Exelon's PPC Monitoring Improvement Initiative

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Exelon Generation®

Background – Exelon PPC Replacement Plan and LTAM Strategy

PPC Replacement Plan Approved in 2002 to replace obsolete, legacy PPCs with a fleet-standard solution (Scientech R*Time)

PPC Long Term Asset Management (LTAM) Strategy implemented in 2011 to address Continuous PPC Life-cycle Management by performing consistent and timely base system upgrades and server/hardware refreshes needed to maintain system reliability, compatibility for digital upgrades, and ongoing support of the fleet's Plant Process Computers.

- Continues PPC replacement plan and includes periodic refreshes through end of plant life
- Refresh hardware, O/S, and applications every 7 years
- Full system and DAS replacement every 21 years
- Plant Process Computer corporate strategic pool budget established in 2013 to support funding refresh projects needed to maintain reliability and support IAW PPC LTAM Strategy.

PPC LTAM Strategy Status

Replacement Projects Completed:

- Ginna (2001)
- LaSalle (2003/2004)
- Oyster Creek (2004)
- Dresden (2005/2006)
- Clinton (2008)
- Quad Cities (2009/2010)
- Nine Mile Point 1 (2011/2012)
- Byron (2011/2012)
- Braidwood (2011/2012)
- TMI (2016)
- Limerick (2016/2017)
- Nine Mile Point 2 (2019)

Refresh Projects Completed/Underway:

- LaSalle (2016)
- Oyster Creek (2016)
- Dresden (2017)
- Quad Cities (2018 - 2019)
- Ginna (2017 - 2019)
- Clinton (2018 – 2020)
- Nine Mile Point 1 (2020)
- Braidwood/Byron (2020 – 2022)

Replacement Projects Underway/Planned:

- Peach Bottom (2017 – 2020)
- Fitzpatrick (2018 – 2021)

Problem Statement

While the LTAM Strategy does a great job addressing obsolescence and ensuring continued reliability of our fleet PPCs, the individual replacement projects did not always put a strong focus on enhancing the PPC displays and alarms beyond the inherent improvements of moving to the R*Time platform. And at many sites, some of the base R*Time features intended to improve plant monitoring are not fully utilized.

As a result, the use of the PPC as a diagnostic tool by CR Operators is significantly under-utilized. This has resulted in:

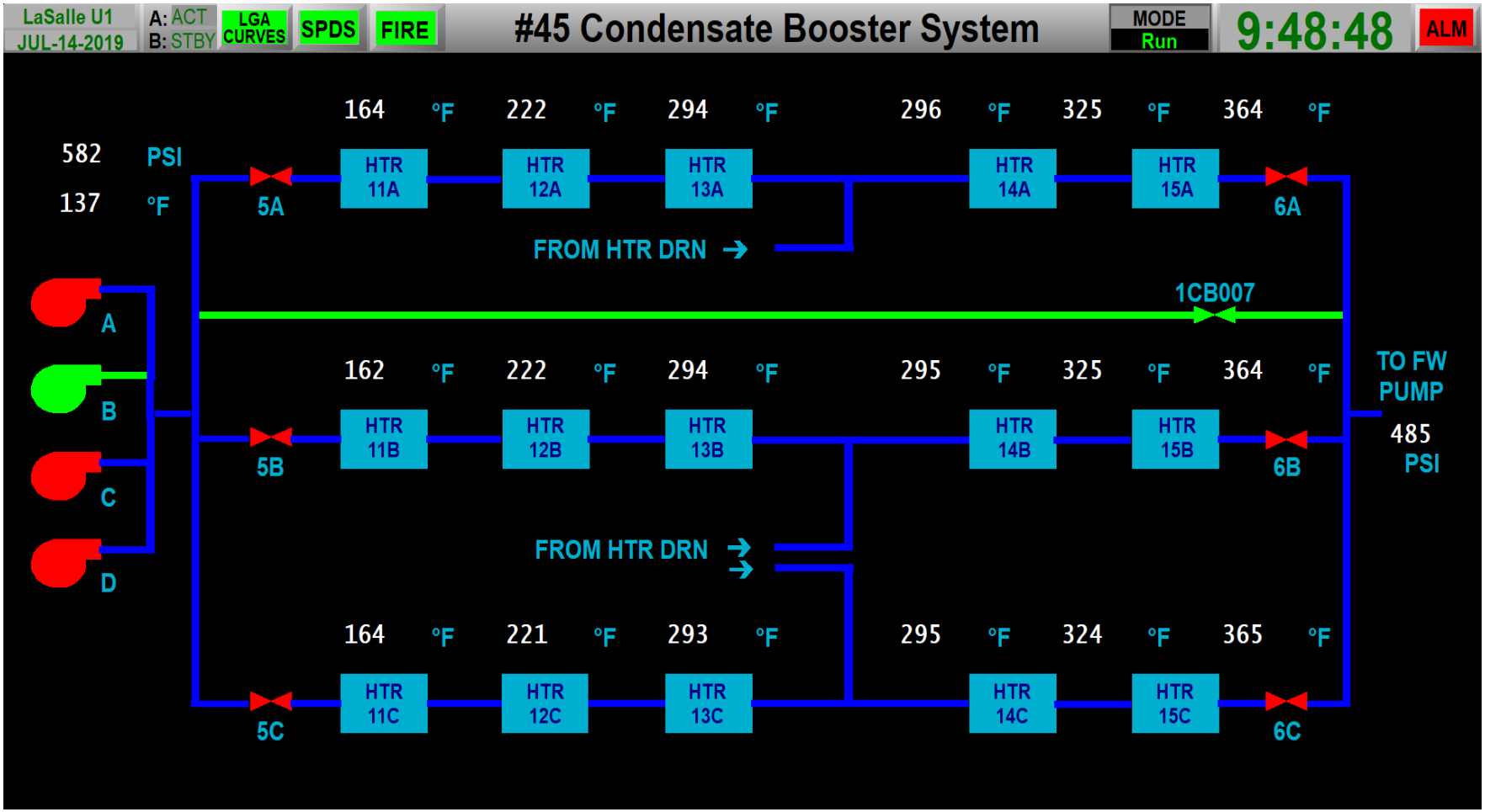
- Avoidable Plant Transients
- Loss of Generation
- Equipment Damage
- Emergent Radiation Exposure
- Safety Challenges
- Financial Impacts

