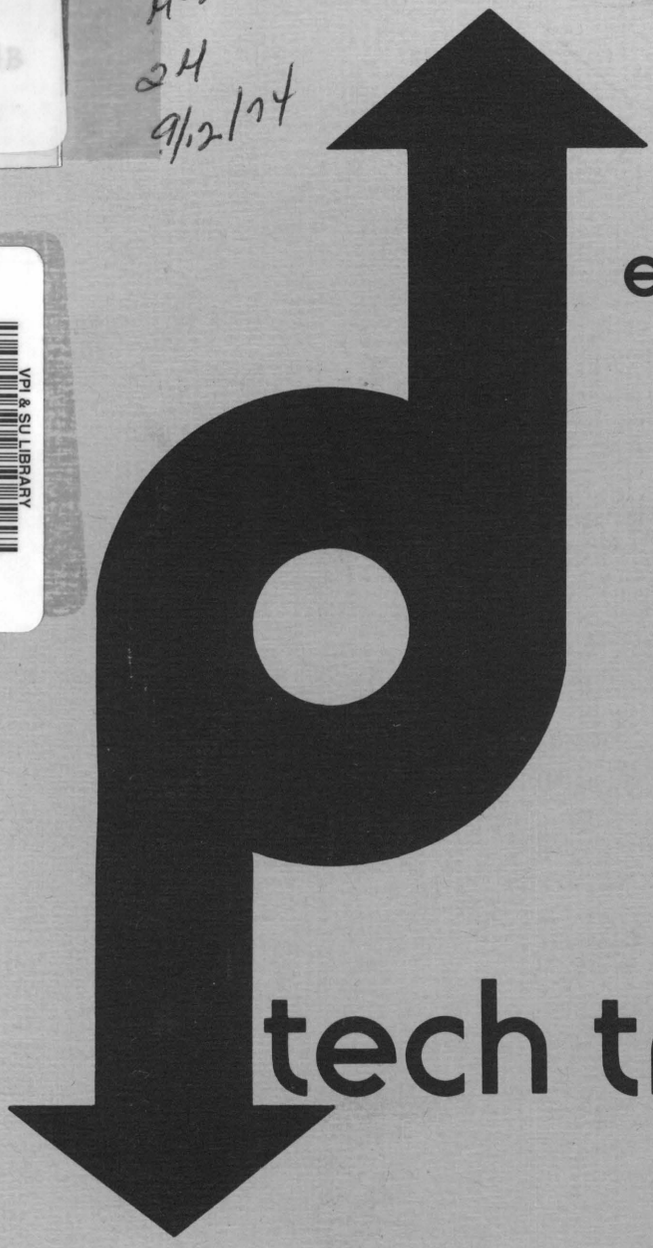

guidelines for energy conservation for immediate implementation;

small business and light industries

tech tran report

virginia state technical services
extension division
virginia polytechnic institute and state university
blacksburg, virginia 24061

The Virginia State Technical Services Program is a multi-university effort with participants being Old Dominion University and Virginia Polytechnic Institute and State University. The Program is supported by state and institutional funds and is administered through the Extension Division of Virginia Polytechnic Institute and State University.

The purpose of the Program is to stimulate the economic growth of the State by encouraging technological innovation through the transfer of technology to Virginia enterprise.

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INTRODUCTION

This report is reprinted with the permission of the office of the Chief Engineer of the Federal Power Commission from their staff report FPC/OCE/1, which was prepared jointly with the United States Department of Commerce Staff of the office of Energy Programs, and with the technical assistance of the staff of the Institute for Applied Technology, of the National Bureau of Standards.

The purpose is to provide guidelines to Virginia business and industry in their efforts to conserve fuel. Most of the suggestions listed herein can be performed with the resources existing within the company. Some will require the expertise of a Consulting Mechanical Engineer. State Technical Services has compiled a geographical list from the Directory of Engineering Services in Virginia of those engineers who have an expertise in heating, and will supply this information to companies wishing this type of help. This information is available from the Administrative STS office in Blacksburg or from any of the district STS offices.

