U. S. Department of Energy
Energy Savings Assessment (ESA)

Compressed Air Best Practices Tools

Compressed Air Challenge®
DOE AIRMaester+ Software
CAC LogTool Software

Date: May 15, 2007
Instructor: Tom Taranto
Agenda

- Training Webcast Introduction
- Introduction of Tools - 10 minutes
- Compressed Air Challenge® Tools - 25 minutes
- AIRMaster+ Software Tool - 25 minutes
- LogTool v2 - 25 minutes
- ESA Process - 20 minutes
- Q&A / Summary - 15 minutes
Training Web Cast Series

- **Purpose:**
  To provide information on Compressed Air Best Practices tools used during DOE’s Energy Savings Assessments (ESA).

- **Format:**
  - Brief introduction to the functionality and use of the DOE Compressed Air System Best Practices tools.
  - Provides an overview, not in-depth training. (Formal training is available for most tools.)

- **Tools in Brief:**
  - Identify opportunities
  - Provide estimates of energy and cost savings
  - Not a replacement for in-depth project analysis
Compressed Air Challenge® Tools
What is the (CAC) ?

- The Compressed Air Challenge is a voluntary collaboration of:
  - Industrial users,
  - Manufacturers and their associations,
  - Distributors and their associations,
  - Facility operating personnel and their associations,
  - Consultants,
  - State energy research and development agencies,
  - Energy efficiency organizations,
  - United States Department of Energy, and
  - Utilities.

- This group has one purpose in mind:

- **Helping you improve the performance of your compressed air system.**
CAC Sponsors

- US Department of Energy Office of Industrial Technologies
- State of Illinois, Energy Department
- Pacific Gas & Electric
- NSTAR Electric and Gas Company
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- Northeast Utilities Company
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- Iowa Energy Center
- Energy Center of Wisconsin
- Consortium for Energy Efficiency
- Compressor Distributors Association
- Compressed Air and Gas Institute
- Association of Ingersoll-Rand Distributors
- Manitoba Hydro
- BC Hydro
CAC Instructors

- Niff Ambrosino, Scales Industrial Technologies
- Roger Antonioli, Scales Industrial Technologies
- Chris Beals, Air Systems Management, Inc
- David Booth, Sullair Corporation
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- Joe Ghislain, Ford Motor Corp
- Greg Harrell, Univ. of Tennessee
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- Mike Mallard, Johnson Controls, Inc.
- David McCulloch, Mac Consulting Services
- Frank Moskowitz, Draw Professional Services
- Ross Orr, Scales Industrial Technologies I
- Wayne Perry, Kaeser Corporation
- Bill Scales, Scales Industrial Technologies
- Gary Shafer, Ingersoll Rand
- Paul Shaw, Scales Industrial Technologies
- Dean Smith, Air Science Engineering
- Roy Stuhlman, Kaeser Corporation
- Jody Sutter, Compressed Air Systems Solutions
- Jerry Swedeen, Case Consulting, Inc.
- Tom Taranto, ConservAIR/Pneumatech
- Bob Terrell, Alliant Energy
- Hank Van Ormer, Air Power USA
- Greg Wheeler, Oregon State University
- Robert Wilson, ConservAIR/Pneumatech
- Jeff Yarnall, Rogers Machinery Co.
- Jan Zuercher, Quincy Compressor
AIRMaster+ is but one tool in a large portfolio of Compressed Air Challenge offerings designed to assist the end user in improving the performance of compressed air systems. AIRMaster+ allows for objective and repeatable compressed air system assessment results and can be used to improve the performance and efficiency of operation. However, AIRMaster+ is not meant to replace an experienced auditor in the evaluation of a compressed air system. AIRMaster+ is intended to model airflow and associated electrical demands as seen by the supply side of the system. AIRMaster+ does not model the dynamic effects of the distribution and end uses. Such issues should be addressed through consultation with an experienced auditor before implementing efficiency recommendations.

