BSR/ASHRAE Standard 15.2P

Public Review Draft

Safety Standard for Refrigeration Systems in Residential Applications

First Public Review (May 2020)
(Draft Shows Complete Proposed Standard)

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FOREWORD

This proposed standard is the "residential" companion to the existing ANSI/ASHRAE Standard 15, Safety Standard for Refrigeration Systems. As the title implies, this standard is focused for residential applications. SSPC 15 and the Standard 15.2 subcommittee notes the following aspects of the proposed standard. Historically, residential HVAC systems have not been subjected to as rigorous application safety requirements as commercial HVAC systems related to accidental refrigerant release primarily due to: a) only refrigerants classified as A1 by ASHRAE Standard 34 have been permitted by product safety standards such as UL 1995 and UL 60335-2-40 and b) acute toxicity exposure limit (ATEL) limits of the pertinent refrigerants in residential applications would typically not be exceeded in the event of a catastrophic leak. The current movement towards refrigerants having lower global warming potential (GWP) – many of which are classified as A2L by ASHRAE 34 – has resulted in the need for an application safety standard on which building codes could rely. The primary objective of this proposed Standard 15.2 is to craft a stakeholder document that can be utilized to seek changes in the model building codes. It is the intention that this standard can be understood and applied by manufacturers, installers, contractors, service technicians, building code officials and any other stakeholder.

North American product safety standards for residential products have been modified to address flammable refrigerants. UL/CSA 60335-2-40 3rd edition was released in December of 2019. This proposed ASHRAE application safety standard was developed in parallel and is more conservative than the UL standard in several places and never less conservative.

The following is a summary of the contents in the key sections.

1/2. PURPOSE/SCOPE

This limits the application to listed, fixed, direct systems in residential applications with details of the building types that are included

3. ADMINISTRATIVE

Outlines standard approach to conflicts with local codes and recognizes authority of AHJ's.

5. GENERAL REQUIREMENTS

Here the standard explicitly limits coverage to only the equipment listed to UL 60335 2-40, "Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers". This eliminates built in refrigerators, wine coolers, ice makers, and other similar appliances. It also requires field installed accessories to be listed, identifies the standards that ductwork need to meet, and what additional markings are needed after installation. It does not specify the nameplate as that is explicitly covered by the UL standard.

6. REFRIGERANT CLASSIFICATION AND REQUIREMENTS

The section limits refrigerants to A1's and A2L's giving the typical requirements for purity, recycling, recovering and reclaiming. It prohibits mixing refrigerants with different designations and prohibits converting the refrigerant to one in a different safety group than was used originally. No ammonium systems are covered by this standard.

7. LOCATION OF REFRIGERATION SYSTEMS AND RESTRICTIONS

This section provides basic information on placement of indoor and outdoor equipment.

8. PIPING REQUIREMENTS

This section gives explicit requirements on interconnecting piping; materials, joining, routing, protecting, and testing with pressure and vacuum. Extra requirements for piping with A2L's are also provided.

9. MAXIMUM REFRIGERANT CHARGE

This section provides the methods to determine the dispersal volume and a set of tables that makes the determination of allowable charge level for the dispersal volume easy to do without needing to use equations. This is done using a "worst case" refrigerant density based on known A2L's. This provides a bit more conservative installation than would

result if the equations were used, but the option to use the equations is given in Section 13. The values in the tables follow the equations provided in UL 60335 2-40 with some exceptions:

- *The maximum charge in any single system is limited to* m^2
- *The amount of ventilation allowed to keep a space < 25% LFL is limited to 200 cfm*
- *To allow an adjacent space to be included in the volume calculation there can be no doors that can be closed between the spaces unless there is a transfer fan.*

10. SYSTEM INSTALLATION

This section provides requirements for piping safeguards (referring to section 8), access, and for following the manufacturer's installation instructions.

11. MECHANICAL VENTILATION

This section provides requirements for mechanical ventilation including use of detection systems, what to do with airflow control devices and emergency control devices.

12. ADD-ON HEAT PUMPS

This covers what are commonly called furnace coils which are the indoor coils of air conditioning systems that use the furnace blower for air flow. The requirements in this section call for integral detector(s), appropriate interconnecting wiring, appropriate airflow in the case of a leak, the maximum inductive load of the indoor blower, and testing for proper operation after installation.

13. REFRIGERANT CHARGE CALCULATION METHOD FOR A2L REFRIGERANTS

This section provides the equations and methodology for calculating the maximum allowable charge of a system which can be followed instead of using the tables in section 9.

14. MAXIMUM INDUCTIVE ELECTRICAL LOAD FOR ADD-ON HEAT PUMPS

The switched electrical load (inductive load) for the indoor blower sections that coils are added on to is limited to prevented possible ignition of an A2L leak when the blower is turned on the mitigate. This section gives the equations for calculating that load. Section provided the level when R32 is used which is the lowest of the A2L's currently being considered.

INFORMATIVE APPENDIX B—GENERAL SERVICE AND MAINTENANCE

1. PURPOSE

This standard specifies the minimum requirements for the safe design and installation of *refrigeration systems* used in residential applications.

2. SCOPE*

2.1 This standard applies to *listed direct refrigeration systems* in the following residential applications that are limited to serving only a single *dwelling unit* or *sleeping unit*:

a. one- and two-family *dwellings* and townhouses;

b. detached outbuildings associated with a one- or two-family *dwelling* or townhouse and located on the same property included in a) above, and

c. individual *dwelling units* and *sleeping units* located in a multi-family occupancy.

3. ADMINISTRATIVE

3.1 Precedence with Conflicting Requirements. Where there is a conflict between this standard and local building, electrical, fire, mechanical, or other adopted codes, the provisions of the local or adopted code *shall* take precedence, unless otherwise stated in those codes.

3.2 Alternative Materials, Methods, *Equipment*, and *Appliances*. The provisions of this standard are not intended to prevent the installation of any material or to prohibit any method of construction not specifically prescribed by this standard, provided that any alternative is *approved* by the *authority having jurisdiction*.

3.3 Nothing in this standard *shall* be construed as a restriction on new technologies or alternative methods, provided that the level of safety as herein described is not reduced and is acceptable to the *authority having jurisdiction*.

4. DEFINITIONS

access (to): that which enables a device, appliance, or equipment to be reached by *ready access* or by a means that first requires the removal or movement of a panel, door, or similar obstruction.

****add-on heat pump:*** a *refrigeration system* for heating and cooling, cooling only, or heating only that normally consists of an *outdoor section*, one or more *indoor sections* (without a circulating fan), and related control devices.

air conditioner: a *refrigeration system* used to transfer heat from a *space* or substance.

appliance: *equipment*, generally other than industrial, that is normally built in standardized sizes or types and is installed or connected to perform one or more functions such as clothes washing, air-conditioning, food mixing, deep frying, and so forth.

approved: acceptable to the *authority having jurisdiction*.

authority having jurisdiction (AHJ): an organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving *equipment*, materials, an installation, or a procedure.

attic: the unfinished *space* between the ceiling assembly and the roof assembly.

blends: *refrigerants* consisting of mixtures of two or more different chemical compounds that are often used individually as *refrigerants* for other applications.

brazed joint: a gas-tight joint obtained by the joining of metal parts with metallic mixtures or alloys that melt at temperatures above 842°F (450°C) but less than the melting temperatures of the joined parts.

circulation: mechanically inducing airflow movement within a *space* or *duct* connected *spaces*.

compressor: a machine used to compress *refrigerant* vapor.

conditioned floor area: the horizontal projection of the floors associated with the *conditioned space*.

conditioned air: air that has been heated, cooled, humidified, or dehumidified.

conditioned space: an area, room, or *space* that is enclosed within the building thermal envelope that is directly or indirectly heated or cooled. *Spaces* are indirectly heated or cooled where they communicate through openings with *conditioned spaces*, where they are separated from *conditioned spaces* by uninsulated walls, floors, or ceilings, or where they contain uninsulated *ducts*, *tubing*, or other sources of heating or cooling.

crawl space: an uninhabitable *space* between the bottom of the floor joists and the earth under a *dwelling* to which service personnel have *access*.

design pressure: the maximum gage pressure for which a specific part of a *refrigeration system* is designed.

direct (refrigeration) system: a refrigeration system in which the evaporator or condenser of the refrigeration system is in direct contact with the air or other substances to be cooled or heated.

dispersal volume: the cubic measure of space into which *refrigerant* flows in the event of a *refrigerant* leak.

duct: a tube or conduit used to convey or encase. ***Informative Note:*** *Ductwork* and *duct* system may be used interchangeably with *duct*.

air duct: a tube or conduit used to convey air. (Air passages in *self-contained systems* are not *air ducts*).

pipe duct: a tube or conduit used to encase pipe or *tubing*.

ducted HVAC: an *air conditioner*, *heat pump*, *whole house dehumidifier*, or *whole house dehumidifying ventilator* in which *conditioned air* is distributed through any amount of *ductwork*.

ductless HVAC: an *air conditioner*, *heat pump* in which *conditioned air* is distributed directly into the *conditioned space* from the *equipment* without the use of *ductwork*.

dwelling: any building that contains one or two *dwelling units* used, intended, or designed to be built, used, rented, leased, or otherwise occupied for living purposes.

dwelling, multi-family: a building that contains three or more *dwelling units*.

dwelling unit: a single unit providing complete independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking, and sanitation.

equipment: all control devices, condensing sections, evaporator sections, combination *appliances*, and other components of *fixed* systems that are integrated to provide control of environmental conditions for buildings.

****field installed accessories:*** components added to comfort conditioning systems during or after installation, including items added directly to the *equipment*.

fixed: a type of *refrigeration system* that is intended to be used while fastened to a support or while secured in a specific location.

fusible plug: a plug containing an alloy that will melt at a *specified* temperature and relief pressure.

header: a pipe or tube (extruded, cast, or fabricated) to which other pipes or tubes are connected.

heat pump: a *refrigeration system* used to transfer heat into a *space* or substance.

heat pump water heater: a *refrigeration system* used to heat potable water.

****ignition source:*** a flame, spark, or hot surface capable of igniting flammable vapors or fumes.

line set: a set of two refrigerant pipes that extends from the condenser to the evaporator in *direct systems*, consisting of a suction line and a liquid line.

listed: *equipment* or materials included in a list published by an *approved, nationally recognized testing laboratory*, inspection agency, or other organization concerned with product evaluation that maintains periodic inspection of production of *listed equipment* or materials and whose listing states either that the *equipment* or material meets nationally recognized standards or has been tested and found suitable for use in a *specified* manner.

lower flammability limit (LFL): the minimum concentration of the *refrigerant* at which a flame is capable of propagating through a homogenous mixture of the *refrigerant* and air under specific test conditions, as defined by ANSI/ASHRAE Standard 34.

manufacturer: the company or organization that evidences its responsibility by affixing its name, trademark, or trade name to *refrigeration equipment*.

manufacturer's installation instructions: printed instructions included with *equipment* as part of the conditions of listing and labeling.

mechanical code: the mechanical code adopted by the jurisdiction.

mechanical joint: a gas-tight joint obtained by joining metal parts with a positive-holding mechanical construction such as flanged, screwed, or flared joints or compression fittings.

micron: a unit of pressure equal to the height of column of mercury in μm of Hg which is used to denote absolute pressure on a scale where a perfect vacuum is 0 microns and atmospheric pressure at sea-level is 760,000 microns.

multi-split system: a *split system air conditioner* or *heat pump* having three or more steps of capacity with two or more independently controlled *indoor sections* on a single *refrigeration system*.

nationally recognized testing laboratory (NRTL): an organization which is recognized by OSHA and which tests for safety, and lists or labels or accepts, *equipment* or materials, as defined by 29 C.F.R. §1910.7.

occupied space: that portion of the *premises* to which people have *access* or can be occupied by people.

piping: see *tubing*.

plenum: a compartment or chamber to which one or more *air ducts* are connected and that forms part of the air distribution system.

premises: a tract of land and the buildings thereon.

pressure-limiting device: a pressure-responsive electronic or mechanical control designed to automatically stop the operation of the pressure-imposing element at a predetermined pressure.

