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Introduction to SCADA for Renewables
(A Six Module Course)

Course Learning Objectives

1. **Describe** SCADA system basics and important differences with other control systems
2. **Demonstrate** competency of the key components of a SCADA system and their functions
3. **Describe** the different communication systems used in SCADA
4. **Demonstrate** competency of the role and capabilities of operator interfaces
5. **Demonstrate** competency of implementing SCADA in real world applications, specifically renewable energy applications (install, operation, maintenance)
6. **Identify** emerging technical trends, shifts, and innovations impacting SCADA and its application in the renewable energy sector

Introduction to SCADA for Renewables

Course Outline / Curriculum Learning Modules:

Module 1 SCADA Overview

Module 2 Components and Functionality

Module 3 Basics of SCADA Communications

Module 4 Human/Machine Interface

Module 5 Applications within Renewable Energy Industry

Module 6 Emerging Trends in SCADA for Renewables

Module 5 – Applications in the Renewable Energy Industry

Learning Objectives

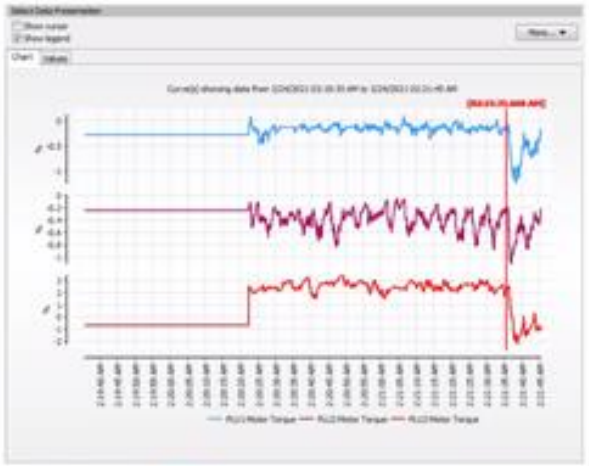
- **Understand** how SCADA functions and is utilized in various RE power generation applications
- **Create and operate** a basic SCADA system for a solar power application project under various scenarios
- **Demonstrate** troubleshooting of issues from solar power application project
- **Generate** data collection, analysis, and operating reports from the application project
- **Understand** how SCADA is used for energy storage applications
- **Understand** how SCADA for RE applications can be combined with energy storage systems
- **Configure** solar power project to include energy storage and operate project under various scenarios
- **Generate** data collection, analysis, and operating reports from the application project
- **Understand** how SCADA for RE applications and/or energy storage is used in grid response applications
- **Understand** positives and negatives of RE grid response with SCADA vs traditional grid response options

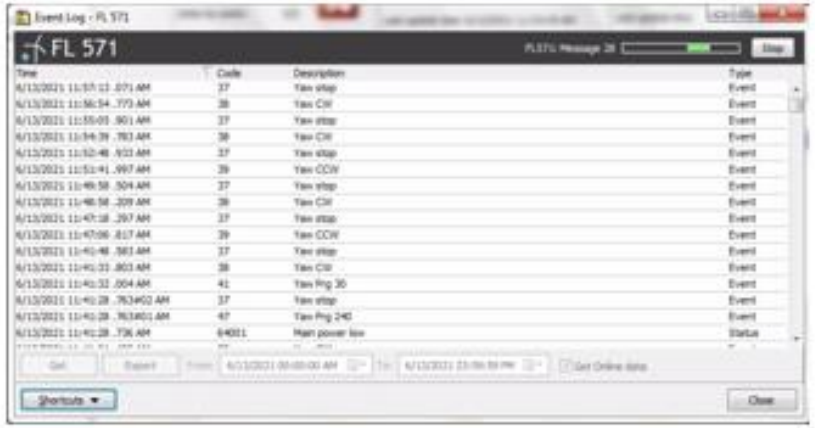
SCADA – How is it used in daily operations?

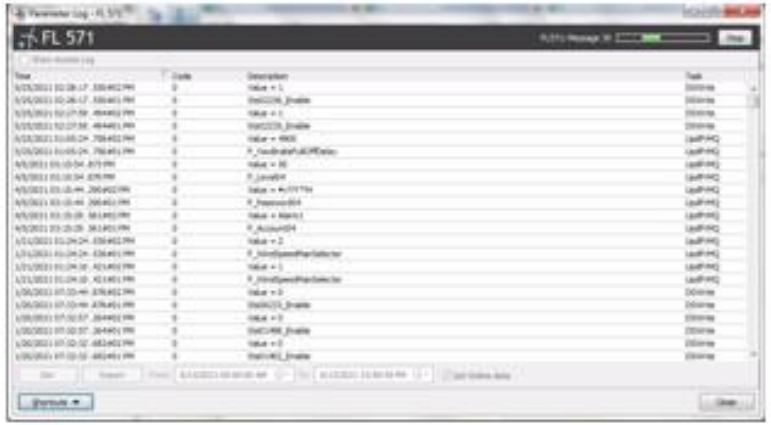
- Software is used to interface between the actual control and the human display
- Makes gathering data easy
- Makes control of the asset easy
- Makes monitoring many assets at one time possible

Data Acquisition

- Data can be processed into many different forms
  - Reports
  - Logs
  - Graphs
  - Lists

