Application of PLC-HMI Pump Controls and Monitoring With or Without SCADA

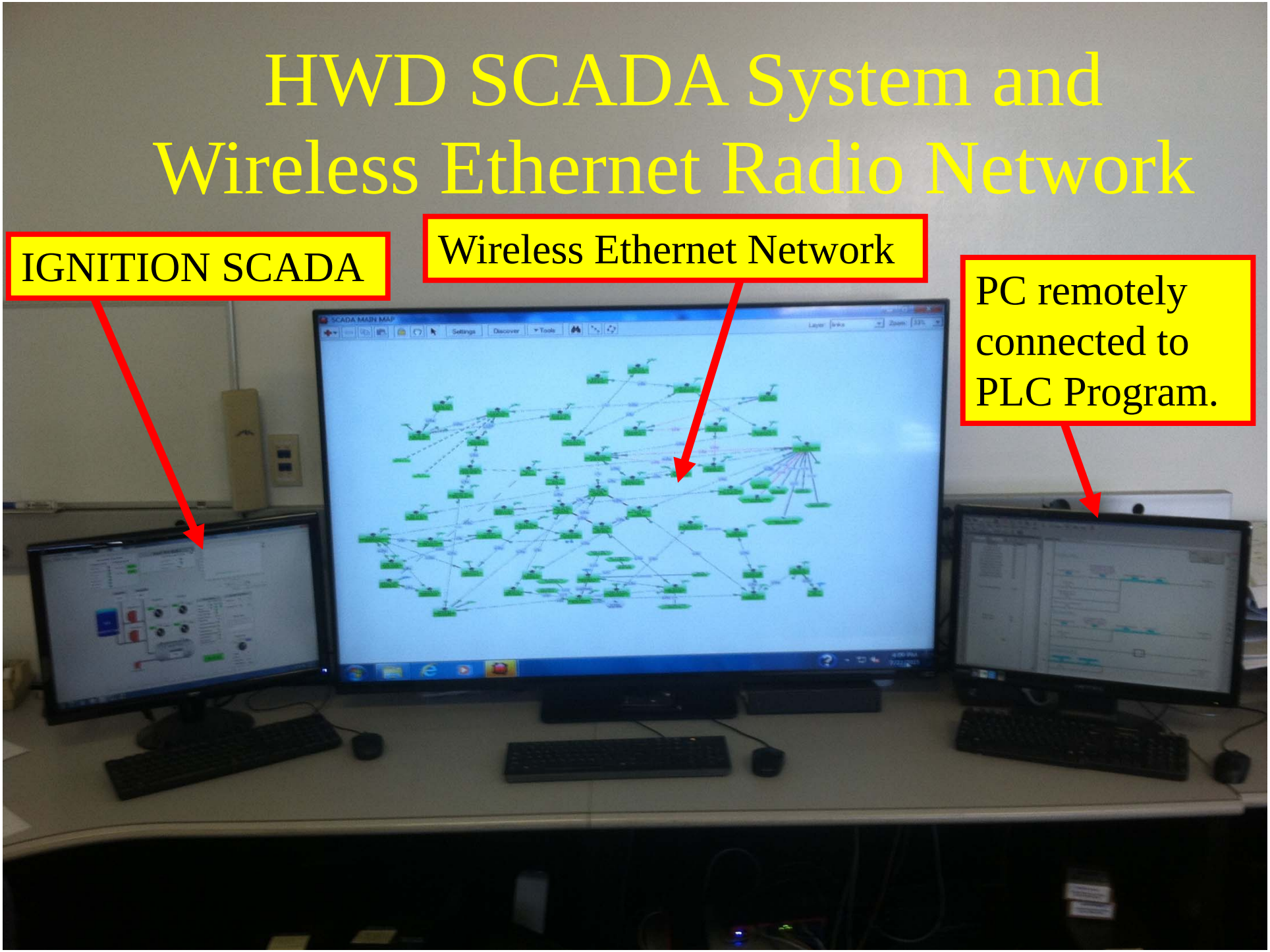
by Bobby Fortuno, Helix Water District (HWD)

SCADA Prog. and Wireless Network Administrator

Helix Water District

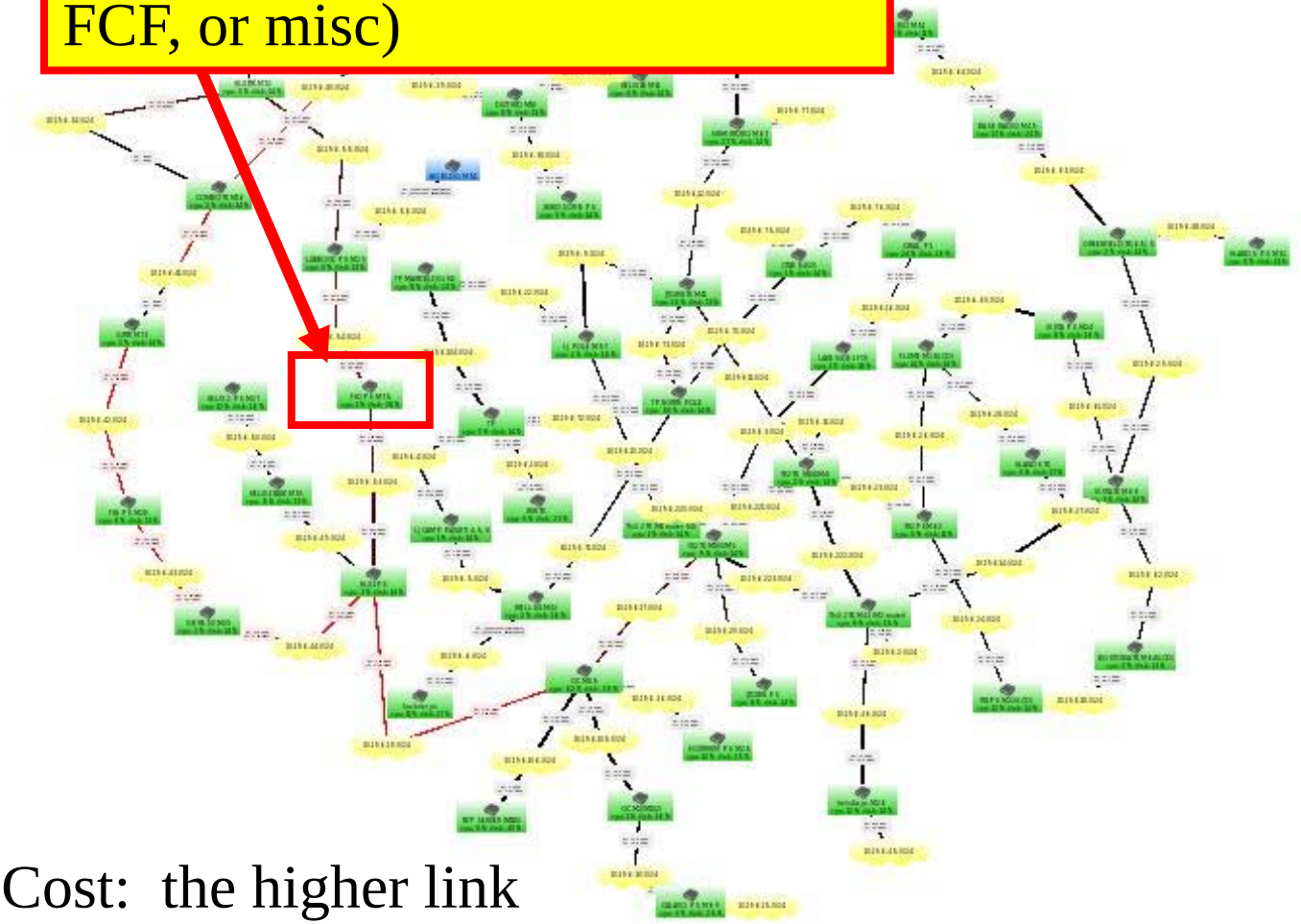
- Celebrated 100 Years (2013)
- San Diego East County
- 270,000 population
- 106 MGD WTP / Ozone
- 50 Site distribution system
- System storage of 68.5 MG
- 722 miles of pipeline
- 50 square miles
- Supply three other districts
  - 3 Connections
  - Up to 36 MGD

HWD SCADA System and Wireless Ethernet Radio Network



SCADA Wireless Ethernet Radio Network (layer3-OSPF)

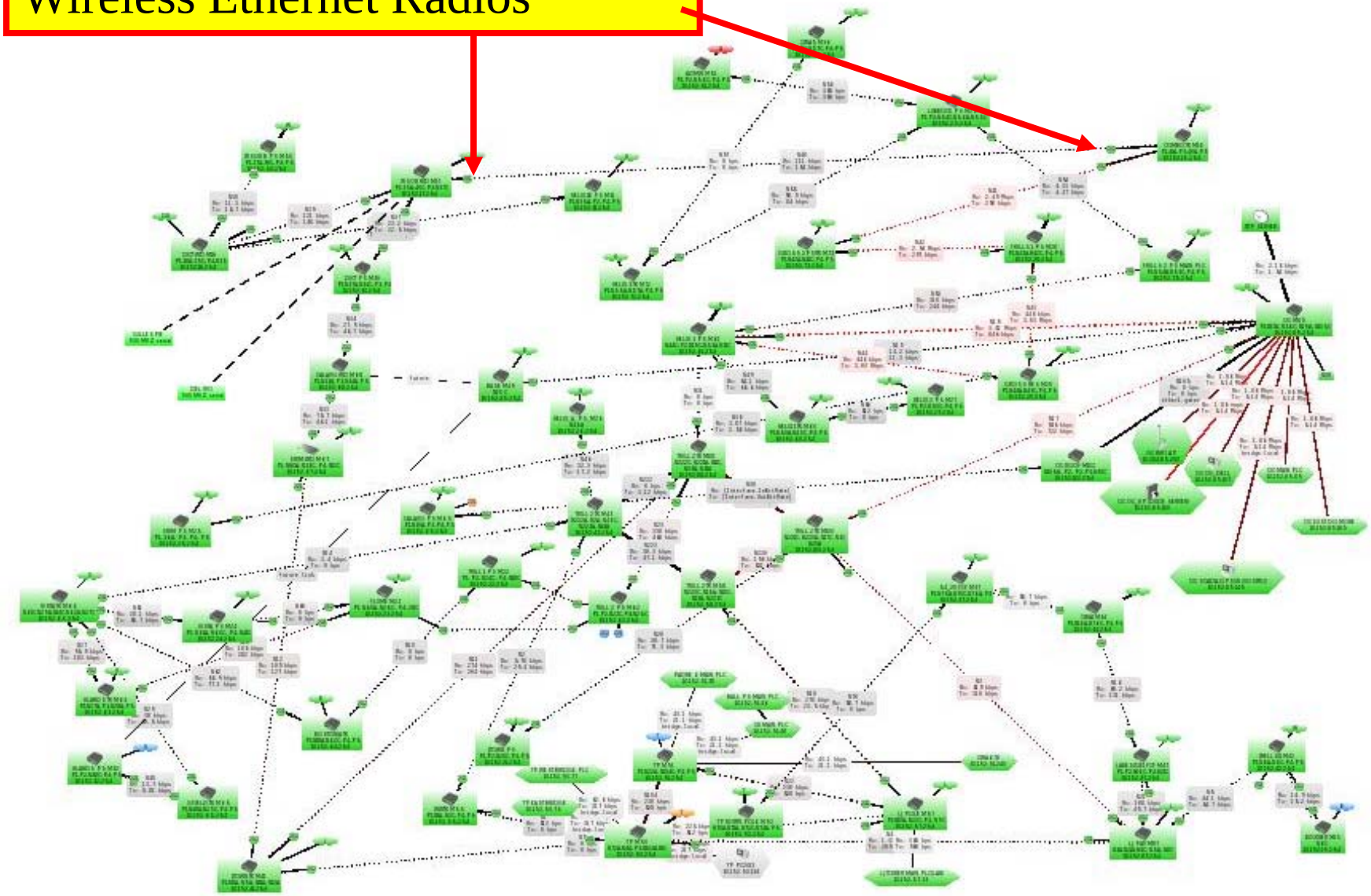
Router (represents a PS, Tank, FCF, or misc)



Cost: the higher link throughput the lesser the cost.