****pressure-relief device:*** a pressure-, not temperature-, actuated valve or *rupture member* designed to automatically relieve pressure higher than its setting.

pressure vessel: any *refrigerant*-containing receptacle in a *refrigeration system*. This does not include evaporators where each separate evaporator section does not exceed 0.5 ft^3 (0.014 m^3) of *refrigerant*-containing volume regardless of the maximum inside dimension. This also does not include evaporator coils, *compressors*, condenser coils, controls, *headers*, pumps, and *piping*.

ready access (to): that which enables a device, appliance, or equipment to be directly reached, without requiring the removal or movement of any panel, door, or similar obstruction.

reclaimed refrigerants: *refrigerants* reprocessed to the same specifications as new *refrigerants* by any means, including distillation. Such *refrigerants* have been chemically analyzed to verify that those specifications have been met.

recovered refrigerants: *refrigerants* removed from a system in any condition without testing or processing them.

recycled refrigerants: *refrigerants* for which contaminants have been reduced by oil separation, removal of non-condensable gases, and single or multiple passes through filter driers or other devices that reduce moisture, acidity, and particulate matter.

refrigerant: the fluid used for heat transfer in a *refrigeration system*; the *refrigerant* absorbs heat and transfers it at a higher temperature and a higher pressure, usually with a change of state.

refrigerant charge: the quantity of *refrigerant* in a *refrigeration system*.

refrigerant charge, actual (m_c): the mass of *refrigerant* in a single *refrigeration system* after completion of field *refrigerant charge* adjustment.

refrigerant charge, maximum ($m_{c,max}$): the largest permissible mass of *actual refrigerant charge*.

refrigerant charge, releasable (m_{rel}): the mass of *refrigerant* that can potentially be released from the *refrigeration system* into the *space*.

refrigerant charge, maximum releasable ($m_{rel,max}$): the largest permissible mass of *releasable refrigerant*.

refrigerant charge, safety shut-off (m_{ssoy}): the mass of *refrigerant* contained in the *refrigeration system* with *safety shut-off valves* closed.

refrigerant charge, ventilation (m_v): the mass of additional *refrigerant* permitted in the *refrigeration system* due to the use of *ventilation air*.

releasable charge (m_{rel}): the portion of the total *system charge* that could potentially be released to an *occupied space*.

refrigerant circuit: any *refrigerant* bearing parts of the *refrigeration system*, including but not limited to, *compressor(s)*, coil(s), *tubing*, *piping*, filter drier(s), accumulator(s), receiver(s), reversing valve(s), and service valve(s).

refrigerant concentration limit (RCL): see definition in ANSI/ASHRAE Standard 34.

refrigerant designation: the unique identifying alphanumeric value or *refrigerant* number assigned to an individual *refrigerant* as published in ANSI/ASHRAE Standard 34.

refrigerant detector: a device that is capable of sensing the presence of *refrigerant* vapor.

refrigeration system: a combination of interconnected *equipment*, connected by *tubing*, which forms a closed *refrigerant circuit* in which *refrigerant* is circulated to extract, then reject, heat.

return system: an assembly of connected *ducts*, air passages, or *plenums* and fittings through which air from the *space* or *spaces* to be *conditioned* is conducted back to the heat exchanger.

rupture member: a non-reclosing device that will rupture and release *refrigerant* to relieve pressure.

safety shut-off valve (SSOV): an automatically controlled *refrigerant* valve that is part of a *refrigerant* detection system to limit the amount of *refrigerant* released into a *space* when a *refrigerant* leak is detected.

self-contained system: a complete, factory-assembled, and factory-tested system that is shipped in one or more sections and has no *refrigerant*-containing parts that are joined in the field by other than companion or block valves.

shall: used in this standard when a provision is mandatory.

shall not: used in this standard when an action is prohibited.

sleeping unit: a single *unit* that provides rooms or *spaces* for one or more persons, includes permanent provisions for sleeping and can include provisions for living, eating, and either sanitation or kitchen facilities but not both. Such rooms and *spaces* that are also part of a *dwelling unit* are not *sleeping units*.

space: an enclosed volume within a residential building.

specified: explicitly stated in detail. *Specified* limits or prescriptions are mandatory.

split system: any *air conditioner* or *heat pump* that has one or more of the major assemblies separated from the others.

indoor section: a component of a *split system* central *air conditioner* or *heat pump* that is designed to transfer heat between *refrigerant* and the *conditioned space*.

outdoor section: a component of a *split system* central *air conditioner* or *heat pump* that is designed to transfer heat between *refrigerant* and heat sink outside the *conditioned space*.

transfer air: air moved from one occupiable *space* to another, usually through doorways, grilles, or other such opening.

transfer fan: an air movement device utilized to move *transfer air* from one occupiable *space* to another occupiable *space*.

tubing: pipe or tube used to convey fluid from one part of a *refrigeration system* to another. *Tubing* includes tubes, flanges, bolting, gaskets, valves, fittings, tube-supporting fixtures, structural attachments, and the pressure-containing parts of other components, such as expansion joints, strainers, filters, and devices that serve such purposes as mixing, separating, muffling, snubbing, distributing, metering, or controlling flow.

ventilation: providing a *space* with *ventilation air*.

ventilation air: external air delivered to a *space* via mechanical methods that is intended to dilute released refrigerant.

whole house dehumidifier: a *refrigeration system* used to remove water vapor from a *dwelling*.

whole house dehumidifying ventilator: a *refrigeration system* used to remove water vapor from outdoor air supplied to a *dwelling* or a combination of outdoor air and recirculated air.

5. GENERAL REQUIREMENTS

5.1 ***Equipment*** **Requirements.** All *fixed refrigeration systems shall* be *listed* to UL 60335-2-40. *Manufacturer's installation instructions*, owner's manuals, service manuals, and any other product literature provided with the *equipment shall* be left with the homeowner or building owner.

5.2 **Field Installed Accessory Requirements.** All *field installed accessories shall* be *listed* to the component standards of UL 60335-2-40. *Field installed accessories* for A2L *refrigeration systems* that are *ignition sources shall* additionally be *listed* to UL 60079-15. All *field installed accessories shall* be installed per the *manufacturer's installation instructions* ensuring that all mitigation features continue to function properly.

5.3 ***Ductwork Duct* Systems.** All *ductwork* and *duct systems shall* comply with one of the following codes: the ICC International Residential Code (Mechanical Section), ICC International Mechanical Code, IAPMO Uniform Mechanical Code, NFPA 90A, and/or NFPA 90B.

5.4 Signs and Identification. Each *refrigeration system shall* have the following information legibly and permanently indicated on a markable label provided by the *equipment manufacturer*:

a. contact information of the responsible company that installed the *refrigeration system*, and
b. the total amount of *refrigerant* contained in the system after the installation is complete.

6. REFRIGERANT CLASSIFICATION AND REQUIREMENTS

6.1 Permissible *Refrigerants*. Only *refrigerants* having a *refrigerant designation* of safety group A1 or A2L in ANSI/ASHRAE Standard 34 *shall* be used in conjunction with this standard. *Refrigeration systems* other than A1 or A2L *shall* be regulated by ANSI/ASHRAE Standard 15.

6.2 ***Refrigerant* Requirements**

6.2.1 ***Refrigerant* Type and Purity.** *Refrigerants* used in a *refrigeration system shall* have a designation *specified* by the *equipment manufacturer* and marked on the *appliance*. *Refrigerants* used to adjust the charge in new *equipment*, *shall* conform to AHRI 700 in purity unless a more restrictive *equipment* is *specified* by the *equipment manufacturer*.

6.2.2 ***Recovered Refrigerants.*** *Recovered refrigerants shall not* be reused except in the system from which they were removed, or in another system of the same owner and using the same *refrigerant designation*, or as provided in Sections 6.2.3 or 6.2.4. When contamination is evident by discoloration, odor, acid test results out of *manufacturer* specifications, or system history, *recovered refrigerants shall* be reclaimed in accordance with Section 6.2.4 before reuse.

6.2.3 ***Recycled Refrigerants.*** *Recycled refrigerants shall not* be reused except in systems using the same *refrigerant* and a compatible lubricant and belonging to the same owner as the systems from which they were removed. When contamination is evident by discoloration, odor, acid test results out of *manufacturer* specification, or system history, *recycled refrigerants shall* be reclaimed in accordance with Section 6.2.4.

6.2.4 ***Reclaimed Refrigerants.*** Used *refrigerants shall* be reclaimed and found to meet the requirements of AHRI 700. *Reclaimed refrigerants* reclaimed by an EPA-certified *refrigerant* reclaimer *shall* be permitted to be used in a different owner's *equipment*. Contaminated *refrigerants shall not* be used.

6.2.5 Mixing. *Refrigerants*, whether single component or *refrigerant blends*, *shall not* be mixed in a system.

6.2.6 ***Refrigerant* Conversion.** Changes of *refrigerant* in an existing *refrigeration system* to a *refrigerant* with a different *refrigerant designation*, *shall* only be allowed where in accordance with all requirements of Sections 6.2.6.1 through 6.2.6.5.

6.2.6.1 The replacement *refrigerant shall* be in the same safety group as the original *refrigerant*.

6.2.6.2 The change of *refrigerant shall* be *approved* by the owner.

6.2.6.3 Requirements that were applicable to the original system *shall* continue to apply.

6.2.6.4 The designation per ANSI/ASHRAE Standard 34 of the new *refrigerant shall* be clearly marked on the *appliance* and references to the replaced *refrigerant* removed or permanently covered.

6.2.6.5 All requirements of Sections 5 and 6 *shall* be met.

7. LOCATION OF REFRIGERATION SYSTEMS AND RESTRICTIONS

7.1 General. *Refrigeration systems shall* be *listed* and installed per *manufacturer's installation instructions*.

7.1.1 Indoor *Equipment.* *Equipment* marked with an ingress protection code of less than IP54 on the nameplate per ANSI/IEC 60529 or CAN/CSA-C22.2 no. 60529:05 (R2016) *shall not* be installed outdoors.

7.1.2 Outdoor *Equipment.* *Equipment* marked "For outdoor use only" *shall* only be installed outdoors. Outdoor *equipment* using A2L *refrigerants shall* be located no closer than 5 ft/1.52 m horizontally from any door or operable window where the lowest point of the door or operable window is below grade.

8. PIPING REQUIREMENTS

8.1 Materials

8.1.1 General. Materials used in the construction and installation of *refrigeration systems shall* be suitable for conveying the *refrigerant* used. Materials *shall not* be used that will deteriorate because of the *refrigerant*, the lubricant, or their combination in the presence of air or moisture to a degree that poses a safety hazard.

8.1.2 *Refrigerant Piping*, Valves, and Fittings. *Refrigerant piping*, valves, and fittings *shall* comply with the requirements of Sections 8.3 through 8.6.

8.2 Alloy Restriction

8.2.1 General. Magnesium alloys *shall not* be used in contact with any halogenated *refrigerants*.

8.3 *Refrigerant Piping*, Valves, Fittings, and Related Parts. *Refrigerant piping*, valves, fittings, and related parts *shall* conform to the requirements of Sections 8.3.1 through 8.3.7.

8.3.1 *Refrigerant piping*, valves, fittings, and related parts having a maximum internal or external *design pressure* greater than 15 psig (103.4 kPa gage) *shall* be *listed* either individually or as part of an assembly or a system by an *approved*, *nationally recognized testing laboratory*, or *shall* comply with ASME B31.5 where applicable.

8.3.2 Reuse of *Piping* Materials on Existing Systems. Reused pipe, fittings, valves, or other materials on existing *refrigerant* systems being renovated or modified *shall* comply with the requirements of Section 8.3.

8.3.3 *Piping* Materials Standards. *Refrigerant* pipe *shall* either be *listed* or demonstrate conformance to one or more of the standards in Table 8.3.3.

Table 8.3.3 *Refrigerant* Pipe

***Piping* Material**	**Standard**
Aluminum Tube	ASTM B210, ASTM B210M, ASTM B491/B491M
Copper Tube	ASTM 68, ASTM B75, ASTM B280, ASTM B819
Copper *Line Sets*	ASTM B1003, ASTM B280

8.3.4 Pipe Fittings. *Refrigerant* pipe fittings *shall* be *approved* for installation with the *piping* materials to be installed and *shall* demonstrate conformance to one or more of the standards listed in Table 8.3.4 or *shall* be *listed* as complying with UL 207.

Table 8.3.4 *Refrigerant* Pipe Fittings

Fitting Material	**Standard**
Aluminum	ASTM B361
Brass (Copper Alloy)	ASME B16.15, ASME B16.24
Copper	ASME B16.15, ASME B16.18, ASME B16.22, ASME B16.24, ASME B16.26, ASME B16.50
Steel	ASTM A105, ASTM A181, ASTM A234, ASTM A420

8.3.5 Copper Brazed Field Swaged. The minimum and maximum cup depth of field fabricated copper brazed swaged fitting connections *shall* comply with Table 8.3.5.

Table 8.3.5 Copper Brazed Swaged Cup Depths

Fitting Size (Inch)	**Minimum (Inch)**	**Maximum (Inch)**
1/8	0.15	0.23

3/16	0.16	0.24
1/4	0.17	0.26
3/8	0.20	0.30
1/2	0.22	0.33
5/8	0.24	0.36
3/4	0.25	0.38
1	0.28	0.42
1-1/4	0.31	0.47
1-1/2	0.34	0.51
2	0.40	0.60
2-1/2	0.47	0.71
3	0.53	0.80
3-1/2	0.59	0.89
4	0.64	0.96

8.3.6 Valves, Flexible Connectors, Expansion, and Vibration Compensators. Valve, flexible connectors and expansion, vibration control devices, or other similar components *shall* be *listed* to UL 207 for the *refrigerant* systems and *shall* meet the *design pressure* for the systems in which they are installed.

