

**ANSI/AHRI Standard 340/360-2007 with Addenda 1 and 2  
(Formerly ARI Standard 340/360-2007)**

**2007 Standard for  
Performance Rating  
of Commercial and  
Industrial Unitary Air-  
Conditioning and  
Heat Pump Equipment**



Approved by ANSI on 27 October 2011



**Air-Conditioning, Heating,  
and Refrigeration Institute**

2111 Wilson Boulevard, Suite 500  
Arlington, VA 22201, USA  
[www.ahrinet.org](http://www.ahrinet.org)

PH 703.524.8800  
FX 703.562.1942



## **ANSI/AHRI STANDARD 340/360-2007 WITH** **ADDENDUM 2,**

# **Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment**

**June 2011**

Addendum 2 (dated June 2011) of ANSI/AHRI Standard 340/360-2007, “*Changes to ANSI/AHRI Standard 340/360-2007*” is provided as follows. The particular additions are shown with shading and deletions shown with strikethroughs. The following changes have been incorporated (additions are shown by shading and deletions are shown by ~~strikethroughs~~) into the already published 2007 version of ANSI/AHRI Standard 340/360 to avoid confusion.

1. The language in Section 6.2.2 associated with units using discrete step fan control and variable air volume units has been revised. An external static equation has been added to the footnotes of Table 6.

### **External Static**

The following equation has been added to the footnote of Table 6 of ANSI/AHRI Standard 340/360-2007:

$$ExternalStatic = FullLoadExternalStatic \times \left( \frac{PartLoadCFM}{FullLoadCFM} \right)^2$$



## **ANSI/AHRI STANDARD 340/360-2007 WITH** **ADDENDUM 1,**

# **Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment**

**December 2010**

Addendum 1 (dated December 2010) of ANSI/AHRI Standard 340/360-2007, “*Changes to ANSI/AHRI Standard 340/360-2007*” is provided as follows. The particular additions are shown with shading and deletions shown with strikethroughs. The following changes have been incorporated (additions are shown by shading and deletions are shown by ~~strikethroughs~~) into the already published 2007 version of ANSI/AHRI Standard 340/360 to avoid confusion.

1. The certification program scope, on the inside front cover, has been revised.
2. New provisions have been added to the footnotes of Tables 5 and 6 to specify the tolerances associated with external static pressure for all units, and the leaving air dry-bulb temperature on variable air volume (VAV) units, respectively.

## **Tolerances**

The following tolerance has been added to the footnote of Table 5 of ANSI/AHRI Standard 340/360-2007:

The tolerance for external static pressure (averaged during the run time) for all equipment is -0 in H<sub>2</sub>O [0 Pa], +0.05 in H<sub>2</sub>O [12.5 Pa].

The following tolerance has been added to the footnote of Table 6 of ANSI/AHRI Standard 340/360-2007:

The tolerance for the leaving air dry-bulb temperature on VAV units is  $\pm 0.3$  °F [ $\pm 0.2$  °C].

## IMPORTANT

### **SAFETY DISCLAIMER**

AHRI does not set safety standards and does not certify or guarantee the safety of any products, components or systems designed, tested, rated, installed or operated in accordance with this standard/guideline. It is strongly recommended that products be designed, constructed, assembled, installed and operated in accordance with nationally recognized safety standards and code requirements appropriate for products covered by this standard/guideline.

AHRI uses its best efforts to develop standards/guidelines employing state-of-the-art and accepted industry practices. AHRI does not certify or guarantee that any test conducted under its standards/guidelines will be non-hazardous or free from risk.

### **APPLICABILITY**

Integrated Energy Efficiency Ratio (IEER) is effective beginning January 1, 2010. Integrated Part-Load Value (IPLV) is was in effect until January 1, 2010 December 31, 2009. On January 1, 2010, IEER will supersede IPLV. IEER superseded IPLV on January 1, 2010.

### **AHRI CERTIFICATION PROGRAM PROVISIONS**

#### **Scope of the Certification Program**

The Certification Program includes:

- all air-cooled, water-cooled and evaporatively-cooled unitary air-conditioning, air-source unitary heat pump equipment, and air-conditioning condensing units rated at or above 65,000 Btu/h [19,000 W] at AHRI Standard Rating Conditions (Cooling) but below 250,000 Btu/h [73,200 W] at AHRI Standard Rating Conditions (Cooling).
- all air-cooled packaged unitary air-conditioners from 250,000 Btu/h to less than 760,000 Btu/h at AHRI Standard Rating Conditions (Cooling).

#### **Certified Ratings**

The following Certification Program ratings are verified by test:

##### *Unitary Air-Conditioners and Air-Conditioning Condensing Units*

Air-cooled, water-cooled and evaporatively-cooled from 65,000 Btu/h [19,000 W] to below 250,000 Btu/h [73,200 W].

1. AHRI Standard Rating Cooling Capacity, Btu/h
2. Energy Efficiency Ratio, EER, Btu/W·h
3. Integrated Energy Efficiency Ratio, (IEER) (effective January 1, 2010) or Integrated Part-Load Value, (IPLV) (effective through December 31, 2009)

##### *Air-Source Unitary Heat Pump Equipment*

Air-cooled from 65,000 Btu/h [19,000 W] to below 250,000 Btu/h [73,200 W].

1. AHRI Standard Rating Cooling Capacity, Btu/h
2. Energy Efficiency Ratio, EER, Btu/W·h
3. High Temperature Heating Standard Rating Capacity, Btu/h
4. High Temperature Coefficient of Performance (COP 47°F)
5. Low Temperature Heating Standard Rating Capacity, Btu/h
6. Low Temperature Coefficient of Performance (COP 17°F)
7. Integrated Energy Efficiency Ratio, (IEER) (effective January 1, 2010) or Integrated Part-Load Value, (IPLV) (effective through December 31, 2009)

Unitary Air-Cooled Packaged Air-Conditioners from 250,000 Btu/h [73,200 W] to below 760,000 Btu/h [220,000 W].

1. AHRI Standard Rating Cooling Capacity, Btu/h
2. Energy Efficiency Ratio, EER, Btu/W·h
3. Integrated Part-Load Value, IPLV (effective through 31 December, 2009) or Integrated Energy Efficiency Ratio, (IEER) (effective 1 January, 2010)

Conformance to the requirements of the Maximum Operating Condition Test, Cooling Low Temperature Operation Test, Insulation Efficiency Test (Cooling), and Condensate Disposal Test (Cooling) are also verified by test.

Note:

This standard supersedes ARI Standard 340/360-2004.

## TABLE OF CONTENTS

| SECTION     |                                                      | PAGE |
|-------------|------------------------------------------------------|------|
| Section 1.  | Purpose .....                                        | 1    |
| Section 2.  | Scope .....                                          | 1    |
| Section 3.  | Definitions .....                                    | 1    |
| Section 4.  | Classifications.....                                 | 3    |
| Section 5.  | Test Requirements .....                              | 4    |
| Section 6.  | Rating Requirements .....                            | 4    |
| Section 7.  | Minimum Data Requirements for Published Ratings..... | 13   |
| Section 8.  | Operating Requirements .....                         | 13   |
| Section 9.  | Marking and Nameplate Data.....                      | 15   |
| Section 10. | Conformance Conditions.....                          | 15   |

## TABLES

|          |                                                                                     |   |
|----------|-------------------------------------------------------------------------------------|---|
| Table 1. | Classification of Commercial and Industrial Unitary Air-Conditioning Equipment..... | 3 |
| Table 2. | Classification of Commercial and Industrial Unitary Heat Pump Equipment ...         | 4 |
| Table 3. | Conditions for Standard Rating and Operating Tests.....                             | 5 |
| Table 4. | Expression of Standard Capacity Ratings .....                                       | 6 |
| Table 5. | Minimum External Pressure .....                                                     | 7 |
| Table 6. | IEER Part-Load Rating Conditions .....                                              | 9 |



## APPENDICES

|             |                                                                                                   |    |
|-------------|---------------------------------------------------------------------------------------------------|----|
| Appendix A. | References - Normative .....                                                                      | 16 |
| Appendix B. | References - Informative .....                                                                    | 16 |
| Appendix C. | Capacity Calculation for Unitary Equipment Using an Outdoor<br>Air Cooling Coil – Normative ..... | 17 |
| Appendix D. | Method and Example of Calculating Integrated Part-Load Values (IPLV)<br>– Normative .....         | 19 |

## TABLES FOR APPENDICES

|           |                                            |    |
|-----------|--------------------------------------------|----|
| Table D1. | Example IPLV Calculation (I-P Units) ..... | 22 |
|-----------|--------------------------------------------|----|

## FIGURES FOR APPENDICES

|            |                                                   |    |
|------------|---------------------------------------------------|----|
| Figure C1. | Test Set-Up for Units Using an Outdoor Coil ..... | 18 |
| Figure D1. | Part-Load Factor Example.....                     | 21 |

# PERFORMANCE RATING OF COMMERCIAL AND INDUSTRIAL UNITARY AIR-CONDITIONING AND HEAT PUMP EQUIPMENT

## Section 1. Purpose

**1.1 Purpose.** The purpose of this standard is to establish for Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment: definitions; classifications; test requirements; rating requirements; minimum data requirements for Published Ratings; operating requirements; marking and nameplate data; and conformance conditions.

**1.1.1 Intent.** This standard is intended for the guidance of the industry, including manufacturers, engineers, installers, contractors and users.

**1.1.2 Review and Amendment.** This standard is subject to review and amendment as technology advances.

## Section 2. Scope

**2.1 Scope.** This standard applies to factory-made Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment as defined in Section 3.

**2.1.1 Energy Source.** This standard applies only to electrically operated, vapor compression refrigeration systems.

**2.2 Exclusions.** This standard does not apply to the following:

**2.2.1** Rating and testing of individual assemblies, such as condensing units or coils, for separate use.

**2.2.2** Unitary Air-Conditioners as defined in AHRI Standard 210/240, *Unitary Air-Conditioning and Air-Source Heat Pump Equipment*, with capacities less than 65,000 Btu/h [19,000 W], or to Unitary Heat Operated Air-Conditioning Equipment, or Water-Source Heat Pumps as defined in ISO 13256-1, *Water-source heat pumps – Testing and rating for performance – Part I: Water-to-air and Brine-to-air heat pumps*.

