LOUISIANA COOPERATIVE EXTENSION SERVICE
LOUISIANA STATE UNIVERSITY AGRICULTURAL CENTER

LOUISIANA SEA GRANT College Program
Center for Wetland Resources
Louisiana State University

ENERGY DIVISION
Expanding Louisiana's Energy Potential

Louisiana Department of Natural Resources

ENERGY CONSERVATION SELF-AUDIT MANUAL FOR FISH PROCESSING PLANTS

DEVELOPED FOR
LOUISIANA DEPARTMENT OF NATURAL RESOURCES
ENERGY DIVISION
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BY

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INTRODUCTION

If you are a typical processor of fish, the cost of utilities is a significant portion of your processing costs. The fact is, except for labor, the cost of utilities is the highest single component of processing. It is also a component that may be most easily controlled. It is the purpose of this manual to introduce you to low-cost/no-cost ways to save energy to increase your profit. An important aspect of energy conservation considered in this manual is quality and quality control. Energy conservation does not mean just using less energy; rather, it is the wise use of energy to produce a quality product.

A major focus of this manual will be those areas/operations of a fish processing plant which account for the highest energy consumption. These areas are looked at in some detail with suggestions given for low-cost/no-cost ways to improve or maintain the energy efficiency. Some general principles of energy conservation are given. These suggestions are not all inclusive, but rather a starting point for you in your energy conservation and profit improvement efforts.

QUALITY CONTROL

Seafood product quality control is one of the most important considerations of seafood processing. It is directly related to energy conservation. Seafood products are among the most perishable of all foods, most having a shelf-life of only a few days under proper storage conditions. Proper refrigeration, heat processing times, and freezer storage are essential to achieve the maximum shelf-life. In an effort to maintain the proper storage and processing times and temperatures, seafood processors may waste energy or may, unknowingly not provide enough cooling or heating capacity to process the seafood satisfactorily. Consequently, a quality control audit should be performed in conjunction with the energy audit.

TYPICAL PROCESSING PROCEDURES

Fish processing is as varied as the types and amounts of species processed. Generally, fish (other than catfish) are trucked to the processing plant where they are de-iced, graded for size and quality, chilled, then processed or iced and stored in coolers till they can be processed. Processing of fish involves gutting, scaling, skinning, deheading, filleting, deboning, or combinations of these. Value added products such as breading or patties can extend the process. Fish are then packaged and prepared for shipment.

Catfish are generally brought to the processing plant alive then shocked before being processed. Catfish processing is basically an assembly line process in which the fish are deheaded, split, vacuum eviscerated, skinned, then sorted by size and chilled. A majority of the catfish are cut into fillets, but some are sold whole, cut into steaks or nuggets, then packaged for shipment.

Oysters to be processed are washed, graded, then some are boxed for shipment for the half-shell trade and the rest are brought to the shucking tables. Oysters are then shucked, washed and packaged for shipment.

ENERGY USAGE IN PLANT

In a fish plant, most of the energy consumption is confined to just a few areas. Refrigeration and air conditioning account for about 60 - 70 percent of the electrical usage. Lighting is the next largest consumer of electricity. Water heating for clean up may be done either electrically or with gas.

GENERAL PRINCIPLES

There are five basic principles or guidelines to follow to save energy and reduce your utility cost in your plant. These are the same guidelines that you would follow to reduce your utility bill at home. Actually, they break down into nothing more than common sense. The guidelines are: minimize the work you need to do, do it right, use efficient equipment to do the work, practice good preventive maintenance and management.

MINIMIZE WORK:

One of the best ways of reducing energy consumption is to minimize the amount of work that has to be done. This doesn't mean sacrificing quality. You may think of it in terms of your house. If you wanted to reduce the cost of your air conditioning, one of the first things you would do is to improve the insulation in the house, make sure you keep your windows closed and do a good job of weatherstripping. You may even put in a ceiling fan so that you would be as comfortable as before, but at a higher temperature. You can do the same type of thing in your processing plant. For example, coolers and freezers should be well insulated, and doors should be weatherstripped. Insulation and weatherstripping should suit the application. For example, when the possibility of condensation exists, insulation which stands up to moisture should be used. In this type of application, insulations such as urethane foam would be a better choice than fiberglass mats. You must know your application so that you or your supplier can choose suitable materials. The doors should be closed whenever possible. You may want to consider plastic curtains to reduce the infiltration load on the coolers.

