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

Compressed Air Best Practices Tools

Compressed Air Challenge®
DOE AIRMaster+ 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 BestPractices 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
- Northwest Energy Efficiency Alliance
- Northeast Utilities Company
- New York State Energy Research and Development Authority
- National Grid USA
- 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
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- 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+

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

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®

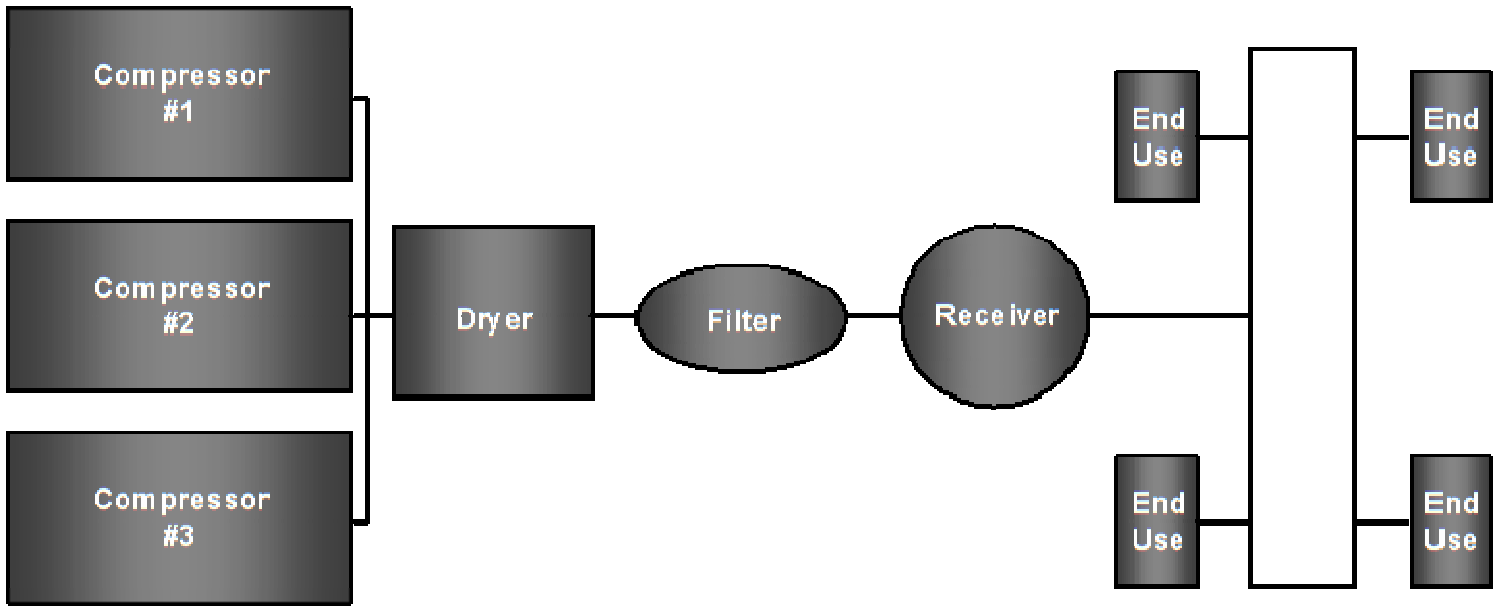
Best Practices Tools

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

End-Use Audit Checklist

High End-Use Pressure Requirements

How are the pressure setpoints on the compressors' controls configured?

	Load	Unload/Modulate
Pressure setting:	_____ psig	_____ psig
Pressure setting:	_____ psig	_____ psig
Pressure setting:	_____ psig	_____ psig

What is the pressure going into the main header?
Pressure: _____ psig

What is the end-use pressure required for typical applications in the plant?
Pressure: _____ psig

List any applications that require higher than typical pressure:

Application	Approximate End-Use Pressure Req'd
_____	_____ psig
_____	_____ psig
_____	_____ psig
_____	_____ psig

List any applications that require lower than typical pressure:

Application	Approximate End-Use Pressure Req'd
_____	_____ psig
_____	_____ psig
_____	_____ psig
_____	_____ psig

List any applications where users complain about low pressure:

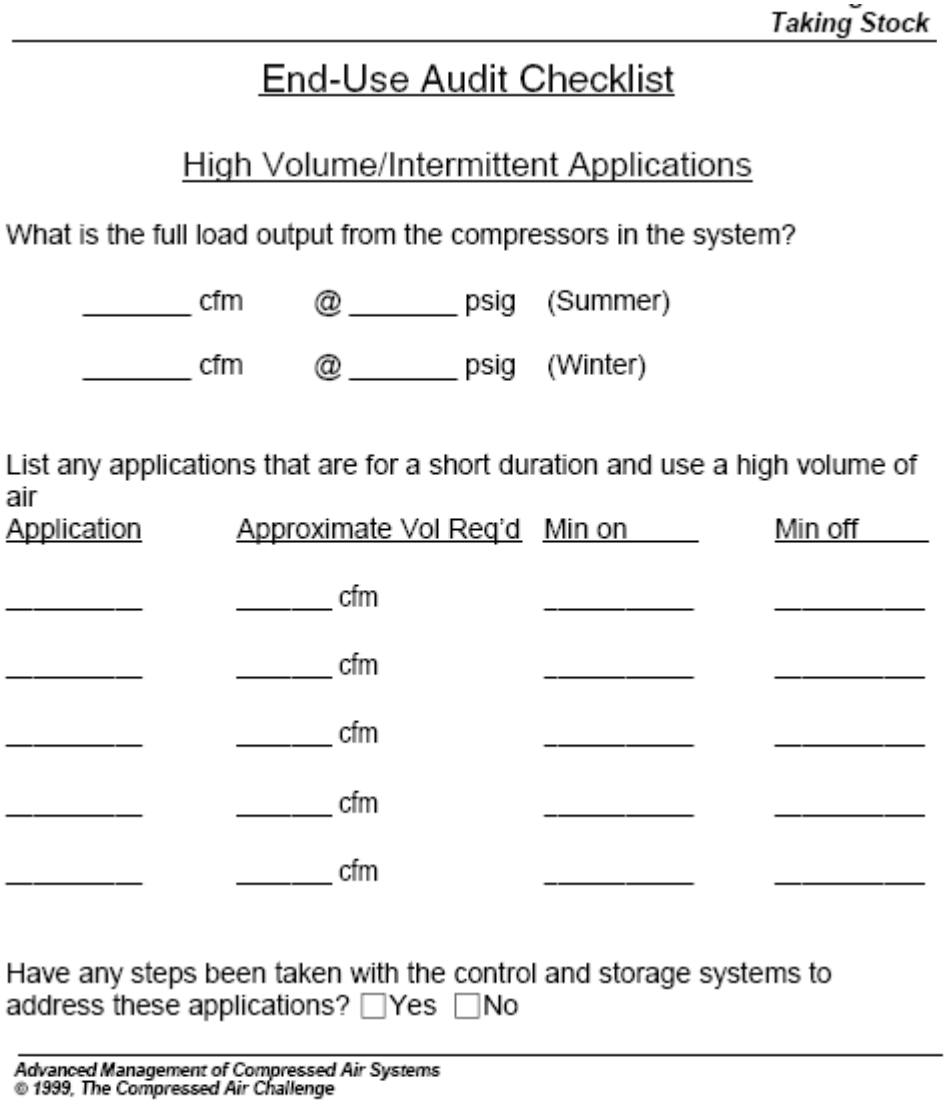
Application	Approximate End-Use Pressure Req'd
_____	_____ psig
_____	_____ psig
_____	_____ psig
_____	_____ psig

Have compressor setpoints been raised to try and compensate for low pressure at end-use applications? ☐ Yes ☐ No

Advanced Management of Compressed Air Systems

CAC End Use Solutions Finder

- On-site work
  - High Volume Intermittent Applications



Taking Stock

End-Use Audit Checklist

High Volume/Intermittent Applications

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

_____ cfm @ _____ psig (Summer)

_____ cfm @ _____ psig (Winter)

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

Application	Approximate Vol Req'd	Min on	Min off
_____	_____ cfm	_____	_____
_____	_____ cfm	_____	_____
_____	_____ cfm	_____	_____
_____	_____ cfm	_____	_____
_____	_____ cfm	_____	_____

