

**2006
STANDARD for**

**SPECIFICATIONS
FOR
FLUOROCARBON
REFRIGERANTS**



Standard 700

IMPORTANT

SAFETY DISCLAIMER

ARI 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.

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

This standard supersedes ARI Standard 700-2004.

ARI CERTIFICATION PROGRAMS 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 ARI 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).
- e. Particulates/Solids (pass/fail).
- f. Non Condensables (% by volume).
- g. Volatile Impurities Including Other Refrigerants (% by volume).

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).
- c. Non Condensables (% by volume).
- d. Volatile Impurities Including Other Refrigerants (% by volume).

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SPECIFICATIONS FOR FLUOROCARBON 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 fluorocarbon refrigerants regardless of source (new, reclaimed and/or repackaged) for use in new and existing refrigeration and air-conditioning products within the scope of ARI.

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 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 ARI for review.

Section 2. Scope

2.1 *Scope.* This standard specifies acceptable levels of contaminants (purity requirements) for fluorocarbon refrigerants (hereinafter referred to as refrigerants) regardless of source and lists acceptable test methods. These refrigerants are: 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-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-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-418A; R-419A; R-420A; R-421A; R-421B; R-422A; R-422B; R-422C; R-422D; R-423A; R-424A; R-425A; R-426A; R-500; R-502; R-503; R-507A; R-508A; R-508B; and R-509A as referenced in the ANSI/ASHRAE Standard 34 with Addenda.

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 *"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 refrigerants and contaminants are listed in the following general classifications:

- a. Water
- b. Chloride
- c. Acidity
- d. High boiling residue
- e. Particulates/solids
- f. Non condensables
- g. Volatile impurities including other refrigerants

Identification of the refrigerant and volatile impurities shall be carried out by gas chromatography (GC).

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 ARI 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.

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. 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. Since R-11, R-113, R-123, R-141b, and R-245fa have normal boiling points near or above room temperature, non condensable determination is not required for these refrigerants.

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.

5.2.4 *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.

5.2.4.2 *Special Handling for Low Critical Temperature Refrigerant.* A liquid phase sample is required for all testing except non condensables and 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.

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 to ARI 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, and 1C.

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, and 1C). 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 refrigerants; however, high boiling residue in excess of the amounts in Tables 1A, 1B, and 1C can interfere with the test results.

The test method shall be that described in Appendix C to ARI 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 ARI 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 5.8. The test requires a 100 to 120 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, and 1C.

5.8 *High Boiling Residue.*

5.8.1 *Method.* High boiling residue shall be determined by measuring the residue from a standard volume of refrigerant after evaporation. Oils and/or organic acids will be captured by this method. An alternative gravimetric method is described in Appendix C to ARI Standard 700.

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

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 ARI Standard 700.

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 ARI 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 23.9 °C as shown in Tables 1A, 1B, and 1C.

5.11 *Volatile Impurities Including 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 ARI Standard 700.

5.11.2 *Limits.* The test sample shall not contain more than 0.5% by weight of volatile impurities including other refrigerants as shown in Tables 1A, 1B, and 1C.

5.11.2.1 *Unsaturated Compound Volatile Impurities.* The test sample of a saturated fluorinated refrigerant shall not contain more than 40 ppm by weight of halogenated unsaturated volatile impurities, unless listed individually in 5.11.2.2.

5.11.2.2 *Individual Listed Volatile Impurities.* Tables 1A, 1B and 1C list specific volatile impurities and their maximum allowable concentrations in ppm by weight.

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, and 1C. 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 the standard in any written, oral, or electronic communication.

