 / DG12	STA SERV TRANS IF OVER CURRENT RELAY	GE/IAC53B	
51 / DG13	4160V SWITCHGEAR IJ OVER CURRENT RELAY	GE/IAC53	
86 / LCP	BUS DIFFERENTIAL LOCKOUT RELAY	GE/HEA	
87 / LCP	BUS IG 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 IG UNDER VOLTAGE RELAY	GE/IAV54E	
WH / DG15	START-UP TRANS IB WATT HOUR METER	JEMSTAR JS05R6010 -B6-DNP	
81-(1,2&3) / DG14	BUS IG UNDER FREQUENCY RELAY	GE/SFF201B14	DIESEL GENERATOR IB 2/3 LOGIC CIRCUIT
51 / LCP	START UP TRANS IB OVER CURRENT RELAY	GE/IAC53B	
86 / LCP	START UP TRANS IB LOCKOUT RELAY	GE/HEA	
86 / LCP	START UP TRANS IA LOCKOUT RELAY	GE/HEA	
51G / LCP	VERY INVERSE TIME GROUND RELAY	GE/IAC54A	APPLICABLE TO CELLS DG01 & DG15

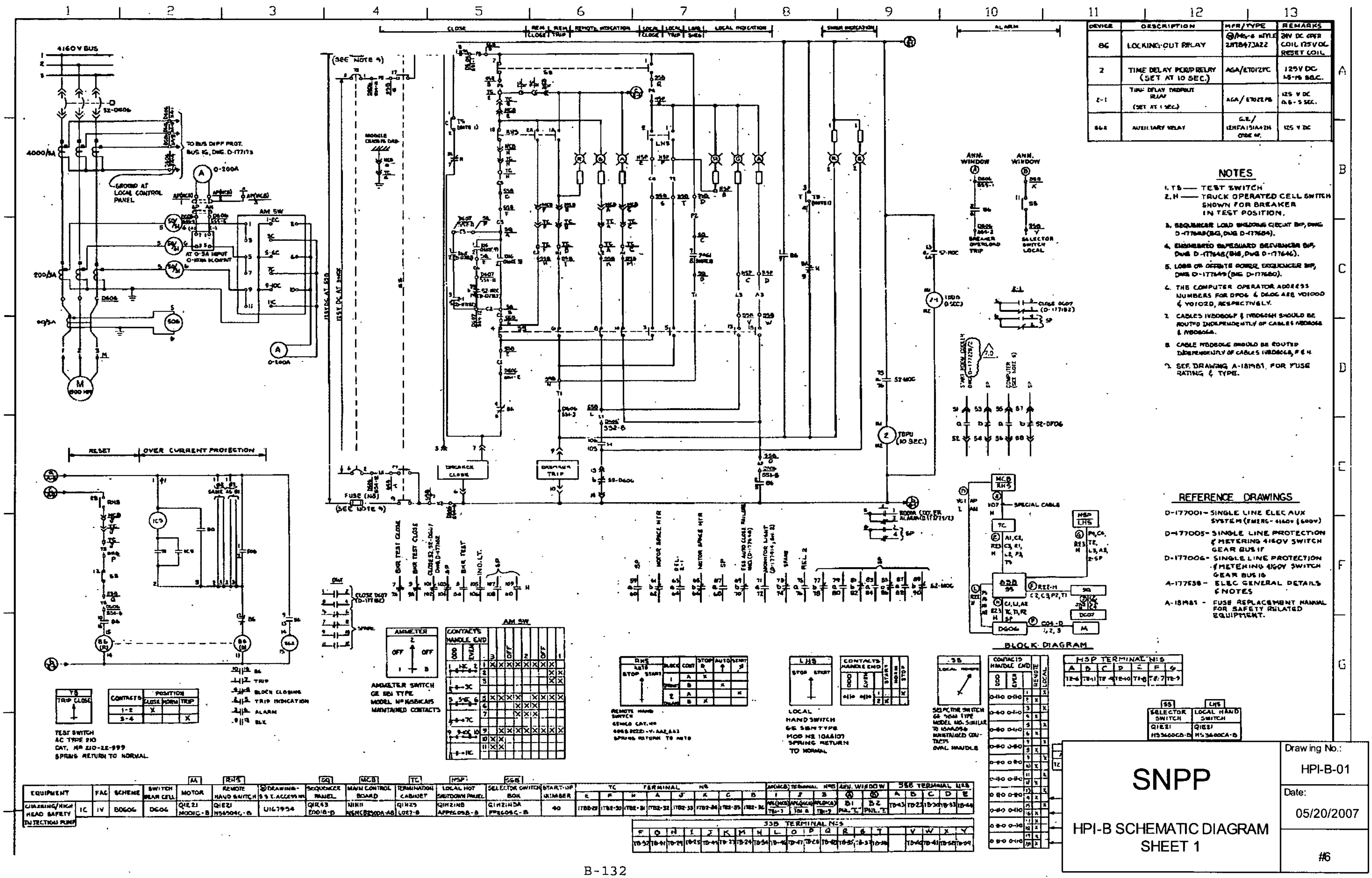
NOTES:

