

ENERGY EFFICIENCY PROJECTS

NO-COST AND LOW-COST UPGRADES
FOR YOUR FACILITY

In partnership with: Refrigerating Engineers & Technicians Association

INTRODUCTION

Save Money, Improve Operations

Today's refrigeration professionals strive to improve operations, safety, and the bottom line at their facilities. By making energy-efficient upgrades to your site operators and managers alike can achieve these goals, as well as saving on both operational and capital equipment costs. Most upgrades are low- or no-cost, and many are easy to complete – some even improve the quality of the workplace, support career development, and enhance your facility's competitive advantage with supplier contracts.

Certified Refrigeration Energy Specialist (CRES)

CRES is offered by the Refrigerating Engineers and Technicians Association (RETA) and is an energy efficiency certification for industrial refrigeration professionals. The certification is made up of two parts: an exam covering operations, safety, and energy-efficient refrigeration practices, and the required completion of energy efficiency activities at your facility.

Directions

This resource is intended to provide you with ideas for implementing energy-efficient upgrades at your facility. Though each facility is unique in its operation, these activities have been successfully implemented across a variety of different plants and are a good place to start when thinking about low-cost and no-cost energy-efficiency activities. As a refrigeration professional, it is your duty to understand the operating limits of your equipment and ensure safety is maintained when making changes to equipment or set points.

Benefits of Energy Efficiency

By upgrading your facility using energy-efficient activities, you will achieve:

- Immediate bottom line savings
- Equipment longevity
- Improved safety
- Long term cost savings on capital expenditures
- Competitive advantage for contracts
- Professional development and new skillsets

ABBREVIATIONS

- RETA** Refrigerating Engineers & Technicians Association
- CRES** Certified Refrigeration Energy Specialist
 - RP** Refrigeration Professional
- RCD** RETA Certification Database
- SOP** Standard Operating Procedure
- DP** Differential Pressure
- TXV** Thermal Expansion Valve
- LIOC** Liquid Injection Oil Cooling
 - Vi** Volume Index
 - TD** Temperature Difference



ENERGY EFFICIENCY ACTIVITIES

Direct Savings

Activities and projects for your facility that demonstrate direct, measurable energy savings.

RAISE SUCTION PRESSURE

What: Increase compressor suction pressure set point during off-hours and on-hours when acceptable.

Why: The lower the suction pressure, the more compressor energy is needed. Compressor power decreases 2% to 3% for every degree Fahrenheit that suction temperature increases.

Average compressor plants (1200 HP) can save up to \$5,000/year by raising suction pressure.



RAISE SUCTION PRESSURE

Look to raise the suction pressure during off-hours when loads are lower, and/or increase suction pressure during on-hours if your suction temperature is lower than an evaporator's rated TD (including line losses). Refrigerated systems, such as freeze tunnels, may not be necessary to operate during off-hours. Analyzing the coldest load on the system during off-hours can allow for raising the suction pressure. If you raised your suction pressure by only 5 psig on weekends you could save 3% of your annual compressor energy use.



IMPORTANT TIPS

- Determine which equipment is critical to run during off-hours and if it can run at a higher suction pressure.
- Look for opportunity to raise suction pressure during times of daily clean-up as well. Remember you will have to lower suction pressure again after clean-up.
- Document your system set point as part of your SOP.
- There is a balance to raising suction pressure. Though it will save energy at the compressors it may increase evaporator fan energy or refrigeration runtime to satisfy the same load. The key is to find a balance that reduces energy use of the entire system.

DEFROST MANAGEMENT

What: Check the defrost cycle semi-annually.

Why: Defrosting for more time than needed adds unwanted heat to the space. Cutting your defrost time in half can cut approximately \$5,000 off your annual compressor costs.



DEFROST MANAGEMENT

Adopt a written procedure for checking evaporator defrost performance so the process is scheduled and performed twice annually. By performing this task, you may have an opportunity to cut defrost load by half as well as to increase evaporator reliability.



