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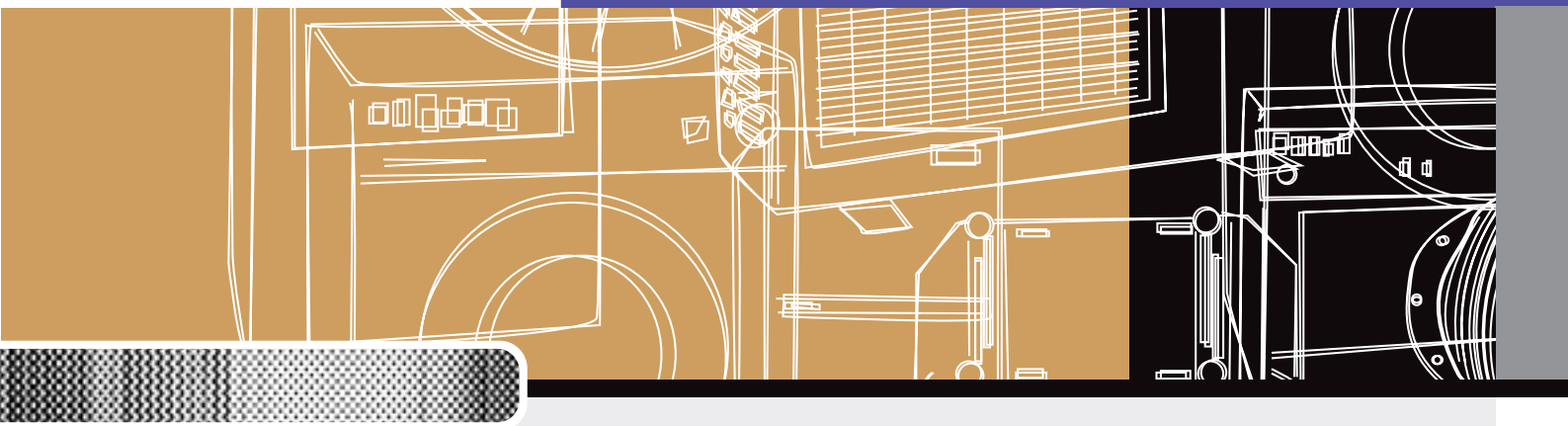
NATIONAL APPLIANCE AND EQUIPMENT ENERGY EFFICIENCY PROGRAM

REPORT ON THE SUCCESS OF COMPRESSED AIR PROGRAMS



FINAL REPORT

February 2002

PREPARED FOR AUSTRALIAN GREENHOUSE OFFICE

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INTRODUCTION

Background

The Australian Greenhouse Office (AGO) is the lead Commonwealth agency on greenhouse matters, responsible for both the coordination of domestic climate change policy and for managing the delivery of major new and existing Commonwealth greenhouse programs.

The National Appliance and Equipment Energy Efficiency Committee (NAEEEC) comprises officials from the Commonwealth, State and Territory government agencies, together with representatives from New Zealand and is responsible for implementing product energy efficiency initiatives in those jurisdictions. NAEEEC's role is to coordinate the National Appliance and Equipment Energy Efficiency Program (NAEEEP). Through this program, the various Governments work together to develop and introduce measures that improve the energy efficiency of appliances and equipment used by households and businesses.

In March 2001, the Energy Efficiency Team (EET) on behalf of NAEEEC released plans rejecting MEPS for Packaged Air Compressors. NAEEEC do not consider the development of MEPS for packaged air compressors to be cost effective for the following reasons:

- the majority of the potential savings accrue from the improvement in the design operation and maintenance of the whole compressed air system and the associated downstream uses, which are not amenable to influence through MEPS
- the most significant barrier to improved efficiency appears to be the supply of information to the purchaser
- NAEEEC implemented MEPS for electric motors in October 2001, which will go some way towards improving the performance of air compressors
- MEPS have not been introduced for air compressors elsewhere in the world.

However MEPS for packaged air compressors are now under consideration for a voluntary Best Practice Program. This voluntary program will promote better practice for improving the selection of high efficiency equipment by consumers and support other measures to improve the sales of the best available and most efficient products.

The main reason for considering packaged air compressors for a voluntary Best Practice Program is that greenhouse gas emissions resulting from the current installed stock in Australia are significant, estimated to be 4,100 kt $C0_2$-e per annum. More than 90% of emissions are estimated to be attributable to compressors, in the range between 2.25kW and 20kW.

Objectives of this Study

The AGO commissioned EnergyConsult Pty Ltd to identify and report on the options available for a voluntary Best Practice Program that will improve the efficiency of packaged air compressors.

This study aims to:

1. Provide a list of preferred options that examine local and overseas programs specifically targeting the United States Compressed Air Challenge and the United Kingdom Energy Efficiency Best Practice Program for Air Compressors.
2. Conduct interviews with key Australian stakeholders to determine the most appropriate program direction and mechanisms for cooperation to ensure program effectiveness and success.
3. Submit a draft report that provides recommendations on the most practical program options based on the above research.

It should be noted that this report is exploratory only and can be considered as an investigation into possible program options and not the final recommended program. The objective of this report is to inform the reader of the range of potential program options and our assessment of

which are the most appropriate, based on the research conducted. The report also provides draft recommendations on the way forward for a voluntary Best Practice Program for air compressors.

Of course, the report does not represent the views of the Australian Greenhouse Office nor any particular stakeholder.

Methodology

The research focused on obtaining information on international Best Practice Programs for air compressors and how such a program might be applied within Australia. Techniques used included:

- comprehensive search on similar best practice programs via the Internet
- telephone interviews with key stakeholders.

RESEARCH OF OVERSEAS BEST PRACTICE PROGRAMS

The aim of this task was to determine the key characteristics of successful best practice programs implemented overseas to encourage air compressor efficiency. The characteristics considered included:

- presentation of website information and interactive tools available
- training requirements
- who conducts and funds the training
- who is the target of the training (occupations, industry groups).