Just as in your house, insulation is a key factor here, as is reducing infiltration. Insulation in general is a very cost effective method of energy conservation, and it is particularly cost effective when the area or equipment that you are insulating has long hours of use throughout the year. The most efficient levels of insulation depend on your operation, the cost of utilities and cost of installing the insulation.

As a starting point, American Society of Heating, Refrigeration and Air Conditioning Engineers handbooks can be consulted for typical levels for most applications. In addition, you may want to do an economic comparison of different insulation levels/treatments, taking into account first cost (including refrigeration equipment whose capacity can usually be reduced as insulation levels increase), utility costs and lifetime of the application.

EQUIPMENT SELECTION:

There are three key considerations to choosing efficient equipment. First, choose equipment designed to operate under the conditions in which you will be using it. For example, if you intend to hold a cooler at 35 degrees Fahrenheit, choose a refrigeration system designed to operate at this temperature, not one designed to operate at 20 or 30 degrees below zero.

The second key is to choose equipment with the correct capacity. For example, if a 60-watt lamp is sufficient, you will waste energy by putting in a 400-watt lamp. The same thing holds true for equipment such as boilers and refrigeration equipment. If they are greatly oversized, they will not operate as efficiently as if they are sized correctly for their particular need.

The third key is to choose equipment that operates efficiently. For example, fluorescent lamps will produce about four or five times the amount of light for the same amount of electricity as incandescent bulbs. Unless your existing equipment is particularly inefficient and costly to operate, particularly with long hours of use, it may not be cost effective to replace it with more efficient equipment.

It would be a good idea, however, to consider options for more efficient operation when new equipment is needed or if expensive repairs are needed for existing equipment.

MAINTENANCE:

No matter how good or bad your equipment is, maintenance is the key to getting all the performance it can deliver. Routine preventive maintenance should be an integral part of your operation. It can result in better operation and quality control, lower energy costs and longer equipment life, particularly when compared with "fix it when it breaks" type of maintenance. Routine maintenance also includes making sure that controls are adjusted properly and that systems are operating efficiently.

MANAGEMENT:

The key to both energy savings and quality control is management. Neither will just happen. They require commitment. You should establish operating procedures to obtain your goal, make your commitment known to your employees and work to see that your operating scheme is carried out. Once this has been done, there are several tools to track how well your plan is working. Your primary tool in tracking the success of energy conservation measures should be your utility bill.

You should understand each cost on the bill and your rate structure. At the same time, you may wish to inquire if there is a more favorable rate structure that you would be eligible for. You should also compare your utility kwh usage from month to month, particularly the usage compared to the same month the previous year. Be alert for any significant increases which cannot be explained by weather conditions, increased volume of business or other identifiable factors. If such increases occur, take an even closer look at your equipment and procedures. The increases could be caused by faulty equipment or procedures which should be changed to cut down on energy usage. You may be able to break your utility bills down further into cost-per-1000-pound for each operation and compare this with your own operation from month to month and with others who are in a similar business.

Similarly, your quality control should also be tracked. This will be particularly important under the anticipated record keeping provisions of the HACCP (Hazardous Analysis of Critical Control Points Program).

There are several areas of particular concern for fish processing plants, from both the standpoint of energy savings and production of a quality product. In the following sections, refrigeration and air conditioning, which typically account for 60 to 80 percent of the electrical usage, lighting, and management control and quality control will be discussed in some detail. New technology which may be applicable to the processing industry in improving quality and increasing energy conservation will also be discussed. Finally, a survey or checklist, which could serve as a starting point for your energy and quality control efforts, is included for your use.

LIGHTING

Lighting is a very visible part of energy usage. The two main rules to follow to get the most of your lighting dollars are:

1. Use efficient lighting.
2. Turn the lights off when not needed.

The first rule, use efficient lighting, is followed by most plants, particularly in the picking and packaging rooms. In these rooms, a high level of lighting with good color rendition is required. Fluorescent lighting is a good choice.

