

# **DSOM<sup>®</sup> - Decision Support for Operations and Maintenance – Application to a USMC Base Centralized Energy System**

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# Discussion Topics

- ▶ Parris Island Background
- ▶ Central Energy Co-generation Plant
- ▶ Weapons Area Steam Plant
- ▶ Energy Management and Control System
- ▶ Wastewater Treatment SCADA System
- ▶ Savings Summary

# Background

- ▶ USMC Facilities aging
- ▶ Various control systems could not talk to each other
- ▶ PNNL requested to provide latest technology solution
- ▶ PNNL designed technology applications from a facility-wide perspective
- ▶ Built in diagnostics and energy conservation recommendations

# Central Energy Plant

- ▶ Three 400 psig steam boilers can provide steam to supply three 1-kW extraction steam turbine generators plus 125 psig site steam loads
- ▶ One 125 psig boiler to supply site steam when generation is not required
- ▶ Natural Gas fired with #2 oil backup
- ▶ Costly penalties for exceeding electrical demand peak for more than 15 minutes

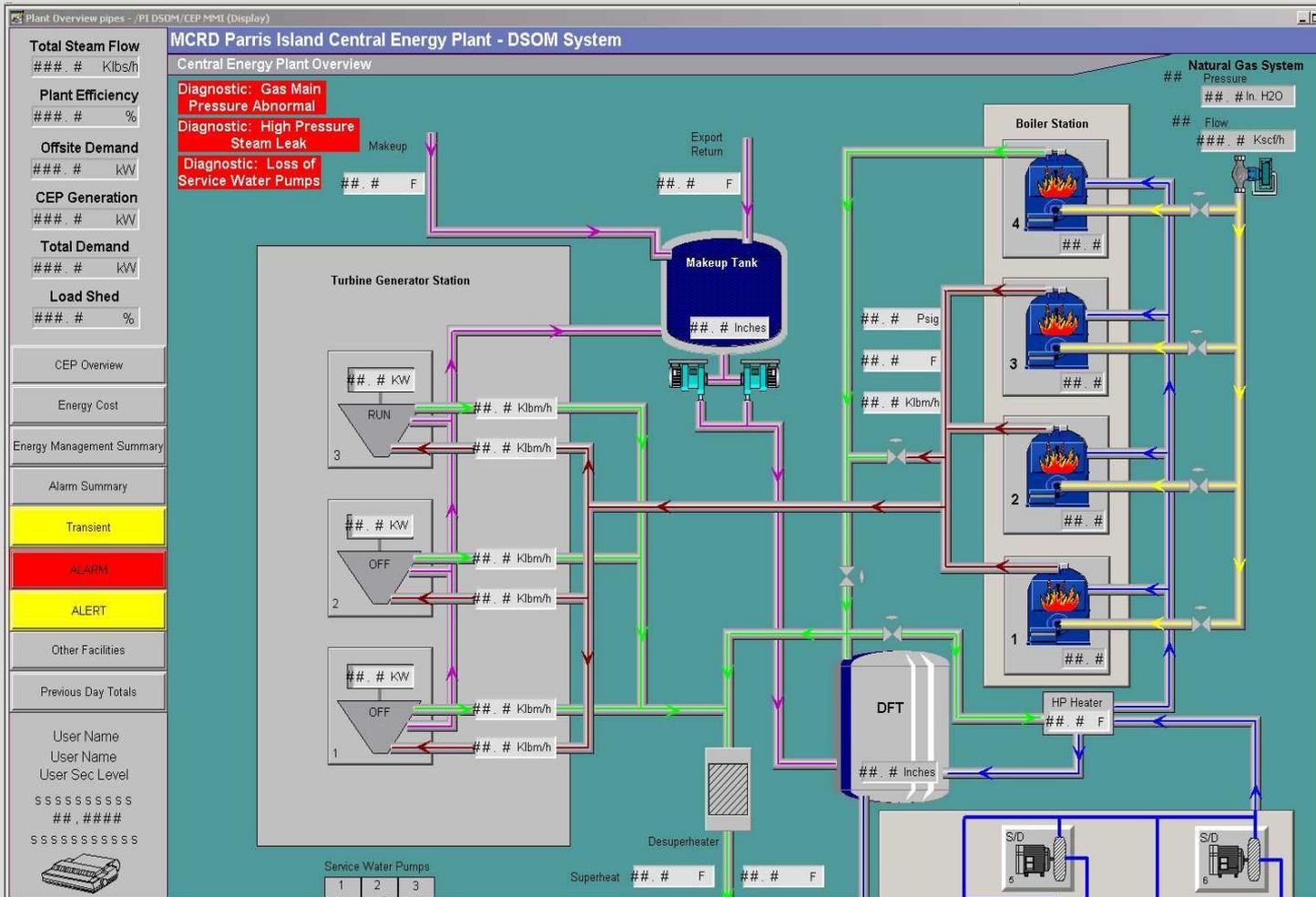
# DSOM

- ▶ Tells operator :
  - What current condition is
  - What current condition should be
  - What to do about it
- ▶ Provides information for approximately 40 diagnostics
- ▶ Provides similar information for all alert and alarm conditions

# DSOM – CEP Asset Manager

- ▶ Provides operator guidance on:
  - When to start boilers
  - Which boilers to start
  - When to bring steam turbine generators on-line
  - Which generation combination is most efficient
  - How to distribute loading
  - When to shutdown generators
  - When to shutdown boilers