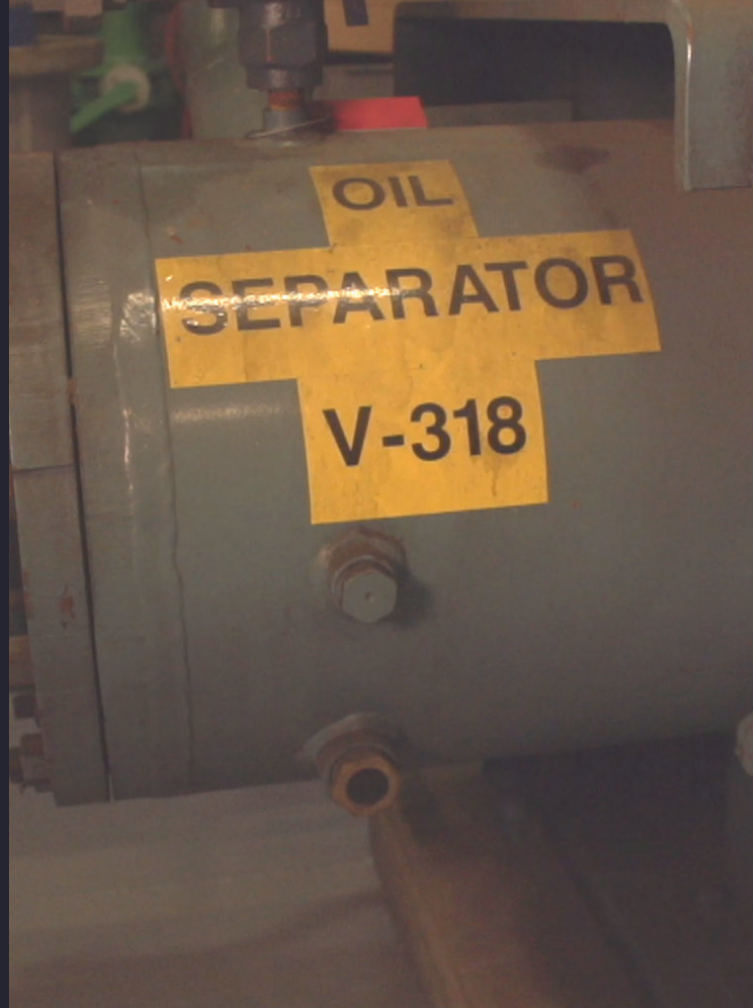
IMPORTANT TIPS

- Adjust evaporator settings seasonally for variations in humidity and operating conditions; spring and fall are the best time to schedule them.
- Incorporate an evaporator defrost check into a scheduled maintenance program to make sure it doesn't get overlooked.
- SOP should include observing each evaporator as it goes through a defrost to ensure proper set points are used as well as checking for common valve malfunctions.
- Addressing root problems such as a failed solenoid valves really helps to manage frost problems rather than just increasing hot gas time or pressure.
- Proper pump out times and defrost times are important items to investigate. Sites often set pump out times too low, requiring longer hot gas cycles to deal with residual liquid in the tubes. This hinders the heat exchange effectiveness of the hot gas to properly perform a defrost.

REDUCE MINIMUM CONDENSING PRESSURE

What: Operate condensing pressure as low as possible while maintaining safe and adequate system function.

Why: The higher condensing pressures used, the more compressor energy increases. Reducing condensing pressure reduces the compressor power up to 1.5% for every degree Fahrenheit reduction.



REDUCE MINIMUM CONDENSING PRESSURE

Compressors and refrigeration systems are commonly designed to operate as low as 90 psig. The limiting factor often is the compressor oil separator, which will determine the minimum condensing pressure achievable. The control system increases the condensing pressure set point during defrost, so defrost performance is not affected, thus it is safe to make incremental reductions.



IMPORTANT TIPS

- Completing this task will likely increase the condenser fan energy use slightly as the condensers work harder to drive the condensing pressure down, but the compressor savings outweigh the increase.
- Lowering the minimum condensing pressure by 10 psig can yield an average of 3% savings on your annual compressor energy use depending on the load profile of your plant.
- Common barriers to completing this activity include the potential for oil carryover due to increased velocity through an oil separator, refrigerant stacking in the condenser, and maintaining proper feed and dp to TXV's at evaporators, LIOC, and chillers. Ensure proper refrigeration system operation can be maintained at all pressure levels.

