ISPE Carolina-South Atlantic Chapter

Lean Manufacturing & Energy Management Projects at Morrisville Facility
Merck Biomanufacturing Network

• RTP Facility is part of the Merck’s BioManufacturing Network in conjunction with a biomanufacturing facility in Bilingham, England
• In November 2009, Merck completed its merger with Schering-Plough Corporation
• Third Party Biopharmaceutical Contract Manufacturing
• Manufacturing of Active Pharmaceutical Ingredients (API)
  – Commercial
  – Clinical
Merck Rationale

- Exists as a top tier CMO now
- Retains and builds technical excellence across a range of biologics
Programs offered by Diosynth

• Program 1: Process Development
  – Fermentation
  – Purification
  – Analytical Development

• Program 2: Scale-up and Clinical Manufacture
  – Tech Transfer
  – Engineering run(s)
  – cGMP Manufacture to support Phase III

• Program 3: Process Validation
  – Laboratory process characterization
  – Analytical method validation
  – Engineering run
  – Process Validation runs

• Program 4: Commercial Manufacture
Lean Manufacturing at Diosynth

• Integrated Production Team (IPT) Structure
  – Fermentation
  – Cell Culture
  – Centers of Excellence (CoE)

• Number of current MPS Projects
  – >20 Projects

• # Kaizen executed
  – ~15 Kaizen’s
  – Target of 2 per month
Merck’s Stance on Energy

• Merck believes that reducing our environmental impact is consistent with our values as a health care company
• The 2010 ENERGY STAR Sustained Excellence Award
• Merck, has been an ENERGY STAR partner since 2004
• Recognized by the EPA for five consecutive years
• Merck is committed to energy conservation and our vision to be the most efficient energy steward in the Pharmaceutical Industry
What is motivating the Pharmaceutical industry to improve energy efficiency?

- Cost Reduction
- Energy/Utility Use Reduction
- Increasing cost & global volatility of energy supply
- Environmental responsibility and sustainability
- Greenhouse Gas Reduction
  - 10% reduction in GHG emissions based on 2008 baseline
Guidelines for Energy Management Overview
# Self Assessment

## ENERGY STAR® Energy Management Assessment Matrix

<table>
<thead>
<tr>
<th>Make Commitment to Continuous Improvement</th>
<th>Little or no evidence</th>
<th>Some elements</th>
<th>Fully implemented</th>
<th>Next Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Director</td>
<td>No central organizational resource</td>
<td>Central or organizational resource not encouraged</td>
<td>Empowered central organizational leader with full support management support</td>
<td></td>
</tr>
<tr>
<td>Energy Team</td>
<td>No companywide program</td>
<td>Inhouse organization</td>
<td>Active cross-functional team guiding energy program</td>
<td></td>
</tr>
<tr>
<td>Energy Policy</td>
<td>No formal policy</td>
<td>Preferably in environmental or energy policies</td>
<td>Formal plan of EE policy endorsed by senior management</td>
<td></td>
</tr>
</tbody>
</table>

## Gather and Track Data

<table>
<thead>
<tr>
<th>Make Commitment to Continuous Improvement</th>
<th>Little or no evidence</th>
<th>Some elements</th>
<th>Fully implemented</th>
<th>Next Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gather and Track Data</td>
<td>Little or no tracking</td>
<td>Limited data tracking</td>
<td>All facilities report level of energy usage</td>
<td></td>
</tr>
<tr>
<td>Normalize</td>
<td>Not addressed</td>
<td>Some areas need improvement</td>
<td>All meaningful data is tracked</td>
<td></td>
</tr>
<tr>
<td>Establish baselines</td>
<td>No baselines</td>
<td>Various baselines established</td>
<td>Standardized organizational data year and metrics established</td>
<td></td>
</tr>
</tbody>
</table>

## Benchmark

<table>
<thead>
<tr>
<th>Make Commitment to Continuous Improvement</th>
<th>Little or no evidence</th>
<th>Some elements</th>
<th>Fully implemented</th>
<th>Next Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark</td>
<td>Not addressed</td>
<td>Only some sites</td>
<td>Regular basis are compared among</td>
<td></td>
</tr>
</tbody>
</table>

