



Integrating Human Performance Initiatives as Part of a Consolidated Edison Power Plant Upgrade

2014 IDEA Conference Seattle, WA
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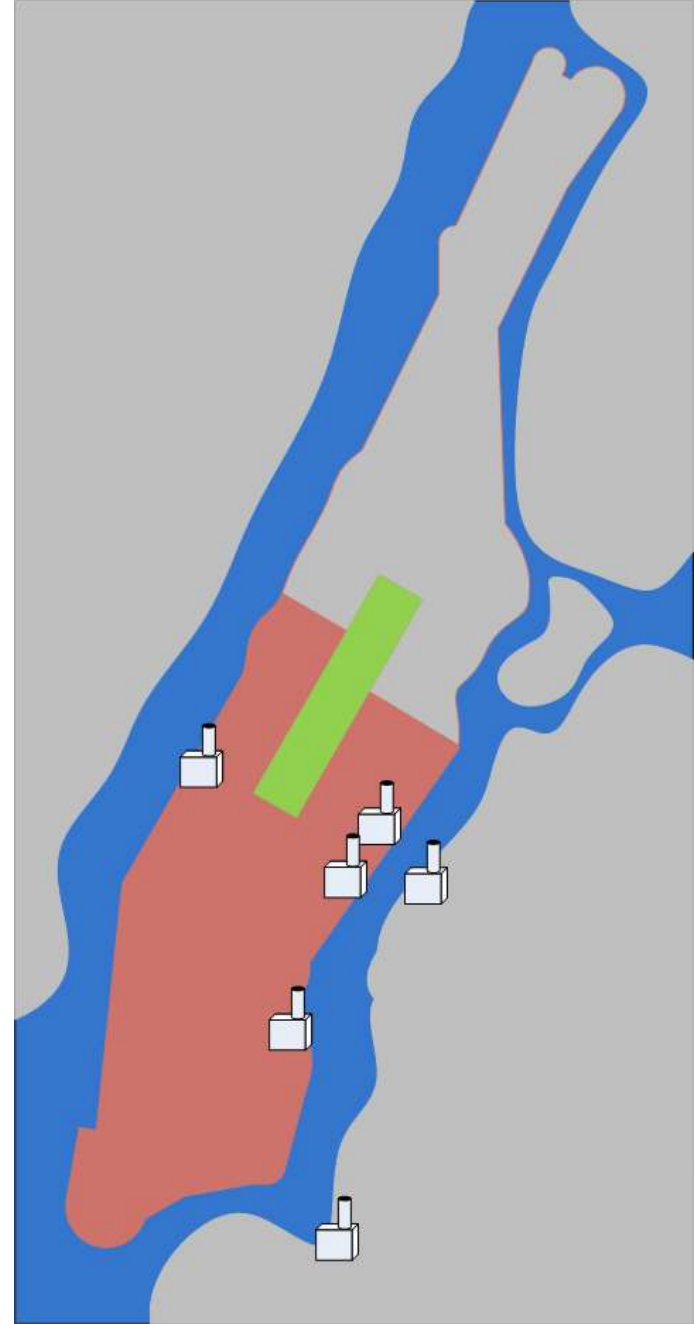
Con Edison Steam System

Steam Operations Statistics

- **Con Edison operates the largest steam system in the U.S.**
 - ~ 1,700 customer accounts
 - ~ 105 miles of mains and service pipes
 - Service Territory is Manhattan only
- **Approximately 20 billion pounds of steam send out each year**
 - Space heating
 - Air conditioning
 - Domestic water heating
 - Humidification
 - Sterilization
- **Seasonal Peak Forecasts**
 - 9600 Mlbs/hr Winter peak load
 - 5300 Mlbs/hr Summer peak load

Con Edison Steam System

- The Con Edison Steam System is operated to meet the following priorities:
 - Safety
 - Environmental Compliance – NO_x
 - Reliability
 - Economics

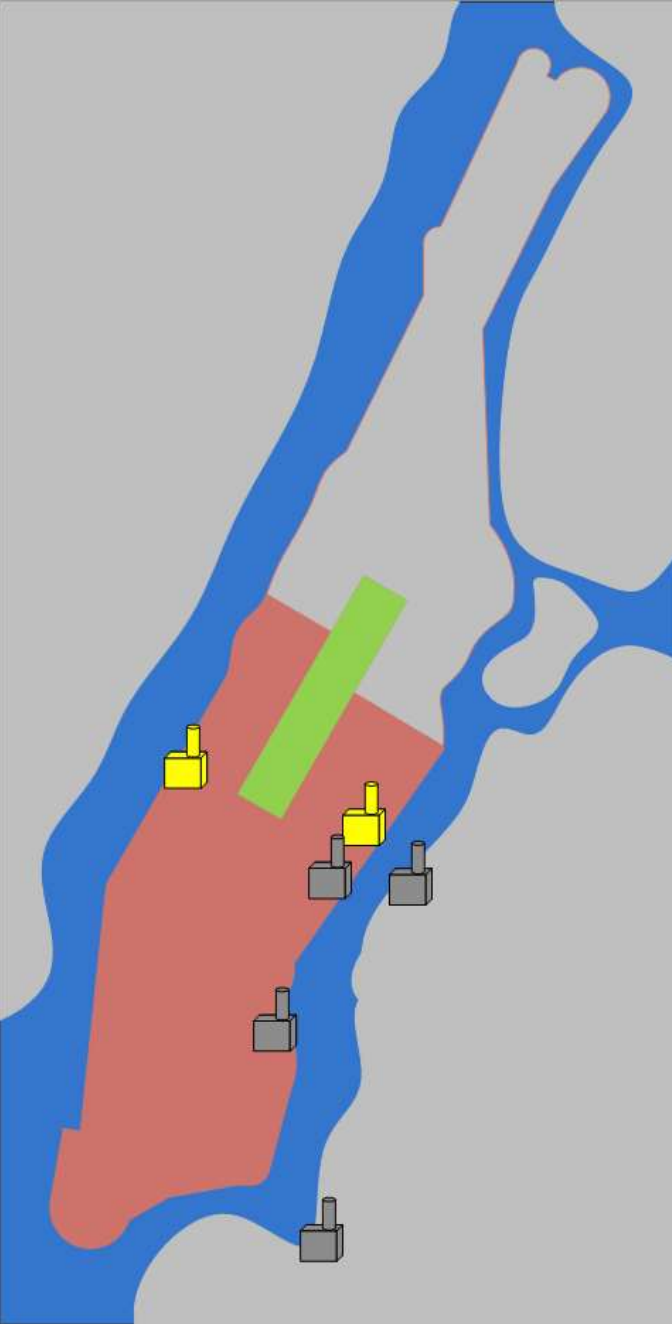


Steam Generating Station Capacity

| Station | Steam (1,000lb/hr) | Electric (MW) |
|-------------------------------|-----------------------|------------------|
| East River Units 1/10 & 2/20 | 3,200 | 293.5 |
| East River Units 6/60 & 7/70 | 1,975 | 312.7 |
| East River South | 650 | |
| Hudson Avenue | 0 | 42.9 |
| BNYCP | 985 | 256.9 |
| 59th Street | 1,381 | 17.1 |
| 60 th Street | 707 | |
| 74 th Street | 2,008 | 37.2 |
| Ravenswood Steam | 750 | |
| <hr/> | | |
| Total Capacity | 11,656 | 957.3 |

Gas Addition Projects

- Gas addition was performed at 59th Street and 74th Street Stations.
 - 59th Street
 - Annex boilers – 1000 klbs/hr
 - Package boilers – 381 klbs/hr
 - 74th Street
 - HP boilers – 1300 klbs/hr
 - Package boilers – 708 klbs/hr



Reasons for Converting to Natural Gas

- Compliance with Environmental Regulations
 - NYSDEC NO_x RACT Regulation Effective July 2014
- Environmental Benefits to NYC
- Economic Benefit of Natural Gas Burning



