

# AHRI Standard 700 with Addendum 1

## 2015 Standard for Specifications for Refrigerants



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# AHRI STANDARD 700-2015 WITH ADDENDUM 1, *SPECIFICATIONS FOR REFRIGERANTS*

**September 2015**

Addendum 1 (dated September 2015) of AHRI Standard 700-2015, Specifications for Refrigerants, modifies AHRI Standard 700-2015 as follows. The following changes have been incorporated (additions are shown with shading and the deletions shown with strikethroughs) as well as the addition of refrigerants R-1336mzz(Z), R-449A, R-451A, R-451B, R-452A, R-453A, R-454A, R-454B, and R-513A to the scope of Section 2 and to Table 1A, Table 2A, and Table 3 respectively of AHRI Standard 700-2015. The September 2015 Addendum 1 has been incorporated into the already published 2015 version of AHRI Standard 700 to avoid confusion.

The changes include:

**2.1.1** Single-Component Fluorocarbon Refrigerants: R-11; R-12; R-13; R-22; R-23; R-32; R-113; R-114; R-115; R-116; R-123; R-124; R-125; R-134a; R-141b; R-142b; R-143a; R-152a; R-218; R-227ea; R-236fa; R-245fa; R-1233zd(E); R-1234yf; R-1234ze(E); and ~~R-1336mzz(Z)~~

**2.1.4** Zeotropic Blend Refrigerants: R-401A; R-401B; R-402A; R-402B; R-403A; R-403B; R-404A; R-405A; R-406A; R-407A; R-407B; R-407C; R-407D; R-407E; R-407F; R-408A; R-409A; R-409B; R-410A; R-410B; R-411A; R-411B; R-412A; R-413A; R-414A; R-414B; R-415A; R-415B; R-416A; R-417A; R-417B; R-417C; R-418A; R-419A; R-419B; R-420A; R-421A; R-421B; R-422A; R-422B; R-422C; R-422D; R-422E; R-423A; R-424A; R-425A; R-426A; R-427A; R-428A; R-429A; 430A; R-431A; R-434A; R-435A; R-437A; R-438A; R-439A; R-440A; R-442A; R-444A; R-444B; R-445A; R-446A; R-447A; R-448A; R-449A; R-449B; R-450A; R-451A; R-451B; R-452A; R-453A; R-454A; and R-454B

**2.1.6** Azeotropic Blend Refrigerants: R-500; R-502; R-503; R-507A; R-508A; R-508B; R-509A; R-510A; R-511A; R-512A; and R-513A.

## New refrigerants added:

| Table 1A. Single Component Fluorocarbon Refrigerants and their Allowable Levels of Contaminants                                                                                                                                                                                                                                                                                                                                                                                                |                               |                         |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|-------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Reporting Units               | R-1336mzz(Z)            |
| CHARACTERISTICS:                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                               |                         |
| Boiling Point <sup>1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | °C @ 101.3 kPa                | 33.4                    |
| Boiling Point Range <sup>1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                               | K                             | N/A                     |
| Critical Temperature <sup>1</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                              | °C                            | 171.3                   |
| Isomer Content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | % by weight                   | 0 - 0.1<br>R-1336mzz(E) |
| Isomer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                               |                         |
| VAPOR PHASE CONTAMINANTS:                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                               |                         |
| Air and Other Non-condensables, Maximum                                                                                                                                                                                                                                                                                                                                                                                                                                                        | % by volume @<br>25.0°C       | N/A <sup>2</sup>        |
| LIQUID PHASE CONTAMINANTS:                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                               |                         |
| Water, Maximum                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ppm by weight                 | 20                      |
| All Other Volatile Impurities, Maximum                                                                                                                                                                                                                                                                                                                                                                                                                                                         | % by weight                   | 0.5                     |
| High Boiling Residue, Maximum                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | % by volume or % by<br>weight | 0.01                    |
| Halogenated Unsaturated Volatile Impurities, Maximum                                                                                                                                                                                                                                                                                                                                                                                                                                           | ppm by weight                 | N/A                     |
| Particulates/Solids                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Pass or Fail                  | Visually clean          |
| Acidity, Maximum                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ppm by weight (as<br>HCl)     | 1                       |
| Chloride <sup>3</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Pass or Fail                  | No visible turbidity    |
| Notes:<br>1. Boiling points, boiling point ranges and critical temperatures, although not required, are provided for informational purposes. Refrigerant data compiled from Refprop 9.1.<br>2. Since R-11, R-113, R-123, R-141b, R-245fa, R-1233zd(E), and R-1336mzz(Z) have normal boiling points near or above room temperature, non-condensable determinations are not required for these refrigerants.<br>3. Recognized chloride level for pass/fail is about 3 ppm.<br>N/A Not Applicable |                               |                         |