**2.2.3** Rating of units equipped with desuperheater/water heating devices (as defined in ANSI/ASHRAE Standard 137) in operation.

## Section 3. Definitions

All terms in this document follow the standard industry definitions in the current edition of *ASHRAE Terminology of Heating, Ventilation Air-Conditioning and Refrigeration*, unless otherwise defined in this section.

**3.1 Coefficient of Performance.** A ratio of the cooling/heating capacity in watts [W] to the power input values in watts [W] at any given set of rating conditions expressed in watts/watts [W/W]. For heating COP, supplementary resistance heat shall be excluded.

**3.1.1 Standard Coefficient of Performance.** A ratio of the capacity to power input value obtained at Standard Rating Conditions.

**3.2 Commercial and Industrial Unitary Air-Conditioner.** One or more factory-made assemblies, which normally include a cooling coil, an air moving device, a compressor(s) and condenser combination, and may include a heating Function as well. Where such equipment is provided in more than one assembly, the separate assemblies shall be designed to be used together, and the requirements of rating outlined in this standard shall be based upon the use of matched assemblies.

**3.2.1 Functions.** The Functions of Commercial and Industrial Unitary Air-Conditioners, either alone or in combination with a heating plant, are to provide air-circulation, cooling, dehumidification, and may include the Functions of heating, humidifying, outdoor air ventilation, and air cleaning.

**3.3 Commercial and Industrial Unitary Heat Pump.** One or more factory-made assemblies, which normally include an indoor conditioning coil, an air moving device, compressor(s), and an outdoor coil(s), including means to provide a heating Function and may or may not include a cooling Function. When such equipment is provided in more than one assembly, the separate assemblies shall be designed to be used together, and the requirements of rating outlined in the standard shall be based upon the use of matched assemblies.

**3.3.1 Functions.** Commercial and Industrial Unitary Heat Pumps shall provide the Function of heating and may include the Function of air circulation, air cooling, dehumidifying or humidifying, outdoor air ventilation, and air cleaning.

**3.4 Cooling Capacity.** The capacity associated with the change in air enthalpy which includes both the Latent and Sensible Capacities expressed Btu/h [W].

**3.4.1 Latent Capacity.** Capacity associated with a change in humidity ratio.

**3.4.2 Sensible Capacity.** Capacity associated with a change in dry-bulb temperature.

**3.5 Energy Efficiency Ratio (EER).** A ratio of the Cooling Capacity in Btu/h to the power input values in watts at any given set of rating conditions expressed in Btu/W·h.

**3.6 Integrated Energy Efficiency Ratio (IEER).** A single number cooling part-load efficiency figure of merit calculated per the method described in 6.2.2.

**3.7 Integrated Part-Load Value (IPLV).** A single number cooling part-load figure of merit calculated per the method described in Appendix D.

**3.8 Published Rating.** A statement of the assigned values of those performance characteristics, under stated Rating Conditions, by which a unit may be chosen to fit its application. These values apply to all units of like nominal size and type (identification) produced by the same manufacturer. The term Published Rating includes the rating of all performance characteristics shown on the air-conditioner or heat pump or published in specifications, advertising, or other literature controlled by the manufacturer, at stated Rating Conditions.

**3.8.1 Application Rating.** A rating based on tests performed at application Rating Conditions (other than Standard Rating Conditions).

**3.8.2 Standard Rating.** A rating based on tests performed at Standard Rating Conditions.

**3.9 Rating Conditions.** Any set of operating conditions under which a single level of performance results and which causes only that level of performance to occur.

**3.9.1 Standard Rating Conditions.** Rating conditions used as the basis of comparison for performance characteristics.

**3.10 "Shall" or "Should".** "Shall" or "should" shall be interpreted as follows:

**3.10.1 Shall.** Where "shall" or "shall not" is used for a provision specified, that provision is mandatory if compliance with the standard is claimed.

**3.10.2 Should.** "Should" is used to indicate provisions which are not mandatory but which are desirable as good practice.

**3.11 Standard Air.** Air weighing 0.075 lb/ft<sup>3</sup> [1.2 kg/m<sup>3</sup>] which approximates dry air at 70°F [21°C] and at a barometric pressure of 29.92 in Hg [101.3 kPa].

## Section 4. Classifications

Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment within the scope of this standard shall be classified as shown in Tables 1 and 2.

| Table 1. Classification of Commercial and Industrial Unitary Air-Conditioning Equipment                                                                                                                                                                                                                                                            |                                     |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|------|------|------|--|
| Types of Commercial and Industrial Unitary Air-Conditioners                                                                                                                                                                                                                                                                                        |                                     |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
| Designation                                                                                                                                                                                                                                                                                                                                        | AHRI Type <sup>1,2</sup>            | Arrangement                                                                                                                                                                |      |      |      |      |      |      |      |  |
| Single Package                                                                                                                                                                                                                                                                                                                                     | SP-A<br>SP-E<br>SP-W                | <table border="1"> <tr> <td>FAN</td> <td>COMP</td> </tr> <tr> <td>EVAP</td> <td>COND</td> </tr> </table>                                                                   | FAN  | COMP | EVAP | COND |      |      |      |  |
| FAN                                                                                                                                                                                                                                                                                                                                                | COMP                                |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
| EVAP                                                                                                                                                                                                                                                                                                                                               | COND                                |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
| Year-Round Single Package                                                                                                                                                                                                                                                                                                                          | SPY-A<br>SPY-E<br>SPY-W             | <table border="1"> <tr> <td>FAN</td> <td></td> </tr> <tr> <td>HEAT</td> <td>COMP</td> </tr> <tr> <td>EVAP</td> <td>COND</td> </tr> </table>                                | FAN  |      | HEAT | COMP | EVAP | COND |      |  |
| FAN                                                                                                                                                                                                                                                                                                                                                |                                     |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
| HEAT                                                                                                                                                                                                                                                                                                                                               | COMP                                |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
| EVAP                                                                                                                                                                                                                                                                                                                                               | COND                                |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
| Condensing Unit, Coil and Blower                                                                                                                                                                                                                                                                                                                   | RCU-A-CB<br>RCU-E-CB<br>RCU-W-CB    | <table border="1"> <tr> <td>FAN</td> <td>COMP</td> </tr> <tr> <td>EVAP</td> <td>COND</td> </tr> </table>                                                                   | FAN  | COMP | EVAP | COND |      |      |      |  |
| FAN                                                                                                                                                                                                                                                                                                                                                | COMP                                |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
| EVAP                                                                                                                                                                                                                                                                                                                                               | COND                                |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
| Year-Round Condensing Unit, Coil and Blower                                                                                                                                                                                                                                                                                                        | RCUY-A-CB<br>RCUY-E-CB<br>RCUY-W-CB | <table border="1"> <tr> <td>FAN</td> <td></td> </tr> <tr> <td>HEAT</td> <td>COND</td> </tr> <tr> <td>EVAP</td> <td>COMP</td> </tr> </table>                                | FAN  |      | HEAT | COND | EVAP | COMP |      |  |
| FAN                                                                                                                                                                                                                                                                                                                                                |                                     |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
| HEAT                                                                                                                                                                                                                                                                                                                                               | COND                                |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
| EVAP                                                                                                                                                                                                                                                                                                                                               | COMP                                |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
| Remote Condenser                                                                                                                                                                                                                                                                                                                                   | RC-A<br>RC-E<br>RC-W                | <table border="1"> <tr> <td>FAN</td> <td></td> </tr> <tr> <td>EVAP</td> <td>COND</td> </tr> <tr> <td>COMP</td> <td></td> </tr> </table>                                    | FAN  |      | EVAP | COND | COMP |      |      |  |
| FAN                                                                                                                                                                                                                                                                                                                                                |                                     |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
| EVAP                                                                                                                                                                                                                                                                                                                                               | COND                                |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
| COMP                                                                                                                                                                                                                                                                                                                                               |                                     |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
| Condensing Unit, Coil Alone                                                                                                                                                                                                                                                                                                                        | RCU-A-C<br>RCU-E-C<br>RCU-W-C       | <table border="1"> <tr> <td>EVAP</td> <td>COND</td> </tr> <tr> <td></td> <td>COMP</td> </tr> </table>                                                                      | EVAP | COND |      | COMP |      |      |      |  |
| EVAP                                                                                                                                                                                                                                                                                                                                               | COND                                |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
|                                                                                                                                                                                                                                                                                                                                                    | COMP                                |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
| Year-Round Remote Condenser                                                                                                                                                                                                                                                                                                                        | RCY-A<br>RCY-E<br>RCY-W             | <table border="1"> <tr> <td>FAN</td> <td></td> </tr> <tr> <td>EVAP</td> <td>COND</td> </tr> <tr> <td>HEAT</td> <td></td> </tr> <tr> <td>COMP</td> <td></td> </tr> </table> | FAN  |      | EVAP | COND | HEAT |      | COMP |  |
| FAN                                                                                                                                                                                                                                                                                                                                                |                                     |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
| EVAP                                                                                                                                                                                                                                                                                                                                               | COND                                |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
| HEAT                                                                                                                                                                                                                                                                                                                                               |                                     |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
| COMP                                                                                                                                                                                                                                                                                                                                               |                                     |                                                                                                                                                                            |      |      |      |      |      |      |      |  |
| <p>Note:</p> <p><sup>1</sup> A suffix of “-O” following any of the above classifications indicates equipment not intended for use with field-installed duct systems (6.1.3.2b).</p> <p><sup>2</sup> A suffix of “-A” indicates air-cooled condenser, “-E” indicates evaporatively-cooled condenser, and “-W” indicates water-cooled condenser.</p> |                                     |                                                                                                                                                                            |      |      |      |      |      |      |      |  |