The main programs targeted in this research were the US Compressed Air Challenge and the UK Energy Efficiency Best Practice Program as requested by the AGO.

TELEPHONE INTERVIEWS WITH KEY INDUSTRY STAKEHOLDERS

To ensure that the views of Australian stakeholders were included in this study, telephone interviews were conducted with key industry stakeholders including:

- Champion Compressors
- Atlas Copco
- Energetics
- SEDA

The aims of conducting interviews with industry stakeholders were to obtain the views of Australian stakeholders on the program options that would be suitable and how a program may be successful. Industry stakeholders were selected to cover the views from manufacturers, state government energy efficiency agencies and energy consultants.

ANALYSIS AND RECOMMENDATIONS

Following the completion of the research and an assessment of the possibilities for an energy efficiency best practice program, recommendations were developed. See page 19 for detailed analysis and recommendations.

RESULTS

Research of Overseas Best Practice Programs

COMPRESSED AIR CHALLENGE (USA)

The Compressed Air Challenge (CAC) was launched in 1997 and operates as a voluntary collaboration between industry stakeholders. These include air compressor users, manufacturers, and distributors; industry associations; utilities; government and research organizations. Participants may choose to be a sponsor, providing financial support, a contributor providing information and/or technical support, or simply a user. The program is run by the Project Development committee, which has members from the US Department of Energy, Utilities, and Industry Associations.

Underlying the development of the CAC is a desire to:

- save energy (goal of 10%)
- reduce plant operating costs
- increase the reliability and quality of industrial production processes.

The fundamental purpose of the CAC is to provide the best and most up-to-date information on compressed air system design, performance and assessment methods. The program aims to continually increase and refine the types of resources being provided. Currently participants are being offered:

- fact sheets
- resource texts including: *Improving Compressed Air System Performance – An Industry Source Book*
- a newsletter – *Pressure Point*
- *AIRMaster*$^{+}$ Software
- training seminars.

WEB SITE INFORMATION

The CAC provides a series of fact sheets to assist companies in improving the performance of compressed air systems. These brief documents range from 1 to 4 pages of information and cross-reference each other encouraging the reader to gain a broader understanding of compressed air. The fact sheets currently available are:

1. Assessing Compressed Air Needs
2. Inappropriate Uses of Compressed Air
3. Compressed Air System Audits
4. Pressure Drop & Controlling System Pressure
5. Maintenance of Compressed Air Systems for Peak Performance
6. Compressed Air System Controls
7. Compressed Air System Leaks
8. Packaged Compressor Efficiency Ratings
9. Compressed Air System Economics
10. Heat Recovery with Compressed Air Systems
11. Proven opportunities at the Component Level

The Industry Source Book is another tool developed by the CAC and it is available free on-line or a hard copy can be purchased. It is also given to training seminar participants. The book has been designed as a reference manual that outlines the opportunities for system performance improvements, detailing some of the significant opportunities, and directs users to additional sources of assistance. The Source Book is divided into the three main sections and appendices including:

- *Section 1. Introduction to industrial compressed air systems* – which provides an overview of the components and applications of an industrial compressed air system.
- *Section 2. Performance improvement opportunity roadmap* – this section outlines the "system approach" which requires the analysis of both the supply and demand side of a system. This is viewed as crucial in obtaining peak system performance. The focus is away from individual components to

total system performance. To apply this approach: current conditions and operating parameters, including benchmarking of inefficiencies need to be established. The fact sheets outlined above are used to explain how to do this. Additionally the fact sheets are linked diagrammatically to each stage of a compressed air system as shown in Figure 1 below.

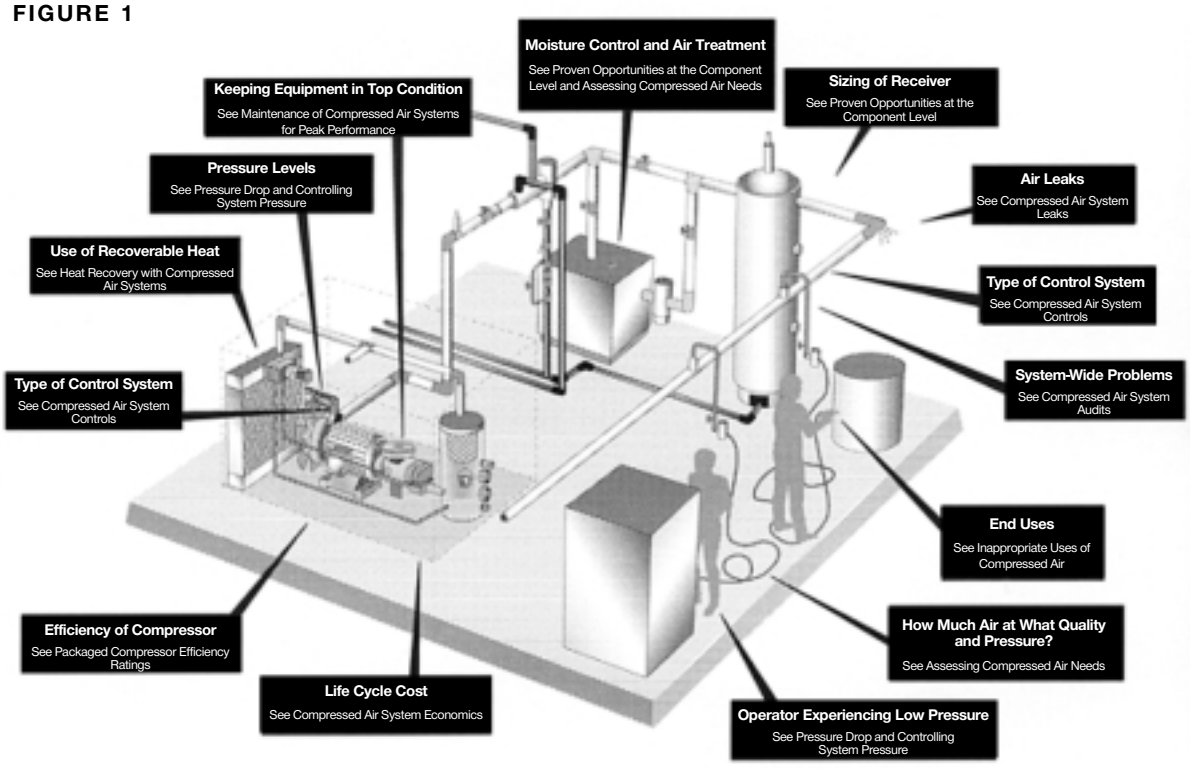
- *Section 3. Where to find help* – this section directs users to resources, tools, and information that are available to help them improve their compressed air systems. It includes a description of the Motor Challenge, a national program sponsored by the U.S. Department of Energy; a directory of associations and other organizations involved in the compressed air system market and a listing and description of compressed air system-related resources and tools, including books, brochures, periodicals, software, videos, workshops, and training courses.
- *Appendix A* is a glossary defining terms used in the compressed air industry.
- *Appendix B* contains 3 Data Sheets, which outline the information users need to collect in order to compare compressors. The sheets can be used for Rotary Screw Compressors, Regenerative Desiccant Type Dryers and Refrigerant Dryers. Copies of the sheet are contained in Appendix of this report.
- *Appendix C* presents an overview of the compressed air systems marketplace, including market size and dynamics, and a description of the stakeholders.
- *Appendix D* contains highlights from the CAC web site.

