Treatment Plant SCADA & Instrumentation

Water and Wastewater Operator's School
August 5, 2010

Marc Pedrotti, P.E.

REP ***R.E. Pedrotti Co.***

R. E. Pedrotti Company, Inc.

- Celebrating 34 Years in Water & Wastewater Industry
- Manufacture's Representative
- System Integrator

Overview

- Basics of SCADA
  - Understanding the Alphabet Soup
  - System Components
  - Communication Methods
- Developing a System
  - Define Level of Control
  - Control Networks
  - Future SCADA

Alphabet Soup

- SCADA
- HMI
- I/O
- PLC
- DCS
- RTU
- GUI
- CMMS
- CPU

SCADA

Supervisory

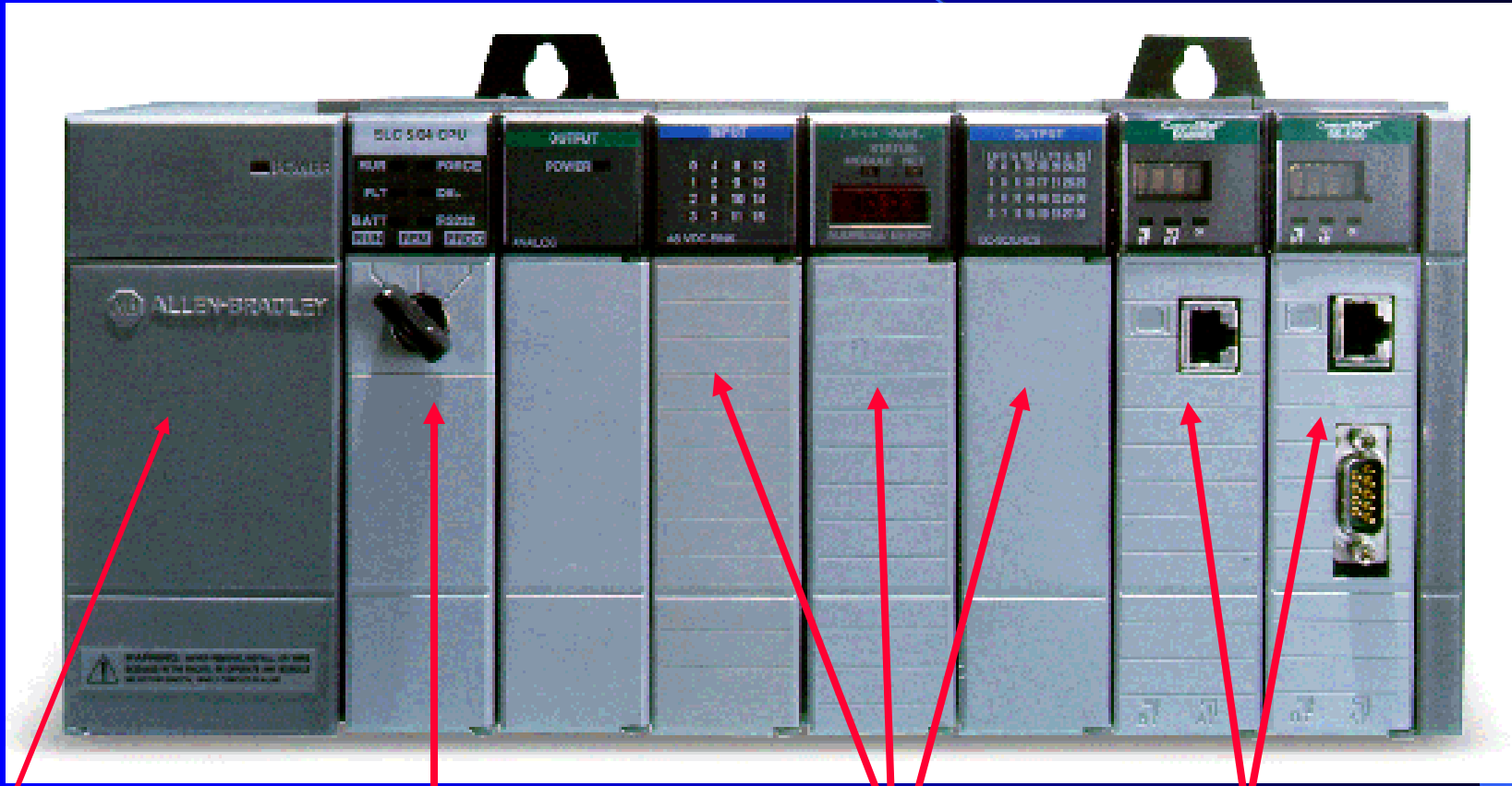
Control

And

Data

Acquisition

Programmable Logic Controller



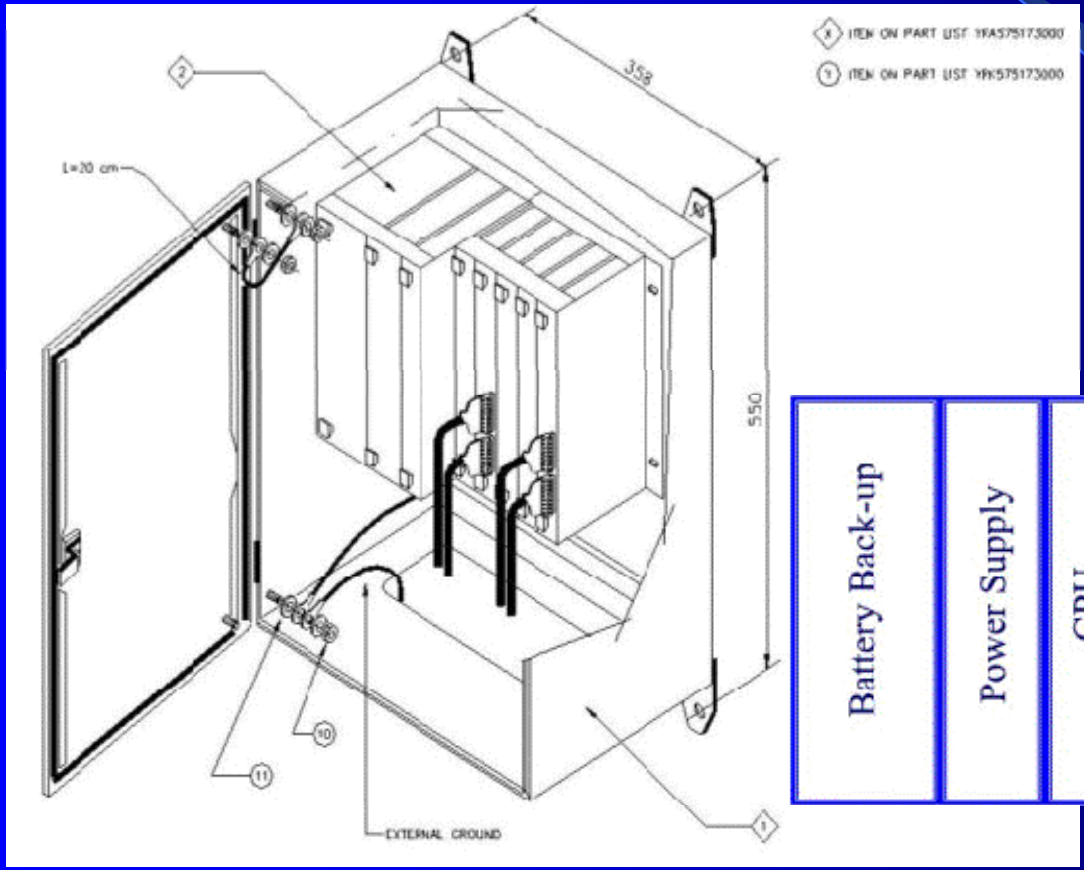
Power Supply

CPU

I/O

Communication Cards

Remote Terminal Unit



- Battery Back-up
- Power Supply
- CPU
- I/O or Communication
- I/O Board
- I/O Board
- I/O Board
- I/O Board

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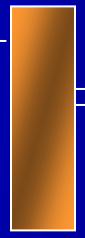
Simple Discrete Control