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

Advanced Management of Compressed Air Systems

Compressed Air Challenge®
Do You Want to Cut Costs? **STACOLM**

ST orage
A ppropriate Uses
CO ntrols
L eaks
M aintenance

CAC
Data Forms

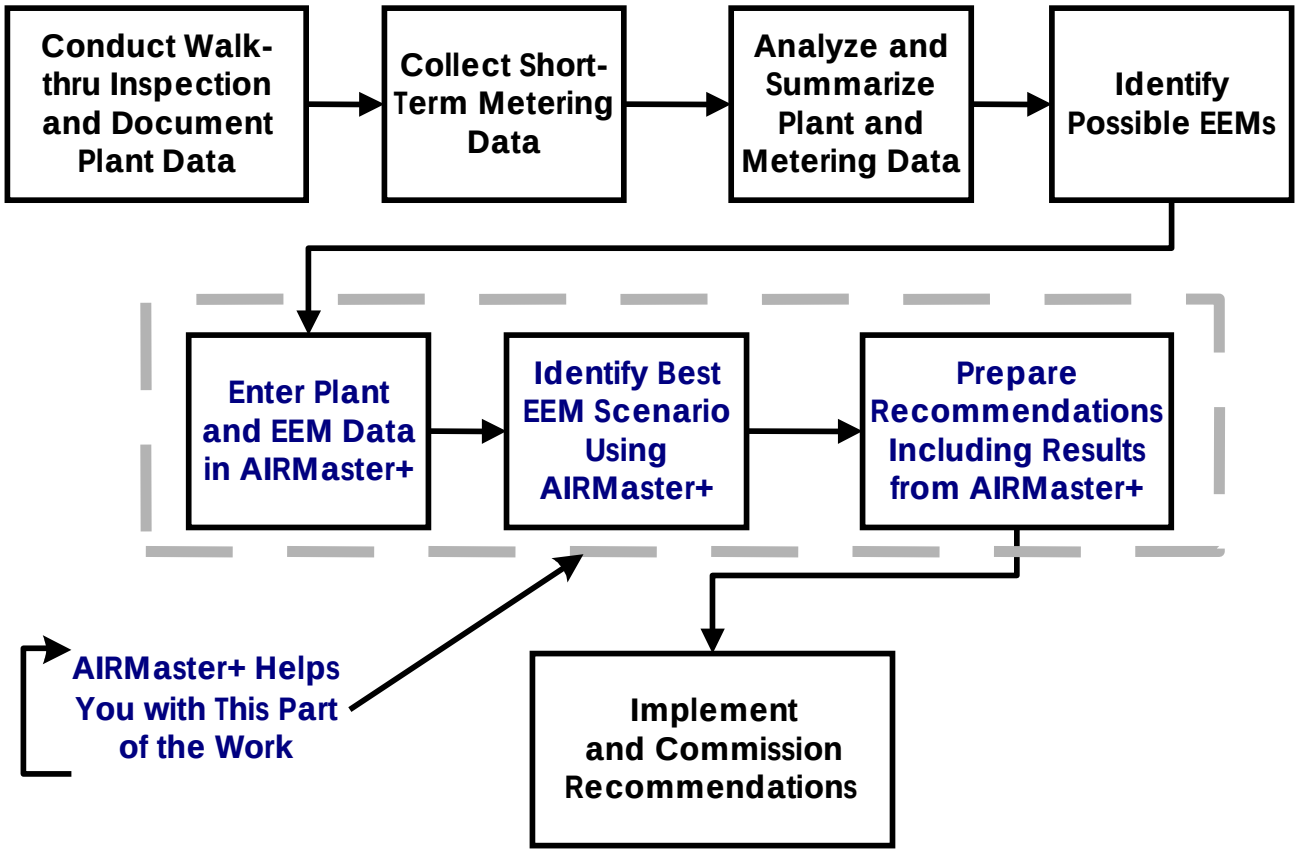
- High Pressure End Use Requirements
- High Volume Intermittent Applications
- Potentially Inappropriate Applications
- Summing End–Use Requirements
- End–Use Solutions Finder
- **S**torage Opportunities
- **A**ppropriate Use Strategy
- **CO**ntrol Strategy
- **L**eak Estimates / Repair & Ongoing Management
- **M**aintenance Plan

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

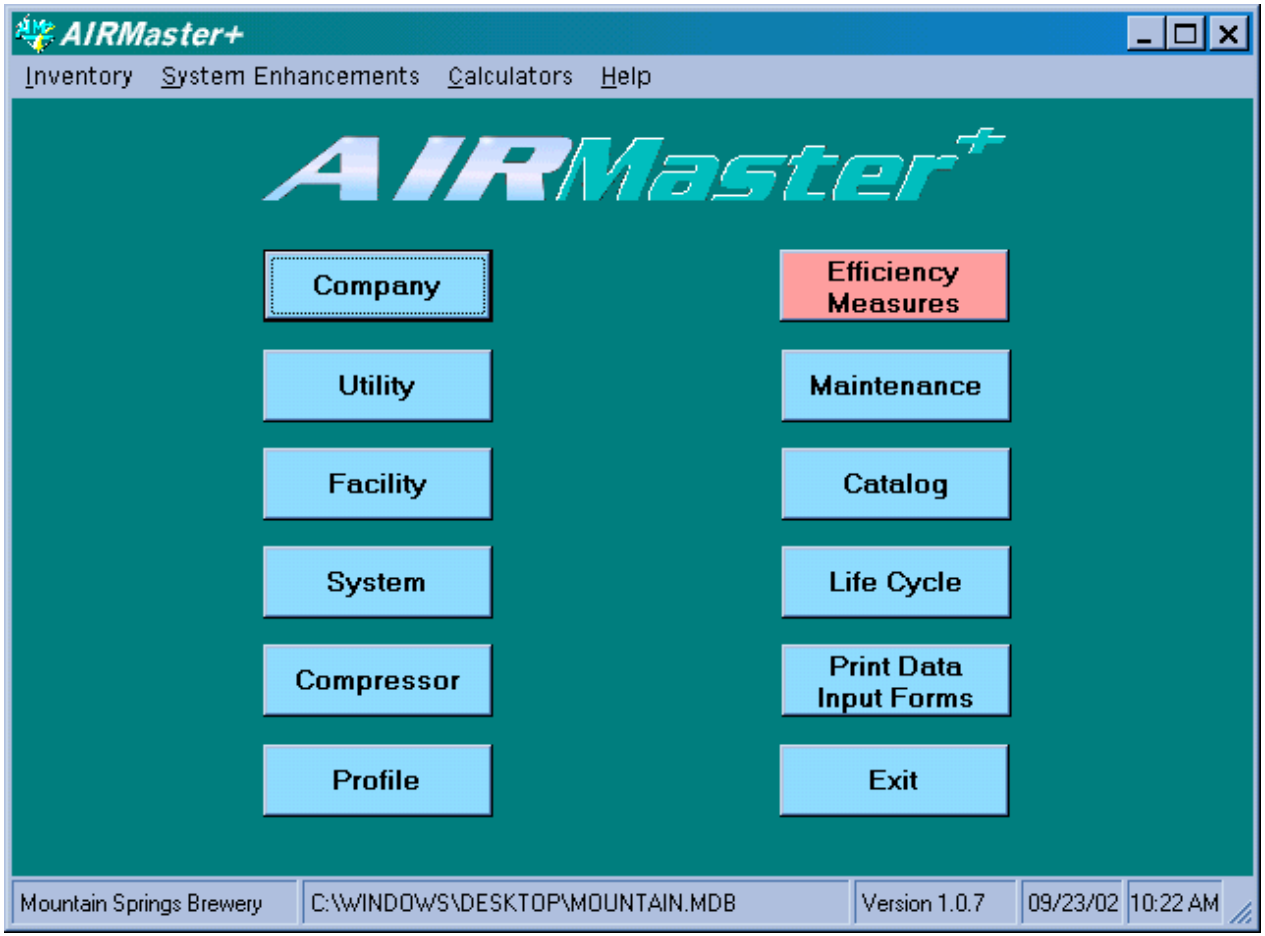
AIRMaster+

Best Practices Tools

How Does AIRMaster+ Help You Conduct a Performance Assessment?



