PLC / Servo Control & Monitoring -
Dual Fuel Prime Mover / Synchronous Generator

POWER GENERATION

PROJECT OBJECTIVES

- Replace outdated control system with modern PLC controls. New motor control for auxiliary equipment.

- Replace engine governor operations with servo positioned linear actuators. Rotary actuators control fuel flows. Encoder senses speed and position of engine

- Increase the monitoring and alarming ability for the generator, engine, and the auxiliary equipment

- Automate the startup, running, and shutdown processes including all auxiliary support equipment.

- Add detailed data collection and reporting

- Provide secure local operation of a single system and centralized operation of multiple coordinated systems.

PLC control system with touch screen user interface

A single air-conditioned enclosure houses the control system and metering / sequence relays. Touch screen operation via Allen Bradley VersaView / RSView FactoryTalk Station .

Allen Bradley ControlLogix PLC and support systems.

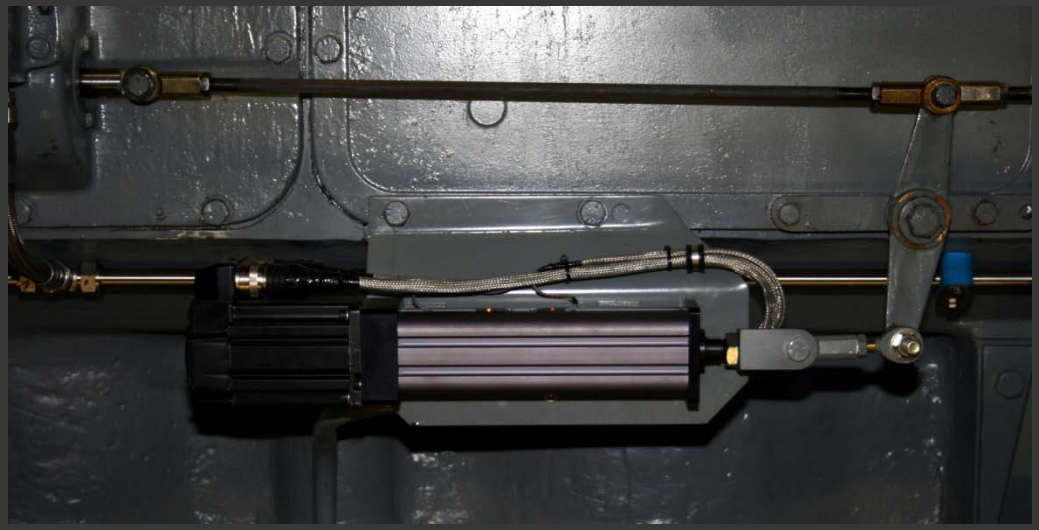
Allen Bradley Kinetix 6000 Servo for governor operations.

Allen Bradley CGCM for generator excitation and protection.

Motor Control Center with DeviceNet

Allen Bradley Intellicenter Motor Control was used for automatic operation of auxiliary pumps, fans, etc. Since DeviceNet communications to each starter was used, motor currents and overload status can be directly monitored by the PLC.

Servo linear actuators replaces governor

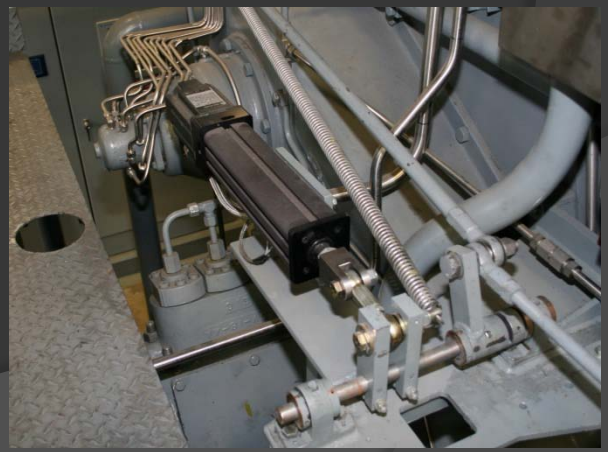


Fuel timing

Allen Bradley servo motors coupled to Exlar linear actuators provide fast and accurate position control over elements previously controlled by the governor. Independent control of each axis allows precise tuning of the engine's operation with each fuel type and during different modes of operation.

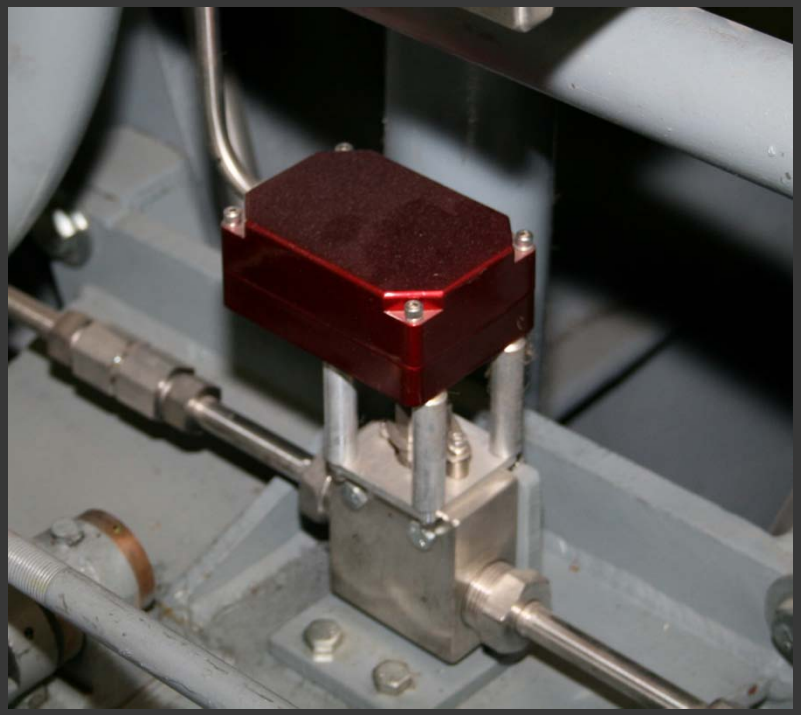
Air intake

Turbo



Fuel rail

Fuel controlled with rotary positioned valves



Diesel fuel flow control

Precise fuel flow control is coordinated with the servo actuator positions for a very flexible and highly tuneable performance.

Natural gas flow control

Speed and position sensed with encoder

Encoder mounted near original governor location

Engine speed and rotational position accurately detected by a heavy duty industrial encoder.

Encoder

Increased monitoring and alarming

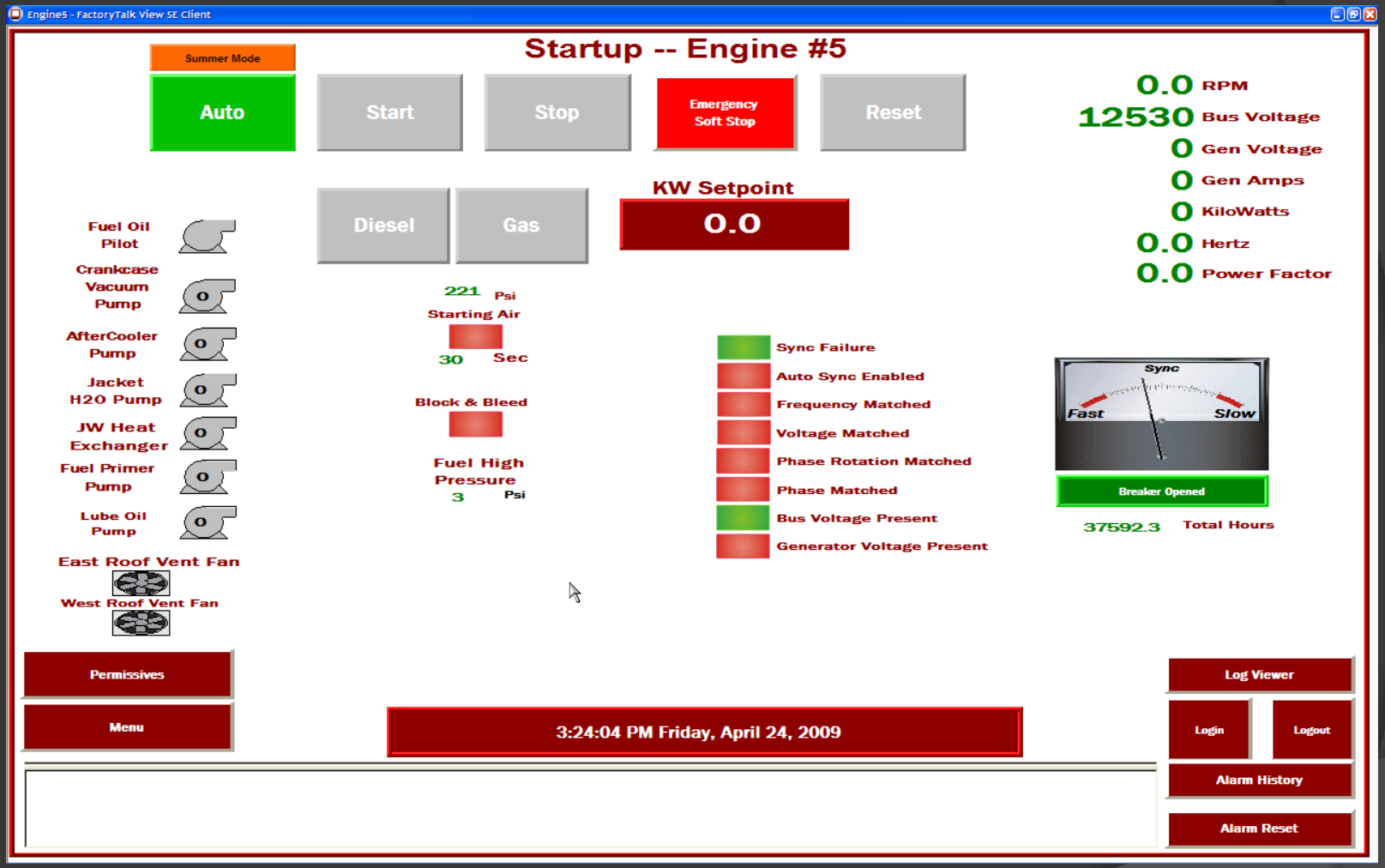
RTD Temperature sand pressures

Many new RTD, thermocouple, pressure, level, flow, and vibration sensors have been added to create a whole new dimension to the depth of data available about the system's operation. The CGCM module provides a complete built-in suite of electrical system values for monitoring, alarming, and protecting the generator.