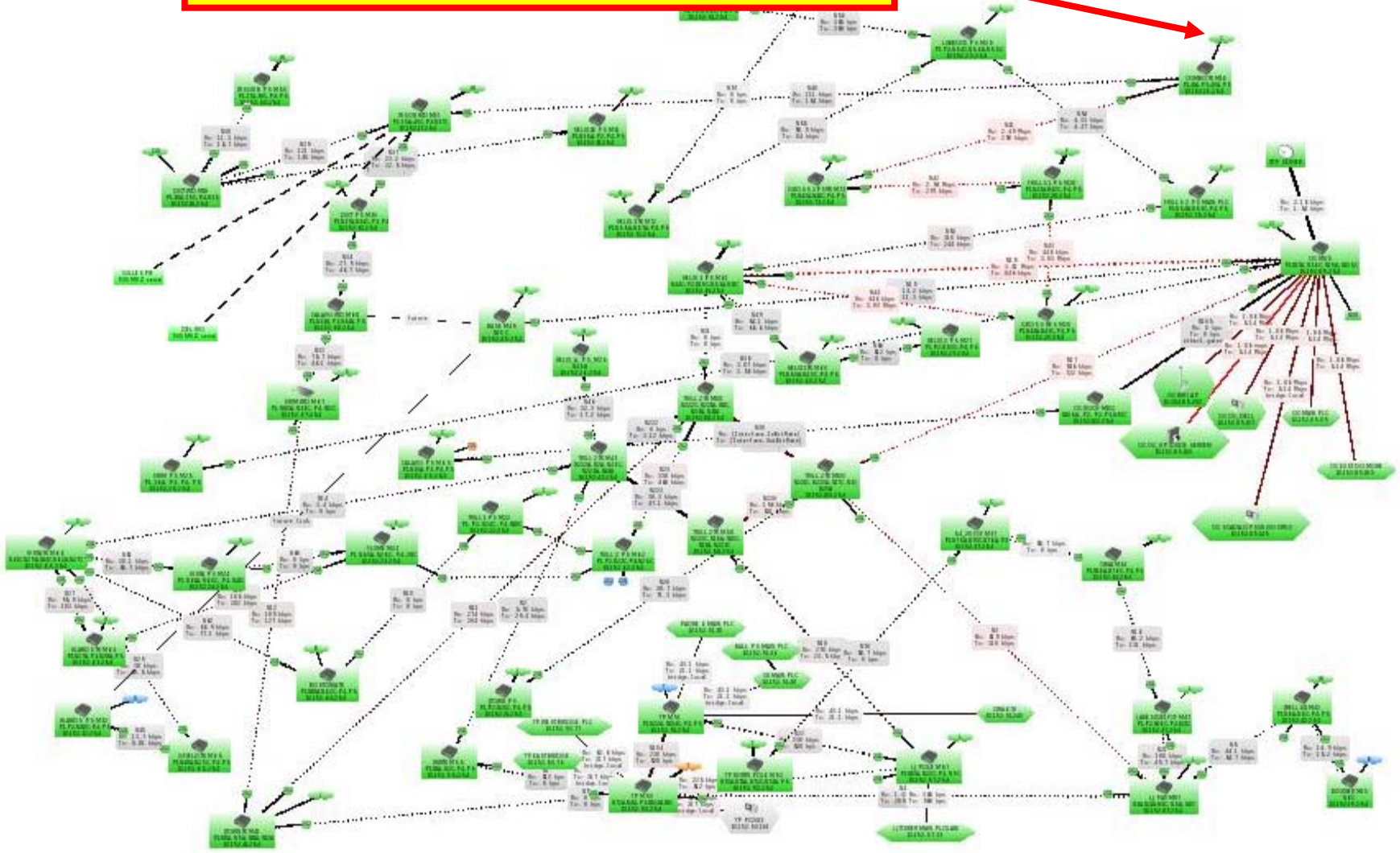
SCADA Network

Wireless Ethernet Radios

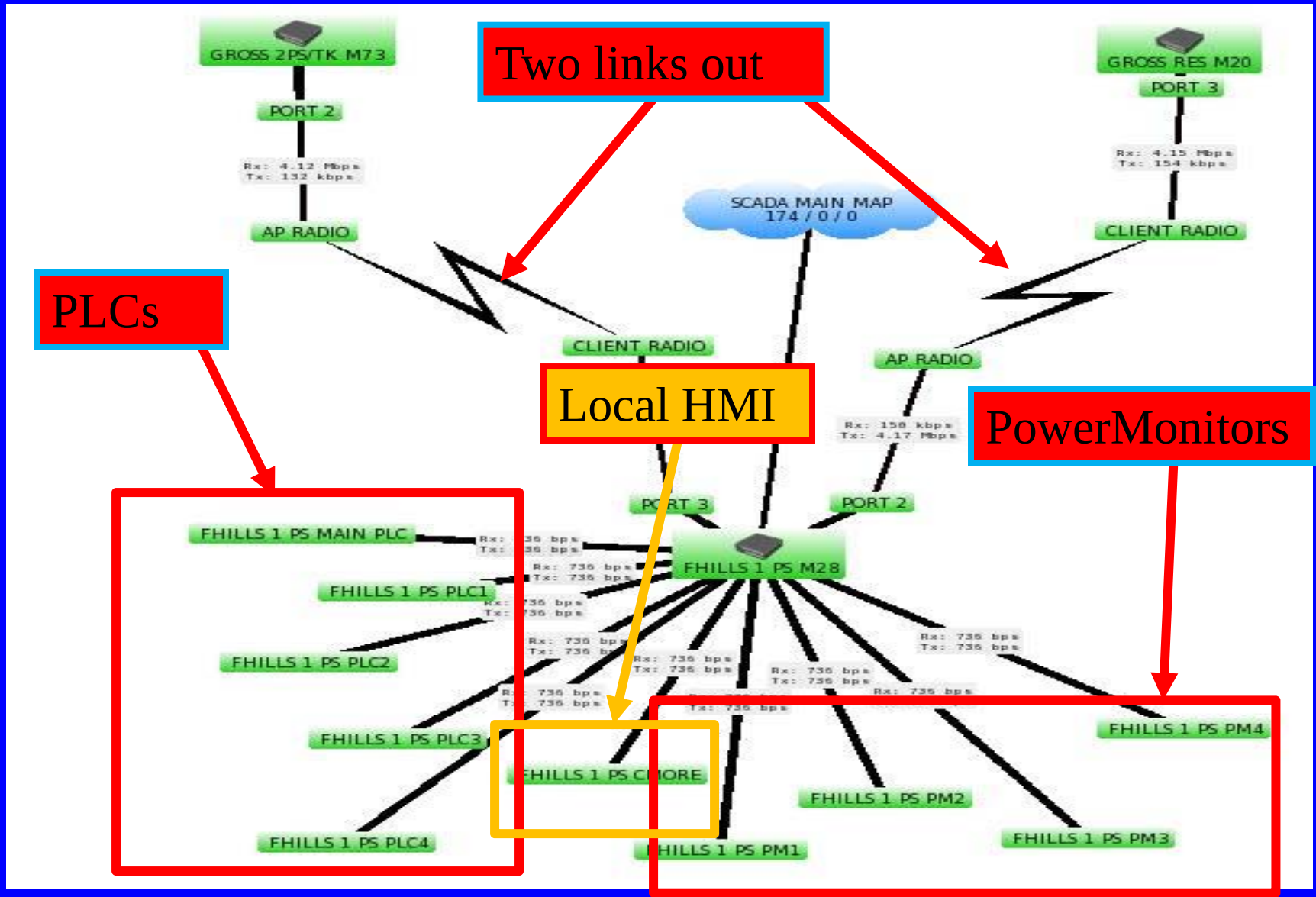


SCADA Network

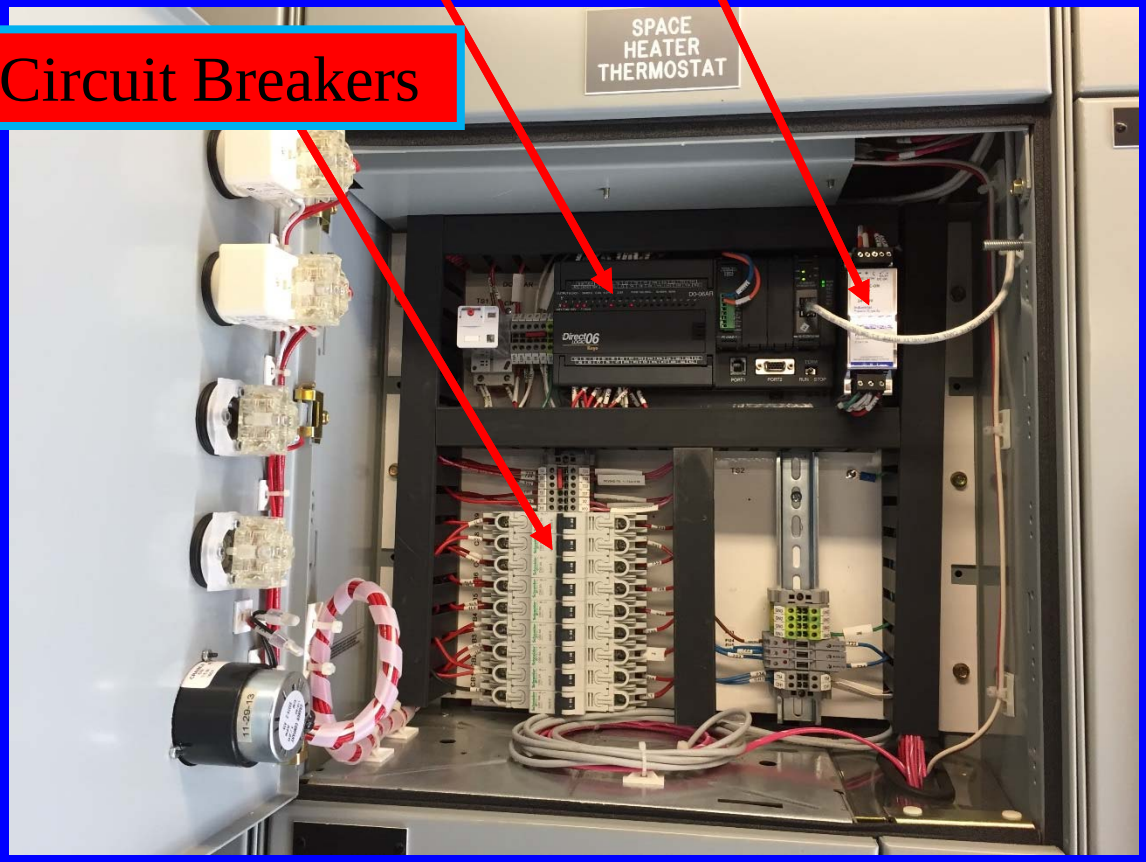
Cloud icon → link to LAN

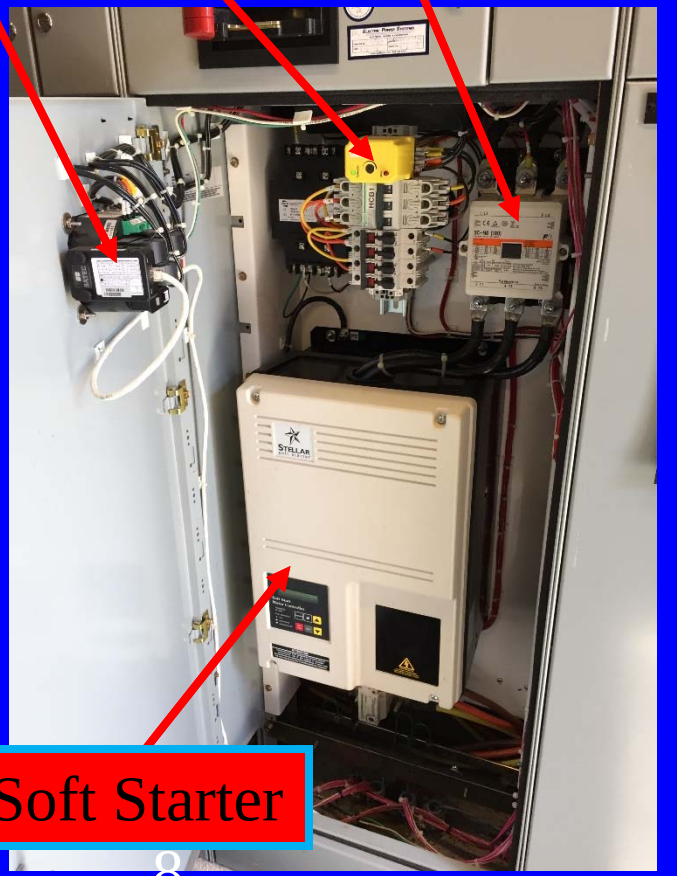


Local Area Network (LAN)



Typical Pump Control Circuits





PLC

24VDC PS

Power monitor

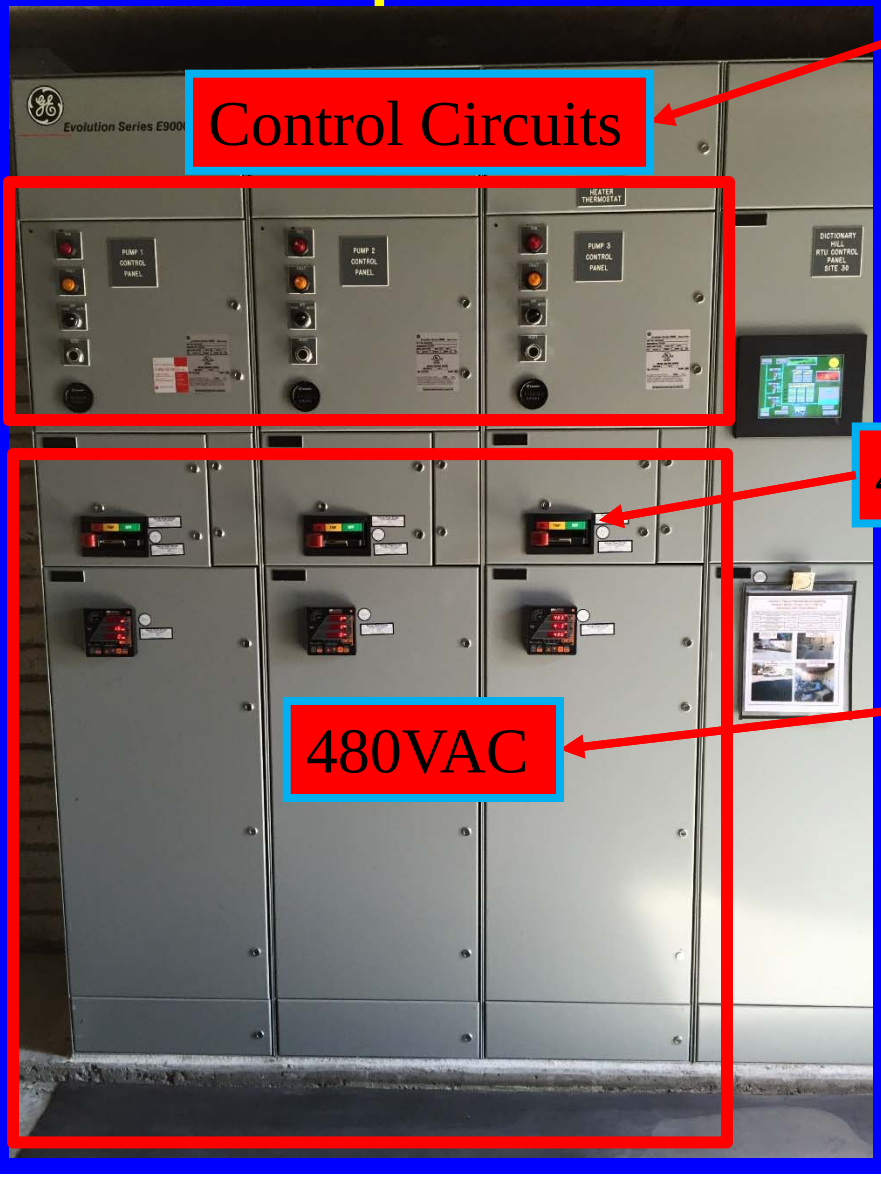
PFR

In-line Starter

Circuit Breakers

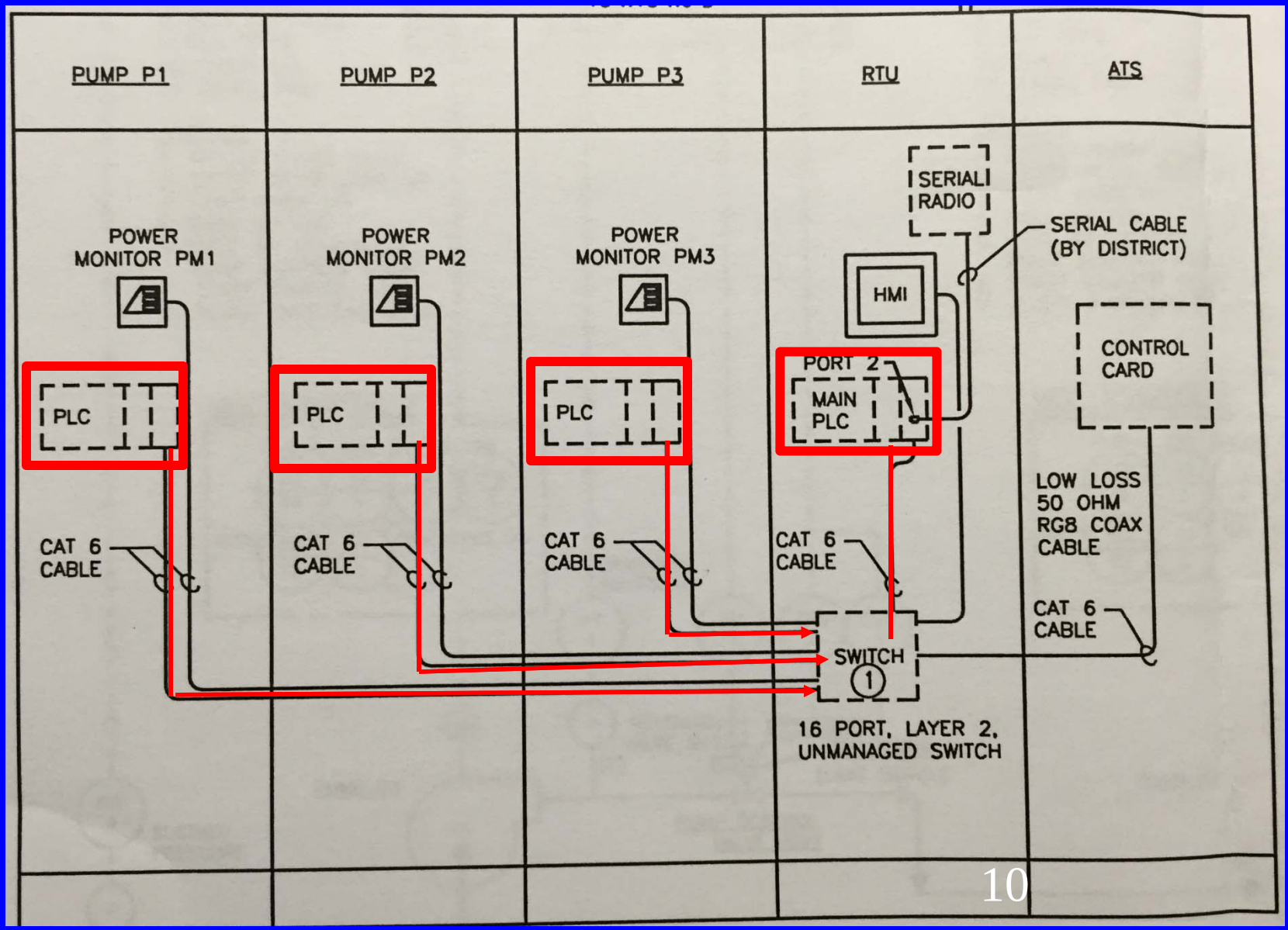
Soft Starter

Reduces Arc Flash Requirements

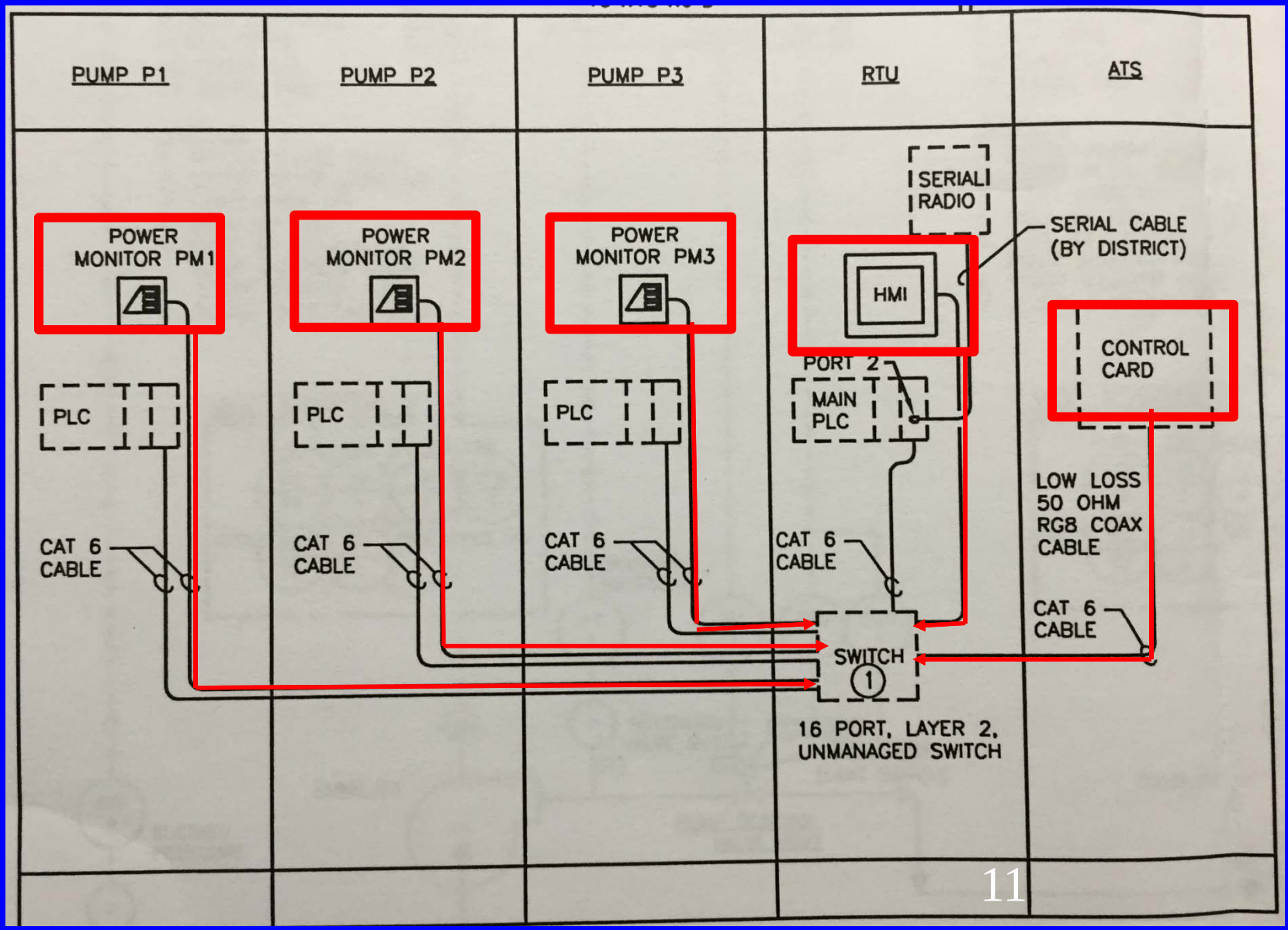


PLC (120Vac or 24 Vdc)

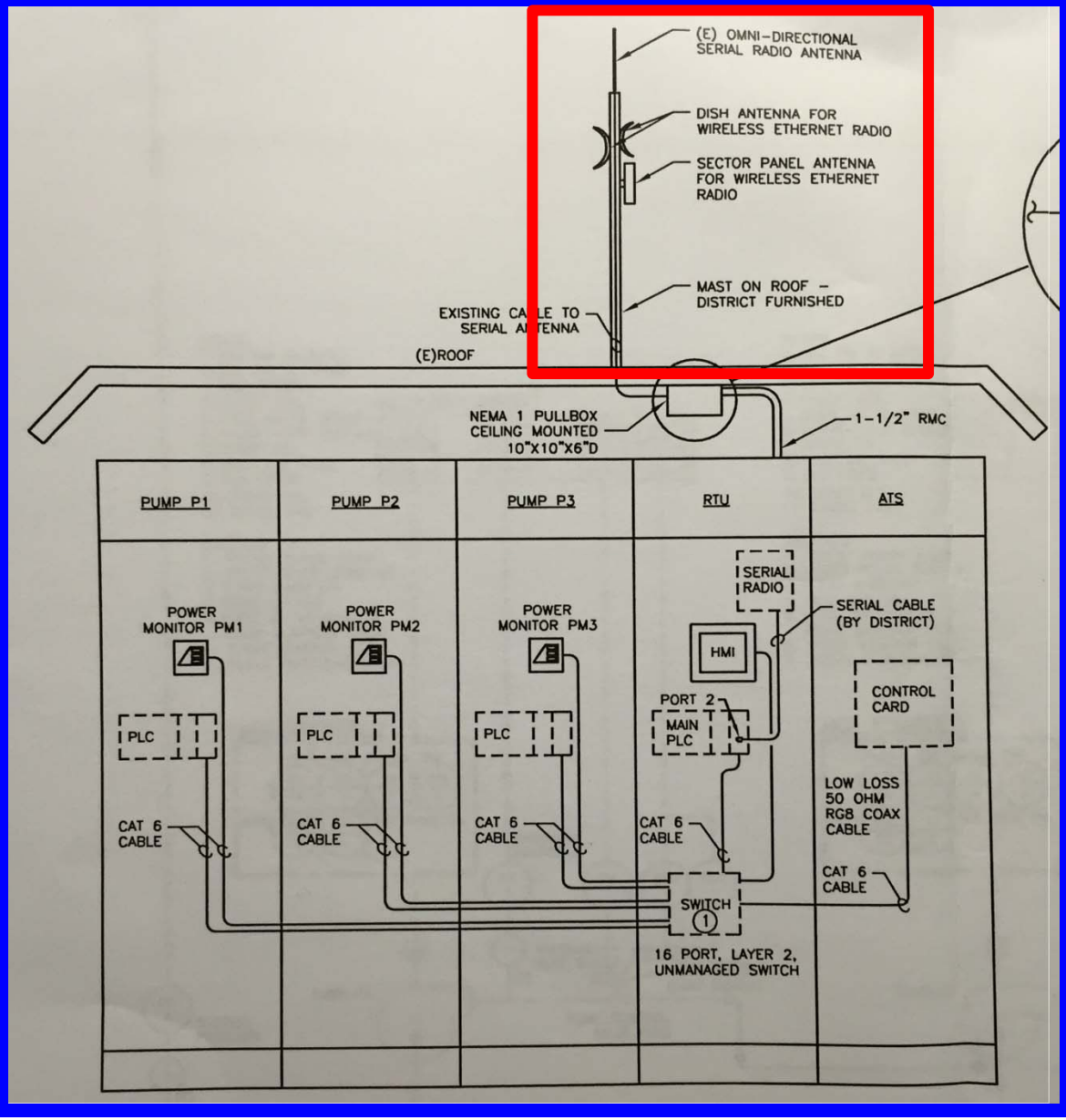
Ethernet Communication



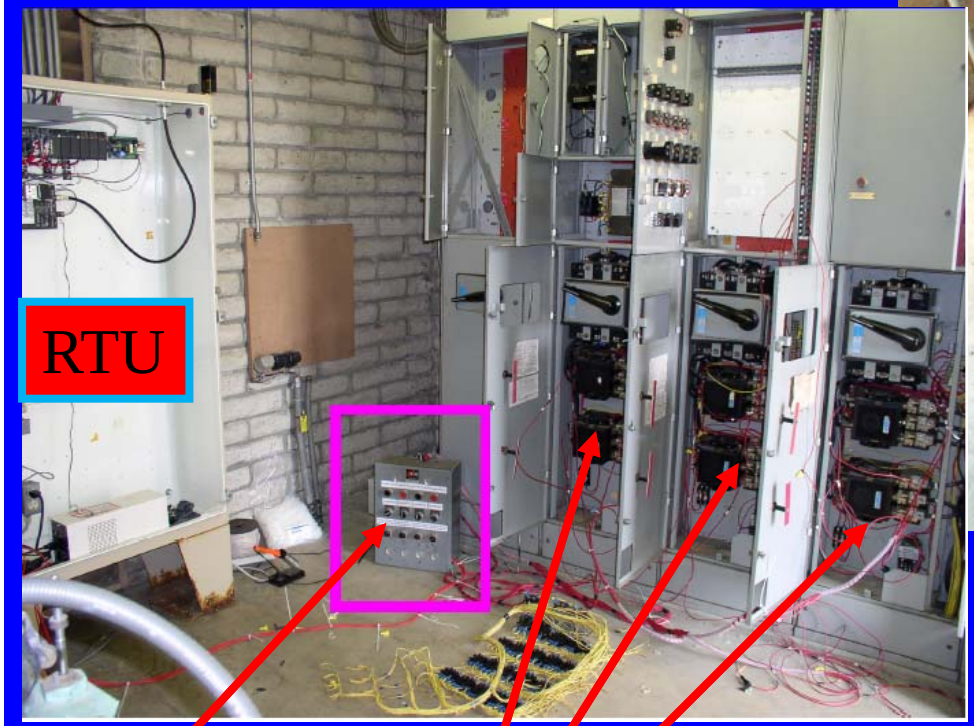
Ethernet Communication

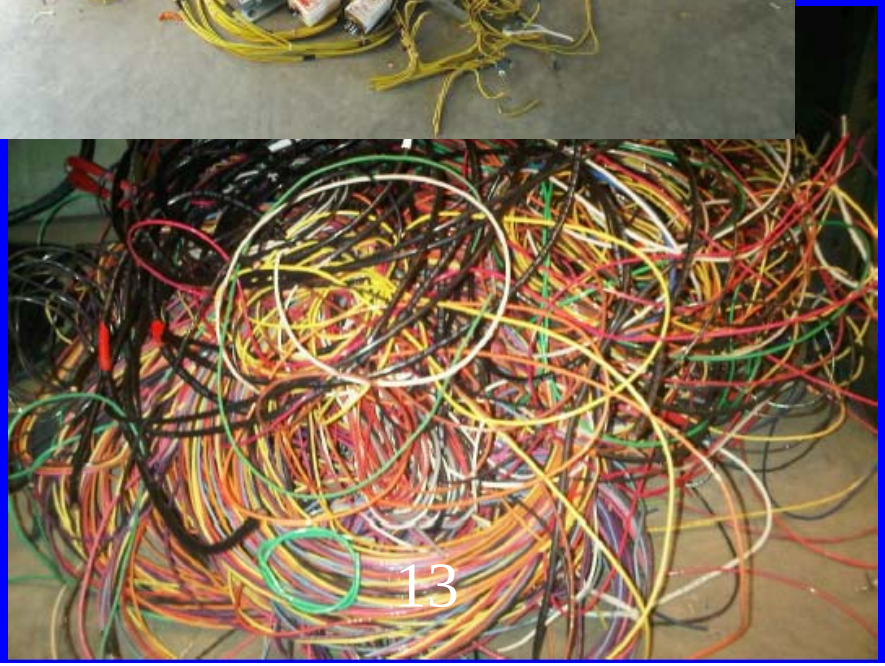


Ethernet Communication



PLC installation eliminated hardwires and relays.

