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**ARTI REFRIGERANT DATABASE
DATA SUMMARIES - VOLUME 2:
BLENDS (ZEOTROPES AND AZEOTROPES)**

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prepared by

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Introduction

This report provides data summaries from the *ARTI Refrigerant Database*. [Volumes 1](#) and [2](#) present refrigerant profiles for single-compound refrigerants and refrigerant profiles, respectively. [Volume 3](#) presents data summaries for compatibility and toxicity. They are part of a series to provide a record of the database entries in printed form.

Purpose

The Refrigerant Database is an information system on alternative refrigerants, associated lubricants, and their use in air conditioning and refrigeration. It consolidates and facilitates access to property, compatibility, environmental, safety, application, and other information. It provides corresponding information on older refrigerants, to assist manufacturers and those using alternative refrigerants to make comparisons and determine differences. The underlying purpose is to accelerate phase out of chemical compounds of environmental concern.

Contents

The database identifies sources of specific information on R-22, R-23, R-32, R-41, R-116, R-123, R-124, R-125, R-134, R-134a, R-141b, R-142b, R-143a, R-152a, R-218, R-227ea, R-236fa, R-245ca, R-245fa, R-290 (propane), R-C318, R-717 (ammonia), R-718 (water), R-744 (carbon dioxide), R-1270 (propylene), ethers, and others as well as azeotropic and zeotropic blends of these fluids. These blends include R-400, R-401A, R-401B, R-401C, R-402A, R-402B, R-403A, R-403B, R-404A, R-405A, R-406A, R-407A, R-407B, R-407C, R-407D, R-408A, R-409A, R-409B, R-410A, R-410B, R-411A, R-411B, R-412A, R-413A, R-414A, R-414B, R-415A, R-416A, R-500, R-501, R-502, R-503, R-504, R-505, R-506, R-507A, R-508A, R-508B, R-509A, and others for which information is available even though standard designations may not have been assigned yet. It addresses lubricants including alkylbenzene, polyalkylene glycol, polyolester, and other synthetics as well as mineral oils. It also references documents addressing compatibility of refrigerants and lubricants with metals, plastics, elastomers, motor insulation, and other materials used in refrigerant circuits.

The database provides bibliographic citations and abstracts for publications that may be useful in research and design of air-conditioning and refrigeration equipment. The complete docu-

ments are not included, though some may be added at a later date. Incomplete citations or abstracts are provided for some documents. They are included to accelerate availability of the information and will be completed or replaced in future updates.

Limitations

The Refrigerant Database is intended as a means to assist users in locating sources of information on alternative refrigerants. But, the database is:

- neither a comprehensive nor authoritative reference source,
- not a substitute for independent data collection by users,
- not a substitute for examination of the data, information on how they were arrived at, assumptions, and caveats in the cited documents, and
- not an endorsement of suitability or accuracy of the referenced publications.

The information in the database was obtained from published and unpublished sources, or calculated from them, without verification. Some of the data may be imprecise or incorrect, as manifested - in some cases - by inclusion of conflicting data based on disagreement among identified sources. Similarly, errors may have occurred in assembling and processing the database. Users are cautioned to check the data and associated limitations and caveats in the referenced documents and other sources before use, particularly if such use might risk harm to life or property. Newer or more complete data may be available from refrigerant suppliers or elsewhere.

Materials compatibility, properties, safety considerations, and other characteristics affecting suitability or desirability may be influenced by a number of factors. Among them are specific application conditions, preparation such as drying before use, additives including fillers, impurities, catalytic interactions with other materials used, and changes in compounding between one source or batch and another. Similarly, new findings or corrections may supersede previously published data. The database is an aid in locating data that may be pertinent; it is not and should not be viewed as the source of data for research, design, analysis, or other purposes.

Database Form

The database is available in both computerized ("electronic") and report ("manual" or "listing") versions.

Computerized Version

The computerized version includes both data summaries and bibliographic citations organized into a number of segments ("files"). These segments can be searched individually or together, in any combination.

The computerized database provides 606 specially-prepared data summaries, including refrigerant (single compound and blend) profiles, tabular compatibility summaries for plastics and

Distribution of the Refrigerant Database

	computerized (diskette)	report (listing)	documents (copies)
data summaries			
• refrigerant profiles	yes	no	^a
• compatibility	yes	no	^a
• toxicity	yes	no	^a
bibliographic citations and synopses (detailed abstracts)			
• recently added and key	yes	yes	^a
• copper supplement ^b	yes	^b	^a
• archival and historical	yes	no	^a
search and retrieval software	yes ^c	no	no
additions and changes flagged	no	yes	no
distributed on cost-recovery basis			
• subscription (periodic updates)	yes	yes	no
• as ordered	no	yes	yes ^d

^a Data summaries, citations, and synopses may be printed with the computerized version.

^b The Copper Development Association (CDA) sponsored supplement provides additional citations and synopses, most of which address compatibility with or use of copper in air-conditioning and refrigeration systems. The supplement is included and searchable with the computerized version, but published as a separate report.

^c Use of the search and retrieval software is subject to acceptance of the license agreement for it; both accompany the computerized version.

^d Distribution is limited to documents in the public domain or for which authorization has been obtained. Others may be ordered from their publishers, which are identified in the bibliographic citations.

elastomers, and toxicity reviews for refrigerants. The refrigerant profiles cover designations, common uses, chemical and trade names, other identifiers, molecular mass, critical properties (pressure, temperature, specific volume, and density at the critical point), physical and thermo-physical properties for selected conditions, safety classifications, toxicity and flammability data, exposure limits, atmospheric lifetime, ozone depletion potential, global warming potential, halogen global warming potential, commercialization, phaseout, and other data.

The computerized version also provides more than 6,100 citations. They are organized into a primary file that includes recently added and key references, a supplement on copper in air conditioning and refrigeration, and an archival group covering historical and superseded documents.

The search and retrieval software provided with the computerized version enables very fast searches for user-selected terms or combinations of terms. The search program offers several automated features to simplify use. They include optional prompting by search category, an automated "thesaurus" of synonyms and related terms, chain searches to broaden or narrow prior searches, a "wildcard" capability to allow entry of word segments, and a configuration capability to customize a number of options. The program also allows printing of selected portions of the database. Printing the entire database would yield more than 8,000 pages, so a printed version is available for those who prefer to use the database manually.