LaSalle FW Heater Drains Pilot

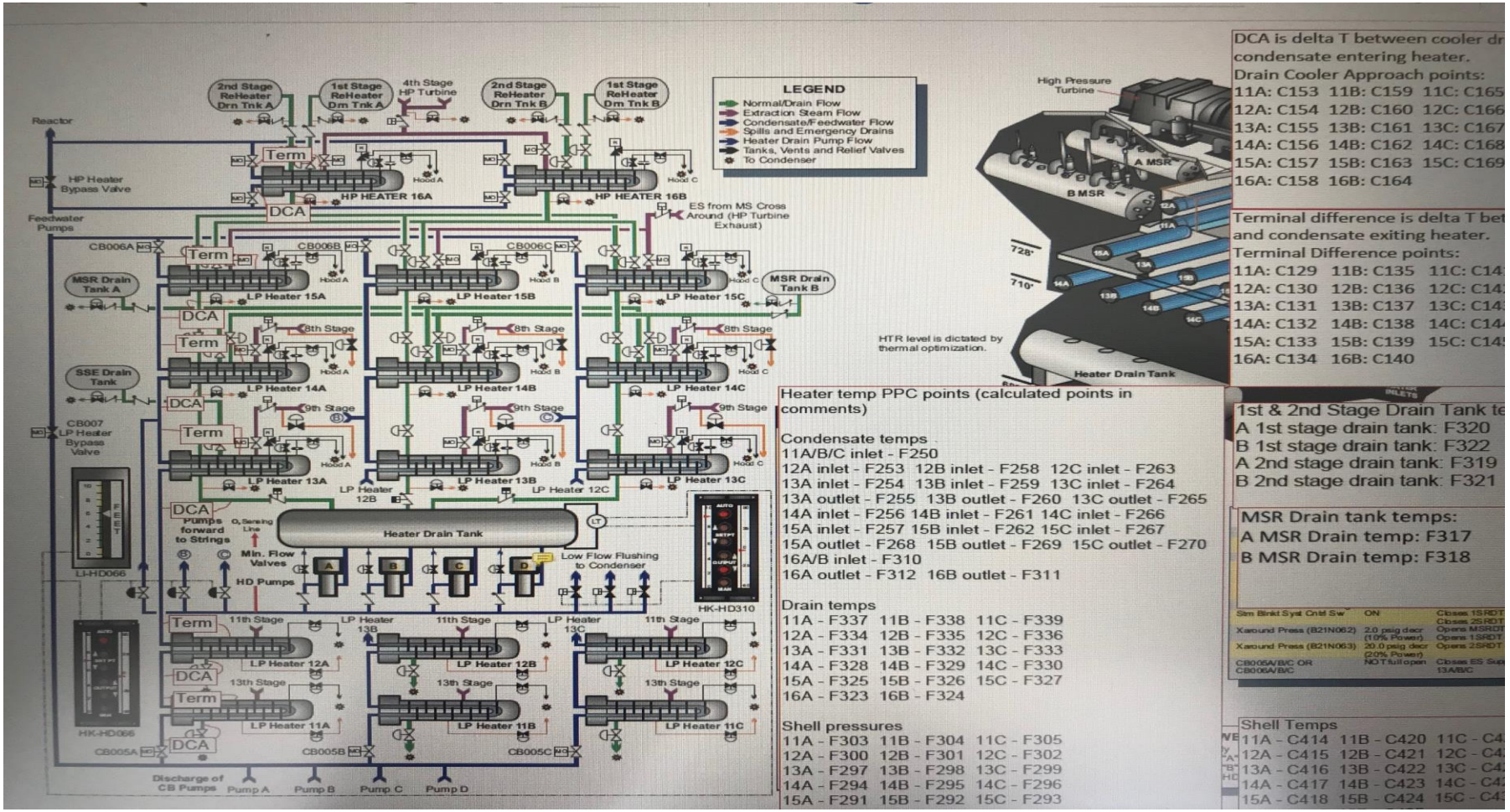
Initially, BOP systems (Off Gas, Turbine Lube Oil, Stator Cooling, Hydrogen Seal Oil, Condensate, Heater Drains, etc…) were the focus, as the PPC monitoring capabilities for these systems was considered to be particularly ineffective.

The LaSalle Feedwater Heater Drain system was selected as the pilot based on Site and fleet OPEX, current PPC capabilities and the availability of an engaged and knowledgeable Control Room Operator.

Typical of Current PPC Monitoring in the Fleet



“Big Note” used in Site System Training



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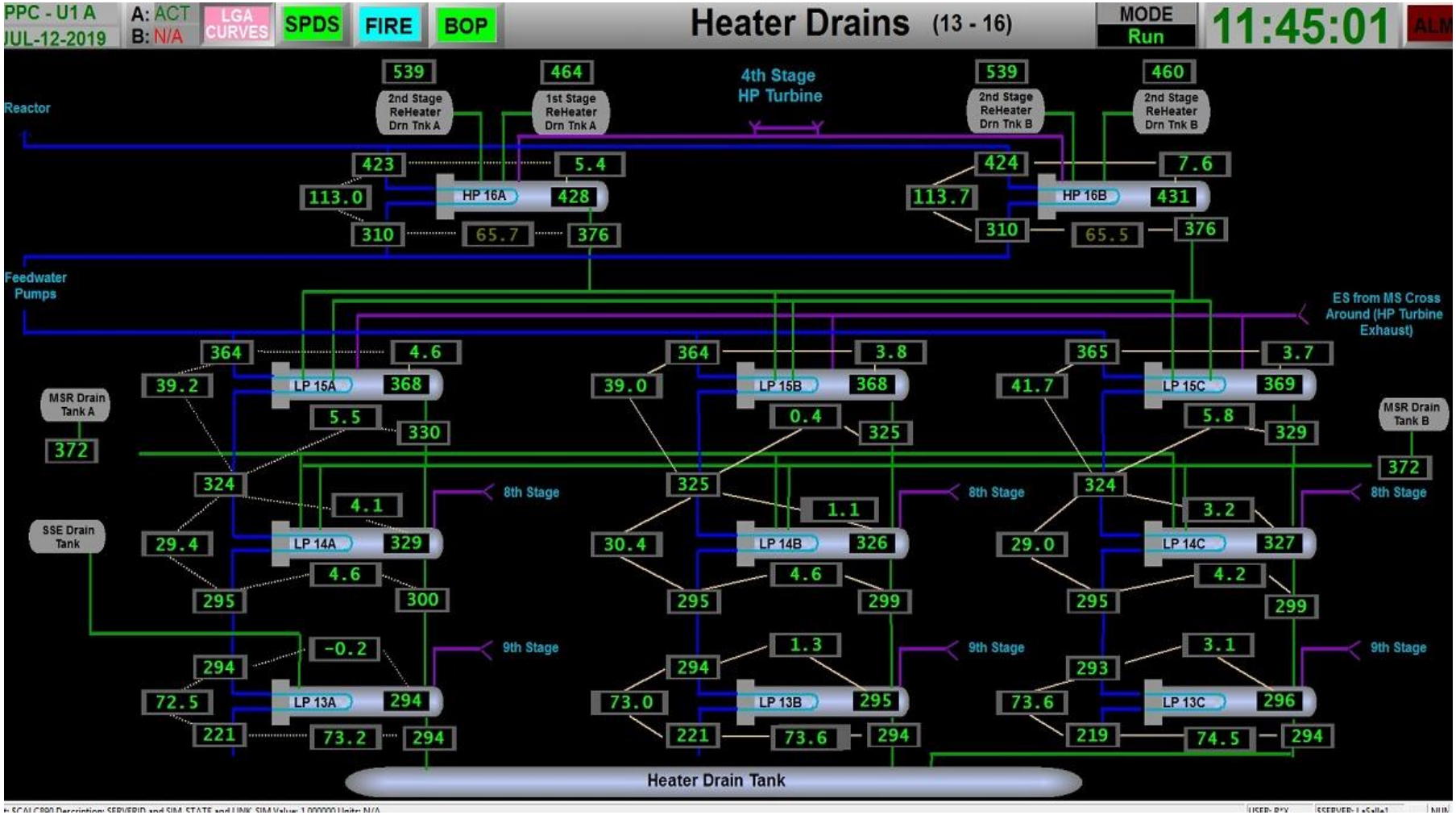
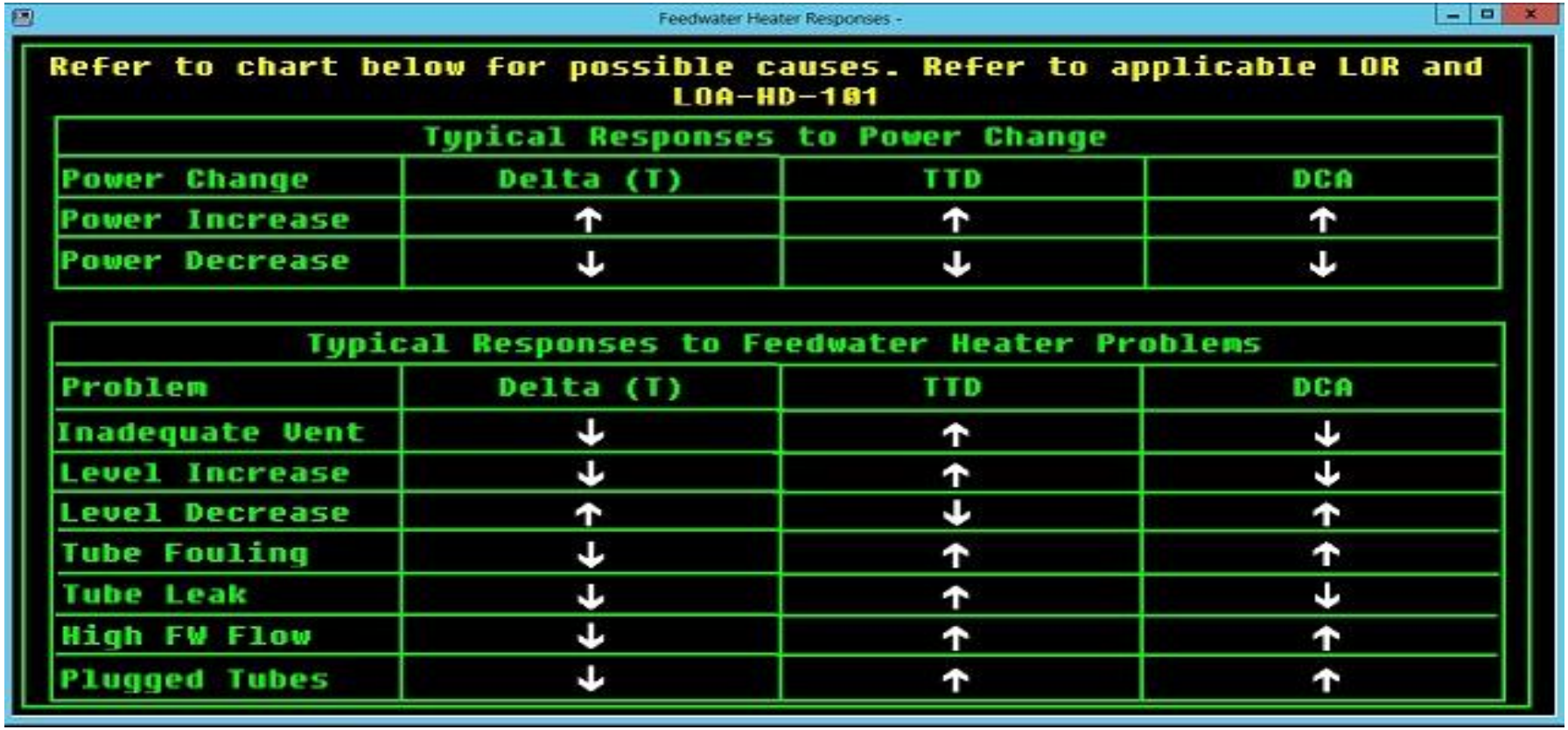
Newly Developed LaSalle HD PPC Video Display