AIRMaster+ Main Menu



AIRMaster+ Data Input Form

- Utility Rates

Data Input Form
Utility Rates

AIRMaster+

Utility Name : ______________

Utility Code : ______________

Address 1 : ______________

Address 2 : ______________

City, State, Zip : ______________

Contact : ______________

Phone : ______________

Rate Schedule: ________		Season 1	Season 2
Start Month/Day		______	______
Demand Rate, $/kW-mo		______	______
Energy Rate, $/kWh:	Block 1	______	______
	Block 2	______	______
	Block 3	______	______

Rate Schedule: ________		Season 1	Season 2
Start Month/Day		______	______
Demand Rate, $/kW-mo		______	______
Energy Rate, $/kWh:	Block 1	______	______
	Block 2	______	______
	Block 3	______	______

Rate Schedule: ________		Season 1	Season 2
Start Month/Day		______	______
Demand Rate, $/kW-mo		______	______
Energy Rate, $/kWh:	Block 1	______	______
	Block 2	______	______
	Block 3	______	______

Rate Schedule: ________		Season 1	Season 2
Start Month/Day		______	______
Demand Rate, $/kW-mo		______	______
Energy Rate, $/kWh:	Block 1	______	______
	Block 2	______	______
	Block 3	______	______

AIRMaster+ Data Input Form

- Compressor

Data Input Form
Compressor

AIRMaster+

Facility : _____ User-Assigned ID : _____
System : _____ In Service, Y/N : _____
Compressor : _____ Sequencer Used, Y/N : _____

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 : _____

After Cooling info

Cooling type : _____
Fan motor rating, HP : _____

Unloading Controls

Unload point, %Capacity : _____
# of unload steps : _____
Unloaded sump pressure, psig : _____
Automatic shutdown timer, Y/N : _____

Compressor Performance

Performance Points	Discharge Pressure, psig	Airflow, acfm	Power, kW
Full Load			
Max full flow			
Unload Point or surge point for centrifugal			
No load (fully modulated or unloaded)			

Inlet Conditions

Avg. temperature, °F : _____
Atmos. pressure, psia : _____
Blowdown time, sec. : _____

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

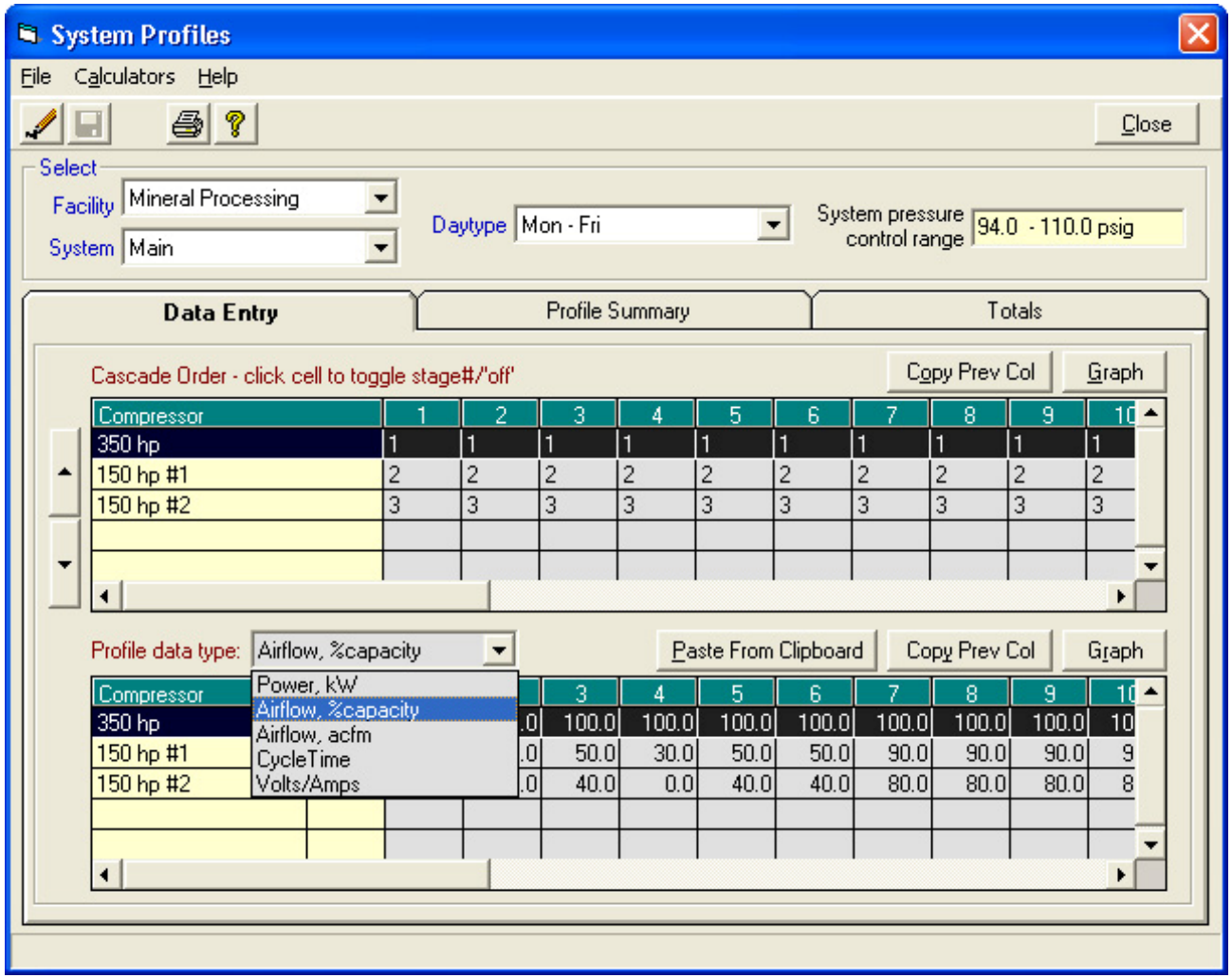
Informational Objectives
On-Site Assessment