Report Version

A listing of the recent and key citations is provided in report form. The citations are grouped under the primary or first subject addressed; they are not cross-referenced under other topics. The computerized version, therefore, is better suited to search for information by subject.

Citations and summaries from the supplement on copper in air conditioning and refrigeration are published separately. They also are arranged by subject.

Archival and historic citations are included in a third report. They are presented in reverse chronological order, beginning with the most recent. These citations remain accessible through the computerized version.

Documents

The database also includes a collection of published and unpublished documents, copies of which can be ordered individually. Approximately one third of the documents cited in the database are included in this collection. They include documents that are not protected by copyright or proprietary restrictions. They also include documents for which the authors or copyright owners granted permission for reproduction and distribution. Documents that are not dis-

tributed through the database can be obtained from their publishers, libraries, and other sources (please refer to the database User's Manual for suggestions).

Ordering Information

The computerized version of the database and the report version for recently added and key references can be ordered along with a subscription for updates. The report versions of the copper supplement, archival citations, and data summaries are available as separate documents distributed through the database.

An order form for the Refrigerant Database, which indicates the pricing, accepted methods of payment, and applicable terms and conditions, may be downloaded from the Internet from <http://www.arti-21cr.org/db>. Alternatively, a copy may be obtained by mail or fax by calling +1-703/524-8800 or faxing +1-703/522-2349. Questions should be sent by e-mail to database@spectrum-internet.com. Please note that the same form may be used to obtain the computerized database and remaining scheduled updates, the report version and remaining scheduled updates for primary and key references, and database documents by completing the corresponding portions of the form.

Additions

Future updates and expansions to the database are planned. Please help in making it more useful, and facilitating use of alternative refrigerants, by submitting the following:

- corrections to errors identified in the database,
- copies of helpful papers - whether your own or written by others - for citation, and
- suggestions for improving the database.

Authors or those holding rights to published or unpublished works pertinent to the database are invited - and encouraged - to authorize their reproduction and unrestricted distribution through the database. Product literature normally is not included, but technical bulletins and papers providing relevant information, whether on proprietary or generic substances, will be considered.

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Thank you for your help with and use of the database. Its objective is to accelerate phase out of chemical compounds of environmental concern by sharing the information needed to do so.

ARTI Refrigerant Database - Data Summaries

The parameter descriptions that follow summarize the information included in data summaries for refrigerants, also referred to as *refrigerant profiles*. Each entry consists of the following parts:

- a label to identify and/or explain the data,
- a data value, typically rounded to common representation or limits of precision, generally expressed metric units or dimensionless form (metric units conform to the International System, SI, modified to use the Celsius scale for temperatures in place of the Kelvin scale),
- units of measure if applicable,
- converted data and units in the inch-pound (IP) system for data expressed in metric units,
- qualifying information on the data such as the animal species, exposure duration, and fraction of responses for toxicity test results, exposure periods, or manufacturer identity where the source is a safety data sheet, and
- four-digit alphanumeric Refrigerant Database ("RDB") number (discussed below).

The specific data included for each single-compound refrigerant or blend depend upon availability. Multiple values are cited for the same or related parameters in some cases, for example when conflicting data were published by multiple credible sources. The purpose of the database is to assist users in locating data rather than to endorse or verify specific data or to resolve inconsistencies and conflicts. Older data generally are deleted for simplification when the original source reports later results or when scientific consensus is reported, but that does not suggest endorsement of the newer data. Please refer to the discussion of data limitations on [page 2](#). The data values shown are included to assist users, but the primary information for each entry is the four alphanumeric digit "RDB" number in the right-most column, which indicates the document or other source from which the data were taken. Those sources may be located by searching for the number prefixed by "RDB" (for example *RDB9901*) in the database.

Identifiers

The refrigerant number shown in the heading is the standard designation based on those assigned by or recommended for addition to ANSI/ASHRAE Standard 34-1997, *Designation and Safety Classification of Refrigerants*, as well as pending addenda and common industry extensions thereto. These familiar designations are used almost universally, usually preceded by "R-", "R", the word "Refrigerant", composition-designating prefixes (for example "CFC-", "HCFC-", "HFC-", or "HC-"), or manufacturer trade names. Nonstandard and pending designations generally are flagged as such or identified in notes included with the common uses.

The chemical formula indicates the molecular makeup of the single-compound refrigerants, namely those consisting of a single chemical substance. The blend composition is substituted for refrigerant blends, namely those consisting of two or more chemicals that are mixed to obtain desired characteristics. The composition consists of two parts. The first identifies the components, in order of increasing normal boiling points and separated by slashes. The second part, which is enclosed in parentheses, indicates the mass fractions (as percentages) of those components in the same order. The profiles also indicate alternative chemical names, the common and historic names, index numbers for common reference databases, empirical and structural chemical formulae, and standard container colors. Among the identifiers shown are the:

- standard designation following American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), Standard 34-1997 (*Designation and Safety Classification of Refrigerants*) as well as addenda, pending addenda (flagged), and common industry extensions to it (flagged),
- variants using the "R-", "R", "R ", composition-designating prefixes (for example "CFC-", "HCFC-", or "HFC-"),
- common fluorochemical number and variants,
- halon number for chemicals also used or considered as fire suppressants,
- chemical name following the International Union of Pure and Applied Chemistry (IUPAC) convention,
- chemical name following other common conventions,
- common names,
- structural formula following the IUPAC convention,
- structural formula following other common conventions,
- empirical formula following the Hill convention,
- other formulae including some flagged as "not recommended" to enable location by them

- Chemical Abstracts Service (CAS) registry number,
- Beilstein registry number,
- European Inventory of Existing Chemical Substances (EINECS) number,
- Merck index (volume and number),
- National Institute of Occupational Safety and Health (NIOSH) Registry of Toxic Effects of Chemical Substances (RTECS) index number,
- trade name(s),
- historical name(s),
- names used for rule making notices for proprietary refrigerants in U.S. Environmental Protection Agency (EPA) Significant New Alternatives Program (SNAP) notices,
- standard container color name and Pantone number as assigned by Air-Conditioning and Refrigeration Institute (ARI) Guideline N (*Assignment of Refrigeration Container Colors*),
- composition for blends
- both mass and mole formulations for blends, and
- standard mass formulation tolerances for blends with ASHRAE safety classifications.

In some cases, primarily for proprietary blends, additional identifying information is included in the description of common uses.

