ANSI/ASHRAE Addenda a, b, c, d, e, f, g, and h to
ANSI/ASHRAE Standard 34-2007

ASHRAE ADDENDA

Designation and Safety Classification of Refrigerants

Approved by the ASHRAE Standards Committee on June 23, 2007, by the ASHRAE Board of Directors on June 27, 2007, and by the American National Standards Insitute on June 28, 2007.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE Web site, http://www.ashrae.org, or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada).

ISSN 1041-2336

Approved American National Standard

ANSI

www.ansi.org

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SPECIAL NOTE

This American National Standard (ANS) is a national voluntary consensus standard developed under the auspices of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). *Consensus* is defined by the American National Standards Institute (ANSI), of which ASHRAE is a member and which has approved this standard as an ANS, as "substantial agreement reached by directly and materially affected interest categories. This signifies the concurrence of more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that an effort be made toward their resolution." Compliance with this standard is voluntary until and unless a legal jurisdiction makes compliance mandatory through legislation.

ASHRAE obtains consensus through participation of its national and international members, associated societies, and public review.

ASHRAE Standards are prepared by a Project Committee appointed specifically for the purpose of writing the Standard. The Project Committee Chair and Vice-Chair must be members of ASHRAE; while other committee members may or may not be ASHRAE members, all must be technically qualified in the subject area of the Standard. Every effort is made to balance the concerned interests on all Project Committees.

The Assistant Director of Technology for Standards and Special Projects of ASHRAE should be contacted for:

a. interpretation of the contents of this Standard,
b. participation in the next review of the Standard,
c. offering constructive criticism for improving the Standard, or
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(This foreword 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.)

FOREWORD

This addendum adds a designation of R-429A to the blend R-E170/152a/600a (60.0/10.0/30.0) with composition tolerances of (±1.0/±1.0/±1.0), a safety classification of A3, and an RCL of 6300 ppm, 13 g/m^3, 0.81lb/Mcf.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum a to 34-2007

Add to Table 2 the following entries for R-429A:

Refrigerant Number = 429A
Composition (Mass %) = R-E170/152a/600a (60.0/10.0/30.0)
Composition Tolerances = (±1.0/±1.0/±1.0)
Safety Group = A3
RCL = 6300 (ppm v/v), 13 (g/m^3), 0.81 (lb/Mcf)

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FOREWORD

This addendum adds a designation of R-430A to the blend R-152a/600a (76.0/24.0) with composition tolerances of (±1.0/±1.0), a safety classification of A3, and an RCL of 8000 ppm, 21 g/m^3, 1.3 lb/Mcf.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum b to 34-2007

Add to Table 2 the following entries for R-430A:

Refrigerant Number = 430A
Composition (Mass %) = R-152a/600a (76.0/24.0)
Composition Tolerances = (±1.0/±1.0)
Safety Group = A3
RCL = 8000 (ppm v/v), 21 (g/m^3), 1.3 (lb/Mcf)

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FOREWORD

This addendum adds a designation of R-431A to the blend R-290/152a (71.0/29.0) with composition tolerances of (±1.0/±1.0), a safety classification of A3, and an RCL of 5500 ppm, 11g/m³, 0.69 lb/Mcf.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum c to 34-2007

Add to Table 2 the following entries for R-431A:

Refrigerant Number = 431A
Composition (Mass %) = R-290/152a (71.0/29.0)
Composition Tolerances = (±1.0/±1.0)
Safety Group = A3
RCL = 5500 (ppm v/v), 11 (g/m³), 0.69 (lb/Mcf)

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FOREWORD

This addendum adds a designation of R-432A to the blend R-1270/E170 (80.0/20.0) with composition tolerances of (±1.0/±1.0), a safety classification of A3, and an RCL of 1200 ppm, 2.1 g/m^3, 0.13 lb/Mcf.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum d to 34-2007

Add to Table 2 the following entries for R-432A:

Refrigerant Number = 432A
Composition (Mass %) = R-1270/E170 (80.0/20.0)
Composition Tolerances = (±1.0/±1.0)
Safety Group = A3
RCL = 1200 (ppm v/v), 2.1 (g/m^3), 0.13 (lb/Mcf)

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FOREWORD

This addendum adds a designation of R-433A to the blend R-1270/290 (30.0/70.0) with composition tolerances of (±1.0/±1.0), a safety classification of A3, and an RCL of 3100 ppm, 5.5 g/m³, 0.34 lb/Mcf.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum e to 34-2007

Add to Table 2 the following entries for R-433A:

Refrigerant Number = 433A
Composition (Mass %) = R-1270/290 (30.0/70.0)
Composition Tolerances = (±1.0/±1.0)
Safety Group = A3
RCL = 3100 (ppm v/v), 5.5 (g/m^3), 0.34 (lbs/Mcf)

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FOREWORD

This addendum updates the RCL value for R-C318 in Table 1 to 80,000 ppm and adds RCL values for R-427A and R-428A in Table 2.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum f to 34-2007

Modify Table 1 for R-C318 as shown below:

RCL = ~~69,000~~ 80,000 (ppm v/v), ~~570~~ 660 (g/m^3), ~~35~~ 41 (lb/Mcf)

Add RCL values to Table 2 for R-427A and R-428A as shown below:

R-427A
RCL = 76,000 (ppm v/v), 280 (g/m^3), 18 (lb/Mcf)

R-428A
RCL = 83,000 (ppm v/v), 370 (g/m^3), 23 (lb/Mcf)

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FOREWORD

This addendum modifies the method of calculating the heat of combustion to more closely represent what actually occurs. It also adds an informative appendix with an example calculation.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum g to 34-2007

Revise clauses 6.1.3.5a and 6.1.3.5b as follows:

6.1.3.5 The heat of combustion shall be calculated for conditions of 25°C (77°F) and 101.3 kPa (14.7 psia).

a. For single-component refrigerants, the heat of combustion ~~can~~shall be calculated~~, if the heat of formation (enthalpy of formation) of the refrigerant and its products of reaction are known. Values for heats of formation are tabulated in several chemical and physical properties handbooks and databases.~~ The heat of combustion is the enthalpy of formation of the reactants (refrigerant and oxygen) minus the enthalpy of formation of the products of reaction. Values for heats of formation are tabulated in several chemical and physical properties handbooks and databases. In this standard, the heat of combustion is positive for exothermic reactions. Calculated values shall be based on the complete combustion of one mole of refrigerant with enough oxygen for a stoichiometric reaction. The reactants and the combustion products shall be assumed to be in the gas phase. The combustion products shall be HF(g) [note, not aqueous solution (aq)], CO_2(g), (N_2(g) or SO_2(g) if nitrogen or sulfur are part of the refrigerant's molecular structure) HCl(g), and H_2O(g) ~~CO_2, (N_2 or SO_2 if nitrogen or sulfur are part of the refrigerant's molecular structure) HF and HCl, if there is enough hydrogen in the molecule. If there is insufficient hydrogen available for the formation of both HF and HCl, then the formation of HF takes preference over the formation of HCl. The remaining F and Cl produce F_2 and Cl_2. Excess H shall be assumed to be converted to H_2O~~.

If there is insufficient H (hydrogen) available for the formation of HF(g), HCl(g), and H_2O(g) then the formation of HF(g) takes preference over the formation of HCl(g) which takes preference over the formation of H_2O. If there is insufficient hydrogen available for all of the F (fluorine) to form HF(g), then the remaining F produces COF_2(g) or CF_4(g) in preference of C (carbon) forming CO_2. Any remaining Cl (chloride) produces Cl_2(g) (chlorine).

b. For refrigerant blends, the heat of combustion shall be ~~measured or~~ calculated from a balanced stoichiometric equation of all component refrigerants. This can be thought of conceptually as breaking the refrigerant molecules into their constituent atoms and creating a hypothetical molecule with the same molar ratio of total carbons, hydrogen, fluorine, etc. as is in the original blend. The hypothetical molecule would then be treated as a pure refrigerant as in section 6.1.3.5 (a). The heat of formation for this hypothetical molecule is the molar average of the heats of formation for the original blend molecules.

Note: The molar percent or mass percent weighted average of the HOC of the pure component of a blend produces incorrect results. For an example see Appendix F.

Add informative Appendix F as follows:

(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.)

APPENDIX F
EXAMPLE CALCULATIONS FOR HEATS OF COMBUSTION (INFORMATIVE)

F.1. REACTION STOICHIOMETRY FOR A REFRIGERANT BLEND

Consider the combustion of the mixture R-125/290 (45/55), which corresponds to a mole fraction ratio of (0.2311/0.7689). If the R-125 and R-290 were to burn individually, they would undergo the following reactions:

$$\text{R-125: } C_2HF_5 + O_2 \rightarrow CO_2 + CF_4 + HF \qquad \text{(F.1)}$$

and

$$\text{R-290: } C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_20 \qquad \text{(F.2)}$$

