Unique Tracking Number Assigned by MORTS RTAR 1434
RESEARCH TOPIC ACCEPTANCE REQUEST (RTAR) FORM
(2 pages suggested, 3 pages maximum)
TC/TG: 10.5 Refrigerated Distribution and Storage Facilities

Title:
Refrigerated Facilities Doorway Infiltration Air Energy Reduction

Applicability to ASHRAE Research Strategic Plan:
This directly meets the needs of:

A6. Develop integrated, best practice design methods that will allow energy consumption, life cycle cost, and environmental impact to be minimized, and that will allow system life span and IEQ to be maximized.

A8. Establish benchmark data on energy use in industrial refrigeration

C6. Establish design tools to improve the installed energy efficiency of heating, ventilating, cooling, and refrigeration systems and their components.

D1. Establish techniques to improve the energy efficiency and reliability of heating, ventilating, cooling, and refrigeration system components (e.g.., heat exchangers, compressors, pumps, fans, distribution systems).

D7. Develop techniques that reduce the installed energy use of HVAC&R system auxiliary equipment 50 % by 2015.

E1. Make the results of ASHRAE sponsored and cooperative research available to the technical community.

See "Justification and Value to ASHRAE" for additional information.

Research Category:
Energy Conservation; Food Processing and Preservation; Refrigeration Systems

Research Classification:
Basic/Applied Research

TC/TG Priority:
2

TC Vote:
For __11_;Against__0___;Abstentions___0__;Absent__2___;Total___13_____

Reasons for Negative Votes and Abstentions:

*George Briley was one of the absent members. His is a senior member that has a hard time communicating. Please forgive our single absent vote.

Estimated Cost:
$160,000

Estimated Duration:
(18 months duration)

Other Interested TC/TGs:
TC 10.8 Refrigeration Load Calculations (voted support at Chicago meeting)

Possible Co-funding Organizations:
International Association of Refrigerated Warehouses (IARW) (Approached and considering)

Tyson Foods has indicated that the researcher could have access to some of their facilities for the necessary field monitoring.

Application of Results:
ASHRAE Handbook, Refrigeration
Chapter 12, Refrigeration Load
Chapter 13, Refrigeration Facility Design
ASHRAE *Design Essentials for Refrigerated Storage Facilities*
Preparation of an ASHRAE Special Publication titled "Design Guide for Refrigerated Facilities Doorway Air Infiltration and Energy Reduction"

State-of-the-Art Background:
ASHRAE research completed in 1989 verified the validity of the 1975 Gosney and Olama research covering infiltration air exchange through cold storage doorway openings that provided mathematical equations for determining air exchange for fully established flow. Follow-up ASHRAE research in 1993 provided a general effectiveness rating of infiltration air reduction devices and methods then available for use at cold storage doors used primarily for transporting items via fork lift trucks. These research results are incorporated in Chapters 12 and 13 of the Refrigeration Handbook and provide the only ASHRAE recognized method for determining infiltration air refrigeration loads.

Heat gain from air infiltration at doorways is a widely variable component and can be a substantial portion of the total facility load in high traffic or poorly operated facilities. Air infiltration also contributes to safety hazards related to ice formation, moisture sorption by paper-based packaging, and air relative humidity levels. The above research provided the ability to determine the infiltration air load accurately versus the air change or load percentage methods then in common use. The 1989 research remains a solid basis for calculating air infiltration without infiltration devices. The 1993 research, however, covers only those devices and systems that may have been available prior to 1992. Since then there have been several new devices and changes to existing designs, some of which consume energy as a method to eliminate frost in the doorway rather than to reduce infiltration air.

In addition, the 1993 research only measured effectiveness for one rate of traffic movement through doorways, and did not address multiple door opening applications. Current flow factors and effectiveness ratings have large uncertainties meaning heat load predictions can be out by a factor of two.

Advancement to the State-of-the-Art:
The primary advancement will be to authenticate effectiveness ratings of various doorway infiltration air devices and systems in actual applications and to market to practitioners, end users and suppliers that the application and use of the most effective design, systems and methods can have significant impact on energy reduction at doorways for both new and existing facilities. This will be presented in a user-friendly manual to provide easy to analyze solutions that has been absent as a follow-up to previous research.

