ENERGY
MANAGEMENT
SERIES

20

FOR INDUSTRY
COMMERCE
AND INSTITUTIONS

Planning and Managing Guide

Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

Canada

Foreword

The ***Energy Planning and Managing Guide*** is meant to be a working manual. In the following pages you will find useful information on how to establish an effective energy management program, how to change your equipment maintenance practices to save energy, and what technology can help you save on your energy costs.

Everything recommended in this Guide has been tried and proven, however, results may vary when techniques and technologies are applied in specific industrial environments. It is to your advantage to consider energy-conserving processes and procedures. Dollars invested now will save you more and more money as time passes and energy costs continue to rise.

Most of this material is based upon a series of Chief Executive Officer seminars on how to introduce a corporate energy management program and make it effective, and on 35 one-day technical workshops held across Canada during 1980. These were sponsored by The Canadian Manufacturers' Association with the co-operation and support of the Energy Conservation and Oil Substitution Branch (ECOS) of Energy, Mines and Resources Canada and directed at industry. Technical content for the workshops was developed from material contained in the ten Enersave Series of Industrial Conservation Manuals.

To convert the information and data produced for and from these seminars and workshops into a practical and useful working manual, the technical parts of this Guide have been set up with marginal columns and also footnotes at the close of each section. The marginal columns provide comments on suggested actions as well as space for checking off activity or progress on each. The footnotes contain suggestions about assigning responsibility for taking action, the steps to be taken, and space for recording dates and entering notes. The key words in each section have been highlighted for emphasis and to facilitate easy review.

The comments and suggestions offered here are not intended to be either exhaustive or exclusive. Each user should adapt and modify to suit the particular situation. It is hoped that this manual will prompt efforts to conserve energy that will save your company dollars and increase its profitability.

If you wish further information on any of the material contained in this manual or regarding the availability of the Enersave Series which includes material used at workshops and actual case studies, please write to:

Industrial Energy Division,
Energy Conservation and Oil
Substitution Branch,
Dept. of Energy, Mines and Resources,
580 Booth St.,
Ottawa, Ontario,
K1A 0E4

Table of Contents

Setting up and running an effective energy management program

Energy management is the application of ***sound business techniques*** to energy use. These are basically the same techniques as are applied to finance, production, marketing or administration in order to make and keep the enterprise successful. The bottom line is on the balance sheet—profit or loss. Using these ***techniques*** effectively to ***reduce waste*** will ***increase profits*** by keeping energy consumption and costs at a controlled minimum. Potential savings exist even in well-run plants, ***but it takes effort to realize them.***

Energy management is first and foremost a management and organizational effort. ***Without*** proper attention to ***organization,*** an ***energy management*** program will be only marginally successful or ***will fail.***

Energy management depends on people—the more people involved, the more effective the ***program.*** Their involvement, however, ***must be structured and planned.*** Regardless of the size or type of organization, the following ***four elements are essential*** to any successful energy management program:

- top management commitment
- clearly designated responsibility and accountability for the program
- defined realistic goals
- program planning and implementation

Top Management Commitment

Top management's full support and enthusiastic participation ***must be clearly*** expressed and visibly ***demonstrated*** to employees not only at the outset but also for the duration of the program.

As a first step, ***tell line supervisors*** why effective energy management is needed and ***what their related responsibilities are.*** If the workplace is governed by a collective agreement, ***discuss*** the ***plan*** of action ***with union officials and obtain their support.*** Then ***launch*** the ***program with a strong policy statement*** by the chief executive ***and follow it up*** immediately ***by a presentation to employees*** explaining the need for efficient energy use.

Without ongoing top management commitment, an energy management program is doomed to failure. Also, ***employees*** will ***apply*** their ***best efforts*** to the program only ***if they see the same kind of commitment by their supervisors.***

Program Responsibility

In smaller organizations make management staff responsible for reducing energy consumption as part of their management duties. ***In larger*** manufacturing ***firms,*** appoint an energy program committee, headed by a ***coordinator,*** preferably an experienced line manager who ***will be fully responsible*** for carrying out the program ***and accountable for the result.*** Give the coordinator orientation training and have him or her report to senior management. In most cases, the program will be effective only to the degree the coordinator is allowed to spend time and effort on it. Make sure adequate funds are made available to operate the program effectively.

The ***committee*** should have ***members from each major energy-using department*** as well as ***representation from the factory floor, particularly*** from ***plant maintenance. Members should*** be prepared to ***make recommendations*** affecting their areas, ***and conduct investigations and studies. Energy*** resource ***management*** generally ***yields*** the ***best results when specific accountable responsibilities are assigned.***

Defining Realistic Program Goals

The coordinator should brief the committee fully on all available information about energy use, challenging the members to explore ways of conserving energy in their respective areas or departments.

Set ***energy savings goals*** at the start to ***provide a program target.*** Establish a system of reporting progress toward these goals. ***Review*** the ***goals periodically*** as your information about energy use becomes more accurate. ***Goals should be realistic, specific, and measurable,*** and should offer enough incentive that employees are challenged to achieve them.

Set realistic goals by applying standards which indicate how much energy should be used for a particular application. Measure current performance against industry standards or calculated practical or theoretical energy requirements. Always ***set goals*** and standards ***in familiar energy units*** such as MCF, BTU, therms, kWh, etc.

Program Implementation

The ***first*** technical ***step*** in the energy management program ***is*** the ***energy audit*** which is made from a series of surveys and shows where and how energy is being used and/or wasted.

Begin by reviewing the oil and utility bills. Obtain data for at least a one-year period to ***establish*** a ***12-month revolving base period*** upon which estimates and performance comparisons can be made without seasonal distortions.

Audit energy use ***on a departmental basis, and*** finally ***on individual systems and equipment.*** Basic energy use data on production equipment is usually obtainable from the nameplate on each unit.

An ideal audit lists each process step, the minimum practical or theoretical energy required for each step, the actual energy used and the variance between the minimum and actual use. The goal is to ***reduce*** the variance to a minimum by identifying ***wasteful practices*** which can be corrected. The ***audit*** also ***identifies areas requiring further analysis,*** and ***pinpoints places where*** on-line energy flow measurement is needed and can be justified economically. One rule of thumb suggests that ***in-plant metering should be installed*** when the annual cost of energy exceeds five times the cost of the meter.

In the first physical plant survey, ***identify*** wasteful operations and develop a checklist covering the normal housekeeping functions plus such items as ***leaking utility lines, damaged insulation, equipment*** that is permitted to ***idle when it could be turned off,*** or other examples of improper operation or maintenance. Survey ***energy use during non-working hours.***

Energy can be measured in any unit compatible with the way it is purchased and ***should be correlated as required to an equivalent unit for all energy sources.*** BTU or gigajoule (GJ) is recommended as a common denominator. From measurements of energy input ***and*** production records, the ***energy intensity ratio*** (i.e. energy used per unit of output) can be ***calculated.***

A thorough energy audit is to good energy management as a thorough financial audit is to good financial management. It serves essentially the same purpose. ***Without*** an ***energy audit*** it is ***difficult*** to find out how to conserve energy, and ***to measure*** the ***success of*** an energy management ***program.***

Energy audits can often be done by in-plant personnel. If this is not possible, a ***qualified consultant may help*** the co-ordinator and his committee ***identify where energy management can be improved and energy saved.*** The ***government*** provides ***assistance*** towards the cost of feasibility studies by consultants. Investigate this assistance, ***and*** also the ***free energy audits conducted by competent engineers under*** the federal- provincial ***energy bus program.*** This confidential service also provides tangible evidence of a company's energy management program.