Clicking on an alarming point will bring up graphs similar to these. Also note the Alarm Reference button in the bottom right corner.

Example of Additional Functionality Added

- In this example, a reference table is accessed by clicking on the “Alarm Reference” button form the previous slide
- Provides guidance on how to interpret different trends in heater temperatures
- Can be used to reference approved station procedures



Typical Responses to Power Change			
Power Change	Delta (T)	TTD	DCA
Power Increase	↑	↑	↑
Power Decrease	↓	↓	↓

Typical Responses to Feedwater Heater Problems			
Problem	Delta (T)	TTD	DCA
Inadequate Vent	↓	↑	↓
Level Increase	↓	↑	↓
Level Decrease	↑	↓	↑
Tube Fouling	↓	↑	↑
Tube Leak	↓	↑	↓
High FW Flow	↓	↑	↑
Plugged Tubes	↓	↑	↑

Limerick U2 Loss of Condenser Vacuum Scram

June 3, 2019:

Unit 2 was manually scrammed due to lowering condenser vacuum following the trip of the feeder breaker to D214-G-D safeguard 480VAC MCC. The trip was caused by a blown fuse. The loss of power to the MCC de-energized several offgas system level control valves on the aftercondenser and holdup pipe. The offgas system filled with water and vacuum decayed at the rate of 0.1" Hg/minute. The crew entered OT-116 for loss of vacuum and manually scrammed the reactor as directed by the OT.

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Limerick U2 Loss of Condenser Vacuum Scram

- Immediate actions taken by operators were effective, however the plant impacts that were not called out by procedures challenged the operators.
- The operators did not recognize that Bailey controllers fail as-is on a loss of electrical power: level will indicate the same as it was at the time that power is lost. Unlike some controllers, Bailey controllers do not feature a light indication or other means of verifying electrical power present.
- As a result of this gap, no manual action was taken to swap to the backup offgas level control train.
- The root cause team also identified issues related to monitoring capabilities available on the PPC and use of the limited points that are available. For example, Offgas System Flow is not available on the PPC.
- **Key takeaway: Had the PPC been better configured for monitoring Offgas system indications, the operating crew may have been able to diagnose the underlying issues earlier and avoided the scram.**

OPCC and PPC Monitoring Improvement

- This Limerick Scram and multiple other events have occurred across the Exelon fleet related to Single Point Vulnerabilities (also referred to as Operational Critical Components (OPCCs))
- As a result, several actions were assigned by the SLT related to monitoring and mitigation of OPCC-related events
- With these actions, one project with two key elements were established:
  - A Plant Process Computer (PPC) Monitoring Plan led by Operations
  - An OPCC Monitoring Plan implemented by Operations and Engineering
- PPC Monitoring Improvement is not intended to replace the functions of the M&D Center, but to support real-time station response to emerging equipment issues 24/7

PPC Monitoring Improvement Initiative Goals

- Enhanced PPC Monitoring will directly improve Operations ability to identify and mitigate transients or degrading trends prior to them progressing to significant power reductions or scrams by:
  - Enhancing existing PPC displays and adding new displays for critical systems to greatly increase monitoring and diagnostic capabilities of operators
  - Analyzing existing PPC alarms and adding or modifying alarm level/setpoints/dead-bands to improve operator awareness of plant equipment issues and degrading trends while minimizing nuisance alarms
  - Initial system scope for PPC displays include: Reactor Recirc, Feedwater, Feedwater heaters, Condensate, Offgas, Turbine generator, Turbine auxiliaries (Oil / EHC / Exciter / H2 Cooling / Stator Water / Seal Oil, etc.)

PPC Monitoring Improvement - Next Steps

- Core team to include 1-2 Ops SMEs and an Engineering resource per site, and 2 dedicated corporate IT resources
- Ops SMEs at each site select target systems and develop display markups using existing displays, training “big notes”, etc…
- Ops and Engineering perform site PPC alarm analysis and provide updated alarm configurations
- Corp IT Display Builders work with Ops at each site to develop new and revised displays based on markups and iterative discussion
- New displays and alarm settings will be tested on corporate development systems and at the site-specific Simulator before turnover to the Site IT teams for implementation
- Recommendations requiring Engineering Changes (new scanned points, code changes, etc…) will be captured for future implementation

PPC Monitoring Improvement - Timeline

- Final approval for OPCC/PPC Monitoring Initiative in progress now
- PPC Monitoring improvements will start with a pilot at Limerick in Feb-Mar to ensure staffing and process assumptions are valid
- R*Time Display Builder Training for core team in April in conjunction with Peach Bottom PPC Replacement training offering
- Display and alarm revisions to proceed site-by-site throughout 2020

Questions?

