Federal Register

Thursday,
September 9, 2010

Part III

Department of Energy

10 CFR Part 431

Energy Conservation Program: Test Procedures for Walk-In Coolers and Walk-In Freezers; Proposed Rule

DEPARTMENT OF ENERGY

10 CFR Part 431

[Docket No. EERE–2008–BT–TP–0014]

RIN 1904–AB85

Energy Conservation Program: Test Procedures for Walk-In Coolers and Walk-In Freezers

AGENCY: Office of Energy Efficiency and Renewable Energy, Department of Energy.

ACTION: Supplemental notice of proposed rulemaking.

SUMMARY: The U.S. Department of Energy (DOE) previously published a notice of proposed rulemaking to adopt test procedures for measuring the energy consumption of walk-in coolers and walk-in freezers, pursuant to the Energy Policy and Conservation Act (EPCA), as amended. DOE is continuing to consider those proposals, but is now soliciting comments on several alternative proposed options. Once any final test procedure is effective, any representation as to the energy use of walk-in equipment must reflect the results of testing that equipment using the test procedure. Concurrently, DOE is undertaking an energy conservation standards rulemaking for this equipment. If DOE receives data in this test procedure rulemaking that are pertinent to the development of standards, it will use that data in evaluating potential standards for this equipment. Once these standards are promulgated, the adopted test procedures will be used to determine compliance with the standards.

DATES: DOE will accept comments, data, and information regarding this supplemental notice of proposed rulemaking (SNOPR) no later than October 12, 2010. See section V of this SNOPR for details.

ADDRESSES: Any comments submitted must identify the SNOPR for Test Procedures for Walk-In Coolers and Walk-In Freezers and provide docket number EERE–2008–BT–TP–0014 and/or Regulation Identifier Number (RIN) 1904–AB85. Comments may be submitted using any of the following methods:

1. *Federal eRulemaking Portal: http://www.regulations.gov.* Follow the instructions for submitting comments.

2. *E-mail: WICF–2008–TP–0014@hq.doe.gov.* Include the docket number EERE–2008–BT–TP–0014 and/or RIN 1904–AB85 in the subject line of the message.

3. *Postal Mail:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, Mailstop EE–2J, 1000 Independence Avenue, SW., Washington, DC 20585–0121. Please submit one signed original paper copy.

4. *Hand Delivery/Courier:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, 950 L'Enfant Plaza, 6th Floor, Washington, DC 20024. Please submit one signed original paper copy.

For detailed instructions on submitting comments and additional information on the rulemaking process, see section V of this document.

Docket: For access to the docket to read background documents or comments received, visit the U.S. Department of Energy, Resource Room of the Building Technologies Program, 950 L'Enfant Plaza, 6th Floor, Washington, DC 20024, (202) 586–2945, between 9 a.m. and 4 p.m. Monday through Friday, except Federal holidays. Please call Ms. Brenda Edwards at the above telephone number for additional information regarding visiting the Resource Room.

FOR FURTHER INFORMATION CONTACT: Mr. Charles Llenza, U.S. Department of Energy, Building Technologies Program, EE–2J, 1000 Independence Avenue, SW., Washington, DC 20585–0121, (202) 586–2192, *Charles.Llenza@ee.doe.gov*; Mr. Michael Kido, U.S. Department of Energy, Office of General Counsel, GC–71, 1000 Independence Avenue, SW., Washington, DC 20585–0121, (202) 586–8145, *Michael.Kido@hq.doe.gov*; or Ms. Elizabeth Kohl, U.S. Department of Energy, Office of General Counsel, GC–71, 1000 Independence Avenue, SW., Washington, DC 20585–0121, (202) 586–7796. E-mail: *Elizabeth.Kohl@hq.doe.gov.*

SUPPLEMENTARY INFORMATION:

I. Authority and Background

Title III of the Energy Policy and Conservation Act of 1975, as amended ("EPCA" or, in context, "the Act") sets forth a variety of provisions designed to improve energy efficiency. Part B of Title III (42 U.S.C. 6291–6309) provides for the Energy Conservation Program for Consumer Products Other Than Automobiles. The National Energy Conservation Policy Act (NECPA), Public Law 95–619, amended EPCA to add Part C of Title III, which established an energy conservation program for certain industrial equipment. (42 U.S.C. 6311–6317) (These parts were subsequently redesignated as Parts A and A–1, respectively, for editorial reasons.) Section 312 of the Energy Independence and Security Act of 2007 ("EISA 2007") further amended EPCA by adding certain equipment to this energy conservation program, including walk-in coolers and walk-in freezers (collectively "walk-in equipment," "walk-ins," or "WICF"), the subject of this rulemaking. (42 U.S.C 6311(1), (20), 6313(f), and 6314(a)(9))

At its most basic level, the term "walk-in equipment" encompasses enclosed storage spaces of under 3,000 square feet that can be walked into and are refrigerated to specified temperatures—above 32 degrees Fahrenheit (°F) for coolers and at or below 32 °F for freezers. (42 U.S.C. 6311(20)(A)) The term does not include equipment designed and marketed exclusively for medical, scientific or research purposes. (42 U.S.C. 6311(20)(B))

Walk-ins that meet this definition may be located indoors or outdoors. They may be used exclusively for storage, but they may also have transparent doors or panels for the purpose of displaying stored items. Examples of items that may be stored in walk-ins include, but are not limited to, food, beverages, and flowers.

Under the Act, the overall program consists of three parts: testing, labeling, and Federal energy conservation standards. The testing requirements consist of test procedures prescribed under the authority of EPCA. These test procedures are used in several different ways: (1) DOE uses them to aid in the development of standards for covered products or equipment; (2) manufacturers of covered equipment must use them to establish that their equipment complies with standards promulgated under EPCA and when making representations about equipment efficiency; and (3) DOE must use them to determine whether equipment complies with applicable standards.

Section 343 of EPCA (42 U.S.C. 6314) sets forth generally applicable criteria and procedures for DOE's adoption and amendment of such test procedures. That provision requires that the test procedures promulgated by DOE be reasonably designed to produce test results which reflect energy efficiency, energy use, and estimated operating costs of the covered equipment during a representative average use cycle. It also requires that the test procedure not be unduly burdensome to conduct. (42 U.S.C. 6314(a)(2)) As part of the process for promulgating a test procedure, DOE must publish a proposed procedure and offer the public an opportunity to present oral and written comments in response to that procedure. DOE solicited comments on the notice of proposed rulemaking ("NOPR") setting forth proposed test procedures, published on January 4, 2010 ("the January NOPR"). 75 FR 186. DOE also held a public meeting to discuss the January 2010 NOPR on March 24, 2010. DOE is now soliciting further comment through this SNOPR.

The January NOPR and the March 2010 meeting provided interested parties an opportunity to submit comments on the proposals. Interested parties raised significant issues and suggested changes to the proposed test procedures. DOE determined that some of these comments warrant further consideration. In today's notice, DOE addresses those comments and proposes adjustments to the initial test procedures proposed for walk-in equipment in the January 2010 NOPR.

II. Summary of the Proposal

DOE is proposing several changes to the proposal presented in the January NOPR. These changes involve:

(1) Definition of walk-in cooler and walk-in freezer.
(2) Testing and compliance responsibility.
(3) Versions of standards incorporated by reference.
(4) Basic model for envelope.
(5) Basic model for refrigeration system.
(6) Conduction through structural members.
(7) Alternatives to ASTM C1303.
(8) Heat transfer through concrete.
(9) U-factor of glass and non-glass doors.
(10) Steady-state infiltration through panel interfaces and doors.
(11) Door opening infiltration assumptions.
(12) Infiltration reduction device effectiveness.
(13) Relative humidity assumptions.
(14) Definition of refrigeration system.
(15) Annual walk-in energy factor.

Concurrently, DOE is undertaking an energy conservation standards rulemaking to address the statutory requirement to establish performance standards for walk-in equipment no later than January 1, 2012. (42 U.S.C. 6313(f)(4)(A)) DOE will use the test procedure in the concurrent process of evaluating potential performance standards for the equipment. After performance standards become applicable, manufacturers must use the test procedures to determine compliance with the standards, and DOE must use the test procedure to ascertain compliance with the standards in any enforcement action. Moreover, once any final test procedure is effective, any representation as to the energy use of walk-in equipment must reflect the results of testing that equipment using the test procedure.

III. Discussion

This section addresses issues raised by interested parties in response to the January NOPR and provides detail regarding DOE's proposed changes to the test procedure. Interested parties include trade associations (American Chemistry Council/Center for the Polyurethanes Industry (ACC/CPI), AHRI); manufacturers of the covered equipment (Craig Industries, Metl-Span, Nor-Lake, Carpenter, Master-Bilt, American Panel Corporation, Arctic Industries, Amerikooler, Kason, Hill Phoenix, TAFCO/TMP (TAFCO), International Cold Storage (ICS), ThermalRite, Manitowoc, Kysor Panel, HeatCraft, and Crown Tonka); suppliers of components used in the covered equipment (Honeywell, BASF, Dyplast, ITW Insulation, Owens Corning, HH Technologies (Hired Hand), Dow Chemical, and Schott Gemtron); utilities (Southern California Edison (SCE), San Diego Gas and Electric (SDGE), and the Sacramento Municipal Utility District (SMUD)); and energy efficiency advocates (American Council for an Energy-Efficient Economy (ACEEE)).

A. Overall Issues

1. Definition of Walk-In Cooler or Freezer: Temperature Limit

EPCA defines walk-in equipment as follows:

> (A) In general.—
> The terms "walk-in cooler" and "walk-in freezer" mean an enclosed storage space refrigerated to temperatures, respectively, above, and at or below 32 degrees Fahrenheit that can be walked into, and has a total chilled storage area of less than 3,000 square feet.
> (B) Exclusion.—
> The terms "walk-in cooler" and "walk-in freezer" do not include products designed and marketed exclusively for medical, scientific, or research purposes. (42 U.S.C. 6311(20))

During the public meeting on the January NOPR and in written comments, several interested parties stated that DOE should clarify this definition with respect to temperature limits and exclusions. Multiple interested parties commented that DOE should set an upper temperature limit for walk-ins. Three temperature limits were proposed: (1) 40 or 41 °F; (2) 45 °F; and (3) between 31 °F and 55 °F. Kysor stated that DOE should align with the National Sanitation Foundation (NSF) definition of 41 °F as the maximum high temperature for food storage. (Kysor, Public Meeting Transcript, No. 1.2.010 at p. 85) ICS agreed with Kysor but cautioned that this temperature could be different from the temperature set by the customer. (ICS, Public Meeting Transcript, No. 1.2.010 at p. 86)

In written comments, Kysor also suggested 40 °F as the upper limit because NSF/ANSI Standard 7, "Commercial Refrigerators and Freezers" uses such a requirement. See NSF/ANSI Standard 7, "Commercial Refrigerators and Freezers," Section 6.10.1, "Performance ("Storage refrigerators and refrigerated food transport cabinets shall be capable of maintaining an air temperature of 40 °F (4 °C) or lower in the interior.") (Kysor, No. 1.3.035 at p. 1) Craig and Hired Hand both indicated that 45 °F or 41 °F would be an acceptable upper limit. (Craig, Public Meeting Transcript, No. 1.2.010 at p. 86; Craig, No. 1.3.017 at p. 1 and Public Meeting Transcript, No. 1.2.010 at p. 19; Hired Hand, Public Meeting Transcript, No. 1.2.010 at p. 88) A comment submitted jointly by SCE, SDGE, and SMUD, hereafter referred to collectively as "the Joint Comment," recommended that DOE develop a definition to clarify that walk-in coolers operate at temperatures between 55 °F and 32 °F. (Joint Comment, No. 1.3.019 at p. 17) SCE pointed out that California's building energy standards consider 55 °F and below to be refrigerated. (SCE, Public Meeting Transcript, No. 1.2.010 at p. 85) TAFCO agreed that DOE should impose an upper limit of 55 °F because this is the highest temperature at which most refrigeration systems will operate. (TAFCO, No. 1.3.022 at p. 1) Craig disagreed with a 55 °F limit because this temperature is the typical holding temperature for wine coolers, but the walk-in wine cooler might be rated at a lower temperature. (Craig, Public Meeting Transcript, No. 1.2.010 at p. 86) DOE infers from the comment that Craig was concerned that the energy consumption of a wine cooler at the test procedure rating temperature might not represent the energy consumption at the actual holding temperature. Hired Hand stated that air conditioning is the first stage of cooling for walk-ins inside air-conditioned warehouses, which echoed the concerns of other commenters that the complete absence of an upper temperature limit might inadvertently include a wider variety of conditioned spaces than contemplated. (Hired Hand, Public Meeting Transcript, No. 1.2.010 at p. 87)

EPCA defines walk-in equipment, in part, as meaning a space that is "refrigerated," and as having a "chilled storage area." (42 U.S.C. 6311(20)) DOE proposes clarifying the term "refrigerated" within the statutory definition to distinguish walk-in equipment from air-conditioned storage spaces. DOE could not find a consensus among the industry for the definition of "refrigerated" or "chilled storage." However, the Joint Comment, SCE, and TAFCO suggested that 55 °F represented a boundary between "refrigerated space" and "conditioned space" as refrigeration systems typically do not operate above 55 °F, and air-conditioning systems typically do not operate below this limit. DOE found that preparation rooms, wine coolers, and storage coolers for most fruits and vegetables are considered refrigerated spaces and are typically cooled to temperatures between 45 °F and 55 °F. DOE proposes adopting a clarifying definition that would set an upper limit of 55 °F for walk-in equipment. DOE believes that using the upper limit of food storage temperatures (*i.e.,* 40 °F or 45 °F) to define walk-in equipment, as suggested by some commenters, would exclude some equipment that is "refrigerated" and has a "chilled storage area." Such an approach would, in DOE's view, exclude from coverage equipment that falls within the statutorily-prescribed scope of EPCA's walk-in definition. The space in which a walk-in is located (*e.g.,* a grocery store, warehouse, or other conditioned space) would not itself be considered a walk-in unless it meets the statutory definition of a walk-in and DOE's proposed clarifying definition that would set an upper limit on the temperature range. DOE requests comment on its proposal of clarifying "refrigerated" to mean at or below 55 °F.

2. Testing and Compliance Responsibility

In responding to comments received on the framework document, the January NOPR detailed DOE's proposal to create separate test procedures for the envelope and the refrigeration system, the two discrete systems that comprise a walk-in. 75 FR 191. These two systems may or may not each be manufactured by a separate manufacturing entity. Additionally, other manufacturers may be involved in producing secondary components—such as fan assemblies or lighting—that are then incorporated as parts of the refrigeration system or envelope.

In the January NOPR, DOE proposed that the envelope manufacturer would be responsible for testing the envelope according to the envelope test procedure, and the refrigeration system manufacturer would be responsible for testing the refrigeration system according to the refrigeration system test procedure. 75 FR 191. DOE believed that the manufacturers of the envelope and refrigeration systems—as parties most likely to be intimately familiar with the design and operation of their own equipment—would be more likely than installers to have the resources, equipment, and trained personnel needed to conduct the tests necessary to certify WICF equipment as compliant with any energy conservation standards that DOE develops. 75 FR 191.

However, interested parties commented that DOE's concept of a single envelope manufacturer may not align with the actual market. Commenters suggested that the panel manufacturers, whom DOE assumed would serve as the envelope manufacturers for purposes of testing compliance, did not necessarily control the design of the walk-in envelopes for which their panels were used. Many of the comments from interested parties suggested that DOE should assign compliance testing responsibility to parties involved in the physical assembly (*e.g.,* installers) and/or design-level specification (*e.g.,* general contractors) of the walk-in envelope because actions taken by these parties could have a significant effect on walk-in performance over its lifetime. Some commenters suggested various forms of joint responsibility between the manufacturer(s) of the envelope components and the parties responsible for the physical assembly and/or design-level specification of the envelope. Other interested parties commented that these options would not constitute a viable approach and that DOE should focus on the panel manufacturers for compliance testing because they would be more likely to have the proper equipment and expertise to test the panels.

Likewise, interested parties commented that DOE's concept of a single refrigeration system manufacturer may be inaccurate because the condensing unit and unit cooler of a single refrigeration system may be manufactured by separate entities and the whole system may be manufactured from these separate parts by a third manufacturer. Commenters generally suggested assigning joint responsibility between the manufacturer(s) of the unit cooler and condensing unit and the manufacturer of the system as a whole. Others suggested that DOE break a refrigeration system down into its individual components (*e.g.,* compressor, coils) and regulate each component separately.

DOE believes that many of the comments concerning compliance testing responsibility stem from the definition of the term "manufacture," which EPCA defines as "to manufacture, produce, assemble or import." (42 U.S.C. 6291(10)) Several interested parties requested clarification of the definition of "manufacture" and the implications of that role. DOE generally requires a single party, whose role falls under the term "manufacture," to assume compliance responsibility for a given appliance or equipment; typically, the party responsible for demonstrating compliance would conduct the necessary testing or arrange for testing to be conducted by a third party (e.g., a testing lab). DOE recognizes that the walk-in envelope and refrigeration system markets rely on multiple supply chain scenarios in which several distinct parties could serve different roles that may fall under the term "manufacture." In the case of both walk-in envelopes and refrigeration systems, DOE recognizes that assigning compliance responsibility to a single entity that may not be involved in all aspects of the design and construction of these systems may present certain logistical issues. Accordingly, DOE plans to further address these issues during the standards rulemaking when developing the required efficiency levels and when developing certification and compliance responsibilities.

3. Basic Model of Envelope

Although often manufactured according to the same basic design, many walk-in envelopes can be highly customized. To address this possibility, DOE proposed the following approach in the January NOPR: (1) Grouping walk-in envelopes with essentially identical construction methods, materials, and components into a single basic model; and (2) adopting a calculation methodology for determining the energy consumption of units within the basic model. For walk-in envelopes, DOE proposed to define a "basic model" as "all units of a given type of walk-in equipment manufactured by a single manufacturer, and—(1) With respect to envelopes, which do not have any differing construction methods, materials, components, or other characteristics that significantly affect the energy consumption characteristics." 75 FR 189.

Master-Bilt, BASF, ACC/CPI, Craig, Kason, and ThermalRite supported the concept of the basic model for WICF envelopes. (Master-Bilt, No. 1.3.009 at p. 1; BASF, No. 1.3.003 at p. 3; ACC/CPI, No. 1.3.006 at p. 2 and No. 1.3.028 at p. 1; Craig, Public Meeting Transcript, No. 1.2.010 at p. 102; Kason, No. 1.3.037 at p. 1 and Public Meeting Transcript, No. 1.2.010 at p. 124; and ThermalRite, No. 1.3.031 at p. 1) Craig supported an approach consisting of a single basic model test on a baseline model and adding component loads. (Craig, Public Meeting Transcript, No. 1.2.010 at p. 123) Kason stated that the basic model test should include provisions at the component level, where manufacturers could pick new components as long as the components were certified to exceed the performance of the old components. (Kason, Public Meeting Transcript, No. 1.2.010 at p. 124) Kysor and Nor-Lake both believed that the concept of the basic model may not be realistic if envelope components such as doors and lights were not purchased or installed by the panel manufacturers; in that case, Kysor and Nor-Lake stated that component manufacturers should be responsible for rating individual components. (Nor-Lake, No. 1.3.029 at p. 2; Kysor, No. 1.3.035 at p. 2) Arctic proposed expanding the basic model concept to eliminate testing for units using the same materials and construction methods as a previously certified model, adding that it would be impractical and infeasible for them to test every kind of equipment they manufacture because of the great variety of box dimensions. (Arctic, No. 1.3.012 at p. 1) BASF and Kason also stated that manufacturers must be able to reduce the number of models to test to ensure minimal manufacturer burden. (BASF, No. 1.3.003 at p. 3 and Kason, No. 1.3.037 at p. 1)

Other interested parties disagreed with the proposed basic model approach. Bally stated that the company produces tens of thousands of basic models, making basic model testing infeasible. (Bally, Public Meeting Transcript, No. 1.2.010 at p. 132) Hill Phoenix believed that use of a basic model for testing would not accurately represent the energy usage of most walk-ins because of equipment variability, that an energy usage calculation program would have to be created and maintained and be consistent across the industry, and that basic model testing would require costly government oversight. Instead, Hill Phoenix recommended component-level modeling. (Hill Phoenix, No. 1.3.023 at p. 2)

Several interested parties requested clarification of the proposed definition of basic model. ACC/CPI and Honeywell recommended that different types of foam and/or different blowing agents should trigger different basic models (ACC/CPI, No. 1.3.006 at p. 2 and Public Meeting Transcript, No. 1.2.010 at p. 43; Honeywell, No. 1.3.020 at p. 1) Honeywell also recommended that a different facer material should trigger a new basic model. (Honeywell, No. 1.3.020 at p. 1) Owens Corning stated that the insulation material should not trigger a new basic model because the R-value of the insulation is addressed in EISA and that panel construction (framed or frameless) should be used to differentiate between basic models. (Owens Corning, No. 1.3.030 at p. 2) ICS stated that different applications should constitute different basic models: holding storage, quick chilling or freezing, or blast freezing. (ICS, No. 1.3.027 at p. 1) TAFCO commented that the use of strip curtains or air curtains should not constitute a new basic model. (TAFCO, No. 1.3.022 at p. 2)

Other interested parties requested that DOE specify standard characteristics for a certain basic unit that every manufacturer would test. American Panel, ThermalRite, and Craig recommended that DOE specify a standardized basic model size. (American Panel, No. 1.3.024 at p. 2; ThermalRite, No. 1.3.031 at p. 1; Craig, Public Meeting Transcript, No. 1.2.010 at pp. 102, 106, and 119) Craig suggested a basic size applicable to the food industry—an 8 foot × 10 foot cooler and a 6 foot × 8 foot freezer, both with a height of 7 feet 6 inches tall—and added that size would only be applicable to the infiltration test because other characteristics could be calculated. (Craig, Public Meeting Transcript, No. 1.2.010 at p. 105 and No. 1.2.010 at pp. 102, 106, and 119) Kysor suggested that only height could be specified, arguing that walk-ins cannot be characterized by size. (Kysor, Public Meeting Transcript, No. 1.2.010 at p. 106)

Finally, interested parties commented on the proposed scaling methodology associated with the basic model concept. Manitowoc stated that a scaling methodology based on surface area would not give an accurate representation of energy use because energy scales not only with surface area but with other factors as well such as the number of installed doors and door size. In other words, individual component loads scale with individual component characteristics. (Manitowoc, Public Meeting Transcript, No. 1.2.010 at p. 108) ThermalRite also questioned whether there is a linear relationship between energy consumption and WICF size that would allow for scaling. (ThermalRite, Public Meeting Transcript, No. 1.2.010 at p. 110)

Upon consideration of these comments, DOE believes that the basic model concept would provide manufacturers with a standardized method of categorizing their products. However, the definition of basic model proposed in the January NOPR could make the concept difficult to use as originally intended to reduce testing burden. Specifically, the phrase "* * * characteristics that significantly affect the energy consumption * * *" could be interpreted inconsistently by manufacturers. The paragraphs below describe DOE's proposed alternative approach to defining the term "basic model". Additionally, feedback from interested parties indicated a desire for DOE to specify prescriptive design characteristics for a basic model. Because EPCA requires DOE to promulgate performance-based standards for this equipment, DOE does not intend to specify design characteristics that do not affect normalized energy consumption, as suggested by ACC/CPI, Honeywell, Owens Corning, ICS and TAFCO. See 42 U.S.C. 6313(f) (instructing DOE to set performance-based standards for walk-ins).

DOE is considering adopting a revised definition of the term "basic model" that would be consistent with the definition of basic model used elsewhere in the appliance standards program, improve the clarity of the definition, and narrow the scope of the basic model concept. Most notably, this revision would not allow walk-in models to differ in terms of their normalized energy consumption. Models grouped within a basic model could still differ in terms of their non-energy characteristics (*e.g.,* color, shelving, metal skin material type, exterior finish, door kick-plate) but any change to a characteristic that affects normalized energy consumption (*e.g.*, panel systems, door systems, electrical components, and infiltration reduction devices) would constitute a new basic model.

DOE's proposed revision, while reducing the possibility of inconsistent interpretation of the term "basic model", could increase the testing burden relative to the burden under the definition of "basic model" as proposed in the January NOPR. Some of the burden may be offset, however, by burden-reducing measures proposed elsewhere in the test procedure. These measures include incorporating scaling factors for the infiltration test (section III.B.9), the panel U-factor test (section III.B.1), and representative doorway sizes for infiltration reduction device testing. With these measures, DOE attempts to minimize the number of physical tests that would need to be performed for the test procedure and instead provide a calculation methodology that would allow for rating equipment based on physical tests conducted on other equipment. DOE believes that this approach would sufficiently address the concerns of BASF, Kason, Arctic, Bally, and Hill Phoenix regarding the number of basic models to be tested and the cost of testing. A DOE-specified calculation methodology would also address Hill Phoenix's recommendation that the energy use calculation program be consistent across the industry. Regarding Arctic's view that the basic model concept should be expanded to include similar units with the same materials and construction methods that have been previously certified, DOE notes that models with the same characteristics as previously certified models would be considered the same basic model only if they met the conditions in the basic model definition. In other words, the models would need to have the same manufacturer and not have any differing characteristics that affect normalized energy consumption.

The proposed test procedure revisions considered in this SNOPR also rely more heavily on component testing, consistent with the suggestions made by Craig, Kason, Kysor, Nor-Lake, and Hill Phoenix. This approach removes the burden of testing an entire walk-in for which only one component is different from a previously rated walk-in: the test procedure revisions in this SNOPR would allow for testing the new component and then using the proposed calculation methodology to obtain the new rating of the walk-in. Additionally, the proposed component tests allow for testing one component and then applying those results to other components that meet certain similar criteria. DOE believes this method is more accurate than allowing for scaling of the entire walk-in, because each walk-in could contain many customized parts. Adopting this method would address the concerns raised by Manitowoc and ThermalRite that energy may not scale directly with walk-in external surface area or other size characteristics. For some proposed component tests, DOE specifies characteristics of the part that must be physically tested (i.e., the geometry of a panel test sample), instead of specifying characteristics of the tested walk-in unit as a whole as suggested by American Panel, ThermalRite, Craig, and Kysor, because (1) complete walk-in units may be very different from one another even if they use similar components, and (2) the scaling calculations are more accurate on the component level than on the level of the entire walk-in, which supports testing certain components as part of the compliance procedure. For additional details on these proposed component tests, see section III.B.