# CEP Overview Display



# DSOM – CEP Alert Display Example

The screenshot displays a software window titled "Alarm Faults" with a yellow header "DSOM Alarm Monitor". The main content is organized into several sections:

- Boiler Number 1** and **Boiler Stack Temperature** are displayed at the top.
- Low Warning** is the primary alert status.
- Problem:** A box contains the text "Stack Temperature Low Warning".
- Impact:** Two boxes contain the text "Stack Temperature Low Warning" and "Condensation of stack gas causing acid formation in stack and corrosion."
- Likely Cause:** Three boxes list "Low firing of boiler", "Failed damper controller", and "Insufficient Air Supply".
- Recommended Corrective Actions:** Three boxes list "Ensure process is being controlled within design band", "Check for proper operation of sensor and transmitter", and "Check O2 level for proper burner control - adjust or shut down boiler".
- Current Sensor Value:** A bar chart titled "Current Setpoints" shows four levels: High Alarm (600.0), High Warning (500.0), Low Warning (350.0), and Low Alarm (250.0). The current value is 275.0 Deg F, which is between the Low Warning and Low Alarm setpoints.
- Buttons:** "Acknowledge" (highlighted with a green border), "Goto Trend", "Generate Job Ticket", and "Procedure".

# DSOM Diagnostic Display

Normal Alarm Faults

## DSOM Diagnostic Alarm Monitor

### Boiler Number 1

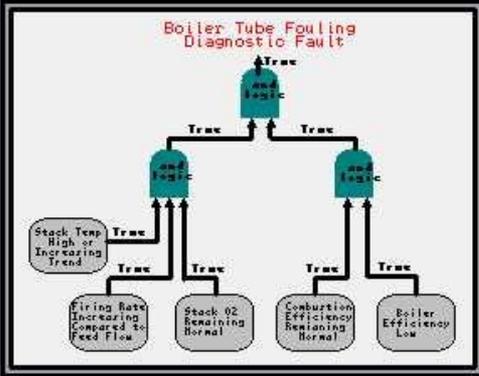
**Problem:**  
Boiler tube fouling

**Impact:**  
Reduced Efficiency.  
Shortened tube life

### DSOM Tube Fouling Diagnostic

**Likely Cause:**  
Internal tube fouling from incomplete combustion  
External tube fouling from poor water chemistry  
Ineffective make-up water purification