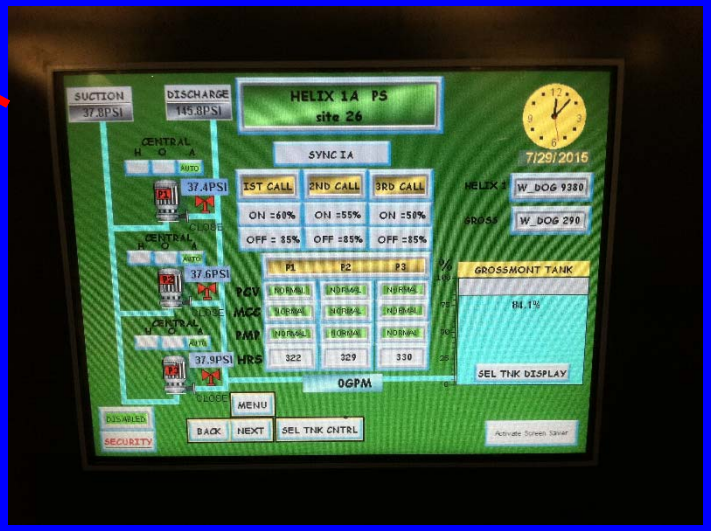




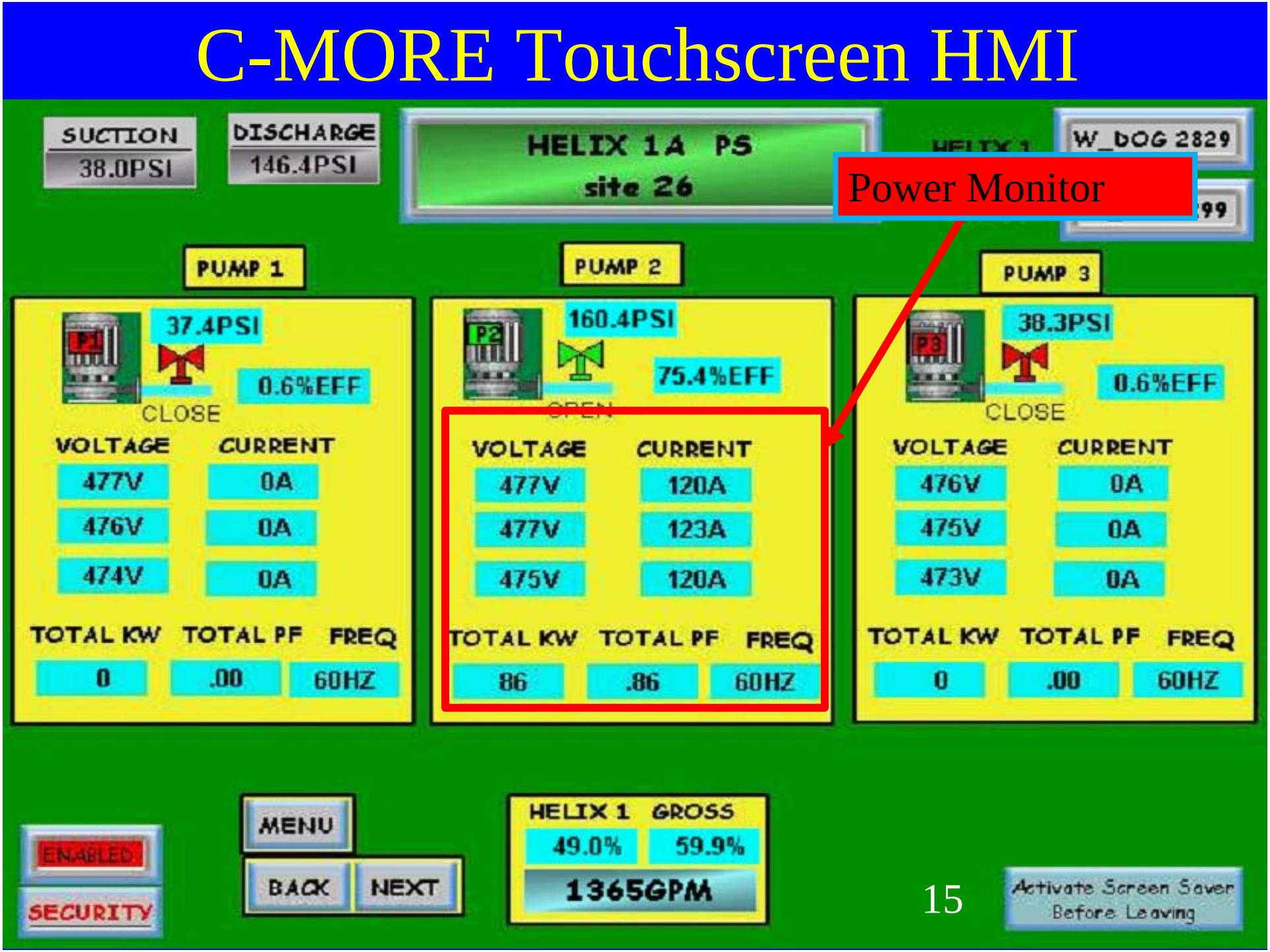
New and Upgraded MCCs.

Power Monitor

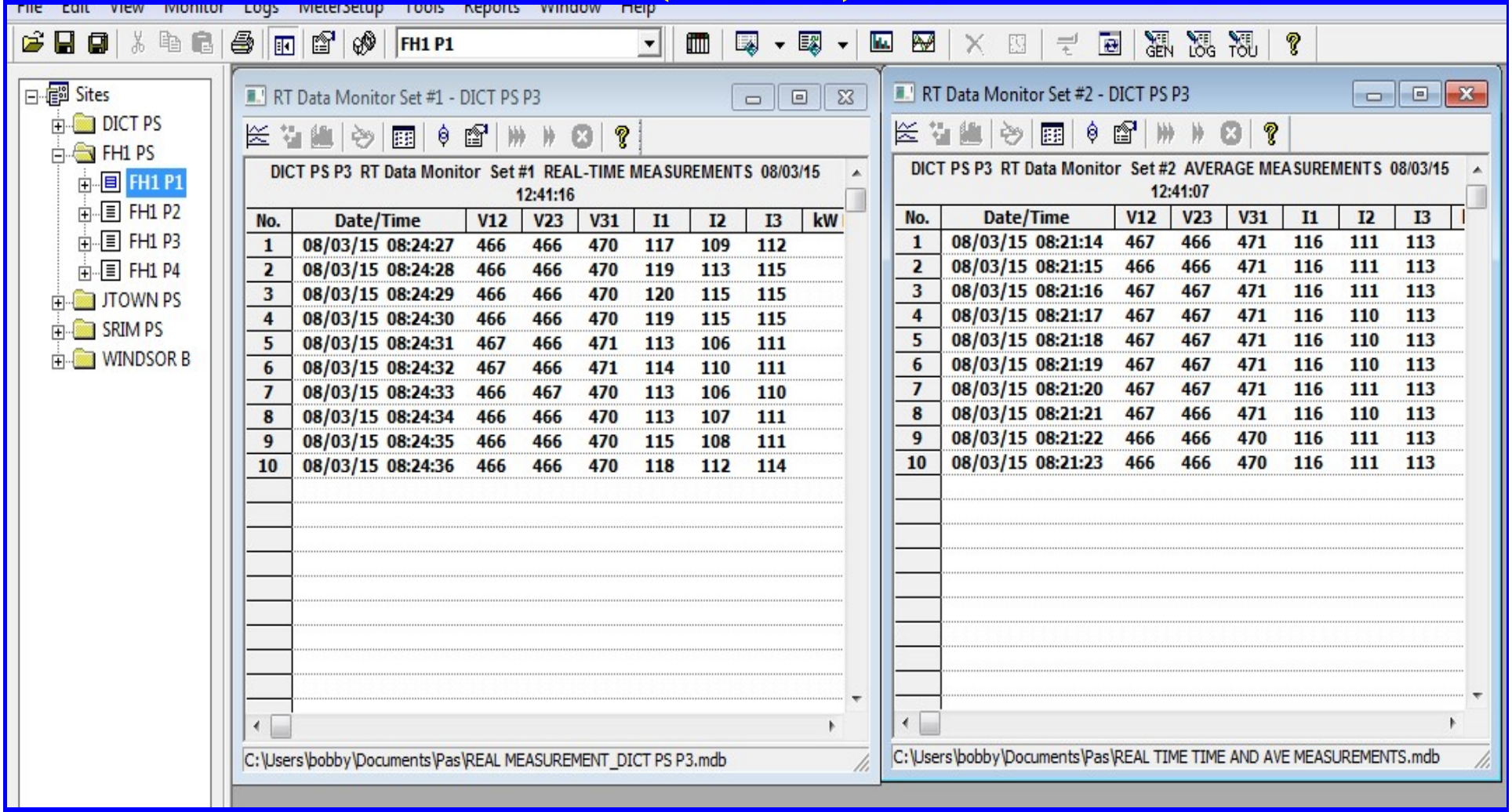
C-MORE HMI



C-MORE Touchscreen HMI



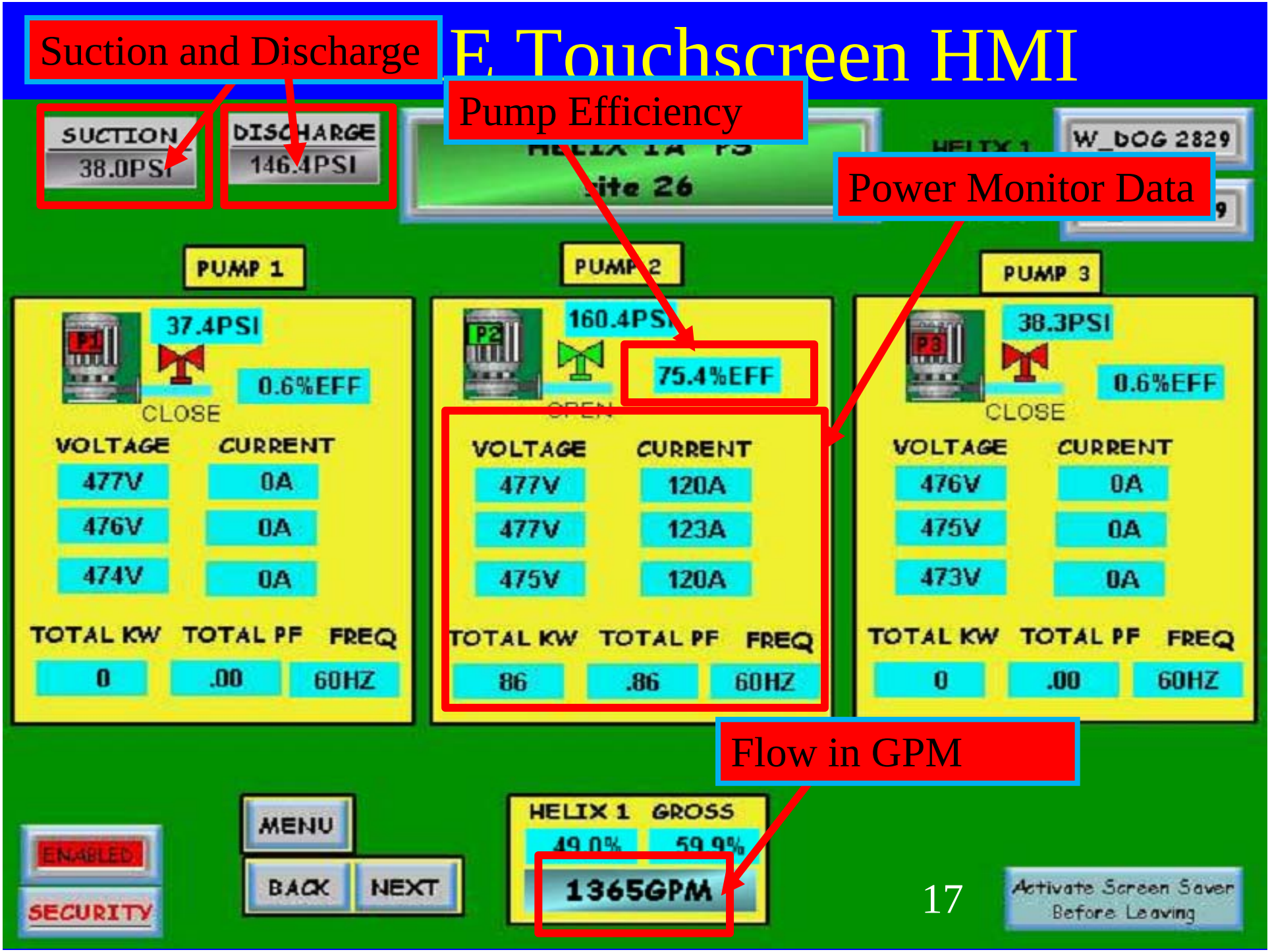
Power Monitor Web browser (PAS)



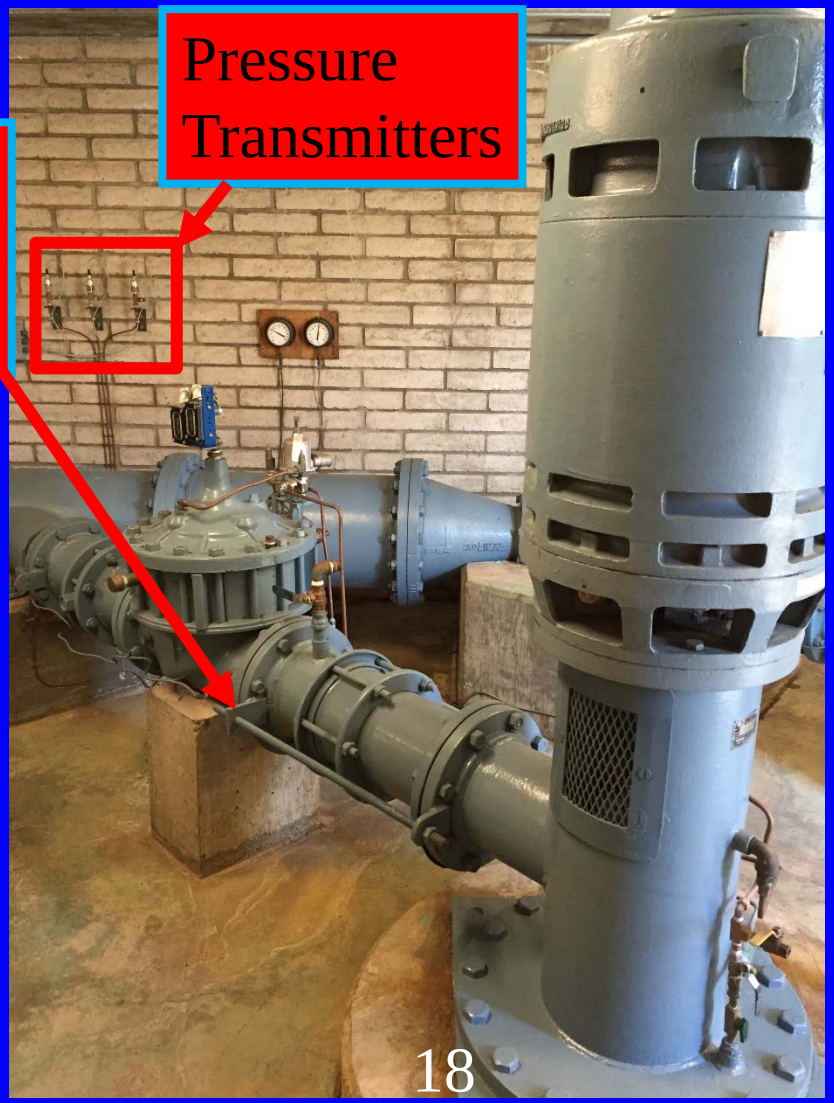
No.	Date/Time	V12	V23	V31	I1	I2	I3	kW
1	08/03/15 08:24:27	466	466	470	117	109	112	
2	08/03/15 08:24:28	466	466	470	119	113	115	
3	08/03/15 08:24:29	466	466	470	120	115	115	
4	08/03/15 08:24:30	466	466	470	119	115	115	
5	08/03/15 08:24:31	467	466	471	113	106	111	
6	08/03/15 08:24:32	467	466	471	114	110	111	
7	08/03/15 08:24:33	466	467	470	113	106	110	
8	08/03/15 08:24:34	466	466	470	113	107	111	
9	08/03/15 08:24:35	466	466	470	115	108	111	
10	08/03/15 08:24:36	466	466	470	118	112	114	

No.	Date/Time	V12	V23	V31	I1	I2	I3
1	08/03/15 08:21:14	467	466	471	116	111	113
2	08/03/15 08:21:15	466	466	471	116	111	113
3	08/03/15 08:21:16	467	467	471	116	111	113
4	08/03/15 08:21:17	467	467	471	116	110	113
5	08/03/15 08:21:18	467	467	471	116	110	113
6	08/03/15 08:21:19	467	467	471	116	110	113
7	08/03/15 08:21:20	467	467	471	116	111	113
8	08/03/15 08:21:21	467	466	471	116	110	113
9	08/03/15 08:21:22	466	466	470	116	111	113
10	08/03/15 08:21:23	466	466	470	116	111	113