Common Uses

The uses focus on application as refrigerants followed, if applicable, by terse indications of other applications if known. Limiting considerations such as toxicity, flammability, reactivity, or environmental concerns are cited for some substances.

This section also includes notes on pending changes in standard designations and safety classifications.

Physical Properties

The refrigerant profiles indicate key physical, thermodynamic, and transport properties at representative conditions, including the normal boiling point, 20 °C (68 °F), 60 °C (140 °F), and the critical point.

The molecular mass is a calculated value based on the atomic weights recognized by International Union of Pure and Applied Chemists (IUPAC). It indicates the mass in grams of a mole of the refrigerant or, for blends, the mass-weighted average of a mole of the mixture.

The normal boiling point (NBP) is the temperature at which liquid refrigerant will boil at standard atmospheric pressure, namely 101.325 kPa (14.6959 psia). The NBP and most dimensional units in the tables are shown in both metric (SI) and inch-pound units of measure. Both the bubble point (temperature at which a bubble first appears, hence the temperature at which boiling begins, for a blend) and dew point typically are shown for blends.

The critical temperature (T_c) is the temperature at the critical point of the refrigerant. The T_c values shown for blends are the mass weighted averages of the component T_c s unless actual values have been determined.

The critical pressure (P_c) is the pressure at the critical point.

The NBP and critical properties suggest the application range for which an individual refrigerant might be suitable. Those with extremely low NBP lend themselves to ultra-low temperature refrigeration, for example in cryogenic applications. Those with high NBPs generally are limited to high-temperature applications, such as for use in chillers or high-temperature heat pumps. Both capacity and efficiency decline in a typical vapor-compression (reverse Rankine) cycle, the one most commonly used, when condensing temperatures approach the T_c . The P_c will exceed the operating pressure, except in transcritical cycles, which are uncommon except for R-744 (carbon dioxide).

Environmental Data

The atmospheric lifetime (τ_{atm}) is an indication of the average persistence of the refrigerant, if released into the atmosphere, until it decomposes or reacts with other chemicals. The values shown are composite atmospheric lifetimes. Separate lifetimes also are shown if known for the tropospheric (lower atmosphere where we live), stratospheric (next layer where global depletion of ozone is a concern), and higher layers, since the atmospheric chemistry changes between layers.

The ozone depletion potential (ODP) is a normalized indicator, based on a value of 1.000 for R-11, of the ability of refrigerants (and other chemicals) to destroy stratospheric ozone molecules. The data shown are the modeled values adopted by the international scientific assessment. The ODPs shown for blends are mass-weighted averages. The values shown typically are *modeled ODP* values, the most indicative of environmental impacts. *Semi-empirical* ODP and regulatory values adopted in the Montreal Protocol also are indicated for some refrigerants.

The semi-empirical ODPs are calculated values that incorporate adjustments for observed atmospheric measurements. The concept is conceptually more accurate, but it is difficult to measure the data needed for representative adjustments accurately.

The regulatory values generally are required for specific purposes, but may not be updated with newer findings after adoption. The ODP values listed in the annexes to the Montreal Protocol, for example, have not been updated since 1987 for chlorofluorocarbons (CFCs) and 1992 for hydrochlorofluorocarbons (HCFCs). A note in the Protocol indicates that the values "are estimates based on existing knowledge and will be reviewed and revised periodically."

The global warming potential (GWP) is a similar indicator of the potency to warm the planet by action as a greenhouse gas. The values shown are relative to carbon dioxide (CO₂) for an integration period of 100 yr. Both the ODP and GWP are calculated from the τ_{atm} , measured chemical properties, and other atmospheric data. The GWPs shown for blends are mass-weighted averages.

The τ_{atm} , ODP, and GWP values indicated for blends were calculated for the nominal blend compositions.

The database also indicates halocarbon global warming potential (HGWP) and photochemical reactivity at ground level if known.

Safety Data

The safety section is subdivided into classifications, recommended exposure limits, acute (short-term, single exposure) and chronic (long-term, repeated exposure) toxicity data, flammability data, and detection (appearance and odor) information. The exposure limits are further separated into short-term occupational, long-term occupational, and emergency exposures. Depending on the refrigerant, more than 100 parameters - some with differing values for species or exposure durations in toxicity tests - are reported. The following brief summary addresses only the chronic toxicity and flammability indices used to determine standard refrigerant safety classifications.

The first value is an occupational exposure limit, namely the Threshold Limit Value - Time Weighted Average (TLV-TWA) or a consistent measure. It is an indication of chronic (long-term, repeat exposure) toxicity of the refrigerant. Some of the consistent toxicity indices are the workplace Environmental Exposure Level (WEEL) guides and the Permissible Exposure Limit (PEL). These measures indicate adopted limits for workplace exposures for trained personnel for typical workdays and work weeks.

The Lower Flammability Limit (LFL) is the lowest concentration at which the refrigerant will burn in air under prescribed test conditions. It is an indication of flammability. The absence of an LFL or even an indication of nonflammable does not assure that a substance will not burn or exacerbate an existing fire under some conditions, such as when mixed with other fuels (such as lubricants) or at elevated pressures and temperatures.

The Heat of Combustion (HOC) is an indicator of how much energy the refrigerant will release when it burns in air, assuming complete reaction to the most stable products in their vapor state. Negative values indicate endothermic reactions (those that require heat to proceed) while positive values indicate exothermic reactions (those that liberate heat).

The ASHRAE Standard 34 safety group is an assigned classification that is based on the TLV-TWA (or consistent measure), LFL, and HOC. It comprises a letter (A or B) that indicates relative toxicity followed by a number (1, 2, or 3) that indicates relative flammability. These classifications are widely used in mechanical and fire construction codes, to determine requirements to promote safe use. Most of these code provisions are based on ASHRAE Standard 15, *Safety Code for Mechanical Refrigeration*.

Production Data

The final section of the refrigerant profiles indicates initial commercialization if known and the last year production is allowed in developed countries under the Montreal Protocol.