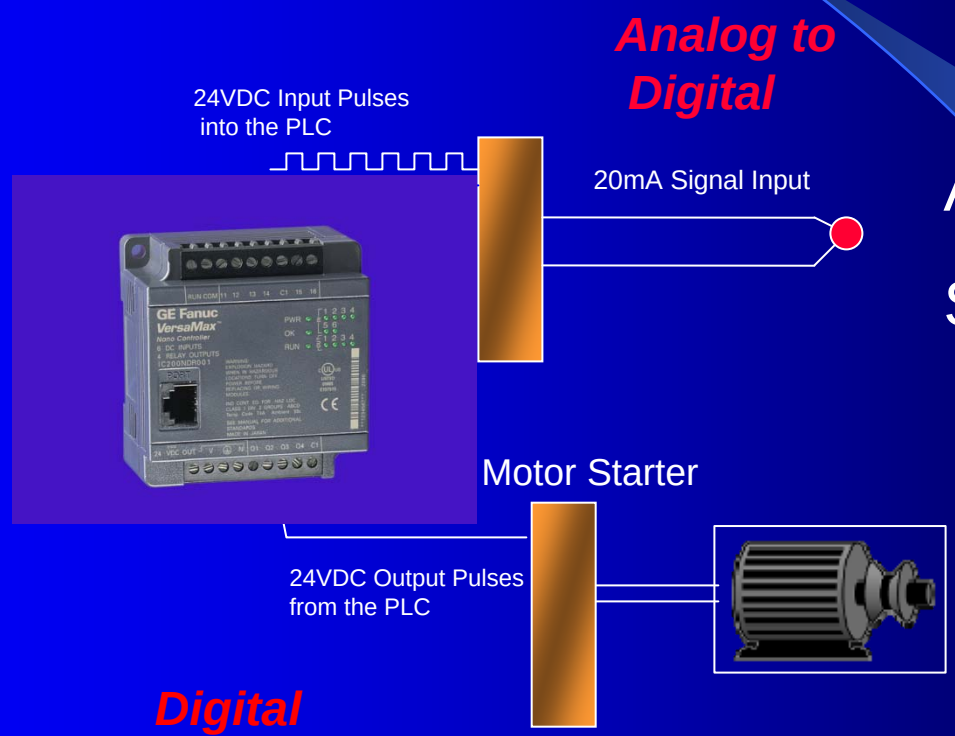
Level Switches

Motor Starter



24VDC Output Pulses
from the PLC

Analog Control



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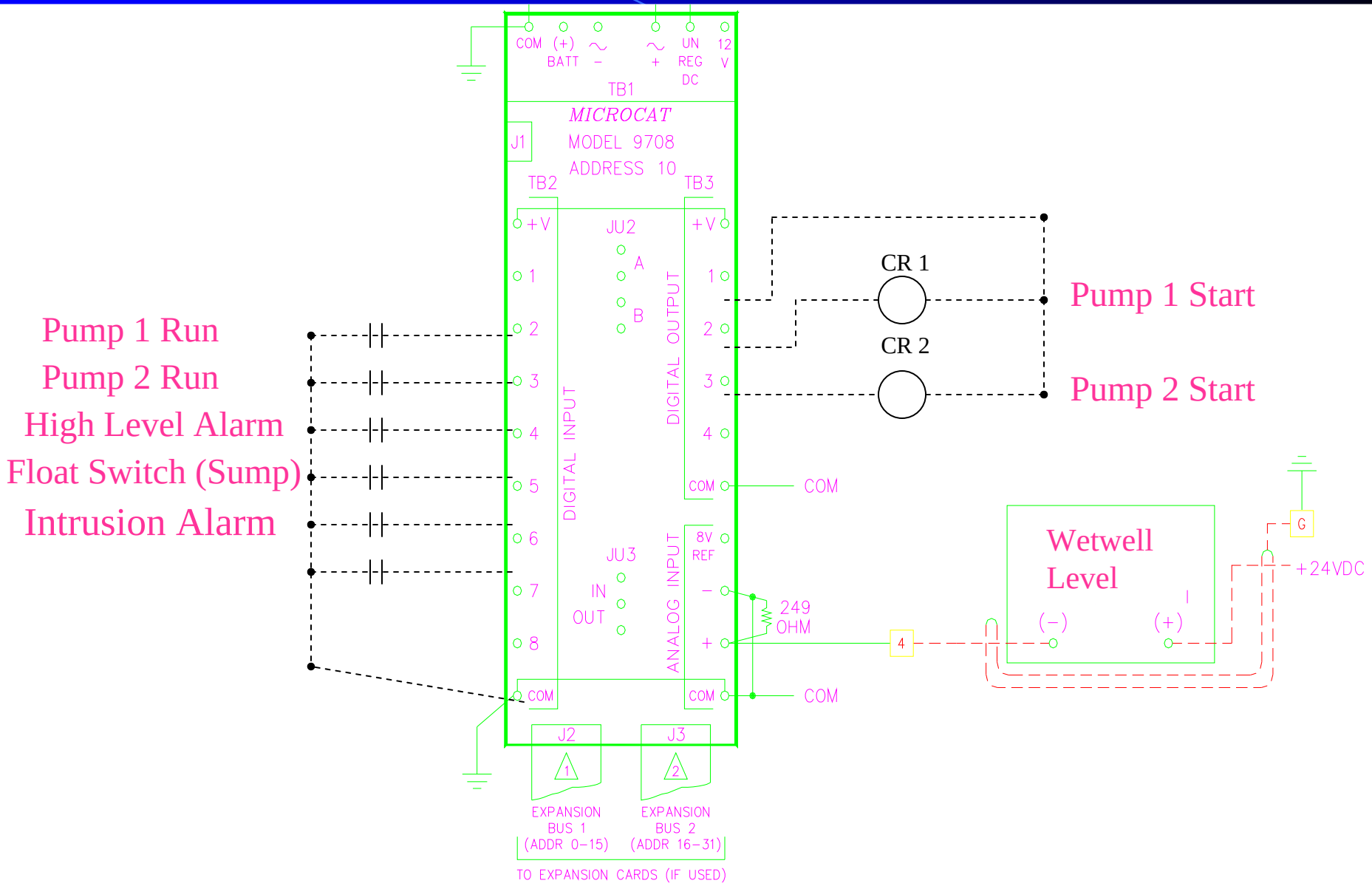
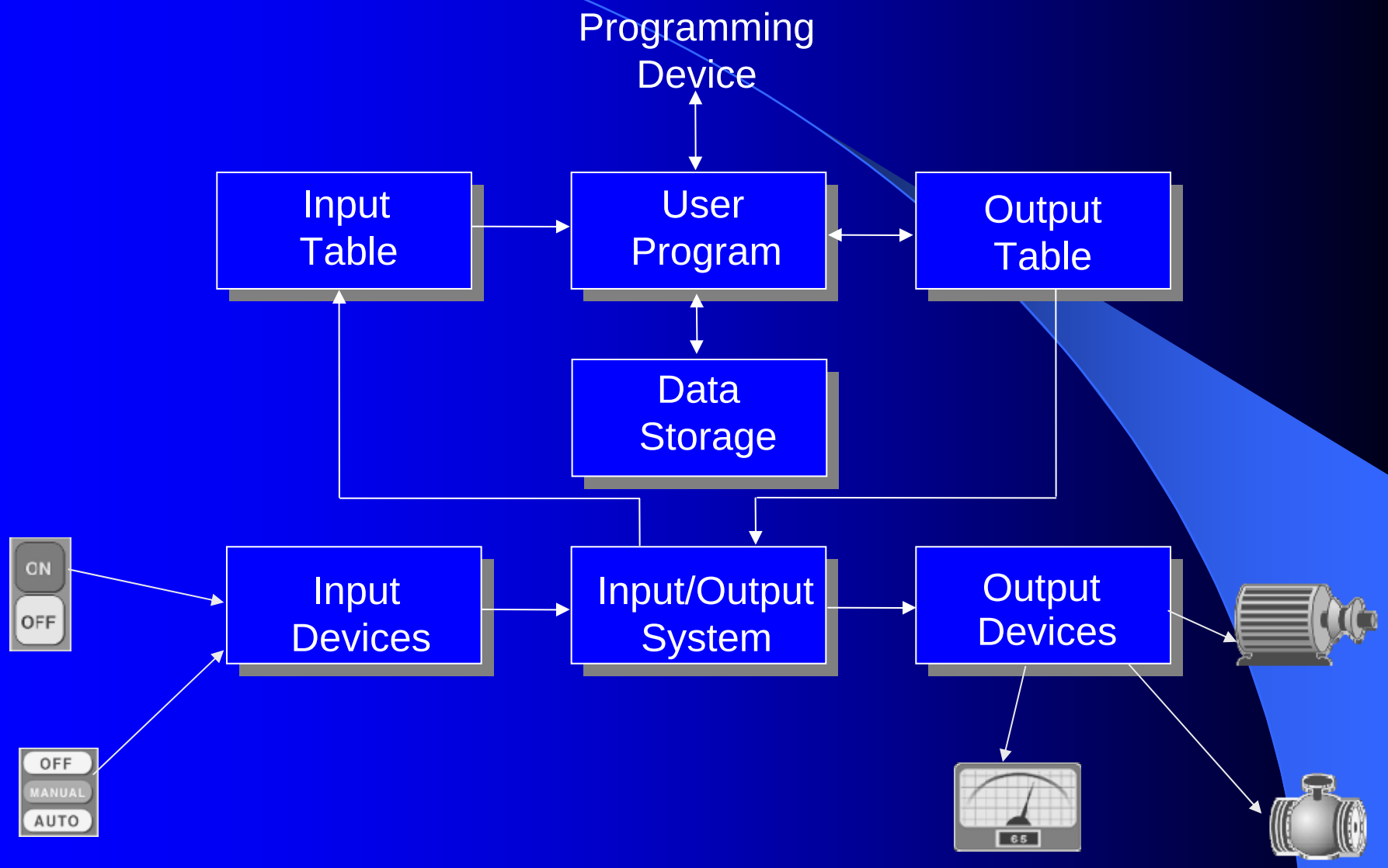

COM
(+) BATT
~ −
~ +
UN REG DC
12 V
TB1
MICROCAT
MODEL 9708
ADDRESS 10
J1
TB2
TB3
+V
JU2
A
B
1
2
3
4
5
6
7
8
COM
DIGITAL INPUT
DIGITAL OUTPUT
JU3
IN
OUT
8V REF
ANALOG INPUT
249 OHM
CR 1
CR 2
Pump 1 Start
Pump 2 Start
Pump 1 Run
Pump 2 Run
High Level Alarm
Float Switch (Sump)
Intrusion Alarm
Wetwell Level
(−)
(+)
G
+24VDC
J2
J3
EXPANSION BUS 1 (ADDR 0−15)
EXPANSION BUS 2 (ADDR 16−31)
TO EXPANSION CARDS (IF USED)

Introduction to Control



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SCADA Components

- HMI (Human Machine Interface)
- OIT (Operator Interface Terminal)
- PC (Personal Computer)
- CPU (Central Processing Unit)
- Instrumentation

Instrumentation

- Pressure
- Flow
- Level
- Dissolved Oxygen
- Gas Detection
- Chlorine Monitors
- Turbidity
- pH
- Temperature
- TSS
- Nitrates
- Phosphate
- BOD
- Ammonia
- TOC
- Chemical Security

Personal Computer and Servers

- Computer
  - Size
  - Back-Up
  - CD Rom (RW)
  - DVD
  - Monitor
  - Redundant
  - Modem (Remote Access)

