# UL 2182

## STANDARD FOR SAFETY

Refrigerants

UL Standard for Safety for Refrigerants, UL 2182

Second Edition, Dated April 21, 2006

***Summary of Topics***

***This revision of ANSI/UL 2182 dated February 11, 2022 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.***

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

The requirements are substantially in accordance with Proposal(s) on this subject dated December 24, 2021.

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**APRIL 21, 2006**
(Title Page Reprinted: February 11, 2022)

**ANSI/UL 2182-2017 (R2022)**



# UL 2182

## Standard for Refrigerants

First Edition – December, 1994

**Second Edition**

**April 21, 2006**

This ANSI/UL Standard for Safety consists of the Second Edition including revisions through February 11, 2022.

The most recent designation of ANSI/UL 2182 as a Reaffirmed American National Standard (ANS) occurred on February 11, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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## INTRODUCTION

### 1 Scope

1.1 This standard contains test procedures and methods to evaluate refrigerants and mark their containers according to the extent of the refrigerant's flammability with regard to their intended use as components of air-conditioning and refrigeration equipment.

1.2 *Deleted*

1.3 The refrigerants covered in this standard are shipped either as:

a) Liquids or gases in United States (US) Department Of Transportation (DOT) Code of Federal Regulations (CFR) Title 49 (or the equivalent specifications in a given country of origin) containers where applicable, or

b) Gases compressed to liquids in US DOT CFR Title 49 (or the equivalent specifications in a given country of origin) containers where applicable.

This standard does not contain requirements for the containers that hold the refrigerants.

1.4 The data developed by this standard is with respect to the risk of fire only.

1.5 This standard does not cover the physiological effects of the decomposition products of refrigerants, in any form, nor does it cover the efficiency or effectiveness of the refrigerants in their intended uses. This standard does not contain requirements to investigate the toxicity of the refrigerants.

1.6 This standard does not cover the evaluation of refrigerants with regard to hazard communication systems (e.g. Globally Harmonized System of Classification and Labeling of Chemicals or GHS).

### 2 General

#### 2.1 Units of measurement

2.1.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

#### 2.2 Undated references

2.2.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

### 3 Glossary

3.1 For the purpose of this Standard, the following definitions apply.

3.2 AMBIENT TEMPERATURE – 23.0 ±3.0°C (73.4 ±5.4°F).

3.3 AUTOIGNITION TEMPERATURE – The minimum temperature to which any part of a vapor-air mixture must be raised by application of heat to produce self-sustained (autogenous) combustion, as indicated by the appearance of flame or glow. The autoignition temperature of a liquid or gas is not a physical constant, and is affected by variables such as the size, shape, and degree of confinement of the space in which the ignition occurs, catalytic and other actions of the heated surface, surface combustion, initial pressure, and the concentration of the vapor-air mixture.

3.4 AZEOTROPIC – Blends comprising multiple components of different volatilities that, when used in refrigeration cycles, do not change volumetric composition or saturation temperature as they evaporate (boil) or condense at constant pressure (also see definition of ZEOTROPIC). Such blends are assigned an R-500 series number in accordance with ANSI/ASHRAE Standard 34, Standard for Designation and Safety Classification of Refrigerants.

3.5 BLENDS – Refrigerants consisting of mixtures of two or more different chemical compounds.

3.6 COMPOUNDS – Substances formed by the chemical combination of two or more elements in definite proportions by mass.

3.7 FLAME PROPAGATION – Combustion causing a flame which moves continuously upward and outward from the point of ignition without help from the ignition source.

3.8 FRACTIONATION – A change in composition of a blend by preferential evaporation of the more volatile component(s) or condensation of the less volatile component(s).

3.9 HALOCARBON – A hydrocarbon derivative containing one or more halogens; hydrogen also may be present.

3.10 HALOGEN – One of the electronegative elements (fluorine, chlorine, bromine, iodine, astatine) found in Group VII A of the Periodic Table.