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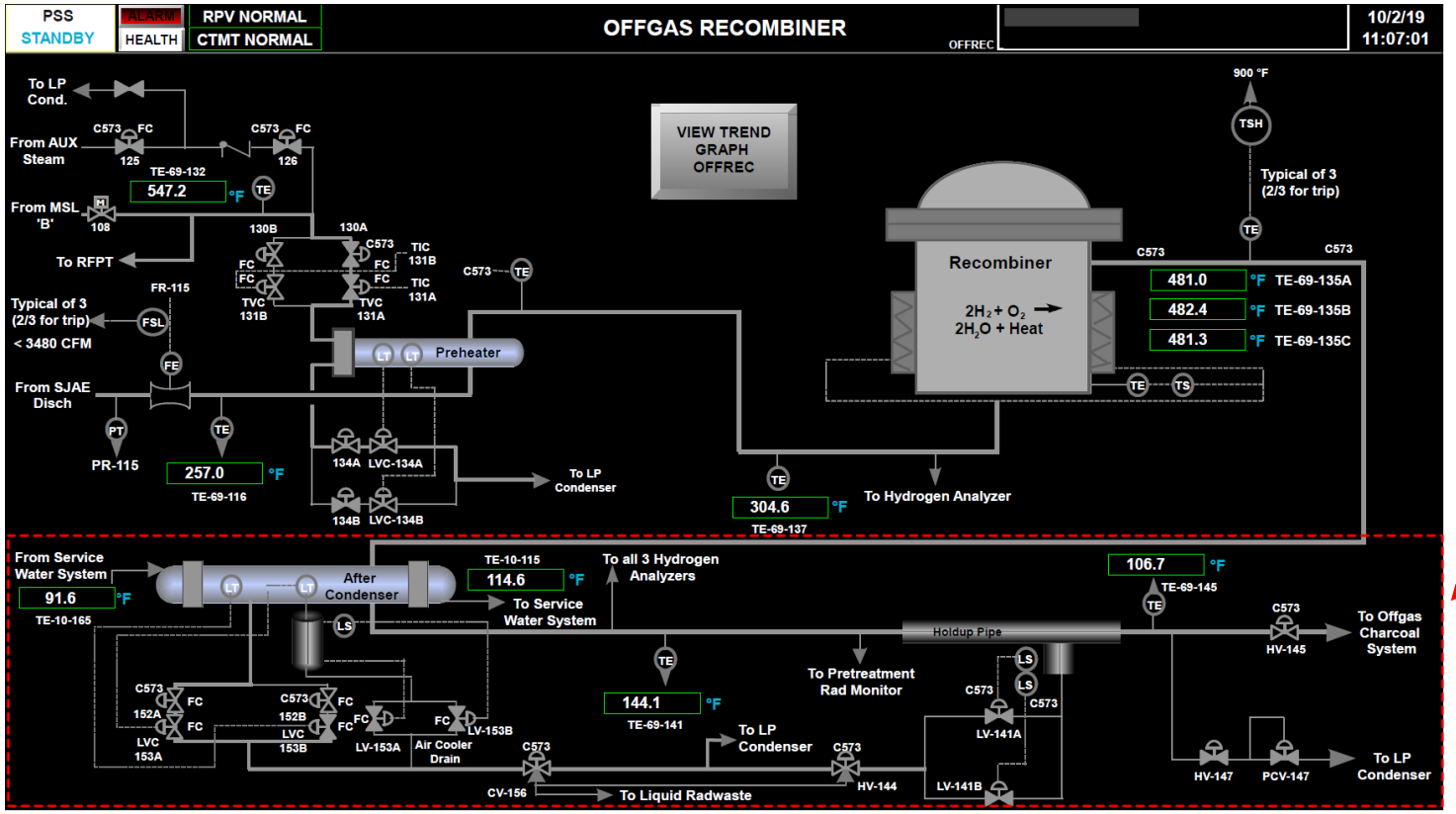
Appendix:
Limerick OffGas Display Implementation

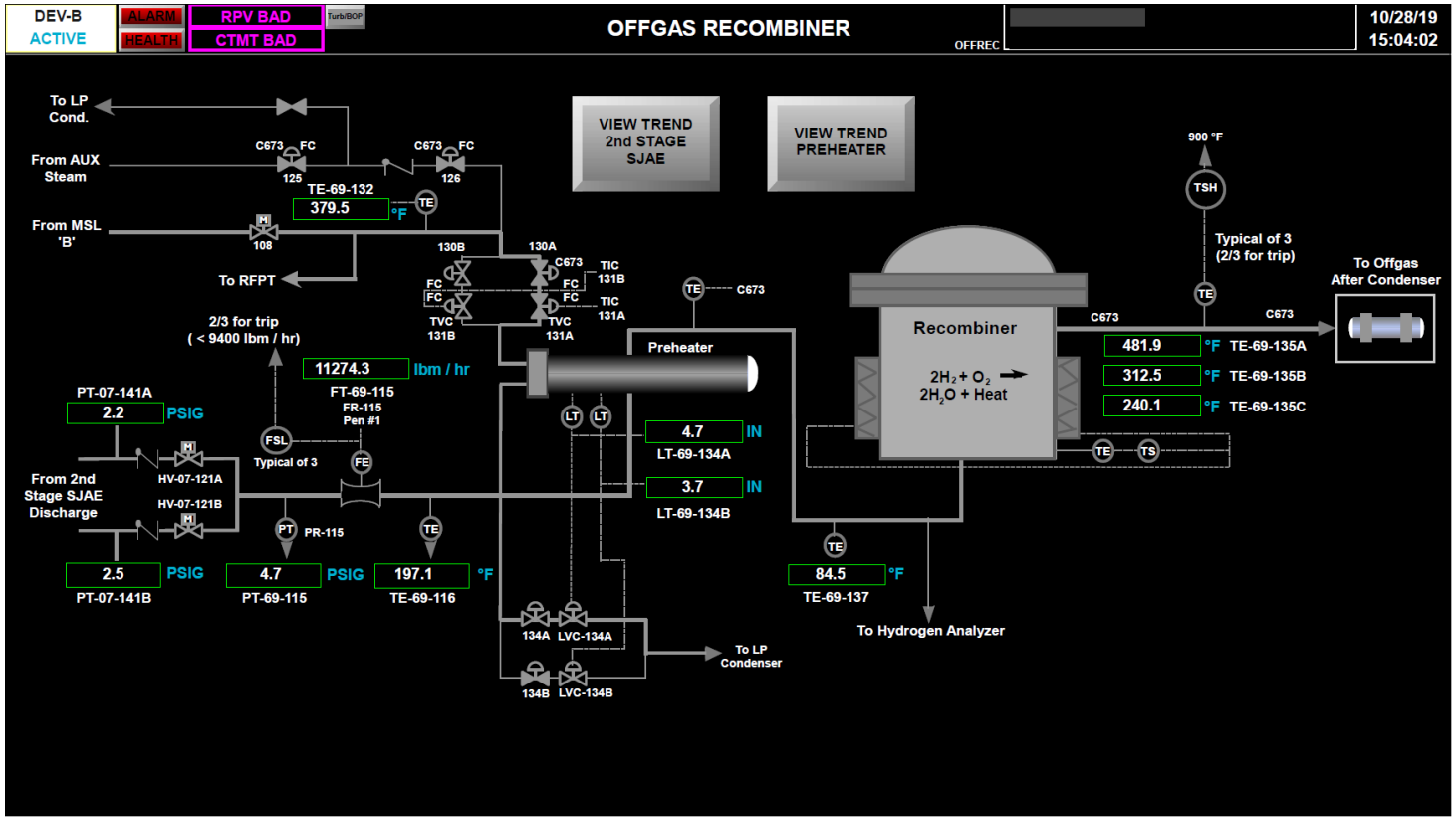
- Changes to the Limerick Unit 1 & 2 Database
  - 12 new RTP I/O points
  - All 12 new I/O points have alarm setpoints assigned and will Chime to audible alarm at the MCR console
  - Creation of 14 new calculated points – used to drive New Alarm logic on OffGas displays
- Changes to the Limerick OffGas Displays
  - Revision of 2 existing OffGas displays (Recombiner and Charcoal)
  - Creation of new After Condenser display
  - 7 New Trends assigned to buttons / graphic on OffGas displays
  - Addition of display dynamics to the Turbine / BOP Menu
  - Addition of “TURB/BOP” Alarm box on top frame of all PPC displays to represent overall alarm status for new points
  - Revision of existing and creation of new Point Groups – used for assigned Trends