Taking $x = 0.2311$ (the mole fraction of R-125) and $y = 0.7689$ (the mole fraction of R-290), the mixture might be thought to undergo the following combustion reaction:

$$xC_2HF_5 + yC_3H_8 + (x + 5y)O_2 \rightarrow (x + 3y)CO_2 + xCF_4 + xHF + 4yH_2O \qquad \text{(F.3)}$$

But Equation F.3 would be incorrect. Instead combine the atoms of the R-125 and R-290 into a hypothetical molecule:

$$xC_2HF_5 + yC_3H_8 \rightarrow C_{2x+3y}H_{x+8y}F_{5x} \qquad \text{(F.4)}$$

This hypothetical molecule is then reacted with oxygen:

$$C_{2x+3y}H_{x+8y}F_{5x} + (x + 5y)O_2 \rightarrow (2x + 3y)CO_2 + 5xHF + (x + 8y - 5x) / 2H_2O \qquad \text{(F.5)}$$

In comparing Equations F.3 and F.5 note that the products of combustion are different. There is no CF_4 formed in (F.5); instead, the H (hydrogen) from the R-290 combines with the F (fluorine) from the R-125 to form additional HF.

F.2. HEAT OF COMBUSTION FOR A REFRIGERANT BLEND

The enthalpy of formation of the hypothetical blend molecule is the mole-fraction weighted average of the components:

$$\begin{aligned} \Delta h_f(\text{blend}) &= x\Delta h_f(\text{R125}) + y\Delta h_f(\text{R290}) \\ &= 0.2311\ (-264.0\ \text{kcal/mol}) + 0.7689\ (-25.02\ \text{kcal/mol}) \\ &= -80.25\ \text{kcal/mol} \end{aligned} \tag{F.6}$$

The heat of combustion is the enthalpy of formation of the reactants (refrigerant and oxygen) minus the enthalpy of formation of the products of reaction:

$$\begin{aligned} \Delta h_{combustion} &= \sum \Delta h_f(\text{reactants}) - \sum \Delta h_f(\text{products}) \\ &= \{\Delta h_f(C_{2x+3y}H_{x+8y}F_{5x}) + (x+5y)\Delta h_f(O_2)\} \\ &\quad - \{(2x+3y)\Delta h_f(CO_2) + (5x)\Delta h_f(HF) + (-4x+3y)\Delta h_f(H_2O)\} \\ &= \{-80.25 + [0.2311 + 5(0.7689)][0]\} \\ &\quad - \{[2(0.2311) + 3(0.7689)][-94.05] + [5(0.2311)][-65.32] + [-2(0.2311) + 4(0.7689)][-57.80]\} \\ &= 406.70\ \text{kcal/mol} \end{aligned} \tag{F.7}$$

Note that the enthalpy of formation of any element (*i.e.* O_2) in its normal state at 25°C is zero, by definition.

TABLE F1 Sample Heats of Formation

Refrigerant	Heat of Formation, (kcal/mol)
CO_2 (g)	–94.05
H_2O (g)	–57.796
HF (g)	–65.32
HCl (g)	–22.06
HI(g)	6.33
HBr(g)	–8.69
SO_2 (g)	–70.94
SO_3 (g)	–105.41
CF_4 (g)	–223.0
CF_2O (g)	–152.7
$COCl_2$ (g)	–52.32
R290 (g)	–25.02
R125 (g)	–264.0

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FOREWORD

This addendum adds an informative appendix showing an example of the calculation of the ATEL and RCL for a refrigerant blend. Section 7.2 is also modified to refer the reader to the informative appendix.

Note: In this addendum, changes to the current standard are indicated in the text by underlining (for additions) and ~~strikethrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes.

Addendum h to 34-2007

Revise Section 7.2 as follows:

7.2 Blends. The RCL for refrigerants comprising multiple compounds shall be determined by the method in Section 7.1 except that individual parameter values in Section 7.1.1 (a) through (d) shall be calculated as the mole-weighted average, by composition of the nominal formulation, of the values for the components. The calculation used to determine the ATEL and RCL of a refrigerant blend is summarized in Appendix G. The calculation can also be performed using a computer program or spreadsheet.

Add informative Appendix G as follows:

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APPENDIX G CALCULATION OF RCL AND ATEL FOR BLENDS (INFORMATIVE)

The ATEL for a refrigerant blend shall be set as the lowest of the blend acute toxic concentration factors (TCFs) (*a*)–(*d*) in Section 7.1.1, where each blend acute TCF quantity is calculated from the acute TCF values of its individual components, following the Additivity Method for Mixtures (reference the 2006 American Conference of Governmental Industrial Hygienists (ACGIH), *Threshold Limit Values for Chemical Substances and Physical Agents).* The additivity method is especially applicable to materials of similar chemical properties, for example, hydrocarbons or halogenated hydrocarbons.