Table 1A. Characteristics of Single Component Refrigerants and their Maximum Allowable Levels of Contaminants

	Reporting Units	Reference Section	R-11	R-12	R-13	R-22	R-23	R-32	R-113	R-114
CHARACTERISTICS¹:										
Boiling Point ¹	°C @ 101.3 kPa °F @ 14.70 psia	N/A	23.7 74.7	-29.8 -21.6	-81.50 -114.7	-40.8 -41.5	-82.00 -115.6	-51.7 -61.0	47.60 117.7	3.60 38.5
Boiling Point Range ¹	K °R	N/A	0.3 0.5	0.3 0.5	0.5 0.9	0.3 0.5	0.5 0.9	0.3 0.5	0.3 0.5	0.3 0.5
Critical Temperature ¹	°C °F	N/A	198.0 388.4	112.0 233.6	28.9 84.0	96.20 205.2	26.1 79.0	78.10 172.6	214.1 417.4	145.7 294.3
Isomer Content Isomer	% by weight	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0-1 R-113a	0-30 R-114a
VAPOR PHASE CONTAMINANTS:										
Air and Other Non Condensables	% by volume @ 23.9°C	5.10	N/A ²	1.5	1.5	1.5	1.5	1.5	1.5	N/A ²
LIQUID PHASE CONTAMINANTS:										
Water	ppm by weight	5.4	20	10	10	10	10	10	20	10
All Other Volatile Impurities	% by weight	5.11	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
High Boiling Residue	% by volume	5.8	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Particulates/Solids	Visually clean to pass	5.9	pass	pass	pass	pass	pass	pass	pass	pass
Acidity	ppm by weight (as HCl)	5.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Chloride ³	No visible turbidity	5.6	pass	pass	pass	pass	pass	pass	pass	pass

¹ Boiling points, boiling point ranges and critical temperatures, although not required, are provided for informational purposes.

² Since R-11, R-113, R-123, R-141b, and R-245fa have normal boiling points near or above room temperature, non condensable determinations are not required for these refrigerants.

³ Recognized chloride level for pass/fail is about 3 ppm.

N/A Not Applicable

-- Data Not Available

Refrigerant data compiled from Refprop 7.0.

Table 1A (continued). Characteristics of Single Component Refrigerants and their Maximum Allowable Levels of Contaminants

	Reporting Units	Reference Section	R-115	R-116	R-123	R-124	R-125	R-134a	R-141b
<i>CHARACTERISTICS¹:</i>									
Boiling Point ¹	°C @ 101.3 kPa °F @ 14.70 psia	N/A	-38.9 -38.1	-78.20 -108.8	27.8 82.1	-12.0 10.4	-48.1 -54.6	-26.1 -14.9	32.0 89.6
Boiling Point Range ¹	K °R	N/A	0.3 0.5	0.3 0.5	0.3 0.5	0.3 0.5	0.3 0.5	0.3 0.5	0.3 0.5
Critical Temperature ¹	°C °F	N/A	80.00 176.0	19.9 67.8	183.7 362.7	122.3 252.1	66.00 150.8	101.1 214.0	206.8 404.2
Isomer Content Isomer	% by weight	N/A	N/A	N/A	0-8 R-123a+ R-123b	0-5 R-124a	N/A	0-0.5 R-134	0-0.1ea R-141, R- 141a
<i>VAPOR PHASE CONTAMINANTS:</i>									
Air and Other Non Condensables	% by volume @ 23.9°C	5.10	1.5	1.5	N/A ²	1.5	1.5	1.5	N/A ²
<i>LIQUID PHASE CONTAMINANTS:</i>									
Water	ppm by weight	5.4	10	10	20	10	10	10	100
All Other Volatile Impurities	% by weight	5.11	0.5	0.5	0.5	0.5	0.5	0.5	0.9
High Boiling Residue	% by volume	5.8	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Particulates/Solids	Visually clean to pass	5.9	pass	pass	pass	pass	pass	pass	pass
Acidity	ppm by weight (as HCl)	5.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Chloride ³	No visible turbidity	5.6	pass	pass	pass	pass	pass	pass	pass

¹ Boiling points, boiling point ranges and critical temperatures, although not required, are provided for informational purposes.

² Since R-11, R-113, R-113, R-123, R-141b, and R-245fa have normal boiling points near or above room temperature, non condensable determinations are not required for these refrigerants.