Vibration and cylinder head / bearing temperatures (temperature units not shown)

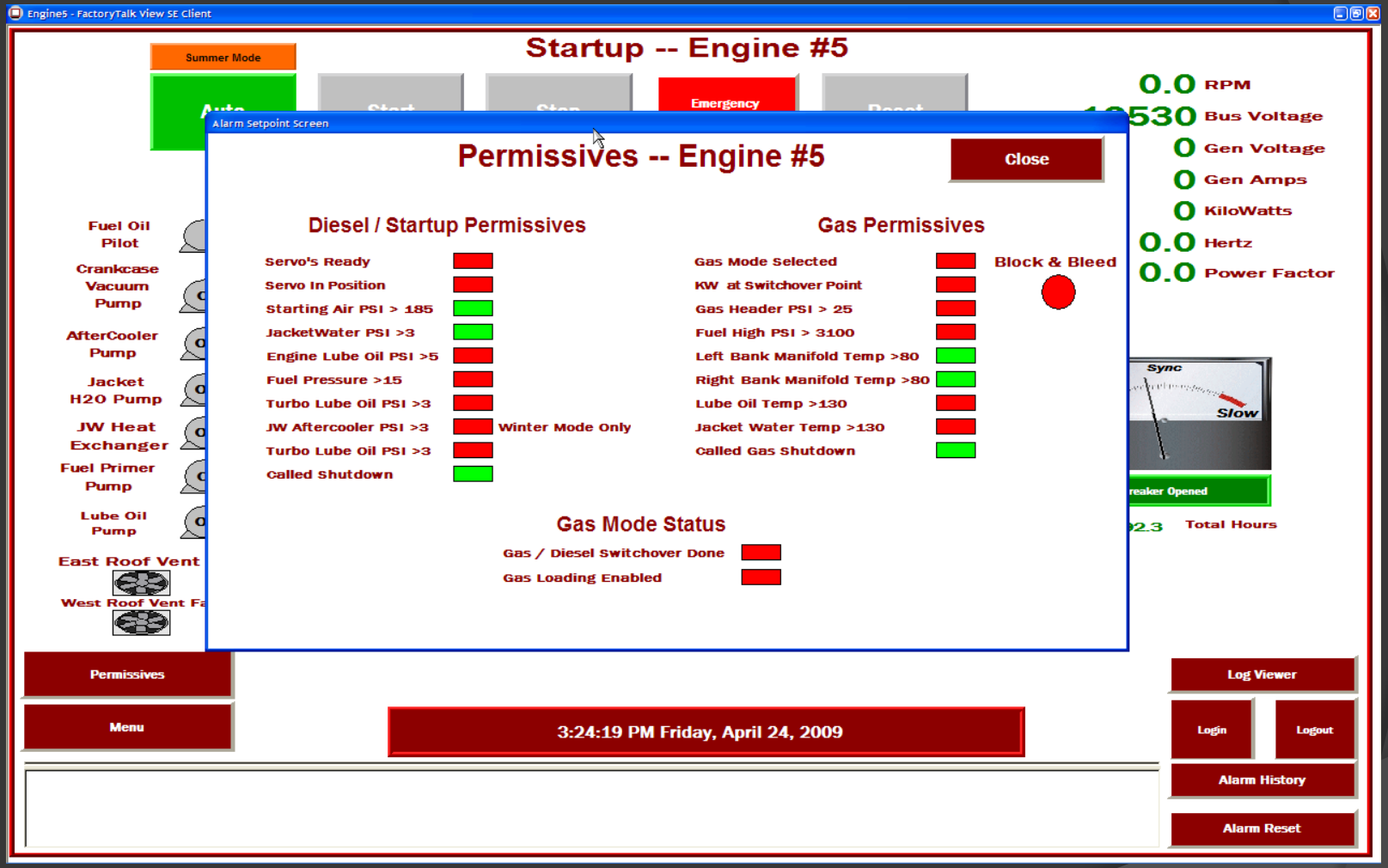
High pressure fuel

Automate the operation - Starting



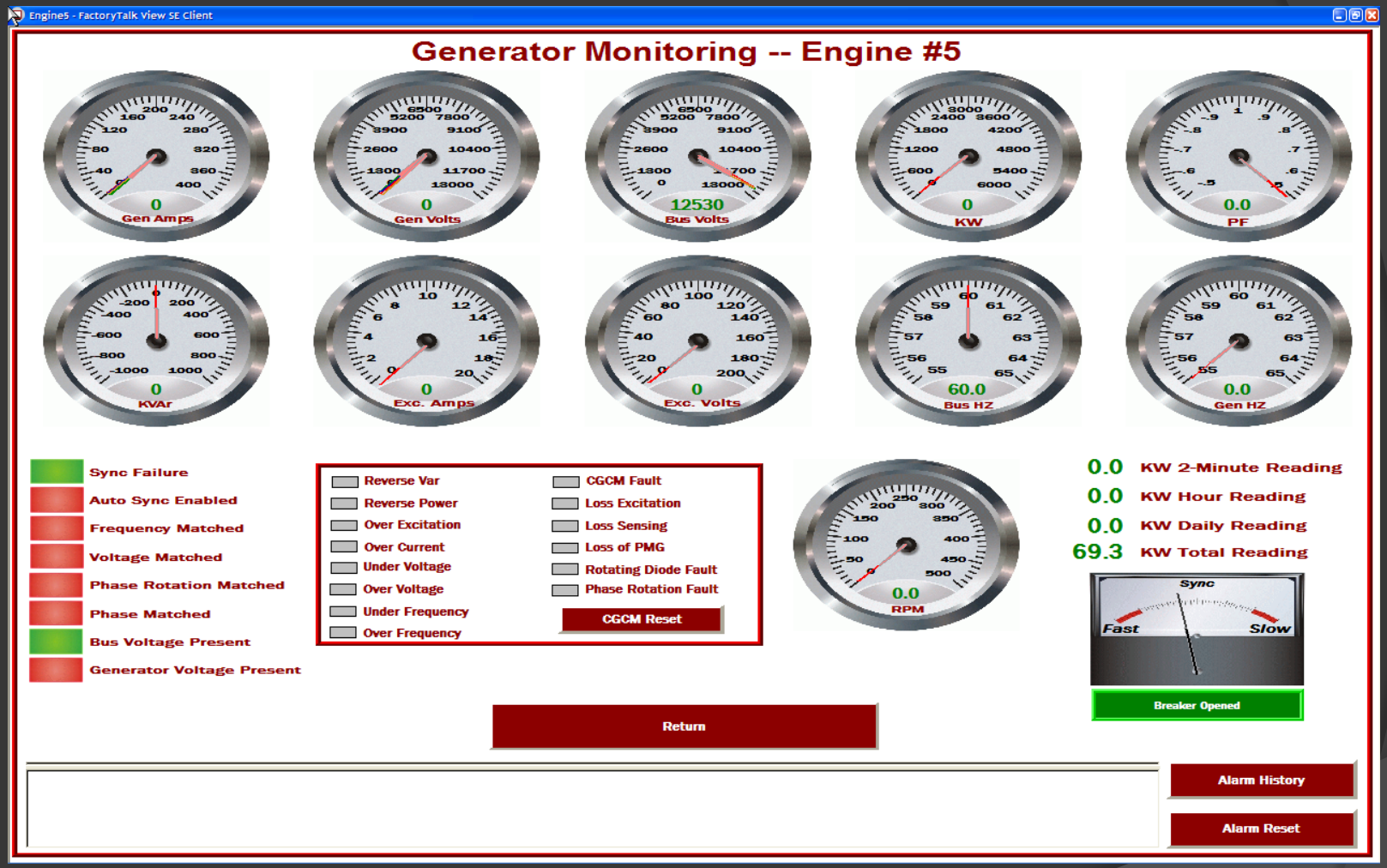
Now that all the monitoring and control was in place, automating the startup involved establishing the sequence of events necessary for a smooth, successful operation each time. The operator makes a few selections and starts.

Automate the operation - Starting



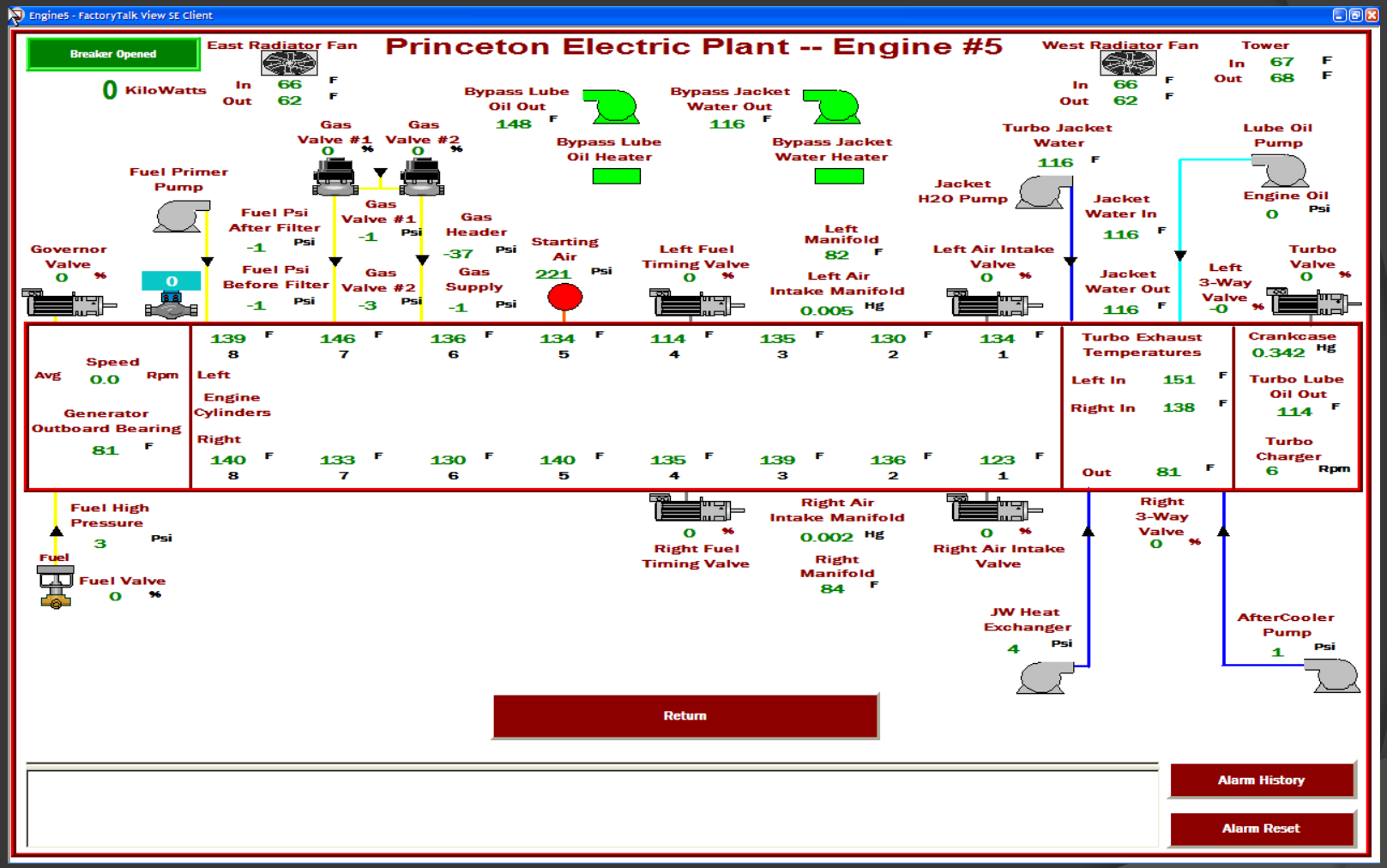
All of the required auxiliary equipment for the selected operation is started and verified. Once all the "permissives" are in place, the engine starts. All this happens the same way each time without further input from the operator.

