Professional Retail Store Maintenance Association

HVAC: CONSIDERATIONS FOR TOTAL COST OF OWNERSHIP

WHITE PAPER

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The Professional Retail Store Maintenance (PRSM) Association is the leading membership association that empowers Retail Facilities Professionals to make informed business decisions by delivering best practices, education, forums, partnerships and other relevant industry resources. PRSM delivers on its commitment to members by investing resources into quality programs that empower you in your dynamic Facilities Maintenance role to achieve success for your company's brand and the retail industry.

We advocate Retail Facilities Management credibility and the value of retail and supplier members by enabling you to explore and share ideas, learn best practices and make trusted industry connections. We prepare you to influence corporate strategy by equipping you to make informed facilities business decisions which translate into improved operating efficiencies, cost savings and risk management for your brand. To learn more about PRSM, please visit www.prsm.com.

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ABOUT THIS PROJECT

The PRSM Supplier Exchange is a forum organized to promote education and better business within the PRSM Supplier Members. This group, started by PRSM's Supplier Relations Committee, aims to identify and address specific topics that affect the Retailer/Supplier Partnership. One topic, in particular, is how to better understand the total cost of ownership. To accomplish this goal, this white paper, "HVAC: Considerations for Total Cost of Ownership," was created. PRSM would like to thank the following for making this resource possible:

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INTRODUCTION

Total Cost of Ownership (TCO) is a financial estimate intended to help owners determine the direct and indirect costs of a product or system. This white paper will outline and detail these costs as they relate to heating, ventilation, and air conditioning (HVAC) systems that are in the retail store environment.

Retail stores can be conditioned by many different types of HVAC systems. The vast majority of retail stores utilize packaged rooftop units and split systems. Other systems such as chilled water, variable air volume (VAV), water source heat pumps, and built up systems serve retail sites but are far less common. Since rooftops and split systems are most prevalent, the majority of information that will be presented here applies to these systems. The equipment may vary but the TCO concepts remain the same and apply to all.

There are four basic components that make up the TCO equation. They are:

Installed Cost

This is the total cost of installation that includes all design, engineering, equipment, labor, incidentals, air distribution, and energy controls. Every aspect of the total installation is included in this cost.

Energy Cost

This refers to the total cost of the energy required to operate the units or system. This includes the electric costs to operate the cooling and ventilation components as well as electrically powered heating components if applicable. Natural gas costs for heating are also included in this category.

Maintenance Cost

This is the cost of routine preventive maintenance associated with the equipment.

Service/Repair Cost

This is the cost of all repairs made to the system including replacement parts and the labor for the repair.

LIFE EXPECTANCY OF SPECIFIC EQUIPMENT

The very first question often asked by an end user of any HVAC system is the anticipated life expectancy of the specific piece of equipment. This is very difficult to answer since there are many factors that come into play when trying to determine what the life span of that asset should be. Here are some of those considerations:

QUALITY OF EQUIPMENT PURCHASED

As with any major piece of equipment or asset, there are units designed and manufactured for lowest first cost as the primary driver and others where the driver is longevity and lower operating cost. Justification for the pricing is based upon efficiency, unit features, and unit construction. This applies to all brands of HVAC systems. There are markets for all levels of quality and cost. If your need is short term, a lower cost product may be sufficient. If you are looking for a high efficiency, better constructed product, the cost will be higher. Generally speaking, higher quality units do tend to have a longer life span particularly if they are properly maintained.

LOCATION OF THE FACILITY

Geographic location plays a significant role in the life expectancy of HVAC equipment. The most common threat to equipment is the outdoor environment. Proximity to salt water is a factor that reduces efficiency and life expectancy. The salt causes corrosion to the unit structure and, more importantly, to the condenser (outdoor) coils. In addition, pollutants from certain types of manufacturing facilities can cause shortened life if the air contains any substance that can damage the unit material. Climate also affects equipment life. Increased number of annual operating hours due to extreme climates causes an increase in component failure and a shorter life.

PREVENTIVE MAINTENANCE

Proper preventive maintenance has a large effect in determining the life span of all HVAC units. An increased life span reduces the total cost of ownership because the installed cost is spread over a longer period of time. Preventive maintenance also reduces repair costs as minor issues can be diagnosed and corrected prior to possibly causing major component failure. To get a better understanding of how proper maintenance affects the life expectancy of the equipment, a basic understanding of how the unit operates is necessary.