A recent addition to the program is a newsletter to keep participants up to date with the latest information including training opportunities, research and program administration details. The Pressure Point newsletter is available on the website.

INTERACTIVE TOOLS

AIRMaster+ is a software tool that enables assessment and analysis of compressed air systems. In 1993 the US Department of Energy (USDOE) funded the development of an earlier version of the software (AIRMaster). While the software tool was the end point, the project also

FIGURE 1



required the development of a methodology for general auditors or plant personnel to evaluate compressed air system operation. Research was conducted in the field, allowing the assessment not only of the evaluation process but the savings potential from six common Operation and Maintenance measures (these measures typically have low capital costs, quick paybacks, and low risks). Under the guidance of a Technical Advisory Committee, comprising of manufacturers, energy utilities, auditors, and energy resource centres the research was transformed into an operational software tool in 1997. Two years later Washington State University Energy Program was contracted by (USDOE) to develop a Windows-based enhancement *AIRMaster+.*

The software is designed to be used by companies or distributors of compressed air equipment, compressor system auditors, industrial plant personnel, and utility representatives. *AIRMaster+* states the program allows users to:

- manage multiple facilities and compressed air systems
- maintain two databases of air compressors (1-3500 hp): an actual in-plant inventory of air compressors, and generic or industry standard air compressors
- simulate existing and modified compressed air system operation
- model part load system operation for an unlimited number of interconnected rotary screw (multiple-stage lubricant-free or lubricant-injected), reciprocating and centrifugal air compressors operating simultaneously with independent control strategies and operating schedules
- enter and assign seasonal electrical utility energy and demand charge schedules
- enter 24-hour metered airflow or power data load profiles for each compressor and any number of daytimes, and then calculate electrical operating costs
- evaluate air system energy savings potential from up to eight of the following Energy Efficiency Measures (EEM), considering interactive effects of EEMs, including:
  - 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
  - manage end use loads and pressures.
- calculate the following:
  - cycle times
  - system air storage capacity
  - actual required airflow for a known airflow at standard conditions re-rated for measured conditions
  - conversion from airflow values in scfm to acfm, and vice versa.
- track maintenance histories of various facility, system, and compressor components
- calculate life cycle costs
- generate enhanced graphics and reports.

AIRMaster+ users need to enter information about the company's energy provider, sites; compressed air systems; the air compressor(s) in each system; and airflow or power profiles for each system. Once this data has been input the software can be used to:

1. Calculate the energy, airflow, and dollar savings from any combination of the 8 energy efficiency measures.
2. Keep a maintenance record system including scheduling when checks need repairs to be undertaken.
3. Analyse replacement compressors using the catalogue of air compressors. The list contains detailed information on each unit including control type, horsepower rating, full load shaft power, rated capacity, full load operating pressure, total package power input, specific package power input, part load details and motor rating.
4. Run the life cycle module that analyses the financial situation of a project or piece of equipment at any time.

The assessments provided by the software tool model airflow and associated electrical demands as seen by the supply side of the system. It does not

take into account the effects of distribution and end uses. In this sense *AIRMaster*$^{+}$ is meant to be used as an advisory tool rather than to replace consultation and evaluation by experienced auditors.

The software is available for free and can be downloaded from the CAC site or a disc version can be ordered. USDOE funds a hotline through the Industries of the Future (IOF) Clearinghouse that *AIRMaster*$^{+}$ users can call for technical assistance.

TRAINING

There are three training courses. The *Fundamentals of Compressed Air Systems* is a one day course which covers:

- calculating the energy cost of compressed air
- improving efficiency and reliability of compressed air systems
- identifying inappropriate uses of compressed air
- establishing a baseline by which efficiency improvements can be measured
- matching system supply to production requirements for pressure and flow
- finding and fixing leaks and establishing a leak prevention program
- improving system management enabling an increase productivity and profitability.

Also on offer is a two day course; *Advanced Management of Compressed Air Systems*. Topics covered include:

- Taking Measurements
- Developing a System Profile
- Air Quality Requirements
- High Pressure Applications
- High Volume, Intermittent Applications
- Taking Stock of What You Have
- Compressed Air System Maintenance
- Viewing the System from the Supply Side
- Understanding Controls
- Aligning Supply with Demand
- Heat Recovery
- Putting It All Together
- Selling the Project to Management.