Table 2A. Zeotropic Blends (400 Series Refrigerants) and their Allowable Levels of Contaminants

|                                                                                                                                                                                                                                                                   | Reporting Units            | R-449B                                     | R-451A                | R-451B                | R-452A                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|--------------------------------------------|-----------------------|-----------------------|--------------------------------|
| <b>CHARACTERISTICS:</b>                                                                                                                                                                                                                                           |                            |                                            |                       |                       |                                |
| Refrigerant Components                                                                                                                                                                                                                                            | N/A                        | R-32/125/1234yf /134a                      | R-1234yf/134a         | R-1234yf/134a         | R-32/125/1234yf                |
| Nominal Comp                                                                                                                                                                                                                                                      | % by weight                | 25.2 / 24.3 / 23.2 / 27.3                  | 89.8 / 10.2           | 88.8 / 11.2           | 11.0 / 59.0 / 30.0             |
| Allowable Comp                                                                                                                                                                                                                                                    | % by weight                | 23.7-25.5 /24.0-25.8 /21.7-23.5 /27.0-28.8 | 89.6-90.0 / 10.0-10.4 | 88.6-89.0 / 11.0-11.4 | 9.3-12.7 /57.2-60.8 /29.0-30.1 |
| Bubble Point                                                                                                                                                                                                                                                      | °C @ 101.3 kPa             | -46.1                                      | -30.8                 | -31.0                 | -47.0                          |
| Dew Point                                                                                                                                                                                                                                                         | °C @ 101.3 kPa             | -40.2                                      | -30.5                 | -30.6                 | -43.2                          |
| Critical Temperature                                                                                                                                                                                                                                              | °C                         | 84.2                                       | 95.4                  | 95.5                  | 74.9                           |
| <b>VAPOR PHASE CONTAMINANTS:</b>                                                                                                                                                                                                                                  |                            |                                            |                       |                       |                                |
| Air and Other Non-condensables                                                                                                                                                                                                                                    | % by volume @ 25.0°C       | 1.5                                        | 1.5                   | 1.5                   | 1.5                            |
| <b>LIQUID PHASE CONTAMINANTS:</b>                                                                                                                                                                                                                                 |                            |                                            |                       |                       |                                |
| Water                                                                                                                                                                                                                                                             | ppm by weight              | 10                                         | 10                    | 10                    | 10                             |
| All Other Volatile Impurities                                                                                                                                                                                                                                     | % by weight                | 0.5                                        | 0.5                   | 0.5                   | 0.5                            |
| High Boiling Residue                                                                                                                                                                                                                                              | % by volume or % by weight | 0.01                                       | 0.01                  | 0.01                  | 0.01                           |
| Particulates/Solids                                                                                                                                                                                                                                               | Pass or Fail               | Visually clean                             | Visually clean        | Visually clean        | Visually clean                 |
| Acidity                                                                                                                                                                                                                                                           | ppm by weight (as HCl)     | 1                                          | 1                     | 1                     | 1                              |
| Chloride                                                                                                                                                                                                                                                          | Pass or Fail               | No visible turbidity                       | No visible turbidity  | No visible turbidity  | No visible turbidity           |
| Notes:<br>1. Bubble points, dew points and critical temperatures, although not required, are provided for informational purposes. Refrigerant data compiled from Refprop 9.1.<br>2. Recognized chloride level for pass/fail is about 3 ppm.<br>N/A Not Applicable |                            |                                            |                       |                       |                                |

