ANSI/AHRI Standard 740

2015 Standard for

Performance Rating of Refrigerant Recovery Equipment and Recovery/Recycling Equipment

Approved American National Standard

ANSI

Approved by ANSI on November 6, 2015

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IMPORTANT

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Note:

This standard supersedes AHRI Standard 740-98.

AHRI CERTIFICATION PROGRAM PROVISIONS

Scope of the Certification Program

The Certification Program includes Recovery, Recovery/Recycling and Recycling Equipment including System Dependent Equipment.

Certified Ratings

The following Certified Ratings are verified by tests at Rating Conditions specified in Section 4:

1. Push/pull Liquid Recovery Rate, kg/min
2. Liquid Recovery Rate, kg/min
3. Vapor Recovery Rate, kg/min
4. High Temperature Vapor Recovery Rate, kg/min
5. Final Recovery Vacuum Level, kPa
6. Recycle Flow Rate, kg/min
7. Refrigerant Loss, kg
8. Residual Trapped Refrigerant, kg
9. Quantity of Refrigerant Processed at Rated Conditions, kg
10. Moisture Content, ppm by wt.
11. Chloride Ions, pass/fail
12. Acid Content, ppm by wt.
13. High Boiling Residue, % by vol.
14. Particulates/solids, pass/fail
15. Non-condensables, % by vol.

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PERFORMANCE RATING OF REFRIGERANT RECOVERY EQUIPMENT AND RECOVERY/RECYCLING EQUIPMENT

Section 1. Purpose

1.1 *Purpose.* The purpose of this standard is to establish for refrigerant Recovery Equipment and Recovery/Recycling Equipment: definitions; test requirements, rating requirements, minimum data requirements for Published Ratings, operating requirements, marking and nameplate data; and conformance conditions. It establishes methods of testing for rating and evaluating the performance of refrigerant Recovery Equipment and Recovery/Recycling Equipment for contaminant or purity levels, capacity, speed, purge loss to minimize emission into the atmosphere of designated refrigerants and to assure that Recovery Equipment and Recovery/Recycling Equipment meets the minimum purity requirements for refrigerants in Section 7.8.

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

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

Section 2. Scope

2.1 *Scope.* This standard applies to equipment for recovering and/or recycling non-flammable (safety Class I), as per ASHRAE Standard 34, single refrigerants, azeotropes, zeotropic blends, and their normal contaminants from refrigerant systems. This standard defines the test apparatus, test gas mixtures, sampling procedures and analytical techniques that will be used to determine the performance of refrigerant Recovery Equipment and Recovery/Recycling Equipment.

2.1.1 Equipment shall be as defined in Sections 3.2.1 and 3.2.2.

2.1.2 Refrigerants used to evaluate equipment within the scope of this standard shall be pure halogenated hydrocarbons, and blends containing halogenated hydrocarbons that are listed in AHRI Standard 700 and either are defined as ozone depleting substances (ODS) under 40 CFR 82.3 or have been designated as acceptable or acceptable with use restrictions by the U.S. EPA Significant New Alternatives Policy (SNAP) program.

Section 3. Definitions

All terms in this document shall follow the standard industry definitions in the current edition of ASHRAE Terminology website (https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology) unless otherwise defined in this section.

3.1 *Clearing Refrigerant.* Procedures used to remove Trapped Refrigerants from the refrigerant Recovery Equipment and Recovery/Recycling Equipment before switching from one refrigerant to another.

3.2 *Equipment Classification.*

3.2.1 *Self-contained Equipment.* Recovery Equipment or Recovery/Recycling Equipment that is capable of refrigerant extraction without the assistance of components contained within an air-conditioning or refrigeration system.

3.2.2 *System Dependent Equipment.* Refrigerant Recovery Equipment, which requires for its operation the assistance of components contained in an air-conditioning or refrigeration system.

3.3 *High Temperature Vapor Recovery Rate.* For equipment within the scope of this standard having at least one designated refrigerant (see Section 8.2) with a boiling point in the range of -50 to +10°C, the rate will be measured for R-22, or the lowest boiling point refrigerant if R-22 is not a designated refrigerant.

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

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

3.5 *Push/Pull Method.* The process of transferring liquid refrigerant from a refrigeration system to a receiving vessel by lowering the pressure in the vessel and raising the pressure in the system, and by connecting a separate line between the system liquid port and the receiving vessel.

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

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

3.7 *Reclaim.* To process used refrigerant to new product specifications. Chemical analysis of the refrigerant shall be required to determine that appropriate specifications are met. The identification of contaminants and required chemical analysis shall be specified by reference to national or international standards for new product specifications.

3.8 *Recover.* To remove refrigerant in any condition from a system and store it in an external container.

3.9 *Recovery Equipment.* Equipment that removes refrigerant in any condition from a system into an external container.

3.10 *Recycle.* To reduce contaminants in used refrigerants by separating oil, removing non-condensables and reducing moisture, acidity and particulate matter to the levels prescribed in Section 7.8.

3.11 *Recovery/Recycling Equipment.* Equipment that recovers refrigerant from a system and recycles the refrigerant, or equipment that only recycles the refrigerant (i.e. "Recycling Equipment").

3.12 *Recycle Flow Rate.* The ratio of the amount of refrigerant processed to the time elapsed in the recycling mode. For equipment within the scope of this standard which uses a separate recycling sequence, the recycle rate does not include the recovery rate. For equipment which does not use a separate recycling sequence, the recycle rate is a rate based solely on the higher of the liquid or vapor recovery rate, as determined by the method used to measure the contaminant levels.

Note: For equipment within the scope of this standard which uses a separate recycling sequence, the recycle rate also does not include elapsed time.

3.13 *Residual Trapped Refrigerant.* Refrigerant remaining in refrigerant Recovery Equipment and Recovery/Recycling Equipment after Clearing Refrigerant.

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

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

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

3.15 *Standard Contaminated Refrigerant Sample.* A mixture of new or reclaimed refrigerant and specified quantities of identified contaminants which constitute the mixture to be processed by the equipment within the scope of this standard under test. These contaminant levels are expected only from severe service conditions.

3.16 *Trapped Refrigerant.* The amount of refrigerant remaining in the refrigerant Recovery Equipment and Recovery/Recycling Equipment after the recovery or recovery/recycling operation before Clearing Refrigerant.

3.17 *Vapor Recovery Rate.* The average rate that refrigerant is withdrawn from the mixing chamber between two pressures as vapor recovery rate is changing depending on the pressure.

Note: The initial condition is vapor only at saturation pressure and temperature at either 24°C or at the boiling point at 100 kPa, whichever is higher. The final pressure condition is 10% of the initial pressure, but not lower than the equipment within the scope of this standard final recovery vacuum and not higher than 100 kPa.