Automate the operation – Sync & Load



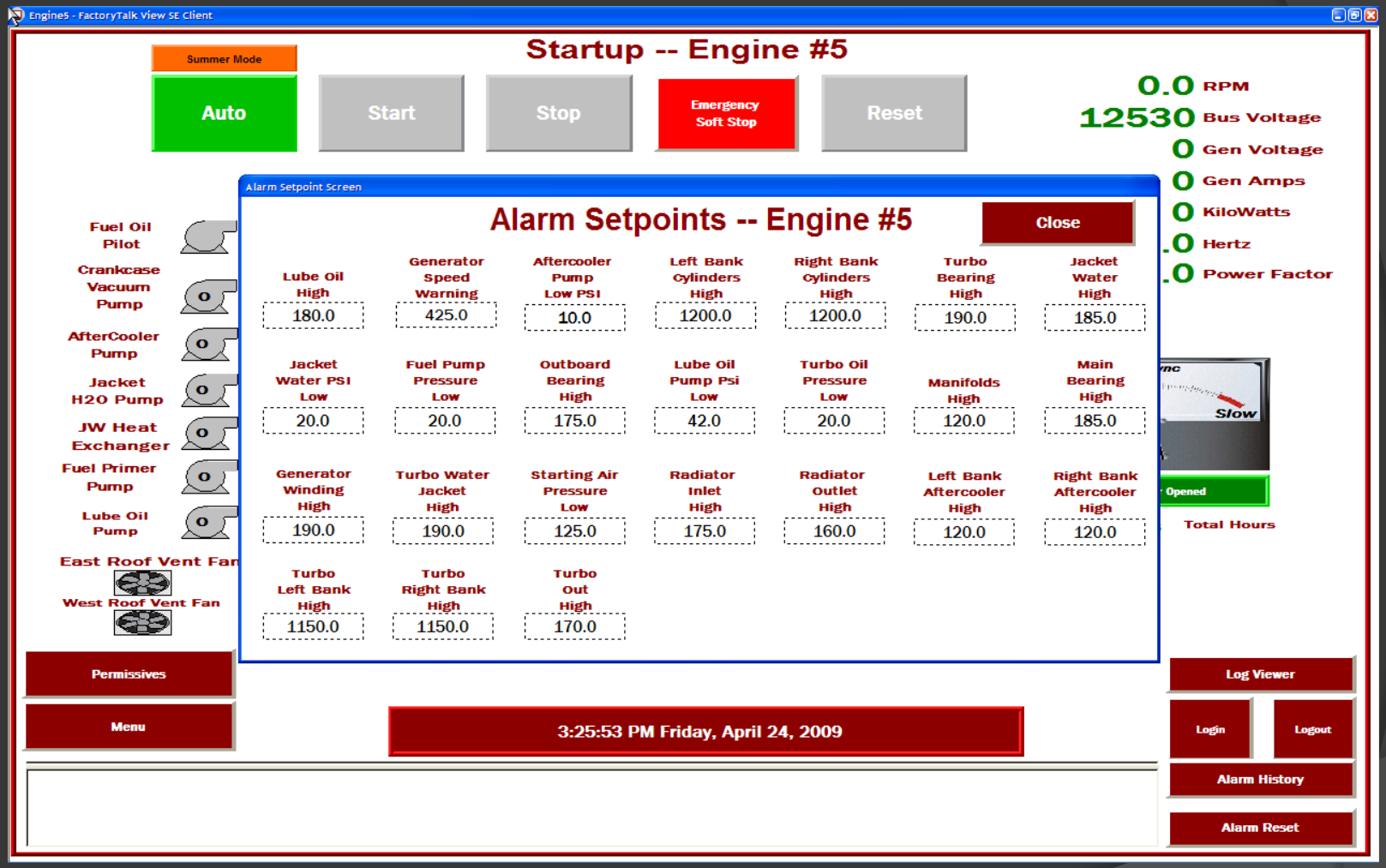
With the engine at synchronous speed, the breaker will close automatically and the loading process, to the operator selected setpoint, will continue. Warm-up and fuel switchover processes will occur without the operator's involvement.

Automate the operation – Monitoring



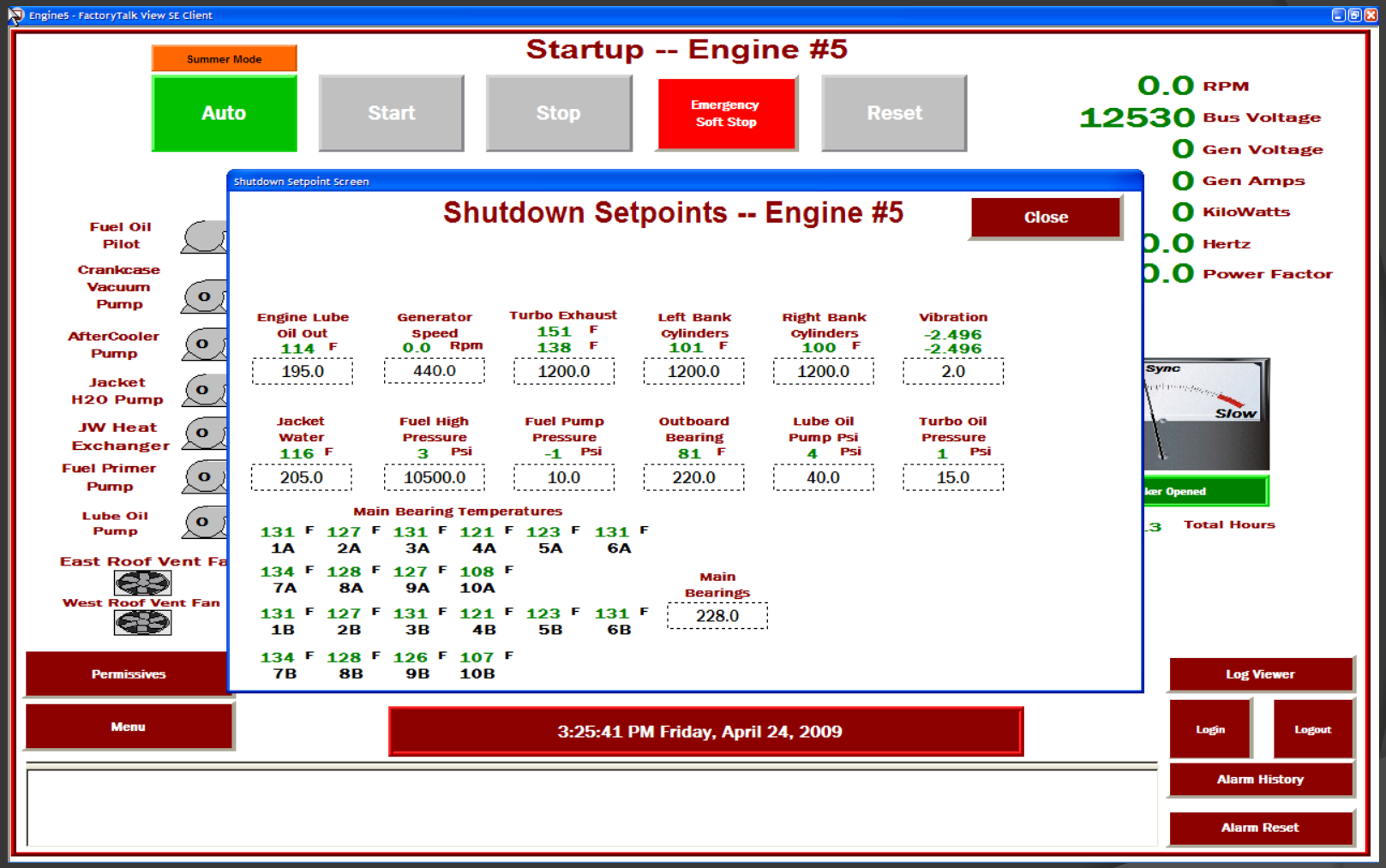
All aspects of the system are monitored closely while running and presented for the operator's review.

