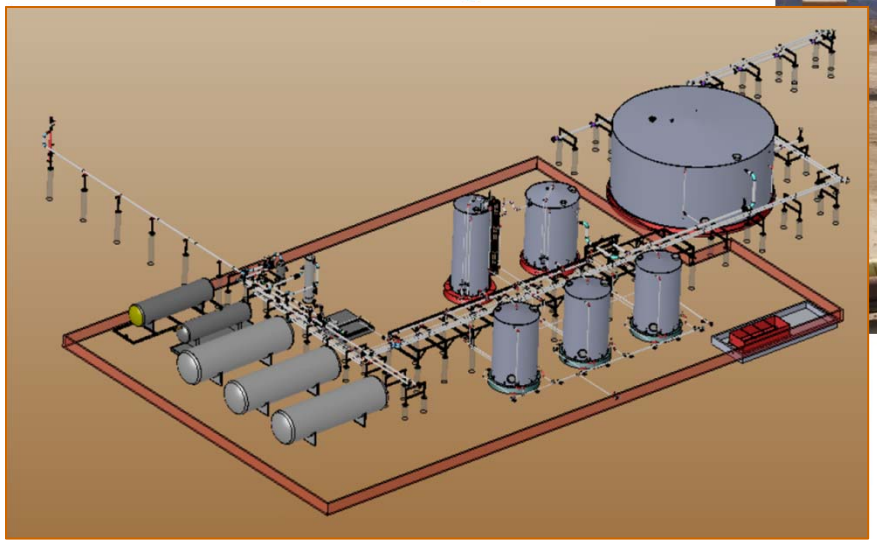
InterAct

Integrating Applied Technology in the Design and Installation of a Solar Powered, Wireless Tank Control System



Jeff Hall, B.S.I.T.
Senior Project Manager

Kern County Oil Processing Facility Expansion

- **Independent Start-Up Oil Company**
  - **Limited Engineering and Project Management Capability**
- **InterAct Technical Solution Provider**
  - **Problem**
    - ***Prevent Water Tank Overflow on 24/7 basis with 8/5 Operation***
  - **Solution**
    - ***Design and install a remote, self-contained tank monitoring and water control system***

Temporary 500 bbl Injection Water Tanks

New 10,000 bbl Injection Water Tank

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Statement of Work

- **Objectives**
  - Integrate Process Logic Control (PLC) with low voltage, solar powered, tank and pump controls to maintain equilibrium in a water disposal tank.
  - Remote alarm notification to operators via cell phone, prior to well pump shut down.

- **Deliverables**
  - Process and Instrument Diagram (P&ID)
  - Electrical Load Calculations (kW/Day)
  - Control Logic Spreadsheet
  - Component Specification
  - Purchasing Budget
  - Implementation Schedule
  - Operation Manual

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Wireless Control Research

- **Existing Wireless Instrument Systems**
  - Wireless 900 MHz radio telemetry is predominant for linking remote pumps and tanks in water distribution systems.
    - **Applications**
      - •Municipal Water & Wastewater
      - •Reservoir Control
      - •Oil & Gas Waste Disposal
    - **Features & Specs**
      - •License-free 900 MHz
      - •20 Mile Range
      - •Analog and Digital I/O
      - •10 to 28 VDC Power

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Wireless Communication Research

- **Cellular Service Option**
  - Remote location did not offer reliable cell phone service for notifying operators of water tank alarm levels.
- **Satellite Internet Service**
  - Utilize existing satellite service to access Internet and send Short Message Service (SMS) text message to operators cell phone
- **Ethernet Modem**
  - Wireless 2.4 GHz telemetry provides local area network (LAN) connection between tank control PLC and field office PC.
    - **Features & Specs**
      - 802.11b WiFi Compliant
      - Range 6 miles Line of Sight
      - Data Encryption