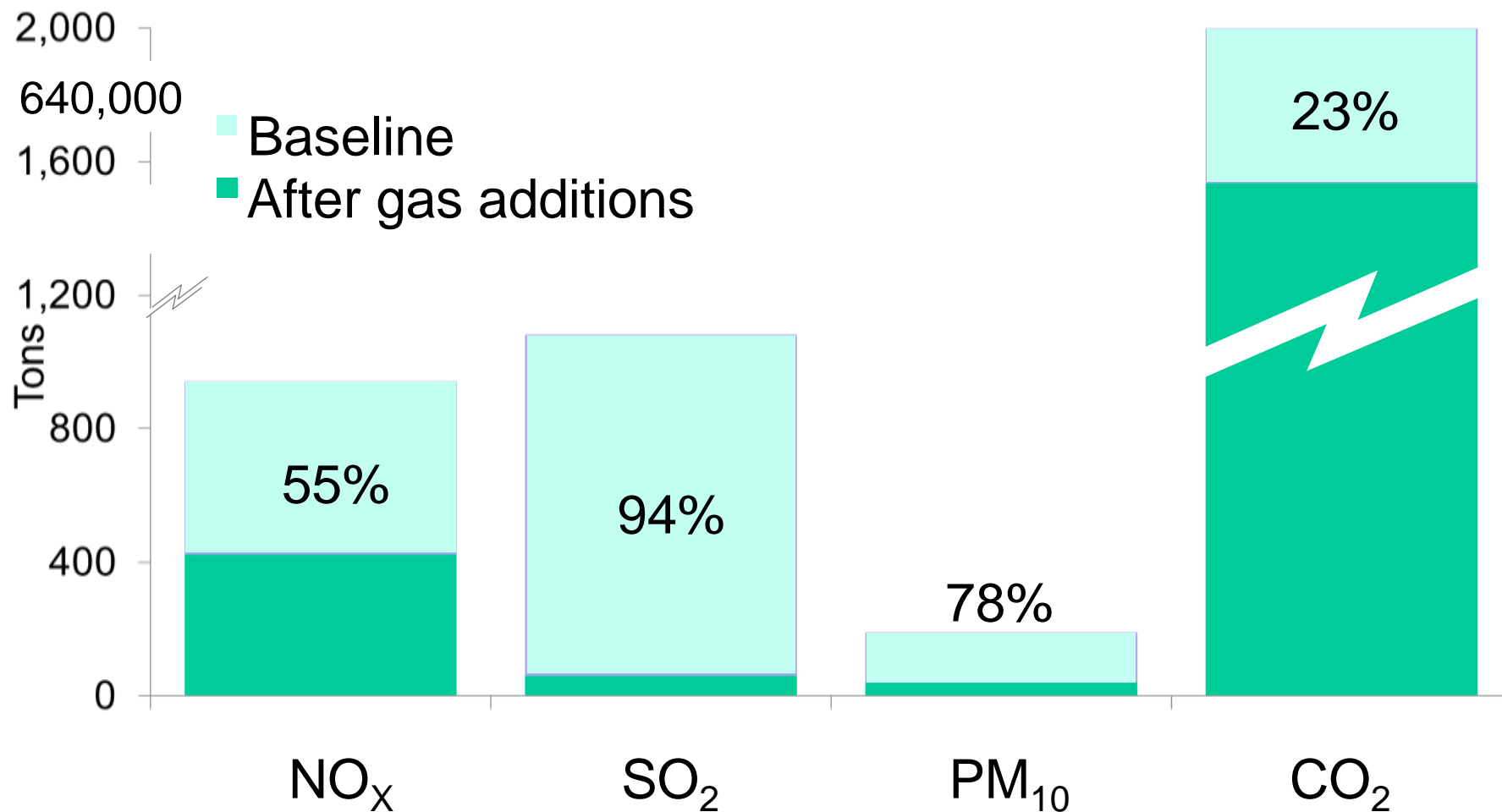
Customer & Community Benefits

- Reduced emissions
- Reduce opacity events
- Fuel diversity & increased reliability
- Bill reduction
 - ~ \$81 million fuel savings
 - ~10% annually