With respect to certification, in general, DOE requires that manufacturers of a covered basic model submit a certification report providing details, which demonstrate compliance with the applicable energy conservation standards or design standards prescribed by DOE or established by Congress. DOE estimates that approximately 50 percent of the market consists of standardized walk-ins that are produced in large quantities. For the other half of the market, walk-ins may have custom features and components that could qualify each as a different basic model. In this situation, manufacturers could produce many basic models in a year.

DOE is unsure, however, how burdensome this would be in terms of the actual number of hours or personnel required to certify additional basic models under this approach. If requiring a certification report for each basic model under the approach outlined in today's SNOPR would impose an unreasonable burden, DOE may consider a compliance certification approach similar to that taken for distribution transformers (another case in which some equipment is highly customized). 10 CFR 431.371(a)(6)(ii). Distribution transformer manufacturers are required to maintain records on all basic models sold (or built), but must submit a compliance report to DOE that certifies only the least efficient basic model within larger groupings that may encompass many basic models. 10 CFR 431.371(a)(6)(ii). The manufacturer would certify that every other transformer in the larger grouping is no less efficient than the certified basic model certified to DOE. Given the nature of the market, DOE is willing to consider variations on this approach for walk-ins, such as requiring certification for the least and most efficient basic models within a larger group. Such an approach could help address the concern of Hill Phoenix about the cost of an oversight strategy.

DOE requests comment on its proposed definition and approach regarding basic models for envelopes.

4. Basic Model of Refrigeration Systems

In the January NOPR, DOE proposed that the definition of the term "basic model" in the context of a refrigeration system would refer to all units with the same energy source and without any different electrical, physical, and functional characteristics that affect energy consumption. DOE then stated during the NOPR public meeting that it was considering a new definition that would not allow units within a basic model to differ in energy consumption. DOE also stated during the public meeting that it would consider the default of including no provision for a basic model, under which manufacturers would be required to test every model they manufacture.

AHRI and ACEEE agreed with DOE's proposed approach and definition of basic model. (AHRI, No. 1.3.032 at p. 2 and Public Meeting Transcript, No. 1.2.010 at p. 169; ACEEE, No. 1.3.034 at p. 2) Craig also agreed with the proposed approach given that improvements could be applied to existing systems. (Craig, Public Meeting Transcript, No. 1.2.010 at p. 172) ICS, Manitowoc, and HeatCraft recommended that the basic model of refrigeration be allowed to vary minimally (a 5 percent tolerance) in energy consumption, while HeatCraft also stated that in Europe, the tolerance is typically 8 percent. (ICS, No. 1.3.027 at p. 1; Manitowoc, Public Meeting Transcript, No. 1.2.010 at p. 159; and HeatCraft, Public Meeting Transcript, No. 1.2.010 at p. 162) On the other hand, Master-Bilt expressed concern that too many refrigeration system combinations may exist for the basic model concept to be applied effectively. (Master-Bilt, No. 1.3.009 at p. 1) HeatCraft stated that it was concerned about testing highly variable refrigeration systems and combinations, and whether they would be able to incorporate new technologies. (HeatCraft, Public Meeting Transcript, No. 1.2.010 at p. 42) Nor-Lake was also concerned about the potential testing burden because it has distinct energy efficiency ratio values on over 250 models. It recommended either defining basic model to account for how many basic models a manufacturer would have or to replace the basic model approach with a component-based one. (Nor-Lake, No. 1.3.005 at pp. 2 and 5 and No. 1.3.029 at p. 2) Manitowoc suggested considering a unit cooler its own basic model (not the combination of unit cooler and condensing unit), making it unnecessary to test all combinations but only individual parts of the system. (Manitowoc, Public Meeting Transcript, No. 1.2.010 at p. 158)

TAFCO identified refrigeration system components that, if changed, would significantly affect energy consumption. These components include the compressor, condensing coil, fan motors, head pressure control, and evaporator coil. (TAFCO, No. 1.3.022 at p. 2) American Panel added that headmasters (which control pressure) must be included on outdoor condensing units if the unit will be exposed to low temperatures. (American Panel, No. 24 at p. 3) Some interested parties discussed whether DOE should specify certain characteristics of the basic model. Specifically, HeatCraft stated that the basic model should include some common parts such as a filter dryer to permit a valid comparison between manufacturers, but manufacturers should be allowed to add unique features. (HeatCraft, Public Meeting Transcript, No. 1.2.010 at p. 162) ACEEE agreed that the basic model should include parts that have a reasonable probability of affecting energy consumption to encourage manufacturers to include all necessary components in their WICF equipment. (ACEEE, Public Meeting Transcript, No. 1.2.010 at p. 168) AHRI disagreed, stating that DOE should not specify design requirements in defining basic model groups, but rather agreed with DOE's proposed definition. (AHRI, Public Meeting Transcript, No. 1.2.010 at p. 169) (Although ACEEE did not elaborate further on what it considers "all necessary components," DOE is interpreting this phrase as referring to any components that would be needed to have the unit work in a manner as designed without the addition of aftermarket components that would impact the equipment's energy usage.)

As with envelopes, DOE must ensure that all refrigeration systems are accurately rated and comply with the standard. To avoid differing interpretations of what a "significant difference" in energy consumption might be, DOE believes that it is appropriate to clarify certain aspects of that definition to eliminate differences in the measured energy consumption of models belonging to the same basic model group. Accordingly, DOE proposes a revised definition of basic model of refrigeration where units cannot differ in electrical, physical, or functional characteristics that affect energy consumption. DOE recognizes that the components identified by TAFCO affect the energy consumption of the refrigeration system. Nevertheless, DOE believes that listing only certain components where changes would constitute a new basic model could overlook changes to other components that affect energy consumption. In addition, the question of significance would remain under such an approach. DOE believes that the definition proposed here is sufficient to define basic model—a basic model would necessarily have to include all components that affect energy consumption.

DOE also acknowledges the concerns of interested parties, specifically Master-Bilt, HeatCraft, and Nor-Lake, that a manufacturer could produce many condensing unit and unit cooler combinations—*i.e.,* many basic models —and that testing could be burdensome. DOE notes that the proposed refrigeration system test procedure, AHRI 1250–2009, allows for testing the condensing unit and unit cooler separately and then, using the calculation methodology in AHRI 1250–2009, determining the performance of the combined system, similar to the approach suggested by Manitowoc. Under this approach, each combination would not have to be tested, which would decrease the number of physical equipment tests, even though each different combination would be considered a different basic model and would receive a different rating.

At this time, DOE does not intend to incorporate a tolerance into the definition of basic model, as suggested by ICS, Manitowoc, and HeatCraft, in order to ensure that the rating applying to each basic model is as accurate as possible. DOE notes that one potential issue with introducing a tolerance approach may be that neither DOE nor the eventual purchaser of the equipment could expect that the rating of a particular model would be equal to that model's actual energy consumption. It is unclear to DOE how significant this issue may be if such an approach were adopted.

DOE acknowledges, however, that units within a basic model are expected to differ slightly as a result of manufacturing and materials variations. As a result, DOE may consider accounting for these variations in sampling plans used for compliance testing and developed as part of any future certification and enforcement rulemaking. DOE's existing compliance and certification regulations, developed for certain other commercial equipment, provide that when a random sample of equipment is taken for determining compliance with the standard for commercial refrigeration equipment, represented values of estimated energy consumption of a basic model shall be no less than the higher of the mean of the test sample or the upper 95 percent confidence limit of the true mean divided by 1.10. 75 FR 652, 666–71 (Jan. 5, 2010), codified at 10 CFR 431.372. This rule also provides that, in enforcement proceedings, DOE's determination that a basic model complies with the standard is based on a confidence limit which accounts for statistical variation within a basic model. 75 FR 674, codified at 10 CFR part 431, Appendix D to Subpart T.

These sampling provisions are only intended to reduce the burden on manufacturers associated with certification and enforcement. Manufacturers would still be required to use the test procedure to rate their equipment and, once energy conservation standards take effect, to determine whether each basic model of the equipment they manufacture complies with the standard.

As discussed above for envelopes, DOE could consider a compliance certification approach similar to that taken for distribution transformers (another case in which some equipment is highly customized) to reduce the burden while ensuring that the energy conservation standards are being met. 10 CFR 431.371(a)(6)(ii). DOE describes this approach in detail in section III.A.3.

DOE requests comment on the definition of and approach to basic model of refrigeration systems.

B. Envelope

The envelope consists of the insulated box in which items are stored and refrigerated. To meet one element of the statutory requirement that the DOE test procedure "measure the energy use" of walk-ins (42 U.S.C. 6314(a)(9)(B)(i)), DOE had proposed to incorporate a metric for the energy use associated with the envelope of a walk-in cooler or walk-in freezer. Under the applicable EPCA definition of "energy use"—the amount of energy directly consumed by a piece of equipment at the point of use (42 U.S.C. 6311(4))—DOE has tentatively determined that the energy use of a walk-in envelope is the sum of (1) the electrical energy consumption of envelope components and (2) other energy consumption of the walk-in equipment resulting from the heat transfer performance of the envelope.

The proposed envelope test procedure contains methods for evaluating the performance characteristics of insulation, testing thermal energy gains related to air infiltration and determining direct electricity use and heat gain due to internal electrical components. The proposed procedure uses data obtained from these methods to calculate a measure of energy use associated with the envelope by calculating the effect of the envelope's characteristics and components on the energy consumption of the walk-in as a whole. These characteristics and components would include the energy consumption of electrical components present in the envelope (such as lights) and variation in the energy consumption of the refrigeration system due to heat loads introduced as a function of envelope performance, such as conduction of heat through the walls of the envelope. The effect on the refrigeration system would be determined by calculating the energy consumption of a theoretical or "nominal" refrigeration system if it were paired with the tested envelope. The test procedure uses the same nominal refrigeration system efficiency for all tested envelopes to allow for direct comparison of the performance of walk-in envelopes across a range of sizes, product classes, and levels of feature implementation.

1. Heat Conduction Through Structural Members

In the January NOPR, DOE proposed that the long-term thermal resistance (LTTR) value of the insulating foam after 5 years of equivalent aging be determined using ASTM C1303–08, "Standard Test Method for Predicting Long-Term Thermal Resistance of Closed-Cell Foam Insulation." This value would be used as the R-value for all non-glass envelope sections constructed with foam insulation, for purposes of calculating the energy consumption of the walk-in. Other components of the panel, such as structural members, were not included in the conduction calculations of the test procedure.

Craig, Owens Corning, and American Panel pointed out that conduction through structural members must be considered when determining the R-value of a composite walk-in insulation panel. (Craig, No. 1.3.036 at p. 3 and Public Meeting Transcript, No. 1.2.010 at pp. 20 and 61; Owens Corning, Public Meeting Transcript, No. 1.2.010 at p. 56; and American Panel, No. 1.3.024 at p. 3) The Joint Comment recommended that the current R-value requirement for the foam be converted to an overall U-factor requirement for the assembled panel. (Joint Comment, No. 1.3.019 at p. 11) (U-factor is a measure of heat transmission, including conduction and radiation. A lower U-factor indicates a lower rate of heat transmission.) Metl-Span, BASF, Kysor, and ACC/CPI agreed with the approach of determining the performance of the panel as a whole and recommended that DOE use ASTM C1363–05, "Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus," for evaluating the fully assembled panel. (Metl-Span, No. 1.3.004 at p. 1; BASF, No. 1.3.003 at p. 2; Kysor, No. 1.3.035 at p. 2; ACC/CPI, No. 1.3.006 at p. 2)

In view of these comments, DOE proposes to account for conduction through structural members, as urged by Craig and American Panel, by measuring the overall U-factor of fully assembled panels as recommended by the Joint Comment. All panels (walls, ceiling, and floor) would be tested using ASTM C1363–05 for measuring the overall U-factor of fully assembled panels, as stated by Metl-Span, BASF, Kysor, and ACC/CPI. The resulting composite panel U-factor from ASTM C1363–05 would then be corrected using the LTTR results from ASTM C1303–10, if foam is used as the primary insulating material. See section 3.1.6 of Appendix A for details. DOE believes using the results from ASTM C1363–05 modified by ASTM C1303–10 best captures the effect of structural members and long-term R-value of foam products.

DOE recognizes the burden involved when testing an entire representative walk-in using ASTM C1363–05; *i.e.,* requiring a representative walk-in composed of 18 panels to be tested 18 times. DOE also notes that testing a single representative panel would be less burdensome but very inaccurate. Panels are often manufactured in dimensions close to 8 feet long by 4 feet wide, but panel geometry frequently deviates from this size as walk-ins are made larger. In addition, structural members are normally placed in the perimeter of panels (if used at all). Therefore, the heat transfer of a given panel is most closely related to the ratio of perimeter structural materials to non-perimeter core panel materials.

If DOE were to require an ASTM C1363–05 test using only one panel size, the test would be representative of only this single perimeter-to-core ratio. If a walk-in were constructed of panels that deviated from this representative size in either extreme (*i.e.,* much smaller or larger), the resulting energy calculations could be inaccurate. To balance the competing interests of minimizing burden while ensuring measurement accuracy, DOE is proposing to specify two test regions of a pair of representative panels. At one test region, the tester would measure the U-factor of the perimeter and panel-to-panel interface area ("Panel Edge"), while at the other region the tester would measure the U-factor of the core area of the panel ("Panel Core"). The details of this procedure are described in section 4.1.1 of Appendix A.

DOE seeks comment on the use of ASTM C1363–05 for this portion of the test procedure.

2. Use of ASTM C1303 or EN 13165:2009–02

In the January NOPR, DOE proposed using ASTM C1303–08, "Standard Test Method of Predicting Long Term Thermal Resistance of Closed-Cell Foam Insulation," to determine the long-term R-value of foam insulations used in walk-ins. 75 FR 194. (That test method has since been updated to ASTM C1303–10, which, as discussed in section III.B.4, DOE is now proposing to adopt as part of this test procedure. All references to ASTM C1303 in today's notice refer to the ASTM C1303–10 version of the protocol.) As discussed later in section III.B.3, DOE also proposes, in the alternative, the use of EN 13165:2009–02 (a European-developed material standard), and seeks comment on the use of these procedures.

DOE recognizes that R-value decline occurs over time in unfaced and permeably faced foams. In the published January NOPR, DOE cited a body of research indicating that R-value decline also occurs in foams with impermeable facers because the metal skins delay, but do not prevent, R-value decline because the panel edges are unprotected. DOE recognized that using ASTM C1303–10 would require testing foams without their metal facers because the test procedure was designed for unfaced or permeably faced foams. In the published NOPR and at the NOPR public meeting, DOE requested that interested parties submit data related to using ASTM C1303–10 for walk-ins.

DOE received many comments related to ASTM C1303–10. Supporting documents submitted during the comment period are listed in the table below and identified with reference numbers. DOE conducted further research and identified additional documents that provide information on the use of ASTM C1303–10. These are also listed in the table below with reference numbers preceded by "DOE."

TABLE III.1—RESEARCH CITED BY INTERESTED PARTIES AND BY DOE

Commenter	Paper Citation	Ref. No.
ACC/CPI	SPI Polyurethane Division k Factor Task Force, "Rigid Polyurethane and Polyisocyanurate Foams: An Assessment of Their Insulating Properties," Proceedings of the SPI 31st Annual Technical/Marketing Conference, Oct. 18–21, 1988 Philadelphia, PA. pp. 323–327.	1
ACC/CPI, Carpenter, Honeywell	Wilkes, K. E., Yarbrough, D.W., Nelson, G. E., Booth, J. R., "Aging of Polyurethane Foam Insulation in Simulated Refrigerator Panels—Four-Year Results with Third-Generation Blowing Agents", The Earth Technologies Forum, Washington, DC, April 22–24, 2003.	2
ACC/CPI, Honeywell	Norton, F.J., "Thermal Conductivity and Life of Polymer Foams", Journal of Cellular Plastics, 1967, pp. 23–37.	3
ACC/CPI, Honeywell	Shankland, I. R. "Blowing Agent Emissions from Insulation Foam", Polyurethanes World Congress 1991 pp. 91–98.	4
Dow	Oertel, Dr. Gunter, *Polyurethane Handbook,* p. 256	5
Dow	Ottens *et al.,* "Industrial Experiences with CO_2 Blown Polyurethane Foams in the Manufacture of Metal Faced Sandwich Panels," Polyurethane World. Congress '97'	6
Dow	Bertucelli *et al.,* "Phase-Out of Ozone Depleting Substances in the Manufacture of Metal Faced Sandwich Panels with Polyurethane Foam Core," Utech Asia '99'.	7
Owens Corning	The Role of Barriers in Reducing the Aging of Foam Panels by Leon R. Glicksman	8
Dow	European standard EN 13165	9
DOE	Wilkes, K. E., Yarbrough, D. W., Nelson, G. E., Booth, J. R., "Aging of Polyurethane Foam Insulation in Simulated Refrigerator Panels—Four-Year Results with Third-Generation Blowing Agents," The Earth Technologies Forum Conference Proceedings, 2003.	DOE 1
DOE	Paquet, A., Vo C., "An Evaluation of the Thermal Conductivity of Extruded Polystyrene Foam Blown with HFC–134a and HCFC–142b," Journal of Cellular Plastics, Volume 40, May 2004.	DOE 2
DOE	Federal Trade Commission, "Labeling and Advertising of Home Insulation: Trade Regulation Rule; Final Rule,16 CFR Part 460," Federal Register/Vol. 70, No. 103/Tuesday, May 31, 2005.	DOE 3
DOE	Roe, Richard, "Long-Term Thermal Resistance (LTTR): 5 Years Later" RCI–057–Interface, March 2007.	DOE 4
DOE	Stovall, Therese, "Measuring the Impact of Experimental Parameters upon the Estimated Thermal Conductivity of Closed-Cell Foam Insulation Subjected to an Accelerated Aging Protocol: Two-Year Results, Journal of ASTM International, Vol. 6, No. 5 Paper ID JAI102025, April 2009.	DOE 5
DOE	Kalinger, P., and Drouin, M. (Johns Manville), "Closed Cell Foam Insulation: Resolving the issue of thermal performance," October/November 2001.	DOE 6
DOE	Mukhopadhyaya, P., Bomberg, M. T., Kumaran, M. K., Drouin, M., Lackey, J., van Reenen, D., and Normandin, N., "Long-Term Thermal Resistance of Polyisocyanurate Foam Insulation with Impermeable Facers ," Insulation Materials: Testing and Applications: 4th Volume, ASTM STP 1426, A. O. Desjarlais, Ed., American Society for Testing and Materials, West Conshohocken, PA, 2002.	DOE 7

TABLE III.1—RESEARCH CITED BY INTERESTED PARTIES AND BY DOE—Continued

Commenter	Paper Citation	Ref. No.
DOE	Mukhopadhyaya, P., Bomberg, M. T., Kumaran, M. K., Drouin, M., Lackey, J., van Reenen, D., and Normandin, N., "Long-term Thermal Resistance of Polyisocyanurate Foam Insulation with Gas Barrier," IX International Conference on Performance of Exterior Envelopes of Whole Buildings, Clearwater Beach, Florida, Dec. 5–10, 2004, pp. 1–10.	DOE 8
DOE	Mukhopadhyaya, P.; Kumaran, M.K., "Long-Term Thermal Resistance of Closed-Cell Foam Insulation: Research Update From Canada," 3rd Global Insulation Conference and Exhibition, Oct. 16–17, 2008, Barcelona, Spain, pp. 1–12, NRCC–50839.	DOE 9
DOE	Bomberg, M., Branreth, D., "Evaluation of Long-Term Thermal Resistance of Gas-Filled Foams: State of the Art," Insulation Materials, Testing and Applications, ASTM STP 1030, ASTM, Philadelphia, 1990, p. 156–173.	DOE 10
DOE	H. Macchi-Tejeda, H. Opatova, D. Leducq, Contribution to the gas chromatographic analysis for both refrigerants composition and cell gas in insulating foams—Part I: Method, International Journal of Refrigeration, Volume 30, Issue 2, March 2007, Pages 329–337.	DOE 11
DOE	H. Macchi-Tejeda, H. Opatova, J. Guilpart, Contribution to the gas chromatographic analysis for both refrigerants composition and cell gas in insulating foams—Part II: Aging of insulating foams, International Journal of Refrigeration, Volume 30, Issue 2, March 2007, Pages 338–344.	DOE 12

ACC/CPI, in reference to paper [1], stated that the Task Force found that polyurethane foam encased in and adhered to impermeable facers does not age significantly. (ACC/CPI, No. 1.3.006 at p. 3) In reference to [2], Honeywell stated that Wilkes et al. concluded that "the increment of thermal conductivity of foams with facers is less than those of enclosed foams", and regarding that, ASTM C1303–08 is likely to underestimate the aged thermal insulation value of panel foams with facers. (Honeywell, No. 1.3.020 at p. 3) Honeywell suggested that "DOE consider adapting the aging prediction methodology presented" in either [3] or [4]. (Honeywell, No. 1.3.020 at p. 2) Dow stated that [5], [6], and [7] indicated that change in thermal conductivity due to aging is limited in blown polyurethane foams. (Dow, No. 1.3.026 at p. 2) In reference to [8], Owens Corning stated that the study showed that blowing agent can diffuse under metal skins, that it migrates to the surface and that it can permeate out even underneath an air-impermeable surface. (Owens Corning, No. 1.2.010 at p. 256) Dow noted that [9] "provides methods for evaluating the aged lambda (λ) or R-values for both exposed foam and faced foam using an accelerated procedure. The standard uses safety factors depending on thickness and blowing agent used in the foam and also uses incremental factors for exposed foams versus foams with facings." However, Dow also noted that "even though the standard and the procedure apply to foams with and without impermeable facings," the aging factor is four times higher for exposed foam than it is for impermeably faced foam. (Dow, No. 1.3.026 at p. 1)

With regard to papers cited by interested parties, DOE makes the following observations (the numbering refers to the paper reference number in Table III.1).

1. On p. 325 of paper [1], the SPI Polyurethane Division k Factor Task Force states "* * * thermal performance changes little with time if the foam is protected against gas diffusion by a non-permeable facer that adheres well to the foam." However, immediately following this statement SPI says, "The literature emphasizes that not only the foam but the entire package or composite must resist gas diffusion." This statement supports DOE's position that it is critical to ensure that all of the foam is encapsulated by an impermeable barrier to prevent diffusion of gases, not just the face of the material. However, the study also provides a number of studies that suggest that aging is delayed on the order of three to nine years rather than two to three years as DOE previously suggested.

2. In paper [2], Wilkes *et al.* measured the LTTR of 2-inch-thick foam samples faced with either Acrylonitrile Butadiene Styrene (ABS) or High Impact Polystyrene (HIPS) plastic. The edges of the samples were covered with aluminum foil tape to reduce lateral diffusion through the panel edges. The samples were aged for 4 years in 90 °F, 40 °F, and −10 °F environments. In conclusion, Wilkes *et al.* found that for "both ABS and HIPS plastics, the conductivity increases after four years were less than those predicted for unenclosed full-thickness core-foam, showing that the plastic liners reduce the rate of aging. The panels with HIPS sheets showed average increases of [thermal conductivity] of 19 percent to 28 percent with aging at 90 °F, 12 percent to 23 percent at 40 °F, and 3 percent to 8 percent at −10 °F. The panels with ABS sheets showed smaller increases of 14 percent to 21 percent at 90 °F, 10 percent to 17 percent at 40 °F, and 2 percent to 5 percent at −10 °F." (p. 10). The results demonstrate that facers reduce the rate of aging. However, the plastic facers used, with the exception of the foil around the edges, are gas permeable. In addition, Wilkes *et al.* specifically attempted to eliminate lateral diffusion with the foil tape on the edges of the samples, which is not representative of actual walk-in panels.

3. Honeywell suggested that DOE adopt aging methodology presented by the Norton article [3], which was one of the key citations for the development of ASTM C1303–10. Norton completed much of the original research in the field of foam insulation aging. Therefore, DOE is proposing to adopt a test procedure, ASTM C1303–10, which already incorporates Honeywell's suggested methodology.

4. The Shankland paper [4] proposes an analytical approach to calculating lateral gas diffusion through foam panels with open edges. A similar methodology is proposed in [DOE 8] and [DOE 9], but researchers have had difficulty modeling and predicting blowing agent diffusion coefficients. [DOE 8] has found that direct analytical approach is not possible, but numerical computer simulation to predict lateral gas diffusion rates may be viable in a few years.

5. The Oertel paper [5] describes research conducted to predict the amount of blowing agent that permeates through building walls after being

released from the underlying foam insulation. The researcher notes, "if the rigid foam is faced with a diffusion barrier, the equilibration process cannot occur. The original composition of the cell gas remains unchanged and the low initial thermal conductivity is maintained. This was proven when impermeable facing materials were used. Only metallic surfaces are impermeable." This section does not cite research confirming this claim, but as previously mentioned, DOE agrees that metal facers, particularly ones used in WICF panels, are gas impermeable. However, because the metal skins used in WICF panels do not fully encapsulate the foam in a contiguous manner (*i.e.,* metal skin on the panel face and all edges), gas diffusion may still occur laterally through the panel edges.

6. DOE notes that the Ottens study [6] is one of two of which DOE is aware that has been completed on polyurethane foam-in-place panels, with open edges intended to simulate metal skinned walk-in panels. This paper summarizes studies completed by IMA (Materialforschungs- und Anwendungstechnik Dresden GmbH, translation: Materials and Applications Research) as requested by Arbeitsgemeinschaft Industrieller Forschung (translation: Association of Industrial Research) to assess the long-term insulating behavior of sandwich elements. In particular, this paper cites data on carbon dioxide (CO_2) blown foams as an alternative to other blowing agents. On page 30 of the study, Figures 4 and 5 show aging results for both core and edge regions of test panels. The areas greater than approximately 12 inches from the edge exhibit 2 to 3 percent aging after 6 months at a temperature of approximately 160 °F. Regions within 12 inches of the edge show 5 to 17 percent aging, with the highest rate of aging occurring at the panel corners. Dow noted in its reference to this paper that CO_2 "has higher diffusion speeds, [therefore] the aged thermal conductivity would be even better for the HFC blown foams used in many walk-in applications." DOE agrees with Dow that CO_2 exhibits a faster rate of diffusion than hydrofluorocarbon (HFC) blowing agents typically used in foams, which indicates that the study is likely more representative of a worst case aging scenario. This study clearly demonstrates that lateral gas diffusion occurs in metal faced panels with open edges. DOE also notes that the majority of aging has occurred at the panel perimeter, which is an expected result because the rate of diffusion should decay exponentially with increased distance (or thickness of foam) from the exposed edge as described in ASTM C1303–10. The authors did not note the aging period that their test, which was conducted over 6 months at an elevated temperature, was intended to simulate, but because elevated temperature dramatically increases gas diffusion rates, the tests are likely representative of panels aged for at least 5 years.