8.3.7 Annealed Copper Tube Limitation. Soft annealed copper *tubing* larger than 1-3/8 in. (35 mm) O.D. *shall not* be used for field assembled *refrigerant piping*, unless it is protected from mechanical damage.

8.4 Joints and Connections

8.4.1 General. Joints and connections *shall* be either a *listed* or an *approved* type. Joints and connections *shall* be tight for the pressure of the *refrigerant* system when tested in accordance with Section 8.6.

8.4.2 Joints Between Different *Piping* Materials. Joints between different *piping* materials *shall* be made with either *listed* or *approved* adapter fittings. Joints between dissimilar metallic *piping* materials *shall* be designed to prevent galvanic corrosion which includes but is not limited to the use of a dielectric fitting or a dielectric union conforming to dielectric tests of ASSE 1079. Adapter fittings with threaded ends between different materials *shall* be joined with proper thread lubricant in accordance with Section 8.4.5.5.

8.4.3 Allowable Joints. The allowable joints for a specific *piping* material *shall* be in accordance with Table 8.4.3.

Table 8.4.3 Allowable Joints

Material	Brazed (Section 8.4.5.1)	Mechanical (Section 8.4.5.2)	Flared (Section 8.4.5.3)	Press-Connect (Section 8.4.5.4)
Aluminum Tube	X	X		X
Copper Tube	X	X	X	X

8.4.4 Preparation of Pipe Ends. Pipes *shall* be cut square, reamed, and chamfered, and *shall* be free of burrs and obstructions. Pipe ends *shall not* be undercut to reduce pipe wall below the minimum thickness as required for the application.

8.4.5 Joint Preparation and Installation. Where required by Sections 8.4.4 through 8.4.9, the preparation and installation of brazed, flared, mechanical, press-connect, soldered, and threaded joints *shall* comply with Sections 8.4.5.1 through 8.4.5.5.

8.4.5.1 *Brazed Joints*. Joint surfaces *shall* be cleaned. A flux *approved* for the application *shall* be applied where required by the braze filler metal *manufacturer*. The *piping* being brazed *shall* be purged of air to remove the oxygen and filled with one of the following inert gases: oxygen-free nitrogen, helium, or argon. The *piping* system *shall* be pre-purged with an inert gas for a minimum time corresponding to five volume changes through the *piping* system prior to brazing. The pre-purge rate *shall* be at a minimum velocity

of 100 feet per minute. The inert gas *shall* be directly connected to the tube system being brazed to prevent the entrainment of ambient air. After the pre-purge, the inert gas supply *shall* be maintained through the *piping* during the brazing operation at a minimum pressure of 1.0 psi and a maximum pressure of 3.0 psi. The joint *shall* be brazed with a filler metal conforming to AWS A5.8.

8.4.5.2 ***Mechanical Joints.*** *Mechanical joints shall* be installed in accordance with the *manufacturer's installation instructions*.

8.4.5.3 **Flared Joints.** Flared fittings *shall* be installed in accordance with the *manufacturer's installation instructions*. The flared fittings *shall* be used with the tube materials *specified* by the fitting *manufacturer*. The flared tube end *shall* be made by a tool designed for that operation.

8.4.5.4 **Press-Connect Joints.** Press-connect joints *shall* be installed in accordance with the *manufacturer's installation instructions*.

8.4.5.5 **Threaded Joints.** Threads *shall* conform to ASME B1.20.1, ASME B1.20.3, ASME B1.13M. or ASME B1.1. Thread lubricant, pipe-joint compound, or tape *shall* be applied on the external threads only and *shall* be *approved* for application on the *piping* material.

8.5 *Refrigerant* Pipe Installation

8.5.1 ***Piping*** **Location.** *Refrigerant piping shall* comply with the installation location requirements of Sections 8.5.1.1 through 8.5.1.8. *Refrigerant piping* for Group A2L *shall* also comply with the requirements of Section 8.5.2.

8.5.1.1 **Minimum Height.** Exposed *refrigerant piping* installed in open *spaces* that afford passage *shall* be not less than 7 feet 3 inches (2210 mm) above a walking surface.

8.5.1.2 **Pipe Protection.** The exterior of the pipe *shall* be protected from corrosion and degradation. *Refrigerant piping shall* be:

1. Within either the building elements or protective enclosure: in concealed locations where aluminum tube or copper tube is installed through holes or notches in studs, joists, or similar members less than 1-1/2 inches (38 mm) from the nearest edge of the member, the tube *shall* be protected by steel shield plates having a minimum thickness of 0.0575 inch (1.463 mm) (No. 16 gage). Protective steel shield plates *shall* cover the area of the tube where the member is notched or bored, and *shall* extend not less than 2 inches (51 mm) above sole plates and below top plates, or
2. More than 7 feet 3 inches (2.2 m) above the finished floor, or
3. Inside the building exposed within 72 inches (1830 mm) of the *appliance*, or
4. In an *attic* or *crawl space*: aluminum tube or copper tube *shall* be protected in accordance with Item 1 when located within 1-1/2 inches (38 mm) from the nearest edge of the member, or
5. Outside the building:
    a. Protected from damage from the weather, including but not limited to hail, ice, and snow loads, and
    b. Protected from damage within the expected foot or traffic path
    c. Outside underground installed below the frost line, but not less than 8 inches below finished grade and protected against corrosion.

8.5.1.3 **Prohibited Locations.** *Refrigerant piping shall not* be installed in any of the following locations:

1. Exposed within a fire-resistance-rated exit *access* corridor
2. Exposed within an interior exit stairway
3. Interior exit ramp
4. Exit passageway
5. Elevator, dumbwaiter, or other shaft containing a moving object
6. Inside an *air duct*

8.5.1.4 ***Piping*** **in Concrete Floors.** *Refrigerant piping* installed in concrete floors *shall* be encased in pipe, conduit, or *ducts*. The *piping shall* be protected to prevent damage from vibration, stress, and corrosion.

8.5.1.5 ***Refrigerant*** **Pipe Shafts.** *Refrigerant piping* that penetrates two or more floor/ceiling assemblies *shall*

be enclosed in a fire-resistance-rated shaft enclosure in accordance with building code.

Informative Note: Other building utilities or *piping* systems are permitted to be in the *refrigerant piping* shaft.

8.5.1.5.1 Shaft Not Required. A shaft enclosure *shall not* be required for the *refrigerant piping* for any of the following systems:

1. *Piping* in a *direct system* using Group A1 *refrigerant* where the *refrigerant* quantity does not exceed the *RCL* for the smallest *occupied space* through which the *piping* passes.
2. *Piping* located on the exterior of the building where leaked *refrigerant* is vented to the outdoors.

8.5.1.6 Exposed *Piping* Surface Temperature. Exposed *piping* with *ready access* having temperatures greater than 120°F (49°C) or less than 5°F (–15°C) *shall* be protected from contact or have thermal insulation which limits the exposed insulation surface temperature to a range of 5°F (–15°C) to 120°F (49°C).

8.5.1.7 Pipe Support. *Piping shall* be supported at intervals *specified* in Table 8.5.1.7 or in accordance with ANSI/MSS SP-58.

Table 8.5.1.7 Pipe Hanger Spacing

***Piping* Material**	**Maximum Horizontal Spacing (ft)**	**Maximum Vertical Spacing (ft)**
Aluminum Tube		
1/4 inch to 1-1/4 inch	10	15
Copper Tube		
1/4 inch	5	10
3/8 to 1/2 inch	6	10
3/4 inch	7	10
1 inch	8	10
1-1/4 inch	9	10

8.5.2 Installation Requirements for A2L *Refrigerants*. *Piping* systems using Group A2L *refrigerant shall* comply with the requirements of Section 8.5.2.1 through 8.5.2.3.

8.5.2.1 Pipe Protection. In addition to the requirements in Section 305.5, aluminum or copper tube for Group A2L *refrigerants* located in concealed locations where *tubing* is installed in studs, joists, rafters, or similar member *spaces* and located less than 1-1/2 inches (38 mm) from the nearest edge of the member, *shall* be continuously protected by shield plates. Protective steel shield plates having a minimum thickness of 0.0575 inch (1.463 mm) (No. 16 gage) *shall* cover the area of the tube and *shall* extend a minimum of 2 inches (51 mm) beyond the outside edge of the tube. *Refrigerant* tube *shall not* be in direct contact with metal that can cause galvanic corrosion. *Refrigerant* tube *shall not* be in contact with building material that can abrade the tube.

8.5.2.2 Field Applied Joints. When a *refrigeration system* is installed with field applied joints at the *indoor section*, the joints *shall* be:

a. in compliance with UL 207; or
b. enclosed to vent to the *appliance* where a leak would be detected.

8.5.2.3 Shaft *Ventilation*. *Refrigerant* pipe shafts required by Section 8.5.1.5 for systems using Group A2L *refrigerants shall* be naturally or mechanically ventilated and *shall* comply with one of the following:

a. Naturally ventilated shafts *shall* have a minimum of a 4-inch diameter pipe, *duct*, or conduit that connects at the lowest point of the shaft and connects to the outdoors. The pipe, *duct*, or conduit *shall* be level or pitched to the outdoors. A makeup air opening *shall* be provided at the top of the shaft. Required *ventilation* openings *shall* open directly to the outside air and *shall* be protected to prevent the entry of birds, rodents, snakes, and other similar creatures.

b. Mechanically ventilated shafts *shall* have a minimum air velocity in accordance with Table 8.5.2.3. The mechanical *ventilation shall* either be continuously operated or activated by a *refrigerant detector*. Systems utilizing a *refrigerant detector shall* activate the mechanical *ventilation* at a detection threshold not exceeding the *RCL* of the *refrigerant*. The detector, or a sampling tube that draws air to the detector, *shall* be located in an area where *refrigerant* from a leak will concentrate. Make up air *shall* be provided at the inlet to the shaft for mechanically ventilated shafts.

c. The shaft *shall not* be required to be ventilated for double wall *refrigerant* pipe where the interstitial space of the double wall pipe is vented to the outdoors.

Table 8.5.3.2 Shaft *Ventilation* Velocity

Cross-Sectional Area of Shaft (Sq. In.)	Minimum *Ventilation* Velocity (feet per minute)
≤20	100
>20 to ≤250	200
>250 to ≤1250	300
>1250	400

8.5.3 *Refrigerant* Pipe Penetrations. The annular space between the outside of a *refrigerant* pipe and the inside of a pipe sleeve or opening in a building envelope wall, floor, or ceiling assembly penetrated by a *refrigerant* pipe *shall* be sealed in an *approved* manner with caulking material, foam sealant, or closed with a gasketing system. The caulking material, foam sealant, or gasketing system *shall* be designed for the conditions at the penetration location and *shall* be compatible with the pipe, sleeve, and building materials in contact with the sealing materials. *Refrigerant* pipes penetrating fire-resistance-rated assemblies or membranes of fire-resistance-rated assemblies *shall* be sealed or closed in accordance with the *AHJ*.

8.5.4 Stress and Strain. *Refrigerant piping shall* be installed so as to prevent strains and stresses that exceed the structural strength of the pipe. Where necessary, provisions *shall* be made to protect *piping* from damage resulting from vibration, expansion, contraction, and structural settlement.

8.6 Provision for Service

8.6.1 All serviceable components of *refrigeration systems shall* have *access* by service personnel.

8.6.2 *Outdoor sections* or outdoors sections with enclosures *shall* have *access* by service personnel.

9. MAXIMUM REFRIGERANT CHARGE

9.1 General Requirements. All *refrigeration systems shall* have *refrigerant charge* added or adjusted per *equipment manufacturer's installation instructions*. The total *refrigerant charge* level, *mc*, is the total charge after completion of field *refrigerant charge* adjustment.

For Group A2L *refrigerants*, a simplified *maximum refrigerant charge* procedure is given in Sections 9.2 to 9.6. Alternatively, the comprehensive procedure described in Section 13 may be used. The use of Section 13 *shall* be required for *refrigeration systems* using Group A2L *refrigerants* with a *LFL* < 0.28 kg/m^3 (0.0175 lb$_m$/ft^3).

9.2 Flammable A2L *Refrigerant Charge* Levels for Mitigation

9.2.1 *Refrigerant charge* limits for Group A2L *refrigerants* essential to delineate maximum charge level and levels of mitigation for leaks are given in Table 9.2-1.