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SHORT-TERM MEASURES FOR ENERGY CONSERVATION IN INDUSTRY AND BUSINESS:

Reports of fuel conservation efforts already conducted in industry, particularly in small business and light industry, indicate that certain short-term measures can lower fuel requirements, without adverse effect on business operations. The key to these is to improve the efficiency of fuel utilization.

Through the efforts of plant managers, businessmen and consulting engineers in various parts of the country, a substantial body of experience in improving fuel utilization already has been gained. The following summarizes this experience, and suggests ways through which opportunities for fuel conservation can be identified and acted upon.

A Possible Course of Action:

The short-term projects already conducted in industry suggest a course of action for energy conservation along the following four lines:

1) Control of Plant Space Heating (30-50 percent of industrial fuel consumption),
2) Maintenance and Adjustment of Combustion Equipment (can save 5-12 percent),
3) Adoption of Effective Controls, and
4) Modification and Upgrading of Existing Equipment

Some detailed descriptions of energy savings in these areas are given in Appendix II.

APPENDIX I

Some Examples of Fuel Conservation:

Building Heat: Present data indicate that 30 to 50 percent of the fuel used by industry is used for plant heating. This is true even in thermal processing such as rubber and plastics manufacturing, heat treating and for automobile repair garages and welding shops. The reason for the high level of fuel consumption is that the plant operations themselves often generate dust, volatile chemicals and fumes which must be removed from the working space. Very high rates of ventilation are required to maintain health and safety standards. In a typical plant, cold outdoor ventilating air is drawn in, heated and then exhausted to the outside, carrying with it the energy of the heating fuel.

One basic technique, which has been very successful, is to seal the building and then make use of a mechanical ventilation system, so that all the air entering and leaving the plant space can be controlled. Further, savings can be made by using thermal energy from the warm outgoing air to heat the incoming cooler air by using a heat exchanger. Plant space heating savings of 30 percent or more, with some savings as high as 80 percent, have been attained by this method.

In addition, interior circulating fans, local infrared heating, electronic air cleaners, and other immediately implementable measures, can be used to conserve plant heating fuel. In buildings having excessive glass area, covering the unneeded windows with insulating material has been shown to yield space heating savings of 10 percent, and more.

Longer range measures for supplying plant space heating might be considered now. For example, the use of heat recuperators to extract heat from low temperature (500°F to 900°F) flue gas, and the use of this energy for plant heating, offers a significant opportunity for future reduction of plant heating fuel.

Combustion Equipment Adjustment:

Some of America's leading combustion experts have estimated that in any combustion plant not presently equipped with continuous flue gas analysis, proper manual adjustment of combustion equipment checked at frequent intervals, could yield fuel savings of 5 to 10 percent. Checks of equipment in the field confirm this estimate. In fact, in isolated instances, fuel savings as high as 30 percent have been attained, simply through exacting and frequent readjustment of combustion equipment. The costs involved in eliminating excess fuel consumption in these ways are minimal. According to combustion experts, the basic problem with adjustment of combustion equipment is that few people are fully trained and equipped to do the job. It is

not possible to adjust a combustion unit properly without a measurement of the flue gas composition. Combustion equipment should be readjusted on a 2 to 4 week schedule and should be checked throughout the range of firing. Equipment should be readjusted immediately if a significant change of weather occurs (e.g., a "cold snap"). The original manufacturer of your burner equipment can probably be of help in burner adjustment procedures.

Effective Process Control:

In metal processing operations (e.g., heat treating plants, steel reheat operations, annealing furnaces) the application of scheduling controls, automatic combustion controls (to maintain the proper air-fuel ratio) and other similar measures have been shown to yield significant reductions in fuel requirements. In one steel reheating plant the application of on-line computer controls on stock scheduling yielded a 25 percent reduction in fuel consumption. An additional benefit gained in this instance was an increase in production of somewhat more than 12 percent. The control system enabled the plant manager to eliminate several bottlenecks in this process, which had not yielded to manual control procedures.