FREEZER DOOR MANAGEMENT

What: Raise awareness of closing freezer doors through employee education and signage.

Why: Leaving freezer doors open unnecessarily leads to wasted energy and the potential for build-up of frost.

Keeping a freezer door closed for just 30 minutes more a day can save around \$1,500 a year.



FREEZER DOOR MANAGEMENT

By monitoring freezer doors and ensuring they are closed when not in use, facilities can maintain a more consistent product temperature and prevent frost from developing in the freezer. A facility that operates most hours of the year can save substantially by reducing unnecessary loads on their refrigeration system.



IMPORTANT TIPS

- Put signs up to remind operators to close the door with each use.
- Install buzzers to indicate if the door is open longer than 1 minute.
- Raising awareness about how much the facility spends on electricity goes a long way in engaging staff.
- For a facility that operates 365 days/year, an average freezer door can waste up to \$1,500 per year when left open unnecessarily. Multiplied by the number of freezer doors at a facility, savings can easily reach close to \$10,000/year.

OPTIMIZE VFD SPEEDS

What: Reduce evaporator fan VFD minimum and maximum speed set points.

Why: Optimizing VFD fan speed settings can reduce energy significantly because there is a cubic relationship between fan speed and power.

Limiting a fan to 90% maximum and 40% minimum can save around 5% of annual fan energy use.



OPTIMIZE VFD SPEEDS

Even if VFD's are installed, they can be further optimized to run at lower speeds. Keeping evaporators at lower speeds takes advantage of the “cubic law” of fan energy savings. Further, reduced fan speed reduces product moisture loss, increasing profits. And even better: evaporator fans are a little quieter at 90% speed, improving the work environment for the workers operators and facility staff.



IMPORTANT TIPS

- Make sure evaporator fan motors are compatible with fan speed settings.
- Evaporator fans use about 75% power at 90% speed, 38% power at 70% speed and only 8% power at 40% speed.
- Evaporators can typically operate as low as 40% speed without affecting temperatures or causing motor issues, but the fan manufacturer or service contractor should be consulted to determine the appropriate setting for your equipment.
- Document the revised minimum and maximum setpoint settings in your SOP.
- Before reducing fan speeds, take into account proper air delivery down aisles. An evaporator's ability to adequately throw air down a long aisle is dependent on fan hp and the length of air throw.
- In addition to fan energy savings, you also save energy at the compressors and condensers due to the reduction in heat dissipation.

SWITCH CONDENSER NOZZLES

What: Switch to non-clogging condenser nozzles to save energy and reduce nozzle cleaning maintenance.

Why: Clogged nozzles reduce the heat transfer capacity of the condenser. If your existing nozzles are clogged, switching to non-clogging nozzles can save up to 15% on annual condenser fan energy use.



SWITCH CONDENSER NOZZLES

Facilities often find around 30% of condenser nozzles to be clogged – but this can be prevented by switching to non-clogging condenser nozzles. These new nozzle kits typically only cost a few thousand dollars and can be installed by facility staff. Pump energy may also be reduced if the condenser is once again operating at full capacity since less water may be needed to obtain the correct heat transfer.



IMPORTANT TIPS

- Condenser nozzles can become clogged over time, reducing the available water flow and heat rejection capability of the equipment.
- With old nozzles, condensers may not be getting their full water flow and portions of the tube bundle can remain fully dry, which reduces condenser capacity.
- With the new non-clogging nozzles condensers are getting their full water flow.
- Facility staff may also benefit from reduced condenser maintenance because of reduced cleaning times. This reduction in maintenance time can help pay for the cost of the new nozzles.
- Condenser fans are estimated to work 15% harder to compensate for having 30% less water flow with clogged nozzles.

COGGED V-BELTS

What: Switch traditional condenser fan belts to cogged V-belts.

Why: Traditional fan belts have a tendency to slip and lengthen as they wear over time, which wastes energy. Save up to 2% on the energy use of each fan that receives a cogged V-belt.



