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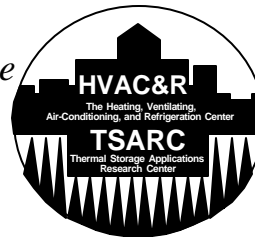
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# HVAC & R NEWSLETTER

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## **HVAC&R Center Develops new "Residential Duct Design Guide"**

*By Bob Gansler*

The level of comfort that heating and cooling units can provide is highly dependent on the correct design and installation of the air distribution system associated with those units. In an energy-efficient residential space-conditioning design, the air distribution systems will supply the needed quantity of properly conditioned air to each room and then return room air to the equipment to be rec conditioned. The capabilities of the conditioning equipment – static pressure, air volume, heating and cooling capacity, and sound level – must be considered in establishing the proper design and installation of a duct system. Losses within the duct system should be minimized in order to ensure proper operation of the overall space conditioning system.

The objective in designing a space conditioning system is to conveniently, dependably, and cost-effectively deliver comfort. Although owners want low first cost and low operating cost systems, these goals tend to conflict. As a result, contractors often guide the homeowner in system selection to achieve acceptable performance at reasonable first cost and operating cost. Simplicity and directness in design are key elements in cost-effective and satisfactory performing space conditioning systems.

In order to address these needs, the HVAC&R Center began in late 1999 the development of a new Residential Duct Design Guide for EPRI. The new version serves as an update to the original guide published by EPRI in 1991. The new guide is complete and undergoing final review prior to publication.

.....continued on page 3

# Energy Evaluation of a Frozen Foods Plant

By Jim Elleson

A large producer of frozen meals located in northwest Arkansas sought to reduce energy use and costs while maintaining or increasing product quality and production capabilities. The plant utilities staff have been aggressively pursuing energy efficiency improvements and wanted to do more. The utilities manager asked Southwestern Electric Power Company (SWEPCO) and the HVAC&R Center to help identify opportunities for increasing the efficiency and effectiveness of the refrigeration and space-conditioning systems.

HVAC&R Center Technical Services Director Jim Elleson and consultant Jim Denkmann visited the plant, met with plant personnel and observed the layout and operation of the plant. The investigators then prepared a report that describes the existing conditions in the plant, recommends specific improvements, and provides guidance to the utilities staff in developing a comprehensive, prioritized list of opportunities for further analysis. Some of the findings of the report are summarized below.

## Ammonia Refrigeration System

Overall, the ammonia refrigeration system is very well designed, operated, and maintained. The engine room consists of 17 twin screw compressors, most of which are 350 hp, in a two-stage configuration. All compressors have thermosiphon oil coolers.

Compressor head pressures are normally held between 150 and 160 psig but sometimes rise as high as 190 psig during summer months. The high summer head pressures are evidence of insufficient heat rejection capacity. Factors that could be contributing to this shortfall include:

- Evaporative condenser capacity not matched to the load
- Waterside fouling or scaling of condenser tubes
- Uneven water or air distribution in evaporative condensers
- Accumulation of noncondensibles in the system
- Liquid ammonia hanging up in the condensers

We recommend that the plant implement floating head-pressure control, allowing the head pressure to move up and down with seasonal swings in the ambient wet-bulb temperature. Reducing the head pressure when the wet-bulb temperature is low provides tremendous energy savings. To achieve significant reductions in head pressure, we recommend dedicating one evaporative condenser to serve the thermosiphon oil coolers, converting existing high-pressure receivers to controlled-pressure receivers, and installing liquid drainers on the evaporative condensers. To take advantage of additional capacity and efficiency benefits, we recommend adding a compressor to handle the flash gas produced at the new controlled-pressure receivers.

Additional recommendations for the ammonia refrigeration system include investigating the static pressure penalty at the suction risers for the spiral freezer evaporators, and modifying the evaporators in the storage freezer vestibule to operate with a surface temperature of 33-34°F for maximum moisture removal.

## Makeup Air

Any air that is exhausted from a space must be balanced by an equal volume of makeup air. If the makeup air is not mechanically supplied to the space, it will flow from other areas or from outside the building, with a detrimental effect on temperature and humidity control. Makeup air flowing from one production area to another can also carry odors and other contaminants.

We noticed substantial airflows between areas, indicating that exhaust air is not properly balanced by makeup air. For example, there was significant airflow into the casing area from nearby loading docks. This uncontrolled makeup air increases the space-conditioning load and contributes to moisture-control problems in the casing area. We also noticed air flowing between conditioned and unconditioned areas. While this airflow may help to moderate temperatures in unconditioned areas, it increases the air-conditioning loads and diminishes the ability to control space temperatures and energy use.

We recommend that the exhaust-makeup air balance in the entire plant and in each individual space be evaluated to ensure that airflows within the plant are properly controlled. Relocate or add makeup air as needed to provide an appropriate balance in each area. If new makeup air units are added, consider exhaust air heat recovery for preheating makeup air.

## Desiccant Dehumidification

A desiccant dehumidifier uses a desiccant medium to adsorb water vapor from a moist air stream. The medium is regenerated at intervals by heating it to drive off the adsorbed moisture. A desiccant dryer can effectively reduce the latent load in a space, reducing or eliminating defrost and preventing other problems with frost and ice. However, the desiccant dehumidification process also increases the sensible load, because of the heat that is added to regenerate the desiccant medium. Our studies to date indicate that neither desiccant nor vapor-compression dehumidification is clearly preferred from an energy-efficiency standpoint. The best approach for a given application is determined by site-specific details such as infiltration loads, equipment limitations, and special conditions in the particular space.