Refrigerant Profiles: Zeotropic Blends with Assigned Designations

R-400

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----- REFRIGERANT DATA SUMMARY -----
R-400          R-12/114 (formulation must be indicated)      see
zeotrope       binary blend                                  RDB#
-----

```

COMMON USE(S)

industrial air conditioners usually for high-condensing temperatures such as crane-cab air conditioning in foundries; composition must be specified to determine properties

IDENTIFIERS

```

common name(s):  R-400; R400; or R 400 (??/??)  2909
                  formulation must be indicated  2909
                  CFC/CFC-400 (??/??)          8601
                  not CFC-400 (??/??)          8601
                  CFC-12/CFC-114 (??/??)       8601
                  not CFC-12/114 (??/??)       8601
trade name(s):   Allied Genetron(R) 12/114 mix  MSDS
ARI container color / Pantone number: none, use light green grey/413 6601

```

PHYSICAL

```

· nominal blend formulation -----
  composition:      R-12/114                    2909
  component weight fractions: formulation must be indicated  2909
  %

```

SAFETY

```

· classification -----
  safety group (ASHRAE Standard 34): A1/A1                    8601
  NFPA 704 degrees of hazard (H-F-R-S): AlliedSignal: 2-0-0    MSDS
                                          health-flammability-reactivity
                                          [-special]: 0=no, 4=severe
  NPCA HMIS hazard ratings (H-F-R): AlliedSignal: 2-0-0    MSDS
                                          health-flammability-reactivity
                                          0=insignificant, 4=extreme
· long-term occupational limit -----
  OSHA PEL (permissible exposure limit): none, components 1,000/1,000  3904
                                          ppm v/v TWA for 8 hr/day and
                                          40 hr/wk
· flammability -----
  LFL-UFL (flammability limits in air): none (nonflammable as tested)
  flash point: AlliedSignal: no flash point    MSDS
                AlliedSignal: not applicable  MSDS
  autodecomposition temperature: AlliedSignal: >250°C (>482°F)  MSDS
· detection -----
  appearance: AlliedSignal: clear, colorless  MSDS
  odor:       AlliedSignal: faint ethereal    MSDS

```

PRODUCTION