AIRMaster Specialist Training is a 2–day course, which teaches participants how to use the *AIRMaster*$^{+}$ software. The course includes classroom instruction, a practical exam testing hands-on measurement, and a written exam. To become a Qualified *AIRMaster*$^{+}$ Specialist, participants must have previously completed the Advanced Management of Compressed Air Systems course. The course covers:

- methodology behind the software
- how to collect field data
- how to enter data
- how to evaluate compressed air systems and develop a measurement plan
- how to make measurements for hourly trends of typical daily data vs. making dynamic measurements
- how to characterise system events, pressure and flow profiles
- how to create operating scenarios, accounting for the affect of system dynamics, pressure profiles, characteristics of flow vs. pressure, and compressor control operation.

Training instructors have been selected from within the Compressed Air Challenge community. They are chosen for their broad range of experience within the compressed air industry and come from diverse backgrounds. Examples include suppliers, manufacturers, auditors, academics and industrial users. The instructors are qualified by the CAC.

The costs of attending the training ($US 225 & $US 495) are the responsibility of the participants although some utilities and States offer to pay all or part of this cost through various subsidy programs. (Additionally these programs are also available through the US Department of Energy BestPractices Program).

The systems training is aimed at plant engineers, maintenance supervisors and other professionals who are responsible for compressed air systems. The *AIRMaster*$^{+}$ training is specifically for compressed air specialists who use the software to perform plant assessments.

ENERGY EFFICIENCY BEST PRACTICE PROGRAM (UK)

The UK Government's Energy Efficiency Best Practice Programme (EEBPP) was established in 1989 and aims to help organisations reduce their energy bills by between 10 and 20%. It provides energy efficiency information through publications, newsletters and training seminars. The program also offers on-site visits to assist in the assessment of energy usage and the development of an action plan for energy savings. The environment and energy telephone service provides business with access to tailored technical advice. Additionally EEBPP maintains the biggest library of independent information on energy efficiency in the UK. All these services are free to companies operating in the UK.

WEB SITE INFORMATION

One component of the EEBPP is the Compressed Air Focal Point. This web page highlights the issues of energy wastage within compressed air systems and introduces five key guides that demonstrate where and how savings can be gained. The Guides include:

- Compressing Air Costs
- Compressed Air and Energy Use
- Compressed Air Cost – Generation
- Compressed Air Cost - Leakage
- Compressed Air Cost – Treatment

The main focus of the guides is on improved maintenance and control. The EEBPP has also published more than a dozen other documents, which assist companies with compressed air. These include titles such *The Manager's Guide to Saving Energy*, *The performance of a variable speed air compressor*, *Refurbishment of a Compressed Air System*, *The Essentials Compressed Air* and *Expand Your Knowledge of Compressed Air Systems*. Appendix C (available from the Australian Greenhouse Office) contains a complete list of publications along with other highlights from the EEBPP web page.

Additionally, the Compressed Air focal point allows participants to subscribe to the Airlines newsletter, which is a joint publication between EEBPP and the British Compressed Air Society. Participants are also encouraged to seek advice from the Environment and Energy telephone help line.

INTERACTIVE TOOLS

The UK Best Practice Program does not have any interactive tools for compressed air users.

TRAINING

The training course, *Compressed Air and the Climate Change Levy* covers:

- compressed air policy
- maintenance
- the role of the workforce in minimising waste in compressed air use
- technical issues such the use of higher efficiency motors and variable speed drives in compressed air systems.

The course also provides hands on experience requiring participants to work in groups on monitoring, measurement and identifying low cost actions for implementation.

Qualified instructors run the training sessions and the training course is provided free of charge. It is held periodically at different locations across the United Kingdom.

The training course is designed for workers who are responsible for compressed air systems.

US DEPARTMENT OF ENERGY BESTPRACTICES PROGRAM

The US DOE's Office of Industrial Technologies (OIT) runs the BestPractices program. The program helps industry to identify plant-wide opportunities for energy savings and process efficiency. The program provides information, training and grants for up to 50% of energy efficiency research and implementation projects. One area the program focuses on is compressed air systems. As well as promoting the CAC web site as a source of information, the BestPractices website contains a list of compressed air resources and relevant technical reports such as the *Energy Matters Compressed Air Supplement* and the recent *Assessment of the Market for Compressed Air Services*. The market assessment report provides a comprehensive view of the market for engineering and consulting services that improve the energy efficiency of compressed air systems. These services include plant assessments to identify improvement opportunities for compressed air

systems, preventive maintenance services, and redesign of system components to reduce energy use. A copy of this report is available in Appendix D (available from the Australian Greenhouse Office).

BestPractices also offers training on a resource-available basis with the primary targets being companies in the agriculture, mining, metal casting, aluminium, chemical, petroleum, forestry, glass and steel industries (known as Industries of the Future). Training is provided free to these industry members who qualify for entry to the BestPractices program. The BestPractices program offers the CAC compressed air training courses to selected companies. The program web page can be found in Appendix E (available from the Australian Greenhouse Office).

NEW JERSEY COMPRESSED AIR SYSTEM PROGRAM

The Clean Energy for New Jersey Program has seen the gas and electric utilities join together to provide consistent energy efficiency programs across the state. Incorporated in this scheme is the Compressed Air System Program. Utilities sponsor customers, equipment suppliers and service providers to undertake the training provided by the National Compressed Air Challenge Program. Customers can also apply for financial incentives for technical studies and equipment upgrades grants, which will reduce energy costs associated with compressed air systems. The program is available to Industrial customers with facilities containing compressed air systems over 100 HP.