7. The Bertucelli paper [7], other than [5], is the only one that DOE has reviewed that directly tests aging of actual walk-in panels. Bertucelli *et al.* state that, "in practice, for metal faced sandwich panels the diffusion phenomena can only take place through the open sides of the panels. The initial thermal conductivity value remains for a long time practically unchanged for the largest part of the panel due to the long path for diffusion." (p. 2) Again, this research supports DOE's claim that significant lateral diffusion occurs through open edges of panels. This statement appears to be based on data shown on page 17 that are very similar to data shown in [6] for CO_2 blown foams. However, this test was on a 4 foot by 8 foot panel aged at room temperature for a year. Close to the geometric center of the panel, the thermal performance has aged by 2 to 5 percent from its initial value. Measurements approximately 20 inches from the edges range from 2 to 6 percent. These data are similar to data submitted by Carpenter (see Table III.2) which were also from a panel aged at room temperature but with an HFC blowing agent. The Bertucelli paper also notes that EN 13165, a European material standard that was developed in Germany but certified by the European Committee for Standardization (CEN), provides certified aging values for various blowing agents used in metal faced sandwiched foam-in-place panels. The researchers also note that the certified aging value for water-blown foams, HCFC–141b and pentane is 10 percent.

8. The Glicksman paper [8] found that the effectiveness of impermeable facers is highly dependent on adhesion of the foam to the facer. Slight separation allows gas diffusion to occur perpendicularly to the barrier and laterally between the barrier and the foam, which permits more rapid aging than if the diffusion is forced through the foam material only in the lateral direction. This research supports DOE's assertion that delamination is a major contributing factor to aging of panels.

9. EN 13165 is a material standard for "factory made rigid polyurethane foam (PUR) products." Dow noted that this standard has provisions for accelerated aging of panels. This is one of the material standards that uses the aging factor described in [7]. DOE was previously unaware that the CEN had established aging factors for insulated panels and believes that this standard may serve as an alternative to ASTM C1303–10 (see section III.B.3 for more details).

In addition to comments on specific papers submitted by stakeholders, DOE received many general comments on the use of ASTM C1303. DOE addresses these additional comments below.

BASF stated that there was insufficient evidence to support DOE's assertion that the diffusion as a result of delamination, holes drilled for shelves, and gaps at windows and doors causes a dramatic decrease in insulation performance of the panel, and that DOE should publish and make available any supporting data. (BASF, No. 1.3.003 at p. 3–4) Honeywell stated that ASTM C1303 was inappropriate because the data used to select it were based on foil-faced board stock rather than metal-faced panels. (Honeywell, No. 1.3.002 at p. 1) BASF proposes to delay a decision on modifying ASTM C1303 to apply to impermeably skinned panels due to a lack of data, and instead proposes that DOE first test and compare (1) panels from the field that are at a known age that is greater than 5 years, (2) newly manufactured panels measuring the R-value at different points in the panels, and (3) newly manufactured panels that are sliced and aged according to the methods in ASTM C1303–10. (BASF, No. 1.3.003 at p. 4)

Carpenter submitted data, shown in Table III.2, of panels that had been in the field for one year. These data suggest that R-value decreases approximately 3.1 to 4.3 percent within 1 year. (Carpenter, No. 1.3.007a at p. 3) Dow stated that ASTM C1303–10 states that it is not to be used with impermeably faced foams, and that industry literature states that metallic, impermeable surfaces will prevent blowing agent diffusion. (Dow, No. 1.3.026 at p. 1) Owens Corning submits that research has shown that an effective barrier can substantially reduce the rate of foam aging. In its view, to be effective, the barrier must have a low permeability and the foam/barrier interface must not allow lateral gas flow. However, all cellular foams have some amount of lateral gas flow. (Owens Corning, No. 1.3.030 at p. 1) In addition, Owens Corning referenced a Massachusetts Institute of Technology study on insulation with metal skins using dye to observe the diffusion of blowing agent. The study showed that blowing agent can diffuse under metal skins, that it migrates to the surface, and that it can permeate out even underneath an air-impermeable surface. (Owens Corning, No. 1.2.010 at p. 256)

TABLE III.2—TESTED DATA SUBMITTED BY CARPENTER

Sample ID	R-value ft² hr° F/Btu in			
	20° F		55° F	
	11/2008 (initial)	01/2010 (aged)	11/2008 (initial)	01/2010 (aged)
Panel middle	7.89	7.63	7.00	6.78
Panel edge	7.89	7.54	7.00	6.70

In response to BASF's comment that DOE should publish and make available any supporting data for the use of ASTM C1303–10, DOE lists all papers in Table III.1. Most of these papers were already described in detail in January NOPR, but DOE welcomes further comment on these studies.

In response to Honeywell's comment regarding foil facers, DOE recognizes that foil faced foams may not have identical characteristics to metal skins, but believes that foils would serve as a reasonable proxy for general aging behavior.

With regard to BASF's comment that DOE should collect field data on panels older than 5 years of age, DOE believes that the data submitted by Carpenter support DOE's assertion that significant aging occurs over the 15 to 20 year life of a panel and that the diffusion is occurring laterally because aging of 3–4 percent occurred within about 1 year, with the edge samples aging more than the core. DOE welcomes additional data on this issue from panel manufacturers and other interested parties.

As to Dow's comments regarding the scope of ASTM C1303–10, although DOE agrees with Dow that ASTM C1303–10 states that the test does not apply to impermeably faced foams, DOE has not proposed the use of ASTM C1303–10 on panels themselves. Instead, DOE has proposed that the procedure be followed when testing the underlying unfaced foam as a proxy for the actual aging provisions outlined in the NOPR that describe how the unfaced foam samples are prepared for testing by ASTM C1303–10. See section 4.1.2 of Appendix A for details.

With regard to Owens Corning's comments that an effective barrier can substantially reduce the rate of foam aging, DOE agrees that impermeable facers affect the diffusion pathway of gases through foam. However, DOE believes that impermeable facers delay aging, rather than eliminate it as Dow and ACC/CPI suggest. In addition, the International Institute of Refrigeration (IIR), which serves as an international body with 61 member countries to "promote knowledge of refrigeration technology and all its applications in order to address today's major issues, including food safety and protection of the environment," states that the thermal properties of insulation can change over time: "It is well known that thermal conductivity can increase in plastic foams in which gaseous blowing agent has been used * * * with such materials, there will inevitably be a deterioration of insulation properties over time due to the diffusion of the blowing agent." (Insulation and Airtightness of Cold Rooms, 2002 Edition, IIR, p.154) Because walk-in panel perimeters are not protected by gas impermeable materials such as the metal skins, gas diffusion can still occur laterally through the panel. DOE notes that Owens Corning's second comment regarding the Massachusetts Institute of Technology study on diffusion of blowing agents points to data that suggest the lateral flow of gas occurs at the foam surface to metal skin interface due to poor adhesion of the foam to metal.

In addition to the data presented above, DOE presents aged R-values of a number of foam types in Table III.3. These results are based on CAN/ULC S–770, the Canadian thin slicing method that is based on various versions of ASTM C1303. Each data point is an average of dozens of tests at the thicknesses shown.

TABLE III.3—FOAM THIN-SLICING TEST RESULTS, SOURCE: CANADIAN LABORATORY

Product	5-Year Long Term Thermal Resistance, CAN/ULC S–770, @ 75° F mean temperature		
	Permeably Faced Polyisocyanurate Board Thermal Resistivity °F-ft²-h/Btu-in.	Extruded Polystyrene Board Thermal Resistivity °F-ft²-h/Btu-in.	Spray-in-Place Polyurethane Foam Thermal Resistivity °F-ft²-h/Btu-in.
Thickness	Thermal Resistivity	Thermal Resistivity	Thermal Resistivity
(mm)	(°F.ft².h/Btu.in)	(°F.ft².h/Btu.in)	(°F.ft².h/Btu.in)
100	6.178	5.607	6.197
75	6.127	5.490	5.958
50	6.028	5.339	5.703
25	5.880	5.019	

These data address concerns raised by various interested parties that the thin slicing method would unfairly predict that polyurethane would perform at a lower level than extruded polystyrene and, in some cases, would perform at a level as low as expanded polystyrene. Instead, these data appear to predict that polyurethane products would continue to outperform extruded polystyrene on a per inch basis. It is also important to note that if DOE were not to propose the use ASTM C1303–10, DOE would still be indirectly accounting for aging in one of two classes of foams: Board stock foams such as extruded polystyrene. Because board-stock insulation is manufactured at one location, stored for a period of time, and then shipped to WICF panel manufacturers, the foam is exposed to ambient temperatures and unprotected by metal skins for a significant period of time prior to its installation in a WICF envelope. Therefore, before board stock based foams are even laminated into WICF panels, significant aging has already occurred. DOE believes that all of the above factors tend to support the use of a test procedure that, as accurately as possible, will uniformly represent aging of all foam classes.

In light of the research and data submitted by interested parties, and the German data regarding the use of aging factors specifically for foam-in-place metal faced panels, DOE continues to maintain that (1) foam aging occurs in WICF panels, (2) the aging is possible, even with metal facers, due to the gas permeable edges of panels, and (3) R-value degradation is significant enough, over the life of a walk-in cooler or freezer, to warrant a long-term foam aging test. DOE continues to urge manufacturers and interested parties to submit R-value data for panels aged 5 or more years to support their particular claims. While DOE believes there are enough indirect and direct data to incorporate aging into the WICF test procedure, DOE is interested in ensuring, to the extent possible, that it incorporates manufacturer-submitted data as part of its analysis.

DOE requests comments from interested parties regarding the proposal to use ASTM C1303–10 to measure the long-term R-value decline in WICF foam insulation. DOE requests that interested parties consider in their comments the research and papers provided by DOE and other commenters.

3. EN 13165:2009–02 as a Proposed Alternative to ASTM C1303–10

As noted in the previous section, Germany has developed a test procedure (that was certified as a European standard by the CEN) and calculation methodology to determine the aged R-value of metal skin panels. EN 13165:2009–02, Thermal insulation products for buildings—Factory made rigid polyurethane foam (PUR) products—Specification describes two alternatives in Annex C, the fixed increment procedure and the accelerated aging procedure for determining aged R-value. An overview of the two alternatives is shown in Figure 1 below:

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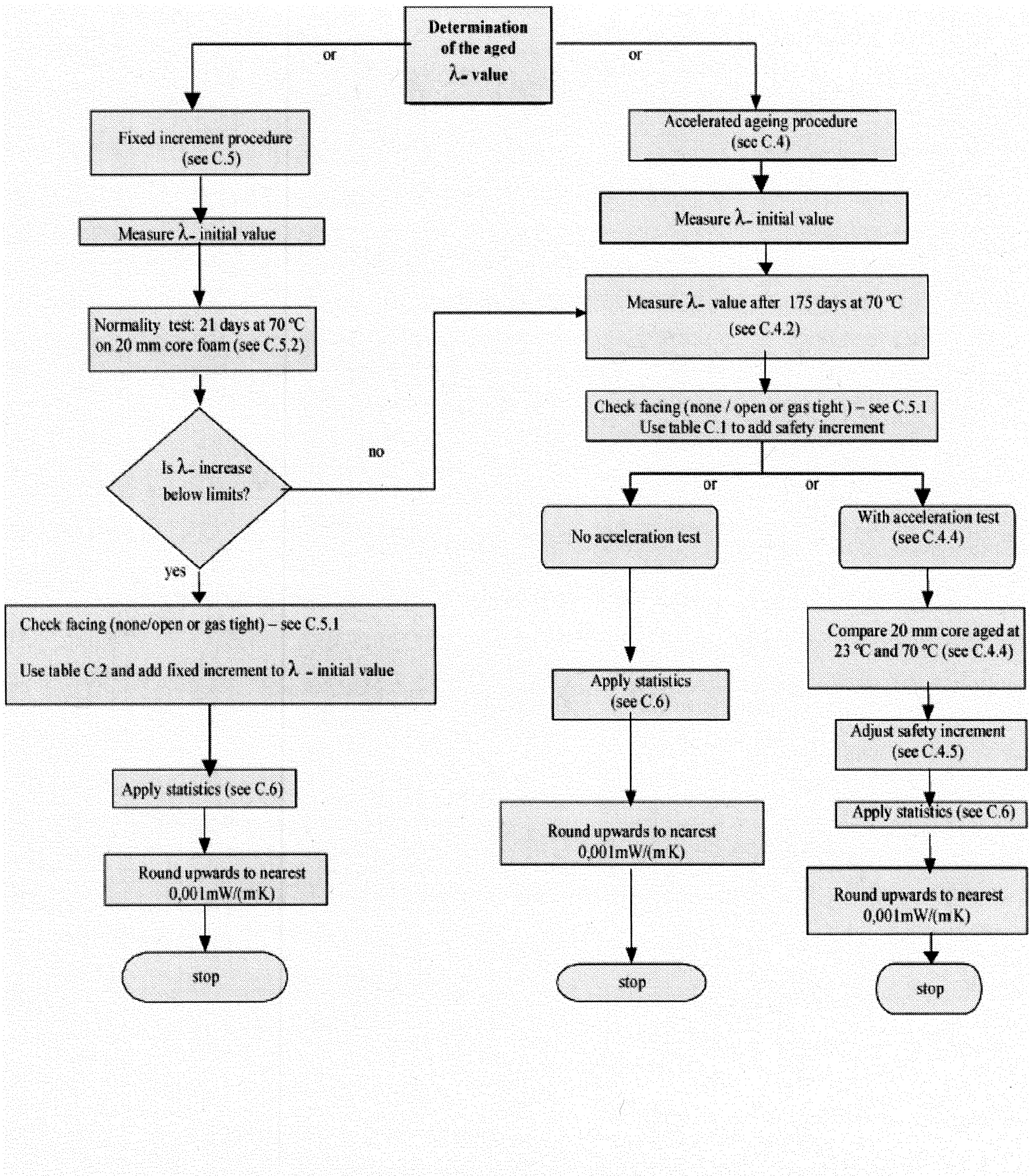

Figure 1 Flow Chart of Alternative Aging Procedures in EN 13165:2009-02

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The alternative procedures—the fixed increment procedure and the accelerated aging procedure—are selected based on certain criteria and availability of historical data as defined in EN 13165:2009–02. In summary, the fixed increment procedure determines if a facing or panel construction is "gas diffusion tight" by subjecting it to an elevated temperature for 60 days and determining whether there is any decrease in the R-value. If the panel is found to be gas tight and the test material is also made with blowing agents of known characteristics, then the LTTR of the foam is determined using assumed increments of R-value loss. The assumed aging values have been certified by Germany through testing. Otherwise, the accelerated aging procedure must be used to determine the LTTR. The accelerated aging procedure subjects the panel to an elevated temperature for 180 days and determines the decrease in the R-value.

Like EN 13165:2009–02, which is a standard for polyurethane products, a similar standard exists for extruded polystyrene: EN 13164:2009–02 Thermal insulation products for buildings—Factory made products of extruded polystyrene foam (XPS)—Specification. Annex C of EN 13164:2009–02 also provides a methodology for determining the LTTR of impermeably faced or "gas tight" products. DOE proposes, as an alternative to ASTM C1303–10, the use of the test procedures of these respective standards for determining the LTTR of walk-in polyurethane and extruded polystyrene products. DOE proposes to directly rely on the methods described in EN 13164:2009–02 and EN 13165:2009–02 with two exceptions: (1) The initial R-value must be measured at the EPCA defined mean test temperatures (instead of the specified ~75 °F) of 55 °F for coolers and 20 °F for freezers and (2) the final R-value must also be measured using the EPCA defined mean test temperatures. Using the initial and final R-values, a calculated foam "derating" factor would be used in place of the similar calculation using results from ASTM C1303–10. DOE seeks comment on the use of EN 13164:2009–02 and EN 13165:2009–02 for determining the LTTR of walk-in panels made from extruded polystyrene or polyurethane, respectively.

DOE also seeks comment on the proposed use of CEN's certified aged values as an alternative to requiring testing using ASTM C1303–10.

4. Version of ASTM C1303

As indicated earlier, DOE initially proposed that the test procedure incorporate ASTM C1303–08. 75 FR 194. Nor-Lake pointed out that a more recent version of this testing method was published in 2009, ASTM C1303–09a. (Nor-Lake, No. 1.3.005 at p. 3) DOE then determined that an even more recent version has recently been published, ASTM C1303–10. To address these comments, DOE compared ASTM C1303–08, ASTM C1303–09a and ASTM C1303–10 and found no substantive differences between them that would appreciably affect the accuracy or manner in which to measure a given foam's R-value. In light of this finding, DOE is revising its proposal to adopt the most recent version, ASTM C1303–10.

DOE invites comment on this proposed approach.

5. Improvements to ASTM C1303 Methodology

In the January NOPR, DOE proposed several exceptions to ASTM C1303–08 related to sample preparation of foam-in-place products. 75 FR 194. Specifically, DOE proposed that, rather than requiring that foam be sprayed onto a single sheet of wood in accordance with section A2.3 of ASTM C1303–08, the sample "shall be foamed into a fully closed box of internal dimension 60 cm × 60 cm by desired product thickness (2 ft × 2 ft × desired thickness). The box shall be made of ¾ inch plywood and internal surfaces are wrapped in 4 to 6 mil polyethylene film to prevent the foam from adhering to the box material." DOE had intended for this proposed approach to minimize manufacturer burden while ensuring uniform sample preparation.

In reference to this proposal, Honeywell stated that the sample preparation method is too prescriptive for foam-in-place products and argued that DOE should not dictate materials for building the sample mold or dimensions of the mold. Rather, it recommended that foam-in-place samples be prepared in a fashion that represents the average foam properties (or bulk foam properties) of the commercial panel. (Honeywell, No. 1.3.020 at p. 3) ACC/CPI stated that the sample preparation methods of polyurethane foam are too prescriptive when describing mold materials that must be used, and instead recommended adopting a modified version of section 3.1 of ASTM C1303–10 to account for a product manufacturer's typical method of panel cavity preparation, foam injection and cure time. (ACC/CPI, No. 1.3.006 at p. 5)

DOE agrees that spatial variation during foam injection is a relevant concern. To represent foam properties more closely for various manufacturers, DOE proposes the following changes:

1. Mold/Sample Panel Geometry

a. A panel must be prepared following the manufacturer's injection, curing and assembly methods. The width and length of the panel must be 48 inches ±1 inch and 96 inches ±1 inch, respectively.

b. As proposed in the January NOPR, the panel thickness shall be equal to the desired test thickness. 75 FR 194.

2. Materials

The panel should be identical to panels sold by the manufacturer, with one key exception: The inner surfaces must be lined with a material, such as 4 to 6 mil polyethylene film, to prevent the foam from adhering to the panel internal surfaces. (This ensures that when the panel metal skin is removed for testing, the underlying foam is not damaged.)

3. Sample Preparation

a. After the foam has cured and the panel is ready to be tested, the facing and framing materials must be carefully removed to ensure that the underlying foam is not damaged or altered.

b. A 12-inch × 12-inch square (× desired thickness) cut from the exact geometric center of the panel must be used as the sample for completing ASTM C1303–08.

These additions will allow for more representative samples while maintaining consistency across manufacturers. DOE also believes, based on its analysis of the likely impacts from the adoption of this procedure, that these proposed modifications will not lead to any appreciable deviations from the measured energy use of the envelope. DOE invites comments from interested parties on the reasonableness of this prediction.

Certain interested parties raised specific concerns as to the applicability of ASTM C1303 to "bun stock" foam. "Bun stock" foam is foam formed in large cylindrical tubes or "buns." Dyplast, ACC/CPI, Honeywell, and ITW all stated that DOE should not consider ASTM C1303 because ASTM C1303 specifically states that the test method does not apply to rigid closed-cell bun stock foams. (Dyplast, No. 1.3.008 at p. 1; ACC/CPI, No. 1.3.006 at p. 3; Honeywell, No. 1.3.020 at p. 2; and ITW, No. 1.3.013 at p. 1) Dyplast mentioned that this was due to the non-homogenous nature of the bun stock foams. (Dyplast, No. 1.3.008 at p. 1) ITW further stated that ASTM C1303 would not be applicable because it is not possible to determine a consistent initial time for the test and because sheets may be cut from bun stock in different orientations, resulting in different form morphology. (ITW, No. 1.3.013 at p. 1)

DOE recognizes that bun stock foam is different from other types of foam used in WICF equipment. The foam resembles the wood grain found in trees and has cells that vary in size and density by location. When the buns are cut into board stock of various dimensions, the foam morphology varies from one board to another as the boards may be cut from the bun stock in different orientations.

DOE specified in the January NOPR that manufacturers must use the prescriptive method defined in ASTM C1303 (Part A: The Prescriptive Method), but as noted by interested parties, the prescriptive method is not applicable to bun stock foam. 75 FR 193. However, in addition to Part A of ASTM C1303, Part B: Research Method allows for testing of bun-stock or other non-homogenous foams. DOE believes that the research method in Part B is appropriate and applicable for testing of bun-stock foams. Therefore, to address the comments from Dyplast, ACC/CPI, Honeywell, and ITW, DOE proposes that the research method of ASTM C1303–10, Part B be used for testing the LTTR for bun stock foam only.

6. Heat Transfer Through Concrete

In the January NOPR, DOE proposed the use of the following equation to calculate the heat transfer through the floor of both insulated and uninsulated WICF. 75 FR 213. That equation, along with its defined variables, is as follows:

$$Q_{cond\text{-}door\text{-}glass} = \sum_{1}^{i}\left(\Delta T_i \times \frac{A_{walls,i}}{R_{non\ glass\ wall,i}}\right) + \sum_{1}^{j}\left(\Delta T_j \times \frac{A_{floor,j}}{R_{non\ glass\ floor,j}}\right) + \sum_{1}^{k}\left(\Delta T_k \times \frac{A_{ceiling,k}}{R_{non\ glass\ ceiling,k}}\right) + \sum_{1}^{l}\left(\Delta T_l \times \frac{A_{non\ glass\ doors,l}}{R_{non\ glass\ doors,l}}\right) \qquad \text{Eq. 1}$$

Where:

$R_{non\text{-}glass,wall,\ i}$ = R-value of foam used in wall panels, of type i, h-ft² − °F/Btu,

$R_{non\text{-}glass,floor,\ j}$ = R-value of foam used in floor panels, of type j, h-ft² − °F/Btu,

$R_{non\text{-}glass,ceil,\ k}$ = R-value of foam used in ceiling panels, of type k, h-ft² − °F/Btu,

$R_{non\text{-}glass,door,\ l}$ = R-value of foam used in non-glass doors, of type l, h-ft² − °F/Btu,

$A_{walls,I}$ = area of wall, of thickness and underlying materials of type i,

$A_{floor,j}$ = area of floor, of thickness and underlying materials of type j,

$A_{ceiling,k}$ = area of ceiling, of thickness and underlying materials of type k,

$A_{non\text{-}glass\ door,l}$ = area of doors, of thickness and underlying materials of type l,

ΔT_i = dry bulb temperature differential between internal and external air, of type i, °F,

ΔT_j = dry bulb temperature differential between internal and external air, of type j, °F,

ΔT_k = dry bulb temperature differential between internal and external air, of type k, °F, and

ΔT_l = dry bulb temperature differential between internal and external air, of type l, °F.

To complete the calculation, DOE proposed temperature assumptions for the internal cooled air and the surface temperature of the floor. The cooled air temperature was selected based on WICF type: 35 °F and −10 °F for coolers and freezers, respectively. DOE also assumed that the finished subfloor surface material was made of concrete. Additionally, DOE proposed a 55 °F subfloor surface temperature for all walk-ins. The temperature difference across the floor (ΔT) could be calculated using the 55 °F subfloor surface temperature and the internal cooled air assumption. With a known floor area (A_{floor}), ΔT, and floor R-value, the heat transfer through the floor could be readily calculated. However, the specific floor R-value was incorporated into the calculation based on certain conditions. These conditions are described in greater detail below.

Floorless Coolers: For the scenario of uninsulated ("floorless") coolers, DOE proposed a concrete R-value of 0.6 ft² − °F − h/Btu, based on typical concrete density and thickness as reported in the 2009 ASHRAE Fundamentals Handbook.

Pre-Installed Freezer Floor: For the scenario where (1) a manufacturer does not provide a freezer floor; and (2) an insulated floor has been installed on-site by the end-user, DOE proposed that manufacturers use R = 28 ft² − °F − h/Btu for completing the heat transfer calculations. This R-value is the same as the EPCA-prescribed minimum requirement for freezer floors. BASF, ThermalRite, and American Panel supported using an assumption of R–28, while Nor-Lake stated that a value of R–20 would be more appropriate but did not specify why. (BASF, No. 1.3.003 at p. 4; ThermalRite, No. 1.3.031 at p. 2; American Panel, Public Meeting Transcript, No. 1.2.010 at p. 263; Nor-Lake, No. 1.3.029 at p. 4) DOE, however, continues to hold the view that its proposed approach best reflects the statutory framework set out by Congress because R–28 is the minimum freezer floor R-value required by EISA 2007. See 42 U.S.C. 6313(f)(1)(D).

Insulated Floor Shipped by Manufacturer: For both coolers and freezers, if a manufacturer provided the floor, DOE proposed in the January NOPR that the floor R-value (as measured by the test procedure) be used for the heat transfer calculations. 75 FR 198.