3.11 HEAT OF COMBUSTION – The heat released when substances are combusted, determined as the difference in enthalpy (heat of formation) between the reactants, fuel (refrigerant) and oxygen, and the reaction products after combustion. The heat of combustion exceeds zero for exothermic reactions (those that give off heat) and is negative for endothermic reactions (those that require heat). The heat or enthalpy of combustion is often expressed as energy per mass (e.g., kJ/kg or Btu/lb).

3.12 HYDROCARBON – A compound containing only the elements hydrogen and carbon.

3.13 LIMITS OF FLAMMABILITY – The range of refrigerant concentrations in air, minimum and maximum, capable of flame propagation in accordance with the Standard Test Method for Concentration Limits of Flammability of Chemicals (Vapors and Gases), ASTM E681, using a spark ignition source and a 5 L (hydrocarbon single or blends) or 12 L (halocarbon single or blends) flask.

3.14 LOWER FLAMMABILITY LIMIT (LFL) – The minimum concentration of the refrigerant that is capable of propagating a flame in a homogeneous mixture of the refrigerant and air under specific conditions of tests. The LFL normally is expressed as refrigerant percentage by volume under ambient atmospheric temperature and pressure conditions. Conversion factors for expressing LFL in units of mass per unit volume (i.e. $kg/m^3$ or $lb/ft^3$) are dependent upon the temperature and pressure of the tested refrigerant-air mixture.

3.15 NOMINAL FORMULATION – The bulk manufactured composition of the refrigerant which shall be represented by the liquid composition in a cylinder which is 80 percent or more liquid filled.

3.16 REFRIGERANT – The fluid used for heat transfer in a refrigerating or air conditioning system; the refrigerant absorbs heat and transfers it, usually with a phase change. Substances added to provide other functions such as lubricants, leak detection, absorption or drying are not refrigerants.

3.17 WORST-CASE FORMULATION – The nominal formulation, which includes the manufacturer's sales specification tolerances, that contains the most flammable concentration of components.

3.18 WORST-CASE FRACTIONATED FORMULATION(S), (WCFF) – The composition during fractionation of the worst-case formulation that results in the highest concentration of flammable component(s) in the vapor or liquid phase for a mixture containing one flammable component, or the most flammable composition for a mixture containing two or more flammable components. (See 5.1.2, 5.1.3, and 5.2 for fractionation conditions).

3.19 ZEOTROPIC – Blends comprising multiple components of different volatilities that, when used in refrigeration cycles, change volumetric composition and saturation temperatures as they evaporate (boil) or condense at constant pressure. Such blends are assigned an R-400 series number in accordance with ANSI/ASHRAE Standard 34, Designation and Safety Classification of Refrigerants.



## 3A Refrigerant Purity

3A.1 Refrigerant purity shall comply with the requirements of AHRI Standard 700 "Specification for Fluorocarbon Refrigerants" (most current revision). Refrigerants not covered by AHRI Standard 700 shall not contain more than 0.5 % by weight of volatile impurities including other refrigerants.

## 4 Storage Containers

4.1 The storage container shall comply with US DOT CFR Title 49 specifications, or the equivalent specifications in a given country of origin.

4.2 The storage container shall include a means to discharge liquid when the container holds a refrigerant blend.

## PERFORMANCE

## 5 Fractionation Analysis

### 5.1 Leakage testing

5.1.1 Blends containing a flammable component(s) shall be evaluated to determine their worst-case fractionated formulation(s), WCFF, during storage, shipping or use. Tests shall be conducted to simulate vapor leaks from:

a) A container under storage/shipping conditions,

b) A container representing air conditioning and refrigeration equipment during normal operation, standby and shipping conditions.

5.1.2 The container used for these tests shall be able to withstand the vapor pressure of the blends at the highest temperature encountered.

5.1.3 To simulate vapor leaks under storage/shipping conditions, the container is to be liquid filled with the WCF at ambient temperature to 90 percent of mass (of maximum permissible by US DOT CFR Title 49 or the equivalent specifications in a given country of origin) fill and then vapor leaked (2 percent by weight of the initial charge per hour) at the following temperatures:

a) 54.4°C (130°F),

b) Minus 40°C (minus 40°F) or the normal boiling point plus 10°C (18°F) or bubble point at 1 atm. plus 10°C (18°F), whichever is warmer,

c) Ambient Temperature,

d) If (c) produces a more flammable blend than shown in (a) or (b), a temperature between (a) and (c) or (b) and (c) that causes the worst-case fractionation should be conducted.