**Table 2. Classification of Commercial and Industrial Unitary Heat Pump Equipment**

| Types of Commercial and Industrial Unitary Heat Pumps |                        |              |                                                                                                                                                |             |              |              |              |
|-------------------------------------------------------|------------------------|--------------|------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------|--------------|--------------|
| Designation                                           | AHRI Type <sup>1</sup> |              | Arrangement                                                                                                                                    |             |              |              |              |
|                                                       | Heating and Cooling    | Heating Only |                                                                                                                                                |             |              |              |              |
| Single Package                                        | HSP-A                  | HOSP-A       | <table border="1"> <tr> <td>FAN</td> <td>COMP</td> </tr> <tr> <td>INDOOR COIL</td> <td>OUTDOOR COIL</td> </tr> </table>                        | FAN         | COMP         | INDOOR COIL  | OUTDOOR COIL |
| FAN                                                   | COMP                   |              |                                                                                                                                                |             |              |              |              |
| INDOOR COIL                                           | OUTDOOR COIL           |              |                                                                                                                                                |             |              |              |              |
| Remote Outdoor Coil                                   | HRC-A-CB               | HORC-A-CB    | <table border="1"> <tr> <td>FAN</td> <td rowspan="3">OUTDOOR COIL</td> </tr> <tr> <td>INDOOR COIL</td> </tr> <tr> <td>COMP</td> </tr> </table> | FAN         | OUTDOOR COIL | INDOOR COIL  | COMP         |
| FAN                                                   | OUTDOOR COIL           |              |                                                                                                                                                |             |              |              |              |
| INDOOR COIL                                           |                        |              |                                                                                                                                                |             |              |              |              |
| COMP                                                  |                        |              |                                                                                                                                                |             |              |              |              |
| Remote Outdoor Coil with No Indoor Fan                | HRC-A-C                | HORC-A-C     | <table border="1"> <tr> <td>INDOOR COIL</td> <td rowspan="2">OUTDOOR COIL</td> </tr> <tr> <td>COMP</td> </tr> </table>                         | INDOOR COIL | OUTDOOR COIL | COMP         |              |
| INDOOR COIL                                           | OUTDOOR COIL           |              |                                                                                                                                                |             |              |              |              |
| COMP                                                  |                        |              |                                                                                                                                                |             |              |              |              |
| Split System                                          | HRCU-A-CB              | HORCU-A-CB   | <table border="1"> <tr> <td>FAN</td> <td>COMP</td> </tr> <tr> <td>INDOOR COIL</td> <td>OUTDOOR COIL</td> </tr> </table>                        | FAN         | COMP         | INDOOR COIL  | OUTDOOR COIL |
| FAN                                                   | COMP                   |              |                                                                                                                                                |             |              |              |              |
| INDOOR COIL                                           | OUTDOOR COIL           |              |                                                                                                                                                |             |              |              |              |
| Split System with No Indoor Fan                       | HRCU-A-C               | HORCU-A-C    | <table border="1"> <tr> <td rowspan="2">INDOOR COIL</td> <td>COMP</td> </tr> <tr> <td>OUTDOOR COIL</td> </tr> </table>                         | INDOOR COIL | COMP         | OUTDOOR COIL |              |
| INDOOR COIL                                           | COMP                   |              |                                                                                                                                                |             |              |              |              |
|                                                       | OUTDOOR COIL           |              |                                                                                                                                                |             |              |              |              |

Note:  
<sup>1</sup> A suffix of “-O” following any of the above classifications indicates equipment not intended for use with field-installed duct systems (6.1.3.2b).

## Section 5. Test Requirements

**5.1** All standard ratings shall be verified by tests conducted in accordance with ASHRAE Standard 37 and with the test methods and procedures as described in this standard.

## Section 6. Rating Requirements

**6.1** *Standard Ratings.* Standard Ratings shall be established at the Standard Rating Conditions specified in Table 3. Standard Ratings related to cooling or heating capacities shall be net values, including the effects of circulating fan heat, but not including supplementary heat. Standard Ratings (Cooling) shall be stated as total Cooling Capacity.

Standard Ratings shall be based on the total power input to the compressor(s) and fan(s), plus controls and other items required as part of the system for standard rating operation.

Table 3. Conditions for Standard Rating and Operating Tests

| TEST    |                                                                    | INDOOR SECTION         |                         | OUTDOOR SECTION              |                                           |                              |                              |                                           |                              |
|---------|--------------------------------------------------------------------|------------------------|-------------------------|------------------------------|-------------------------------------------|------------------------------|------------------------------|-------------------------------------------|------------------------------|
|         |                                                                    | Air Entering           |                         | Air Entering                 |                                           |                              |                              | Water                                     |                              |
|         |                                                                    | Dry-Bulb<br>°F<br>[°C] | Wet-Bulb<br>°F<br>[°C]  | Air Cooled                   |                                           | Evaporative                  |                              | IN<br>°F<br>[°C]                          | OUT<br>°F<br>[°C]            |
|         |                                                                    |                        |                         | Dry-Bulb<br>°F<br>[°C]       | Wet-Bulb<br>°F<br>[°C]                    | Dry-Bulb<br>°F<br>[°C]       | Wet-Bulb<br>°F<br>[°C]       |                                           |                              |
| COOLING | Standard Rating Conditions Cooling <sup>3</sup>                    | 80.0<br>[26.7]         | 67.0<br>[19.4]          | 95.0<br>[35.0]               | 75.0 <sup>1</sup><br>[23.9]               | 95.0<br>[35.0]               | 75.0<br>[23.9]               | 85.0<br>[29.4]                            | 95.0<br>[35.0]               |
|         | Low Temperature Operating Cooling <sup>3</sup>                     | 67.0<br>[19.4]         | 57.0<br>[13.9]          | 67.0<br>[19.4]               | 57.0 <sup>1</sup><br>[13.9]               | 67.0<br>[19.4]               | 57.0<br>[13.9]               | --                                        | 70.0 <sup>2</sup><br>[21.1]  |
|         | Maximum Operating Conditions <sup>3</sup>                          | 80.0<br>[26.7]         | 67.0<br>[19.4]          | 115<br>[46.1]                | 75.0 <sup>1</sup><br>[23.9]               | 100<br>[37.8]                | 80.0 <sup>4</sup><br>[26.7]  | 90.0 <sup>2</sup><br>[32.2]               | --                           |
|         | Part-Load Conditions ( <i>IEER</i> ) <sup>3</sup>                  | 80.0<br>[26.7]         | 67.0<br>[19.4]          | Varies with load per Table 6 | <sup>1</sup> Varies with load per Table 6 | Varies with load per Table 6 | Varies with load per Table 6 | <sup>2</sup> Varies with load per Table 6 | Varies with load per Table 6 |
|         | Part-Load Conditions (IPLV) <sup>3</sup>                           | 80.0<br>[26.7]         | 67.0<br>[19.4]          | 80.0<br>[26.7]               | 67.0 <sup>1</sup><br>[19.4]               | 80.0<br>[26.7]               | 67.0<br>[26.7]               | 75.0 <sup>2</sup><br>[23.9]               | --                           |
|         | Insulation Efficiency <sup>3</sup>                                 | 80.0<br>[26.7]         | 75.0<br>[23.9]          | 80.0<br>[26.7]               | 75.0 <sup>1</sup><br>[23.9]               | 80.0<br>[26.7]               | 75.0<br>[23.9]               | --                                        | 80.0<br>[26.7]               |
|         | Condensate Disposal <sup>3</sup>                                   | 80.0<br>[26.7]         | 75.0<br>[23.9]          | 80.0<br>[26.7]               | 75.0 <sup>1</sup><br>[23.9]               | 80.0<br>[26.7]               | 75.0<br>[23.9]               | --                                        | 80.0<br>[26.7]               |
| HEATING | Standard Rating Conditions (High Temperature Steady State Heating) | 70.0<br>[21.1]         | 60.0<br>[15.6]<br>(max) | 47<br>[8.3]                  | 43<br>[6.1]                               | --                           | --                           | --                                        | --                           |
|         | Standard Rating Conditions (Low Temperature Steady State Heating)  | 70.0<br>[21.1]         | 60.0<br>[15.6]<br>(max) | 17<br>[-8.3]                 | 15<br>[-9.4]                              | --                           | --                           | --                                        | --                           |
|         | Maximum Operating Conditions                                       | 80.0<br>[26.7]         | --                      | 75.0<br>[23.9]               | 65.0<br>[18.3]                            | --                           | --                           | --                                        | --                           |

**NOTES:**

- <sup>1</sup> The wet-bulb temperature condition is not required when testing air cooled condensers which do not evaporate condensate except for units with optional outdoor cooling coil.
- <sup>2</sup> Water flow rate as determined from Standard Rating Conditions Test.
- <sup>3</sup> Cooling rating and operating tests are not required for heating only heat pumps.
- <sup>4</sup> Make-up water temperature shall be 90°F [32°C].

Standard Ratings of units which do not have indoor air-circulating fans furnished as part of the model, i.e., split systems with indoor coil alone, shall be established by subtracting 1250 Btu/h per 1000 cfm [775 W/m<sup>3</sup>/s] from the total cooling capacity, and by adding the same amount to the heating capacity. Total power input for both heating and cooling shall be increased by 365 W per 1000 cfm [226 W/m<sup>3</sup>/s] of indoor air circulated.

Standard Ratings of water-cooled units from 65,000 to below 135,000 Btu/h [19,000 to 39,600 W] shall include a total allowance for cooling tower fan motor and circulating water pump motor power inputs to be added in the amount of 10.0 W per 1000 Btu/h [34.1 W per 1000 W] cooling capacity.

**6.1.1** *Values of Standard Capacity Ratings.* These ratings shall be expressed in terms of Btu/h [W] as shown in Table 4.

| Capacity Ratings,<br>Btu/h [W]                  | Multiples,<br>Btu/h [W] |
|-------------------------------------------------|-------------------------|
| 65,000 up to 135,000<br>[19,000 up to 39,600]   | 1,000 [300]             |
| 136,000 up to 400,000<br>[39,800 up to 117,000] | 2,000 [600]             |
| above 400,000<br>[above 117,000]                | 5,000 [1,500]           |

**6.1.2** *Values of Energy Efficiency Ratios and Coefficients of Performance.* Energy Efficiency Ratios (EER) and Integrated Energy Efficiency Ratio (IEER) or Integrated Part-Load Value (IPLV) for cooling, whenever published, shall be expressed in multiples of the nearest 0.1. Coefficients of Performance (COP) for heating or cooling, whenever published, shall be expressed in multiples of the nearest 0.01.

