OPAL Engineering
Early Modifications Relating to AOC: Loss of Offsite Power (LOOP)

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OPAL Engineering and Maintenance
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Technical Session 7: Research Reactor Safety

Contents

SAR Requirements Specification

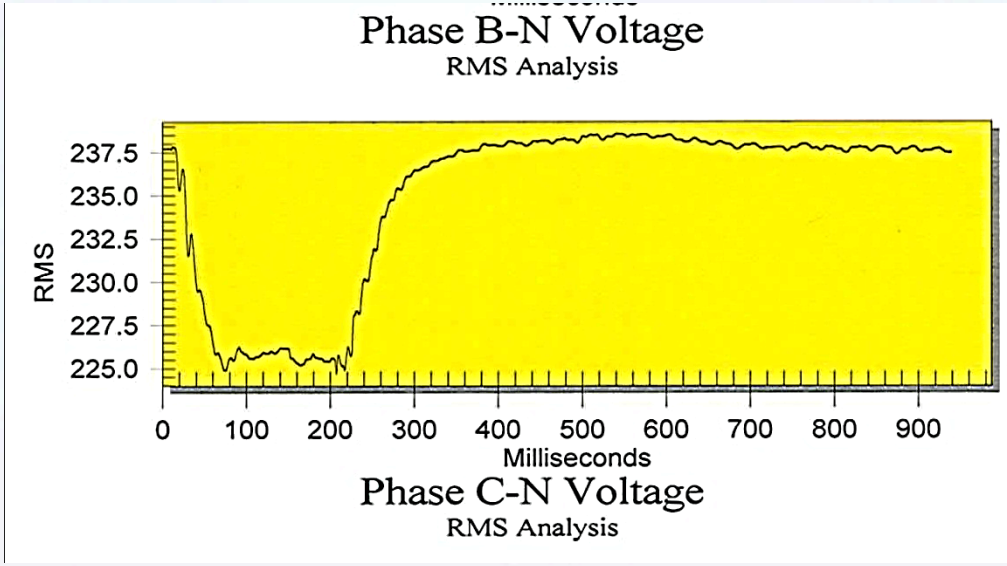
- **SAR: Loss of Offsite Power Anticipated Operational Occurrence**
- **DBA: Total Blackout for 30 Minutes. Start of 1/2 Standby Diesel Generators at 30 Minutes**

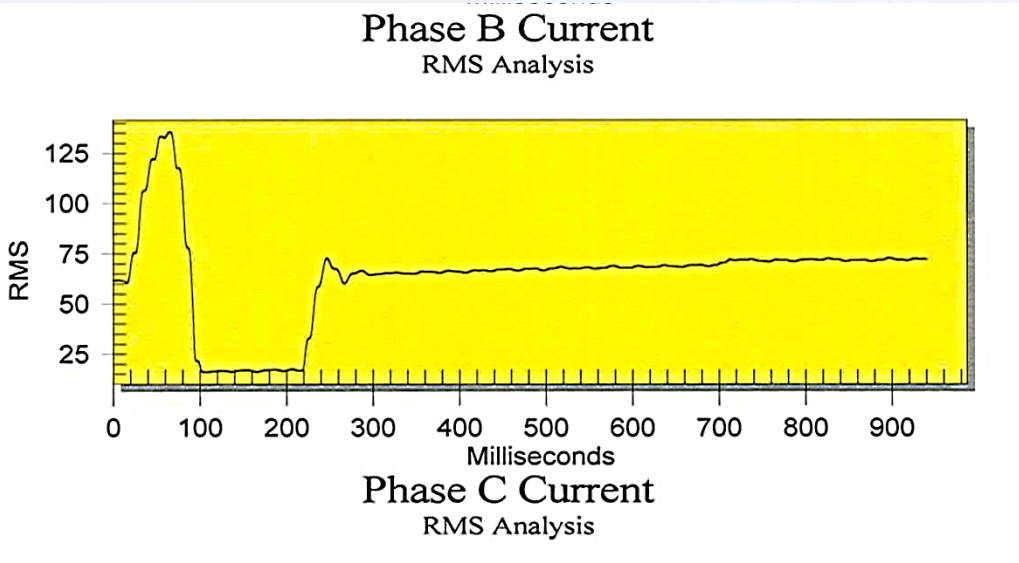
Motivation

- **Improve Safety by ensuring full compliance with Safety Analysis Report**
- **Improve Plant Performance and Reliability WRT Voltage Dips**

Voltage Dip (IEC)

- **A sudden reduction of the voltage at a point in the system, followed by voltage recovery after a short period of time, from a few cycles to a few seconds**





OPAL Voltage Dip Factoids

- **Most generated offsite (supplier)**
- **Approximately one detected per month**
- **Approximately 3 poison-outs per year**
- **Estimated Annual Cost: $500k USD**