Between the publication of the January NOPR and the public meeting, DOE completed additional finite element model (FEM) computer simulations of floorless coolers. Based on FEM simulation results, DOE described a new equation during the public meeting for calculating heat transfer through floorless coolers:

$$Q_{cond\ non\text{-}glass} = \sum_{1}^{i}\left(\Delta T_i \times \frac{A_{walls,i}}{R_{non\ glass\ wall,i}}\right) + q_{floor} \times A_{floor} + \sum_{1}^{k}\left(\Delta T_k \times \frac{A_{ceiling,k}}{R_{non\ glass\ ceiling,k}}\right) + \sum_{1}^{l}\left(\Delta T_l \times \frac{A_{non\ glass\ doors,l}}{R_{non\ glass\ doors,l}}\right) \qquad \text{Eq. 2}$$

Where:

If $A_{floor} \leq 750$ ft², $q_{floor} = 33.153 \times A_{floor}^{-0.364}$,

If $A_{floor} > 750$ ft², $q_{floor} = 0.0002 \times A_{floor} + 2.84$,

q_{floor} = heat flow correction factor,

$R_{non\text{-}glass,wall,\ i}$ = R-value of foam used in wall panels of type i, h − ft² − °F/Btu,

$R_{non\text{-}glass,floor,\ j}$ = R-value of foam used in floor panels of type j, h − ft² − °F/Btu,

$R_{non\text{-}glass,ceil,\ k}$ = R-value of foam used in ceiling panels of type k, h − ft² − °F/Btu,

$R_{non\text{-}glass,door,\ l}$ = R-value of foam used in non-glass doors of type l, h − ft² − °F/Btu,

$A_{ceiling,k}$ = area of ceiling of thickness and underlying materials of type k,

$A_{non\text{-}glass\ door,l}$ = area of doors of thickness and underlying materials of type l,

A_{floor} = area of floor, ft²,

ΔT_i = dry bulb temperature differential between internal and external air, of type i, °F,

ΔT_j = dry bulb temperature differential between internal and external air, of type j, °F,

ΔT_k = dry bulb temperature differential between internal and external air, of type k, °F, and

ΔT_l = dry bulb temperature differential between internal and external air, of type l, °F.

The FEM simulations demonstrated that using 60 °F and 65 °F would result in more accurate energy calculations. DOE indicated at the NOPR public meeting that it was considering modifying the surface temperature assumptions for freezers and coolers to 60 °F and 65 °F, respectively, and sought comment from interested parties on these revised temperatures.

Several manufacturers recommended that DOE maintain the original assumption of 55 °F for sub-floor surface temperature. ThermalRite requested that

55 °F be retained because it believed that the equations were based on solid engineering principles and data. (ThermalRite, No. 1.3.031 at p. 2) Nor-Lake agreed that 55 °F would be more appropriate. (Nor-Lake, No. 1.3.029 at p. 4) Kysor and TAFCO preferred 55 °F because it would be consistent with industry assumptions. (Kysor, Public Meeting Transcript, No. 1.2.010 at p. 270 and TAFCO, No. 1.3.022 at p. 3) ICS recommended that 55 °F be maintained as the assumption for both coolers and freezers because a walk-in with an insulated floor would not have an effect on sub-floor temperature regardless of WICF temperature. (ICS, No. 1.3.027 at p. 2) In light of this general support and the absence of any comments explaining why use of a 55 °F temperature assumption would be inappropriate, DOE proposes continuing to apply its 55 °F assumption for all WICF for three reasons: (1) 55 °F is the general industry accepted value; (2) using a single assumption simplifies calculations; and (3) using a single temperature avoids the complexity of accounting for various field installation variations (such as concrete thickness and proximity to building walls).

Regarding the heat transfer calculations for floorless coolers, Nor-Lake supported using Eq. 1 as proposed in the January NOPR. (Nor-Lake, No. 1.3.029 at p. 4) Master-Bilt and Nor-Lake recommended that DOE consider using the minimum thickness of 3.5 inches rather the 6 inches as proposed in the January NOPR for calculating the concrete R-value, because the building industry uses 3.5 inches. (Master-Bilt, No. 1.3.009 at p. 2 and Nor-Lake, No. 1.3.005 at p. 4)

In this SNOPR, DOE proposes different equations for calculating heat transfer through floor panels, non-floor panels (*i.e.*, wall and ceiling panels), and non-glass doors. Although Nor-Lake supported using Eq. 1 as proposed in the January NOPR, the equations proposed in this SNOPR allow greater flexibility in calculating heat transfer through the envelope because they are able to account for unique temperature differences across each component. See section III.B.7 for a more detailed description of the equations in the SNOPR. The equation for floor heat transfer incorporates the results of FEM simulation by using the values for the heat flow correction factor (q_{floor}) that appear in Eq. 2 above. In performing the FEM simulation, DOE assumed 6-inch-thick concrete despite Master Bilt and Nor-Lake's comments, because that is the recommended floor thickness in the ASHRAE Handbook of Fundamentals (ASHRAE Fundamentals 2005). However, DOE will continue to consider other values if they are more appropriate for the application and asks for comment on a more appropriate value.

7. Walk-In Sited Within a Walk-In: A "Hybrid" Walk-In

In the January NOPR, the calculation procedure provided a means of rating all walk-ins, including the scenario where a freezer is sited inside a cooler or where a cooler and freezer share a common wall.

Modifications described in this SNOPR ensure that the rating of these walk-in cooler/freezer hybrids is properly captured. For example, every panel or door may have a unique temperature differential across the material to reflect either a panel that divides a cooler and freezer or a door that may open from freezer temperatures to cooler temperatures. See section 3.1 of Appendix A for details. In the event an individual non-floor panel, floor panel or door spans two temperature regimes, the lower temperature must be used for the purpose of calculating the heat transfer across that component. For example, if a floor panel spans a section of the floor, where 80 percent of the panel is exposed to cooler temperatures and the other 20 percent is exposed to freezer temperatures, the heat transfer calculation through the floor panel must use only the freezer temperature.

DOE believes the equations shown in section 3.1 of Appendix A provide an accurate means of testing a given walk-in cooler, freezer or hybrid walk-in. DOE seeks comment on the equations and their accuracy, particularly for hybrid walk-ins.

8. U-Factor of Doors and Windows

Conduction heat gain through doors and windows contributes to the energy load of the envelope. To account for this fact, DOE proposes to measure heat gain through doors (with and without glass) and any other glass surfaces such as windows, as well as through the framing materials used for doors and windows. In the January NOPR, DOE proposed measuring heat gain through doors and windows using one of the following options: (1) For doors with a National Fenestration Rating Council (NFRC) rating, thermal performance would have been determined from the NFRC label; or (2) for doors without an NFRC rating, thermal performance parameters would have been determined using Window 5.2, a computer program developed by Lawrence Berkeley National Laboratory. 75 FR 198. (The NRFC is a non-profit, public-private partnership of the window, door, and skylight industry.) In either case, DOE proposed using the thermal performance parameters as inputs for calculations specified in the Test Procedure NOPR.

DOE's proposed method was supported by BASF, Master-Bilt, and Nor-Lake. (BASF, No. 1.3.003 at p. 4; Master-Bilt, No. 1.3.009 at p. 2; Nor-Lake, No. 1.3.005 at p. 4) Kason agreed that using third-party software (such as Window 5.2) to evaluate window performance is reasonable. (Kason, No. 1.3.037 at p. 4) However, NFRC recommended using a standard size door for all calculations to ensure a full rating that includes frame effects and allow for accurate reporting. (NFRC, Public Meeting Transcript, No. 1.2.010 at p. 280) Furthermore, Schott Gemtron pointed out that the standard glass door in Window 5.2 is not the same as a typical glass door used in walk-ins. (Schott Gemtron, Public Meeting Transcript, No. 1.2.010 at p. 284) ACEEE stated that the manufacturers of doors with glass surfaces should use NFRC rating methods to certify performance. (ACEEE, No. 1.3.034 at p. 2)

In response to the comment from Schott Gemtron, the Window 5.2 program does not incorporate WICF-specific doors at this time because NFRC, the primary user of Window 5.2, has never rated WICF doors. To remedy this situation, the typical WICF door geometries would simply need to be added to the Window 5.2 database. Because use of the NFRC ratings would avoid the need for DOE to prescribe specific geometries or testing scenarios, however, DOE proposes in this SNOPR that instead of using Window 5.2, manufacturers shall rate the total thermal transmittance (known as U-factor) of doors and windows, including their framing materials, using the test procedure NFRC 100–2010–E0A1, "Procedure for Determining Fenestration Product U-Factors." NFRC 100–2010–E0A1 specifies a test procedure but does not specify test conditions, which depend on the product. Details of proposed test conditions may be found in section 4.1.3 of Appendix A. DOE welcomes comments on improvements that could be made to Window 5.2, however, and would consider allowing use of Window 5.2 provided that such improvements led to results as consistent as those achieved with the NFRC rating.

In addition, DOE proposes applying the provisions in section 5.2 of NFRC 100–2010–E0A1, which would provide a uniform and reasonably accurate method of measuring the thermal transmittance of the door and window components installed in a walk-in. The section contains reference methods for determining heat transfer properties for specific side-hinged exterior door systems, to all doors (*i.e.* doors without any glass, doors with glass windows, glass display doors, etc.) and glass walls. Doors, as defined in Appendix A 2.1(b) of these proposed regulations, includes the user movable components and the framing components that support the door hinges such as the center mullions in display doors or door plugs found commonly in passage doors. The complete assembly must be tested to find the door U-factor.

NFRC 100–2010–E0A1 provides a means of testing representative door geometry that can then be extrapolated to other doors of similar materials and geometry. This approach is less costly but generally results in more conservative test results. However, if a door manufacturer or other party responsible for testing would prefer to perform the complete physical test described in NFRC 100–2010–E0A1 for all doors (*i.e.* not rely on NFRC's extrapolation methodology), the testing entity may do so.

DOE seeks comment on the proposal requiring windows and doors, including their framing materials, to be rated using NFRC 100–2010–E0A1. As stated above, DOE also seeks comment on improvements to the Window 5.2 program that would make its use in the test procedure appropriate.

9. Walk-In Envelope Steady-State Infiltration Test

In the January NOPR, DOE noted two air exchange pathways for walk-in envelopes: (1) Air exchange ("infiltration") occurring during door opening events, the extent of which depended on door opening area and the frequency of door opening, and (2) infiltration during "steady-state" conditions. DOE defined steady-state as the period of time when all access methods, such as doors, were in the closed position. During steady-state conditions, infiltration could occur via cracks in door sweeps, bi-directional pressure relief valves, and panel-to-panel interfaces. Infiltration during door opening events accounts for the majority of infiltration into the envelope, but steady-state infiltration could be significant as well. Because air infiltration plays a role in determining the overall efficiency of a given WICF and the likely energy consumption in keeping its refrigerated areas cool, DOE proposed using ASTM E741–06, "Standard Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution," for testing the steady-state air infiltration of walk-in coolers and walk-in freezers. DOE detailed a number of requirements, such as internal and external temperatures during testing, sampling methods, and gas tracer calculation type.

In comments on the January NOPR, interested parties noted the role that pressure relief valves play with respect to infiltration testing. These valves are standard equipment with walk-in envelopes and are designed to ensure the proper operation of a WICF unit by relieving pressure changes that accompany rapid cooling of warm air after door opening events. Craig stated that the standard pressure relief valve on walk-ins could interfere with infiltration testing, and Kason added that WICF manufacturers use pressure relief ports that allow gas to move through the envelope and further suggested that these ports would need to be blocked to test infiltration. (Craig, No. 1.3.017 at p. 2 and Kason, No. at p. 3)

Because bi-directional pressure relief valves are considered standard equipment for all walk-in freezers, today's notice clarifies that they should be included in the general steady-state infiltration test if they are part of the walk-in being tested. In addition, because valves contribute to steady-state infiltration, it is necessary to measure their contribution. The duration of the steady-state test is long enough to ensure that the average valve operation time is accurately represented. In addition, properly sited and designed valves should not be opening and closing frequently, if at all, during steady-state conditions. Because these valves are intended to relieve large pressure swings caused by rapid cooling of warm air that has entered during door opening events, the pressure differential across the valve should be low enough that it remains closed during steady state operation.

In the January NOPR, DOE also proposed to reduce testing burden by allowing manufacturers to test the infiltration of a limited number of envelopes and then scale those results to all other envelopes manufactured. Interested parties agreed with DOE's approach to reduce the testing burden but suggested that it was necessary for DOE to provide detailed requirements of how the test units should be constructed. Craig, American Panel, and ThermalRite stated that DOE must specify the basic unit to be tested in terms of size and certain components, which would be standardized across all manufacturers. (Craig, No. 1.2.010 at pp. 102–103; American Panel, No. 1.3.024 at p. 2; ThermalRite, No. 1.3.031 at p. 1)

DOE agrees with this approach and proposes that with respect to the steady-state infiltration test, the techniques, materials, and final assembly must be identical to units that are shipped to customers. The unit must be assembled following the instruction manual supplied by the manufacturer. Details may be found in section 4.2 of Appendix A.

DOE seeks comment on the modifications to the steady-state infiltration testing.

10. Door Steady-State Infiltration Test

In the January NOPR, DOE proposed testing steady-state infiltration on fully assembled envelopes using the gas tracer method described in ASTM E741–06, "Standard Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution." The NOPR proposed an additional series of tests, using ASTM E741–06, under certain conditions, and would have required testing of all possible combinations of panels and doors.

Interested parties recommended several alternatives for DOE to consider. The Joint Utilities recommended the NFRC rating method for determining infiltration related to doors, in part because this method, in their collective view, provides a means to test and sample products that would assure that the sold product matches the quality of the tested sample. (Joint Utilities, No. 1.3.019 at p. 12–13) Hired Hand recommended ASTM E330–97, "Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference," or ASTM E283–92, "Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen." (Hired Hand, No. 1.3.033 at p. 5)

In this SNOPR, DOE is proposing measuring steady-state infiltration through panels and doors using separate tests for each rather than using a single test for both as proposed in the January NOPR. DOE is considering this modification to reduce testing burden; the January NOPR proposed to require a new test for each unique panel and door configuration, which could be overly burdensome to test because of the many possible configurations. For all doors, DOE is considering NFRC 400–2010–E0A1, "Procedure Determining Fenestration Product Air Leakage." NFRC 400–2010–E0A1 is based on ASTM E283–04, the most recent version of ASTM E283–92, one of the test methods recommended by Hired Hand. This test method is appropriate for this application because it was specifically designed to measure the air leakage through doors and fenestration products. DOE adapted NFRC 400–2010–E0A1 for use with doors on walk-in envelopes by establishing standard assumptions for the pressure differences, in Pascals (Pa), across cooler and freezer doors and requiring the infiltration at these pressures to be determined using a pressure-infiltration relationship determined through testing. Section 4.4.2 of proposed Appendix A contains the assumptions and the method for finding the pressure-infiltration relationship. DOE does not intend to incorporate ASTM E330–97, "Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference," as suggested by Hired Hand because this procedure measures structural performance, which does not impact efficiency; but DOE invites Hired Hand to submit further justification in support of this standard. DOE seeks comment on the proposal to test steady-state infiltration through doors separately from steady-state infiltration through panels and using NFRC 400–2010–E0A1 for both tests. DOE seeks comment on the proposed assumptions for the pressure differential across cooler doors (1.5 Pa) and freezer doors (3.5 Pa). DOE seeks comment on the proposal to determine infiltration across cooler and freezer doors using tests of infiltration and exfiltration at 10 Pa to 60 Pa to establish a pressure-infiltration relationship with which to extrapolate the infiltration occurring across cooler and freezer doors.

11. Door Opening Infiltration Assumptions

In the January NOPR, DOE proposed to incorporate several assumptions from the ASHRAE Handbook of Fundamentals 2009 related to door opening infiltration that would be used to calculate the portion of time each doorway is open, D_t:

$$D_t = \frac{\left[\left(P \times \theta_p\right) + \left(60 \times \theta_o\right)\right]}{\left[3600 \times \theta_d\right]} \qquad \text{Eq. 3}$$

Where:

P = number of doorway passages (*i.e.,* number of doors opening events),
θ_p = door open-close time (seconds/P),
θ_o = time door stands open (minutes), and
θ_d = daily time period (h). 75 FR 197.

For glass display doors and all other doors, DOE specified P = 72 and 60, respectively. Required values for θ_p: (1) reach-in glass doors, θ_p = 8 seconds; (2) all other doors, θ_p = 15 seconds; and (3) if an automatic door opener/closer is used, θ_p = 10 seconds. DOE required glass display doors θ_o = 0 minutes and all other doors, θ_o= 15 minutes.

Hired Hand proposed revised parameters for the number of door openings (P), steady-state time, and all other parameters in the equation for infiltration due to door openings both for doors with automatic door closures and manually closed larger doors, because, in its view, the proposed parameters are adequate for display cases and small walk-ins but insufficient for evaluating large retail supermarket applications (storage warehouse coolers and freezers where door entry width is greater than 4 feet and serviced by employees only). (Hired Hand, No. 1.3.033 at p. 3) Schott Gemtron stated that DOE needs to distinguish between glass display doors and service doors because service doors are not opened as often. (Schott Gemtron, Public Meeting Transcript, No. 1.2.010 at p. 314) Hired Hand also stated that DOE should clarify the coverage of doors because they believe the intent of EISA 2007 was targeted mainly at retail applications with doors smaller than 45 inches in width. (Hired Hand, No. 1.3.033 at p. 1)

DOE agrees with Hired Hand and Schott Gemtron that additional refinement to assumptions can be made to differentiate between glass display, passage (or service), and freight doors. In addition, to reflect the benefit from the use of automated doors, DOE proposes to modify the value of θ_o when a sensor and automated open/close system is included. Therefore, DOE proposes to define "glass display door" as a door designed for the movement and/or display of product rather than the passage of persons, "passage door" (or "service door") as an opaque door that is less than or equal to a 45-inch width and designed for the passage of persons, and "freight door" as an opaque door that is greater than 45-inch width. DOE cannot specifically exclude doors wider than 45 inches if they are used on a walk-in cooler or walk-in freezer that is not excluded from coverage by EISA 2007, as suggested by Hired Hand.

The new assumptions regarding doors are reflected in Table III.4.

TABLE III.4—ASSUMPTIONS TO DIFFERENTIATE DOOR TYPES

Door type	P	θ_p *sec*	θ_p,w sensor *sec*	θ_o *min*	θ_o,w/sensor *min*	θ_d *hrs*	Note
Glass Display	72	8	—	0	—	24	Proposed in NOPR.
Passage	60	15	10	15	—	24	
Freight	60	15	10	15	—	24	
Glass Display	72	8	—	0	—	24	SNOPR.
Passage	60	15	10	30	10	24	
Freight	120	60	30	60	20	24	

DOE seeks comment on this alternative approach and modified assumptions.

12. Infiltration Reduction Device Effectiveness

DOE discovered an error in Eq. 3–25 after the January NOPR was published. DOE notified stakeholders of the error and correction at the public meeting.

DOE proposes to use the corrected Eq. 3–25 in the final rule.

ThermalRite supported the infiltration reduction device (IRD) effectiveness test methodology, but stated that manufacturers of IRDs should perform the testing. (ThermalRite, No. 1.3.031 at p. 2) DOE acknowledges that it may be more appropriate for a third party to test an IRD by itself, whether that third party is the IRD manufacturer or a different entity, because IRD effectiveness is largely independent of other envelope characteristics. Therefore, DOE proposes several modifications to the IRD effectiveness test that it initially proposed. These modifications would permit testing to be done by the IRD manufacturer, the envelope manufacturer, or another entity. The modifications that DOE is considering as alternatives to its initially proposed approach may be found in section 4.3 of Appendix A.

Hired Hand stated that DOE should include an assumed performance value for IRDs that are subject to degradation and do not perform consistently over time. (Hired Hand, No. 1.3.033 at p. 5 and Public Meeting Transcript, No. 1.2.010 at p. 310) DOE believes it is reasonable to incorporate assumed performance values because an established body of research supports these values. While the assumptions do not reflect all real-world WICF door use scenarios or applications, it is necessary for DOE to assume values to ensure a uniform testing method to rate walk-ins. These assumptions are stated in section 4.3 of proposed Appendix A to this SNOPR.

DOE seeks comment on this alternative approach.

13. Relative Humidity Assumptions

In the January NOPR, DOE proposed the assumption of an internal walk-in relative humidity of 45 percent. This value was selected to match AHRI–1250 test dry-coil conditions. However, these conditions do not necessarily reflect general walk-in humidity conditions; rather, the conditions were chosen to test refrigeration systems when there is little or no frost load on the evaporator coil. DOE recognizes that, in practice, the relative humidity (RH) varies significantly depending on the product stored within a walk-in.

In order to reflect higher RH values experienced in practice, DOE proposes a new assumption of 75 percent RH for both freezer and cooler internal conditions. This RH level is within the 65–85 percent range of humidity levels used in practice for products from canned beverages such as beer to packaged fruits and vegetables. DOE seeks comment on this assumption in addition to assumptions found in proposed Appendix A, section 2.1(e).

C. Refrigeration System

As previously discussed, DOE is proposing for the purposes of this test procedure to draw a distinction between the envelope or structure of the walk-in cooler or walk-in freezer and the mechanical refrigeration system performing the physical work necessary to cool the interior space. The refrigeration system itself could be one of three types: (1) Single-package systems containing the condensing and evaporator units; (2) split systems with the condensing unit and unit cooler physically separated and connected via refrigerant piping; or (3) rack systems utilizing unit coolers, which receive refrigerant from a shared loop. The following section addresses issues raised by interested parties that prompted DOE to consider other options in addition to those proposed in the January NOPR.

1. Definition of Refrigeration System

During the NOPR public meeting, DOE stated that it was considering the following changes to the definition of refrigeration system: substituting "integrated single package refrigeration unit" with "a packaged system where the unit cooler and condensing unit are integrated into a single piece of equipment" in order to clarify the term and substituting "central rack system" with "multiplex condensing system" because the latter is a more inclusive term and may be more technically accurate.

Thermal-Rite and Nor-Lake expressed support for the revised definition of refrigeration system. (Thermal-Rite, No. 1.3.031 at p. 1; Nor-Lake, No. 1.3.029 at p. 2) ACEEE stated that the definition proposed in the January NOPR seemed appropriate and seems to recognize the varieties serving the marketplace. (ACEEE, No. 1.3.034 at p. 2) Master-Bilt, BASF, and Kason all stated that they agreed with the definition but did not specify which version they supported. (Master-Bilt, No. 1.3.009 at p. 2; BASF, No. 1.3.003 at p. 5; Kason, No. 1.3.037 at p. 4) On the other hand, Craig stated that the definition of refrigeration system should include a temperature limit and suggested 45 °F as the upper limit. (Craig, No. 1.3.036 at p. 84) A person affiliated with Gonzaga Law also viewed the proposed definition of refrigeration equipment as too inclusive but did not specify how DOE could improve it. (William Gray, Gonzaga Law, No. FDMS 0003 at p. 1) HeatCraft stated that DOE should have an exemption for refrigeration equipment that serves loads other than walk-ins. (HeatCraft, Public Meeting Transcript, No. 1.2.010 at p. 92)

Regarding the above comments, DOE believes that adding a temperature limit to the definition of refrigeration system, as suggested by Craig, is unnecessary because DOE is already proposing to add a temperature limit to the definition of walk-ins that will cover both envelopes and refrigeration systems. To address HeatCraft's concern, DOE has included the term "multiplex equipment" in the definition to refer to refrigeration equipment serving loads other than walk-ins. DOE's revised definition includes unit coolers connected to multiplex systems, meaning that only the unit cooler is covered in any refrigeration system that incorporates a multiplex system. The multiplex systems themselves would not be covered.

Consistent with its discussions at the public meeting, DOE is also proposing to revise its proposed definition of the term "refrigeration system" with respect to WICF equipment. DOE requests comment on the proposed alternative definition.

2. Version of AHRI 1250

In the January NOPR, DOE proposed to incorporate the industry standard AHRI 1250P–2009, "Standard for Performance Rating of Walk-In Coolers and Freezers," into the test procedure. The January NOPR inadvertently referred to the preliminary version of this standard, while the final published version is AHRI 1250–2009, which was published in September 2009. DOE found no significant differences between the preliminary version and the final version; nevertheless, DOE proposes to incorporate the most recent version, AHRI 1250–2009, into the final test procedure.

3. Annual Walk-In Energy Factor

DOE is required by EPCA to establish a test procedure to measure the energy use of walk-in coolers and walk-in freezers. (42 U.S.C. 6314(a)(9)(B)(i)) AHRI 1250–2009 determines the annual walk-in energy factor (AWEF) as its final metric, the ratio of the annual net heat removed from the box, which includes the internal heat gains from non-refrigeration components but excludes the heat gains from the refrigeration components in the box to the annual energy consumption. Because AWEF is essentially a measure of efficiency, DOE proposed in the January NOPR to develop equations to derive energy consumption from AWEF. 75 FR 202–203. DOE also proposed to require manufacturers to report both AWEF and energy consumption and asked for comment on this approach. 75 FR 202–203.

Nor-Lake agreed with the proposed method of measuring and calculating the energy use of refrigeration systems (Nor-Lake, No. 1.3.005 at p. 4) but also cautioned that both the methodology for deriving annual energy consumption from AWEF and the reporting requirements should be consistent across all manufacturers. (Nor-Lake, No. 1.3.029 at p. 5) Manitowoc, on the other hand, stated that AWEF is a more useful metric than energy consumption because the calculated energy consumption may not be an accurate representation of actual energy consumption in the field as the load profile in the test procedure is arbitrary. Rather, AWEF can be used to easily estimate actual energy consumption if the actual load is known, and AWEF also allows for comparisons between higher and lower efficiency systems. (Manitowoc, Public Meeting Transcript, No. 1.2.010 at p. 375) Arctic suggested that DOE could develop software to assist businesses with calculating energy consumption. (Arctic, Public Meeting Transcript, No. 1.2.010 at p. 392)

Because EISA requires that the test procedure measure energy use, as explained above, DOE continues to propose that manufacturers measure and report both AWEF and the measure of energy use derived from AWEF as determined by the test procedure. The calculation methodology and reporting requirements will be consistent across manufacturers as suggested by Nor-Lake.

DOE notes that in the course of performing the test procedure and determining AWEF, the annual energy use of a walk-in refrigeration system may be found as an intermediate result or easily derived from AWEF or other intermediate results. Thus, DOE proposes to simplify the method by which energy use is determined by introducing revised calculations in the rule language. DOE requests comment on the simplified calculations.

DOE does not intend to develop software for calculating energy use, as suggested by Arctic, because this is outside the scope of the rulemaking. The proposed test procedure contains all the necessary calculations for determining AWEF and energy use, and manufacturers may develop or use their own software that assists them in performing these calculations if they choose.