E Touchscreen HMI

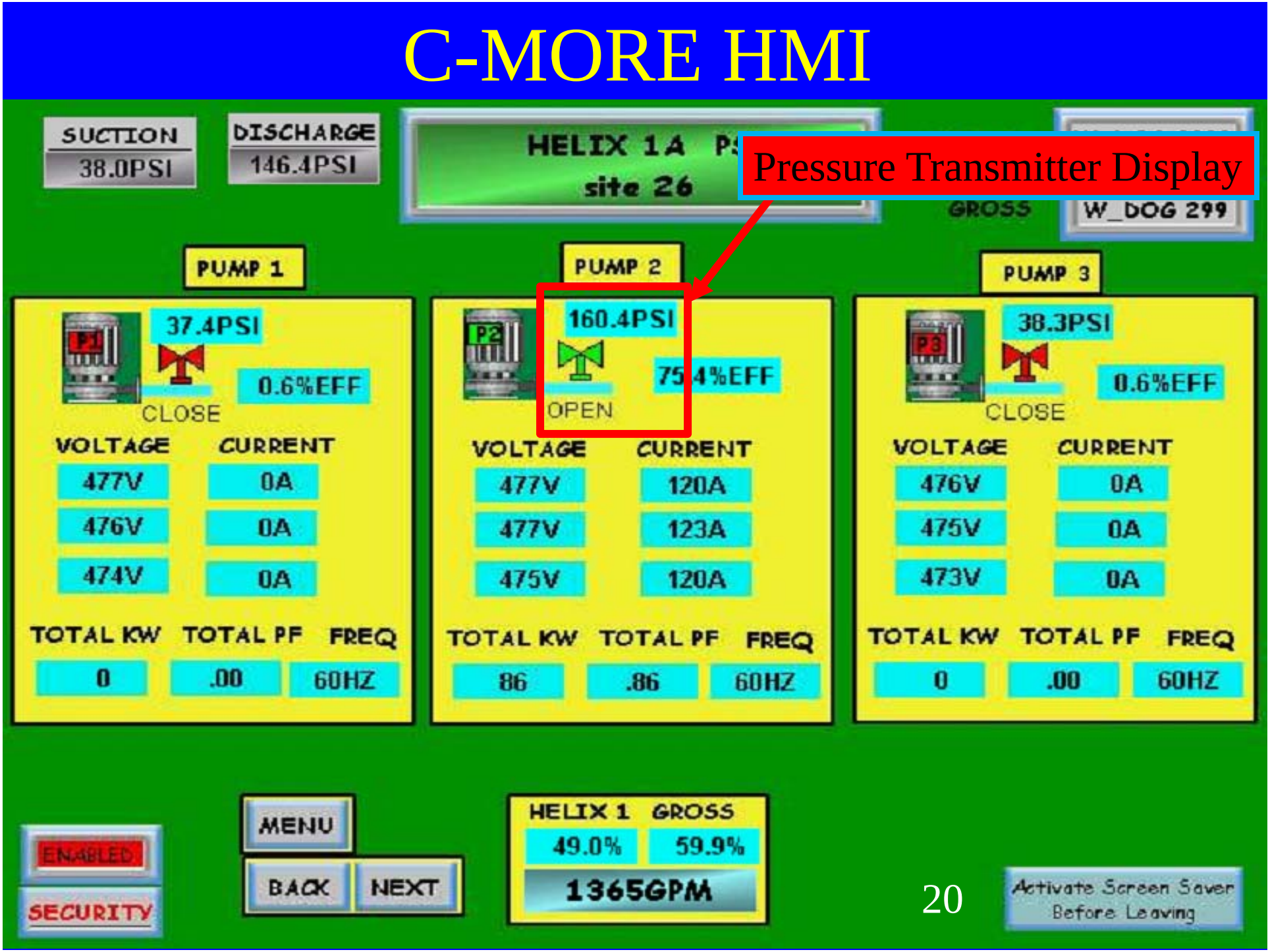


Pressure Transmitter for Run Status instead of Pressure Sw

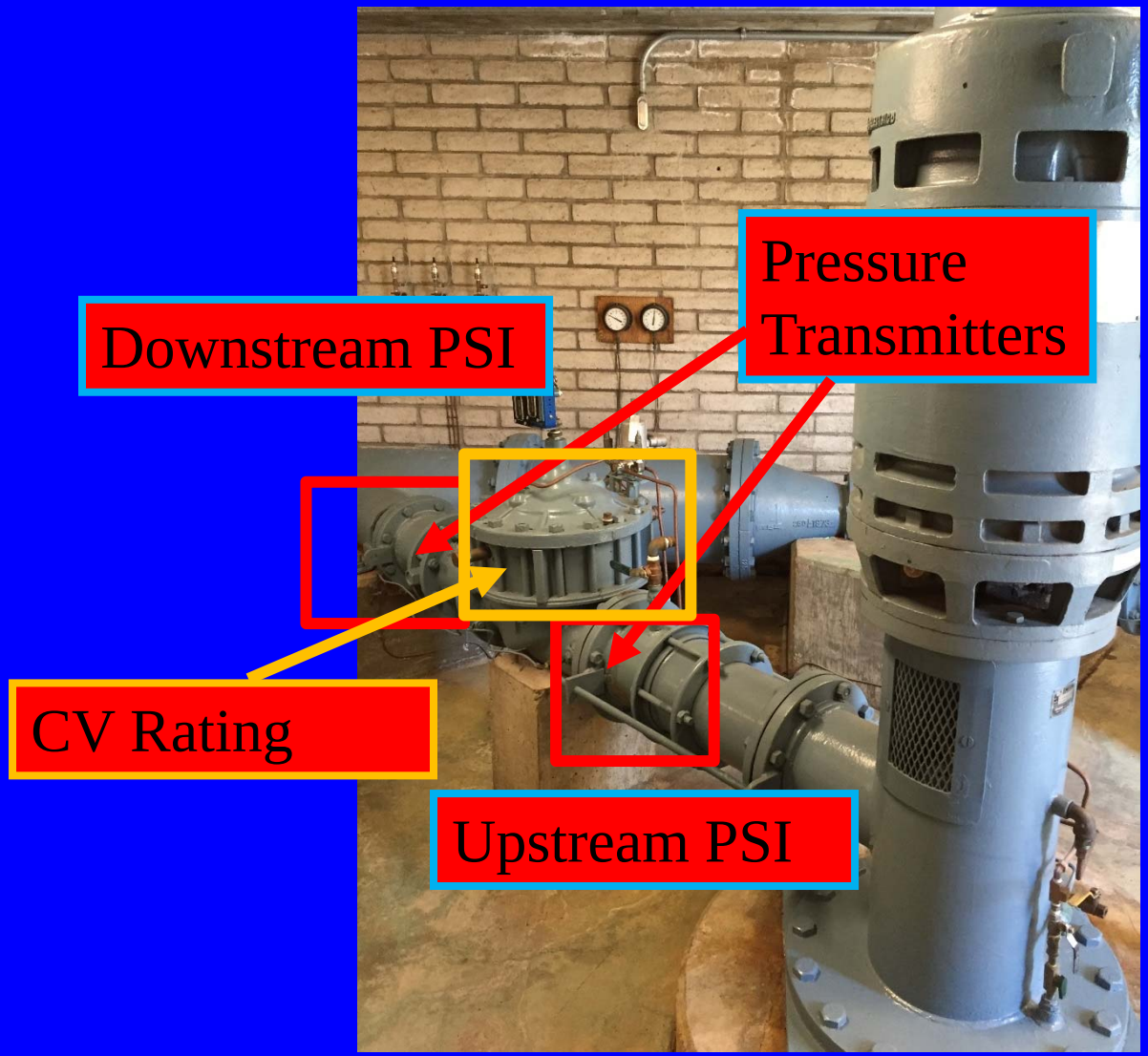


Blind Pressure Transmitter no moving parts and contacts to corrode.

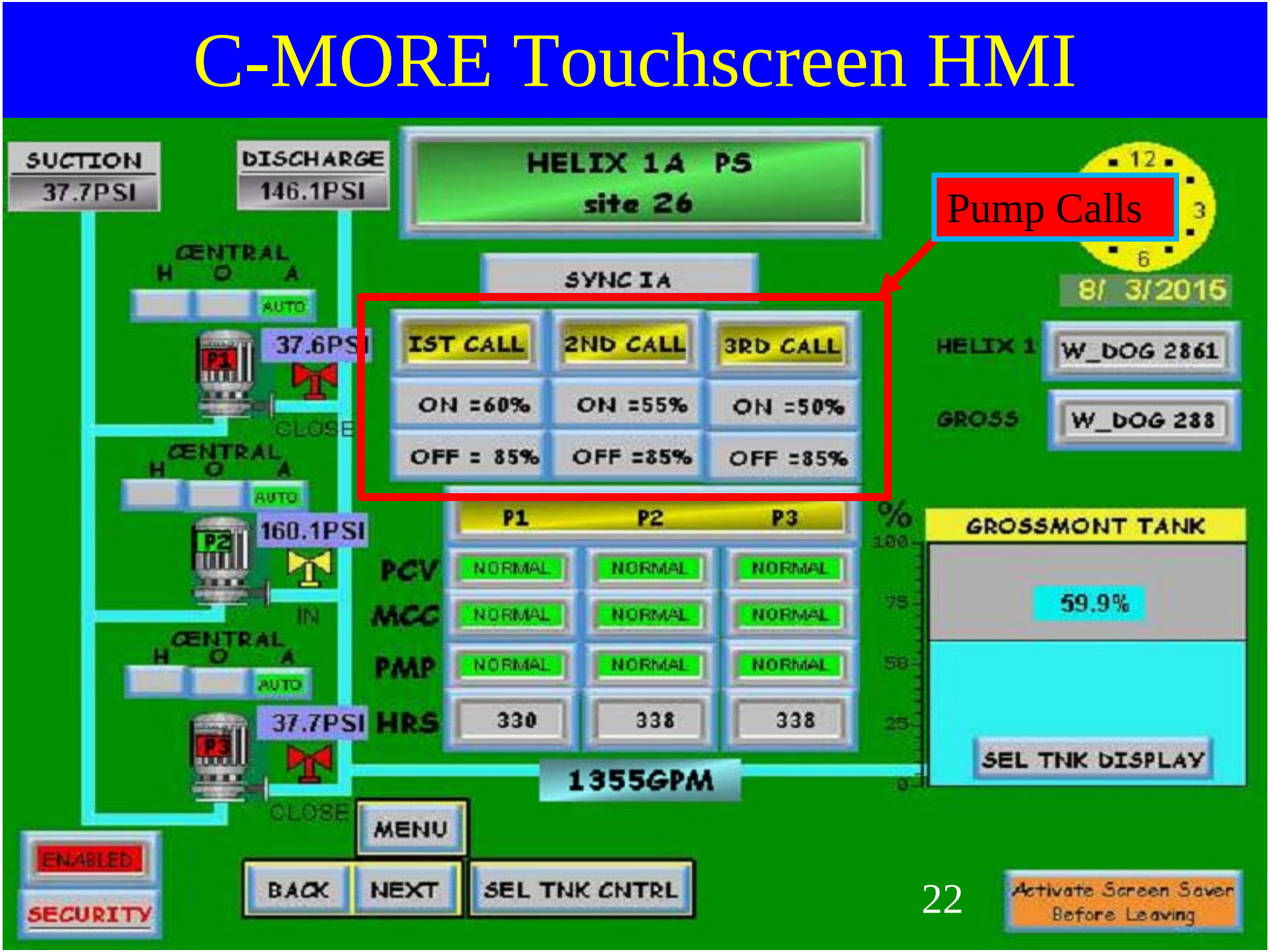
C-MORE HMI


SUCTION
38.0PSI
DISCHARGE
146.4PSI
HELIX 1A
site 26
GROSS
W_DOG 299
Pressure Transmitter Display
PUMP 1
37.4PSI
0.6%EFF
CLOSE
VOLTAGE
CURRENT
477V
0A
476V
0A
474V
0A
TOTAL KW
TOTAL PF
FREQ
0
.00
60HZ
PUMP 2
160.4PSI
75.4%EFF
OPEN
VOLTAGE
CURRENT
477V
120A
477V
123A
475V
120A
TOTAL KW
TOTAL PF
FREQ
86
.86
60HZ
PUMP 3
38.3PSI
0.6%EFF
CLOSE
VOLTAGE
CURRENT
476V
0A
475V
0A
473V
0A
TOTAL KW
TOTAL PF
FREQ
0
.00
60HZ
ENABLED
SECURITY
MENU
BACK
NEXT
HELIX 1 GROSS
49.0%
59.9%
1365GPM
Activate Screen Saver
Before Leaving

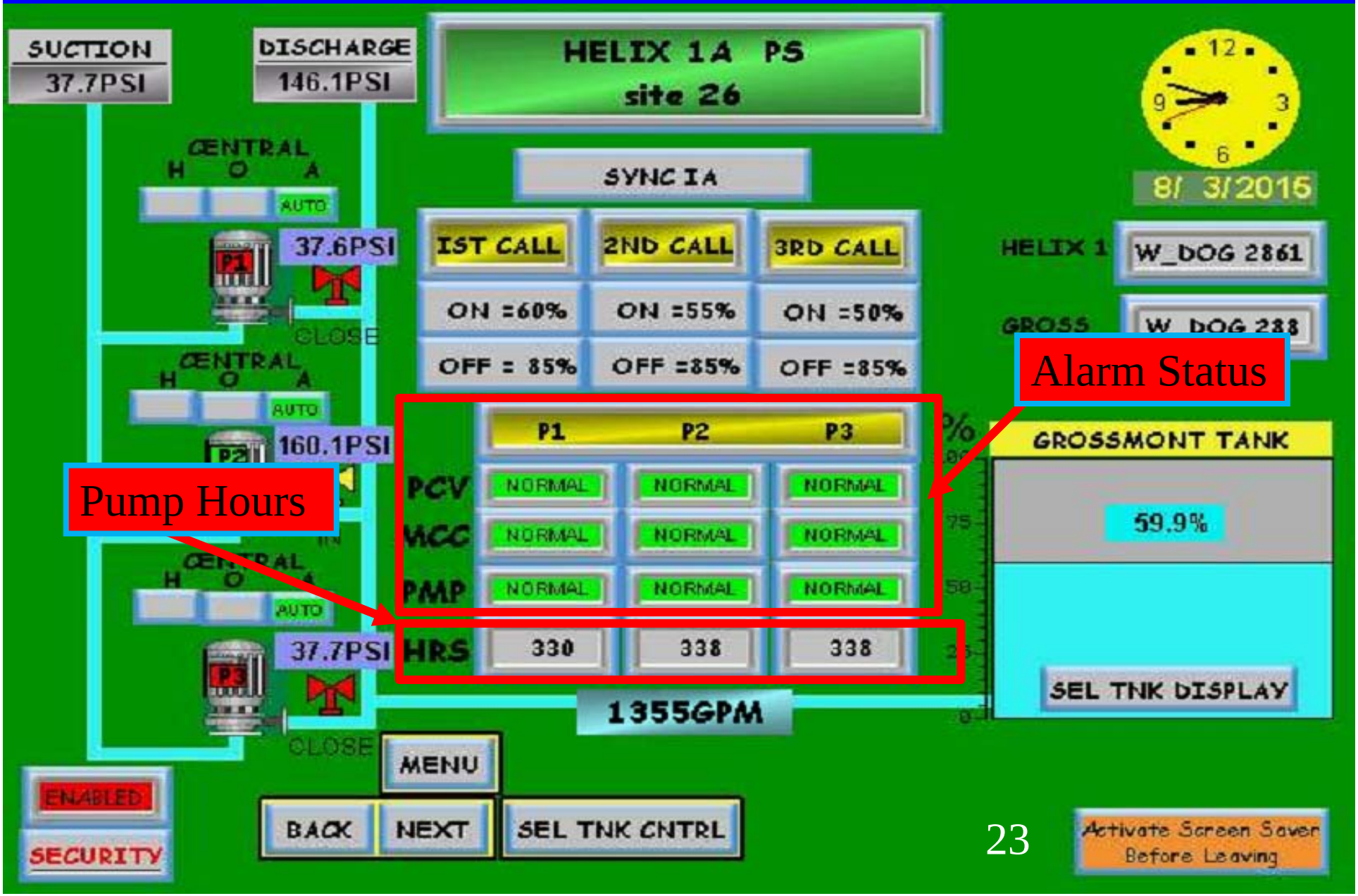
PLC logic Flow calculation using Q=CV rating X SQRT PSI diff