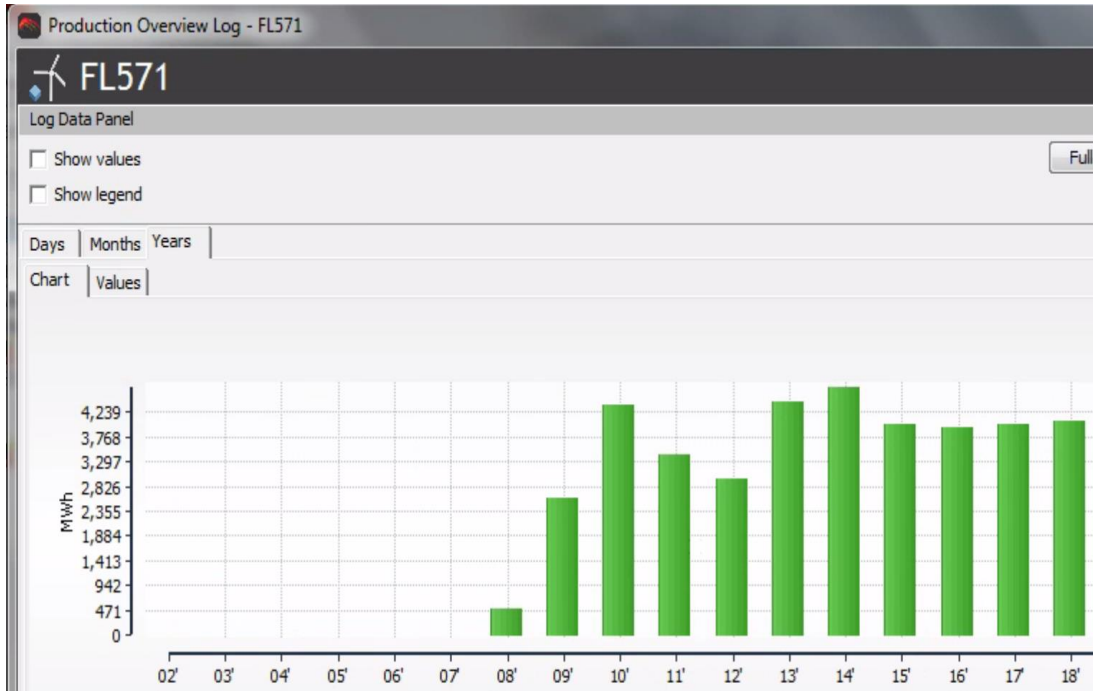






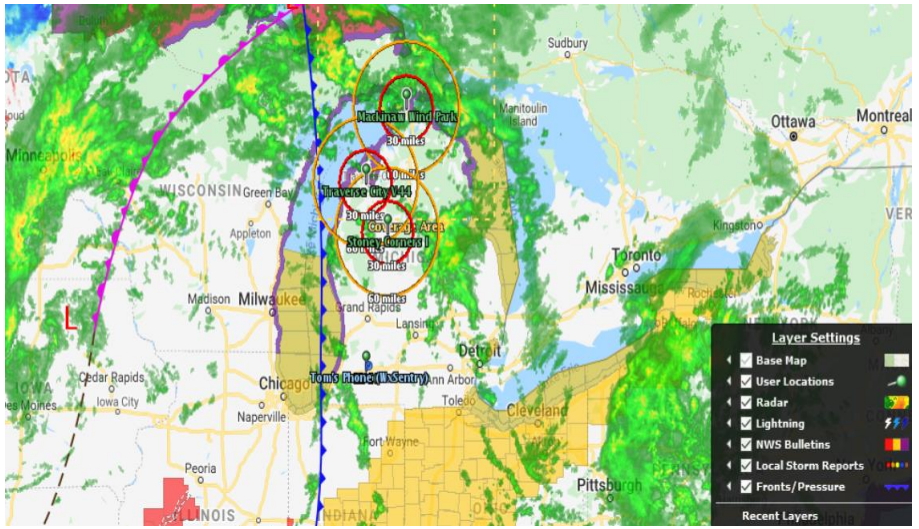
Users of Data

- System Operators
- Local Managers
- Technicians
- Utility Companies



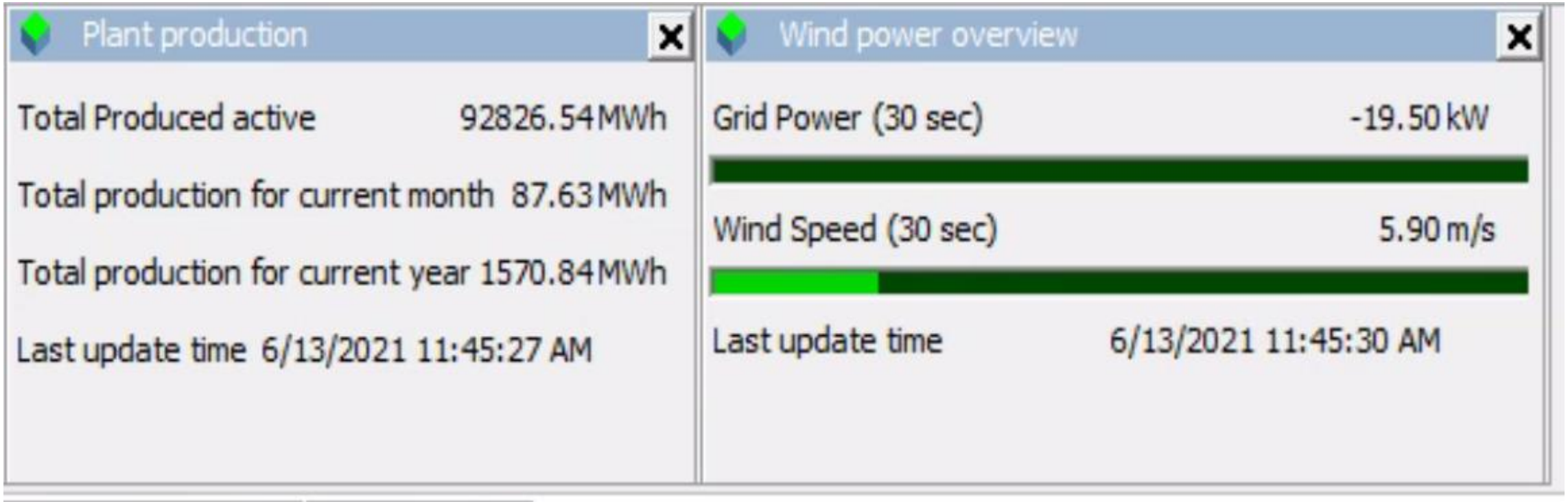
System Operators

- Use Data to Monitor Power Production
- Dispatch Assets to Correct Faults
- Plan Work Schedules
- Plan Shutdown of Production for Maintenance



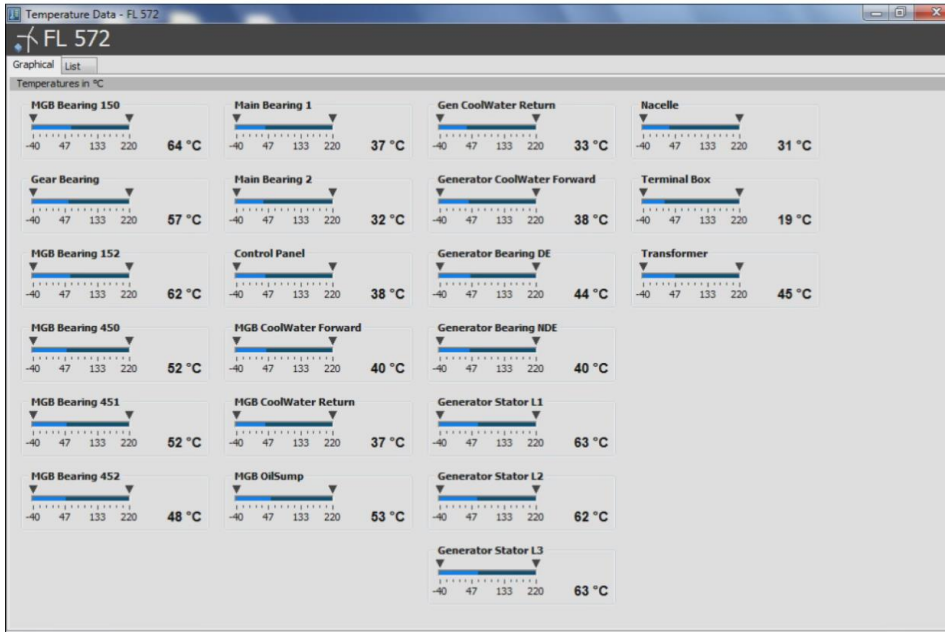
Local Managers

- Coordinate Scheduled and Unscheduled Maintenance
- Produce Daily Production Reports
- Produce Daily Availability Reports
- Monitor Performance of Assets



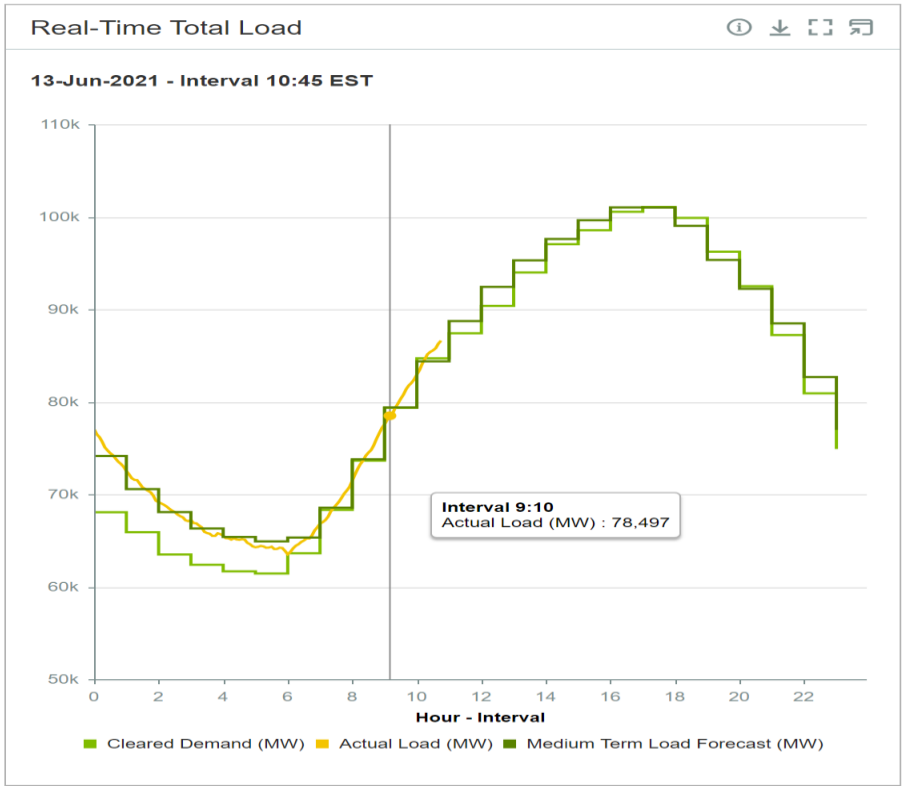
Technicians

- Gather Data to Troubleshoot a Fault
- Use Data from Other Machines to Compare
- Collect Parameter Lists for Comparison
- Use Data to Commission the Assets