Environmental Benefits

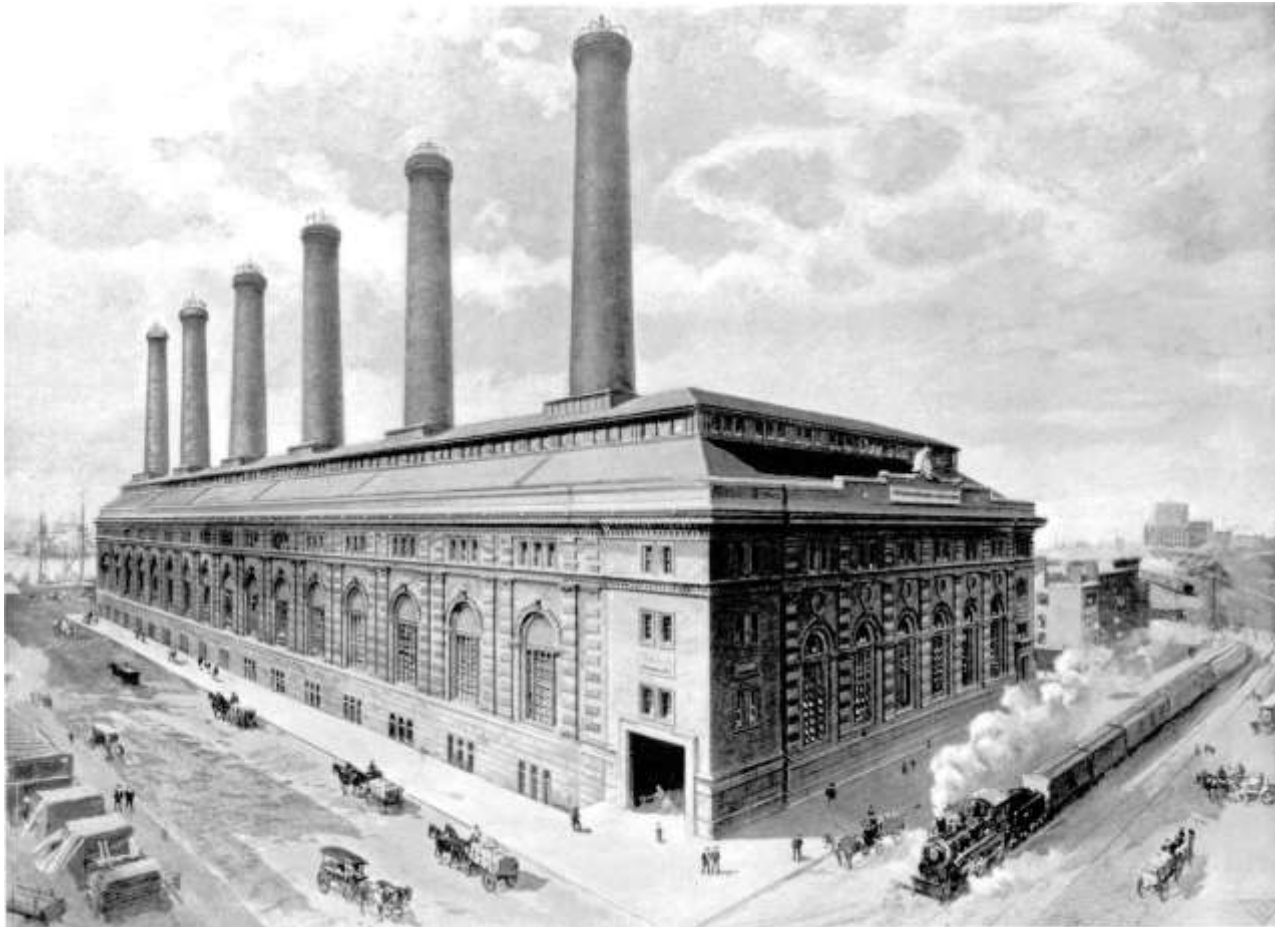
Emissions Reduction Projections



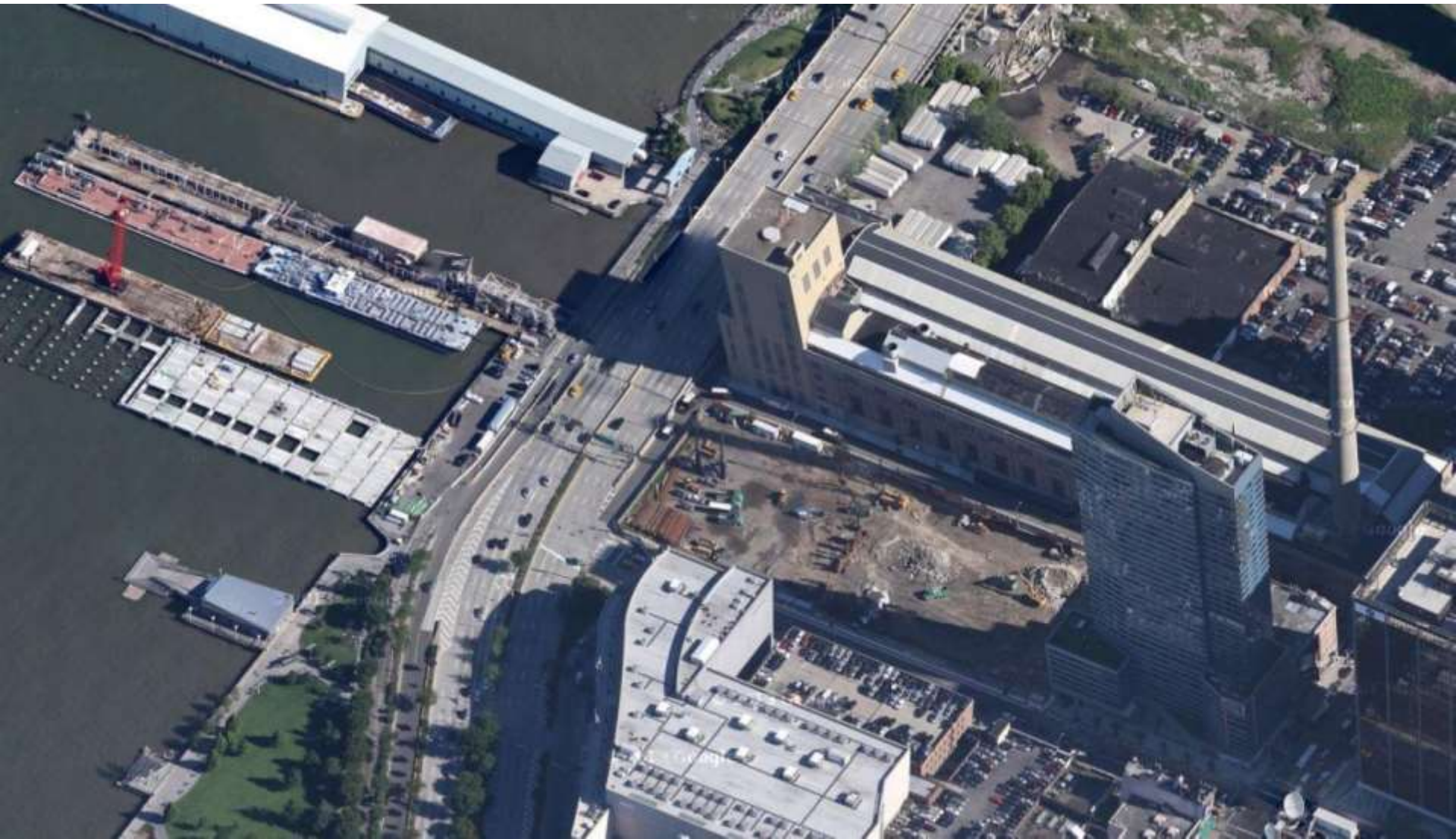
59th Street Station Overview

59TH Street Station

1904 59th Street Station (Interborough Rapid Transit Co.)



59th Street Station today

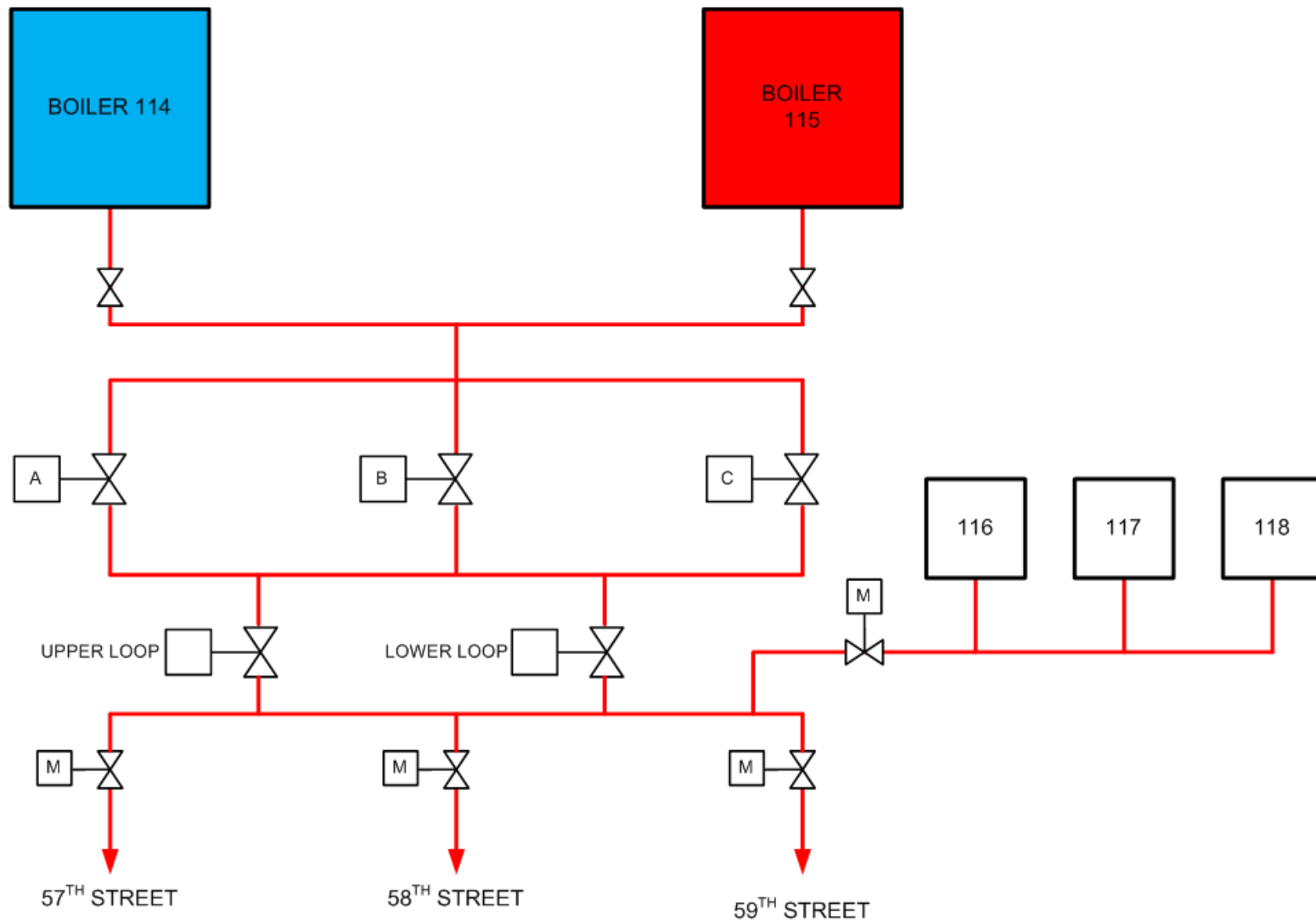


59th Street Boilers

- Annex boilers 114 and 115
 - Prior to gas addition burned only #6 fuel oil
 - Each boiler capable to 500 klbs/hr send out each
 - 1000 klbs/hr total output to steam distribution system
- Package Boilers 116, 117, and 118
 - Already dual fuel capable
 - Each boiler capable to 150 klbs/hr send out each
 - 350 klbs/hr total output to steam distribution system
- Gas Turbine GT1
 - Prior to gas addition burned only kerosene