It can provide the same level of lighting at one-fourth the energy cost of incandescent and has good color rendition. The lamps also last much longer than ordinary incandescent -- 10 to 20 times as long, which means lower replacement cost. Over its lifetime, each standard fluorescent lamp can save you $80 in electricity costs as compared to incandescent producing the same amount of light.

You can obtain even more savings using energy-efficient fluorescent. There are also fluorescent which are intended for low temperature areas and for areas where moisture is condensing, conditions which are tough on standard fluorescent. These cost a little more than standard fluorescent, but payback is several times the initial cost difference. There are also differences among standard fluorescent. Longer lamps are usually more efficient than shorter lamps. The key is the amount of light (lumens) you get for each unit of electricity you use (watts).

There are other types of efficient lighting such as metal halides, and high and low pressure sodium. Although some of these may be more efficient than fluorescent, not all produce good color rendition. Some require a cool-down period between off and on cycles, while others require a high placement to use the light output efficiently. These factors may make them unsuitable for certain applications, such as picking rooms, but the lamp of choice for applications such as warehouses or parking lots. The characteristics of each type such as color renditions, light efficiency, lifetime, cost and switching requirements should be considered along with the application. A hidden benefit of efficient lighting in picking and packaging rooms is reduced air conditioning load and less energy usage and cost by the air conditioning system.

Lighting efficiency can also be increased by use of light, reflective colors for the interior of the room and by maintaining the fixtures in good condition. This can be done by cleaning lenses as needed and replacing badly yellowed or discolored ones.

The second rule is simple. If you are not using the light, turn the lights off. This also applies for fluorescent lights. In a large room, multiple zones, each controlled by a light switch, increase your ability to manage. If only part of the room is being used, you may be able to light only part of the room.

REFRIGERATION

Most refrigeration systems operate on the same principle as an air conditioner. The heart of these systems is the compressor, which does the actual work of refrigeration. It and the condenser coil, the cooling coil and the control systems must be chosen to match the requirements both in capacity and in temperature. A unit needs to be big enough to do the job, but should not be too large. A unit which is too large will either cycle frequently, reducing energy efficiency and lifetime, or require a large swing in freezer temperature which adversely affects product quality. This is one reason that one freezer should not be expected both to freeze the product and store the frozen product since the capacity required for freezing (or cooling down) is usually much greater than that needed to maintain the product temperature.

The refrigerated temperature is an important factor in selecting the right equipment. As the temperature of the refrigerated space drops, the capacity of a given piece of equipment also drops. In addition, operating a unit at temperature lower than designed may cause unit failure, either accelerated or immediate. Operating at too high a temperature in the refrigerated space could overload the equipment and cause premature failure. In either case, it means your cooler is out, and you may lose product.

Even with the right compressor, condenser coils and evaporator, you still have other considerations. You also need a proper control system, correctly sized refrigerant lines and correct installation. The control system should match the

requirements and capacity of the system. Refrigerant lines must be of correct size--too small will reduce capacity and increase operating cost; too large can result in a loss of oil to the compressor and compressor failure. The vapor line (cold line) should be insulated to avoid loss of capacity and efficiency. When these systems are put together, they must be free of leaks, moisture and air, and they must be charged with the correct amount of the required refrigerant. This requires a professionally competent refrigeration professional.

Preventive Maintenance

Beyond proper sizing and installation, the most important consideration regarding your refrigeration equipment is its maintenance. Preventive maintenance directly affects operating cost, repair cost and equipment life. In a less direct manner, though no less significant, it also affects product quality. The real tragedy is not the lost money, but that many breakdowns can be avoided.

Some call preventive maintenance a form of insurance, but it's much better than that. You only benefit from insurance when misfortune strikes. Thorough, planned maintenance prevents misfortune. Best of all, it almost always saves more than it costs. Studies have shown that money invested in preventive maintenance is usually recovered in a matter of months. This is even without factoring in savings for reduced repairs and longer equipment life. Keeping your equipment clean is the single most important factor in preventing energy waste and premature failures. If your refrigeration system uses air-cooled condensers, it needs cleaning on a scheduled basis. Condenser coils restricted by dust, leaves or other debris cause excessively high temperatures and pressures that have a very negative effect on energy consumption and equipment life. These coils must be cleaned with chemicals and water, or high pressure water. Also, boxes, walls and fences should be at least three feet away from the air intake of the coils, and at least five feet away from the air discharge. If your units are in an enclosed room, ventilation should be sufficient to prevent the room temperature from exceeding the outdoor temperature.