- 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

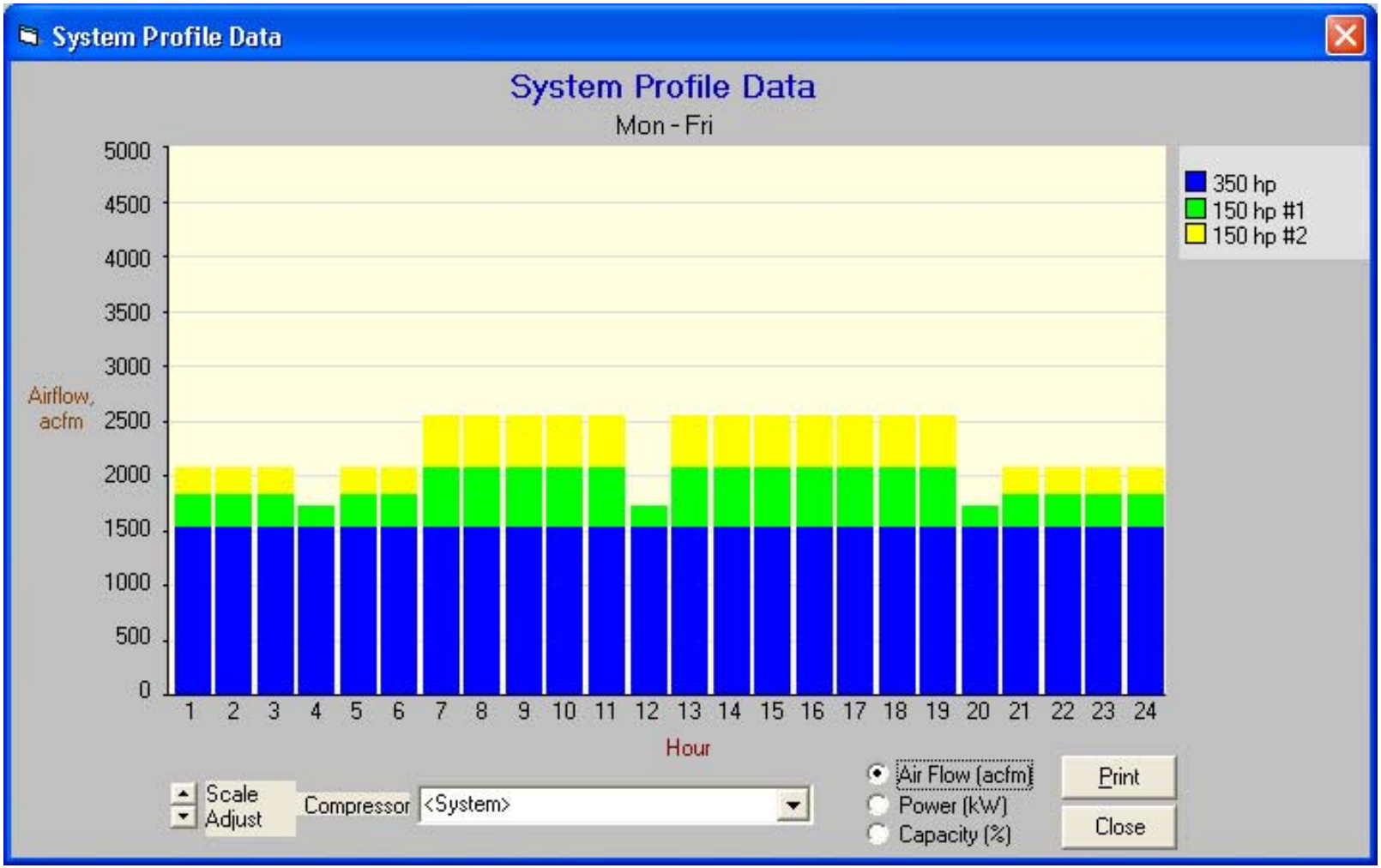
Informational Objectives - Results

- 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

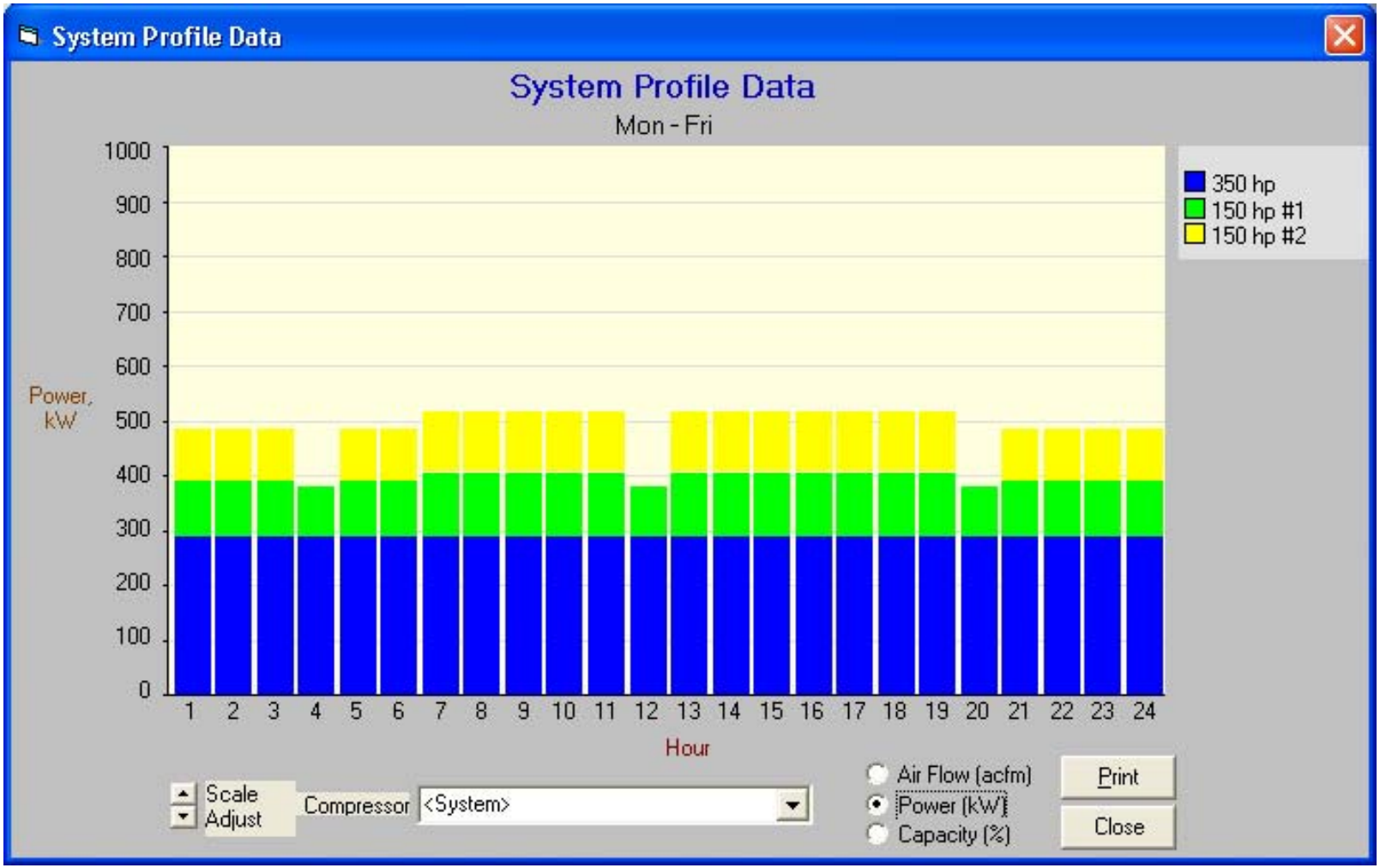
AIRMaster+
System Profile – Data



AIRMaster+
System Profile – Air Flow



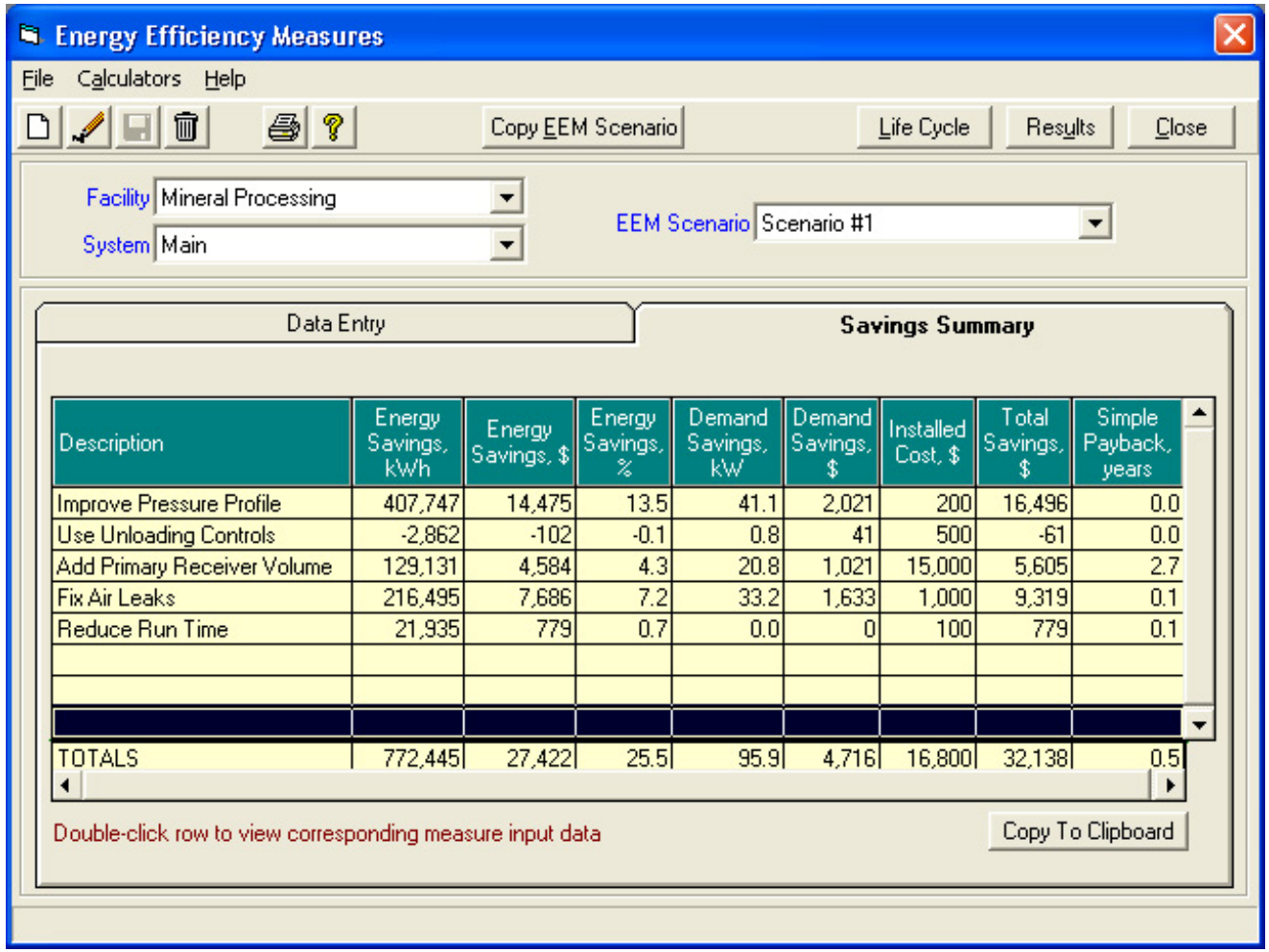
AIRMaster+
System Profile – Power (kW)