59TH Street Steam Output Diagram



Modernization of 59th Street

Modernizing Drivers considered during upgrade

- In addition to Installation of a new Gas System, a new control system for operation of all boilers at the power plant was installed
 - Emission Reduction
 - Combustion Control
 - Hazard Mitigation
 - Aging Technology



Control Room Prior to Upgrade



Control Room After Upgrade



Human Performance Initiatives Were Required to Make This Major Transition



March 2013

July 2013



Human Performance Initiatives

- New Digital Control System (DCS) Installed
- Training
- Simulator
- SMARTboard



New Digital Control System (DCS)



Boiler Controls and Operator Interface

- Boiler Protection System
- Combustion Control
- Human Machine Interface
- State-of-the-Art Alarming



Pre-Commissioning

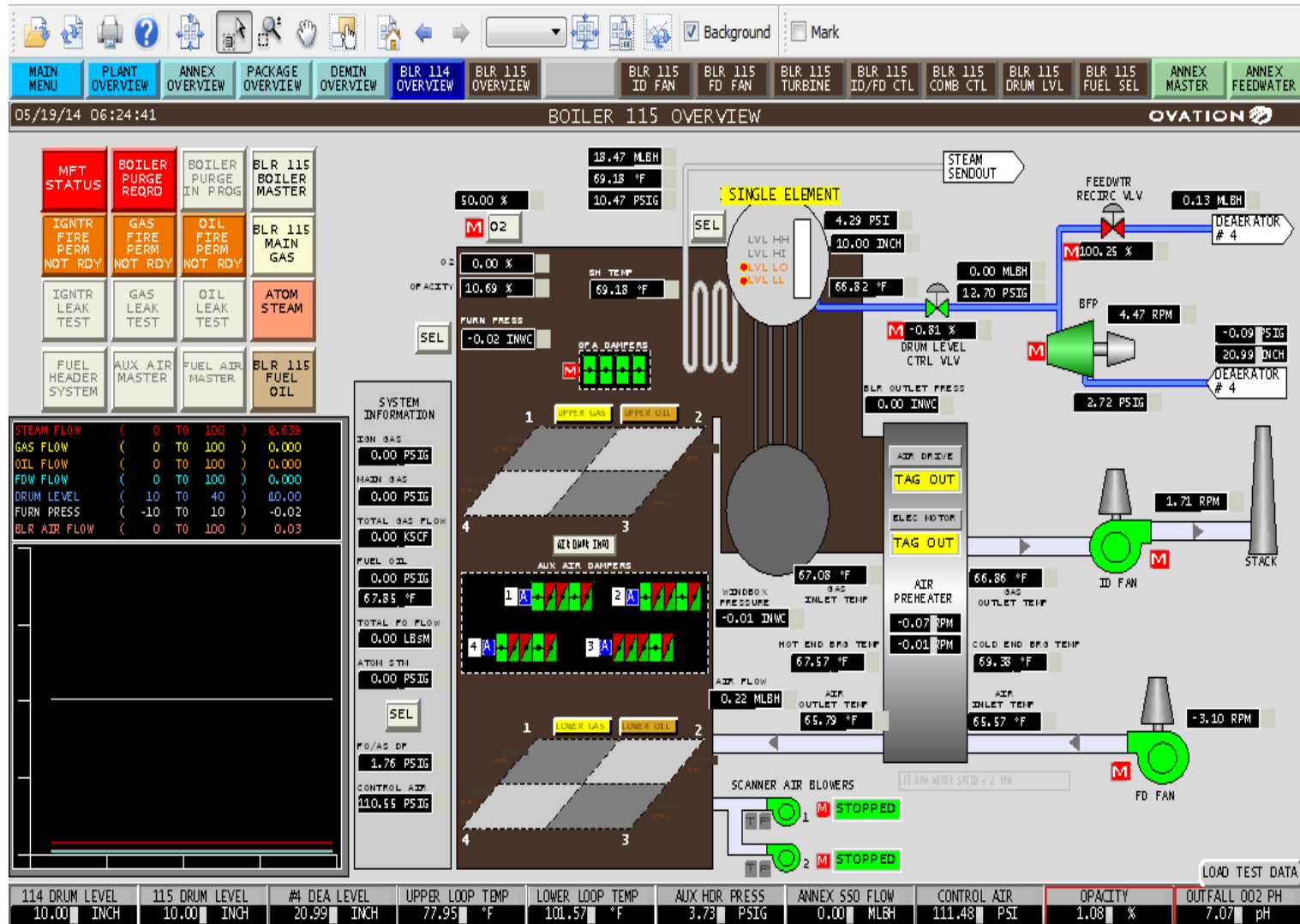
- Prior to construction key Engineering and Plant personnel spent significant time off-site conducting acceptance tests of equipment
 - Design Review - 1 week
 - Functional Review - 2 weeks
 - Hardware Test - 1 week
 - Factory Acceptance - 3 weeks



Operators helped develop DCS

- Control Room Operators directly involved with development
- HPI impacts
 - Developed and recommended screens which they knew would be useful based on their knowledge of the plant
 - Recommended Color Coding of boilers
 - 114 Boiler – Blue
 - 115 Boiler – Brown
 - 116 Boiler – Yellow
 - 117 Boiler – Green
 - 118 Boiler - Purple