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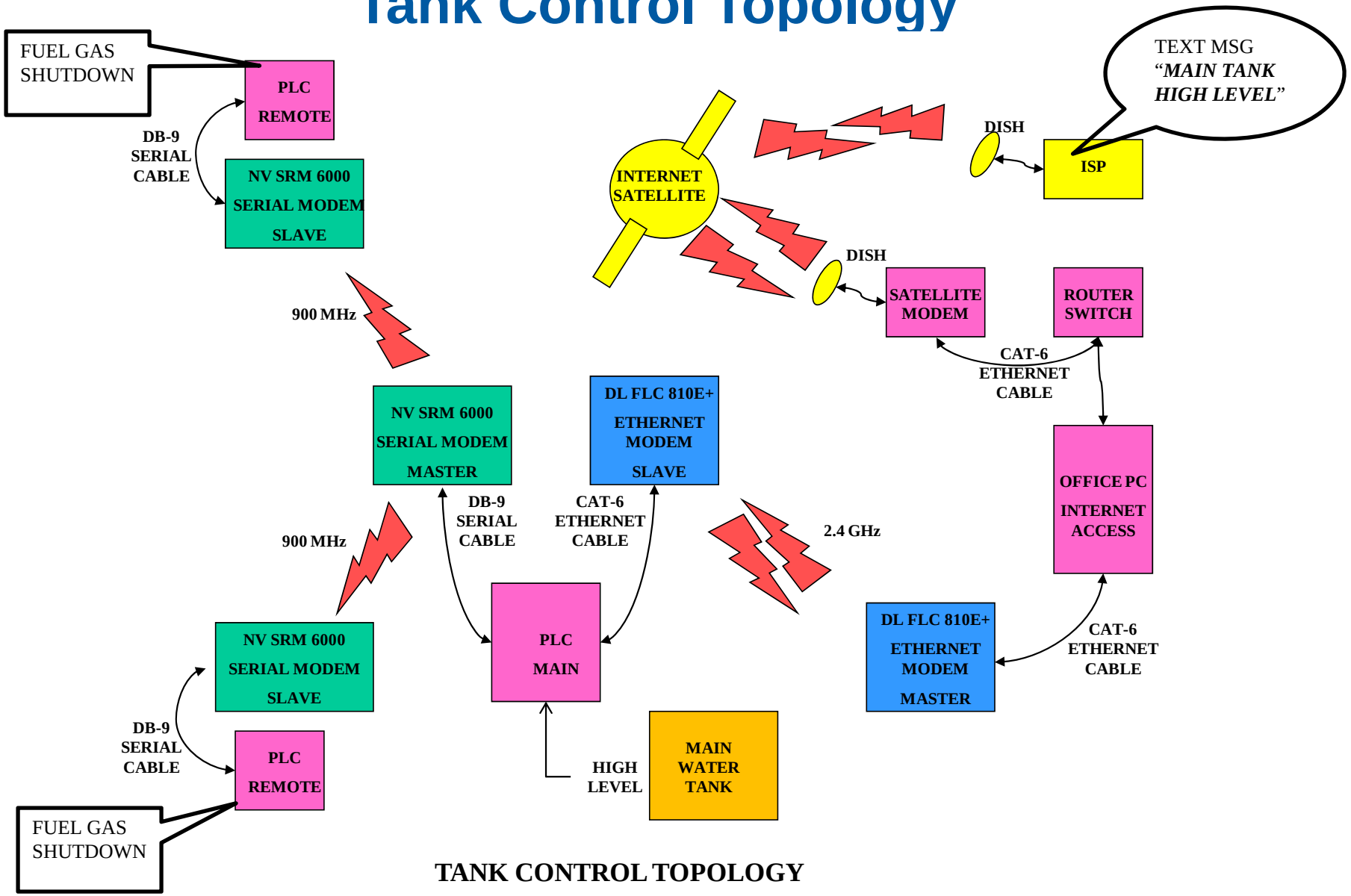
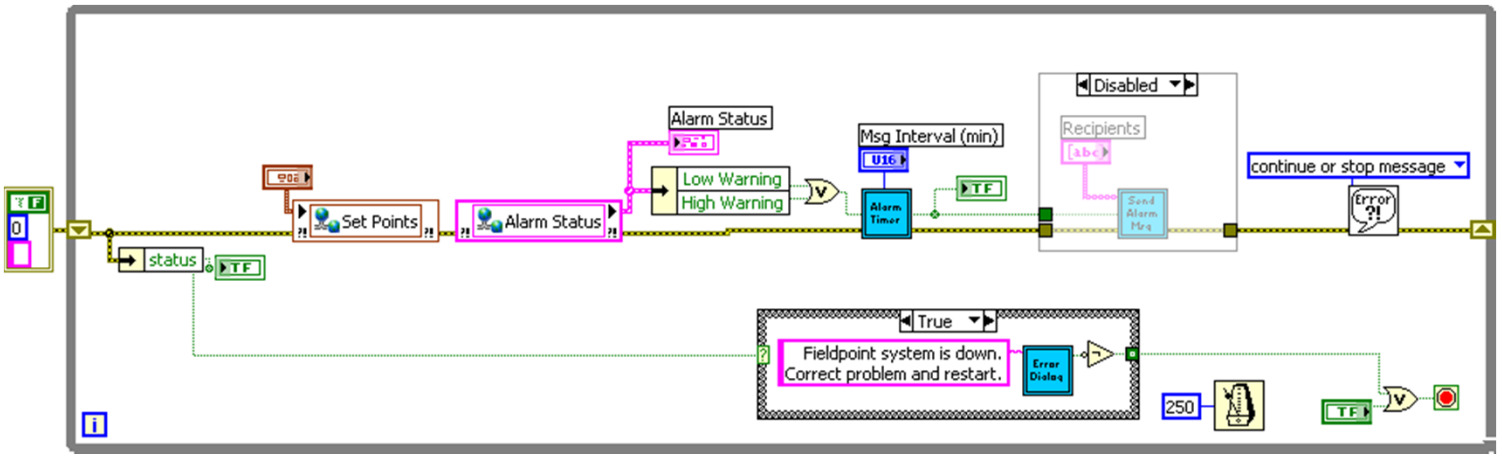
Tank Control Topology