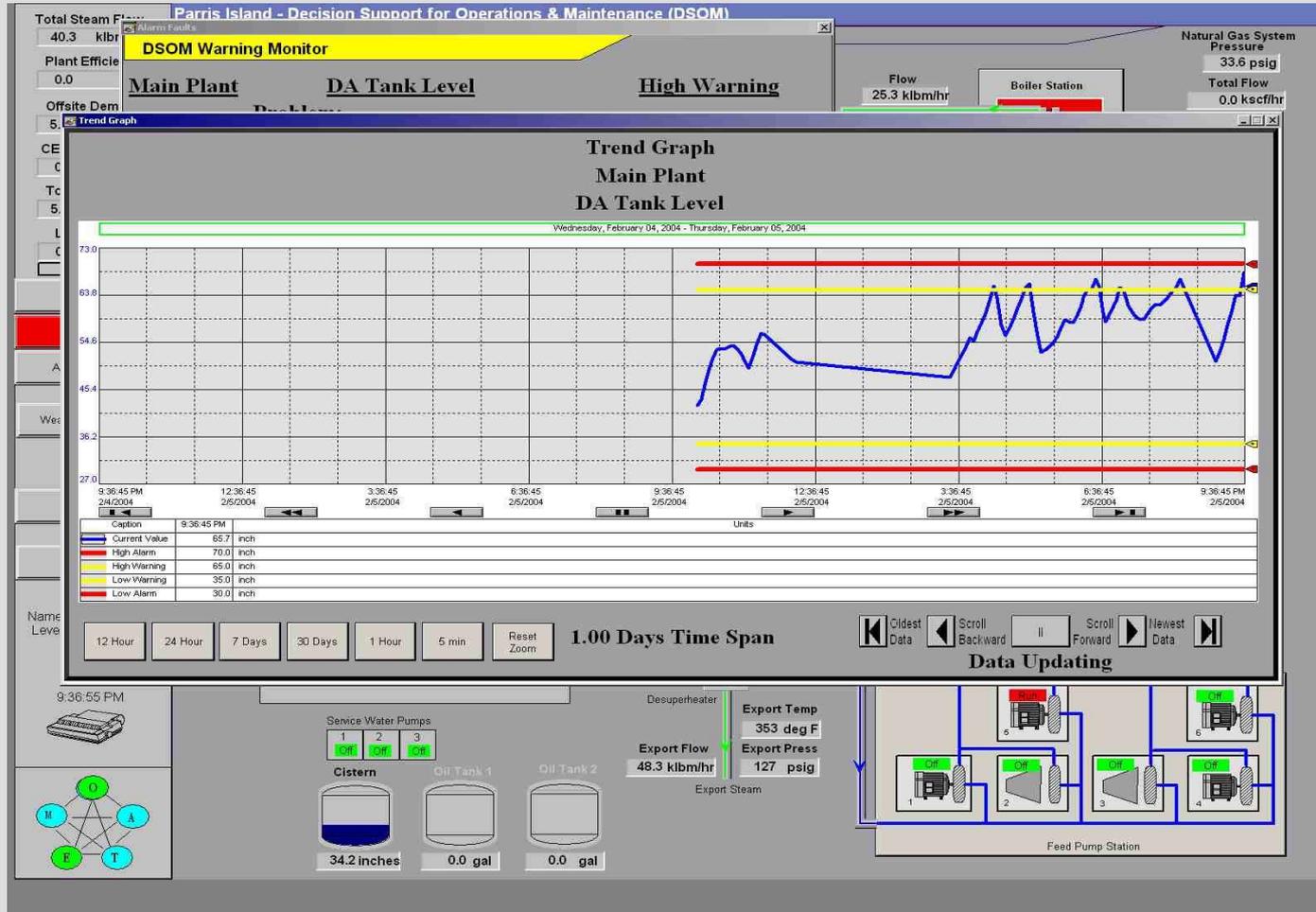
**Recommended Corrective Actions:**  
Inspect fire side of boiler tubes and clean if necessary  
Inspect water side of heat transfer surfaces and clean if necessary  
Check makeup water for proper function



The diagram is a fault tree for 'Boiler Tube Fouling Diagnostic Fault'. At the top is the fault event, 'Boiler Tube Fouling Diagnostic Fault'. Below it are two intermediate events, both labeled 'and Logic'. The left intermediate event is connected to three basic events: 'Stack Temp High or Increasing Trend', 'Firing Rate Increasing Compared to Feed Flow', and 'Stack O2 Remaining Normal'. The right intermediate event is connected to two basic events: 'Combustion Efficiency Remaining Normal' and 'Boiler Efficiency Low'. All connections are labeled 'True'.