**6.1.3** *Standard Rating Tests.* Table 3 indicates the tests and test conditions which are required to determine values of standard capacity ratings and values of energy efficiency. Standard cooling ratings are not applicable for heating-only heat pumps.

**6.1.3.1** *Voltage and Frequency.* Standard Rating tests shall be performed at the nameplate rated voltage(s) and frequency.

For air-conditioners and heat pumps with dual nameplate voltage ratings, Standard Rating tests shall be performed at both voltages, or at the lower of the two voltages, if only a single Standard Rating is to be published.

**6.1.3.2** *Indoor-Coil Airflow Rate.* All Standard Ratings shall be determined at an indoor-coil airflow rate as outlined below. All airflow rates shall be expressed in terms of Standard Air.

- a. Equipment with indoor fans intended for use with field installed duct systems shall be rated at the indoor-coil airflow rate (not to exceed 37.5 SCFM per 1000 Btu/h [0.06 m<sup>3</sup>/s per 1000 W] of rated capacity) delivered when operating against the minimum external resistance specified in Table 5 or at a lower indoor-coil airflow rate if so specified by the manufacturer.
- b. Equipment with indoor fans not intended for use with field installed duct systems (free discharge) shall be rated at the indoor-side air quantity delivered when operating at 0 in H<sub>2</sub>O [0 Pa] external pressure as specified by the manufacturer.
- c. 100% recirculated air shall be used except when the rating with outside air is claimed (6.1.3.6). For units equipped for multi-zone or dual duct operation, the hot deck shall be closed off using dampers supplied with the unit.

| <b>Table 5. Minimum External Pressure</b> |                |                                          |      |
|-------------------------------------------|----------------|------------------------------------------|------|
| <sup>1</sup> Standard Capacity Ratings    |                | <sup>2</sup> Minimum External Resistance |      |
| Btu/h x 1000                              | W x 1000       | In H <sub>2</sub> O                      | kPa  |
| 65 thru 70                                | 19 thru 21     | 0.20                                     | 0.05 |
| 71 thru 105                               | 21 thru 30.8   | 0.25                                     | 0.06 |
| 106 thru 134                              | 31.1 thru 39.3 | 0.30                                     | 0.07 |
| 135 thru 210                              | 39.6 thru 61.5 | 0.35                                     | 0.09 |
| 212 thru 280                              | 62.1 thru 82.1 | 0.40                                     | 0.10 |
| 282 thru 350                              | 82.6 thru 103  | 0.45                                     | 0.11 |
| 352 thru 400                              | 103 thru 117   | 0.55                                     | 0.14 |
| 405 thru 500                              | 118 thru 147   | 0.65                                     | 0.16 |
| 505 and over                              | 147 and over   | 0.75                                     | 0.19 |

<sup>1</sup> Cooling Capacity for units with cooling function; high temperature heating capacity for heating-only units.

<sup>2</sup> The tolerance for external static pressure (averaged during the run time) for all equipment is -0 in H<sub>2</sub>O [0 Pa], +0.05 in H<sub>2</sub>O [12.5 Pa].

- d. Equipment which does not incorporate an indoor fan, but is rated in combination with a device employing a fan shall be rated as described under 6.1.3.2a. For equipment of this class which is rated for general use to be applied to a variety of heating units, the indoor-coil airflow rate shall be the lesser of: (1) the manufacturer specified Standard Ratings, not to exceed 37.5 SCFM/1000 Btu/h [0.06 m<sup>3</sup>/s per 1000 W] of rated capacity or (2) the airflow rate obtained through the indoor coil assembly when the pressure drop across the indoor coil assembly and the recommended enclosures and attachment means is not greater than 0.30 in H<sub>2</sub>O [75 Pa].
- e. Indoor-coil airflow rates and pressures as referred to herein apply to the airflow rate experienced when the unit is cooling and dehumidifying under the conditions specified in this section. This airflow rate, except as noted in 6.1.3.2b and 8.3, shall be employed in all other tests prescribed herein without regard to resulting external static pressure. Heating-only units shall use the airflow rate experienced when the unit is operating under the high temperature steady-state heating standard test at Standard Rating Conditions.

**6.1.3.3 Outdoor-Side Airflow Rate.** All Standard Ratings shall be determined at the outdoor-side airflow rate specified by the manufacturer where the fan drive is adjustable. Where the fan drive is non-adjustable, they shall be determined at the outdoor-side airflow rate inherent in the equipment when operated with all of the resistance elements associated with inlets, louvers, and any ductwork and attachments considered by the manufacturer as normal installation practice. Once established, the outdoor-side air circuit of the equipment shall remain unchanged throughout all tests prescribed herein unless automatic adjustment of outdoor airflow rates by system function is made.

**6.1.3.4 Requirements for Separate Assemblies.** All Standard Ratings for equipment in which the outdoor section is separated from the indoor section, as in Types RC, RCY, RCU, RCUY, HRC, HORC, HRCU, and HORCU (shown in Section 4), shall be determined with at least 25 ft [7.6 m] of interconnecting tubing on each line of the size recommended by the manufacturer. When interconnecting tubing is furnished as an integral part of the machine and is not recommended for cutting to length, the equipment shall be tested with the complete length of tubing furnished, or with 25 ft [7.6 m] of tubing, whichever is greater. At least 5.0 ft [1.5 m] of the interconnecting tubing shall be exposed to the outside conditions. The line sizes, insulation and details of installation shall be in accordance with the manufacturer's published recommendation.



**6.1.3.5 External Resistances.** Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment shall be tested at the minimum external resistances in Table 5 when delivering the rated capacity and airflow rate specified in 6.1.3.2.

Indoor air-moving equipment not intended for use with field installed duct systems (free discharge) shall be tested at 0 in H<sub>2</sub>O [0 Pa] external pressure.

**6.1.3.6 Rating Conditions for Air Conditioning Equipment with Optional Outdoor Air Cooling Coil.** Commercial and Industrial Unitary Air Conditioners which incorporate an outdoor air cooling coil shall use the Standard Rating Conditions (Table 3) for rating except for the following changes:

- a. Unit shall be adjusted to take in 20% outdoor air at conditions specified in Table 3.
- b. Return air temperature conditions shall be 80°F [27°C] dry-bulb, 67°F [19°C] wet-bulb.

Refer to Appendix C for capacity calculations.

**6.2 Part-Load Rating.** Integrated Part-Load Value (IPLV) is in effect until January 1, 2010. See Appendix D for the method and calculation of IPLV. Effective January 1, 2010, all units rated in accordance with this standard shall include an Integrated Energy Efficiency Ratio (IEER), even if they only have one stage of cooling capacity control.

**6.2.1 General.** The IEER is intended to be a measure of merit for the part load performance of the unit. Each building may have different part load performance due to local occupancy schedules, building construction, building location and ventilation requirements. For specific building energy analysis an hour-by-hour analysis program should be used.

**6.2.2 Integrated Energy Efficiency Ratio (IEER).** For equipment covered by this standard, the IEER shall be calculated using test derived data and the following formula.

$$\text{IEER} = (0.020 \cdot A) + (0.617 \cdot B) + (0.238 \cdot C) + (0.125 \cdot D) \quad 1$$

Where:

- A = EER at 100% net capacity at AHRI standard rating conditions
- B = EER at 75% net capacity and reduced ambient (see Table 6)
- C = EER at 50% net capacity and reduced ambient (see Table 6)
- D = EER at 25% net capacity and reduced ambient (see Table 6)

The IEER rating requires that the unit efficiency be determined at 100%, 75%, 50% and 25% load (net capacity) at the conditions specified in Table 6. If the unit, due to its capacity control logic cannot be operated at the 75%, 50%, or 25% load points, then the 75%, 50%, or 25% EER is determined by plotting the tested EER vs. the percent load and using straight line segments to connect the actual performance points. Linear interpolation is used to determine the EER at 75%, 50% and 25% net capacity. For the interpolation, an actual capacity point equal to or less than the required rating point must be used to plot the curves. Extrapolation of the data is not allowed.

~~If the unit has a variable indoor airflow rate, the external static pressure shall remain constant at the full load rating point as defined in Table 4, but the airflow rate should be adjusted to maintain the unit leaving dry bulb air temperature measured at the full load rating point.~~

If the unit cannot be unloaded to the 75%, 50%, or 25% load then the unit should be run at the minimum step of unloading at the condenser conditions defined for each of the rating load points and then the efficiency should be adjusted for cyclic performance using the following equation.

$$\text{EER} = \frac{\text{LF} \cdot \text{Net Capacity}}{\text{LF} \cdot [\text{C}_D \cdot (\text{P}_C + \text{P}_{CF})] + \text{P}_{IF} + \text{P}_{CT}} \quad 2$$

Where:

- Net Capacity = Measured net capacity at the lowest machine unloading point operating at the desired part load rating condition, Btu/h
- $P_C$  = Compressor power at the lowest machine unloading point operating at the desired part load rating condition, watts
- $P_{CF}$  = Condenser fan power, if applicable at the minimum step of unloading at the desired part load rating condition, watts
- $P_{IF}$  = Indoor fan motor power at the fan speed for the minimum step of capacity, watts
- $P_{CT}$  = Control circuit power and any auxiliary loads, watts
- $C_D$  = The degradation coefficient to account for cycling of the compressor for capacity less than the minimum step of capacity.  $C_D$  should be determined using the following equation.

$$C_D = (-0.13 \cdot LF) + 1.13 \quad 3$$

Where:

LF = Fractional “on” time for last stage at the desired load point.

$$LF = \frac{\left(\frac{\% \text{ Load}}{100}\right) \cdot (\text{Full Load Unit Net Capacity})}{\text{Part Load Unit Net Capacity}} \quad 4$$

%Load = The standard rating point i.e. 75%, 50%, 25%.