A somewhat simpler form of control which can be applied very quickly to save fuel in business operations is the automatic night setback thermostat. By setting the thermostat in a small building (or a residence) back from 68°F during the day to 60°F during the night (say 11: 30 p.m. to 6: 30 a.m.)

approximately 9 percent of the space heating fuel can be conserved. Of course, this practice can be conducted manually, but inexpensive automatic thermostats are available so that one need not rely upon memory to use this effective fuel conservation measure.

A number of industrial combustion plants have controls which vary the fuel flow rate to control heating rates, while the air flow rate is kept constant. Controls to maintain the proper air-fuel ratio may be available from the manufacturer of the burner equipment. These controls have been shown to yield fuel savings of 20 percent and more in some combustion plants.

In general, the application of effective thermal controls to equipment presently lacking such controls can yield significant savings in both fuel and costs.

Modification of Equipment:

Some modification of equipment can be installed easily and yield immediate savings in fuel and longer run savings in costs. For example, additional insulation for industrial furnaces has been shown to save large quantities of fuel and to pay for itself within as little as six months. Heat recuperators for combustion air preheating are available for certain types of heat treating furnaces. These devices can save from 10 percent to 30 percent of the fuel

required in various types of furnaces. Flue gas heat recuperators of various sorts are also available for other applications. Approximately 45-50 percent of the heating content of the fuel consumed in industrial furnaces is lost in the flue gas exhaust. Much of this heat can be recovered for use in plant processes, and for plant space heating through the use of recuperation equipment. The payout period for this type of equipment, as indicated by industrial projects already conducted in the field, has been attractive to businessmen. Indeed, in some cases, the normal payout period of the equipment itself, as attractive as it was, was secondary to the fact that through use of the equipment, businessmen continued operations as planned despite a fuel supply problem. In other cases, the use of more efficient fuel utilization permitted expansion with the same fuel supply.

The use of special heat transfer fluids to replace water in process steam installations improves heat transfer and thus reduces fuel consumption. Special heat transfer media are available from chemical manufacturers. In some process steam plants, certain of these fluids have been used in conjunction with some other straightforward measures such as plugging steam leaks and exact metering to reduce heating fuel consumption by as much as 50 percent.

The examples of measures and devices cited above were drawn from field projects and can be adopted rapidly. The above is, in any event, only a partial list of quickly implementable fuel conservation measures. The use of any of these, or other fuel conservation measures, depends upon the specific circumstances in a given plant.

APPENDIX II

Suggested Guidelines for an Energy Conservation Survey:

The following pages offer guidelines for surveying energy conservation opportunities in a given plant. These pages were prepared with the help of consulting engineers who have gained wide experience assisting businessmen and plant operators to improve fuel utilization. These guidelines are a checklist of places to look for energy conservation opportunities and suggest possible corrective measures to be applied. Of course, any changes should be made in compliance with all applicable codes and safety requirements.

The Survey is divided into two major sections: Plant Building and Processes and Equipment.

GUIDELINES FOR ENERGY CONSERVATION SURVEY

Plant Building

Item	Why Important	How to Conserve	How Long to Implement	Who Can Help	Energy Savings	Remarks
1. Plant Air - Outside Air/Exhaust Air	Generally, all the outside air that enters the plant must be heated to interior conditions. Exhaust air represents a loss of heated air.	• Reduce the quantity of outside air required and the quantity of exhaust air required to the minimum amount required for each process and consistent with codes and regulations. • Recover heat from exhaust air to heat incoming air.	2-4 weeks	• Plant manager. • Plant employees. • Consulting mechanical engineer. • Manufacturer's representative. • Utility representative.	Approximate heat required for outside air is: BTU/yr. = 1.10 x CFM x hrs. of operation per day x degree days per year.	When electric motor is used for fan drive the approximate energy used in KWH is equal to 3750 x CFM static pressure in inches of water x hours of operation.
2. Ventilation	Ventilation air may be required for dilution and makeup.	• Requirements for ventilation may have changed. Evaluate present requirements. • Measure present ventilation. Use minimum possible, but not below requirements of code.	2-4 weeks	• Consulting mechanical engineer.	See Item 1.	