Table 9.2-1 Flammable A2L *Refrigerant Charge* Limits

Charge Limit	kg	lb$_m$
m_1	1.7	3.7

m_2	14.6	32.1

9.2.2 *Refrigeration systems* using A2L *refrigerants shall not* have a *refrigerant* charge greater than m_2. However, if the *RCL* of the Group A2L *refrigerant* is less than 0.25**LFL*, then the maximum charge *shall* be calculated as for a Group A1 *refrigerant* (see Section 9.3).

9.2.3 *Refrigeration systems* with *refrigerant charge* levels as shown in Table 9.2-2 requiring leak mitigation *shall* have mitigation integral to the *equipment* as supplied from the *manufacturer*, and *approved* to UL 60335 2-40.

9.2.4 *Refrigeration systems* with a charge level, m_c, greater than m_1, as defined below in Table 9.2-2, *shall* be evaluated for compliance with Section 9.4.

Table 9.2-2 Flammable A2L *Refrigerant Charge* Limits for Mitigation

Charge m_c	Mitigation for Leaks Required	Evaluate for Compliance with Section 9.3
$m_c \le m_1$	No	No
$m_1 < m_c \le m_2$	Yes	Yes

9.3 Maximum Allowable *Refrigerant Charge* for A1 *Refrigerants*

The concentration of *refrigerant* in a *space* from a complete discharge of a single *refrigeration system shall not* exceed the *RCL* shown in ANSI/ASHRAE Standard 34, Table 4-1 or 4-2.

9.4 Maximum Allowable *Refrigerant Charge* for A2L *Refrigerants*

9.4.1 The *maximum refrigerant charge*, $m_{c,max}$, permitted for a single *refrigeration system* installed in a *space shall* be as *specified* in the *manufacturer's installation instructions* of the *listed equipment*. In the absence of the *manufacturer's installation instructions*, the maximum allowable *refrigerant charge*, $m_{c,max}$, for any single *refrigeration system shall* be determined using Tables 9.4-1, 9.4-2, and 9.4-3. In all situations, $m_{c,max}$ for Group A2L *refrigerants shall not* exceed m_2 as shown in Table 9.2-1.

Table 9.4-1 Maximum Charge for A2L *Refrigerants*

Safety Shut-Off Valve Installed	*Ventilation* Installed	A2L Charge
No	No	Table 9.4-2
Yes	No	14.6 kg/32.2 lbm
No	Yes	Table 9.4-2 and Table 9.4-3
Yes	Yes	14.6 kg/32.2 lbm

Table 9.4-2 Maximum Charge for A2L Systems with No *Safety Shut-Off Valves* or *Ventilation* Installed—Based on 7.2 ft (2.2 m) Space Height*

Area**		Maximum Released Charge***	
ft^2	m^2	lbm	kg
25	2.3	0.8	0.4
50	4.6	1.6	0.7
75	7.0	2.4	1.1
100	9.3	3.2	1.4

Table 9.4-2 Maximum Charge for A2L Systems with No *Safety Shut-Off Valves* or *Ventilation* Installed—Based on 7.2 ft (2.2 m) Space Height*

Area**		Maximum Released Charge***	
ft^2	m^2	lbm	kg
125	11.6	3.9	1.8
150	13.9	4.7	2.1
175	16.3	5.5	2.5
200	18.6	6.3	2.9
225	20.9	7.1	3.2
250	23.2	7.9	3.6
275	25.5	8.7	3.9
300	27.9	9.5	4.3
325	30.2	10.3	4.6
350	32.5	11.0	5.0
375	34.8	11.8	5.4
400	37.2	12.6	5.7
425	39.5	13.4	6.1
450	41.8	14.2	6.4
475	44.1	15.0	6.8
500	46.5	15.8	7.2
525	48.8	16.6	7.5
550	51.1	17.3	7.9
575	53.4	18.1	8.2
600	55.7	18.9	8.6
625	58.1	19.7	8.9
650	60.4	20.5	9.3
675	62.7	21.3	9.7
700	65.0	22.1	10.0
725	67.4	22.9	10.4
750	69.7	23.7	10.7
775	72.0	24.4	11.1
800	74.3	25.2	11.4
825	76.6	26.0	11.8
850	79.0	26.8	12.2
875	81.3	27.6	12.5
900	83.6	28.4	12.9
925	85.9	29.2	13.2
950	88.3	30.0	13.6
975	90.6	30.8	13.9
1000	92.9	31.5	14.3
1025	95.2	32.2	14.6

* For space heights (h) less than 7.2 ft (2.2 m), multiply the charge sizes in this table by a correction factor of h_c, where $h_c = h/7.2$ ft (2.2 m). Volume heights ≥ 7.2 ft (2.2 m) *shall* determine charge using the values shown in this table.

** *Dispersal volumes* are determined per the requirements of Section 9.5.

*** For area sizes falling in between the values listed in this table, interpolation may be used to determine precise charges. Alternatively, the closest lower value for area may be used in lieu of interpolation.

Table 9.4-3 Additional Charge Permitted for A2L Systems without *Safety Shut-Off Valves* but Using *Ventilation*

***Ventilation* Rate**		**Additional Charge***	
cfm	**m^3/hr**	**lbm**	**kg**
20	34	0.4	0.2
40	68	0.7	0.3
60	102	1.1	0.5
80	136	1.4	0.6
100	170	1.8	0.8
120	204	2.1	1.0
140	238	2.5	1.1
160	272	2.8	1.3
180	306	3.2	1.4
≥200	340	3.5	1.6

* For *ventilation* rates falling between the values listed in this table, interpolation may be used to determine precise increase in charge size. Alternatively, the closest lower value for volume may be used in lieu of interpolation.

9.4.2 *Releasable Charge* for *Multi-Split Systems* Using *Safety Shut-Off Valves* with A2L *Refrigerants*. The *releasable charge, m_{rel}, shall* be the largest value determined in Sections 9.4.2.1 and 9.4.2.2. The *releasable charge, m_{rel}, shall not* exceed the *maximum releasable charge, $m_{rel,max}$* (as calculated in Section 9.4). As an alternative, the *releasable charge shall* be permitted to be calculated in accordance with Section 13. Three pipe *multi-split systems shall* have the *releasable charge* calculated in accordance with Section 13.

9.4.2.1 *Releasable Refrigerant Charge* in Heating Mode. The *releasable charge* in heating mode *shall* be the *releasable charge* in interconnecting *tubing* plus the charge in the *indoor section* located downstream of the *safety shut-off valve*. Table 9.4.2-3 *shall* be permitted to be used to calculate the *indoor section releasable charge* based on the internal volume of *indoor section* coil, *headers*, and *tubing*. *Releasable charge* in interconnecting *tubing shall* be the value from Table 9.4.2-1 corresponding to the outer diameter of the liquid interconnecting *tubing* and the length of the liquid interconnecting *tubing* plus the value from Table 9.4.2-2 corresponding to the outer diameter of the vapor interconnecting *tubing* and the length of the vapor interconnecting *tubing*. The length of interconnecting *tubing shall* be calculated from the *safety shut-off valve* to the *indoor section*.

9.4.2.2 *Releasable Refrigerant Charge* in Cooling Mode. The *releasable charge* in cooling mode *shall* be the *releasable charge* in interconnecting *tubing* plus the charge in the *indoor section* located downstream of the *safety shut-off valve*. Table 9.4.2-6 *shall* be permitted to be used to calculate the *indoor section releasable charge* based on the internal volume of *indoor section* coil, *headers*, and *tubing*. *Releasable charge* in interconnecting *tubing shall* be the value from Table 9.4.2-4 corresponding to the outer diameter of the liquid interconnecting *tubing* and the length of the liquid interconnecting *tubing* plus the values from Table 9.4.2-5 corresponding to the outer diameter of the vapor interconnecting *tubing* and the length of the vapor interconnecting *tubing*. The length of interconnecting *tubing shall* be calculated from the *safety shut-off valve* to the *indoor section*.

Table 9.4.2-1 *Refrigerant Charge* Contained in Liquid Interconnecting *Tubing* from *Safety Shut-Off Valves* to Each *Indoor Section* in Heating Mode (SI)

	Tube Length (m)											
	1.0	**2.0**	**3.0**	**4.0**	**5.0**	**6.0**	**7.0**	**8.0**	**9.0**	**10.0**	**11.0**	**12.0**
Tube OD (mm)	***Releasable Charge* (kg)**											
6.35	0.02	0.04	0.06	0.08	0.11	0.13	0.15	0.17	0.19	0.21	0.23	0.25
7.94	0.04	0.07	0.11	0.15	0.18	0.22	0.26	0.29	0.33	0.37	0.41	0.44
9.53	0.06	0.11	0.17	0.23	0.29	0.34	0.40	0.46	0.51	0.57	0.63	0.68
12.70	0.11	0.22	0.33	0.44	0.55	0.66	0.77	0.88	0.99	1.10	1.21	1.32
15.90	0.18	0.35	0.53	0.71	0.89	1.06	1.24	1.42	1.59	1.77	1.95	2.12
19.10	0.25	0.51	0.76	1.02	1.27	1.53	1.78	2.03	2.29	2.54	2.80	3.05
22.20	0.35	0.70	1.06	1.41	1.76	2.11	2.46	2.81	3.17	3.52	3.87	4.22
25.40	0.46	0.92	1.39	1.85	2.31	2.77	3.24	3.70	4.16	4.62	5.08	5.55
28.60	0.60	1.20	1.79	2.39	2.99	3.59	4.18	4.78	5.38	5.98	6.57	7.17
31.80	0.74	1.48	2.22	2.96	3.70	4.44	5.18	5.92	6.66	7.40	8.14	8.88
38.10	1.08	2.16	3.24	4.32	5.41	6.49	7.57	8.65	9.73	10.81	11.89	12.97
41.30	1.28	2.57	3.85	5.13	6.42	7.70	8.98	10.26	11.55	12.83	14.11	15.40
54.00	2.23	4.47	6.70	8.93	11.17	13.40	15.64	17.87	20.10	22.34	24.57	26.80
66.70	3.43	6.87	10.30	13.73	17.17	20.60	24.03	27.47	30.90	34.34	37.77	41.20

Note: The *releasable charge shall* be determined by interpolation of the values in the table or by selecting the next highest value.

Table 9.4.2-1 *Refrigerant Charge* Contained in Liquid Interconnecting *Tubing* from *Safety Shut-Off Valves* to Each *Indoor Section* in Heating Mode (I-P, values for reference)

	Tube Length (ft)											
	3.0	**6.0**	**9.0**	**12.0**	**15.0**	**18.0**	**21.0**	**24.0**	**27.0**	**30.0**	**33.0**	**36.0**
Tube OD (inch)	***Releasable Charge* (lbm)**											
0.250 (1/4)	0.05	0.09	0.14	0.18	0.23	0.27	0.32	0.36	0.41	0.46	0.50	0.55
0.313 (5/16)	0.08	0.16	0.24	0.32	0.40	0.48	0.56	0.64	0.72	0.80	0.88	0.96
0.375 (3/8)	0.12	0.25	0.37	0.49	0.62	0.74	0.86	0.99	1.11	1.23	1.36	1.48
0.500 (1/2)	0.24	0.48	0.72	0.96	1.20	1.44	1.68	1.92	2.16	2.40	2.64	2.88
0.625 (5/8)	0.38	0.77	1.15	1.54	1.92	2.31	2.69	3.08	3.46	3.85	4.23	4.62
0.750 (3/4)	0.55	1.10	1.66	2.21	2.76	3.31	3.86	4.41	4.97	5.52	6.07	6.62
0.875 (7/8)	0.76	1.53	2.29	3.05	3.82	4.58	5.34	6.11	6.87	7.63	8.40	9.16
1.000	1.00	2.00	3.00	4.01	5.01	6.01	7.01	8.01	9.01	10.01	11.01	12.02
1.125 (1–1/8)	1.29	2.59	3.88	5.18	6.47	7.77	9.06	10.36	11.65	12.95	14.24	15.54
1.250 (1–1/4)	1.60	3.21	4.81	6.42	8.02	9.63	11.23	12.83	14.44	16.04	17.65	19.25
1.500 (1–1/2)	2.34	4.67	7.01	9.35	11.68	14.02	16.35	18.69	21.03	23.36	25.70	28.04
1.625 (1–5/8)	2.78	5.56	8.34	11.13	13.91	16.69	19.47	22.25	25.03	27.81	30.59	33.38
2.125 (2–1/8)	4.85	9.70	14.55	19.40	24.25	29.10	33.95	38.81	43.66	48.51	53.36	58.21
2.625 (2–5/8)	7.45	14.91	22.36	29.82	37.27	44.72	52.18	59.63	67.09	74.54	81.99	89.45

Note: The *releasable charge shall* be determined by interpolation of the values in the table or by selecting the next highest value.