## Define Technical Scope and Target

<table>
<thead>
<tr>
<th>Make Commitment to Continuous Improvement</th>
<th>Little or no evidence</th>
<th>Some elements</th>
<th>Fully implemented</th>
<th>Next Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define technical scope and target</td>
<td>Not addressed</td>
<td>Limited data tracking</td>
<td>Detailed multi-level targets with milestones</td>
<td></td>
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</tbody>
</table>

## Determine Roles and Resources

<table>
<thead>
<tr>
<th>Make Commitment to Continuous Improvement</th>
<th>Little or no evidence</th>
<th>Some elements</th>
<th>Fully implemented</th>
<th>Next Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine roles and resources</td>
<td>Not addressed</td>
<td>Some roles are defined</td>
<td>Adequate resources to support the project</td>
<td></td>
</tr>
</tbody>
</table>

## Implement Action Plan

<table>
<thead>
<tr>
<th>Make Commitment to Continuous Improvement</th>
<th>Little or no evidence</th>
<th>Some elements</th>
<th>Fully implemented</th>
<th>Next Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implement action plan</td>
<td>Not addressed</td>
<td>Limited data tracking</td>
<td>All stakeholders are addressed on a regular basis</td>
<td></td>
</tr>
<tr>
<td>Raise awareness</td>
<td>No promotion of energy use</td>
<td>Portable reference to energy use</td>
<td>All levels of organization support energy goals</td>
<td></td>
</tr>
<tr>
<td>Build capacity</td>
<td>No training</td>
<td>Some training is available</td>
<td>Broad understanding of technology &amp; best practices</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>No organizational context with energy use and staff</td>
<td>Thematic for non-performance or periodic reminders</td>
<td>Recognition, financial &amp; performance incentives</td>
<td></td>
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</tbody>
</table>

## Track and Monitor

<table>
<thead>
<tr>
<th>Make Commitment to Continuous Improvement</th>
<th>Little or no evidence</th>
<th>Some elements</th>
<th>Fully implemented</th>
<th>Next Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Track and monitor</td>
<td>No system for monitoring progress</td>
<td>Annual reviews by facilities</td>
<td>Regular reviews with updates of centralized system</td>
<td></td>
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</tbody>
</table>

## Evaluate Progress

<table>
<thead>
<tr>
<th>Make Commitment to Continuous Improvement</th>
<th>Little or no evidence</th>
<th>Some elements</th>
<th>Fully implemented</th>
<th>Next Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measure results</td>
<td>Not reviewed</td>
<td>Historical comparisons</td>
<td>Compare usage &amp; costs as goals, plan, and strategies</td>
<td></td>
</tr>
<tr>
<td>Review action plan</td>
<td>Not reviewed</td>
<td>Informal check on progress</td>
<td>Status report based on results, feedback &amp; business factors</td>
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</tbody>
</table>

## Recognize Achievements

<table>
<thead>
<tr>
<th>Make Commitment to Continuous Improvement</th>
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<th>Some elements</th>
<th>Fully implemented</th>
<th>Next Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide internal recognition</td>
<td>Not addressed</td>
<td>Identify successful projects</td>
<td>Acknowledge contributions of individuals, teams, and leaders</td>
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</tr>
<tr>
<td>Get external recognition</td>
<td>Not sought</td>
<td>It is notable</td>
<td>Accolades and highlighting achievements</td>
<td></td>
</tr>
</tbody>
</table>
Make a Commitment

• Commit to Continuous Improvement
  – Changing the Culture
• Appoint an Energy Champion
• Create an Energy Team
• Start putting together Energy Policies
Assess Performance

• Identify Savings Potential by Benchmarking
• Pharmaceutical Manufacturing Plant Energy Performance Indicator
  – US EPA's ENERGY STAR partnered with pharmaceutical companies to improve energy efficiency
  – EPA helps industry overcome barriers to using energy efficiently and provides energy management resources
  – Merck has 3 manufacturing plants that are ENERGY STAR certified
• http://www.energystar.gov/
# Benchmarking Tools