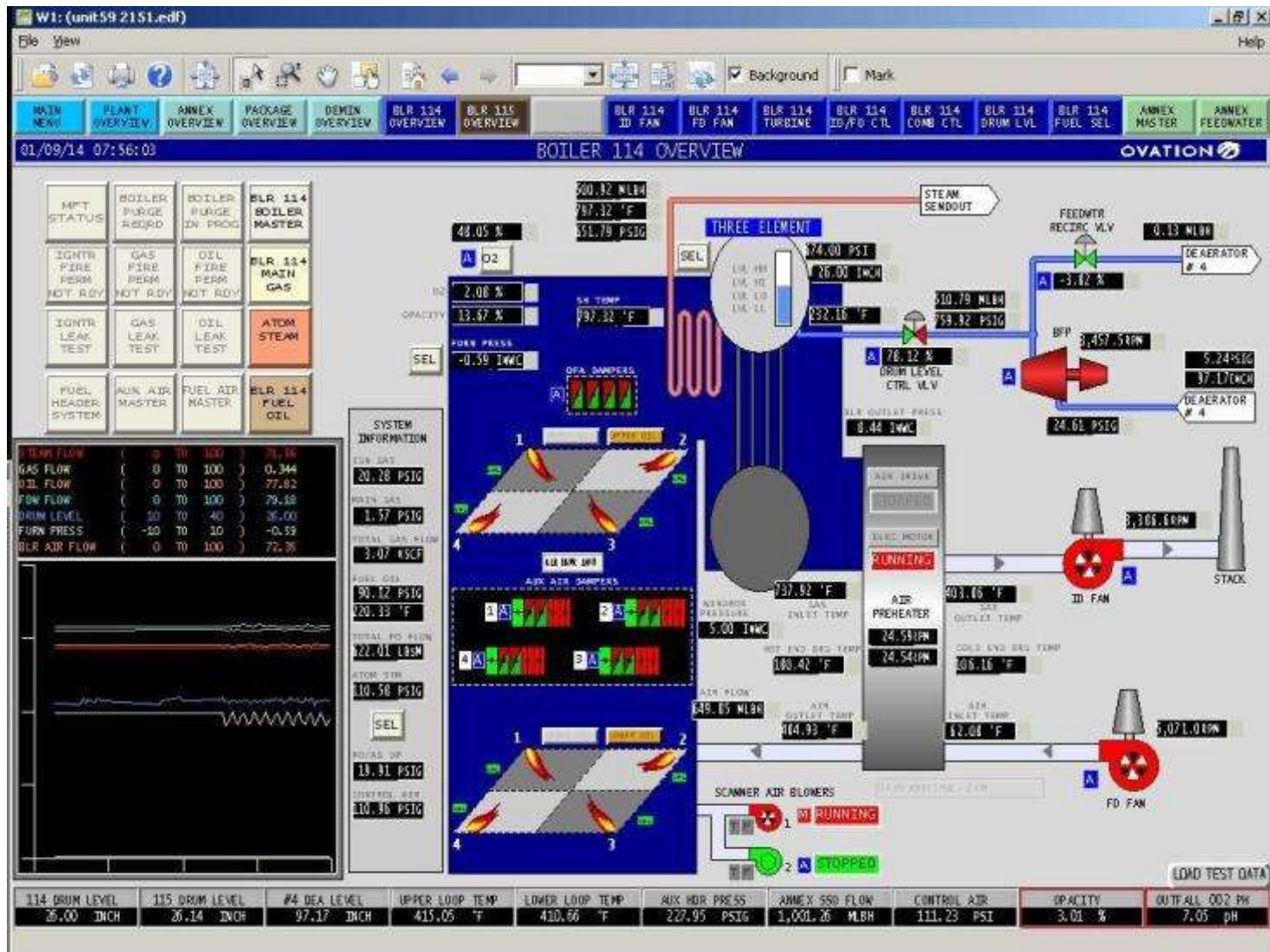
Boiler 115 - Offline



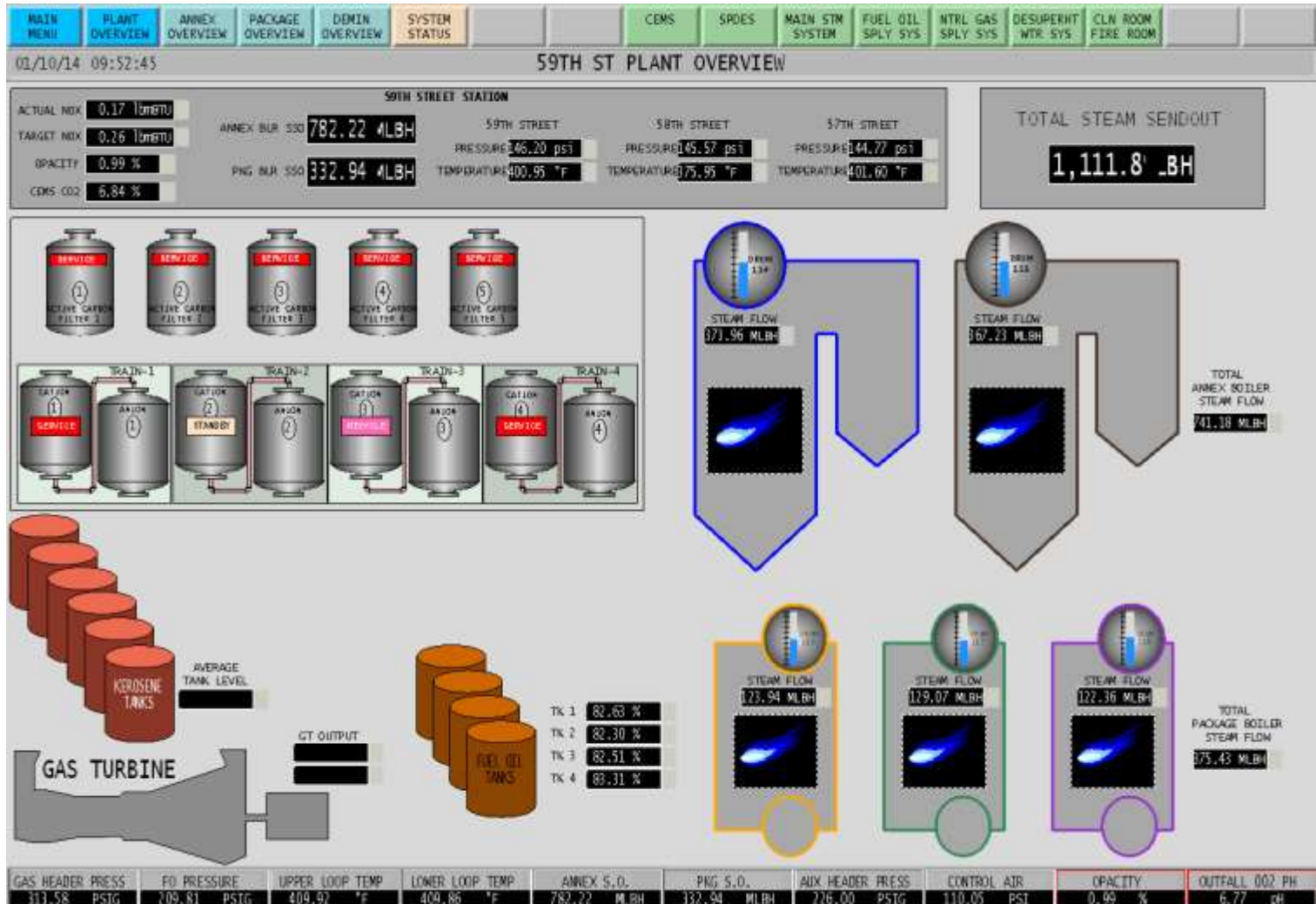
Boiler 114 – Online



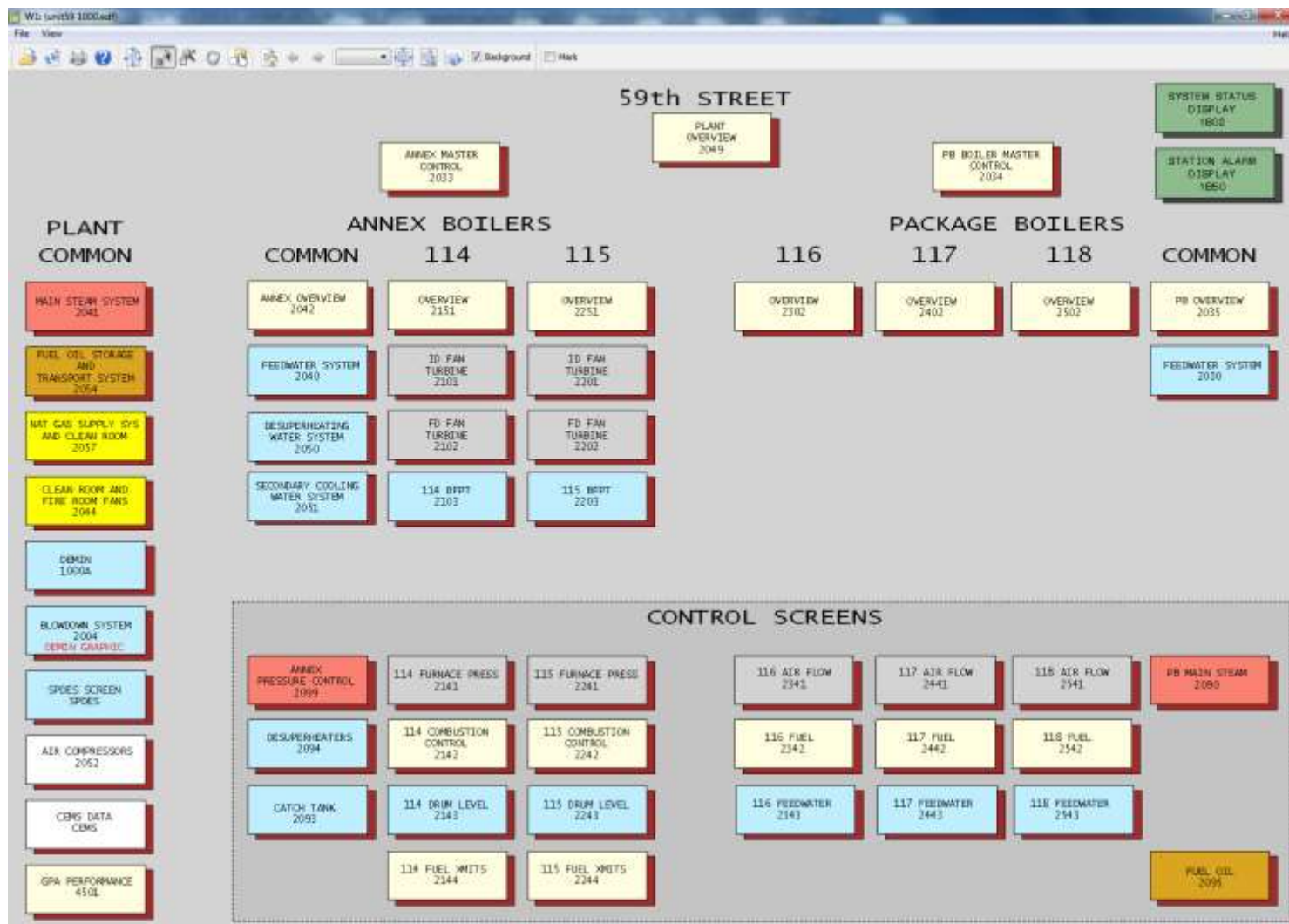
Boiler 114 – Online Burning Oil



Plant Overview Screens



Human Machine Interfaces



Training

- Operators underwent weeks of training learning new gas system. Included review of new station prints, classroom training, and review of new procedures.