Table 9.4.2-2 *Refrigerant Charge* Contained in Vapor Interconnecting *Tubing* from *Safety Shut-Off Valves* to Each *Indoor Section* in Heating Mode (SI)

	Tube Length (m)											
	1.0	**2.0**	**3.0**	**4.0**	**5.0**	**6.0**	**7.0**	**8.0**	**9.0**	**10.0**	**11.0**	**12.0**
Tube OD (mm)	***Releasable Charge* (kg)**											
6.35	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
7.94	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03
9.53	0.00	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.05
12.70	0.01	0.02	0.02	0.03	0.04	0.05	0.05	0.06	0.07	0.08	0.08	0.09
15.90	0.01	0.02	0.04	0.05	0.06	0.07	0.09	0.10	0.11	0.12	0.13	0.15
19.10	0.02	0.04	0.05	0.07	0.09	0.11	0.12	0.14	0.16	0.18	0.19	0.21
22.20	0.02	0.05	0.07	0.10	0.12	0.15	0.17	0.19	0.22	0.24	0.27	0.29
25.40	0.03	0.06	0.10	0.13	0.16	0.19	0.22	0.25	0.29	0.32	0.35	0.38
28.60	0.04	0.08	0.12	0.16	0.21	0.25	0.29	0.33	0.37	0.41	0.45	0.49
31.80	0.05	0.10	0.15	0.20	0.26	0.31	0.36	0.41	0.46	0.51	0.56	0.61
38.10	0.07	0.15	0.22	0.30	0.37	0.45	0.52	0.60	0.67	0.75	0.82	0.89
41.30	0.09	0.18	0.27	0.35	0.44	0.53	0.62	0.71	0.80	0.88	0.97	1.06
54.00	0.15	0.31	0.46	0.62	0.77	0.92	1.08	1.23	1.39	1.54	1.69	1.85
66.70	0.24	0.47	0.71	0.95	1.18	1.42	1.66	1.89	2.13	2.37	2.60	2.84

Note: The *releasable charge shall* be determined by interpolation of the values in the table or by selecting the next highest value.

Table 9.4.2-2 *Refrigerant Charge* Contained in Vapor Interconnecting *Tubing* from *Safety Shut-Off Valves* to Each *Indoor Section* in Heating Mode (I-P)

	Tube Length (ft)											
	3.0	**6.0**	**9.0**	**12.0**	**15.0**	**18.0**	**21.0**	**24.0**	**27.0**	**30.0**	**33.0**	**36.0**
Tube OD (inch)	***Releasable Charge* (lbm)**											
0.250 (1/4)	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04
0.313 (5/16)	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.06	0.06	0.07
0.375 (3/8)	0.01	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.09	0.10
0.500 (1/2)	0.02	0.03	0.05	0.07	0.08	0.10	0.12	0.13	0.15	0.17	0.18	0.20
0.625 (5/8)	0.03	0.05	0.08	0.11	0.13	0.16	0.19	0.21	0.24	0.27	0.29	0.32
0.750 (3/4)	0.04	0.08	0.11	0.15	0.19	0.23	0.27	0.30	0.34	0.38	0.42	0.46
0.875 (7/8)	0.05	0.11	0.16	0.21	0.26	0.32	0.37	0.42	0.47	0.53	0.58	0.63
1.000	0.07	0.14	0.21	0.28	0.35	0.41	0.48	0.55	0.62	0.69	0.76	0.83
1.125 (1–1/8)	0.09	0.18	0.27	0.36	0.45	0.54	0.62	0.71	0.80	0.89	0.98	1.07
1.250 (1–1/4)	0.11	0.22	0.33	0.44	0.55	0.66	0.77	0.88	1.00	1.11	1.22	1.33
1.500 (1–1/2)	0.16	0.32	0.48	0.64	0.81	0.97	1.13	1.29	1.45	1.61	1.77	1.93
1.625 (1–5/8)	0.19	0.38	0.58	0.77	0.96	1.15	1.34	1.53	1.73	1.92	2.11	2.30
2.125 (2–1/8)	0.33	0.67	1.00	1.34	1.67	2.01	2.34	2.68	3.01	3.34	3.68	4.01
2.625 (2–5/8)	0.51	1.03	1.54	2.06	2.57	3.08	3.60	4.11	4.63	5.14	5.65	6.17

Note: The *releasable charge shall* be determined by interpolation of the values in the table or by selecting the next highest value.

Table 9.4.2-3 *Refrigerant Charge* Contained in *Indoor Section* in Heating Mode (SI)

Internal Volume of *Indoor Section* (m^3)	*Releasable Charge* (kg)
0.001	3.40
0.002	4.14
0.003	4.89
0.004	5.63
0.005	6.38
0.006	7.13
0.007	7.87
0.008	8.62
0.009	9.36
0.010	10.11
0.011	10.85
0.012	11.60
0.013	12.34
0.014	13.09
0.015	13.84
0.016	14.58
0.017	15.33
0.018	16.07
0.019	16.82
0.020	17.56
0.021	18.31
0.022	19.06
0.023	19.80
0.024	20.55
0.025	21.29

Note: The *releasable charge shall* be determined by interpolation of the values in the table or by selecting the next highest value.

Table 9.4.2-3 *Refrigerant Charge* Contained in *Indoor Section* in Heating Mode (I-P)

Internal Volume of *Indoor Section* (ft^3)	*Releasable Charge* (lbm)
0.04	7.71
0.08	9.57
0.12	11.43
0.16	13.29
0.20	15.16
0.24	17.02
0.28	18.88
0.32	20.74
0.36	22.60
0.40	24.47
0.44	26.33
0.48	28.19
0.52	30.05
0.56	31.91
0.60	33.77
0.64	35.64
0.68	37.50
0.72	39.36
0.76	41.22
0.80	43.08
0.84	44.95
0.88	46.81
0.92	48.67
0.96	50.53
1.00	52.39

Note: The *releasable charge shall* be determined by interpolation of the values in the table or by selecting the next highest value.

Table 9.4.2-4 *Refrigerant Charge* Contained in Liquid Interconnecting *Tubing* from *Safety Shut-Off Valves* to Each *Indoor Section* in Cooling Mode (SI)

	Tube Length (m)											
	1.0	**2.0**	**3.0**	**4.0**	**5.0**	**6.0**	**7.0**	**8.0**	**9.0**	**10.0**	**11.0**	**12.0**
Tube OD (mm)	***Releasable Charge* (kg)**											
6.35	0.02	0.04	0.06	0.08	0.10	0.12	0.14	0.17	0.19	0.21	0.23	0.25
7.94	0.04	0.07	0.11	0.14	0.18	0.22	0.25	0.29	0.33	0.36	0.40	0.43
9.53	0.06	0.11	0.17	0.22	0.28	0.34	0.39	0.45	0.50	0.56	0.62	0.67
12.70	0.11	0.22	0.33	0.43	0.54	0.65	0.76	0.87	0.98	1.09	1.19	1.30
15.90	0.17	0.35	0.52	0.70	0.87	1.04	1.22	1.39	1.57	1.74	1.91	2.09
19.10	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00
22.20	0.35	0.69	1.04	1.38	1.73	2.07	2.42	2.77	3.11	3.46	3.80	4.15
25.40	0.45	0.91	1.36	1.82	2.27	2.73	3.18	3.64	4.09	4.54	5.00	5.45
28.60	0.59	1.18	1.76	2.35	2.94	3.53	4.11	4.70	5.29	5.88	6.46	7.05
31.80	0.73	1.46	2.18	2.91	3.64	4.37	5.09	5.82	6.55	7.28	8.01	8.73
38.10	1.06	2.13	3.19	4.25	5.32	6.38	7.44	8.50	9.57	10.63	11.69	12.76
41.30	1.26	2.52	3.78	5.05	6.31	7.57	8.83	10.09	11.35	12.62	13.88	15.14
54.00	2.20	4.39	6.59	8.78	10.98	13.18	15.37	17.57	19.77	21.96	24.16	26.35
66.70	3.38	6.75	10.13	13.50	16.88	20.26	23.63	27.01	30.38	33.76	37.14	40.51

Note: The *releasable charge shall* be determined by interpolation of the values in the table or by selecting the next highest value.

Table 9.4.2-4 *Refrigerant Charge* Contained in Liquid Interconnecting *Tubing* from *Safety Shut-Off Valves* to Each *Indoor Section* in Cooling Mode (I-P)

	Tube Length (ft)											
	3.0	**6.0**	**9.0**	**12.0**	**15.0**	**18.0**	**21.0**	**24.0**	**27.0**	**30.0**	**33.0**	**36.0**
Tube OD (inch)	***Releasable Charge* (lbm)**											
0.250 (1/4)	0.04	0.09	0.13	0.18	0.22	0.27	0.31	0.36	0.40	0.45	0.49	0.54
0.313 (5/16)	0.08	0.16	0.24	0.31	0.39	0.47	0.55	0.63	0.71	0.79	0.86	0.94
0.375 (3/8)	0.12	0.24	0.36	0.49	0.61	0.73	0.85	0.97	1.09	1.21	1.34	1.46
0.500 (1/2)	0.24	0.47	0.71	0.95	1.18	1.42	1.65	1.89	2.13	2.36	2.60	2.84
0.625 (5/8)	0.38	0.76	1.14	1.51	1.89	2.27	2.65	3.03	3.41	3.78	4.16	4.54
0.750 (3/4)	0.54	1.09	1.63	2.17	2.71	3.26	3.80	4.34	4.88	5.43	5.97	6.51
0.875 (7/8)	0.75	1.50	2.25	3.00	3.75	4.50	5.25	6.00	6.75	7.50	8.25	9.00
1.000	0.98	1.97	2.95	3.94	4.92	5.91	6.89	7.88	8.86	9.85	10.83	11.81
1.125 (1–1/8)	1.27	2.55	3.82	5.09	6.37	7.64	8.91	10.19	11.46	12.73	14.01	15.28
1.250 (1–1/4)	1.58	3.15	4.73	6.31	7.89	9.46	11.04	12.62	14.20	15.77	17.35	18.93
1.500 (1–1/2)	2.30	4.59	6.89	9.19	11.49	13.78	16.08	18.38	20.67	22.97	25.27	27.57
1.625 (1–5/8)	2.73	5.47	8.20	10.94	13.67	16.41	19.14	21.88	24.61	27.35	30.08	32.82
2.125 (2–1/8)	4.77	9.54	14.31	19.08	23.85	28.62	33.39	38.15	42.92	47.69	52.46	57.23
2.625 (2–5/8)	7.33	14.66	21.99	29.32	36.65	43.97	51.30	58.63	65.96	73.29	80.62	87.95

Note: The *releasable charge shall* be determined by interpolation of the values in the table or by selecting the next highest value.

Table 9.4.2-5 *Refrigerant Charge* Contained in Vapor Interconnecting *Tubing* from *Safety Shut-Off Valves* to Each *Indoor Section* in Cooling Mode (SI)

	Tube Length (m)											
	1.0	**2.0**	**3.0**	**4.0**	**5.0**	**6.0**	**7.0**	**8.0**	**9.0**	**10.0**	**11.0**	**12.0**
Tube OD (mm)	***Releasable Charge* (kg)**											
6.35	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
7.94	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
9.53	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03
12.70	0.00	0.01	0.01	0.002	.002	0.02	0.03	0.03	0.04	0.04	0.04	0.05
15.90	0.01	0.01	0.02	0.03	0.03	0.04	0.05	0.05	0.06	0.07	0.07	0.08
19.10	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.08	0.09	0.10	0.11
22.20	0.01	0.03	0.04	0.05	0.06	0.08	0.09	0.10	0.12	0.13	0.14	0.16
25.40	0.02	0.03	0.05	0.07	0.09	0.10	0.12	0.14	0.15	0.17	0.19	0.20
28.60	0.02	0.04	0.07	0.09	0.11	0.13	0.15	0.18	0.20	0.22	0.24	0.26
31.80	0.03	0.05	0.08	0.11	0.14	0.16	0.19	0.22	0.25	0.27	0.30	0.33
38.10	0.04	0.08	0.12	0.16	0.20	0.24	0.28	0.32	0.36	0.40	0.44	0.48
41.30	0.05	0.09	0.14	0.19	0.24	0.28	0.33	0.38	0.43	0.47	0.52	0.57
54.00	0.08	0.17	0.25	0.33	0.41	0.50	0.58	0.66	0.74	0.83	0.91	0.99
66.70	0.13	0.25	0.38	0.51	0.63	0.76	0.89	1.01	1.14	1.27	1.40	1.52

Note: The *releasable charge shall* be determined by interpolation of the values in the table or by selecting the next highest value.