INDUSTRIAL ENERGY EFFICIENCY DEMONSTRATION PROGRAM – ILLINOIS

The Illinois Department of Commerce and Community Affairs' administers the Industrial Energy Efficiency Demonstration Program. The program goal is to reduce the cost of doing business in Illinois. Grants are available for cost-effective energy retrofits or to provide energy efficiency improvements, such as compressed air leak reduction, compressor controls and compressor waste heat recovery. The department selects those industry groups that have the greatest potential for cost-effective energy-efficiency investments. Companies within these sectors are then eligible to apply for a grant up to US$50,000. Companies are required to contribute at least 50% of the project costs.

SOUTHERN EDISON CTAC

Edison CTAC is a large technology centre offering residential, commercial, and industrial customers educational services. The centre houses the Compressed Air Systems display, which includes several types of end-use air nozzles and guns allowing hands-on demonstrations of air flow (cfm), pressure drop, and pressure differentials between efficient and inefficient nozzles and guns. Other demonstrations include ultra-sonic leak detection equipment, three types of piping systems, a pressure amplifier, and an automatic condensate draining system. The aim of the display is to make obvious to industrial customers the cost effectiveness of operating an efficient compressed air system and the expense of operating an inefficient system.

BRITISH COMPRESSED AIR SOCIETY

In addition to the programs mentioned above the British Compressed Air Society sells a booklet called *Guide to the Selection & Installation of Compressed Air Services*. This A5 pocket reference book provides independent advice and guidance for designers, constructors, installers, and users of compressed air. It is available for £12.

Relevant Australian Programs

SEDA COMPRESSED AIR CALCULATOR

The SEDA web site offers companies the opportunity to estimate the running costs of their compressed air system (it can be found at http://www.seda.nsw.gov.au/inbus_calc.asp). Participants input system pressure, operating hours and electricity cost data. They then have the choice of calculating the cost of fixing leaks, reducing pressure and/or lowering air temperature of the system by inputting the relevant information. The site also provides links to information and audit services. This site can be viewed in Appendix F (available from the Australian Greenhouse Office).

DEPARTMENT OF INDUSTRY, TOURISM AND RESOURCES MOTOR SELECTOR SOFTWARE

As part of the Department of Industry, Tourism and Resources Motor Solutions program, companies have free access to a Motor Selector software tool. (www.isr.gov.au/motors/motor/motorsoftware.html) The software allows analysis of factors such as purchase price, load profile, life cycle costs, plant data, efficiency, financial risk, noise, warranty, tariff, CO2 emissions, etc. enabling industry to determine the motor that will provide the greatest long-term cost benefits.

Analysis of Best Practice Programs

Overseas compressed air programs focus mainly on maintenance and operation rather than improving the sales of efficient air compressors. As was noted in the AGO study *Analysis of Potential for MEPS for Packaged Air Compressors* (Mark Ellis & Associates, 2001), the majority of the savings accrue from 'system' measures and control rather than from improvements to the efficiency of the prime movers (electric, petrol or diesel motors) or to the compressors themselves. This has been confirmed by the analysis of the current operative international best practice programs.

INTERACTIVE TOOLS

There are no interactive tools within Australia to assist in the **purchase** of efficient air compressors, although a software tool in the US – the *AIRMaster*$^+$ – allows users to enter different compressor units as part of a system analysis.

There are two software tools that provide assistance to the end user for calculating energy efficiency gains from changes to compressed air systems are:

- the SEDA tool is an interactive web site that provides rudimentary calculations on the potential savings from three common energy efficiency measures (reduced leakage, reduced pressure and lower temperature intake air). This tool is quite basic and suitable for very quick calculations by untrained end users
- the US *AIRMaster*$^+$ software tool is a professional scenario analysis tool for extensive testing of energy efficiency opportunities in large facilities. This tool requires training to use (2.5 day training) and would be suitable for professional or certificate qualified specialists in mechanical engineering.

There is significant development costs associated with the development of a software tool such as *AIRMaster*$^+$ although it would be suitable for large industrial users of compressed air. The market for such analysis of compressed air systems using a sophisticated software tool in Australia would need to be investigated to ensure adequate return to the software investment. The customisation of the *AIRMaster*$^+$ to Australian conditions would require the conversion of the US units to SI (i.e., psi to KPa), which would probably be undertaken by the software developer, Washington State University (WSU). The WSU has not been asked to estimate of the costs to undertake this conversion, however EnergyConsult estimate that a budget in the range of US$10,000 to US$30,000 would be required.

As indicated earlier, the *AIRMaster*$^+$ software does allow the comparison of compressor units within a compressed air system, by using a database of compressor unit characteristics. There are approximately 50 fields of data that can be entered into the *AIRMaster*$^+$ Catalogue, although most contain data in about 15 fields. One of the key

measures of efficiency utilised in the catalogue is **Specific Package Power Input at Rated Conditions**, in kW/100 acfm (kilowatts per 100 actual cubic feet per minute), which is a measure of air compressor efficiency, power required to deliver a fixed airflow at rated capacity and full-load operating pressure. A full list of the fields contained in the *AIRMaster*$^{+}$ catalogue is shown in Appendix G (available from the Australian Greenhouse Office). The ability to compare more efficient compressor units as an energy efficiency measure (i.e., on the basis of capital and running cost savings) is not included in the *AIRMaster*$^{+}$ software.

It is not technically appropriate to develop selection tools for air compressor units when there is not a currently suitable Australian standard for their measurement. In fact, as noted by Mark Ellis & Associates (2001), there are problems with measuring efficiency with industry not agreeing to common variables such as operating compressors at half load or tolerance factors.

The motors selection software demonstrates an effective method to assist companies in purchasing energy efficient products and can be compared in some aspects to the *AIRMaster*$^{+}$ software for compressed air systems. However, without an industry agreed performance test standard, the development of a similar compressed air software tool will not be effective. In addition, the software user must be familiar with the software tool and compressed air system performance improvement opportunities to maximise the use of the software. At this stage, the market in Australia would probably be less experienced (compared to the US) with compressed air performance optimisation. Hence, the program options to be examined in detail are more targeted at the design, operation and control of **whole** compressed air systems than the selection of efficient compressed air units.