**Table 6. IEER Part-Load Rating Conditions**

| CONDITIONS                                 | °F                                                                                 | °C                                                                                  |
|--------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>Indoor Air</b>                          |                                                                                    |                                                                                     |
| Return Air Dry-Bulb Temperature            | 80.0                                                                               | 26.7                                                                                |
| Return Air Wet-Bulb Temperature            | 67.0                                                                               | 19.4                                                                                |
| Indoor Airflow Rate                        | Note 1                                                                             | Note 1                                                                              |
| <b>Condenser (Air Cooled)</b>              |                                                                                    |                                                                                     |
| Entering Dry-Bulb Temperature (OAT)        | For % Load > 44.4%,<br>OAT = 0.54 · % Load + 41<br>For % Load ≤ 44.4%, OAT = 65.0  | For % Load > 44.4%,<br>OAT = 0.30 · % Load + 5.0<br>For % Load ≤ 44.4%, OAT = 18.3  |
| Condenser Airflow Rate (cfm)               | Note 2                                                                             | Note 2                                                                              |
| <b>Condenser (Water Cooled)</b>            |                                                                                    |                                                                                     |
| Entering Condenser Water Temperature (EWT) | For % Load > 34.8%,<br>EWT = 0.460 · % LOAD + 39<br>For % Load ≤ 34.8%, EWT = 55.0 | For % Load > 34.8%,<br>EWT = 0.256 · % LOAD + 3.8<br>For % Load ≤ 34.8%, EWT = 12.8 |
| Condenser Water Flow Rate (gpm)            | full load flow                                                                     | full load flow                                                                      |
| <b>Condenser (Evaporatively Cooled)</b>    |                                                                                    |                                                                                     |
| Entering Wet-Bulb Temperature (EWB)        | For % Load > 36.6%,<br>EWB = 0.35 · % Load + 40<br>For % Load ≤ 36.6%, EWB = 52.8  | For % Load > 36.6%,<br>EWB = 0.19 · % Load + 4.4<br>For % Load ≤ 36.6%, EWB = 11.6  |

**NOTES**

- 1 For fixed speed indoor fans the airflow rate should be held constant at the full load airflow rate. For VAV units the airflow rate at part load should be adjusted to maintain the full load measured leaving air dry-bulb temperature, but with the design external static and the external static should be reduced per the following equation. The tolerance for the leaving air dry-bulb temperature on VAV units is ±0.3 °F [±0.2 °C]. For units using discrete step fan control, the fan speed should be adjusted as specified by the controls and the external static should be reduced per the following equation.

$$\text{ExternalStatic} = \text{FullLoadExternalStatic} \times \left(\frac{\text{PartLoadCFM}}{\text{FullLoadCFM}}\right)^2$$

- 2 Condenser airflow should be adjusted as required by the unit controls for head pressure control.

### 6.2.3 Example calculations.

Example 1 - Unit with proportional capacity control and can be run at the 75%, 50%, and 25% rating points and has a fixed speed indoor fan.

Assume that the unit has the following measured capacity

| Stage | Ambient | Actual % Load | Net Cap | Cmpr (P <sub>C</sub> ) | Cond (P <sub>CF</sub> ) | Indoor (P <sub>IF</sub> ) | Control (P <sub>CT</sub> ) | EER   |
|-------|---------|---------------|---------|------------------------|-------------------------|---------------------------|----------------------------|-------|
|       | (F)     | (Net Cap)     | Btu/h   | W                      | W                       | W                         | W                          | Btu/W |
| 4     | 95.0    | 100           | 114,730 | 8,707                  | 650                     | 1,050                     | 100                        | 10.92 |
| 3     | 81.5    | 75            | 86,047  | 5,928                  | 650                     | 1,050                     | 100                        | 11.13 |
| 2     | 68.0    | 50            | 57,365  | 3,740                  | 650                     | 1,050                     | 100                        | 10.35 |
| 1     | 65.0    | 25            | 28,682  | 2,080                  | 650                     | 1,050                     | 100                        | 7.39  |

Using the measured performance you can then calculate the IEER as follows:

$$\text{IEER} = (0.020 \cdot 10.92) + (0.617 \cdot 11.13) + (0.238 \cdot 10.35) + (0.125 \cdot 7.39) = 10.48$$

Example 2 – Unit has a single compressor with a fixed speed indoor fan.

Assume the unit has the following measured capacity

| Stage | Ambient | Actual % Load | Net Cap | Cmpr (P <sub>C</sub> ) | Cond (P <sub>CF</sub> ) | Indoor (P <sub>IF</sub> ) | Control (P <sub>CT</sub> ) | EER   |
|-------|---------|---------------|---------|------------------------|-------------------------|---------------------------|----------------------------|-------|
|       | (°F)    | (Net Cap)     | Btu/h   | W                      | W                       | W                         | W                          | Btu/W |
| 1     | 95.0    | 100           | 114,730 | 8,707                  | 650                     | 1,050                     | 100                        | 10.92 |
| 1     | 81.5    | 104.8         | 120,264 | 7,623                  | 650                     | 1,050                     | 100                        | 12.76 |
| 1     | 68.0    | 108.6         | 124,614 | 6,653                  | 650                     | 1,050                     | 100                        | 14.74 |
| 1     | 65.0    | 109.1         | 125,214 | 6,450                  | 650                     | 1,050                     | 100                        | 15.18 |

You can see that the unit cannot unload to the 75%, 50% or 25% points so tests were run with the compressor on at the ambients specified for 75%, 50%, and 25%

| Stage | Ambient | Actual % Load | Net Cap | Cmpr (P <sub>C</sub> ) | Cond (P <sub>CF</sub> )         | Indoor (P <sub>IF</sub> ) | Control (P <sub>CT</sub> ) | EER   | C <sub>D</sub> | LF    |
|-------|---------|---------------|---------|------------------------|---------------------------------|---------------------------|----------------------------|-------|----------------|-------|
|       | (F)     | (Net Cap)     | Btu/h   | W                      | W                               | W                         | W                          | Btu/W |                |       |
| 1     | 95.0    | 100.0         | 114,730 | 8,707                  | 650                             | 1,050                     | 100                        | 10.92 |                |       |
| 1     | 81.5    | 104.8         | 120,264 | 7,623                  | 650                             | 1,050                     | 100                        | 12.76 |                |       |
|       |         | 75.0          |         |                        | Adjusted for Cyclic Performance |                           |                            | 11.81 | 1.037          | 0.715 |
| 1     | 68.0    | 108.6         | 124,614 | 6,653                  | 650                             | 1,050                     | 100                        | 14.74 |                |       |
|       |         | 50.0          |         |                        | Adjusted for Cyclic Performance |                           |                            | 12.08 | 1.070          | 0.460 |
| 1     | 65.0    | 109.1         | 125,214 | 6,450                  | 650                             | 1,050                     | 100                        | 15.18 |                |       |
|       |         | 25.0          |         |                        |                                 |                           |                            | 9.76  | 1.100          | 0.229 |

With this you can then calculate the Load Factor (LF) and the C<sub>D</sub> factors and then calculate the adjusted performance for the 75%, 50%, and 25% points and then calculate the IEER.

The following is an example of the C<sub>D</sub> calculation for the 50% point:

$$\text{LF} = \frac{\left(\frac{50}{100}\right) \cdot 114,730}{124,614} = .460$$

$$\text{C}_D = (-0.13 \cdot .460) + 1.13 = 1.070$$

$$EER_{50\%} = \frac{.460 \times 124,614}{.460 \cdot (1.070 \cdot (6,653 + 650)) + 1,050 + 100} = 12.08$$

$$IEER = (0.020 \cdot 10.92) + (0.617 \cdot 11.81) + (0.238 \cdot 12.08) + (0.125 \cdot 9.76) = 11.60$$

Example 3 – Unit has 2 refrigeration circuits with 1 compressor in each circuit and 2 stages of capacity with a fixed speed indoor fan.

Assume the unit has the following measured performance.

| Stage | Ambient<br>(F) | Actual %<br>Load<br>(Net Cap) | Net Cap<br>Btu/h | Cmpr<br>(P <sub>C</sub> )<br>W | Cond<br>(P <sub>CF</sub> )<br>W | Indoor<br>(P <sub>IF</sub> )<br>W | Control<br>(P <sub>CT</sub> )<br>W | EER<br>Btu/W |
|-------|----------------|-------------------------------|------------------|--------------------------------|---------------------------------|-----------------------------------|------------------------------------|--------------|
| 2     | 95.0           | 100                           | 114,730          | 8,707                          | 650                             | 1,050                             | 100                                | 10.92        |
| 1     | 71.0           | 55.5                          | 63,700           | 3,450                          | 325                             | 1,050                             | 100                                | 12.93        |
| 1     | 68.0           | 55.9                          | 64,100           | 3,425                          | 325                             | 1,050                             | 100                                | 13.08        |
| 1     | 65.0           | 56.1                          | 64,400           | 3,250                          | 325                             | 1,050                             | 100                                | 13.63        |

You will note that the unit can unload to get to the 75% point, but cannot unload to get to the 50% and 25% points so additional tests are run at the 50% and 25% load ambients with the stage 1 loading.

With this you can then calculate the 50% and 25% load factors and C<sub>D</sub> factors as shown below.

| Stage | Ambient<br>(F) | Actual %<br>Load<br>(Net Cap) | Net Cap<br>Btu/h | Cmpr<br>(P <sub>C</sub> )<br>W | Cond<br>(P <sub>CF</sub> )<br>W | Indoor<br>(P <sub>IF</sub> )<br>W | Control<br>(P <sub>CT</sub> )<br>W | EER<br>Btu/W | C <sub>D</sub> | LF    |
|-------|----------------|-------------------------------|------------------|--------------------------------|---------------------------------|-----------------------------------|------------------------------------|--------------|----------------|-------|
| 2     | 95.0           | 100.0                         | 114,730          | 8,707                          | 650                             | 1,050                             | 100                                | 10.92        |                |       |
| 1     | 71.0           | 55.5                          | 63,700           | 3,450                          | 325                             | 1,050                             | 100                                | 12.93        |                |       |
|       |                | 75.0                          |                  |                                |                                 |                                   | interpolation                      | 12.05        |                |       |
| 1     | 68.0           | 55.9                          | 64,100           | 3,425                          | 325                             | 1,050                             | 100                                | 13.08        |                |       |
|       |                | 50.0                          |                  |                                |                                 |                                   | Adjusted for Cyclic Performance    | 12.60        | 1.014          | 0.895 |
| 1     | 65.0           | 56.1                          | 64,400           | 3,250                          | 325                             | 1,050                             | 100                                | 13.63        |                |       |
|       |                | 25.0                          |                  |                                |                                 |                                   |                                    | 10.04        | 1.072          | 0.445 |

With this you can then calculate the Load Factor (LF) and the C<sub>D</sub> factors and then calculate the adjusted performance for the 75%, 50%, and 25% points and then calculate the IEER:

$$IEER = (0.020 \cdot 10.92) + (0.617 \cdot 12.05) + (0.238 \cdot 12.60) + (0.125 \cdot 10.04) = 11.91$$

Example 4 – Unit has 3 refrigeration circuits with 1 compressor in each circuit and 3 stages of capacity with a fixed speed indoor fan.