## Pharmaceutical Manufacturing Plant Energy Performance Indicator

### Plant Characteristics

**Definitions**

- **ZIP Code:** 20480
- **Location:** Washington, DC

**Current Plant**

- **Select Year:** 2009
- **Units:** 8,760
- **Total Plant Size:** 300 $10^3$ sq. ft.
- **Percentage of Plant - Bulk Chemicals:** 50%
- **Percentage of Plant - Fill and Finish:** 30%
- **Percentage of Plant - R & D:** 20%
- **Percentage of Plant - All Other:** 10%

**Reference Plant**

- **Select Year:** 2009
- **Units:** 8,760
- **Total Plant Size:** 300 $10^3$ sq. ft.
- **Percentage of Plant - Bulk Chemicals:** 50%
- **Percentage of Plant - Fill and Finish:** 30%
- **Percentage of Plant - R & D:** 20%
- **Percentage of Plant - All Other:** 10%

**Default Degree Days:**

- **30-Year HDD:** 4,047
- **30-Year CDD:** 1,548

### Energy Consumption

**Definitions**

**Select Units**

- **Enter Name:** Annual Purchases 20,000 | Natural Gas 275,000
- **(2009)**

- **Enter Name:** Annual Cost G | Gas 275,000
- **(2009)**

**Enter Name:** Annual Purchases 20,000 | Natural Gas 300,000
- **(2009)**

**Enter Name:** Annual Cost G | Gas 300,000
- **(2009)**

*Entering cost data is optional and does not impact the computation of the EPI score.*
## Benchmarking Tools

### Results

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Your Current Plant</th>
<th>Your Reference Plant</th>
<th>Average Plant</th>
<th>Efficient Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Performance Score</td>
<td>54</td>
<td>50</td>
<td>50</td>
<td>75</td>
</tr>
<tr>
<td>Annual Energy Cost ($/year)</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>$ Energy sq. ft</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>Total Source Energy (MMBtu)</td>
<td>480,376</td>
<td>505,376</td>
<td>507,435</td>
<td>254,539</td>
</tr>
<tr>
<td>Total Site Energy (MMBtu)</td>
<td>343,240</td>
<td>362,749</td>
<td>362,574</td>
<td>243,327</td>
</tr>
<tr>
<td>Total Source Energy (MMBtu) / sq. ft</td>
<td>1.48</td>
<td>1.53</td>
<td>1.54</td>
<td>1.07</td>
</tr>
</tbody>
</table>

### Graphs

- **Enter Name (2009)**: EPI = 54
- **Enter Name (2009)**: EPI = 50
Set Goals

- Understand how much energy is being used, where it is being used, potential savings and put it in context
- Set a Metric
  - $500,000 per year over 3 years
  - Reduce Electricity Usage by 4,000,000 kWh per year
  - Reduce Natural Gas use by 14,000 decatherms per year
  - Reduce Water/Sewer by 11,000,000 gallons per year
  - Normalize the data
Put it in Context

- Reduce Electric by 4,000,000 kWh per year
  - Enough electricity to power 220 houses for a year (1600-2000sq.ft)
- Reduce Natural Gas use by 14,000 decatherms per year
  - Equivalent to burning 2400 barrels of oil
- Reduce Water/Sewer by 11,000,000 gallons per year
  - Enough water to fill 18 Olympic size swimming pools
Prioritize Potential Solutions

- Place your solutions in the Effort-Benefit Grid
How did we do it?

– Brainstorming Sessions
– Subject Matter Experts – Voice of the Customer (VOC)
  – What does the customer need?
– Go and See
  – Walk down to see where the wastes are
Create Action Plan