Program Implementation and Continuing Energy Management Efforts

Correct the ***obvious wastes*** found in the initial survey ***immediately,*** and record the corrective action. You can ***eliminate most*** of these wastes ***by procedural changes*** requiring little capital investment, and ***resulting in savings of 10 to 20 per cent in the first year.***

Start your ***program with modest but quickly-obtainable savings.*** Obvious targets are plant and office lighting, heating and cooling. The measurable savings you achieve in these areas will encourage the energy management committee to seek greater savings in the less obvious areas of energy use by production machinery and processes. A ***short-term target of 5 per cent savings during*** the ***first six months*** of an energy management program ***is generally acceptable.*** Too long a lead time, with a correspondingly higher target, may cause loss of enthusiasm.

Analyze the ***energy surveys*** to ***reveal which energy services show the most potential for immediate improvement.*** Make a ***cost-benefit analysis*** based on future energy costs to reveal the merit of each potential improvement project and ***help you to set priorities.*** Implement selected projects as soon as approved.

Calculate energy intensive ratios (energy used per unit of output) for the entire plant, every operating department, and each significant process. Do this ***regularly on a monthly or quarterly basis.*** The ***ratio will*** act as a monitor to ***show unfavourable trends which should be explained and corrected*** as soon as possible.

Have the energy management ***co-ordinator hold regular meetings with his committee to review progress and update project lists.*** Previously set goals will require evaluation and new goals should be established as necessary. ***Have*** the ***committee conduct*** a ***continuing program of energy management activities and communication to maintain employee interest.*** The ***co-ordinator should*** also ***make periodic progress reports to management*** and use these as an opportunity to review the program and re-establish continuing support for it.

Every manufacturer who has an energy management program in place ***should consider*** seriously the many advantages of ***joining*** the appropriate voluntary Industry Energy ***Conservation Task Force.*** The industrial sectors represented in this network are:

- Chemicals
- Electrical & Electronics
- Ferrous Metals
- Food and Beverage
- Industrial Minerals
- Canadian Farm and Industrial Equipment
- Machinery and Equipment
- Mining and Metallurgical
- Petroleum Refining
- Plastics
- Pulp and Paper
- Textiles
- Transportation Manufacturing
- Wood Products (Western)
- Wood Products (Eastern)
- General Manufacturing
- Non-Prescription Medicines

Membership in a Task Force ***is free. Non-proprietary energy information*** is shared with other participants, ***and information on energy management programs and conservation techniques is exchanged*** through seminars, workshops, Task Force newsletters and other appropriate means. ***If your company is not already a member,*** you should ***consider joining*** your fellow manufacturers in ***the Task Force Program. It is through this Program that industry has been able to demonstrate the effectiveness of the voluntary effort and thus avoid government legislation and bureaucratic regulation.***

Summary

The management of energy means achieving the most productive use of energy relative to its cost. A well designed and properly run energy management program will increase profits by keeping energy consumption and costs at a controlled minimum. The crucial elements of a successful program are:

- active support of top management to meet clearly defined goals
- the establishment of ways to monitor and evaluate progress
- implement corrective action by involving employees at all levels

Successful programs are those which start with modest but quickly obtainable savings, usually by improving housekeeping functions within the plant. Companies with energy management programs will find it highly beneficial to join a voluntary Industrial Energy Conservation Task Force.

Responsibility for action:

- ☐ Chief Executive
- ☐ Energy Co-ordinator
- ☐ Energy Committee
- ☐ Consultant
- ☐ Other

Suggested steps

Things to check

Persons to contact

Record of action to date and notes to remember	
Date	Description or note

Heating, ventilating, air conditioning (HVAC) and building envelope

Activity and Action

Because heating and ventilating are common to all ***industrial facilities*** the opportunities for energy conservation are perhaps the most basic of all. It is normal, however, to find that the ***HVAC*** or environmental ***equipment*** is often the ***least understood and*** the ***most neglected*** in an industrial facility.

Of all the significant energy using systems in industry HVAC equipment is most neglected and least understood, hence effective maintenance and care offers significant payback.

Basically, ***HVAC systems*** are designed to ***compensate for heat loss or heat gain and*** are intended to ***provide temperature control, ventilation*** and perhaps ***humidity control for the comfort*** of the people or for the operation of processes and equipment.

Many plants operate at a negative pressure because exhausts have been added for various reasons without providing makeup air to replace the exhaust. This ***negative pressure*** causes infiltrated air to enter the plant through any available opening and ***add to the load on the heating or air conditioning systems.*** In certain instances, this problem can become so bad as to cause employee discomfort. ***Opportunities for the recovery of waste heat for use in heating makeup air should be sought*** as a means toward providing an overall reduction in energy use and improving the plant environment.

HVAC is primarily a system for human comfort. System changes may need the understanding and support of the workers if these changes are to be effective.

Exhaust and makeup air should be examined for ***minimum quantities to meet*** the comfort, dust, odor or other ***requirements.*** Operating hours and peak versus average demand should be examined. Process-actuated dampers or interlocks may be worthwhile to reduce quantities or confine operating time to what is needed.

Check your air balance. All exhausts versus all makeup or supply. Add temperature to the above and do an air energy balance.

For most plants, warehouses and office areas, which operate less than 24 hours per day and seven days per week, there is an opportunity for ***temperature setback during unoccupied or non-production hours.***The higher the unoccupied time, the greater the savings will be and this opportunity should not be overlooked.

Recover heat where practical. Cut down exhausts where possible. Stop leakage and infiltration.

When the exhaust and supply air are relatively balanced, the building shell should be examined for ***infiltration and leakage. Seals and caulking*** should be ***renewed or added*** as necessary. One basic question is to determine whether ***doors or windows*** are needed, and if not, whether the expense of ***blocking them up*** to match or blend with the remainder of the building can be justified. Another source of loss is ***seasonal vents*** if they are open when not needed.

Turn off unneeded exhaust fans whenever possible. Block unneeded windows and doors. Install air-lock doorways.

Heat stratification in plants is common. If you have 10° to 12°F temperature difference during the heating season between the working level and the roof, some type of destratification system may be justified. If the plant requires makeup air and also has a stratification problem, devices are available to introduce unheated outside air to roof level to mix with the hot air and provide a solution to both problems.

Eliminate heat stratification in high buildings where temperature gradient indicates fans, etc. are warranted.

Adding ***insulation and double glazing to the building envelope*** may be worth investigating in light manufacturing or warehouse operations under certain circumstances. In plants generating a lot of internal heat from the process, lights, etc., reducing transmission losses may cause worker discomfort. The first cost of adding insulation or upgrading windows may prove difficult to justify with the energy savings in most existing plants.

Check and add insulation where economically justifiable; also double glaze where feasible.

In certain plant areas where ***infiltration*** is high (such as shipping or receiving areas, truck repair bays, etc.,) it can be worthwhile to look at an alternative type of heat, such as radiant, instead of convection heating. Heating costs can be reduced and employee comfort improved.

Examine possibility of using radiant heat in exposed high infiltration areas such as shipping/receiving docks.

