

# AHRI Standard 700 with Addendum 1

## 2017 Standard for Specifications for Refrigerants



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# AHRI STANDARD 700-2017 WITH ADDENDUM 1, *SPECIFICATIONS FOR REFRIGERANTS*

**September 2017**

Addendum 1 (dated September 2017) of AHRI Standard 700-2017, Specifications for Refrigerants, modifies AHRI Standard 700-2017 as follows. The following changes have been incorporated (additions are shown with shading) as well as the addition of refrigerants R-407H, R-461A, R-462A, R-514A, and R-516A to the scope of Section 2 and to Table 2A and Table 3 respectively of AHRI Standard 700-2017. The September 2017 Addendum 1 has been incorporated into the already published 2017 version of AHRI Standard 700 to avoid confusion.

The changes include:

**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-407G; R-407H; 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; R-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-447B; R-448A; R-449A; R-449B; R-449C; R-450A; R-451A; R-451B; R-452A; R-452B; R-452C; R-453A; R-454A; R-454B; R-454C; R-455A; R-456A; R-457A; R-458A; R-459A; R-459B; R-460A; R-460B; R-461A; and R-462A

**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; R-513A; R-513B; R-514A; R-515A; and R-516A.

## 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 700-2017.

### **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)

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-407G; R-407H; 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; R-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-447B; R-448A; R-449A; R-449B; R-449C; R-450A; R-451A; R-451B; R-452A; R-452B; R-452C; R-453A; R-454A; R-454B; R-454C; R-455A; R-456A; R-457A; R-458A; R-459A; R-459B; R-460A; R-460B; R-461A; and R-462A.

**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; R-513A; R-513B; R-514A; R-515A; and R-516A.

### 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** Particulates/solids (see Tables 1A, 2A, 3)
- 4.1.7** Acidity (see Tables 1A, 2A, 3)
- 4.1.8** 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 (see Tables 1B, 2B)
- 4.2.2** Other allowable impurities (see Table 1B)
- 4.2.3** Air and other non-condensables (see Tables 1B, 2B)
- 4.2.4** Sulfur odor (see Tables 1B, 2B)
- 4.2.5** High boiling residue (see Tables 1B, 2B)
- 4.2.6** Particulates/solids (see Tables 1B, 2B)
- 4.2.7** Acidity (see Tables 1B, 2B)
- 4.2.8** Water (see Tables 1B, 2B)
- 4.2.9** All other volatile impurities (see Tables 1B, 2B)
- 4.2.10** Total C<sub>3</sub>, C<sub>4</sub> and C<sub>5</sub> polyolefins (see Tables 1B, 2B)
- 4.2.11** Chloride (see Table 2B)

**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 (see Table 1C)
- 4.3.2** Air and other non-condensables (see Table 1C)
- 4.3.3** Water (see Table 1C)
- 4.3.4** High boiling residue (see Table 1C)
- 4.3.5** Particulates/solids (see Table 1C)

## 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.

**5.2.2 Cylinder Preparation.** Place a clean, empty sample cylinder with the valve open in an oven at 110°C for one hour. Remove it from the oven while hot, immediately connect it to an evacuation system and evacuate it to less than 56 kPa. Close the valve and allow it to cool. Weigh the empty cylinder.

**5.2.3 Vapor Phase Sampling.** A vapor phase sample shall be obtained for determining the non-condensables. The source temperature shall be measured and recorded at the time the sample is taken.

**5.2.3.1 Special Handling for Low Critical Temperature Refrigerant.** A vapor phase sample is required to determine non-condensables and volatile impurities, including other refrigerants. The vapor phase sample is obtained by regulating the sample container temperature to 5 K or more above the refrigerant critical temperature.

**5.2.3.2 Handling for Liquid Refrigerants with Boiling Points Near or Above Room Temperature.** Since R-11, R-113, R-123, R-141b, R-245fa, and R-1233zd(E) have normal boiling points near or above room temperature, non-condensable determination is not required for these refrigerants.

Note: Non-condensable gases, if present, will concentrate in the vapor phase of the refrigerant; care must be exercised to eliminate introduction of either air or liquid phase refrigerant during the sample transfer.