All HVAC equipment is designed for one purpose - heat transfer. For cooling, the heat is extracted from the space to lower the temperature and is rejected to the outdoors. In the heating cycle, energy (heat) from burning fossil fuels or electric heating elements is transferred to the air in the space to increase the temperature.

On the cooling side, air is passed through a coil that contains either a refrigerant or water that is lower in temperature than the air passing over it so that the heat is transferred from the air to these substances. Once the heat is transferred to the outdoor air, it is transported back to the space at the lower temperature (and lower humidity level) until the desired temperature is met.

Whatever process or type of equipment is utilized to increase or decrease the temperature inside the space, it is critical to keep all components that transfer heat or move the air clean and free of dirt and debris that can build up over time. Issues caused by fouling of these components can cause reduction of heat transfer due to the dirt acting as an “insulator,” or a reduction in airflow due to the buildup of the dirt as well. This reduction of heat transfer and airflow causes the equipment to operate at conditions outside its intended design range which can cause premature component failure as well as a shortened life span.

The way that these components keep clean is with filters. Filter changes are a primary task performed during each preventive maintenance visit. Annual drive belt replacement is required to assure proper airflow rates. A complete operational check of the equipment is required to confirm that it is operating efficiently thereby reducing energy usage as well as having the technician diagnose any malfunctions.

Retail Facilities 101: Anatomy of a Trade

PRSM Online Education provides courses that deliver the knowledge you need and provides an exceptional learning experience. These programs can be viewed online 24/7/365, and videos can be stopped and resumed at a later time or day.

One section of the PRSM Online Education features Retail Facilities 101, nine dedicated courses for retail facility management professionals with basic technical trade knowledge that is valuable in the marketplace. For example, the course "Retail Facilities 101: HVAC" showcases:

- How an HVAC Unit Operates and System Types
- HVAC Component Identification, Operation, and Common Failures
- Preventive Maintenance and an Onsite video
- Controlling the Equipment and Energy Considerations
- Refrigerants and Climate Change

This course is perfect for additional information on the basic principals of HVAC mentioned throughout this paper. Please email education@prsm.com if you have any questions.

FOUR FACTORS THAT DETERMINE TOTAL COST OF OWNERSHIP

INSTALLED COST

The installed cost includes the equipment and the labor to install it along with any factory installed options, field installed accessories, controls, air distribution systems, and commissioning. Generally speaking, higher efficiency equipment has a higher first cost than entry level equipment. However, since higher efficiency equipment costs less to operate, there is a trade-off between first cost and energy cost that must be calculated over the anticipated life span of the equipment. This will be addressed in the "Energy Cost" section below.

Manufacturers offer a multitude of factory installed options that allow equipment to be custom configured. Some examples are:

- Disconnect switches
- 115-volt convenience outlets
- Smoke detectors
- Economizers
- Power exhaust fans and relief dampers
- Coated coils for corrosive protection
- Various controls options

Typically, anything that can be factory installed will cost significantly less than the same device installed in the field. For example, having factory installed smoke detectors in rooftop units result in installed cost, maintenance cost, and repair cost savings. Installed cost is reduced because field labor is replaced by factory labor at lower rates and greater efficiency. If the detectors are field installed, they are typically located in the ductwork below the roof deck where access to service them is extremely difficult, often requiring the use of a scissor lift and two technicians at significant cost.

ENERGY COST

The total cost of the energy required to operate your HVAC system will depend on the type of system, the efficiency of the equipment, the type of energy used, local cost for the energy itself (such as the cost per kilowatt of electricity and cost per therm for natural gas), unit runtime, the type of controls, and temperature set points.

The following illustration shows the difference in the cost of power for cooling in four metropolitan areas around the country. There are two examples shown below.

The first is a store with 50 tons of packaged rooftop equipment and the second is a store with 10 tons of packaged rooftop equipment. This is comparing the energy required for cooling on 20-year-old equipment versus new equipment. This example assumes energy efficiency ratings that are typical for each group of equipment.

For this illustration, a software tool was used to calculate the number of hours of equipment operation at part load and full load in each of the four cities. Based upon local utility rates the software calculates the annual estimated cooling cost of power.

It is important to note that this is a hypothetical illustration. The cost of the energy and operating hours can vary from the estimates used in these calculations. It is simply being used to show the degree to which equipment efficiency can affect total cost of ownership. Both examples are based on US Dollars.