TANK CONTROL TOPOLOGY

Process Logic Control Research

- **Rockwell Automation by Allen Bradley**
  - Expensive component cost and education requirements to develop control logic lead to research cost effective PLC solution
- **Lab VIEW by National Instruments**
  - Competitive hardware cost with low power consumption
  - Graphic based, drag and drop style programming
  - Sales Engineering Support



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Power Consumption Calculations

- **Main Tank System**
  - 24 Amp/Hr/Day (24Watts @ 24Vdc = 1 Amp x 24Hr)
    - Controller 6.1 W
    - Relay 3.0 W
    - I/O Module 0.5 W
    - 900 MHz Modem 4.8 W
    - 2.4 GHZ Modem 4.8 W
    - Level Transmitter 3.6 W

- **Remote Stations**
  - 18 Amp/Hr/Day (9 Watts @ 12Vdc = .75 Amp x 24 Hr)
    - Modem 4.8 W
    - RS 232 Module 1.0 W
    - 422 Relay 1.75 W
    - Solenoid (10% Duty) 1.0 W

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Solar Power System Research

- **OKSolar.com**
  - Limited Configuration Information
  - Limited Load Configurations
    - 2.5A 24 Vdc system cost $2,250
    - 50A 24 Vdc system cost $22,500

- **SunWize Technologies**
  - Global Insolation map to calculate peak winter sun hours based on latitude and longitude
  - Fully integrated power supply and battery for 99.9% reliability
  - Multiple web-based configuration options
    - 12V, 120 Amp/hr system $1,997
    - 24V, 252 Amp/hr system $5,767

SW Part Number:
PR720

Application:
Water Level Monitoring System

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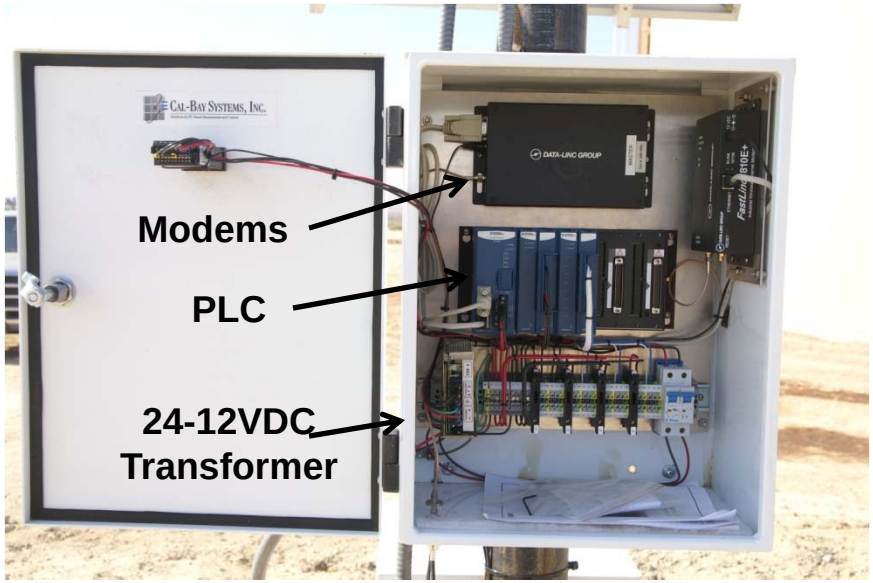
Tank Control System Installation