**5.2.4 Liquid Phase Sampling.** A liquid phase sample is required for all tests listed in this standard except the test for non-condensables.

**5.2.4.1 Liquid Sampling.** Accurate analysis requires that the sample cylinder, at ambient temperature, be filled to at least 60% by volume; however, under no circumstances should the cylinder be filled to more than 80% by volume. This can be accomplished by weighing the empty cylinder and then the cylinder with refrigerant. When the desired amount of refrigerant has been collected, close the valve(s) and immediately disconnect the sample cylinder.

Note: Care should be taken to ensure that all connections and transfer lines are dry and evacuated to avoid contaminating the sample.

Note: Low critical temperature refrigerants can have extremely high pressure and the sampling vessel, all connections and transfer lines must be designed to handle high pressures.

**5.2.4.2 Special Handling for Low Critical Temperature Refrigerant.** A liquid phase sample is required for all testing except volatile impurities, including other refrigerants. The liquid phase

sample is obtained by regulating the sample cylinder temperature to 2°C below the critical temperature of the refrigerant.

Note: If free water is present in the sample, cooling to below 0°C may result in the formation of ice. Clathrates may form at temperatures above 0°C with some fluorocarbon refrigerants.

**5.2.4.3 Record Weight.** Check the sample cylinder for leaks and record the gross weight.

**5.3 Refrigerant Identification.** The required method shall be gas chromatography as described in Appendix C with the corresponding gas chromatogram figures as illustrated in Informative Appendix D to AHRI Standard 700. The chromatogram of the sample shall be compared to known standards.

**5.4 Water Content.**

**5.4.1 Method.** The Coulometric Karl Fischer Titration, as described in Appendix C, shall be used for determining the water content of refrigerants. This method can be used for refrigerants that are either a liquid or a gas at room temperature. For all refrigerants, the sample for water analysis shall be taken from the liquid phase of the container to be tested.

**5.4.2 Limits.** The value for water content shall be expressed in parts per million (ppm) by weight and shall not exceed the maximum specified in Tables 1A, 1B, 1C, 2A, 2B and 3.

**5.5 Conductivity.** (*Alternative to chloride and acidity tests*).

**5.5.1 Method.** A refrigerant may be tested for conductivity as an indication of the presence of acids, metal chlorides, and any compound that ionizes in water. This alternative procedure is intended for use with new or reclaimed refrigerants, however, significant amounts of oil can interfere with the test results.

**5.5.2 Limits.** The value for conductivity shall be converted to and expressed in ppm by weight calculated as HCl and shall be compared with the maximum acidity value specified (see in Tables 1A, 1B, 1C, 2A, 2B, and 3). If the conductivity is above this amount, then the chloride and acidity tests shall be conducted. If the conductivity is not greater than this amount, then the chloride and acidity tests may be omitted.

**5.6 Chloride.**

**5.6.1 Method.** The refrigerant shall be tested for chloride as an indication of the presence of hydrochloric acid and/or metal chlorides. The referee procedure is intended for use with new or reclaimed halogenated refrigerants; however, high boiling residue in excess of the amounts in Tables 1A, 1B, 1C, 2A, 2B and 3 can interfere with the test results.

The test method shall be that described in Appendix C to AHRI Standard 700. The test will show noticeable turbidity at chloride levels of about 3 ppm or greater by weight.

**5.6.2 Limits.** The results of the test shall not exhibit any sign of turbidity. Report the results as “pass” or “fail.”

**5.7 Acidity.**

**5.7.1 Method.** The acidity test uses the titration principle to detect any compound that is soluble in water and ionizes as an acid. The test method shall be that described in Appendix C to AHRI Standard 700. This test may not be suitable for determination of high molecular weight organic acids; however, these acids will be found in the high boiling residue test outlined in Section 5.8. The test requires a 50 to 60 gram sample and has a detection limit of 0.1 ppm by weight calculated as HCl.

**5.7.2 Limits.** The value for acidity shall be expressed in ppm by weight as HCl and shall not exceed the limits in Tables 1A, 1B, 2A, 2B and 3.