Plant Building

Item	Why Important	How to Conserve	How Long to Implement	Who Can Help	Energy Savings	Remarks
3. Openings in Structure (e.g., loading docks)	Excessive infiltration of cold outside air requires extra energy to provide comfort.	•Close off all unnecessary openings--unused exhaust fans, broken windows, structural openings. •Enclose the trucks or railroad cars at the loading platforms.	1-2 weeks 2-5 weeks	•Plant maintenance. •Outside contractor. •Plant employees.	See item 1.	•Improves working environment with the possibility of reducing air temperature required for comfort.
4. Wall and Roof Insulation	Most uninsulated walls and roof structures may allow 2 to 3 times the heat loss of an insulated structure.	•Insulate roof and walls which reduces heat loss through the building structure.	Varies with building.	•Plant maintenance. •Outside contractor.	Heat loss can be reduced by as much as 2/3 or more.	•Increases the inside surface temperature of the walls and roof. •Improves the comfort level for the same air temperature.
5. Fenestration (Windows/ Doors)	Heat loss by transmission/ infiltration.	•Add storm windows or change to insulating glass. Add weather stripping or seal windows. •As a temporary measure to conserve energy, the windows or unused doors may be closed off with plywood and insulation. •Add door closers.	1-3 weeks	•Plant maintenance. •Outside contractor.	Heat loss can be reduced by 1/3 or more.	•Insulating glass and storm windows increases the surface temperature of the glass, which improves comfort without raising the air temperature.
	Doors and windows on opposite walls permit excessive infiltration by direct flow of air through building.	•Lock, seal or change doors or windows on one wall. •Use door closers.	3-6 weeks	•Plant maintenance. •Outside contractor.		

Plant Building

Item	Why Important	How to Conserve	How Long to Implement	Who Can Help	Energy Savings	Remarks
6. Space Heating System	• The space heating system uses energy to provide a comfortable working environment. • It offsets heat losses through the building and heats cold air entering the building.	• Supply only as much heat as is necessary for comfort--don't overheat. • Reduce losses from heating system.		• Heating, ventilating and air conditioning consulting engineer.		Have specialist check control system for optimum operation.
7. Central System Boilers	• Combustion of fuels to generate steam or hot water.	• Perform periodic combustion analyses and adjust burners. • Consider heat recovery from flue gases. • Clean, blow down to maintain operating efficiency. • Check feedwater chemical control to minimize waterside buildup.		• Plant engineer. • Combustion specialist. • Consulting engineer. • Original equipment manufacturer.	• Improper adjustment of combustion may be wasting 10% or more of the fuel. • Heat recovery from the stack gases may save 10% of the boiler fuel input even at lower stack temperatures.	Many boilers operate at low efficiency due to lack of proper maintenance.
8. Steam/Hot Water	• Central boiler system produces steam or hot water.	• Insulate lines. • Repair leaks. • Check operation of traps. • Use of insulated storage tanks to receive heated water during off-peak hours can produce operating efficiencies.		• Plant maintenance.		

Plant Building

Item	Why Important	How to Conserve	How Long to Implement	Who Can Help	Energy Savings	Remarks
9. Unit Heaters Direct Fired	Combustion of fuels for heating air.	•Readjust burners for maximum efficiency. •Clean heat exchanger surfaces. •Cycle fan operation.	Immediately	•Combustion specialist. •Plant engineer.	Improper combustion may be wasting 10% or more of the fuel.	
10. Infrared Radiant -Direct Fired or Electric		•For applications with low temperatures of the surrounding walls and roof, it may be better to provide direct radiant heating rather than heating the air. •Periodic cleaning and maintenance.		•HVAC consulting engineer. •Plant engineer. •Manufacturer's representative.	Many applications of infrared space heating show savings of greater than 20% over unit heater systems.	Good for spot heating
11. Space Air Conditioning and Heating Systems	The energy required by the heating, ventilating and air conditioning system is used for fan motors, refrigeration systems and heating systems.	•A complete analysis is required to minimize the energy required. •Control settings should not be changed without considering the effect on the whole system. •Clean filters on a regular basis. •Lock out refrigeration system by a return air thermostat.		•HVAC consulting engineer.		Some combination heating and air conditioning systems will use more energy if the thermostat is set at a high temperature for summer operation (reverse for winter) unless other changes are made.