INFORMATION AND TRAINING

The most prevalent program approaches used in international best practices programs are information provision, training, and opportunity identification assistance (either on-site checks with and without software). These program components are more suitable for targeting the operation and maintenance of compressed air systems and provide varying levels of technical assistance – from fact sheets to on-site audits with trained personnel.

At the most basic level, fact sheets and educational materials are essential for assisting the interested end user or professional with improving the energy efficiency of compressed air systems. They also serve to provide evidence of the benefits of improving efficiency of compressed air systems. This level of information is required as the base for any program targeted efficiency of compressed air systems.

The types and targeting of training is varied and can be used to target:

- end-users (operators, technicians and engineering staff)
- engineering/technical consultants
- specialist equipment suppliers (controls/ compressed air equipment suppliers)
- educators/technical teachers.

In addition, the training can be provided at cost (such as the USA CAC) or free (such as in the UK EEBP), or a mixture of both. It is difficult to assess which approach is best, as in Australia, different approaches have worked best for differing target audiences. This issue of cost/free training can be tested with the interviews.

ON-SITE ASSISTANCE

To overcome one of the largest identified barriers to energy efficiency, there are a number of programs that offer both free and fee based on-site technical assistance. This is provided for free in the UK and offered for a fee by private companies in the USA. The UK Energy Efficiency Best Practice Program is being expanded and now funded by the UK Climate Change Levy, which is a substantial tax for end users of carbon based fuels. The issue of funding would need to be discussed at the policy level and would then affect the approach chosen if on-site assistance is provided in Australia. The certification of qualified professionals to undertake compressed air "audits" or opportunity analysis is a key characteristic of the US program and provides the end users with some assurance that quality services will be provided by the professionals they pay.

The two options for on-site assistance are:

- free audits and opportunity identification assistance, funded by the government
- fee based assistance by qualified and certified (by the government and/or industry) professionals.

PROGRAM OPTIONS

The options available for an Australian Compresses Air Challenge are examined below. The options presented are distilled from the research of overseas and Australian programs and include the advantages and disadvantages of each approach.

Alternative Program Elements

The options are:

- technical guides and fact sheets on selection, operation and savings opportunities of compressed air systems
- comprehensive training manual
- training courses
- web based opportunities selection guide
- on-site analysis and identification assistance.

TECHNICAL GUIDES, FACT SHEETS AND CASE STUDIES

A series of technical guides could be developed each tackling a key area such as selection, assessment, operation, leakages, etc. The guides would provide users with a step-by-step approach allowing a complete analysis of a compressed air system and providing the necessary information to act on energy saving opportunities, as well as examples and case studies of successful installations. The guides could be made available in electronic and hard copy. The US and UK programs have both developed such resources. The *advantages* of this approach are that information can be quickly and easily be disseminated and users can select the information specific to their requirements. Additionally if an agreement could be reached with the publishers of the existing resources then the cost of reproducing an Australian version of the documents may be greatly reduced. The *disadvantages* of technical guides are that they can only provide generalised information and they engage the audience less than more interactive forms of communication.

COMPREHENSIVE COMPRESSED AIR MANUAL

A detailed book of resources could be compiled that would not only provide users with technical advice but resources/contacts where they could seek further assistance. Topics covered may include an overview of compressed air system for non-technical decision makers, guide to selection & installation, identification of saving opportunities, guide to operation and maintenance, information describing organisations and market intermediaries that can provide advice and assistance on energy saving activities. The manual could be made available in electronic and hard copy and depending upon the market could carry a small purchase charge. Similar resources are available through the US CAC program and the British Compressed Air Society. The *advantages* of this resource are that it would provide comprehensive information in the one location and allow information to be distributed broadly throughout the community. The inclusion of relevant organisations and market intermediaries would make the manual relevant to the whole industry not just the end-users. This increases the likelihood of acceptance by the industry and promotion through informal networks. As with technical guides the *disadvantages* of a manual are the generalised nature of the information and passivity of written documents. However, it should be noted that with a more detailed manual opportunities exist to include activities such as worksheets to record site-specific information that promotes engagement and provides a stimulus to take action.

TRAINING COURSES

Training courses suitable for decision makers and practitioners could be established. Once again the course would take participants through identification of energy saving opportunities and methods on how to act upon these. An important aspect of overseas programs has been to provide practical hands on experience during the training. Additionally a two-tiered training program such as that run by the US CAC may prove beneficial. This allows basic information to be provided to novices such as non-technical management, while

experienced operators can undertake training that deals with more complex technical details. The feedback from the access participants is one of the *advantages* of a training program. Trainees can ask questions and have the opportunity to interact and network with peers, providing an opportunity to benefit from the experience of others. Training empowers participants and provides the knowledge and most importantly the confidence to act. It can be a *disadvantage* if the participants are required to pay for these training sessions, and also overcoming the time demands and pressures of the workplace.

WEB/SOFTWARE BASED SELECTION & OPPORTUNITIES TOOL

A web based program could be implemented to assist companies to select compressed air systems and identify energy saving opportunities. The SEDA Compressed Air Calculator already provides a simple calculation tool looking at the effects of changes to operation and maintenance. This program could be enhanced or replaced by an Australian version of *AIRMaster*+ and, depending on the degree of software sophistication, it could provide greater levels of efficiency measure calculation. One *advantage* of such a program is that companies can quickly and easily tailor information to suit their needs. Web programs or downloadable software can reach a broad range of companies for relatively low cost. A *disadvantage* of the web tool is the limitations placed on providing detailed and customised advice. If the software includes compressors characteristics, problems with stating the measured compressor efficiency, may decrease the credibility of the program. Additionally the web tool relies on the user understanding and accurately collecting the required information as well as interpreting the results. This difficulty could be overcome providing clear information guides accompanied the tool.