Automate the operation – Alarming



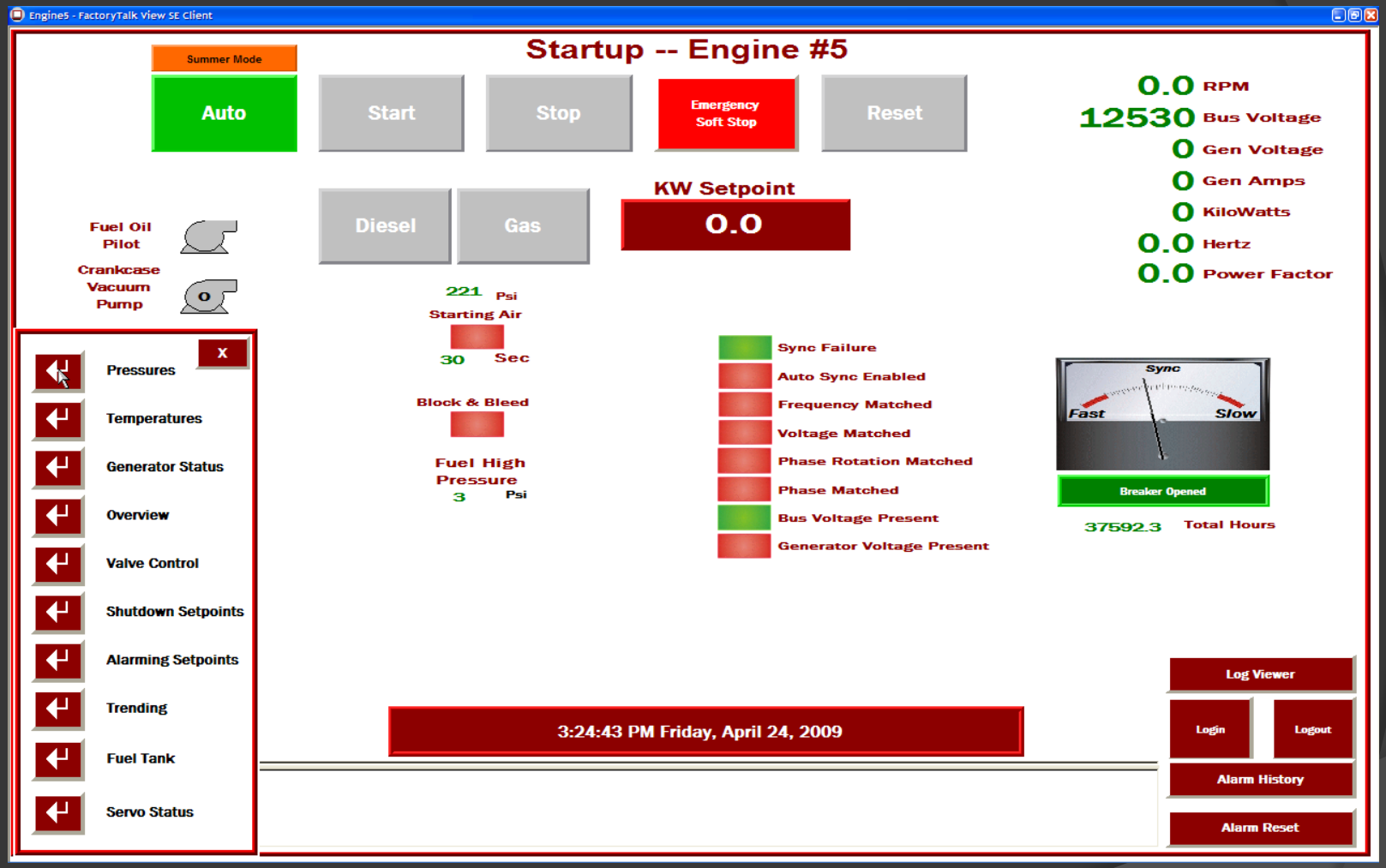
Many of the process values are compared against alarm setpoints. Some alarms are warnings to notify the operator of a condition they may be able to correct before it turns into a more serious situation.

Automate the operation – Shutdown



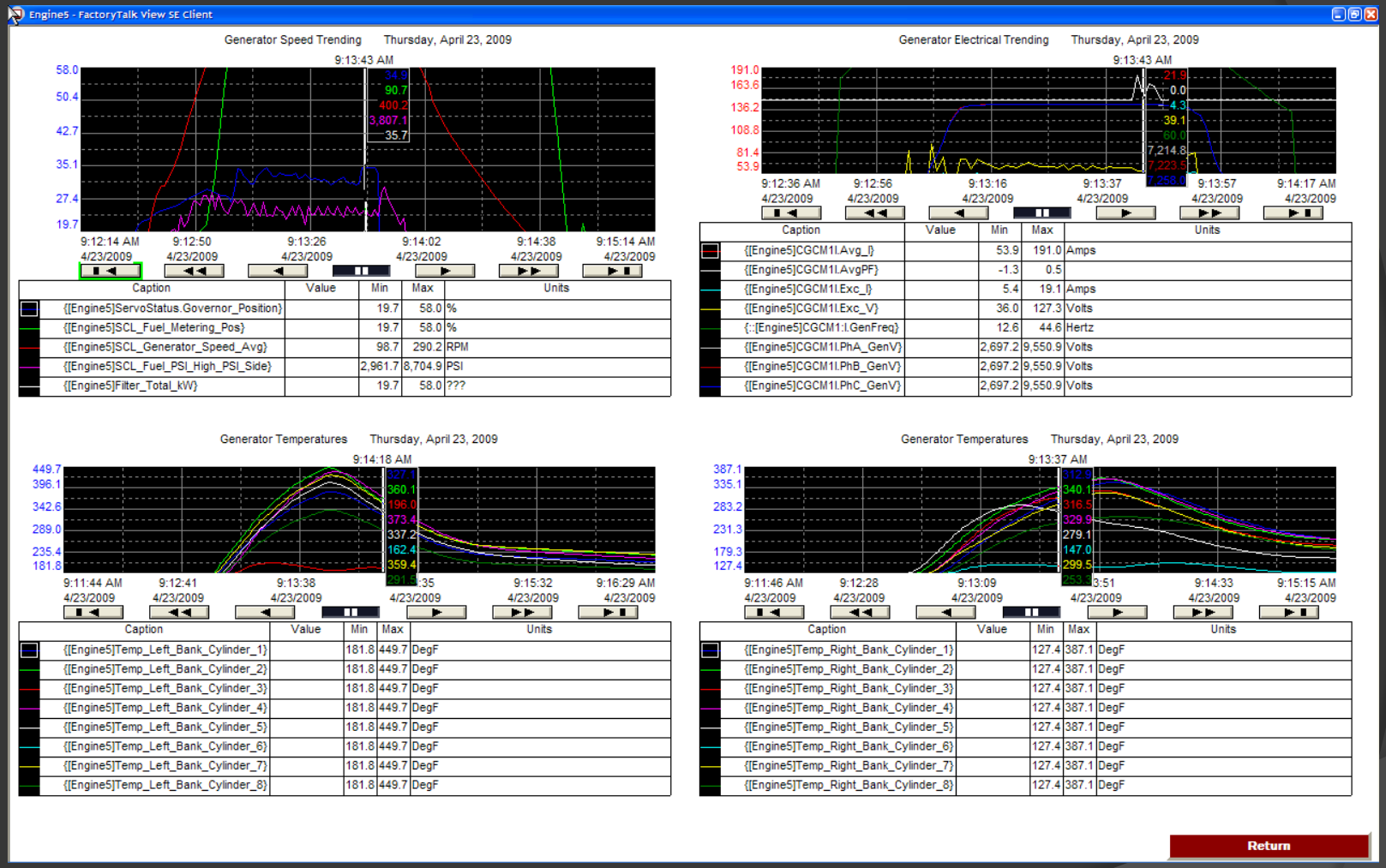
Some of the process values are compared against shutdown setpoints. These alarms are serious situations which will quickly and safely shutdown the generator's operation without the operator's intervention.

Automate the operation – Shutdown



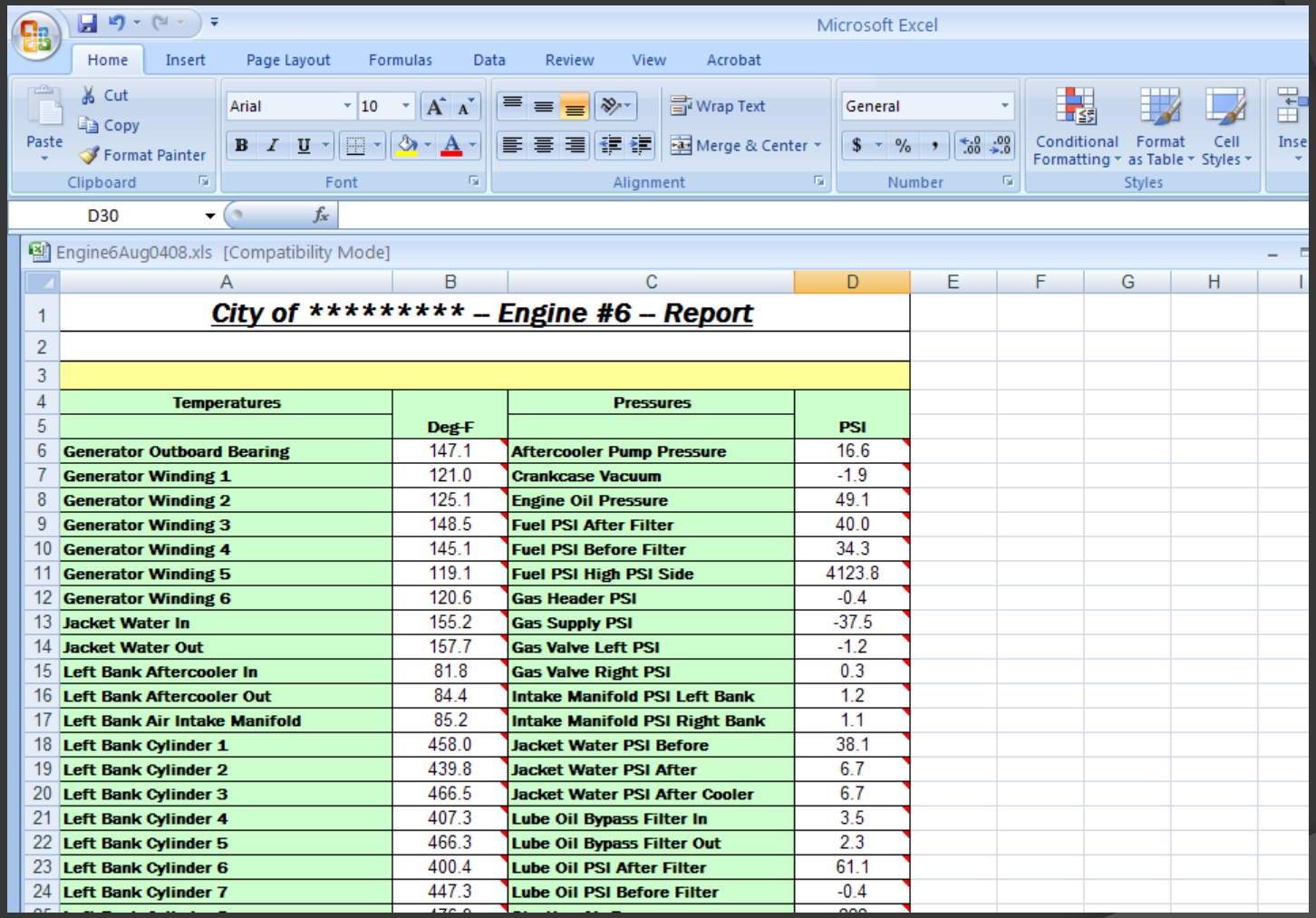
An operator invoked normal shutdown automatically unloads the generator and takes it offline. Cool down, fuel switchover, and other shutdown processes all occur without needing the operator's involvement to return the system to the pre-startup state.