Simulator

- Operators learned operation of plant on the simulator
- Simulator is effective training tool
- Different Scenarios are drilled for operators
- Re-fresher training now available for Operators



Simulator – Scenarios for Training

- Start-up and Shut-down of boilers
- Equipment Malfunctions
- Alarm Response Drills
- Qualification of New Operators
- Demineralization Plant Training



Procedures

- New start-up and shut-down procedures were developed for all plant equipment
- Gas specific procedures
 - Gas in for the station
 - Performing Nitrogen purge of gas mains
- Alarm Response Procedures
 - ARP's linked directly into new DCS



Alarm Response Procedures

The image shows a stack of overlapping 'Main Gas Ax Press Hi' alarm response procedure forms. The top form is the most visible and contains the following information:

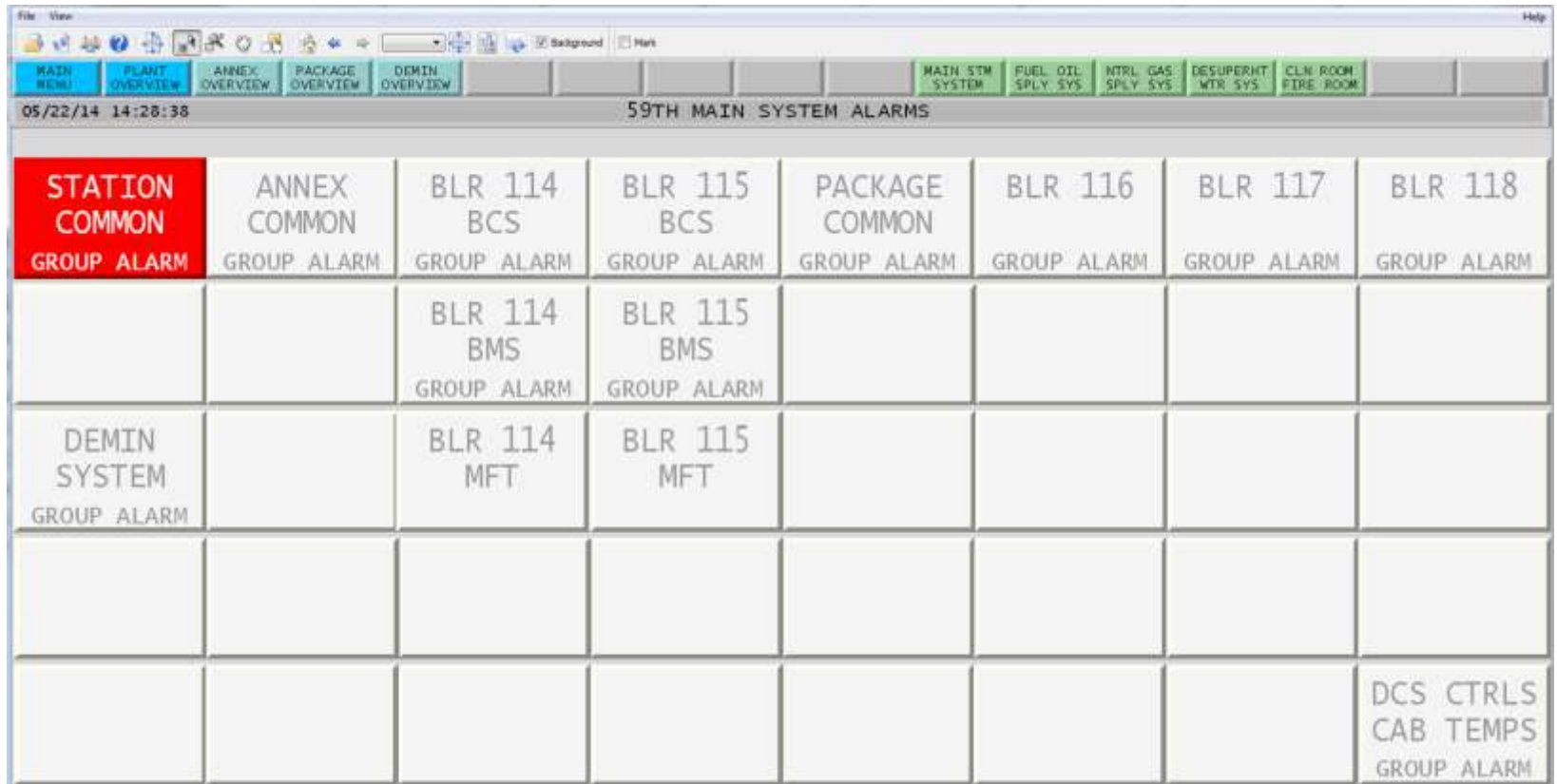
| Con Edison | | Operations | |
|------------------------------|--|-------------------------------|--|
| Alarm Title | 500 STREET STATION ALARM RESPONSE PROCEDURE | Revision 0 | Feb 2013 |
| Device | 500 STREET STATION ALARM RESPONSE PROCEDURE | ID No. | 6-ALD-25-000-001 |
| SETPOINT | Two (2) of Three (3) Transmitters > 150/PSIG | CD/PSIG | 201 |
| AUTOMATIC ACTION | Alarm Activates in DCS | Panel | 201 |
| CONTROL ROOM OPERATOR ACTION | <ul style="list-style-type: none"> Reverse Pressure Trend Check Flow Trends | Room Operator Action | <ul style="list-style-type: none"> Walkdown System And Report Findings To Control Room Verify Valve 1-001 Position Verify Local Pressure Indicators Check Operation of PRTs |
| ROOM OPERATOR ACTION | <ul style="list-style-type: none"> Notify I&C To Investigate If Problem Is Suspected To Be In The Mechanical Notify Maintenance To Investigate If Problem Is Suspected To Be In The Mechanical | NOTIFICATIONS and INFORMATION | <ul style="list-style-type: none"> Notify I&C To Investigate If Problem Is Suspected To Be In The Mechanical Notify Maintenance To Investigate If Problem Is Suspected To Be In The Mechanical |