Summary

HVAC offers significant opportunity to cut costs without reducing human comfort. Ways to save include: tighten the building envelope, control, balance, minimize quantities of exhaust and makeup air to meet requirements, temperature setback, proper maintenance, etc.

Responsibility for action:

- ☐ Production Manager
- ☐ Chief Engineer
- ☐ Maintenance Chief
- ☐ Other

Progress report and dates

Examination & Evaluation	Planning Stage	In Progress	Completed

Suggested steps

Things to check

Persons to contact

Suppliers/contractors

Record of action to date and notes to remember

Date	Description or note

Insulation

Activity and Action

Insulation is used in manufacturing buildings or in process systems ***to prevent heat loss or heat gain.*** Its ***primary purpose*** is an ***economic*** one, but it ***also*** serves the related purposes of ***accurate control of process temperatures and protection of personnel.*** An ***additional purpose*** is the ***prevention of condensation*** on the surface of the equipment being covered, and therefore loss of equipment by corrosion or the nuisance effect of condensation in work areas. Insulation is of particular interest in today's energy management discussions because of the possibility that the original systems were inadequately designed, that they have been inadequately maintained since the original installation, and most importantly, that they are inadequate in the light of increased fuel costs since the original installation decisions were made.

Insulation reduces cost of heating and cooling. It also makes possible the accurate control of temperature and protects employees against excessive heat or burns. Insulation is also used to prevent condensation.

The most significant analysis of insulation involves determination of ***economical thickness*** and, as is the case with most engineering decisions, it is a trade-off of installation (and in some cases maintenance) costs as opposed to the ***value of energy saved.*** In examining insulation systems to maintain and improve effectiveness, the obvious first step is to eliminate all bare surfaces and to provide the optimum amount of insulation. It is sometimes economical to re-examine the design of heat tracing systems to improve their efficiency.

Remember that the cost of energy wasted from an uninsulated steam pipe equals the price of installed insulation every 40 to 60 days. Can you afford it?

Selection of insulation should be reviewed to assure that the most effective present or added material is being considered. These limitations include compatibility with the process or environment in which it is used, temperature range, physical limitations, and moisture exposure.

Choose the type and the thickness of insulation with technical care and economic study - (evaluation). Anticipate future energy costs.

Exposure to moisture is perhaps the factor most often missed in the selection or maintenance of an insulating system. To understand the importance of moisture, it is helpful to ***keep in mind that insulation saturated with water transfers heat approximately fifteen to twenty times faster than dry insulation, while insulation which has been saturated with ice transfers heat approximately fifty times as fast as dry insulation.*** These relative factors make it clear that ***critical attention to vapor barrier installation and maintenance and,*** to a lesser degree, ***the selection and maintenance of proper weather barriers*** are just as important as selection of proper thickness and type of insulation. Contrary to what is quite often found in process systems, retrofitting insulation to existing buildings in general is not an economical approach unless there is considerable rehabilitation going on at the same time. There are, however, specific exceptions to this statement—additional insulation can be readily added to suspended ceilings, open attics and the like. It is also possible when re-roofing to add rigid board insulation or a light-weight poured insulating material between the old roof and the new one. There are also products available which make it possible to add a weather-protected styrene board to either the inside or outside walls of an existing building. In all of these additions or modifications, the examination of vapor and weather barriers is extremely critical if the system is to be effective.

Vapour and weather barriers are vital parts of insulation. Make sure they are intact.

An insulation survey, then, ***should include*** a detailed ***maintenance check list*** to examine ***existing conditions,*** a review of ***economic thicknesses,*** and the ***cost to modify*** the insulation in light of today's and ***future energy costs,*** as well as a review of the ***type of insulation*** being used.

Do a complete insulation survey or audit of your plant and offices.

Summary

Insulation is the energy stabilizer—it keeps the wanted in and the unwanted out, or vice versa. It protects, controls and saves.

Responsibility for action:

- ☐ Plant Engineer
- ☐ Pipe Foreman
- ☐ Building Superintendent
- ☐ Other

Progress report and dates

Examination & Evaluation	Planning Stage	In Progress	Completed

Suggested steps

Things to check

Persons to contact

Suppliers/contractors

Record of action to date and notes to remember

Date	Description or note

Lighting

Activity and Action

There are generally several cost-effective measures which can be taken in plants, warehouses and office areas with regard to lighting. A ***review*** should be made ***of the lighting level required*** for the type of activity in each area. In many cases it will be possible to reduce lighting levels because the tendency in recent years has been to over-specify the level of illumination.

Reduce lighting level to acceptable intensity. Remove unneeded lamps and ballasts.

One ***basic ground rule*** should be ***to turn off lights when not required.*** This can be done manually if proper switching is provided although this may prove unreliable. ***Timers and photocells*** should be ***considered*** or, in certain cases, integration with an energy management control system. Good rules of thumb are that incandescent light should be turned off whenever not needed, fluorescent when the off period will be 15 minutes minumum and high intensity discharge when the off period will be one hour minimum.

Turn off all unneeded illumination. Use timers and photocells where practical.

Delamping of overlit areas is worthwhile and ballasts, which consume up to 20 per cent of input power, should be disconnected for fluorescent and high intensity discharge fixtures.

Task or work-site lighting should be considered instead of general area lighting where the requirements vary widely within a building.

Try task lighting instead of large general area lighting.

Use of ***low wattage energy-efficient*** fluorescent, halide or sodium ***lamps*** is usually cost-effective and consideration should be given to changing these units.

Incandescent lights are the ***least efficient*** of the common systems and should be used less or replaced with more efficient sources such as fluorescent or high intensity discharge. Where the operating hours of a system are high, upgrading of fluorescent systems to metal halide or high pressure sodium may be cost-effective. Fluorescent are three times as efficient as incandescent; metal halide, 1 1/2 to 2 times as efficient as fluorescent depending on size and high pressure sodium 1 1/2 to 2 1/2 times as efficient as fluorescent.

Check cost effectiveness of replacement with low wattage energy-efficient fluorescent halide or sodium. Take account of colour changes.

Other than efficiency, ***considerations*** for upgrading ***are fixture cost, lamp cost, lamp life and maintenance frequency.***

Factors to consider before upgrading include costs, lamp life and maintenance.

Dimming systems for high intensity discharge fixtures can be worthwhile to provide a proper light level with good fixture spacing and also where the area has more than one use requiring more than one light level. Such dimming systems can be combined with a photocell-actuated control which reduces energy consumption over the lamp life by compensating for lumen depreciation.

Energy savings in lighting systems involve not only the energy and demand charges for electric power, but also the cooling load involved in air conditioned situations.

Summary

Worthwhile savings can be achieved by a sensible approach to adequate but not excessive lighting levels. Additional steps may also prove economically justifiable energy saving opportunities.

Responsibility for action:

- ☐ Maintenance Manager
- ☐ Production Manager
- ☐ Chief Engineer
- ☐ Electrical Foreman
- ☐ Other

Progress report and dates

Examination & Evaluation	Planning Stage	In Progress	Completed

Suggested steps

Things to check

Persons to contact

Suppliers/contractors

Record of action to date and notes to remember	
Date	**Description or note**

Electrical systems

Activity and Action

The electrical devices in an operating plant represent the most commonly used of all energy consuming devices. Yet the electrical system and the opportunities for energy conservation are perhaps the least understood except by electrical specialists.