(OIT) Operator Interface Terminal

HMI Software

- Wonderware
- Intellution
- RS View
- Foxboro I/A
- Factory Link

Menu | Trends | Reports | Home | Alarms Events

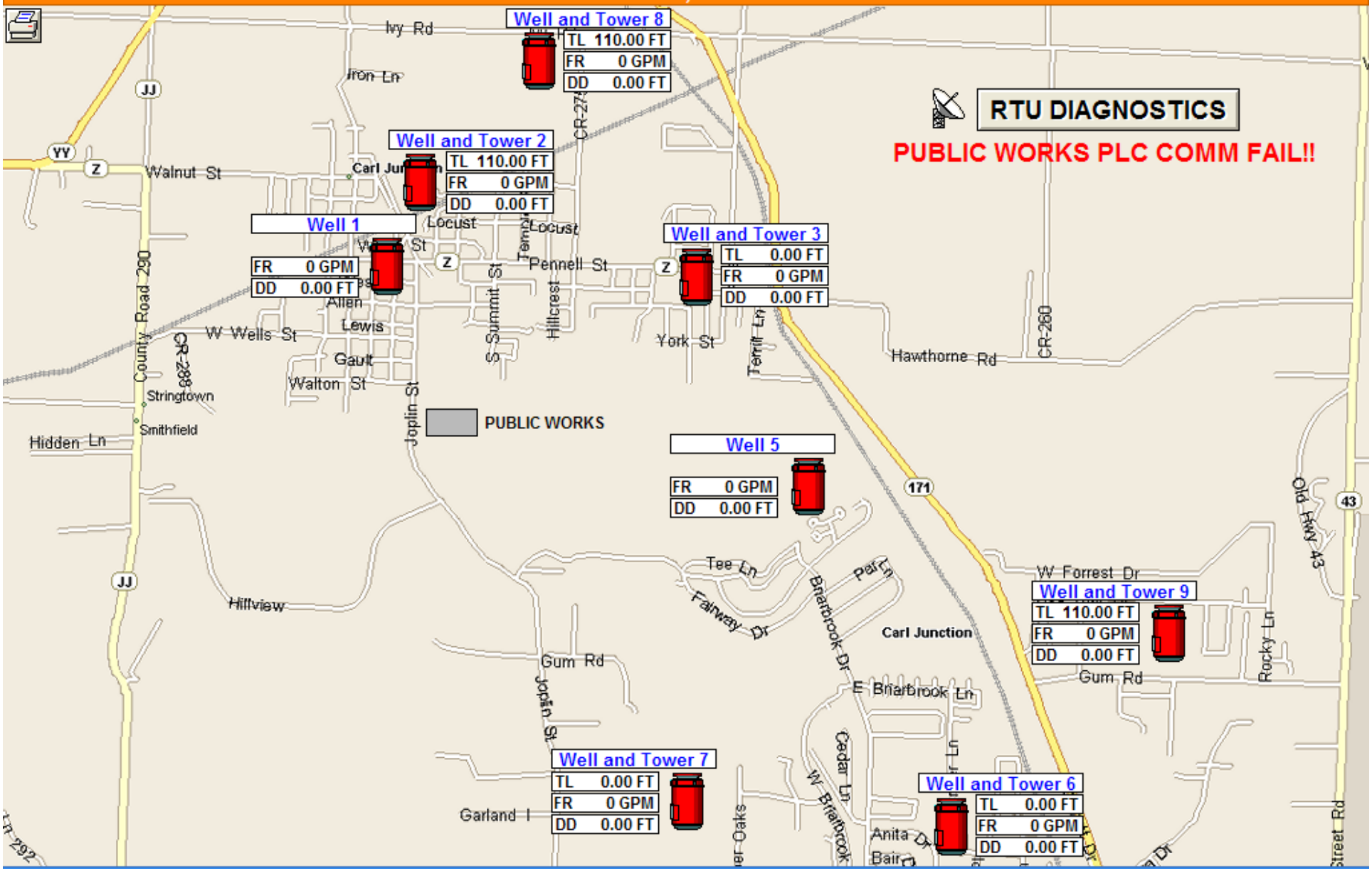
City of Carl Junction
Carl Junction, MO

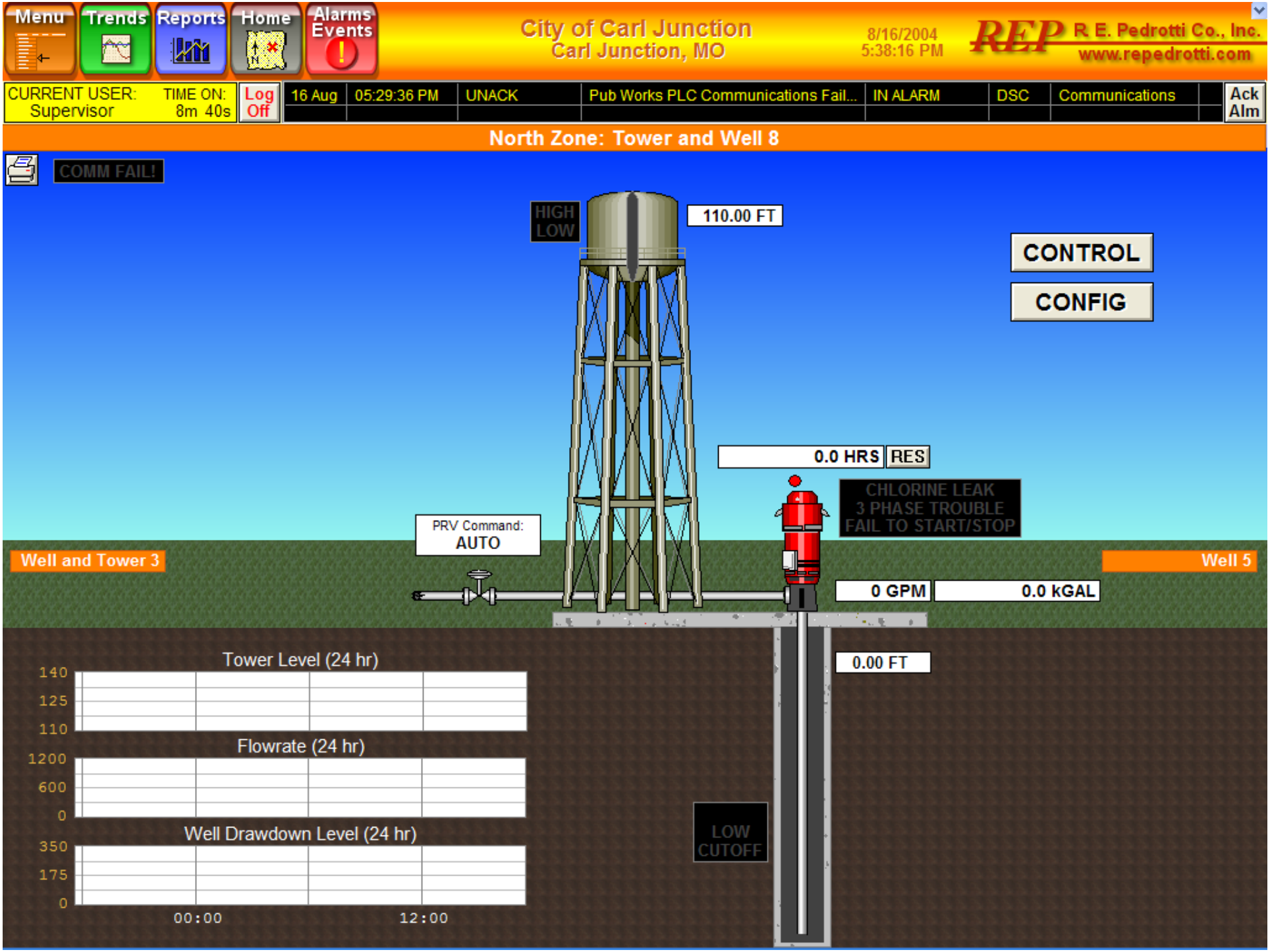
8/16/2004
5:38:33 PM

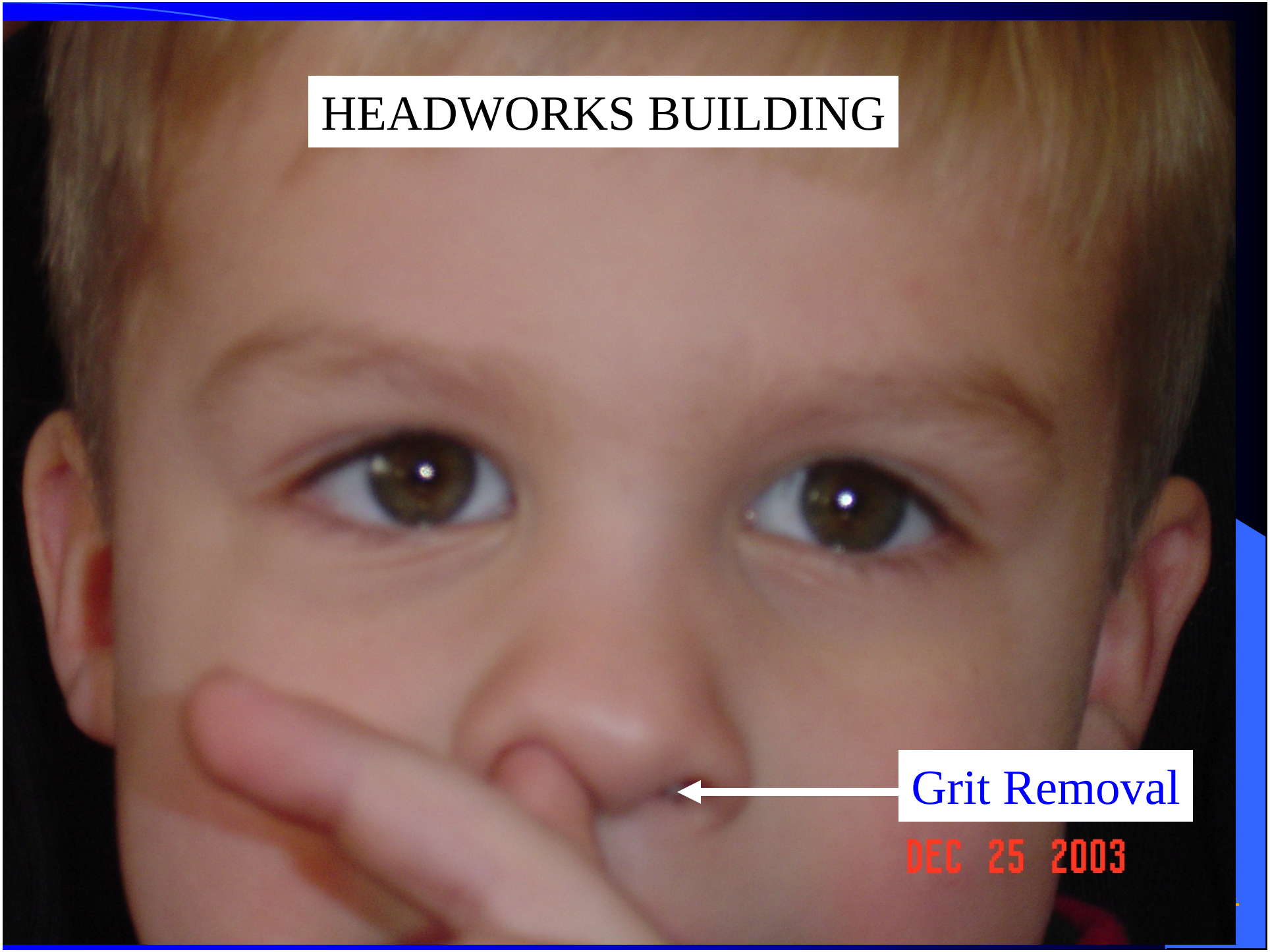
REP R. E. Pedrotti Co., Inc.
www.repedrotti.com

CURRENT USER:	TIME ON:	Log	16 Aug	05:29:36 PM	UNACK	Pub Works PLC Communications Fail...	IN ALARM	DSC	Communications	Ack Alm
Operator	0m 3s	Off								

Carl Junction, MO Overview




Menu
Trends
Reports
Home
Alarms Events
City of Carl Junction
Carl Junction, MO
8/16/2004
5:38:16 PM
REP
R E. Pedrotti Co., Inc.
www.repedrotti.com
CURRENT USER: Supervisor
TIME ON: 8m 40s
Log Off
16 Aug
05:29:36 PM
UNACK
Pub Works PLC Communications Fail...
IN ALARM
DSC
Communications
Ack Alm
North Zone: Tower and Well 8
COMM FAIL!
HIGH
LOW
110.00 FT
CONTROL
CONFIG
0.0 HRS
RES
CHLORINE LEAK
3 PHASE TROUBLE
FAIL TO START/STOP
PRV Command:
AUTO
Well and Tower 3
Well 5
0 GPM
0.0 kGAL
0.00 FT
Tower Level (24 hr)
140
125
110
Flowrate (24 hr)
1200
600
0
Well Drawdown Level (24 hr)
350
175
0
00:00
12:00
LOW
CUTOFF


HEADWORKS BUILDING
Grit Removal
DEC 25 2003

Station - default.stn - Oak Valley Well Pumps (306)

Station Edit System Displays Oak Valley Eastridge View Action Configure Help

Station Status

Redundant Control	OK	
Power	OK	
Communication	OK	
Lead Well Pump	Active	
Lag Well Pump	InActv	
Well Pump No.9 Flow	3.2	GPM
Total	3.2	Kgal
Status	OK	
Well Pump No.10 Flow	3.2	GPM
Total	3.2	Kgal
Status	OK	
System Pressure	3.2	PSI
Status	OK	
Chlorine Residual	3.2	mg/L
Status	OK	
Chlorine Leak	OK	
Chlorine Low Vacuum	OK	
Fluoride Residual	3.2	mg/L
Status	OK	
PH	3.2	pH
Status	OK	

Well Pump No.9

Run

3.2 Hrs

HOA

Auto

Hand Off Auto

Well Pump No.10

Off

3.2 Hrs

HOA

Off

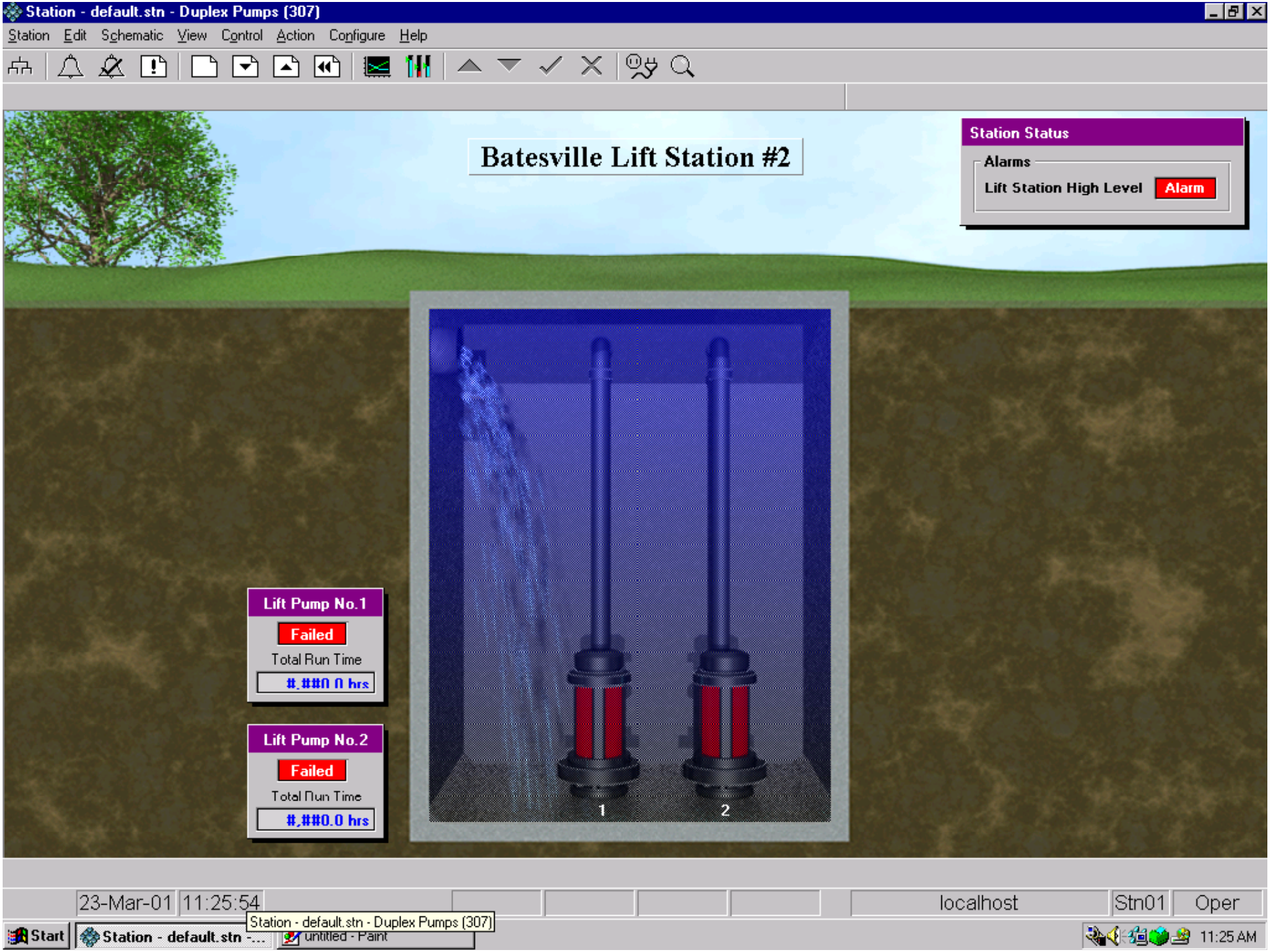
Hand Off Auto

Oak Valley Well Pumps

Setpoints | Oak Valley WTP

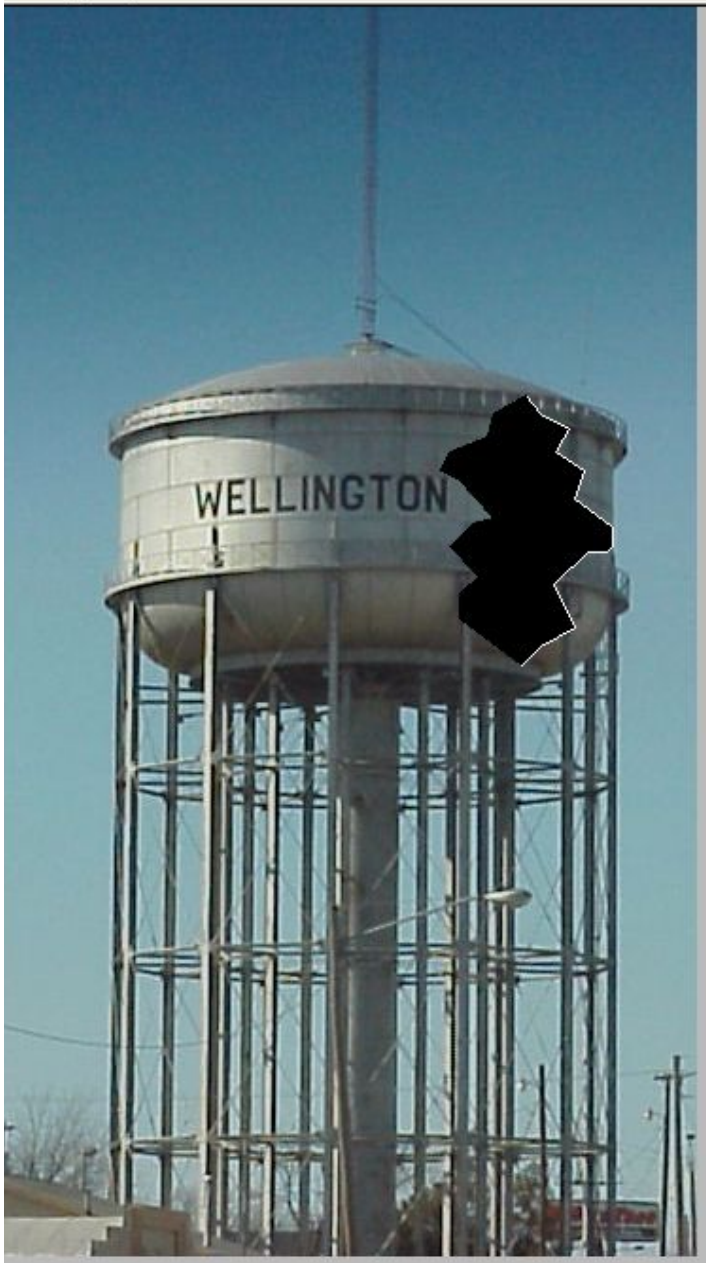
29-May-01 12:04:12 | Alarm | localhost | Stn01 | Mngr

Start | Station - default.stn -... | Display Builder - [Oak Vall... | System Summary.bmp - Pa... | Exploring - C:\WINNT\Pro... | 12:04 PM


