

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

Paul Metcalf and Chris Humphrey
OPAL Engineering and Maintenance
September 2010



IGORR 2010: KNOXVILLE TN SEPTEMBER 19-23 2010
Technical Session 7: Research Reactor Safety

Contents

1. Introduction

- SAR Requirements Specification
- Motivation
- Voltage Dip (IEC)
- OPAL Voltage Dip Factoids
- Voltage Dip Classification

2. Body

- LOOP Related Projects
- E0051 / E0092: CERS Logic Modifications
- E0118: CAS Upgrade Project
- E0193: Replacement of SCS-VSD
- E0162: Relocation / Upgrade of SCS-VSD

3. Conclusions

- Results / Conclusions
- Further Work
- Questions

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

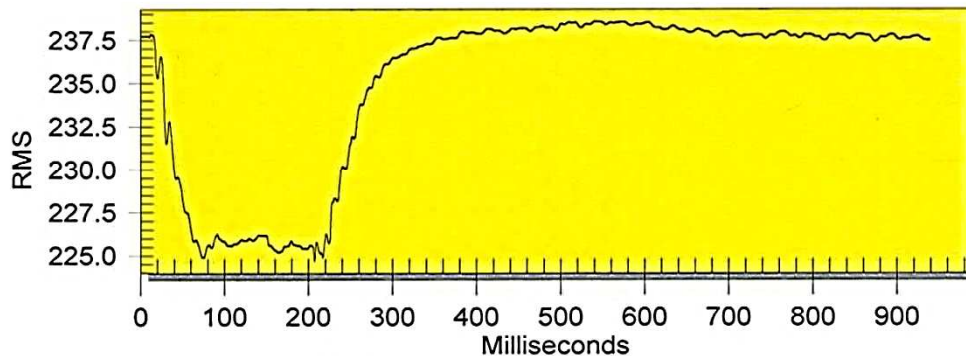


- **Improve Safety by ensuring full compliance with Safety Analysis Report**
- **Improve Plant Performance and Reliability WRT Voltage Dips**