IV. Regulatory Review

A. Review Under Executive Order 12866

The Office of Management and Budget (OMB) has determined that test procedure rulemakings do not constitute "significant regulatory actions" under Executive Order (E.O.) 12866, "Regulatory Planning and Review." 58 FR 51735 (October 4, 1993). Accordingly, this action was not subject to review under that Executive Order by the Office of Information and Regulatory Affairs (OIRA) of the OMB.

B. Review Under the National Environmental Policy Act

In this proposed rule, DOE proposes to adopt test procedures and related provisions for walk-in equipment. The test procedures would be used initially for considering the adoption of energy conservation standards for walk-ins, and DOE would require their use only if standards were subsequently adopted. The proposed test procedures will not affect the quality or distribution of energy and therefore will not result in environmental impacts. Therefore, DOE determined that this rule falls into a class of actions that are categorically excluded from review under the National Environmental Policy Act of 1969 (42 U.S.C. 4321 *et seq.*) and DOE's implementing regulations at 10 CFR part 1021. More specifically, today's proposed rule is covered by the categorical exclusion in paragraph A5 to subpart D, 10 CFR part 1021. Accordingly, neither an environmental assessment nor an environmental impact statement is required.

C. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of an initial regulatory flexibility analysis (IRFA) for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by E.O. 13272, "Proper Consideration of Small Entities in Agency Rulemaking", 67 FR 53461 (August 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of General Counsel's Web site, *http://www.gc.doe.gov*.

DOE reviewed the test procedures considered in today's supplemental notice of proposed rulemaking under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003.

As discussed in more detail below, DOE found that because the proposed test procedures have not previously been required of manufacturers, all manufacturers, including small manufacturers, could experience a financial burden associated with new testing requirements. While examining this issue, DOE determined that it could not certify that the proposed rule, if promulgated, would not have a significant effect on a substantial number of small entities. Therefore, DOE prepared an IRFA for this rulemaking. The IRFA describes potential impacts on small businesses associated with walk-in cooler and freezer testing requirements. DOE has transmitted a copy of this IRFA to the Chief Counsel for Advocacy of the Small Business Administration (SBA) for review. This SNOPR includes changes made to the IRFA in light of comments from interested parties on the January NOPR, specifically regarding the number of small entities regulated and the potential testing burden. The revised IRFA also considers the burden of new tests that DOE is proposing in this SNOPR.

1. Reasons for the Proposed Rule

The reasons for this proposed rule are discussed elsewhere in the preamble and not repeated here.

2. Objectives of and Legal Basis for the Proposed Rule

The objectives of and legal basis for the proposed rule are discussed elsewhere in the preamble and not repeated here.

3. Description and Estimated Number of Small Entities Regulated

DOE uses the SBA small business size standards published on January 31, 1996, as amended, to determine whether any small entities would be required to comply with the rule. 61 FR 3286; see also 65 FR 30836, 30850 (May 15, 2000), as amended. 65 FR 53533, 53545 (September 5, 2000). The size standards are codified at 13 CFR part 121. The standards are listed by North American Industry Classification System (NAICS) code and industry description and are available at *http://www.sba.gov/idc/groups/public/documents/sba_homepage/serv_sstd_tablepdf.pdf.*

In the January NOPR, DOE classified walk-in cooler and freezer equipment manufacturing under NAICS 333415, "Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing," which has a size standard of 750 employees. 75 FR 204. After reviewing industry sources and publicly available data, DOE identified at least 37 small manufacturers of walk-in cooler and freezer envelopes and at least 5 small manufacturers of walk-in cooler and freezer refrigeration systems that met this criterion.

In comments on the January NOPR, both American Panel and Kysor said that virtually all panel and walk-in manufacturers are small businesses under this standard. (American Panel, Public Meeting Transcript, No. 1.2.010 at p. 379; Kysor, No. 1.3.035 at p. 3) Craig said that it was a small business under this standard. (Craig, Public Meeting Transcript, No. 1.2.010 at p. 17) Schott Gemtron stated that over 90 percent of the membership of the trade association of North American Food Equipment Manufacturers (NAFEM) was under $12 million in sales. (Schott Gemtron, Public Meeting Transcript, No. 1.2.010 at p. 389) Several commenters listed sources DOE could use to identify small businesses: Nor-Lake recommended the NSF Standard 7 listings, Arctic recommended the NAFEM database, and ICS recommended the central contractor registry. (Nor-Lake, No. 1.3.029 at p. 5; Arctic, Public Meeting Transcript, No. 1.2.010 at p. 388; and ICS, Public Meeting Transcript, No. 1.2.010 at p. 390)

In light of these comments and additional research conducted by DOE, the industry can be characterized by a few manufacturers that are subsidiaries of much larger companies (who would not be considered small businesses) and a large number of small companies as categorized by NAICS code 333415. Furthermore, more than half of small walk-in manufacturers have 100 or fewer employees. DOE acknowledges the sources provided by Nor-Lake, Arctic, and ICS and will consider these sources in its characterization of the industry in the final regulatory flexibility analysis (FRFA).

4. Description and Estimate of Compliance Requirements

In the NOPR, DOE described potential impacts of the proposed test procedures. DOE received comments from manufacturers regarding the estimated impacts. Arctic stated that potential impacts of the proposed test procedures on manufacturers, including small businesses, come from impacts associated with the cost of testing. (Arctic, No. 1.3.012 at p. 1) ICS commented that burden would come both from testing cost and length of time required to perform the tests. (ICS, No. 1.3.027 at p. 2) BASF commented on specific tests, stating that ASTM C1303–08 is more expensive than ASTM C518–04 and that ASTM E741–06 and AHRI 1250–2009 were even more expensive. (BASF, No. 1.3.003 at p. 5) Master-Bilt, American Panel, and Hill Phoenix all commented that the test procedure would be particularly burdensome to small businesses. (Master-Bilt, No. 1.3.009 at p. 3; American Panel, No. 1.3.024 at p. 4; Hill Phoenix, No. 1.2.023 at p. 3) Craig asserted that the cost of testing could be up to $1 million and would be likely to put small companies out of business or force them to sell noncompliant products. (Craig, No. 1.3.017 at p. 1; No. 1.3.036 at p. 4; and Public Meeting Transcript, No. 1.2.010 at p. 18)

Envelope Manufacturer Testing Impacts

In the January NOPR, DOE proposed to require envelope manufacturers to test their equipment in accordance with two industry test standards: ASTM C1303–08, "Standard Test Method of Predicting Long Term Thermal Resistance of Closed-Cell Foam Insulation," and ASTM E741–06, "Standard Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution" (ASTM C1303–08 has since been updated to ASTM C1303–10, but the updated version contains no substantive changes that would affect the testing cost). DOE spoke with industry experts to determine the approximate cost of each test and determined that a test using ASTM C1303–08 costs between approximately $5,000 and $10,000, and a test using ASTM E741–06 costs between $1,000 and $5,000. Therefore, in the January NOPR, DOE estimated that the cost of testing for one walk-in would range from $6,000 to $15,000. Also, DOE estimated that a typical manufacturer would have approximately 8 basic envelope configurations that would need to be tested, so the total cost of compliance due to testing would be approximately $84,000 (ranging from $48,000 to $120,000). This estimated total cost only includes the cost of one test on each basic configuration, and does not include additional testing on the same basic model that may be required as part of a sampling plan. DOE may consider development of a sampling plan in a future rulemaking.

The revisions to the proposed test procedure that are proposed in this SNOPR for envelope manufacturers would require testing in accordance with the two tests mentioned above as well as an additional test: ASTM C1363–05, "Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus." The SNOPR would also require the measurement of heat gain through doors (with and without IRD and including glass doors) to be tested using NFRC procedures, rather than allowing for use of either the NFRC procedures or the Window 5.2 program. DOE determined that a test using ASTM C1363–05 costs between $1,000 and $3,000, and NFRC testing cost varies between $1,000 and $10,000 for all doors and IRDs depending on product lines. However, NFRC has reduced fees for small businesses, which it defines as companies with less than $1 million in sales.[1] These reduced fees are 50 percent of members' annual fees and product line fees (33 percent of non-members' annual fees and product line fees), and a waiver of label fees. DOE realizes that this definition differs from the SBA size threshold set out for walk-in envelope manufacturers but believes that some entities that are small businesses pursuant to SBA's size threshold could also qualify for these reduced fees.

To address the comments from Arctic, ICS, BASF, Master-Bilt, American Panel, Hill Phoenix, and Craig regarding testing costs, DOE notes that provisions in the January NOPR and revisions to the proposed test procedure that are considered in this SNOPR allow manufacturers to test a limited number of models and model components and then calculate the performance of other models from the test results. Measurements incorporating these revisions include heat transfer through panels (see section III.B.1), steady state infiltration through the envelope (see section III.B.9), and door and IRD performance (see section III.B.12). DOE estimates that a typical envelope manufacturer could be required to perform ASTM C1303–10 on between 1 and 2 types of foam; ASTM C1363–05 on 1 to 2 types of panel pairs; ASTM E741–06 on 1 to 2 envelopes; and NFRC testing on 1 to 3 types of doors and 1 to 3 types of IRD. The total cost of one test on each type of walk-in or component listed could range from $8,000 to $46,000. This estimated cost could vary significantly depending on the number of unique components incorporated into a particular manufacturer's walk-ins. Furthermore, the estimated total cost only includes the cost of one test on each item listed. DOE may consider developing a sampling plan in a future rulemaking to determine how many tests need to be performed on the same type of envelope or component, to ensure the test results are repeatable and statistically valid. Therefore, DOE welcomes comment on this estimate.

Refrigeration System Manufacturer Testing Impacts

The proposed test procedure for refrigeration systems would require manufacturers to perform testing in accordance with a single industry test standard: AHRI Standard 1250–2009, "2009 Standard for Performance Rating of Walk-In Coolers and Freezers." Because this test was recently developed by the industry and has not

[1] *http://www.nfrc.org/documents/ProgramCostsFactsheet.pdf*.

yet been widely used to test refrigeration systems, DOE could not determine how much the test currently costs. However, DOE researched the cost of other, similar standards and estimated in the January NOPR that a test using AHRI Standard 1250–2009 would likely cost approximately $5,000. DOE has not received evidence to the contrary and thus maintains this estimate for the SNOPR for a single test. In the January NOPR, DOE estimated that the total testing cost for a typical refrigeration manufacturer could be approximately $250,000, based on an estimate of 50 basic models, but it could be higher for manufacturers of more customized equipment. For instance, a manufacturer with 200 basic models would incur a testing cost of approximately $1 million. Master-Bilt stated that they sell over 160 models of condensing units and 130 models of evaporators, with over 1500 combinations. (Master-Bilt, No. 1.3.009 at p. 3) (DOE notes that Master-Bilt is not considered a small business because it has more than 750 employees including its parent company.) In comments on the January NOPR, Craig stated that under DOE's estimated cost of $250,000, small manufacturers would be forced to discontinue assembling their own refrigeration systems and instead purchase units from large manufacturers, making them less competitive. (Craig, No. 1.3.017 at p. 2) DOE further notes that the estimated testing cost does not include cost of the tested equipment and asks whether manufacturers could sell equipment that had been tested, thus reducing this cost.

To address these concerns, DOE is proposing burden-reducing measures for refrigeration system manufacturers similar to those for envelope manufacturers. The test procedure proposed in the January NOPR, AHRI 1250–2009, which DOE continues to propose in this SNOPR, allows for rating the condensing unit and the unit cooler separately and then calculating their combined efficiency; this would reduce testing burden by not requiring every combination to be tested. Allowing for the use of such a calculation would significantly decrease the number of tests.

DOE recognizes the particular burden of the envelope and refrigeration tests on small manufacturers. Because the cost of running each test is the same for all manufacturers, both small and large, and because DOE has proposed measures to reduce burden on all such manufacturers, manufacturers would likely incur comparable absolute costs as a result of the proposed test procedures. However, Kason stated that the burden of testing will be greater on small manufacturers because they will sell fewer units per type of basic model. (Kason, No. 1.3.037 at p. 4) Indeed, DOE does not expect that small manufacturers would have fewer basic models than large manufacturers, because the equipment is highly customized throughout the industry. A small manufacturer could have the same total cost of testing as a large manufacturer, but this cost would be a higher percentage of a small manufacturer's annual revenues. Thus, the differential impact associated with walk-in cooler and walk-in freezer test procedures on small businesses may be significant even if the overall testing burden is reduced as described above. DOE requests comment on quantitative differential impacts and will consider presenting such impacts in the FRFA.

To further address concerns about costs, DOE notes that for both envelopes and refrigeration systems, DOE may consider development of a sampling plan to determine how many units must be tested to establish compliance and enforcement requirements. In such a rulemaking, however, DOE could also consider additional methods to reduce the testing burden on manufacturers. For example, DOE could consider allowing manufacturers to rely on component suppliers for test results, and manufacturers could then use these values in their calculations of energy consumption of the walk-in. DOE could also allow manufacturers to group basic models into a "family" of models and only require the lowest-efficiency basic model in the family to be certified. DOE could also consider allowing manufacturers to use validated alternative efficiency determination methods, or AEDMs, which could consist of a calculation or computer program, to rate their equipment. DOE will consider the impacts to small businesses of future certification, compliance, and enforcement provisions for walk-in coolers and freezers in a later rulemaking.

5. Duplication, Overlap, and Conflict with Other Rules and Regulations

DOE is not aware of any rules or regulations that duplicate, overlap, or conflict with the rule being considered today.

6. Significant Alternatives to the Rule

DOE considered a number of alternatives to the proposed test procedure, including test procedures that incorporate industry test standards other than the three proposed standards, ASTM C1303–08, ASTM E741–06, and AHRI Standard 1250P–2009, described above. Instead of requiring ASTM C1303–08 for testing the long-term thermal properties of insulation, DOE could require only ASTM C518–04, "Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus," which tests the thermal properties of insulation at a certain point in time (*i.e.,* the point of manufacture). (Because ASTM C1303–08 incorporates ASTM C518–04, requiring ASTM C1303–08 is consistent with the statutory requirement for basing measurement of the thermal conductivity of the insulation on ASTM C518–04.) (42 U.S.C. 6314(a)(9)(A)) A test of ASTM C518–04 alone costs approximately $500 to $1,000. However, DOE is considering ASTM C1303 for other reasons; namely, the concern that ASTM C518–04 alone does not capture the performance characteristics of a walk-in over the period of its use, because it does not account for significant changes in the thermal properties of insulation over time.

DOE also considered ASTM E1827–96(2007), "Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door," instead of ASTM E741–06, for testing infiltration. ASTM E1827–96(2007) costs about $300–$ to 500 for a single test. However, DOE believes that ASTM E1827–96(2007) is not appropriate for walk-ins because it is conducted by placing test equipment in the door and thus does not account for infiltration through the door, which is a major component of infiltration in walk-ins. In addition, it is not intended for testing envelope systems, such as a walk-in, that have a large temperature difference between the internal and external air. Therefore, to complete a blower-door test, the walk-in could not be tested at or close to operational temperatures, resulting in a test that does not accurately reflect its performance.

In the framework document, DOE considered adapting an existing test procedure for commercial refrigeration equipment, such as ARI Standard 1200–2006, "Performance Rating of Commercial Refrigerated Display Merchandisers and Storage Cabinets," as an alternative to AHRI Standard 1250–2009. The two tests are based on a similar methodology for rating refrigeration equipment in general, but ARI Standard 1200–2006 requires testing at only one set of ambient conditions, whereas AHRI Standard 1250–2009 requires testing at three sets of ambient conditions for refrigeration systems with the condensing units located outdoors. The additional time required to test the system at three sets of conditions would incur additional cost and could make AHRI Standard 1250–2009 more burdensome than ARI Standard 1200–2006. However, DOE believes that AHRI Standard 1250–2009 is more appropriate for testing walk-ins than ARI Standard 1200–2006. A test procedure based on ARI Standard 1200–2006 would require the entire walk-in to be tested as a whole, but manufacturers might not have a large enough test facility to make the measurements necessary for the ARI 1200–2006 test procedure in a controlled environment. Also, the refrigeration system is often manufactured separately from the insulated envelope. In this case, whoever assembled the two components would bear the burden of conducting ARI 1200–2006; this party might not be the manufacturer of the refrigeration system. In contrast, AHRI 1250–2009 tests only the refrigeration system. It does not require a larger test chamber than other, similar tests and can be conducted by the manufacturer of the refrigeration system. Because AHRI 1250–2009 requires the system to be tested at three ambient temperatures, it captures energy savings from features (*e.g.,* floating head pressure) that allow the system to use less energy at lower ambient temperatures.

DOE requests comment on the impacts to small business manufacturers for these and any other possible alternatives to the proposed rule.

D. Review Under the Paperwork Reduction Act

DOE recognizes that if it adopts standards for walk-in coolers and walk-in freezers, once the standards become operative, manufacturers would become subject to record-keeping requirements associated with compliance with the standards. Such record-keeping requirements would require OMB approval pursuant to the Paperwork Reduction Act, 44 U.S.C. 3501, *et seq.* DOE will comply with the requirements of the Paperwork Reduction Act if and when energy conservation standards are adopted.

E. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (Pub. L. 104–4) (UMRA) requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. With respect to a proposed regulatory action that may result in the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish estimates of the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed "significant intergovernmental mandate" and requires an agency plan for giving notice and opportunity for timely input before establishing any requirements that might significantly or uniquely potentially affect small governments. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR12820. (also available at *http://www.gc.doe.gov*). The proposed rule published today does not provide for any Federal mandate likely to result in an aggregate expenditure of $100 million or more. Therefore, the UMRA does not require a cost benefit analysis of today's proposal.

F. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105–277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This proposed rule would not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

G. Review Under Executive Order 13132

Executive Order 13132, "Federalism," 64 FR 43255 (August 4, 1999), imposes certain requirements on agencies formulating and implementing policies or regulations that preempt State law or that have federalism implications. The Executive Order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and carefully assess the necessity for such actions. The Executive Order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE has examined today's proposed rule and has determined that it does not preempt State law and does not have a substantial direct effect on the States on the relationship between the national government and the States or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of today's proposed rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297) No further action is required by E.O. 13132.

H. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of E.O. 12988, "Civil Justice Reform", 61 FR 4729 (February 7, 1996), imposes on Federal agencies the general duty to adhere to the following requirements: (1) Eliminate drafting errors and ambiguity; (2) write regulations to minimize litigation; and (3) provide a clear legal standard for affected conduct rather than a general standard and promote simplification and burden reduction. Section 3(b) of E.O. 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation (1) clearly specifies the preemptive effect, if any; (2) clearly specifies any effect on existing Federal law or regulation; (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction; (4) specifies the retroactive effect, if any; (5) adequately defines key terms; and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of E.O. 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this proposed rule meets the relevant standards of E.O. 12988.

I. Review Under the Treasury and General Government Appropriations Act, 2001

The Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516, note) provides for agencies to review most disseminations of information to the public under guidelines established by each agency pursuant to general guidelines issued by OMB. Both OMB's and DOE's guidelines were published. 67 FR 8452 (February

22, 2002) and 67 FR 62446 (October 7, 2002), respectively. DOE has reviewed today's notice under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

J. Review Under Executive Order 13211

Executive Order 13211, "Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use", 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to the Office of Information and Regulatory Affairs (OIRA), OMB, a Statement of Energy Effects for any proposed significant energy action. A "significant energy action" is defined as any action by an agency that promulgated or is expected to lead to promulgation of a final rule, and that is (1) a significant regulatory action under E.O. 12866, or any successor order; and (2) likely to have a significant adverse effect on the supply, distribution, or use of energy; or (3) designated by the Administrator of OIRA as a significant energy action. For any proposed significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use. Today's regulatory action is not a significant regulatory action under E.O. 12866. Moreover, it would not have a significant adverse effect on the supply, distribution, or use of energy. The Administrator of OIRA also did not designate today's action as a significant energy action. Therefore, it is not a significant energy action, and DOE has not prepared a Statement of Energy Effects.

K. Review Under Executive Order 12630

DOE has determined pursuant to E.O. 12630, "Governmental Actions and Interference with Constitutionally Protected Property Rights", 53 FR 8859 (March 18, 1988), that this proposed rule would not result in any takings which might require compensation under the Fifth Amendment to the U.S. Constitution.

L. Review Under Section 32 of the Federal Energy Administration (FEA) Act of 1974

Under section 301 of the Department of Energy Organization Act (Pub. L. 95–91), DOE must comply with section 32 of the Federal Energy Administration Act of 1974, as amended by the Federal Energy Administration Authorization Act of 1977. (15 U.S.C. 788) Section 32 provides in part that where a proposed rule contains or involves use of commercial standards, the rulemaking must inform the public of the use and background of such standards. The rule proposed in this notice incorporates testing methods contained in the following commercial standards: ASTM C1303–08, "Standard Test Method of Predicting Long Term Thermal Resistance of Closed-Cell Foam Insulation;" ASTM E741–06, "Standard Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution;" and AHRI Standard 1250P, "2009 Standard for Performance Rating of Walk in Coolers and Freezers." DOE has evaluated these standards and is unable to conclude whether they fully comply with the requirements of section 32(b) of the Federal Energy Administration Act, *i.e.,* whether they were developed in a manner that fully provides for public participation, comment, and review. As required by section 32(c) of the Federal Energy Administration Act of 1974, as amended, DOE will consult with the Attorney General and the Chairman of the Federal Trade Commission before prescribing a final rule concerning the impact on competition of requiring manufacturers to use the methods contained in these standards to test walk-in equipment.

V. Public Participation

A. Submitting Public Comment

DOE will accept comments, data, and information regarding the supplement to the proposed rule no later than the date provided at the beginning of this notice. Comments, data, and information submitted to DOE's e-mail address for this rulemaking should be provided in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format. Interested parties should avoid the use of special characters or any form of encryption, and wherever possible, comments should include the electronic signature of the author. Comments, data, and information submitted to DOE via mail or hand delivery/courier should include one signed original paper copy. No telefacsimiles (faxes) will be accepted.

According to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit two copies: One copy of the document including all the information believed to be confidential, and one copy of the document with the information believed to be confidential deleted. DOE will make its own determination as to the confidential status of the information and treat it according to its determination.

Factors of interest to DOE when evaluating requests to treat submitted information as confidential include (1) a description of the items; (2) whether and why such items are customarily treated as confidential within the industry; (3) whether the information is generally known by or available from other sources; (4) whether the information has previously been made available to others without obligation concerning its confidentiality; (5) an explanation of the competitive injury to the submitting person which would result from public disclosure; (6) a date upon which such information might lose its confidential nature due to the passage of time; and (7) why disclosure of the information would be contrary to the public interest.

B. Issues on Which DOE Seeks Comment

DOE is particularly interested in receiving comments on the following issues:

1. Upper Limit of Walk-In Cooler

EPCA defines walk-in cooler or walk-in freezer as "an enclosed storage space refrigerated to temperatures, respectively, above, and at or below 32 degrees Fahrenheit that can be walked into, and has a total chilled storage area of less than 3,000 square feet." (42 U.S.C. 6311(20)(A)) DOE proposes clarifying the term "refrigerated" within the definition of walk-in cooler or walk-in freezer to distinguish walk-ins from conditioned storage spaces. DOE proposes an upper limit of 55 °F because this is a generally accepted boundary between "refrigerated space" and "conditioned space." DOE requests comment on this proposal. For details, see section III.A.1.

2. Basic Model of Envelope

Although often manufactured according to the same basic design, walk-in envelopes are so highly customized that each walk-in a manufacturer builds may be unique. To address this possibility, DOE proposed the following in the January NOPR: (1) Grouping walk-in envelopes with essentially identical construction methods, materials, and components into a single basic model; and (2) adopting a calculation methodology for determining the energy consumption of units within the basic model. 75 FR 189.

Upon further consideration, DOE proposes in this SNOPR that a basic model of walk-in envelope should include equipment with the same design features, components, manufacturing method, etc., such that units within the basic model are the same with respect to the normalized energy consumption as determined by the test procedure (*i.e.,* the energy consumption divided by square feet of surface area.) DOE believes that this definition of basic model will ensure that all equipment is accurately rated and complies with the standard.

DOE recognizes this revised definition of "basic model" is narrower than the definition proposed in the January NOPR. However, the increase in test burden resulting from the narrower definition could be offset by the burden-reducing measures proposed elsewhere in the test procedure. Additionally, this definition would be consistent with the definition of basic model elsewhere in the appliance standards program. The proposed definition would provide a way of distinguishing walk-ins that differ in energy consumption from walk-ins that differ only in cosmetic or non-energy-related features. DOE requests comment on the proposed definition. For details, see section III.A.3.

3. Basic Model of Refrigeration

Interested parties commented that the definition proposed in the January NOPR was ambiguous; thus, DOE proposes to clarify the definition.

As with envelopes, DOE must ensure that all refrigeration systems are accurately rated and comply with the standard. Therefore, DOE proposes a definition for basic model of walk-in refrigeration such that units within the basic model must be the same with respect to energy consumption as determined by the test procedure. To relieve potential testing burden of many combinations of equipment, the proposed test procedure provides for rating a refrigeration system's condenser and evaporator separately and then calculating the system energy consumption. DOE requests comment on the revised approach and definition of basic model of refrigeration. For details, see section III.A.4.

4. Updates to Standards

After the NOPR was published, DOE learned that two of the standards incorporated by reference had been updated. DOE proposes to incorporate the updated versions in the final rule. For details, see sections III.B.4 and III.C.2.

5. Heat Conduction Through Structural Members

Interested parties commented that DOE's proposed test procedure did not account for heat conduction through structural members of the envelope such as a wood frame. Therefore, in this SNOPR, DOE proposes that panels (walls, ceilings, and floors) made with foam insulation are tested using ASTM C1363–05, "Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus," for measuring the overall U-factor of fully-assembled panels. The resulting composite panel U-factor found by ASTM C1363–05 will then be corrected using the LTTR results from ASTM C1303–10. DOE believes that using the results from ASTM C1363–05 modified by ASTM C1303–10 best captures the impact of structural members and long-term R-value of foam products. DOE requests comment on this approach. For details, see section III.B.1.

6. Alternatives to ASTM C1303–10

DOE proposes the use of alternative test methods found in Annex C of EN 13165:2009–02 and EN 13164:2009–02 for determining the long term thermal resistance (LTTR) of walk-in panels made using foam insulation. For details, see section III.B.3.

7. Improvements to ASTM C1303 Methodology

DOE proposes several modifications to the ASTM C1303 methodology to address sample preparation and applicability to certain types of foam used in walk-ins and requests comment on these modifications. For details, see section III.B.5.