- Multigenerational Approach

<table>
<thead>
<tr>
<th>Goals</th>
<th>Projects/Activities</th>
<th>Who</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
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<tbody>
<tr>
<td>1. Generation 1 of Multigenerational Project</td>
<td>Claim the VFD Project for this project</td>
<td>High Level</td>
<td>GH</td>
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<td>Summary of complete and financial benefit</td>
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<tr>
<td>2. Steal CA project from Wilson (Green Belt Project)</td>
<td>Define</td>
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<td>Improve</td>
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<td>3. Quick Wins</td>
<td>Decon Autoclave</td>
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<td></td>
<td>Environmental Chambers</td>
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<td></td>
<td>Weston Boiler</td>
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</tr>
<tr>
<td>4. Generation 1 of Multigenerational Project</td>
<td>Lighting -Energy Police</td>
<td>Start gathering baseline data</td>
<td></td>
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<tr>
<td></td>
<td>Chiller Cooling Tower</td>
<td>Summarize baseline data and put together cost benefit analysis for CAPEX</td>
<td></td>
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<tr>
<td></td>
<td>Clean Steam System Efficiency</td>
<td>Start collecting baseline data and defining</td>
<td></td>
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<tr>
<td></td>
<td>Generation 3</td>
<td>Gather baseline data for future projects</td>
<td></td>
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</tr>
</tbody>
</table>
Implement the Action Plan

• Setting Up the Project
  – Business Case
    – Baseline Data
  – Problem Statement
  – A3/Charter
  – Lean Six Sigma
  – DMAIC (Define, Measure, Analyze, Improve, Control)
  – Kaizen
  – Just Do It – Low hanging fruit
<table>
<thead>
<tr>
<th>S</th>
<th>I</th>
<th>P</th>
<th>O</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Company</td>
<td>Electricity</td>
<td>1. Electricity</td>
<td>Clean Air</td>
<td>User</td>
</tr>
<tr>
<td>Air Equipment</td>
<td>Water for Cooling</td>
<td>2. Compressors</td>
<td>Instrument Air</td>
<td>Equip/Process</td>
</tr>
<tr>
<td>Water Company</td>
<td>Air Demand</td>
<td>3. Driers</td>
<td>Plant Air</td>
<td>Budget holder</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Distribution</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Use</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **S**: Supplier
- **I**: Influencer
- **P**: Process
- **O**: Objective
- **C**: Customer
Compressed Air Example

- Define the System
  - Compressed Air Audit
  - Compressor Information
    - Full Load HP
    - Partial Load HP
  - Type of Compressor
    - Centrifugal, Rotary, Reciprocating
  - Type of Dryer
    - Refrigerator, desiccant, heat of compression
  - Compressor Control
  - Current Supply Pressure
  - Minimum Acceptable Pressure
## Inventory Equipment

<table>
<thead>
<tr>
<th>Equipment Number</th>
<th>KM-8501</th>
<th>Year Installed</th>
<th>6/1/2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>Kobelco</td>
<td>SN 06J0419</td>
<td>Model</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>KNW 0-D/L</td>
</tr>
<tr>
<td>Rated Capacity</td>
<td>332 CFM</td>
<td>110 Psig</td>
<td>3550 RPM</td>
</tr>
<tr>
<td>Motor Rating</td>
<td>75 Hp</td>
<td>460 Voltage</td>
<td>104 Amps</td>
</tr>
<tr>
<td>Brake horse Power</td>
<td>83 BHP</td>
<td>110 psig</td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td>Motor Efficiency 94.5%...Need performance curve.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Evaluate Progress

• Measurement System Analysis
  – Our ability to assess the performance of a process is only as good as our ability to measure it
  – The measurement system is the ‘eye” of the process
  – Identify and filter your X’s (outputs)
  – Which Y’s (inputs) impact your X’s
X’s and Y’s

- **Outputs**
  - Dew point
  - PRV Set Point
  - PSV Set Point
  - CA Required Set Point
  - Alarms
  - Compressor Temperature
  - Temperature
  - Pressure
  - Leaks
  - Cost
  - Run time
  - Full/Half/No Load Time
  - Control Strategy
  - Compressor Capacity
  - Air inlet temp
  - Air inlet pressure
  - Air outlet pressure
  - Cooling water temp
  - Air dew point temp
  - Evaporator press

- **Inputs**
  - Cooling Water Temp
  - Intake Air Temperature
  - Electricity
Detailed Process Map
Compressed Air Audit

Group Comp By Distribution

Calculate Cost per CFM for System

Are Compressors dispatched as to optimize load

Can Operating pressure be reduced

Test distributions system and end-use for leaks and worn orifices. Control Operating times to reduce waste