Page 1 of 1

Alarm Response Procedures

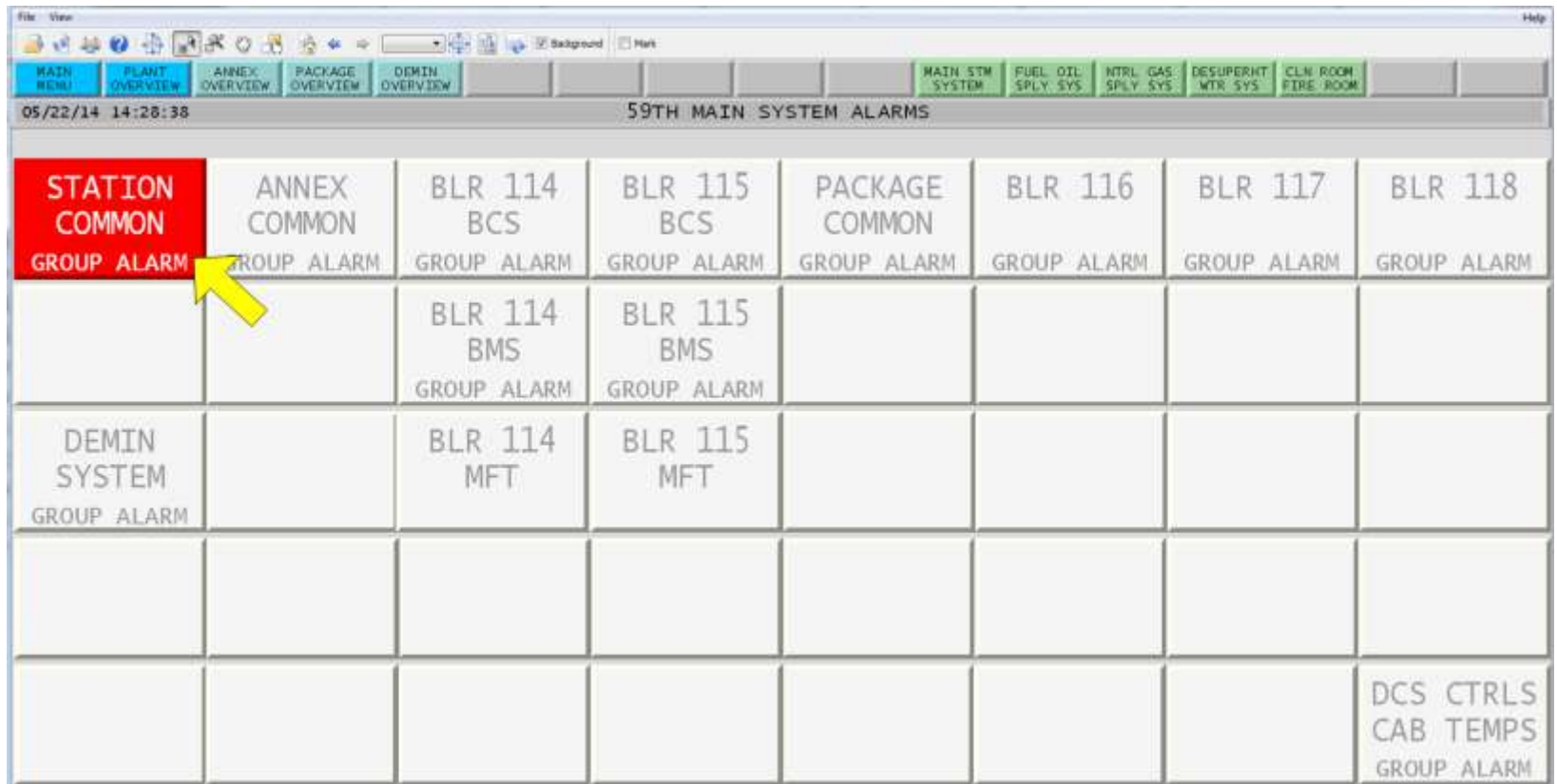
| Timestamp | Type | Kind | Priority | Name | Description | Value | Level |
|---------------------|------|------|----------|------------------------------------|-------------------------------|---------|-------|
| 05/22/2014 11:15:39 | ALRM | | 2 | CC-00-LX-0136-HI.59ST@COED59ST | COOLING WTR TANK LVL HI | ALARM | |
| 05/22/2014 11:15:39 | ALRM | | 2 | G-AX0-PX-0002-L.O.L.59ST@COED59ST | MAIN GAS AX PRESS LO | TRUE | |
| 05/22/2014 11:14:20 | ALRM | | 1 | FP-UA-6.59ST@COED59ST | LFCP FIRE PNL TRBL/SUPERVISRY | TRUE | |
| 05/22/2014 11:14:20 | ALRM | | 1 | FP-UA-8.59ST@COED59ST | MFCP FIRE PNL TRBLE/SUPV | TRUE | |
| 05/20/2014 09:57:12 | ALRM | | 3 | FO-00-ZX-0003A-DEV.59ST@COED59ST | FO N&S PCV-0003A FB DEV | ALARM T | |
| 05/09/2014 02:46:31 | ALRM | | 3 | CBA-118-AIX-1810-L.O.59ST@COED59ST | 118 WINDBOX O2 LOW | ALARM T | |
| 05/09/2014 02:43:57 | ALRM | | 3 | CBA-116-AIX-1810-L.O.59ST@COED59ST | 116 WINDBOX O2 LOW | ALARM T | |
| 05/08/2014 20:31:13 | ALRM | | 3 | FG-118-FI-TAG.59ST@COED59ST | 118 ID FAN TAG-OUT | ALARM T | |
| 05/08/2014 19:08:23 | ALRM | | 3 | CBA-118-FD-TAG.59ST@COED59ST | 118 FD FAN TAG-OUT | ALARM T | |
| 05/08/2014 19:08:07 | ALRM | | 3 | CBA-118-AH-TAG.59ST@COED59ST | 118 AIR HEATER TAG-OUT | ALARM T | |
| 05/08/2014 14:23:26 | ALRM | | 3 | FG-115-TE0080-BQ.59ST@COED59ST | 115 ID FAN I/B BRG TEMP BQ | 1 T | |
| 05/08/2014 14:14:22 | ALRM | | 3 | FG-115-TE0081-BQ.59ST@COED59ST | 115 ID FAN O/B BRG TEMP BQ | 1 T | |
| 05/08/2014 14:04:18 | ALRM | | 3 | FG-114-TE0039-BQ.59ST@COED59ST | 114 ID FAN I/B BRG TEMP BQ | 1 T | |
| 05/08/2014 13:55:09 | ALRM | | 3 | CBA-115-TE0045-BQ.59ST@COED59ST | 115 FD FAN I/B BRG TEMP BQ | 1 T | |
| 05/08/2014 13:46:43 | ALRM | | 3 | CBA-117-FD-TAG.59ST@COED59ST | 117 FD FAN TAG-OUT | ALARM T | |
| 05/08/2014 13:46:35 | ALRM | | 3 | FG-117-FI-TAG.59ST@COED59ST | 117 ID FAN TAG-OUT | ALARM T | |
| 05/08/2014 13:46:30 | ALRM | | 3 | CBA-117-AH-TAG.59ST@COED59ST | 117 AIR HEATER TAG-OUT | ALARM T | |
| 05/08/2014 13:45:46 | ALRM | | 3 | CBA-116-AH-TAG.59ST@COED59ST | 116 AIR HEATER TAG-OUT | ALARM T | |
| 05/08/2014 13:45:39 | ALRM | | 3 | CBA-116-FD-TAG.59ST@COED59ST | 116 FD FAN TAG-OUT | ALARM T | |

Alarm Response Procedures



| STATION COMMON GROUP ALARM | ANNEX COMMON GROUP ALARM | BLR 114 BCS GROUP ALARM | BLR 115 BCS GROUP ALARM | PACKAGE COMMON GROUP ALARM | BLR 116 GROUP ALARM | BLR 117 GROUP ALARM | BLR 118 GROUP ALARM |
|----------------------------------|--------------------------------|-------------------------------|-------------------------------|----------------------------------|------------------------|------------------------|---------------------------------------|
| | | BLR 114 BMS GROUP ALARM | BLR 115 BMS GROUP ALARM | | | | |
| DEMIN SYSTEM GROUP ALARM | | BLR 114 MFT | BLR 115 MFT | | | | |
| | | | | | | | |
| | | | | | | | DCS CTRLS CAB TEMPS GROUP ALARM |

Alarm Response Procedures



The screenshot displays a software interface for monitoring system alarms. At the top, there is a menu bar with 'File', 'View', and 'Help'. Below it is a toolbar with various icons. A row of buttons provides navigation: 'MAIN MENU', 'PLANT OVERVIEW', 'ANNEX OVERVIEW', 'PACKAGE OVERVIEW', 'DEMIN OVERVIEW', and several system-specific buttons like 'MAIN STM SYSTEM', 'FUEL OIL SPLY SYS', 'NTRL GAS SPLY SYS', 'DESUPERHT WTR SYS', and 'CLN ROOM FIRE ROOM'. The main display area is titled '59TH MAIN SYSTEM ALARMS' and shows a timestamp '05/22/14 14:28:38'. It contains a grid of alarm categories. A yellow arrow points to the 'STATION COMMON GROUP ALARM' cell in the first row, first column.