OFFGAS RECOMBINER display - Existing



This Section was split off and created into a new OFFGAS AFTER CONDENSER display

OFFGAS RECOMBINER display - Revised



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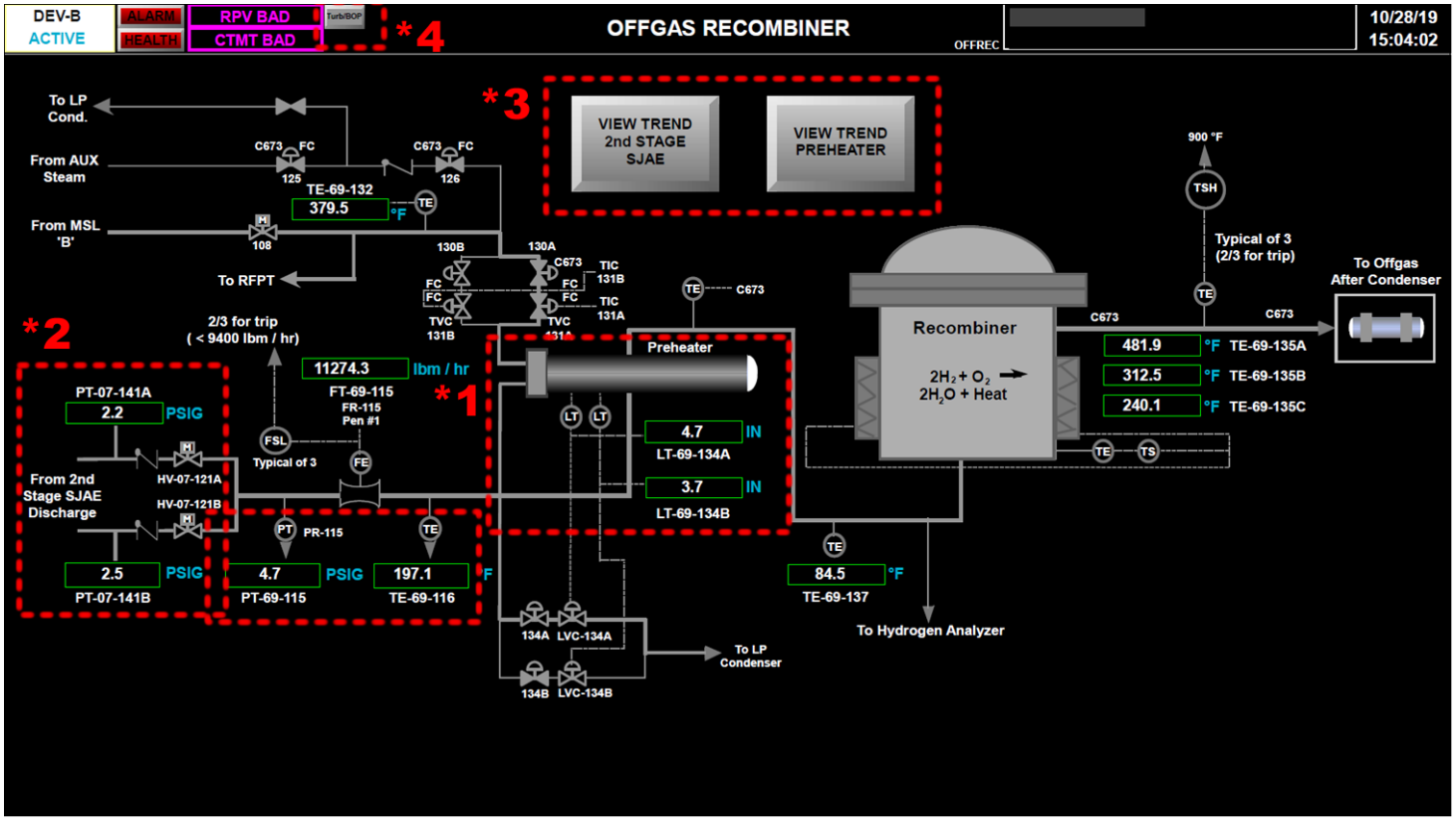
OFFGAS RECOMBINER display - Dynamics



*1 Preheater graphic starts **Blinking Red** when
LT-69-134A alarms
-OR-
LT-69-134B alarms

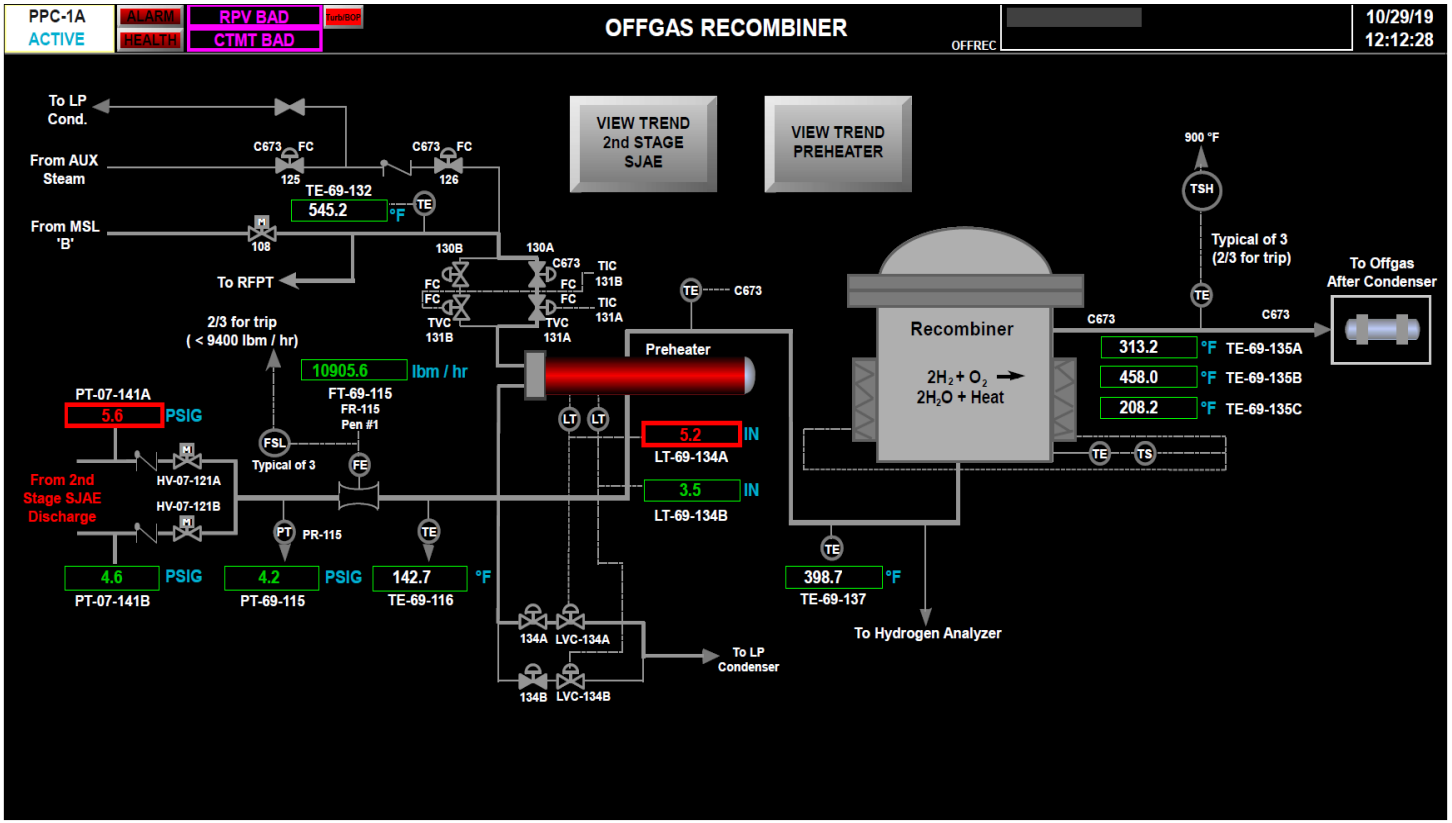
*2 **From 2nd Stage SJAE Discharge** text starts Blinking RED when
PT-07-141A alarms
-OR-
PT-07-141B alarms
-OR-
PT-69-115 alarms
-OR-
TE-69-116 alarms

*3 Pulls up TR001 and TR002 Trend displays

*4 Overall "Turb/BOP" Alarm indication. Clicking on it will take you to the Turbine/BOP Menu