Utilities and Grid Operators

- Use Data to Help Balance the Grid
- Meet Customer Demands for Electricity
- Set Pricing for Electricity
- Plan Generation Levels Day Ahead

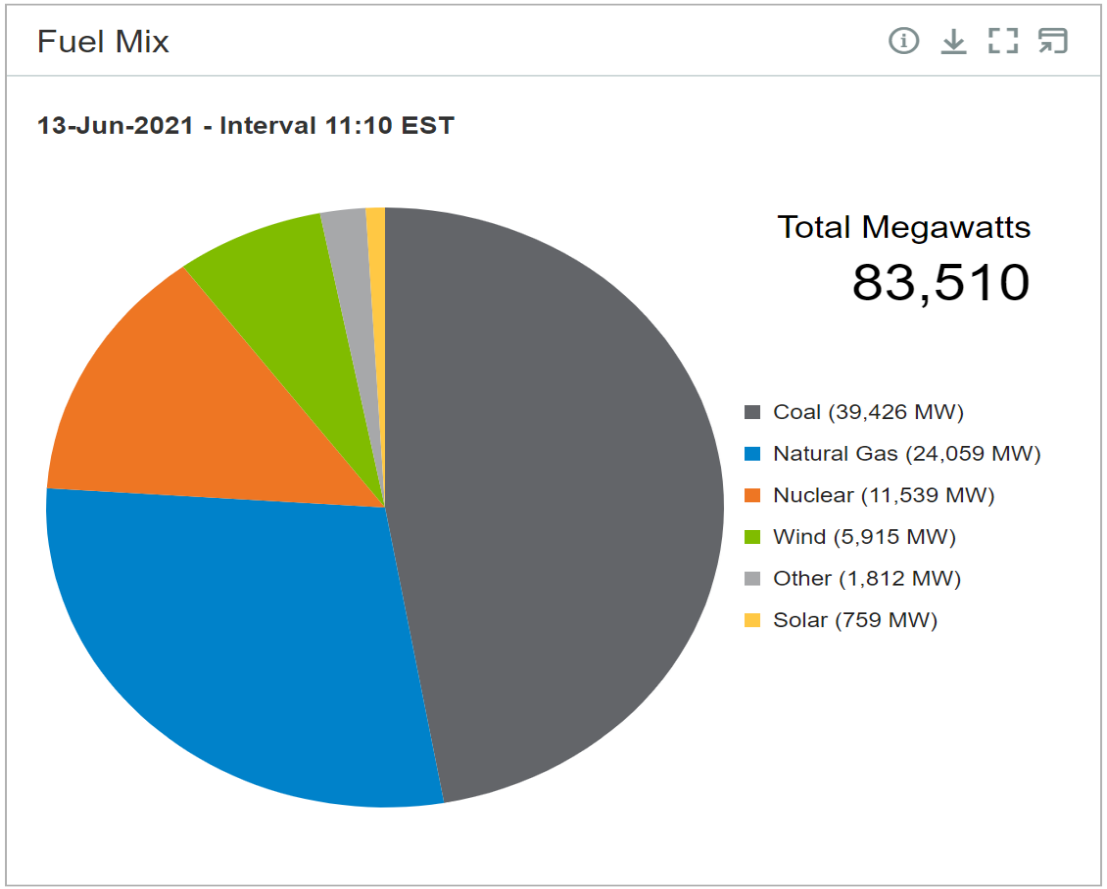


Other Data

- Fuel Mix
- Import and Export
- Pricing and Demand
- Weather Related

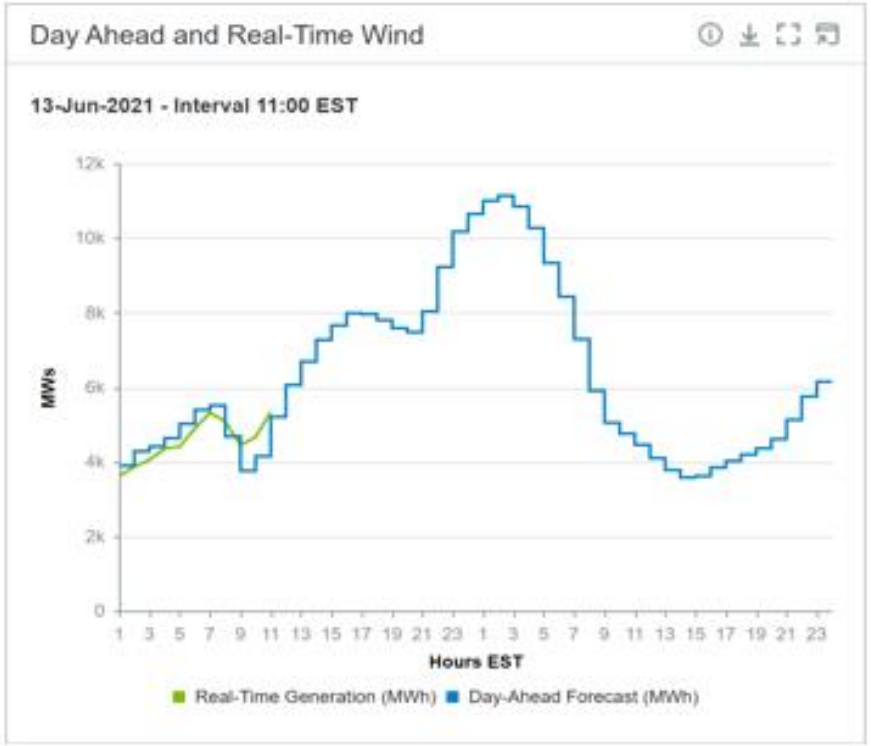
Fuel Mix

- Data Collected From All Sources
- Renewable Production Varies
- More Wind = More Wind Power
- More Sun = More Solar Power



Day Ahead Forecasting

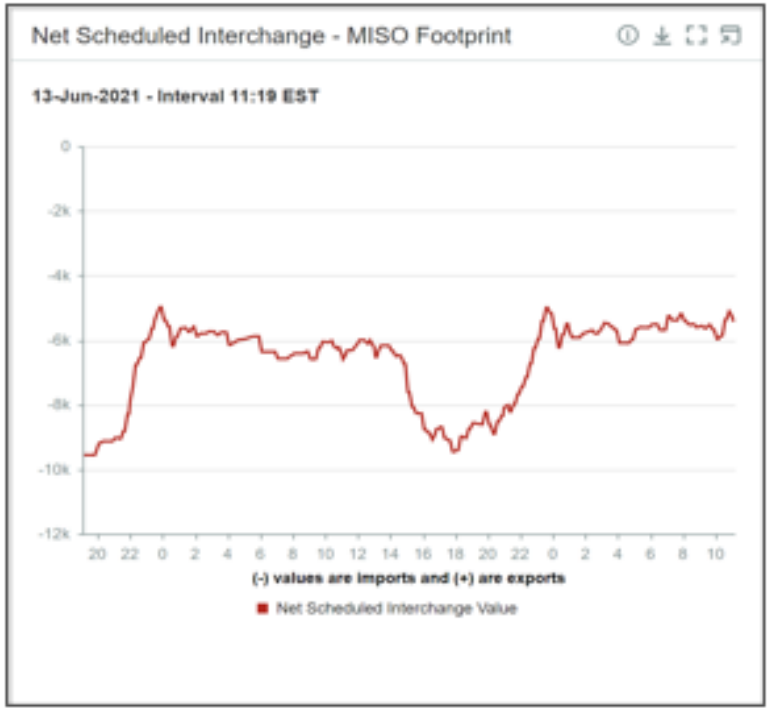
- Weather Predictions Determine Amount of Renewable Power Expected
- Bids are Placed by Generating Units Based on Expected Power