Detailed data collection and reporting



All process values are logged and trended for analysis. Historical operating values are reviewed and compared to current values to detect changes in operation.

Detailed data collection and reporting

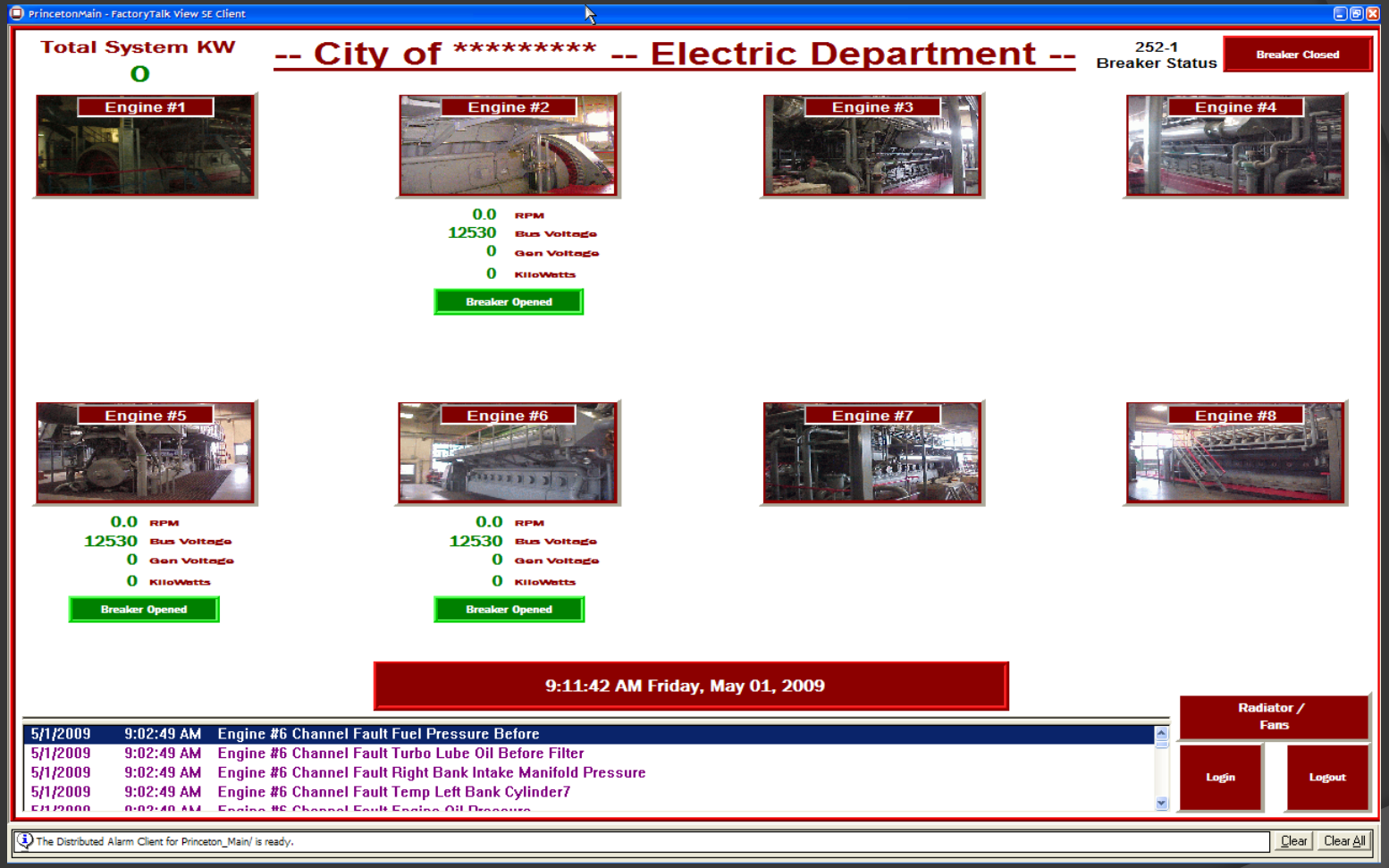


City of ******* – Engine #6 – Report**

Temperatures	Deg-F	Pressures	PSI
Generator Outboard Bearing	147.1	Aftercooler Pump Pressure	16.6
Generator Winding 1	121.0	Crankcase Vacuum	-1.9
Generator Winding 2	125.1	Engine Oil Pressure	49.1
Generator Winding 3	148.5	Fuel PSI After Filter	40.0
Generator Winding 4	145.1	Fuel PSI Before Filter	34.3
Generator Winding 5	119.1	Fuel PSI High PSI Side	4123.8
Generator Winding 6	120.6	Gas Header PSI	-0.4
Jacket Water In	155.2	Gas Supply PSI	-37.5
Jacket Water Out	157.7	Gas Valve Left PSI	-1.2
Left Bank Aftercooler In	81.8	Gas Valve Right PSI	0.3
Left Bank Aftercooler Out	84.4	Intake Manifold PSI Left Bank	1.2
Left Bank Air Intake Manifold	85.2	Intake Manifold PSI Right Bank	1.1
Left Bank Cylinder 1	458.0	Jacket Water PSI Before	38.1
Left Bank Cylinder 2	439.8	Jacket Water PSI After	6.7
Left Bank Cylinder 3	466.5	Jacket Water PSI After Cooler	6.7
Left Bank Cylinder 4	407.3	Lube Oil Bypass Filter In	3.5
Left Bank Cylinder 5	466.3	Lube Oil Bypass Filter Out	2.3
Left Bank Cylinder 6	400.4	Lube Oil PSI After Filter	61.1
Left Bank Cylinder 7	447.3	Lube Oil PSI Before Filter	-0.4

Time scheduled and on demand reports are automatically created in Excel. The reports are based on paper forms that were previously filled out by the operator manually.

Multiple coordinated systems



Although each generator can be controlled from it's secure local user interface and work independently, these fully automated units can be controlled and coordinated to work together from a centralized location. That location could be the local control room, as it is in this case, or a remote facility.

PROJECT OBJECTIVES ACHIEVED and RESULTING BENEFITS

- *Replace outdated control system with modern PLC controls. New motor control for auxiliary equipment.*

  New controls and a motor control center provides the foundation for the sophisticated monitoring and control features of this system. Service and parts are now readily available.

- *Replace engine governor operations with servo positioned linear actuators. Rotary actuators control fuel flows. Encoder senses speed and position of engine.*

  Linear and rotational actuators allow precision control of all elements effecting operation of the engine. Combined with digital speed and position sensing, these elements are tuned and coordinated to produce the best possible performance under all operating conditions.

- *Increase the monitoring and alarming ability for the generator, engine, and the auxiliary equipment.*

  Basic monitoring and alarming has been increased more than ten-fold. All aspects of the operation is closely monitored for out of range conditions and any problems are quickly brought to the operators attention. This relieves the operator of this task and prevents unnoticed changes developing into major problems.

PROJECT OBJECTIVES ACHIEVED and RESULTING BENEFITS

- *Automate the startup, running, and shutdown processes including all auxiliary support equipment.*

  All the required operational steps have been fully integrated and automated. The operator makes a few mode selections, such as fuel type and loading , then start. The automation takes care of the rest requiring far less operator involvement and experience.

- *Add detailed data collection and reporting.*

  Monitored data, alarms, and other runtime information is collected and recorded for analysis and reporting. Automated report generation eliminates the need for the operator to record the data and create the report by hand while minimizing errors. Changes in operation over time can be spotted and aid preventative maintenance.

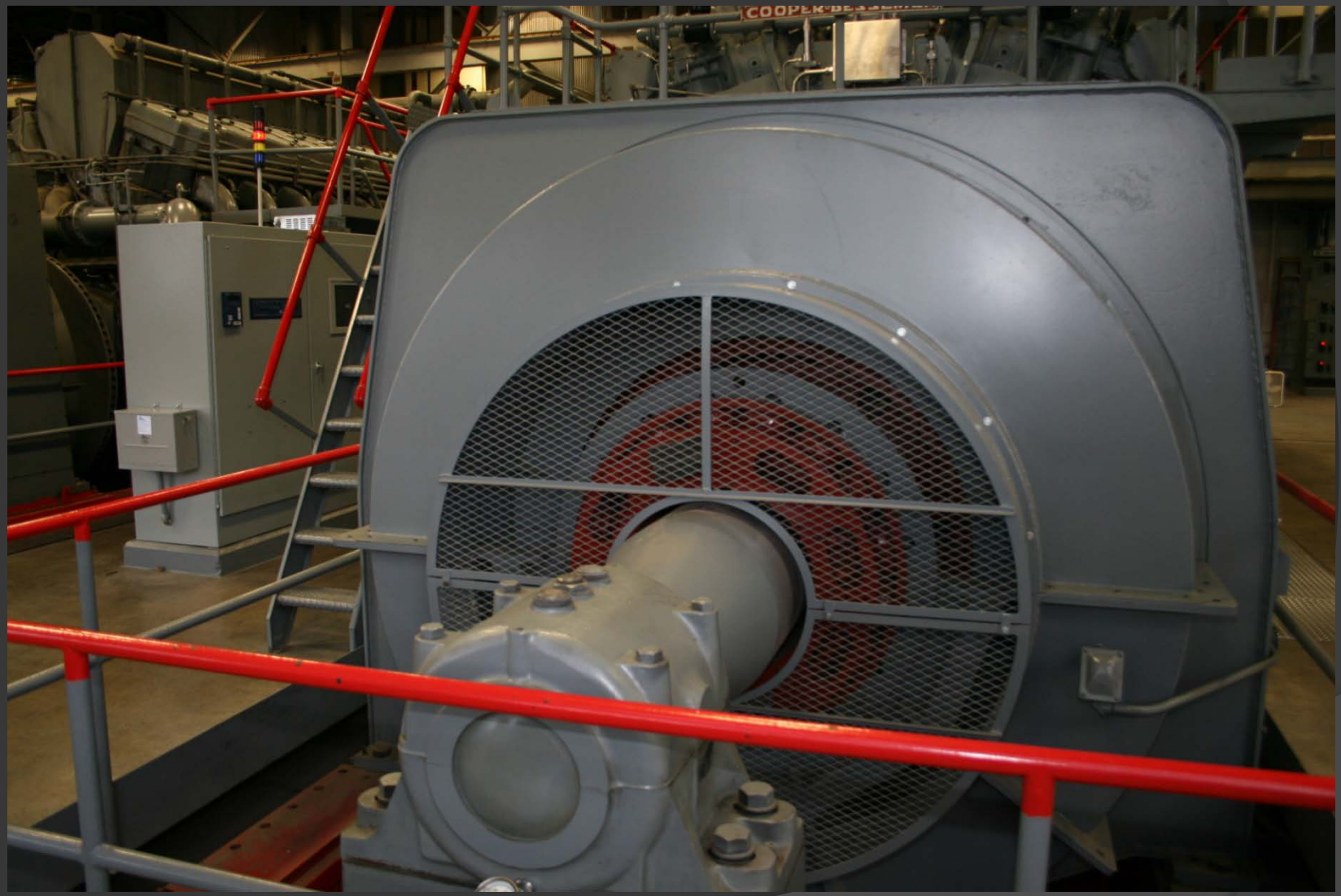
- *Provide secure local operation of a single system and centralized operation of multiple coordinated systems.*

  Complete automation of the process allows secure local operation of a single unit from a nearby user interface. Over a secure network connection, remote operation of one or more units can now be controlled and coordinated by a single operator regardless of the distance.