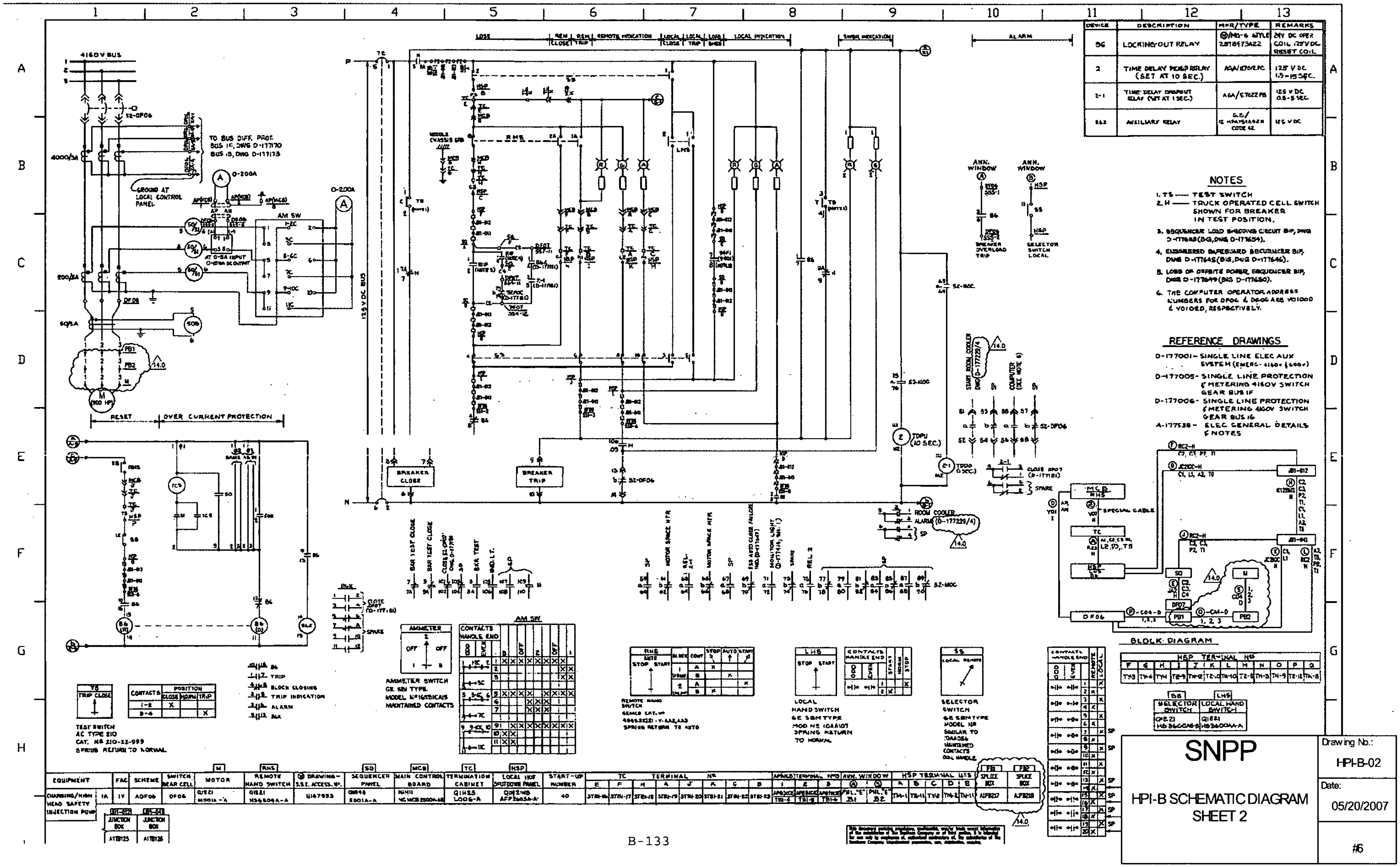
1. * - DENOTES MAIN CONTROL BOARD IN MAIN CONTROL ROOM.
2. DIESEL GENERATOR UNDER FREQUENCY PROTECTION FUNCTIONS ONLY WHEN DIESEL IB IS OPERATING IN PARALLEL WITH SYSTEM.
3. WH METER IS BI-DIRECTIONAL.
4. FOR KEY INTERLOCKING OF BKR. 52-DG12 (SEE DWG. C-177118)
5. FOR KEY INTERLOCKING OF BKR. 52-DG05 (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.

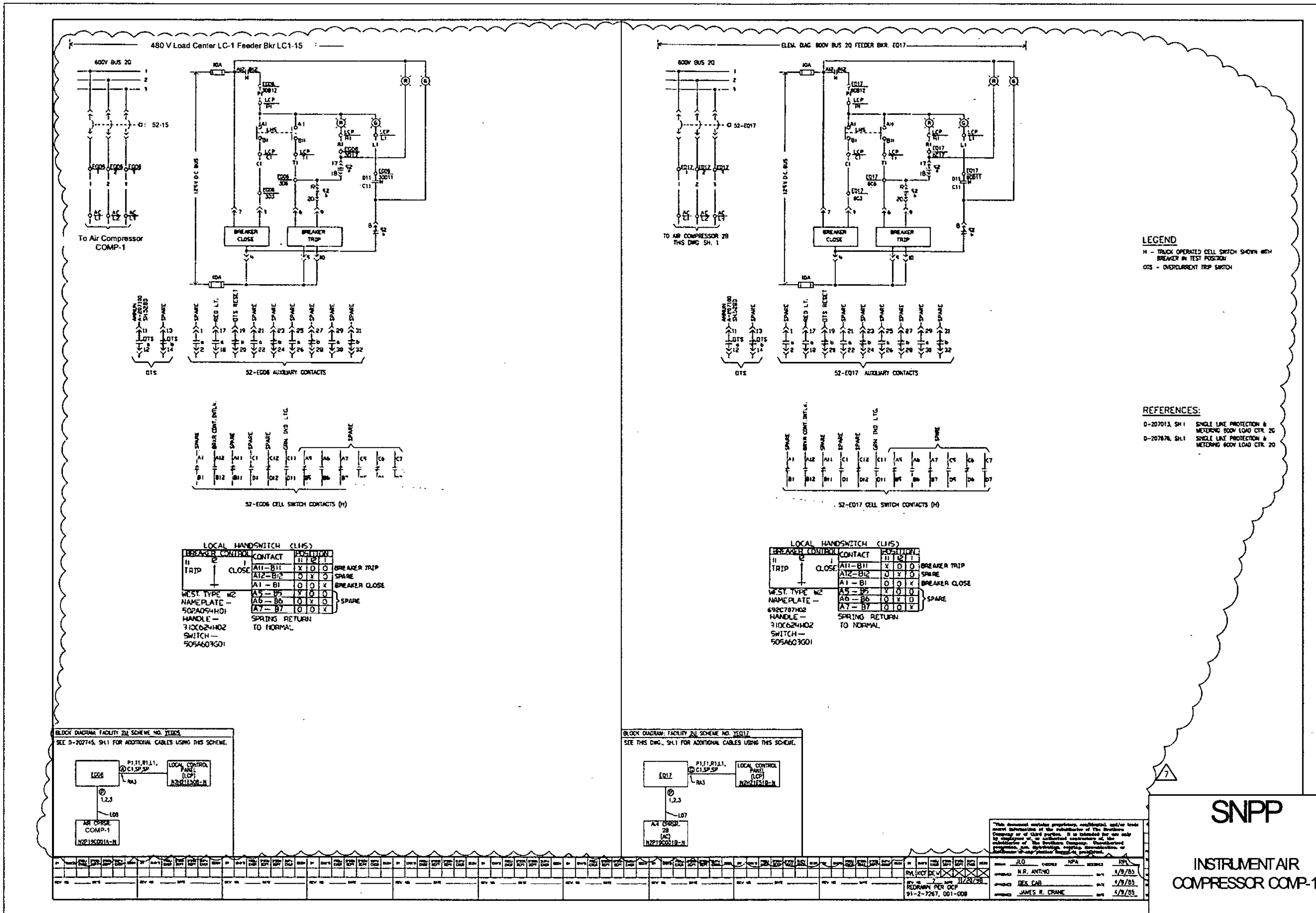
REFERENCE DRAWINGS:

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
	#6


4160V BUS
RESET
OVER CURRENT PROTECTION
BLOCK DIAGRAM
DEVICE | DESCRIPTION | MFR/TYPE | REMARKS
86 | LOCKING-OUT RELAY | 2878473A22 | 24V DC OPER COIL 125V DC RESET COIL
2 | TIME DELAY PICKUP RELAY (SET AT 10 SEC.) | AGA/ET012YC | 125V DC 15-16 SEC.
2-1 | TIME DELAY DROPOUT RELAY (SET AT 1 SEC.) | AGA/ET022PB | 125 V DC 0.6-5 SEC.
86A | AUXILIARY RELAY | G.E./12HFA151A42H | 125 V DC
NOTES
1. TS — TEST SWITCH
2. H — TRUCK OPERATED CELL SWITCH SHOWN FOR BREAKER IN TEST POSITION.
9. SEE DRAWING A-181981, 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-181981 - FUSE REPLACEMENT MANUAL FOR SAFETY RELATED EQUIPMENT.
SNPP
Drawing No.:
HPI-B-01
Date:
05/20/2007
HPI-B SCHEMATIC DIAGRAM
SHEET 1
#6