This shows on all displays

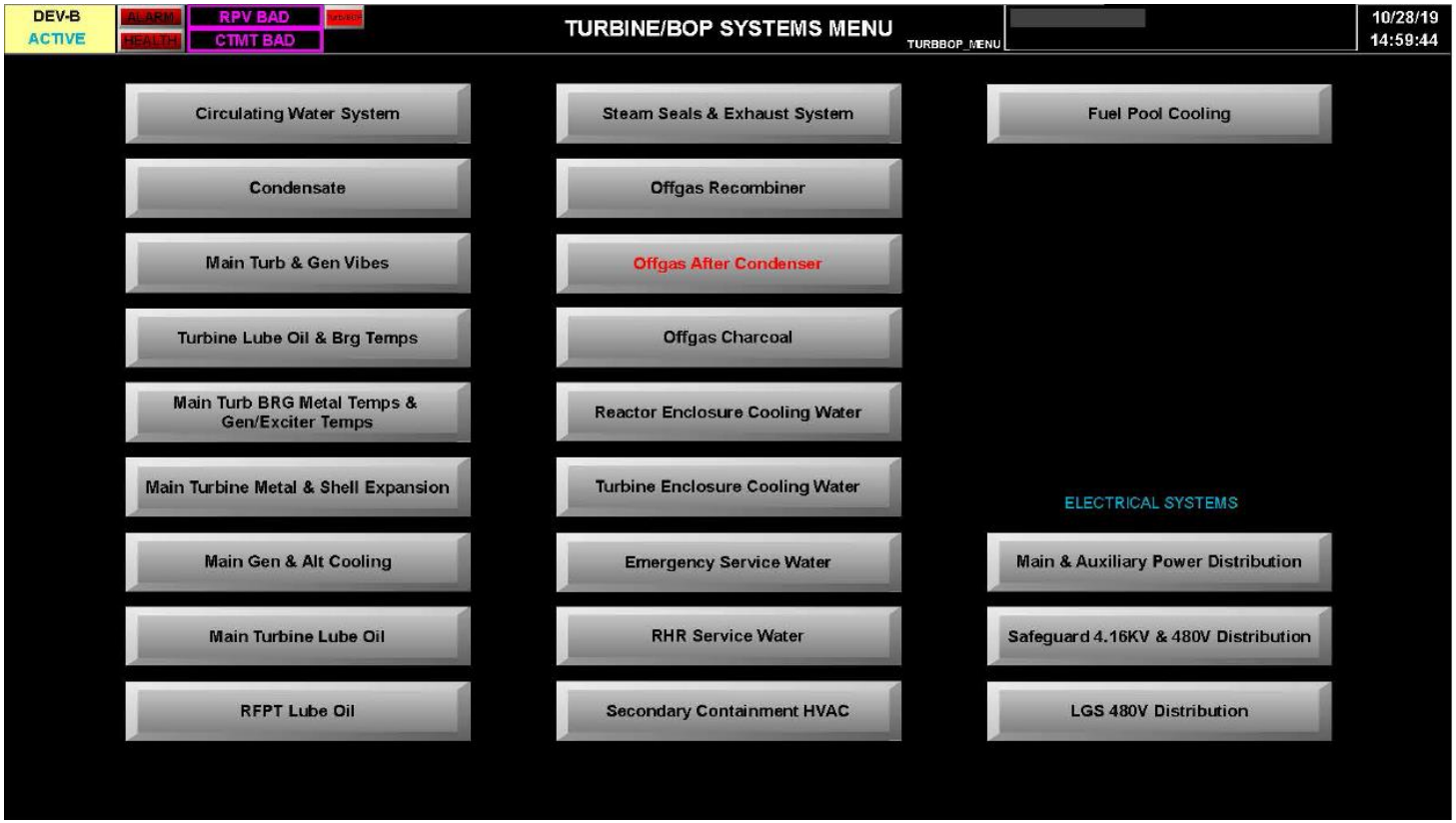
OFFGAS RECOMBINER display – Dynamics Alarmed



New Alarm Dynamics will BLINK RED when their constituent points have alarmed and are UNACKNOWLEDGED

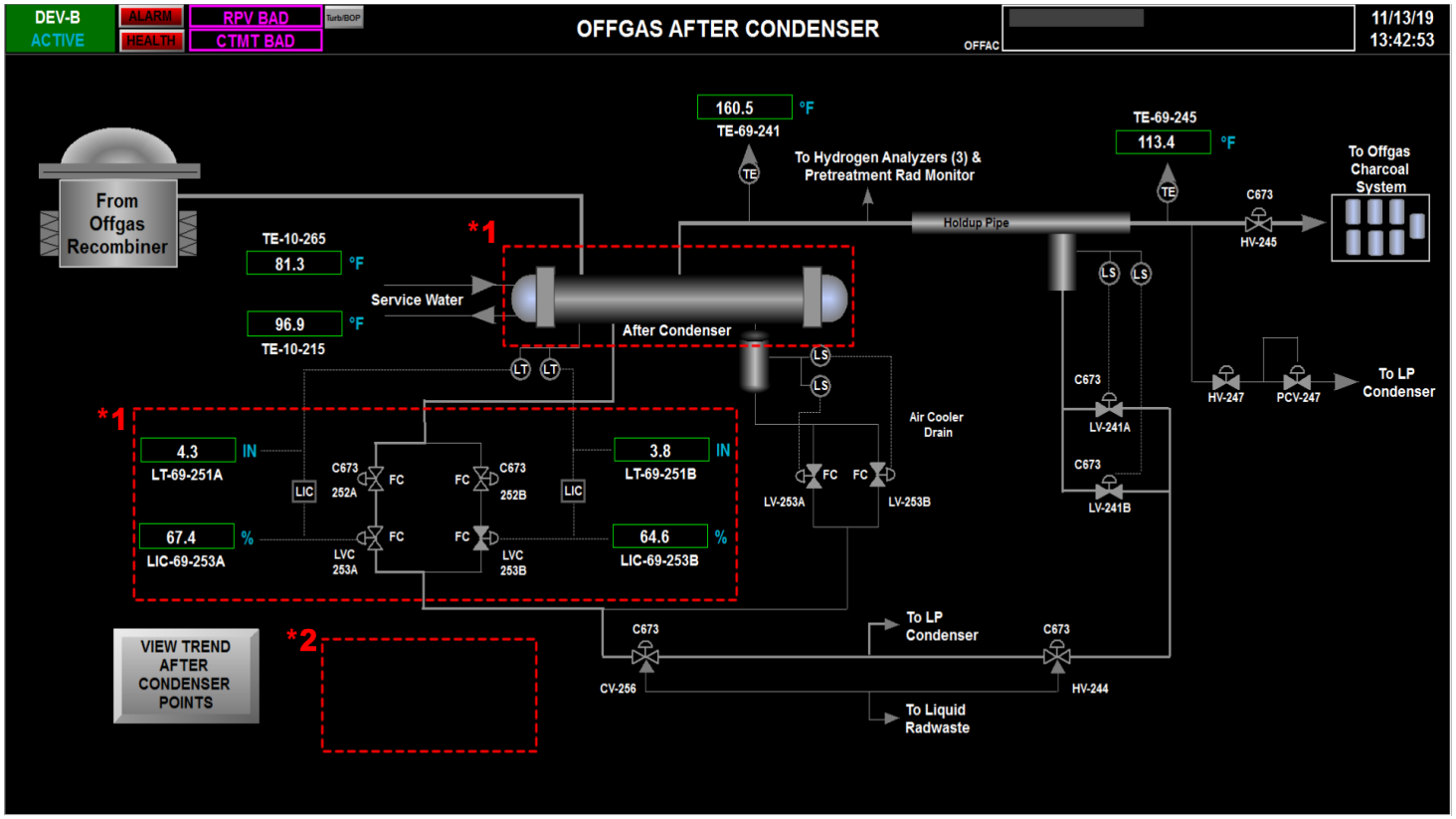
After the MCR Operator ACKnowledges the alarm, the Alarm Dynamics will stay Solid RED until the alarm clears.

Turbine / BOP MENU display – Dynamics Alarmed



New Alarm Dynamics will BLINK RED when their constituent points have alarmed.

OFFGAS AFTER CONDENSER display - Dynamics



*1 After Condenser graphic starts **Blinking Red** when
(LT-69-251A alarms
-AND-
LT-69-251B alarms)
-OR-
(LIC-69-253A alarms
-AND-
LIC-69-253B alarms)

*2 **Potential Controller Failure** text shows up and starts Blinking RED when The above condition (*1) is met.