Section 4. Test Requirements

4.1 *Testing Requirements.* All Standard Ratings shall be verified by tests conducted in accordance with the provisions set forth in Appendix C to this standard.

4.1.1 *Equipment.* Equipment shall be tested using all components as recommended by the manufacturer.

4.1.2 *Electrical Conditions.* Tests shall be performed at the electrical characteristics specified on the unit nameplate.

Section 5. Rating Requirements

5.1 *Standard Rating Conditions.* Published Ratings shall include all of the Standard Ratings as shown in Tables 1 and 2, for each refrigerant designated by the manufacturer. The Standard Contaminated Refrigerant Sample shall have the characteristics specified in Table 3, except that Recovery Equipment not rated for any specific contaminant shall be tested with new or reclaimed refrigerant. Testing shall be conducted at an ambient temperature of 24°C ±1°C except high temperature vapor recovery shall be 40°C ±1°C.

Refrigerants have been categorized as shown in Table 4. For the purpose of simplifying performance testing, refrigerant(s) have been selected as representative(s) for performance evaluation within each category. If desired, a manufacturer may substitute the highest pressure refrigerant for the recommended refrigerant(s) for a given category (per Table 4). Performance testing using the representative refrigerant or the highest pressure refrigerant will allow the recovery unit to be certified for multiple individual refrigerants within a chosen category.

5.2 *Tolerances.* Performance related parameters shall be equal to or better than the Published Ratings.

Section 6. Minimum Data Requirements for Published Ratings

6.1 *Minimum Data Requirements for Published Ratings.* As a minimum, Published Ratings shall include all of the Standard Ratings as shown in Tables 1 and 2 for each refrigerant designated by the manufacturer. All claims to rating within the scope of this standard shall include the statement "Rated in accordance with ANSI/AHRI Standard 740." All claims to ratings outside the scope of this standard shall include the statement "Outside the scope of ANSI/AHRI Standard 740."

Table 1. Performance Ratings for Refrigerant Recovery Equipment and Recovery/Recycling Equipment[4,5]

Parameter	Type of Equipment			
	Recovery	Recovery/ Recycling	Recycling	System Dependent Equipment
Push/Pull Liquid Recovery Rate, kg/min	X[1]	X[1]	N/A	N/A
Liquid Refrigerant Recovery Rate, kg/min	X[1]	X[1]	N/A	N/A
Vapor Refrigerant Recovery Rate, kg/min	X[1]	X[1]	N/A	N/A
High Temperature Vapor Recovery Rate, kg/min	X[1]	X[1]	N/A	N/A
Final Recovery Vacuum Level, kPa	X	X	N/A	X
Recycle Flow Rate, kg/min	N/A	X	X	N/A
Refrigerant Loss, kg	X[2]	X	X	X[3]
Residual Trapped Refrigerant, kg	X[3]	X[2]	X[2]	X[2]
Quantity of Refrigerant Processed at Rated Conditions, kg	N/A	X	X	N/A

Notes:
1. For a recovery or recovery/recycling unit, establish a rating for either liquid refrigerant recovery rate or vapor refrigerant recovery rate or both. If rating only one, the other rate shall be indicated by N/A, "not applicable."
2. Mandatory rating if multiple refrigerants, oil separation or non-condensable purge are rated.
3. Mandatory rating for equipment within the scope of this standard tested for multiple refrigerants.
4. "X" denotes mandatory rating or equipment requirements.
5. "N/A" indicates "Not Applicable" for a parameter that does not have a rating.

Table 2. Contaminant Removal Ratings for Refrigerant Recovery Equipment and Recovery/Recycling Equipment[1,2]

Contaminant	Type of Equipment			
	Recovery	Recovery/Recycling	Recycling	System Dependent Equipment
Moisture Content, ppm by weight	N/A	X	X	N/A
Chloride Ions, pass/fail	N/A	X	X	N/A
Acid Content, ppm by weight	N/A	X	X	N/A
High Boiling Residue, % by volume	N/A	X	X	N/A
Particulates/solids, pass/fail	N/A	X	X	N/A
Non-condensables, % by volume	N/A	X	X	N/A

Notes:
1. X denotes Mandatory rating.
2. N/A indicates "Not Applicable."

Table 3. Standard Contaminated Refrigerant Samples[4]

Contaminants	Refrigerant Type															
	R-11	R-12	R-13	R-22	R-23	R-113	R-114	R-123	R-124	R-134a	R-500	R-502	R-503	R-401A	R-401B	R-402A
Moisture Content: ppm by Weight of Pure Refrigerant	100	80	30	200	30	100	85	200	200	200	200	200	30	200	200	200
Particulate Content: ppm by Weight of Pure Refrigerant[1]	80	80	Note[4]	80	Note[4]	80	80	80	80	80	80	80	Note[4]	80	80	80
Acid Content: ppm by Weight of Pure Refrigerant[2]	100	200	Note[4]	100	Note[4]	100	100	100	100	100	200	100	Note[4]	100	100	100
Oil (HBR) Content: % by Weight of Pure Refrigerant	20	5	Note[4]	5	Note[4]	20	20	20	5	5	5	5	Note[4]	5	5	5
Viscosity/Type[3]	300/MO	150/MO	Note[4]	300/MO	Note[4]	300/MO	300/MO	300/MO	150/MO	150/MO	150/MO	150/MO	Note[4]	150/AB	150/AB	150/AB
Non-Condensable Gases (Air Content): % by Volume	Note[4]	3	3	3	3	Note[4]	3	Note[4]	3	3	3	3	3	3	3	3

Notes:
1. Particulate content shall consist of inert materials and shall comply with particulate requirements in Appendix D.
2. Acid consists of 60% oleic acid and 40% hydrochloric acid on a total number basis.
3. POE = Polyoester, AB = Alkylbenzene, MO = Mineral Oil.
4. Not Applicable.

Table 3. Standard Contaminated Refrigerant Samples (Continued)[4]

Contaminants	Refrigerant Type																		
	R-402B	R-404A	R-406A	R-407A	R-407B	R-407C	R-407D	R-408A	R-409A	R-410A	R-410B	R-411A	R-411B	R-417C	R-419B	R-422E	R-445A	R-507	R-508A	R-508B
Moisture Content: ppm by Weight of Pure Refrigerant	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	20	20
Particulate Content: ppm by Weight of Pure Refrigerant[1]	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	Note[4]	Note[4]
Acid Content: ppm by Weight of Pure Refrigerant[2]	100	100	200	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	Note[4]	Note[4]
Oil (HBR) Content: % by Weight of Pure Refrigerant	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	Note[4]	Note[4]
Viscosity/Type[3]	150/ AB	150/ POE	150/ AB	150/ POE	150/ POE	150/ POE	150/ POE	150/ MO	150/ MO	150/ POE	150/ POE	150/ MO	150/ MO	150/ POE	150/ POE	150/ POE	150/ POE	150/ POE	Note[4]	Note[4]
Non-Condensable Gases (Air Content): % by Volume	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Notes:
1. Particulate content shall consist of inert materials and shall comply with particulate requirements in Appendix D.
2. Acid consists of 60% oleic acid and 40% hydrochloric acid on a total number basis.
3. POE = Polyolester, AB = Alkylbenzene, MO = Mineral Oil.
4. Not Applicable.