GUIDELINES FOR ENERGY CONSERVATION SURVEY

Plant Building

Item	Why Important	How to Conserve	How Long to Implement	Who Can Help	Energy Savings	Remarks
12. Controls--Systems and Settings	• Controls determine the actual operating characteristics of the system.	• Original system design and operation may have been based on different parameters and energy costs. A new look may "tune up" system for lower energy costs.		• Control specialist. • Consulting engineer. • Plant maintenance.		Many systems are out of adjustment and are not operating as designed or with optimum use of energy.
13. Domestic Hot Water	• Heat is required to raise the temperature of the water from the entering temperature, usually 40 to 70°F, to the desired temperature. • Heat required is approximately BTU/HR. = 500 x GPM x TEMP. RISE.	• Repair leaks at hot water taps. • Check to see that hot water taps are shut off when not in use. • Repair leaks in hot water lines. • Reduce hot water thermostat setting to the lowest temperature which is acceptable. • Separate system from space heating or other hot water system. • Clean heaters regularly, following the manufacturers recommendations. Should be flushed and cleaned periodically.		• Plant maintenance. • Plant employees.		

Plant Building

Item	Why Important	How to Conserve	How Long to Implement	Who Can Help	Energy Savings	Remarks
14. Lighting		• Turn off lights when not in use. • Install lighting only to that required for task. • Consider replacing lighting with more efficient lamps--incandescent to fluorescent to gaseous discharge lamp.		• Illuminating engineer. • Electric utility representative. • Plant engineer. • Plant employees.		Approximate light effect per unit electric power (lumen per watt) Incandescent 21 Mercury Vapor 50 Flourescent 70 Multi-vapor 76 H.P. Sodium 100

GUIDELINES FOR ENERGY CONSERVATION SURVEY

Processes and Equipment

Item	Why Important	How to Conserve	How Long to Implement	Who Can Help	Energy Savings	Remarks
1. Industrial Furnaces	•Heat loss through furnace structure increases energy consumption.	•Repair furnace linings. •Inspect insulation for periodic maintenance and/or update. •Check furnace doors and other openings for tighter closure. •Reduce the holding temperature during idle time. •Schedule work to reduce heat up and cool down periods. •Periodically check on the furnace pressure control.	Immediate inspection.	•Plant maintenance. •Furnace manufacturer. •Plant employees.		
2. Burners	•Either incomplete combustion or too great an amount of excess air wastes significant amounts of fuel.	•Perform periodic combustion analysis and adjust burners. •Maintain, repair or replace inefficient burners.	Usually less than 1/2 day for combustion check per furnace.	•Plant maintenance. •Combustion specialist. •Burner manufacturer. •Fuel utility representative.		

Processes and Equipment

Item	Why Important	How to Conserve	How Long to Implement	Who Can Help	Energy Savings	Remarks
3. Combustion Gases - Heat Recovery	•Products of combustion which leave at temperatures higher than supply air represent a loss of energy.	•Use exhaust gases to preheat combustion air by use of a recuperator heat exchanger. •Use exhaust gases to generate steam, hot water, secondary fluids or air for other uses.		•Consulting engineer. •Recuperator manufacturer representative. •Utility representative.	•20 % to 40% of fuel consumption can be saved depending upon furnace temperature. •Radiation recuperators for furnace temps greater than 1800 °F will usually show a payback period of less than two years.	Use of recuperators may require changes in burners and combustion air systems.
4. Process Heat Distribution System (steam, condensate, hot water, gas, propane oil)	•Any losses in the distribution system requires greater energy input for the same end use.	•Insulate steam condensate, and hot water and chilled water lines. •Repair leaks in any lines. Shut off or remove unused lines. •Provide for periodic maintenance checks on controls, valves, and accessories. •Meter consumption and compare on regular intervals to identify unusual changes.		•Plant engineer and maintenance. •Utility representative. •Plant employees.		