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**

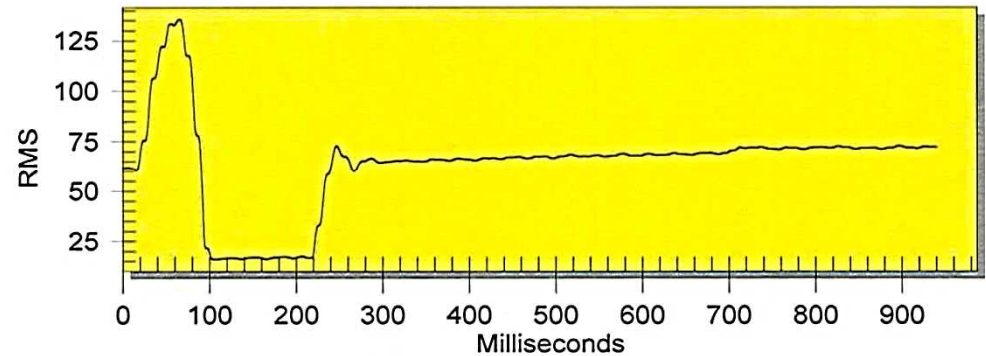
Phase B-N Voltage
RMS Analysis



Phase C-N Voltage
RMS Analysis



Phase B Current
RMS Analysis



Phase C Current
RMS Analysis



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

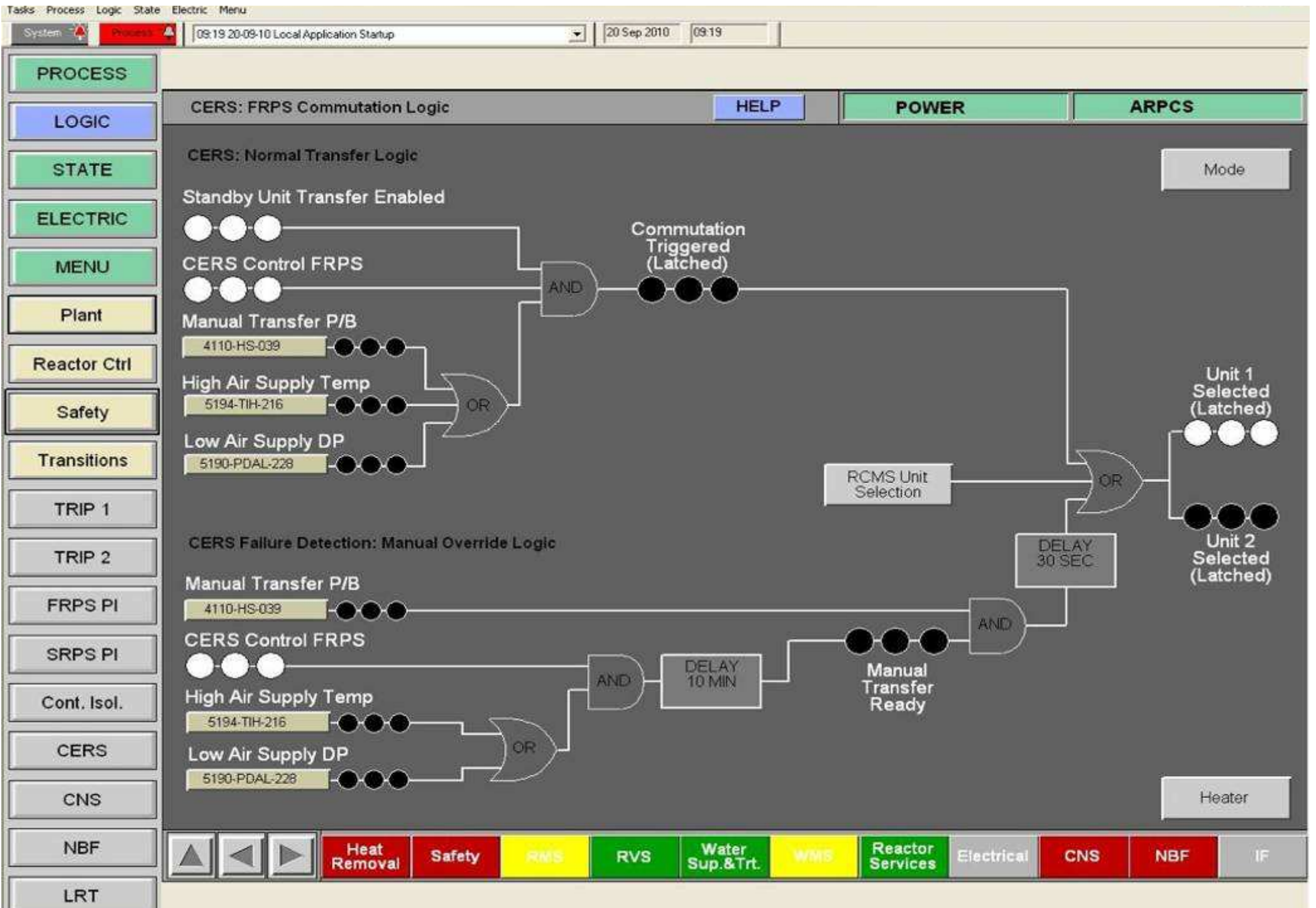
LOOP Related Projects

- **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**



E0118: CAS Upgrade Project

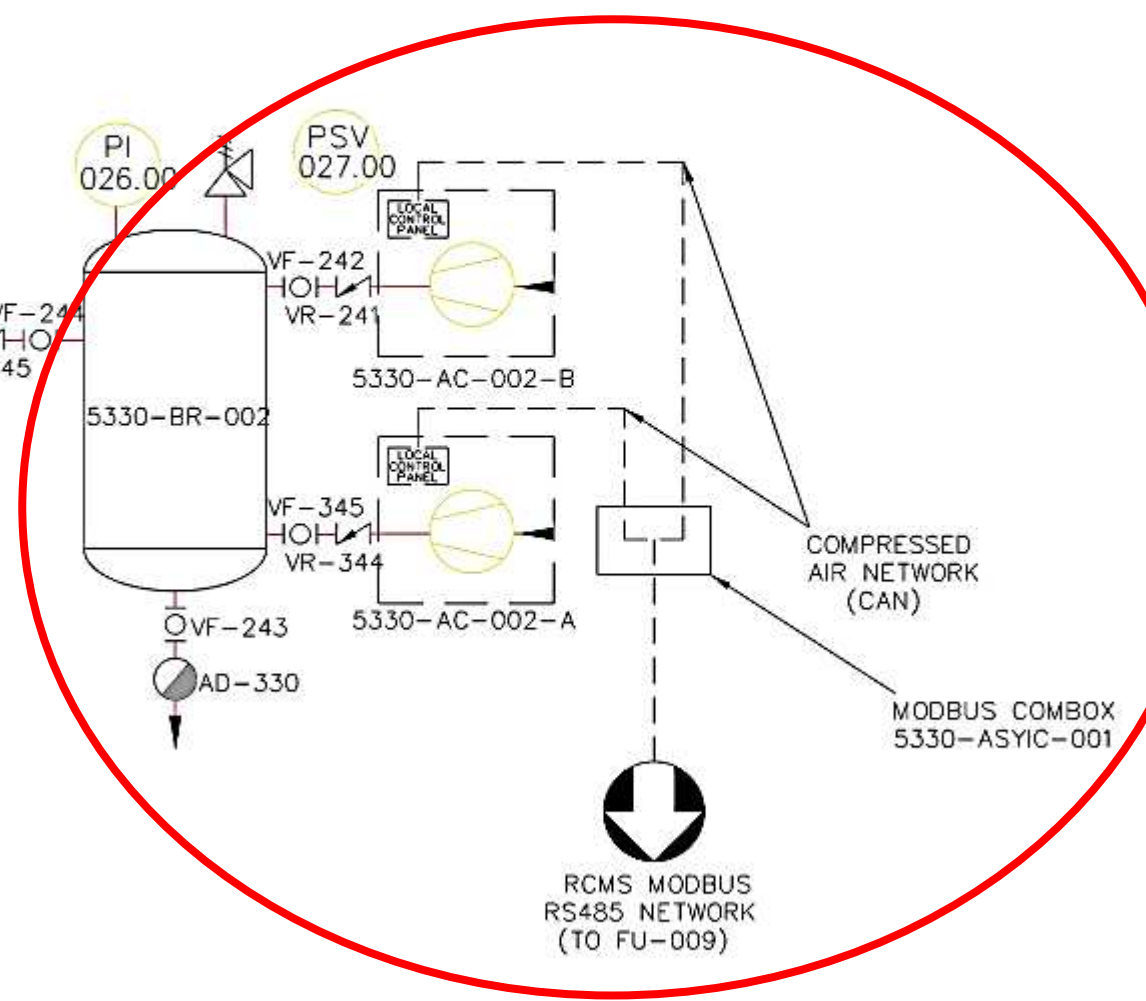