Opportunities for conserving electrical power and thus ***reducing costs*** involve ***reduction of peak demand*** requirements and hence the demand charge levied by the electric utility, as well as ***reduction of total energy consumed.*** Reduction of total energy consumed is the simplest portion of this type of study and should be approached first. It involves all of the usual engineering/cost-saving approaches: turning off lights, shutting down equipment when not really needed, and examining department-by-department for opportunities.

Launch two-pronged attack on electrical energy.
1. Reduce total energy used.
2. Reduce peak demand.
   Reduced peak saves money— not energy.

Reduction of ***peak demand*** becomes more complicated and requires an ***analysis*** of the ***frequency and the magnitude of peaks,*** definition of the cycle or cycles in which they occur, and then identification of the cause for each peak. Once the causes for the peaks are identified, a study can be made on methods of ***staggering the use of equipment*** or of ***shedding non-essential loads*** during the period when peak producers must be operated.

Study reduction of demand peaks.
- stagger equipment use
- shed non-essential loads when production demand is high

Power factor improvements as a means of reducing power costs depend on the penalty levied by the individual electric utility for less than standard power factors and the cost of correction. Although most efforts to reduce total energy consumption do not require capital investment in an existing plant, improvement of power factor generally does require it—but returns can be high.

Low power factor is caused normally by A.C. ***induction motors,*** particularly ***underloaded ones,*** transformers, lighting ballasts. Adding capacitors to the system is the most common corrective measure and is usually cost-effective when done in a bank.

Power factor correction will reduce electricity costs.

Addition of individual capacitors to large induction motors offers the advantage of reducing current drawn from the system and can be useful in closely sized installations.

Monitoring of electrical power consumption and techniques for the control of consumption are relatively new in most industries and are the logical outgrowth of the peak demand study mentioned previously. The peak consumption study must be complete and accurate; in many cases a complete management program will require detailed specialized recording to give thc required information. Once the picture is clearly developed, the application of power control methods and devices can be applied. These devices can range from very basic "unintelligent" limit switches or controllers to sophisticated "intelligent" computer-based data acquisition and control systems.

Measure, monitor and control electrical power usage, peaks, and costs. Have utility meters calibrated. Don't assume they are accurate.

A.C. induction motors are the ***workhorse of industry*** and ***models with improved efficiency*** are being offered by many manufacturers. While present electric power rates will not allow an economic justification for replacing existing motors, new motor purchases should be looked at carefully. Rewinding of existing motors usually decreases their efficiency and replacement with energy-efficient models should be examined. Application of energy-efficient motors is best suited to situations requiring three shifts per day operation to maximize the savings.

More energy-efficient induction motors are now on the market. Consider them when replacement motor is required if the extra cost vs. saving justifies their purchase. Write performance warranties into equipment purchase contracts.

Summary

Electrical devices are the most common of energy users. Reduced costs can be achieved by reducing peak demand and total electricity consumed. Other techniques will also help to save energy money.

Responsibility for action:

- ☐ Production Manager
- ☐ Mill Services or Engineering Manager
- ☐ Chief Electrician or Foreman
- ☐ Purchasing Manager
- ☐ Other

Progress report and dates

Examination & Evaluation	Planning Stage	In Progress	Completed

Suggested steps

Things to check

Persons to contact

Suppliers/contractors

Record of action to date and notes to remember

Date	Description or note

Combustion and fuels

Activity and Action

While there are several ***sources of heat loss*** associated with any ***combustion system,*** most industrial processes which burn fossil fuels can usually be optimized by attention to the most important one or two.

Fuels containing higher ratios of carbon to hydrogen (such as Bunker oils) will intrinsically have lower stack losses than those with substantial amounts of hydrogen (such as natural gas) because the water vapor formed from the combustion of hydrogen is inevitably lost along with its latent heat. Likewise, moisture in the fuel and combustion air causes a loss, but in most situations these losses are not controllable. The only really controllable moisture is in the fuel and this applies primarily to coal-fired systems.

Reduce heat loss by getting fuel analysis from supplier. Compare energy against alternative source and also against cost.

The dry products of combustion i.e. ***the stack gases from a combustion*** unit, ***represent*** an area of ***loss which should be attacked from two directions:*** first the ***stack gas temperature;*** second, the amount of ***excess air*** involved in the operation. While the theoretical amount of air for a given fuel will provide the exact amount of oxygen to completely burn the fuel with no oxygen or fuel left over, each burner and control system will require excess air to maintain a proper flame and provide complete combustion. The amount of air necessary will also vary with the firing rate. Without upgrading the combustion system, excess air should be optimized by flue gas analysis techniques to reduce the dry flue gas loss to a minimum. Beyond tuning of existing controls, the economics of replacing the control system or even the burner to allow lower excess air quantities should be examined.

To increase efficiency and reduce waste, check stack gases for exit temperature and excess air. Make sure environmental standards for smoke are met.

Unburned fuel also represents a significant source of loss if combustion control is not adequately monitored. It occurs with both coal and oil and is apparent with gas combustion to a lesser degree. Attempts to reduce excess air with simple control systems through oxygen analysis in the flue gas can produce unburned fuel and smoke. Flue gas analysis should therefore include determination of combustibles.

Eliminate incomplete combustion. Reduce loss. Save money. Assure compliance with environmental protection laws.

Radiation loss is a relatively minor subject but one that should be mentioned in passing. Here, the solution normally involves a critical examination during boiler overhauls to assure that casings and insulation have not deteriorated or been damaged.

Check insulation, fire brick and casing. Infra-red surveys can help detect heat loss.

Heat recovery from combustion processes offers good potential but a use for that heat must exist. Normally, return of waste heat to the same process or to an associated process will offer the best economics. Integration of the heat is usually better from a scheduling point-of-view and the installation costs are lower. Supply of building heat can be economic in the absence of other uses. Obviously, the recovered heat can only be used during the heating season and control can be expensive.

Recover heat wherever there's a use for it and wherever practical.

Summary

Fine tune and control the combustion system. Also reduce losses; a) from stack gases due to high temperature b) unburned fuel c) Radiation loss d) by recovery of heat.

Responsibility for action:

- ☐ Stationary Engineer
- ☐ Maintenance Chief
- ☐ Plant Engineer
- ☐ Purchasing Manager
- ☐ Other

Progress report and dates

Examination & Evaluation	Planning Stage	In Progress	Completed

Suggested steps

Things to check

Persons to contact

Suppliers/contractors

Record of action to date and notes to remember

Date	Description or note

Steam generating units and powerhouses

Activity and Action

The entire ***boiler system*** should be considered ***as a single unit including fuel supply, combustion control system, feedwater treatment and heating, deaeration, blowdown and condensate return.***

Consider all facets of the entire system.

Generally speaking, boilers are rated on a design basis and are performance-tested on initial acceptance in accordance with a well documented and very specific procedure outlined by the ASME. From an operating standpoint, this type of test is not practical except in extreme situations. ***Long term average performance should be monitored on the basis of fuel to steam efficiency by*** the use of properly sized and maintained ***metering and measuring*** equipment. ***An operating log should be maintained*** by responsible operators and a summary report on a daily, weekly or monthly basis should be ***reviewed*** by responsible management personnel. A good understanding of the measuring equipment is necessary to ensure valid information and ***regular calibration*** and maintenance ***is important.***

Monitor steam-to-fuel efficiency.

Maintain metering and measuring equipment. Keep operating log. Periodic review of reports and log by responsible management.