Station - default.stn - Duplex Pumps (307)
Station Edit Schematic View Control Action Configure Help
Batesville Lift Station #2
Station Status
Alarms
Lift Station High Level
Alarm
Lift Pump No.1
Failed
Total Run Time
#,##0.0 hrs
Lift Pump No.2
Failed
Total Run Time
#,##0.0 hrs
1
2
23-Mar-01
11:25:54
localhost
Stn01
Oper
Start
Station - default.stn -...
untitled - Paint
11:25 AM

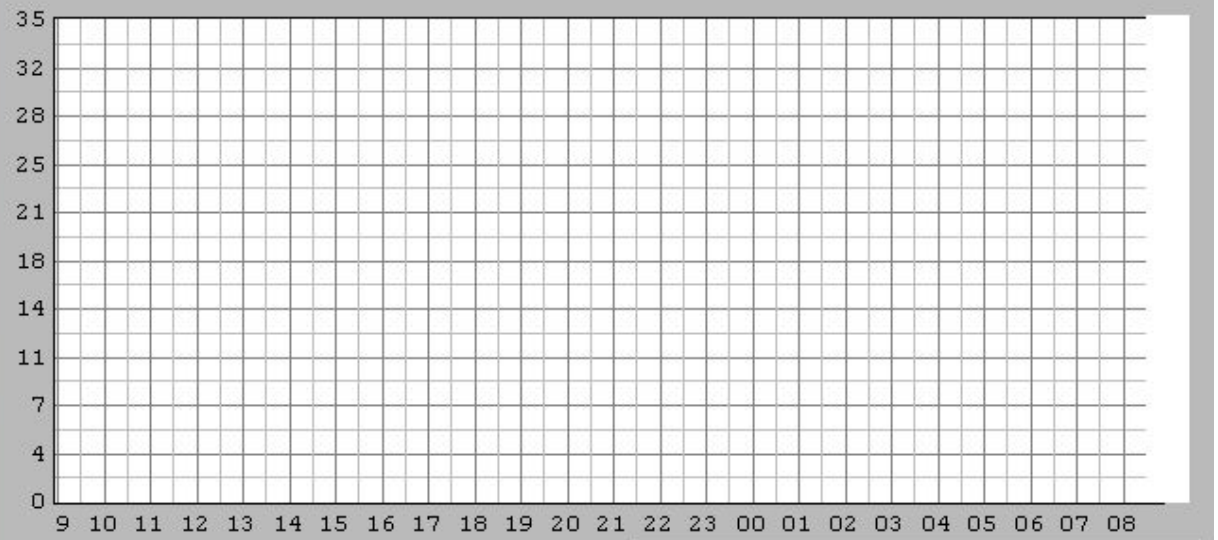
InTouch - WindowViewer - C:\DOCUMENTS AND SETTINGS\SCADA\MY DOCUMENTS\MY INTOUCH APPLICATIONS\WELKEA

File Logic Special Development!



WATER TOWER

TOWER LEVEL: 0.0 FT
HIGH LEVEL SETPOINT: 0.0 FT
LOW LEVEL SETPOINT: 0.0 FT



LOCATION	COMM	POWER
RTU 3 at the City Water Tower:	OK	OK

REP R. E. Pedrotti Co., Inc.
Instrumentation, Controls & Computer Systems

R. E. Pedrotti Co., Inc.
5855 Beverly Avenue, Suite A
Mission, KS 66202

(913)677-3366
(913)677-3460 fax
www.repedrotti.com

Time: 8:54:44 AM
Date: 8/17/2004

RETURN

Menu | Trends | Reports | Home | Alarms Events

City of Carl Junction
Carl Junction, MO

8/16/2004
5:38:42 PM

REP R. E. Pedrotti Co., Inc.
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CURRENT USER:	TIME ON:	Log Off	16 Aug	05:29:36 PM	UNACK	Pub Works PLC Communications Fail...	IN ALARM	DSC	Communications	Ack Alm
Operator	0m 12s									

Alarms and Events

OPEN ALARMS DIRECTORY | ALL | UNACKED | ACKED | Alarms | Events

16 Aug	05:38:30 PM		$AccessLevel	5000	USER	$System
16 Aug	05:38:30 PM		$Operator	Operator	USER	$System
16 Aug	05:38:30 PM		$OperatorName	Operator	USER	$System
16 Aug	05:38:25 PM		$AccessLevel	0	USER	$System
16 Aug	05:38:25 PM		$Operator	None	USER	$System
16 Aug	05:38:25 PM		$OperatorName	None	USER	$System
16 Aug	05:29:41 PM		$StartDdeConversations	OFF	SYS...	$System
16 Aug	05:29:41 PM		$StartDdeConversations	ON	OPR	$System
16 Aug	05:29:37 PM		$AccessLevel	6000	SYS...	$System
16 Aug	05:29:37 PM		$OperatorName	Supervisor	SYS...	$System
16 Aug	05:29:37 PM		$Operator	Supervisor	SYS...	$System
16 Aug	05:29:37 PM		$LogicRunning	ON	SYS...	$System
16 Aug	05:29:37 PM		$OperatorName	None	SYS...	$System
16 Aug	05:29:37 PM		$OperatorDomain	InTouch	SYS...	$System
16 Aug	05:29:36 PM		$HistoricalLogging	ON	SYS...	$System
16 Aug	05:29:36 PM	UNACK	Pub Works PLC Communications Fail ALARM	IN ALARM	DSC	Communicati...
16 Aug	05:29:36 PM		$NewAlarm	ON	SYS...	$System
16 Aug	05:29:36 PM		$Operator	None	SYS...	$System

Update Successful

SHOW DATA FOR:

- [x] System Wide
- [ ] Communications
- [ ] North Zone
  - [ ] Well and Tower 8
  - [ ] Well and Tower 3
  - [ ] Well and Tower 2
  - [ ] Well 1
- [ ] South Zone
  - [ ] Well and Tower 9
  - [ ] Well and Tower 7
  - [ ] Well and Tower 6
  - [ ] Well 5
- [ ] Runtime Hours
- [ ] Flow Totalizers

UPDATE

ACK ALL | ACK DISPLAYED | ACK SELECTED

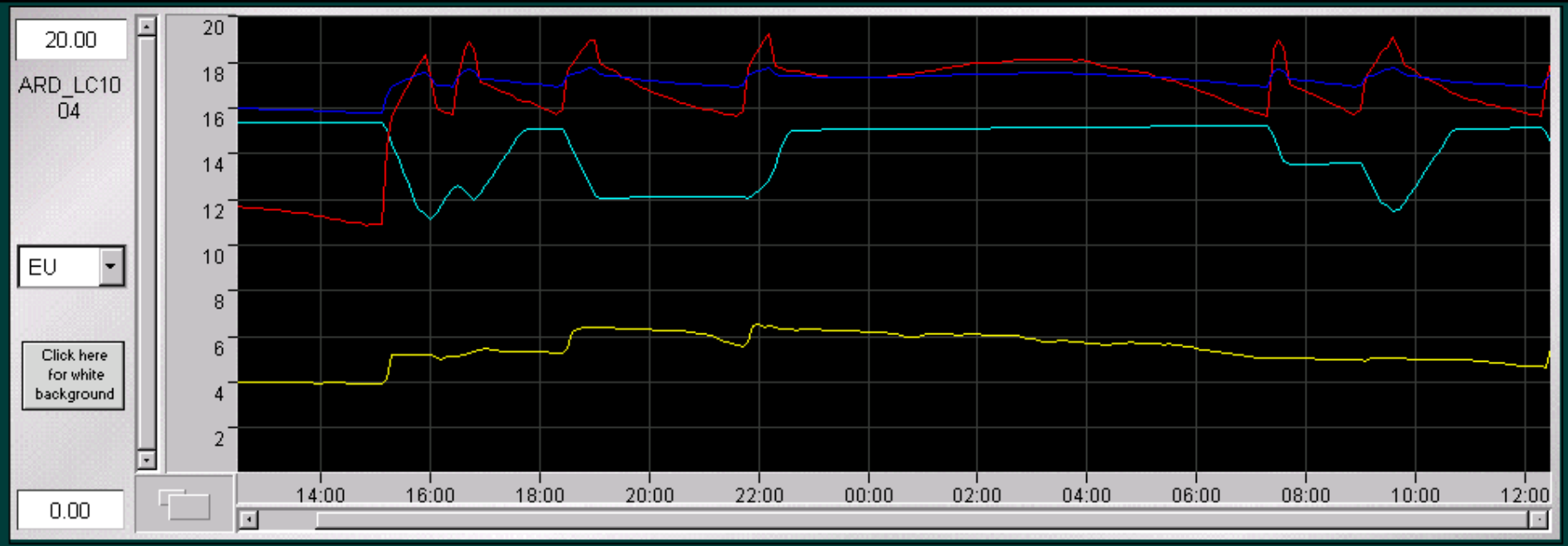
Alarms and Events Legend

- ACKNOWLEDGED
- UNACKED/UNACTIVE ALARM
- EVENT
- PRIORITY 1 - UNACKED
- PRIORITY 2 - UNACKED
- PRIORITY 3 - UNACKED
- PRIORITY 4 - UNACKED

Station - ps1a.stn - Multirange Plot Trend (sysTnd06)

Station Edit WWTP View WTP Control Action Configure Help

Trend 20 | Ardice Trend | Type Multirange | Samples 240 | Interval 6 min avg



Pen on/off	Point ID	Parameter	Description	Range		value at: 12:35:51
☒	ARD_LC10040	PV	ARD GST High/Low/SP	0.00	20.00	13.820513 Ft
☐				0.00	100.00	
☐		PV		0.00	70.00	
☒	ARD_AI10030	PV	Chlorine Residue	0.00	5.00	1.4499999 ppm
☐				0.00	100.00	
☒	ARD_LI10029	PV	Ardice Tower Level	0.00	36.00	33.380768 Ft
☒	ARD_PC10029	PV	Ardice System Pres	0.00	65.00	57.307693 psi
☐				0.00	100.00	

History offset 0:00:00 Archive directory

23-Mar-01 12:36:00 Alarm ps1a Stn04 Mngr

Start | Carbon Copy 32 | Station - ps1a.stn - M... | untitled - Paint | 11:39 AM

Alarm Dialer

Pager Enable		Name	Phone No. Pager ID	Available Times Start	Stop	Available Days M	T	W	T	F	S	S	H	Page Alarms from Areas Assigned to Operator	Minimum Priority
☑	1	Electrical	9353 7234	8:00	17:00	☑	☑	☑	☑	☑	☐	☐	☐	James Burns	Urgent
☑	2	Maintenance	9283 2821	1:00	0:00	☑	☑	☑	☑	☑	☑	☑	☐	Peter Davis	Low

Message Content

- ☑ Date
- ☑ Time
- ☑ Point ID
- ☐ Alarm
- ☐ Priority
- ☐ Description
- ☑ Value
- ☑ Units
- ☐ Message Text

Specific Alarms to Page

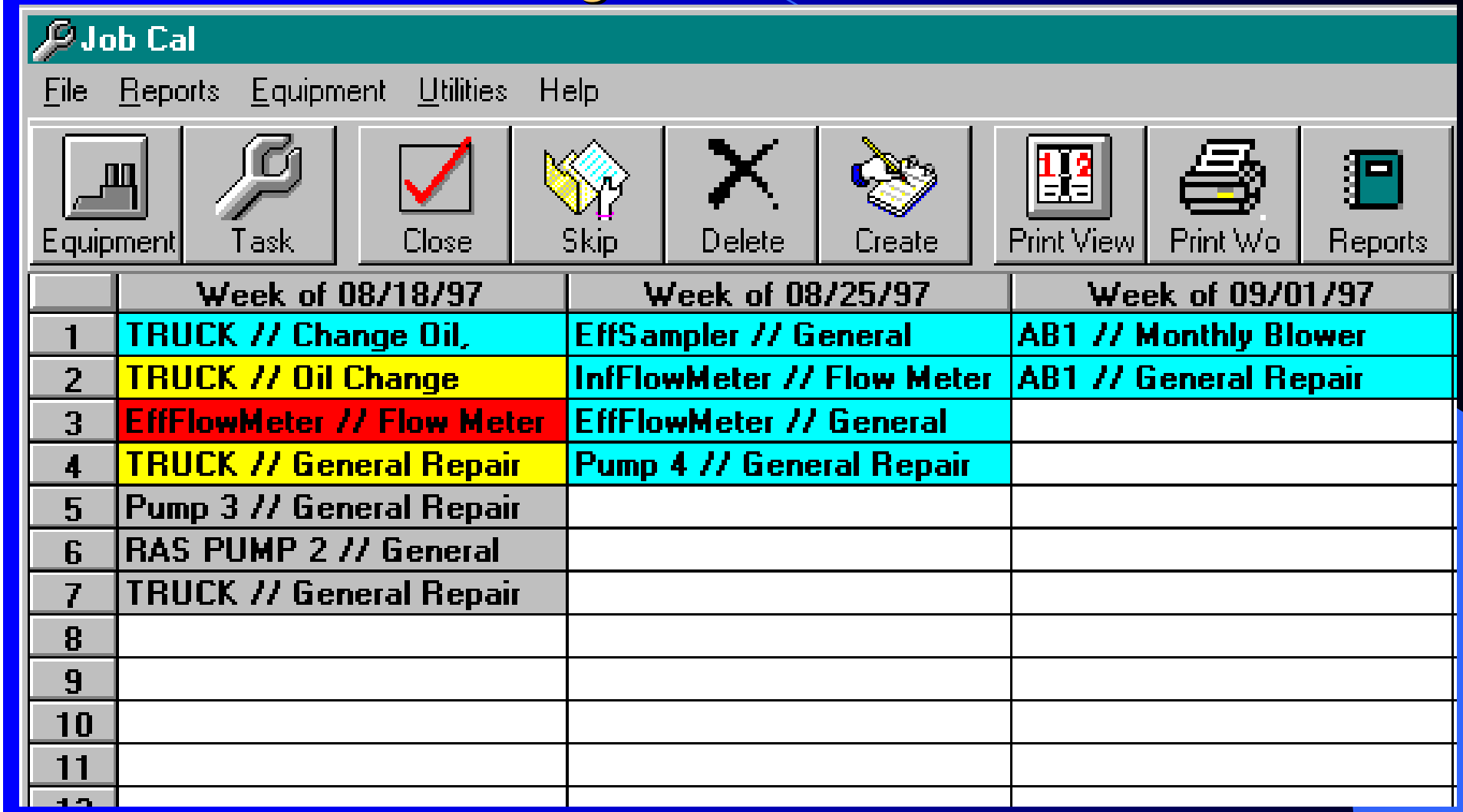
	Enable	Point ID	Minimum priority
1	☑	PANA567890123456	Urgent
2	☑	P010	Urgent

