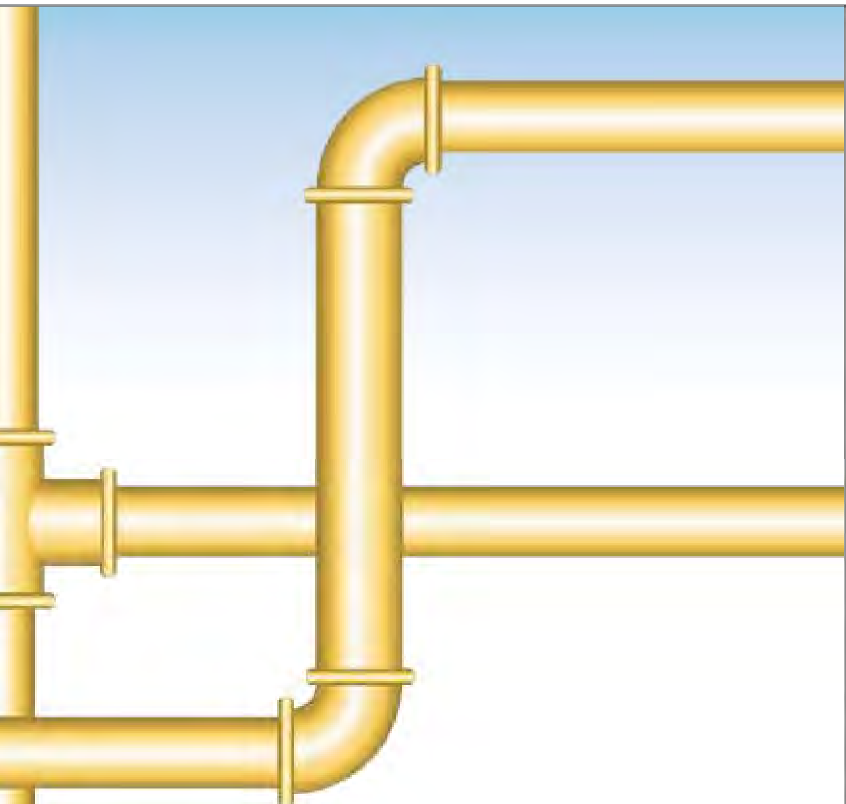
ASME EA-4-2010 — ENERGY ASSESSMENT FOR COMPRESSED AIR SYSTEMS

By Joe Ghislain for the Compressed Air Challenge®

Over the years, analyzing compressed air system operation and efficiency has gone under various names and taken many different shapes and forms. You may know these as; Assessments, Audits, Studies, and Surveys, but in all cases the compressed systems are analyzed using techniques, such as metering and measuring, to assess the system's performance and identify opportunities for improvement. The problem is that the results of these activities have varied widely; leaving the end-user to try and determine what is usable, credible and implementable. This has led to a lot of "no actions", resulting in assessments, audits, studies, and surveys being put on the shelf to collect dust. This issue is not unique to compressed air systems and applies to many other industrial systems as well. To try and alleviate this, a decision was made through work on the Superior Energy Performance program (www.superiorenergyperformance.net), which is an initiative guided by the U.S. Council for Energy Efficient Manufacturing, and supported by the Department of Energy, to develop system assessment standards. Applying these standards will assist plant personnel in identifying energy reduction opportunities through system improvements using a consistent and standard method.

In 2008, the American Society of Mechanical Engineers (ASME) Project Teams started work on the initial four system assessment standards, which cover Process Heating Systems, Pumping Systems, Steam Systems, and Compressed Air Systems. The standards were developed by cross functional teams of experts, and their work was overseen and approved by an ASME Standards Committee. For example, the compressed air project team included both members and instructors of the Compressed Air Challenge® (CAC), additional compressed air experts and knowledgeable industrial end-users. ASME issued drafts of the four new standards on August 19, 2008 for trial use to test and validate the standards. During the trial period, which ran through the end of 2009, the standards were field tested by consultants, utilities and industrial facilities. The standards were then revised, released for public comment, approved and issued as an approved ASME standard. On April 23, 2010, ASME EA-4-2010 — *Energy Assessment for Compressed Air Systems* was released as a standardized framework for conducting compressed system energy assessments.



The ASME EA-4 standard takes the same system approach that is taught in the Compressed Air Challenge® Fundamentals and Advanced Compressed Air System Management courses and provides a prescriptive but scalable process that can be tailored to each facility. Along with system definition, it sets requirements for organizing and conducting the assessment, analyzing the data, and reporting and documenting of the findings. Included in the standard are eight sections:

- Scope and Introduction
- Definitions
- References
- Organizing the Assessment
- Conducting the Assessment
- Analysis of the Data from the Assessment
- Reporting
- Documentation

The document also includes figures and appendices to further clarify the standard. The standard divides the requirements into Mandatory and Non-mandatory for further flexibility and shades the Non-mandatory items for quick reference. This standard along with its companion document ASME EA-4G-2010, *Guidance for ASME EA-4, Energy Assessment for Compressed Air Systems* provides a long need comprehensive framework for compressed air system assessment.