| Table 2A. Zeotropic Blends (400 Series Refrigerants) and their Allowable Levels of Contaminants                                                                                                                                                                   |                            |                                                                       |                         |                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-----------------------------------------------------------------------|-------------------------|-------------------------|
|                                                                                                                                                                                                                                                                   | Reporting Units            | R-453A                                                                | R-454A                  | R-454B                  |
| <b>CHARACTERISTICS:</b>                                                                                                                                                                                                                                           |                            |                                                                       |                         |                         |
| Refrigerant Components                                                                                                                                                                                                                                            | N/A                        | R-32/125/134a<br>/227ea/600/601a                                      | R-32/1234yf             | R-32/1234yf             |
| Nominal Composition                                                                                                                                                                                                                                               | % by weight                | 20.0/20.0/53.8<br>/5.0/0.6/0.6                                        | 35.0 / 65.0             | 68.9 / 31.1             |
| Allowable Composition                                                                                                                                                                                                                                             | % by weight                | 19.0-21.0<br>/19.0-21.0<br>/52.8-54.8<br>/4.5-5.5<br>/0.4-0.7/0.4-0.7 | 33.0-37.0<br>/63.0-67.0 | 67.9-69.9<br>/30.1-32.1 |
| Bubble Point <sup>1</sup>                                                                                                                                                                                                                                         | °C @ 101.3 kPa             | -42.2                                                                 | -48.4                   | -50.9                   |
| Dew Point <sup>1</sup>                                                                                                                                                                                                                                            | °C @ 101.3 kPa             | -35.0                                                                 | -41.6                   | -50.0                   |
| Critical Temperature <sup>1</sup>                                                                                                                                                                                                                                 | °C                         | 88.0                                                                  | 86.2                    | 76.5                    |
| <b>VAPOR PHASE CONTAMINANTS:</b>                                                                                                                                                                                                                                  |                            |                                                                       |                         |                         |
| Air and Other Non-condensables, Maximum                                                                                                                                                                                                                           | % by volume @ 25.0°C       | 1.5                                                                   | 1.5                     | 1.5                     |
| <b>LIQUID PHASE CONTAMINANTS:</b>                                                                                                                                                                                                                                 |                            |                                                                       |                         |                         |
| Water, Maximum                                                                                                                                                                                                                                                    | ppm by weight              | 10                                                                    | 10                      | 10                      |
| All Other Volatile Impurities, Maximum                                                                                                                                                                                                                            | % by weight                | 0.5                                                                   | 0.5                     | 0.5                     |
| High Boiling Residue, Maximum                                                                                                                                                                                                                                     | % by volume or % by weight | 0.01                                                                  | 0.01                    | 0.01                    |
| Particulates/Solids                                                                                                                                                                                                                                               | Pass or Fail               | Visually clean                                                        | Visually clean          | Visually clean          |
| Acidity, Maximum                                                                                                                                                                                                                                                  | ppm by weight (as HCl)     | 1                                                                     | 1                       | 1                       |
| Chloride <sup>2</sup>                                                                                                                                                                                                                                             | Pass or Fail               | No visible turbidity                                                  | No visible turbidity    | No visible turbidity    |
| Notes:<br>1. Bubble points, dew points and critical temperatures, although not required, are provided for informational purposes. Refrigerant data compiled from Refprop 9.1.<br>2. Recognized chloride level for pass/fail is about 3 ppm.<br>N/A Not Applicable |                            |                                                                       |                         |                         |

| Table 3. Azeotropic Blends (500 Series Refrigerants) and their Allowable Levels of Contaminants                                                                                                                                                                   |                            |                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|----------------------|
|                                                                                                                                                                                                                                                                   | Reporting Units            | R-513A               |
| <i>CHARACTERISTICS:</i>                                                                                                                                                                                                                                           |                            |                      |
| Refrigerant Components                                                                                                                                                                                                                                            | N/A                        | R-1234yf/134a        |
| Nominal Composition                                                                                                                                                                                                                                               | % by weight                | 56.0/44.0            |
| Allowable Composition                                                                                                                                                                                                                                             | % by weight                | 55.0-57.0/43.0-45.0  |
| Bubble Point <sup>1</sup>                                                                                                                                                                                                                                         | °C @ 101.3 kPa             | -29.2                |
| Dew Point <sup>1</sup>                                                                                                                                                                                                                                            | °C @ 101.3 kPa             | -29.1                |
| Critical Temperature <sup>1</sup>                                                                                                                                                                                                                                 | °C                         | 96.5                 |
| <i>VAPOR PHASE CONTAMINANTS:</i>                                                                                                                                                                                                                                  |                            |                      |
| Air and Other Non-condensables, Maximum                                                                                                                                                                                                                           | % by volume @ 25.0°C       | 1.5                  |
| <i>LIQUID PHASE CONTAMINANTS:</i>                                                                                                                                                                                                                                 |                            |                      |
| Water, Maximum                                                                                                                                                                                                                                                    | ppm by weight              | 10                   |
| All Other Volatile Impurities, Maximum                                                                                                                                                                                                                            | % by weight                | 0.5                  |
| High Boiling Residue, Maximum                                                                                                                                                                                                                                     | % by volume or % by weight | 0.01                 |
| Particulates/Solids                                                                                                                                                                                                                                               | Pass or Fail               | Visually clean       |
| Acidity, Maximum                                                                                                                                                                                                                                                  | ppm by weight (as HCl)     | 1                    |
| Chloride <sup>2</sup>                                                                                                                                                                                                                                             | Pass or Fail               | No visible turbidity |
| Notes:<br>1. Bubble points, dew points and critical temperatures, although not required, are provided for informational purposes. Refrigerant data compiled from Refprop 9.1.<br>2. Recognized chloride level for pass/fail is about 3 ppm.<br>N/A Not Applicable |                            |                      |