Table 9.4.2-5 *Refrigerant Charge* Contained in Vapor Interconnecting *Tubing* from *Safety Shut-Off Valves* to Each *Indoor Section* in Cooling Mode (I-P)

	Tube Length (ft)											
	3.0	**6.0**	**9.0**	**12.0**	**15.0**	**18.0**	**21.0**	**24.0**	**27.0**	**30.0**	**33.0**	**36.0**
Tube OD (inch)	***Releasable Charge* (lbm)**											
0.250 (1/4)	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02
0.313 (5/16)	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.04
0.375 (3/8)	0.00	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.05
0.500 (1/2)	0.01	0.02	0.03	0.04	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.11
0.625 (5/8)	0.01	0.03	0.04	0.06	0.07	0.09	0.10	0.11	0.13	0.14	0.16	0.17
0.750 (3/4)	0.02	0.04	0.06	0.08	0.10	0.12	0.14	0.16	0.18	0.20	0.22	0.24
0.875 (7/8)	0.03	0.06	0.08	0.11	0.14	0.17	0.20	0.23	0.25	0.28	0.31	0.34
1.000	0.04	0.07	0.11	0.15	0.18	0.22	0.26	0.30	0.33	0.37	0.41	0.44
1.125 (1–1/8)	0.05	0.10	0.14	0.19	0.24	0.29	0.33	0.38	0.43	0.48	0.53	0.57
1.250 (1–1/4)	0.06	0.12	0.18	0.24	0.30	0.36	0.41	0.47	0.53	0.59	0.65	0.71
1.500 (1–1/2)	0.09	0.17	0.26	0.35	0.43	0.52	0.60	0.69	0.78	0.86	0.95	1.04
1.625 (1–5/8)	0.10	0.21	0.31	0.41	0.51	0.62	0.72	0.82	0.92	1.03	1.13	1.23
2.125 (2–1/8)	0.18	0.36	0.54	0.72	0.90	1.08	1.25	1.43	1.61	1.79	1.97	2.15
2.625 (2–5/8)	0.28	0.55	0.83	1.10	1.38	1.65	1.93	2.20	2.48	2.75	3.03	3.30

Note: The *releasable charge shall* be determined by interpolation of the values in the table or by selecting the next highest value.

Table 9.4.2-6 *Refrigerant Charge* Contained in *Indoor Section* in Cooling Mode (SI)

Internal Volume of *Indoor Section* (m^3)	*Releasable Charge* (kg)
0.001	3.60
0.002	4.54
0.003	5.48
0.004	6.43
0.005	7.37
0.006	8.31
0.007	9.26
0.008	10.20
0.009	11.14
0.010	12.09
0.011	13.03
0.012	13.97
0.013	14.92
0.014	15.86
0.015	16.80
0.016	17.74
0.017	18.69
0.018	19.63
0.019	20.57
0.020	21.52
0.021	22.46
0.022	23.40
0.023	24.35
0.024	25.29
0.025	26.23

Note: The *releasable charge shall* be determined by interpolation of the values in the table or by selecting the next highest value.

Table 9.4.2-6 *Refrigerant Charge* Contained in *Indoor Section* in Cooling Mode (I-P)

Internal Volume of *Indoor Section* (ft^3)	*Releasable Charge* (lbm)
0.04	8.20
0.08	10.56
0.12	12.91
0.16	15.27
0.20	17.62
0.24	19.98
0.28	22.34
0.32	24.69
0.36	27.05
0.40	29.40
0.44	31.76
0.48	34.11
0.52	36.47
0.56	38.82
0.60	41/18
0.64	43.54
0.68	45.89
0.72	48.25
0.76	50.60
0.80	52.96
0.84	55.31
0.88	57.67
0.92	60.02
0.96	62.38
1.00	64.74

Note: The *releasable charge shall* be determined by interpolation of the values in the table or by selecting the next highest value.

9.5 *Dispersal Volume* Calculations. The following applies to the calculation of *dispersal volume* for all types of systems.

9.5.1 *Dispersal Volume*. The *dispersal volume* is calculated by multiplying the floor area of all *spaces* that are connected by the lesser of the actual ceiling height or 7.2 ft (2.2 m). *Plenum* space above a suspended ceiling *shall not* be included.

9.5.2 Systems Serving More Than One Floor. Where different stories and floor levels connect through an opening, the *dispersal volume shall* be calculated using only the floor space and ceiling height of the lowest floor.

9.5.3 Non-Connecting *Spaces*. Where a *refrigeration system*, or a part thereof, is located in one or more enclosed *occupied spaces* that do not connect through permanent openings or HVAC supply *ducts*, the *dispersal volume* of the smallest *occupied space shall* be used to determine the *refrigerant* quantity limit in the system. Doors that could be closed *shall not* be considered to be permanent openings.

9.5.4 *Ductless HVAC* Single *Split System*. Adjacent *space*(s) *shall not* be included in the *dispersal volume* calculation unless there is a *transfer fan* connecting the *spaces*, and the *transfer fan* always operates when the system fan operates. The *dispersal volume shall* then be the *conditioned floor area* of the areas connected by a *transfer fan* multiplied by the height of the bottom of the *indoor section*, but not less than 1.97 ft (0.6 m). For floor-amounted sections, the air delivery height as *specified* by the *manufacturer shall* be used in lieu of the height of the bottom of the *indoor section*.

9.5.5 ***Ductless HVAC Multi-Split Systems*** **or Multiple** ***Single Split Systems.*** The *dispersal volume shall* be the *conditioned floor area* of the smallest area served by an individual *indoor section*, including any areas connected by a *transfer fan*, multiplied by the height of the bottom of the *indoor section* of the *space*, but not less than 1.97 ft (0.6 m). For floor-mounted sections, the air delivery height as *specified* by the *manufacturer shall* be used in lieu of the height of the bottom of the *indoor section*.

9.5.6 ***Heat Pump Water Heater.*** The *dispersal volume shall* be the floor area of the *space* containing the *heat pump water heater* multiplied by height of the *appliance* but not less than 2.0 ft (0.6 m).

9.6 *Safety Shut-Off Valves* for *Multi-Split Systems* Using A2L *Refrigerants*

9.6.1 *Safety shut-off valves shall* be *specified* for use in the *manufacturer's installation instructions*. When *safety shut-off valves* are activated by the *refrigerant* detection system, the valves *shall* close and remain closed until corrective action is taken. *Safety shut-off valves shall* be designed to close in the event of an electric power failure.

9.6.2 ***Safety Shut-Off Valve*** **Location.** *Safety shut-off valves shall* either be located in a *space* with a room volume large enough so that the total system charge calculated per Section 9.3 is not exceeded or *shall* be located outside. *Safety shut-off valves shall* have *access* by service personnel.

10. SYSTEM INSTALLATION

10.1 *Refrigerant Piping* System Test

10.1.1 General. *Refrigerant piping* systems erected in the filed *shall* be pressure-tested for strength and leak-tested for tightness, after installation and before being placed in operation, in accordance with the requirements of this section. Tests *shall* include both the high- and low-pressure sides of each system. *Listed equipment*, including but not limited to *compressors*, condensers, pre-charged *line sets*, *pressure vessels*, evaporators, safety devices, pressure gauges, and control mechanisms, is not required to be pressure-tested for strength. Field installed connections *shall* be leak-tested.

10.1.2 Exposure of *Refrigerant Piping* System. *Refrigerant* pipe and joints installed in the field *shall* be exposed for visual inspection and testing prior to being covered or enclosed.

10.1.3 Test Gases. The medium used for pressure-testing the *refrigeration system shall* be one of the following inert gases: oxygen-free nitrogen, helium, argon, or premixed nonflammable oxygen-free nitrogen with a tracer gas of hydrogen or helium. Oxygen, air, *refrigerant*, combustible gases and mixtures containing such gases *shall not* be used as a test medium.

10.1.4 Field Test Apparatus. The means used to pressurize the *refrigerant piping* system *shall* have a *pressure-limiting device* or pressure-reducing device and a test pressure measuring device on the outlet side. The test pressure measuring device for strength testing and leakage testing *shall* have an accuracy of not less than ±3% of the test pressure and *shall* have a resolution of not less than 3% of the test pressure.

10.1.5 ***Piping*** **System Strength Test and Leak Test.** The *refrigerant piping* system *shall* be tested in accordance with the stricter of the *manufacturer's installation instructions* or this section. Separate tests for low-side and high-side sections of the *piping* system *shall* be allowed. The *refrigerant piping* system *shall* be tested in accordance with both of the following methods:

1. Pressurized for a minimum of sixty minutes to not less than the lower of the *design pressures* or the setting of the *pressure-relief devices* and/or pressure-relief valves. The *design pressures* for testing *shall* be the pressure listed on the label nameplate of the *outdoor section*, *compressor*, *pressure vessel*, or other system component of the *refrigerant circuit* with a nameplate. No additional test gas *shall* be added to the system after the start of the pressure test. The system *shall* show no loss of pressure on the test pressure measuring device during the pressure test.
2. After completing the pressure test, a vacuum of 500 *microns shall* be achieved. After achieving a vacuum, the system *shall* be isolated from the vacuum pump. The system pressure *shall not* rise above 1500 *microns* for a minimum period of ten minutes.

10.2 General System Requirements

10.2.1 Safeguards. Means *shall* be taken to safeguard *tubing* per Section 8, controls, and other refrigeration *equipment* to minimize accidental damage or rupture by external sources.

10.2.2 ***Access*.** Per *manufacturer's installation instructions*, a clear and unobstructed approach and *space shall* be provided for inspection, service, and emergency shutdown of *applicances*.

10.2.3 HVAC *appliances shall* be installed per *manufacturer's installation instructions*.

10.2.3.1 ***Air Duct* Installation.** *Air duct* systems using mechanical refrigeration *shall* be sized per ANSI/ACCA 1 Manual D and sealed per requirements of ANSI/ACCA 5 QI Standard, or per *AHJ* requirements.

10.2.3.2 Water Connections. Water supply and discharge connections *shall* be made in accordance with the system *manufacturer's installation instructions*, industry practices, or *AHJ* requirements.

10.2.3.3 Field Provided Controls. Field installed operating controls and safety controls are to be compatible with the system type and application, and the operation of the field installed controls/safeties are in accordance with system *manufacturer's installation instructions* or *AHJ* requirements.

10.2.3.4 Electrical Safety. Electrical *equipment* and wiring *shall* be installed in accordance with *manufacturer's installation instructions*, local code requirements, and, if applicable, NFPA 70.

10.2.3.5 Heating and Cooling *Equipment*. Heating and cooling *equipment shall* be sized, selected, and installed per the requirements in ANSI/ACCA Standard 5 QI–2015, *HVAC Quality Installation Specification*, or per *AHJ* requirements.

10.2.3.6 Gas- and Oil-Fired *Appliances*. Gas- and oil-fired *appliances* used with *refrigeration systems shall* be installed in accordance with the system *manufacturer's installation instructions* and local codes or *AHJ* requirements.

10.3 General *Refrigerant* Requirements

10.3.1 ***Refrigerant Access*.** All *refrigerant circuit* service ports *shall* be secured to prevent unauthorized *access*. A tool *shall* be required, either directly on the service port or within a service panel, to *access* the service port.

10.3.2 ***Refrigerant* Pressure-Measuring Instruments.** Pressure-measuring instruments *shall* be checked for accuracy and adjusted according to the pressure-measuring instruments *manufacturer's* instructions.

10.3.3 Charging, Withdrawal, and Disposition of *Refrigerants*. No service containers *shall* be left connected to a system except while charging or withdrawing *refrigerant*. *Refrigerants* withdrawn from *refrigeration systems shall* be transferred into *approved* containers only. Except for discharge of *pressure-relief devices* and *fusible plugs*, incidental releases due to leaks, purging of non-condensables, draining oil, and other routine operating or maintenance procedures in accordance to EPA §608 requirements, no *refrigerant shall* be discharged to the atmosphere.

11. MECHANICAL VENTILATION

11.1 ***Ventilation Air*.** For *refrigeration systems* where the *actual refrigerant charge*, m_C, exceeds the values of Tables 9.3.1 and 9.3.2, *ventilation air* as *specified* in Table 9.3-3 *shall* be provided per this section.

11.1.1 *Ventilation air* required per Section 9.3 *shall* either be operated continuously or *shall* be controlled by a *refrigerant detector* provided by the *manufacturer* that is integral to the *appliance*.

11.1.1.1 Continuous Operation. *Ventilation air shall* be operated continuously except during maintenance of the system.

11.1.1.2 Operation by *Refrigerant* Detection System. *Ventilation air* after initiation by *refrigerant* detection system *shall* operate continuously for a minimum of five minutes after the *refrigerant* detection system is automatically reset after *refrigerant* is no longer detected.

11.1.2 Airflow Control Devices. Airflow control devices such as air valves or dampers *shall* be driven fully open when a *refrigerant* detection system detects *refrigerant*. Zone dampers (if applicable) *shall* be driven fully open when a *refrigerant* detection system detects *refrigerant*.