Voltage Dip Classification

Classification	Description	Alarms
Level 0	No Plant Affected	None
Level 1	Minor Plant Affected	Some Alarms
Level 2	Some Main Reactor Plant Affected	Many Alarms
Level 3	Reactor SCRAM (Indirect SCRAM)	Many Alarms
Level 4	RPS SCRAM (Direct SCRAM)	Alarm Flood
Level 5	SPS-DG Connection	Alarm Flood

LOOP Related Projects

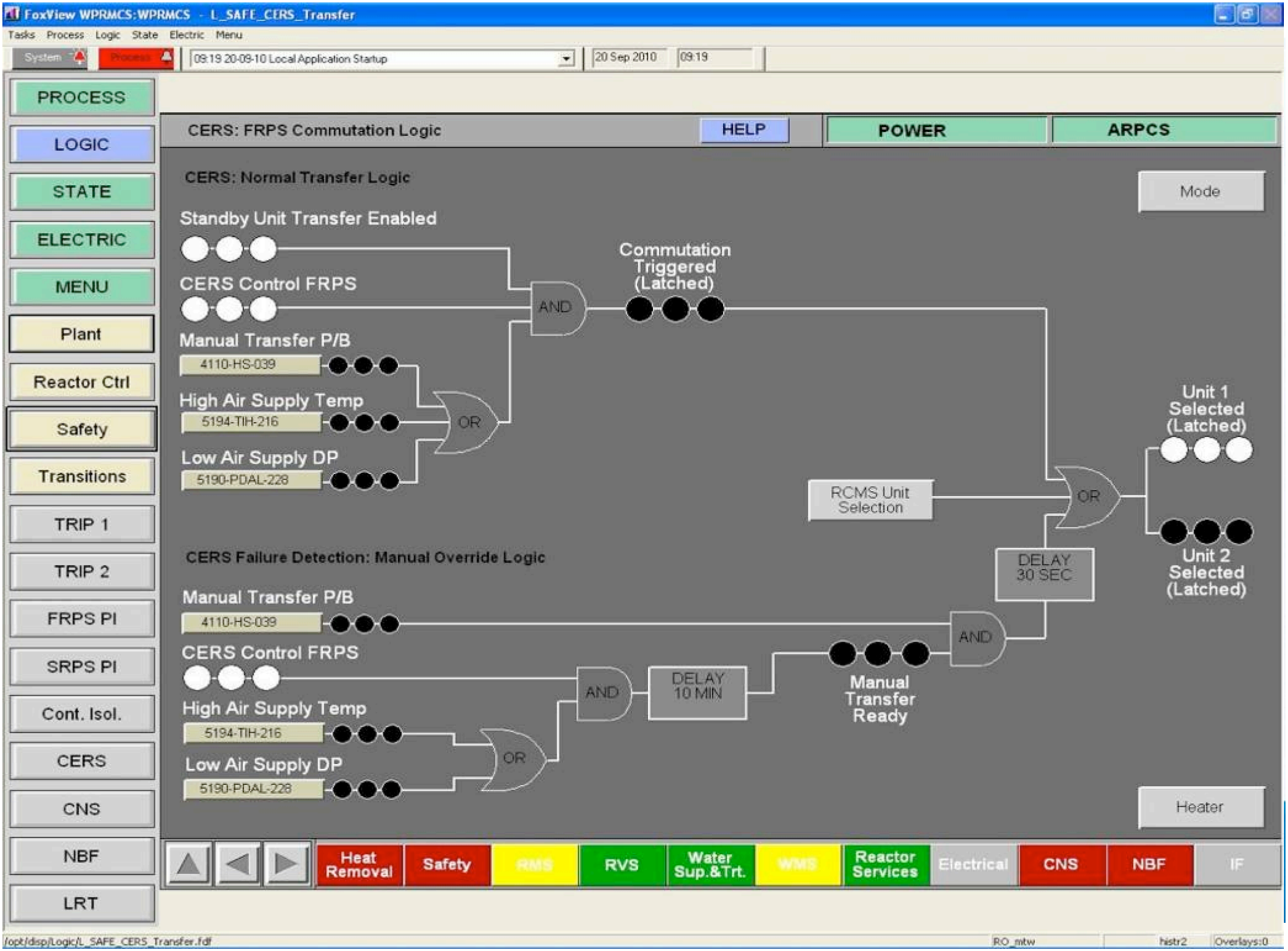
- **Past (Safety Category 1)**
  E0051 / E0092: CERS Logic Modifications

- **Present (Safety Category 2)**
  E0118: CAS Upgrade

- **Future (Safety Category 3)**
  E0193: Replacement of CNS Variable Speed Drive
  E0162: Relocation of SCS Variable Speed Drives