In the fractionation experiment, the composition of the head space gas and remaining liquid shall be determined by analysis (i.e., gas chromatography). Analyses shall be made initially after 2 percent of the total charge has leaked, next at 10 percent weight loss, and then at intervals of 10 percent weight losses until the cylinder reaches atmospheric pressure or no liquid remains. In the event that liquid remains and atmospheric pressure is not reached, the last analysis shall be made at 95 percent weight loss.

5.1.4 To simulate vapor leaks from equipment, the container is to be liquid filled at ambient temperature to 15 percent of mass (of maximum permissible by US DOT CFR Title 49 or the equivalent specifications in a given country of origin) fill and then leaked, at the following temperatures:

a) 60°C (140°F),

b) Minus 40°C (minus 40°F) or the normal boiling point plus 10°C (18°F) or bubble point at 1 atm. plus 10°C (18°F), whichever is warmer,

c) Ambient Temperature,

d) If (c) produces a more flammable blend than shown in (a) or (b), a temperature between (a) and (c) or (b) and (c) that causes the worst-case fractionation should be conducted.

In the fractionation experiment, the composition of the head space gas and remaining liquid shall be determined by analysis (i.e., gas chromatography). Analyses shall be made initially after 2 percent of the total charge has leaked, next at 10 percent weight loss, and then at intervals of 10 percent weight losses until the cylinder reaches atmospheric pressure or no liquid remains. In the event that liquid remains and atmospheric pressure is not reached, the last analysis shall be made at 95 percent weight loss.



### 5.2 Leak/Recharge testing

5.2.1 Refrigerant blends containing a flammable component(s) shall be evaluated in accordance with 5.2.2 to determine the fractionation effect of successive leakage and recharging on the composition of the blend.

5.2.2 A cylinder is to be charged to 15 percent (of maximum permissible by DOT or the equivalent specifications in a given country of origin) fill with the worst-case formulation. A vapor leak at a rate of 2 percent by weight of the starting charge per hour from the vapor phase of the cylinder is to be created and maintained at ambient temperature [23°C (73°F)] until 20 percent of the starting charge has leaked. The cylinder is to be again charged with the worst-case formulation to 15 percent full and caused to leak in the same manner. The charge/leak cycle is to be performed a total of five times. At the conclusion of the fifth leakage, the composition of the head space gas and liquid shall be determined by analysis.

### 5.3 Fractionation determination by computer modeling

5.3.1 Computer or mathematical modeling may be used to obtain worst-case fractionation composition (WCFF) data. The model accuracy shall be verified if used to simulate the leakage and the leak/recharge testing conditions described in 5.1 and 5.2.