A gas-fired desiccant dryer was installed in an area that formerly suffered from excessive humidity. This has solved the humidity problem and eliminated unwanted ice formation. It appears that the additional sensible load from the desiccant unit is being taken up by other units in the vicinity, and that the desiccant unit is meeting latent loads from adjacent areas. This cross-loading could represent unnecessary energy use if the dehumidification requirements in the other areas are not as strict.

The availability of relatively high-temperature exhaust air offers an opportunity for desiccant dehumidification. Exhaust air at 200-250°F could be used for regeneration, drastically reducing the desiccant system's operating cost.

### Guidelines for Identifying and Prioritizing Energy Conservation Projects

The following basic guidelines are useful for identifying and prioritizing energy conservation opportunities:

- ❖ Develop an end-use breakdown of the energy used in the plant. Measure, calculate, or estimate the amount of energy used in each major system: refrigeration, space conditioning, steam. Break these down further into usage for specific subsystems and processes. Account for all the energy purchased by the plant.
- ❖ Determine the energy cost for each process, in terms of cost per hour of operation or per pound of product. Calculate the energy cost of each product. Identify those processes that add the most energy cost to the products. Identify those products whose energy cost is a significant percentage of their total production cost.
- ❖ Consider the effects of space conditioning on comfort, productivity and labor costs. If productivity goes down during very hot weather, estimate the value of improved comfort conditions in terms of increased productivity.
- ❖ Focus on the products and the processes that have the most significant energy costs for possible modifications and improvements.
- ❖ Measure the impacts of conservation projects on energy use and productivity.

#### Status

The plant management was pleased with the report and is currently investigating implementation of the recommendations.

### Checked Our Website Lately?

If you haven't had a chance to check out our website, this might be a good time to take a look around. Among several other things, you'll find the Center's Newsletters in pdf format.

In fact, if you like, we can notify you via e-mail as new editions get posted. If you are interested in reading the newsletters in electronic copy, why not send us your e-mail address? You can send us your preference (paper copy or e-mail notification of electronic copy) by e-mail to Diana at: [dlarpke@facstaff.wisc.edu](mailto:dlarpke@facstaff.wisc.edu) or you can contact us directly off the website, at :

<http://www.hvacr.wisc.edu>

## EPRI Releases the "Refrigerator/Freezer Selection Guide"

By Dan Dettmers

Nearly every household in the United States has at least one refrigerator. More than 40% of domestic households have a stand-alone freezer as well. Sales of new refrigerators for homes have climbed from 8 million in 1989 to 10 million in 1997 and 1998. Approximately 60% of the refrigerators are purchased to replace older models, while the remaining 40% are bought for new households or as second refrigerators. Unfortunately, the majority of these units are purchased based on the criteria of first cost, features, and color. Both the consumers and organizations that provide information to the consumers often overlook the energy consumption of these units. To provide a new perspective, the HVAC&R Center, with Energy International Inc., developed the Refrigerator/Freezer Selection Guide for EPRI's Residential funders. ....continued on page 4

## HVAC&R Center Develops new "Residential Duct" ..... continued from page 1

The new Residential Duct Design Guide contains nine sections.

- Section 1 introduces some basics about the air properties and duct system design
- Section 2 describes the components involved in a residential duct system
- Section 3 details the factors influencing duct layout
- Section 4 shows how the information from the previous three sections fits together
- Section 5 describes the steps involved in supply and return duct design
- Section 6 provides a detailed example of supply and return duct design
- Section 7 discusses the issue of duct cleaning
- Section 8 summarizes the recent research regarding duct sealants
- Section 9 provides information on applicable standards relating to residential duct design

This guidebook is intended to serve as a useful reference for duct design and installation procedures. Beginning with basic engineering principles, this guidebook progresses through the different types of air distribution systems to the methodologies for designing supply and return air ducts.

Each section begins with a stated objective and the key terms and ends with review questions. The Appendices include a glossary, friction charts, line drawings of ductwork, duct design formulae, and a design worksheet form.

## EPRI Releases the “Refrigerator/Freezer Selection Guide” *(continued)*

EPRI’s Refrigerator/Freezer Selection Guide serves as a no nonsense aid for making decisions concerning new and replacement purchases of refrigerators and freezers. The Guide makes it possible for customers to compare the purchase price and energy costs associated with different new models and compare the annual energy costs among new units versus existing less-efficient units that should often be replaced. The Refrigerator/Freezer Selection Guide is not just an appliance-selection tool. In fact, it is a mini-encyclopedia of refrigeration, offering comprehensive coverage of refrigerators and freezers for residential applications. The guide provides details on:

- the refrigeration cycle and the function of a refrigerator’s components
- the types of refrigerators and freezers available on the market
- the various processes that cause food to spoil
- the freezing process and proper methods of thawing perishable food
- energy-saving tips for refrigerators and freezers

The guide also includes background on the history of refrigeration and sketches the future of refrigeration technology, citing insulation and compressor improvements and other changes that could further increase unit efficiency. Much of this information is designed to assist consumers in selecting equipment, but it is also intended to serve as handy online reference material for utility customer service and marketing personnel, who will find the glossary, search engine, and responses to Frequently Asked Questions helpful. The Residential Refrigerator Selection Guide has been designed to provide knowledgeable information to assist in the selection of a refrigerator and/or freezer for residential use. The Guide can function as:

- ❖ A self-directed guide to residential refrigerators and freezers for the average homeowner
  - ❖ A self-directed guide to residential refrigerators and freezers to train residential utility representatives
  - ❖ An on-line reference tool for utility phone center marketing and technical support staff
  - ❖ A demonstration tool for utility personnel to educate attendees of garden and home shows
  - ❖ A comparison tool that can be used by consumers, retailers, and utility personnel to compare various models of refrigerators and freezers
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