Although indoor coils are not as susceptible to dust, they should be periodically inspected. The same clearances regarding air intake and discharge described above apply to the indoor coils.

While there is considerable variation in the sophistication of equipment designs and applications, many maintenance requirements are universal. The refrigerant charge of the system should be checked routinely to assure maximum efficiency. Refrigerant leaks are costly, not only in that they increase energy consumption, but chances are that the type of refrigerant your cooler or freezer uses is much more expensive than that in your home A/C and is much more harmful to the atmosphere.

Most coolers and freezers have defrost timers and heaters. A timer that calls for defrost too often wastes energy. One that fails to call for defrost when needed will also waste energy and can cause equipment damage or unacceptable temperatures. The same problems can arise from defective defrost heaters. Occasionally heaters will not turn off when they should, and the equipment has to run more to overcome the extra heat.

Many commercial refrigeration systems have some form of low ambient control which allows the system to operate when outside temperatures are much lower than the design temperature of the system. Although this temperature varies greatly from one system to another, it is generally under 55° F. Below this temperature, something has to help the condenser do its job.

There are many ways this can be accomplished. Often the outdoor fans are controlled to reduce the amount of air flowing through the coils. On a coil that has multiple fans, one or more of those fans may be automatically turned off. On a coil with only one fan, the speed of the motor may be reduced.

Some refrigeration systems achieve low ambient control through a method called hot-gas-bypass. In these systems a small amount of the hot refrigerant gas leaving the compressor is routed back to the return side of the compressor to keep pressures and temperatures at an acceptable level.

Whatever method your system uses (if any), check it during preventive maintenance. Have your service contractor demonstrate its operation to you so that you won't be alarmed by the "unusual" sights or sounds created.

Waste heat recovery units are becoming a more and more common companion to refrigeration systems. These units capture heat that is rejected by the refrigeration system, normally just wasted into the air, and use it to heat water to be used for valuable purposes. This process lowers water heating cost, refrigeration cost and increases refrigeration capacity. The recovery unit should be checked periodically to see that its operation does not conflict with the low ambient controls mentioned above.

Preventive maintenance can be scheduled at your convenience. Breakdowns rarely occur at a convenient time. Many service contractors will offer discounts for scheduled service. On the other hand, most charge a premium for emergency calls in the middle of the night.

Cryogenic Systems

Several processors have used cryogenic freezing. Cryogenic freezing differs from the normal refrigeration process in that the cryogenic (a refrigerant such as liquid carbon dioxide which evaporates at an extremely low temperature) is not cycled but is used only once and then dumped into the surroundings. The work and energy of supplying the refrigeration is done at the plant which produced the cryogenic.

Cryogenics have several advantages, particularly for individual quick freezing and very low temperature requirements. The very low temperatures lead to rapid freezing. The refrigeration capacity is controlled by opening or closing a valve, thus large capacity variations are possible. For a given freezing capacity, capital costs are less than for conventional systems. The simplicity of the system, essentially opening a valve and exhausting the refrigerant, means that maintenance is simple and reliability high.

The primary disadvantage of cryogenics is "energy cost." The cost of the cryogenic which is expended is usually many times that of the electricity required to produce the same amount of cooling when cryogenic temperatures are not required. This is particularly true at higher refrigeration temperatures. For example, an application requiring a -10°F space temperature with moderately good conventional refrigeration system and electric costs of eight cents/kwh would cost only one-fourth as much to operate as a <u>good</u> CO_2 cryogenic system with CO_2 costs of three cents/lb. The gap in operating cost increases as the required temperature of the refrigerated space increases, and decreases as the temperature decreases.

Cost and energy efficiency for cryogenic systems depend on efficient use of the cryogenic. Enough cryogenic must be used to maintain the desired temperature, but not so much that cryogenic which still has considerable cooling capacity is exhausted. Thus, obtaining the performance that a cryogenic system is capable of is primarily a matter of correct adjustment of cryogenic controls and management. An additional consideration for the manager is safety. Cryogenics produce extremely low temperatures which could be hazardous to the careless. Also, adequate ventilation must be supplied since cryogenics could displace oxygen.