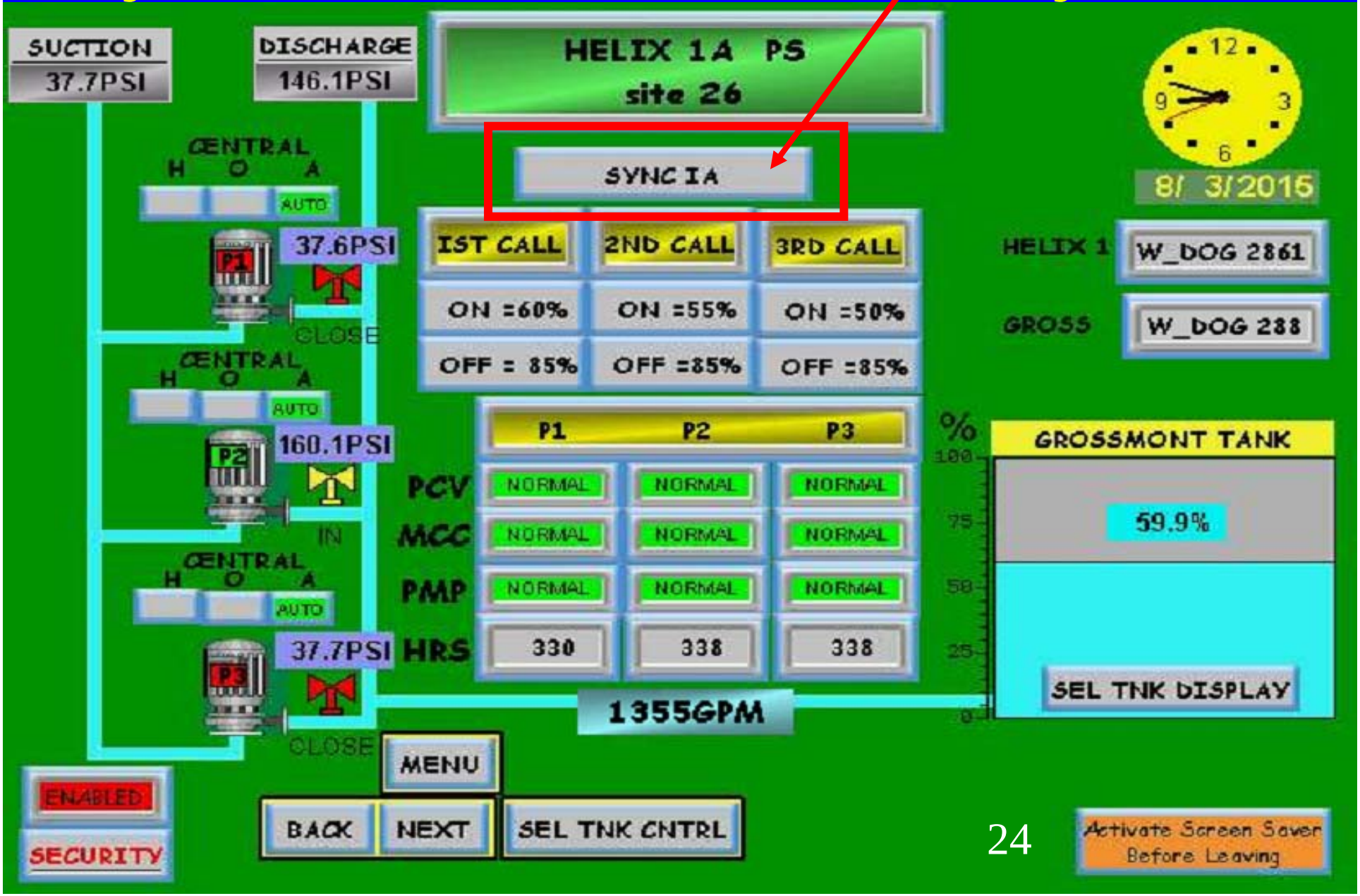
C-MORE Touchscreen HMI



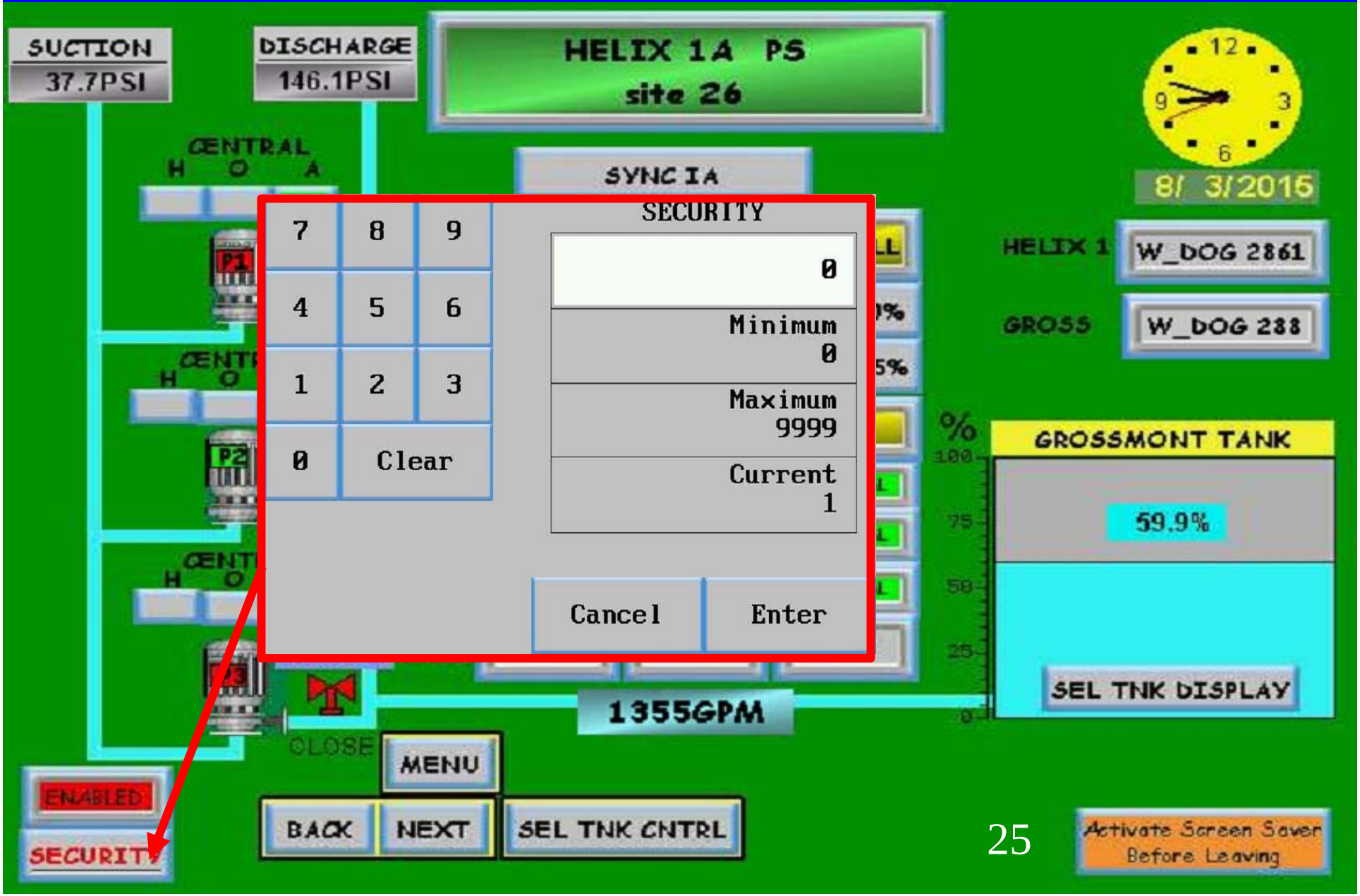
C-MORE Touchscreen HMI

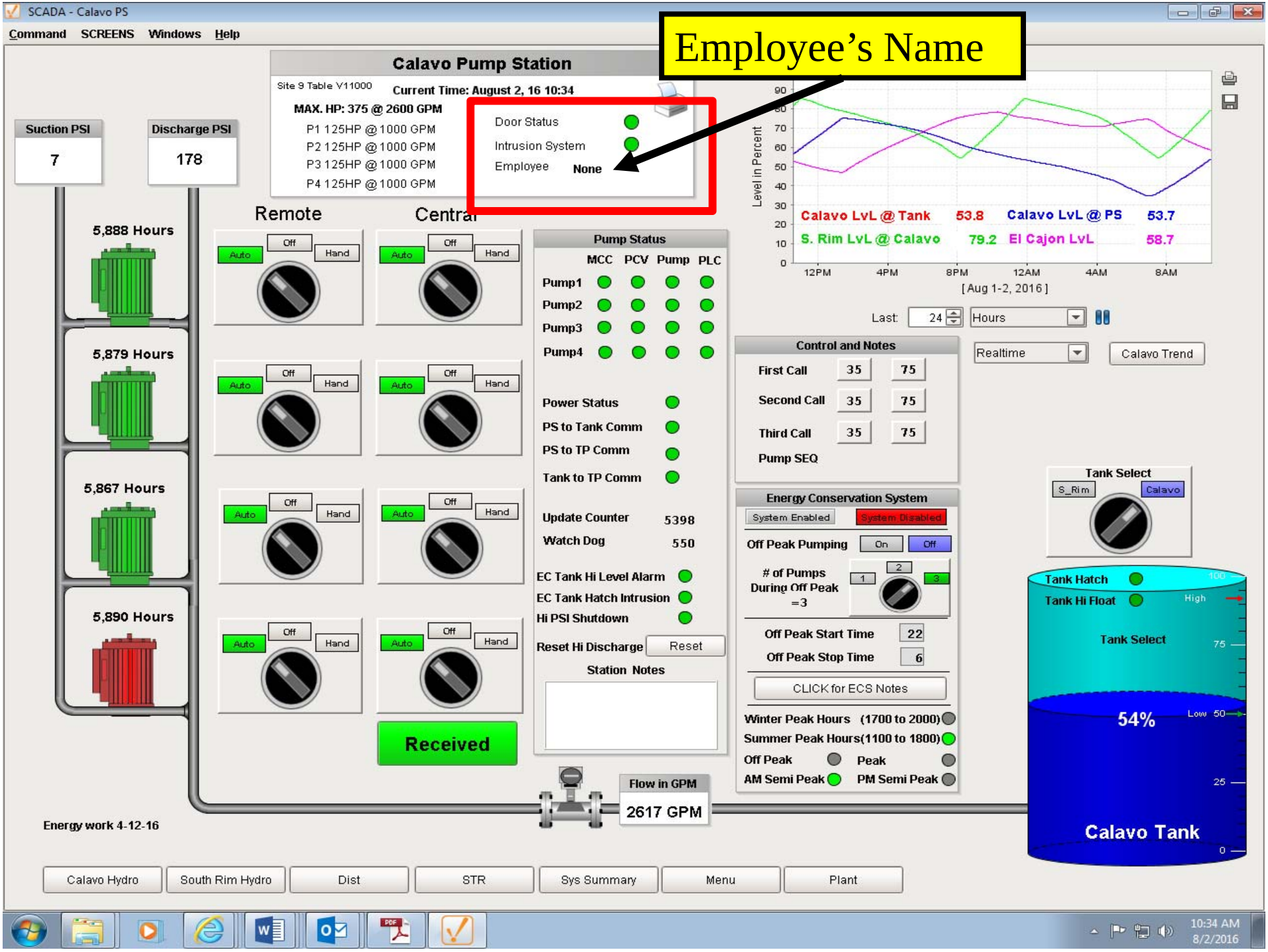


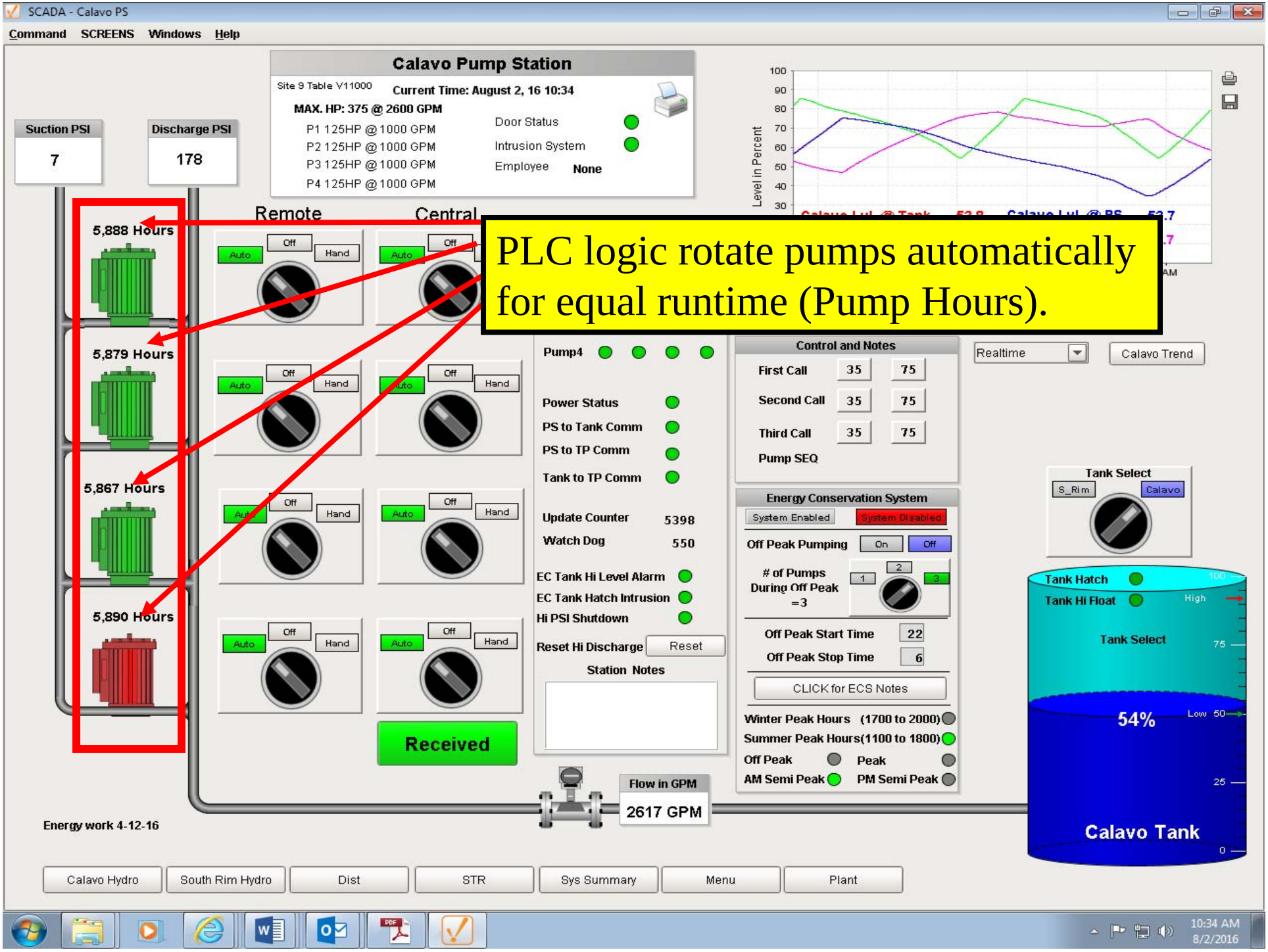
Synchronize Main SCADA System



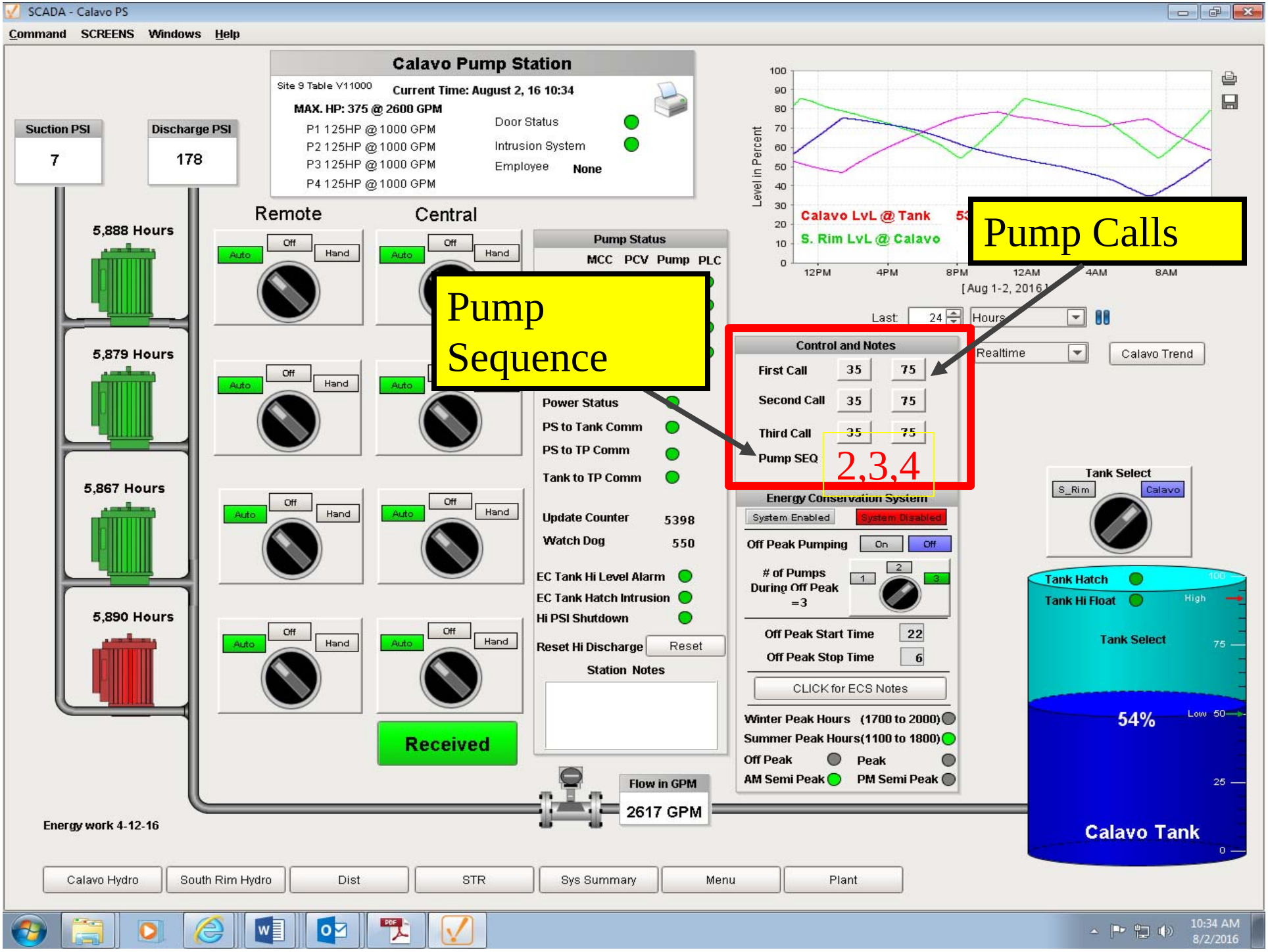
Security Keypad




SCADA - Calavo PS
Command SCREENS Windows Help
Employee's Name
Calavo Pump Station
Site 9 Table V11000
Current Time: August 2, 16 10:34
MAX. HP: 375 @ 2600 GPM
P1 125HP @1000 GPM
P2 125HP @1000 GPM
P3 125HP @1000 GPM
P4 125HP @1000 GPM
Door Status
Intrusion System
Employee None
Suction PSI
7
Discharge PSI
178
5,888 Hours
5,879 Hours
5,867 Hours
5,890 Hours
Remote
Central
Auto
Off
Hand
Pump Status
MCC PCV Pump PLC
Pump1
Pump2
Pump3
Pump4
Power Status
PS to Tank Comm
PS to TP Comm
Tank to TP Comm
Update Counter 5398
Watch Dog 550
EC Tank Hi Level Alarm
EC Tank Hatch Intrusion
Hi PSI Shutdown
Reset Hi Discharge
Reset
Station Notes
Received
Level in Percent
Calavo LvL @ Tank 53.8
Calavo LvL @ PS 53.7
S. Rim LvL @ Calavo 79.2
El Cajon LvL 58.7
12PM 4PM 8PM 12AM 4AM 8AM
[Aug 1-2, 2016]
Last: 24 Hours
Realtime
Calavo Trend
Control and Notes
First Call 35 75
Second Call 35 75
Third Call 35 75
Pump SEQ
Energy Conservation System
System Enabled
System Disabled
Off Peak Pumping On Off
# of Pumps During Off Peak =3
Off Peak Start Time 22
Off Peak Stop Time 6
CLICK for ECS Notes
Winter Peak Hours (1700 to 2000)
Summer Peak Hours(1100 to 1800)
Off Peak
Peak
AM Semi Peak
PM Semi Peak
Tank Select
S_Rim
Calavo
Tank Hatch
Tank Hi Float
High
Tank Select
54%
Low 50
Calavo Tank
Flow in GPM
2617 GPM
Energy work 4-12-16
Calavo Hydro
South Rim Hydro
Dist
STR
Sys Summary
Menu
Plant
10:34 AM
8/2/2016



PLC logic rotate pumps automatically for equal runtime (Pump Hours).