8. Conduction Through Floors

In the January NOPR, DOE proposed an equation to calculate the heat transfer through the floor of both insulated and uninsulated WICF, and proposed assumptions for subfloor temperature and floor R-value (where the floor is provided separately from the panels). Between the publication of the January NOPR and the public meeting, DOE completed additional finite element model (FEM) computer simulations of floorless coolers. Based on FEM simulation results, DOE described a new equation during the public meeting for calculating heat transfer through floorless coolers. In light of this modeling and additional comments from interested parties, DOE is proposing a new method for calculating the heat transfer through certain floors. See section III.B.6 for more details.

9. "Hybrid" Walk-ins

In the January NOPR, the calculation procedure provided a means of rating all walk-ins including the scenario when a freezer is sited inside a cooler or a cooler and freezer share a wall. Modifications described in this SNOPR ensure that the rating of these walk-in cooler/freezer hybrids is properly captured. DOE seeks comment on these modifications and the accuracy of the new equations. See section III.B.7 for details.

10. U–Factor of Doors and Windows

DOE proposes to base the calculation of U-factor of doors and glass windows on NFRC 100–2010–E0A1, "Procedure for Determining Fenestration Product U–Factors" and requests comment on this proposal. For details, see section III.B.7.

11. Envelope Infiltration

DOE proposes modifications to its calculations and methodology for determining steady state infiltration rate through panel-to-panel and door-to-panel interfaces. DOE also modified its proposed assumptions for door opening infiltration and effectiveness of infiltration reduction devices. DOE requests comment on its approach and assumptions related to infiltration. For details, see sections III.B.9, III.B.10, III.B.11, and III.B.12.

12. Relative Humidity Assumptions

In the January NOPR, DOE proposed the assumption of an internal walk-in relative humidity of 45 percent to be consistent with dry-coil conditions in the proposed refrigeration system test. DOE recognizes that in practice the relative humidity (RH) varies significantly depending on the product stored within a walk-in. Therefore, in order to reflect higher RH values experienced in practice, DOE proposes a new assumption of 75 percent RH for both freezer and cooler internal conditions. DOE seeks comment on this assumption. See section III.B.7 for details.

13. Definition of Refrigeration System

In the January NOPR, DOE proposed a definition of refrigeration system and then presented a revised definition at the NOPR public meeting. In light of comments from interested parties, DOE is proposing to incorporate its revised definition with some modification. DOE requests comment on the revised definition and whether any previously proposed versions of the definition are preferable. See section III.C.1 for details.

14. Annual Walk-In Energy Factor

DOE is required by EPCA to establish a test procedure to measure the energy use of walk-in coolers and walk-in freezers. (42 U.S.C. 6314(a)(9)(B)(i)) AHRI 1250–2009 determines the annual walk-in energy factor (AWEF) as its final metric, which is the ratio of the annual net heat removed from the box, which includes the internal heat gains from non-refrigeration components but excludes the heat gains from the refrigeration components in the box, to the annual energy consumption. In the course of performing the test procedure and determining AWEF, the annual energy use of a walk-in refrigeration system may be found as an intermediate result or easily derived from AWEF or other intermediate results. Thus, DOE proposes to simplify the method by which energy use is determined and require manufacturers to determine both energy use and AWEF. DOE requests comment on the simplified calculations in the rule language. For details, see section III.C.3.

15. Impacts on Small Businesses

In the January NOPR, DOE prepared an initial regulatory flexibility analysis (IRFA) as required by the Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) because it could not certify that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. DOE received comment from interested parties on the number of small entities and the expected economic impact of the proposed test procedure on small entities and has revised the IRFA accordingly. DOE continues to request comment on impacts to small business manufacturers, particularly differential impacts to small and large businesses. More information, along with revisions to the IRFA, can be found in section IV.C.

VI. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this supplement to the proposed rule.

List of Subjects in 10 CFR Part 431

Administrative practice and procedure, Confidential business information, Energy conservation, Incorporation by reference, Reporting and recordkeeping requirements.

Issued in Washington, DC, on August 23, 2010.

Cathy Zoi,

Assistant Secretary, Energy Efficiency and Renewable Energy.

For the reasons stated in the preamble, DOE proposes to revise part 431 of chapter II of title 10, of the Code of Federal Regulations, to read as set forth below.

PART 431—ENERGY EFFICIENCY PROGRAM FOR CERTAIN COMMERCIAL AND INDUSTRIAL EQUIPMENT

1. The authority citation for part 431 continues to read as follows:

Authority: 42 U.S.C. 6291–6317.

2. Section 431.302 is amended by adding the definitions for "Basic Model," "Envelope," "Refrigerated," "Refrigeration system," and "Walk-in equipment" in alphabetical order to read as follows:

§ 431.302 Definitions concerning walk-in coolers and walk-in freezers.

Basic model means—

(1) With respect to envelopes, all units manufactured by a single entity, which do not have any differing features or characteristics that affect normalized energy consumption.

(2) With respect to refrigeration systems, all units manufactured by a single entity, which do not have any differing electrical, physical, or functional characteristics that affect energy consumption.

Envelope means—

(1) The portion of a walk-in cooler or walk-in freezer that isolates the interior, refrigerated environment from the ambient, external environment; and

(2) All energy-consuming components of the walk-in cooler or walk-in freezer that are not part of its refrigeration system.

Refrigerated means held at a temperature at or below 55 degrees Fahrenheit using a refrigeration system.

Refrigeration system means the mechanism (including all controls and other components integral to the system's operation) used to create the refrigerated environment in the interior of a walk-in cooler or freezer, consisting of:

(1) A packaged system where the unit cooler and condensing unit are integrated into a single piece of equipment,

(2) A split system with separate unit cooler and condensing unit sections, or

(3) A unit cooler that is connected to a multiplex condensing system.

* * * * *

Walk-in equipment means either the envelope or the refrigeration system of a walk-in cooler or freezer.

3. In § 431.303, add new paragraphs (b)(2), (b)(3), (b)(4), (b)(5), (c), (d), and (e) to read as follows:

§ 431.303 Materials incorporated by reference.

* * * * *

(b) * * *

(2) ASTM C1303–10, Standard Test Method of Predicting Long Term Thermal Resistance of Closed-Cell Foam Insulation, approved 2010, IBR approved for § 431.304.

(3) ASTM C1363–05, Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus, approved 2005, IBR approved for § 431.304.

(4) ASTM E283–04, Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen, approved 2004, IBR approved for § 431.304.

(5) ASTM E741–06 Standard Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution, approved October 1, 2006, IBR approved for Sec. 431.304.

(c) *AHRI.* Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Boulevard, Suite 500, Arlington, VA 22201, (703) 600–0366, or *http://www.ahrinet.org.*

(1) AHRI Standard 1250–2009, 2009 Standard for Performance Rating of Walk-In Coolers and Freezers, approved September 2009, IBR approved for § 431.304.

(2) [Reserved].

(d) *CEN.* European Committee for Standardization (French: Norme or German: Norm), Avenue Marnix 17, B–1000 Brussels, Belgium, Tel: + 32 2 550 08 11, Fax: + 32 2 550 08 19 or *http://www.cen.eu/.*

(1) EN 13164:2009–02, Thermal insulation products for buildings—Factory made products of extruded polystyrene foam (XPS)—Specification, approved February 2009, IBR approved for § 431.304.

(2) EN 13165:2009–02, Thermal insulation products for buildings—Factory made rigid polyurehane foam (PUR) products—Specification, approved February 2009, IBR approved for § 431.304.

(e) *NFRC.* National Fenestration Rating Council, 6305 Ivy Lane, Ste. 140, Greenbelt, MD 20770, (301) 589–1776, or *http://www.nfrc.org.*

(1) NFRC 100–2010–E0A1, Procedure for Determining Fenestration Product U-factors, approved June 2010, IBR approved for § 431.304.

(2) NFRC 400–2010–E0A1, Procedure for Determining Fenestration Product Air Leakage, approved June 2010, IBR approved for § 431.304.

4. Section 431.304 is revised to read as follows:

§ 431.304 Uniform test method for the measurement of energy consumption of walk-in coolers and walk-in freezers.

(a) *Scope.* This section provides test procedures for measuring, pursuant to

EPCA, the energy consumption of walk-in coolers and walk-in freezers.

(b) *Testing and Calculations*

(1) Determine the energy consumption of walk-in cooler and walk-in freezer envelopes by conducting the test procedure specified in Appendix A to this subpart.

(i) Determine the Annual Walk-in Energy Factor of walk-in cooler and walk-in freezer refrigeration systems by conducting the test procedure set forth in AHRI Standard 1250–2009 (incorporated by reference, see § 431.303).

(ii) Determine the annual energy consumption of walk-in cooler and walk-in freezer refrigeration systems:

(A) For systems consisting of an integrated single-package refrigeration unit or a split system with separate unit cooler and condensing unit sections, where the condensing unit is located outdoors, by conducting the test procedure set forth in AHRI Standard 1250–2009 (incorporated by reference, see § 431.303) and recording the annual energy consumption term in the equation for annual walk-in energy factor in section 7:

$$\text{Annual Energy Consumption} = \sum_{j=1}^{n} E\left(t_j\right)$$

where t_j and n represent the outdoor temperature at each bin j and the number of hours in each bin j, respectively, for the temperature bins listed in Table D1 of AHRI Standard 1250–2009 (incorporated by reference, see § 431.303).

(B) For systems consisting of an integrated single-package refrigeration unit or a split system with separate unit cooler and condensing unit sections, where the condensing unit is located in a conditioned space, by performing the following calculation:

$$\text{Annual Energy Consumption} = \frac{0.33 \times B\dot{L}H + 0.67 \times B\dot{L}L}{\text{Annual Walk-in Energy Factor}}$$

where $B\dot{L}H$ and $B\dot{L}L$ for refrigerator and freezer systems are defined in section 6.2.1 and 6.2.2, respectively, of AHRI Standard 1250–2009 (incorporated by reference, see § 431.303) and the annual walk-in energy factor is calculated from the results of the test procedures set forth in AHRI Standard 1250–2009 (incorporated by reference, see § 431.303).

(C) For systems consisting of a unit cooler connected to a rack system, by performing the following calculation:

$$\text{Annual Energy Consumption} = \frac{0.33 \times B\dot{L}H + 0.67 \times B\dot{L}L}{\text{Annual Walk-in Energy Factor}}$$

where $B\dot{L}H$ and $B\dot{L}L$ refrigerator and freezer systems are defined in section 7.9.2.2 and 7.9.2.3, respectively, of AHRI Standard 1250–2009 (incorporated by reference, see § 431.303) and the annual walk-in energy factor is calculated from the results of the test procedures set forth in AHRI Standard 1250–2009 (incorporated by reference, see § 431.303).

5. Appendix A is added to subpart R of part 431 to read as follows:

Appendix A to Subpart R of Part 431—Uniform Test Method for the Measurement of Energy Consumption of the Envelopes of Walk-In Coolers and Walk-In Freezers

1.0 SCOPE

This appendix covers the test requirements used to measure the energy consumption of the envelopes of walk-in coolers and walk-in freezers.

2.0 DEFINITIONS

The definitions contained in § 431.302 are applicable to this appendix.

2.1 Additional Definitions

(a) Steady-state: The condition where the average internal temperature changes less than 1°C (2 °F) from one hour period to the next.

(b) Door: An assembly installed in or on an interior or exterior wall; that is movable in a sliding, pivoting, hinged, or revolving manner of movement; and that is used to produce or close off an opening in the walk-in. For walk-ins, a door includes the door panel, glass, framing materials, door plug, mullion, and any other elements that form the door or part of its connection to the wall.

(1) Passage door: A door designed for human passage or movement of product through the walk-in. A passage door may accommodate a hand cart or equivalent.

(2) Freight door: A door designed for human passage or movement of product through the walk-in. A freight door may accommodate a forklift or equivalent.

(3) Display door: A door designed for the movement and/or display of product rather than the passage of persons

(4) Glass door: A door comprised of 50 percent or more glass, irrespective of intended use.

(c) Surface area: Unless explicitly stated otherwise, the surface area for all measurements is the area as measured on the external surface of the walk-in.

(d) Automatic door opener/closer: A device or control system that "automatically" opens and closes doors without direct user contact (*e.g.,* a motion sensor that senses when a forklift is approaching the entrance to a door, opens, and then closes after the forklift has passed).

(e) Rating conditions: Unless explicitly stated otherwise, all calculations and test procedure measurements shall use the temperature and relative humidity data shown in Table A.VI.1. For installations where two or more walk-in envelopes share any surface(s), the "external conditions" of the shared surface(s) should reflect the internal conditions of the neighboring walk-in.

TABLE A.VI.1—TEMPERATURE AND RELATIVE HUMIDITY CONDITIONS

	Value	Units
Internal Conditions (cooled space within envelope)		
Cooler:		
Dry Bulb Temperature ..	35	°F
Relative Humidity	75	%
Freezer:		
Dry Bulb Temperature ..	−10	°F
Relative Humidity	75	%
External Conditions (space external to the envelope)		
Freezer and Cooler:		
Dry Bulb Temperature ..	75	°F
Relative Humidity	52	%
Subfloor Temperature		
Freezers & Coolers:		
Temperature	55	°F

3.0 TEST APPARATUS AND GENERAL INSTRUCTIONS

3.1 Conduction Heat Gain

3.1.1 Glass Area

(a) All dimensional measurements for glass doors include the door frame and glass.

(b) Calculate the individual and total glass door surface area, $A_{glass\ door}$, as follows, ft²:

$$A_{glass\ door,i} = \left(W_{glass\ door,i} \times H_{glass\ door,i}\right) \times n_i \qquad (3\text{-}1)$$

$$A_{glass\ door,tot} = \sum_{1}^{i}\left[\left(W_{glass\ door,i} \times H_{glass\ door,i}\right) \times n_i\right] \qquad (3\text{-}2)$$

Where:

i = index for each type of unique glass door used in cooler or freezer being tested;

n_i = number of identical glass doors of type i;

$W_{glass\ door,i}$ = width of glass door (including door frame), ft; and

$H_{glass\ door,i}$= height of glass door (including door frame), ft.

(c) Calculate the glass wall individual and total glass surface area, $A_{glass,wall}$, as follows, ft²:

$$A_{glass\ wall,i} = \left(W_{glass\ wall,i} \times H_{glass\ wall,i}\right) \times n_i \qquad (3\text{-}3)$$

$$A_{glass\ wall,tot} = \sum_{1}^{i}\left[\left(W_{glass\ wall,i} \times H_{glass\ wall,i}\right) \times n_i\right] \qquad (3\text{-}4)$$

Where:

i = index for each type of unique glass wall used in cooler or freezer being tested;

n_i = number of identical glass walls of type i;

$W_{glass,wall,i}$ = width of glass wall (including glass framing), ft; and

$H_{glass,wall,i}$= height of glass wall (including glass framing), ft.

(d) Calculate the total combined glass door and glass wall area, $A_{glass,tot}$, as follows, ft²:

$$A_{glass,tot} = A_{glass\ door,tot} + A_{glass\ wall,tot} \qquad (3\text{-}5)$$

Where:

$A_{glass\ door,\ tot}$= total glass door area, ft²; and

$A_{glass\ wall,\ tot}$= total glass wall area, ft².

3.1.2 Temperature Difference Across Glass Areas

(a) Calculate the temperature differential(s) $\Delta T_{glass\ door,j}$ for each unique glass door as follows, °F:

$$\Delta T_{glass\ door,j} = T_{DB,int,glass\ door,j} - T_{DB,ext,glass\ door,j} \qquad (3\text{-}6)$$

Where:

j= index for each type of unique glass door temperature differential used—for example if a freezer glass door opens into a cooler internal conditioned temperature and a freezer glass door opens into external temperature, j=2;

$T_{DB,int,glass\ door,j}$ = dry-bulb air temperature inside the cooler or freezer where the door is located, °F;

$T_{DB,ext,glass\ door,j}$ = dry-bulb air temperature external to the door of type j, °F.

(b) Calculate the temperature differential(s) $\Delta T_{glass,wall,j}$ for each unique glass wall, as follows (°F):

$$\Delta T_{glass\ wall,j} = T_{DB,int,glass\ wall,j} - T_{DB,ext,glass\ wall,j} \qquad (3\text{-}7)$$

Where:

j = index for each type of unique glass wall temperature differential used;

$T_{DB,int,glass,wall,j}$ = dry-bulb air temperature inside the cooler or freezer, °F; and

$T_{DB,ext,glass,wall,j}$ = dry-bulb air temperature external to cooler or freezer, °F.

3.1.3 Non-Glass Area

Calculate the individual and total surface area of the walk-in non-glass envelope components $A_{non\text{-}floor\ panel\ edge,i}$, $A_{non\text{-}floor\ panel\ edge,tot}$, $A_{non\text{-}floor\ panel\ core,i}$, $A_{non\text{-}floor\ panel\ core,tot}$, $A_{floor\ panel\ edge,i}$, $A_{floor\ panel\ edge,tot}$, $A_{floor\ panel\ core,i}$, $A_{floor\ panel\ core,tot}$, $A_{non\text{-}glass\ door,i}$, and $A_{non\text{-}glass\ door,tot}$, as follows (ft²):

(a) $A_{\text{non-floor panel edge,i}}$, ft^2, (see Figure 2 to help visualize the area calculations)

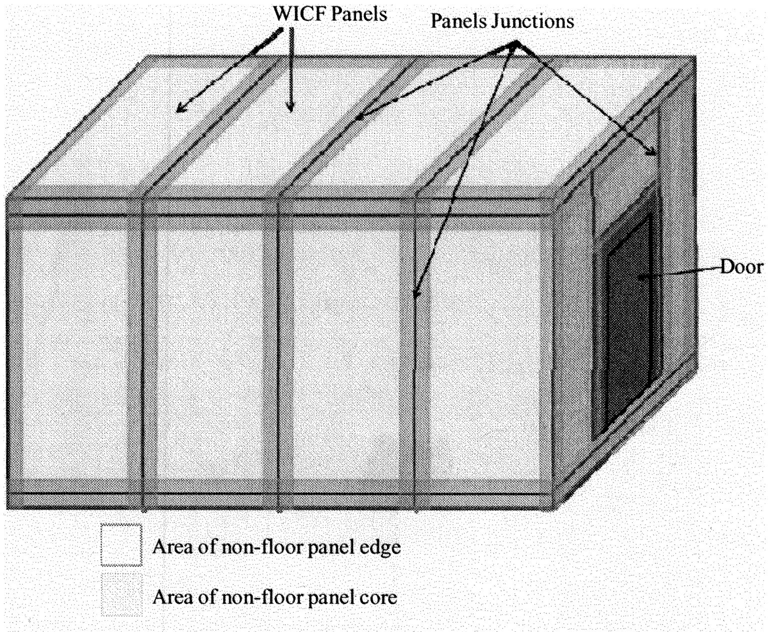

Figure 2 Diagram of Area Calculation Methodology

$$A_{\text{non-floor panel edge,i}} = \sum_{1}^{i} \left[X_{\text{edge test region}} \times \left[W_{\text{non-floor panel,i}} + L_{\text{non-floor panel,i}} - X_{\text{edge test region}} \right] \times n_i \right] \quad (3\text{-}8)$$

Where:

i = index for each type of unique non-floor panel—for example, if a walk-in is constructed of non-floor panels that are of two different thicknesses or manufactured using two different foam insulation products but panel dimensions are all identical, i=2 or, if a walk-in is constructed of non-floor panels that are all of identical thicknesses and identical materials but of non-floor panels of 15 different dimensions, i=15;

n_i = number of identical panels of type i;

$X_{\text{edge test region}}$ = Panel Edge Test Region width, as shown in Figure 3, ft;

$W_{\text{non-floor panel,i}}$ = non-floor panel width, of thickness and underlying materials of type i, ft; and

$L_{\text{non-floor panel,i}}$ = non-floor panel length, of thickness and underlying materials of type i, ft;

(b) $A_{\text{non-floor panel edge,tot}}$, ft^2

$$A_{\text{non-floor panel edge,tot}} = \sum_{1}^{i} A_{\text{non-floor panel edge,i}} \quad (3\text{-}9)$$

Where:

i = index for each type of unique non-floor panel; and

$A_{\text{non-floor panel edge, i}}$= non-floor panel edge area, of thickness and underlying materials of type i, ft^2.

(c) $A_{\text{non-floor panel core,i}}$, ft^2

$$A_{\text{non-floor panel core,i}} = \sum_{1}^{i} \left[W_{\text{non-floor panel,i}} \times L_{\text{non-floor panel,i}} \times n_i \right] - A_{\text{non-floor panel edge,i}} \quad (3\text{-}10)$$

Where:

i = index for each type of unique non-floor panel;

n_i = number of identical panels, of thickness and underlying materials of type i;

$A_{\text{non-floor panel edge,i}}$= panel non-floor edge area, of thickness and underlying materials of type i, ft^2;

$W_{\text{non-floor panel,i}}$ = non-floor panel width, of thickness and underlying materials of type i, ft; and

$L_{\text{non-floor panel,i}}$ = non-floor panel length, of thickness and underlying materials of type i, ft;

(d) $A_{\text{non-floor panel core,tot}}$, ft^2

$$A_{\text{non-floor panel core,tot}} = \sum_{1}^{i} A_{\text{non-floor panel core,i}} \qquad (3-11)$$

Where:

i = index for each type of unique non-floor panel; and

$A_{\text{non-floor panel core, i}}$= non-floor panel core area, of thickness and underlying materials of type i, ft².

(e) $A_{\text{floor panel edge,i}}$, ft²

$$A_{\text{floor panel edge,i}} = \sum_{1}^{i} \left[X_{\text{edge test region}} \times \left[W_{\text{floor panel,i}} + L_{\text{floor panel,i}} - X_{\text{edge test region}} \right] \times n_1 \right] \qquad (3-12)$$

Where:

i = index for each type of unique floor panel;

n_i = number of identical panels, of thickness and underlying materials of type i;

$X_{\text{edge test region}}$ = Panel Edge Test Region width, as shown in Figure 3, ft;

$W_{\text{floor panel,i}}$ = floor panel width, of thickness and underlying materials of type i, ft; and

$L_{\text{floor panel,i}}$ = floor panel length, of thickness and underlying materials of type i, ft;

(f) $A_{\text{floor panel edge,tot}}$, ft²;

$$A_{\text{floor panel edge,tot}} = \sum_{1}^{i} A_{\text{floor panel edge,i}} \qquad (3-13)$$

Where:

i = index for each type of unique floor panel; and

$A_{\text{floor panel edge, i}}$= floor panel edge area, of thickness and underlying materials of type i, ft².

(g) $A_{\text{floor panel core,i}}$, ft²

$$A_{\text{floor panel core,i}} = \sum_{1}^{i} \left[W_{\text{floor panel,i}} \times L_{\text{floor panel,i}} \times n_i \right] - A_{\text{floor panel edge,i}} \qquad (3-14)$$

Where:

i = index for each type of unique floor panel;

n_i = number of identical panels, of thickness and underlying materials of type i;

$A_{\text{floor panel edge,i}}$= floor panel edge area, of thickness and underlying materials of type i, ft²;

$W_{\text{non-floor panel,i}}$ = floor panel width, of thickness and underlying materials of type i, ft; and

$L_{\text{non-floor panel,i}}$ = floor panel length, of thickness and underlying materials of type i, ft;

(h) $A_{\text{floor panel core,tot}}$, ft²

$$A_{\text{floor panel core,tot}} = \sum_{1}^{i} A_{\text{floor panel core,i}} \qquad (3-15)$$

Where:

i = index for each type of unique floor panel; and

$A_{\text{floor panel core, i}}$= floor panel core area, of thickness and underlying materials of type i, ft².

(i) $A_{\text{non-glass door,i}}$, ft²

$$A_{\text{non-glass door,i}} = \sum_{1}^{i} \left[W_{\text{non-glass door,i}} \times H_{\text{non-glass door,i}} \right] \times n_i \qquad (3-16)$$

Where:

i = index for each type of unique non-glass door;

n_i = number of identical glass doors, of thickness and underlying materials of type i;

$W_{\text{non-glass door,i}}$ = non-glass door width, of thickness and underlying materials of type i, ft; and

$H_{\text{non-glass door,i}}$ = non-glass door height, of thickness and underlying materials of type i, ft.

(j) $A_{\text{non-glass door,tot}}$, ft²

$$A_{\text{non-glass door,tot}} = \sum_{1}^{i} A_{\text{non-glass door,i}} \qquad (3\text{-}17)$$

Where:

i = index for each type of unique non-glass door; and

$A_{\text{non-glass door,i}}$= non-glass door area, of thickness and underlying materials of type i, ft^2.

(k) $A_{\text{non-glass tot}}$, ft^2

$$A_{\text{non-glass tot}} = A_{\text{non-floor panel edge,tot}} + A_{\text{non-floor panel core,tot}} + A_{\text{floor panel edge,tot}} + A_{\text{floor panel core,tot}} + A_{\text{non-glass door,tot}} \qquad (3\text{-}18)$$

Where:

$A_{\text{non-floor panel edge, tot}}$= non-floor panel edge total area, ft^2;

$A_{\text{non-floor panel core, tot}}$= non-floor panel core total area, ft^2;

$A_{\text{floor panel edge, tot}}$= floor panel edge total area, ft^2;

$A_{\text{floor panel core, tot}}$= floor panel core total area, ft^2; and

$A_{\text{non-glass door,tot}}$= non-glass door total area, ft^2.

3.1.4 *Temperature Difference Across Non-Glass Areas*

Calculate the temperature differential(s) $\Delta T_{\text{non-floor panel,j}}$, $\Delta T_{\text{floor panel,j}}$, and $\Delta T_{\text{non-glass door,j}}$, °F, as follows:

(a) $\Delta T_{\text{non-floor panel, j}}$, °F

$$\Delta T_{\text{non-floor panel, j}} = T_{\text{DB,int,non-floor panel, j}} - T_{\text{DB,ext,non-floor panel, j}} \qquad (3\text{-}19)$$

Where:

j = index for each type of non-floor panel temperature differential;

$T_{\text{DB,int, non-floor panel,j}}$ = dry-bulb air internal temperature, °F. If the panel spans both cooler and freezer temperatures, the freezer temperature must be used; and

$T_{\text{DB, ext, non-floor panel, j}}$ = dry-bulb air external temperature, °F.