```

last year production allowed: 1995 by components in          8C01
                              developed countries under the
                              Montreal Protocol

```

R-400 (50.0/50.0)

----- REFRIGERANT DATA SUMMARY -----
 R-400(50/50) R-12/114 (50.0/50.0) see
 zeotrope binary blend RDB#

COMMON USE(S)

formerly used in industrial heat pumps with high-condensing
 temperatures

IDENTIFIERS

common name(s): R-400 (50.0/50.0)
 R400 (50.0/50.0)
 R 400 (50.0/50.0)
 CFC/CFC-400 (50/50)
 not CFC-400 (50/50)
 CFC-12/CFC-114 (50/50)
 not CFC-12/114 (50/50)
 "R-50/50" (not a standard
 designation)

trade name(s): Allied Genetron(R) 12/114 mix MSDS
 ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

· nominal blend formulation -----
 composition: R-12/114
 component weight fractions: 50.0 / 50.0 %
 component mole fractions: 58.568 / 41.432 % 8820

· properties -----
 molar mass: 141.63211 g/mol (0.312245 8820
 lb/mol)

· normal boiling point -----
 bubble point temperature: -20.8 °C (-5.5 °F) 8401
 dew point temperature: -10.9 °C (12.4 °F) 8401
 maximum temperature glide: 9.95 °C (17.9 °F) 8401
 density, saturated liquid: 1517 kg/m³ (94.68 lb/cf) 8401
 density, saturated vapor: 6.82 kg/m³ (0.426 lb/cf) 8401
 specific volume, saturated liquid: 0.659 L/kg (0.0106 cf/lb) 8401
 specific volume, saturated vapor: 146.5 L/kg (2.3473 cf/lb) 8401
 heat of vaporization: 158.3 kJ/kg (68.0 Btu/lb) 8401
 velocity of sound, saturated liquid: 696 m/s (2284 ft/s) 8401
 velocity of sound, saturated vapor: 127 m/s (416 ft/s) 8401
 viscosity, saturated liquid: 371 µPa·s (0.371 cp) 8401
 viscosity, saturated vapor: 9.97 µPa·s (0.00997 cp) 8401
 thermal conductivity, liquid: 0.0772 W/m·K (0.0446 8401
 Btu/hr·ft·°F)
 thermal conductivity, vapor: 0.0083 W/m·K (0.0048 8401
 Btu/hr·ft·°F)

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 6.038 kg/m³ (0.3769 lb/cf) 8401

· normal pressure, 21.1 °C (70 °F) ----
 density, vapor: 6.013 kg/m³ (0.3754 lb/cf) 8401

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 405.3 kPa (58.79 psia) 8401
 pressure, vapor (dew point): 310.3 kPa (45.00 psia) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

density, saturated liquid:	1392 kg/m ³ (86.87 lb/cf)	8401
density, saturated vapor:	19.63 kg/m ³ (1.225 lb/cf)	8401
specific volume, saturated liquid:	0.719 L/kg (0.0115 cf/lb)	8401
specific volume, saturated vapor:	51.0 L/kg (0.8162 cf/lb)	8401
velocity of sound, saturated liquid:	539 m/s (1770 ft/s)	8401
velocity of sound, saturated vapor:	128 m/s (421 ft/s)	8401
viscosity, saturated liquid:	234 µPa·s (0.234 cp)	8401
viscosity, saturated vapor:	11.1 µPa·s (0.0111 cp)	8401
thermal conductivity, saturated liquid:	0.0654 W/m·K (0.0378 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.00988 W/m·K (0.00571 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1111 kPa (161.1 psia)	8401
pressure, vapor (dew point):	939 kPa (136.2 psia)	8401
heat of vaporization:	114.7 kJ/kg for liquid and vapor both at nominal composition (49.3 Btu/lb)	8401
	94.0 kJ/kg coexisting liquid and vapor at bubble-point pressure (40.4 Btu/lb)	8401
· critical point -----		
temperature:	128.9 °C (264.0 °F)	8401
pressure:	3919 kPa (568.4 psia)	8401
density:	565 kg/m ³ (35.3 lb/cf)	8401
specific volume:	1.77 L/kg (0.0283 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.835 mass-weighted average (model-derived relative to R 11)	9501
	0.875 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	10,200 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	5.1 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	A1/A1	8601
NFPA 704 degrees of hazard (H-F-R-S):	AlliedSignal: 2-0-0	MSDS
	health-flammability-reactivity [-special]: 0=no, 4=severe	
NPCA HMIS hazard ratings (H-F-R):	AlliedSignal: 2-0-0	MSDS
	health-flammability-reactivity 0=insignificant, 4=extreme	
· long-term occupational limit -----		
OSHA PEL (permissible exposure limit):	none, components 1,000/1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	3904
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	28,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		

LFL-UFL (flammability limits in air): none (nonflammable as tested)
flash point: AlliedSignal: no flash point MSDS
AlliedSignal: not applicable MSDS
autodecomposition temperature: AlliedSignal: >250°C (>482°F) MSDS
· detection -----
appearance: AlliedSignal: clear, colorless MSDS
odor: AlliedSignal: faint ethereal MSDS

PRODUCTION

last year production allowed: 1995 by components in 8C01
developed countries under the
Montreal Protocol

R-400 (60.0/40.0)

----- REFRIGERANT DATA SUMMARY -----
 R-400(60/40) R-12/114 (60.0/40.0) see
 zeotrope binary blend RDB#

COMMON USE(S)

industrial air conditioners usually for high-condensing temperatures
 such as crane-cab air conditioning in foundries

IDENTIFIERS

common name(s): R-400 (60.0/40.0)
 R400 (60.0/40.0)
 R 400 (60.0/40.0)
 CFC/CFC-400 (60/40)
 not CFC-400 (60/40)
 CFC-12/CFC-114 (60/40)
 not CFC-12/114 (60/40)
 "R-60/40" (not a standard
 designation)
 trade name(s): Allied Genetron(R) 12/114 mix MSDS
 ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

• nominal blend formulation -----
 composition: R-12/114
 component weight fractions: 60.0 / 40.0 %
 component mole fractions: 67.953 / 32.047 % 8820
 • properties -----
 molar mass: 136.93903 g/mol (0.301899 8820
 lb/mol)
 • normal boiling point -----
 bubble point temperature: -23.2 °C (-9.7 °F) 8401
 dew point temperature: -14.1 °C (6.7 °F) 8401
 maximum temperature glide: 9.08 °C (16.3 °F) 8401
 density, saturated liquid: 1511 kg/m3 (94.34 lb/cf) 8401
 density, saturated vapor: 6.68 kg/m3 (0.417 lb/cf) 8401
 specific volume, saturated liquid: 0.662 L/kg (0.0106 cf/lb) 8401
 specific volume, saturated vapor: 149.7 L/kg (2.3983 cf/lb) 8401
 heat of vaporization: 160.5 kJ/kg (69.0 Btu/lb) 8401
 velocity of sound, saturated liquid: 704 m/s (2308 ft/s) 8401
 velocity of sound, saturated vapor: 133 m/s (435 ft/s) 8401
 viscosity, saturated liquid: 366 µPa·s (0.366 cp) 8401
 viscosity, saturated vapor: 9.93 µPa·s (0.00993 cp) 8401
 thermal conductivity, liquid: 0.0792 W/m·K (0.0457 8401
 Btu/hr·ft°F)
 thermal conductivity, vapor: 0.0081 W/m·K (0.0047 8401
 Btu/hr·ft°F)
 • normal pressure, 20 °C (68 °F) -----
 density, vapor: 5.831 kg/m3 (0.3640 lb/cf) 8401
 • normal pressure, 21.1 °C (70 °F) ----
 density, vapor: 5.807 kg/m3 (0.3625 lb/cf) 8401
 • 20 °C (68 °F) -----
 pressure, liquid (bubble point): 441.0 kPa (63.96 psia) 8401
 pressure, vapor (dew point): 347.9 kPa (50.45 psia) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

density, saturated liquid:	1378 kg/m ³ (86.03 lb/cf)	8401
density, saturated vapor:	21.42 kg/m ³ (1.337 lb/cf)	8401
specific volume, saturated liquid:	0.726 L/kg (0.0116 cf/lb)	8401
specific volume, saturated vapor:	46.7 L/kg (0.7479 cf/lb)	8401
velocity of sound, saturated liquid:	536 m/s (1760 ft/s)	8401
velocity of sound, saturated vapor:	130 m/s (427 ft/s)	8401
viscosity, saturated liquid:	226 μ Pa·s (0.226 cp)	8401
viscosity, saturated vapor:	11.2 μ Pa·s (0.0112 cp)	8401
thermal conductivity, saturated liquid:	0.0661 W/m·K (0.0382 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.00988 W/m·K (0.00571 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1200 kPa (174.0 psia)	8401
pressure, vapor (dew point):	1035 kPa (150.2 psia)	8401
heat of vaporization:	114.9 kJ/kg for liquid and vapor both at nominal composition (49.4 Btu/lb)	8401
	96.9 kJ/kg coexisting liquid and vapor at bubble-point pressure (41.7 Btu/lb)	8401
· critical point -----		
temperature:	125.4 °C (257.7 °F)	8401
pressure:	3993 kPa (579.1 psia)	8401
density:	564 kg/m ³ (35.2 lb/cf)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.832 mass-weighted average (model-derived relative to R 11)	9501
	0.880 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	10,280 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	4.7 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	A1/A1	8601
NFPA 704 degrees of hazard (H-F-R-S):	AlliedSignal: 2-0-0	MSDS
	health-flammability-reactivity [-special]: 0=no, 4=severe	
NPCA HMIS hazard ratings (H-F-R):	AlliedSignal: 2-0-0	MSDS
	health-flammability-reactivity 0=insignificant, 4=extreme	
· long-term occupational limit -----		
OSHA PEL (permissible exposure limit):	none, components 1,000/1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	3904
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	30,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	Elf Atochem: nonflammable	MSDS

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

flash point: AlliedSignal: no flash point MSDS
AlliedSignal: not applicable MSDS
autodecomposition temperature: Elf Atochem: >427 °C (>800 °F) MSDS
· detection -----
appearance: AlliedSignal: clear, colorless MSDS
odor: Elf Atochem: faint ether-like MSDS

PRODUCTION

last year production allowed: 1995 by components in 8C01
developed countries under the
Montreal Protocol

R-401A

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----- REFRIGERANT DATA SUMMARY -----
R-401A      R-22/152a/124 (53.0/13.0/34.0)      see
zeotrope    ternary blend                               RDB#
-----

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COMMON USE(S)

medium-temperature refrigeration systems, including commercial refrigeration and home refrigerators, primarily for aftermarket use to service or retrofit existing equipment as an alternative for refrigerant 12; comparable capacities and efficiencies are expected at evaporator temperatures of -23 °C (-10 °F) and above

IDENTIFIERS

```

common name(s):  R-401A; R401A; R 401A      3B01
                  HCFC/HFC/HCFC-401A      3B01
                  not HCFC-401A           3B01
trade name(s):   AlliedSignal Genetron(R) MP39  MSDS
                  DuPont Suva(R) MP39      3441
                  ICI R-401A              CSDS
ARI container color / Pantone number:  pinkish-red (coral) / 177  6601