The standard starts with the Compressed Air System Hierarchy definition shown in Fig. 1 from the ASME EA-4-2010 standard.

The system is divided into three subsystems: Supply, Transmission and Demand. The Supply subsystem covers the conversion of primary energy to compressed air and includes the air compressors, air

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Joe Ghislain is currently Manager, Lean Supplier Optimization — Powertrain and a 6-Sigma Black Belt in Ford Motor Company's Lean Supplier Optimization Group. He has had over 25 years in the Automotive Industry and over 30 years' experience with Energy, Powerhouse Operations, Compressed Air Systems, and Operational/Manufacturing Efficiency Improvements. Some of the positions he has held include: Licensed Stationary Engineer, Power House Chief Engineer, Corporate Energy Engineer, Manufacturing Planning Manager, & Manager of Energy Efficiency Programs where he was responsible for developing and implementing energy management programs to reduce energy cost and usage through increased operational efficiency and improved energy practices.(including compressed air system improvements) within all of Ford's plants and divisions globally.

Joe has been part of the Compressed Air Challenge since its inceptions, serving on the Project Development Committee, Technical Advisory Committee, and as the End User Representative on Board of Directors. He is an instructor for both CAC Fundamentals and Advanced Compressed Air System Training and contributed to the development of both courses, as well as the Improving Compressed Air System Performance: A Sourcebook for Industry a CAC/ DOE Publication. Joe is CAC's designated ASME Standards Committee Member.

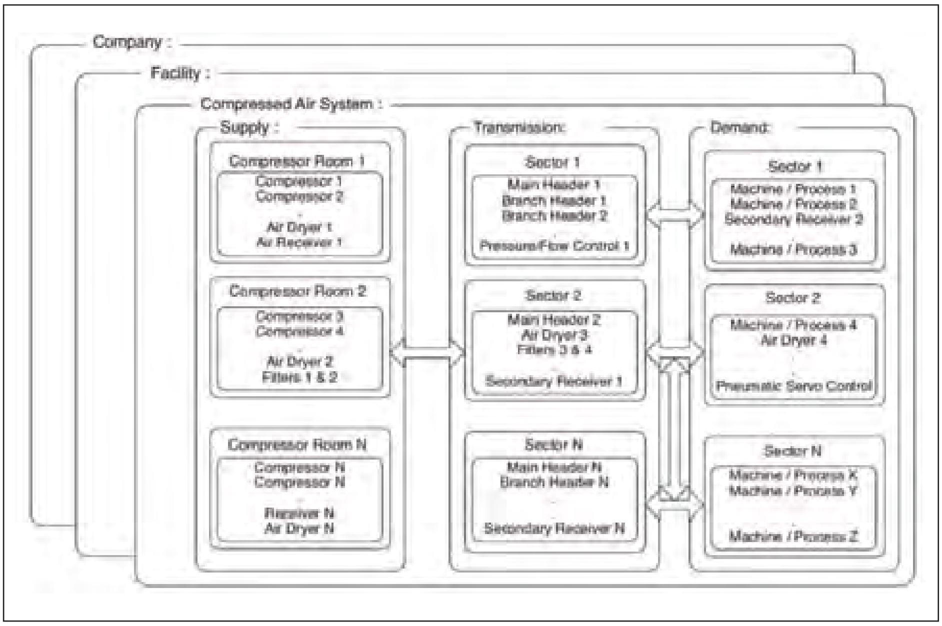

Fig. 1: Compressed Air System Hierarchy

treatment equipment and all piping and ancillary equipment up to and including the primary receiver. The Transmission subsystems covers the movement of the compressed air and includes the main header distribution piping, branch header and drops, secondary storage, treatment and controls associated with this subsystem. The Demand subsystem includes the total of all compressed air consumers including both productive end uses applications and sources of compressed air waste. This subsystem includes all end uses, point of use piping, secondary storage, treatment and controls associated with the end uses. When performing an assessment to this standard, all areas of the system are reviewed, not every application has to be addressed equally, but the study has to be comprehensive enough to be able to identify major energy efficiency opportunities for system improvement.

As with all energy systems the demand drives the supply. Taking a systems approach helps address overall system efficiency and puts the focus on total system performance rather than only concentrating on individual components, which may lead to sub-optimization of the system. A comprehensive systems approach requires understanding compressed air points of use, identifying and correcting poor performing applications, eliminating wasteful practices (including leaks, inappropriate uses, and artificial demand), creating and maintaining a balance between supply and demand, and optimizing compressed air storage and compressor controls. To accomplish this, the standard utilizes a Systems Engineering Approach, shown in ASME EA-4 Fig. 3. This 10 step methodical process covers all aspects of the planning and execution of an assessment, including defining the roles and responsibility of the assessment team.