Developed for the U.S. Department of Energy
by the Washington State University Energy Program
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AIRMaster+ Features

- AIRMaster+ a Windows based software tool used to analyze industrial compressed air systems:
  - Measure / Calculate Annual Baseline Energy & Cost
  - Input 24-hour metered airflow or power data
  - Assign electrical utility energy schedules
  - Simulate compressed air system operation
  - Model system operation at various loads
  - Estimate Savings of Energy Efficiency Measures
  - Is not a substitute for an experienced auditor!
LogTool v2

- LogTool is a public domain tool available from Compressed Air Challenge™ in cooperation with SBW Consulting

- Import data from different types of data loggers

- Display trend plots with one or two Y axes

- assist in the analysis of compressed system performance measurements

- Display DayType plots

- a companion tool for AIRMaster+, also available from the Compressed Air Challenge
U. S. Department of Energy
Energy Savings Assessment (ESA)

Compressed Air Challenge®
Best Practices Tools
Compressed Air Challenge®

CAC Seven Step Action Plan

1. Develop a basic block diagram.

2. Measure your baseline and calculate energy use and costs.

3. Work with your compressed air system specialist to implement an appropriate compressor control strategy.

4. Once controls are adjusted, re-measure baseline. Re-calculate energy use and costs.

5. Walk through to check for obvious preventive maintenance items and other opportunities to reduce costs and improve performance.

6. Identify and fix leaks and correct inappropriate uses – know costs, re-measure, and adjust controls as above.

7. Evaluate Steps 1-6, implement awareness and continuous improvements programs, and report results to management.
Compressed Air Challenge®

- **Block Diagram**
  - Graphic representation of compressed air system and the relationship of individual components
CAC End Use Solutions Finder

- On-site work
  - Potentially Inappropriate Uses

End-Use Audit Checklist

Potentially Inappropriate Applications

Is compressed air being used for any of the applications on this list?

- Open blowing
- Sparging (agitating, stirring, mixing)
- Aspirating
- Atomizing
- Padding
- Dilute phase transport
- Dense phase transport
- Vacuum generation
- Personnel cooling
- Open hand held blowguns or lances
- Cabinet cooling
- Vacuum venturis
- Diaphragm pumps
- Timer drains/open drains
- Air Motors

Note: A Handout titled Inappropriate Uses of Compressed Air has been included.
CAC End Use Solutions Finder

- On-site work
  - High Pressure End-Use Requirements
CAC End Use Solutions Finder

- **On-site work**
  - High Volume Intermittent Applications

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**End-Use Audit Checklist**

**High Volume/Intermittent Applications**

What is the full load output from the compressors in the system?

<table>
<thead>
<tr>
<th>cfm</th>
<th>psig</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Summer)

<table>
<thead>
<tr>
<th>cfm</th>
<th>psig</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Winter)

List any applications that are for a short duration and use a high volume of air:

<table>
<thead>
<tr>
<th>Application</th>
<th>Approximate Vol Req’d</th>
<th>Min on</th>
<th>Min off</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

Have any steps been taken with the control and storage systems to address these applications?  [ ] Yes  [ ] No

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*Advanced Management of Compressed Air Systems*  
© 1999, The Compressed Air Challenge
Compressed Air Challenge®
Do You Want to Cut Costs? **STACOLM**

**ST**orage
**A**ppropriate Uses
**CO**ntrols
**L**eaks
**M**aintenance
CAC
Data Forms

- High Pressure End Use Requirements
- High Volume Intermittent Applications
- Potentially Inappropriate Applications
- Summing End–Use Requirements
- End–Use Solutions Finder
- Storage Opportunities
- Appropriate Use Strategy
- COntrol Strategy
- Leak Estimates / Repair & Ongoing Management
- Maintenance Plan
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AIRMaster+
Best Practices Tools
How Does AIRMaster+ Help You Conduct a Performance Assessment?

1. Conduct Walk-thru Inspection and Document Plant Data
2. Collect Short-Term Metering Data
3. Analyze and Summarize Plant and Metering Data
4. Identify Possible EEMs
5. Enter Plant and EEM Data in AIRMaster+
6. Identify Best EEM Scenario Using AIRMaster+
7. Prepare Recommendations Including Results from AIRMaster+
8. Implement and Commission Recommendations

AIRMaster+ Helps You with This Part of the Work
AIRMaster+ Main Menu
AIRMaster+
Data Input Form

- Utility Rates
# AIRMaster+ Data Input Form

- **Compressor**

## Nameplate Information
- Compressor type:
- Manufacturer:
- Model:
- Horsepower rating:
- Full load operating pressure, psig:
- Rated capacity @ full load operating pressure, acfm:
- Serial #:
- Installation date:
- Compressor location:

## Control Information
- Control type:
- Unloading Controls:
  - Unload point, %Capacity:
  - # of unload steps:
- After Cooling info:
  - Cooling type:
  - Unloaded dump pressure, psig:
  - Automatic shutdown timer, YN:
- Fan motor rating, HP:

## Compressor Performance

<table>
<thead>
<tr>
<th>Performance Points</th>
<th>Discharge Pressure, psig</th>
<th>Airflow, acfm</th>
<th>Power, kW</th>
<th>Inlet Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Load</td>
<td></td>
<td></td>
<td></td>
<td>Avg. temperature, °F:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Atmos. pressure, psig:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Blowdown time, sec.:</td>
</tr>
<tr>
<td>Max full flow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unload Point or surge point for centrifugal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No load (fully modulated or unloaded)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
AIRMaster+  
Data Input Forms

- Company / Facility
- Utility Rates
- System
- End Uses
- Compressor
- Compressor Details
- Profile Order
- Profile Data

- EEM: Reduce Air Leaks
- EEM: Improve End Use Efficiency
- EEM: Reduce System Air Pressure
- EEM: Using Unloading Controls
- EEM: Adjust Cascading Set Points
- EEM: Use Automatic Sequencer
- EEM: Reduce Run Time
- EEM: Add Primary Receiver Volume
Informational Objectives - Input

- AIRMaster+ Information
  - Company Information => AIRMaster+ Forms
  - Utility Information => Energy Bill
  - Facility Information => AIRMaster+ Form
  - System Information => Compressors
  - Compressor Signature => Performance Points
  - Nameplate Compressor => Motor Data
  - System Profile => Measure Power or Flow Trends
  - Typical operating days => Day-types
Informational Objectives
On-Site Assessment

- System Information
  - Measure System Profile Power and/or Airflow
  - Pressure & Flow Dynamic Profiles
  - Compressor Control Response Dynamics
  - Perceived High Pressure Demands
  - High Volume Intermittent Demand Events
  - Distribution Gradients
  - Overall Leakage Estimate
Informational Objectives - Results

- **System Assessment**
  - Identify Lowest Optimum Target Pressure
  - Resolve Pressure Profile & Control Issues
  - Validate Perceived High Pressure Uses
  - Air Storage for High Volume Intermittent Demand
  - Resolve Piping Deficiencies & Eliminate Gradients

- **AIRMaster+ Software**
  - Assess Various Energy Efficiency Measures
  - Consider Multiple Scenarios w/ Various Measures
  - Recommend Cost Effective Remedial Measures
AIRMaster+
System Profile – Data
AIRMaster+
System Profile – Air Flow

Compressed Air System Assessment – Introduction
AIRMaster+
System Profile – Power (kW)
AIRMaster+ Energy Efficiency Measures

- Reduce Air Leaks
- Improve End Use Efficiency
- Reduce System Air Pressure
- Use Unloading Controls
- Adjust Cascading Set Points
- Use Automatic Sequencer
- Reduce Run Time
- Add Primary Receiver Volume
Energy Efficiency Measures
Savings Summary

<table>
<thead>
<tr>
<th>Description</th>
<th>Energy Savings, kWh</th>
<th>Energy Savings, $</th>
<th>Energy Savings, %</th>
<th>Demand Savings, kWh</th>
<th>Demand Savings, $</th>
<th>Installed Cost, $</th>
<th>Total Savings, $</th>
<th>Simple Payback, years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve Pressure Profile</td>
<td>407,747</td>
<td>14,475</td>
<td>13.5</td>
<td>41.1</td>
<td>2,021</td>
<td>200</td>
<td>16,496</td>
<td>0.0</td>
</tr>
<tr>
<td>Use Unloading Controls</td>
<td>-2,862</td>
<td>-102</td>
<td>-0.1</td>
<td>0.8</td>
<td>41</td>
<td>500</td>
<td>-61</td>
<td>0.0</td>
</tr>
<tr>
<td>Add Primary Receiver Volume</td>
<td>123,131</td>
<td>4,584</td>
<td>4.3</td>
<td>20.8</td>
<td>1,021</td>
<td>15,000</td>
<td>5,605</td>
<td>2.7</td>
</tr>
<tr>
<td>Fix Air Leaks</td>
<td>216,495</td>
<td>7,686</td>
<td>7.2</td>
<td>33.2</td>
<td>1,633</td>
<td>1,000</td>
<td>9,319</td>
<td>0.1</td>
</tr>
<tr>
<td>Reduce Run Time</td>
<td>21,935</td>
<td>779</td>
<td>0.7</td>
<td>0.0</td>
<td>0</td>
<td>100</td>
<td>779</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>772,445</strong></td>
<td><strong>27,422</strong></td>
<td><strong>25.5</strong></td>
<td><strong>95.9</strong></td>
<td><strong>4,716</strong></td>
<td><strong>16,800</strong></td>
<td><strong>32,138</strong></td>
<td><strong>0.5</strong></td>
</tr>
</tbody>
</table>