SCADA - Calavo PS
Command SCREENS Windows Help
Calavo Pump Station
Site 9 Table V11000
Current Time: August 2, 16 10:34
MAX. HP: 375 @ 2600 GPM
P1 125HP @1000 GPM
P2 125HP @1000 GPM
P3 125HP @1000 GPM
P4 125HP @1000 GPM
Door Status
Intrusion System
Employee None
Suction PSI
7
Discharge PSI
178
5,888 Hours
5,879 Hours
5,867 Hours
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Remote
Central
Auto
Off
Hand
Received
Pump Status
MCC PCV Pump PLC
Power Status
PS to Tank Comm
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Tank to TP Comm
Update Counter 5398
Watch Dog 550
EC Tank Hi Level Alarm
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Station Notes
Flow in GPM
2617 GPM
Level in Percent
Calavo LvL @ Tank
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12PM 4PM 8PM 12AM 4AM 8AM
[Aug 1-2, 2016]
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Calavo Trend
Pump Calls
Pump Sequence
Control and Notes
First Call 35 75
Second Call 35 75
Third Call 35 75
Pump SEQ 2,3,4
Energy Conservation System
System Enabled
System Disabled
Off Peak Pumping On Off
# of Pumps During Off Peak =3
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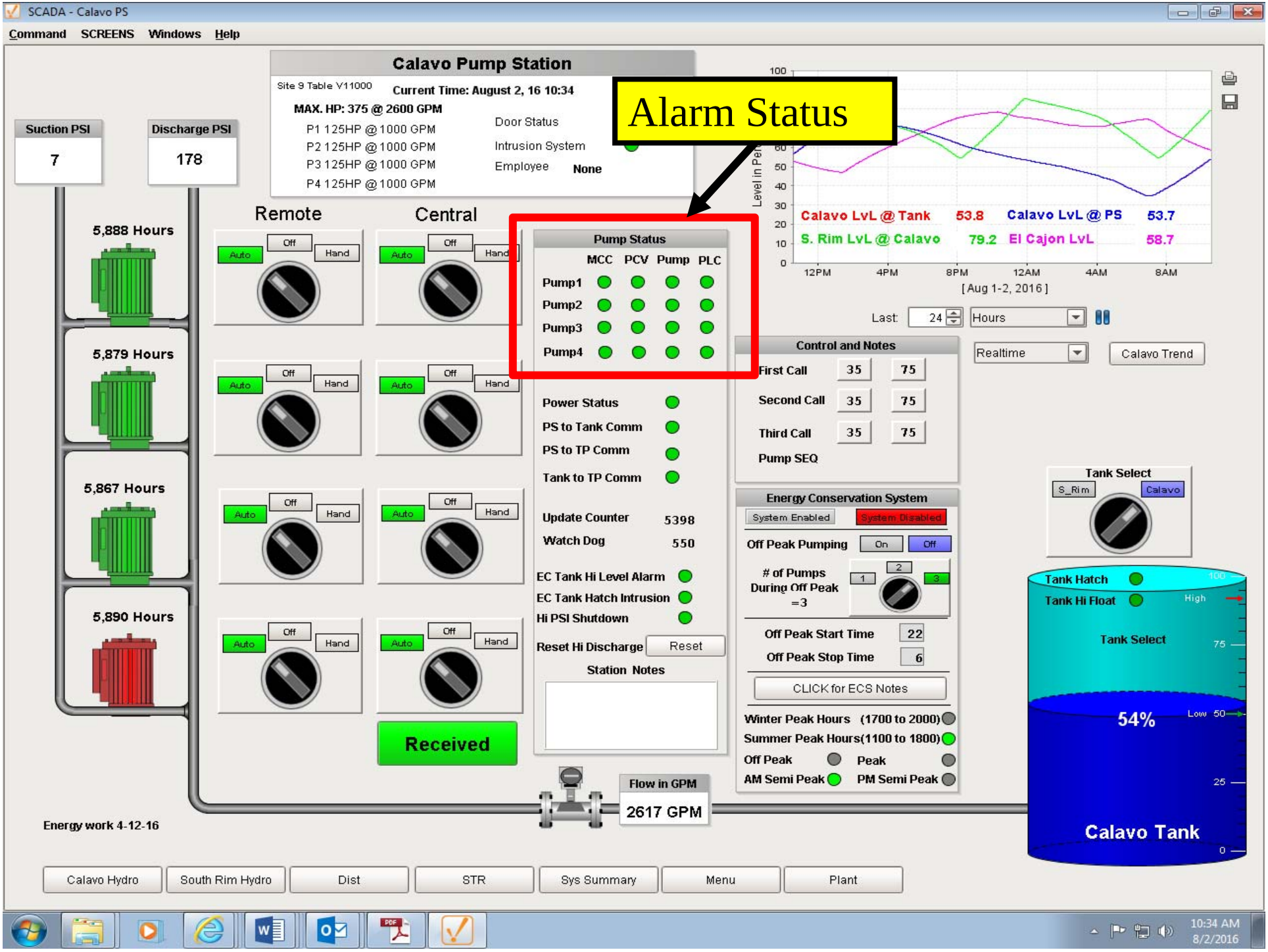
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Door Status
Intrusion System
Employee None
Alarm Status
Suction PSI
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5,888 Hours
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10:34 AM
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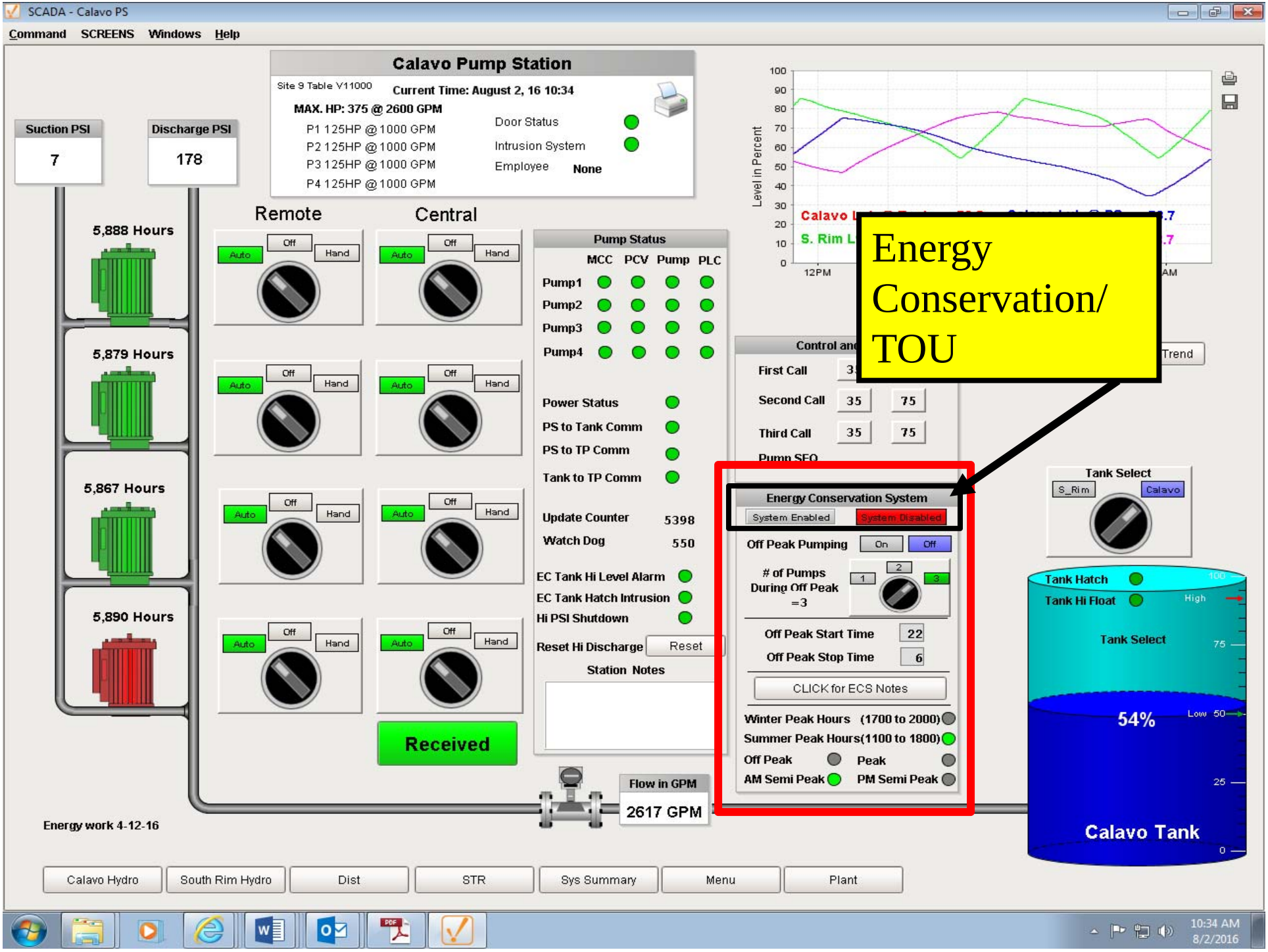
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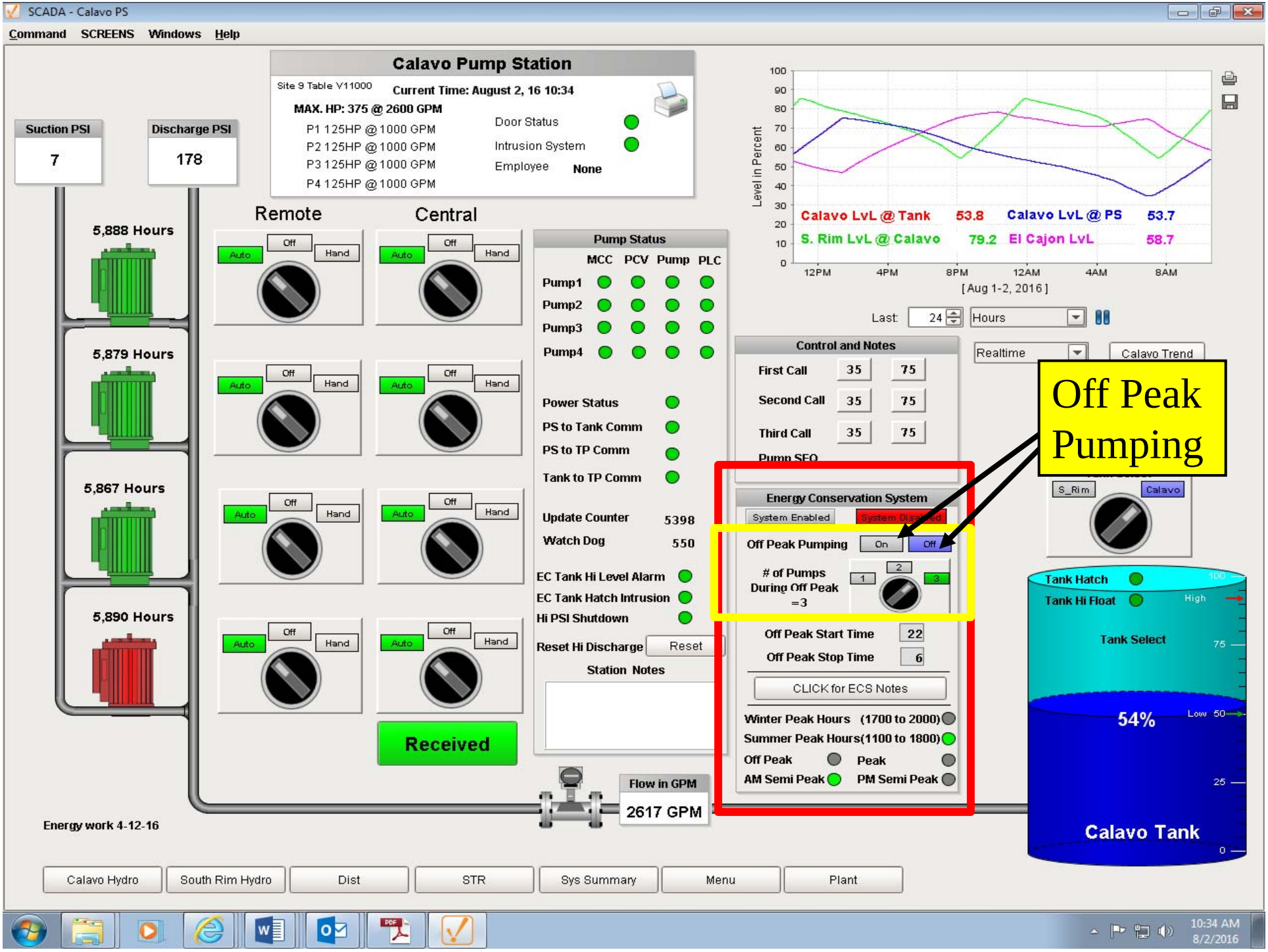
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System Disabled
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Calavo Tank
Energy work 4-12-16
Calavo Hydro
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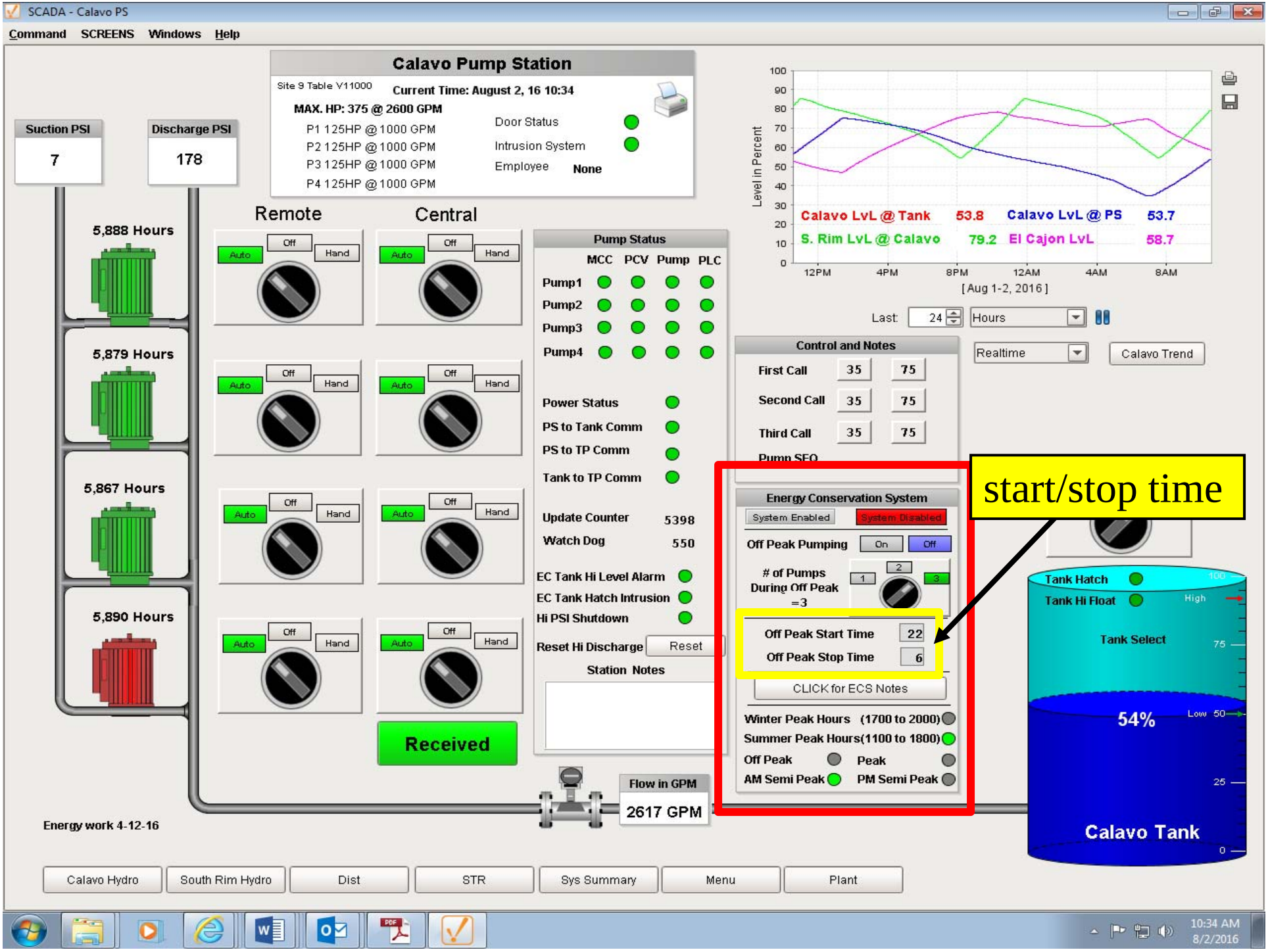
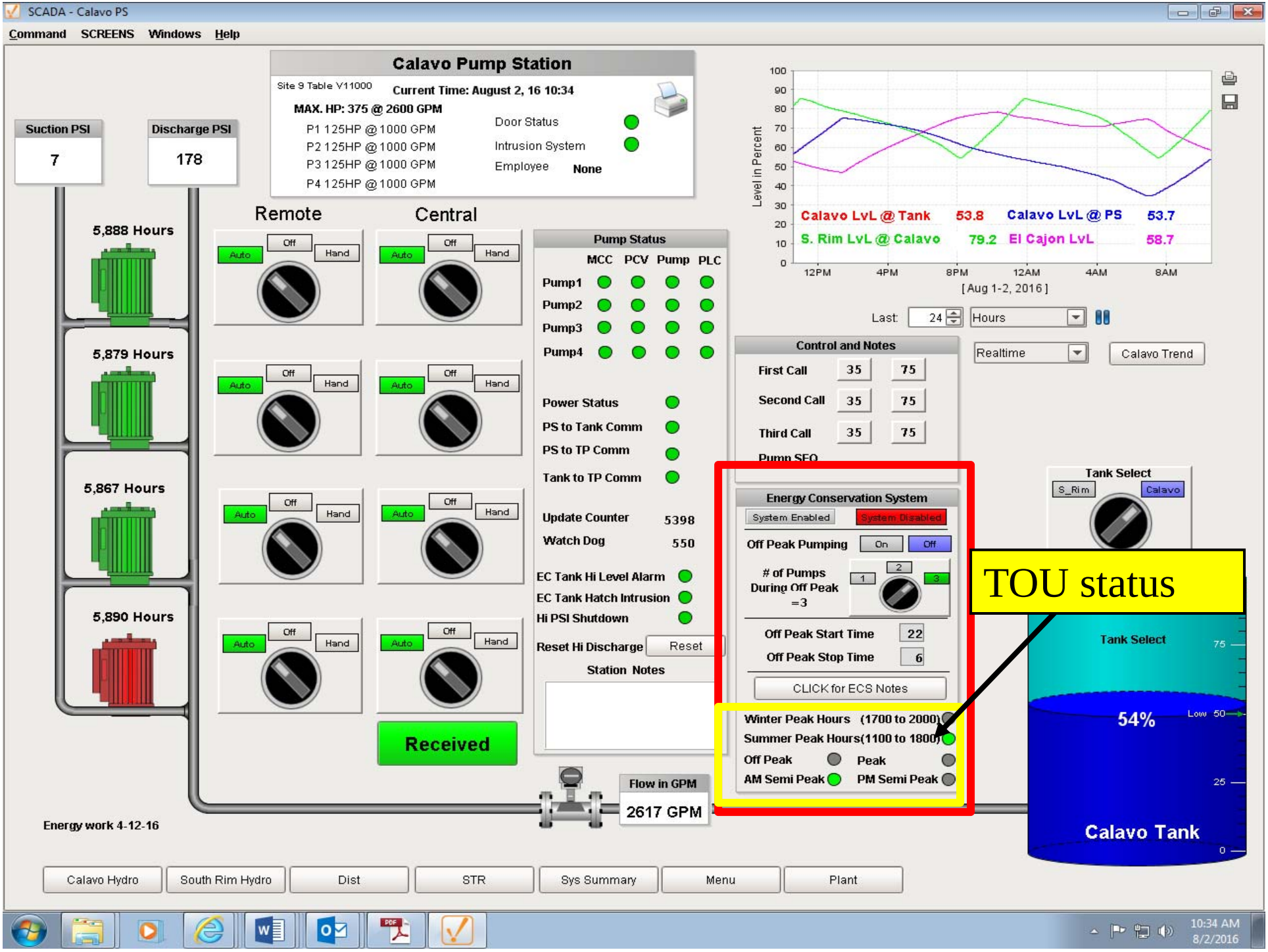
10:34 AM
8/2/2016