E0051 / E0092:
CERS Logic Modifications

- **Removed CHILLER AHU Trip on LOOP**
- **Added Manual Override Logic Path**


FoxView WPRMCS:WPRMCS - L_SAFE_CERS_Transfer
Tasks Process Logic State Electric Menu
System
Process
09:19 20-09-10 Local Application Startup
20 Sep 2010
09:19
PROCESS
LOGIC
STATE
ELECTRIC
MENU
Plant
Reactor Ctrl
Safety
Transitions
TRIP 1
TRIP 2
FRPS PI
SRPS PI
Cont. Isol.
CERS
CNS
NBF
LRT
CERS: FRPS Commutation Logic
HELP
POWER
ARPCS
CERS: Normal Transfer Logic
Mode
Standby Unit Transfer Enabled
CERS Control FRPS
Manual Transfer P/B
4110-HS-039
High Air Supply Temp
5194-TIH-216
Low Air Supply DP
5190-PDAL-228
AND
OR
Commutation Triggered (Latched)
RCMS Unit Selection
OR
Unit 1 Selected (Latched)
Unit 2 Selected (Latched)
DELAY 30 SEC
CERS Failure Detection: Manual Override Logic
Manual Transfer P/B
4110-HS-039
CERS Control FRPS
High Air Supply Temp
5194-TIH-216
Low Air Supply DP
5190-PDAL-228
AND
DELAY 10 MIN
AND
Manual Transfer Ready
OR
Heater
Heat Removal
Safety
RMS
RVS
Water Sup.&Trt.
WMS
Reactor Services
Electrical
CNS
NBF
IF
/opt/disp/Logic/L_SAFE_CERS_Transfer.fdf
RO_mtw
histr2
Overlays:0