Quality Control

As stated previously, seafoods are very perishable products. Obviously, any seafood whose quality deteriorates to such an extent that it is no longer useful or salable constitutes a waste. To prevent the waste of the product and the time, effort, expense and energy that has gone into producing and processing it is the function of a good quality control program.

An important part of quality control is proper sanitation. The purpose of sanitation is to keep the populations of both pathogenic and non-pathogenic bacteria under control. Controlling these organisms helps to insure that the seafood being processed is safe, wholesome, and has a long shelf life. Not only is management legally and morally responsible for the quality of its products, but is good business sense to do so. Products having off-flavors or odors are unsuitable to the consumer, can result in wasted product and will in time do harm to the business.

In order for sanitizers to be applied properly it is critical that they be applied to surfaces free of visible soil. These soils include rust deposits, blood, grease, oil, protein, and mineral buildup. These soils provide areas for growth both below and within the soil, and in most cases hold food and water necessary for bacteria's growth. Chemical sanitizers that would normally destroy the bacteria cannot adequately penetrate these soil deposits to do the job. That is why it is imperative to clean the equipment before sanitizing, or else the sanitation effort is largely a waste of time.

Characteristics of Some Commonly Used Sanitizers (see also Table 1)

1. Steam--Sanitizing with steam is not a very effective way to do the job. The problem is that people mistake water vapor for steam and thus the equipment does not get the necessary contact time to do the job. Thus, it is very hard to have good control. With the soaring cost of energy, it is also an expensive procedure. Steam is not amenable to continuous sanitation of conveyors.

2. Active Chlorine--Active chlorine solutions are extremely active sanitizers, particularly as free chlorine and in slightly acid solutions. Those species are believed to act through protein denaturization and enzyme inactivation. Although effective against gram positive and gram negative bacteria, as well as some viruses and spores under certain conditions, it is quickly inactivated by organic soil and is corrosive. Active chlorine is economical to use, but is irritating. Concentrations of active chlorine can be easily measured by test kits and dispensed at a desired concentration.

3. Active Iodine--Active iodine solutions, like active chlorine solutions, can be rated as excellent all around sanitizers. Combined with proper wetting agents to form iodophors, low staining and increased stability is imparted to the iodine. Iodophors are very stable products and, therefore, have a much longer shelf life than hypochlorites. Iodophors are not as affected by organic soil as is chlorine, and they are active at a much lower concentration. They are also easily measured and dispensed, and the brown color gives visual control. Iodophors exhibit good penetration qualities, and their acid nature prevents film formation and spotting on equipment. The temperature of the use of solution should not be above 120°F, since free iodine will dissipate.

4. Quaternary Ammonium Compounds--The "quats" as they are commonly known have become widely used on floors, walls, equipment, and furnishings. They are by nature wetting agents and thus have built-in detergency properties. They are good to use on porous surfaces, as they are good penetrants. Quats act against microorganisms in a different manner than chlorine and iodine compounds. They are often quite selective in the destruction of various types of organisms. They form a bacteriostat film when applied to surfaces. This film inhibits bacterial growth. Quat solutions are also easy to measure and they are more stable in the presence of organic matter than chlorine or iodine solutions.

5. Acid Sanitizers--The use of acid sanitizers combines the third and fourth steps of the cleaning procedure, that is, the rinse and sanitize steps. The acid neutralizes the excess alkalinity left behind by the cleaning procedure, prevents formation of alkaline deposits, and sanitizes. Acid sanitizers show good kill against both gram positive and gram negative bacteria. The mechanism of kill is believed to be caused by disruption of cell membranes.

   They are non-staining, odorless, stable, and easily measured in use solutions. They are limited, however, due to their effectiveness only at acid pH, and due to the generation of foam.

Table 2 lists some specific areas or conditions found in seafood processing plants and the sanitizer of choice. Also listed are concentrations of the sanitizer necessary to do the job. In some cases such factors as water supply and cleaning procedures have to be taken into account before the best sanitizer for the specific situation is applied.

The indiscriminate use of sanitizers will not insure that the job is being done. To be effective the surfaces to be sanitized must be clean, and the sanitizer must be applied at a proper concentration.

Although there are some rules of thumb as to which sanitizer should be used, it is necessary to take into account the cleaning procedures, the type and amount of soil, the nature of the equipment, and the chemistry of the water.