Table 4. AHRI Categories of Refrigerants			
Category	Example of Refrigerants	Pressure, kPa - Based on REFPROP 9.0	Representative Test Refrigerants (Designated Category Refrigerants)
I	Low Pressure (Below 319.3 kPA at 40.6°C for Liquid Phase Saturation)		
	R-113	79.78	R-11 or R-123
	R-1233zd(E)	117.6	
	R-123	157.3	
	R-11	177.5	
II	Medium Pressure – Low Moisture (319.3 – 827.4 kPA at 40.6°C for Liquid Phase Saturation)		
	R-114	343.8	R-124
	R-124	602.6	
III	Medium Pressure (Above 827.4 – 1172 kPA at 40.6°C for Liquid Phase Saturation)		
	R-12	972.0	R-134a
	R-134a	1032	
	R-406A	1100	
	R-500	1153	
IV	Medium High Pressure (Above 1172 – 1851 kPA at 40.6°C for Liquid Phase Saturation)		
	R-401A	1168 (at equilibrium)	R-22 or R-407C
	R-409A	1198 (at equilibrium)	
	R-417C	1219 (at equilibrium)	
	R-401B	1234 (at equilibrium)	
	R-419B	1397 (at equilibrium)	
	R-411A	1465 (at equilibrium)	
	R-407D	1520 (at equilibrium)	
	R-22	1555	
	R-411B	1560 (at equilibrium)	
	R-422E	1598 (at equilibrium)	
	R-502	1685	
	R-427A	1701 (at equilibrium)	
	R-408A	1724 (at equilibrium)	
	R-407C	1773 (at equilibrium)	
	R-402B	1850 (at equilibrium)	
V	High Pressure (Above 1851 – 2448 kPA at 40.6°C for Liquid Phase Saturation)		
	R-404A	1854 (at equilibrium)	R-410A
	R-407A	1862 (at equilibrium)	
	R-507A	1895	
	R-407B	1956 (at equilibrium)	
	R-402A	1980 (at equilibrium)	
	R-410B	2443 (at equilibrium)	
	R-410A	2459 (at equilibrium)	
VI	Very High Pressure – High Moisture (Above 2448 kPA at 40.6°C for Liquid Phase Saturation)		
	R-13	No output because temperature 40.6°C is greater than its critical temperature	R-508A
	R-23	No output because temp 40.6°C is greater than its critical temperature.	
	R-508A	No output because temperature 40.6°C is greater than its critical temperature.	
	R-503	No output because temperature 40.6°C is greater than its critical temp.	
	R-508B	No output because temperature 40.6°C is greater than its critical temperature.	

Section 7. Operating Requirements

7.1 *Equipment Information.* Equipment within the scope of this standard shall provide operating instructions, necessary maintenance procedures and source information for replacement parts and repair.

7.2 *Filter Replacement for Recycling Equipment.* Equipment within the scope of this standard shall indicate when any filter/drier(s) needs to be replaced. This requirement can be met by use of a moisture transducer and indicator light, by use of a sight glass/moisture indicator or by some measurement of the amount of refrigerant processed such as a flow meter or hour meter. The equipment manufacturer must provide maximum quantity recycled or filter change interval in its written instructions.

7.3 *Purge of Non-condensable*. If non-condensables are purged, equipment within the scope of this standard shall either automatically purge non-condensables or provide an indicating means to guide the purge process. Recycling Equipment must provide purge means.

7.4 *Purge Loss.* The total refrigerant loss due to purging non-condensables, draining oil and Clearing Refrigerant (see Section C7.5) shall be less than 3% (by weight) of total processed refrigerant.

7.5 *Permeation Rate.* High pressure hose assemblies 16 mm nominal and smaller shall not exceed a permeation rate of 3.9 g/cm^2/yr (internal surface) at a temperature of 48.8°C. Hose assemblies which have been UL recognized as having passed ANSI/UL 1963 requirements shall be accepted without testing. See Section C5.1.4.

7.6 *Clearing Trapped Refrigerant.* For equipment within the scope of this standard rated for more than one refrigerant, the manufacturer shall provide a method and instructions which will accomplish connections and clearing within 15 minutes. Special equipment, other than a vacuum pump or manifold gauge set, shall be furnished. The clearing procedure shall not rely upon the storage cylinder below saturated pressure conditions at ambient temperature.

7.7 *Temperature.* Equipment within the scope of this standard shall be evaluated at 24°C with additional limited evaluation at 40°C. Normal operating conditions range from 10°C to 40°C.

7.8 *Purity Requirements*. Recycling Equipment must be capable of bringing the refrigerants to the purity requirements prescribed in Table 5.

Table 5. Maximum Levels of Contaminants Permissible in Refrigerant Processed Through Equipment Advertised as "Recycling" Equipment[1]

Contaminants	Low-pressure (R-11, R-123, R-113)	R-12	All others
Acid Content by weight, ppm	1.0	1.0	1.0
Moisture Content (by wt.), ppm	20	10	20
Non-condensable Gas (by vol.), %	N/A	2.0	2.0
High Boiling Residues (by vol.), %	1.0	0.02	0.02
Chlorides by Silver Nitrate Test	No turbidity	No turbidity	No turbidity
Particulates/solids	Visually clean	Visually clean	Visually clean

Note:
1. 58 FR 28712, May 14, 1993, as amended at 59 FR 42957, Aug. 19, 1994; 68 FR 43807, July 24, 2003; 73 FR 34649, June 18, 2008

7.9 *Exemptions*. Recovery Equipment shall be exempt from Sections 7.2, 7.3 and 7.8.

Section 8. Marking and Nameplate Data

8.1 *Marking and Nameplate Data.* The nameplate shall display the manufacturer's name, model designation, type of equipment, designated refrigerant(s) and electrical characteristics where applicable.

Recommended nameplate voltages for 60 Hertz systems shall include one or more of the equipment nameplate voltages shown in Table 1 of ANSI/AHRI Standard 110. Recommended nameplate voltages for 50 Hertz systems shall include one or more of the utilization voltages shown in Table 1 of IEC Standard Publication 60038.