NOTES
1. TS — TEST SWITCH
2. H — TRUCK OPERATED CELL SWITCH SHOWN FOR BREAKER IN TEST POSITION.
REFERENCE DRAWINGS
BLOCK DIAGRAM
SNPP
HPI-B SCHEMATIC DIAGRAM
SHEET 2
Drawing No.:
HPI-B-02
Date:
05/20/2007
#6



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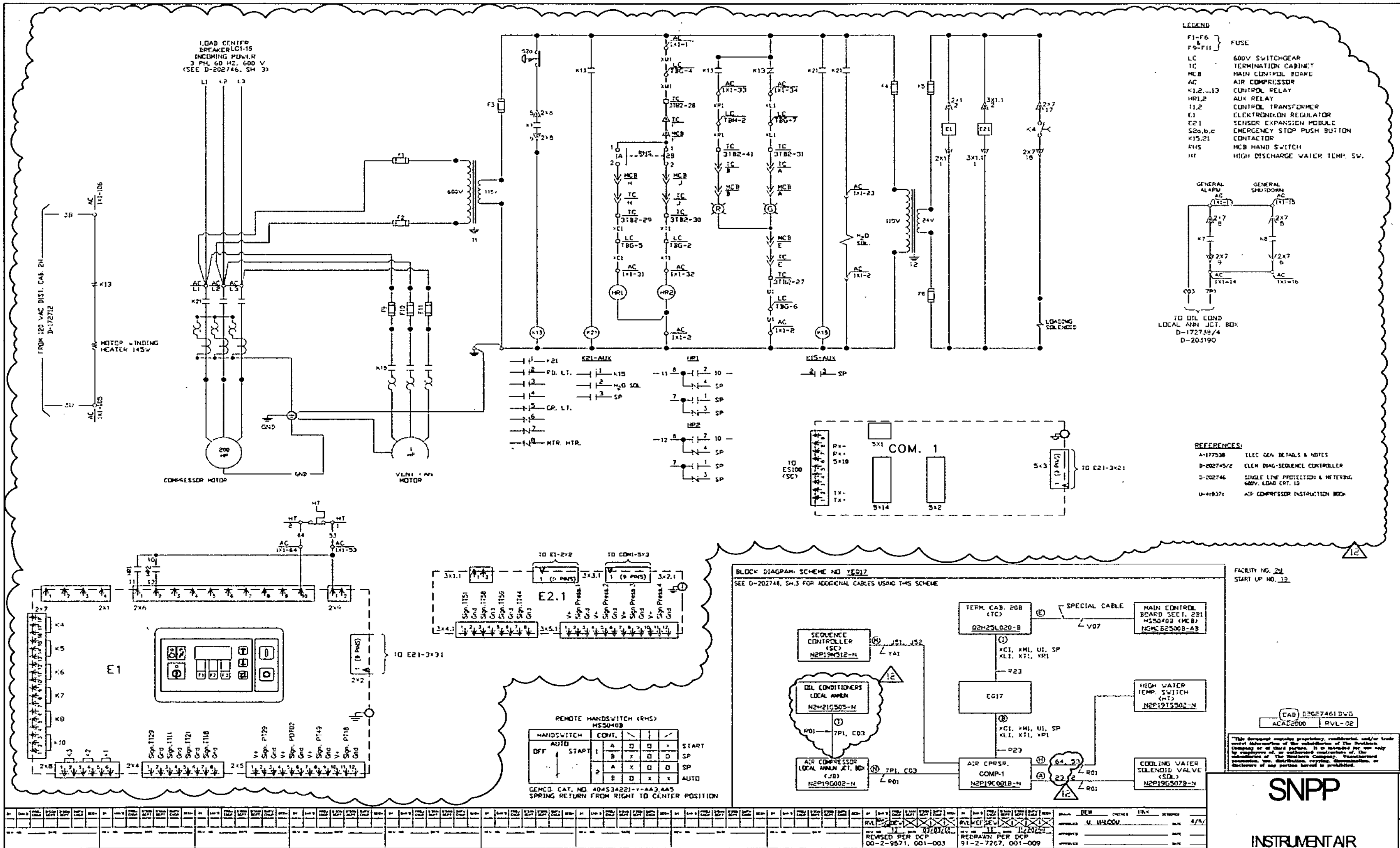

SNPP	Drawing No.: COMP-1-02
INSTRUMENT AIR COMPRESSOR COMP-1	Date: 05/20/2007
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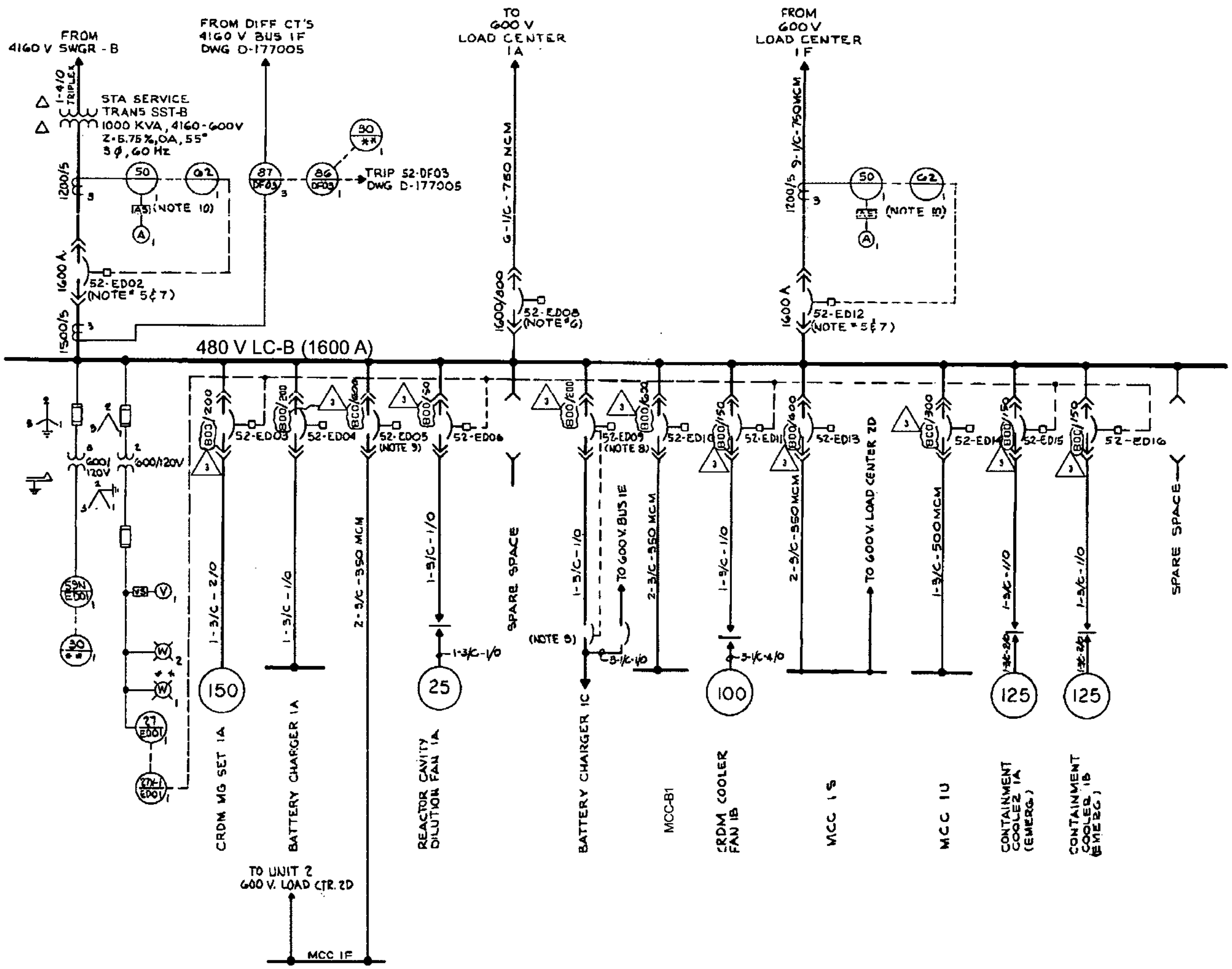