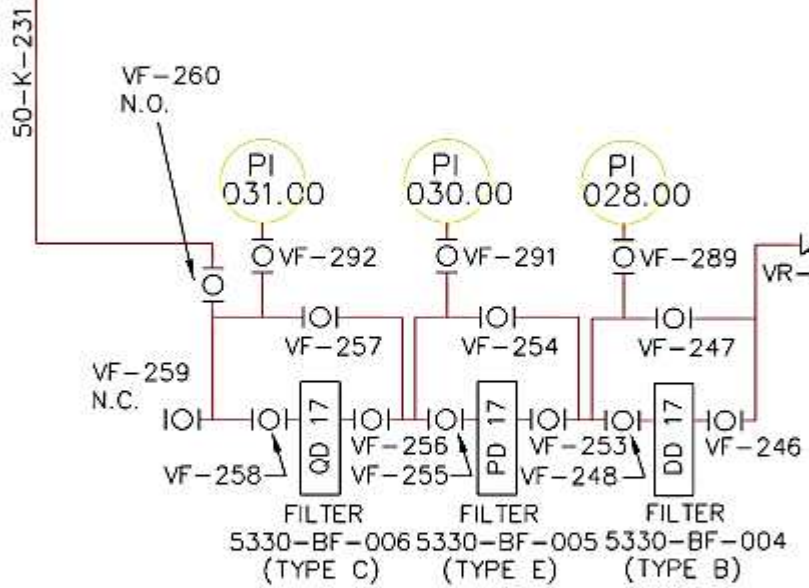
- **Priority:** Raised after 27 March 2009 – 2 hr loss of power to ANSTO
- **Problem:** During LOOP – Grp1 CIV close, [5330-AC-002] is powered from NPS
- **Effects:**
 1. **Rapid loss of plant air – due to FSS bleed**
 2. **Inoperability of CIV Grp 2 valves – fail as is design**
 3. **Fail open of RCPS 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 LTFC 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**

SUPPLY TO
ECA-DG
(CONTAINMENT)