Nominated Pagers

1	2	3	4	5
Electrical				
Electrical				Electrica

REP *R.E. Pedrotti Co.*

Computerized Maintenance Management Software



	Week of 08/18/97	Week of 08/25/97	Week of 09/01/97
1	TRUCK // Change Oil,	EffSampler // General	AB1 // Monthly Blower
2	TRUCK // Oil Change	InfFlowMeter // Flow Meter	AB1 // General Repair
3	EffFlowMeter // Flow Meter	EffFlowMeter // General	
4	TRUCK // General Repair	Pump 4 // General Repair	
5	Pump 3 // General Repair		
6	RAS PUMP 2 // General		
7	TRUCK // General Repair		
8			
9			
10			
11			

REP *R.E. Pedrotti Co.*

Work Order

Edit/Close Work Order

Equipment: Car#1 -- Mazda RX8
Date Due: 06/03/2001
Task Description: Oil Change
Meter Due: 1000
Last Meter Reading/Date: 900 06/01/2001
Closing Meter Reading:
Date Complete: 07/13/2001
Assigned To: John Doe
Work Order #: 1

Labor | **Items Used** | WO Notes | Task Instructions | Equipment Notes

Item#	Qty Used	UOM	Description
10W30 Oil	4.00	Quart	10W30 Oil
Fan Belt	1.00	unit	42" Fan Belt

Add Item
Remove Item

Cost

Labor Cost	+	Inventory Cost	+	Misc Cost	=	TOTAL COST
$12.50		$17.20		0		$29.70

REP R.E. Pedrotti Co.

Reports

5/21/98 Saukville WWTP

Equipment History Report

02/01/1998 To 05/21/1998

Equipment# TRUCK Ford Truck

Location Garage

Job Description	Due Date	Date Complete	Hours	Cost	Notes
General Repair	2/26/98	2/26/98	1.00	30.00	flaT TIRE
General Repair	2/27/98	2/27/98	2.00	34.00	flat tire
General Repair	2/27/98	2/27/98	2.00	3120.00	Tail gate
Change Oil, check Tires	1/26/98	3/31/98	0.50	38.00	muffler might need
General Repair	4/2/98	4/2/98	2.00	312.00	oil leak
General Repair	4/14/98	4/14/98	0.50	38.00	flat tire
General Repair	4/15/98	4/15/98	0.50	37.50	OIL LOW
General Repair	4/15/98	4/15/98	3.00	368.00	brakes
General Repair	4/16/98	4/16/98	1.00	32,200.00	engine
Oil Change	4/13/98	4/13/98	0.70	312.00	
Totals			13.20	32,439.50	

This report shows you everything that has happened to a piece of equipment.

REP ***R.E. Pedrotti Co.***

R.E.Padratti Co.

Daily Flow Report

30-Apr-04

Print

Calc

Day	North Zone				South Zone			
	Well 1 (kGal)	Well 2 (kGal)	Well 3 (kGal)	Well 8 (kGal)	Well 5 (kGal)	Well 6 (kGal)	Well 7 (kGal)	Well 9 (kGal)
1:00 AM	0	0	0	0	0	0	0	0
2:00 AM	0	0	0	0	0	0	0	0
3:00 AM	0	0	0	0	0	0	0	0
4:00 AM	0	0	0	0	0	0	0	0
5:00 AM	0	0	0	0	0	0	0	0
6:00 AM	0	0	0	0	0	0	0	0
7:00 AM	0	0	0	0	0	0	0	0
8:00 AM	0	0	0	0	0	0	0	0
Shift Total	0	0	0	0	0	0	0	0
9:00 AM	0	0	0	0	0	0	0	0
10:00 AM	0	0	0	0	0	0	0	0
11:00 AM	0	0	0	0	0	0	0	0
12:00 PM	0	0	0	0	0	0	0	0
1:00 PM	0	0	0	0	0	0	0	0
2:00 PM	0	0	0	0	0	0	0	0
3:00 PM	0	0	0	0	0	0	0	0
4:00 PM	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!
Shift Total	0	0	0	0	0	0	0	0
5:00 PM	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!
6:00 PM	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!
7:00 PM	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!
8:00 PM	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!
9:00 PM	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!
10:00 PM	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!
11:00 PM	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!
12:00 AM	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!	INVALID!
Shift Total	0	0	0	0	0	0	0	0
DD Totalizer	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA
Total								
Average								
Maximum								
Minimum								

Page1

R.E.Pridvalli Co.

Monthly Chemical Usage Report

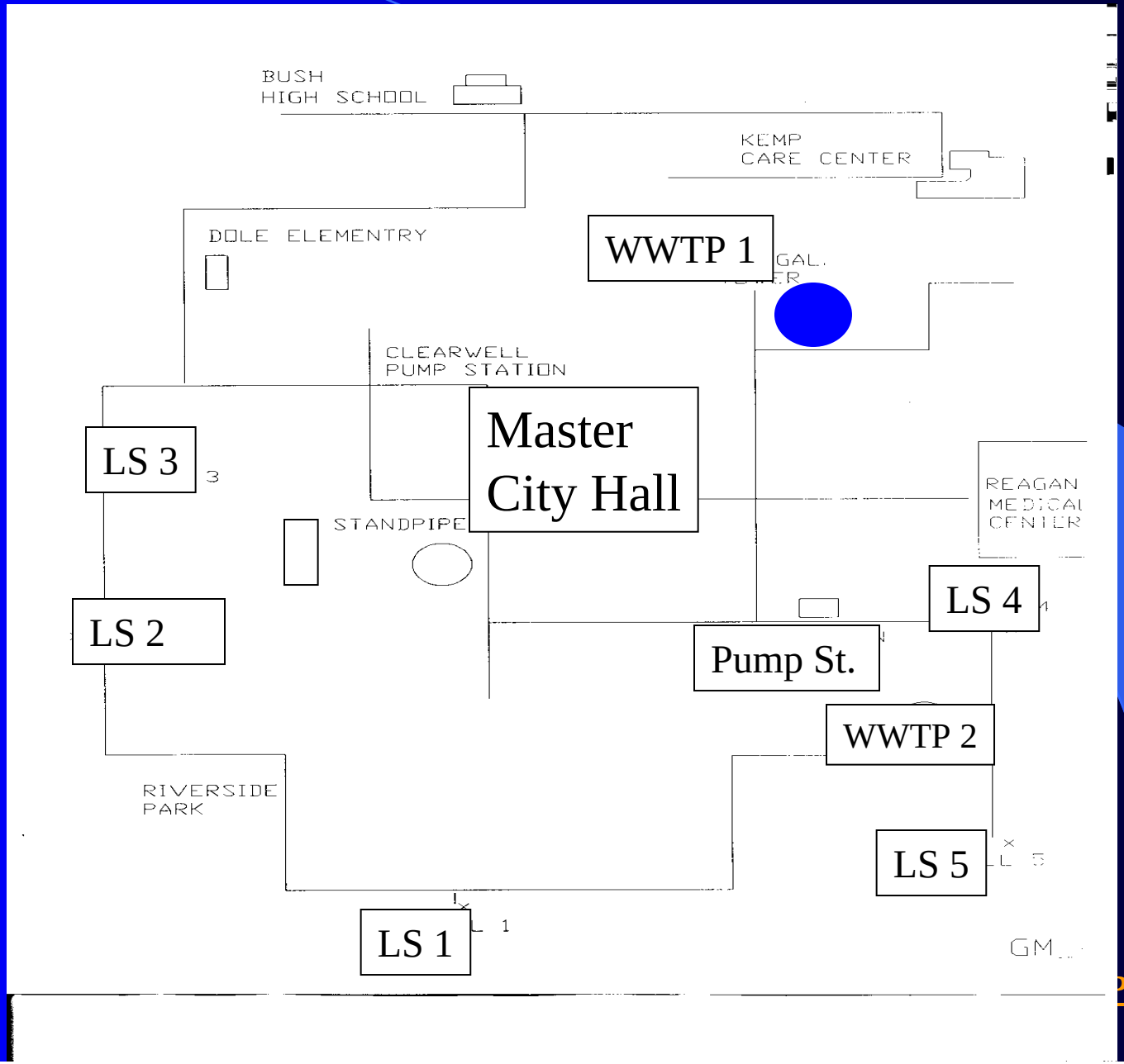
January, 2004

Print

Calc

Day	Aqua Ammonia (gals)	Lime Feed: North Feeder 1 (lbs)	Lime Feed: South Feeder 2 (lbs)	Ferric Sulfate Feeder 1 (lbs)	Ferric Sulfate Feeder 2 (lbs)	Chlorine Feed: Feeder 1 Inferred Gas Flow (lbs)	Chlorine Feed: Feeder 2 Inferred Gas Flow (lbs)	Chlorine Feed: Feeder 3 Inferred Gas Flow (lbs)	Chlorine Feed: Feeder 4 Inferred Gas Flow (lbs)	Chlorine Feed: Combined Inferred Gas Flow (lbs)
1	0.0	2,665.0	127,281.5	66,925.5	66,925.5	0.0	0.0	10.0	0.0	10.
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	10.
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	5.
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.4	0.0	7.4
6	5.2	Regular Flow	Regular Flow	Regular Flow	Regular Flow	0.0	0.0	7.7	0.0	7.7
7	15.0	50.2	5,385.6	0.0	115.4	0.0	0.0	6.0	0.0	6.
8	16.0	50.2	4,347.7	0.0	124.4	0.0	0.0	6.0	0.0	6.
9	17.0	50.2	4,345.7	0.0	124.4	0.0	0.0	6.0	0.0	6.
10	18.0	51.6	4,188.0	0.0	125.0	0.0	0.0	5.5	0.0	5.5
11	17.0	52.2	4,118.5	0.0	124.4	0.0	0.0	4.0	0.0	4.
12	16.5	51.5	4,252.5	0.0	125.0	0.0	0.0	5.4	0.0	5.4
13	5.6	85.6	5,382.7	0.0	57.5	0.0	0.0	5.7	0.0	5.7
14	12.0	50.2	5,615.4	0.0	185.5	0.0	0.0	10.0	0.0	10.
15	0.0	51.2	5,665.0	0.0	185.6	0.0	0.0	5.0	0.0	5.
16	0.0	51.4	5,880.2	0.0	185.4	0.0	0.0	0.0	0.0	0.0
17	6.0	51.4	2,511.0	0.0	55.2	0.0	0.0	7.0	0.0	7.
18	7.0	50.2	2,587.5	0.0	51.2	0.0	0.0	0.0	0.0	0.
19	6.0	50.2	5,528.6	0.0	185.2	0.0	0.0	7.0	0.0	7.
20	5.0	51.2	5,515.5	0.0	115.5	0.0	0.0	7.0	0.0	7.
21	5.0	51.2	5,750.5	0.0	111.5	0.0	0.0	7.0	0.0	7.
22	5.0	51.2	5,554.2	0.0	112.5	0.0	0.0	6.0	0.0	6.
23	7.0	52.2	5,827.6	0.0	55.2	0.0	0.0	6.0	0.0	6.
24	6.0	52.2	2,855.7	0.0	85.7	0.0	0.0	6.0	0.0	6.
25	6.0	55.2	1,315.2	0.0	68.1	0.0	0.0	6.0	0.0	6.
26	5.7	50.7	2,258.5	0.0	78.5	0.0	0.0	8.2	0.0	8.2
27	0.0	51.2	5,525.5	0.0	187.5	0.0	0.0	11.0	0.0	11.
28	0.0	51.6	5,286.0	0.0	115.5	0.0	0.0	11.0	0.0	11.
29	7.5	85.0	5,788.6	0.0	111.4	0.0	0.0	10.4	0.0	10.4
30	0.0	85.2	5,511.5	0.0	112.5	0.0	0.0	5.0	0.0	5.
31	0.0	50.2	5,551.4	0.0	112.5	0.0	0.0	0.0	0.0	0.
EOM Totalizer	245.5	2,258.4	88,448.1	0.0	2,655.6	0.0	0.0	245.5	0.0	
Total	245.5	2,258.4	88,448.1	0.0	2,655.6	0.0	0.0	245.5	0.0	
Average	5.6	158.1	8,252.4	66,925.5	2,676.5			7.5		7.07
Maximum	17.0	2,665.0	127,281.5	66,925.5	66,925.5			11.0		11
Minimum	5.2	85.0	1,315.2	66,925.5	68.1			4.0		4