The first step in the process is Organizing the Assessment. This is the initial pre-work required to make sure that the goals, objectives and deliverables are understood and that the onsite work is a quality event. There are nine subsections in Organizing the Assessment:

- Identification of the Assessment Team Members
- Facility Management Support
- Communications
- Access to Equipment, Resources and Information
- Assessment Goals and Scope
- Initial Data Collection and Evaluation
- Site-Specific Assessment Goals
- Assessment Plan of Action
- Goal Check

The first step starts with the Identification of the Assessment Team Members. The right people with the right skills, knowledge and authority are critical to not only to a successful assessment but more importantly to the implementations of the actions identified. The next four steps outline the guidelines and the requirements from the facility personnel and an agreement by the team on the roles and responsibilities, scope and goals. This buy-in and understanding from the facility/site personnel is essential for the success of the assessment. Gathering and analyzing the right initial data gives important insight into the facility and operations, which can save valuable time on site. The standard provides a mandatory appendix in the Preliminary Data Collection Matrix. This insures that if the standard is followed the proper data will be reviewed. The Site-Specific Assessment Goals are used to complete the Statement of Work. The Plan of Action is assessed using the Mandatory Appendix II, Plan of Action Matrix. The final step before conducting the assessment is verifying that the assessment plan will meet the stated goals.

Conducting the Assessment is the action phase that implements the plan in accordance with assessment plan and statement of work. There are nine subsections in the standard that cover this phase:

- Measurement Plan
- Site Access Procedures
- Assessment Kick-Off Meeting
- Deploy Data Collection Equipment
- Coordinate Data From Permanently Installed Data System
- Validate Data
- Plant Functional Baseline
- Functional Investigation
- Progress and Wrap-up Meeting

Establishing a baseline and understanding the system operation is critical, to creating an accurate baseline, so the measurement plan is important. In the Measurement Plan section, the standard covers measurement instruments, techniques, baseline periods, types of measurements, test points and parameters, which encompasses all of the best practices for baselining. The next two bullet points, the logistics and the kick-off meeting, are both important items in setting the stage for a successful assessment. The next four sections cover the implementation and validation of the measurement plan. The Functional Investigation is the heart of the assessment. This establishes the development and implementation of the detailed plan to perform the necessary measurements and observations of the compressed air system/

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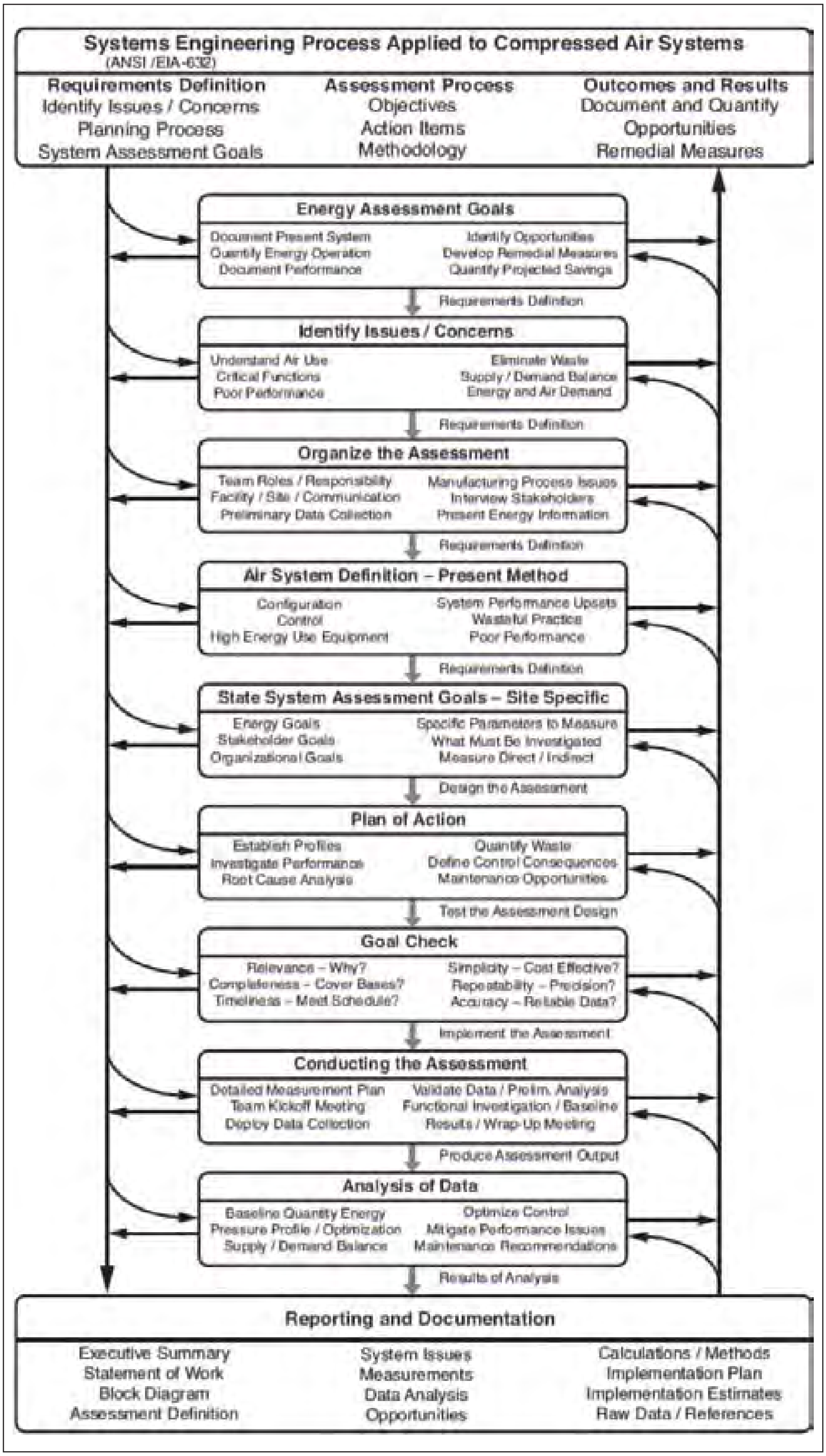