DEVICE	DESCRIPTION	MFR/TYPE	REMARKS
50 / NOTE 10	STA. SERVICE TRANSF. 1D OVER CURRENT RELAY, 3ϕ	GE/PJC32G	
62 / NOTE 10	TIME DELAY RELAY	AGASTAT/ E7012PA	
50 / NOTE 10	OVER CURRENT RELAY, 3ϕ, FOR INC FDR FROM LOAD CTR 1F	GE/PJC32G	
62 / NOTE 10	TIME DELAY RELAY	AGASTAT/ E7012PA	
87 / DF03	STA. SERVICE 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

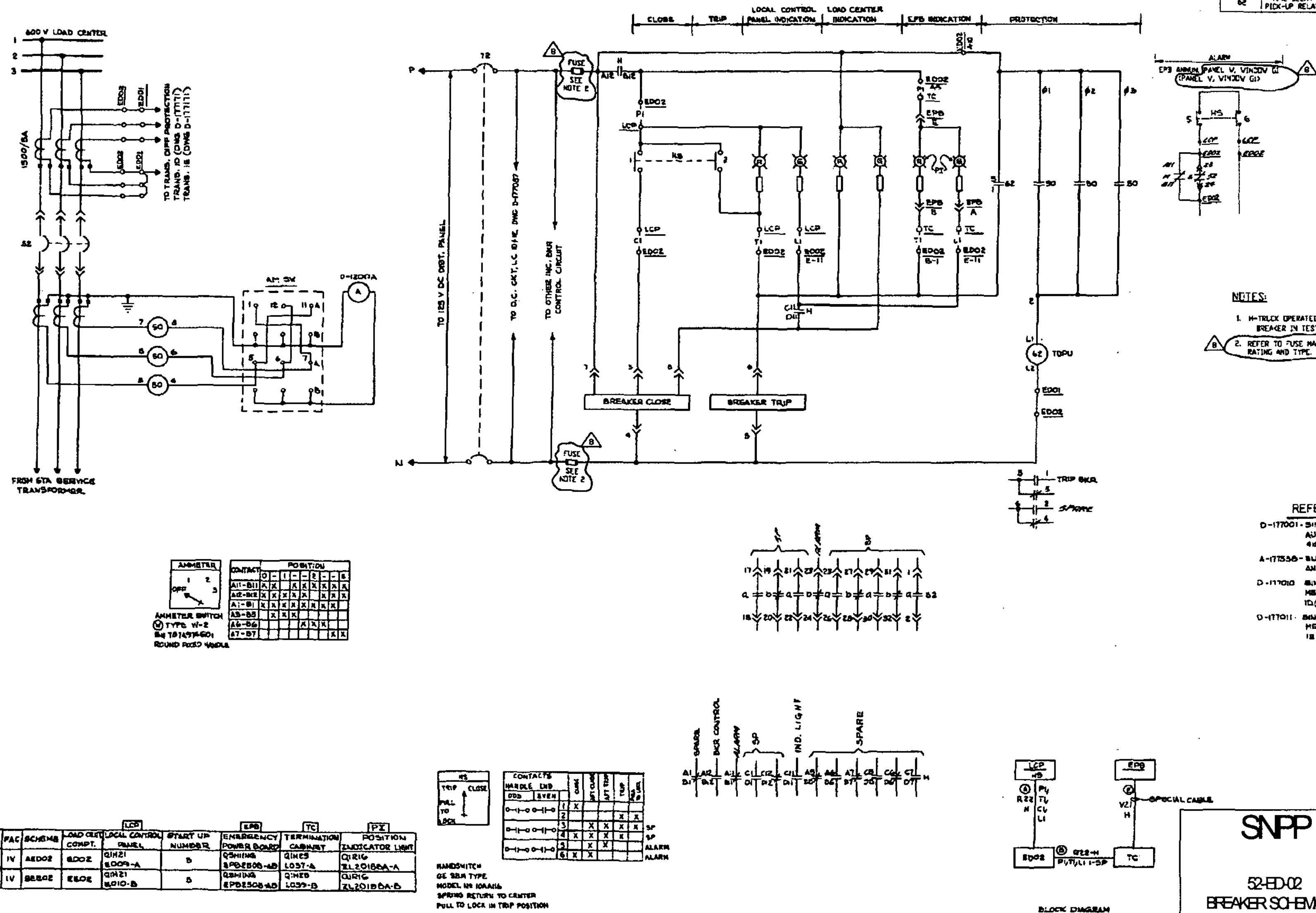
1. ** - DENOTES EMERG. POWER BOARD IN MAIN CONT. RM.
2. INTERRUPTING RATING OF ACB'S IS 22,000 AMPS RMS SYMMETRICAL (MIN)
3. BUS SHORT CIRCUIT RATING 22,000 AMPS SYMMETRICAL.
4. STATION SERVICE TRANSFORMER "ASKAREL" TYPE.
5. BREAKERS 52-ED02 AND 52-ED12 ARE KEY INTERLOCKED SO THAT ONLY ONE CAN BE CLOSED 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-177153).
9. UNIT 1 BREAKER ED06 IS ELECTRICALLY INTERLOCKED WITH UNIT 2 BREAKER ED06 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-177558 - 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
	#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)

EQUIPMENT		FAC	SCHEME	LOAD CENT COMPT.	LCP LOCAL CONTROL PANEL	START UP NUMBER	EPB EMERGENCY POWER BOARD	TC TERMINATION CABINET	PX POSITION INDICATOR LIGHT
INCOMING BREAKER TO 600V LOAD CENTER	1D	IV	AED02	ED02	QIH21 ED09-A	5	Q5HIIG EPB2508-AB	QIHE5 L037-A	QIRIG ZL2018BA-A
	1E	IV	BEE02	EE02	QIH21 EO10-B	5	Q5HIIG EPB2508-AB	QIHE8 L039-B	QIRIG ZL2018BA-B