## 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 tests conducted under its standards/guidelines will be non-hazardous or free from risk.

Note:

This standard supersedes AHRI Standard 700-2014.

### AHRI CERTIFICATION PROGRAM PROVISIONS

#### **Scope of the Certification Programs**

The Reclaimed Refrigerant and Refrigerant Testing Laboratory Certification Programs are based on this standard. The Reclaimed Refrigerant Certification Program includes purity specifications for reclaimed refrigerants. The Refrigerant Testing Laboratory Certification Program includes verification for refrigerant testing laboratories that perform testing of refrigerants to AHRI Standard 700.

#### **Certified Ratings**

The following ratings are verified by test for the Reclaimed Refrigerant Certification Program:

- a. Water (ppm by weight)
- b. Chloride (pass/fail)
- c. Acidity (ppm by weight)
- d. High boiling residue (% by volume or % by weight)
- e. Particulates/solids (pass/fail)
- f. Air and other non-condensables (% by volume)
- g. All other volatile impurities (% by weight)
- h. Halogenated unsaturated volatile impurities (ppm by weight)

The following contaminants are verified by test for the Refrigerant Testing Laboratory Certification Program:

- a. Water (ppm by weight)
- b. High boiling residue (% by volume or % by weight)
- c. Air and other non-condensables (% by volume)
- d. All other volatile impurities (% by weight)

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# SPECIFICATIONS FOR REFRIGERANTS

## Section 1. Purpose

**1.1 Purpose.** The purpose of this standard is to establish purity specifications, to verify composition, and to specify the associated methods of testing for acceptability of the refrigerants listed in Section 2.1 regardless of source (new, reclaimed and/or repackaged) for use in new and existing refrigeration and air-conditioning products within the scope of AHRI.

**1.1.1 Intent.** This standard is intended for the guidance of the industry including manufacturers, reclaimers, repackagers, distributors, installers, servicemen, contractors and users of fluorocarbon, hydrocarbon and carbon dioxide containing refrigerants.

**1.1.2 Review and Amendment.** This standard is subject to review and amendment as technology advances or as additional data becomes available. This data can be submitted to AHRI for review.

## Section 2. Scope

**2.1 Scope.** This standard specifies acceptable levels of contaminants (purity requirements) for fluorocarbon, hydrocarbon, and carbon dioxide refrigerants regardless of source and lists acceptable test methods. These refrigerants are as referenced in the ANSI/ASHRAE Standard 34 with Addenda:

**2.1.1 Single-Component Fluorocarbon Refrigerants:** R-11; R-12; R-13; R-22; R-23; R-32; R-113; R-114; R-115; R-116; R-123; R-124; R-125; R-134a; R-141b; R-142b; R-143a; R-152a; R-218; R-227ea; R-236fa; R-245fa; R-1233zd(E); R-1234yf; R-1234ze(E); and R-1336mzz(Z)

**2.1.2 Single Component Hydrocarbon Refrigerants:** R-50; R-170; R-E170; R-290; R-600; R-600a; R-601; R-601a; R-610; R-1150; and R-1270