System Layout



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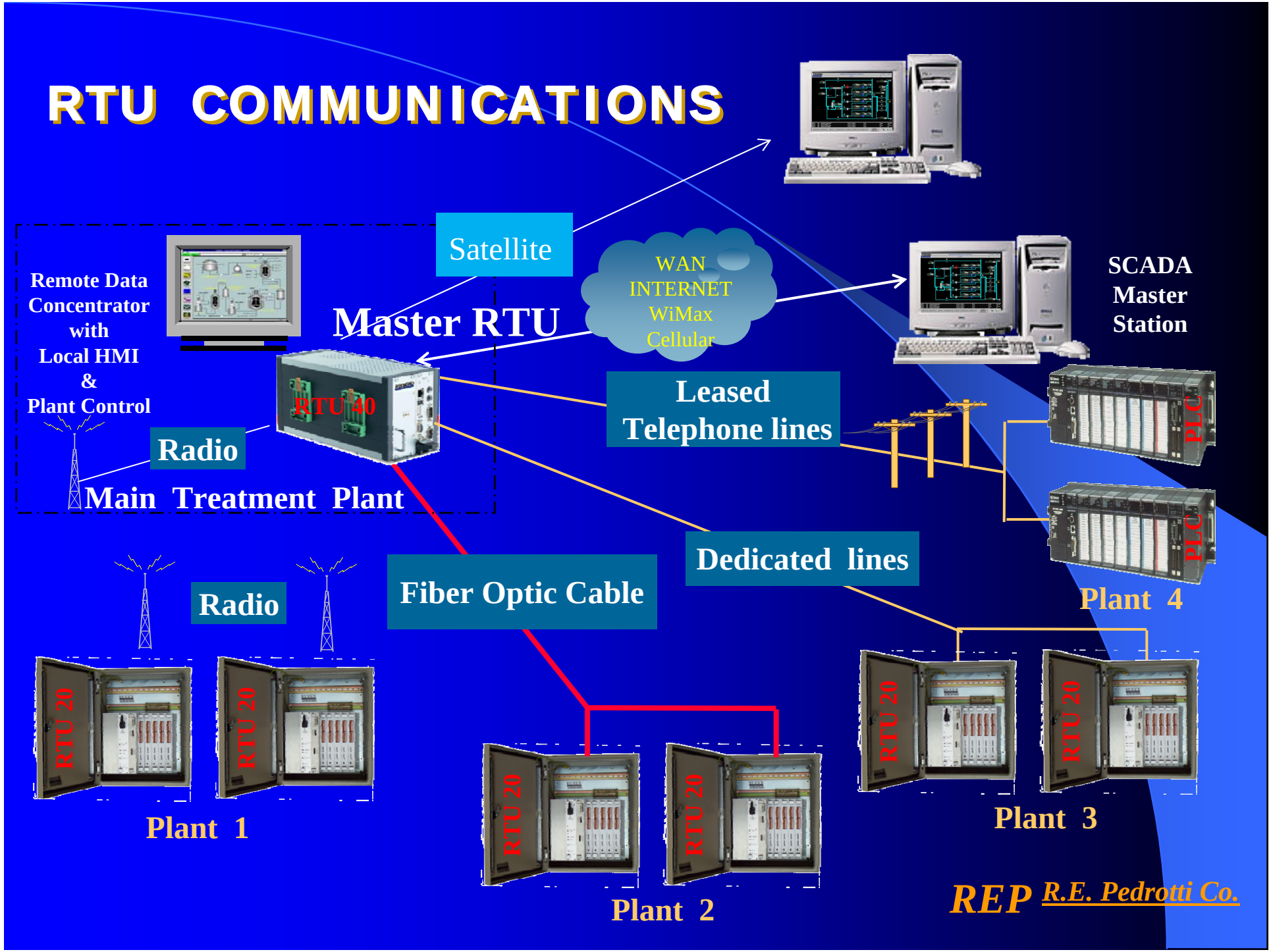
RTU COMMUNICATIONS



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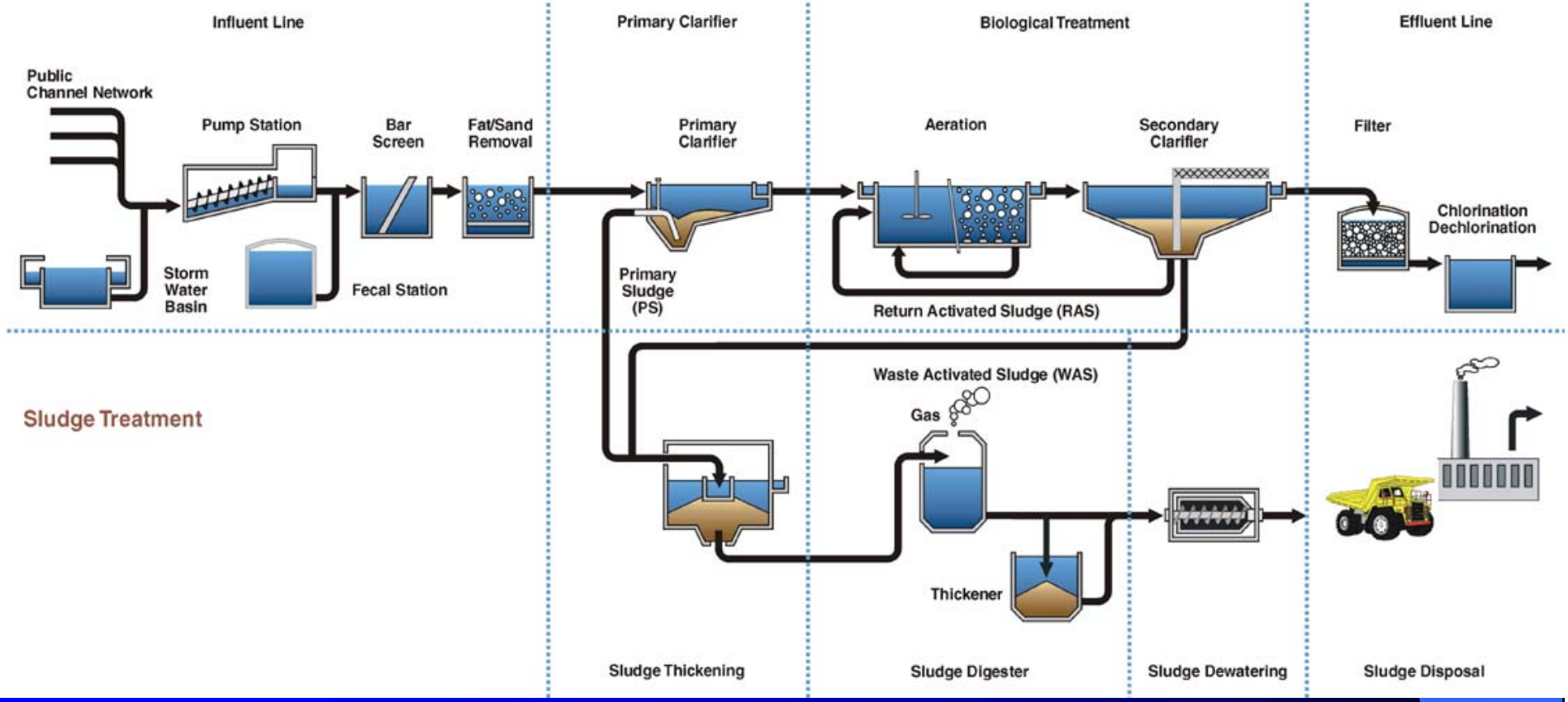
Wastewater Treatment Plant Overview

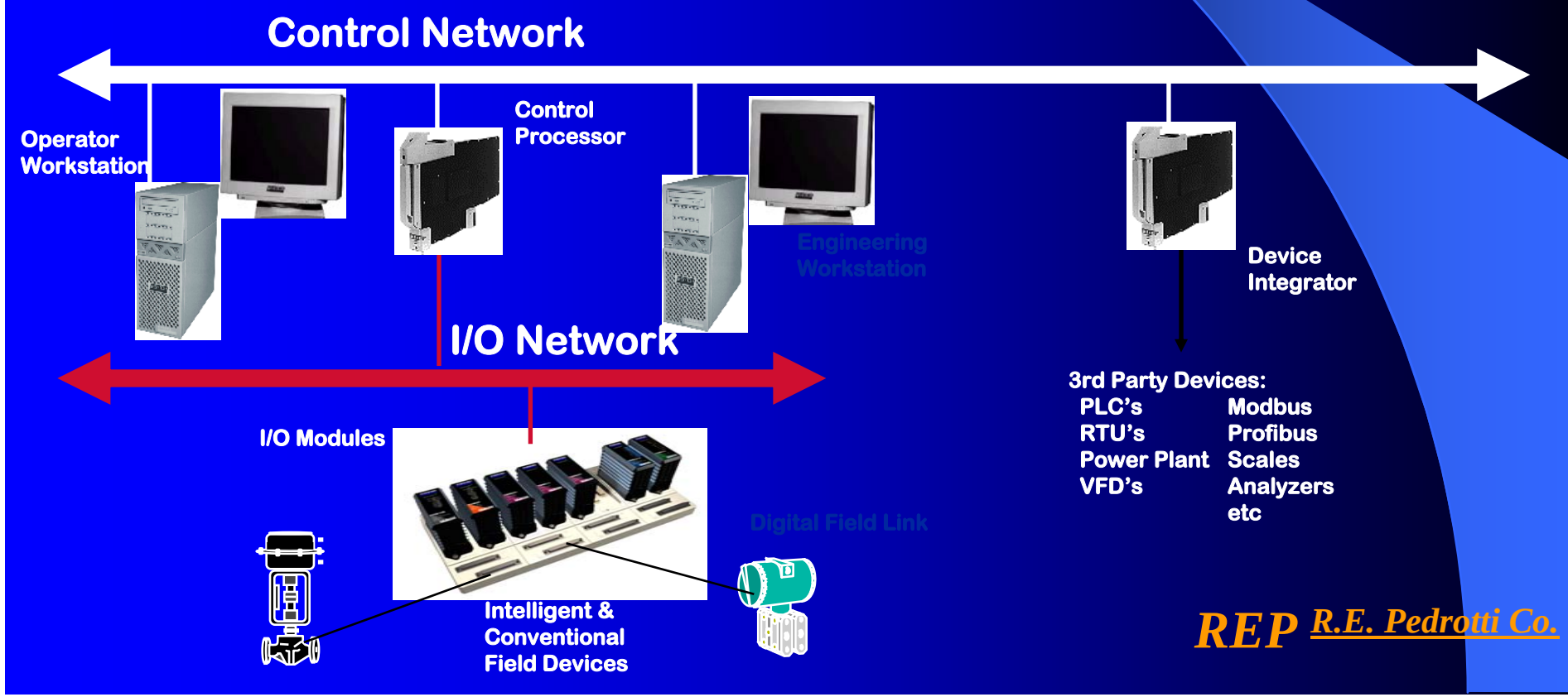
Wastewater Treatment



Desired Control & Status

- Start/Stop Pump Control & Status
- Open/Close Valve Control & Status
- Flow Monitoring
- Wetwell Level
- Discharge/Suction Pressure
- VFD Speed Control & Status
- Intrusion Alarm