- **Solar Powered Tank Monitoring System**
  - Monitors water level and controls pump speed to maintain setpoint
  - Shuts down fuel gas to wells at high water alarm levels

Wiring the Ultrasonic Level Transmitter for Calibration



LabVIEW PLC with Wireless Modems for Communication

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Process Logic Control Requirements

- **Variable Set-Points with PLC Control Functions**
  - Low Alarm Level
    - Shut down all injection pumps
    - Turn on Yellow and Red Flashing Lights
  - Low & High Warning Levels
    - Send SMS text message to operator cell phone
    - Turn on Yellow Flashing Light
  - Low Pump Limit Level
    - Switch injection pump speed to SLOW
  - High Pump Limit Level
    - Switch injection pump speed to FAST
  - High Alarm Level
    - Shutdown #1 remote fuel gas valve and stop (12) wells
    - Turn on Yellow and Red Flashing Lights
  - High-High Alarm Level
    - Shutdown #2 remote fuel gas valve to stop (12) additional wells
    - Turn on Yellow and Red Flashing Lights

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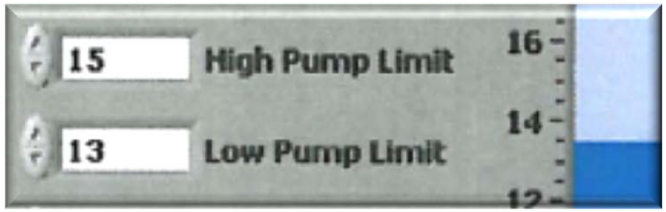
Tank Level Control System

- **PLC Pump Speed Control**
  - User defined setpoint for low and high engine speed
  - PLC controls Murphy throttle positioner
  - Maintains tank level within 2 ft hysteresis

Graphic User Interface



Water Injection Engines with PLC Speed Control

Main Panel with SunWize 24VDC Solar Array

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Remote Fuel Control System

- **Wireless Communication**
  - Main panel sends shutdown signal to remote panels
  - Remote Panels are 12VDC solar powered
  - Control valves use supply gas to operate