Assume the unit has the following measured performance.

| Stage | Ambient<br>(F) | Actual %<br>Load<br>(Net Cap) | Net Cap<br>Btu/h | Cmpr<br>(P <sub>C</sub> )<br>W | Cond<br>(P <sub>CF</sub> )<br>W | Indoor<br>(P <sub>IF</sub> )<br>W | Control<br>(P <sub>CT</sub> )<br>W | EER<br>Btu/W |
|-------|----------------|-------------------------------|------------------|--------------------------------|---------------------------------|-----------------------------------|------------------------------------|--------------|
| 3     | 95.0           | 100.0                         | 114,730          | 8,707                          | 650                             | 1,050                             | 100                                | 10.92        |
| 2     | 79.5           | 71.3                          | 81,841           | 5,125                          | 433                             | 1,050                             | 100                                | 12.20        |
| 1     | 65.0           | 38.3                          | 43,980           | 2,250                          | 217                             | 1,050                             | 100                                | 12.16        |

You will note that the stage 1 operates at 38.3% capacity which is above the minimum 25% load point, but because the ambient condition was 65 °F, another test at the 25% load ambient condition is not required as it would be the same test point.

With this you can then calculate the IEER which requires interpolation for the 75% and 50% point and the use of the

degradation factor for the 25% point.

| Stage | Ambient | Actual % Load | Net Cap | Cmpr (P <sub>C</sub> ) | Cond (P <sub>CF</sub> )         | Indoor (P <sub>IF</sub> ) | Control (P <sub>CT</sub> ) | EER   | C <sub>D</sub> | LF    |
|-------|---------|---------------|---------|------------------------|---------------------------------|---------------------------|----------------------------|-------|----------------|-------|
|       | (F)     | (Net Cap)     | Btu/h   | W                      | W                               | W                         | W                          | Btu/W |                |       |
| 3     | 95.0    | 100.0         | 114,730 | 8,707                  | 650                             | 1,050                     | 100                        | 10.92 |                |       |
| 2     | 79.5    | 71.3          | 81,841  | 4,950                  | 433                             | 1,050                     | 100                        | 12.53 |                |       |
|       |         | 75.0          |         |                        |                                 | interpolation             |                            | 12.32 |                |       |
| 2     | 79.5    | 71.3          | 81,841  | 4,950                  | 433                             | 1,050                     | 100                        | 12.53 |                |       |
| 1     | 65.0    | 38.3          | 43,980  | 2,250                  | 217                             | 1,050                     | 100                        | 12.16 |                |       |
|       |         | 75.0          |         |                        |                                 | interpolation             |                            | 12.57 |                |       |
| 1     | 65.0    | 38.3          | 43,980  | 2,250                  | 217                             | 1,050                     | 100                        | 12.16 |                |       |
|       |         | 25.0          |         |                        | Adjusted for Cyclic Performance |                           |                            | 10.13 | 1.045          | 0.652 |

$$IEER = (0.02 \cdot 10.92) + (0.617 \cdot 12.32) + (0.238 \cdot 12.57) + (0.125 \cdot 10.13) = 12.08$$

Example 5 – Unit is a VAV unit and has 5 stages of capacity and a variable speed indoor.

Assume the unit has the following measured performance.

| Stage | Ambient | Actual % Load | Net Cap | Cmpr (P <sub>C</sub> ) | Cond (P <sub>CF</sub> ) | Indoor (P <sub>IF</sub> ) | Control (P <sub>CT</sub> ) | EER   |
|-------|---------|---------------|---------|------------------------|-------------------------|---------------------------|----------------------------|-------|
|       | (F)     | (Net Cap)     | Btu/h   | W                      | W                       | W                         | W                          | Btu/W |
| 5     | 95.0    | 100.0         | 229,459 | 17,414                 | 1,300                   | 2,100                     | 200                        | 10.92 |
| 4     | 85.1    | 81.7          | 187,459 | 11,444                 | 1,300                   | 1,229                     | 150                        | 13.27 |
| 3     | 74.0    | 61.0          | 140,064 | 6,350                  | 1,300                   | 575                       | 150                        | 16.72 |
| 2     | 69.6    | 52.9          | 121,366 | 6,762                  | 650                     | 374                       | 150                        | 15.29 |
| 1     | 65.0    | 30.6          | 70,214  | 2,139                  | 650                     | 85                        | 150                        | 23.2  |

This unit can unload down to 30.6% so a degradation calculation will be required but because the stage 1 was already run at the lowest ambient and the ambient for the 25% load point no additional tests are required.

Using this data you can then calculate the standard load points.

| Stage | Ambient | Actual % Load | Net Cap | Cmpr (P <sub>C</sub> ) | Cond (P <sub>CF</sub> )         | Indoor (P <sub>IF</sub> ) | Control (P <sub>CT</sub> ) | EER   | C <sub>D</sub> | LF    |
|-------|---------|---------------|---------|------------------------|---------------------------------|---------------------------|----------------------------|-------|----------------|-------|
|       | (F)     | (Net Cap)     | Btu/h   | W                      | W                               | W                         | W                          | Btu/W |                |       |
| 5     | 95.0    | 100.0         | 229,459 | 17,414                 | 1,300                           | 2,100                     | 200                        | 10.92 |                |       |
| 4     | 85.1    | 81.7          | 187,459 | 11,444                 | 1,300                           | 1,229                     | 150                        | 13.27 |                |       |
| 3     | 74.0    | 61.0          | 140,064 | 6,350                  | 1,300                           | 575                       | 150                        | 16.72 |                |       |
|       |         | 75.0          |         |                        |                                 | interpolation             |                            | 14.39 |                |       |
| 2     | 69.6    | 52.9          | 121,366 | 6,762                  | 650                             | 374                       | 150                        | 15.29 |                |       |
| 1     | 65.0    | 30.6          | 70,214  | 2,139                  | 650                             | 85                        | 150                        | 23.22 |                |       |
|       |         | 50.0          |         |                        |                                 | interpolation             |                            | 16.32 |                |       |
|       |         | 25.0          |         |                        | Adjusted for Cyclic Performance |                           |                            | 22.34 | 1.024          | 0.817 |

With this you can then calculate the IEER:

$$IEER = (0.02 \cdot 10.92) + (0.617 \cdot 14.39) + (0.238 \cdot 16.32) + (0.125 \cdot 22.34) = 15.78$$

**6.3 Tolerances.** To comply with this standard, measured test results shall not be less than 95% of Published Ratings for capacities, EER values, and COP values and not less than 90% of Published Ratings for IEER or IPLV values.

## Section 7. Minimum Data Requirements for Published Ratings

**7.1** *Minimum Data Requirements for Published Ratings.* As a minimum, Published Ratings shall consist of the following information:

- a. For Commercial and Industrial Unitary Air-Conditioning Equipment
  - 1. AHRI Standard Rating Cooling Capacity
  - 2. Energy Efficiency Ratio, EER
  - 3. Integrated Energy Efficiency Ratio, IEER (effective January 1, 2010) or Integrated Part-Load Value, (IPLV) (effective through December 31, 2009)
- b. For Commercial and Industrial Unitary Heat Pump Equipment
  - 1. AHRI Standard Rating Cooling Capacity
  - 2. Energy Efficiency Ratio, EER
  - 3. Integrated Energy Efficiency Ratio, IEER (effective January 1, 2010) or Integrated Part-Load Value, (IPLV) (effective through December 31, 2009)
  - 4. High Temperature Heating Standard Rating Capacity
  - 5. High Temperature Coefficient of Performance
  - 6. Low Temperature Heating Standard Rating Capacity
  - 7. Low Temperature Coefficient of Performance

All claims to ratings within the scope of this standard shall include the statement “Rated in accordance with AHRI Standard 340/360”. All claims to ratings outside the scope of this standard shall include the statement “Outside the scope of AHRI Standard 340/360”. Wherever Application Ratings are published or printed, they shall include a statement of the conditions at which the ratings apply.

**7.2** *Latent Capacity Designation.* The moisture removal designation shall be published in the manufacturer's specifications and literature. The value shall be expressed consistently in either gross or net in one or more of the following forms:

- a. Sensible capacity/total capacity ratio and total capacity
- b. Latent capacity and total capacity
- c. Sensible capacity and total capacity

## Section 8. Operating Requirements

**8.1** *Operating Requirements.* Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment shall comply with the provisions of this section such that any production unit will meet the requirements detailed herein.

**8.2** *Maximum Operating Conditions Test (Cooling and Heating).* Commercial and Industrial Unitary Air-Conditioners and Heat Pump Equipment shall pass the following maximum cooling and heating operating conditions test with an indoor coil airflow rate as determined under 6.1.3.2 (refer to test for equipment with optional air cooling coils in 6.1.3.6).

**8.2.1** *Temperature Conditions.* Temperature conditions shall be maintained as shown in Table 3.

**8.2.2** *Voltages.* Tests shall be run at the minimum and maximum utilization voltages of Voltage Range B as shown in Table 1 of AHRI Standard 110, at the unit's service connection and at rated frequency.

**8.2.3** *Procedure.*

**8.2.3.1** Commercial and Industrial Unitary Air-Conditioners and Heat Pump Equipment shall be operated continuously for one hour at the temperature conditions and voltage(s) specified.

**8.2.3.2** All power to the equipment shall be interrupted for a period sufficient to cause the compressor to stop (not to exceed five seconds) and then be restored.

**8.2.4** *Requirements.*

**8.2.4.1** During both tests, the equipment shall operate without failure of any of its parts.

**8.2.4.2** The unit shall resume continuous operation within one hour of restoration of power and shall then operate continuously for one hour. Operation and resetting of safety devices prior to establishment of continuous operation is permitted.