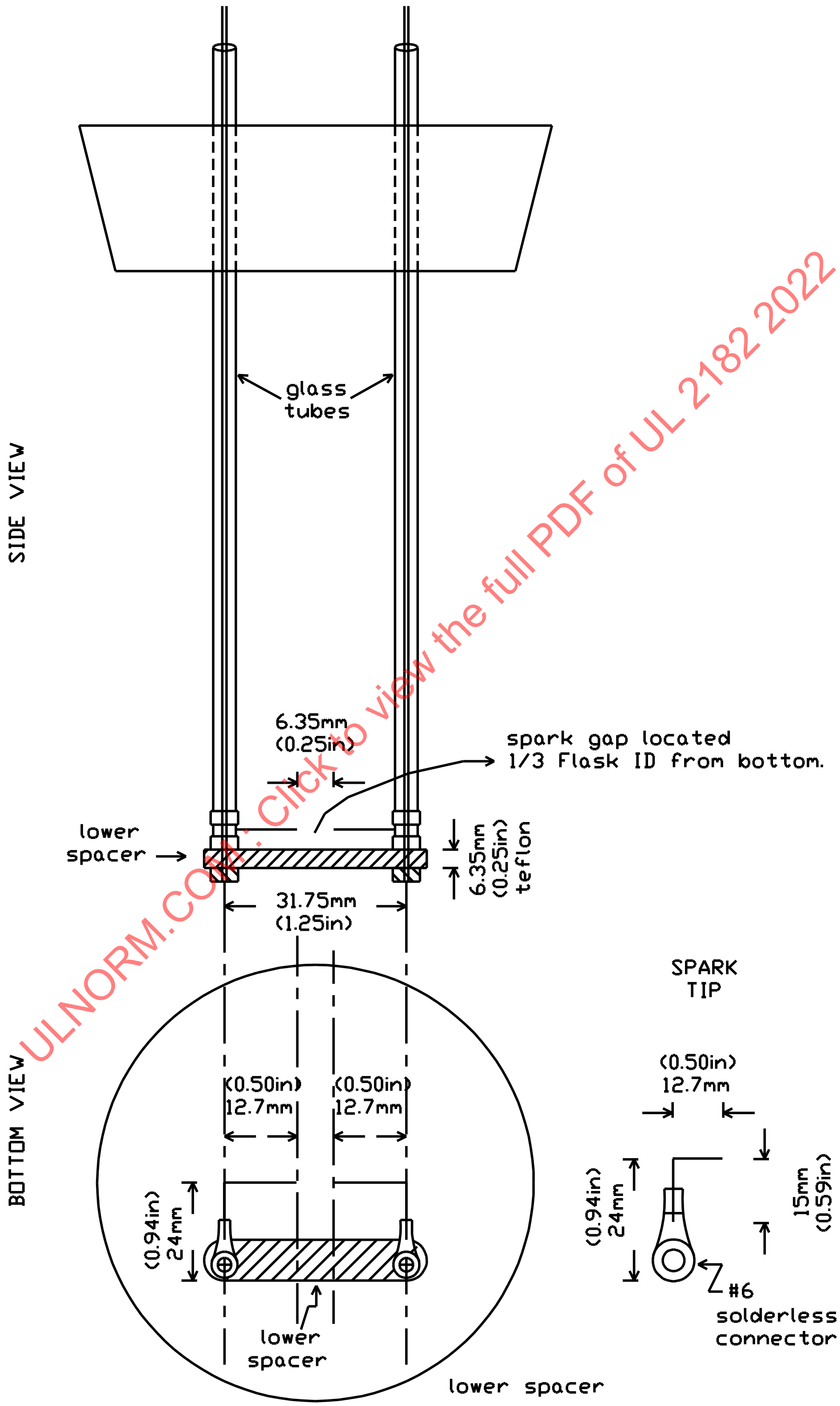
5.3.2 The fractionation composition(s) determined by modeling to be the WCFF(s) shall be confirmed by experimental verification. Experimental verification of the model shall take the form of leakage experiments (carried out in accordance with 5.1) that result in a WCFF. For blends of three or fewer components where the initial composition of the vapor or liquid phase results in a WCFF, the verification may be experimental vapor-liquid equilibrium data (VLE) at the temperature of the WCFF or over a range of temperatures that includes the temperature of the WCFF; such experiments may be carried out by performing the required tests described in 5.1 or VLE data may be taken from peer-reviewed literature.

## 6 Flammability Limit Testing

6.1 Flammability tests shall be conducted in accordance with ASTM E681, Standard Test Method for Concentration Limits of Flammability of Chemicals (Vapors and Gases). The absolute humidity of the air used for mixing is to be 0.0086 ±0.0005 grams water vapor per gram dry air [which equates to 50 percent relative humidity at 23°C (73°F)]. Tests shall be conducted at the conditions specified in 6.4 and at 0.1 percent by volume (refrigerant/air) increments. The ignition source is to be the spark as described in ASTM E681, with a 0.4 s spark duration (see spark assembly diagram, Figure 6.1). The vessel size is to be a nominal 5 L (0.177 $ft^3$) flask for hydrocarbon refrigerants or a nominal 12 L (0.424 $ft^3$) flask for halocarbon refrigerants or difficult to ignite materials.

**Figure 6.1**

**Spark assembly**

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