8.1.1 *Type of Equipment*.

8.1.1.1 Recovery or Recovery/Recycling
8.1.1.2 Self-Contained or System Dependent

8.1.2 *Designated Refrigerants.*

8.1.2.1 *Category(ies).* If rating for all refrigerants within a category.
8.1.2.2 *Refrigerant(s).* If rating for designated individual refrigerants.

8.2 *Data for Designated Refrigerants.* For each refrigerant category designated, the manufacturer shall include all the following that are applicable per Table 1 for all refrigerants per Section C5.1.2.

8.2.1 Push/pull liquid recovery rate, kg/min
8.2.2 Liquid recovery rate, kg/min
8.2.3 Vapor recovery rate, kg/min
8.2.4 High temperature vapor recovery rate, kg/min
8.2.5 Final recovery vacuum level, kPa
8.2.6 Recycle Flow Rate, kg/min
8.2.7 Refrigerant loss, kg
8.2.8 Residual trapped refrigerant, kg
8.2.9 Quantity of refrigerant processed at rated conditions, kg

Section 9. Conformance Conditions

9.1 *Conformance.* While conformance with this standard is voluntary, conformance shall not be claimed or implied for products or equipment within its *Purpose* (Section 1) and *Scope* (Section 2) unless such claims meet all of the requirements of this 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.

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 AHRI Standard 700-2015, *Specifications for Refrigerants*, 2015, Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd., Suite 500, Arlington, Virginia, 22201, U.S.A.

A1.2 ANSI/AHRI Standard 110-2012, *Air-Conditioning, Heating and Refrigerating Equipment Nameplate Voltages*, 2012, Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd., Suite 500, Arlington, VA 22201, U.S.A.

A1.3 ANSI/ASHRAE Standard 34-2013 *Designation and Safety Classification of Refrigerants*, 2013, 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.

A1.4 ANSI/ASHRAE Standard 63.2-1996 (RA 2010) *Method of Testing Liquid-Line Filter Drier Filtration Capability*, 2010, 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.

A1.5 ANSI/UL Standard 1963, *Refrigerant Recovery/Recycling Equipment*, First Edition, 2011, American National Standards Institute/Underwriters Laboratories, Inc., 11 West 42nd Street, New York, New York 10036, U.S.A./333 Pfingsten Road, Northbrook, Illinois, 60062, U.S.A.

A1.6 Appendix C to AHRI Standard 700-2008, *Analytical Procedures for AHRI Standard 700-2014 - Normative*, 2008, Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd., Suite 500, Arlington, Virginia, U.S.A.

A1.7 *ASHRAE Terminology*, https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology, 2014, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA 30329, U.S.A.

A1.8 International Standard IEC 60038, *IEC Standard Voltages*, 2009, International Electrotechnical Commission, 3, rue de Varembe, P.O. Box 131, 1211 Geneva 20, Switzerland.

A1.9 REFPROP Reference Fluid Thermodynamic and Transport Properties NIST Standard Reference Database 23 Version 9.1, 2013, U.S. Department of Commerce, Technology Administration, National Institute of Standards and Technology, Standard Reference Data Program, Gaithersburg, Maryland 20899, U.S.A.

A1.10 U.S. Code of Federal Regulations, Title 40, Part 82, Protection of Stratospheric Ozone, 2013, Office of the Federal Register, National Archives and Records Administration, 800 North Capitol Street, NW, Washington, DC 20402, 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.

None.

APPENDIX C. METHODS OF TESTING FOR PERFORMANCE RATING OF REFRIGERANT RECOVERY EQUIPMENT AND RECOVERY/RECYCLING EQUIPMENT - NORMATIVE

C1 *Purpose.* The purpose of this appendix is to specify methods of testing for rating refrigerant Recovery Equipment and Recovery/Recycling Equipment. Specified are: test apparatus and instrumentation, performance test procedures, sampling and chemical analysis methods, and performance calculations for ratings.

C2 *Scope.* This appendix applies to refrigerant Recovery Equipment and Recovery/Recycling Equipment as defined in Section 3 of this Standard.

C3 *Definitions.* Definitions for this appendix are identical with those in Section 3 of this standard.

C4 *Test Apparatus and Instrumentation.*

C4.1 *General Recommendations.* The recommended test apparatus is described in the following paragraphs. If alternate test apparatus are employed, the user shall be able to demonstrate that they produce results equivalent to the specified reference apparatus.

C4.2 *Self-contained Equipment Test Apparatus.* The apparatus, shown in Figure C1, shall consist of:

C4.2.1 *Mixing Chamber.* A mixing chamber consisting of a tank with a conical-shaped bottom, a bottom port and piping for delivering refrigerant to the equipment within the scope of this standard, various ports and valves for adding refrigerant to the chamber and stirring means for mixing.

C4.2.2 *Filling Storage Cylinder.* The storage cylinder to be filled by the refrigerant transferred shall be cleaned and at the pressure of the recovered refrigerant at the beginning of the test. It will not be filled over 80%, by volume.

C4.2.3 *Vapor Feed.* Vapor refrigerant feed consisting of evaporator, control valves and piping to create a 3.0°C superheat condition at an evaporating temperature of 21°C ± 2°C.

C4.2.4 *Alternative Vapor Feed.* An alternative method for vapor feed shall be to pass the refrigerant through a boiler and then through an automatic pressure regulating valve set at different saturation pressures, moving from saturated pressure at 24°C to final pressure of recovery.

C4.2.5 *Liquid Feed.* Liquid refrigerant feed consisting of control valves, sampling port and piping.

C4.2.6 *Instrumentation.* Instrumentation capable of measuring weight, temperature, pressure and refrigerant loss, as required.

C4.2.7 *Size.* The size of the mixing chamber and filling storage cylinder used during testing shall correspond to the size of the equipment within the scope of this standard being tested per Section C4.2.7.1 or C4.2.7.2:

C4.2.7.1 For equipment within the scope of this standard utilizing nominal 1/4" or 3/8" flare ports and hoses, the mixing chamber shall be 0.09 m^3 and all ports, valves, mixing valves and piping shall be 1/2" or larger, reduced down to the port size of the equipment by fittings at the connection ports of the mixing chamber. The filling storage cylinder used during testing shall be a nominal 50 pound water capacity DOT 4Bx cylinder with 1/4" flare liquid and vapor ports.