Heat losses specific to boilers ***involve*** particularly the ***heat transfer surfaces,*** and monitoring of ***flue gas*** temperatures provides an ongoing check. ***Slagging*** on the fire side, ***scale*** on the water side, ***damaged baffles*** and build-up of ***soot*** on the convection sections ***contribute to losses. Control*** of ***these*** conditions requires careful inspection during shutdown periods, exacting control of feedwater and attention to the use of cleaning equipment such as soot blowers or manual lances.

Reduce heat losses by on-going check of heat transfer surfaces, flue gas temperature, slagging, scale, damaged baffles, soot.

Carefully inspect heat transfer surfaces during shutdowns.

Another major source of energy loss is boiler blowdown where the loss is ***not only water,*** but ***also chemicals and heat.*** A regular program of testing for total dissolved solids in the boiler water and adjustment of the blowdown rate is a minimum measure. For boilers of 200 HP and more, automatic control of blowdown using conductivity meters should be considered, particularly where condensate return rates vary or operator testing of boiler water is not reliable. ***Recovery*** of the ***energy*** contained ***in*** the necessary ***blowdown*** can be economical through the use of a flash tank to provide low pressure steam for deaeration and heat exchange to preheat makeup water.

Recover energy in blowdown.

Although the ***loss of condensate*** and the resulting makeup water requirement should not be expressed directly in terms of a loss, it ***does represent an energy requirement.*** Return of as much condensate to the boiler as economically possible. Boiler feedwater control and the tendency for ***scale formation*** on the water side of the tubes become ***more troublesome with low rates of condensate return.*** Also, the ***makeup water must be heated*** and the cost of water ***and chemical loss*** must be considered.

Recover and return all condensate possible to boiler feedwater.

Exit gases represent a major source of heat loss and can be ***reduced*** by the use of ***economizers*** for feedwater heating as well as preheaters for heating combustion air. An economizer is usually preferable to an air preheater on high pressure boilers.

Determine whether economizer would justify expense of purchase and installation.

Summary

In steam generation, consider the complete system as a single unit, requiring constant care, monitoring and attention to each and all facets: metering, measuring, calibrating and review of all performance criteria to ensure top efficiency and minimum costs.

Responsibility for action:

- ☐ Chief Stationary Engineman
- ☐ Boiler Operator
- ☐ Plant Engineer
- ☐ Maintenance Chief
- ☐ Other

Progress report and dates

Examination & Evaluation	Planning Stage	In Progress	Completed

Suggested steps

Things to check

Persons to contact

Suppliers/contractors

Record of action to date and notes to remember

Date	Description or note

Steam heated equipment

Activity and Action

Several ***items*** are ***worthy of mention*** in a summary of conservation in steam heated equipment. ***Improperly maintained or designed steam traps*** can cause substantial losses of energy. In some cases, redesign of a transfer system can be justified to use the motive forces more efficiently. ***Incorrect selection*** of type of trap or ***improper sizing*** for the equipment and/or condition can result in ***substantial energy loss.*** In terms of energy cost, a leaky trap will waste its purchase and installation cost every 10 to 40 days depending on size of leak and size of trap. An uninsulated steam pipe will waste, in radiation heat loss, the price of pipe insulation and its installation every 30 to 60 days depending on size of pipe and the pressure and temperature of the steam.

Establish a regular planned trap inspection and maintenance program. Dollar losses from leaky traps can be enormous.

Inspect steam piping periodically to ensure all is properly insulated and in good repair.

Where ***steam*** is used in ***ejectors*** for creation of vacuum, comparison with mechanical ***vacuum pumps*** should be made.

Already mentioned under Steam Generation Units is the ***importance of condensate recovery.*** In some cases, it is possible to use condensate, when it cannot be economically returned to the boiler system, for preheating process fluids or makeup air.

Recover and reuse condensate. It is costly and valuable.

Another opportunity is to ***obtain low pressure steam*** from the primary pressure condensate system ***by flashing the high temperature condensate*** partially to steam in a suitable low pressure tank. Such a system generally involves a rather moderate investment and can prevent loss of flash steam at the condensate receiver/deaerator.

Outdoor pipe insulation can become very ineffective when it gets wet. In addition to assuring that the proper insulation thickness is in place, moisture barriers must be in good repair.

Inspect and repair moisture barriers.

Enlist operating personnel, as well as the maintenance department, for reporting steam leaks and insulation needs. Institute a reporting and follow-up procedure.

Summary

Steam supply and distribution pipelines and associated apparatus require regular attention in the form of planned, periodic, preventive maintenance. Nothing less.

Responsibility for action:

- ☐ Maintenance Chief
- ☐ Plumbing or Steam Fitter Foreman
- ☐ Chief Engineer
- ☐ Other

Progress report and dates

Examination & Evaluation	Planning Stage	In Progress	Completed

Suggested steps

Things to check

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Suppliers/contractors

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Heat recovery

Activity and Action

Heat recovery ***possibilities*** present themselves in ***nearly every plant:*** in the power plant, in the ***process*** or in the ***building*** environmental ***equipment.*** Use of the recovered heat in a system which is economically justifiable narrows the possibilities substantially. ***Return*** of the ***recovered heat*** to the process from which it came should be the ***first priority*** since such systems usually require less control and are less expensive to install.

Great potential to save energy and money through heat recovery in most plants.

With all heat recovery devices, ***ongoing effectiveness*** of the ***heat transfer*** and maintenance requirements should be a ***primary consideration.*** Actual ***payback*** on the initial investment may be substantially ***affected by deterioration in performance due to fouling of transfer surfaces.***

After installation maintain effectiveness and ensure payback by maintaining clean heat transfer surfaces.

Air-to-air heat recovery devices are applied over a wide temperature range and consist of the following types.

- plate
- rotary heat wheel
- run-around loop
- heat pipe
- recuperator

Select the most suitable recovery device for your application.

For general ***retrofit applications,*** particularly where recovered heat will be used elsewhere than in the originating process or where multiple exhaust and use points exist, the ***run-around loop offers*** many ***advantages.*** Although the efficiency of recovery is generally lower, the need to bring two air streams to a common device is eliminated.

Consider retrofitting existing equipment as well as heat recovery on new installations.

Plate exchangers offer a ***relatively high efficiency*** with a ***low*** possibility of ***cross-contamination. Rotary heat wheels*** offer a ***high efficiency,*** simple capacity control and moisture recovery if desirable with ***some cross- contamination. Heat pipes*** offer a ***high efficiency*** with close temperature approach if desired, ***no cross-contamination*** and no moving parts, but higher cost and reduced efficiency when the receiving end of the heat pipe becomes fouled.

Study and compare alternatives.
Review factors:
- Cost/Savings at current and future energy prices
- Efficiency
- Contamination

Recuperator: Recuperation is a term applied to an ***air-to-air device used to transfer heat*** from a high temperature furnace exhaust ***to the combustion air.*** These are usually somewhat less efficient than other devices but are ***built to withstand the high temperatures*** exhausted from fired equipment. Application of such devices must consider the existing combustion control system for regulating fuel-to-air ratio since preheating combustion air will substantially change its density. Air metering must be done prior to the preheat or compensated for the density change. Obviously, a large rise in the combustion air temperature will also require specially designed burners.