COGGED V-BELTS

Compared to standard fan belts, cogged V-belts have a longer lifespan due to reduced bending resistance and better length stability, leading to more efficient operation. Cogged V-belts have been shown to save around 2% of fan energy.

IMPORTANT TIPS

- Cogged V-belts have less friction loss and are less prone to slip.
- Ensure fan belts are at the right tension so they operate efficiently.
- Stock replacement cogged V-belts to ensure an efficient replacement belt is used during regular maintenance.



TRACK ENERGY INTENSITY

What: Set up a method to track and review monthly energy intensity using indicators such as production or weather.

Why: Tracking energy use builds awareness among staff. Facilities that track energy intensity have greater insight into production efficiency, leading to the possibility of much larger energy savings.



TRACK ENERGY INTENSITY

Track monthly utility bill information in a spreadsheet alongside monthly production totals and monthly average dry bulb temperature. Dividing monthly kWh by monthly total production provides a simple kWh/pound metric to evaluate how efficient the facility is operating from month to month.



IMPORTANT TIPS

- Savings will vary from site to site. Many facilities set up a savings goal target, such as 10% over 2 years, to work toward.
- Refrigeration operators don't often see the utility bills and don't know how much that the facility spends on electricity. By creating a process and sharing data, the entire staff becomes invested in success.
- Raising awareness about how much the facility spends on electricity goes a long way in engaging and educating staff.
- These meetings improve communication and collaboration between production and maintenance.
- Many facilities set a realistic, achievable goal the first year to spur confidence among staff, then ratchet it up in following years to help push innovation.

ENERGY EFFICIENCY ACTIVITIES

Indirect Savings

Activities and projects for your facility that complement measurable energy savings.

EVAPORATOR FAN CYCLING

What: Enable fan cycling so that fans only run when the evaporator is cooling.

Why: Many non-VFD evaporator fans run at full speed all the time except during defrost, which wastes energy.

Fans which are not yet on VFDs can save 25% by cycling them off when not needed.



EVAPORATOR FAN CYCLING

Enable fan cycling for any non-VFD evaporators so that the evaporator fans turn off with the liquid feed when the space temperature is satisfied. As such, the fans only run when the evaporator is actually cooling.