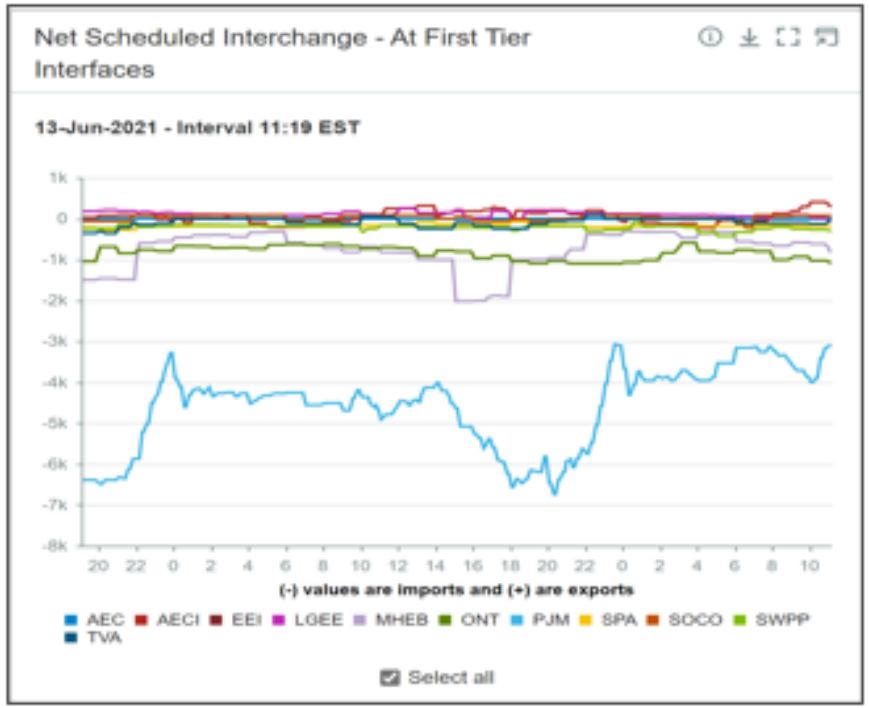


Region	Market Participant Code	Date/Time Beginning (EST)	Date/Time End (EST)	MW	LMP	Type of Bid	Bid ID	PRICE1	MW1
North	122062236	3/15/2021 0:00	3/15/2021 1:00	1740	0.93	F	122073042		1740
Central	122062236	3/15/2021 0:00	3/15/2021 1:00	1318	20.17	F	122073033		1318
North	122062236	3/15/2021 0:00	3/15/2021 1:00	3	3.49	F	122073561		3
North	122062236	3/15/2021 0:00	3/15/2021 1:00	16	-15.06	F	767746013		16
Central	122062236	3/15/2021 1:00	3/15/2021 2:00	1330	19.71	F	122073033		1330
North	122062236	3/15/2021 1:00	3/15/2021 2:00	1754	2.78	F	122073042		1754
North	122062236	3/15/2021 1:00	3/15/2021 2:00	16	-11.66	F	767746013		16
North	122062236	3/15/2021 1:00	3/15/2021 2:00	3	4.68	F	122073561		3

Planning for Import and Export

- Sometimes Excess Power can be Exported to Other Areas
- Sometimes Power Needs to be Imported from Other Areas





Data Capabilities

All Parts of the Grid have Data Capability

- Generation Source
- Substations
- Transmission Systems
- All used together to Make Grid Management Possible

Troubleshooting Remote

- Depends on Good Data Collection
- Individual Generation Assets Collect Data Continuously
- Data is Accessed and Used to Determine the Source of the Fault
- Technicians and System Operators Depend on Processed Data

Case Study

Pitch Servo Motor Overheat Fault

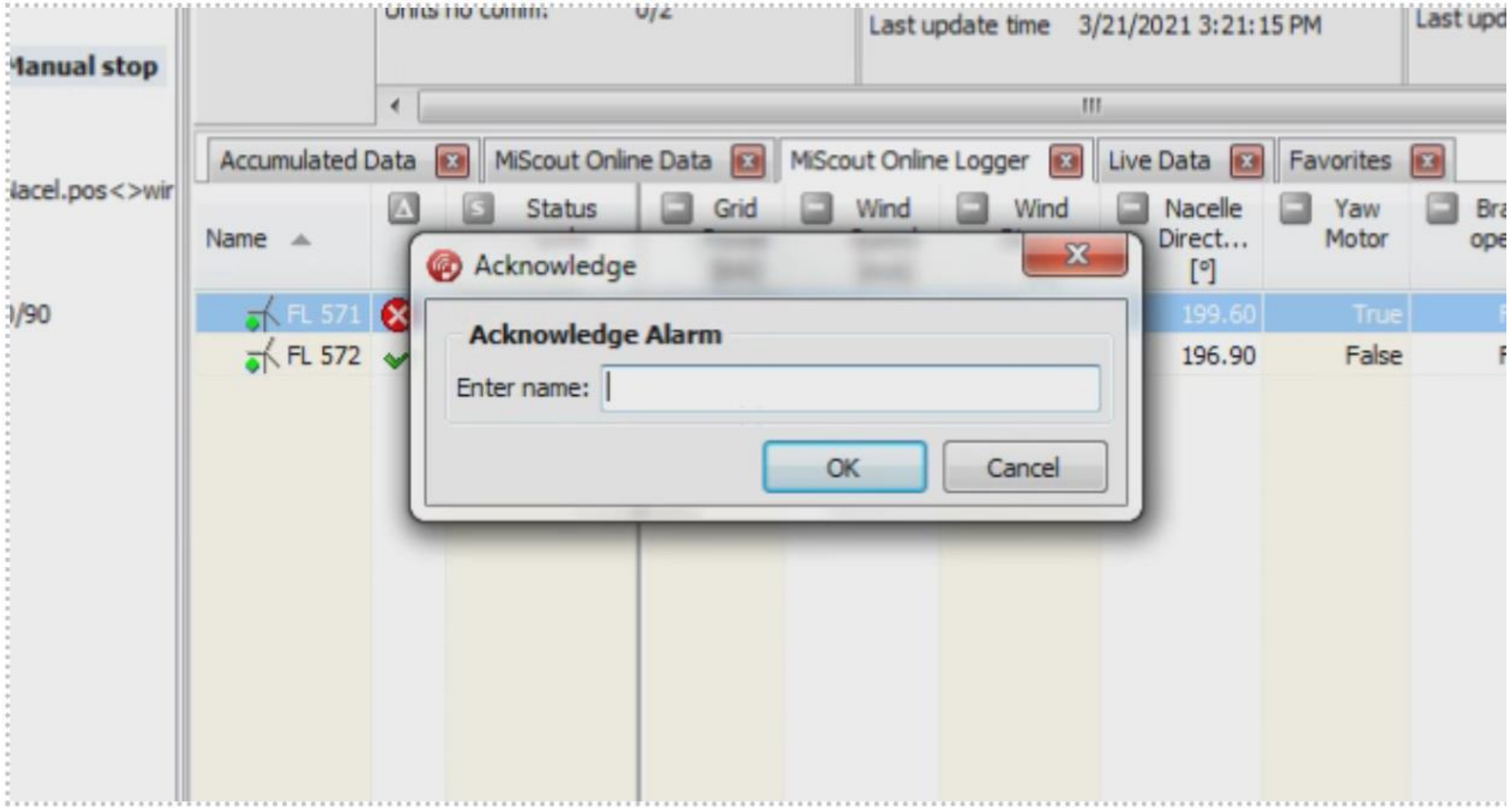
- Electric Pitch Control System in a Wind Turbine
- Servo Motor Temperature is Monitored by the Control System
- Parameters are Established Within the Controller to Protect the Motor
- Control System Takes Specific Actions When Temperature Reaches Set Point

Start of Event

- The Control System in the Wind Turbine Detects a High Temperature
- Alarm is Sent to the Monitoring Operator (Local and System Operators)
- The Operator can Acknowledge the Alarm and Start Working the Problem