Acknowledge    Goto Trend    Procedure    Generate Job Ticket

# DSOM – CEP Engineering Trend Display



# DSOM – CEP Energy Cost Analysis

Energy Cost Comparison

MCRD Parris Island Central Energy Plant - DSOM System

DSOM Energy Cost Analysis

## Energy Cost

Gas			Current Cost of Steam klbs:	
Gas Price / DecaTherm:	Gas price / Therm:	Current flow cost /hr:	Current flow rate:	
\$ 3.50	\$ 0.35	\$ 0.00	<input type="text"/>	klbm/hr \$ 0.00 /klbm
#2 Oil			Previous day totals	
Oil price / gallon:	Oil price / Therm:	Current flow cost / hr:	Oil <input type="text"/> gal	<input type="text"/> dollars
\$ 0.63	\$ 0.44	\$ 0.00	Gas <input type="text"/> kscf	<input type="text"/> dollars
Water price / cu ft: <input type="text" value="0.50"/>			MU Wtr <input type="text"/> gal	<input type="text"/> dollars
			Xprt Sim <input type="text"/> klbm	<input type="text"/> dollars
<b>hhv value:</b> Gas 1050 hhv #2 Oil 143800 hhv		<b>Current flow rate:</b> 0.00 kscfh 0.00 gph		