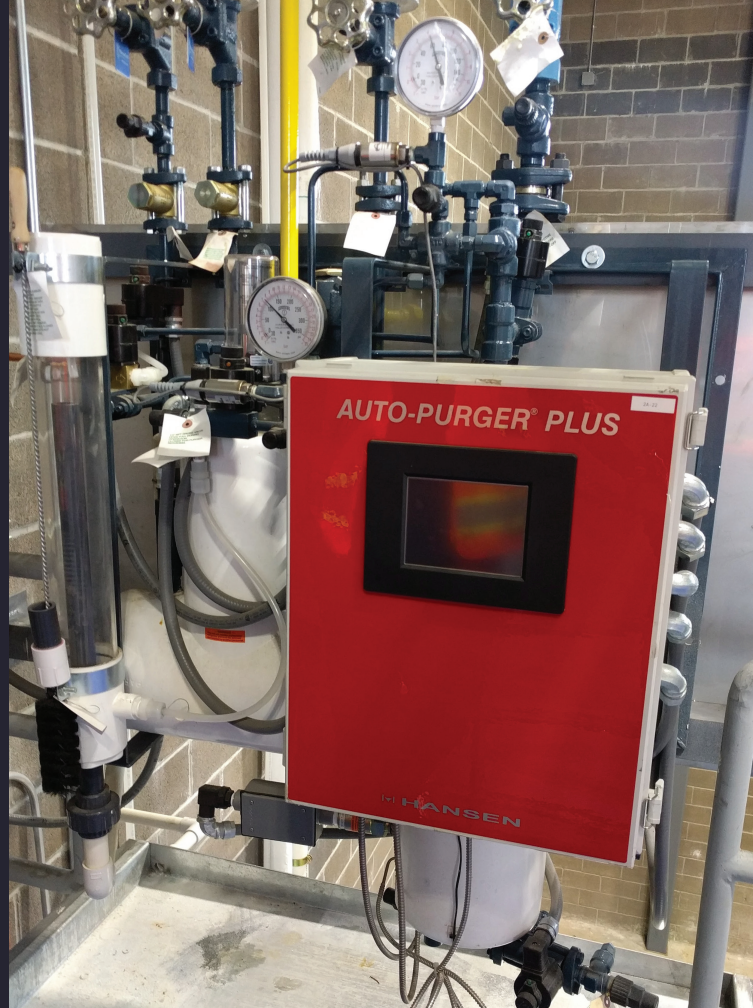
IMPORTANT TIPS

- It may make sense to include a stir cycle every 30 minutes or so if fans will be off for a long period of time.
- When the evaporators aren't cooling, the fans don't need to be on. The reduced fan heat also reduces the refrigeration load.
- Instead of controlling fan cycling, installing a VFD on evaporator fans can potentially save even more energy.
- Fan cycling can be combined with efficient evaporator fan VFD control. Once fans have reached minimum speed and zone temps are satisfied, the fans can cycle off.

SCHEDULED CONDENSER CHECK

What: Check for non-condensable gases in condensers and complete a checklist for other condenser performance issues.

Why: Non-condensable gases in a condenser can severely impact performance and energy use.



SCHEDULED CONDENSER CHECK

Incorporating condenser checks into a scheduled maintenance program will help ensure the condensers are running efficiently and non-condensable gas effects are kept to a minimum. Properly performing condensers are important for the whole system to operate efficiently. Fan and pump energy are reduced, as well as condensing pressure which helps save compressor energy.



IMPORTANT TIPS

- Lower summer condensing pressures prevent compressor shut downs from high amps that sometimes cause production stoppages.
- Incorporate check into scheduled maintenance program to make sure it doesn't get overlooked. It is important to have a written procedure that details tasks and equipment that should be checked.
- Include an automatic work order that will be generated alerting maintenance personnel to perform the procedure.
- Check auto-purger for proper operation as these have finite lifespans.

REGULAR COMPRESSOR CHECK

What: Check your compressor operation twice a year.

Why: Incorrect compression ratio settings can waste energy. Adopting a written procedure for checking compressor operation can help reduce routine maintenance issues, such as incorrect Vi settings.



REGULAR COMPRESSOR CHECK

Adopt a written procedure for checking compressor energy performance and incorporate it into scheduled maintenance so the process is performed twice annually. Properly performing compressors are important and help the whole system to operate efficiently and reliably.



IMPORTANT TIPS

- Includes checking set points, calibrating pressure transducers, slide valve calibration, volume index, current limiting calibration, checking oil cooling settings and checking economizer operation.
- Check compressors seasonally at least twice a year or whenever significant changes are made to the system.
- Incorporate automated alerts that are sent to facility staff to avoid overlooking compressor checks.
- Using the correct, calibrated current limiting settings prevent compressor shut downs from high amps that may cause production stoppages.

CAPITAL EQUIPMENT ACTIVITIES

ACTIVITIES INVOLVING CAPITAL EQUIPMENT AND INVESTMENTS WITH LONG TERM PAYBACK

BE SURE TO CHECK WITH YOUR LOCAL UTILITY FOR FINANCIAL INCENTIVES THAT MAY BE AVAILABLE FOR CAPITAL ACTIVITIES.

INSTALL VFDS ON COMPRESSORS

What: A VFD can be retrofitted for some existing compressor packages or factory installed on a new compressor package.

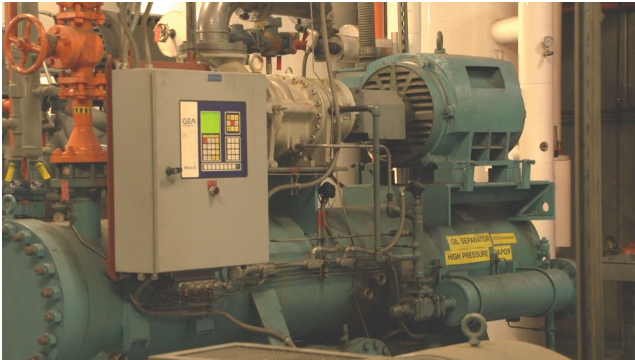
Why: A VFD allows a compressor to meet part-load conditions by slowing the speed of the screw. This is a more efficient means of capacity control than a slide valve, which simply adjusts the length of screw available for compression.