**8.2.4.3** Units with water-cooled condensers shall be capable of operation under these maximum conditions at a water-pressure drop not to exceed 15 psi [100 kPa] measured across the unit.

**8.2.5** *Maximum Operating Conditions Test for Equipment with Optional Outdoor Cooling Coil.* Commercial and Industrial Unitary Air Conditioning and Heat Pump Equipment which incorporates an outdoor air cooling coil shall use the conditions, voltages, and procedure (8.2 thru 8.2.3) and meet the requirements of 8.2.4 except for the following changes.

- a. Outdoor air set as in 6.1.3.6
- b. Return air temperature conditions shall be 80.0°F [26.7°C] dry-bulb, 67.0°F [19.4°C] wet-bulb
- c. Outdoor air entering outdoor air cooling coil shall be 115°F [46.1°C] dry-bulb and 75.0°F [23.9°C] wet-bulb

**8.3** *Cooling Low Temperature Operation Test.* Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment shall pass the following low-temperature operation test when operating with initial airflow rates as determined in 6.1.3.2, 6.1.3.3, and with controls and dampers set to produce the maximum tendency to frost or ice the indoor coil, provided such settings are not contrary to the manufacturer's instructions to the user.

**8.3.1** *Temperature Conditions.* Temperature conditions shall be maintained as shown in Table 3.

**8.3.2** *Voltage and Frequency.* The test shall be performed at nameplate rated voltage and frequency.

For air-conditioners and heat pumps with dual nameplate voltage ratings, tests shall be performed at the lower of the two voltages.

**8.3.3** *Procedure.* The test shall be continuous with the unit in the cooling cycle for not less than four hours after establishment of the specified temperature conditions. The unit will be permitted to start and stop under control of an automatic limit device, if provided.

**8.3.4** *Requirements.*

**8.3.4.1** During the entire test, the equipment shall operate without damage to the equipment.

**8.3.4.2** During the entire test, the indoor airflow rate shall not drop more than 25% from that specified for the Standard Rating test.

**8.3.4.3** During all phases of the test and during the defrosting period after the completion of the test, all ice or meltage must be caught and removed by the drain provisions.

**8.4** *Insulation Efficiency Test (Cooling) (Not Required for Heating-Only Units)*. Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment shall pass the following insulation efficiency test when operating with airflow rates as determined in 6.1.3.2, 6.1.3.3, and with controls, fans, dampers, and grilles set to produce the maximum tendency to sweat, provided such settings are not contrary to the manufacturer's instructions to the user.

**8.4.1** *Temperature Conditions*. Temperature conditions shall be maintained as shown in Table 3.

**8.4.2** *Procedure*. After establishment of the specified temperature conditions, the unit shall be operated continuously for a period of four hours.

**8.4.3** *Requirements*. During the test, no condensed water shall drop, run, or blow off from the unit casing.

**8.5** *Condensate Disposal Test (Cooling)\* (Not Required for Heating-Only Units)*. Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment which rejects condensate to the condenser air shall pass the following condensate disposal test when operating with airflow rates as determined in 6.1.3.2, 6.1.3.3, and with controls and dampers set to produce condensate at the maximum rate, provided such settings are not contrary to the manufacturer's instructions to the user.

\* This test may be run concurrently with the insulation efficiency test (8.4).

**8.5.1** *Temperature Conditions*. Temperature conditions shall be maintained as shown in Table 3.

**8.5.2** *Procedure*. After establishment of the specified temperature conditions, the equipment shall be started with its condensate collection pan filled to the overflowing point and shall be operated continuously for four hours after the condensate level has reached equilibrium.

**8.5.3** *Requirements*. During the test, there shall be no dripping, running-off, or blowing-off of moisture from the unit casing.

**8.6** *Tolerances*. The conditions for the tests outlined in Section 8 are average values subject to tolerances of  $\pm 1.0^\circ\text{F}$  [ $\pm 0.6^\circ\text{C}$ ] for air wet-bulb and dry-bulb temperatures,  $\pm 0.5^\circ\text{F}$  [ $\pm 0.3^\circ\text{C}$ ] for water temperatures, and  $\pm 1.0\%$  of the readings for specified voltage.

## Section 9. Marking and Nameplate Data

**9.1** *Marking and Nameplate Data*. As a minimum, the nameplate shall display the manufacturer's name, model designation, and electrical characteristics.

Nameplate voltages for 60 Hertz systems shall include one or more of the equipment nameplate voltage ratings shown in Table 1 of AHRI Standard 110. Nameplate voltages for 50 Hertz systems shall include one or more of the utilization voltages shown in Table 1 of IEC Standard 60038.

## Section 10. Conformance Conditions

**10.1** *Conformance*. While conformance with this standard is voluntary, conformance shall not be claimed or implied for products or equipment within the standard's *Purpose* (Section 1) and *Scope* (Section 2) unless such product claims meet all of the requirements of the standard and all of the testing and rating requirements are measured and reported in complete compliance with the standard. Any product that has not met all the requirements of the standard shall not reference, state, or acknowledge the standard in any written, oral, or electronic communication.



## APPENDIX A. REFERENCES – NORMATIVE

**A1** Listed here are all standards, handbooks and other publications essential to the formation and implementation of the standard. All references in this appendix are considered as part of the standard.

**A1.1** AHRI Standard 110-2002 (formerly ARI Standard 110-2002), *Air-Conditioning and Refrigerating Equipment Nameplate Voltages*, 2002, Air-Conditioning, Heating and Refrigeration Institute, 2111 Wilson Boulevard, Suite 500, Arlington, VA 22201, U.S.A.

**A1.2** ANSI/AHRI Standard 210/240-2006 (formerly ARI Standard 210/240-2006), *Unitary Air-Conditioning and Air-Source Heat Pump Equipment*, 2006, Air-Conditioning, Heating and Refrigeration Institute, 2111 Wilson Boulevard, Suite 500, Arlington, VA 22201, U.S.A.

**A1.3** ANSI/ASHRAE Standard 137-1995 (RA 2001), *Methods of Testing for Efficiency of Space-Conditioning/Water-Heating Appliances that include a Desuperheater Water Heater*, 2001, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 1791 Tullie Circle N.E., Atlanta, GA 30329, U.S.A.

**A1.4** ASHRAE Standard 37-2005, *Methods of Testing for Rating Unitary Air-Conditioning and Heat Pump Equipment*, 2005, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 1791 Tullie Circle N.E., Atlanta, GA 30329, U.S.A.

**A1.5** ASHRAE *Terminology of Heating, Ventilation, Air Conditioning & Refrigeration*, Second Edition, 1991, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 1791 Tullie Circle N.E., Atlanta, GA 30329, U.S.A.

**A1.6** IEC Standard 60038, *IEC Standard Voltages*, 2002, International Electrotechnical Commission, 3, rue de Varembe, P.O. Box 131, 1211 Geneva 20, Switzerland.

**A1.7** ISO 13256-1, *Water-source heat pumps – Testing and rating for performance – Part 1: Water-to-air and Brine-to-air heat pumps*, 1998, International Organization for Standardization, Case Postale 56, CH-1211, Geneva 21 Switzerland.

## APPENDIX B. REFERENCES – INFORMATIVE

None

## APPENDIX C. CAPACITY CALCULATION FOR UNITARY EQUIPMENT USING AN OUTDOOR AIR COOLING COIL – NORMATIVE

**C1** *Capacity Calculation for Unitary Equipment Using an Outdoor Air Cooling Coil.*

**C1.1** To determine the capacity of Commercial and Industrial Unitary Air Conditioning and Heat Pump Equipment using an outdoor air cooling coil (Figure C1 for test facility), the following equations shall be used.

$$q_u = \frac{w_{oa}(h_{oa} - h_{sa}) + w_{ra}(h_{ra} - h_{sa})}{1000} \quad \text{C1}$$

where:

- $q_u$  = Net capacity of unit, Btu/h [W]
- $w_{oa}$  = Mass flow rate of outside make-up air, lb/h [kg/s]
- $w_{ra}$  = Mass flow rate of return air, lb/h [kg/s]
- $h_{oa}$  = Enthalpy of outside air, Btu/lb [J/kg] of standard air
- $h_{ra}$  = Enthalpy of return air, Btu/lb [J/kg] of standard air
- $h_{sa}$  = Enthalpy of supply air, Btu/lb [J/kg] of standard air