Fig. 3: Systems Engineering Process Overview

plant operations, and covers the supply, transmission and demand. The Mandatory Appendix II has extensive coverage of the elements and parameters required for proper system evaluation. The final step of the onsite process is the progress and wrap-up meetings. The progress meetings give a snapshot of where the team is in the process and identifies any additional assistance that the team may need to complete the tasks. The wrap-up meeting reviews the preliminary findings and establishes the "next steps" for the team.

Once the assessment is complete then the data analysis phase begins. Analysis of Data from the Assessment has twelve subsections that guide this process:

- Baseline Profiles
- System Volume
- Pressure Profile
- Perceived High Pressure Demand
- Demand Profile
- Critical Air Demands
- Compressed Air Waste
- Optimize Air Treatment
- Reduce System Operating Pressure
- Balance Supply and Demand
- Assessment Maintenance Opportunities
- Evaluate Heat Recovery Opportunities

For anyone that has taken the Compressed Air Challenge Fundamentals and Advanced training, this list will look very familiar as it is not only a big part of the training and CAC action plans, but the key to optimizing compressed air systems and identifying energy savings opportunities. Analysis of the Baseline Profiles gives an understanding of the system operation and establishes a baseline to compare and quantify the savings and effectiveness of future actions. These profiles can also be used to identify demand events that are adversely affecting the compressed air system including high volume intermittent uses. The remaining bullet points deal with the identification of system efficiency and operational improvements that could lead to energy usage and cost reductions.

The final section in the standard is Reporting and Documentation. The four subsections cover:

- Final Assessment Report
- Final Assessment Report Contents
- Data for Third Party Review
- Review of Final Report by Assessment Team Members

The heart of this section is in the Final Assessment Report Contents; the other three sections contain short guideline descriptions. The assessment report includes the following:

- Executive Summary
- Facility Information
- Assessment Goals and Scope
- Descriptions of System(s) Studied in Assessment and Significant System Issues
- Assessment of Data Collection and Measurement
- Data Analysis
- Annual Energy Use Baseline
- Performance Improvement Opportunities and Prioritization
- Recommendation for Implementation Activities
- Appendices

The final report outlined in the Standard is very detailed and comprehensive. The two sections, Performance Improvement Opportunities and Prioritization, and Recommendations for Implementation Activities, are the key and critical sections for system optimization and energy efficiency improvements. They have to provide the necessary detail for the recommendations to be acted upon and bought into by the plant personnel. The EA-4 standard provides a standardized framework for conducting an energy assessment for compressed air systems. The use of this standard will provide clearer, more consistent, relevant, and repeatable results from these studies. This will lead to more frequent implementation of recommended improvements and result in less studies lingering on the shelf gathering dust.

For more information, the complete standard and guidance document are available from the American Society of Mechanical Engineers at www.asme.org. Information about training in Compressed Air System Management and the comprehensive manual, Best Practices for Compressed Air Systems are available through the Compressed Air Challenge at www.compressedairchallenge.org. BP

Reference: American Society of Mechanical Engineers, ASME EA-4-2010 - Energy Assessment for Compressed Air Systems

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