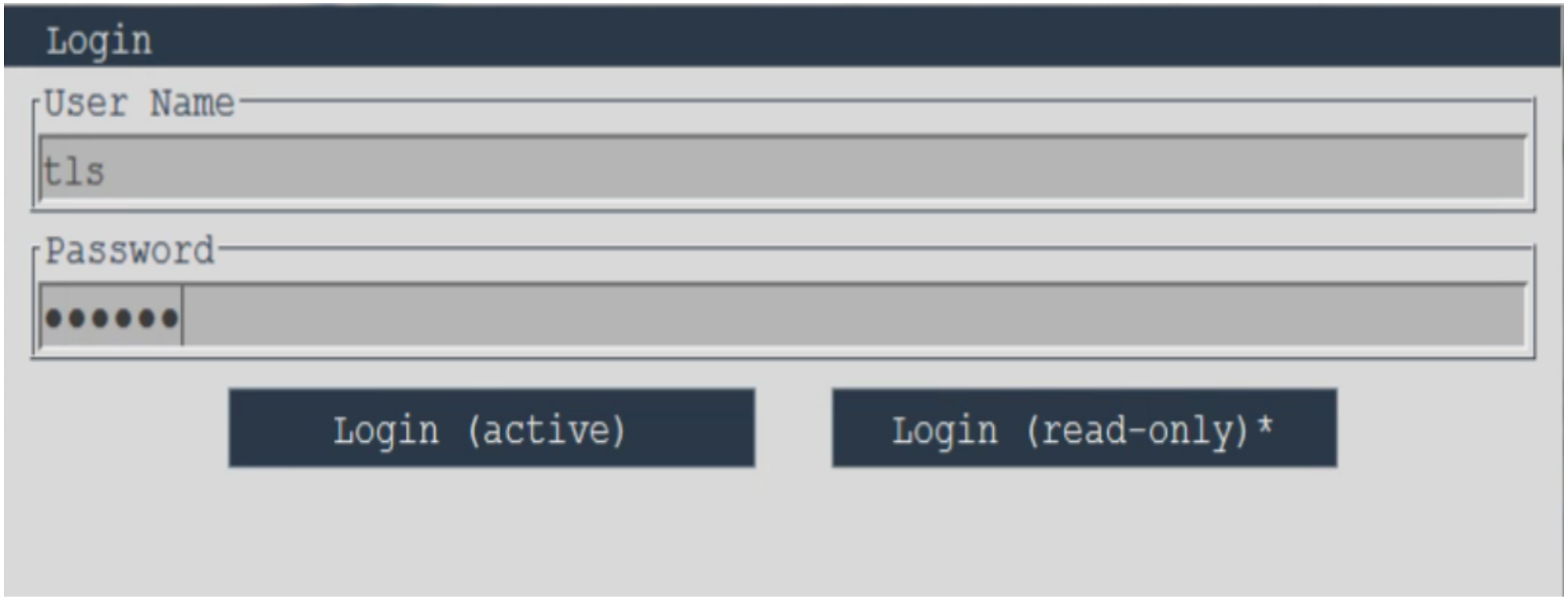
Operator Action

- Operator Acknowledges the Alarm



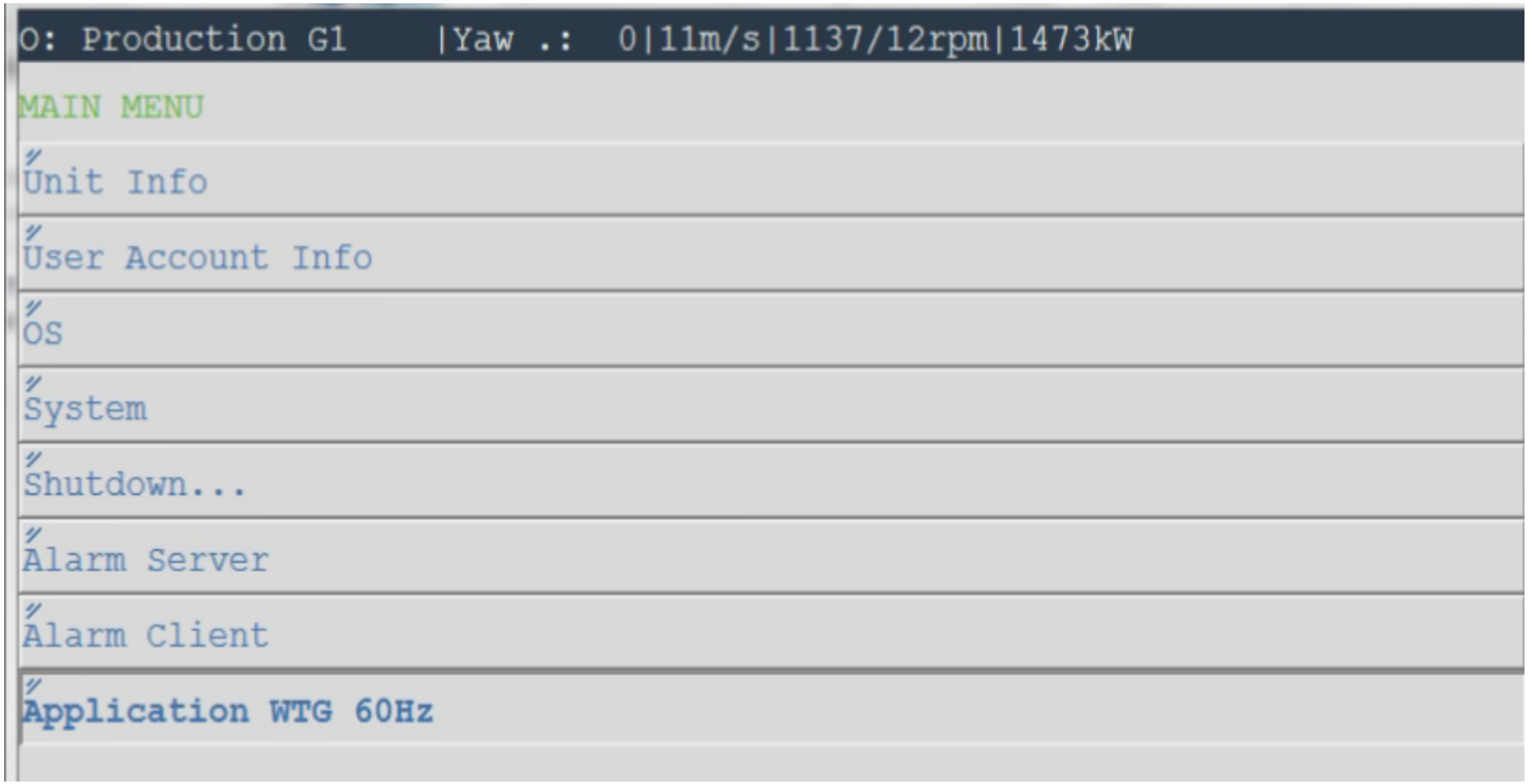
Investigating the Cause

- The Operator (or Technician) Starts to Investigate Possible Causes
- Logs Into the Controller to Gather Data About the Fault