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PHYSICAL

```

· nominal blend formulation -----
      composition:  R-22/152a/124          3B01
      component weight fractions:  53.0 / 13.0 / 34.0 %  3B01
      component weight tolerances:  ±2.0 / +0.5,-1.5 / ±1.0  3B01
      component mole fractions:     57.885 / 18.587 / 23.527 %  8820
· properties -----
      molar mass:     94.43835 g/mol (0.208201 lb/mol)  8820
· normal boiling point -----
      bubble point temperature:  -34.4 °C (-30.0 °F)  8401
      dew point temperature:     -28.8 °C (-19.9 °F)  8401
      maximum temperature glide:  5.58 °C (10.0 °F)  8401
      density, saturated liquid:  1367 kg/m3 (85.33 lb/cf)  8401
      density, saturated vapor:   4.89 kg/m3 (0.306 lb/cf)  8401
      specific volume, saturated liquid:  0.732 L/kg (0.0117 cf/lb)  8401
      specific volume, saturated vapor:  204.3 L/kg (3.2731 cf/lb)  8401
      heat of vaporization:       226.6 kJ/kg (97.4 Btu/lb)  8401
      velocity of sound, saturated liquid:  807 m/s (2647 ft/s)  8401
      velocity of sound, saturated vapor:  154 m/s (504 ft/s)  8401
      viscosity, saturated liquid:  353 µPa·s (0.353 cp)  8401
      viscosity, saturated vapor:   9.87 µPa·s (0.00987 cp)  8401
      thermal conductivity, liquid:  0.1042 W/m·K (0.0602 Btu/hr·ft·°F)  8401
      thermal conductivity, vapor:  0.0079 W/m·K (0.0046 Btu/hr·ft·°F)  8401
· normal pressure, 20 °C (68 °F) -----
      density, vapor:  4.003 kg/m3 (0.2499 lb/cf)  8401
· normal pressure, 21.1 °C (70 °F) ---
      density, vapor:  3.987 kg/m3 (0.2489 lb/cf)  8401
· 20 °C (68 °F) -----
      pressure, liquid (bubble point):  707.6 kPa (102.63 psia)  8401
      pressure, vapor (dew point):     618.8 kPa (89.75 psia)  8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

density, saturated liquid:	1199 kg/m ³ (74.85 lb/cf)	8401
density, saturated vapor:	27.57 kg/m ³ (1.721 lb/cf)	8401
specific volume, saturated liquid:	0.834 L/kg (0.0134 cf/lb)	8401
specific volume, saturated vapor:	36.3 L/kg (0.5810 cf/lb)	8401
velocity of sound, saturated liquid:	560 m/s (1837 ft/s)	8401
velocity of sound, saturated vapor:	155 m/s (508 ft/s)	8401
viscosity, saturated liquid:	186 µPa·s (0.186 cp)	8401
viscosity, saturated vapor:	11.9 µPa·s (0.0119 cp)	8401
thermal conductivity, saturated liquid:	0.0818 W/m·K (0.0472 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01138 W/m·K (0.00657 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1918 kPa (278.2 psia)	8401
pressure, vapor (dew point):	1772 kPa (257.1 psia)	8401
heat of vaporization:	145.0 kJ/kg for liquid and vapor both at nominal composition (62.3 Btu/lb)	8401
	132.5 kJ/kg coexisting liquid and vapor at bubble-point pressure (57.0 Btu/lb)	8401
· critical point -----		
temperature:	105.3 °C (221.5 °F)	8401
pressure:	4613 kPa (669.1 psia)	8401
density:	495 kg/m ³ (30.9 lb/cf)	8401
specific volume:	2.02 L/kg (0.0324 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.027 mass-weighted average (model-derived relative to R 11)	9501
	0.035 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1240 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.20 mass-weighted average relative to R 11 for infinite integration period	DW
	0.22 relative to R 11 for infinite integration period	7214
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	A1/A1	8601
NFPA 704 degrees of hazard (H-F-R-S):	AlliedSignal: 2-0-1 health-flammability-reactivity [-special]: 0=no, 4=severe	MSDS
NPCA HMIS hazard ratings (H-F-R):	AlliedSignal: 1-0-1 DuPont: 1-0-1 health-flammability-reactivity 0=insignificant, 4=extreme	MSDS MSDS
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	DuPont estimated AEL: 1000 ppm v/v TWA for 8 hr/day and 40 hr/wk	MSDS
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	20,000 ppm v/v (preliminary	

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

R-401B

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----- REFRIGERANT DATA SUMMARY -----
R-401B      R-22/152a/124 (61.0/11.0/28.0)      see
zeotrope    ternary blend                          RDB#
-----

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COMMON USE(S)

low-temperature refrigeration systems with evaporator temperatures below -23 °C (-10 °F), including commercial and transport refrigeration as well as home freezers, primarily for aftermarket use to service or retrofit existing equipment as an alternative for refrigerants 12 and 500

IDENTIFIERS

```

common name(s):  R-401B; R401B; R 401B      3B01
                  HCFC/HFC/HCFC-401B      3B01
                  not HCFC-401B           3B01
trade name(s):   AlliedSignal Genetron(R) MP66  MSDS
                  DuPont Suva(R) MP66       3441
ARI container color / Pantone number:  yellow-brown (mustard) / 124  6601