Trimming with a VFD instead of slide valve can save up to 30% of annual compressor energy.



INSTALL VFDs ON COMPRESSOR

When operating a VFD compressor it is important to consider the minimum speed setpoint. Reducing this setpoint increases energy savings, however operating at lower speeds can result in unstable operation. Check with the manufacturer to confirm minimum speed recommendations.



IMPORTANT TIPS

- VFD compressors should be set to operate as the trim machine because they operate very efficiently at part-load, but less efficiently at full load.
- Consult the manufacturer before retrofitting a VFD to an existing compressor package to confirm the package is VFD compatible.
- Confirm the compressor motor is inverter duty rated before installing a VFD.
- Conduct a load analysis prior to installing the VFD to ensure that the compressor package has significant part-load operation.
- In addition to compressor savings, adding a VFD will also yield condenser savings due to the reduced heat of compression.

INSTALL VFDS ON FANS

What: VFDs can be retrofitted on existing evaporator and condenser fans, or factory mounted on new equipment.

Why: VFDs on evaporator and condenser fans save considerable energy because both flow and pressure are reduced when operated at reduced speeds. This behavior is defined by the affinity laws, and results in a significant fan power decrease as fan speed is reduced. Additionally, fan power reductions in refrigerated spaces also yield compressor and condenser savings.

A fan at 75% speed requires less than 50% of the input power at full speed.



INSTALL VFDS ON FANS

Installing VFDs on fans is a great way to save fan energy and reduce refrigeration load. However, fan speed setpoints must be considered. The ideal range for fans on VFDs is between 80% and 40% speed, where fans still provide significant capacity but at significantly reduced input power. While we often recommend a minimum speed of 40% for evaporators to ensure proper throw, minimum condenser fans setpoints can be reduced to as low as 10%.



IMPORTANT TIPS

- Evaporator air throw must be considered when setting the minimum speed setpoint. Take temperature measurements to ensure that air is being circulated throughout the facility with the evaporator fans operating at their minimum speed.
- Confirm that fan motors are inverter duty rated before installing VFDs.
- VFDs can provide an additional benefit of reducing the number of motor starts and enabling soft-starts. Both of these functions reduce stress on the moving parts of the fan system.
- Little additional work is accomplished by operating an evaporator fan at 100% speed compared to 95% speed because of the increased fan heat. Therefore, we recommend setting a maximum fan speed of 95% or lower.

HIGH SPEED DOORS

What: Existing doors designed for material handling equipment traffic can be replaced with high speed doors to reduce how long the doors are open during each cycle.

Why: Unintended air flow and increased refrigeration load occurs when doors separating refrigerated spaces are open longer than necessary. Installing high speed doors reduces the time doors are open and therefore reduces refrigeration load.

Reducing refrigeration load has multiple benefits including compressor, condenser and evaporator fan energy savings.



HIGH SPEED DOORS

In addition to faster open and close times, high speed doors can be outfitted with auto-closure features to ensure doors are not accidentally left open as well as photo-eyes to sense when the door should be opened. These features not only save energy but also improve productivity as material handling equipment can move more swiftly through the facility.



IMPORTANT TIPS

- High speed roll-up doors are common but may not be appropriate for all applications. For very tall doors, consider high speed bi-parting doors to reduce the amount of time the door is open.
- The time delay setting on the auto-closure feature is important to consider. Some facilities are able to operate smoothly with a 3 second time delay, while others may need longer.
- High speed doors save energy throughout the refrigeration system. They also can reduce the moisture load on evaporators, which can reduce the need to defrost.
- Energy savings for this upgrade are dictated by the temperature difference across the door and the amount that door open time can be reduced. Energy savings are maximized on doors that cycle frequently and separate spaces with significantly different temperatures.

EFFICIENT LIGHTING AND CONTROLS

What: Replace or retrofit high-bay lighting with more efficient lighting technology and controls.