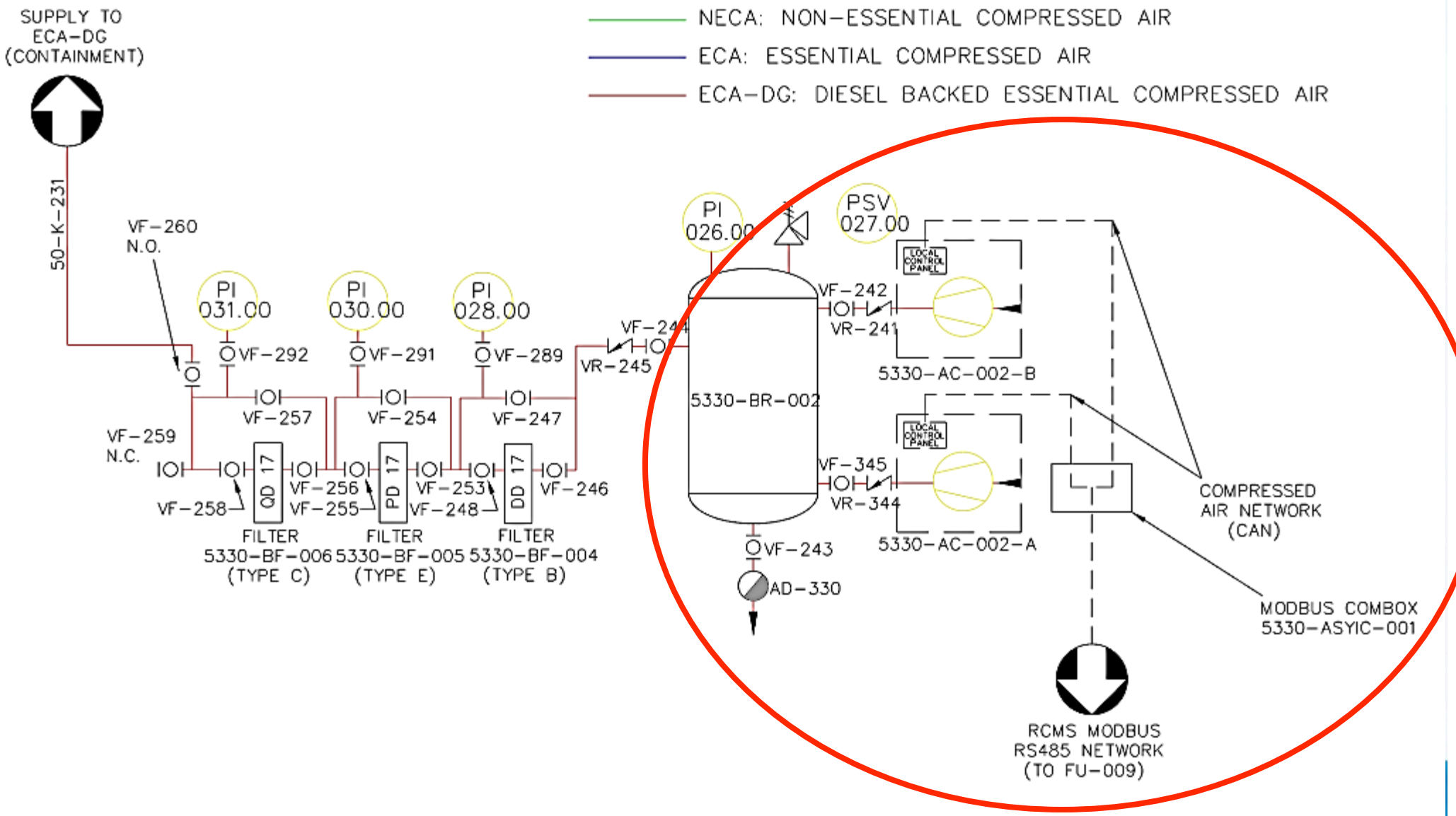
E0118: CAS Upgrade Project

- **Priority:** **Raised after 27 March 2009 – 2 hr loss of power to ANSTO**
- **Problem:** **During LOOP – Grp1 CIV close, [5330-AC-002] is powered from NPS**
- **Effects:**

1. **Rapid loss of plant air – due to FSS bleed**
2. **Inoperability of CIV Grp 2 valves – fail as is design**
3. **Fail open of RCPS helium relief valve – vents tritiated helium into room (Note: also solved by Project E0112 – PSV Replacement in Dec 2009)**
4. **Spurious actuation of SSS - @ 5.5 bar**
5. **Failure of Hot Cells Ventilation – OLC 3.5.4 entry**
6. **Inoperability of Control Rod Room Door – LOCA Barrier**
7. **Heavy Water Ventilation System Failure**
8. **Inoperability of RSPCS in LTPC Mode – SC2 core heat removal**

E0118: CAS Upgrade Project Outcomes

1. **Reclassify internal compressed air from SC3 to SC 2-P (ECA-DG)**
2. **Install redundant air compressor inside containment [5330-AC-002-A / B]**
3. **Move power for compressors to SPS (Diesel Generator)**
4. **Modbus communication link from compressors to RCMS**
5. **Auto close of FSS valve [0290-NV-603] after LOOP**
6. **Instrument upgrades: 5390-PT-024, LHC pressure indication, PSV replacement**


NECA: NON-ESSENTIAL COMPRESSED AIR
ECA: ESSENTIAL COMPRESSED AIR
ECA-DG: DIESEL BACKED ESSENTIAL COMPRESSED AIR
SUPPLY TO ECA-DG (CONTAINMENT)
50-K-231
VF-260 N.O.
PI 031.00
PI 030.00
PI 028.00
PI 026.00
PSV 027.00
VF-292
VF-291
VF-289
VF-244
VR-245
VF-257
VF-254
VF-247
VF-259 N.C.
VF-258
QD 17
VF-256
VF-255
PD 17
VF-253
VF-248
DD 17
VF-246
FILTER 5330-BF-006 (TYPE C)
FILTER 5330-BF-005 (TYPE E)
FILTER 5330-BF-004 (TYPE B)
5330-BR-002
VF-242
VR-241
5330-AC-002-B
VF-345
VR-344
5330-AC-002-A
LOCAL CONTROL PANEL
VF-243
AD-330
COMPRESSED AIR NETWORK (CAN)
MODBUS COMBOX 5330-ASYIC-001
RCMS MODBUS RS485 NETWORK (TO FU-009)