Photo Gallery

Generator and control panel

Photo Gallery



Generator and control panel

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Generator and control panel

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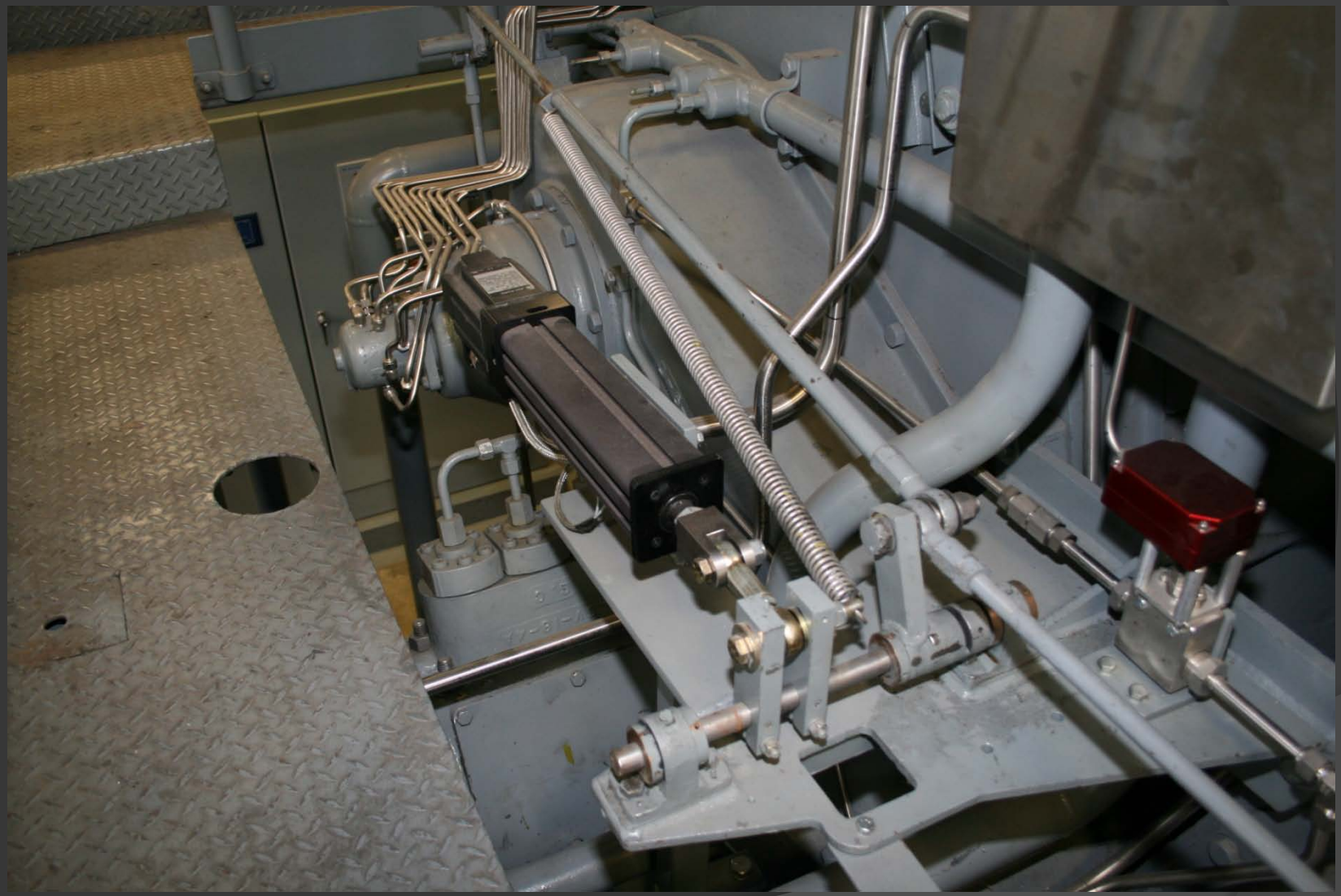
Control panel showing stack light and field resistor cage

Photo Gallery

Servo mounted on engine

Photo Gallery



Servo mounted on engine

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Servo mounted on engine

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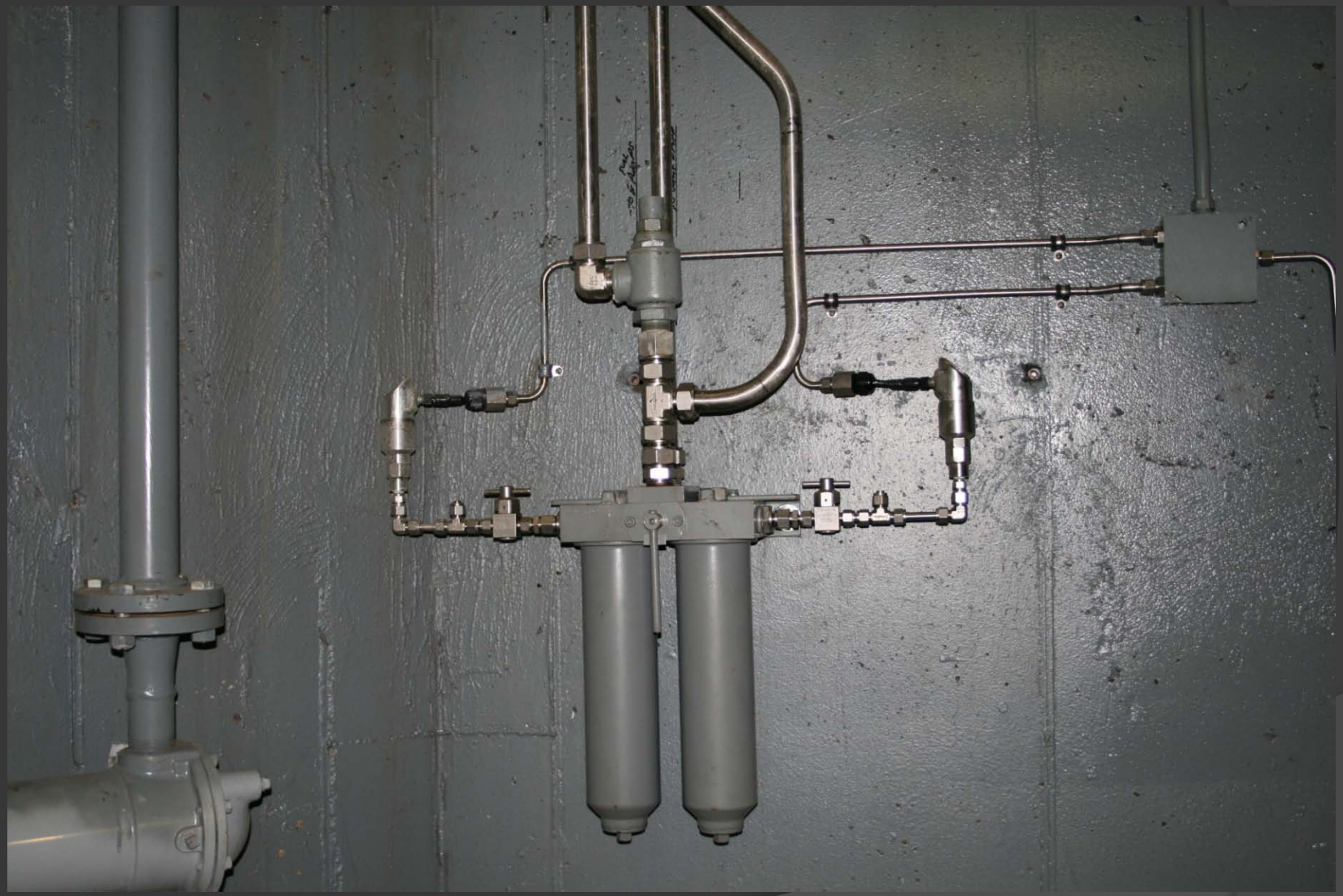
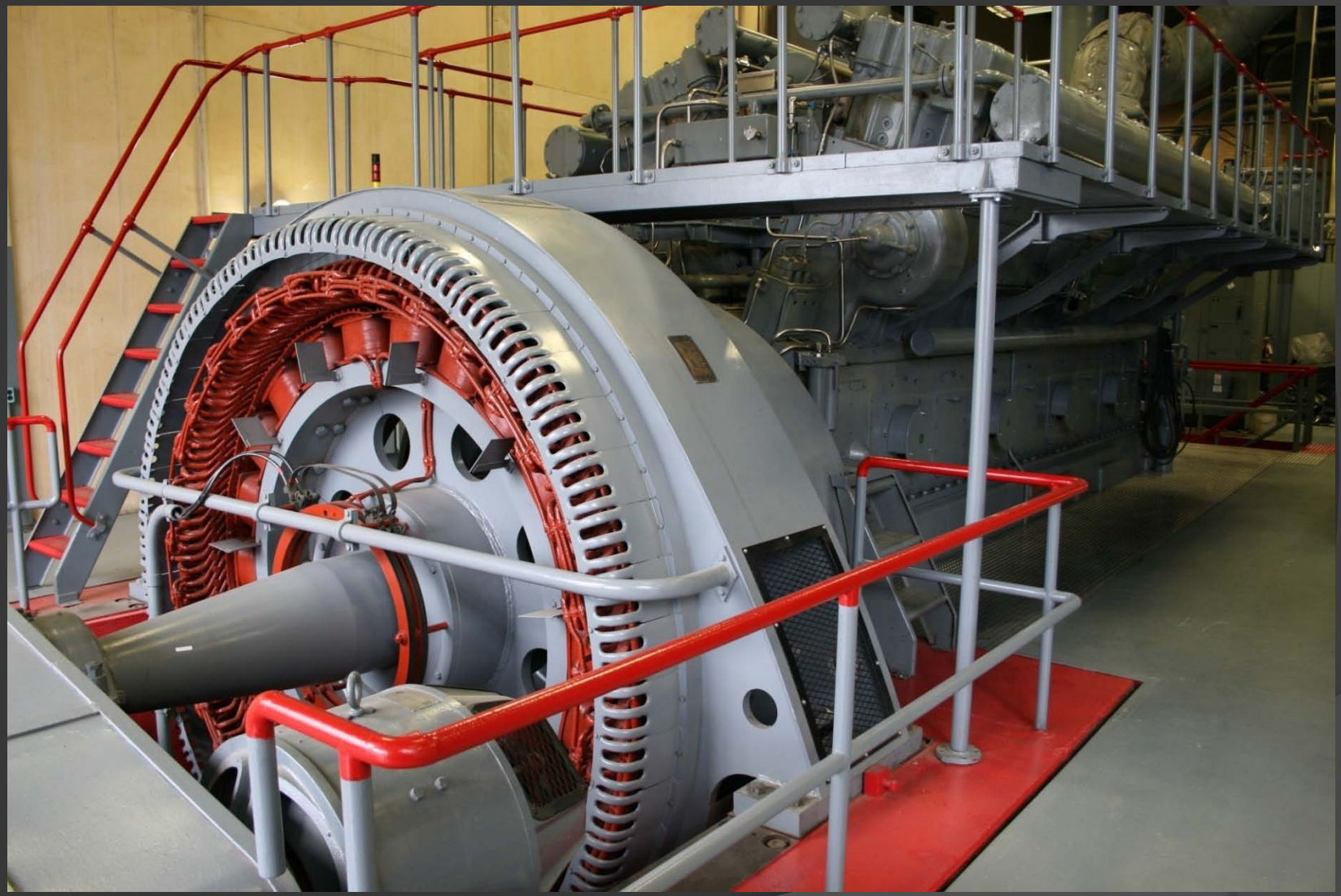
Three-way control valve