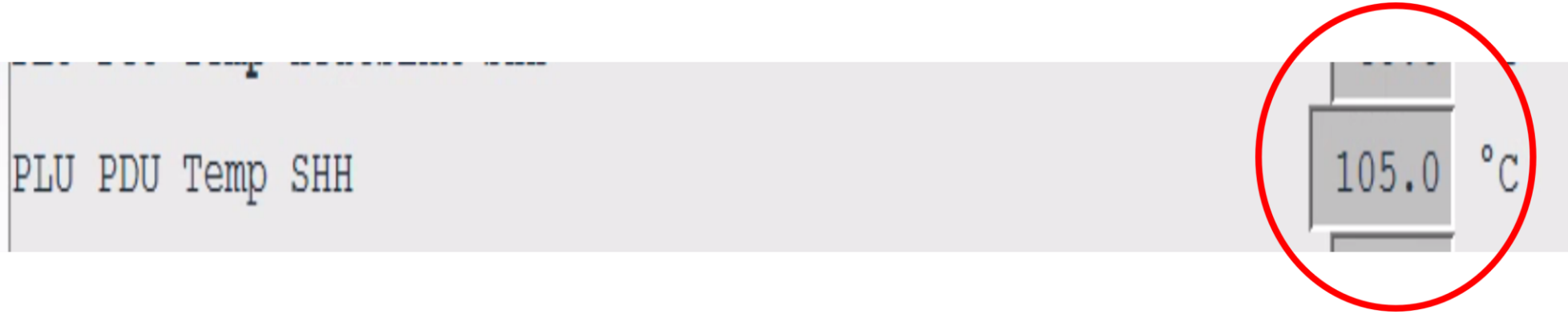
Logged Into the Control System

- Once Logged In the Control Menu Options Appear



Checking Parameters

- The Pitch Motor Temperature Parameter can be Checked



Referencing the Manufacturers Material

- Checking Documentation for Parameters

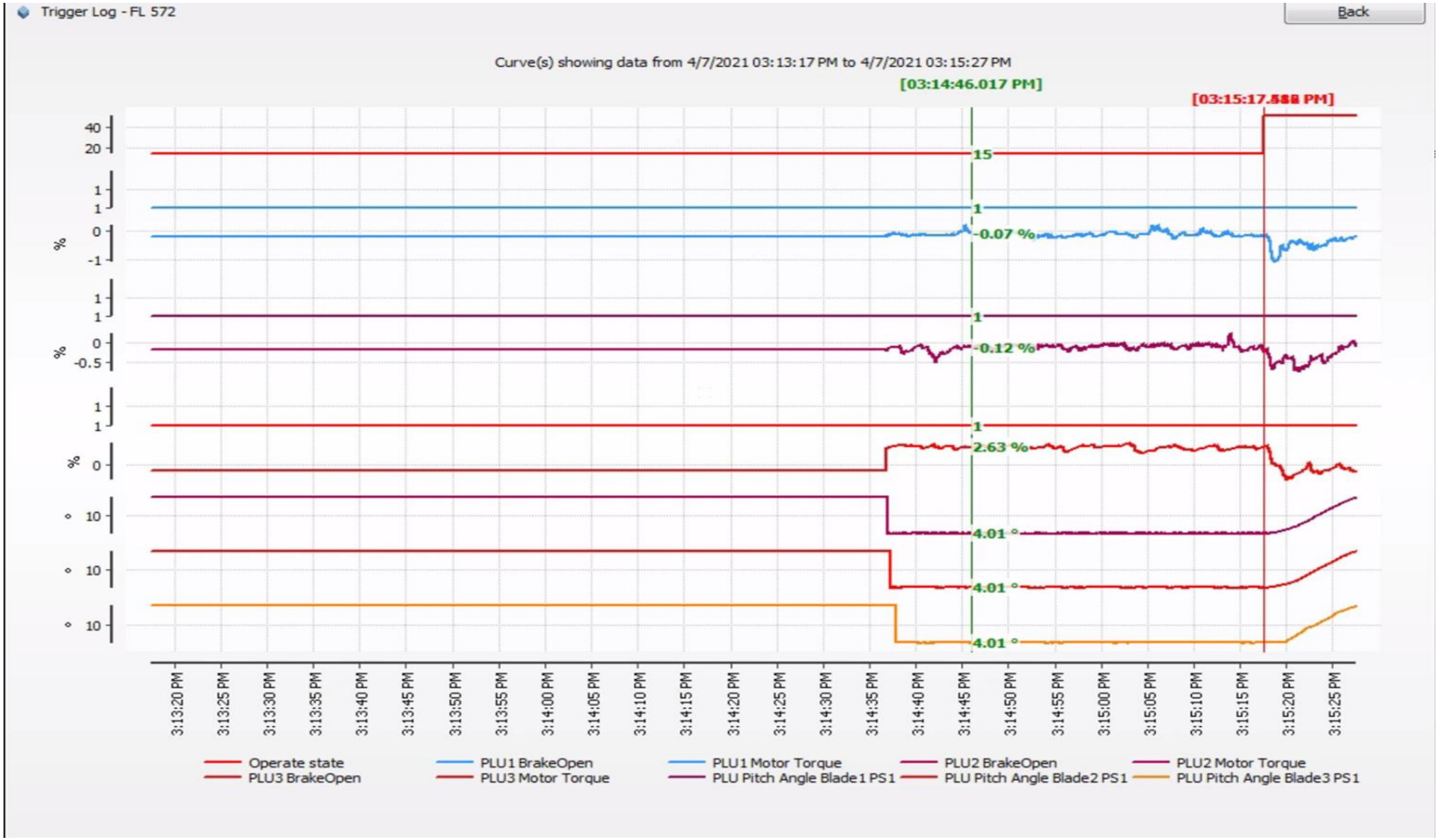
PLU PDU Temp SHH xx °C

- ***View:*** 99, ***Edit:*** 99
- ***Min.:*** 0, ***Max.:*** 150, ***Default:*** 60
- Max. temperature for the PLU pitch motors.

Checking the Fault Data

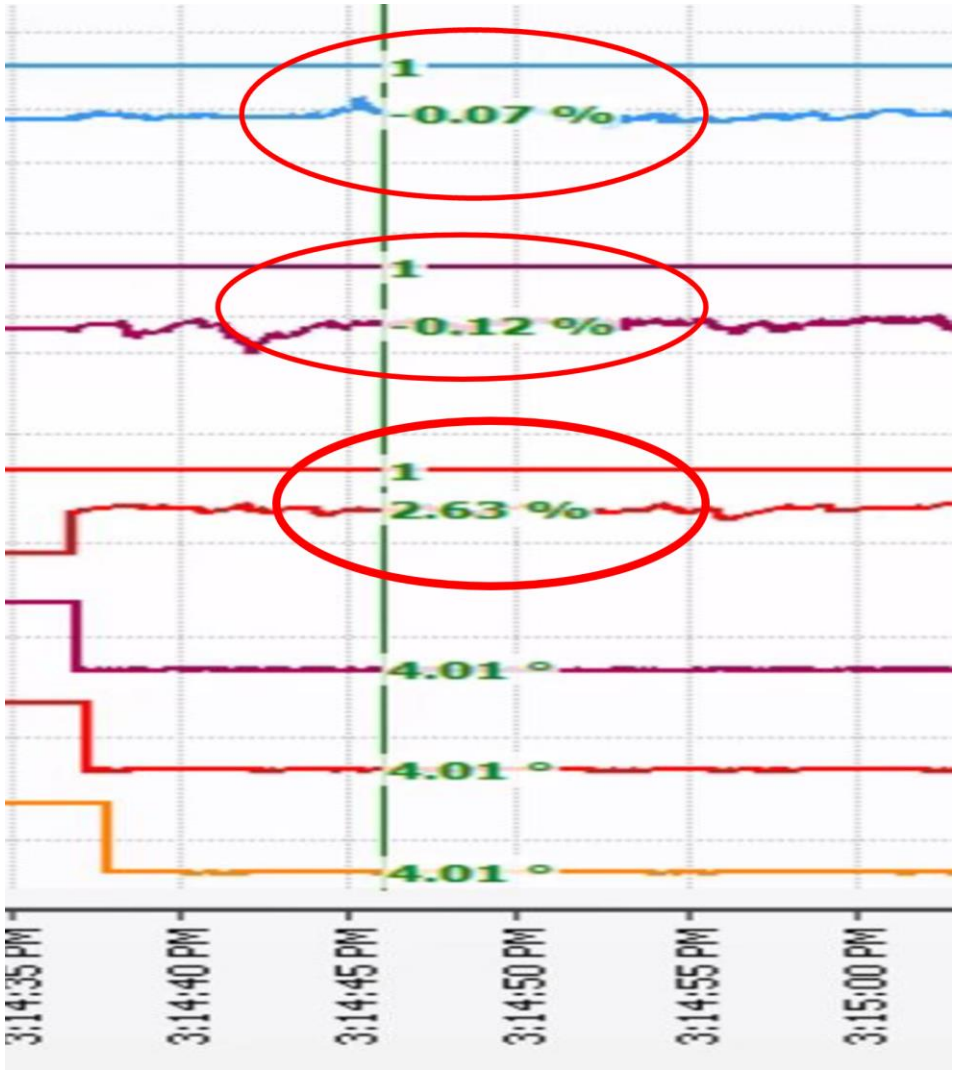
- Modern Machines Store Data Before and After a Fault
- This Data Can be Used to Gain Information About the Fault
- Can Be Compared to Other Data
- Data Used to Support Theories About Cause of Fault