**2.1.3 Carbon Dioxide Refrigerant:** R-744

**2.1.4 Zeotropic Blend Refrigerants:** R-401A; R-401B; R-402A; R-402B; R-403A; R-403B; R-404A; R-405A; R-406A; R-407A; R-407B; R-407C; R-407D; R-407E; R-407F; R-408A; R-409A; R-409B; R-410A; R-410B; R-411A; R-411B; R-412A; R-413A; R-414A; R-414B; R-415A; R-415B; R-416A; R-417A; R-417B; R-417C; R-418A; R-419A; R-419B; R-420A; R-421A; R-421B; R-422A; R-422B; R-422C; R-422D; R-422E; R-423A; R-424A; R-425A; R-426A; R-427A; R-428A; R-429A; 430A; R-431A; R-434A; R-435A; R-437A; R-438A; R-439A; R-440A; R-442A; R-444A; R-444B; R-445A; R-446A; R-447A; R-448A; R-449A; R-449B; R-450A; R-451A; R-451B; R-452A; R-453A; R-454A; and R-454B

**2.1.5 Zeotropic Hydrocarbon Blend Refrigerants:** R-432A; R-433A; R-433B; R-433C; R-436A; R-436B; R-441A; and R-443A

**2.1.6 Azeotropic Blend Refrigerants:** R-500; R-502; R-503; R-507A; R-508A; R-508B; R-509A; R-510A; R-511A; R-512A; and R-513A.

## Section 3. Definitions

All terms in this document will follow the standard industry definitions in the *ASHRAE Terminology* website (<https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology>) unless otherwise defined in this section.

**3.1 “Shall” or “Should”.** “Shall” or “should” shall be interpreted as follows:

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

**3.1.2 Should.** “Should” is used to indicate provisions which are not mandatory but which are desirable as good practice.

## Section 4. Characterization of Refrigerants and Contaminants

**4.1** *Characterization.* Characterization of single component fluorocarbon (Table 1A) and zeotropic/azeotropic blend (Table 2A/3) refrigerants and contaminants are listed in the following general classifications:

- 4.1.1 Isomer content (see Table 1A)
- 4.1.2 Air and other non-condensables (see Tables 1A, 2A, 3)
- 4.1.3 Water (see Tables 1A, 2A, 3)
- 4.1.4 All other volatile impurities (see Tables 1A, 2A, 3)
- 4.1.5 High boiling residue (see Tables 1A, 2A, 3)
- 4.1.6 Halogenated unsaturated volatile impurities (see Table 1A)
- 4.1.7 Particulates/solids (see Tables 1A, 2A, 3)
- 4.1.8 Acidity (see Tables 1A, 2A, 3)
- 4.1.9 Chloride (see Tables 1A, 2A, 3)

**4.2** *Hydrocarbon Characterization.* Characterization of hydrocarbon refrigerants (Tables 1B and 2B) and contaminants are listed in the following general classifications:

- 4.2.1 Nominal composition
- 4.2.2 Other allowable impurities
- 4.2.3 Air and other non-condensables
- 4.2.4 Sulfur odor
- 4.2.5 High boiling residue
- 4.2.6 Particulates/solids
- 4.2.7 Acidity
- 4.2.8 Water
- 4.2.9 All other volatile impurities
- 4.2.10 Total C<sub>3</sub>, C<sub>4</sub> and C<sub>5</sub> polyolefins

**4.3** *Carbon Dioxide Characterization.* Characterization of carbon dioxide (Table 1C) and its contaminants are listed in the following general classifications:

- 4.3.1 Purity
- 4.3.2 Air and other non-condensables
- 4.3.3 Water
- 4.3.4 High boiling residue
- 4.3.5 Particulates/solids

## Section 5. Sampling and Summary of Test Procedures

**5.1** *Referee Test.* The referee test methods for the various contaminants are summarized in the following paragraphs. Detailed test procedures are included in Appendix C to AHRI Standard 700. If alternative test methods are employed, the user shall be able to demonstrate that they produce results at least equivalent to the specified referee test method.

**5.2** *Refrigerant Sampling.*

**5.2.1** *Sampling Precautions.* Special precautions should be taken to ensure that representative samples are obtained for analysis. Sampling shall be done by qualified personnel following accepted sampling and safety procedures. Refrigerants with critical temperatures near or below ambient temperature cannot be reliably sampled for both liquid and vapor phase without special handling.

Note: Flammable refrigerants which are ASHRAE 34 Class 2L, 2 or 3 present additional safety challenges and require additional measures for sampling safety procedures compared to nonflammable halocarbons documented in this standard.