- NECA: NON-ESSENTIAL COMPRESSED AIR
- ECA: ESSENTIAL COMPRESSED AIR
- ECA-DG: DIESEL BACKED ESSENTIAL COMPRESSED AIR





Installation

**Modbus
COMBOX**

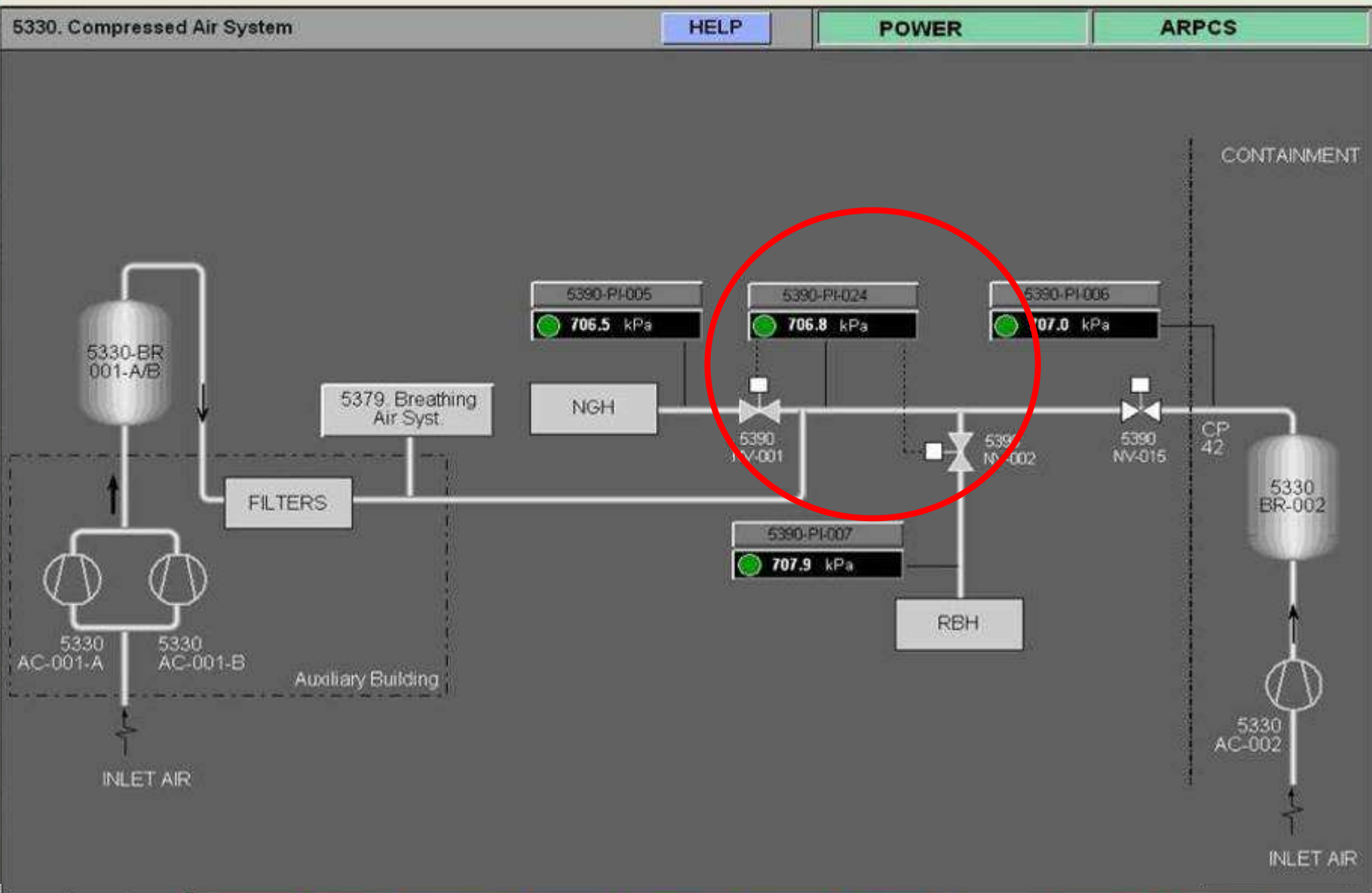
**Original
Compressor**

**New
Compressor**



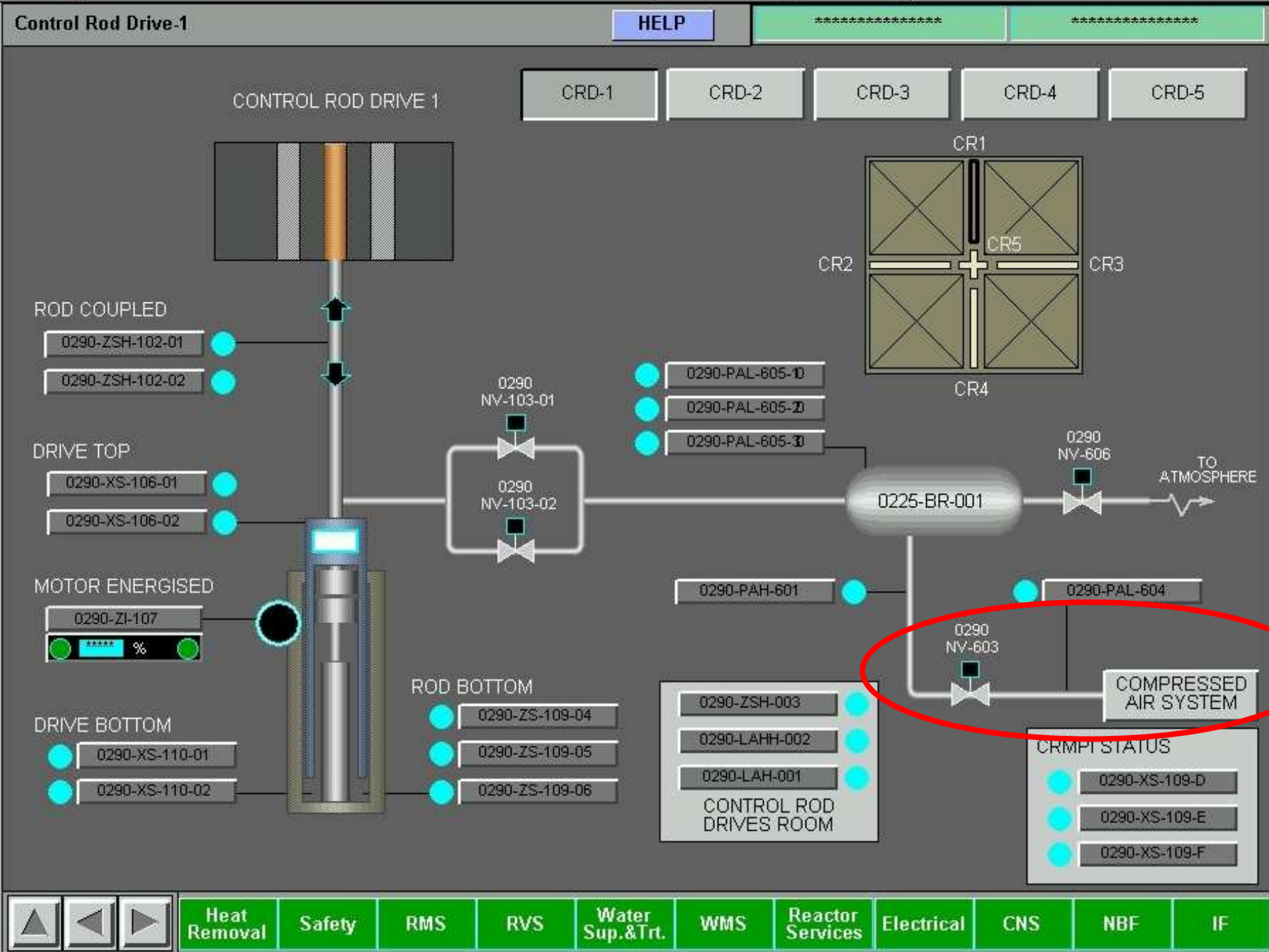
Completion

- PROCESS
- LOGIC
- STATE
- ELECTRIC
- MENU
- Plant
- Reactor Ctrl
- Safety
- Transitions
- TRIP 1
- TRIP 2
- FRPS PI
- SRPS PI
- Cont. Isol.
- CERS
- CNS
- NBF
- LRT



Heat Removal Safety RMS RVS Water Sup.&Trt. WMS Reactor Services Electrical CNS NBF IF

- PROCESS
- LOGIC
- STATE
- ELECTRIC
- MENU
- Heat Removal
- Reactor Ctrl
- SAFETY
- Radioprotection
- Ventilation
- Water Supply
- Waste
- Services
- CNS
- NBF
- IF



- 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 °C	85.5 °C
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