Trigger Data



Data Supported Theories

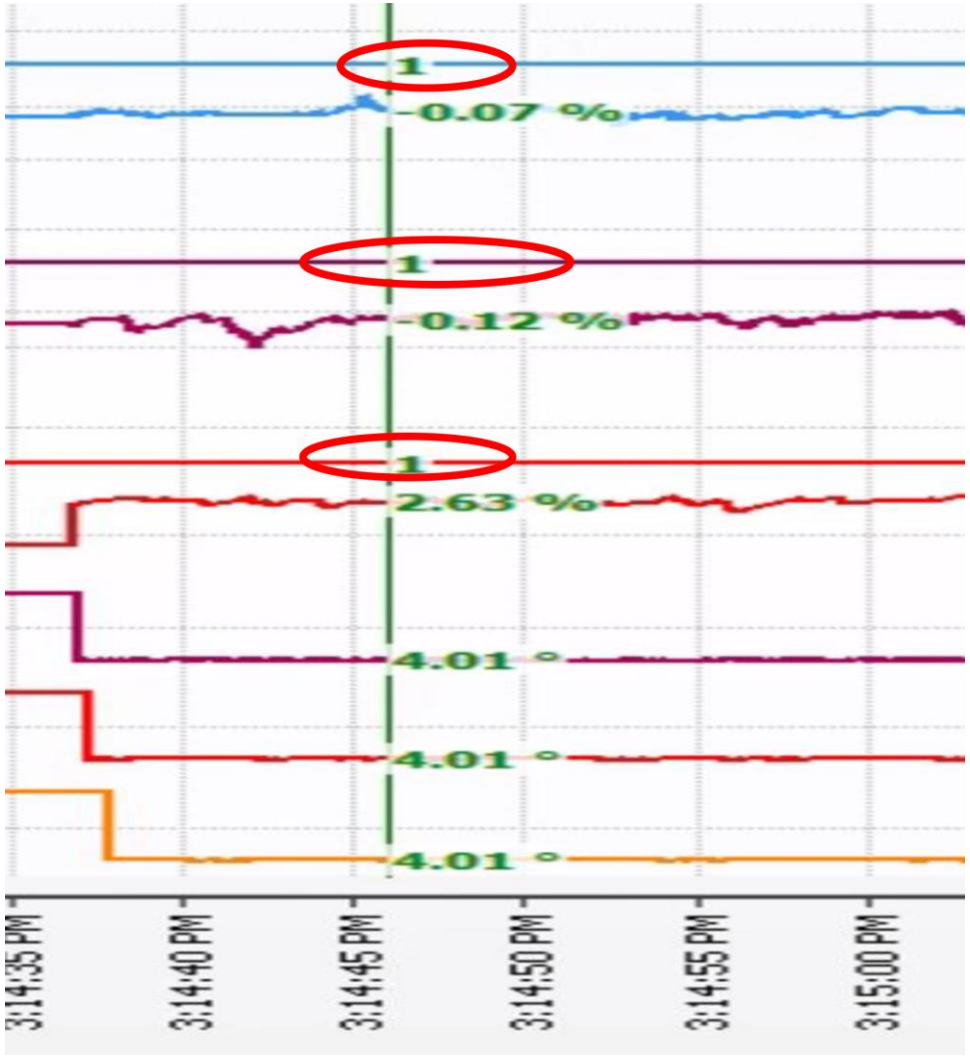
- Increased Torque on Motor Could Cause It
- The Motor Torque is Compared to the Other Blades
- Motor Torque is Higher on the Faulted Blade
- More Information is Required to Determine Cause



Other Theories

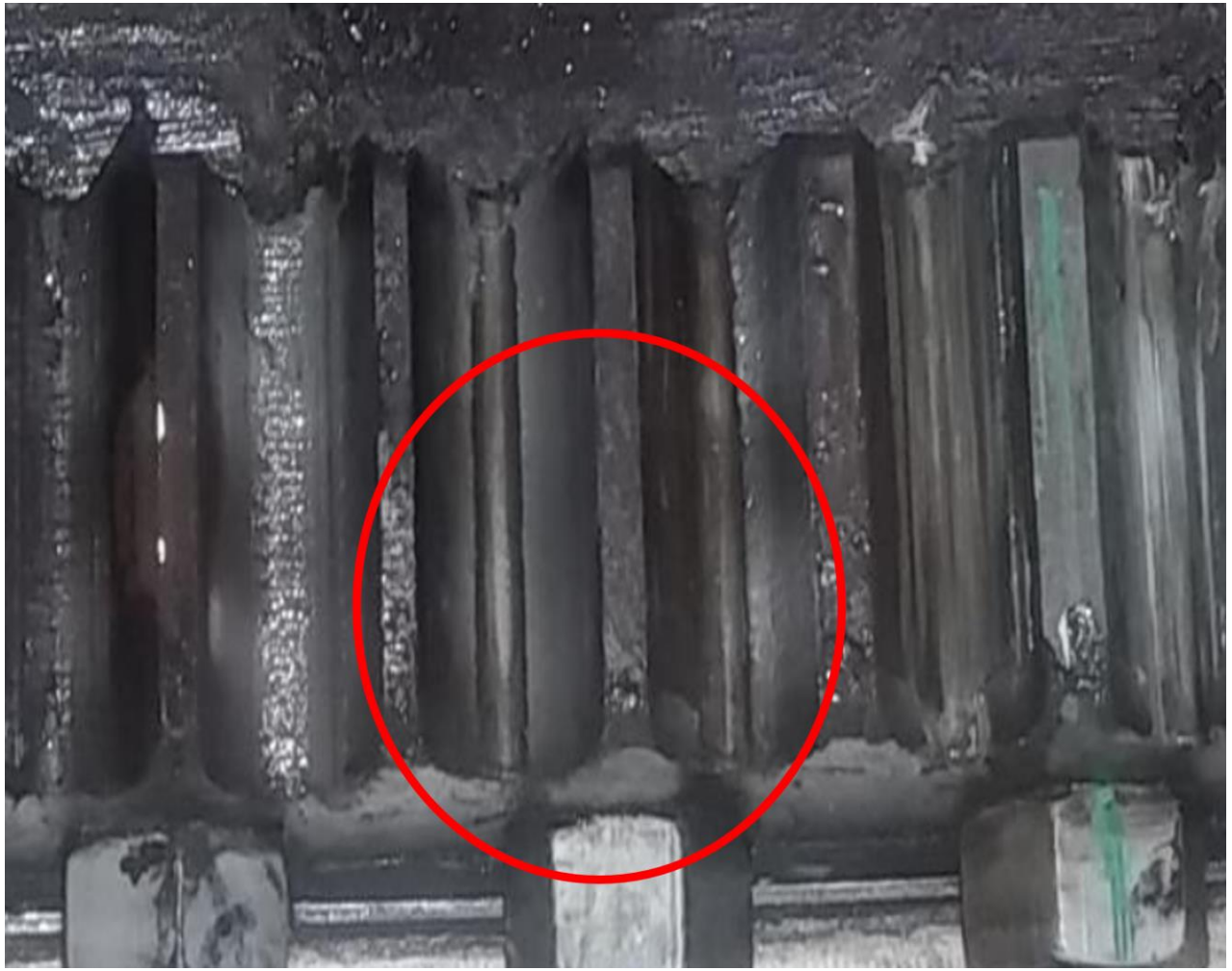
- Motor Brake Stuck On
- Blade Bearing Binding
- Pitch Gear Box Issue
- Worn Open Gear Teeth

  Requiring More Holding Torque
- All Motor Brakes Appear to Be Open



Root Cause Determined

- Technicians Dispatched to Machine
- Inspection Found Worn Teeth on the Open Gear
- Caused Increased Torque Demand
- Blade Open Gear Was Replaced



Case Study Summary

- The Control System Reported the Fault
- The System Operator Started Diagnostics
- Site Technicians Inspected Based on Theories Supported by Data
- Root Cause was Improper Heat Treatment on Gear

Supervisory Control

- Allows Control of Machine
- Can Be Local – at Machine Through Human Machine Interface (HMI)
- Can Be Remote – Through Software and Remote Connection
- Passwords Assign Different Levels of Privilege (access to control level)