C4.2.7.2 For equipment within the scope of this standard utilizing 1/2" or larger flare ports and hoses, the mixing chamber shall be 0.45 m^3 (or nominal 1000 pound water capacity DOT 4Bx cylinder) and

all ports, valves, mixing valves and piping shall be 1-1/2" or larger, reduced down to the port size of the equipment by fittings at the connection ports of the mixing chamber. The filling storage cylinder used during testing shall be a nominal 1000 pound water capacity DOT 4Bx cylinder with liquid and vapor ports, valves and piping sized 3/4" NPT and reduced or increased to the port size of the equipment by fittings at the connection ports of the filling storage cylinder.

C4.3 *System Dependent Equipment Test Apparatus.* This test apparatus is to be used for final recovery vacuum rating of all System Dependent Equipment.

C4.3.1 *Test Setup.* The test apparatus shown in Figure C2 consists of a complete refrigeration system. The manufacturer shall identify the refrigerants to be tested. The test apparatus can be modified to facilitate operation or testing of the System Dependent Equipment if the modifications to the apparatus are specifically described within the manufacturer's literature. A 6.3 mm balance line shall be connected across the test apparatus between the high and low pressure sides, with an isolation valve located at the connection to the compressor high side (see Figure C2). A 6.3 mm access port with a valve core shall be located in the balance line for the purpose of measuring final recovery vacuum at the conclusion of the test.