SCADA - Calavo PS
Command SCREENS Windows Help
Calavo Pump Station
Site 9 Table V11000
Current Time: August 2, 16 10:34
MAX. HP: 375 @ 2600 GPM
P1 125HP @1000 GPM
P2 125HP @1000 GPM
P3 125HP @1000 GPM
P4 125HP @1000 GPM
Door Status
Intrusion System
Employee None
Suction PSI
7
Discharge PSI
178
5,888 Hours
5,879 Hours
5,867 Hours
5,890 Hours
Remote
Central
Auto
Off
Hand
Pump Status
MCC PCV Pump PLC
Pump1
Pump2
Pump3
Pump4
Power Status
PS to Tank Comm
PS to TP Comm
Tank to TP Comm
Update Counter 5398
Watch Dog 550
EC Tank Hi Level Alarm
EC Tank Hatch Intrusion
Hi PSI Shutdown
Reset Hi Discharge
Reset
Station Notes
Received
Flow in GPM
2617 GPM
Energy work 4-12-16
Level in Percent
Calavo LvL @ Tank 53.8
Calavo LvL @ PS 53.7
S. Rim LvL @ Calavo 79.2
El Cajon LvL 58.7
12PM 4PM 8PM 12AM 4AM 8AM
[Aug 1-2, 2016]
Last: 24 Hours
Realtime
Calavo Trend
Control and Notes
First Call 35 75
Second Call 35 75
Third Call 35 75
Pump SEQ
Energy Conservation System
System Enabled
System Disabled
Off Peak Pumping On Off
# of Pumps During Off Peak =3
Off Peak Start Time 22
Off Peak Stop Time 6
CLICK for ECS Notes
Winter Peak Hours (1700 to 2000)
Summer Peak Hours(1100 to 1800)
Off Peak
Peak
AM Semi Peak
PM Semi Peak
start/stop time
Tank Hatch
Tank Hi Float
Tank Select
High
Low
54%
Calavo Tank
Calavo Hydro
South Rim Hydro
Dist
STR
Sys Summary
Menu
Plant
10:34 AM
8/2/2016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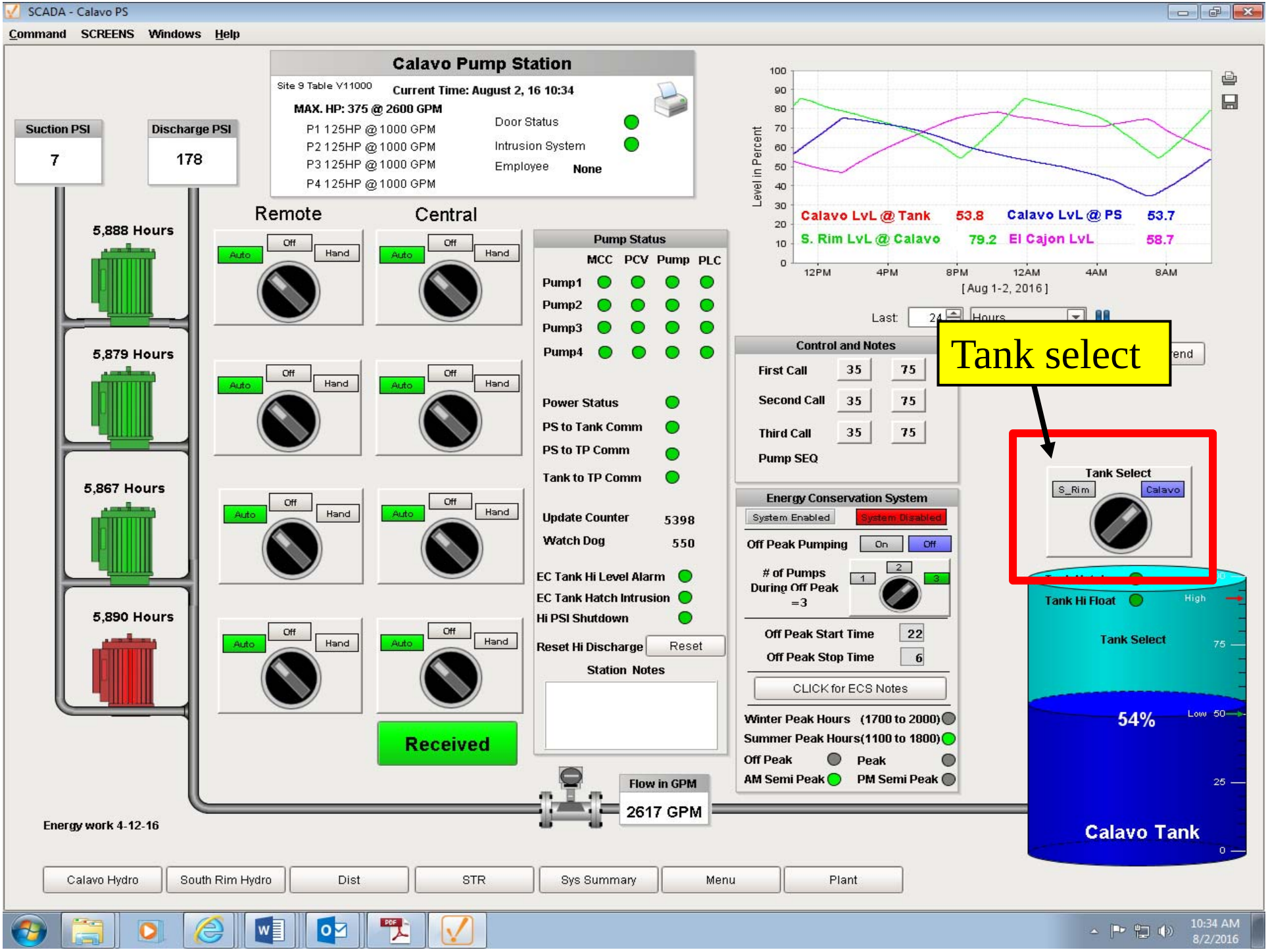
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S_Rim
Calavo
Tank Hi Float
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Tank Select
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Low 50
25
Calavo Tank
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10:34 AM
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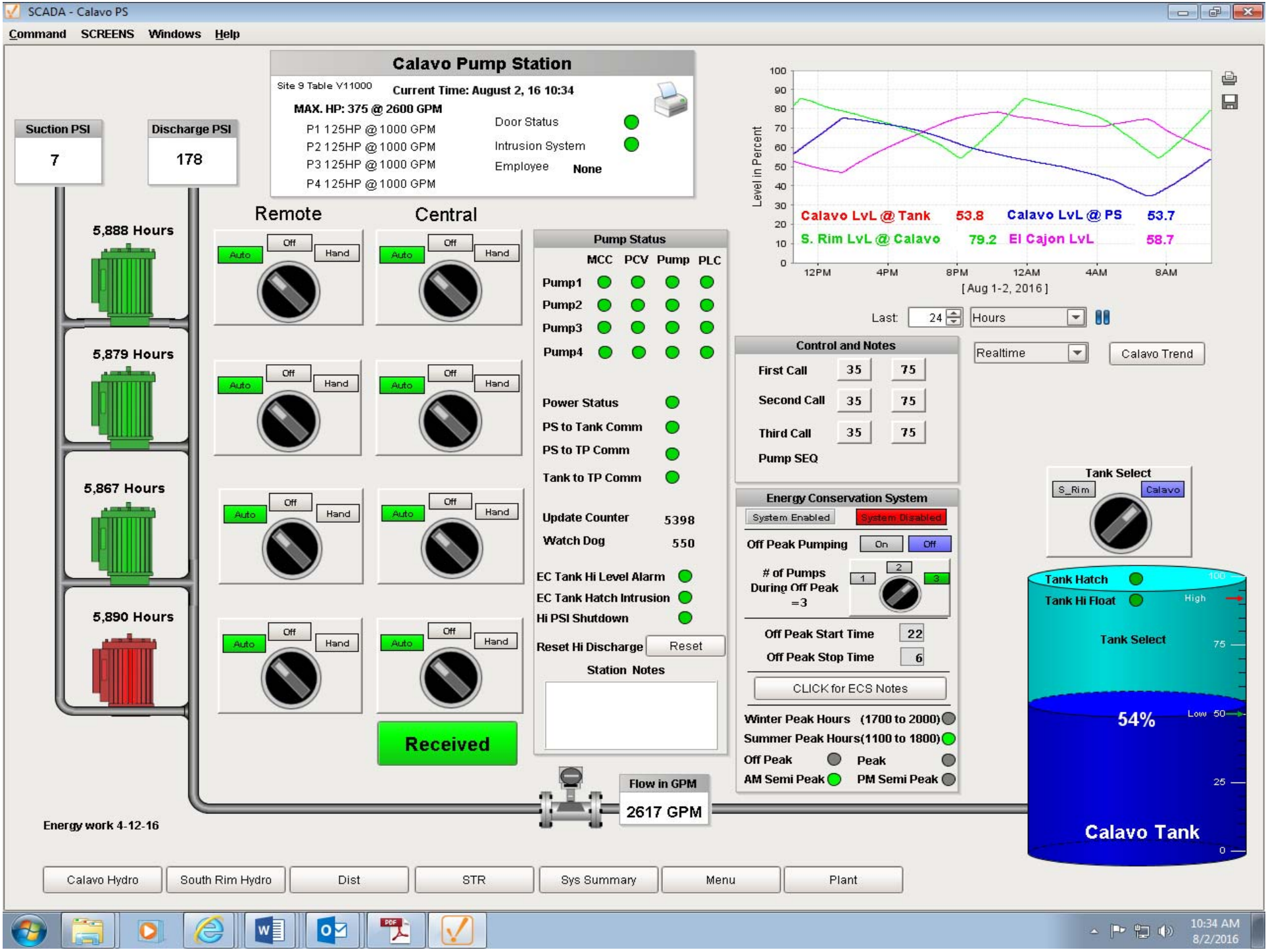
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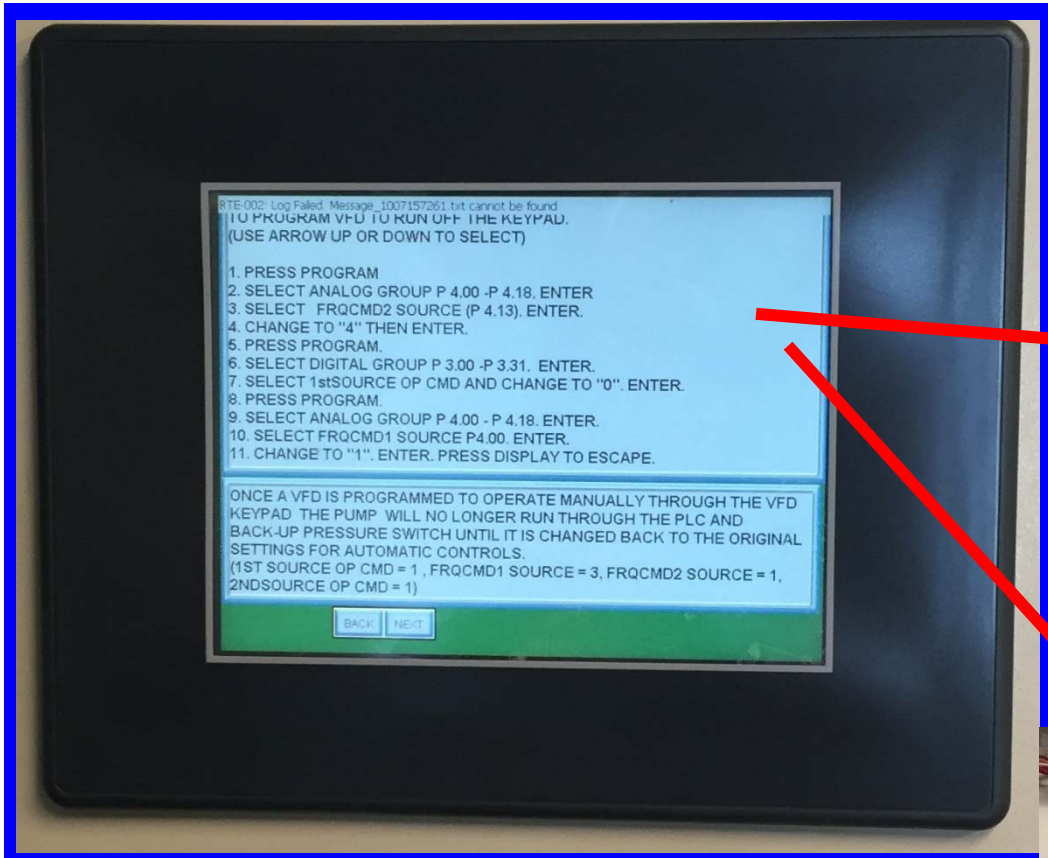
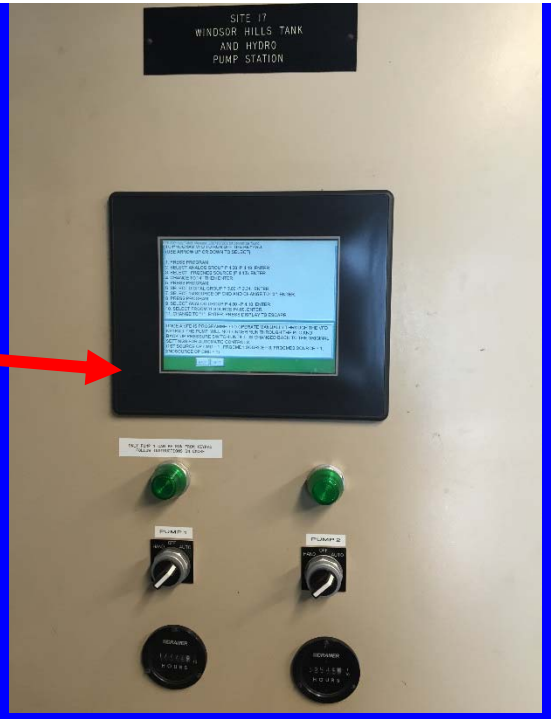
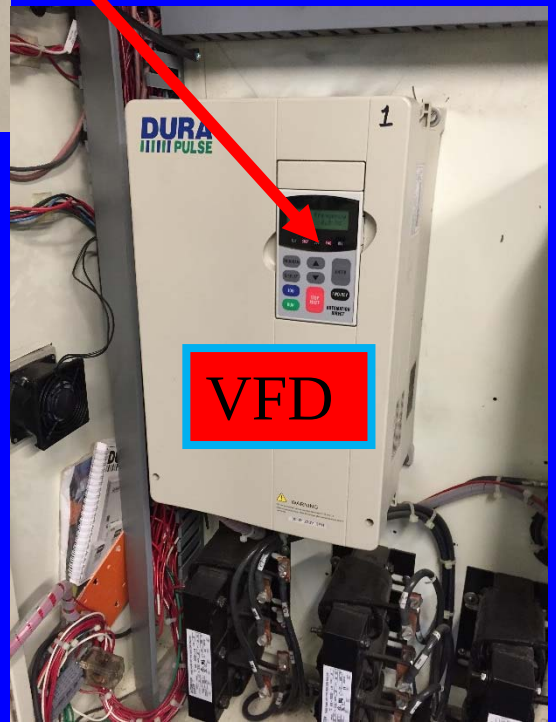


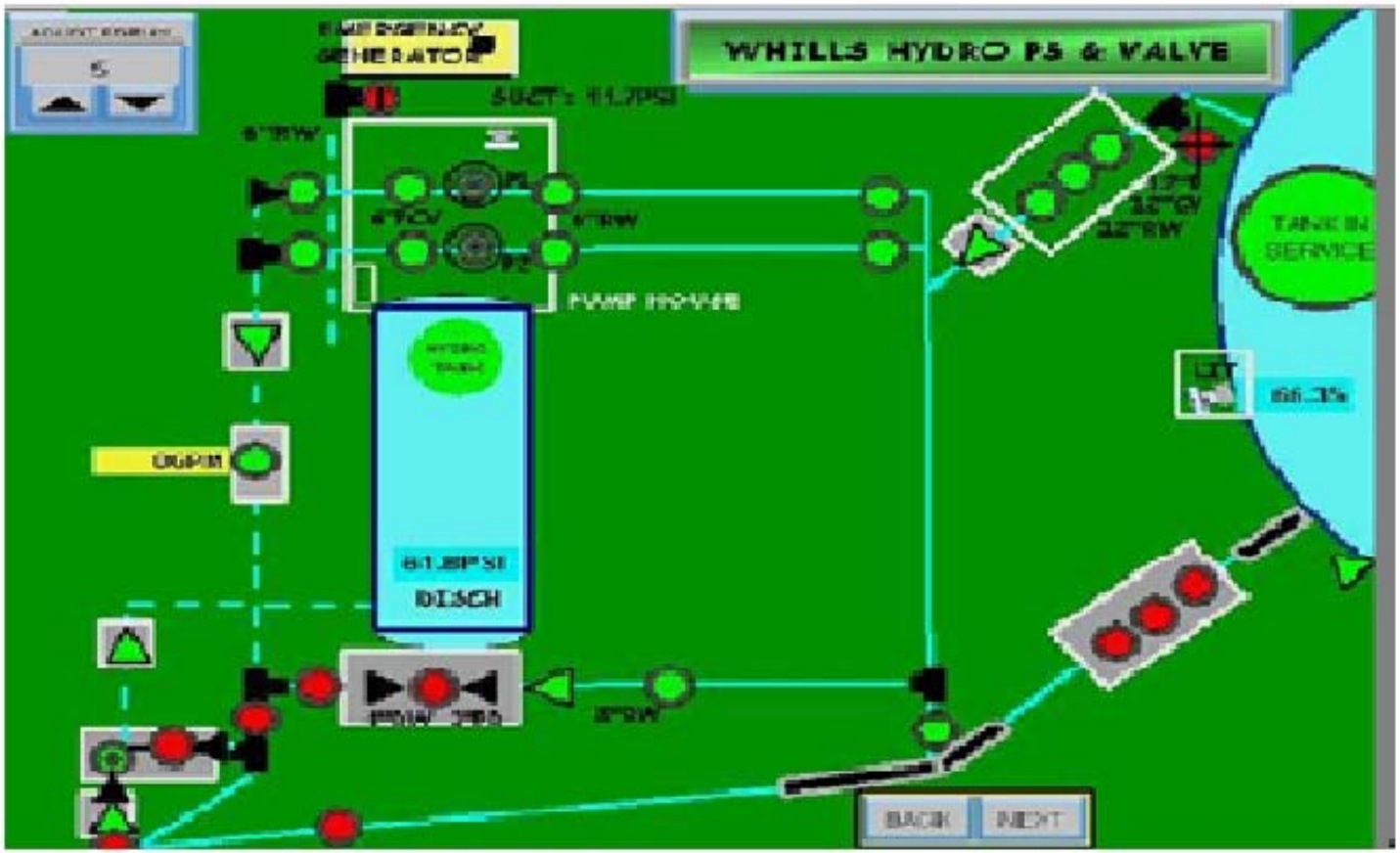




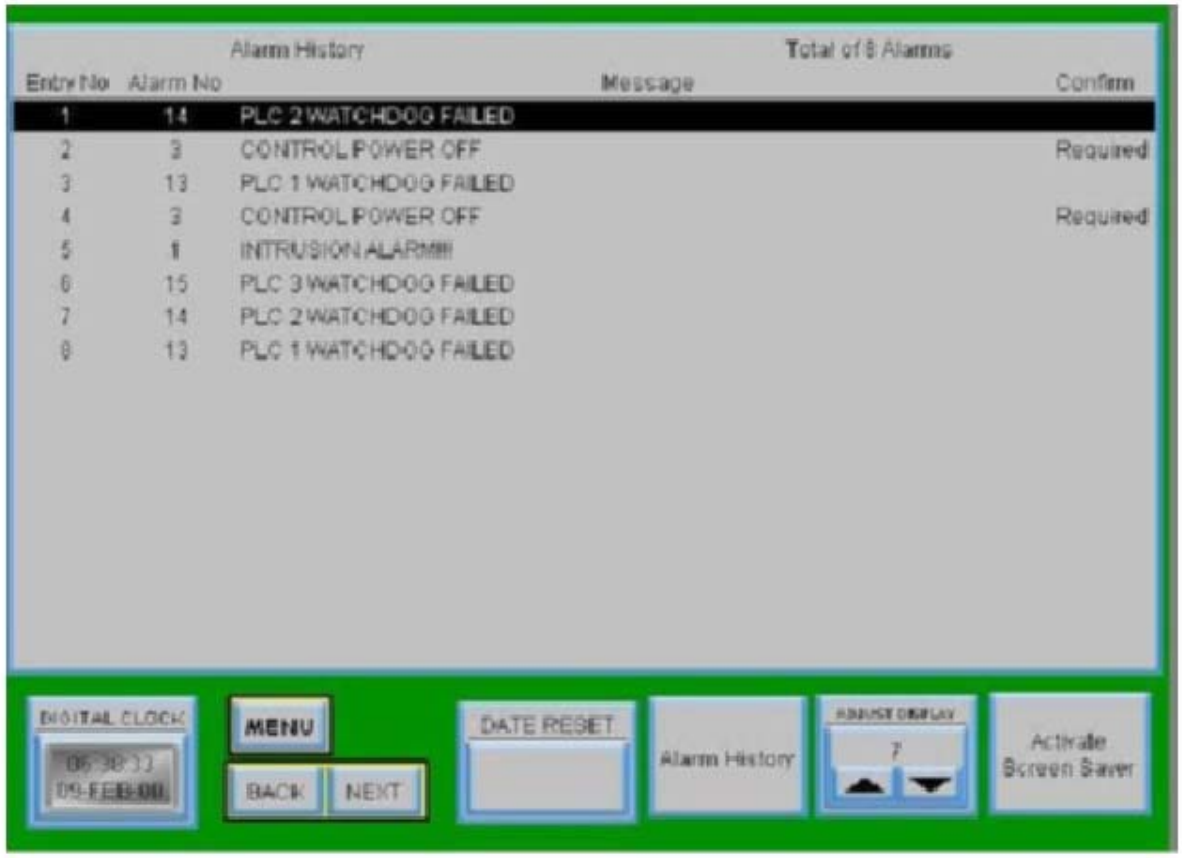
Store and Display Retentive Notes.

e.g. steps for VFD programming for auto or manual control

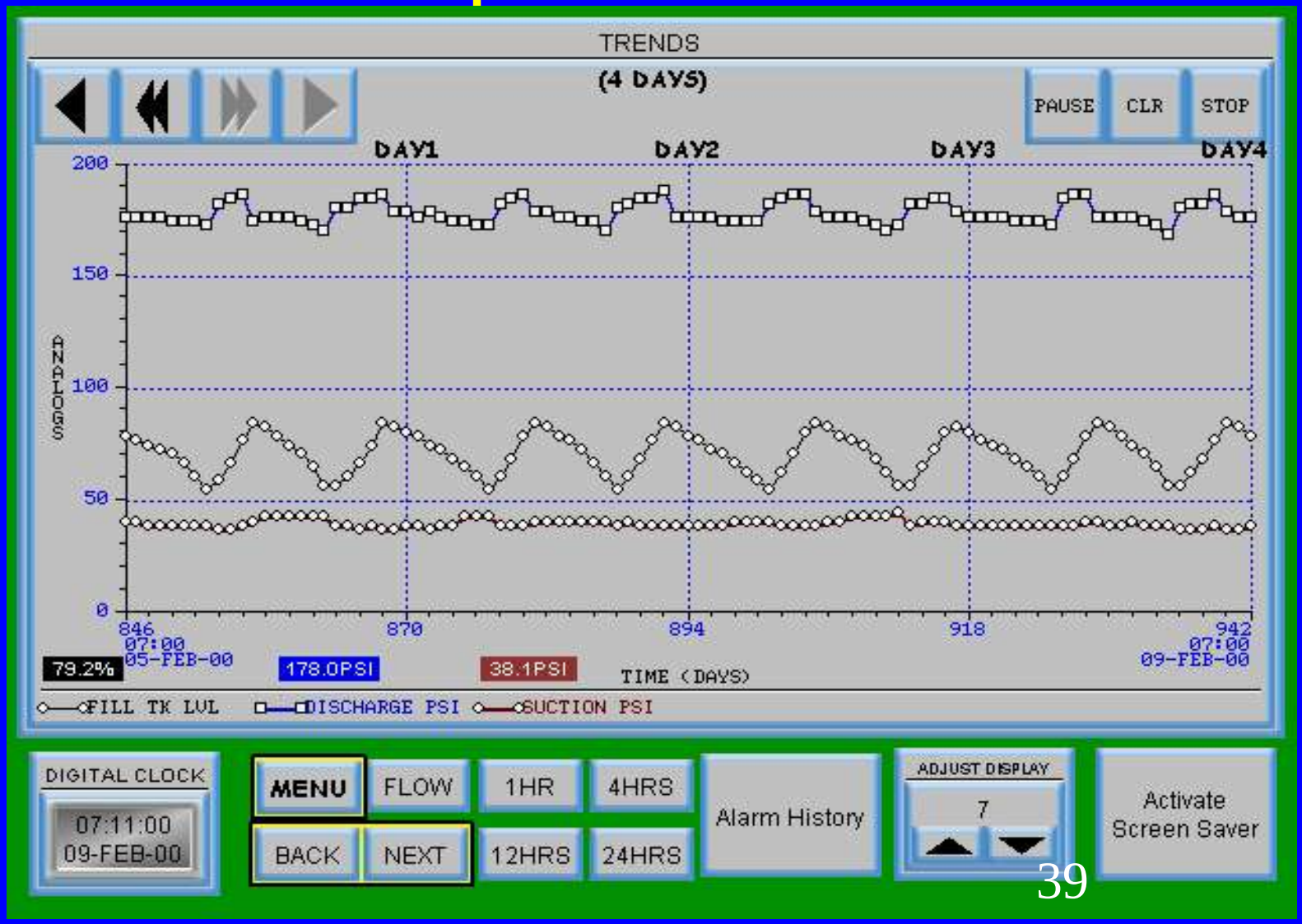
Retentive GIS Map



Alarm Log


Alarm History
Total of 8 Alarms
Entry No
Alarm No
Message
Confirm
1 14 PLC 2 WATCHDOG FAILED
2 3 CONTROL POWER OFF Required
3 13 PLC 1 WATCHDOG FAILED
4 3 CONTROL POWER OFF Required
5 1 INTRUSION ALARM!!!
6 15 PLC 3 WATCHDOG FAILED
7 14 PLC 2 WATCHDOG FAILED
8 13 PLC 1 WATCHDOG FAILED
DIGITAL CLOCK
MENU
BACK
NEXT
DATE RESET
Alarm History
Activate Screen Saver