³ Recognized chloride level for pass/fail is about 3 ppm.

N/A Not Applicable

-- Data Not Available

Refrigerant data compiled from Refprop 7.0.

Table 1A (continued). Characteristics of Single Component Refrigerants and their Maximum Allowable Levels of Contaminants

	Reporting Units	Reference Section	R-142b	R-143a	R-152a	R-218	R-227ea	R-236fa	R-245fa
CHARACTERISTICS¹:									
Boiling Point ¹	°C @ 101.3 kPa °F @ 14.70 psia	N/A	-9.20 15.5	-47.2 -53.0	-24.0 -11.2	-36.8 -34.3	-16.5 2.39	-1.40 29.4	14.9 58.8
Boiling Point Range ¹	K °R	N/A	--	0.3 0.5	0.3 0.5	0.3 0.5	--	0.3 0.5	0.3 0.5
Critical Temperature ¹	°C °F	N/A	137.1 278.8	72.70 162.9	113.3 235.9	72.00 161.6	101.7 215.0	124.9 256.8	154.1 309.4
Isomer Content Isomer	% by weight	N/A	0-0.1ea R-142, R-142a	0-0.01 R-143	N/A	--	--	--	0-0.1ea R-245ca, R-245cb, R- 245ea, R-245eb
VAPOR PHASE CONTAMINANTS:									
Air and Other Non Condensables	% by volume @ 23.9°C	5.10	2.0	1.5	1.5	1.5	1.5	1.5	N/A ²
LIQUID PHASE CONTAMINANTS:									
Water	ppm by weight	5.4	15	10	10	10	10	10	20
All Other Volatile Impurities	% by weight	5.11	0.5	0.5	0.5	0.5	0.5	0.5	0.5
High Boiling Residue	% by volume	5.8	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Particulates/Solids	Visually clean to pass	5.9	pass	pass	pass	pass	pass	pass	pass
Acidity	ppm by weight (as HCl)	5.7	3.0	1.0	1.0	1.0	1.0	1.0	1.0
Chloride ³	No visible turbidity	5.6	pass	pass	pass	pass	pass	pass	pass

¹ Boiling points, boiling point ranges and critical temperatures, although not required, are provided for informational purposes.

² Since R-11, R-113, R-123, R-141b, and R-245fa have normal boiling points near or above room temperature, non condensable determinations are not required for these refrigerants.

³ Recognized chloride level for pass/fail is about 3 ppm.

N/A Not Applicable

-- Data Not Available

Refrigerant data compiled from Refprop 7.0.

Table 1B. Characteristics of Zeotropic Blends (400 Series Refrigerants) and their Maximum Allowable Levels of Contaminants

	Reporting Units	Reference Section	R-401A	R-401B	R-402A	R-402B	R-403A	R-403B	R-404A
CHARACTERISTICS¹:									
Refrigerant Components	N/A	N/A	R-22/ 152a/124	R-22/ 152a/124	R-125/ 290/22	R-125/ 290/22	R-290/ 22/218	R-290/ 22/218	R-125/ 143a/134a
Nominal Comp	% by weight	N/A	53/13/34	61/11/28	60.0/2.0/38.0	38.0/2.0/60.0	5/75/20	5/56/39	44/52/4
Allowable Comp	% by weight	N/A	51-55/11.5- 13.5/33-35	59-63/9.5- 11.5/27-29	58.0-62.0/1.0- 2.1/36.0-40.0	36.0-40.0/1.0- 2.1/58.0-62.0	3-5.2/73- 77/18-22	3-5.2/54- 58/37-41	42-46/51- 53/2-6
Bubble Point ¹	°C @ 101.3 kPa °F @ 14.70 psia	N/A	-33.3 -28.0	-34.9 -30.8	-49.0 -56.2	-47.0 -52.6	-47.8 -54.0	-49.2 -56.6	-46.2 -51.2
Dew Point ¹	°C @ 101.3 kPa °F @ 14.70 psia	N/A	-26.4 -15.5	-28.8 -19.8	-46.9 -52.4	-44.7 -48.5	-44.3 -47.7	-46.8 -52.3	-45.5 -49.9
Critical Temperature ¹	°C °F	N/A	105.3 221.5	103.5 218.3	76.00 168.8	83.00 181.4	87.00 188.6	79.70 175.5	72.10 161.8
VAPOR PHASE CONTAMINANTS:									
Air and Other Non Condensables	% by volume @ 23.9°C	5.10	1.5	1.5	1.5	1.5	1.5	1.5	1.5
LIQUID PHASE CONTAMINANTS:									
Water	ppm by weight	5.4	10	10	10	10	10	10	10
All Other Volatile Impurities	% by weight	5.11	0.5	0.5	0.5	0.5	0.5	0.5	0.5
High Boiling Residue	% by volume	5.8	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Particulates/Solids	Visually clean to pass	5.9	pass	pass	pass	pass	pass	pass	pass
Acidity	ppm by weight (as HCl)	5.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Chloride ²	No visible turbidity	5.6	pass	pass	pass	pass	pass	pass	pass