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



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CAC LogTool v2

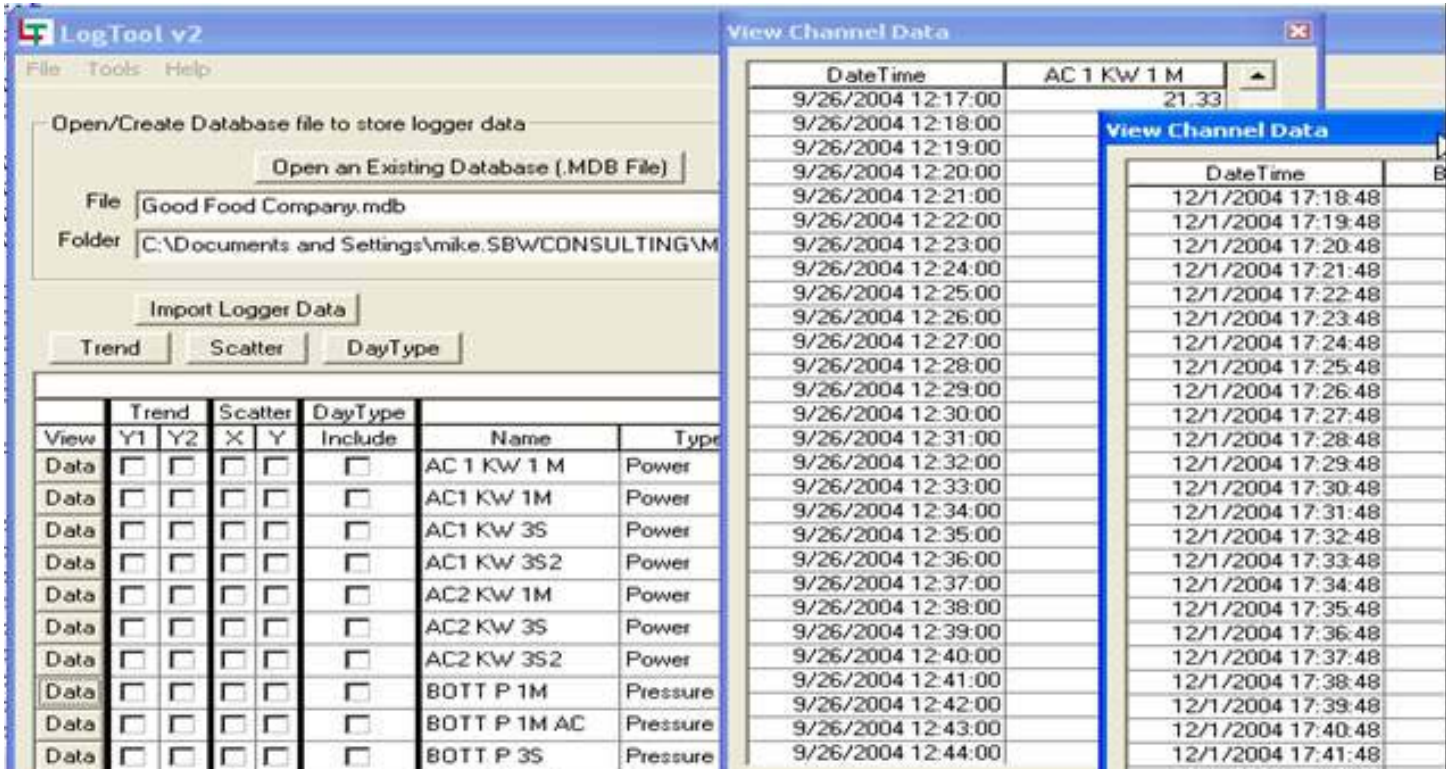
Best Practices Tools

LogTool v2 – Import Data

- The import screen gives you tools to import data from different types of data loggers