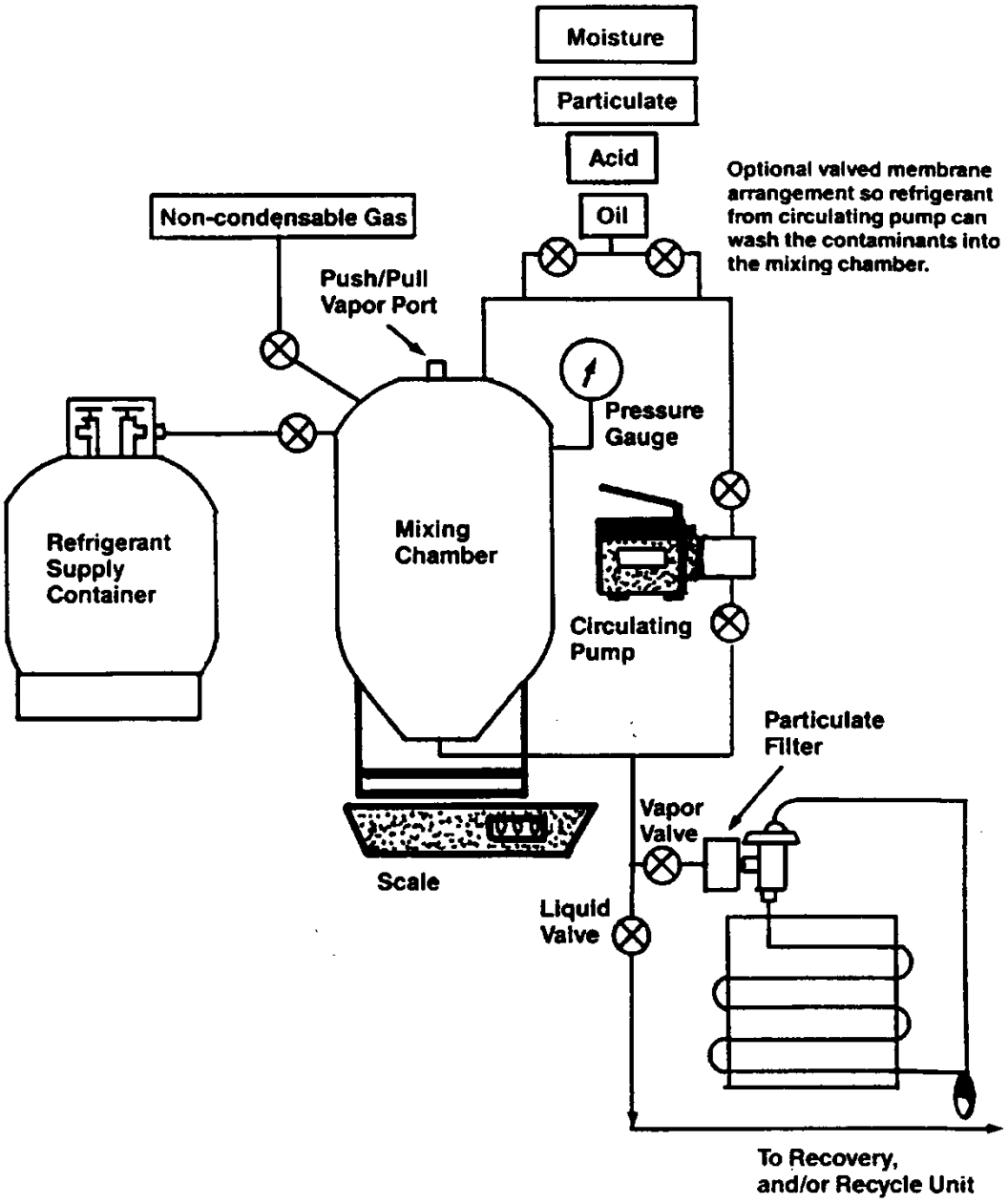

Figure C1. Test Apparatus for Self-contained Equipment

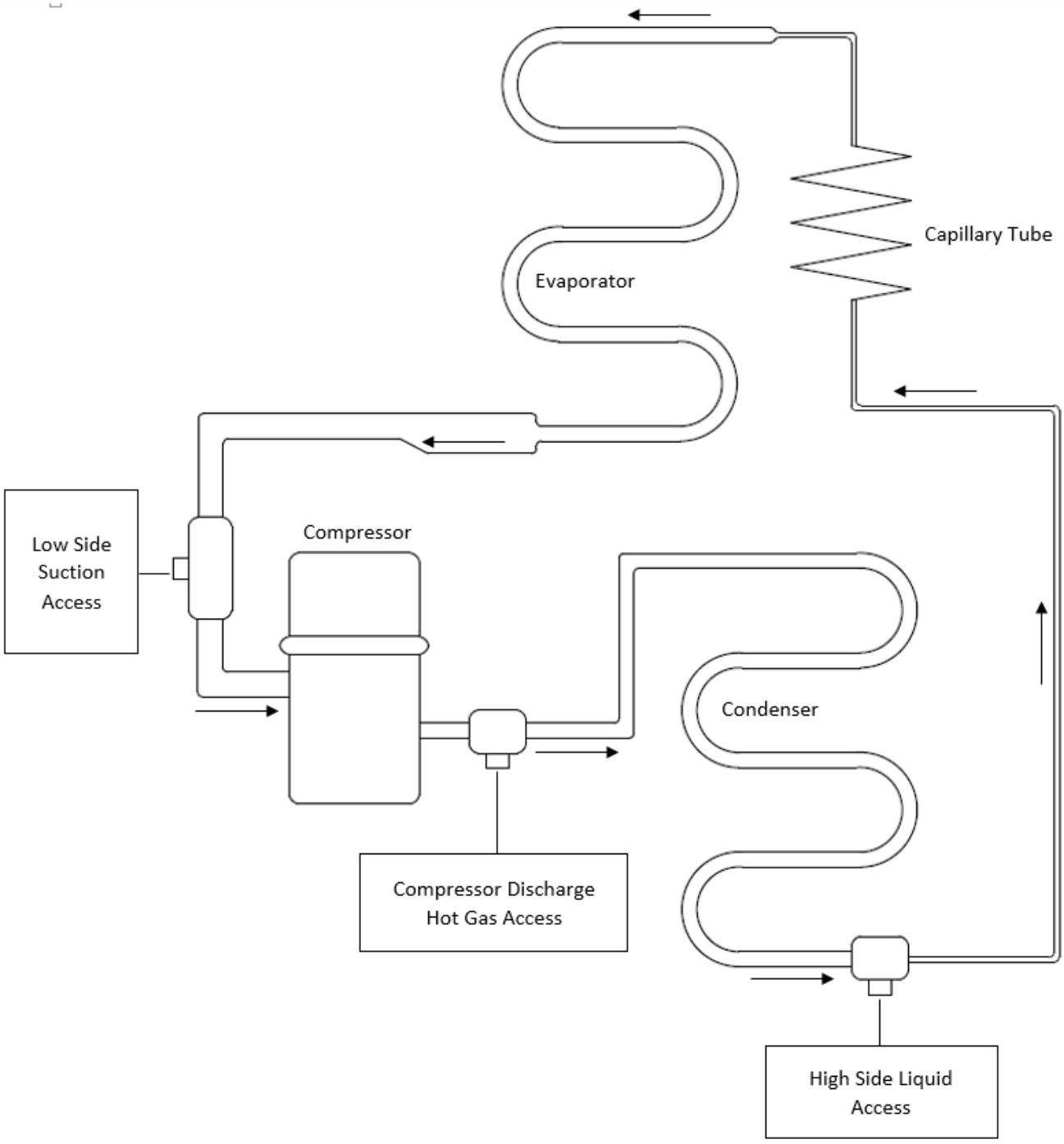

Figure C2. System Dependent Equipment Test Apparatus

C5 *Performance Testing Procedures*.

C5.1 *General Testing.*

C5.1.1 *Temperatures.* Testing shall be conducted at an ambient temperature of 24°C ±1°C except high temperature vapor recovery shall be at 40°C ±1°C. The evaporator conditions of Section C4.2.3 shall be maintained as long as liquid refrigerant remains in the mixing chamber.

C5.1.2 *Refrigerants.* Equipment within the scope of this standard shall be tested for all representative test refrigerants in designated refrigerant categories or designated individual refrigerants. All tests in Section C5 shall be completed for each refrigerant before proceeding with the next refrigerant.

C5.1.2.1 *AHRI Refrigerant Categories.* For purposes of characterized performance, refrigerants have been categorized as shown in Table 4.

C5.1.2.1.1 Representative test refrigerant(s) have been selected within each category for test and rating purposes as shown in Table 4.

C5.1.2.2 *Representative Test Refrigerants*. Representative test refrigerants may be selected for testing and rating to gain certification for the complete refrigerant category as shown in Table 4.

C5.1.2.2.1 Representative test refrigerants other than those designated in the fourth column of Table 4 may be selected for test purposes to form multiple individual refrigerants within a chosen category. If the representative test refrigerant is replacing a normally designated representative test refrigerant per Table 4, then the refrigerant with the highest vapor pressure (at 40°C) within the category is used as the representative test refrigerant.

C5.1.3 *Selected Refrigerants.* An individual non-representative refrigerant may be selected for rating by a manufacturer. The manufacturer may not imply compliance with the category requirements unless tested in accordance with Section C5.1.2.

C5.1.4 *Hose Assemblies.* For the purpose of limiting refrigerant emissions to the atmosphere, hose assemblies shall be tested for permeation according to ANSI/UL Standard 1963.

C5.2 *Equipment Preparation and Operation.* Equipment within the scope of ANSI/AHRI Standard 740 shall be prepared and operated per the operating instructions.

C5.3 *Contaminated Refrigerants.* The Standard Contaminated Refrigerant Sample shall have the characteristics specified in Table 3, except as provided in Section C5.4

C5.4 *Recovery-only Testing.* Recovery Equipment not rated for removal of contaminants shall be tested with new or reclaimed refrigerant.

C5.5 *Test Batch.* The test batch consisting of refrigerant sample (see Section C5.3) of the test refrigerant shall be prepared and thoroughly mixed. Continued mixing or stirring shall be required during the test while liquid refrigerant remains in the mixing chamber. The mixing chamber shall be filled to 80% level by volume.

C5.5.1 *Control Test Batch.* Prior to starting the test for the first batch for each refrigerant, a liquid sample will be drawn from the mixing chamber and analyzed per Section C6 to assure that contaminant levels match Table 3 within ±10 ppm for moisture, ±20 ppm for oleic acid and ±0.5% for oil.

C5.6 *Recovery Tests (Recovery and Recovery/Recycling Equipment).*

C5.6.1 *Determining Recovery Rates.* The Liquid and Vapor Refrigerant Recovery Rates shall be measured during the first test batch for each refrigerant (see Sections C7.1, C7.2, and C7.4). Equipment preparation and recovery cylinder changeover shall not be included in elapsed time measurements for determining Vapor Recovery Rate and Liquid Refrigerant Recovery Rate. Operations such as subcooling the recovery cylinder

shall be included. The recovery cylinder shall be the same size as per Section C4.2.7 or as furnished by the equipment manufacturer. Oversized tanks shall not be permitted.

C5.6.1.1 *Liquid Refrigerant Recovery Rate.* If elected, the recovery rate using the liquid refrigerant feed means (see Section C4.2.5) shall be determined. After the equipment within the scope of this standard reaches stabilized conditions of condensing temperature and/or recovery cylinder pressure, the recovery process shall be stopped and an initial weight shall be taken of the mixing chamber (see Section C7.2). The recovery process shall be continued for a period of time sufficient to achieve the accuracy in Section C7.4. The recovery process shall be stopped and a final weight of the mixing chamber shall be taken.