The blend acute toxicity calculation shall be done as follows:

$$\text{Blend Mortality Indicator } (a)_{blend} = \frac{1}{\frac{mf_1}{a_1} + \frac{mf_2}{a_2} + \ldots + \frac{mf_n}{a_n}}$$

where a_n is the mortality indicator for component *n* in the blend (i.e., the four-hour LC_{50}), and mf_n is the mole fraction of component *n*.

In a similar fashion, Blend Cardiac Sensitization Indicator $(b)_{blend}$ can be calculated from $1/(\sum mf_n / b_n)$, where b_n is the cardiac sensitization indicator for component *n* in the blend (i.e., 100% of the NOEL, or if not determined, 80% of the LOEL), and from the mole fraction mf_n of component *n*, and so forth for the acute TCFs (*a*)–(*d*).

Each acute TCF for a blend can be expressed in ppm (parts per million of substance in air by volume) if the acute TCFs for each component *n* are expressed in ppm and mf_n is expressed as the mole fraction of component n in the blend. [The TCF of each component shall be determined according to the priority indicated in Section 7. Thus, the determining method for each component may not be consistent such as 100% of NOEL of component A and 80% of LOEL of component B.]

Example: ATEL Calculation for R-410A (50/50 wt% R-32/R-125)

R-410A composition expressed in mole fraction is (0.698 mole fraction R-32/0.302 mole fraction R-125).

$$\text{Mortality Indicator (a) of R-410A} = \frac{1}{\frac{0.698}{215,000 \text{ ppm}} + \frac{0.302}{218,000 \text{ ppm}}}$$

where $(a)_{R\text{-}32}$ = the LC_{50} of R-32 or 760,000 ppm · 0.283 = 215,000 ppm and $(a)_{R\text{-}125}$ = the LC_{50} of R-125 or 769,000 ppm · 0.283 = 218,000 ppm. $(a)_{R\text{-}410A}$ = **216,000 ppm as the R-410A mortality indicator**.

$$\text{Cardiac Sensitization Indicator (b) of R-410A} = \frac{1}{\frac{0.698}{200,000 \text{ ppm}} + \frac{0.302}{75,000 \text{ ppm}}}$$

where $(b)_{R\text{-}32}$ = Cardiac Sensitization Indicator NOEL for R-32 or 200,000 ppm and $(b)_{R\text{-}125}$ = Cardiac Sensitization Indicator NOEL for R-125 or 75,000 ppm (NOEL).

$(b)_{R\text{-}410A}$ = **133,000 ppm as the R-410A cardiac sensitization indicator.**

$$\text{Anesthetic Effect Indicator (c) or R-410A} = \frac{1}{\frac{0.698}{200,000 \text{ ppm}} + \frac{0.302}{567,000 \text{ ppm}}}$$

where $(c)_{R\text{-}32}$ = Anesthetic Effect Indicator NOEL for R-32 or 250,000 ppm · 0.8 = 200,000 ppm and $(c)_{R\text{-}125}$ = Anesthetic Effect Indicator NOEL for R-125 or 709,000 ppm · 0.8 = 567,000 ppm. $(c)_{R\text{-}410A}$ = **249,000 ppm as the R-410A anesthetic indicator.**

Note: EC_{50} was not used because there was no value for R-32 or R-125, and LOEL was not used because the values for

R-32 and R-125 affected over half (10/10 and >5/10) the animals. Had legitimate EC_{50}, LOEL, or NOEL values been available, it would have been possible to use a EC_{50} for one blend component, a LOEL for a second, and a NOEL for a third, etc.

There are no pertinent escape-impairing or permanent injury effect indicators (*d*) known for R-410A. Therefore, the ATEL for R-410A is set on the Cardiac Sensitization Effect (*b*), 133,000 ppm, which is the lowest of acute TCFs (*a*)–(*c*) for the blend. Rounding to two significant figures gives 130,000 ppm as the ATEL of R-410A.

RCL for R-410A

Since the blend is nonflammable and the ATEL is less than the oxygen deprivation level of 140,000 ppm, the RCL is also 130,000 ppm.

POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES

ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the standards and guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive technical committee structure, continue to generate up-to-date standards and guidelines where appropriate and adopt, recommend, and promote those new and revised standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating standards and guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.