¹ Bubble points, dew points and critical temperatures, although not required, are provided for informational purposes.

² Recognized chloride level for pass/fail is about 3 ppm.

N/A Not Applicable

-- Data Not Available

Refrigerant data compiled from Refprop 7.0.

Table 1B (continued). Characteristics of Zeotropic Blends (400 Series Refrigerants) and their Maximum Allowable Levels of Contaminants

	Reporting Units	Reference Section	R-405A	R-406B	R-407A	R-407B	R-407C	R-407D	R-407E
CHARACTERISTICS¹:									
Refrigerant Components	N/A	N/A	R-22/152a/ 142b/C318	R-22/ 600a/142b	R-32/125/ 134a	R-32/125/ 134a	R-32/125/ 134a	R-32/125/ 134a	R-32/125/ 134a
Nominal Comp	% by weight	N/A	45/7/5.5/42.5	55/4/41	20/40/40	10/70/20	23/25/52	15/15/70	25/15/60
Allowable Comp	% by weight	N/A	43-47/6-8/4.5- 6.5/40.5-44.5	53-57/3-5/ 40-42	18-22/38-42/ 38-42	8-12/68-72/ 18-22	21-25/23- 27/50-54	13-17/13- 17/68-72	23-27/13- 17/58-62
Bubble Point ¹	°C @ 101.3 kPa °F @ 14.70 psia	N/A	-32.9 -27.2	-32.7 -26.9	-45.3 -49.5	-46.8 -52.2	-43.6 -46.5	-39.5 -39.1	-42.9 -45.3
Dew Point ¹	°C @ 101.3 kPa °F @ 14.70 psia	N/A	-24.5 -12.0	-23.5 -10.4	-38.9 -38.0	-42.5 -44.5	-36.6 -33.9	-32.9 -27.2	-35.8 -32.4
Critical Temperature ¹	°C °F	N/A	106.0 222.8	116.5 241.7	82.30 180.1	75.00 167.0	86.00 186.8	91.40 196.5	88.50 191.3
VAPOR PHASE CONTAMINANTS:									
Air and Other Non Condensables	% by volume @ 23.9°C	5.10	1.5	1.5	1.5	1.5	1.5	1.5	1.5
LIQUID PHASE CONTAMINANTS:									
Water	ppm by weight	5.4	10	10	10	10	10	10	10
All Other Volatile Impurities	% by weight	5.11	0.5	0.5	0.5	0.5	0.5	0.5	0.5
High Boiling Residue	% by volume	5.8	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Particulates/Solids	Visually clean to pass	5.9	pass	pass	pass	pass	pass	pass	pass
Acidity	ppm by weight	5.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Chloride ²	No visible turbidity	5.6	pass	pass	pass	pass	pass	pass	pass

¹ Bubble points, dew points and critical temperatures, although not required, are provided for informational purposes.