C5.6.1.2 *Vapor Refrigerant Recovery Rate.* If elected, the average vapor flow rate shall be measured to accuracy requirements in Section C7.4 under conditions with no liquid refrigerant in the mixing chamber. The liquid recovery feed means shall be used. At initial conditions of saturated vapor at the higher of 24°C or the boiling temperature (100 kPa), the weight of the mixing chamber and the pressure shall be recorded. At final conditions representing pressure in the mixing chamber of 10% of the initial condition, but not less than the final recovery vacuum (see Section C7.6) nor more than 100 kPa, measure the weight of the mixing chamber and the elapsed time. At initial conditions, the recovery cylinder shall be at saturation pressure at ambient conditions.

C5.6.1.3 *High Temperature Vapor Recovery Rate.* This is applicable for equipment within the scope of this standard having at least one designated refrigerant (see Section 8.2) with a boiling point between -50°C and +10°C. Measure the rate for R-22, or the refrigerant with the lowest boiling point if R-22 is not a designated refrigerant. Repeat the test in Section C5.6.1.2 at saturated conditions at 40°C and continue to operate equipment to assure it will operate at this condition. (see Section C5.6.3). At initial conditions, the recovery cylinder shall be at saturated pressure at 40°C.

C5.6.1.4 *Push/Pull Liquid Refrigerant Recovery Rate.* If elected, the average liquid push/pull flow rate shall be measured to accuracy requirements in Section C7.4. The mixing chamber and filling storage cylinder shall be filled with refrigerant vapor at initial conditions of saturated vapor at the higher of 24°C or the boiling temperature at 100 kPa. An amount of liquid refrigerant shall be added to the mixing chamber equivalent to 80% by weight of the capacity of the filling storage cylinder. The pressure between the mixing chamber and filling storage cylinder shall be equalized and stabilized at initial conditions of saturated vapor at the higher of 24°C or the boiling temperature at 100 kPa. The initial weight of the mixing chamber and the pressure shall be recorded. The equipment within the scope of this standard is then operated in push/pull recovery mode and the weight change of the mixing chamber is recorded over time until all of the liquid has been transferred.

C5.6.2 *Recovery Operation.* This test is for determining the final recovery vacuum and the ability to remove contaminants as appropriate. If equipment within the scope of this standard is rated for liquid recovery (see Section C5.6.1.3), liquid recovery feed means described in Section C4.2.5 shall be used. If not, vapor recovery means described in Section C4.2.3 or C4.2.4 shall be used. Continue recovery operation until all liquid is removed from the test apparatus and vapor is removed to the point where equipment shuts down by automatic means or is manually shut off per operating instructions.

C5.6.2.1 *Oil Draining.* Capture oil from the equipment within the scope of this standard at intervals as required in the instructions. Record the weight of the container. Completely remove refrigerant from oil by evacuation or other appropriate means. The weight difference shall be used in Section C.5.7.2.

C5.6.3 *Final Recovery Vacuum.* At the end of the first test batch for each refrigerant, the liquid valve and vapor valve of the apparatus shall be closed. After waiting 1 minute, the mixing chamber pressure shall be recorded (see Section C7.6).

C5.6.4 *Residual Refrigerant.* This test will measure the mass of remaining refrigerant in the equipment within the scope of this standard after clearing and therefore the extent of mixing different refrigerants (see Section C7.6).

C5.6.4.1 *Initial Conditions.* At the end of the last test for each batch for each refrigerant, the equipment within the scope of this standard shall be disconnected from the test apparatus (Figure C1). Recycle per Section C5.7, if appropriate. Perform refrigerant clearing operations as called for in the instruction manual. Capture and record the weight of any refrigerant which would have been emitted to the atmosphere during the clearing process for use in Section C7.5. If two loops are used for recycling, Trapped Refrigerant shall be measured for both.

C5.6.4.2 *Residual Trapped Refrigerant.* Evacuate an empty test cylinder to 1.0 kPa. Record the empty weight of the test cylinder. Open all valves to the equipment within the scope of this standard so as to provide access to all Trapped Refrigerant. Connect the equipment to the test cylinder and operate valves to Recover the residual refrigerant. Record the weight of the test cylinder using a recovery cylinder pressure no less than specified in Section C4.2.2. Place the test cylinder in liquid nitrogen for a period of 30 minutes or until a vacuum of 1000 microns is reached, whichever occurs first.

C5.7 *Recycling Tests (Recovery/Recycling Equipment).*

C5.7.1 *Recycling Operation.* As each recovery cylinder is filled in Section C5.6.2, Recycle according to operating instructions. There will not necessarily be a separate recycling sequence. Note non-condensable purge measurement in Section C7.5.

C5.7.1.1 *Recycle Flow Rate.* While recycling the first recovery cylinder for each refrigerant, determine the recycling flow rate by appropriate means (see Section C7.3) to achieve the accuracy required in Section C7.4.

C5.7.2 *Non-condensable Sample.* After completing Section C5.6.3, prepare a second test batch (see Section C5.5). Recover per Section C5.6.2 until the current recovery cylinder is filled to 80% level by volume. Recycle per Section C5.7.1. Mark this cylinder and set aside for taking the vapor sample. For equipment within the scope of this standard having both an internal tank of at least 3 kg refrigerant capacity and an external recovery cylinder, two recovery cylinders shall be marked and set aside. The first is the cylinder described above. The second cylinder is the final recovery cylinder after filling it to 80% level by volume and recycling.

C5.7.2.1 *Push/Pull Liquid Refrigerant Recovery Rate.* This rate shall be measured by weight change of the mixing chamber divided by elapsed time (see Section C5.6.1.4). The units shall be kg/min and the accuracy shall be per Section C7.4.

C5.7.3 *Liquid Sample for Analysis.* Repeat steps in Sections C5.5, C5.6.2, and C5.7.1 with further test batches until indication means in Sections 7.2 show the filter/drier(s) need replacing.

C5.7.3.1 *Multiple Pass.* For equipment within the scope of this standard with a separate recycling circuit (multiple pass), set aside the current cylinder and draw the liquid sample (see C5.6) from the previous cylinder.

C5.7.3.2 *Single Pass.* For equipment within the scope of this standard with the single pass recycling circuit, draw the liquid sample (see C5.6) from the current cylinder.

C5.8 *Measuring Refrigerant Loss.* Refrigerant loss due to non-condensables shall be determined by appropriate means (see Section C7.5.1). The loss could occur in Sections C5.6.1, C5.6.2, and C5.7.1.

C6 *Sampling and Chemical Analysis Methods.*

C.6.1 *Chemical Analysis.* Chemical analysis methods shall be specified in appropriate standards such as AHRI Standard 700, Appendix-C to AHRI Standard 700 and Addendum 700-1 to Appendix C. If alternate test methods are employed, the laboratory must be able to demonstrate that they produce results equivalent to the specified referee method.