Photo Gallery



Pressure transducers

Photo Gallery



Older generator with new control system in same location

Photo Gallery

Older generator with new control system in same location

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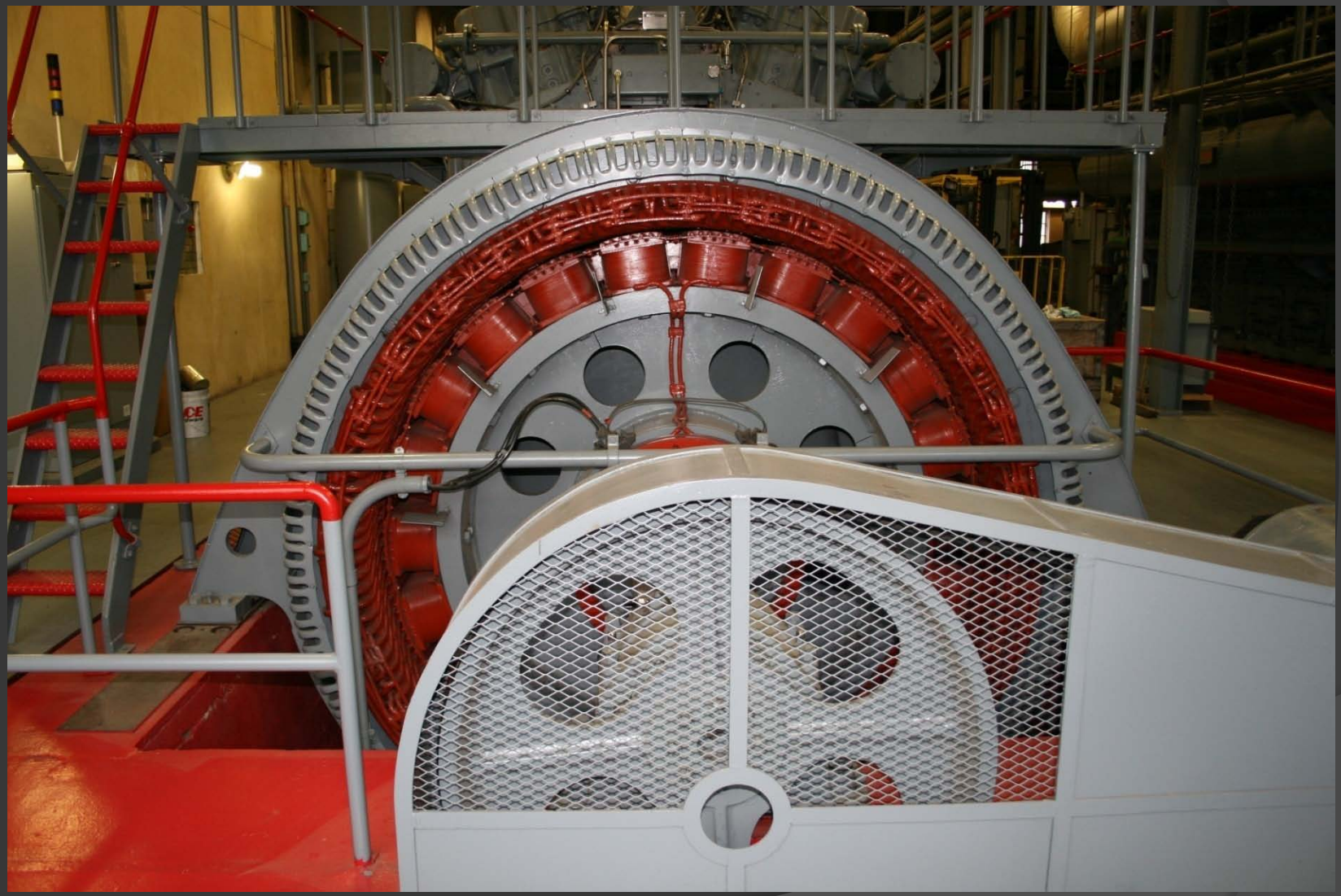

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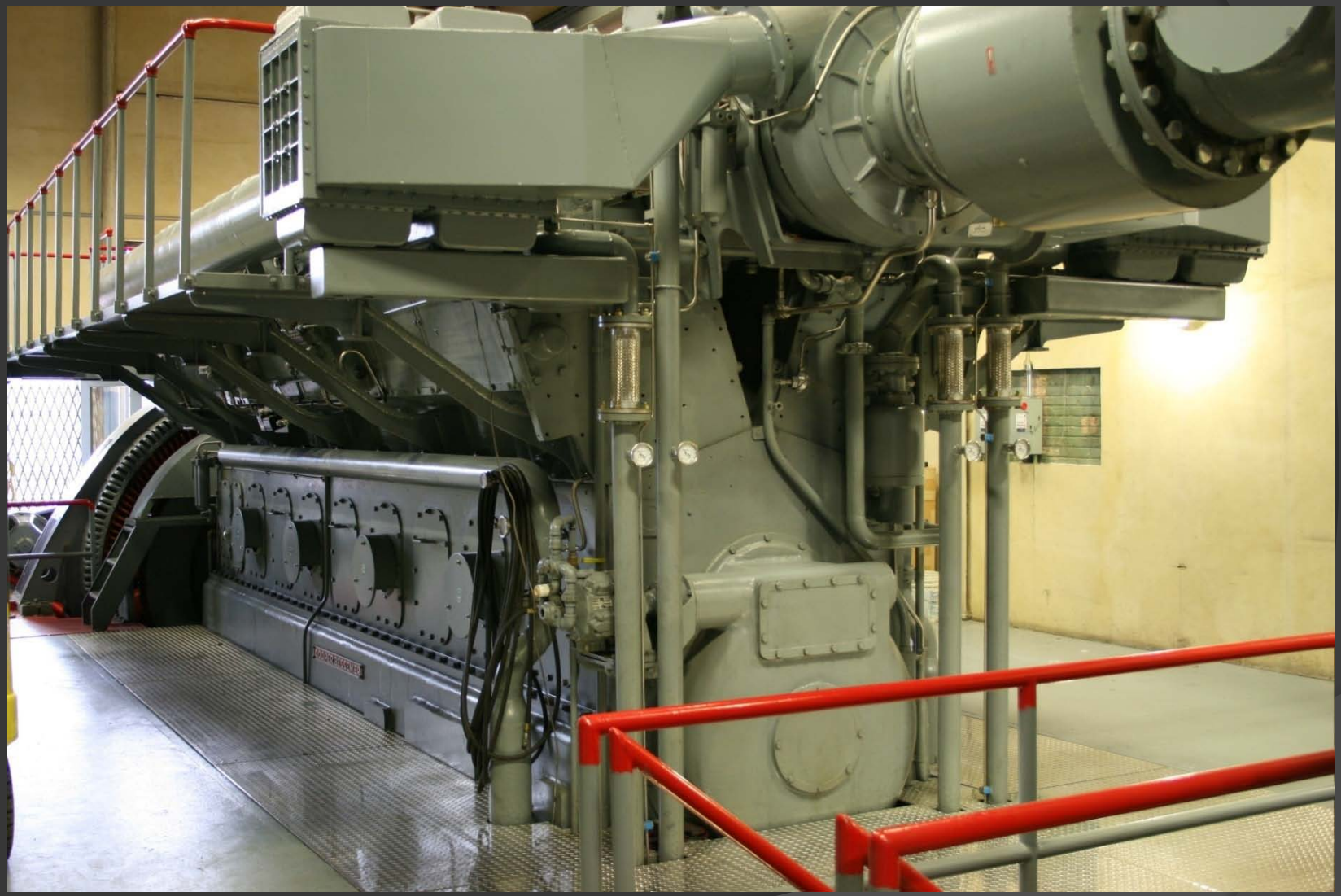