Remote Panel behind Fuel Gas Shutdown Station

Wireless Link

Main Panel with SunWize 24VDC Solar Array

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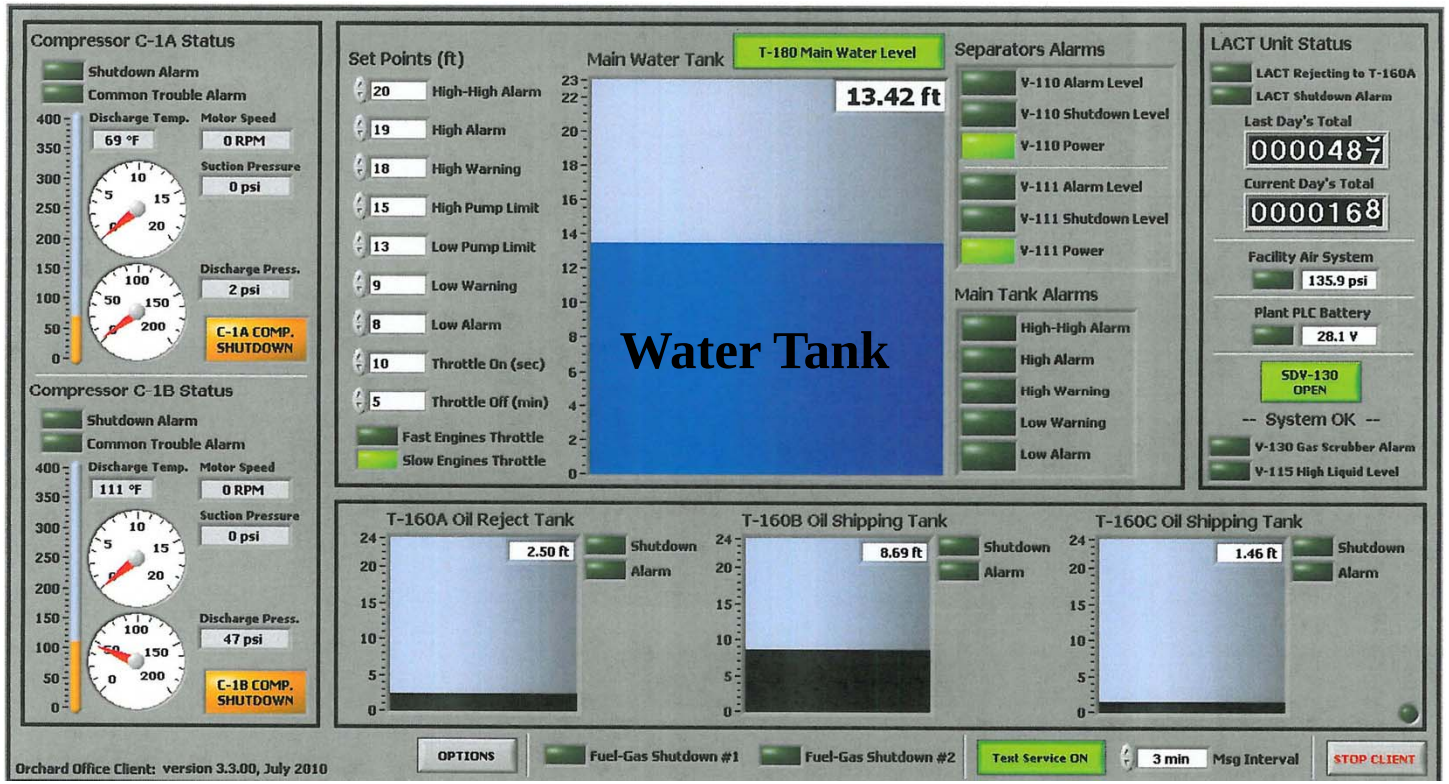
Tank Control System GUI

- **Remote Process Monitoring**
  - Graphic User Interface via PC link to PLC provides real time process monitoring at the facility and remote locations with Internet access.



LACT

Compressors

Oil Tanks

Text Msg Control

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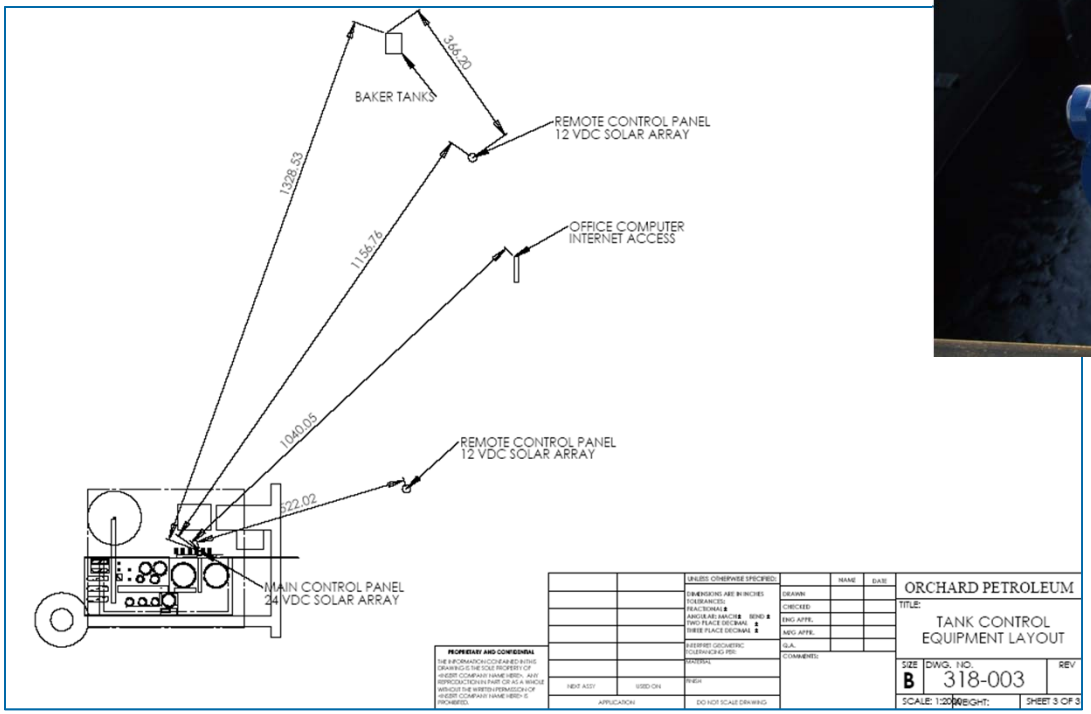
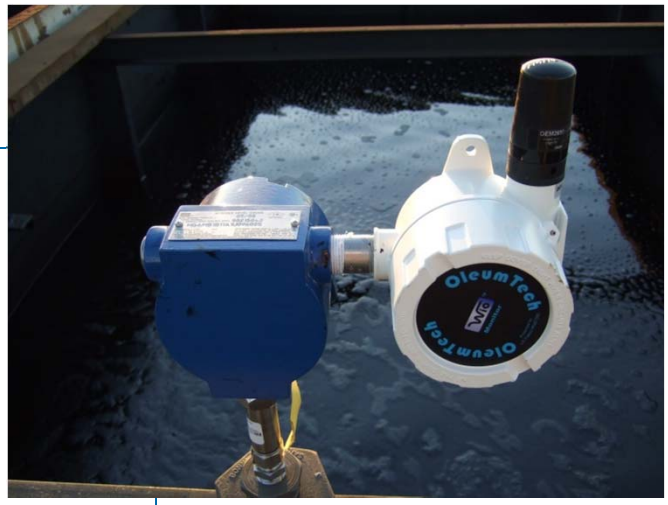
Tank Control System