C6.1.1 *Moisture Content.* The water content in refrigerant shall be measured by Karl Fischer Coulometric Titration Techniques. Report the moisture level in parts per million by weight.

C6.1.2 *Chloride Ions.* Chloride ions shall be measured by turbidity tests. At this time, quantitative results have not been defined. Report chloride content as "pass" or "fail." In the future, when quantitative results are possible, report chloride content as parts per million by weight.

C6.1.3 *Acid Content.* The acidity test uses the titration principle. Report the acidity in parts per million by weight (mg KOH/kg) of sample.

C6.1.4 *High Boiling Residue.* High boiling residues shall use measurement of the volume of residue after evaporating a standard volume of refrigerant. Using weight measurement and converting to volumetric units is acceptable. Report high boiling residues as percent by volume.

C6.1.5 *Particulates/solids.* The particulates/solids measurement employs visual examination. Report results as "pass" or "fail."

C6.1.6 *Non-condensables.* The level of contamination by non-condensable gases in the base refrigerant being recycled shall be determined by gas chromatography. Report results as percent by volume.

C7 *Performance Calculations for Ratings.*

C7.1 *Vapor Refrigerant Recovery Rate.* This rate is a ratio of the measured weight change of the mixing chamber to the elapsed time (see Section C5.6.1.2). The units shall be kg/min and the accuracy shall be per Section C7.4.

C7.1.1 *High Temperature Vapor Recovery Rate.* This rate is a ratio of the measured weight change of the mixing chamber to the elapsed time (see Section C5.6.1.3). The units shall be kg/min and the accuracy shall be per Section C7.4.

C7.2 *Liquid Refrigerant Recovery Rate.* This rate is a ratio of the measured weight change of the mixing chamber to the elapsed time (see Section C5.6.1.3). The units shall be kg/min and the accuracy shall be per Section C7.4.

C7.3 *Recycle Flow Rate.* The Recycle Flow Rate shall be expressed in kg/min and the accuracy shall be per Section C7.4.

C7.3.1 For equipment within the scope of this standard using multi-pass recycling or a separate sequence, the recycle rate shall be determined by dividing the net weight, W of the refrigerant to be recycled by the actual time T required to Recycle. Any set-up or operator interruptions shall not be included in the time, T.

C7.3.2 If no separate recycling sequence is used, the recycle rate shall be the higher of the vapor refrigerant recovery rate or the liquid refrigerant recovery rate. The recycle rate shall match a process which leads to contaminant levels in C7.9. Specifically, a recovery rate determined from bypassing a contaminant removal device cannot be used as a recycle rate when the contaminant levels in Section C7.9 are determined by passing the refrigerant through the contaminant removal device.

C7.4 *Accuracy of Flow Rates.* The accuracy of test measurements in Sections C7.1, C7.2 and C7.3 shall be ± 0.008 kg/min for flow rates up to 0.42 kg/min and ±2.0% for flow rates larger than 0.42 kg/min. Ratings shall be expressed to the nearest 0.02 kg/min.

C7.5 *Refrigerant Loss.* This calculation will be based upon the net loss of refrigerant which would have been eliminated in the non-condensable purge process (see Section C5.7.1), the oil draining process (see Section C5.6.2.1) and the refrigerant clearing process (see Section C5.6.4.1), all divided by the net refrigerant content of the test batches. The refrigerant loss shall not exceed 3% by weight.

C7.5.1 *Non-condensable Purge.* Evacuate an empty container to 2 kPa. Record the empty weight of the container. Place the container in a dry ice bath. Connect the equipment purge connection to the container and operate purge according to operating instructions so as to capture the non-condensables and lost refrigerant. Weigh the cylinder after the recycling is complete. Equivalent means are permissible.

For units which either Recycle or list non-condensable removal, non-condensable gases are purged, operating the recycle device per the manufacturer’s instructions through an evaporator pressure regulator (EPR) valve

into a liquid nitrogen-chilled cylinder. This combination will simulate the atmosphere while allowing the capture of purge gases. The cylinder is weighed before and after the purge procedure.

C7.5.2 *Oil Draining.* Refrigerant removed from the oil after draining shall be collected and measured in accordance with Section C5.6.2.1.

C7.5.3 *Clearing Unit.* Refrigerant captured during the clearing process shall be measured in accordance with Section C5.6.4.1

C7.6 *Final Recovery Vacuum.* The final recovery vacuum shall be the mixing chamber pressure in Section C5.6.3, expressed in kPa at 24° C. The accuracy of the measurement shall be within 0.33 kPa.

C7.7 *Residual Trapped Refrigerant.* The amount of Residual Trapped Refrigerant shall be the final weight minus the initial weight of the test cylinder in Section C5.6.4.2, expressed in kg. The accuracy shall be ±0.02 kg and reported to the nearest 0.05 kg.

C7.8 *Refrigerant Processed.* The amount of refrigerant processed before changing filters (see Section C5.7.3) shall be expressed in kg to an accuracy of ±1%.

C7.9 *Contaminant Levels.* The contaminant levels remaining after testing shall be published as follows:

C7.9.1 Moisture Content, ppm by weight

C7.9.2 Chloride Ions, pass/fail

C7.9.3 Acid Content, ppm by weight

C7.9.4 High Boiling Residue, % (by volume)

C7.9.5 Particulates/solids, pass/fail (visual examination)

C7.9.6 Non-condensables, % (by volume)

APPENDIX D. PARTICULATE USED IN STANDARD CONTAMINATED REFRIGERANT SAMPLE - NORMATIVE

D1 *Particulate Specification.*

D1.1 The particulate material (pm) will be a blend of 50% coarse air cleaner dust as received, and 50% retained on a 200-mesh screen.

D1.2 *Preparation of Particulate Materials.* To prepare the blend of contaminant per ASHRAE Standard 63.2, first wet screen a quantity of coarse air cleaner dust on a 200-mesh screen (particle retention 74 µm).

This is done by placing a portion of the dust on a 200-mesh screen and running water through the screen while stirring the dust with the fingers. The fine contaminant particles passing through the screen are discarded. The larger than 200-mesh particles collected on the screen are removed and dried for one hour at 110°C. The blend of standard contaminant is prepared by mixing 50% by weight of coarse air cleaner dust as received (after drying for one hour at 110°C) with 50% by weight of the >200-mesh screened dust.

D1.3 *Particle Size Analysis.* The coarse air cleaner dust as received and the blend used as the standard contaminant have the following approximate particle size analysis:

Table D1. Weight Percentage in Various µm Size Ranges for Particle Size Analysis

Size Range, µm	As Received, Wt. %	Blend, Wt. %
0-5	12	6
5-10	12	6
10-20	14	7
20-40	23	11
40-80	30	32
80-200	9	38