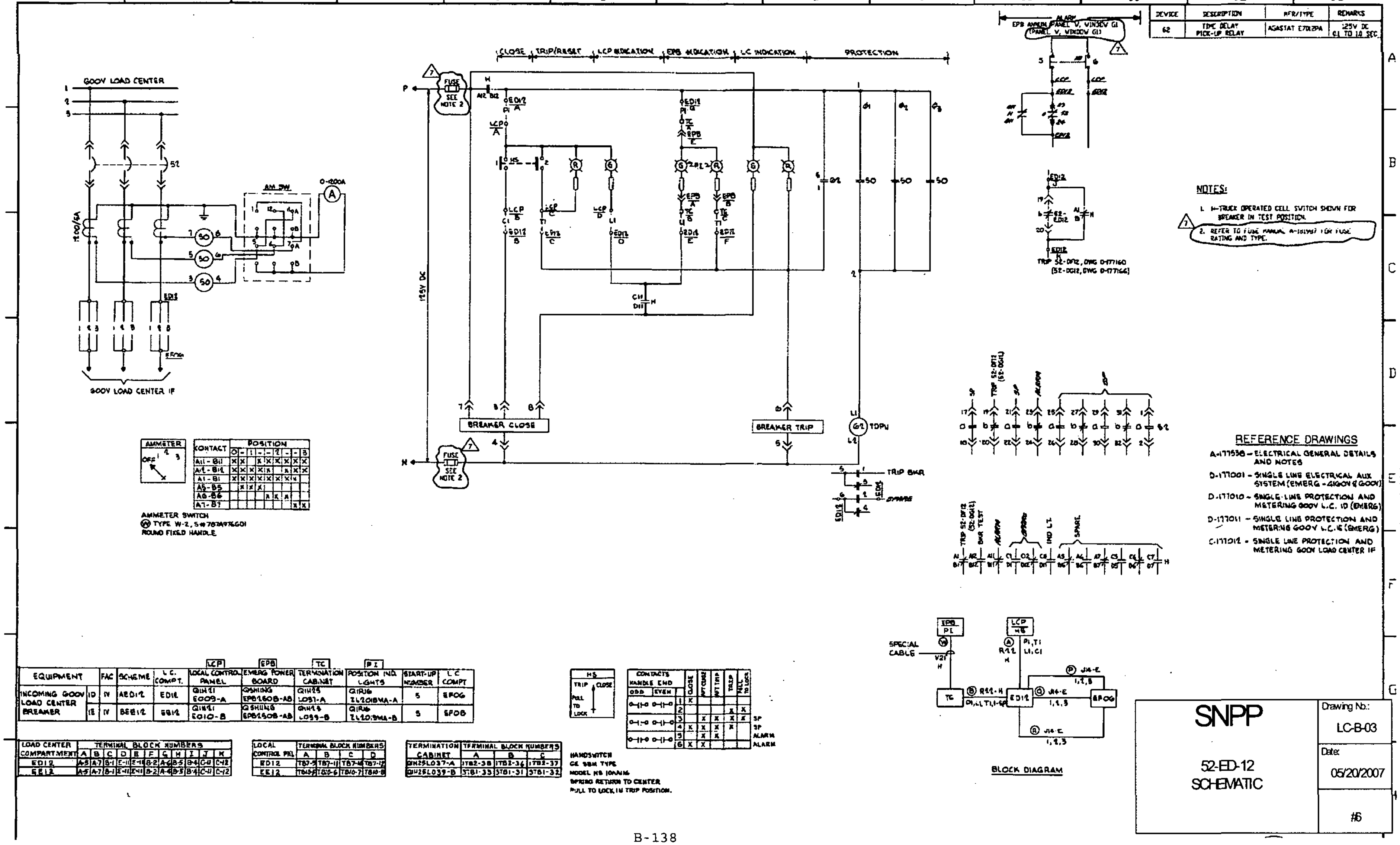
SNPP

52-ED-02 BREAKER SCHEMATIC

Drawing No.: LC-B-02

Date: 05/20/2007

#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-161957 FOR FUSE RATING AND TYPE.

REFERENCE DRAWINGS

A-177536 – 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

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	Q5H146 EPB1608-AB	Q1H25 L037-A	Q1R16 ZL2018MA-A	5	EF06
	1E	IV	BEE12	EE12	Q1H21 E010-B	Q5H146 EPB1508-AB	Q1H15 L039-B	Q1R16 ZL2019MA-B	5	EF08

LOAD CENTER COMPARTMENT	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	A	B	C	D
ED12	TB7-5	TB7-11	TB7-16	TB7-12
EE12	TB10-5	TB10-6	TB10-7	TB10-8

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

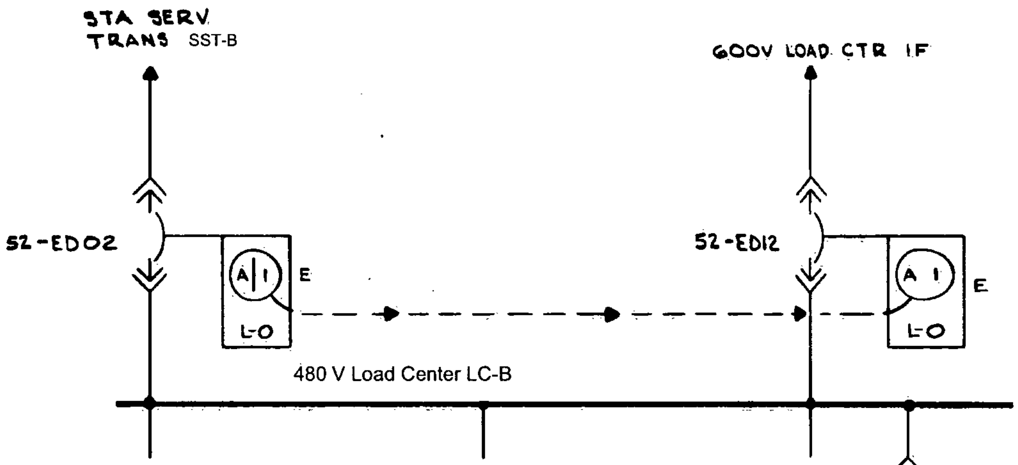
SNPP

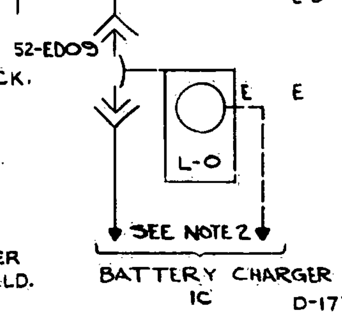
52-ED-12 SCHEMATIC

Drawing No.: LC-B-03

Date: 05/20/2007

#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 IC 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.