GUIDELINES FOR ENERGY CONSERVATION SURVEY

Processes and Equipment

Item	Why Important	How to Conserve	How Long to Implement	Who Can Help	Energy Savings	Remarks
5. Incineration of Industrial Wastes	Possible source of energy.	• Investigate the possibility of incorporating a heat recovery system into the incineration process.		• Consulting engineer/ mechanical or chemical. • Manufacturing representative of heat recovery equipment and of incineration equipment.		Fumes, vapor and industrial wastes which require incineration, especially at high temperatures may provide opportunities for significant heat recovery.
6. Cooling Towers/ Evaporative Coolers	Heat rejection is required by many industrial processes such as die casting machines and plastic molders.	• Investigate the possibility of using the heat for space heating, for preheating boiler feedwater or domestic hot water, for heating stockpiles, for snow melting, or other such low temperature applications. • Check whether cooling towers or evaporative coolers are pulling plant air during the heating season. Should use outside air at intake.		• Consulting mechanical engineer. • HVAC consulting engineer. • Plant engineer.		Take precautions to prevent freeze up of cooling towers during shutdown.

Processes and Equipment

Item	Why Important	How to Conserve	How Long to Implement	Who Can Help	Energy Savings	Remarks
7. Paint Spray Booth	•Air is circulated through the painting area to control the paint spray and vapors. If all the air is exhausted, it would require equal amounts of makeup air from the outside and the energy necessary to heat the air.	•Determine whether it is possible to use recirculated air for a portion of the total air and still meet code requirements. •If makeup air is required for dilution purposes, consider the use of some heat recovery device such as a heat wheel. •Determine the minimum quantity of dilution air required for the specific paints that you are presently using. •Check the possibility for introducing outside air directly to operation area without heating.		•Consulting engineer. •Ventilation specialist. •Manufacturer's representative of heat recovery equipment. •Manufacturer's representative of paints.	Heat recovery devices usually can save 50-70% of the energy needed to heat the makeup air.	
8. Exhaust over vats, tanks, grinding and other operations	•Energy required to heat the makeup air from the outside. •Energy is also needed to maintain the temperature of the bath.	•Consider the use of heat recovery equipment from the exhaust air to the makeup air. •Check the possibility for introducing outside air directly to operation without heating. •Install covers over vats and tanks.		•Consulting engineer. •Ventilation specialist. •Plant engineer.		Check compatability of heat recovery equipment with the vapors in exhausted air.

Processes and Equipment

Item	Why Important	How to Conserve	How Long to Implement	Who Can Help	Energy Savings	Remarks
9. Compressed Air System	•Energy is used to drive the air compressor. •Drive may be either electric motor, engine or turbine drive.	•Repair all leaks. •Operate at the lowest air pressure required. •Consider the possibility of using the heat from the aftercooler for supplementing the plant space heat. •Do not use compressed air for cooling equipment or personal comfort. It is expensive ventilation. •Investigate the possibility of shutting down the compressor when not in use.		•Plant engineer. •Plant maintenance. •Consulting mechanical engineer. •Plant employees.	An air compressor operating at 100PSIG requires approximately 1HP for every 5 CFM.	
10. Electric Power System	•Transmission losses include transformers and line losses. •High peak demand and low power factor both increase the cost. They also increase the electric generating plant size required to service a given job.	•Deenergize transformers whenever possible. •Clean transformer heat exchanger surfaces. •Investigate the possibility for scheduling use of power and for reducing demand. •If power factor is low, have a specialist recommend changes.		•Consulting electrical engineer. •Utility representative. •Plant engineer.	Transformer losses range from .2% at no load to .9% at full load.	A power factor of 85% to 95% may be acceptable but a specialist should be consulted for a specific evaluation of your plant.
11. Electric Motors		•Turn off equipment when not in use. •Replace grossly oversized motors, since motors operate more efficiently near rated capacity and with a better power factor.		•Plant employees. •Plant engineer. •Consulting electrical engineer. •Electric utility representative.