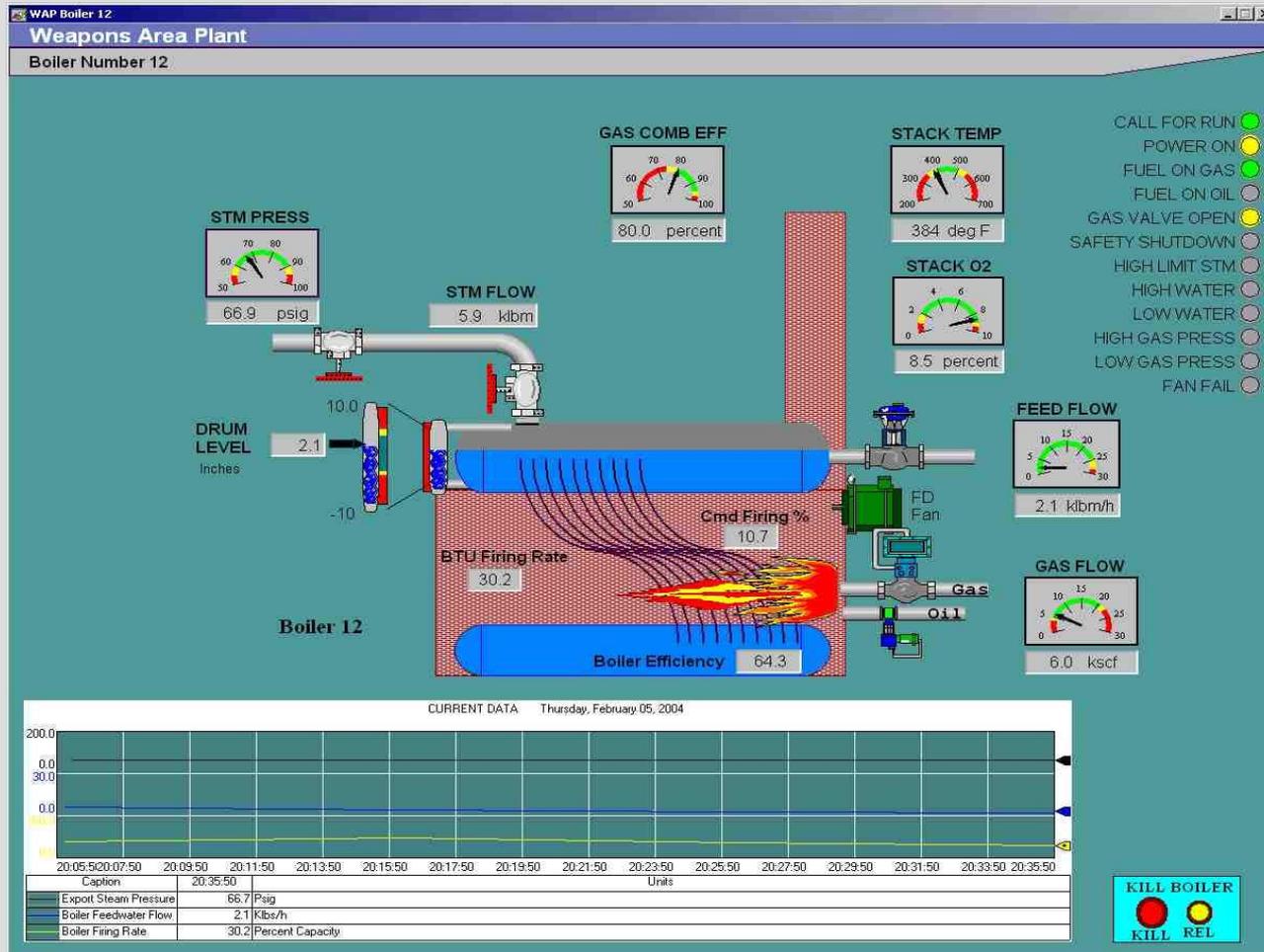
# DSOM – Weapons Area Plant

- ▶ Three 125 psig steam boilers to supply Weapons Area loads
- ▶ Manned 24 hours, 7 days a week
- ▶ Lack of qualified personnel
- ▶ DSOM allowed full remote monitoring with S/D control from CEP
- ▶ DSOM allowed unmanning of the plant

# DSOM – Weapons Area Plant

- ▶ Same software as used at CEP
- ▶ Efficiency and parameter monitoring
- ▶ Can detect
  - Boiler tube leakage
  - Boiler tube fouling
  - Steam drum water level control malfunctions
  - Excessive firebox heat loss
  - Over-firing and stack gas condensation alarms

# DSOM – WAP Boiler 12 Display



# Energy Management and Control Systems

- ▶ Five different independent building control systems installed
- ▶ AC&R shop would send out personnel in trucks to reduce Base load demand
- ▶ PNNL engineered system upgraded all with open protocol system
- ▶ Designed to coordinate with DSOM at CEP to manage and automatically shed load

# EMCS Load Shed Scheme

- ▶ CEP asset manager sequences generation requirements
- ▶ EMCS allows for building zone temperature control and occupied/un-occupied modes
- ▶ When target Base load is exceeded, load shedding sequence is activated
- ▶ Will not allow demand to exceed peak

# EMCS Demand Load and Status

SuperVision Plus - MRT CENTER  
 File View Actions Configure Tools Help  
 Bldg: 160 Central Plant [Manual Commands]

MRT CENTER  
 AREA 1  
 Bldg: 160 Central Plant

Go To Other Bldgs: CENTRAL ENERGY PLANT  
 BLDG 160  
 GO TO:

DEMAND METER FB AREA DEMAND BROADCAST

**Currently**

**7953 kW**

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**Today**

Usage: 6371 kWh  
 Peak: 13:00 10 8219 kW

**Previous day**

Usage: 190531 kWh  
 Peak: 12:56 10 8330 kW

LAN DMD GRP 1: 0  
 LAN DMD GRP 2: 0  
 LAN DMD GRP 3: 0  
 LAN DMD GRP 4: 0  
 LAN DMD GRP 5: 0

DEMAND SETPOINT: 8200.00



DEMAND LEVEL: 5.00 %  
 GENERATOR TOTAL: 2375.52 kW  
 BLR GAS FLOW: 1297.67 kscfm

Recorded Since: 14:12 26

**Month-to-date**

Usage: 7816 mWh  
 Peak: 14:12 26 8409 kW

**Previous month**

Usage: 4358 mWh  
 Peak: 13:47 18 8350 kW

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**Year-to-date**

Usage: 12174 mWh  
 Peak: 14:12 26 8409 kW

**Previous year**

Usage: 6621 mWh  
 Peak: 19:08 4 9100 kW

LAN DMD GRP 6: 1  
 LAN DMD GRP 7: 0  
 LAN DMD GRP 8: 0  
 LAN DMD GRP 9: 0  
 LAN DMD GRP 10: 1

Evaluating expressions Operator: Harris Sales 10:51 AM  
 Address: http://www.unclewebster.com

# EMCS Load Shedding Sequence

Demand Group	Stage 1 (kW)	Stage 2 (kW)	Stage 3 (kW)	Stage 4 (kW)
1	7517	7617	7717	7817
2	7527	7627	7727	7827
3	7537	7637	7737	7837
4	7547	7647	7747	7847
5	7557	7657	7757	7857
6	7567	7667	7767	7867
7	7577	7677	7777	7877
8	7587	7687	7787	7887
9	7597	7697	7797	7897
10	7607	7707	7807	7907