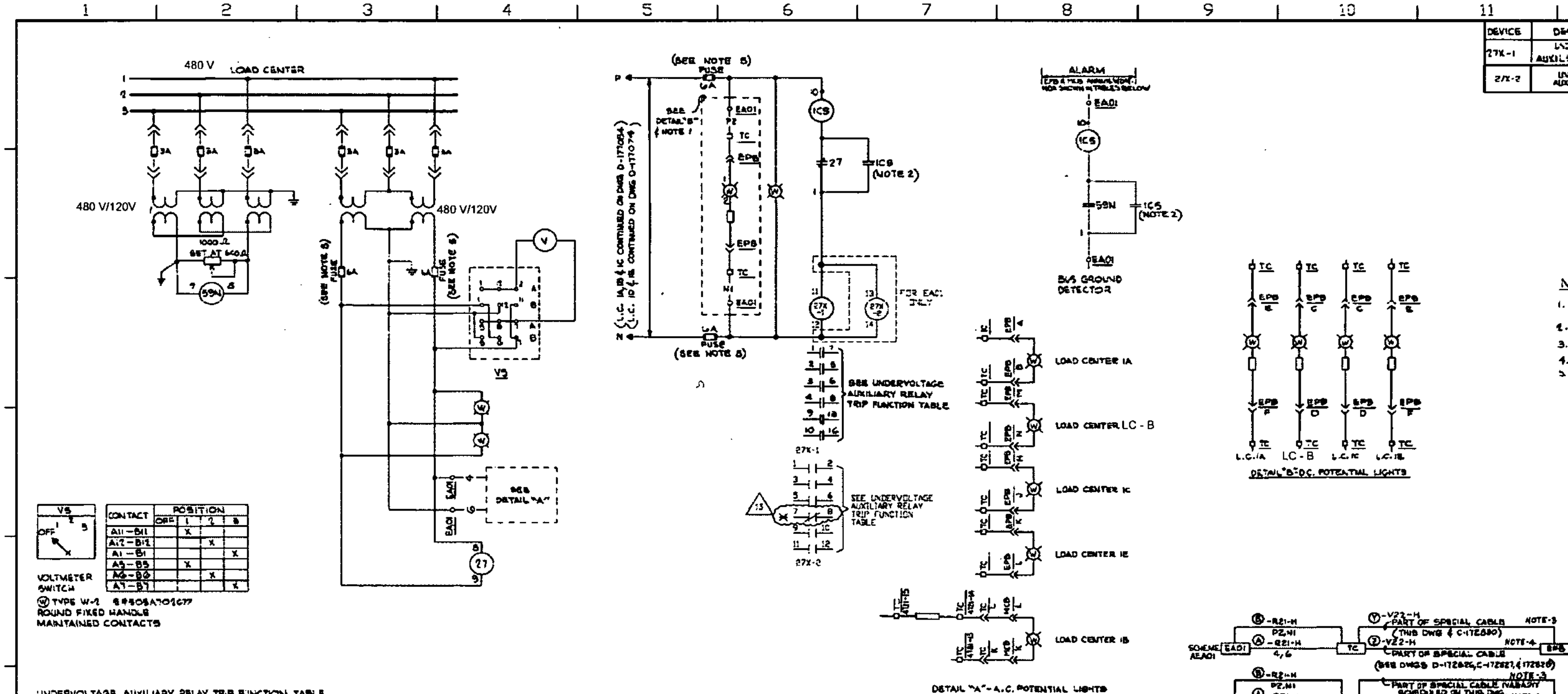
D-177001 - SINGLE LINE ELEC AUX SYSTEM (4160V & 600V)

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
	#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 EAC1, EC01, ED01, AND EE01 ONLY).

REFERENCE DRAWINGS:

A-177836 — 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 IA
C-177008 — SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER IB
C-177009 — SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER IC
D-177010 — SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER ID (EMERG)
D-177011 — SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER IE (EMERG)
A-181987 — FUSE REPLACEMENT MANUAL FOR SAFETY RELATED EQUIPMENT.

UNDERVOLTAGE AUXILIARY RELAY TRIP FUNCTION TABLE

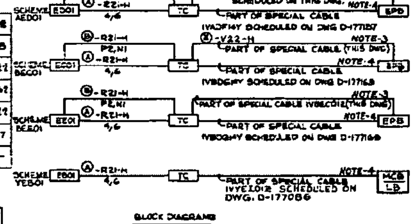
27X-1 EA01	LC BKR COMPT	TRIP FUNCTION	DWG No	27X-1 EB01	LC BKR COMPT	TRIP FUNCTION	DWG No	27X-1 EC01	LC BKR COMPT	TRIP FUNCTION	DWG No	27X-1 ED01	LC BKR COMPT	TRIP FUNCTION	DWG No	27X-1 EE01	LC BKR COMPT	TRIP FUNCTION	DWG No
9-15	EA13	600-480/277V LIGHTING TRANS IA	D-177090	4-8	EB05	CTMT COOLER IB (NORMAL)	D-177221	2-8	EC09	SPENT FUEL POOL PUMP IA	D-177206	4-8	ED05	CRDM MG SET IA	D-177198	4-8	EE05	CRDM MG SET IB	D-177198
2-5	EA06	CTMT PURGE AHU FAN STARTER PANEL	D-177142	3-4	EB06	CTMT COOLER IC (NORMAL)	D-177226	1-7	EC12	CTMT COOLER ID (NORMAL)	D-177221	1-7	ED15	CTMT COOLER IA (EMERG)	D-177221	2-5	EE06	CTMT COOLER IC (EMERG)	D-177222
3-6	EA10	CTMT COOLER IA (NORMAL)	D-177221	2-5	EB10	HYDRO TEST PUMP	D-177241	9-15	—	SPARE	—	3-6	ED11	CRDM COOLER FAN IB	D-177267	1-7	EE15	CRDM COOLER FAN IA	D-177267
4-8	EA12	SPENT FUEL POOL PUMP IB	D-177206	9-15	—	SPARE	—	4-8	EC05	AUX BLDG MAIN EXHAUST FAN IA	D-177157	10-16	ED16	CTMT COOLER IB (EMERG)	D-177222	10-16	EE16	CTMT COOLER ID (EMERG)	D-177222
1-7	EA05	CTMT PURGE EXH. FAN STARTER PANEL	D-177142	1-7	EB11	AUX BLDG MAIN EXHAUST FAN IB	D-177357	3-6	EC06	RADWASTE AHU SUPPLY FAN	D-177250	2-5	ED06	REACTOR CAVITY H2 DIL. SYSTEM AIR COMP. IA	D-177277	3-6	EE09	REACTOR CAVITY H2 DIL. SYSTEM AIR COMP. IB	D-177277
10-16	—	SPARE		10-16	—	SPARE	—	10-16	—	SPARE	—	9-15	—	SPARE	—	9-15	—	SPARE	—