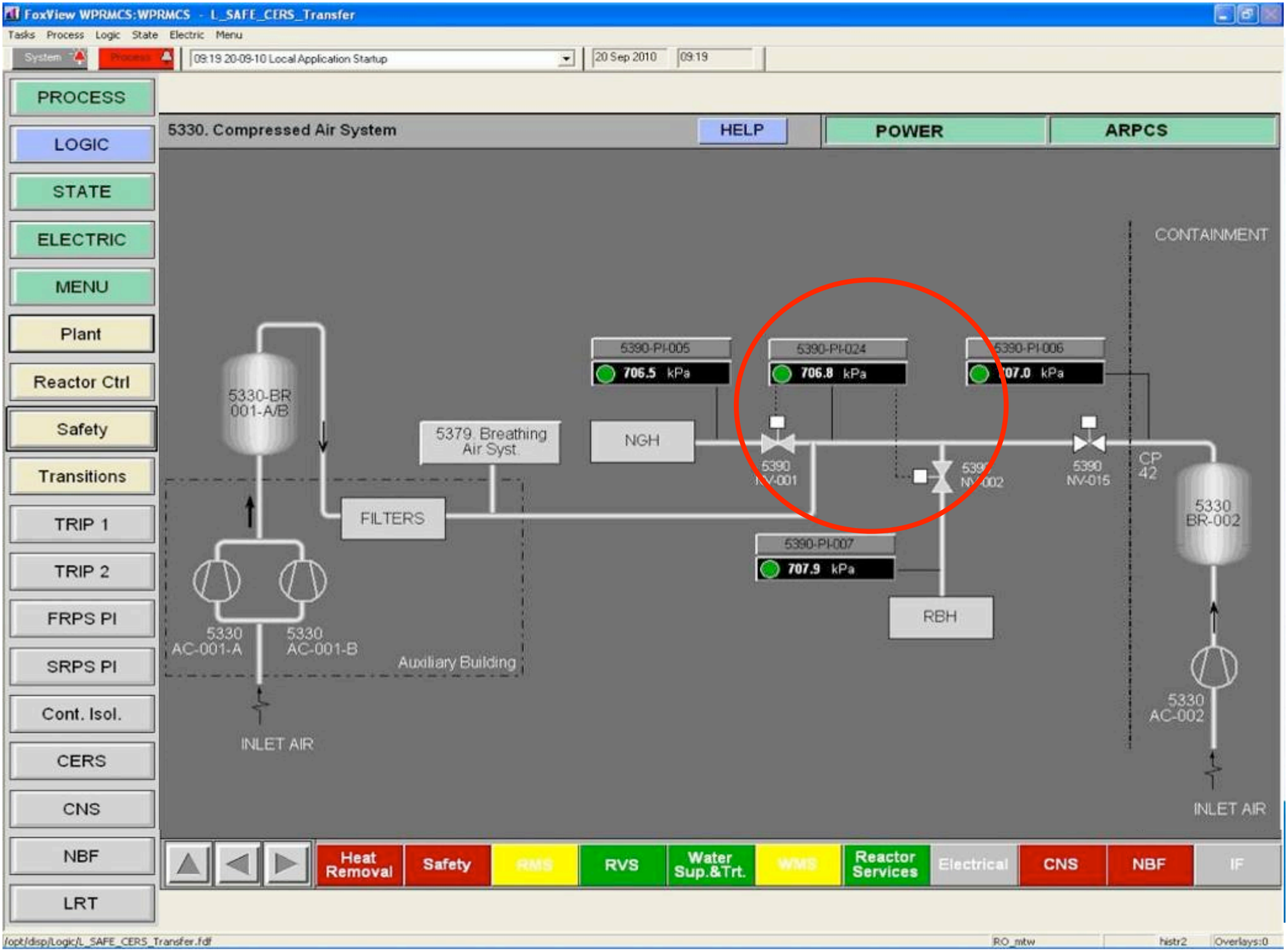
Modbus
COMBOX

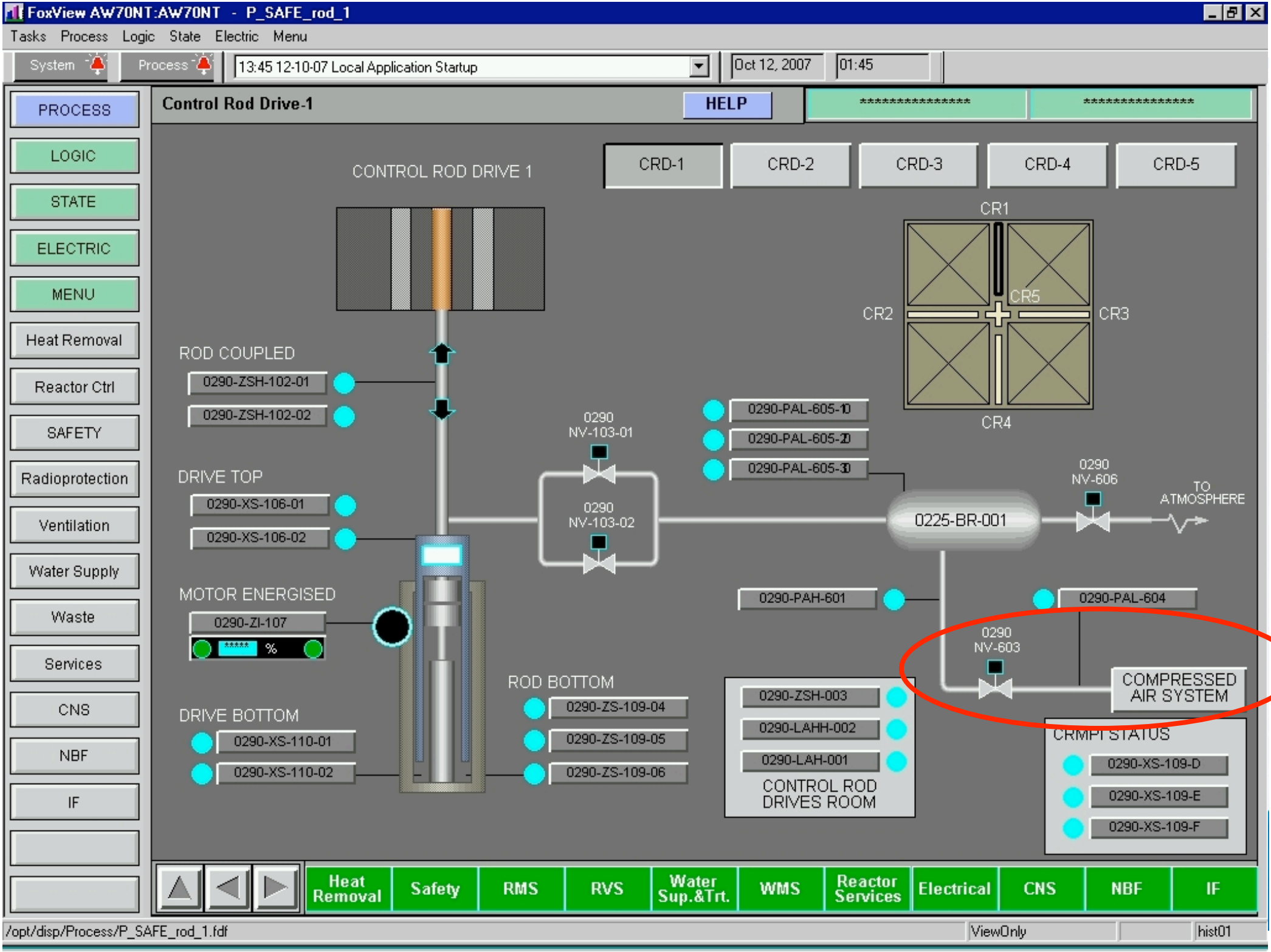
Original
Compressor

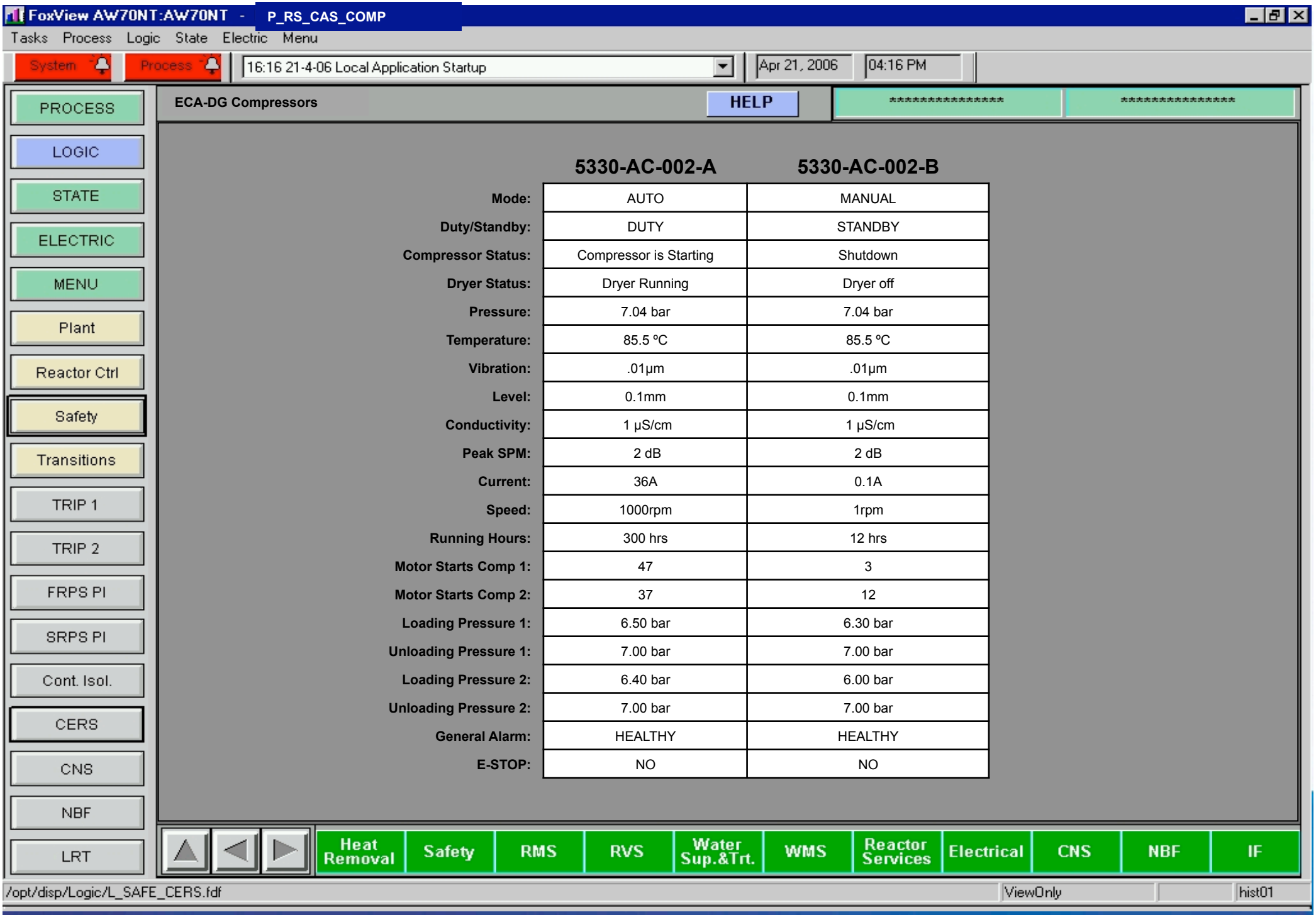
New
Compressor

Installation

Completion


FoxView WPRMCS:WPRMCS - L_SAFE_CERS_Transfer
Tasks Process Logic State Electric Menu
09:19 20-09-10 Local Application Startup
20 Sep 2010
09:19
PROCESS
LOGIC
STATE
ELECTRIC
MENU
Plant
Reactor Ctrl
Safety
Transitions
TRIP 1
TRIP 2
FRPS PI
SRPS PI
Cont. Isol.
CERS
CNS
NBF
LRT
5330. Compressed Air System
HELP
POWER
ARPCS
CONTAINMENT
5330-BR 001-A/B
5379. Breathing Air Syst
NGH
5390-PI-005
706.5 kPa
5390-PI-024
706.8 kPa
5390-PI-006
707.0 kPa
5390 NV-001
5390 NV-002
5390 NV-015
CP 42
5330 BR-002
FILTERS
5390-PI-007
707.9 kPa
RBH
5330 AC-001-A
5330 AC-001-B
Auxiliary Building
INLET AIR
5330 AC-002
INLET AIR
Heat Removal
Safety
RMS
RVS
Water Sup.&Trt.
WMS
Reactor Services
Electrical
CNS
NBF
IF
/opt/disp/Logic/L_SAFE_CERS_Transfer.fdf
RO_mtw
histr2
Overlays:0