For example, a mere 10% increase in effectiveness for one 8 ft. by 10 ft. fork lift truck door in a freezer application could provide a energy savings of 15,000 to 30,000 kWh per 250-day year depending on the door usage.

The potential results for the determination of realistic effectiveness systems coupled with a user-friendly manual for education and promotion of their use at the thousands of refrigerated doorways world-wide is very substantial in terms of energy reductions, cost savings and safe operations.

Justification and Value to ASHRAE:
The principle impact will be to the refrigeration practitioners and those professionals and personnel involved in the design, construction, operation and maintenance of refrigerated facilities. The potential for adoption by industry is high provided there is education, promotion, and follow-up republication of the information that is relatively easy to apply and has wide-spread acceptance.

The post-research emphasis is important as this was not done after the 1993 research project, and it is surmised that the methodology recommended was not widely adopted. This is evidenced by the fact that

air change or load percentage methods are still being published and used. These methods are not nearly as accurate, particularly in the high traffic facilities that are now prevalent.

There may be an opportunity for ASHRAE to benefit with intellectual property particularly if the accomplishments are accompanied with an application manual for use of these excellent tools. It should be recognized that they are not only applicable for new applications but also for improvement in existing doorway energy reduction performance. Frankly, perhaps the most effective use of these infiltration air calculation methods may be in existing doorway applications where substantial energy savings can be achieved with relative ease.

Thus, preparation of a design guide for refrigerated facilities doorway air infiltration and energy reduction that provides examples, calculations and illustrations beyond the scope that can be logically included in the Handbook or an overall facility design guide is part of this project. Such a guide, will provide the marketing, promotion and acceptance that did not occur following the excellent 1989 and 1993 research projects.

This research will contribute to the following ASHRAE strategic plan themes and goals:

(a) Theme I – Energy and Resources
    a. Develop integrated, best practice design methods that will allow energy consumption, life cycle cost, and environmental impact to be minimized, and that will allow system life span and IEQ to be maximized.
    b. Establish benchmark data on energy use in industrial refrigeration
(b) Theme III – Tools and Applications
    a. Establish design tools to improve the installed energy efficiency of heating, ventilating, cooling and refrigerating systems and their components
(c) Theme IV – Equipment, Components and Materials
    a. Establish techniques to improve the energy efficiency and reliability of heating, ventilating, cooling and refrigeration system components.
    b. Develop techniques that reduce the installed energy use of HVAC&R system auxiliary equipment 50% by 2015.
(d) Theme V – Education and Outreach (Technology Transfer)
    a. Make the results of ASHRAE sponsored and cooperative research available to the technical community.

Objective:

This research will provide the additional information required to prepare a design guide. The guide will allow ASHRAE members and others to use the doorway infiltration air calculations and various reduction devices design information effectively to provide solutions to minimize the refrigeration loads at doorways while maximizing doorway performance and safety.

Specific objectives will be to:

Measure the effectiveness of the following forklift door protection devices for a range of forklift traffic movement frequencies and operating conditions (temperature and relative humidity):

- Air curtains
- Air-lock vestibule
- Above systems including additions of heat to alter sensible heat ratios of the infiltrated air
- Open doorway without protection (blocking effect of the traffic)

Measure the air infiltration of truck/trailer dock doors with a range of protection systems (e.g. inflatable cushions, bump cushions, flexible flaps) for a range of operating conditions.

Prepare a design guide for protection of doorways into refrigerated facilities.

Key References:

Gosney, W. B. and H. A. L. Olama. 1975. Heat and enthalpy gains through cold storage doorways. Proceedings of the Institute of Refrigeration, 1975-1976 72:31-41.

Hendrix, W. A., D. R. Henderson and H. Z. Jackson, 1989. Infiltration heat gains through cold storage room doorways. ASHRAE Transactions 95(2): 1155-1168.

Downing, C. G. and W. A. Meffert, 1993. Effectiveness of cold storage infiltration devices. ASHRAE Transactions 99(2): 356-366.