# EMCS LAN Demand Stages

- ▶ **LAN DEMAND Stage # 1** : Resets thermostat set points out 1° F from set point and the chilled water valves stay at 100% capacity.
- ▶ **LAN DEMAND Stage # 2** : Resets thermostat set points out 2° F from set point and the chilled water valves close to 75% capacity.
- ▶ **LAN DEMAND Stage # 3** : Resets thermostat set points out 4° F from set point and the chilled water valves close to 25% capacity.
- ▶ **LAN DEMAND Stage # 4** : Turns main chiller off, and as a backup, closes all the chilled water valves.

# EMCS Summary

- ▶ Energy Controls Technician can program all load shedding groups and stages according to Base priorities
- ▶ 60 buildings are on-line and are controlled to reduce demand by nearly 2 MW over approximately 3.3 million square feet of building space

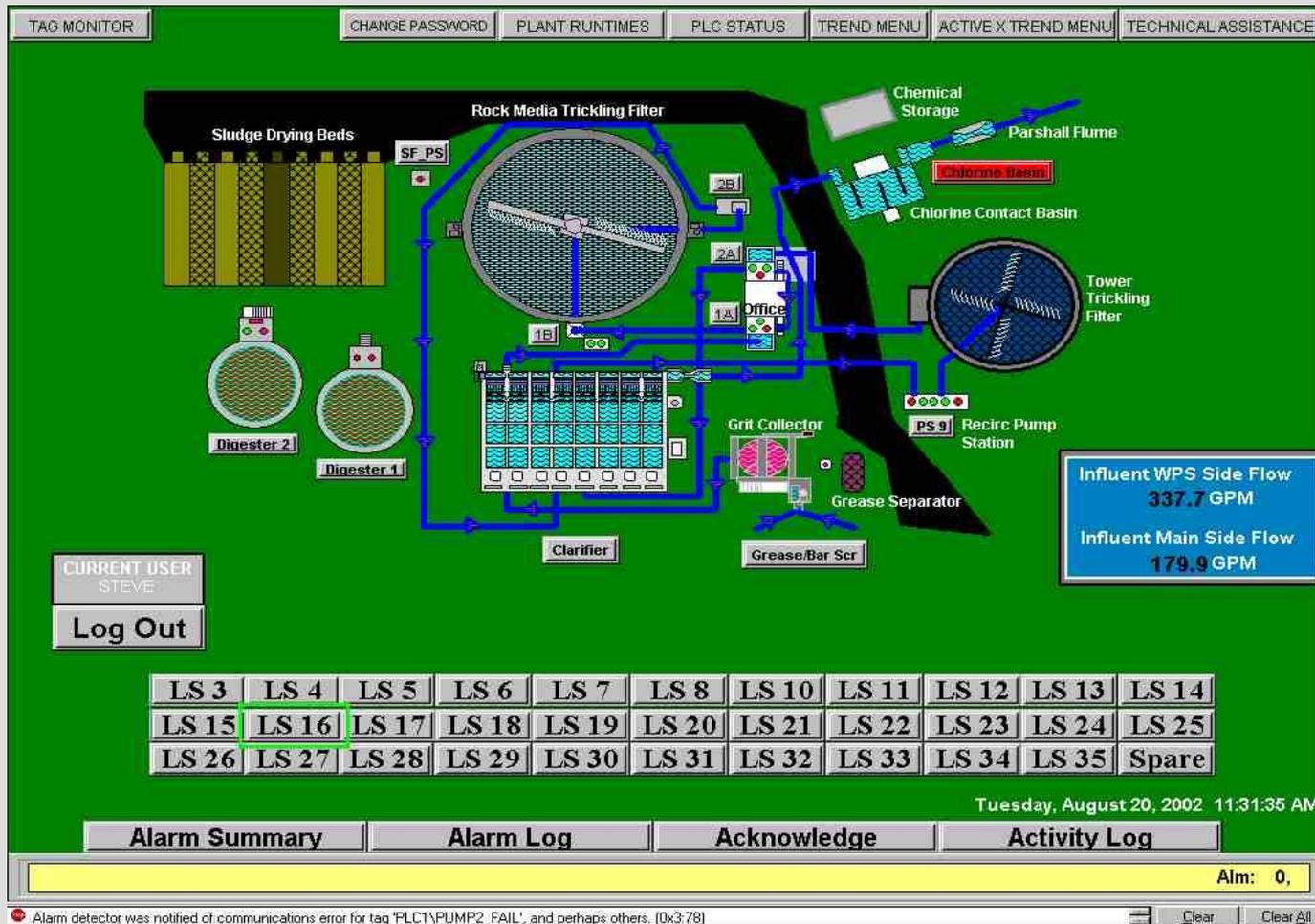
# Wastewater Treatment Plant

- ▶ Main processing plant with 38 lift/pumping stations
- ▶ Capable of processing up to 1.5 million gallons per day
- ▶ Concern for spills and environmental conditions due to aging system in disrepair
- ▶ PNNL engineered master plan to modify, upgrade or replace all of the control software and hardware

# Wastewater Treatment Plant Upgrades

- ▶ New SCADA control cabinets designed and installed at each lift station and main plant pumping stations
- ▶ Radio communications were upgraded
- ▶ UPS provided for lift station control cabinets
- ▶ Interfaced with DSOM system at CEP
- ▶ As with CEP, GUI designed by PNNL for simple point-and-click operation

# Wastewater Treatment Plant Main Display



# Wastewater Treatment Plant Control

- ▶ WWTF office /Supervisor has ability to change
  - pump auto start/stop set points and
  - level alarm setpoints
  - Level control setpoints
- ▶ Lift station and main processing plant equipment is monitored full time with trending capabilities on run times, pump amperage, and pump capacity