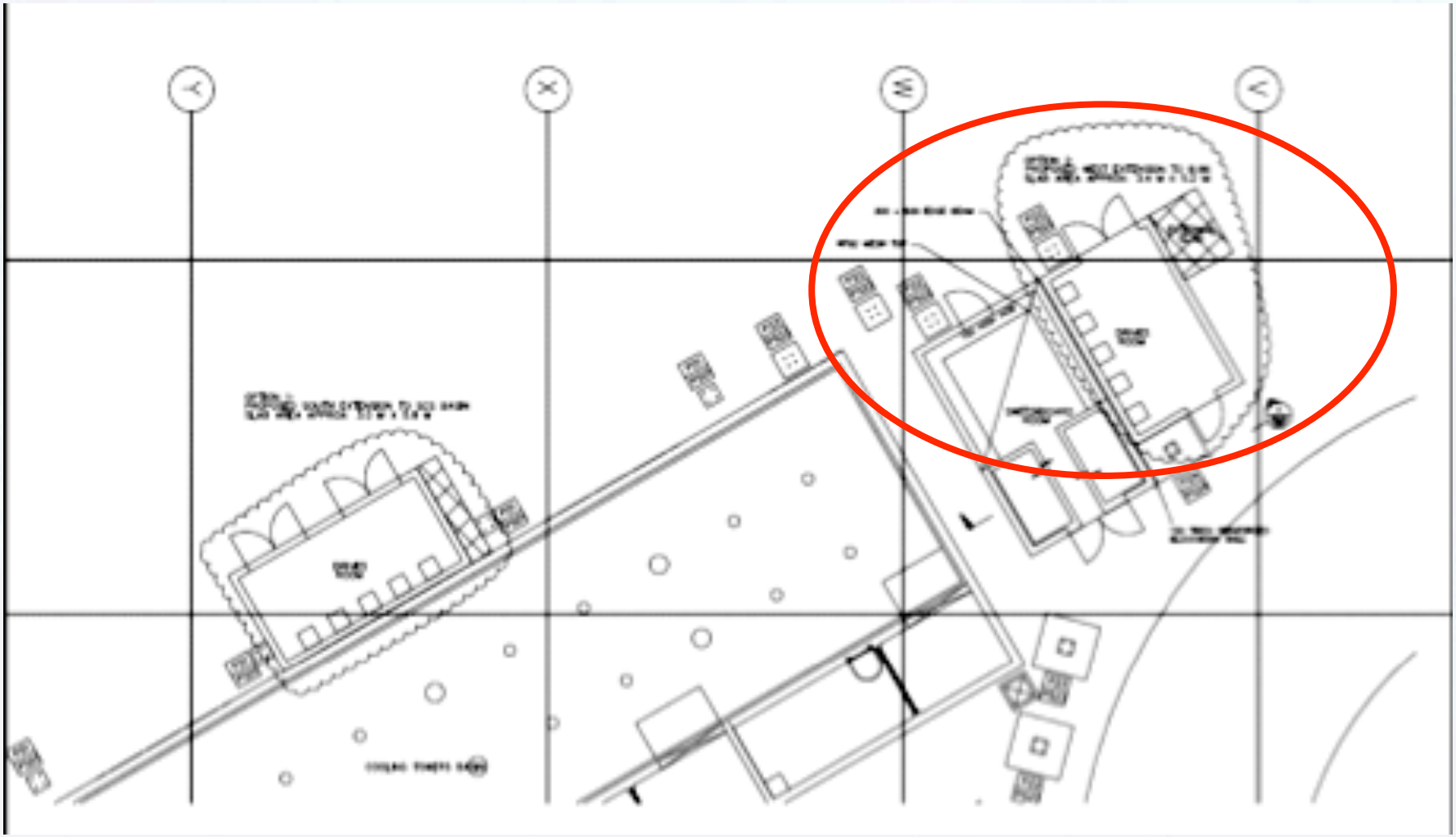

FoxView AW70NT:AW70NT - P_SAFE_rod_1
Tasks Process Logic State Electric Menu
System
Process
13:45 12-10-07 Local Application Startup
Oct 12, 2007
01:45
PROCESS
LOGIC
STATE
ELECTRIC
MENU
Heat Removal
Reactor Ctrl
SAFETY
Radioprotection
Ventilation
Water Supply
Waste
Services
CNS
NBF
IF
Control Rod Drive-1
HELP
CRD-1
CRD-2
CRD-3
CRD-4
CRD-5
CONTROL ROD DRIVE 1
CR1
CR2
CR3
CR4
CR5
ROD COUPLED
0290-ZSH-102-01
0290-ZSH-102-02
DRIVE TOP
0290-XS-106-01
0290-XS-106-02
MOTOR ENERGISED
0290-ZI-107
*****
%
DRIVE BOTTOM
0290-XS-110-01
0290-XS-110-02
0290 NV-103-01
0290 NV-103-02
0290-PAL-605-1
0290-PAL-605-2
0290-PAL-605-3
0225-BR-001
0290 NV-606
TO ATMOSPHERE
0290-PAH-601
0290-PAL-604
0290 NV-603
COMPRESSED AIR SYSTEM
ROD BOTTOM
0290-ZS-109-04
0290-ZS-109-05
0290-ZS-109-06
0290-ZSH-003
0290-LAHH-002
0290-LAH-001
CONTROL ROD DRIVES ROOM
CRMPI STATUS
0290-XS-109-D
0290-XS-109-E
0290-XS-109-F
Heat Removal
Safety
RMS
RVS
Water Sup.&Trt.
WMS
Reactor Services
Electrical
CNS
NBF
IF
/opt/disp/Process/P_SAFE_rod_1.fdf
ViewOnly
hist01


FoxView AW70NT:AW70NT - P_RS_CAS_COMP
Tasks Process Logic State Electric Menu
System
Process
16:16 21-4-06 Local Application Startup
Apr 21, 2006
04:16 PM
PROCESS
LOGIC
STATE
ELECTRIC
MENU
Plant
Reactor Ctrl
Safety
Transitions
TRIP 1
TRIP 2
FRPS PI
SRPS PI
Cont. Isol.
CERS
CNS
NBF
LRT
ECA-DG Compressors
HELP
****
****
5330-AC-002-A
5330-AC-002-B
Mode: AUTO MANUAL
Duty/Standby: DUTY STANDBY
Compressor Status: Compressor is Starting Shutdown
Dryer Status: Dryer Running Dryer off
Pressure: 7.04 bar 7.04 bar
Temperature: 85.5 ºC 85.5 ºC
Vibration: .01µm .01µm
Level: 0.1mm 0.1mm
Conductivity: 1 µS/cm 1 µS/cm
Peak SPM: 2 dB 2 dB
Current: 36A 0.1A
Speed: 1000rpm 1rpm
Running Hours: 300 hrs 12 hrs
Motor Starts Comp 1: 47 3
Motor Starts Comp 2: 37 12
Loading Pressure 1: 6.50 bar 6.30 bar
Unloading Pressure 1: 7.00 bar 7.00 bar
Loading Pressure 2: 6.40 bar 6.00 bar
Unloading Pressure 2: 7.00 bar 7.00 bar
General Alarm: HEALTHY HEALTHY
E-STOP: NO NO
Heat Removal
Safety
RMS
RVS
Water Sup.&Trt.
WMS
Reactor Services
Electrical
CNS
NBF
IF
/opt/disp/Logic/L_SAFE_CERS.fdf
ViewOnly
hist01

E0193: Replacement of CNS-VSD

- **250kW Drive For Helium Compressor**
- **CNS-VSD + Active Front End (AFE)**

E0162: Relocation / Upgrade of SCS-VSD



Results / Conclusions

- **OPAL Electrical System Compliant with SAR**
- **Estimated Total Cost @ Project Completion ~ $500k USD**
- **Recovery Period On Investment: 1 Year**
- **Project Duration: 4 Years**

Further Work

- **Complete Drive Replacement Projects**
- **Perform LOOP Emergency Exercise**


Questions
Questions taken now or by email:
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Nuclear-based science benefiting all Australians