11.1.3 Emergency Control Devices. *Ventilation* systems *shall* be permitted to include smoke dampers, fire dampers, and other devices used only during an emergency.

12. ADD-ON HEAT PUMPS

12.1 Installation of *add-on heat pumps* with A2L *refrigerants shall* include the following:

12.1.1 The sensor of the *refrigerant* detection system *shall* be an integral part of the indoor coil assembly.

12.1.2 Wiring connection of the *refrigerant detector* and any components of the leak detection system to the furnace assembly *shall not* be less than 18 AWG with a minimum insulation thickness of 0.0625 in./1.58 mm or protected from damage.

12.1.3 *Indoor sections* using A2L *refrigerants shall not* be installed on furnaces or modular blowers with an inductive electrical load greater than 2.5 kVA. For A2L *refrigerants* with burning velocities greater than 6.7 cm/sec (2.6 in./sec), Section 14 *shall* be used to determine the maximum allowable inductive load.

12.1.4 Detection of a leak *shall* turn on the indoor fan to supply the airflow *specified* by the *add-on heat pump manufacturer's installation instructions*.

12.1.5 The leak detection system *shall* be tested for proper operation after installation per *manufacturer's installation instructions*.

13. REFRIGERANT CHARGE CALCULATION METHOD FOR A2L REFRIGERANTS

13.1 General Requirements. This section contains the methodology needed to calculate the *maximum charge* and *maximum releasable charge* for A2L *refrigerants*. This section *shall* be required for *refrigeration systems* using A2L *refrigerants* with an *LFL* < 0.28 kg/m^3 (0.0175 lbm/ft^3).

13.2 Flammable *Refrigerant* Charge Levels for Mitigation. The *refrigerant charge* quantities, m_1 and m_2, as defined below delineate the required levels of mitigation. All *refrigeration systems* with a charge level greater than m_1 *shall* be evaluated for compliance with Section 9.4.

For A2L *refrigerants*, m_1 and m_2 are defined as follows:

$$m_1 = A \times LFL \quad \text{(Equation 13.2.1)}$$

$$m_2 = B \times LFL \quad \text{(Equation 13.2.2)}$$

where:

A = 6 m^3 and B = 52 m^3 when *LFL* is expressed in kg/m^3

A = 211.9 ft^3 and B = 1836.4 ft^3 when *LFL* is expressed in lbm/ft^3

13.3 Maximum Allowable *Refrigerant* Charge

The *maximum refrigerant charge*, $m_{c,max}$, in a single *refrigeration system* using an A2L *refrigerant shall* be m_2. However, if the *RCL* of the *refrigerant* is less than 0.25 * *LFL*, then the maximum charge *shall* be calculated as for an AI *refrigerant* (Section 9.3).

The *maximum refrigerant charge*, $m_{c,max}$, permitted in a single *refrigeration system shall* be as *specified* in the *manufacturer's installation instructions* of the *listed equipment*.

In the absence of the *manufacturer's installation instructions*, the *maximum refrigerant charge*, $m_{c,max}$, for any single *refrigeration system shall* be calculated using Equation A1, with *RCL*, *LFL*, and SF values from Table A1 and volumes calculated per Section 9.5.

In all situations, $m_{c,max}$ for A2L *refrigerants shall not* exceed m_2.

If there are neither *ventilation air* nor *safety shut-off valves*, then $m_{rel,max} = m_{c,max}$.

$$m_{c,max} = m_{rel,max} + m_{ssov} + m_v \quad \text{(Equation 13.3.1)}$$

where:

$m_{rel,max}$ = (V * *LFL*/SF) (Equation 13.3.2)

$$m_v = \frac{Q_{act} \times LFL \times 4}{SF \times 60} \quad \text{(Equation 13.3.3)}$$

Q_{act} = the actual *ventilation air* used; Q_{act} *shall* be ≥ Q_{min} (refer to Section 11)

V = volume as determined by Section 9.5

SF = safety factor as given in Table 13.3

Table 13.3 Maximum Charge Formula for A2L *Refrigerants*

***Safety Shut-Off Valve* Installed**	***Ventilation* Installed**	**SF**	m_{ssov}	m_v
No	No	4	0	0
Yes	No	4	$m_2 - m_{rel,max}$	0
No	Yes	4	0	Equation 13.3.3
Yes	Yes	4	$m_2 - m_{rel,max} - m_v$	Equation 13.3.3

13.4 *Releasable Charge* for *Multi-Split Systems* Using *Safety Shut-Off Valves* with Class A2L *Refrigerants*. The *releasable charge*, m_{rel}, *shall* be the largest value as calculated by Sections 13.4.2 or Section 13.4.3 multiplied by 1.30. The *releasable charge shall* be calculated using the internal volume of all interconnecting *tubing* and all *indoor sections* downstream of the *safety shut-off valves*. Internal volume of *tubing shall* be determined by multiplying the length of *tubing* times the internal volume per length *specified* in Table 13.4. The *releasable charge*, m_{rel}, *shall* not exceed the *maximum releasable charge*, $m_{rel,max}$ (as calculated in Section 13.3). *Refrigerant* real gas properties *shall* be from either NIST REFPROP, or ISO Standard 17584, or the *refrigerant manufacturer*.

Table 13.4 Tube Volume Per Unit Length

Tube OD		**Tube Internal Volume per Unit Length**	
mm	**in**	**m^3/m**	**ft^3/ft**
6.35	0.250	1.77E-05	2.05E-04
7.94	0.313	3.10E-05	3.59E-04
9.53	0.375	4.80E-05	5.55E-04
12.7	0.500	9.29E-05	1.08E-03
15.9	0.625	1.49E-04	1.73E-03
19.1	0.750	2.14E-04	2.48E-03
22.2	0.875	2.96E-04	3.43E-03
25.4	1.000	3.89E-04	4.50E-03
28.6	1.125	5.03E-04	5.82E-03
31.8	1.250	6.23E-04	7.21E-03
38.1	1.500	9.10E-04	1.05E-02
41.3	1.625	1.08E-03	1.25E-02
54.0	2.125	1.88E-03	2.18E-02
66.7	2.625	2.89E-03	3.35E-02

NOTE: Values in IP units are for reference only.

13.4.1 *Refrigerant* Density Values for Calculation of *Releasable Charge*. Table 13.4.1 provides values of *refrigerant* density that may be used to calculate *releasable charge* in the absence of *refrigerant* properties from NIST REFPROP, or ISO Standard 17584, or the *refrigerant manufacturer*.

Table 13.4.1 *Refrigerant* Densities to be Used When Calculating *Releasable Charge*

***Refrigerant* Property**	**Density (kg/m^3)**	**Density (lbm/ft^3)**
ρ_{VAP-H}	63.0	3.9
ρ_{LIQ-H}	913.9	57.1
ρ_{MIX-H}	573.5	35.8
ρ_{VAP-C}	33.8	2.1
ρ_{LIQ-C}	898.6	56.1
$\rho_{MIX-C–}$	725.6	45.3
$\rho_{MIX-OFF}$	196.8	12.3

13.4.2 *Releasable Charge* in Heating Mode. The *releasable charge* in the heating mode, $m_{rel\text{-}H}$, *shall* be calculated per the following:

$$m_{rel\text{-}H} = L_{VAP} \times TD_{LIQ} \times \rho_{VAP-H} + L_{LIQ} \times TD_{LIQ} \times \rho_{LIQ-H} + IV_{UNIT} \times \rho_{MIX-H} + [68\ g/s * T_{RESP}]/1000 \quad \text{(Eq. 13.4.2)}$$

where

L_{VAP} is the total length of vapor interconnecting *tubing* from *safety shut-off valves* to each indoor unit, m

TD_{VAP} is the tube volume per length for tube diameter L_{VAP} from Table B1.0, m^3/m

ρ_{VAP-H} is the vapor *refrigerant* density in the heating mode when operating at 8°C (47°F) dry bulb outdoor ambient and 21°C (70°F) dry bulb return air conditions, kg/m^3

L_{LIQ} is the total length of liquid interconnecting *tubing* from *safety shut-off valves* to each indoor unit, m

TD_{LIQ} is the tube volume per length for tube diameter L_{LIQ} from Table B1.0, m^3/m

ρ_{LIQ-H} is the liquid *refrigerant* density in the heating mode when operating at 8°C (47°F) dry bulb outdoor ambient and 21°C (70°F) dry bulb return air conditions, kg/m^3

IV_{UNIT} is the total internal volume of all *indoor sections* including coils, *headers*, *tubing*, and all *refrigerant* containing parts of the units that are downstream of the *safety shut-off valve* as determined by the *manufacturer*, m^3

ρ_{MIX-H} is the *refrigerant* density assuming 60% liquid and 40% vapor (= 0.60 × ρ_{LIQ-H} + 0.40 × ρ_{VAP-H}), kg/m^3

T_{RESP} is the response time for *refrigerant* detection system in seconds, which *shall* be 30 seconds

13.4.3 *Releasable Charge* in Cooling Mode. The *releasable charge* in the cooling mode, $m_{rel\text{-}C}$, *shall* be calculated per the following:

$$m_{rel\text{-}C} = L_{VAP} \times TD_{LIQ} \times \rho_{VAP-C} + L_{LIQ} \times TD_{LIQ} \times \rho_{LIQ-C} + IV_{UNIT} \times \rho_{MIX-C} + [68\ g/s * T_{RESP}]/1000 \quad \text{(Eq. 13.4.3)}$$

where

L_{VAP} is the total length of vapor interconnecting *tubing* from *safety shut-off valves* to each indoor unit, m

TD_{VAP} is the tube volume per length for tube diameter L_{VAP} from Table B1.0, m^3/m

$\rho_{VAP\text{-}C}$ is the vapor *refrigerant* density in the cooling mode when operating at 35°C (95°F) dry bulb outdoor ambient and 27°C (80°F) dry bulb/19°C (67°F) wet bulb return air conditions, kg/m^3

L_{LIQ} is the total length of liquid interconnecting *tubing* from *safety shut-off valves* to each indoor unit, m

TD_{LIQ} is the tube volume per length for tube diameter L_{LIQ} from Table B1.0, m^3/m

$\rho_{LIQ\text{-}C}$ is the liquid *refrigerant* density in the cooling mode when operating at 35°C (95°F) dry bulb outdoor ambient and 27°C (80°F) dry bulb/19°C (67°F) wet bulb return air conditions, kg/m^3

IV_{UNIT} is the total internal volume of all *indoor sections* including coils, *headers*, *tubing*, and all *refrigerant* containing parts of the units that are downstream of the *safety shut-off valve* as determined by the *manufacturer*, m^3

$\rho_{MIX\text{-}C}$ is the *refrigerant* density assuming 80% liquid and 20% vapor (= $0.80 \times \rho_{LIQ\text{-}C} + 0.20 \times \rho_{VAP\text{-}C}$), kg/m^3

T_{RESP} is the response time for *refrigerant* detection system in seconds, which *shall* be 30 seconds

14. MAXIMUM INDUCTIVE ELECTRICAL LOAD FOR ADD-ON HEAT PUMPS

14.1 The maximum allowable inductive load (switched electrical load) in kVA for *add-on heat pumps shall* be calculated with one of the following equations:

$Le = 5 \times (6.7/Su)^4$ when breaking all phases; (Eq. 14.1.1)

or

$Le = 2.5 \times (6.7/Su)^4$ when breaking two legs of a three phase load, or when breaking on or two legs of a single phase load (Eq. 14.1.2)

where:

Le is the switched inductive electrical load in kilovolt amperes (kVA), and

Su is the burning velocity of the *refrigerant* in centimeters per second (cm/s).

The burning velocity (Su) *shall* be the higher value of

- the value *specified* in ISO 817, or
- the measured value in humid air at 27°C ± 0.5°C dew point at 101.3 kPa containing 21.0 ± 0.1% O_2 excluding water vapor determined at the nominal composition as *specified* in ISO 817.

15. NORMATIVE REFERENCES

This section contains a complete list of normative references. A complete list of references that are solely informative are included in Informative Appendix D.

1. ACCA. 2016. ANSI/ACCA 1 Manual D, *Residential Duct Systems*. Arlington, VA: Air Conditioning Contractors of America.

2. ACCA. 2015. ANSI/ACCA Standard 5 QI, *HVAC Quality Installation Specification*. Arlington, VA: Air Conditioning Contractors of America.

3. AHRI. 2019. AHRI Standard 700, *Specifications for Refrigerants*. Arlington, VA: Air-Conditioning, Heating, and Refrigeration Institute.

4. ASHRAE. 2019. ANSI/ASHRAE Standard 15, *Safety Standard for Refrigeration Systems*. Atlanta, GA: ASHRAE.

5. ASHRAE. 2019. ANSI/ASHRAE Standard 34, *Designation and Safety Classification of Refrigerants*. Atlanta,

GA: ASHRAE.