Evaluate performance of individual compressors

Can the quality of intake air be improved

Move intake as required

Evaluate heat recovery from all compressors

Summarize conservation options

Implement options with high priority

Re-calculate cost per CFM

Is the compressor operating near design conditions

Revise operating procedures or replace units as indicated by analysis

Revise operating procedures accordingly

Make maintenance improvements as required

Evaluate performance of individual compressors

Control Operating times to reduce waste

Test distributions system and end-use for leaks and worn orifices. Control Operating times to reduce waste

Evaluate heat recovery from all compressors

Summarize conservation options

Implement options with high priority

Re-calculate cost per CFM
Data Collection Plan

- 3 Compressors
- Loaded Hours
- Unloaded Hours
- Loaded Amps
- Unloaded Amps
- Loaded kWh
- Unloaded kWh
- Calculate $/CF

<table>
<thead>
<tr>
<th>Date</th>
<th>Inter Cooler Drain</th>
<th>After Cooler Drain</th>
<th>Air Filter Cond.</th>
<th>Oil Filter Cond.</th>
<th>Oil Level</th>
<th>1st Stage Discharge Air Pressure</th>
<th>2nd Stage Discharge Air Pressure</th>
<th>Lube Oil Press</th>
<th>1st Stage Disch Temp</th>
<th>2nd Stage Disch Temp</th>
<th>2nd Stage Suction Temp</th>
<th>Disch Temp</th>
<th>Oil Temp</th>
<th>Run Hour</th>
<th>Loaded Hours</th>
<th>Initials</th>
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<tr>
<td>1</td>
<td></td>
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</tbody>
</table>

FOR MONTH/YEAR OF __________________________ AIR COMPRESSOR # _______________________

MERCK
# Summary of Data Collection

<table>
<thead>
<tr>
<th></th>
<th>Loaded Amps</th>
<th>Unloaded Amps</th>
<th>Loaded KW</th>
<th>Unloaded KW</th>
<th>Loaded Hours</th>
<th>Unloaded Hours</th>
<th>KWH/Month</th>
<th>Cost/Month</th>
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<tr>
<td>8500 May</td>
<td>81</td>
<td>17</td>
<td>60.61</td>
<td>12.72</td>
<td>215</td>
<td>87</td>
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<td>1075.34</td>
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<td>12.72</td>
<td>308</td>
<td>104</td>
<td>22584.39</td>
<td>1540.48</td>
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<td>12.72</td>
<td>178</td>
<td>112</td>
<td>13052.02</td>
<td>890.28</td>
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<td>12.72</td>
<td>329</td>
<td>104.5</td>
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<td>1645.51</td>
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<td>78</td>
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<td>922.89</td>
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<tr>
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<td>89</td>
<td>18</td>
<td>66.59</td>
<td>13.47</td>
<td>101</td>
<td>123</td>
<td>8086.06</td>
<td>552.36</td>
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<tr>
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<td>89</td>
<td>18</td>
<td>66.59</td>
<td>13.47</td>
<td>277.4</td>
<td>87.6</td>
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<td>1517.07</td>
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<td>60.61</td>
<td>12.72</td>
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</table>

|               | May-Aug     | 48,956,544 CF | $14,027 |
|               | Average     | 12,239,136 CF | $3,507  |
| Annual Cost based on Average | 146,869,632 CF Annual | $42,080 |
| Cost per 1000 CF |               |              | $0.29   |

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Run Chart of CF/Day

Number of runs about median: 38
Expected number of runs: 62.0
Longest run about median: 14
Approx P-Value for Clustering: 0.000
Approx P-Value for Mixtures: 1.000

Number of runs up or down: 80
Expected number of runs: 81.0
Longest run up or down: 4
Approx P-Value for Trends: 0.414
Approx P-Value for Oscillation: 0.586
### Statistical Summary

#### Summary for CF/day

- **Minimum**: 176400
- **1st Quartile**: 355140
- **Median**: 397980
- **3rd Quartile**: 447462
- **Maximum**: 632340

#### Anderson-Darling Normality Test
- **A-Squared**: 1.42
- **P-Value <**: 0.005

#### Summary Statistics
- **Mean**: 408643
- **StDev**: 76064
- **Variance**: 5785705098
- **Skewness**: 0.43689
- **Kurtosis**: 1.18287
- **N**: 122