# Lift Station Set Points Screen

The screenshot displays a control interface for a lift station. The main window is titled "levelSP - Display" and contains several key components:

- LIFT STATION:** A central diagram of a tank with a total depth of 240 In. The current water level is indicated as 64 In. Three float switches are shown at depths of 12, 97, and 118 In. A yellow highlight is present at the top of the tank diagram.
- Level Set Points:** A panel on the left lists the following set points:
  - Start Lag 2 Pump: 90.0 In. (Tag: LiftSta10\TnkPmpStartLvl)
  - Start Lag 1 Pump: 56.0 In. (Tag: LiftSta10\TnkPmpStartLvl)
  - Start Lead Pump: 55.0 In. (Tag: LiftSta10\TnkPmpStartLvl)
  - Pumps Off: 53.0 In. (Tag: LiftSta10\TnkPmpStopLvl)
- Tank Dim. Set Points:** A panel on the right allows configuration of tank dimensions:
  - Shape:  Square,  Round
  - Depth: 240 In.
  - Width: 60 In.
  - Length: 72 In.
  - Calculated Gallons Per Inch: 18
  - PLC Gallons Per Inch: 10 (Tag: LiftSta10\TnkGalPerInch)
- Input Field:** A text box at the bottom left prompts the user to "Enter Setpoint Commands in Inches" with the example "Set LiftSta4\TnkPmpStartLvl 25".
- Tags:** A list of tags is provided at the bottom center: LiftSta10\HighAlmFloatLvl, LiftSta10\HighWarnFloatLvl, and LiftSta10\LowerAlmFloatLvl.
- Status Bar:** At the bottom, a message reads "Expression: 'WTP\PS1A\Pmp14Status' Invalid tag name." and there are "Clear" and "Clear All" buttons.

# Energy Savings Summary

- ▶ Energy use per square foot went from 51.06 Btu/sqft/dd in the base year FY 1999 down to 45.73 Btu/sqft/dd in FY 2002.
- ▶ This is a reduction of 5.33 Btu/sqft/dd or a 10.4% reduction from the base year. This can be attributed to DSOM and EMCS activities resulting in coordinated energy control at Parris Island.