² Recognized chloride level for pass/fail is about 3 ppm.

N/A Not Applicable

-- Data Not Available

Refrigerant data compiled from Refprop 7.0.

Table 1B (continued). Characteristics of Zeotropic Blends (400 Series Refrigerants) and their Maximum Allowable Levels of Contaminants

	Reporting Units	Reference Section	R-408A	R-409A	R-409B	R-410A	R-410B	R-411A	R-411B
CHARACTERISTICS¹:									
Refrigerant Components	N/A	N/A	R-125/ 143a/22	R-22/ 124/142b	R- 22/124/142b	R-32/125	R-32/125	R-1270/ 22/152a	R-1270/ 22/152a
Nominal Comp	% by weight	N/A	7/46/47	60/25/15	65/25/10	50/50	45/55	1.5/87.5/11.0	3/94/3
Allowable Comp	% by weight	N/A	5-9/45-47/ 45-49	58-62/23- 27/14-16	63-67/23-27/ 9-11	48.5-50.5/ 49.5-51.5	44-46/54-56	0.5-1.5/87.5- 89.5/10-11	2-3/94-96/ 2-3
Bubble Point ¹	°C @ 101.3 kPa °F @ 14.70 psia	N/A	-44.6 -48.2	-34.7 -30.4	-35.6 -32.1	-51.4 -60.6	-51.3 -60.4	-39.5 -39.1	-41.6 -42.8
Dew Point ¹	°C @ 101.3 kPa °F @ 14.70 psia	N/A	-44.1 -47.4	-26.4 -15.5	-27.9 -18.2	-51.4 -60.5	-51.6 -60.2	-36.6 -33.9	-40.0 -40.0
Critical Temperature ¹	°C °F	N/A	83.10 181.6	106.9 224.4	106.9 224.4	71.40 160.5	70.80 159.4	99.10 210.4	96.00 204.8
VAPOR PHASE CONTAMINANTS:									
Air and Other Non Condensables	% by volume @ 23.9°C	5.10	1.5	1.5	1.5	1.5	1.5	1.5	1.5
LIQUID PHASE CONTAMINANTS:									
Water	ppm by weight	5.4	10	10	10	10	10	10	10
All Other Volatile Impurities	% by weight	5.11	0.5	0.5	0.5	0.5	0.5	0.5	0.5
High Boiling Residue	% by volume	5.8	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Particulates/Solids	Visually clean to pass	5.9	pass	pass	pass	pass	pass	pass	pass
Acidity	ppm by weight (as HCl)	5.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Chloride ²	No visible turbidity	5.6	pass	pass	pass	pass	pass	pass	pass

¹ Bubble points, dew points and critical temperatures, although not required, are provided for informational purposes.

² Recognized chloride level for pass/fail is about 3 ppm.

N/A Not Applicable

-- Data Not Available

Refrigerant data compiled from Refprop 7.0.