Look into heating combustion air or plant makeup air through the use of recovered heat.
- Air-to-air device
- Economizer
- Heat Exchanger

Economizers and air preheaters are ***heat recovery devices*** applied specifically to boilers and have been ***mentioned previously.***

These may be air-to-air, liquid-to-liquid, air-to-liquid or liquid-to-air.

Shell and tube or plate type exchangers for liquid-to-liquid heat transfer are well worth mentioning ***for heat recovery.*** Many plants ***discharge waste liquid streams*** at temperatures of 90°F and above. If incoming water or other liquids must be heated from lower temperatures, the economics of heat recovery may be favourable.

Industrial heat pumps are not yet widely used but if the present trend in the costs for fossil fuels versus electric power continues, such equipment may become viable. The possibility of recovering heat from a waste stream at lower temperature for application at a higher temperature will find wide application.

Heat pumps offer new and exciting possibilities.

When recovering process heat by exchanging it with other internal process streams, be sure that any localized failure in one heat transfer system will not cause a total process or plant shutdown. Some backup redundancy may be required.

Summary

Heat recovery from waste streams of hot exhausts or liquid effluents offer great opportunity to save money.

Responsibility for action:

- ☐ Plant Engineer
- ☐ Chief Engineer
- ☐ Maintenance Chief

Progress report and dates

Examination & Evaluation	Planning Stage	In Progress	Completed

Suggested steps

Things to check

Persons to contact

Suppliers/contractors

Record of action to date and notes to remember

Date	Description or note

Instrumentation and controls

Activity and Action

Instrumentation is included in this brief summary not because it conserves energy by itself, but because ***of the importance of instruments in monitoring energy use.*** Plant instrumentation can be divided into ***two categories; permanently installed*** for continuous process monitoring ***and test instrumentation*** used ***for periodic checks*** and audits. Only a select few of each type are briefly discussed here.

Consider the use of instruments to measure and/or monitor and control. You can't manage what you can't measure!

It is ***important*** that all instrumentation be ***calibrated*** and maintained on a regular basis to provide reliable data. Boiler systems, for example, are usually equipped with steam flow measuring and integrating equipment, however, the common orifice type is subject to substantial error if not corrected ***for operating pressures*** different from the pressures at calibration time. Combustion processes using liquid fuels will require some type of reasonably ***accurate measurement of fuel consumed.*** In-line flow meters can be used or level gauges can be installed on the storage tanks. ***For ongoing energy measurement,*** many plants find that such instrumentation must be added to existing systems.

Make sure that instruments are properly calibrated. They should be checked periodically whether they are measuring, recording and/or controlling.

When a plant contains combustion processes consuming significant fuel, investment in a portable ***oxygen and combustibles analyzer*** may be justified. Traditional Orsat chemical analyzers are somewhat cumbersome as portable units. Reliable, compact ***instruments are now available at reasonable cost.***

Incorrect readings mean incorrect adjustments, incorrect settings and inaccurate control; result, wasted energy and lost money.

Control of energy-consuming equipment should receive high priority for energy conservation opportunities. With today's and future fuel costs, upgrading combustion control systems to provide better fuel-to-air ratio control over the burner firing range is worth considering. Fully metered systems and oxygen trim systems are gaining acceptance. Automatic control of blowdown can be a wise investment.

Instruments offer the opportunity for fine control not possible in manual adjustments, and hence for significant potential energy cost saving when proper calibration is maintained.

Automated process control of energy intensive operations by the use of on-line computer control systems can yield fast pay-backs on the investments in instrumentation.

Consider process control of energy-intensive operation.

In heating and air conditioning systems, the function of ***controllers*** is to ***govern or control*** the mechanical system ***operation so that energy output matches the building requirement.*** If controls are out of calibration, energy is wasted. Lower or higher settings for thermostats should be considered along with setback and deadband thermostats to prevent simultaneous heating and cooling. Improperly calibrated or leaking valves and dampers can represent significant opportunities for savings.

Summary

Choice and effective utilization of instruments to measure, record and control energy producing systems and/or energy-using processes provide opportunity for significant energy and dollar saving.

Responsibility for action:

- ☐ Chief Engineer/Maintenance Foreman
- ☐ Mill Services or Plant Engineer
- ☐ Production Manager
- ☐ Instrument Specialist/Technician
- ☐ Other

Progress report and dates

Examination & Evaluation	Planning Stage	In Progress	Completed

Suggested steps

Things to check

Persons to contact

Suppliers/contractors

Record of action to date and notes to remember

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Compressors and drives

Activity and Action

Air compressors are widely used in industrial plants and are ***significant energy users*** at 20 to 25 HP per 100 cfm. There are two general types ***in common use; reciprocating and rotary.***

Significant energy is used up in providing your compressed air needs.

Firstly, pressure requirements in the system should be analyzed and compressor ***controls set to provide*** the ***lowest pressure*** possible ***to meet requirements.*** In this connection, the sizes of the existing pipe system should be examined to assure that excessive pressure drops have not developed over the years with additional system add-ons. ***Multiple compressor*** plants should include arrangements to ***base load*** as ***many units*** as possible leaving ***one unit to load-unload or modulate*** to meet changing requirements. As volume demand lowers, units should be shut down after an established unload time and not be allowed to run on unloaded. Multiple compressor control packages are available to accomplish this automatically and can also be programmed to consider the relative efficiencies of various compressor units.

Check your ***real needs,*** then set control to lowest pressure required. Where multiple compressors are required, cover the consistent base load using a group and leave one unit to cover peak loads.

Check the location of compressor intake ports. Is the lowest available air temperature being taken in? Are compressor intakes causing negative pressures in the building?

When analyzing the compressed air system, ***consider*** satisfying a relatively ***small high pressure requirement with a local compressor*** if this will allow the total system pressure to be lowered significantly. Another modification which may increase energy savings and, at the same time, improve system performance, is a separate instrument air system, free of oil and moisture. Usually the separate system can be operated at a lower pressure and it may allow the main system to be shut down when only instrument air is required.

Can small local requirement be supplied using a local compressor?

Consider a separate instrument air system with clean dry air to save money and protect instruments.

Rotary screw compressors are ***usually*** not as efficient as reciprocating compressors at part load. Whenever possible, rotary screw units should be fully loaded or shut down and ***reciprocating units used to handle the peaks.***

Almost everyone has been exposed many times to the ***high cost of compressed air leaks,*** but we would be remiss not to mention it again in this discussion.

Air leaks cost money.

Summary

Producing and distributing compressed air requires significant energy. To make most effective use of this energy expense consider the suggestions offered here.

Responsibility for action:

- ☐ Chief Engineer or Mill Services Manager
- ☐ Maintenance Chief
- ☐ Project or Planning Committee
- ☐ Other

Progress report and dates

Examination & Evaluation	Planning Stage	In Progress	Completed

Suggested steps

Things to check

Persons to contact

Suppliers/contractors

Record of action to date and notes to remember

Date	Description or note

Industrial water systems

Activity and Action

Water is an almost universal raw material and is the most common vehicle for energy transport in any process plant.

Energy cost saving opportunities in many industries become apparent in the study of water/steam usage.

The ***water/steam balance for the plant*** is the logical ***place to start*** in an audit of cost-saving opportunities. After tabulating the water ***sources and uses*** and developing an ***overall diagram,*** the relative cost of treatment, pumping, and heating should be examined.

Start with a study. Check source and use. Do a "balance".