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

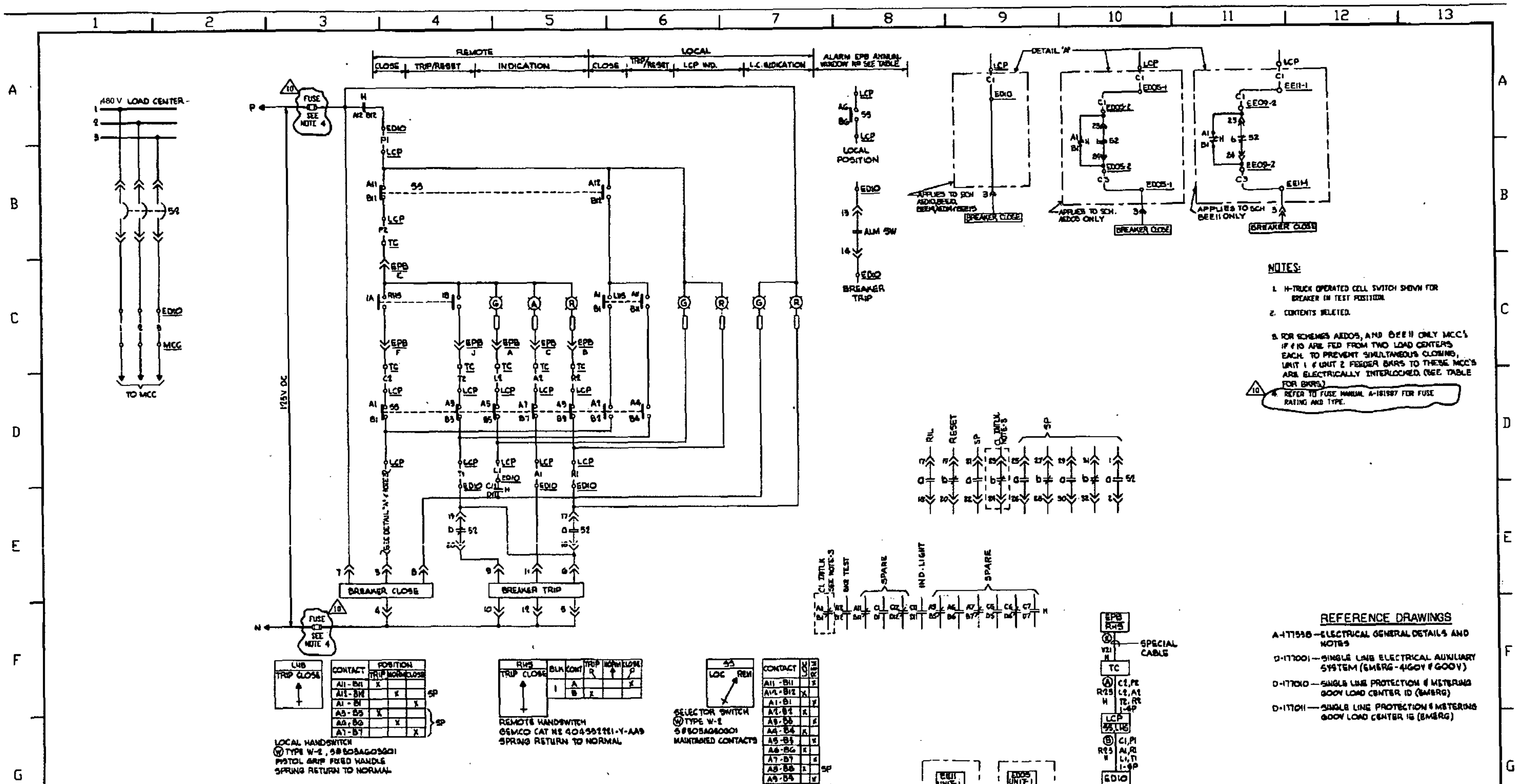
* CONSTRUCTION NOTE: FIELD TO CONVERT NO CONTACT 7-8 TO NC. (13)

EMERGENCY POWER BOARD (EPB)	TERMINATION CABINET (TC)	FAC	SWGR CELL	SCHEME	START-UP NUMBER	ANN. WDW. NO. (EPB)
0SHING EPB2508-A3	01H25L037-A	IV	EAC1	AEA01	5	PANEL "V" 32
0SHING EPB2508-A3	01H25L039-3	IV	EC01	BEC01	5	PANEL "V" 32
0SHING EPB2508-A3	01H25L037-A	IV	ED01	AED01	5	PANEL "V" 32
0SHING EPB2508-A3	01H25L039-3	IV	EE01	BEE01	5	PANEL "V" 32

MAIN CONTROL BOARD (MCB)	TERMINATION CABINET (TC)	FAC	SWGR CELL	SCHEME	START-UP NUMBER	BUS POTENTIAL LIGHT AUX (LB)	ANNUNCIATOR WINDOW NO. (MCB)
01-11NS MCB2503-A3	01H25L016-B	IV	EB01	YEB01	5	N0-01EI2111F-N	PANEL "L" 33



SNPP	Drawing No.: LC-B-05
LOAD CENTER UNDERVOLTAGE SCHEME	Date: 05/20/2007
	#6



NOTES:

1. H-TRUCK OPERATED CELL SWITCH SHOWN FOR BREAKER IN TEST POSITION.
2. CONTENTS DELETED.
3. FOR SCHEMES AEDO5, AND BEE11 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.

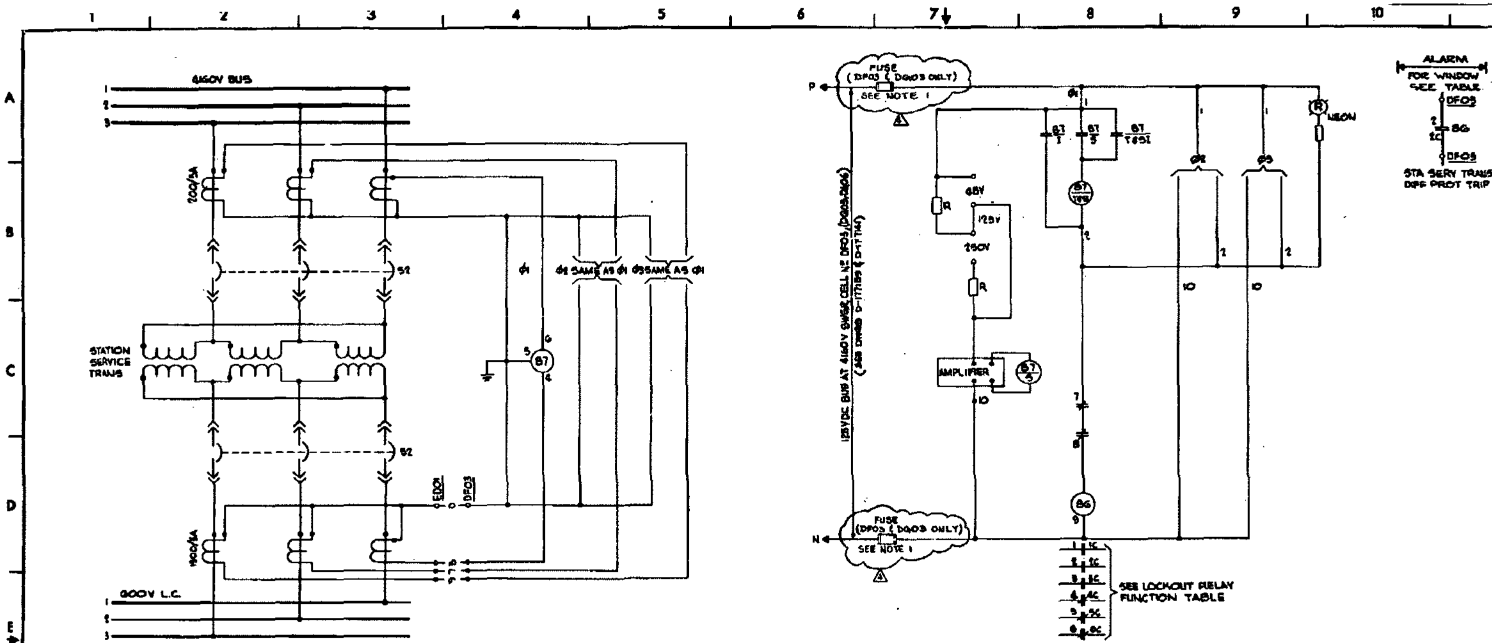
REFERENCE DRAWINGS

A-177536 — ELECTRICAL GENERAL DETAILS AND NOTES
D-177001 — SINGLE LINE ELECTRICAL AUXILIARY SYSTEM (EMERG-4160V & 600V)
D-177010 — SINGLE LINE PROTECTION & METERING 600V LOAD CENTER 1D (EMERG)
D-177011 — SINGLE LINE PROTECTION & METERING 600V LOAD CENTER 1G (EMERG)