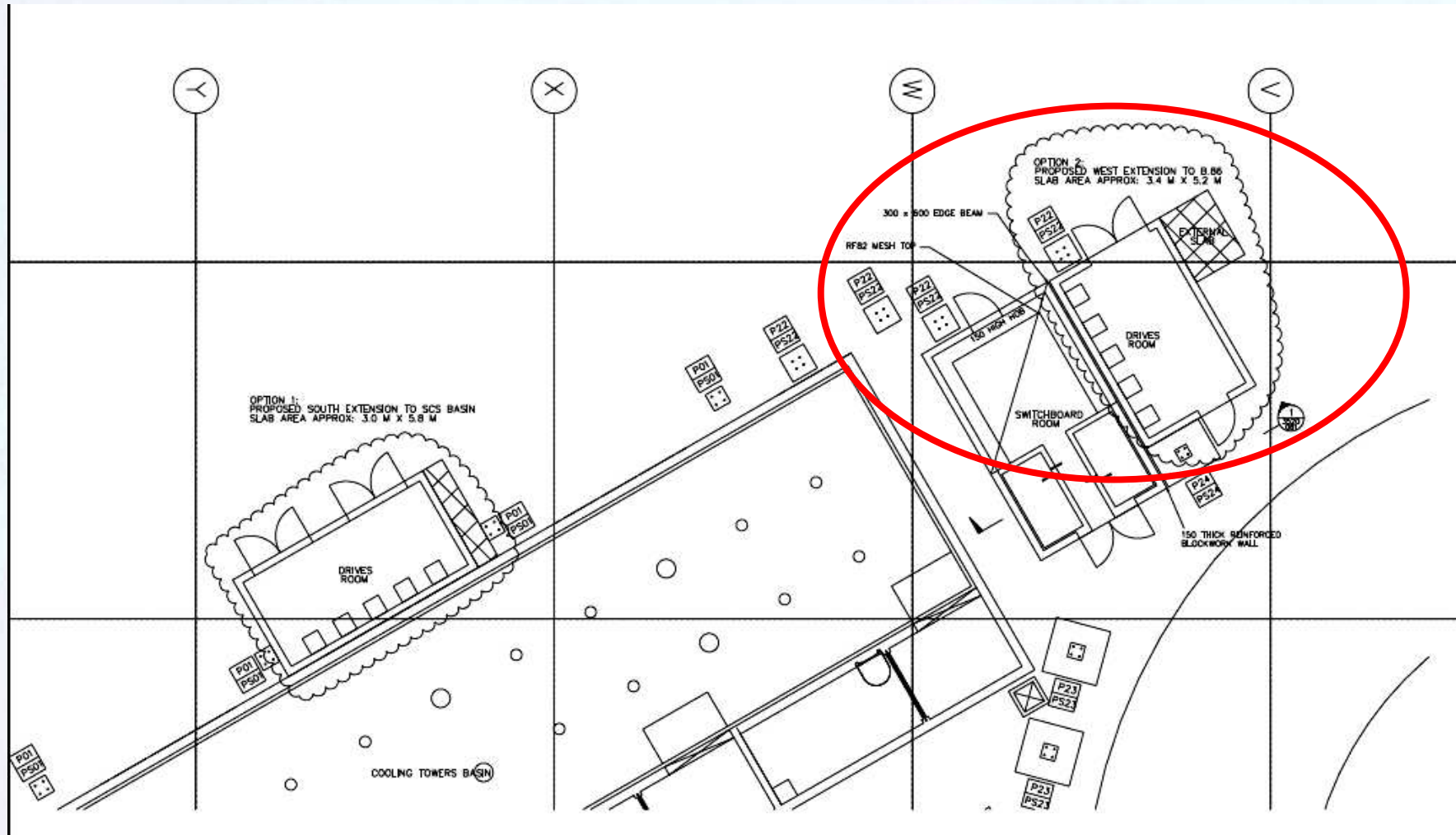
▲ ◀ ▶
Heat Removal
Safety
RMS
RVS
Water Sup.&Trt.
WMS
Reactor Services
Electrical
CNS
NBF
IF

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:
paul.metcalf@ansto.gov.au

The logo for Ansto, featuring the word "Ansto" in a bold, white, sans-serif font. The letter "A" is stylized with a white dot and a vertical line extending downwards from its center, resembling a nuclear symbol or a stylized atom. The background is a vibrant blue with abstract, flowing, light-colored lines that create a sense of motion and energy.

Ansto

Nuclear-based science benefiting all Australians