ON-SITE ANALYSIS AND IDENTIFICATION ASSISTANCE

Companies could be offered the opportunity of an onsite visit as is available in the UK. The advisor could demonstrate to staff how to identify areas where energy waste is occurring and assist in establishing a site-specific strategy that would implement energy savings. These visits would be multi-purpose in that they would provide detailed and specific information, empower staff with the skills to identify and correct energy waste in the future, break down the barrier of complacency by initiating the first step. The *advantages* of providing such a highly individualised program includes better understanding of own system, tailored list of measures, increased likelihood of continued action. Personalised programs also engender a spirit of support and commitment that can lead to greater participation. A major *disadvantage* of this type of program is the time it would take to disseminate the information to a large number of companies. On-site programs usually involve higher costs and commitment of resources.

INTERVIEWS WITH AUSTRALIAN STAKEHOLDERS

Introduction

Telephone interviews were undertaken with four Australian stakeholders. They included representatives from:

- Champion Compressors – a major compressed air supplier
- Atlas Copco – the largest compressed air supplier
- Energetics – who provide energy audits, advice and implementation of compressed air efficiency measures
- SEDA – who have set up a web based calculator for compressed air efficiency measures and provide training.

The aim of the interviews was to obtain the views of Australian stakeholders on the program options that would be suitable and how a program may be successful. Those interviewed were selected as being representative of the range of equipment and service providers. The stakeholders were told of the background to the project and asked the following questions:

1. What are the most appropriate elements for the Australian situation? Why?
2. Do you think information materials are appropriate? What types (Web-based or print) and targeted at whom?
3. Do you think training is highly useful? Should this be targeted at end users or professionals? Should training participants pay for the training? Do you have any suggestions for training? Who should be best suited to deliver the training (government organisations such as AGO, SEAV, SEDA or contractors)?
4. Do you consider some software tools to be effective for assisting users with identification and justification of efficiency measures? Where should the software be targeted – compressed air unit selection or efficiency measure identification?
5. Would you be willing to support a program? Which parts? and Why?
6. How could governments cooperate with stakeholders to ensure program success?
7. Other technical or market issues to be addressed by a program.

Summary of Interview Results

The interviewees were generally enthusiastic about the potential for compressed air efficiency improvements and were grateful for the opportunity to contribute to the program options. A summary of their responses to the various categories of questions follows.

APPROPRIATE PROGRAM ELEMENTS

The respondents agreed that information materials were the most appropriate program element for Australia. Training or seminars was also suggested as a way to "wake people up" to the opportunities for energy efficiency.

APPROPRIATE INFORMATION MATERIALS

The types of information materials suggested were Fact Sheets and Handbook/Best Practice Guides with examples. These should highlight the cost savings available and be targeted at the appropriate audience – both accounting and operations sides of the business. The respondents were very keen to see some good information on compressed air covering all aspects of system design/selection, monitoring and performance characteristics, opportunity analysis and case studies.

Both web and printed materials were considered necessary as many in the target audience could access the web but printed material was needed to target those who did not have access.

TRAINING

Training was considered useful and appropriate when targeted correctly. The respondents were generally in agreement about the need for "independent" training/seminars on the correct

operation and maintenance of compressed air systems. However, respondents mentioned that the participants need to be motivated to attend the training and put the instruction into practice. It was mentioned that industry does not see the benefits of energy/greenhouse savings at the moment due to low costs of energy and no regulations to comply with any greenhouse target. This was highlighted as a significant barrier that applies to other greenhouse issues. Detailed training was not considered necessary as end users would generally "buy-in" expertise as needed.

Training seminars which highlight the savings opportunities and provided the participants with the principles of compressed air systems were suggested as being most appropriate. The SEDA and SEAV seminars were mentioned as good examples of training. It was suggested that some of the larger company participants could pay for the training but generally; the smaller companies would not pay.

SOFTWARE TOOLS

The respondents agreed that detailed software tools were not necessary. They believe that end users would not use them as they were not sufficiently computer literate nor do they understand the principles of compressed air system analysis. The SEDA compressed air savings calculator provided rough estimates of potential energy savings and was adequate for the end users. According to the respondents, there are too many variables in a compressed air system to properly model in a software tool and the technology changes rapidly.

SUPPORT FOR THE PROGRAM

All respondents were supportive of a program and keen to assist with further program development and operation. They suggested that the government consult with the stakeholders and develop the program further. All were willing to help with this and suggested they could help with content of information materials as required. One respondent suggested that a standard be developed for the presentation of information in supplier brochures, such as common performance measurement specifications so that buyers can compare compressors on a like for like basis. Another respondent suggested that government should provide industry with a "stick" and a "carrot" to motivate them to explore efficiency improvements, such as a greenhouse levy/tax or trading system.

OTHER ISSUES

A wide range of other technical and market issues were mentioned by the respondents, including:

- consulting engineers on fixed price contracts were concerned with minimising the capital cost of a system and not the ongoing costs
- simple housekeeping measures were often overlooked by end users, such as good ventilation, and identification of leaks
- measurement of compressed air systems is essential to identification of poor performance and a program should consider offering subsidised or free measurement services
- life cycle analysis was a good tool for demonstrating the benefits of different systems or technologies.

ANALYSIS AND RECOMMENDATIONS

The range of program options that could be used in a best practice program were described earlier and tested with the industry. From these interviews and the analysis of overseas best practice programs, we provide the following recommendations:

TECHNICAL GUIDES, FACT SHEETS AND CASE STUDIES

1. Fact sheets, technical guides and case studies relevant to Australian conditions should be considered as part of a best practice program.

A series of technical guides should be developed and cover each key area such as selection, assessment, operation, leakages, etc. The guides would provide users with simple step-by-step approaches for the complete analysis of a compressed air system and providing the necessary information to act on energy saving opportunities, as well as examples and case studies of successful installations. These fact sheets should be made available in electronic form and printed. The US and UK programs have both developed such resources.