Double-click row to view corresponding measure input data

Compressed Air System Assessment – Introduction
U. S. Department of Energy
Energy Savings Assessment (ESA)

CAC LogTool v2
Best Practices Tools
LogTool v2 – Import Data

- The import screen gives you tools to import data from different types of data loggers.
LogTool v2 – View Data

- View Data displays a listing of the date/time stamps & data values for the selected channel.
LogTool v2
Trend Plot

- Select Channels to Plot
LogTool v2
Trend Plot

- Create Day Types for AIRMaster+ System Profile
LogTool v2
Paste DayTypes into Excel

- View DayType Profiles in Excel

---

| A   | B       | C          | D               | E                  | F   | G   | H   | I   | J   | K   | L   | M   | N   | O   | P   |
|-----|---------|------------|-----------------|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1   | System | Type       | Period           | DayType            | Channel_Name | Hr_01 | Hr_02 | Hr_03 | Hr_04 | Hr_05 | Hr_06 | Hr_07 | Hr_08 | Hr_09 | Hr_10 | Hr_11 |
| 4   | Main   | Not Assign Baseline | Mon-Tue Production | COMP1 KW         | 22.992666 | 22.632666 | 22.916266 | 22.916266 | 22.056266 | 22.056266 | 22.056266 | 22.056266 | 22.056266 | 22.056266 | 22.056266 |

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Compressed Air System Assessment – Introduction
LogTool v2
Paste DayTypes into AIRMaster+

- Select DayType Profile Data to Paste into AM+
U. S. Department of Energy
Energy Savings Assessment (ESA)

Energy Savings Assessment Process
Energy Savings Assessment Process

- Gather Preliminary Data
- Conduct Plant Visit
- Analyze & Report Results
- Follow-up

- **Train** Plant Staff

- Teams are DOE Energy Experts and plant personnel
- Teams focus on fans, pumps compressors, steam or process heating systems.
- Plant personnel trained on DOE software tools
Gather Preliminary Data

- Company / Facility
- Utility Rates
- System
- End Uses
- Compressor
- Compressor Details
- Block Diagram
- Measurement Plan

- Coordinate preparation of measurement points
- High Pressure End Use Requirements
- High Volume Intermittent Applications
- Potentially Inappropriate Applications
- Summing End–Use Requirements
- End–Use Solutions Finder
Assessment Expert spends 3 days on site

- **Day 1**
  - Safety briefing, tour plant
  - Overview of DOE Tool to plant personnel
  - Agree on potential energy efficiency opportunities to investigate
  - *Initiate Data Collection For Potential Opportunities*

- **Day 2**
  - Continue data collection
  - Apply DOE tool to quantify potential opportunities
  - Plant lead & expert agree on opportunity results

- **Day 3**
  - Wrap up tool analyses
  - Plant lead & expert ensure they agree on opportunity results
  - Closeout meeting in p.m. to review results
Questions and Answers
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  - LogTool – Compressed Air Challenge [www.compressedairchallenge.org](http://www.compressedairchallenge.org)
    - Michael Baker, SBW Consulting; Frank Moskowitz, Draw Professional Services
  - Energy Savings Assessment Process
    - Bob Gemmer, Technology Manager, Industrial Technologies Program
Download the Tool

DOE BestPractices Web site:  
http://www.eere.energy.gov/industry/bestpractices/software.html
Find Additional Training

Visit the DOE BestPractices Training Web site:
www.eere.energy.gov/industry/bestpractices/training

See the Training Calendar for events in your area:
www.eere.energy.gov/industry/bestpractices/events_calendar.asp

Become a Qualified Specialist:
www.eere.energy.gov/industry/qualified_specialists.html
See the “Industrial Energy Savers” Web Site

- 20 ways to save energy now
- Tools & training you can use to identify savings opportunities
- Industry expertise available
- Assessments for your plant
- Develop an Action Plan
- Learn how others have saved
- Access the National Industrial Assessment Center (IAC) Database
EERE Information Center

On-call team of professional engineers, scientists, research librarians, energy specialists, and communications information staff.

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E-mail: eereic@ee.doe.gov
Web site: www.eere.energy.gov/informationcenter
Web Site and Resources

Visit these DOE Web sites for the latest information and resources:

Industrial Technologies Program (ITP) Web site:  
www.eere.energy.gov/industry/

BestPractices Web site:  
www.eere.energy.gov/industry/bestpractices

Save Energy Now Web site:  
www.eere.energy.gov/industry/saveenergynow

- Fact Sheets
- Newsletters
- Tip Sheets
- Brochures
- Reports
- Software Tools
- Data
Acknowledgments

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