50-Ton Load

20-Year-Old Units

(4) 10 Ton RTUs 8.0 EER/8.5 IPLV

(2) 5 Ton RTUs 8 SEER

New Units

(4) 10 Ton RTUs 12.0 EER/13.0 IPLV

(2) 5 Ton RTUs 15 SEER

City	Cost per KWH	20-Year-Old Units	New Units	Cost Difference
Los Angeles, CA	$.15/KWH	$8,739	$6,087	($2,652)
New York, NY	$.17/KWH	$13,511	$8,734	($4,777)
Chicago, IL	$.09/KWH	$6,857	$4,433	($2,424)
Miami, FL	$.10/KWH	$19,425	$12,450	($6,975)

10-Ton Load

20-Year-Old Units

(2) 5 Ton RTU's 10 SEER

New Units

(2) 5 Ton RTU's 15 SEER

City	Cost per KWH	20-Year-Old Units	New Units	Cost Difference
Los Angeles, CA	$.15/KWH	$1,911	$1,221	($690)
New York, NY	$.17/KWH	$3,013	$1,736	($1,277)
Chicago, IL	$.09/KWH	$1,534	$881	($653)
Miami, FL	$.10/KWH	$4,389	$2,463	($1,926)

The energy cost difference between the 20-year-old units and new units is clear. This is due to the relative efficiency of the equipment, difference in cooling degree days, and different utility rates.

Efficiency is measured and recorded with the following four ratings:

SEER - Seasonal Energy Efficiency Ratio
EER - Energy Efficiency Ratio
IPLV - Integrated Part Load Value
IEER - Integrated Efficiency Energy Ratio

SEER and EER measure unit efficiency for full load operation. IPLV and IEER measure unit efficiency at part load operation: the higher the number, the more efficient the unit.

Full load operation is defined as the unit operating at 100 percent of its rated capacity. Part load operation is defined as the unit operating at less than rated capacity as accomplished by cycling compressors off, reducing compressor speed, or unloading compressors. Equipment operating at reduced capacity consumes less energy. The degree to which energy consumption is reduced is determined by system design.

Another opportunity to reduce energy usage as well as service and maintenance cost is through the use of Energy Management Systems (EMS) to control the HVAC and lighting. The primary advantage of energy management systems is the ability to establish temperature set points that cannot be altered by store personnel, ability to establish a dead-band between heating and cooling set points, and the ability to set up or set back temperature set points during unoccupied periods.

Energy usage can be further reduced by varying the amount of air circulated by the equipment based upon the required cooling load. This is commonly known as multi-stage air volume control or single zone variable air volume control and is accomplished by using variable frequency drives (VFD's) or electronically commutated motors (ECM's). Think of this as the fan speed control on an automobile air conditioner. These devices provide a huge potential energy savings, and they are currently required by code on units with capacities of nine tons or greater in many cities and states. However, they must be applied carefully and can cause many service issues and shorten the life of heat exchangers and compressors if not applied correctly. They can also have a negative effect on the relative quantity of air being delivered to different zones within the conditioned space.

PRSM Energy Benchmarking Initiative Study

The ultimate success of many retail FM operations depends upon effective energy management. PRSM's benchmarking report, "Energy Benchmarking Initiative Study" is action-oriented and helps members succeed by taking energy management to the next level, boosting both efficiency and cost savings. The report helps PRSM members understand and achieve energy efficiency goals by providing updated information about the state of energy management within the U.S. and Canadian retail sector and benchmarking data for both organizational and technical best practices.

HVAC was one of the areas for energy efficiency studied in the survey. The survey respondents have implemented 45 percent of the identified HVAC best practices. The survey asked respondents about the age and type of equipment. Additionally, the survey created the following list energy efficiency opportunities that may be applied to various retail facilities, including standalone stores and those within enclosed structures.

Continued on next page

Opportunity Type	Typical Measures Assessed
Category 1 Operational Projects	• Install basic thermostats and implement temperature setback. • Reset chilled/hot water temperature. • Schedule fans. • Add an economizer to an existing air handler.
Category 2 Retrofit Projects	• Apply a variable speed drive to an existing air handler or pumping system. • Apply demand control ventilation. • Install high-efficiency condensing unit heaters and/or furnaces. • Recommission an existing building automation system.
Category 3 Capital Renewal Projects	• Install a new high-efficiency cooling/condensing natural gas rooftop unit. • Install a new variable speed and/or magnetic bearing chiller. • Install a new building automation system.

The full benchmarking report is available on the PRSM website for all PRSM Members. If you have any questions, please email benchmarking@prsm.com.