Table 1B (continued). Characteristics of Zeotropic Blends (400 Series Refrigerants) and their Maximum Allowable Levels of Contaminants										
	Reporting Units	Reference Section	R-412A	R-413A	R-414A	R-414B	R-415A	R-415B	R-416A	
CHARACTERISTICS¹:										
Refrigerant Components	N/A	N/A	R-22/218/ 142b	R-218/ 134a/600a	R-22/124/ 600a/142b	R-22/124/ 600a/142b	R-22/152a	R-22/152a	R-134a/ 124/600	
Nominal Comp	% by weight	N/A	70/5/25	9/88/3	51.0/28.5/ 4.0/16.5	50.0/39.0/ 1.5/9.5	82.0/18.0	25.0/75.0	59.0/39.5/ 1.5	
Allowable Comp	% by weight	N/A	68-72/3- 7/24-26	8-10/86- 90/2-3	49.0-53.0/ 26.5-30.5/ 3.5-4.5/ 15.5-17.0	48.0-52.0/ 37.0-41.0/ 1.0-2.0/ 8.5-10.0	81.0-83.0/ 17.0-19.0	24.0-26.0/ 74.0-76.0	58.0-59.5/ 39.0-40.5/ 1.3-1.6	
Bubble Point ¹	°C @ 101.3 kPa °F @ 14.70 psia	N/A	-38.0 -36.4	-30.6 -23.1	-34.0 -29.2	-32.9 -27.2	-37.5 -35.5	-27.7 -17.8	-23.4 -10.1	
Dew Point ¹	°C @ 101.3 kPa °F @ 14.70 psia	N/A	-28.7 -19.6	-27.9 -18.2	-25.8 -14.4	-24.3 -11.8	-34.7 -30.5	-26.2 -15.2	-21.8 -7.20	
Critical Temperature ¹	°C °F	N/A	107.2 225.0	98.50 209.3	110.7 231.3	111.0 231.8	100.0 212.0	111.3 232.3	108.2 226.8	
VAPOR PHASE CONTAMINANTS:										
Air and Other Non Condensables	% by volume @ 23.9°C	5.10	1.5	1.5	1.5	1.5	1.5	1.5	1.5	
LIQUID PHASE CONTAMINANTS:										
Water	ppm by weight	5.4	10	10	10	10	10	10	10	
All Other Volatile Impurities	% by weight	5.11	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
High Boiling Residue	% by volume	5.8	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
Particulates/Solids	Visually clean to pass	5.9	pass	pass	pass	pass	pass	pass	pass	
Acidity	ppm by weight (as HCl)	5.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
Chloride ²	No visible turbidity	5.6	pass	pass	pass	pass	pass	pass	pass	

¹ Bubble points, dew points and critical temperatures, although not required, are provided for informational purposes.

² Recognized chloride level for pass/fail is about 3 ppm.

N/A Not Applicable

-- Data Not Available

Refrigerant data compiled from Refprop 7.0.

Table 1B (continued). Characteristics of Zeotropic Blends (400 Series Refrigerants) and their Maximum Allowable Levels of Contaminants

	Reporting Units	Reference Section	R-417A	R-418A	R-419A	R-420A	R-421A	R-421B
CHARACTERISTICS¹:								
Refrigerant Components	N/A	N/A	R-125/ 134a/600	R-290/ 22/152a	R-125/134a/ E170	R-134a/ 142b	R-125/134a	R-125/134a
Nominal Comp	% by weight	N/A	46.6/50.0/3.4	1.5/96.0/2.5	77.0/19.0/4.0	88.0/12.0	58.0/42.0	85.0/15.0
Allowable Comp	% by weight	N/A	45.5-47.7/ 49.0-51.0/ 3.0-3.5	1.0-2.0/ 95.0-97.0/ 2.0-3.0	76.0-78.0/ 18.0-20.0/ 3.0-5.0	88.0-89.0/ 11.0-12.0	57.0-59.0/ 41.0-43.0	84.0-86.0/ 14.0-16.0
Bubble Point ¹	°C @ 101.3 kPa °F @ 14.70 psia	N/A	-38.0 -36.4	-41.2 -42.1	-42.6 -44.7	-25.0 -13.0	-40.8 -41.5	-45.7 -50.2
Dew Point ¹	°C @ 101.3 kPa °F @ 14.70 psia	N/A	-32.9 -27.2	-40.1 -40.2	-36.0 -32.8	-24.2 -11.6	-35.5 -31.9	-42.6 -44.6
Critical Temperature	°C °F	N/A	89.90 193.8	96.70 206.1	79.10 174.4	105.4 221.7	78.50 173.3	69.00 156.2
VAPOR PHASE CONTAMINANTS:								
Air and Other Non Condensables	% by volume @ 23.9°C	5.10	1.5	1.5	1.5	1.5	1.5	1.5
LIQUID PHASE CONTAMINANTS:								
Water	ppm by weight	5.4	10	10	20	10	10	10
All Other Volatile Impurities	% by weight	5.11	0.5	0.5	0.5	0.5	0.5	0.5
High Boiling Residue	% by volume	5.8	0.01	0.01	0.01	0.01	0.01	0.01
Particulates/Solids	Visually clean to pass	5.9	pass	pass	pass	pass	pass	pass
Acidity	ppm by weight (as HCl)	5.7	1.0	1.0	1.0	1.0	1.0	1.0
Chloride ²	No visible turbidity	5.6	pass	pass	pass	pass	pass	pass