TABLE 1

Characteristics of Commonly Used Sanitizers

Characteristic	Steam	Iodophors	Active Chlorine	Acid Sanitizer	Quats
Germicidal Efficiency	Good	Vegetative Cells	Good	Good	Somewhat Selective
Toxicity - Use Dilution	--	Depends on Wetting Agent	None	Depends on Wetting Agent	Moderate
Toxicity - Shelf Strength	--	Yes	Yes	Yes	Yes
Stability - Stock	--	Varies With Temperature	Low	Excellent	Excellent
Stability - Use	--	Varies With Temperature	Varies With Temperature	Excellent	Excellent
Speed	Fast	Fast	Fast	Fast	Fast
Penetration	Poor	Good	Poor	Good	Excellent
Film Forming	No	None to Slight	None	None	Yes
Affected by Organic Matter	None	Moderate	High	Low	Low
Affected by Other Water Constituents	No	High pH	Low pH & Iron	High pH	Yes
Ease of Measurement	Poor	Excellent	Excellent	Excellent	Excellent
Ease of Use	Poor	Excellent	Excellent	High Foam	High Foam
Odor	None	Iodine	Chlorine	None	None
Taste	None	Iodine	Chlorine	None	None
Effect on Skin	Burns	None	Some	None	None
Corrosiveness	No	Not to Stainless Steel	Bad on Mild Steel	Bad on Mild Steel	None
Cost	High	Moderate	Low	Moderate	Moderate

TABLE 2

Specific Areas or Conditions Where Particular Sanitizers are Recommended

Specific Area or Condition	Recommended Sanitizer	Concentration
Aluminum Equipment	Iodophor	25 ppm
Bacteriostatic Film	Quat	200 ppm
CIP Cleaning	Acid Sanitizer	130 ppm
	Active Chlorine	
	Iodophor	
Film Formation, Prevention of	Acid Sanitizer	130 ppm
	Iodophor	
Fogging, Atmosphere	Active Chlorine	800-1000 ppm
Hand Dip - Production	Iodophor	25 ppm
Hand Sanitizer - Washroom	Iodophor	25 ppm
	Phenolic	2-3%
Hard Water	Acid Sanitizer	130 ppm
	Iodophor	25 ppm
High Iron Water	Iodophor	25 ppm
Long Shelf Life	Iodophor	
	Quat	
Low Cost	Hypochlorite	--
Non-Corrosive	Iodophor	--
	Quat	--
Organic Matter, Stable in Presence of	Quat	200 ppm
Plastic Crates	Iodophor	25 ppm
Porous Surface	Active Chlorine	200 ppm
	Quat	200 ppm
Processing Equipment - Stainless Steel	Acid Sanitizer	130 ppm
	Active Chlorine	200 ppm
	Iodophor	25 ppm
Rubber Belts	Iodophor	25 ppm
Tile Walls	Iodophor	25 ppm
Visual Control	Iodophor	25 ppm
Walls	Active Chlorine	200 ppm
	Quat	200 ppm
Water Treatment	Active Chlorine	20 ppm
Wood Crates	Active Chlorine	1000 ppm

NEW TECHNOLOGY

Forced air cooling of oysters has been introduced by Louisiana Cooperative Extension Services/Sea Grant and demonstrated under the Louisiana Cooperative Extension Services/Department of Natural Resources Seafood Processing program. In this process, cold air is forced over the oysters resulting in rapid cooling. The industry standard of static cooling might require eight to 12 hours (or more) to cool the oysters, forced cooling requires about one hour. Microbiological data taken during the result-demonstration show a 10 fold bacteria reduction. This means that more product will be acceptable and that product will have a longer shelf-life. The system consists of a fan in an enclosure arranged to force air over the oysters which are in plastic trays with openings which allow air to flow through the trays. A system such as this, which cools the oysters faster, will probably require additional refrigeration capacity.