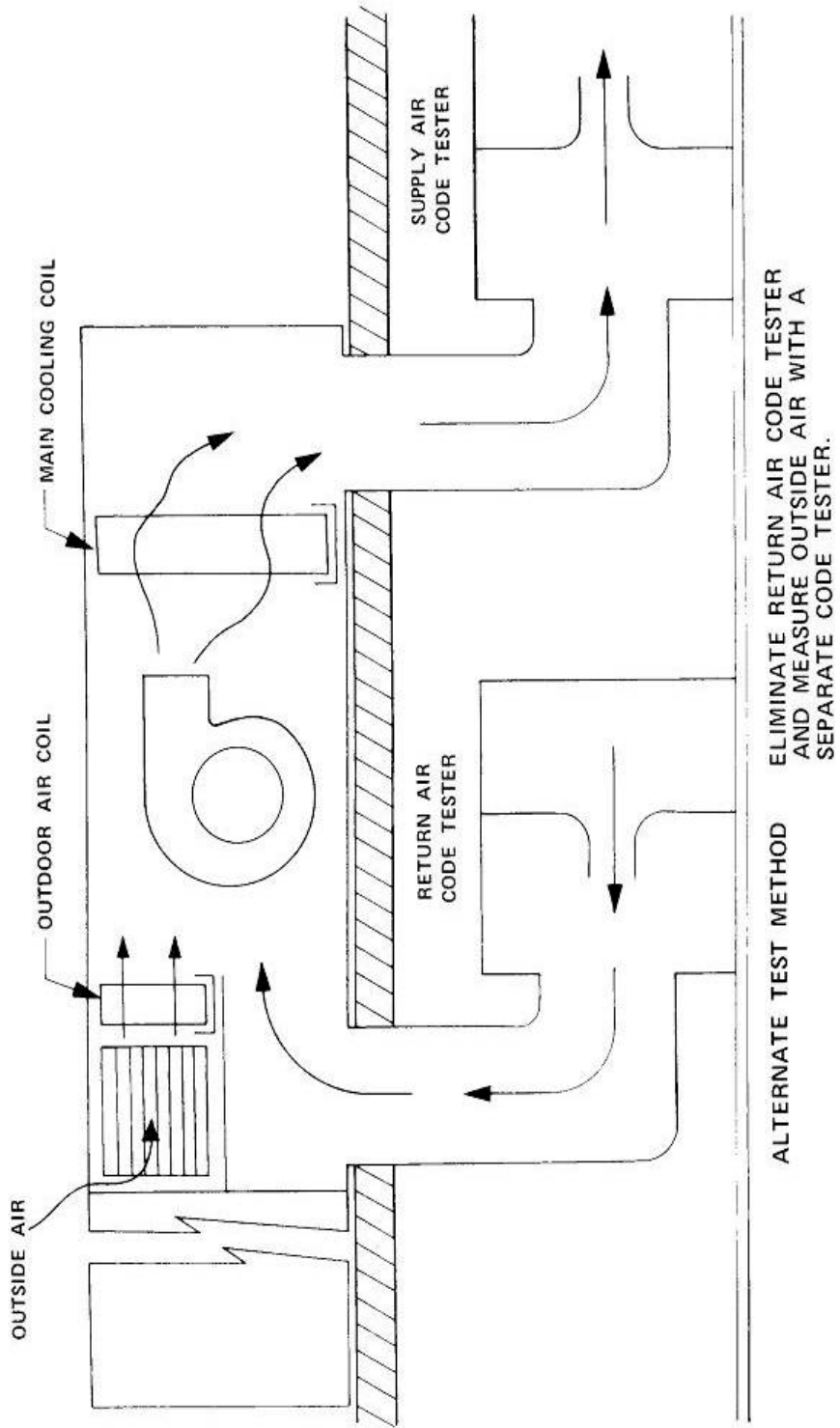


Figure C1. Test Set-Up for Units Using an Outdoor Coil

## APPENDIX D. METHOD AND EXAMPLE OF CALCULATING INTEGRATED PART-LOAD VALUES (IPLV) - NORMATIVE

**D1 Part-Load Rating.** Only systems which are capable of capacity reduction shall be rated at 100% and at each step of capacity reduction provided by the refrigeration system(s) as published by the manufacturer. These rating points shall be used to calculate the IPLV. The controls of the variable air volume units may need to be bypassed so the unit may continue to function and operate at all stages of unloading.

**D1.1 Part-Load Rating Conditions.** Test conditions for part-load ratings shall be per Table 3. Part-load ratings are not required for heating-only heat pumps.

Any water flow required for system function shall be at water flow rates established at (full load) Standard Rating Conditions.

Capacity reduction means may be adjusted to obtain the specified step of unloading. No manual adjustment of indoor and outdoor airflow rates from those of the Standard Rating Conditions shall be made. However, automatic adjustment of outdoor airflow rates by system function is permissible.

**D1.2 Integrated Part-Load Value (IPLV).** For equipment covered by this standard, the IPLV shall be calculated as follows:

- a. Determine the net capacity and EER at the conditions specified in Table 3.
- b. Determine the Part-Load Factor (PLF) from Figure D1, at each rating point.
- c. Use the following equation to calculate IPLV:

$$\begin{aligned} \text{IPLV} = & (\text{PLF}_1 - \text{PLF}_2) \left( \frac{\text{EER}_1 + \text{EER}_2}{2} \right) + (\text{PLF}_2 - \text{PLF}_3) \left( \frac{\text{EER}_2 + \text{EER}_3}{2} \right) \\ & + \dots + (\text{PLF}_{n-1} - \text{PLF}_n) \left( \frac{\text{EER}_{n-1} + \text{EER}_n}{2} \right) + (\text{PLF}_n) (\text{EER}_n) \dots \text{D1} \end{aligned}$$

Where:

PLF = Part-Load Factor determined from Figure D1

n = Total number of capacity steps

Subscript 1 = 100% capacity and EER at part-load rating conditions

Subscript 2, 3, etc. = Specific capacity and EER at part-load steps per D1

**D2 Example Calculation.**

**D2.1** This appendix shows example calculations for determining Integrated Part-Load Values (IPLV).

**D2.2** This appendix is for equipment covered by this standard.

**D2.3** Equation D1 expresses the IPLV general equation and definition of terms.

**D3 Calculation Example for a Four Capacity Step System.**

**D3.1** *Unit Performance Data and Sample Calculation.***D3.1.1** Assume equipment has four capacity steps as follows:

- 1 100% (full load)
- 2 75% of full load
- 3 50% of full load
- 4 25% of full load

**D3.1.2** Obtain Part-Load Factors from Figure D1.**D3.1.3** Obtain EER at each capacity step per D1 of this standard.**D3.1.4** Calculate IPLV using Equation D1:

$$\begin{aligned}n &= 4 \\ \text{PLF}_1 &= 1.0 & \text{EER}_1 &= 8.9 \\ \text{PLF}_2 &= 0.9 & \text{EER}_2 &= 7.7 \\ \text{PLF}_3 &= 0.4 & \text{EER}_3 &= 7.1 \\ \text{PLF}_4 &= 0.1 & \text{EER}_4 &= 5.0\end{aligned}$$

Enter the above values in Equation D1.

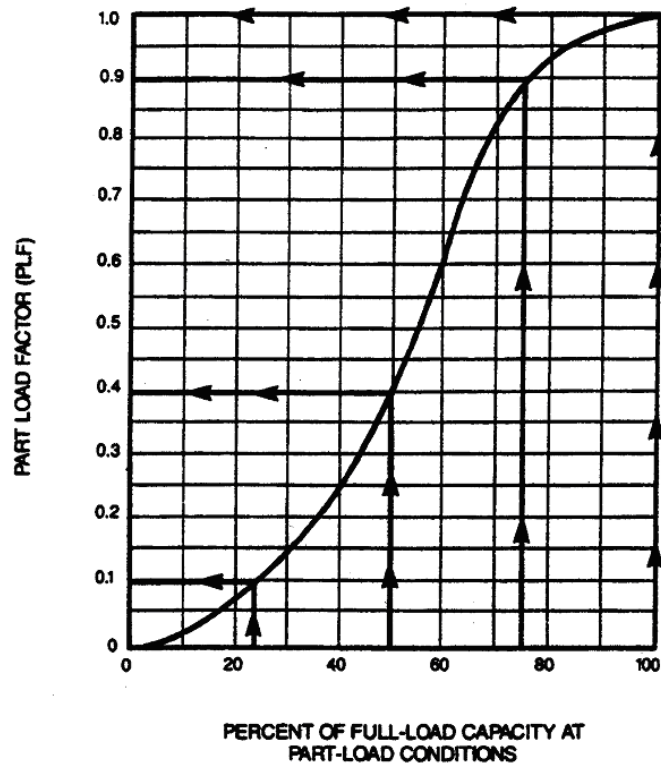
$$\text{IPLV} = (1.0 - 0.9) \left( \frac{8.9 + 7.7}{2} \right) + (0.9 - 0.4) \left( \frac{7.7 + 7.1}{2} \right) + (0.4 - 0.1) \left( \frac{7.1 + 5.0}{2} \right) + 0.1 \times 5.0$$

$$= (0.1 \times 8.3) + (0.5 \times 7.4) + (0.3 \times 6.0) + 0.5$$

$$= 0.83 + 3.70 + 1.80 + 0.5$$

$$\text{IPLV} = 6.8 \text{ (rounded)}$$

To further illustrate the calculation process, refer to the example in Table D1.



Note: The curve is based on following equation:

$$PLF = A0 + (A1 \times Q) + (A2 \times Q^2) + (A3 \times Q^3) + (A4 \times Q^4) + (A5 \times Q^5) + (A6 \times Q^6)$$

where: PLF = Part-Load Factor

Q = Percent of full-load capacity at part-load rating conditions.

$$A0 = -0.12773917 \times 10^{-6}$$

$$A1 = -0.27648713 \times 10^{-3}$$

$$A2 = 0.50672449 \times 10^{-3}$$

$$A3 = -0.25966636 \times 10^{-4}$$

$$A4 = 0.69875354 \times 10^{-6}$$

$$A5 = -0.76859712 \times 10^{-8}$$

$$A6 = 0.28918272 \times 10^{-10}$$

Figure D1. Part-Load Factor Example

| Table D1. Example IPLV Calculation (I-P UNITS) |                               |                  |                     |                    |                   |                        |               |
|------------------------------------------------|-------------------------------|------------------|---------------------|--------------------|-------------------|------------------------|---------------|
| Capacity Step                                  | % Full Load Cap. <sup>2</sup> | PLF <sup>3</sup> | Mfrs. Part-Load EER | Avg. Part-Load EER | PLF Diff.         | Avg. EER x PLF Diff. = | Weighted Avg. |
| 1                                              | 100%                          | 1.0              | 8.92                | = 8.3              | (1.0 - 0.9) = 0.1 | 8.3 x 0.1 =            | 0.83          |
| 2                                              | 75%                           | 0.9              | 7.7                 | = 7.4              | (0.9 - 0.4) = 0.5 | 7.4 x 0.5 =            | 3.70          |
| 3                                              | 50%                           | 0.4              | 7.1                 | = 6.0              | (0.4 - 0.1) = 0.3 | 6.0 x 0.3 =            | 1.80          |
| 4                                              | 25%                           | 0.1              | 5.0                 | = 5.0 <sup>1</sup> | (0.1 - 0.0) = 0.1 | 5.01 x 0.1 =           | <u>0.50</u>   |
|                                                | 0%                            | 0.0              |                     | -----              |                   | Single number IPLV     | 6.83*         |
| *Rounded to 6.8                                |                               |                  |                     |                    |                   |                        |               |

**NOTES:**

<sup>1</sup> For the range between 0% capacity and the last capacity step, use EER of the last capacity step for the average EER.

<sup>2</sup> The 100% capacity and EER are to be determined at the part-load Rating Conditions.

<sup>3</sup> Part-Load Factor from Figure D1.