¹ Bubble points, dew points and critical temperatures, although not required, are provided for informational purposes.

² Recognized chloride level for pass/fail is about 3 ppm.

N/A Not Applicable
-- Data Not Available

Refrigerant data compiled from Refprop 7.0.

Table 1B (continued). Characteristics of Zeotropic Blends (400 Series Refrigerants) and their Maximum Allowable Levels of Contaminants

	Reporting Units	Reference Section	R-422A	R-422B	R-422C	R-422D	R-423A	R-424A	R-425A	R-426A
CHARACTERISTICS¹:										
Refrigerant Components	N/A	N/A	R-125/134a/600a	R-125/134a/600a	R-125/134a/600a	R-125/134a/600a	R-134a/227ea	R-125/134a/600a/601a	R-32/134a/227ea	R-125/134a/600/601a
Nominal Comp	% by weight	N/A	85.1/11.5/3.4	55.0/42.0/3.0	82.0/15.0/3.0	65.1/30.5/3.4	52.5/47.5	50.5/47.0/0.9/1.0/0.6	18.5/69.5/12.0	5.1/93.0/1.3/0.6
Allowable Comp	% by weight	N/A	84.1-86.1/10.5-12.5/3.0-3.5	54.0-56.0/41.0-43.0/2.5-3.1	81.0-83.0/14.0-16.0/2.5-3.1	64.0-66.0/30.5-32.5/3.0-3.5	51.5-53.5/46.5-48.5	49.5-51.5/46.0-48.0/0.7-1.0/0.8-1.1/0.4-0.7	18.0-19.0/69.0-70.0/11.5-12.5	4.1-6.1/92.0-94.0/1.1-1.4/0.4-0.7
Bubble Point ¹	°C @ 101.3 kPa °F @ 14.70 psia	N/A	-46.5 -51.7	-40.5 -40.9	-45.3 -49.5	-43.2 -45.8	-24.2 -11.6	-39.1 38.4	-38.1 -36.6	-28.5 -19.3
Dew Point ¹	°C @ 101.3 kPa °F @ 14.70 psia	N/A	-44.1 -47.4	-35.6 -32.1	-42.3 -44.1	-38.4 -37.1	-23.5 -10.3	-33.3 -27.9	-31.3 -24.3	-26.7 -16.1
Critical Temperature	°C °F	N/A	71.70 161.1	85.70 186.3	76.10 168.9	79.6 175.3	99.00 210.2	87.50 189.5	93.90 201.0	100.2 212.4
VAPOR PHASE CONTAMINANTS:										
Air and Other Non Condensables	% by volume @ 23.9°C	5.10	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
LIQUID PHASE CONTAMINANTS:										
Water	ppm by weight	5.4	10	10	20	10	10	10	10	10
All Other Volatile Impurities	% by weight	5.11	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
High Boiling Residue	% by volume	5.8	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Particulates/Solids	Visually clean to pass	5.9	pass	pass	pass	pass	pass	pass	pass	pass
Acidity	ppm by weight (as HCl)	5.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Chloride ²	No visible turbidity	5.6	pass	pass	pass	pass	pass	pass	pass	pass

¹ Bubble points, dew points and critical temperatures, although not required, are provided for informational purposes.

² Recognized chloride level for pass/fail is about 3 ppm.

N/A Not Applicable

-- Data Not Available

Refrigerant data compiled from Refprop 7.0.