Most current control systems limit how low compressor head pressure can drop. During cool periods, condenser fans are often cycled off to keep the head pressure (condensing temperature) high. Although this causes increased energy consumption, it is necessary with most current controls and expansion devices. Several new pieces of equipment allow a greater range of head pressure (condensing temperature). This is referred to as allowing the head pressure "to float." Since each 1°F drop in condensing temperature (about 2 psi drop) results in about 1 percent energy savings, the importance of lower allowable head pressures is readily seen. The devices allowing greater range include electronic expansion valves, balanced port expansion valves and liquid refrigerant pumps. These should be investigated, since the right device could easily save 20 percent of your refrigeration cost. In fact, tests conducted by Oregon State University Extension Service, and by the University of Kansas resulted in over 20 percent annual savings. These tests were real-world applications of the liquid refrigerant pump that can be used on both refrigeration and air conditioning equipment which does not use cap tubes. As with the other devices, higher savings are obtained during cool weather operation.

ENERGY CHECKLIST

REFRIGERATION:

	Yes	No
Annual or more frequent check made by professional service person.	____	____
Preventive maintenance scheduled and practiced.	____	____
Condenser units have sufficient clearance (3 ft. intake, 5 ft. for discharge).	____	____
Coils free of debris such as grass, leaves or paper. (Inside and outside.)	____	____
Coils are clean.	____	____
Air flow around coils is unrestricted.	____	____
Inside freezers and coolers sources of water (such as open containers) are minimized.	____	____
Defrost cycles are optimized to maintain clear coils without excessive defrost time or frequency. May require resetting as conditions change.	____	____
Correct temperature is maintained in refrigerated space. Temperature should be checked with an accurate thermometer.	____	____
System is matched and adjusted to the job.	____	____
No unusual sounds or operation (Compressors and motors should emit a relatively constant and harmonious sound. Any unusually loud or widely varying sounds should be investigated.)	____	____
Unit cycles normally and does not short cycle.	____	____
Compressor amp draw within recommended limits during normal operation.	____	____
Return lines (cold) are insulated.	____	____
Boxes and Walkins:		
Weatherstripping is serviceable.	____	____
Insulation adequate, no moisture penetration.	____	____

Doors closed when not in use.	_____	_____
High traffic doors have serviceable curtains.	_____	_____

Call your service contractor as soon as you notice something out of the ordinary that you cannot correct. He may help you prevent a small problem from becoming a major breakdown.

NOTES:

Use this section to jot down details of problems/observations.

AIR CONDITIONING

	YES	NO
Filters are changed or cleaned on a regular basis.	____	____
Coils (inside and out) are clean.	____	____
Condenser has sufficient clearance (3 ft. clear for intake, 5 ft. for exhaust).	____	____
Blowers are clean.	____	____
Annual or biannual service by professional serviceperson.	____	____
Duct system is sufficient to direct air where needed.	____	____
Conditioned areas are insulated and weatherstripped.	____	____
Doors to conditioned areas are normally closed.	____	____
Air conditioning is operated only when needed.	____	____

NOTES:

Use this section to jot down details of problems/observations.

LIGHTING

	YES	NO
Energy efficient lights are used.	_____	_____
Lighting level is sufficient without being excessive.	_____	_____
Switching is sufficient to allow lighting flexibility.	_____	_____
Lights are turned off when not needed.	_____	_____

NOTES:
Use this section to jot down details of problems/observations.

HEAT RECOVERY:

	YES	NO
Is there a need for heat in the plant?	_____	_____
Is there a source of waste heat in the plant?	_____	_____
Has waste heat recovery been investigated?	_____	_____

NOTES:

Use this section to jot down details of problems/observations.

REFERENCES

ASHRAE Handbook - 1989 Fundamentals Volume, I-P Edition, Atlanta, Georgia: American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., 1989.

ASHRAE Handbook - 1988 Equipment Volume, Atlanta, Georgia: American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., 1988.

ASHRAE Handbook - 1987 HVAC Systems and Applications, Atlanta, Georgia: American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., 1987.

ASHRAE Handbook - 1986 Refrigeration Volume, Atlanta, Georgia: American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., 1987.

Bankston, David, Moody, Michael, and Roberts, Ken. Brine Freezing, Louisiana Cooperative Extension Service and Louisiana Department of Natural Resources, 1991.

American Society of Agricultural Engineers, Effect of Maintenance on Energy Use of Refrigeration Equipment, St. Joseph, MI 49085-9659, 1989.

Moody, Michael, How Cleaning Compounds Do the Job, Louisiana Cooperative Extension Service

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