- **Wireless Expansion Capability**
  - Wireless Level Transmitters added to Baker Tanks for high level warning and fuel gas shutdown.
  - 900 MHz Radio with 25 mile range





Wireless Transmitter Monitoring Baker Tank Fluid Level

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System Integration

- **Integration Role**
  - **Mechanical Design**
    - Fuel gas shutdown with field installation
  - **Electrical Design**
    - Process control with functional testing
  - **Structural Design**
    - Seismic and static loads for solar panel mounts
  - **Customer Criteria**
    - Process alarms and response with PLC programmer

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System Commissioning

- **Commissioning**
  - **Solar Arrays**
    - Verified for mechanical and electrical integrity
  - **Wireless communication systems**
    - Checked for proper configuration
  - **Remote PC**
    - Configured for Internet access
  - **Remote fuel gas valves**
    - Tested or fail-closed operation

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System Troubleshooting

Electrical-Main Panel

- **Problem** - No 24 Vdc at the PLC and no 12 Vdc at the modems
- **Cause** – 24 Vdc power polarity was reversed at the incoming leads
- **Solution** – Reverse the leads and replace the fuse on the 24-12 volt power supply

Wireless Communication

- **Problem** – 2.4 GHz Modems between PLC and PC were not providing stable link.
- **Initial Solution** – Assign static IP addresses to both modems and re-configure antennas
- **Final Solution** - Send modems back to factory for testing and replacement

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System Troubleshooting

- **SMS Text Message Failure**
  - **Problem** – PC in the field office unable to send SMS via satellite Internet server due to SSL coding requirement
  - **Solution** – Add programming module to software to encode SMS text with SSL code
- **Fuel Gas Shutdown Operation**
  - **Problem** – Spring Return actuator only opened 50% when gas is applied to actuator due to vendor failure to configure the actuator to meet design specifications
  - **Solution** – Remove several springs inside the actuator to reduce the torque required to open the valve.

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Lessons Learned

- **Communication**
  - Sub-Contractor project management added additional layer of communication
  - Schedule regular team meetings to review project scope and methods to achieve design intent

- **Scope**
  - Production requests for additional capability after scope approval.
  - Involve all personnel when defining the scope of work and allow for future expansion

- **Critical Path**
  - Minor unidentified tasks can dictate the critical path
  - Identify all tasks using a timeline (MS Project) with frequent updates to identify potential schedule impacts before the scheduled completion date

- **Cost Control**
  - Fixed price quotations evaluation with low cost priority can result in equipment that does not meet customer specifications.
  - All RFQ's need to be written to cover all details with specifications for FAT's to be performed prior to delivery.

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Acknowledgements:

Orchard Petroleum, Belridge Facility
Cal-Bay Systems, Software Development
National Instruments, PLC Hardware
Thomas & Beers, Structural Engineering
Sun-Wize Technologies, Solar System
CSUF, Industrial Technology Department