Condensate recovery probably represents the greatest dollar savings because it represents high heat levels and high cost of treatment for required makeup. ***Cooling water and wastewater re-use*** should be considered together, since they involve an examination of alternatives to current practices of disposal.

If you can't recover the condensate then at least reclaim the heat from it.

Many plants use purchased ***water for cooling purposes*** and, in some locations, pay again for the disposal of this water in a sewer system. In such situations, ***cooling towers*** very ***often*** will be more ***economical*** than a once-through cooling system. They consist of a spray pond, natural draft towers and mechanical draft towers. The latter represent the most common and have become highly sophisticated. The "approach" to the available wet bulb temperature is the major factor in determining tower size and cost; the closer the approach, the larger and more costly the tower. In most cases, the approach temperature is defined by the process equipment requiring cooling water and the design wet bulb temperature. To evaluate the economics of a cooling tower installation, one must take into account the operating cost in electric power for fans and pumps, water treatment, water loss through evaporation and blowdown as well as maintenance.

Can the costs of once-through cooling water systems be improved by installation of cooling towers?

In all cases, it is more effective to recover waste process heat directly from the process stream. It yields higher level heat sources and reduces cooling water loads.

Can waste heat be used prior to or rather than being water cooled?

Summary

Water and steam are often the center or heart of the heat and energy requirements in many industries. Substantial energy savings are possible and become evident in the study of a plant's water/steam balance.

Responsibility for action:

- ☐ Mill Services Manager
- ☐ Chief Engineer
- ☐ Maintenance Chief
- ☐ Plumber Foreman
- ☐ Chief Engineer
- ☐ Other

Progress report and dates

Examination & Evaluation	Planning Stage	In Progress	Completed

Suggested steps

Things to check

Persons to contact

Suppliers/contractors

Record of action to date and notes to remember

Date	Description or note

Refrigeration

Activity and Action

Refrigeration is an energy "lifting" operation: in essence, low level energy is lifted by the refrigeration system to a level sufficient for discharge to the environment. There are ***two basic*** types of refrigeration systems. ***Vapour compression*** is the one most commonly thought of when the word refrigeration is mentioned; however, from an energy conservation standpoint the ***absorption system*** is quite often of substantial interest because of its ability to use low-pressure steam as the energy source. In certain cases, an ***evaporative system*** utilizing a steam jet as the vacuum-producing device presents significant advantages.

Check your refrigeration system to determine that it is the most suitable for the operating conditions and for the temperature range involved.

The ***key concept*** in refrigeration design is to ***select the proper system for the temperature range involved.*** Generally, the evaporative or steam-vacuum system is useful only at relatively high temperatures, and the mechanical system must be used if low temperatures are required.

Have temperature requirements been overstated in the design of the system in place?

When reviewing a refrigeration system for energy conservation opportunities, the current ***operating condition*** of the system is the first place to look. The condition of heat transfer surfaces should be of first concern: are ***operating temperatures*** being ***monitored,*** and do the ***surfaces*** require ***cleaning*** to return the system to its design operation conditions? ***Mechanical problems*** such as ***bypassing, valve operation,*** and ***excessive friction*** because of bearing condition are all potential sources of loss which should be examined, particularly on annual overhaul schedules.

To maintain efficiency:
- monitor temperatures
- clean surfaces
- check for bypassing, proper valve operation and unwarranted friction loss.

An additional area for consideration is whether there are any sources of ***waste heat*** or ***waste cooling*** liquid that could be used to furnish energy to the system or, in some rare instances, to replace it. As an example, in at least one instance it was found that well water was being used for condenser water. The well water could be used directly for process cooling, completely eliminating the refrigeration system involved.

Recover heat on the backside of the refrigeration cycle and use it where needed elsewhere.

The input energy required for a ton of refrigeration increases as the temperature difference between the evaporator and condenser increases. The suction pressure and temperature should therefore be set as high as possible to provide ***the cold temperature necessary—and nothing lower.*** Likewise, reducing the condensing temperature will lower the heat pressure and reduce the horsepower per ton.

Responsibility for action:
- ☐ Chief Engineer
- ☐ Plant Engineer
- ☐ Maintenance Boss
- ☐ Pipefitter Foreman

Progress report and dates

Examination & Evaluation	Planning Stage	In Progress	Completed

Suggested steps

Things to check

Persons to contact

Suppliers/contractors

Record of action to date and notes to remember

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Direct and indirect fired production equipment

Activity and Action

Most plants contain some type of fired equipment in which heat to the process is supplied directly from the burning fuel rather than from intermediate heat transfer media such as water, steam, thermal fluid or other transfer fluids. In these units, the ***combustion heat*** is ***applied to the material in process either directly or indirectly*** by a surface which transfers the heat by conduction or radiation from the flame to the process material.

• Indirect fired heaters

Operation at maximum efficiency is the first area to examine for energy conservation. The amount of excess air being used, stack gas temperature, and radiation and conduction losses should all be examined. Once the system has been tuned and maximum operating efficiencies achieved, modifications to reduce energy losses should be considered. These should include heat recovery from stack gases and preheating of combustion air through a heat exchanger (recuperator or heat regenerator).

Refer back to Section on Combustion and Fuels for details.

Summary

Fine tuning and control of combustion system—also reduction of losses from all sources.

Responsibility for action:
- ☐ Production Manager
- ☐ Maintenance Foreman
- ☐ Machine Operator
- ☐ Other

• Direct fired heaters

The design of these heaters varies tremendously from one application to another. The system is normally limited by process or product requirements which involve temperature limitations, quality impact and prevention of ***losses from oxidation or scaling of the product.*** These limitations generally result in extremely low efficiencies in comparison with indirect fired heaters or steam generating units.

Eliminate oxidation and scaling wherever possible.

In addition to the usual sources of heat loss, there are specialized losses associated with this type of furnace; ***losses*** at product conveying devices during movement of product into or out of the furnace, and ***from by-pass or leakage air*** resulting from the required ***access doors or ports.***

Reduce leakage and by-pass.

There are greater opportunities for heat conservation in direct fired furnaces than in indirect because of generally ***higher stack temperatures*** which provide more productive opportunities to preheat either the stock being handled or the combustion air. Either ***recuperative or regenerative pre-heaters*** can be used and there is also the opportunity, as with all combustion units, to use ***waste heat boilers.***

Recover and reuse stack exhaust heat.

Summary

Fine tuning and combustion control as well as leakage by-pass and heat recovery. Prevention or reduction of oxidation and scaling.

Responsibility for action:
- ☐ Production Manager
- ☐ Chief Fireman
- ☐ Maintenance Chief/Foreman
- ☐ Machine Operator
- ☐ Other

Progress report and dates

Examination & Evaluation	Planning Stage	In Progress	Completed

Suggested steps

Things to check

Persons to contact

Suppliers/contractors

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Programmable controllers

Activity and Action

In the previous section we dealt with "Instrumentation and Controls". The logical next step would surely seem to be to make those ***instruments and controls*** do even more of what you tell them to do in order to optimize energy savings. They ***are,*** after all, ***the modern servants of industry.*** Instruments measure conditions while controls monitor this measure and operate to maintain established conditions within certain preset limits. Wouldn't it be nice if you could ***give these "servants"*** a whole series of ***simple instructions which they*** would ***follow exactly? Programmable Logics Controllers allow you to do precisely that.*** They are usually called P.C.'s for short.