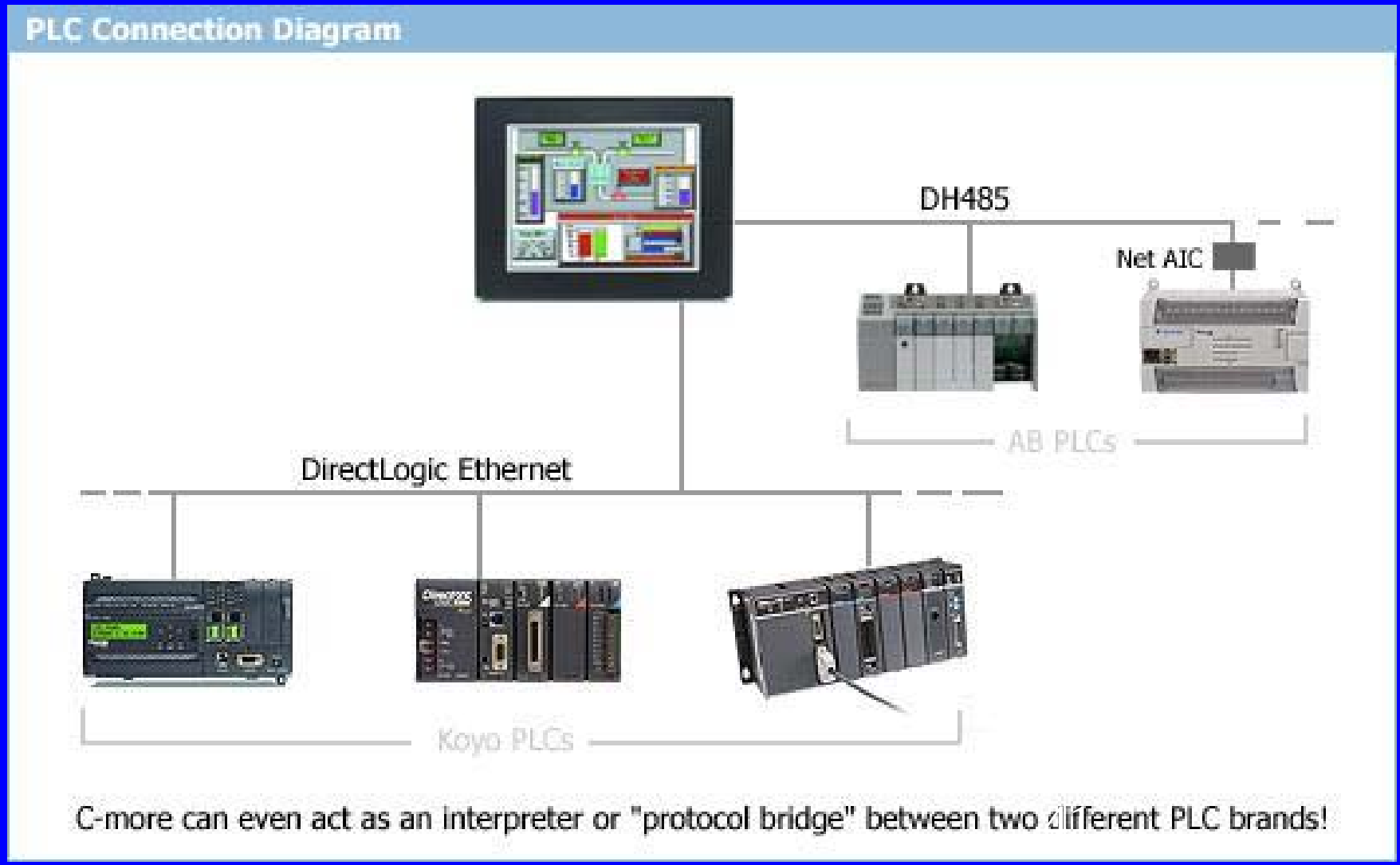
Pump Station Trend



Use Smart Devices to access HMI

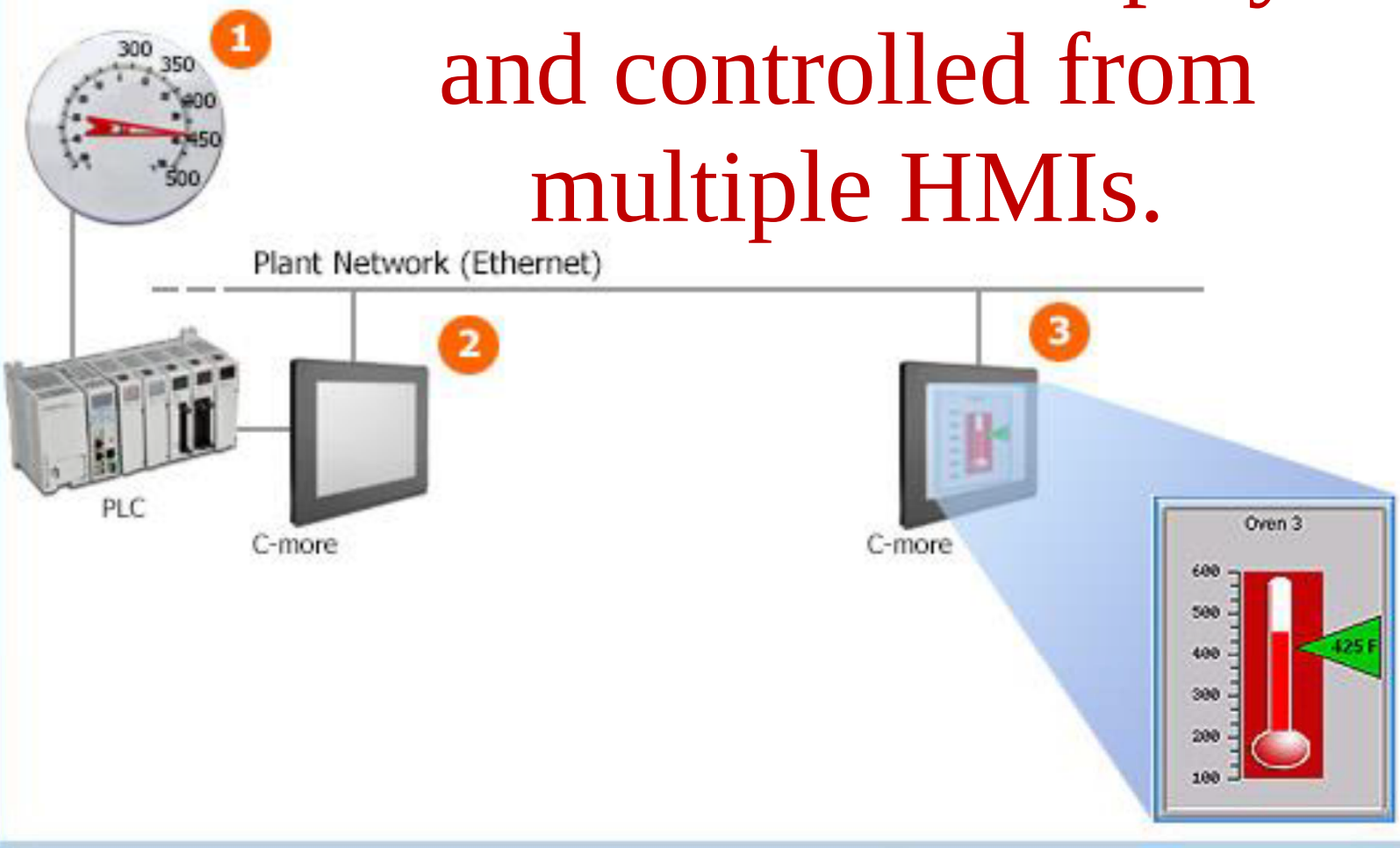
Remote HMI App

HMI acts as a gateway between different PLCs



Panel Pass-through

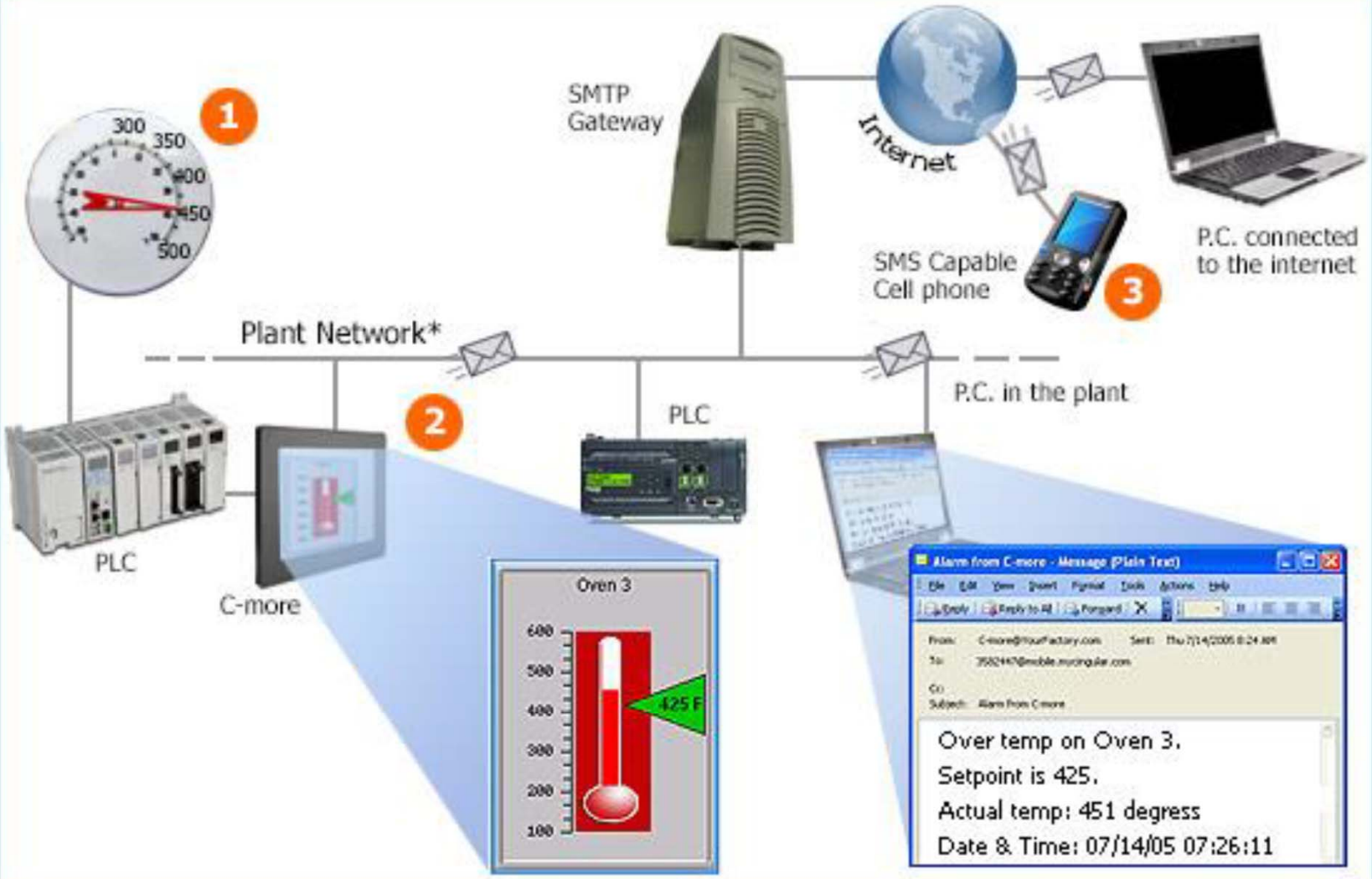
PLC data can be displayed and controlled from multiple HMIs.



1. Temperature is monitored by PLC connected to first C-more touch panel
2. First C-more panel passes-through the data to a second C-more touch panel
3. Second C-more panel accesses (and displays) the PLC data via the Ethernet connection

While dosing theTank, can connect to remote PS through HMI to control pump.

C-more can send e-mail



1. Temperature exceeds allowable range
2. C-more logs an alarm and sends an e-mail to a list of addresses
3. E-mail notification to various devices, both in the plant and on the internet

Stores PLC data on USB flash Drive or SD card.

C-more has a built-in FTP server

1. C-more can collect and log data from the PLC to an SD card or a USB Flash drive. Large Flash devices allow storage of large amounts of data
2. C-more can also capture screens periodically, or when an event occurs, and store these on Flash drives
3. Use FTP to request the data at any time from any connected PC (password protection possible)

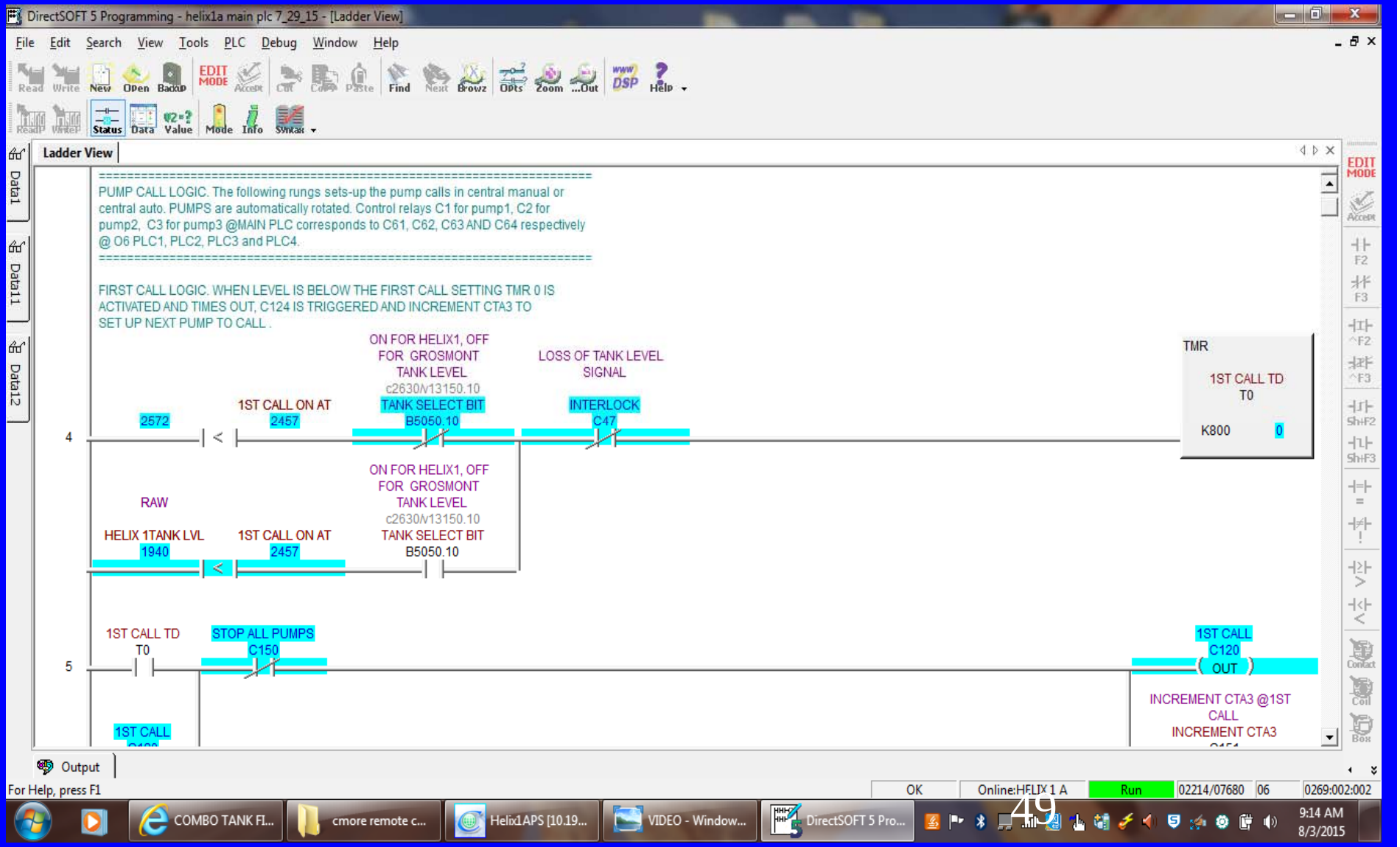
PLC-HMI summary

- Local PLC-HMI application
  - Allows integration of PLC data and control.
  - Remote Connect for full control.
  - Remote Screen development and configuration
  - Serves as a back-up SCADA.
  - Alarm display and notification.
  - Displays up to 255 screens.
  - Trend and stores data.
  - Wireless connection using PC and smart devices

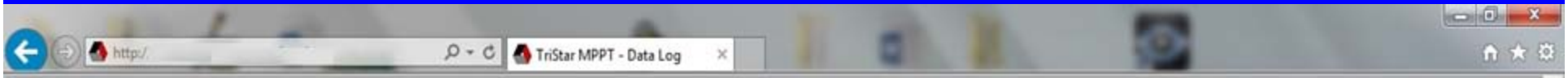
End

bobby.fortuno@helixwater.org
(619) 944-1036

Remotely Connect to PLC



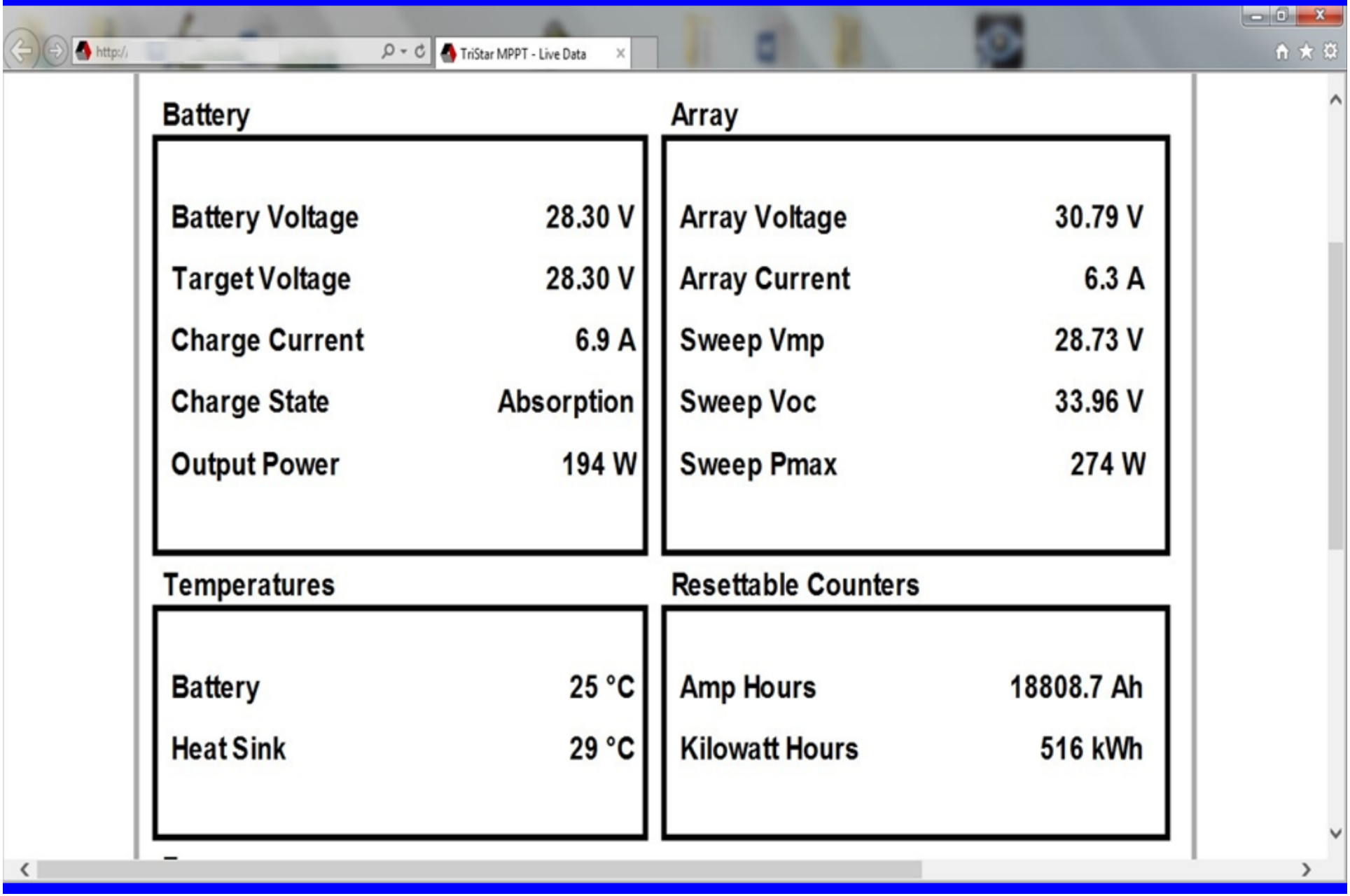
PV System



Days 0 to -84

Day	Today	-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11
Events	-	1	1	1	1	1	1	1	1	1	1	2
Hour Meter	1y299d20h	1y299d17h	1y298d17h	1y297d17h	1y296d17h	1y295d17h	1y294d17h	1y293d17h	1y292d17h	1y291d17h	1y290d17h	1y289d17h
Max. Battery Voltage	28.31	28.33	28.33	28.35	28.36	28.32	28.34	28.43	28.35	28.36	28.35	28.94
Min. Battery Voltage	25.66	25.66	25.68	25.69	25.69	25.65	25.65	25.65	25.69	25.69	25.69	25.70
Max. Array Voltage	33.96	34.51	35.28	34.23	34.88	34.50	34.85	34.48	34.20	34.41	34.56	34.07
Max. Output Power Watts	-	-	-	-	-	-	-	-	-	-	-	-
Amp Hours	9.6	31.7	31.8	32.5	32.0	32.1	31.7	31.9	32.4	32.3	32.1	32.4
Watt Hours	270	870	880	900	890	880	880	880	900	890	890	900
Max. Battery Temp °C	-	-	-	-	-	-	-	-	-	-	-	-
Min. Battery Temp °C	-	-	-	-	-	-	-	-	-	-	-	-
Charging Durations Min:												
Equalize	0	0	0	0	0	0	0	0	0	0	0	65
Float	0	531	485	559	544	547	550	543	544	542	544	463
Absorption	29	149	149	149	149	149	149	149	150	150	150	210
Faults	-	-	-	-	-	-	-	-	-	-	-	-
Alarms	1	1	1	1	1	1	1	1	1	1	1	1

PV System


TriStar MPPT - Live Data
Battery
Battery Voltage 28.30 V
Target Voltage 28.30 V
Charge Current 6.9 A
Charge State Absorption
Output Power 194 W
Array
Array Voltage 30.79 V
Array Current 6.3 A
Sweep Vmp 28.73 V
Sweep Voc 33.96 V
Sweep Pmax 274 W
Temperatures
Battery 25 °C
Heat Sink 29 °C
Resettable Counters
Amp Hours 18808.7 Ah
Kilowatt Hours 516 kWh