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PHYSICAL

```

· nominal blend formulation -----
      composition:  R-22/152a/124          3B01
      component weight fractions:  61.0 / 11.0 / 28.0 %  3B01
      component weight tolerances:  ±2.0 / +0.5,-1.5 / ±1.0  3B01
      component mole fractions:    65.492 / 15.461 / 19.047 %  8820
· properties -----
      molar mass:    92.83607 g/mol (0.204668 lb/mol)  8820
· normal boiling point -----
      bubble point temperature:  -35.7 °C (-32.3 °F)  8401
      dew point temperature:     -30.8 °C (-23.4 °F)  8401
      maximum temperature glide:  4.94 °C (8.9 °F)  8401
      density, saturated liquid:  1373 kg/m3 (85.69 lb/cf)  8401
      density, saturated vapor:   4.85 kg/m3 (0.303 lb/cf)  8401
      specific volume, saturated liquid:  0.728 L/kg (0.0117 cf/lb)  8401
      specific volume, saturated vapor:  206.3 L/kg (3.3044 cf/lb)  8401
      heat of vaporization:       228.3 kJ/kg (98.1 Btu/lb)  8401
      velocity of sound, saturated liquid:  815 m/s (2672 ft/s)  8401
      velocity of sound, saturated vapor:  158 m/s (518 ft/s)  8401
      viscosity, saturated liquid:  352 µPa·s (0.352 cp)  8401
      viscosity, saturated vapor:   9.81 µPa·s (0.00981 cp)  8401
      thermal conductivity, liquid:  0.1058 W/m·K (0.0611 Btu/hr·ft°F)  8401
      thermal conductivity, vapor:  0.0077 W/m·K (0.0045 Btu/hr·ft°F)  8401
· normal pressure, 20 °C (68 °F) -----
      density, vapor:  3.932 kg/m3 (0.2455 lb/cf)  8401
· normal pressure, 21.1 °C (70 °F) ---
      density, vapor:  3.916 kg/m3 (0.2445 lb/cf)  8401
· 20 °C (68 °F) -----
      pressure, liquid (bubble point):  744.2 kPa (107.93 psia)  8401
      pressure, vapor (dew point):     662.2 kPa (96.04 psia)  8401
      density, saturated liquid:       1199 kg/m3 (74.86 lb/cf)  8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

density, saturated vapor:	29.16 kg/m ³ (1.820 lb/cf)	8401
specific volume, saturated liquid:	0.834 L/kg (0.0134 cf/lb)	8401
specific volume, saturated vapor:	34.3 L/kg (0.5494 cf/lb)	8401
velocity of sound, saturated liquid:	560 m/s (1838 ft/s)	8401
velocity of sound, saturated vapor:	156 m/s (512 ft/s)	8401
viscosity, saturated liquid:	184 μ Pa·s (0.184 cp)	8401
viscosity, saturated vapor:	12.0 μ Pa·s (0.0120 cp)	8401
thermal conductivity, saturated liquid:	0.0824 W/m·K (0.0476 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01128 W/m·K (0.00652 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	2009 kPa (291.4 psia)	8401
pressure, vapor (dew point):	1876 kPa (272.1 psia)	8401
heat of vaporization:	144.3 kJ/kg for liquid and vapor both at nominal composition (62.0 Btu/lb)	8401
	133.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (57.5 Btu/lb)	8401
· critical point -----		
temperature:	103.5 °C (218.3 °F)	8401
pressure:	4682 kPa (679.1 psia)	8401
density:	498 kg/m ³ (31.1 lb/cf)	8401
specific volume:	2.01 L/kg (0.0322 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.028 mass-weighted average (model-derived relative to R 11)	5301
	0.038 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1350 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.22 mass-weighted average relative to R 11 for infinite integration period	DW
	0.24 relative to R 11 for infinite integration period	7214
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	A1/A1	8601
NFPA 704 degrees of hazard (H-F-R-S):	AlliedSignal: 2-0-1	MSDS
	health-flammability-reactivity [-special]: 0=no, 4=severe	
NPCA HMIS hazard ratings (H-F-R):	AlliedSignal: 1-0-1	MSDS
	health-flammability-reactivity 0=insignificant, 4=extreme	
	DuPont: 1-0-1	MSDS
	health-flammability-reactivity 0=insignificant, 4=extreme	
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	DuPont estimated AEL: 1000 ppm v/v TWA for 8 hr/day and 40 hr/wk	MSDS
· emergency exposure limit -----		

R-401C

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----- REFRI GERANT DATA SUMMARY -----
R-401C      R-22/152a/124 (33.0/15.0/52.0)      see
zeotrope    ternary blend                          RDB#
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COMMON USE (S)

automobile air conditioners and other mobile air-conditioning (MAC) systems, primarily for aftermarket use to service or retrofit existing equipment as an alternative for refrigerant 12

IDENTIFIERS

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common name(s):  R-401C; R401C; R 401C      3B01
                  HCFC/HFC/HCFC-401C      3B01
                  not HCFC-401C           3B01
trade name(s):   DuPont Suva(R) MP52       3441
ARI container color / Pantone number: blue-green (aqua) / 3268 6601

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PHYSICAL

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· nominal blend formulation -----
  composition:    R-22/152a/124            3B01
  component weight fractions: 33.0 / 15.0 / 52.0 % 3B01
  component weight tolerances: ±2.0 / +0.5,-1.5 / ±1.0 3B01
  component mole fractions: 38.559 / 22.945 / 38.496 % 8820
· properties -----
  molar mass:     101.03413 g/mol (0.222742 lb/mol) 8820
· normal boiling point -----
  bubble point temperature: -30.5 °C (-23.0 °F) 8401
  dew point temperature:   -23.8 °C (-10.9 °F) 8401
  maximum temperature glide: 6.70 °C (12.1 °F) 8401
  density, saturated liquid: 1369 kg/m3 (85.49 lb/cf) 8401
  density, saturated vapor:  5.14 kg/m3 (0.321 lb/cf) 8401
  specific volume, saturated liquid: 0.730 L/kg (0.0117 cf/lb) 8401
  specific volume, saturated vapor: 194.6 L/kg (3.1177 cf/lb) 8401
  heat of vaporization:     217.3 kJ/kg (93.4 Btu/lb) 8401
  velocity of sound, saturated liquid: 781 m/s (2561 ft/s) 8401
  velocity of sound, saturated vapor: 155 m/s (508 ft/s) 8401
  viscosity, saturated liquid: 359 µPa·s (0.359 cp) 8401
  viscosity, saturated vapor:  9.92 µPa·s (0.00992 cp) 8401
  thermal conductivity, liquid: 0.0989 W/m·K (0.0572 Btu/hr·ft°F) 8401
  thermal conductivity, vapor: 0.0084 W/m·K (0.0049 Btu/hr·ft°F) 8401
· normal pressure, 20 °C (68 °F) -----
  density, vapor: 4.291 kg/m3 (0.2679 lb/cf) 8401
· normal pressure, 21.1 °C (70 °F) ---
  density, vapor: 4.274 kg/m3 (0.2668 lb/cf) 8401
· 20 °C (68 °F) -----
  pressure, liquid (bubble point): 611.1 kPa (88.63 psia) 8401