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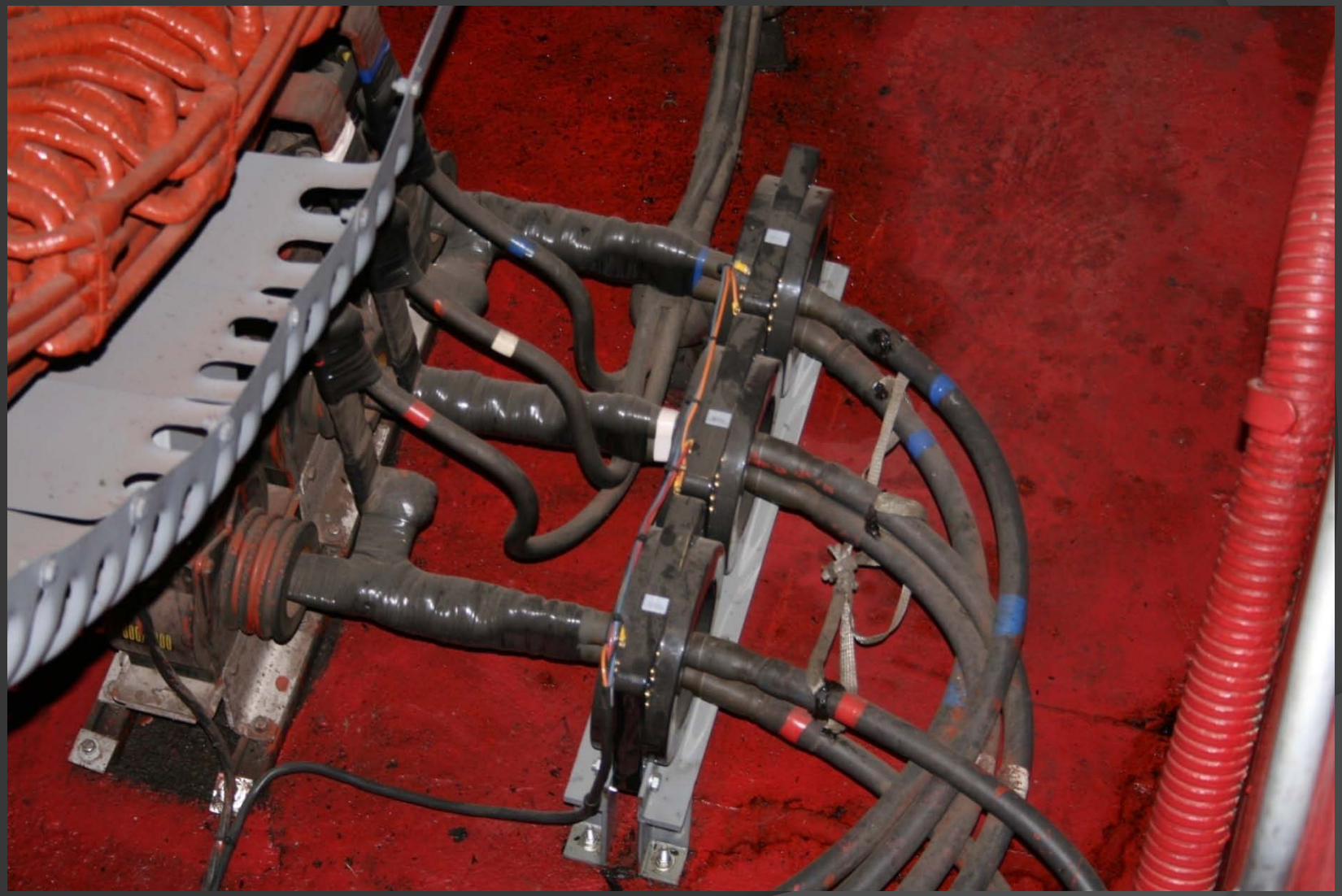
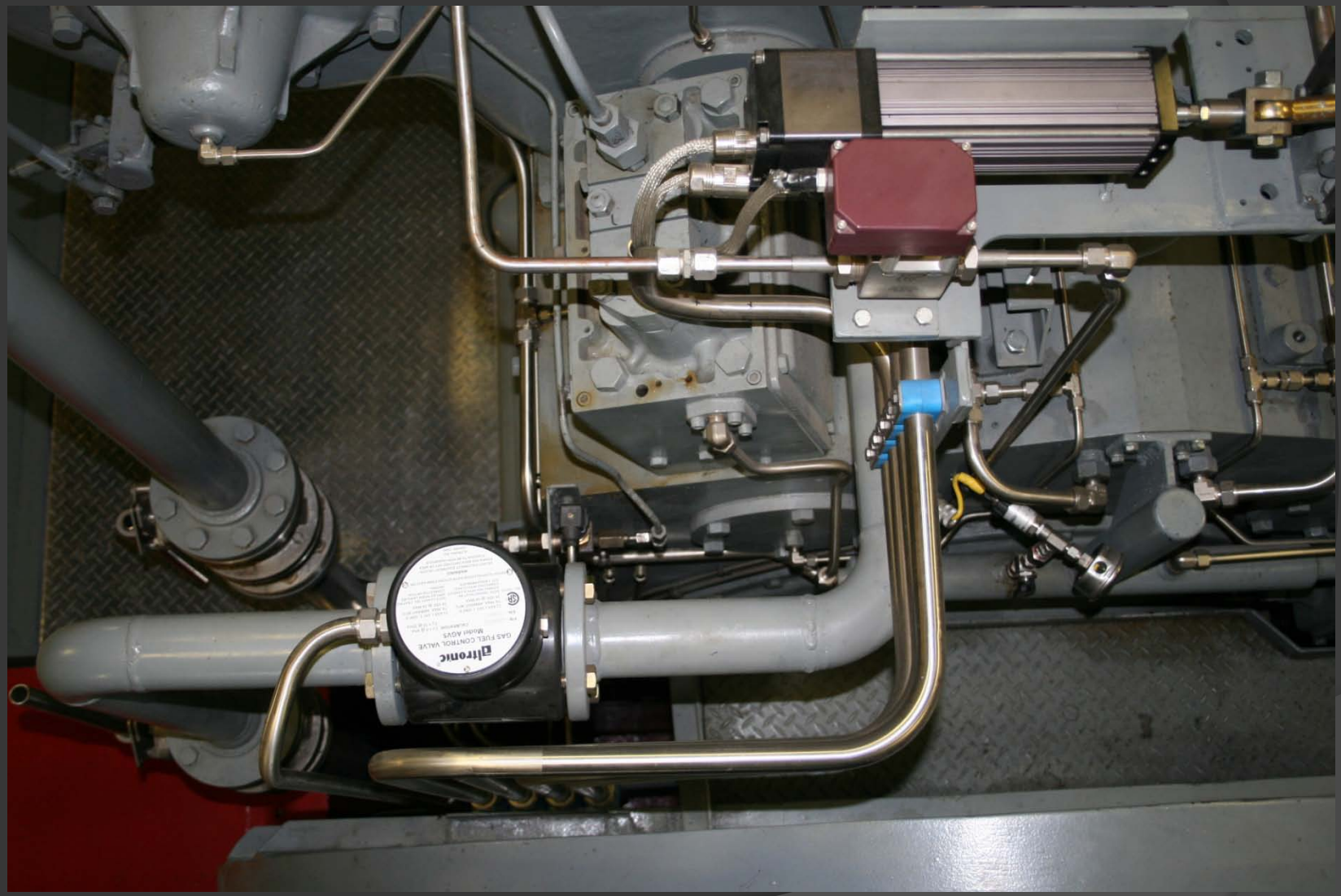


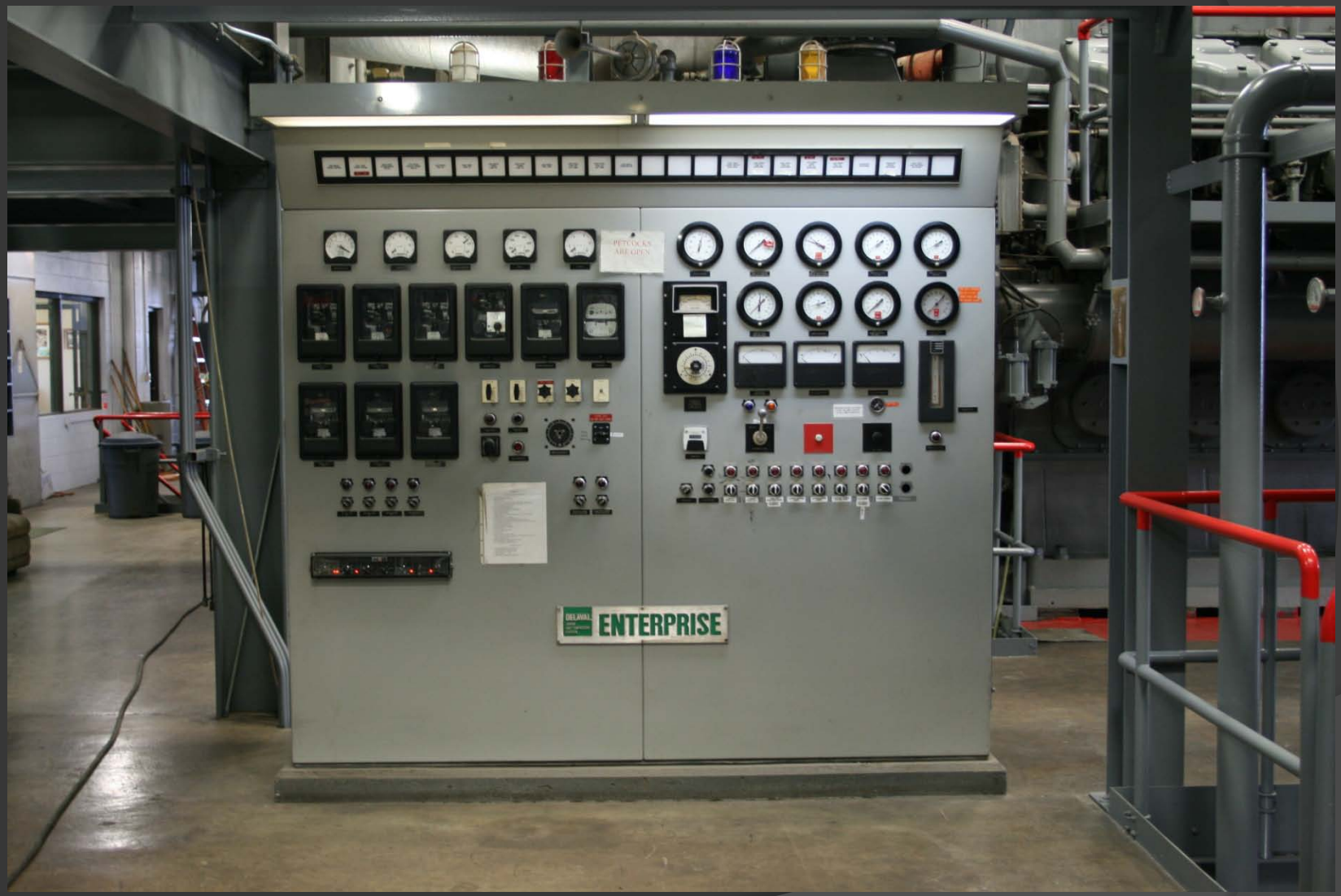
Generator output CT’s

Photo Gallery



Rotary fuel actuators

Photo Gallery



Original control system panels

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This presentation of a case study in
Power Generation
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