(b) $\Delta T_{\text{floor, j}}$, °F

$$\Delta T_{\text{floor panel, j}} = T_{\text{DB,int,floor panel, j}} - T_{\text{DB,ext,floor panel, j}} \qquad (3\text{-}20)$$

Where:

j = index for each type of floor panel temperature differential;

$T_{\text{DB, int, floor panel, j}}$ = dry-bulb air internal temperature, °F. If the panel spans both cooler and freezer temperatures, the freezer temperature must be used; and

$T_{\text{DB, ext, floor panel, j}}$ = 55° F, as defined in Table A.VI.1.

(c) $\Delta T_{\text{non-glass door, j}}$, °F

$$\Delta T_{\text{non-glass door, j}} = T_{\text{DB,int,non-glass door, j}} - T_{\text{DB,ext,non-glass door, j}} \qquad (3\text{-}21)$$

Where:

j = index for each type of non-glass door temperature differential;

$T_{\text{DB, int, non-glass door, j}}$ = dry-bulb air internal temperature, °F. If the panel spans both cooler and freezer temperatures, the freezer temperature must be used; and

$T_{\text{DB, ext, non-glass door, j}}$ = dry-bulb air external temperature, °F.

3.1.5 Conduction Heat Load Across Glass Areas

(a) Calculate the conduction load through the glass doors, $Q_{\text{cond-glass, door}}$, as follows btu/h:

$$Q_{\text{cond,glass door}} = \sum_{1}^{i}\sum_{1}^{j}\left[A_{\text{glass door,i}} \times \Delta T_{\text{glass door, j}} \times U_{\text{glass door,i}} \times n_{i,j}\right] \qquad (3\text{-}22)$$

Where:

i = index for each type of unique glass door;

j = index for each type of glass door temperature differential;

$n_{i,\,j}$ = number of identical glass doors of type i with temperature differential j;

$U_{\text{glass door, i}}$ = thermal transmittance, U-factor of the door, of type i, as rated by NFRC see section 4.4.1, Btu/h-ft^2-°F;

$A_{\text{glass door, i}}$ = total surface area of all walk-in glass doors of type i, ft^2; and

$\Delta T_{\text{glass door, j}}$ = temperature differential between refrigerated and adjacent zones of type j, °F.

(b) Calculate the conduction load through the glass walls, ($Q_{\text{cond-glass, wall}}$), btu/h, as follows:

$$Q_{\text{cond,glass wall}} = \sum_{1}^{i}\sum_{1}^{j}\left[A_{\text{glass wall,i}} \times \Delta T_{\text{glass wall,j}} \times U_{\text{glass wall,i}} \times n_{i,j}\right] \qquad (3\text{-}23)$$

Where:

i = index for each type of unique glass wall;

j = index for each type of glass wall temperature differential;

$n_{i,j}$ = number of identical glass walls of type i with temperature differential j;

$U_{glass, wall, i}$ = thermal transmittance, U-factor of the glass wall, of type i, as rated by NFRC see section 4.4.1 Btu/h-ft²-°F;

$A_{glass, wall, i}$ = total surface area of all walk-in glass walls of type i, ft²; and

$\Delta T_{glass, wall, j}$= temperature differential between refrigerated and adjacent zones of type j, °F.

3.1.6 Panel Long Term Thermal Transmittance

(a) Calculate the foam degradation factor, (DF_i), unitless, as follows:

$$DF_i = \frac{R_{LTTR,i}}{R_{0,i}} \qquad (3\text{-}24)$$

Where:

i= index each type of unique foam used in the walk-in envelope—for example if a walk-in uses one foam type for non-floor panels and another foam type for floor panels, i=2;

$R_{LTTR,i}$ = the R-value, from ASTM C1303–10, per 4.1.2 of foam type i, h-ft²-°F/Btu; and

$R_{0,i}$ = the R-value of foam used for determining EPCA compliance of foam type i, h-ft²-°F/Btu.

(b) Calculate the long term thermal transmittance, ($U_{LT, non-floor panel core, i}$), Btu/h-ft²-°F, as follows:

$$U_{LT,non\text{-}floor\ panel\ core,i} = \frac{U_{non\text{-}floor\ panel\ core,i}}{DF_i} \qquad (3\text{-}25)$$

Where:

i= index each type of unique foam used in the walk-in envelope;

$U_{non-floor panel core, i}$ = the U-factor, per 4.1.1 of foam type i, Btu/h-ft²-°F; and

DF_i = the degradation of foam type i, unitless.

(c) Calculate the long term thermal transmittance, ($U_{LT, floor panel core, i}$), Btu/h-ft²-°F, as follows:

$$U_{LT,floor\ panel\ core,i} = \frac{U_{floor\ panel\ core,i}}{DF_i} \qquad (3\text{-}26)$$

Where:

i= index each type of unique foam used in the walk-in envelope;

$U_{floor panel core, i}$ = the U-factor, per 4.1.1 of foam type i, Btu/h-ft²-°F; and

DF_i = the degradation of foam type i, unitless.

3.1.7 Conduction Heat Load Across Non-Glass Areas

Calculate the conduction heat load through all non-glass components: $Q_{cond-non-floor panel}$, $Q_{cond-floor panel}$, $Q_{cond-non-glass door}$ and $Q_{cond-non-glass}$, as follows btu/h:

(a) $Q_{cond-non-floor panel}$, btu/h,

$$Q_{cond\text{-}non\text{-}floor\ panel} = \sum_{1}^{i}\sum_{1}^{j}\left[\Delta T_{non\text{-}floor\ panel,j} \times \left[\left(A_{non\text{-}floor\ panel\ edge,i} \times U_{non\text{-}floor\ panel\ edge,i}\right) \times n_{i,j} + \left(A_{non\text{-}floor\ panel\ core,i} \times U_{LT,non\text{-}floor\ panel,\ core,i}\right) \times n_{i,j}\right]\right] \qquad (3\text{-}27)$$

Where:

i = index for each type of unique component of type i;

j = index for each unique temperature differential of type j;

$n_{i,j}$ = number of identical non-floor panels of type i with temperature differential;

$\Delta T_{non-floor panel,j}$ = temperature differential across the non-floor panels of type i, °F;

$U_{non-floor panel edge,i}$ = U-factor for panel edge area type i, per 4.1.1, Btu/h-ft²-°F;

$U_{LT,non-floor panel core,i}$ = Long term thermal transmittance of foam type i, per section 4.1.1, Btu/h-ft²-°F;

$A_{non-floor panel edge,i}$ = area of non-floor panel edge of type i, ft²; and

$A_{non-floor panel core,i}$ = area of non-floor panel core of type i, ft².

(b) $Q_{cond-floor panel}$, btu/h,

$$Q_{cond\text{-}floor\ panel\ i,j} = \sum_{1}^{i}\sum_{1}^{j}\left[\Delta T_{floor\ panel,j} \times \left[\left(A_{floor\ panel\ edge,i} \times U_{floor\ panel\ edge,i}\right) \times n_{i,j} + \left(A_{floor\ panel\ core,i} \times U_{LT,floor\ panel\ core,i}\right) \times n_{i,j}\right]\right] \qquad (3\text{-}28)$$

Where:

i = index for each type of unique component of type i;

j = index for each unique temperature differential of type j;

$n_{i,j}$ = number of identical floor panels of type i with temperature differential j;

$\Delta T_{non-floor panel,j}$ = temperature differential across the floor panels of type i, °F;

$U_{floor panel edge,i}$ = U-factor for panel edge area type i, per 4.1.1, Btu/h-ft²-°F;

$U_{LT,floor panel core,i}$ = Long term thermal transmittance of foam type i, per 4.1.1, Btu/h-ft²-°F;

$A_{floor panel edge,i}$ = area of floor panel edge of type i, ft²; and

$A_{floor panel core,i}$ = area of floor panel core of type i, ft².

(1) Exception to $Q_{cond-floor panel}$: If the walk-in is at cooler temperature and has an uninsulated floor, then $Q_{cond-floor panel}$, btu/h, is as follows:

(i) If $A_{floor} \leq 750$ ft², then

$$Q_{cond\text{-}floor\ panel} = 33.153 \times A_{floor}^{-0.364} \times A_{floor} \qquad (3\text{-}28)$$

(ii) If $A_{floor} > 750$ ft², then

$$Q_{\text{cond-floor panel}} = [0.0002 \times A_{\text{floor}} + 2.84] \times A_{\text{floor}} \qquad (3\text{-}29)$$

Where:

A_{floor} = total area of the floor, as measured from the walk-in architectural drawing, ft².

(2) Exception to $Q_{\text{cond-floor panel}}$: If the walk-in is at freezer temperature and an insulated floor has not being shipped with the walk-in, then $Q_{\text{cond-floor panel}}$, is as follows btu/h:

$$Q_{\text{cond-floor panel}} = \Delta T_{\text{floor}} \times A_{\text{floor}} \times \frac{1}{R_{\text{Freezer floor}}} \qquad (3\text{-}30)$$

Where:

A_{floor} = total area of the floor, as measured from the walk-in architectural drawing, ft².

ΔT_{floor} = temperature differential across the freezer floor as defined in 3.1.4(b), °F

$R_{\text{freezer floor}}$ = 28 ft²-°F-h/Btu, as required by EPCA.

(c) $Q_{\text{cond-non-glass door}}$, btu/h,

$$Q_{\text{cond-non-glass door}} = \sum_{1}^{i}\sum_{1}^{j}\left[\Delta T_{\text{non-glass door},j} \times \left[A_{\text{non-glass door},i} \times U_{\text{non-glass door},i}\right] \times n_{i,j}\right] \qquad (3\text{-}31)$$

Where:

i = index for each type of unique component of type i;

j = index for each unique temperature differential of type j;

$n_{i,j}$ = number of identical non-glass doors of type i with temperature differential j;

$\Delta T_{\text{non-non glass door},j}$ = temperature differential across the floor panels of type i, °F;

$U_{\text{non-glass door},i}$ = U-factor for panel edge area type i, per 4.4.1, Btu/h-ft²-°F; and

$A_{\text{non-glass door},i}$ = area of floor panel edge of type i, ft².

(d) Total conduction load for non-glass areas, $Q_{\text{cond-non-glass}}$, as follows btu/h:

$$Q_{\text{cond-non-glass}} = Q_{\text{cond-non-floor panel}} + Q_{\text{cond-floor panel}} + Q_{\text{cond-non-glass door}} \qquad (3\text{-}32)$$

Where:

$Q_{\text{cond-non-floor panel}}$ = conduction through non-floor panels, btu/h;

$Q_{\text{cond-floor panel}}$ = conduction through floor panels, btu/h; and

$Q_{\text{cond-non-glass door}}$ = conduction through non-glass doors, btu/h.

(1) Exception: If calculating $Q_{\text{cond-non-glass}}$ for an uninsulated cooler or for a freezer where an insulated floor is not part of walk-in, calculate as follows:

$$Q_{\text{cond-non-glass}} = Q_{\text{cond-floor panel}} + Q_{\text{cond-non-floor panel}} + Q_{\text{cond-non-glass door}} \qquad (3\text{-}33)$$

Where:

$Q_{\text{cond-non-floor panel}}$ = conduction through non-floor panels, btu/h;

$Q_{\text{cond-floor panel}}$ = conduction through floor, as found in 3.1.7(b)(1) or (2) btu/h; and

$Q_{\text{cond-non-glass door}}$ = conduction through non-glass doors, btu/h.

3.1.8 Total Conduction Load

(a) Calculate total conduction load, Q_{cond}, as follows btu/h:

$$Q_{\text{cond}} = Q_{\text{cond-non-glass}} + Q_{\text{cond,glass wall}} + Q_{\text{cond,glass door}} \qquad (3\text{-}34)$$

Where:

$Q_{\text{cond-non-glass}}$ = total conduction load through non-glass components of walk-in, Btu/h;

$Q_{\text{cond-glass,wall}}$ = total conduction load through walk-in glass walls, Btu/h; and

$Q_{\text{cond-glass,door}}$ = total conduction load through walk-in glass doors, Btu/h.

3.2 Infiltration Heat Gain

3.2.1 Steady State Infiltration Calculations

(a) Convert dry-bulb internal and external air temperatures from °F to Rankine (°R), as follows:

$$T_{\text{DB-int},R} = T_{\text{DB-int}} + 459.67 \qquad (3\text{-}35)$$

$$T_{\text{DB-ext},R} = T_{\text{DB-ext}} + 459.67 \qquad (3\text{-}36)$$

Where:

$T_{\text{DB-int},R}$ = the dry-bulb temperature of internal walk-in air, °R; and

$T_{\text{DB-ext},R}$ = the average dry-bulb temperature of air surrounding the walk-in, °R.

(b) Calculate the water vapor saturation pressure for the external air and the internal refrigerated air, as follows:

(1) If $T_{DB,R}$ < 491.67 °R (32 °F), use the following equation to calculate water vapor saturation pressure (P_{ws} in psia):

$$P_{ws} = \exp\left[\left(\frac{C_1}{T_{DB,R}}\right) + C_2 + \left(C_3 \times T_{DB,R}\right) + \left(C_4 \times T_{DB,R}{}^2\right) + \left(C_5 \times T_{DB,R}{}^3\right) + \left(C_6 \times T_{DB,R}{}^4\right) + \left(C_7 \times 1n\left(T_{DB,R}\right)\right)\right] \quad (3\text{-}37)$$

Where:

$T_{DB,R}$ = dry-bulb temperature in Rankine (for the internal or external air),

C_1 = −1.0214165 E+04,

C_2 = −4.8932428 E+00,

C_3 = −5.3765794 E–03,

C_4 = 1.9202377 E–07,

C_5 = 3.5575832 E–10,

C_6 = −9.0344688 E–14, and

C_7 = 4.1635019 E+00.

(2) If $T_{DB,R}$ > 491.67 °R (32 °F), use the following equation to calculate water vapor saturation pressure, P_{ws}, psia:

$$p_{ws} = \exp\left[\left(\frac{C_8}{T_{DB,R}}\right) + C_9 + \left(C_{10} \times T_{DB,R}\right) + \left(C_{11} \times T_{DB,R}{}^2\right) + \left(C_{12} \times T_{DB,R}{}^3\right) + \left(C_{13} \times 1n\left(T_{DB,R}\right)\right)\right] \quad (3\text{-}38)$$

Where:

$T_{DB,R}$ = dry-bulb temperature (for the internal and external air), °R;

C_8 = −1.0440397 E+04;

C_9 = −1.1294650 E+01;

C_{10} = −2.7022355 E–02;

C_{11} = 1.2890360 E–05;

C_{12} = −2.4780681 E–09; and

C_{13} = 6.5459673 E+00.

(c) Calculate the absolute humidity ratio, w, as follows:

$$\omega = \left[\frac{0.621945 \times \left(RH \times P_{ws}\right)}{14.696 - \left(RH \times P_{ws}\right)}\right] \quad (3\text{-}39)$$

Where:

RH = relative humidity in (for the internal or external air), and

P_{ws} = water vapor saturation pressure, psia.

(d) Calculate air specific volume, v, (ft³/lb), as follows:

$$v = \lfloor (0.025209989) \times T_{DB,R} \times (1 + (1.6078 \times \omega)) \rfloor \quad (3\text{-}40)$$

Where:

$T_{DB,R}$ = dry-bulb temperature (for the internal or external air), °R; and

v = specific volume of air, ft³/lb.

(e) Calculate air density, air density, lb/ft³, as follows:

$$\rho = \frac{1}{v} \quad (3\text{-}41)$$

Where:

v = specific volume of air, ft³/lb.

(f) Calculate the enthalpy for the internal and external air, h, as follows btu/lb:

$$h = \left(0.240 \times T_{DB,F}\right) + \omega \times \left(1061 + \left(0.444 \times T_{DB,F}\right)\right) \quad (3\text{-}42)$$

Where:

$T_{DB,F}$ = dry-bulb temperature (for the internal or external air), °F; and

w = absolute humidity ratio, unitless.

(g) Calculate the total crack length, C_L,(ft), using the architectural drawing of the walk-in,

(h) Calculate the steady state infiltration rate of the walk-in,$\dot{V}_j$, ft³/h:

$$\dot{V}_j = \dot{V}_L \times C_L \quad (3\text{-}43)$$

Where:

j = index of type cooler or freezer;

$\dot{V}_L$ = the normalized infiltration rate per section 4.2 of this document using the architectural drawing of the walk-in, ft³/h-ft; and

C_L = total crack length, ft.

(i) Calculate the total infiltration load due to steady-state infiltration, ($Q_{infilt\ panel}$), Btu/h, as follows:

$$Q_{infilt\ panel} = \left(\rho_{ext,j} \times h_{ext,j} - \rho_{int,j} \times h_{int,j}\right) \times \dot{V}_1 \quad (3\text{-}44)$$

Where:

j = index of cooler or freezer temperature;

$\dot{V}_j$ = the infiltration rate measured at test temperature j, per section 4.2, ft³/h;

$\rho_{int,j}$ = internal air density, lb/ft³;

$\rho_{ext,j}$ = external air density, lb/ft³;

$h_{int,j}$ = internal air enthalpy, Btu/lb; and

$h_{ext,j}$ = external air enthalpy, Btu/lb.

3.2.2 Door Steady-State Infiltration Calculations

(a) Calculate the steady-state infiltration associated with doors as follows, $\dot{V}_{door\ steady,i}$³/h:

$$\dot{V}_{door\ steady,i} = \sum_{1}^{i} \dot{V}_{door_i} \times n_i \quad (3\text{-}45)$$

Where:

i = index of each unique door geometry and temperature differential combination;

n_i = number of identical doors of type i, unitless; and

$\dot{V}_{door_i}$Q = door steady state infiltration as found following section 4.4.2, ft³/h.

(b) Calculate the total infiltration load due to steady-state infiltration through doors, $Q_{door\ steady}$, btu/h, as follows:

$$Q_{door\ steady} = \sum_{1}^{i} \left(\rho_{ext,i} \times h_{ext,i} - \rho_{int,i} \times h_{int,i}\right) \times \dot{V}_{door\ steady,i} \qquad (3\text{-}46)$$

Where:

i = index of type cooler or freezer temperature;

$\dot{V}_{door\ steady,i}$ = total door steady-state infiltration, ft³/h;

$\rho_{int,i}$ = internal air density, as found in 3.2.1 above, lb/ft³;

$\rho_{ext,i}$ = external air density, as found in 3.2.1 above, lb/ft³;

$h_{int,i}$ = internal air enthalpy, as found in 3.2.1 above, Btu/lb; and

$h_{ext,i}$ = external air enthalpy, as found in 3.2.1 above, Btu/lb.

3.2.3 Door Opening Infiltration Calculations

(a) Calculate the portion of time each doorway is open, D_t, unitless, as follows:

$$D_{t,i} = \frac{\left[\left(P \times \theta_p\right) + \left(60 \times \theta_\theta\right)\right]}{\left[3600 \times \theta_d\right]} \qquad (3\text{-}47)$$

Where:

i = index for each unique door—for example a unique door must be of the same geometry, underlying materials, function, and have the same temperature difference across the door;

P = number of doorway passages (i.e., number of door opening events);

θ_p = door open-close time, seconds per opening P;

θ_θ = time door stands open, minutes; and

θ_d = daily time period, h.

(1) Number of doorway passages: For display glass doors, P = 72, for passage doors, P = 60 and for freight doors, P = 120.

(2) Door open-close time: For display glass doors, θ_p = 8 seconds, for passage doors, θ_p = 15 and for freight doors, θ_p = 60.

(3) Door open-close time if an automatic door opener/closer is used: For passage doors, θ_p = 10 and for freight doors, θ_p = 30.

(4) Time door stands open: Display glass doors, θ_o = 0 minutes, for passage doors θ_o = 30 minutes and for freight doors θ_o = 60 minutes.

(5) Time door stands open if an automatic door opener/closer is used: For passage doors θ_o = 10 minutes and for freight doors θ_o = 20 minutes.

(6) Daily time period: All walk-ins, θ_d = 24 hours

(b) Calculate the density factor, F_m, for each door, as follows:

$$F_{m,i} = \left[\frac{2}{1 + \left(\frac{\rho_{int,i}}{\rho_{ext,i}}\right)^{1/3}}\right]^{3/2} \qquad (3\text{-}48)$$

Where:

i = index for each unique door

$\rho_{int,i}$ = internal air density, of door type i, lb/ft³; and

$\rho_{ext,i}$ = external air density, of door type i, lb/ft³.

(c) Calculate the infiltration load for fully established flow through each door, q_i (Btu/h), as follows:

$$q_i = 795.6 \times A_i \times \left(h_{ext,i} - h_{int,i}\right) \times \rho_{int,i} \times \left(1 - \frac{\rho_{ext,i}}{\rho_{int,i}}\right)^{1/2} \times \left(g \times H_i\right)^{1/2} \times F_{m,i} \qquad (3\text{-}49)$$

Where:

i = index for each unique door;

A_i = doorway area, of door type i, ft²;

$h_{int,i}$ = internal air enthalpy, of door type i, Btu/lb;

$h_{ext,i}$ = external air enthalpy, of door type i, Btu/lb;

$\rho_{int,i}$ = internal air density, of door type i, lb/ft³;

$\rho_{ext,i}$ = external air density, of door type i, lb/ft³;

H_i = doorway height, of door type i, ft;

$F_{m,i}$ = density factor, of door type i, and

g = acceleration of gravity, 32.174 ft/sec.².

(d) Calculate the doorway infiltration reduction device effectiveness, E (%), at the same test conditions as described in steady-state infiltration section, as follows:

(1) Calculate the infiltration reduction effectiveness:

$$E_{i,j} = 1 - \frac{V_{rate,with\text{-}device\ i,j}}{V_{rate,without\text{-}device\ i,j}} \qquad (3\text{-}50)$$

Where:

i = index for each unique doorway size of type small, medium or large;

j = index for each unique infiltration reduction device (IRD) of type i;

$V_{rate,with\text{-}device\ i,j}$ = air infiltration rate, with door open and reduction device active, 4.3, 1/h, if a device j is not used with the doorway i, $V_{rate,with\text{-}device\ i,j} = V_{rate,without\text{-}device\ i,j}$; and

$V_{rate,without\text{-}device\ i,j}$ = air infiltration rate, with door open and reduction device disabled or removed, using 4.3, 1/h.

(e) Calculate the total door opening infiltration load for all door-IRD combinations, $Q_{door\ open,}$ (Btu/h), as follows:

$$Q_{door\ open} = \sum_{1}^{i}\sum_{1}^{j} q_i \times D_{t,i} \times D_f \times \left(1 - E_{i,j}\right) \times n_i \qquad (3\text{-}51)$$

Where:

i = index for each unique combination of doorway size, temperature difference and D_t, of type i—for example, if the walk-in has a small, medium and large door, i = 3, or if the walk-in has ten identical dimensioned display doors and one passage door all with the same temperature differential, i = 2;

j = index for the effectiveness of IRD type j;

n_i = number of doorways of type i being considered in the calculation;

q_i = infiltration load for fully established flow, Btu/h;

$D_{t,i}$ = doorway open-time factor as calculated for each unique door way, unitless;

D_f = doorway flow factor, 0.8 for freezers and coolers (from ASHRAE Fundamentals), unitless;

$E_{i,j}$ = effectiveness of doorway type i with IRD type j, as measured by gas tracer test, %.

3.3 Energy Consumption Due to Total Heat Gain

(a) Calculate the total thermal load, Q_{tot}, (Btu/h), as follows:

$$Q_{tot} = Q_{infilt\ panel} + Q_{door\ steady} + Q_{door\ open} + Q_{cond} \qquad (3\text{-}52)$$

Where:

$Q_{infilt\ panel}$ = total load due to steady-state infiltration, Btu/h;
Q_{cond} = total load due to conduction, Btu/h;
$Q_{door\ steady}$ = total load due to door steady-state infiltration, Btu/h; and
$Q_{door\ open}$ = total load due to door opening infiltration, Btu/h.

(b) Select Energy Efficiency Ratio (EER), as follows:

(1) For coolers, use EER = 12.4 Btu/Wh.
(2) For freezers, use EER = 6.3 Btu/Wh.

(c) Calculate the total daily energy consumption due to thermal load, $Q_{tot,EER}$, (kWh/day), as follows:

$$Q_{tot,EER} = \frac{Q_{tot}}{EER} \times \frac{24\ h \times 1\ kW}{1\ day \times 1000\ W} \qquad (3\text{-}53)$$

Where:

Q_{tot} = total thermal load, Btu/h; and
EER= EER of walk-in (cooler or freezer), Btu/Wh.

3.4 Energy Consumption Related to Electrical Components

Electrical components contained within a walk-in could include, but are not limited to: Heater wire (for anti-sweat or anti-freeze application); lights (including display door lighting systems); control system units; and sensors.

3.4.1 Direct Energy Consumption of Electrical Components

(a) Select the required value for percent time off for each type of electricity consuming device, PTO_t (%):

(1) For lights without timers, control system or other demand-based control, PTO=25 percent. For lighting with timers, control system or other demand-based control, PTO=50 percent.

(2) For anti-sweat heaters on coolers (if required): Without timers, control system or other demand-based control, PTO=0 percent. With timers, control system or other demand-based control, PTO=75 percent. For anti-sweat heaters on freezers (if required): Without timers, control system or other auto-shut-off systems, PTO=0 percent. With timers, control system or other demand-based control, PTO=50 percent.

(3) For active infiltration reduction devices: Without control by door open or closed position, PTO=25 percent. With control by door open or closed position for display doors, PTO=99.33 percent. With control by door open or closed position for other doors, PTO=99.17 percent.

(4) For all other electricity consuming devices: Without timers, control system, or other auto-shut-off systems, PTO=0 percent. If it can be demonstrated that the device is controlled by preinstalled timers, control system or other auto-shut-off systems, PTO=25 percent.

(b) Calculate the power usage for each type of electricity consuming device, $P_{comp,t}$, (kWh/day), as follows:

$$P_{comp,u,t} = P_{rated,u,t} \times \left(1 - PTO_{u,t}\right) \times n_{u,t} \times \frac{24h}{day} \qquad (3\text{-}54)$$

Where:

u = index for each type of electricity consuming device sited inside the walk-in envelope and/or sited external the walk-in envelope, inside, u=int, external, u=ext;
t = index for each type of electricity consuming device with identical rated power;
$P_{rated,u,t}$ = rated power of each component, of type t, kW;
$PTO_{u,t}$ = percent time off, for device of type t, %; and
$n_{u,t}$ = number of devices at the rated power of type t, unitless.