This program element was highly supported by the industry and could be implemented with relatively low cost. In fact, the USA DOE have already offered to licence the information to the Australian government from their Compressed Air Challenge web site[1]. The materials could be made available from a specific web site for this purpose (such as www.compressedairchallenge.org.au if available) or part of the AGO or EEBP sites. The state agencies (SEDA, SEAV, etc) would also make use of the material for their programs.

COMPREHENSIVE COMPRESSED AIR MANUAL

2. A comprehensive compressed air manual may be considered as part of a best practice program.

A detailed book of resources could also be developed as a "Best Practice Guide" and be suitable for use in various state and federal energy efficiency programs. The guide could be developed with the assistance of the Australian stakeholders and based on the US DOE compressed Air Source book. The manual may include a links/references to other technical resources/contacts and the types and names of firms where they could seek further assistance. The manual could be made available in electronic and hard copy and depending upon the market could carry a small purchase charge. The inclusion of relevant organisations and market intermediaries would make the manual relevant to the whole industry and the end-users. This program element was supported by the stakeholders, but was not the top priority. If the US material could be used under licence, then the costs to develop such a manual would be very low.

Such a manual could be used as the basis of a training course or seminar that could be provided by the AGO, EEBP, SEDA or SEAV. The maintenance of the links and references could be the responsibility of the AGO or other government agency, and may be a page in an Australian Compressed Air Challenge Web site.

TRAINING COURSES

3. Detail training courses are not recommended at this stage, however seminars and information/exhibition on compressed air system opportunities should be considered as part of a best practice program.

The stakeholders believed that detailed training courses were not required at this stage, with most considering seminars as the best way of engaging the end users. These types of seminars would focus on basic principles of compressed air efficiency improvement and raising awareness. The seminar could be provided at an end user site to provide practical hands on experience of opportunity analysis. In addition, the seminars would provide networking opportunities for the participants, suppliers and consultants in the industry. SEDA have a successful seminar program for their energy smart businesses which last year included a seminar on compressed air. They, and the other state/federal agencies may be willing to support or sponsor the seminars and possibly the establishment of a web site for compressed air energy efficiency.

1 Email to Gordon Smith, AGO from Chris Cockril, DOE, 02/02/02

WEB/SOFTWARE BASED SELECTION & OPPORTUNITIES TOOL

4. The provision of comprehensive software focusing on compressed air opportunities analysis is not recommend as part of a best practice program at this stage.

Software tools, such as *AIRMaster*$^{+}$ are not recommended as part of a best practice program, as the industry stakeholders suggest that sophisticated tools would not be used effectively. They believe that such tools would not adequately capture all the variables required to be analysed within a compressed air system. Instead, the industry stakeholders suggest that simple tools, such as the SEDA compressed air calculator, would be sufficient for end users to test ideas for efficiency opportunities. The SEDA web tool could be used in any web site set up specifically for compressed air efficiency, by linking or with the agreement of SEDA, the code could be transferred and possible improved to include other opportunities for efficiency.

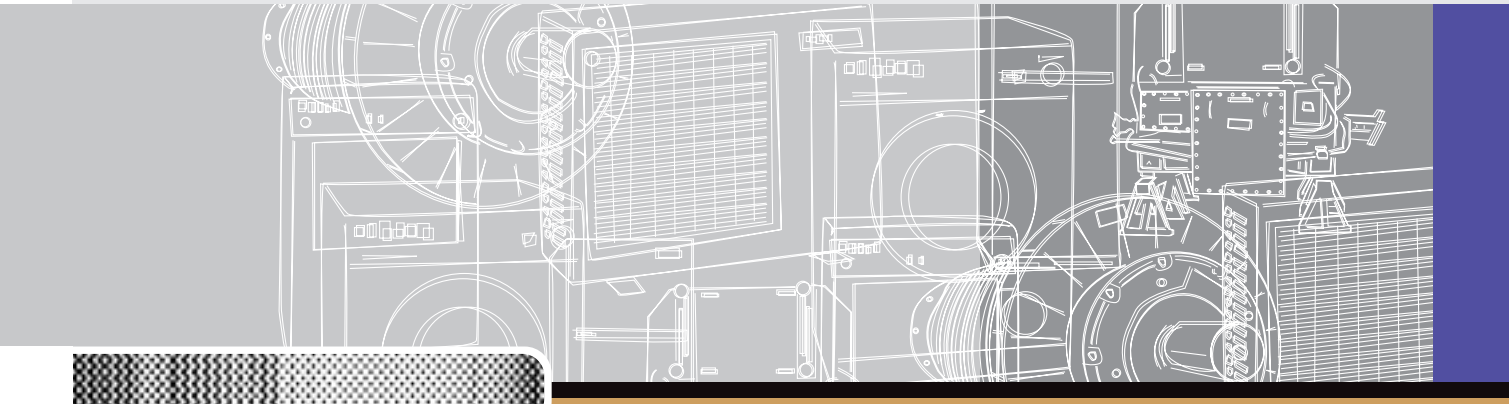
A separate focal point for compressed air efficiency would be an excellent way to encourage awareness of the opportunities and provide resources for end users. As such, consideration should be given to the registering the domain name www.compressedairchallenge.org.au or any number of other names for potential use as a focal point in a program, such as:

- www.compressedairchallenge.net.au
- www.compressedairchallenge.info

ON-SITE ANALYSIS AND IDENTIFICATION ASSISTANCE

5. The consultants in the industry are currently providing on-site analysis and identification. Such a service would be valuable for a program, but on a user pays basis.

Consultants provide on-site analysis and opportunity identification as part of energy/greenhouse audits. This private sector business should be encouraged by the program and not replaced by program services. Obviously, personalised visits engender a spirit of support and commitment that can lead to greater participation; however on-site programs usually involve higher costs and commitment of resources. These types of services are probably best left to the state/federal energy agencies who have established mechanisms and criteria for participation.



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