| STATION COMMON GROUP ALARM | ANNEX COMMON GROUP ALARM | BLR 114 BCS GROUP ALARM | BLR 115 BCS GROUP ALARM | PACKAGE COMMON GROUP ALARM | BLR 116 GROUP ALARM | BLR 117 GROUP ALARM | BLR 118 GROUP ALARM |
|----------------------------|--------------------------|-------------------------|-------------------------|----------------------------|---------------------|---------------------|---------------------------------|
| | | BLR 114 BMS GROUP ALARM | BLR 115 BMS GROUP ALARM | | | | |
| DEMIN SYSTEM GROUP ALARM | | BLR 114 MFT | BLR 115 MFT | | | | |
| | | | | | | | |
| | | | | | | | DCS CTRLS CAB TEMPS GROUP ALARM |

Alarm Response Procedures

05/22/14 14:23:21

STATION COMMON GROUP ALARM

| | | | | | | | |
|----------------------------|-----------------------------|--------------------------|-----------------------------|-----------------------|-----------------------|----------------------------|---------------------------|
| FIRE PROTECTION PANEL | STACK LIGHTING | PRIMARY COOLING SYSTEM | | AC TRANSFER SWITCH | CO2 TROUBLE | G.T. FIRE PROTECTION | F.O. TANK #1 |
| FIRE PROTECTION PUMP ROOM | MAIN GAS | SECONDARY COOLING SYSTEM | OIL WATER SEPARATOR TROUBLE | 2.4 KV BUS | | FO STORAGE FIRE PROTECTION | F.O. TANK #2 |
| FIRE PROTECTION CLEAN ROOM | MAIN GAS COALESCER/STRAINER | | | 2.3 KV BUS | | FUEL OIL & F.O. PUMPS | F.O. TANK #3 |
| | | RE-ALK SKID | DOCK FIRE | | | | F.O. TANK #4 |
| STATION AIR TROUBLE | | | DOCK pH & TEMP | 57TH ST STEAM SENDOUT | 58TH ST STEAM SENDOUT | 59TH ST STEAM SENDOUT | FUEL OIL 500 VALVE CLOSED |

STATION COMMON GRP ALARM

DEMIN SYSTEM GRP ALARM

ANNEX COMMON GRP ALARM

BLK 114 BCS GRP ALARM

BLK 114 BMS GRP ALARM

BLK 114 MFT GRP ALARM

BLK 115 BCS GRP ALARM

BLK 115 BMS GRP ALARM

BLK 115 MFT GRP ALARM

PACKAGE COMMON GRP ALARM

BLK 116 GRP ALARM

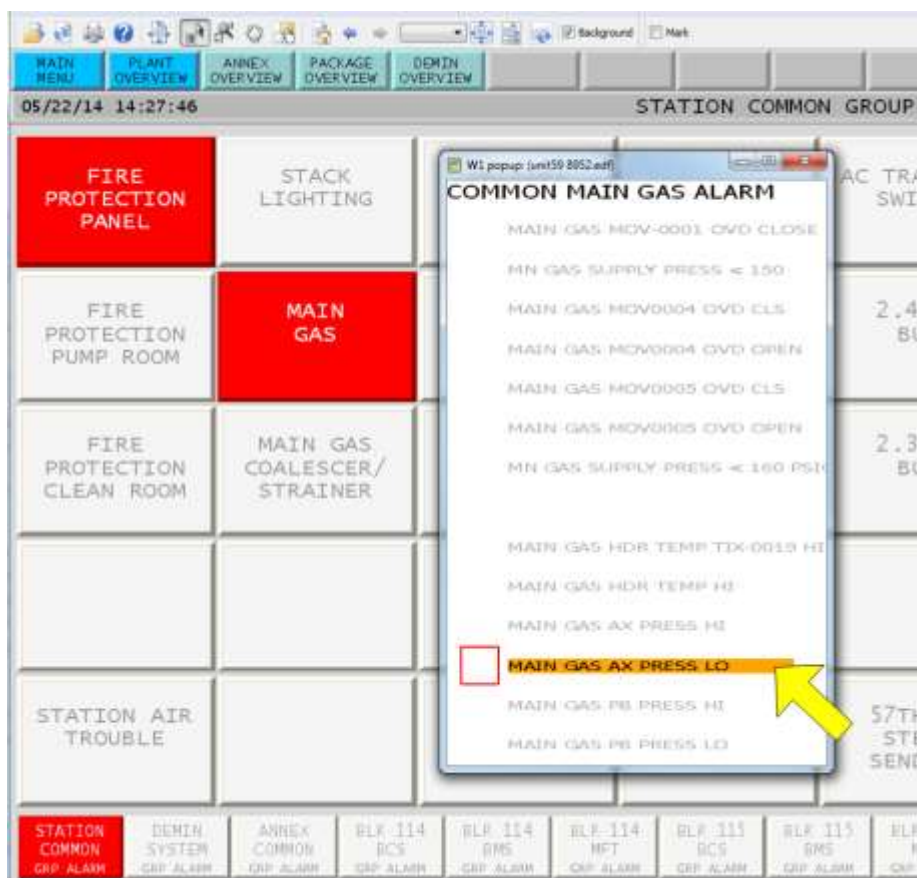
BLK 117 GRP ALARM

BLK 118 GRP ALARM

DCS-CTRLS CAB TEMPS GRP ALARM

59TH MAIN SYS ALARM GRP ALARM

Alarm Response Procedures



| | | |
|-------------|--|----------------------|
| Con Edison | 59th STREET STATION ALARM RESPONSE PROCEDURE | Operations |
| Alarm Title | MAIN GAS AX PRESS LO | Revision: 0 Feb 2013 |

| Device | P&ID | Panel | ID No. |
|--|----------|-------|-------------------|
| W59AXO-G-PIX-0001A W59AXO-G-PIX-0002B W59AXO-G-PIX-0003C | CD375076 | 2057 | G-AXO-PX-0002-LO1 |

| | |
|-------------------------------|--|
| SETPOINT | Two (2) of Three (3) Transmitters < 50 PSIG |
| AUTOMATIC ACTION | Alarm Activates in DCS |
| CONTROL ROOM OPERATOR ACTION | <ul style="list-style-type: none"> Review Pressure Trend Check Flow Trends Check Differential Pressure Across Strainers |
| ROVING OPERATOR ACTION | Walkdown System And Report Findings To Control Room <ul style="list-style-type: none"> Verify Valve V-001 Fully Open Verify Local Pressure Indication Verify Vent Valves Closed Check For Plugged Strainer |
| NOTIFICATIONS and INFORMATION | Notify I&C To Investigate if Problem Is Suspected To Be In Controls Notify Maintenance To Investigate if Problem Is Suspected To Be Mechanical |

Page 1 of 1

SMARTboard

- Job Briefings
- Protection Overview
 - Energy Isolation
 - Portable Grounds
- Interactive Training
 - Drawing prints from memory
- Ability to network with other locations





Results

- Excellent transition from old system to new system
- Operated the new DCS without issues
- Best unit availability in the station's history
- No operating errors
- No lost time accidents
- Reduced Customer Costs
- Opacity reduction

Team Work

- 2013 Emerson Project of the Year Award - 59th Street Gas Addition Controls Upgrade
 - Enabled the company to overcome an industry or business challenge
 - Applied an innovative technology or process to reach a desired economic impact
 - Maximized process efficiency or minimized environmental impact



Future HPI Initiatives

3D Consequential Simulator



- Application and removal of portable grounds
- Testing Dead
 - High Voltage
 - Low Voltage
- Atmospheric Testing
- Energizing a High Energy Steam Line

Google Glass



- Training
 - Recording and watching “How to Instructions”
- Operating
 - Knowing plant conditions while in the field

Questions?