MAINTENANCE COST

Earlier in this paper, there was discussion about the savings realized on initial cost for factory installed options. Additionally, unit design has evolved over the years to lower the cost of preventive maintenance and repairs through the addition of hinged access panels, slide out filter racks and blower assemblies, and improved coil access for cleaning. These innovations reduce the amount of time required to perform filter changes, belt replacements, and coil cleanings.

Unit location and access issues can also impact both maintenance and repair costs. Such things as mall security check in, amount of time needed to gain access to the equipment, location of the equipment within the store, and restrictions on allowable time to service units in the retail space all need to be taken into consideration. It is possible that two technicians may be required on site due to the location of the equipment. Other restrictions can increase cost such as allowing after hours (overtime) access only.

Retailers often ask, "How do you determine the appropriate cost and level of preventive maintenance for an HVAC system?" Cost is determined by the required scope of work and frequency, and the labor rates applicable in the area where the site is located as well as equipment accessibility. There is a minimum work scope required to ensure reliable equipment operation and limited liability on the part of the retailer. This minimum scope includes such items as air filter replacement, drive belt replacement, and operational heating and cooling inspection. Additional tasks are added to the scope based on the trade off between maintaining efficiency and cost of maintenance, as well as the tolerance for equipment downtime.

Retail stores served by packaged units or split systems typically require four maintenance visits per year.

- Spring: There is a cooling start up that includes a filter and belt change along with a complete cooling operational check.
- Summer: This visit consists of a filter change and visual operation check.
- Fall: This visit includes a heating start up and filter change. This also includes a complete inspection of the heating components (if applicable) and operational check.
- Winter: This visit features a filter change and visual operational check.

Different types of systems such as chillers, chilled water air handlers, VAV systems, and others can require a change in work scope and frequency.

SERVICE/REPAIR COST

As mentioned previously, in some ways, equipment design has evolved over the years to lower the cost of repairs. Innovations such as self-diagnostics and technician test modes have reduced service costs. On the other hand, today's equipment is far more complex than older equipment and many components that were repairable in the past now require replacement when they fail. Impact to the repair cost varies based upon the components used in each unit and the specific failure. Some equipment design innovations that reduce the cost of repair are color coded wiring, location of components for better access, slide out blower decks, plugged connections for electrical components, and use of multiple circuits and redundant parts.

The use of OEM (Original Equipment Manufacturer) repair parts may increase the cost of an individual repair however this is strongly recommended for most components. Universal or non-OEM components may be less expensive, but may require labor to adapt them to the particular application or may alter the efficiency or capacity of the unit. OEM replacement parts also tend to have a longer life cycle as well as having better compatibility because they are supplied by the manufacturer of the equipment. In addition, these parts are approved by the manufacturer and their use cannot void manufacturer's extended warranties.

One recent issue that has had a vast impact on the cost of service is the cost and availability of R22 refrigerant. There is a legal mandate for the reduced annual production and eventual elimination of this refrigerant by the year 2020. The Montreal Protocol required the elimination of R22 in all HVAC units manufactured after January 1, 2010 and the eventual phase out of production by January 1, 2020. The result of limited supply has caused a dramatic and dynamic increase in the cost of this refrigerant to contractors. As supply levels continue to be reduced, the cost will continue to increase and there is a fear that demand will exceed available supply. As manufacturers anticipate a reduction in the number of operating R22 units, availability of replacement components specific to units containing R22 will become limited. There are some alternate replacement refrigerants available but there are issues associated with each including capacity or efficiency reduction, oil compatibility, and the need to replace multiple other system components. This situation is resulting in an unprecedented increase in cost involving refrigerant related repairs, including compressor and coil replacements as well as refrigerant leaks.

CONCLUSION

As you can see, determining the Total Cost of Ownership for HVAC systems is not a simple task. Quality and efficiency of equipment, factory installed options, geographic location, temperature set points, store operating hours, cost of energy, cost of labor, cost of repair parts, preventive maintenance scopes, and types of controls are all contributory factors. The most accurate way to determine this cost for a retailer's specific facilities is through mining the historic data for each of the categories above. This information can then be evaluated to determine cost of ownership per ton, per unit, and per square foot. The data can be further evaluated based upon equipment age and geographic location to assist in determining possible trends.

Technology is continuing to evolve with respect to equipment design as well as with maintenance and service innovation. With the advent of IVR (Interactive Voice Response) and GPS, tablets, smart phones, intelligent controls, and specialized apps, efficiencies are gained and cost is reduced. The retail facilities management industry is consistently evolving and HVAC is certainly a part of those changes.

NOTES:

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