#### 95% Confidence Intervals
- **95% Confidence Interval for Mean**: 395009 to 422276
- **95% Confidence Interval for Median**: 388080 to 410400
- **95% Confidence Interval for StDev**: 67569 to 87021
Compressed Air Audits

Based on a review of widely available industry literature below are the most common, highest-payback problems typically found during a professional audit of CA systems:

• (1) Leaks
• (2) Overpressurization
• (3) Double-Check Air Requirements
• (4) Angle Connections
• (5) Bad Piping
• (6) Obsolete Restrictions
• (7) Insufficient Storage
• (8) Inappropriate Use
• (9) Pumps
• (10) Maintain the System
# Leak Survey

<table>
<thead>
<tr>
<th>Date Leak Discovered</th>
<th>Location Description</th>
<th>Approximate Pipe/Tubing Size</th>
<th>Nuisance or Significant (If Significant submit SRF)</th>
<th>Leak Discovered by Initials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Was the leak repaired?</th>
<th>Yes / (Circle one)</th>
<th>No</th>
<th>SRF # if Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Comments:**

<table>
<thead>
<tr>
<th>Administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leak #</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

---

**MERCK**

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Analyze

• Total # of Leaks Found
  – Estimated/Measure Loss in system

• Overpressurization
  – Can you reduce pressure based on actual requirements?

• Air Requirements
  – Dew points, Control strategy, etc.

• Inappropriate Use
  – Address the inappropriate uses in SOPs

• Maintain the System
  – PMs, etc.
Improve

• On-going
• Comprehensive leak detection program
• Compressed air requirements, both pressure (psi) and demand
• Cfm supply vs. demand
• Fix leaks
• Adjust others
Control

- Re-measure
- Mistake Proof – Standardize the work
- Leak Detector Equipment
- PMs
- Education
- Update SOPs
- Install Meters
Merck Wilson (Before & After)
Merck Wilson (Before & After)

Limit of 1st Compressor

Before

Histogram of Weekday CFM
Normal

After

Histogram of Weekday CFM
Normal
Evaluation – 2009 vs 2010

2009 vs 2010 Overall

Month

$ (1000)

$0 $50 $100 $150 $200 $250 $300 $350 $400

1 2 3 4 5 6 7 8 9 10 11 12

2009
2010
Recognize Achievements

- **VFD Project**
  - $100,000 savings/yr

- **Weston Boiler**
  - ~$9,000/yr and 9 metric tons of CO2

- **Compressed Air**
  - DMAIC project, currently in Analyze Phase

- **Lighting**
  - Proposed $50K savings per year, ~ 500 metric tons of CO2

- **Energy Awareness – Think Energy!**
Reducing CO2 Emissions Example

- 10% of the electricity used in our Man. Facility is from the lighting
- Program to retrofit fixtures throughout facility to more efficient lamps and ballasts
- Reduce electricity used by 749,000 kWh
- Reduce cost by >$50,000
- Reduce CO2 emissions by > 500 Metric Tons
Sustaining the Gains

• Education/Awareness
  – Business
    – Make Energy Awareness part of the business plan
  – People
    – Think Energy!
  – Process
    – Incorporate Energy Awareness into planning and operating procedures
  – Capital
    – Address Energy Awareness as part of Capital Investment Plan

www.energystar.gov/ia/business/guidelines/assessment_matrix.xls
Establish Best Practices

• Administration
• Lighting
• Utilities
• Process Applications
• Misc Mechanical
• HVAC
• Electric
• Architectural
Challenges and Lessons Learned

• Be prepared
• Sponsorship is key
• Don’t count on the money
• Change is hard
• QA and Compliance implications
• Time
Conclusion

• Change the Culture
  – Commit to Continuous Improvement
• Assess Performance
• Identify Savings Potential by Benchmarking
• Set Goals
• Create Action Plan
  – Brainstorming, VOC, Best Practices, Prioritize
Conclusion (Cont.)

• Implement the Action Plan
• Tackle the Project
  – Define, Measure, Analyze, Improve, Sustain
• Evaluate Progress
  – Monitor/Re-Assess
• Recognize Achievements
• Sustaining the Gains
Questions?