Treatment Plant SCADA & Instrumentation

Water and Wastewater Operator’s School
August 5, 2010

Marc Pedrotti, P.E.
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
Remote Terminal Unit
Simple Discrete Control

Level Switches

Motor Starter

24VDC Output Pulses from the PLC
Analog Control

20mA Signal Input
24VDC Input Pulses into the PLC

24VDC Output Pulses from the PLC
20mA Signal Input

Analog to Digital

Motor Starter

Analog Level Sensor

Digital to Analog

Analog to Digital
Pump 1 Run
Pump 2 Run
High Level Alarm
Float Switch (Sump)
Intrusion Alarm

Wetwell Level

CR 1
CR 2

Pump 1 Start
Pump 2 Start
Introduction to Control

Programming Device

Input Table → User Program → Output Table

Data Storage

Input Devices → Input/Output System → Output Devices
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

REP R.E. Pedrotti Co.
Personal Computer and Servers

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

20 CHARACTER DISPLAY

KEY:
- OFFLINE
- SAVE LOAD
- QUICK ALL
- CHANGE ENABLE
- CHANGE STATE
- CLEAR
- NEXT
- ENTER
- COMM FAILS
- POWER FAILS
- ADDR ERRORS
- ROTATE
- CURR ALARMS
- ACK ALARMS
- ACK
- LOCATE
- LEVELS
- ANLGs
- FLOWS
- TOOL
- VALVES
- POINTS
- POINTS 1
- STATION
- PUMPS
- ALTRES
- TOTALS
- CB
HMI Software

- Wonderware
- Intellution
- RS View
- Foxboro I/A
- Factory Link
North Zone: Tower and Well 8

COMM FAIL!

Well and Tower 3

Tower Level (24 hr)

<table>
<thead>
<tr>
<th>Tower Level</th>
<th>140</th>
<th>125</th>
<th>110</th>
<th>1200</th>
</tr>
</thead>
</table>

Flowrate (24 hr)

| Flowrate | 600 | 0 | 0 | 0 |

Well Drawdown Level (24 hr)

<table>
<thead>
<tr>
<th>Well Drawdown Level</th>
<th>350</th>
<th>175</th>
<th>0</th>
</tr>
</thead>
</table>
## Computerized Maintenance Management Software

The image displays a screenshot of a job calendar software interface. The software is used for maintaining records of equipment tasks and repairs. The interface includes options for equipment, task, close, skip, delete, create, print view, print work, and reports.

### Job Calendar

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Task Description</th>
<th>Equipment</th>
<th>Task Description</th>
<th>Equipment</th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TRUCK // Change Oil</td>
<td>EffSampler // General</td>
<td>AB1 // Monthly Blower</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>TRUCK // Oil Change</td>
<td>InfFlowMeter // Flow Meter</td>
<td>AB1 // General Repair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>EffFlowMeter // Flow Meter</td>
<td>EffFlowMeter // General</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>TRUCK // General Repair</td>
<td>Pump 4 // General Repair</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Pump 3 // General Repair</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>RAS PUMP 2 // General</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>TRUCK // General Repair</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Work Order

Equipment: Car#1 -- Mazda RX8
Date Due: 06/03/2001

Task Description: Oil Change

Last Meter Reading/Date: 900 06/01/2001

Date Complete: 07/13/2001

Assigned To: John Doe

Work Order #: 1

<table>
<thead>
<tr>
<th>Item#</th>
<th>Qty Used</th>
<th>UOM</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10W30 Oil</td>
<td>4.00</td>
<td>Quart</td>
<td>10W30 Oil</td>
</tr>
<tr>
<td>Fan Belt</td>
<td>1.00</td>
<td>unit</td>
<td>42&quot; Fan Belt</td>
</tr>
</tbody>
</table>

Labor Cost: $12.50 + Inventory Cost: $17.20 + Misc Cost: 0 = TOTAL COST: $29.70
This report shows you everything that has happened to a piece of equipment.
## Daily Flow Report

### 30-Apr-04

<table>
<thead>
<tr>
<th></th>
<th>North Zone</th>
<th>South Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9:00 AM</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10:00 AM</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>11:00 AM</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12:00 PM</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1:00 PM</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2:00 PM</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3:00 PM</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4:00 PM</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5:00 PM</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6:00 PM</td>
<td>INVALID!</td>
<td>INVALID!</td>
</tr>
<tr>
<td>7:00 PM</td>
<td>INVALID!</td>
<td>INVALID!</td>
</tr>
<tr>
<td>8:00 PM</td>
<td>INVALID!</td>
<td>INVALID!</td>
</tr>
<tr>
<td>Shift Total</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Average

<table>
<thead>
<tr>
<th></th>
<th>North Zone</th>
<th>South Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NDA</td>
<td>NDA</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Monthly Chemical Usage Report
### January, 2004

<table>
<thead>
<tr>
<th>Day</th>
<th>Lime Feed</th>
<th>Chlorine Feed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.0</td>
<td>2,560.0</td>
</tr>
<tr>
<td>2</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>3</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>4</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>5</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>6</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>7</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>8</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>9</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>10</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>11</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>12</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>13</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>14</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>15</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>16</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>17</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>18</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>19</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>20</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>21</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>22</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>23</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>24</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>25</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>26</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>27</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>28</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>29</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>30</td>
<td>0.0</td>
<td>8.0</td>
</tr>
<tr>
<td>31</td>
<td>0.0</td>
<td>8.0</td>
</tr>
</tbody>
</table>