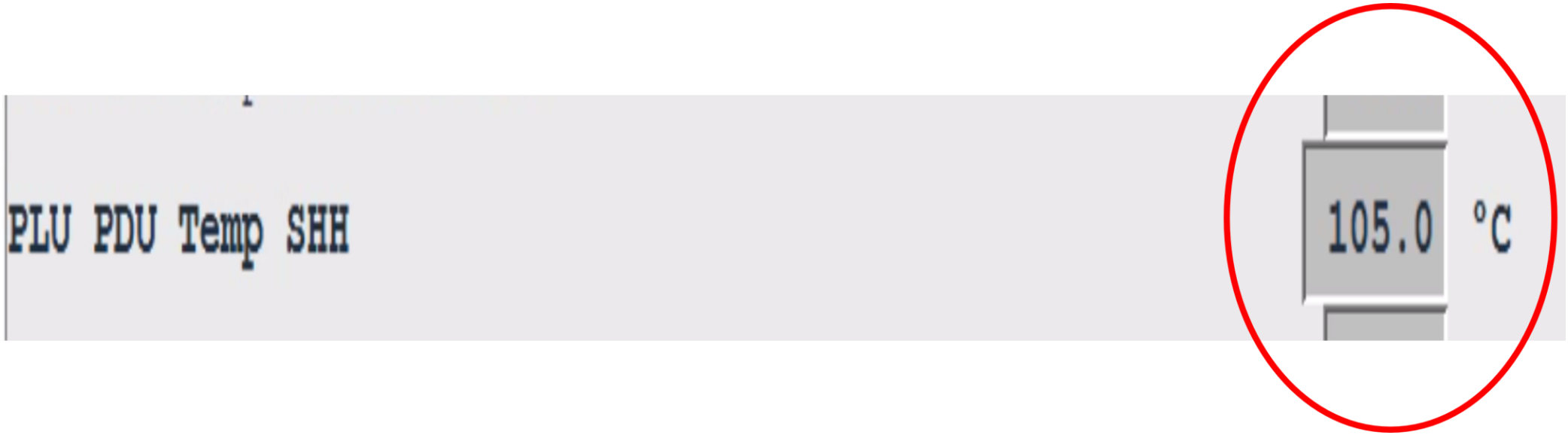
Machine Control

- Software Allows for Control of Systems
- Changing Parameters
- Activating Motors and Heaters
- Changing Signals

Parameter Changes (1)

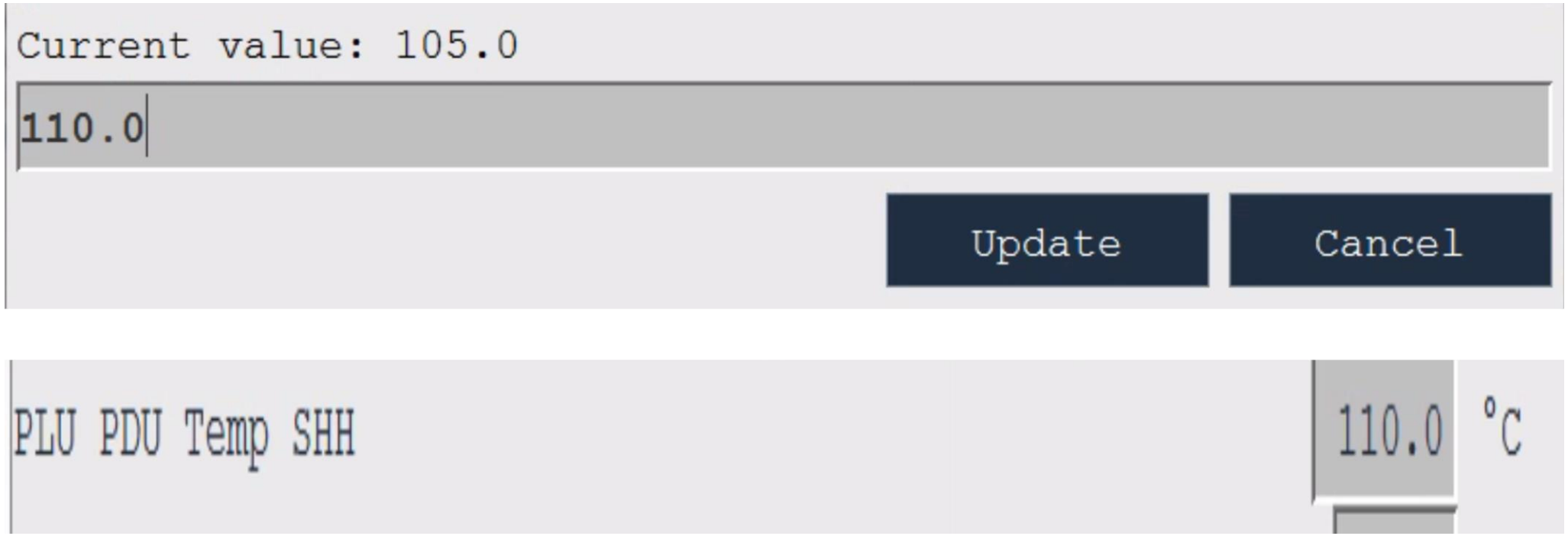
- Adjusting Parameters

- Changing the Pitch Motor Temperature Parameter



Parameter Changes (2)

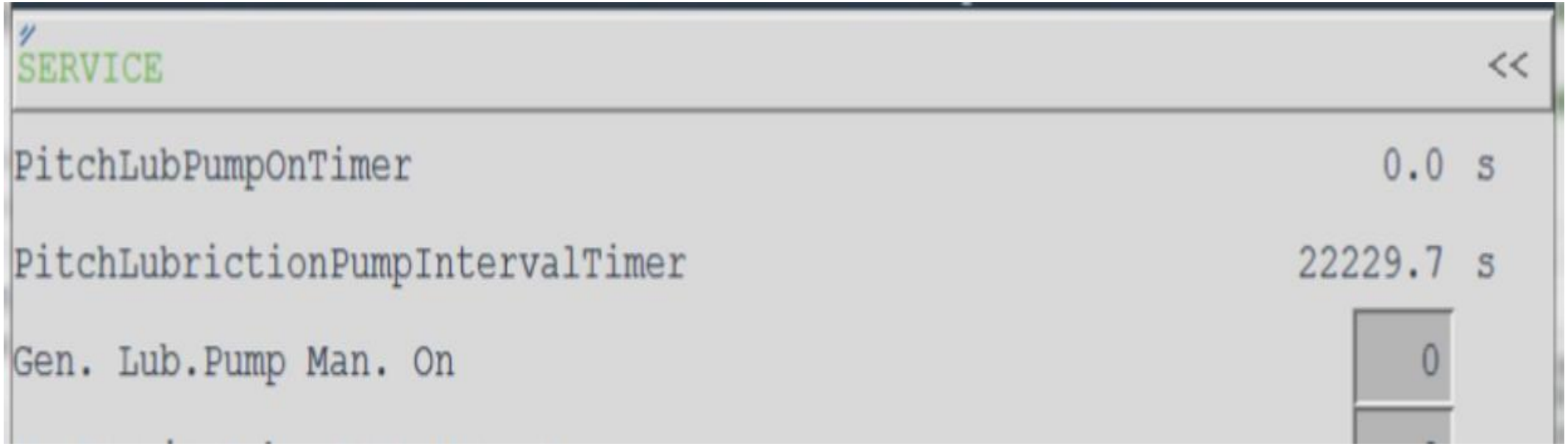
- The Parameter is Selected
- The New Value is Typed In and Updated



Motor Control

- Motors Controlled Through Remote

- Grease Pump Motor Control



Turning the Unit On

- Turning the Unit On

Feedback Data

- Verifying the Unit is On

- Uses a Sensor to Indicate the Piston is Moving From Grease Moving

Curtailment – Local and Remote

- Wind Turbines Are Able to Be Turned Up and Down Easily
- Can Adjust Output Levels Quickly
- Used by Utilities and Grid Operators to Control Grid Levels
- Done Through Remote Signaling

Summary

- Supervisory Control and Data Acquisition (SCADA)
- Allows Remote Control
- Collects and Stores Data for Use Later
- Vital to Operations, Grid Control and Reporting Production

QUESTIONS?