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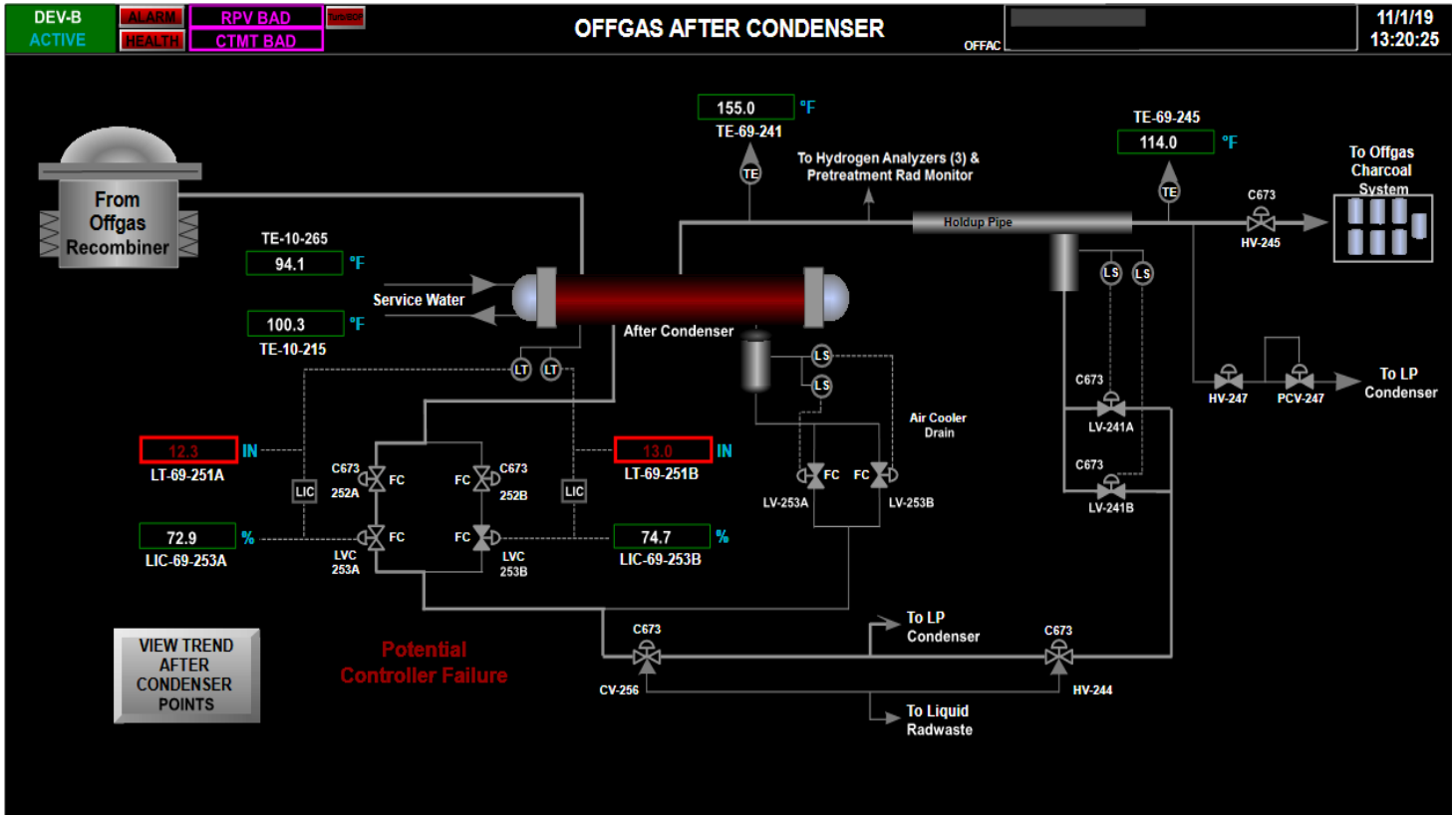
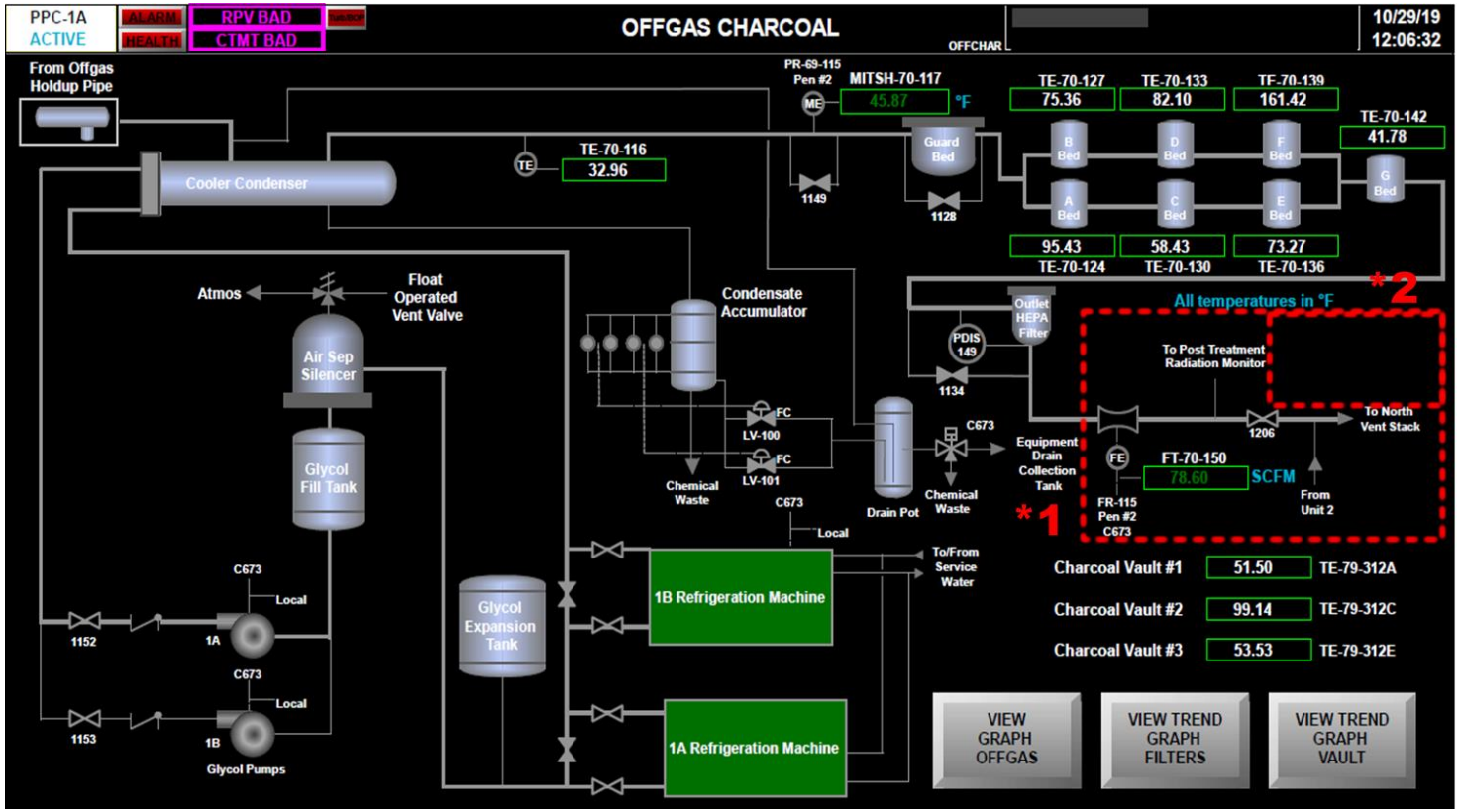
OFFGAS AFTER CONDENSER display – Dynamics Alarmed



New Alarm Dynamics will BLINK RED when their constituent points have alarmed and are UNACKNOWLEDGED

After the MCR Operator ACKnowledges the alarm, the Alarm Dynamics will stay Solid RED until the alarm clears.

OFFGAS CHARCOAL display - Dynamics



*1 Flow Venturi graphic starts **Blinking Red** when FT-70-150 alarms

*2 **Potential OT-116 Entry** text shows up and starts Blinking RED when The above condition (*1) is met.