**TOTALS:**
- **Lime Feed:**
  - Aqua Ammonia [gals]: 243.5
  - North Feeder 1 [lbs]: 2,320.4
  - South Feeder 2 [lbs]: 88,604.1
  - Ferric Sulfate Feeder 1 [lbs]: 2,332.0
  - Ferric Sulfate Feeder 2 [lbs]: 88,604.1
  - Combined Inferred Gas Flow [lbs]: 249.5

- **Chlorine Feed:**
  - North Feeder 1 [lbs]: 2,332.0
  - South Feeder 2 [lbs]: 88,604.1
  - Ferric Sulfate Feeder 1 [lbs]: 2,332.0
  - Ferric Sulfate Feeder 2 [lbs]: 88,604.1
  - Combined Inferred Gas Flow [lbs]: 249.5

- **Average:**
  - Aqua Ammonia [gals]: 8.0
  - North Feeder 1 [lbs]: 8.0
  - South Feeder 2 [lbs]: 8.0
  - Ferric Sulfate Feeder 1 [lbs]: 8.0
  - Ferric Sulfate Feeder 2 [lbs]: 8.0
  - Combined Inferred Gas Flow [lbs]: 8.0
RTU COMMUNICATIONS

- Remote Data Concentrator with Local HMI & Plant Control
- Master RTU
- Satellite
- WAN
  - INTERNET
  - WiMax
  - Cellular
- Leased Telephone lines
- Dedicated lines
- Fiber Optic Cable
- Radio

Main Treatment Plant

RTU 20

Plant 1

Plant 2

Plant 3

Plant 4

SCADA Master Station

REP R.E. Pedrotti Co.
Wastewater Treatment Plant Overview

**Wastewater Treatment**

- Influent Line
  - Public Channel Network
  - Pump Station
  - Storm Water Basin
  - Bar Screen
  - Fat/Sand Removal
  - Fecal Station
  - Primary Clarifier
  - Primary Sludge (PS)
  - Return Activated Sludge (RAS)
  - Biological Treatment
  - Aeration
  - Secondary Clarifier
  - Filter
  - Chlorination Dechlorination

**Sludge Treatment**

- Sludge Thickening
- Sludge Digester
- Sludge Dewatering
- Sludge Disposal
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

Control Network

I/O Network

Operator Workstation

Control Processor

Engineering Workstation

Device Integrator

3rd Party Devices:
- PLC’s
- RTU’s
- Power Plant
- VFD’s
- Modbus
- Profibus
- Scales
- Analyzers
- etc

Intelligent & Conventional Field Devices

Digital Field Link

REP R.E. Pedrotti Co.
Today’s SCADA System

Information Network

Control Network

I/O Network

Tomorrow’s SCADA System

3rd Party Devices:
- PLC’s
- RTU’s
- Power Plant
- Scales
- VFD’s
- Analyzers
- etc

Intelligent & Conventional Field Devices

Computers, Workstations, X-Terminals, PC’s etc

Operator Workstation

Control Processor

Engineering Workstation

I/O Modules

Digital Field Link

Device Integrator
Tomorrow’s SCADA System

Information Network
- Computers, Workstations, X-Terminals, PC’s etc
- Internet Access

Control Network
- Operator Workstation
- Control Processor
- Engineering Workstation
- Device Integrator

I/O Modules
- Intelligent & Conventional Field Devices

Smart MCC’s
- SMART BUS INSTRUMENTATION
- WIRELESS INSTRUMENTATION
- WEB BROWSER HMI
- REMOTE DATA BASE
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

REP R.E. Pedrotti Co.
Marc Pedrotti, PE
R.E. Pedrotti Company, Inc.
Mission, Kansas
(913) 677-3366
marcp@repedrotti.com
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

Central Processing Unit

LAN Ethernet TCP/IP

Operator Stations

Optic Fibers

RTUs

Radio Link

Optic Fibers

RTUs

Optic Fibers

Water Network
MEDIUM SIZE SCADA MASTER STATION CONFIGURATION

- Redundant Server
- Central Processing Unit
- Serial Lines
- RTUs & PLCs
- Printer server
- Local HMI
- System Configurator
- Remote Clients
- Routers
- LAN Ethernet
- TCP/IP
Graphical User Interface

- Overview
- Alarm
- Trends
- Alarm Dialer Software
- Maintenance Management Software
COMPLEX SCADA MASTER STATION CONFIGURATION

- Modems
- Routers
- RTUs & PLCs
- Dual LAN
- Serial Lines
- HUB A
- HUB B
- Operation Station 1
- Operation Station 2
- Advanced Function Station
- Engineer Station
- Hard Copy
- Printer 1
- Printer 2
- Printer 3
- Sharing Device
- Mirror Disk
- Communication Concentrator A
- Switching Sub-system
- Communication Concentrator B
- Digital Router
- Models
- GPS
- PES
- Serial Lines
- RTUs & PLCs

REP R.E. Pedrotti Co.