Table 1C. Characteristics of Azeotropic Blends (500 Series Refrigerants) and their Maximum Allowable Levels of Contaminants

	Reporting Units	Reference Section	R-500	R-502	R-503	R-507A	R-508A	R-508B	R-509A
CHARACTERISTICS¹:									
Refrigerant Components	N/A	N/A	R-12/152a	R-22/115	R-23/13	R-125/143a	R-23/116	R-23/116	R-22/218
Nominal Comp	% by weight	N/A	73.8/26.2	48.8/51.2	40.1/59.9	50/50	39/61	46/54	44/56
Allowable Comp	% by weight	N/A	72.8-74.8/ 25.2-27.2	44.8-52.8/ 47.2-55.2	39-41/ 59-61	49.5-51.5/ 48.5-50.5	37-41/ 59-63	44-48/ 52-56	42-46/ 56-60
Bubble Point ¹	°C @ 101.3 kPa °F @ 14.70 psia	N/A	-33.6 -28.5	-45.2 -49.3	-87.80 -126.0	-46.7 -52.1	-87.40 -125.3	-87.00 -124.6	-49.8 -57.6
Dew Point ¹	°C @ 101.3 kPa °F @ 14.70 psia	N/A	-33.6 -28.5	-45.0 -48.9	-87.80 -125.9	-46.7 -52.1	-87.40 -125.3	-87.00 -124.6	-48.1 -54.5
Critical Temperature ¹	°C °F	N/A	102.1 215.8	80.20 176.3	18.4 65.1	70.60 159.1	10.8 51.4	11.8 53.2	68.60 155.5
VAPOR PHASE CONTAMINANTS:									
Air and Other Non Condensables	% by volume @ 23.9°C	5.10	1.5	1.5	1.5	1.5	1.5	1.5	1.5
LIQUID PHASE CONTAMINANTS:									
Water	ppm by weight	5.4	10	10	10	10	10	10	10
All Other Volatile Impurities	% by weight	5.11	0.5	0.5	0.5	0.5	0.5	0.5	0.5
High Boiling Residue	% by volume	5.8	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Particulates/Solids	Visually clean to pass	5.9	pass	pass	pass	pass	pass	pass	pass
Acidity	ppm by weight	5.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Chloride ²	No visible turbidity	5.6	pass	pass	pass	pass	pass	pass	pass

¹ Bubble points, dew points and critical temperatures, although not required, are provided for informational purposes.

² Recognized chloride level for pass/fail is about 3 ppm.

N/A Not Applicable

-- Data Not Available

Refrigerant data compiled from Refprop 7.0.

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 this standard.

A1.1 ANSI/ASHRAE Standard 34-2004 *Designation and Safety Classification of Refrigerants*, 2004, with Addenda, American National Standards Institute/American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 25 West 43rd Street, 4th Floor, New York, New York 10036 U.S.A., 1791 Tullie Circle N.E., Atlanta, GA 30329, U.S.A.

A.1.2 *Appendix C Analytical Procedures for ARI Standard 700-1999, Specification for Fluorocarbon Refrigerants*, Air-Conditioning and Refrigeration Institute, 1999, 4100 N. Fairfax Dr., Suite 200, Arlington, VA 22203; U.S.A.

A.1.3 *ASHRAE Terminology of Heating, Ventilating, Air Conditioning and Refrigeration*, Second Edition, American Society of Heating, Refrigerating and Air-Conditioning Engineers, 1991, 1791 Tullie Circle N.E., Atlanta, GA 30329-2305; U.S.A.

APPENDIX B. REFERENCES - INFORMATIVE

B1 Listed here are standards, handbooks and other publications which may provide useful information and background but are not considered essential. References in this appendix are not considered part of the standard.

B1.1 U.S. Code of Federal Regulations, Title 40, Part 82, *Protection of Stratospheric Ozone*, 2003, Office of the Federal Register, National Archives and Records Administration, 800 North Capitol Street, NW, Washington, DC 20402, U.S.A.