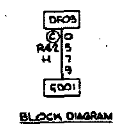
EQUIPMENT		FAC	SCHEME	L.C. COMPT.	LOCAL CONTROL PANEL (LCP)	EMERGENCY POWER BOARD (EPB)	TERMINATION CABINET (TC)	START-UP NUMBER	POWER CABLE CODE	MOTOR CONT CENTER (MCC)	CONDUCTOR NOS CABLE P	CONDUCTOR NOS CABLE G	REMOTE HANDSWITCH (RHS)	EPB ANNUNCIATOR WINDOW NO BKR ON LOCAL CONTROL	EPB ANNUNCIATOR WINDOW NO BKR TRIP	LC COMPT
600V LOAD CENTER BAR'S TO MOTOR CONTROL CENTER	1A	IV	AEDIO	EDIO	Q1H21E009-A	Q1H21NGEPB1508-AB	Q1H25L037-A	6	LO9-F	FA-A2	1,2,3	1,2,3	Q1R06HS2015KA-A	PANEL V, WINDOW G2	PANEL V, WINDOW G1	
	1B	IV	BEEIO	EEIO	Q1H21E010-B		Q1H25L039-B	6	LO9-F	FB-A2	1,2,3	X	Q1R06HS2019KA-B	PANEL V, WINDOW G2	PANEL V, WINDOW G1	
	1F	IV	AEDO5	EDO5	Q1H21E009-A		Q1H25L037-A	6	LO9-F	FF-A2	1,2,3	1,2,3	Q1R16HS2016KA-A	PANEL V, WINDOW G2	PANEL V, WINDOW G1	ED05-2
	1G	IV	BEE11	EE11	Q1H21E010-B		Q1H25L039-B	6	LO9-F	FG-A2	1,2,3	1,2,3	Q1R16HS2017LA-B	PANEL V, WINDOW G2	PANEL V, WINDOW G1	EE09-2
	1T	IV	BEE14	EE14	Q1H21E010-B		Q1H25L039-B	6	LO9-F	FT-A1	1,2,3	1,2,3	Q1R06HS2019PA-B	PANEL V, WINDOW G2	PANEL V, WINDOW G1	
	1U	IV	AEDI4	EDI4	Q1H21E009-A		Q1H25L037-A	6	LIO-F	FU-A1	1,2,3	X	Q1R06HS2028PA-A	PANEL V, WINDOW G2	PANEL V, WINDOW G1	
	1V	IV	BEE15	EE15	Q1H21E010-B		Q1H25L039-B	6	LIO-F	FV-A1	1,2,3	X	Q1R16HS2016QA-B	PANEL V, WINDOW G2	PANEL V, WINDOW G1	

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

DEVICE	DESCRIPTION	MFR/TYPE	REMARKS
86	LOCKOUT RELAY	GE/HEA61A239	125V DC



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



REFERENCE DRAWINGS

A-177536 — 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-177074 — SINGLE LINE PROTECTION AND METERING 600V LOAD CENTER 1I

A-181987 — FUSE REPLACEMENT MANUAL FOR SAFETY RELATED EQUIPMENT.

LOCKOUT RELAY FUNCTION TABLE

86 DF03	FUNCTION	DWG NO	86 DG03	FUNCTION	DWG NO	86 DA06	FUNCTION	DWG NO
1 1C	TRIP BKR 52-DF03	C-177159	1 1C	TRIP BKR 52-DG03	C-177159	1 1C	TRIP BKR 52-DA06	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-DA06	D-177141
5 5C	BLOCK CLOSING BKR 52-DF03	C-177159	5 5C	BLOCK CLOSING BKR 52-DG03	C-177159	5 5C	SPARE	—
6 6C	SPARE	—	6 6C	SPARE	—	6 6C	SPARE	—

EQUIPMENT		FAC	SCHEME	4160V CELL	LOAD CENTER COMPARTMENT	START-UP NUMBER	ANNUNCIATOR WINDOW NO.
DIFFERENTIAL RELAY FOR STATION SERV TRANSFORMER	1D	IV	ADF03	DF03	8D01	6	EPB PANEL "V" C4
	1E	IV	BDG03	DG03	8E01	6	EPB PANEL "V" C4
	1I	IV	KDA06	DA06	E101	5	HCB PANEL "Z" E2

SNPP

STATION SERVICE TRANSFORMER DIFFERENTIAL PROTECTION SCHEME

Drawing No.: LC-B-06

Date: 05/20/2007

#6

NRC FORM 335 (9-2004) NRCMD 3.7 U.S. NUCLEAR REGULATORY COMMISSION **BIBLIOGRAPHIC DATA SHEET** *(See instructions on the reverse)*	1. REPORT NUMBER (Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.) NUREG/CP-0194 Volume 2
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10. SUPPLEMENTARY NOTES

NRC-RES/EPRI Fire PRA Workshops conducted Sept. 28 - Oct. 2, 2008 and Nov. 17-20, 2008 in Bethesda, MD

11. ABSTRACT *(200 words or less)*

The U.S. Nuclear Regulatory Commission (NRC) approved the risk-informed and performance-based alternative regulation 10 CFR 50.48(c) in July 2004, which allows licensees the option of using fire protection requirements contained in the National Fire Protection Association (NFPA) Standard 805, "Performance Based Standard for Fire protection for Light-Water Reactor Electric Generating Plants, 2001 Edition," with certain exceptions. To support licensees' use of that option, the NRC and the Electric Power Research Institute (EPRI) jointly issued NUREG/CR-6850 (EPRI 1011989) "Fire PRA Methodology for Nuclear Power Facilities," in September 2005. That report documents the state-of-the-art methods, tools, and data for conducting a fire Probabilistic Risk Assessment (PRA) in a commercial nuclear power plant (NPP) application. Since the release of NUREG/CR-6850 in 2005, the NRC-RES and EPRI have conducted a number of joint public workshops to provide training in the use of the methodologies and tools contained in the document. The workshops have attracted both domestic and international. The material in this NUREG/CP was recorded during two workshops conducted in 2008. It was adapted by NRC-RES Fire Research Branch (FRB) members for use as an alternative training method for those who were unable to physically attend the training sessions. This report can also serve as a refresher for those who attended one or more training sessions, and would be useful preparatory material for those planning to attend a session.

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