Programmable Controllers are among the newest tools and servants of industry. Not to use them where practical and economical would be to miss a good opportunity.

Use P.C.'s to optimize savings of energy as well as for achieving other industrial process savings.

A P.C. ***(Programmable Controller) is a device which possesses a programmable memory*** for the internal storage of instructions, which it uses for implementing specific functions, ***for controlling various types of machines, processes or systems.*** It is a ***relatively simple*** and yet ***inexpensive*** (not cheap) electronic apparatus consisting of ***three components; an Input System, a Memory and Central Unit for Processing*** (incoming data with memory instructions), ***and an Output System*** (which carries out your programmed logic instructions).

A rather sophisticated, one cost, device that will carry out your precise instructions, repeatedly, accurately, as required, and without being reminded.

For discussion purposes let us ***consider,*** briefly ***a smaller*** energy conservation application such as the P.C. control of an ***air supply system.*** It could include the ***control of such things as temperature*** (heating, cooling or temperating), ***volume*** delivery to ***various locations, humidity, filtering*** washing/cleaning, ***shut-off*** of air flow to areas or sections not in operation, ***exhaust*** volume, etc. It would probably employ a ***less expensive*** P.C. while a low cost portable programmer would be used for program input and trouble-shooting purposes.

When studying "cost justification" compare initial outlay versus assured accuracy of control, energy savings, improved quality and incremental labour reduction or avoidance.

A ***larger*** or more complicated process, system or machine may require a more sophisticated P.C. and ancillary data entry equipment with greater trouble-shooting capabilities. Such equipment ***would obviously cost more*** than for a smaller, less complicated P.C.

A more sophisticated P.C. may be required for a more complicated process or system. Cost/Benefit ratios remain good to excellent.

For smaller companies with little, or no expertise in programming, the use of ***"Ladder Logic"*** for programming and trouble-shooting of P.C.'s is of great value. It ***is simple,*** it ***uses symbols,*** it is ***easily understood and taught*** to most industrial electricians, technicians and instrument men. Production supervisors as well as operations staff and industrial engineers etc. should be able to learn with little difficulty.

Among the vendors of P.C.'s there are many excellent training schools. Most training can be completed in one week at such schools. You should make enquiries now.

The example above of a limited "air supply system" using a P.C. to control functions and save energy will have led some to question or comment— "What's so new about that?" or "We already do that using relays etc!" or "Why should I consider using a P.C. in place of more common hardware?" Below is a listing of some of the ***prime reasons for considering the use of a P.C.*** over relays or other methods.

There are many good reasons for introducing P.C.'s into your plant and operations. They are a powerful new tool which can provide significant advances and advantages.

OPTIMIZE your energy savings and upgrade your operating methods.

Why use a P.C?

- More cost effective than relay panels (generally).
- Energy savings optimized, using flexible program for fast future changes when needed, at reasonable capital cost, and minimum labour and operating cost.
- Little or no previous experience or expertise in programming required. Ladder Logic easily understood and taught.

The federal Government has a Microelectronics Support Program which provides financial assistance to manufacturers who have not used such systems previously as a means of encouraging them to explore their applicability to particular operations.

- P.C. is cheaper than equivalent mini-computer.
- Ruggedly built to withstand industrial environment.
- Program instructions can be quickly, easily, frequently modified or changed, as required, with no delay and little cost.
- Costs and lengthy time and delays on wiring of relay panels, eliminated.
- It is more reliable—no mechanical parts to wear out.
- Downtime reduced—trouble-shooting is faster/easier. Whole module can be replaced in minutes, if necessary.
- Small and compact compared to relay panel—space saving.
- Quality improved generally—whether product, process or system.

Under the program, up to $10,000 will be made available for a feasibility study by a recognized consultant and should the manufacturer proceed further, grants equivalent to 75% of the costs of such assistance up to $100,000 is available. Longer grants may be negotiated.

If you wish to participate, contact a recognized consultant to take a look at your operation and if he thinks you are eligible for the program, he will provide a proposal outlining the feasibility study he believes should be undertaken. You should then obtain an MSP application form from your nearest Industry, Trade and Commerce Business Information Centre, complete it and forward it along with the consultant's proposal to:

Microelectronics and
Instrumentation Division
Electrical and Electronics
Branch (45)
Department of Industry,
Trade and Commerce
235 Queen Street
Ottawa, Ontario K1A 0H5
Telephone: 613-593-4481

Summary

P.C.'s are ***a modern way to significantly increase your energy savings*** (as well as for use on other plant operations to optimize output and quality while avoiding increased labour costs).

Responsibility for action:

- ☐ Plant Manager
- ☐ Production Supervisor
- ☐ Plant Engineer
- ☐ Head Electrician
- ☐ Instrument man

Progress report and dates

Examination & Evaluation	Planning Stage	In Progress	Completed

Suggested steps

Things to check

Persons to contact

Suppliers/contractors

Record of action to date and notes to remember

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Architectural considerations

Activity and Action

Any approach to ***energy management*** would be incomplete without a discussion of the ***architectural considerations*** involved in the building itself. ***Careful selection*** of building ***site, design,*** and use of ***materials*** for building ***walls, roof, and windows*** can have a major effect in reducing the loads on the heating, air conditioning and lighting systems. Today's dependence on air conditioning represents a major change from the days of porches, wide eaves, solid construction, shade trees and landscaping, which all contributed to personal comfort without the use of air conditioning systems and with only rudimentary heating systems.

In most cases may be applied both to design of new buildings as well as to retrofit of existing structures. However, the most important moment is during design and specification. Include energy intensity requirements (kw/sq ft) in the architectural specifications.

Building components should be life cycle costed to assure that initial investments are balanced against long-term operating costs.

Trees act as natural sun shades. Along with grass and greenery, they increase energy absorption from the sun and evaporation of water from the leaf structure, thus producing a ***cooling effect.*** Additionally, the orientation of trees and grounds can be arranged to provide ***protection from wind.***

Trees as well as wind or sun control may be considered at any time.

Building siting is the next major opportunity; the careful selection of window size, window exposure, and absorbing or reflecting glass represents a major opportunity to reduce the absorption of solar energy during the summer air conditioning period, while at the same time permitting the low angle sun rays in winter to enter and thus reduce heating load.

Another feature which permits considerable ***latitude in rejection of solar energy through reflection (for warm climates) or absorption of energy (for colder climates) is the selection of colour and texture for wall and roof surfaces. Specially designed facade, screens, walls, and roof exposure all are features that the architect uses to maximize energy rejection or energy absorption*** to achieve the best overall balance for each climate and location.

Reflective glass with metallic coatings is ***a recent*** major ***contributor.*** In several instances the use of this material not only created a net savings in initial cost but a reduction in total annual operating costs because of reduced requirements for the air conditioning system.

Technology is moving rapidly. Make sure latest building innovations are considered.

Summary

The management of energy is important from the moment of inception and should be reflected in the architecture of the structure, site selection and landscaping as well as selection of energy-conserving construction materials.

Responsibility for action:

- ☐ Company President
- ☐ Engineering Services Manager
- ☐ Architect/Engineer
- ☐ Buildings Superintendent
- ☐ Other

Progress report and dates

Examination & Evaluation	Planning Stage	In Progress	Completed

Suggested steps

Things to check

Persons to contact

Suppliers/contractors

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General Notes...