(c) Calculate the total electrical energy consumption, P_{tot}, (kWh/day), as follows:

$$P_{tot,int} = \sum_{1}^{t} P_{comp,int,t} \qquad (3\text{-}55)$$

$$P_{tot,ext} = \sum_{1}^{t} P_{comp,ext,t} \qquad (3\text{-}56)$$

Where:

t = index for each type of electricity consuming device with identical rated power;
$P_{comp,int,\ t}$ = the energy usage for an electricity consuming device sited inside the walk-in envelope, of type t, kWh/day; and
$P_{comp,ext,\ t}$ = the energy usage for an electricity consuming device sited outside the walk-in envelope, of type t, kWh/day.

3.4.2 Total Indirect Electricity Consumption Due to Electrical Devices

(a) Calculate the additional compressor load due to thermal output from electrical components sited inside the envelope, C_{load}, (kWh/day), as follows:

$$C_{load} = P_{tot,int} \times 3.\frac{412}{EER}\frac{Btu}{Wh} \qquad (3\text{-}57)$$

Where:

EER = EER of walk-in (cooler=12.4 or freezer=6.3), Btu/Wh; and
$P_{tot,int}$ = The total electrical load due to components sited inside the walk-in envelope, kWh/day

3.5 Total Energy Consumption and Normalized Energy Consumption

3.5.1 Total Energy Consumption

Calculate the total energy load of the walk-in envelope per unit of surface area and non-normalized total energy consumption, $E_{tot,non\text{-}glass,norm}$, $E_{tot,glass,norm}$, $E_{tot,electrical,norm}$, and E_{tot},(kWh/ft²/day), as follows:

(a) $E_{tot,non\text{-}glass,norm}$, kWh/ft²/day,

$$E_{tot,non\text{-}glass} = \left[\frac{A_{non\text{-}glass,tot}}{A_{non\text{-}glass,tot} + A_{glass,tot}}\right] \times \left[\frac{Q_{tot,EER}}{A_{non\text{-}glass,tot} + A_{glass,tot}}\right] \qquad (3\text{-}58)$$

(b) $E_{tot,glass,norm}$, kWh/ft²/day.

$$E_{tot,glass} = \left[\frac{A_{glass,tot}}{A_{non\text{-}glass,tot} + A_{glass,tot}} \right] \times \left[\frac{Q_{tot,EER}}{A_{non\text{-}glass,tot} + A_{glass,tot}} \right] \quad (3\text{-}59)$$

(c) $E_{tot,electrical,norm}$, kWh/ft²/day.

$$E_{tot,electric\ device} = \frac{P_{tot} + C_{load}}{A_{non\text{-}glass,tot} + A_{glass,tot}} \quad (3\text{-}60)$$

(d) E_{tot}, kWh/day.

$$E_{tot} = Q_{tot,EER} + P_{tot} + C_{load} \quad (3\text{-}61)$$

Where:

$Q_{tot,EER}$ = the total thermal load, kWh/day;
P_{tot} = the total electrical load, kWh/day;
$A_{non\text{-}glass,tot}$ = total surface area of the non-glass envelope, ft²;
$A_{glass,tot}$ = total surface area glass envelope, ft²; and
C_{load} = additional compressor load due to thermal output from electrical components contained within the envelope, kWh/day.

4.0 TEST METHODS AND MEASUREMENTS

4.1 Conduction Performance Testing and Measurements

4.1.1 Measuring Panel and Floor U-factors using ASTM C1363–05

(a) Test Sample Geometry Requirements

(1) Two (2) panels, 8' ± 1" long and 4' wide ± 1" must be prepared.

(2) The panel edges must be joined using a given manufacturer's panel interface joining system (i.e. camlocks).

(3) Panel Edge Test Region must be cut from the joined panels such that X = 2' ± 0.25" and Z = 7' ± 0.5". (See Figure 3)

(i) Exception: Walk-in panels that utilize vacuum insulated panels (VIP) for insulation, X = 2'± 2". The wider tolerance is meant to allow the cutting line, when preparing the Panel Edge Test Region, to match the VIP junctions such that VIP will not lose vacuum by being pierced by the cutting device.

(4) Panel Core Test Region must also be cut from one of the two panels such that Y = 2' ± 0.25" and Z = 7' ± 0.5". (See Figure 3)

(i) Exception: As above, walk-in panels that use VIP for insulation, Y = 2'± 2".

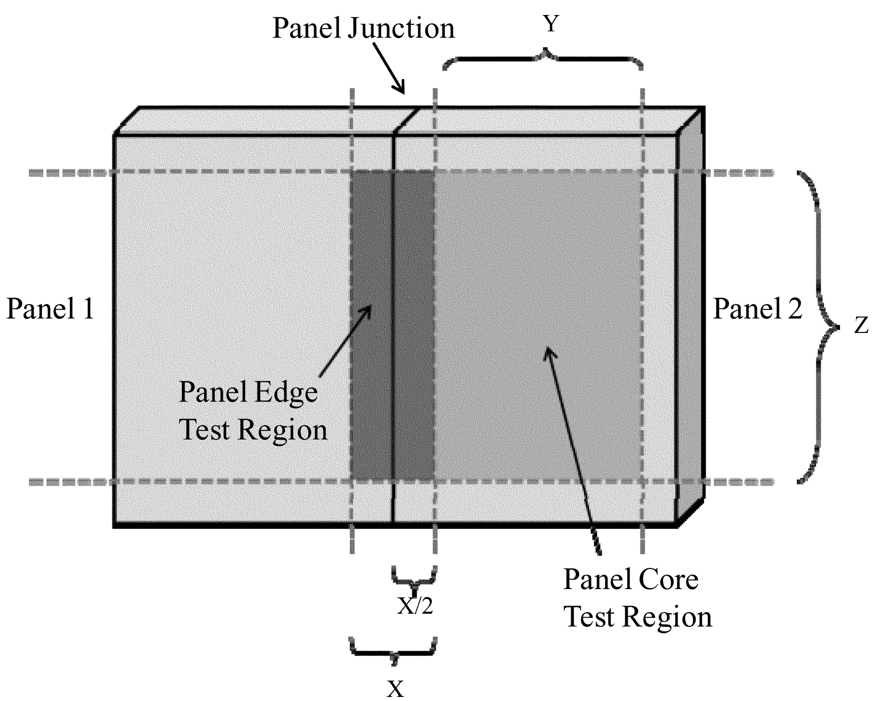

Figure 3 ASTM C1363-05 Test Regions

(b) Testing Conditions

(1) The air temperature on the "hot side" of the box should be maintained at 75 °F ± 1 °F.

(i) Exception: When testing floors, the air temperature should be maintained at 55 °F ± 1 °F.

(2) The temperature in the "cold side" of the envelope should be maintained at 35 °F ± 1 °F for the panels used for walk-in coolers and −10 °F ± 1 °F for panels used for walk-in freezers.

(3) The air velocity should be maintained as natural convection conditions as described in ASTM C1363–05 (incorporated by reference, see § 431.303). The test must be completed using the masked method and with surround panel in place as described in ASTM C1363–05.

(c) Required Test Samples

(1) Wall and Ceiling Panels

(i) Cooler conditions, Panel Edge Region U-factor: $U_{non\text{-}floor\ panel\ edge,cooler}$

(ii) Cooler conditions, Panel Core Region U-factor: $U_{non\text{-}floor\ panel\ core,cooler}$

(iii) Freezer conditions, Panel Edge Region U-factor: $U_{non\text{-}floor\ panel\ edge,freezer}$

(iv) Freezer conditions, Panel Core Region U-factor: $U_{non\text{-}floor\ panel\ core,freezer}$

(2) Floor Panels

(i) Cooler conditions, Floor Panel Edge Region U-factor: $U_{floor\ panel\ edge,cooler}$

(ii) Cooler conditions, Floor Panel Core Region U-factor: $U_{non\text{-}floor\ panel\ core,cooler}$

(iii) Freezer conditions, Floor Panel Edge Region U-factor: $U_{floor\ panel\ edge,freezer}$

(iv) Freezer conditions, Floor Panel Core Region U-factor: $U_{floor\ panel\ core,freezer}$

4.1.2 Measuring R–Value of Insulating Foam

(a) Follow the test procedure in ASTM C1303–10 exactly, with these exceptions (incorporated by reference, see § 431.303):

(1) Mold/Sample Panel Geometry

(i) A panel must be prepared following typical manufacturer injection, curing and assembly methods. The width and length of the panel must be 48 inches ± 1 inch and 96 inches ± 1 inch, respectively.

(ii) The panel thickness shall be equal to the desired test thickness.

(2) Materials

(i) The panel materials should exactly mimic a commercially viable panel; that is, the panel should be exactly identical to panels sold by the manufacturer, with one key exception: The inner surfaces must be lined with a material, such as 4 to 6 mil polyethylene film, to prevent the foam from adhering to the panel internal surfaces. (This ensures that when the panel metal skin is removed for testing, the underlying foam is not damaged).

(3) Sample Preparation

(i) After the foam has cured and the panel is ready to be tested, the facing and framing materials must be carefully removed to ensure that the underlying foam is not damaged or altered.

(ii) A 12-inch × 12-inch square (× desired thickness) cut from the exact geometric center of the panel must be used as the sample for completing ASTM C1303–10.

(4) Section 6.6.2, where several types of hot plate methods are recommended, use ASTM C518–04 (incorporated by reference, see § 431.303), for measuring the R-value. In section 6.6.2.1 of ASTM C1303–10, in reference to ASTM C518–04, the mean test temperature of the foam during R-value measurement must be 20 +/− 4 °F (−6.7 +/− 2 °C) with a temperature difference of 40 +/− 4 °F (22 +/− 2 °C) for freezers and 55 +/− 4 °F (12.8 +/− 2 °C) with a temperature difference of 40 +/− 4 °F (22 +/− 2 °C) for coolers.

(5) Section 6.6.2.1, in reference to ASTM C518–04, the mean test temperature of the foam during R-value measurement must be:

(i) For freezers: −6.7 +/− 2 °C (20 +/− 4 °F) with a temperature difference of 22 +/− 2 °C (40 +/− 4 °F)

(ii) For coolers: 12.8 +/− 2 °C (55 +/− 4 °F) with a temperature difference of 22 +/− 2 °C (40 +/− 4 °F)

(b) At least one sample set must be prepared, comprised of three stacks, while adhering to all preparation methods and uniformity specifications described in ASTM C1303–10 (incorporated by reference, see § 431.303).

(c) The value resulting LTTR for the foam shall be reported as R_{foam}, but for the purposes of calculations in this test procedure calculations it will be converted to R_{LTTR}, as follows:

$$R_{LTTR} = R_{foam} \qquad (4\text{-}1)$$

Where:

R_{foam} = R-value of foam as measured by ASTM C1303–10, h-ft² − °F/Btu.

4.1.3 U-Factor of Doors

(a) All doors must be tested using NFRC 100–2010–E0A1.

(b) Internal conditions:

(1) Air temperature of 35 °F (1.7 °C) for cooler doors and −10 °F (−23.3 °C) for freezer doors.

(2) Mean inside radiant temperature same as shown in (b)(1) above.

(c) External conditions

(1) Air temperature of 75 °F (23.9 °C).

(2) Mean outside radiant temperature same as shown in (c)(1) above.

(d) Direct solar irradiance = 0 W/m2 (0 Btu/h-ft2).

(e) The average convective heat transfer coefficient on both interior and exterior surfaces of the door should be based on "natural convection" as described in section 4.3 of NFRC 100–2010–E0A1 (incorporated by reference, see § 431.303).

4.2 Steady State Infiltration Testing

(a) Follow the test procedure in ASTM E741–06 exactly, except for these changes and exceptions to the procedure. (incorporated by reference, see § 431.303):

(1) *Concentration decay method:* The "concentration decay method" must be used instead of other available options described in ASTM E741–06.

(2) *Gas Tracer:* CO_2 or SF_6 must be used as the gas tracer for all testing.

(3) *Air change rate:* Measure the air change rate in 1/h, rather than the air change flow described in ASTM E741–06 (incorporated by reference, see § 431.303).

(4) *Spatial measurements:* Spatial measurements must be taken in a minimum of six locations or one location/20 ft² of floor area (whichever results in a greater number of measurements) at a height of 3 ft +/− 0.5 ft, at a minimum distance of 2 ft +/− 0.5 ft from the walk-in walls or doors.

(b) The internal air temperature for freezers and for coolers shall be +/− 4 °F (2 °C) of the values shown in Table A.VI.1.

(c) The external air temperature must be 75 °F (24 °C) +/− 5 °F (2.5 °C) surrounding the walk-in.

(d) The test must be completed with the walk-in door closed.

(e) Number of tests:

(1) One unit must be tested at freezer conditions with an insulated floor in place.

(2) One unit must be tested at cooler conditions.

(f) Geometry of standard walk-in test unit:

(1) External dimensions:

(i) Width = 12 ft ± 6"

(ii) Length = 18 ft ± 6"

(iii) Height = 8 ft ± 6"

(2) Rectangular Shape (see Figure 4)

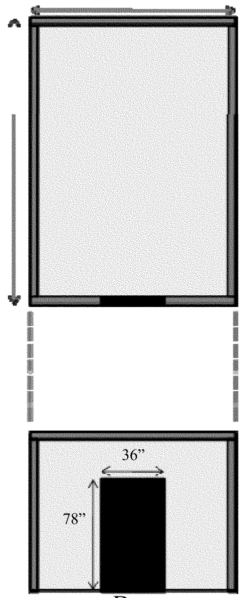

Figure 4 Geometry of Infiltration Test Unit

(g) Equipment Specifications

(1) One Passage Door (see Figure 4)

(i) Width = 36 inches ± 2 inches

(ii) Height = 78 inches ± 4 inches

(2) At freezer temperature, a pressure relief valve must be in-place and operational during testing.

(i) Valve flow rate > 8 cubic ft per minute @ 1 inch of H_2O (250 Pa))

(3) Prescribed wall and ceiling panel geometry

(i) Wall panels

1. Width < 4 ft ± 1 inch

2. Height < 8 ft ± 1 inch

(ii) Ceiling panels

1. Width < 4 ft ± 1 inch

(h) Test Procedure Requirements

(1) The unit must be assemble following instructions provided in the standard panel manufacturer installation instructions that are normally provided with a shipped walk-in.

(2) The unit may be tested only after it has reached a steady-state condition, normally greater than 24 hours after the refrigeration system has been activated.

(3) The infiltration measurement period must be over a duration greater than one hour

(4) The standard unit internal volume must be empty and unoccupied except for items necessary for testing or for cooling the test unit (such as test equipment or evaporator fans).

(i) Test Results

(1) At cooler conditions, the result following ASTM E741–06, is:

(i) First, correct the result to standard test conditions per ASTM E 283.

(ii) The final and corrected infiltration rate, $V_{rate,cooler}$, (1/h)

(2) At freezer conditions,

(i) First, correct the result to standard test conditions per ASTM E 283.

(ii) The final and corrected infiltration rate, $V_{rate,freezer}$, (1/h)

(j) Calculations

(1) Convert $V_{rate,freezer}$ and $V_{rate,cooler}$ to $\dot{V}_{freezer}$ and, $\dot{V}_{cooler}$, (ft^3/h), as follows:

$$\dot{V}_{freezer} = V_{rate,freezer} \times V_{ref\text{-}space} \qquad (4\text{-}2)$$

and

$$\dot{V}_{cooler} = V_{rate,cooler} \times V_{ref\text{-}space} \qquad (4\text{-}3)$$

Where:

$V_{ref\text{-}space}$ = the total enclosed volume of the walk-in, of the test unit shown in Figure 4, ft^3; and

$V_{rate,cooler}$= the infiltration rate from the cooler test, 1/h

$V_{rate,freezer}$= the infiltration rate from the cooler test, 1/h

(2) Using the architectural drawing of the test unit, calculate total effective crack length, $C_{L,wall}$, $C_{L,door\text{-}wall}$, $C_{L,ceiling\text{-}floor}$ and C_L,(ft), as follows:

(i) $C_{L,wall}$, ft:

$$C_{L,wall} = \sum_{1}^{i}\left[\left(H \times N_{panels,i}\right]\right) \qquad (4\text{-}4)$$

Where:

i = index for walls from 1 to 3, i = 1: wall of length 18′ and height 8′, i = 2: other wall of length 18′ and height 8′ and i = 3: wall opposite of the door of width 12′ and height 8′;

H = height of the walk-in unit per Figure 4, ft; and

$N_{panels,i}$ = number of panels used to build wall of type i.

(ii) $C_{L,door\text{-}wall}$, ft:

$$C_{L,door\text{-}wall} = H \times \left[N_{panels,door\text{-}wall} - 2\right] \qquad (4\text{-}5)$$

Where:

H = height of the walk-in unit per Figure 4, ft; and

$N_{panels,door\text{-}wall}$ = number of panels used to build the door wall

(iii) $C_{L,ceiling\text{-}floor}$, ft:

$$C_{L,ceiling\text{-}floor} = W \times \left[N_{panels,ceiling} - 1\right] + P_{floor} + L \times 2 \qquad (4\text{-}6)$$

Where:

W = width of the walk-in unit per Figure 4, ft;

$N_{panels,ceiling}$ = number of panels used to build the door wall, ft;

P_{floor} = external perimeter of the floor, ft; and

L = length of the walk-in unit per Figure 4, ft.

(iv) C_L, ft:

$$C_L = C_{L,wall} + C_{L,door\text{-}wall} + C_{L,ceiling\text{-}floor} \qquad (4\text{-}7)$$

Where:

$C_{L,wall}$ = the total crack length of the non-door walls, ft;

$C_{L,door\text{-}wall}$ = the total crack length of the door wall, ft; and

$C_{L,ceiling\text{-}floor}$ = the total crack length of the ceiling and floor, ft;

(3) Calculate the infiltration per unit crack length for the freezer, $\dot{V}_{freezer\text{-}ft}$ and cooler, $\dot{V}_{cooler\text{-}ft}$, tests, (ft³/h-ft), respectively as follows:

(i) $\dot{V}_{freezer\text{-}ft}$, ft³/h-ft:

$$\dot{V}_{freezer\text{-}ft} = \frac{\dot{V}_{freezer}}{C_L} \qquad (4\text{-}8)$$

Where:

C_L = the total crack length of the test unit as shown in Figure 4, ft; and

$\dot{V}_{freezer\text{-}ft}$ = infiltration rate from the freezer test, ft³/h.

(ii) $\dot{V}_{cooler\text{-}ft}$, ft³/h-ft:

$$\dot{V}_{cooler\text{-}ft} = \frac{\dot{V}_{cooler}}{C_L} \qquad (4\text{-}9)$$

Where:

C_L = the total crack length of the test unit as shown in Figure 4, ft; and

$\dot{V}_{cooler}$ = infiltration rate from the cooler test, ft³/h.

4.3 IRD Effectiveness Testing

4.3.1 IRD Test Alternatives

(a) The following IRD effectiveness assumptions may be used:

(1) Strip Curtains Effectiveness: E = 0.5

(2) Air Curtains Effectiveness: E = 0.3

(b) If an IRD is tested and found to have a higher performing effectiveness than the default values proposed above, that value may be used in the energy calculations.

(c) All non-strip curtain and non-air curtain IRD's must be tested following the test procedure below.

4.3.2 Doorway Testing Geometry

(a) IRD effectiveness tests must use the following door sizes:

(1) The testing must be completed for each device at the correct representative size for small, medium and/or large doorways.

(2) For doors with width ≤ 48 inches and height ≤ 84 inches, the small door test opening size may be used ("small test"): width = 48 inches ± 0.5 inch and height = 84 inches ± 0.5 inch

(3) For doors with width ≤ 96 inches and height ≤ 144 inches, the medium door test opening size may be used ("medium test"): width = 96 inches ± 0.5 inch and height = 144 inches ± 0.5 inch

(4) For doors of any width or height, the large door test opening size may be used ("large test"): Width = 144 inches ± 0.5 inch and height = 180 inches ± 0.5 inch.

(5) For the small door test, a test volume of dimension and construction and door location shown in Figure 4 must be used.

(6) For all medium and large door tests, the width and height of the test unit must be increased in size, directly proportional to the increased door size over the small door test. For example since the medium doorway width is twice the size of the small door, the test unit must be twice as wide as shown in Figure 4.

4.3.3 IRD Test Procedure Requirements

(a) Use ASTM E741–06 (incorporated by reference, see § 431.303), with the following exceptions to the procedure:

(1) Within 3 minutes +/− 30 seconds of achieving gas concentration uniformity, with the infiltration reduction device in place, a hinged door should be opened at an angle greater than or equal to 90 degrees.

(2) The elapsed time, from zero degrees position (closed) to greater than or equal to 90 degrees (open) must be no longer than 5 seconds.

(3) The door must then be held at an angle greater than or equal to 90 degrees for 5 min +/− 5 seconds and then closed over a period no longer than 5 seconds. For non-hinged doors, the door must reach its maximum opened position, be held open, and reach a fully closed position in the same elapsed time as described above for hinge-type doors.

(4) The gas concentration must be sampled again after the door has been closed. Samples should continue being taken until the gas concentration is once again uniform spatially within the walk-in.

(5) A gas concentration sample set must be taken once the tracer gas has uniformly dispersed in the internal space using the methodology described in 4.2.

(i) Following ASTM E741–06, the calculated result is $V_{rate,with\text{-}device\ i,j}$

(6) The test should be repeated exactly as described with the infiltration reduction device (IRD) removed or deactivated.

(i) Following ASTM E741–06, the calculated result is $V_{rate,without\text{-}device\ i,j}$

4.4 NFRC Door Testing

4.4.1 Door Conduction Testing

(a) All doors, as defined in section 2.1(b), must be tested using NFRC 100–2010–E0A1 (incorporated by reference, see § 431.303).

(1) Internal conditions:

(i) Air temperature of 35 °F (1.7 °C) for cooler doors and −10 °F (−23.3 °C) for freezer doors.

(ii) Mean inside radiant temperature same as shown in (1)(i) above.

(2) External conditions.

(i) Air temperature of 75 °F (23.9 °C).

(ii) Mean outside radiant temperature same as shown in (2)(i) above.

(iii) Direct solar irradiance = 0 Btu/h-ft² (0 W/m²).

(iv) The average convective heat transfer coefficient on both interior and exterior surfaces of the door should be based on "natural convection" as described in section 4.3 of NFRC 100–2010–E0A1.

4.4.2 Door Infiltration Testing

(a) All doors must be tested using NFRC 400–2010–E0A1 (incorporated by reference, see § 431.303).

(b) Number of tests:

(1) One door system of representative sizes of "small," "medium," and "large" as defined in 4.3.2(a), that have identical construction (i.e. only differ in dimensional size) may be used for extrapolating the infiltration of other doors that only differ in size as described in 4.3.2(a).

(c) Testing must be completed at six pressure differentials for both positive and negative pressure (exfiltration and infiltration):

(1) 0.0401 in-H_2O (10 Pa).

(2) 0.0803 in-H_2O (20 Pa).

(3) 0.1204 in-H_2O (30 Pa).

(4) 0.1606 in-H_2O (40 Pa).

(5) 0.2007 in-H_2O (50 Pa).

(6) 0.2409 in-H_2O (60 Pa).

(d) At each of the six pressure differentials described above, the airflow rate must be measured.

(e) Using the six pressure differentials and measured flow rates (in both directions) the values for C_i and n_i, must be found using log-linear regression equation below:

$$\dot{V}_{door} = C_i (\Delta P)^{n_i} \qquad (4\text{-}10)$$

Where:

i = index corresponding to the exfiltration or infiltration test;

$\dot{V}_{door}Q$ = the airflow rate, ft³/h (m³/s);

ΔP = the differential pressure, in-H_2O (Pa);

C_i = coefficient determined based on goodness of fit to test data of type i; and

n_i = exponent determined based on goodness of fit to test data of type i.

(f) Find the average C and n:

$$C = \frac{C_{infiltration} + C_{exfiltration}}{2} \qquad (4\text{-}11)$$

$$n = \frac{n_{infiltration} + n_{exfiltration}}{2} \qquad (4\text{-}12)$$

Where:

$C_{infiltration}$ = coefficient determined using log-linear regression of infiltration test;

$C_{exfiltration}$ = coefficient determined using log-linear regression of exfiltration test;

$n_{infiltration}$ = exponent determined using log-linear regression of infiltration test; and
$n_{exfiltration}$ = exponent determined using log-linear regression of exfiltration test.

(g) If n is found to be less than 0.5 or greater than 1.0 the test is considered invalid and the infiltration and exfiltration tests must be repeated until valid value for n is determined.

(h) Using the valid n, corresponding C and the equation below, determine, $\dot{V}_{door}Q$, the infiltration for the corresponding pressure differentials (m^3/s) for both cooler and freezer application:

(1) Coolers: 0.006 in-H_2O (1.5 Pa).

(2) Freezers: 0.014 in-H_2O (3.5 Pa).

$$\dot{V}_{door} = C(\Delta P)^n \qquad (4\text{-}13)$$

Where:

$\dot{V}_{door}Q$ = the airflow rate, ft^3/h (m^3/s);
ΔP = the differential pressure, in-H_2O (Pa);
C = coefficient determined based on goodness of fit; and
n = exponent determined based on goodness of fit.

(i) Using the resulting $\dot{V}_{door}Q$ for coolers and freezers, calculate the normalized infiltration rate per length of "operable crack perimeter," $\dot{V}_{door\ norm}Q$, as defined in ASTM E–283–04 (ASTM E–283–04 section 12.3.1) (incorporated by reference, see § 431.303) must be calculated.

$$\dot{V}_{door\ norm} = \frac{\dot{V}_{door}}{P_{door\ crack}} \qquad (4\text{-}14)$$

Where:

$\dot{V}_{door}Q$ = the airflow rate, ft^3/h (m^3/s); and
$P_{door\ crack}$ = door operable crack perimeter, ft.

(j) $\dot{V}_{door\ norm}Q$, for the corresponding representative door test size, may be used for calculating the infiltration rate of doors with differing operable crack perimeter.

(k) If a testing entity desires such, $\dot{V}_{door}Q$ may be found for all doors instead of calculating an infiltration rate based on $\dot{V}_{door\ norm}Q$.

[FR Doc. 2010–21364 Filed 9–8–10; 8:45 am]

BILLING CODE 6450–01–P