Today's SCADA System



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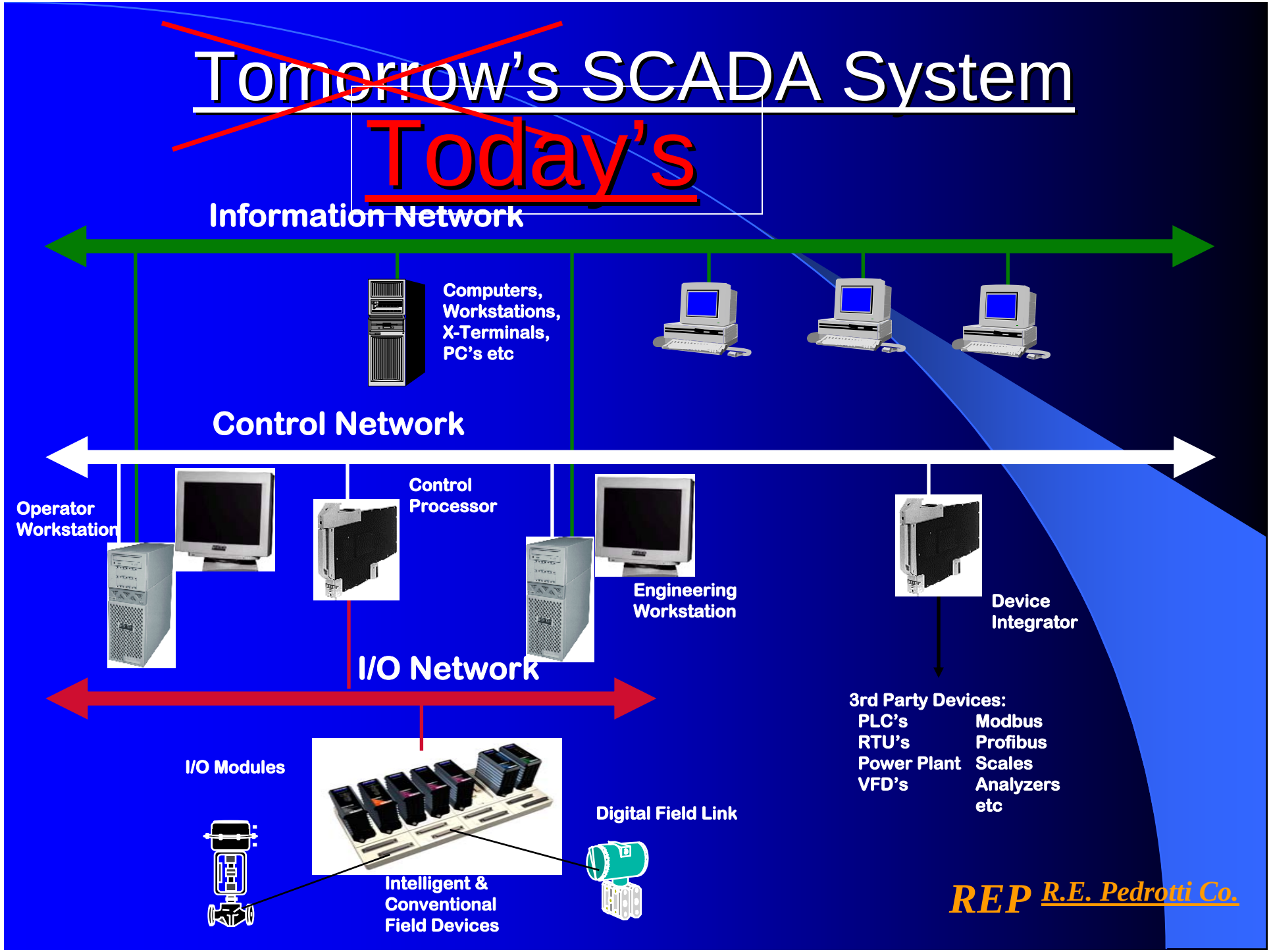
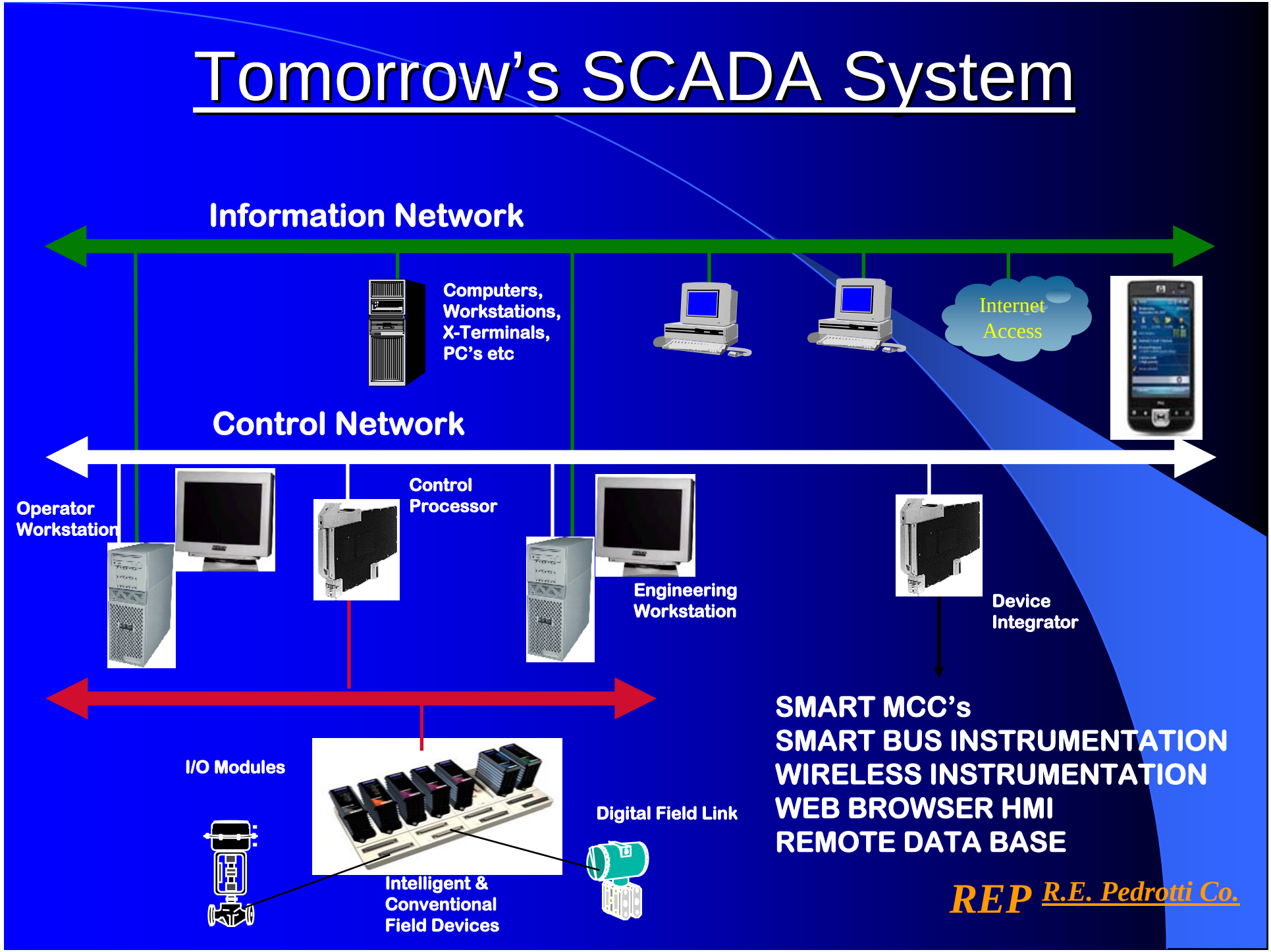
~~Tomorrow's SCADA System~~

Today's



Tomorrow's SCADA System



Remote Access

- Dial-up
- Internet
- Cellular Modems
- Cell Phone

- Remote Monitoring and Control
- Real-time customer usage

Smart Devices for Energy Efficiency

- VFD's
- MCC's
- Switchgear
- Monitor "Smart Grid"
- Smart Instrumentation and Analyzers
- Power Quality
- Power Management

Marc Pedrotti, PE

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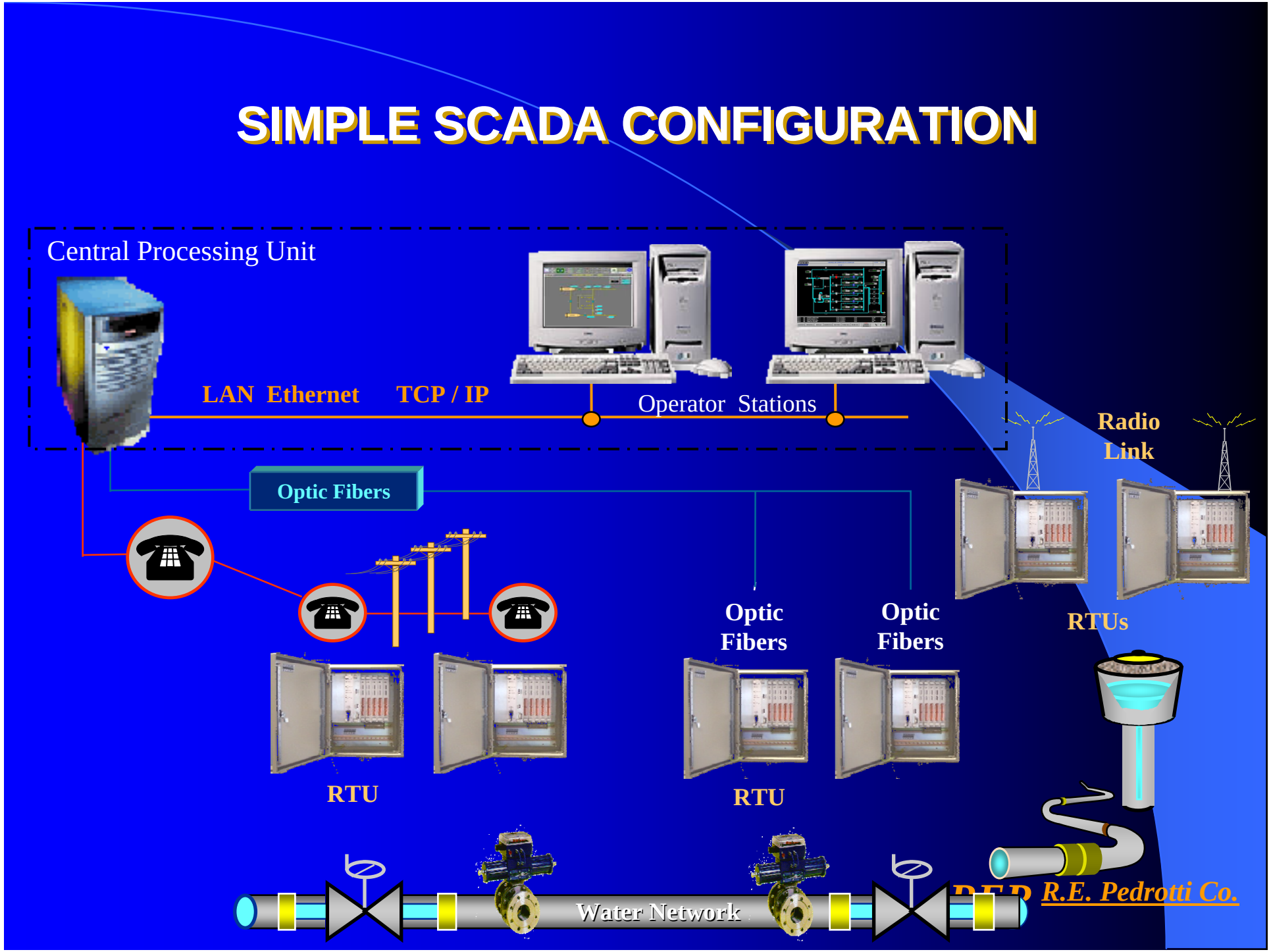
Overview

- Basics of SCADA
  - Understanding the Alphabet Soup
  - Integrating the Enterprise
- Managed Ethernet Networks
- Communication Methods
  - Radio VHF/UHF
  - Spread Spectrum and Ethernet Radios
  - Fiber Optic Communications
  - Cellular Communications
  - VoIP/RoIP Networking

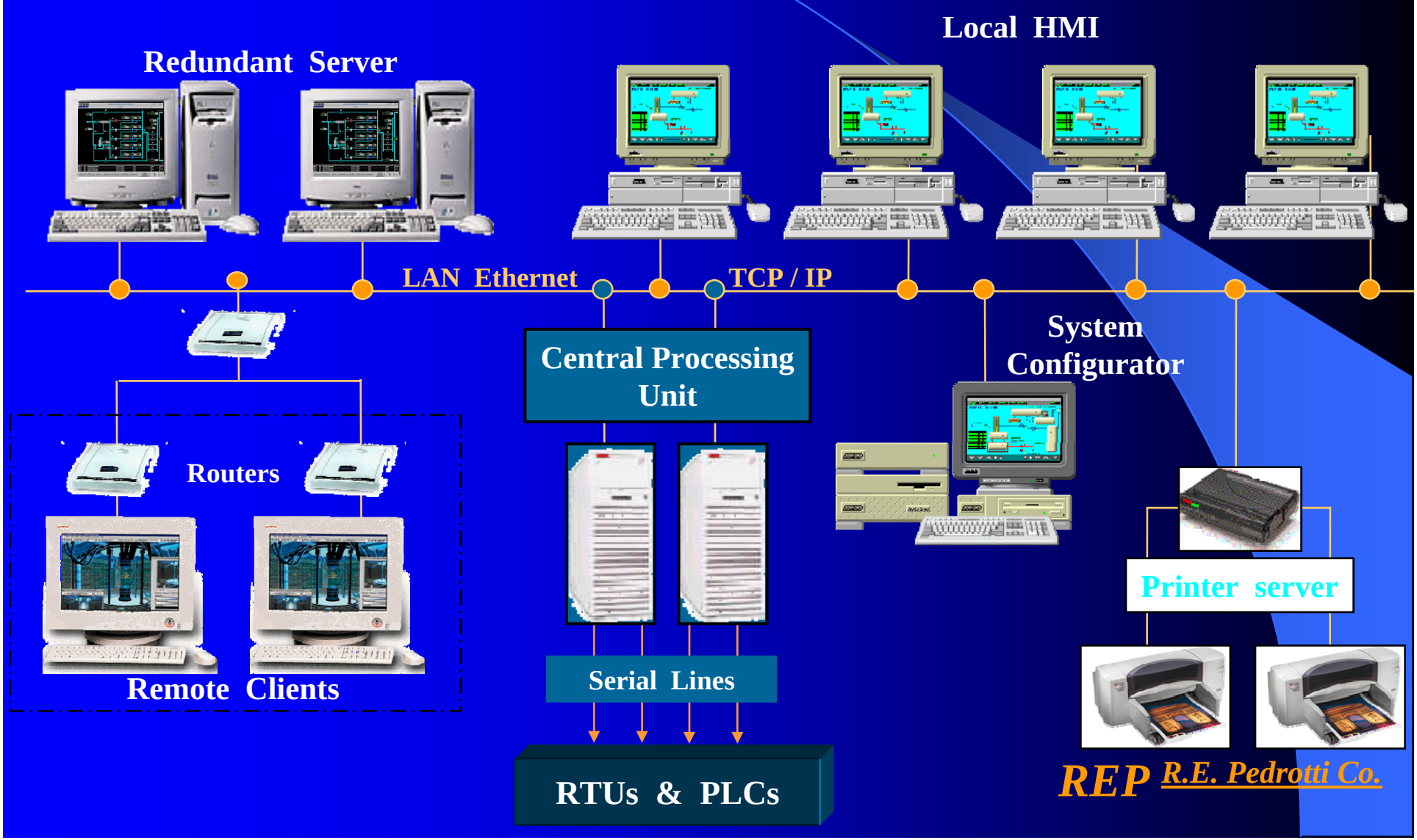
Future of SCADA

- Satellite Communication
- Infrared Communication
- Wireless Instrumentation
- Palm Pilot Interface