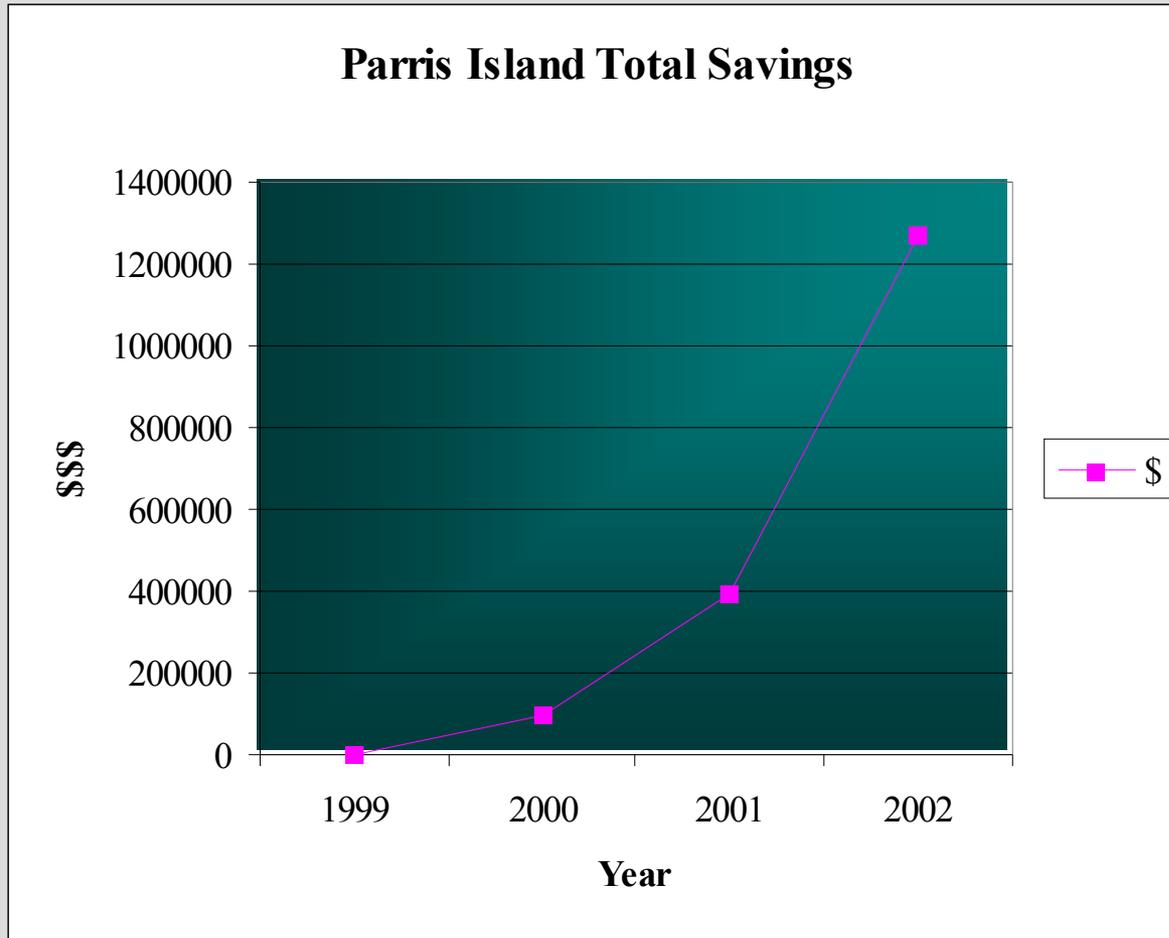
# EMCS Load Shedding Sequence

Fiscal Year		Btu/sqft/dd)	Reduction from Baseline	\$ Saved
1999		51.06		
2000		49.90	1.16	\$94,761
2001		46.82	4.24	\$293,501
2002		45.73	5.33	\$513,491
2003				

# Savings Total

- ▶ As of the end of FY 2002, savings total \$901,753 dollars from the base year of avoided cost in energy only.
- ▶ When additional credit is taken for labor savings (Parris Island has had a net reduction of 8 FTEs because of the DSOM related work), a further reduction of \$368K per year would apply starting in FY 2002
- ▶ The avoided cost of \$513K for FY 2002 corresponds to a 10.4% energy dollar savings and a total labor and energy savings for FY 2002 of \$881K for a 3 year total of \$1.3M.

# Parris Island Energy Savings Graph



# Summary

- ▶ In the similar EMCS only project at MCAS Beaufort, installation of the PNNL engineered EMCS system has saved them approximately \$2.4M over the last 3 years on a \$2.6M investment.
- ▶ These projects demonstrate that the integration of new technologies engineered to provide a facility-wide approach can have a significant impact on energy and personnel savings.