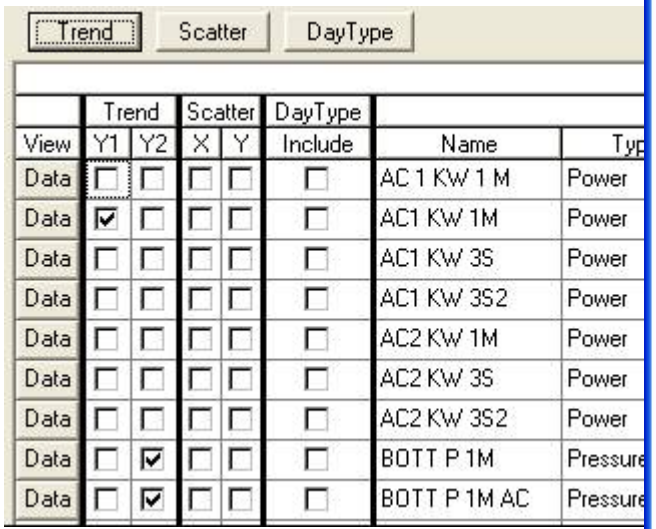
LogTool v2 – View Data

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

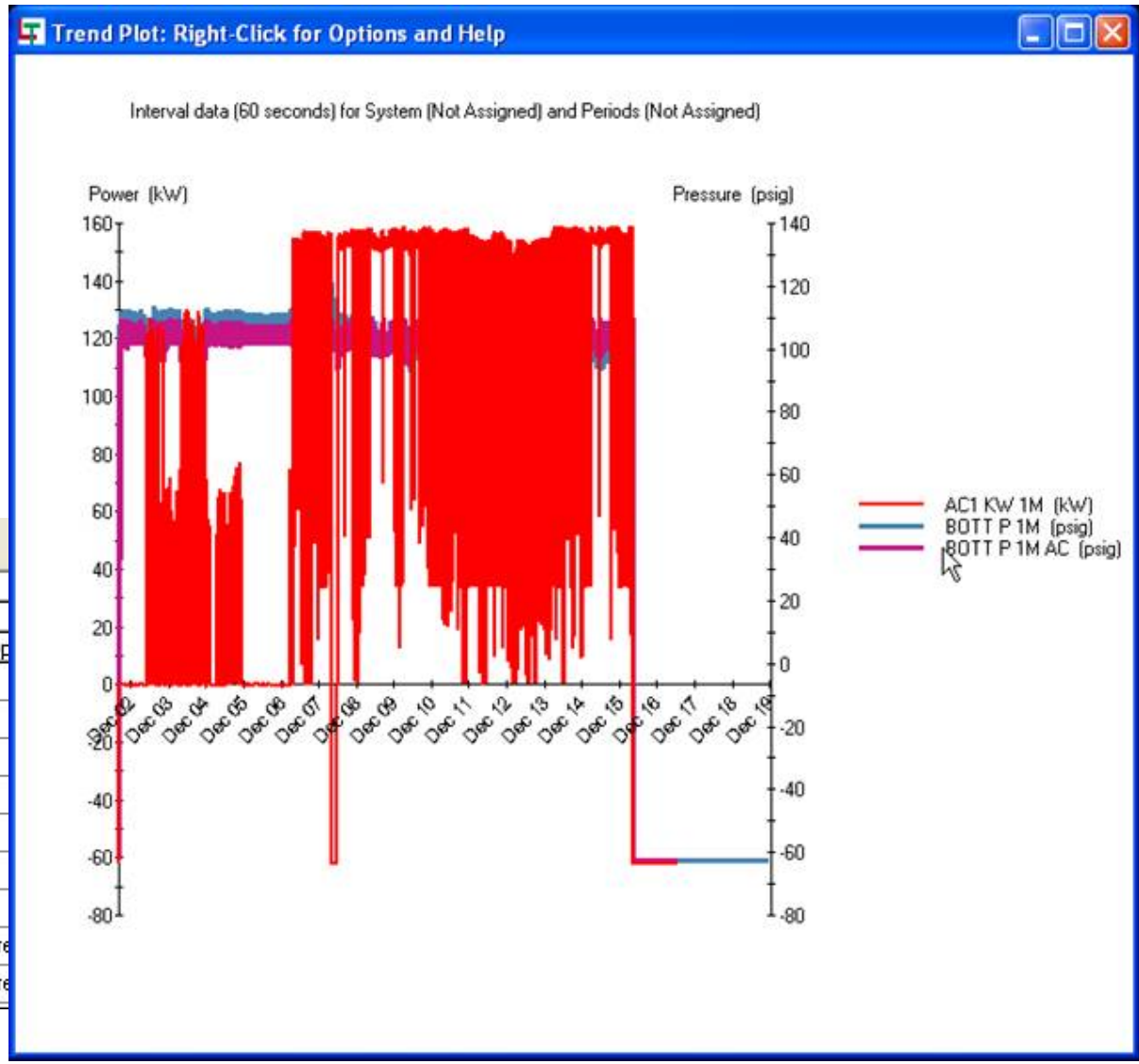


LogTool v2
Trend Plot

- Select Channels to Plot

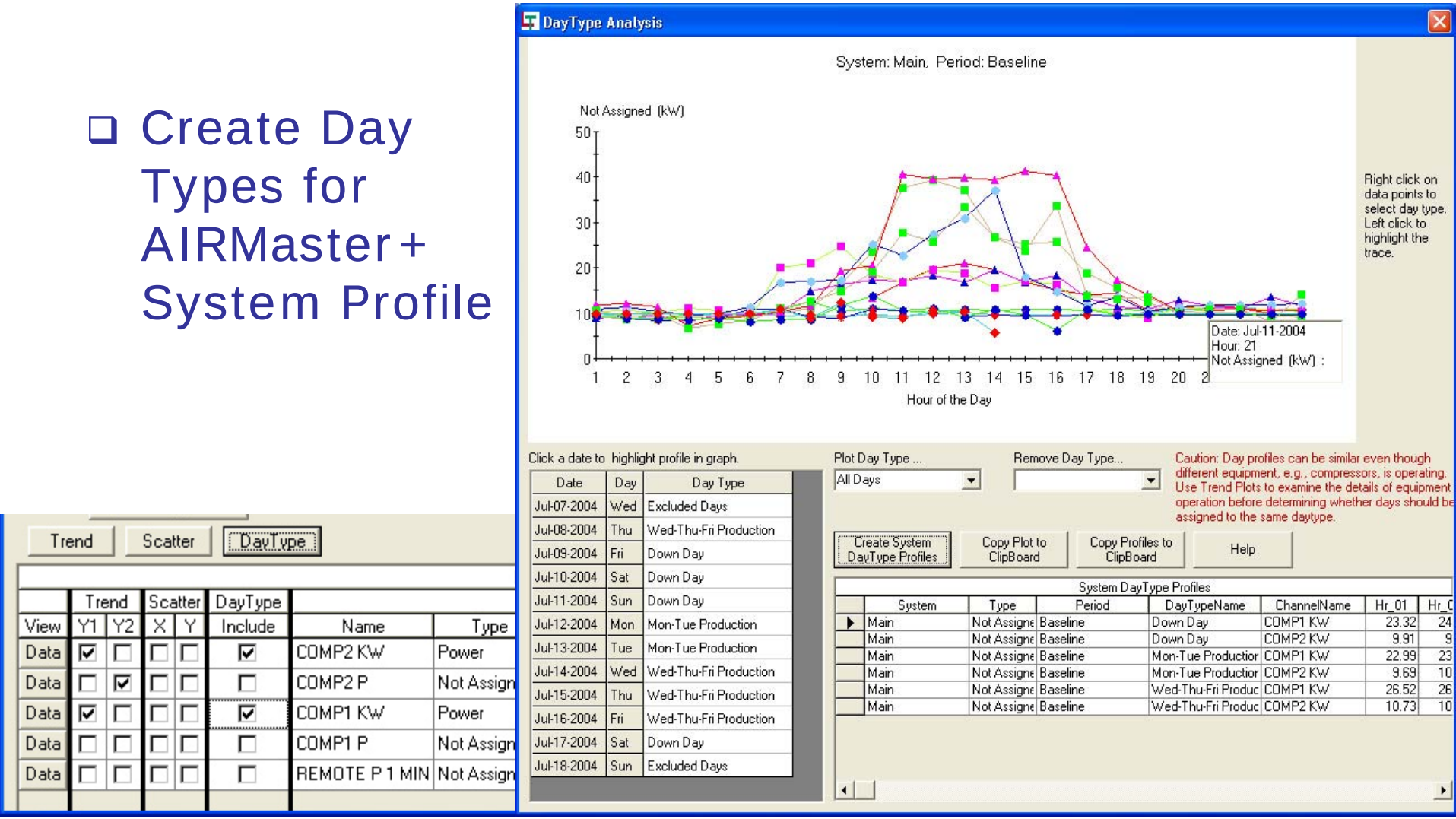


	Trend		Scatter		DayType		
View	Y1	Y2	X	Y	Include	Name	Typ
Data	☐	☐	☐	☐	☐	AC 1 KW 1 M	Power
Data	☑	☐	☐	☐	☐	AC1 KW 1M	Power
Data	☐	☐	☐	☐	☐	AC1 KW 3S	Power
Data	☐	☐	☐	☐	☐	AC1 KW 3S2	Power
Data	☐	☐	☐	☐	☐	AC2 KW 1M	Power
Data	☐	☐	☐	☐	☐	AC2 KW 3S	Power
Data	☐	☐	☐	☐	☐	AC2 KW 3S2	Power
Data	☐	☑	☐	☐	☐	BOTT P 1M	Pressure
Data	☐	☑	☐	☐	☐	BOTT P 1M AC	Pressure



LogTool v2 Trend Plot

- Create Day Types for AIRMaster+ System Profile



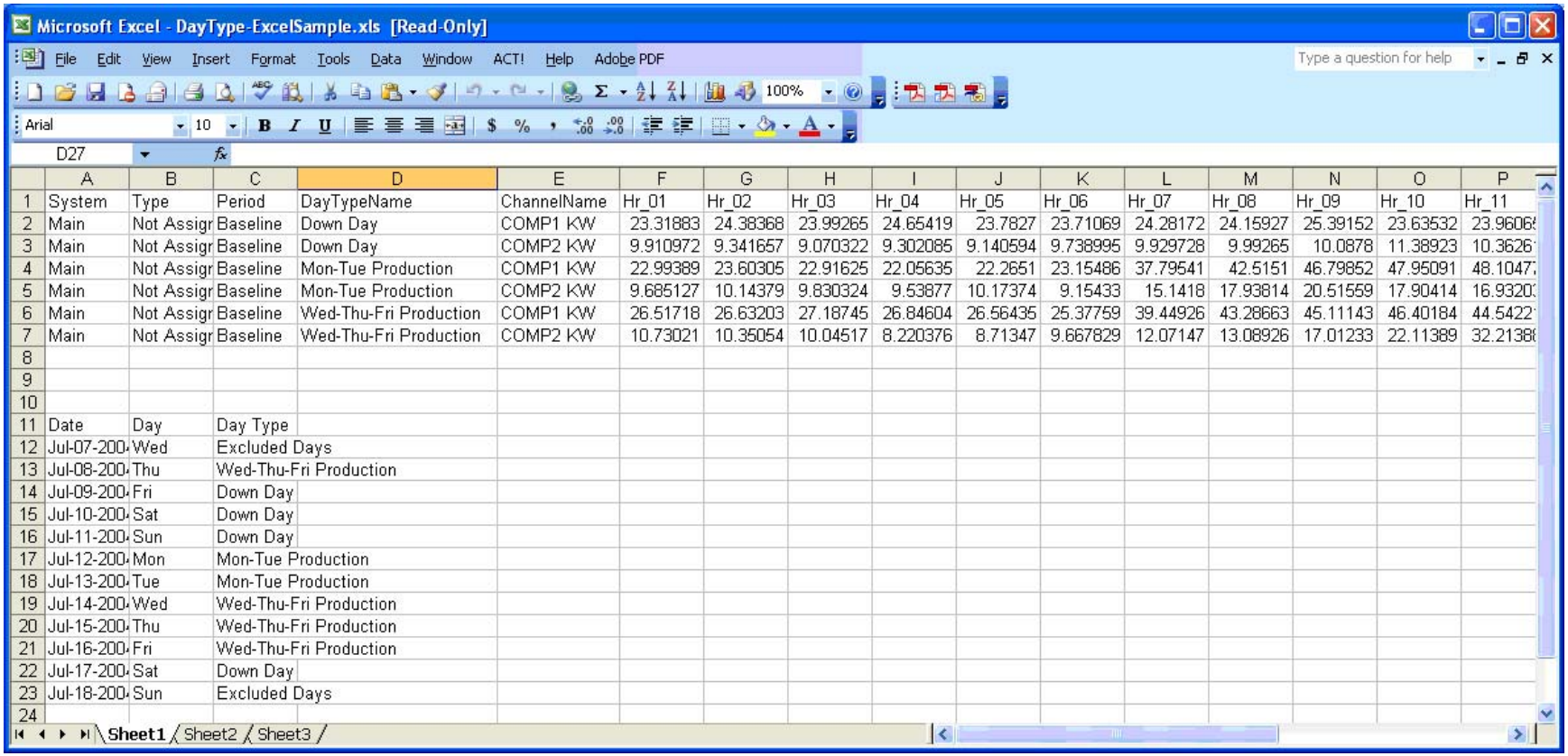
Date	Day	Day Type
Jul-07-2004	Wed	Excluded Days
Jul-08-2004	Thu	Wed-Thu-Fri Production
Jul-09-2004	Fri	Down Day
Jul-10-2004	Sat	Down Day
Jul-11-2004	Sun	Down Day
Jul-12-2004	Mon	Mon-Tue Production
Jul-13-2004	Tue	Mon-Tue Production
Jul-14-2004	Wed	Wed-Thu-Fri Production
Jul-15-2004	Thu	Wed-Thu-Fri Production
Jul-16-2004	Fri	Wed-Thu-Fri Production
Jul-17-2004	Sat	Down Day
Jul-18-2004	Sun	Excluded Days