SIMPLE SCADA CONFIGURATION



MEDIUM SIZE SCADA MASTER STATION CONFIGURATION



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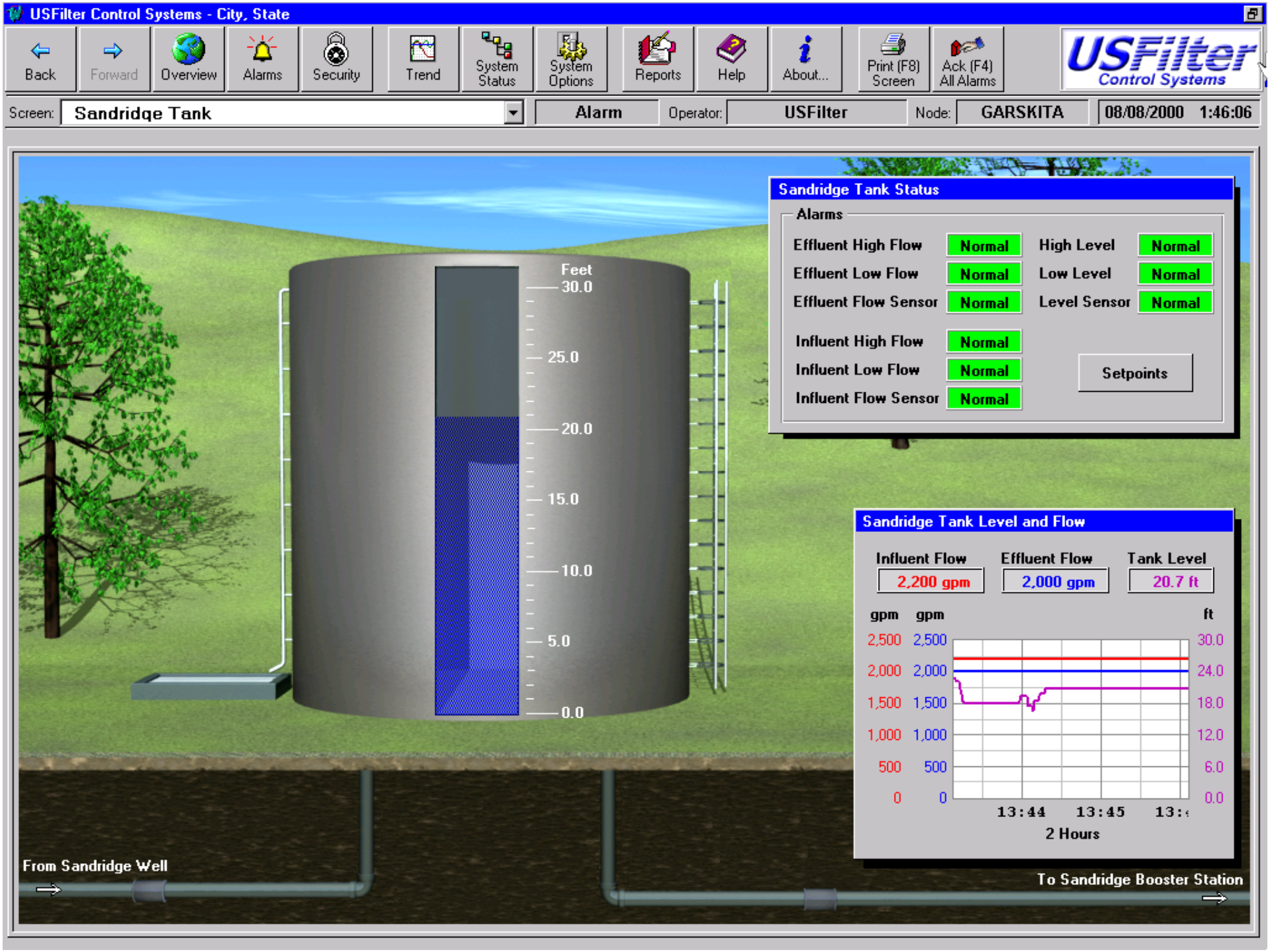
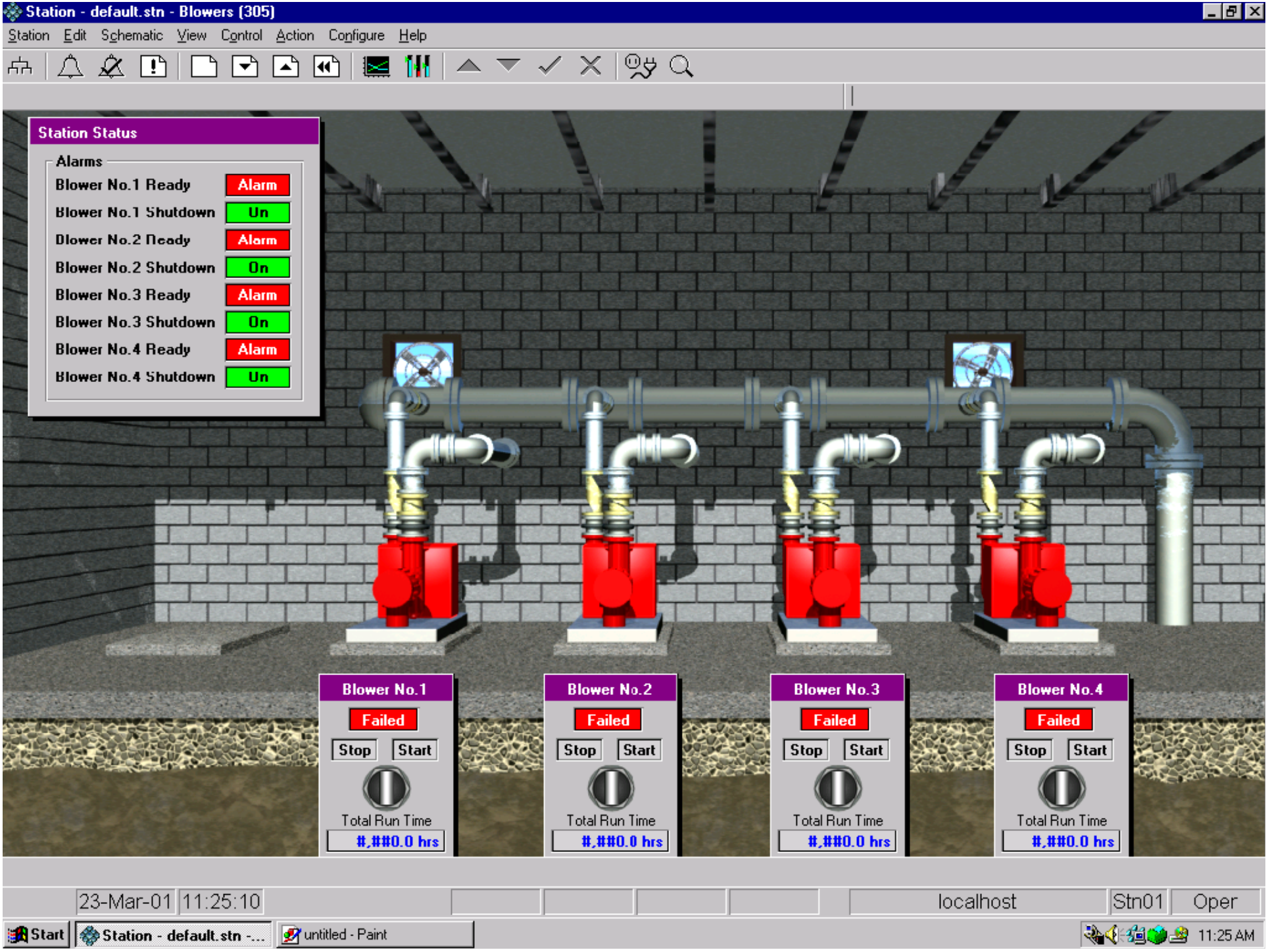
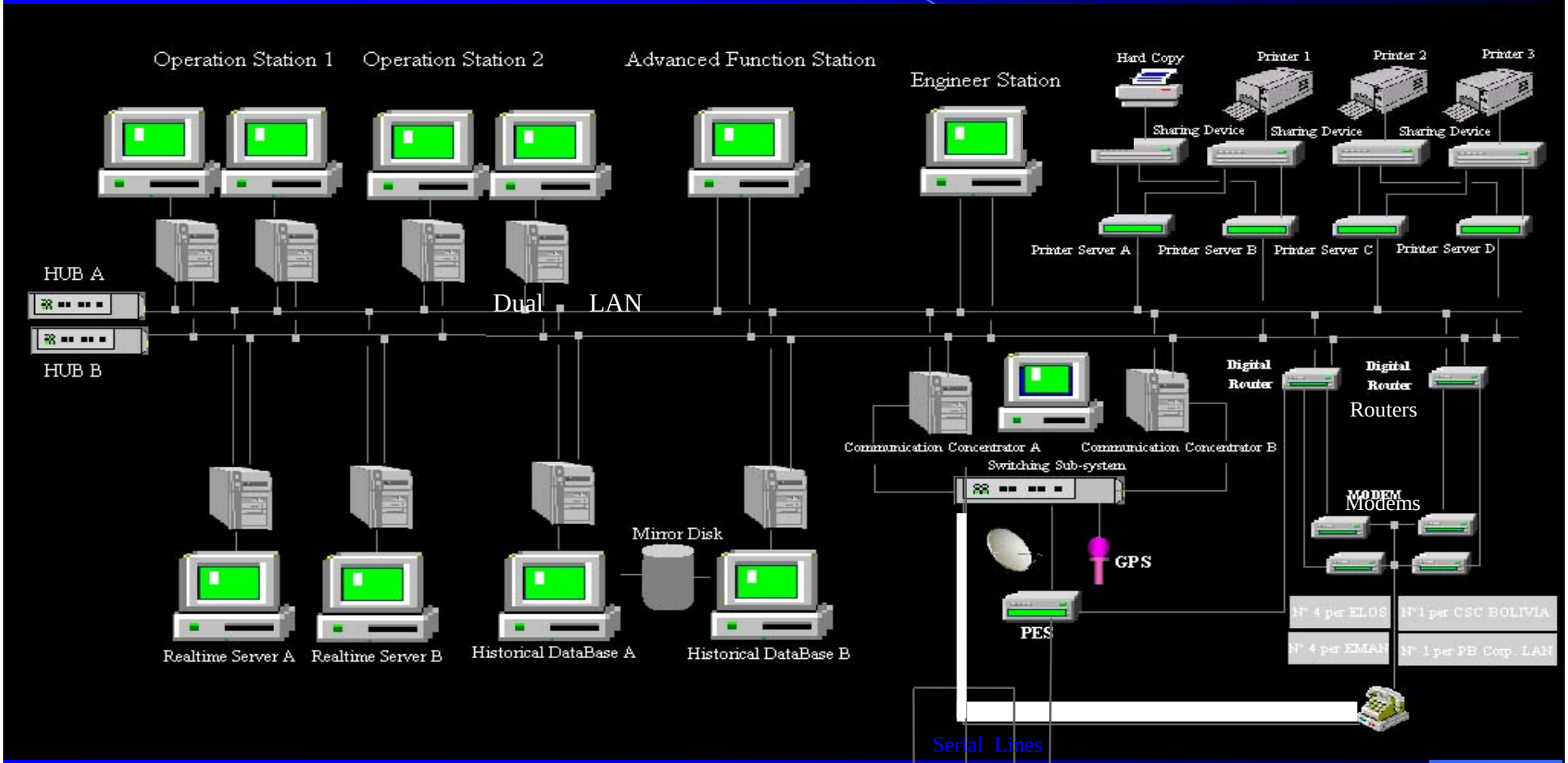

USFilter Control Systems - City, State
Back
Forward
Overview
Alarms
Security
Trend
System Status
System Options
Reports
Help
About...
Print (F8) Screen
Ack (F4) All Alarms
USFilter Control Systems
Screen: Sandridge Tank
Alarm
Operator: USFilter
Node: GARSKITA
08/08/2000 1:46:06
Sandridge Tank Status
Alarms
Effluent High Flow Normal
Effluent Low Flow Normal
Effluent Flow Sensor Normal
High Level Normal
Low Level Normal
Level Sensor Normal
Influent High Flow Normal
Influent Low Flow Normal
Influent Flow Sensor Normal
Setpoints
Feet
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Sandridge Tank Level and Flow
Influent Flow
2,200 gpm
Effluent Flow
2,000 gpm
Tank Level
20.7 ft
gpm
gpm
ft
2,500
2,000
1,500
1,000
500
0
30.0
24.0
18.0
12.0
6.0
0.0
13:44
13:45
2 Hours
From Sandridge Well
To Sandridge Booster Station


Station - default.stn - Blowers (305)
Station Edit Schematic View Control Action Configure Help
Station Status
Alarms
Blower No.1 Ready Alarm
Blower No.1 Shutdown On
Blower No.2 Ready Alarm
Blower No.2 Shutdown On
Blower No.3 Ready Alarm
Blower No.3 Shutdown On
Blower No.4 Ready Alarm
Blower No.4 Shutdown On
Blower No.1
Failed
Stop Start
Total Run Time
#,##0.0 hrs
Blower No.2
Failed
Stop Start
Total Run Time
#,##0.0 hrs
Blower No.3
Failed
Stop Start
Total Run Time
#,##0.0 hrs
Blower No.4
Failed
Stop Start
Total Run Time
#,##0.0 hrs
23-Mar-01 11:25:10
localhost
Stn01
Oper
Start
Station - default.stn -...
untitled - Paint
11:25 AM

Graphical User Interface

- Overview
- Alarm
- Trends
- Alarm Dialer Software
- Maintenance Management Software

COMPLEX SCADA MASTER STATION CONFIGURATION



RTUs & PLCs

REP R.E. Pedrotti Co.