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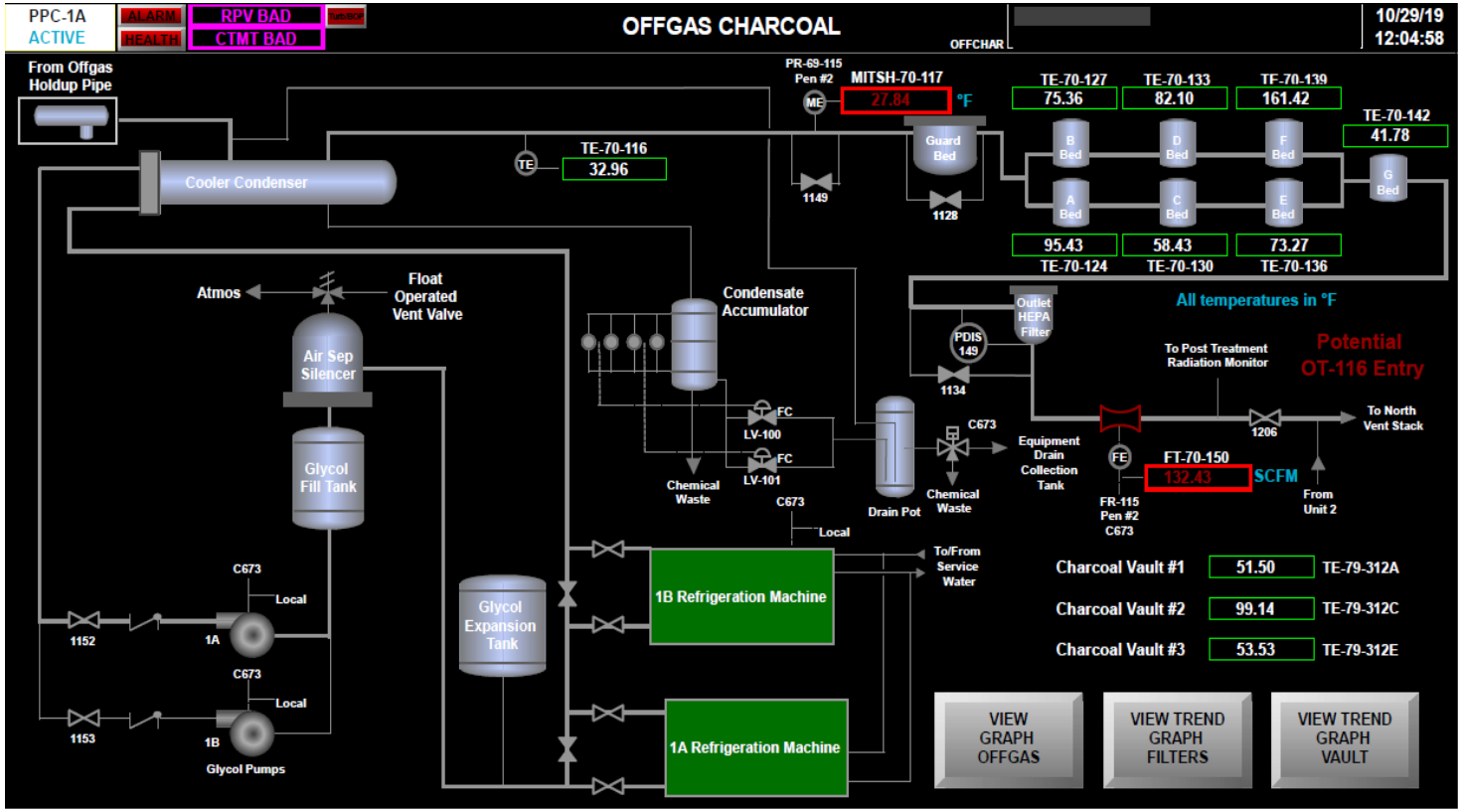
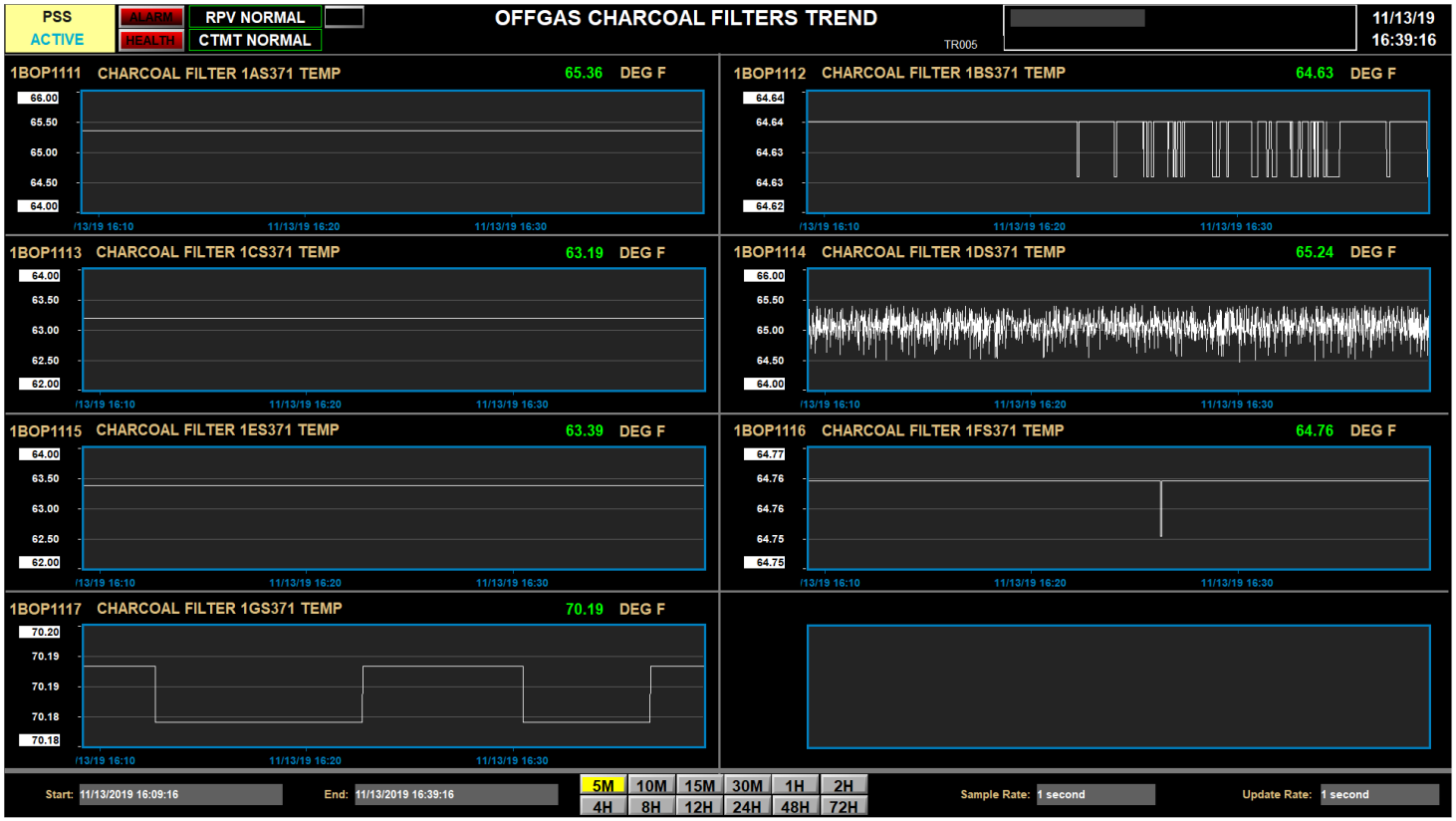
OFFGAS CHARCOAL display – Dynamics Alarmed



New Alarm Dynamics will BLINK RED when their constituent points have alarmed and are UNACKNOWLEDGED

After the MCR Operator ACKnowledges the alarm, the Alarm Dynamics will stay Solid RED until the alarm clears.

OFFGAS TREND displays – Sample TR001 – TR007



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