6. ASTM. 2011. ASTM B68/B68M, *Standard Specification for Seamless Copper Tube, Bright Annealed*. West Conshohocken, PA: American Society for Testing and Materials.
7. ASTM. 2011. ASTM B75/B75M, *Standard Specification for Seamless Copper Tube*. West Conshohocken, PA: American Society for Testing and Materials.
8. ASTM. 2016. ASTM B88, *Standard Specification for Seamless Copper Water Tube*. West Conshohocken, PA: American Society for Testing and Materials.
9. ASTM. 2016. ASTM B280, *Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.* West Conshohocken, PA: American Society for Testing and Materials.
10. ASTM. 2016. ASTM B1003, *Standard Specification for Seamless Copper Tube for Linesets.* West Conshohocken, PA: American Society for Testing and Materials.
11. IAPMO. 2018. IAPMO/ANSI UMC 1, *Uniform Mechanical Code*. Ontario, CA: The International Association of Plumbing and Mechanical Officials.
12. ICC. 2018. International Code Council, *International Mechanical Code*. Falls Church, VA: International Code Council.
13. ICC. 2018. International Code Council, *International Residential Code*, Mechanical Section. Falls Church, VA: International Code Council.
14. ISO. 2005. ISO Standard 17584, *Refrigerant Properties*. Geneva, Switzerland: International Standards Organization.
15. NIST. 2013. NIST Standard Reference Database 23: Reference Fluid Thermodynamic and Transport Properties–REFPROP, Version 9.1. Gaithersburg, MD: National Institute of Standards and Technology.
    NOTE: The referenced software version or more recent version is acceptable. http://www.nist.gov/srd/nist23.cfm, https://pages.nist.gov/REFPROP-docs/, including patch update DLL version 9.1108 (July 29, 2014) and mixing parameter file HMX.BNC (November 9, 2015).
16. NFPA. 2020. NFPA 70, *National Electric Code*. Quincy, MA: National Fire Protection Association.
17. NFPA. 2018. NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*. Quincy, MA: National Fire Protection Association.
18. NFPA. 2018. NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems*. Quincy, MA: National Fire Protection Association.
19. UL. 2020. ANSI/UL 207, *Standard for Refrigerant-Containing Components and Accessories, Nonelectrical*. St. Charles, IL: United Laboratories.
20. UL. 2016. ANSI/UL 60335-1, *Safety of Household and Similar Appliances, Part 1: General Requirements*. St. Charles, IL: United Laboratories.
21. UL. 2019. ANSI/UL 60335-2-40, *Safety of House and Similar Electrical Appliances, Part 2-40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners, and Dehumidifiers*. St. Charles, IL: United Laboratories.

(This appendix is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

INFORMATIVE APPENDIX A—EXPLANATORY MATERIAL

This informative appendix is not part of the standard. It provides explanatory information related to provision in the standard. Sections of the standard with associated explanatory information in this appendix are marked with an asterisk "*" after the section number, and the associated appendix information is located in a corresponding section number preceded by "A".

A2. SCOPE

Although the scope of ASHRAE Standard 15.2 is broad enough to encompass all *refrigerants* and cord-connected *appliances*, provisions currently provided in this standard are limited to Group A1 and A2L *refrigerants*, and cord-connected *appliances* are not addressed. *Refrigeration systems* using *refrigerants* other than Group A1 and A2L are thereby covered by the scope of ANSI/ASHRAE Standard 15, *Safety Standard for Refrigeration Systems*, and the regulation of cord-connected *applicances* is deferred to applicable UL standards. For ammonia *refrigeration systems*, refer to ANSI/IIAR Standard 2, *American National Standard for Safe Design of Closed-Circuit Ammonia Refrigeration Systems*.

A4. DEFINITIONS

add-on heat pump: often referred to as a "furnace coil", which is a cooling coil that sits on top of (or under or beside) a furnace (which can be fossil-fuel-fired or electric).

field installed accessories: such accessories include condensate pumps, UV lights, components having motors, items in the airstream such as supplemental electric heat, duct fans, zone dampers, humidifiers, dehumidifiers, and other items considered part of the system installation, such as circuit boards and controllers.

ignition source: such sources include *appliance* burners, burner ignitions, and electrical switching devices.

pressure-relief device: temperature regulated devices are excluded here because they are covered via the use of a ***fusible plug*****.**

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INFORMATIVE APPENDIX B—GENERAL SERVICE AND MAINTENANCE

B1 Service Instructions

B1.1 Personnel performing service and maintenance of the *refrigeration system shall* be trained and competent with respect to their tasks, meeting all applicable local, state, or national licensing requirements.

B1.2 Personnel performing service and maintenance *shall* follow *manufacturer's* instructions with respect to the addition and removal of *refrigerants*, oils, additives, controls, and accessories. Maintenance and service personnel *shall* adhere to *manufacturer specified* service requirements.

B2 Service and Maintenance Documentation

B2.1 The service or maintenance technician *shall* keep a service record of all service and maintenance performed on the *refrigerant* detection system or when the *refrigeration circuit* is repaired or replaced. This service record *shall* be kept on site. The service record *shall* be protected from weather and moisture.

B1.2 In the service record, the following information *shall* be recorded:

a. Date of service and initials of technician performing the work
b. Details of all maintenance and repair work performed on *refrigerant detectors* or *refrigerant circuits* and validation that maintenance and repair work has left the system in proper working order
c. Quantities and kind (new, reused, or recycled) of *refrigerant* which have been charged on each occasion, and the quantities of *refrigerant* which have been transferred from the system on each occasion (see also Sections 6.1 and 6.2)
d. Changes and replacements of all components of the system
e. Results of all periodic/routine inspections

B3 Maintenance

B3.1 *Refrigeration systems shall* be maintained by the user in a clean condition, free from accumulations of oily dirt, waste, and other debris, and *shall* be kept with *access* at all times.

B3.2 Maintenance, service, and replacement of *refrigerant* detection systems or *refrigerant* detection system components *shall* be performed in accordance with the system *manufacturer's* instructions.

B4 Repair

B4.1 Repairs on *refrigerant* containing components *shall* be performed by certified, licensed personnel and carried out in the following order, if appropriate:

a. Remove *refrigerant*
b. Purge the circuit with inert gas
c. Cut out the component to be repaired
d. Replacing the components to be repaired/replaced (e.g. filter drier, coil, *compressor*, power drive, *pressure vessel*, *tubing*)
e. Leak check per Section 8
f. evacuating and recharging with *refrigerant*
g. functional testing and checking of the repaired component

B4.2 *Refrigerant* Leaks

B4.2.1 For A2L systems, *refrigerant* leaks *shall* be identified, repaired, and verified prior to adding additional *refrigerant* into the system. Patterns of adding *refrigerant* (once per three years or more often) *shall* be considered proof of a leak. Any addition of *refrigerant shall* be marked on the *appliance*, indicating the date and amount.

B4.2.2 After any *refrigerant system* repair the following *shall* be performed:

a. Leak check all joints internal to the building to which service personnel have *access*
b. Verify *refrigerant detector* is functioning per *manufacturer's installation instructions*
c. Verify mitigation *ventilation*/*circulation* system is functioning

B4.3 After a *pressure-relief valve* has been actuated, it *shall* be replaced.

B4.4 When oil is drained from a *refrigeration system* it *shall* be removed safely in accordance with the system *manufacturer's* instruction manual.

B5 Change of *Refrigerant* Type

Refer to Section 6.2.6.

B6 Charging, Withdrawal, and Disposition of *Refrigerants*

B6.1 No service containers *shall* be left connected to a system except while charging or withdrawing *refrigerant*. *Refrigerants* withdrawn from *refrigeration systems shall* be transferred to *approved* containers only. Except for discharge of *pressure-relief devices* and *fusible plugs*, incidental releases due to leaks, purging of non-condensables, draining oil, and other routine operating or maintenance procedures, no *refrigerant shall* be intentionally vented to the atmosphere or to locations such as a sewer, river, stream, or lake.

B6.2 Containers. Containers used for *refrigerants* withdrawn from a *refrigeration system shall* be as prescribed in the pertinent regulations of the U.S. Department of Transportation, or equivalent local enforcement agency, and *shall* be weighed each time they are used for this purpose. Containers *shall not* be filled in excess of the permissible filling weight.

B6.3 Calibration of Pressure-Measuring *Equipment.* Pressure-measuring *equipment shall* be checked for accuracy and calibrated prior to test and immediately after every occasion of unusually high (full-scale) pressure, either by comparison with master gages or a dead-weight pressure gage tester, over the operating range of the *equipment*.

B6.4 Periodic Tests. *Refrigerant* detection systems, alarm(s), and mechanical ventilating systems *shall* be tested in accordance with *manufacturers'* specifications.

(This appendix is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

INFORMATIVE APPENDIX C—REVISIONS TO PREVIOUSLY APPROVED TITLE, PURPOSE, AND SCOPE

The title, purpose, and scope (TPS) of this draft standard has been modified from the originally approved title, purpose, and scope of the project. This page contains the TPS changes, as approved by the ASHRAE Standards Committee in both "track changes" and "clean" format. The TPS in the body of the proposed Standard 15.2P draft is the "clean" version shown below.

The following is the previously approved TPS in addition (underline) and deletion (strikethrough) format.

TITLE: Safety Standard for Refrigeration~~Air-Conditioning and Heat Pump~~ Systems in Residential Applications

PURPOSE: This standard specifies the minimum requirements for the safe design~~,~~ and installation~~, operation, and maintenance~~ of *refrigeration* ~~air-conditioning~~ *systems* used in residential applications.

SCOPE:

~~This standard establishes safeguards for life, limb, health, and property, and prescribes safety requirements~~

This standard applies to ~~the design, installation, operation, and maintenance of mechanical air-conditioning and heat pump systems installed in stationary applications that include~~ *listed direct refrigeration systems* in the following residential applications that are limited to serving only a single *dwelling unit* or *sleeping unit*:

a. One-~~one-~~ and two-family *dwellings* and townhouses,~~(single-family detached, duplexes, and townhomes), or~~
b. Detached outbuildings associated with a one- or two-family *dwelling* or townhouse and located on the same property included in a) above, and
c.~~b.~~ ~~multi-family structures within~~individual *dwelling units* and *sleeping units* located in a *multi-family dwelling*.~~, where each dwelling unit has its own heating and air-conditioning system, or~~
~~c. outbuildings and pool houses located on the same private property as a one- or two-family dwelling~~

The following is the revised TPS in "clean" format.

TITLE: Safety Standard for Refrigeration Systems in Residential Applications

PURPOSE: This standard specifies the minimum requirements for the safe design and installation of *refrigeration systems* used in residential applications.

SCOPE:

~~This standard establishes safeguards for life, limb, health, and property, and prescribes safety requirements~~

This standard applies to ~~the design, installation, operation, and maintenance of mechanical air-conditioning and heat pump systems installed in stationary applications that include~~ *listed direct refrigeration systems* in the following residential applications that are limited to serving only a single *dwelling unit* or *sleeping unit*:

a. One- and two-family *dwellings* and townhouses,
b. Detached outbuildings associated with a one- or two-family *dwelling* or townhouse and located on the same property included in a) above, and
c. individual *dwelling units* and *sleeping units* located in a *multi-family dwelling*.

(This appendix is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

INFORMATIVE APPENDIX D—INFORMATIVE REFERENCES

This appendix contains a full list of informative references only. A full list of normative references is included in Section 15, Normative References.

1. ACCA. 2013. ANSI/ACCA 4 QM, *Quality Maintenance of Residential HVAC Systems.* Arlington, VA: Air Conditioning Contractors of America.
2. IEC. 2004. ANSI/IEC 60529, *Degrees of Protection Provided by Enclosures (IP Code)*. Geneva, Switzerland: International Electrotechnical Commission.
3. ICC. 2018. International Code Council, *International Residential Code*. Falls Church, VA: International Code Council.
4. SMACNA. 2016. *Residential Comfort System Installation Standards Manual*. Chantilly, VA: Sheet Metal and Air Conditioning Contractors' National Association.
5. UL. 2013. ANSI/UL 181, *Standard for Factory-Made Air Ducts and Air Connectors*. St. Charles, IL: United Laboratories.
6. UL. 2013. ANSI/UL 181A, *Standard for Closure Systems for Use with Rigid Air Ducts*. St. Charles, IL: United Laboratories.
7. UL. 2013. ANSI/UL 181B, *Standard for Closure Systems for Use with Flexible Air Ducts and Air Connectors*. St. Charles, IL: United Laboratories.
8. UL. 2015. ANSI/UL 900, *Standard for Air Filter Units*. St. Charles, IL: United Laboratories.