## 5.8 *High Boiling Residue.*

**5.8.1 Method.** High boiling residue shall be determined by either volume or weight. The volume method measures the residue from a standard volume of refrigerant after evaporation. The gravimetric method is described in Appendix C to AHRI Standard 700. Oils and/or organic acids will be captured by these methods.

**5.8.2 Limits.** The value for high boiling residue shall be expressed as a percentage by volume or weight and shall not exceed the maximum percent specified in Tables 1A, 1B, 1C, 2A, 2B and 3.

## 5.9 *Particulates and Solids.*

**5.9.1 Method.** A measured amount of sample shall be placed in a Goetz bulb under controlled temperature conditions. The particulates/solids shall be determined by visual examination of the Goetz bulb prior to the evaporation of refrigerant. For details of this test method, refer to Part 3 of Appendix C to AHRI Standard 700.

Note: R-744 will partially sublime when measuring a known amount of liquid sample into the Goetz bulb and the solid R-744 will interfere with the visual examination of particulates/solids. Determining the particulates/solids shall be completed by visual examination of the Goetz bulb after the evaporation of the refrigerant.

**5.9.2 Limits.** Visual presence of dirt, rust or other particulate contamination is reported as “fail.”

## 5.10 *Non-condensables.*

**5.10.1 Method.** A vapor phase sample shall be used for determination of non-condensables. Non-condensable gases consist primarily of air accumulated in the vapor phase of refrigerants where the solubility of air in the refrigerant liquid phase is extremely low and air is not significant as a liquid phase contaminant. The presence of non-condensable gases may reflect poor quality control in transferring refrigerants to storage tanks and cylinders.

The test method shall be gas chromatography with a thermal conductivity detector as described in Appendix C to AHRI Standard 700.

**5.10.2 Limits.** The maximum level of non-condensables in the vapor phase of a test sample shall not exceed the maximum at 25.0 °C as shown in Tables 1A, 1B, 1C, 2A, 2B and 3.

## 5.11 *All Other Volatile Impurities and/or Other Refrigerants.*

**5.11.1 Method.** The amount of volatile impurities including other refrigerants in the subject refrigerant shall be determined by gas chromatography as described in Appendix C to AHRI Standard 700.

**5.11.2 Limits.** The test sample shall not contain more than 0.5% by weight of volatile impurities including other refrigerants and unsaturates.

**5.11.2.1 Individual Listed Volatile Impurities.** Tables 1A, 1B, 1C, 2A, 2B and 3 list specific volatile impurities and their maximum allowable concentrations in percent (%) by weight.

**5.11.2.2 R-40 Impurities.** Refrigerant shall contain no more than 300 ppm of R-40.

## 5.12 *Total C<sub>3</sub>, C<sub>4</sub> and C<sub>5</sub> Polyolefins in Hydrocarbon Refrigerants.*

**5.12.1 Method.** The amount of polyolefin impurities in the hydrocarbon shall be determined by gas chromatography as described in GPA STD 2177 - *Natural Gas Liquid Mixtures Containing Nitrogen and Carbon Dioxide*.

**5.12.2 Limits.** The test sample shall not contain more than 0.05 % by weight in the hydrocarbon sample as shown in Tables 1B and 2B. Report the results as “pass” or “fail.”

**5.13 Sulfur Odor in Hydrocarbon Refrigerants.**

**5.13.1 Method.** The amount of sulfur containing compounds or other compounds with an odor shall be determined by ASTM method D1296, *Odor of Volatile Solvents and Diluents*.

**5.13.2 Limits.** The test sample paper shall not emit a residual sulfur odor as shown in Tables 1B and 2B.

## **Section 6. Reporting Procedure**

**6.1 Reporting Procedure.** The source (manufacturer, reclaimer or repackager) of the packaged refrigerant shall be identified. The refrigerant shall be identified by its accepted refrigerant number and/or its chemical name. Maximum allowable levels of contaminants are shown in Tables 1A, 1B, 1C, 2A, 2B and 3. Test results shall be tabulated in a similar manner.

## **Section 7. Conformance Conditions**

**7.1 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 cannot reference, state, or acknowledge conformance to the standard in any written, oral, or electronic communication.