Why: Newer lighting technology such as LEDs can significantly reduce input power for the lighting system. New lighting technologies also add less heat to the space, helping to reduce refrigeration load. Adding controls, such as occupancy sensing, can reduce power by up to 50% or more.

Compared to High Intensity Discharge (HID) lighting, LED lighting uses 70% less power.



EFFICIENT LIGHTING AND CONTROLS

Lighting is commonly the second most energy intensive system behind refrigeration in a cold storage facility. Older technology, such as HID lighting uses substantial amounts of energy, has a long warm-up time and a short lifetime before the lamps need replacing. New technology, such as linear fluorescent and LED lamps last longer, and can produce the same amount of light using less energy. New lighting can also reduce the refrigeration load of a facility because they produce very little waste heat.



IMPORTANT TIPS

- Replacing old lighting with newer technology can significantly reduce the number of times lamps need to be replaced. LED lighting can last over 100,000 hours before needing replacement.
- The number of fixtures can sometimes be reduced when replacing old lighting with newer technology. Check with a lighting designer to determine the necessary light levels at the floor and to determine if fewer fixtures are needed.
- An estimated refrigeration savings from a lighting wattage energy reduction can be estimated by multiplying the lighting savings by 15–25 percent for a cooler and 25–45 percent for a freezer. When coupled with occupancy sensing controls or a timer, these energy reductions on the refrigeration system could be much larger.
- LED lighting works better in cooler environments and is instant-start.
- Lighting controls, such as occupancy sensors and dimming are becoming cheaper and can be used to reduce total lighting energy use even further.
- It is important to consider the costs of lighting over the life of the fixture. LED and fluorescent fixtures may cost more upfront but last substantially longer compared with HID technology.

TIPS ON BECOMING CRES CERTIFIED

Study Guides & Activity Documentation Guidelines



WHAT IS CRES?

CRES is offered by the Refrigerating Engineers and Technician Association (RETA) and is an energy efficiency certification for operators, supervisors, and managers of industrial refrigeration. Becoming CRES certified demonstrates knowledge and capability for energy-efficient industrial refrigeration system operation that also reinforces key safety and operations components. CRES can lead to reductions of up to 2 percent of energy costs while improving safety, production, and quality at an industrial refrigeration facility.

The certification is two parts: an exam covering operations, safety, and energy-efficient refrigeration practices, as well as required completion of energy efficiency activities at your facility. To become CRES certified, you must pass an exam and complete three low-cost energy-efficient activities, with the following requirements:

- At least two activities must directly save energy
- At most, one activity may indirectly save energy
- Activities must be completed within one year of applying for your CRES certification

Many CRES operators have seen up to tens of thousands of dollars in operating cost savings while improving safety and production quality at their facility. To succeed on the CRES exam, use the CRES Study Guide and Application Handbook to study and prepare for the exam, as well as this helpful video.

<https://vimeo.com/166997002>

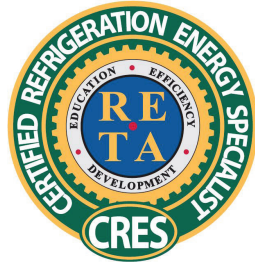
For more information about CRES as well as helpful calculators and resources, visit www.reta.com/cres

HOW TO DOCUMENT ACTIVITIES

Your activities must be documented in the RETA Certification Database (RCD), so that RETA's certification committee may confirm the activities demonstrate energy savings. Once you have passed the exam, submit your activities to the RCD by simply following the process below:

- Go to: https://rcd.reta.com/users/sign_in and login.
- Use the Activity Search bar at the top to look at what other CRES activities have been submitted. You may get ideas for your facility!
- To start your own activity, click the "Add New Activity" button in the lower right.
- Create a title that is descriptive of the activity performed
- Fill in information about where the activity was performed, and hover over any (information) button for hints on how to enter information.
- Upload any screenshots, calculations, or documents using the attachments tab.
- Provide recommendations and helpful tips before submitting your activity – once accepted your activity will be anonymized and searchable by others.





TOGETHER We Are Transforming the Northwest