	Trend		Scatter		DayType		
View	Y1	Y2	X	Y	Include	Name	Type
Data	☑	☐	☐	☐	☑	COMP2 KW	Power
Data	☐	☑	☐	☐	☐	COMP2 P	Not Assign
Data	☑	☐	☐	☐	☑	COMP1 KW	Power
Data	☐	☐	☐	☐	☐	COMP1 P	Not Assign
Data	☐	☐	☐	☐	☐	REMOTE P 1 MIN	Not Assign

	System	Type	Period	DayTypeName	ChannelName	Hr_01	Hr_0
▶	Main	Not Assigne	Baseline	Down Day	COMP1 KW	23.32	24
	Main	Not Assigne	Baseline	Down Day	COMP2 KW	9.91	9
	Main	Not Assigne	Baseline	Mon-Tue Productior	COMP1 KW	22.99	23
	Main	Not Assigne	Baseline	Mon-Tue Productior	COMP2 KW	9.69	10
	Main	Not Assigne	Baseline	Wed-Thu-Fri Produc	COMP1 KW	26.52	26
	Main	Not Assigne	Baseline	Wed-Thu-Fri Produc	COMP2 KW	10.73	10

LogTool v2
Paste DayTypes into Excel

- View DayType Profiles in Excel



Microsoft Excel - DayType-ExcelSample.xls [Read-Only]

File Edit View Insert Format Tools Data Window ACT! Help Adobe PDF

Type a question for help

Arial 10 B I U

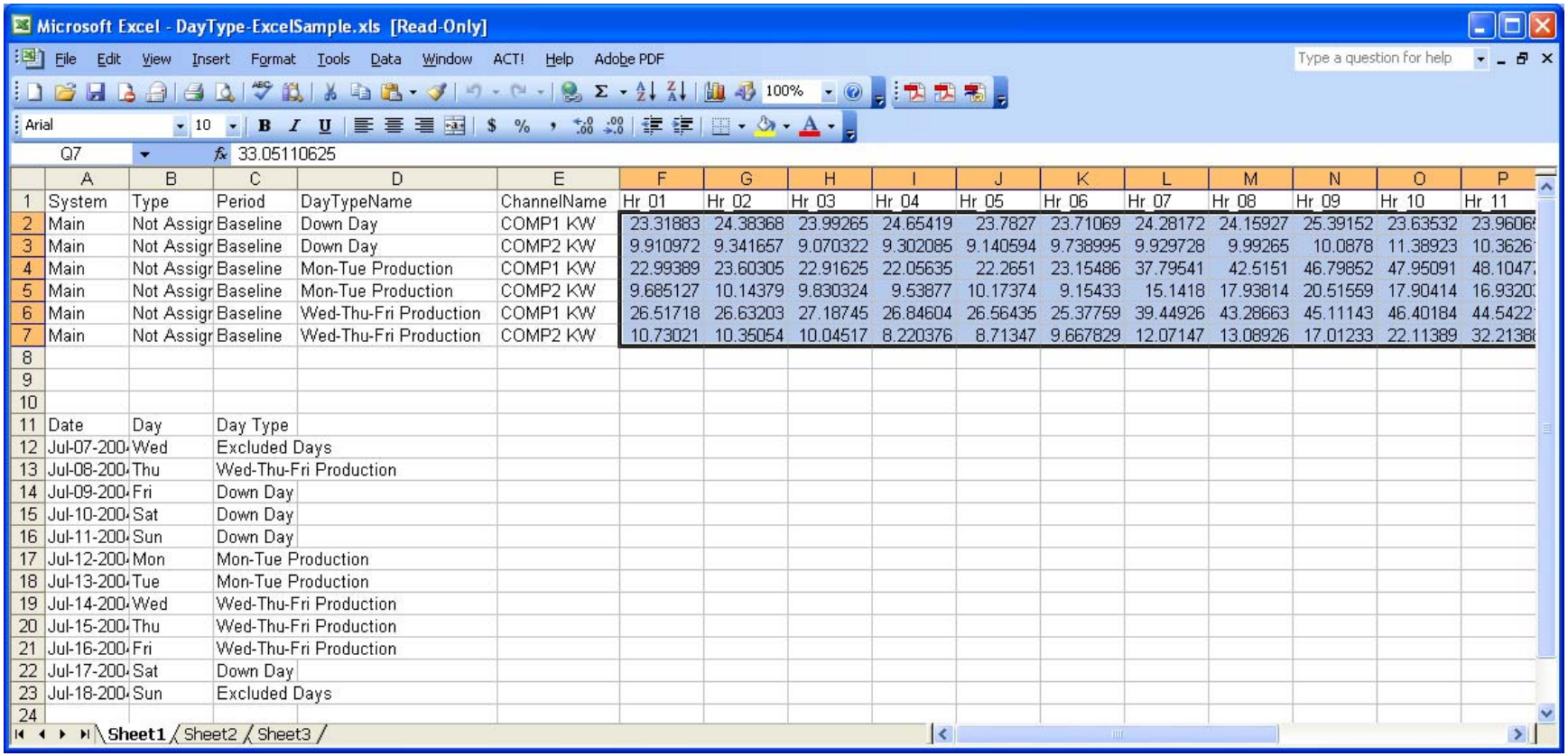
D27

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	System	Type	Period	DayTypeName	ChannelName	Hr_01	Hr_02	Hr_03	Hr_04	Hr_05	Hr_06	Hr_07	Hr_08	Hr_09	Hr_10	Hr_11
2	Main	Not Assigr	Baseline	Down Day	COMP1 KW	23.31883	24.38368	23.99265	24.65419	23.7827	23.71069	24.28172	24.15927	25.39152	23.63532	23.96065
3	Main	Not Assigr	Baseline	Down Day	COMP2 KW	9.910972	9.341657	9.070322	9.302085	9.140594	9.738995	9.929728	9.99265	10.0878	11.38923	10.3626
4	Main	Not Assigr	Baseline	Mon-Tue Production	COMP1 KW	22.99389	23.60305	22.91625	22.05635	22.2651	23.15486	37.79541	42.5151	46.79852	47.95091	48.1047
5	Main	Not Assigr	Baseline	Mon-Tue Production	COMP2 KW	9.685127	10.14379	9.830324	9.53877	10.17374	9.15433	15.1418	17.93814	20.51559	17.90414	16.9320
6	Main	Not Assigr	Baseline	Wed-Thu-Fri Production	COMP1 KW	26.51718	26.63203	27.18745	26.84604	26.56435	25.37759	39.44926	43.28663	45.11143	46.40184	44.5422
7	Main	Not Assigr	Baseline	Wed-Thu-Fri Production	COMP2 KW	10.73021	10.35054	10.04517	8.220376	8.71347	9.667829	12.07147	13.08926	17.01233	22.11389	32.2138
8																
9																
10																
11	Date	Day	Day Type													
12	Jul-07-200	Wed	Excluded Days													
13	Jul-08-200	Thu	Wed-Thu-Fri Production													
14	Jul-09-200	Fri	Down Day													
15	Jul-10-200	Sat	Down Day													
16	Jul-11-200	Sun	Down Day													
17	Jul-12-200	Mon	Mon-Tue Production													
18	Jul-13-200	Tue	Mon-Tue Production													
19	Jul-14-200	Wed	Wed-Thu-Fri Production													
20	Jul-15-200	Thu	Wed-Thu-Fri Production													
21	Jul-16-200	Fri	Wed-Thu-Fri Production													
22	Jul-17-200	Sat	Down Day													
23	Jul-18-200	Sun	Excluded Days													
24																

Sheet1 Sheet2 Sheet3

LogTool v2
Paste DayTypes into AIRMaster+

- Select DayType Profile Data to Paste into AM+



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	System	Type	Period	DayTypeName	ChannelName	Hr_01	Hr_02	Hr_03	Hr_04	Hr_05	Hr_06	Hr_07	Hr_08	Hr_09	Hr_10	Hr_11
2	Main	Not Assigr	Baseline	Down Day	COMP1 KW	23.31883	24.38368	23.99265	24.65419	23.7827	23.71069	24.28172	24.15927	25.39152	23.63532	23.9606
3	Main	Not Assigr	Baseline	Down Day	COMP2 KW	9.910972	9.341657	9.070322	9.302085	9.140594	9.738995	9.929728	9.99265	10.0878	11.38923	10.3626
4	Main	Not Assigr	Baseline	Mon-Tue Production	COMP1 KW	22.99389	23.60305	22.91625	22.05635	22.2651	23.15486	37.79541	42.5151	46.79852	47.95091	48.1047
5	Main	Not Assigr	Baseline	Mon-Tue Production	COMP2 KW	9.685127	10.14379	9.830324	9.53877	10.17374	9.15433	15.1418	17.93814	20.51559	17.90414	16.9320
6	Main	Not Assigr	Baseline	Wed-Thu-Fri Production	COMP1 KW	26.51718	26.63203	27.18745	26.84604	26.56435	25.37759	39.44926	43.28663	45.11143	46.40184	44.5422
7	Main	Not Assigr	Baseline	Wed-Thu-Fri Production	COMP2 KW	10.73021	10.35054	10.04517	8.220376	8.71347	9.667829	12.07147	13.08926	17.01233	22.11389	32.2138
8																
9																
10																
11	Date	Day	Day Type													
12	Jul-07-200	Wed	Excluded Days													
13	Jul-08-200	Thu	Wed-Thu-Fri Production													
14	Jul-09-200	Fri	Down Day													
15	Jul-10-200	Sat	Down Day													
16	Jul-11-200	Sun	Down Day													
17	Jul-12-200	Mon	Mon-Tue Production													
18	Jul-13-200	Tue	Mon-Tue Production													
19	Jul-14-200	Wed	Wed-Thu-Fri Production													
20	Jul-15-200	Thu	Wed-Thu-Fri Production													
21	Jul-16-200	Fri	Wed-Thu-Fri Production													
22	Jul-17-200	Sat	Down Day													
23	Jul-18-200	Sun	Excluded Days													
24																

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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- Presentation author
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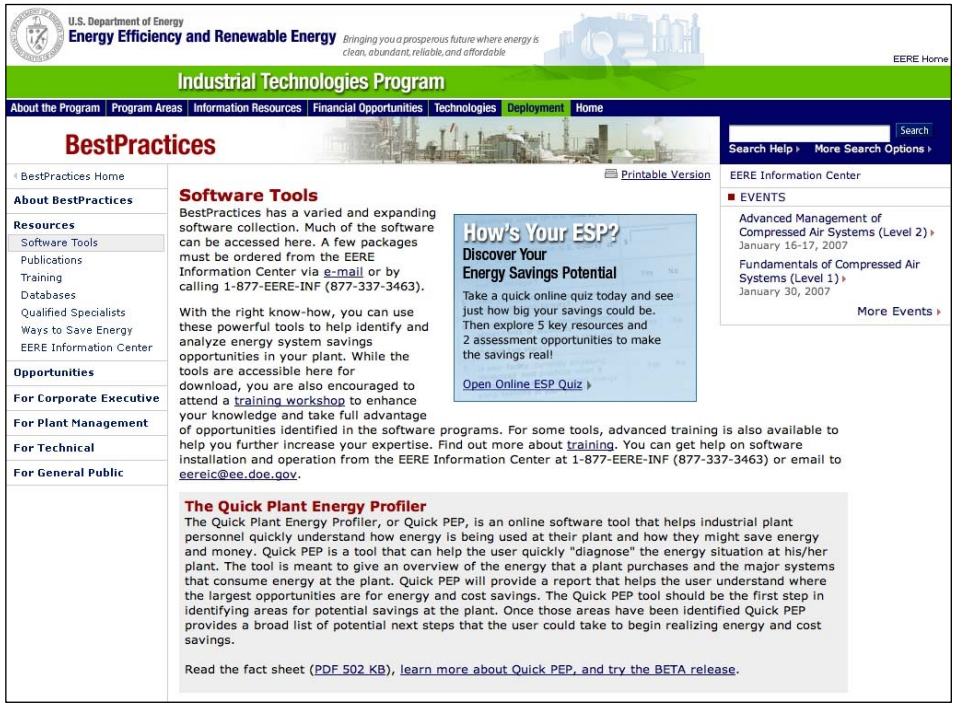
  - LogTool – Compressed Air Challenge www.compressedairchallenge.org
    - Michael Baker, SBW Consulting; Frank Moskowitz, Draw Professional Services
  - Energy Savings Assessment Process
    - Bob Gemmer, Technology Manager, Industrial Technologies Program

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:

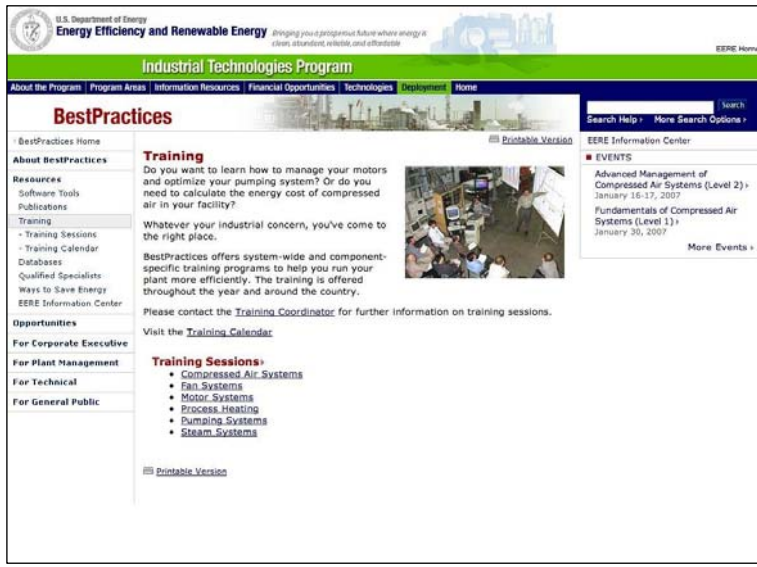
www.eere.energy.gov/industry/bestpractices/training

See the Training Calendar for events in your area:

www.eere.energy.gov/industry/bestpractices/events_calendar.asp

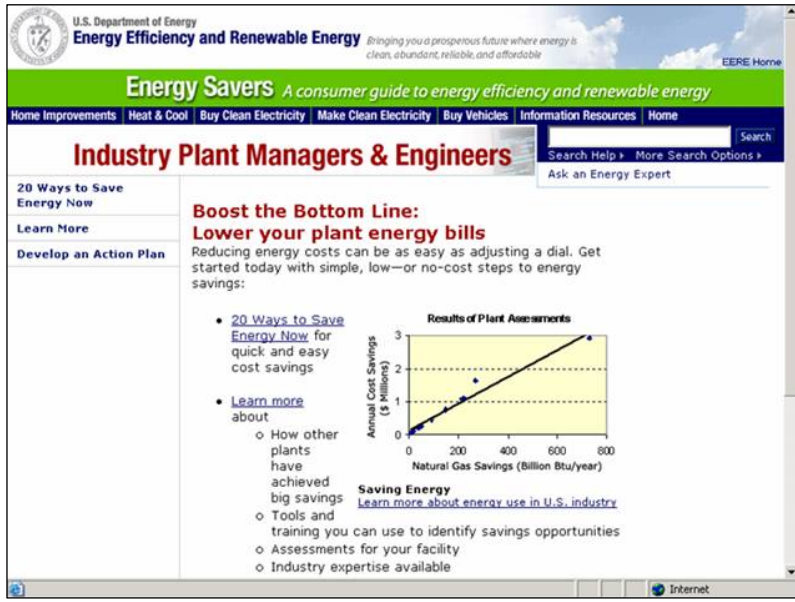
Become a Qualified Specialist:

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



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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
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- Tip Sheets
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- Data

Acknowledgments

U.S. Department of Energy's
Industrial Technologies Program