  pressure, vapor (dew point): 516.5 kPa (74.91 psia) 8401
  density, saturated liquid: 1216 kg/m3 (75.89 lb/cf) 8401
  density, saturated vapor: 24.31 kg/m3 (1.517 lb/cf) 8401
  specific volume, saturated liquid: 0.823 L/kg (0.0132 cf/lb) 8401
  specific volume, saturated vapor: 41.1 L/kg (0.6590 cf/lb) 8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

velocity of sound, saturated liquid:	557 m/s (1826 ft/s)	8401
velocity of sound, saturated vapor:	150 m/s (491 ft/s)	8401
viscosity, saturated liquid:	195 $\mu\text{Pa}\cdot\text{s}$ (0.195 cp)	8401
viscosity, saturated vapor:	11.7 $\mu\text{Pa}\cdot\text{s}$ (0.0117 cp)	8401
thermal conductivity, saturatd liquid:	0.0793 W/m \cdot K (0.0458 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01157 W/m \cdot K (0.00669 Btu/hr \cdot ft $^{\circ}$ F)	8401
· 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	1679 kPa (243.5 psia)	8401
pressure, vapor (dew point):	1517 kPa (220.0 psia)	8401
heat of vaporization:	143.2 kJ/kg for liquid and vapor both at nominal composition (61.6 Btu/lb)	8401
	126.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (54.2 Btu/lb)	8401
· critical point -----		
temperature:	109.9 $^{\circ}$ C (229.8 $^{\circ}$ F)	8401
pressure:	4402 kPa (638.5 psia)	8401
density:	497 kg/m ³ (31.0 lb/cf)	8401
specific volume:	2.01 L/kg (0.0323 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.025 mass-weighted average (model-derived relative to R 11)	9501
	0.030 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	980 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.16 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	A1/A1	8601
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	DuPont: components are 1000 ppm v/v TWA for 8 hr/day and 40 hr/wk	MSDS
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	17,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	3441
flash point:	TOC, DuPont: will not burn	MSDS
· detection -----		
appearance:	DuPont: clear, colorless	MSDS
odor:	DuPont: slightly ethereal	MSDS
PRODUCTION		
first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	2029 by refrigerants 22, 124 in developed countries under	8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

the Montreal Protocol

R-402A

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----- REFRIGERANT DATA SUMMARY -----
R-402A      R-125/290/22 (60.0/2.0/38.0)      see
zeotrope    ternary blend                       RDB#
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COMMON USE(S)

low- and medium-temperature commercial and transport refrigeration equipment, primarily for service or retrofit of existing equipment as an alternative for refrigerant 502; typically offers improved capacity, slightly lower efficiency, and similar discharge temperature compared to that refrigerant

IDENTIFIERS

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common name(s):  R-402A; R402A; R 402A      3B01
                  HFC/HC/HCFC-402A         3B01
                  not HCFC-402A            3B01
trade name(s):   AlliedSignal Genetron(R) HP80  MSDS
                  DuPont Suva(R) HP80       3C02
                  ICI Arcton(R) 402A       CSDS
ARI container color / Pantone number:  light brown (sand) / 461  6601

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PHYSICAL

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· nominal blend formulation -----
      composition:  R-125/290/22            3B01
      component weight fractions:  60.0 / 2.0 / 38.0 %  3B01
      component weight tolerances:  ±2.0 / ±1.0 / ±2.0  3B01
      component mole fractions:     50.766 / 4.606 / 44.628 %  8820
· properties -----
      molar mass:    101.55014 g/mol (0.223880  8820
                    lb/mol)
· normal boiling point -----
      bubble point temperature:  -49.2 °C (-56.5 °F)  8401
      dew point temperature:     -47.0 °C (-52.7 °F)  8401
      maximum temperature glide: 2.11 °C (3.8 °F)  8401
      density, saturated liquid:  1431 kg/m3 (89.31 lb/cf)  8401
      density, saturated vapor:   5.70 kg/m3 (0.356 lb/cf)  8401
      specific volume, saturated liquid:  0.699 L/kg (0.0112 cf/lb)  8401
      specific volume, saturated vapor:  175.5 L/kg (2.8104 cf/lb)  8401
      heat of vaporization:       194.3 kJ/kg (83.5 Btu/lb)  8401
      velocity of sound, saturated liquid:  773 m/s (2536 ft/s)  8401
      velocity of sound, saturated vapor:  142 m/s (464 ft/s)  8401
      viscosity, saturated liquid:  370 µPa·s (0.370 cp)  8401
      viscosity, saturated vapor:   9.50 µPa·s (0.00950 cp)  8401
      thermal conductivity, liquid:  0.1014 W/m·K (0.0586  8401
                    Btu/hr·ft°F)
      thermal conductivity, vapor:  0.0078 W/m·K (0.0045  8401
                    Btu/hr·ft°F)
· normal pressure, 20 °C (68 °F) -----
      density, vapor:  4.288 kg/m3 (0.2677 lb/cf)  8401
· normal pressure, 21.1 °C (70 °F) ---
      density, vapor:  4.271 kg/m3 (0.2666 lb/cf)  8401
· 20 °C (68 °F) -----
      pressure, liquid (bubble point):  1185.4 kPa (171.93 psia)  8401
      pressure, vapor (dew point):     1149.0 kPa (166.65 psia)  8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

density, saturated liquid:	1168 kg/m ³ (72.94 lb/cf)	8401
density, saturated vapor:	60.64 kg/m ³ (3.786 lb/cf)	8401
specific volume, saturated liquid:	0.856 L/kg (0.0137 cf/lb)	8401
specific volume, saturated vapor:	16.5 L/kg (0.2642 cf/lb)	8401
velocity of sound, saturated liquid:	425 m/s (1395 ft/s)	8401
velocity of sound, saturated vapor:	137 m/s (449 ft/s)	8401
viscosity, saturated liquid:	150 µPa·s (0.150 cp)	8401
viscosity, saturated vapor:	12.9 µPa·s (0.0129 cp)	8401
thermal conductivity, saturated liquid:	0.0694 W/m·K (0.0401 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01300 W/m·K (0.00751 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	3049 kPa (442.2 psia)	8401
pressure, vapor (dew point):	3008 kPa (436.3 psia)	8401
heat of vaporization:	84.9 kJ/kg for liquid and vapor both at nominal composition (36.5 Btu/lb)	8401
	84.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (36.4 Btu/lb)	8401
· critical point -----		
temperature:	75.5 °C (167.9 °F)	3437
	76.0 °C (168.9 °F)	8401
pressure:	4135 kPa (599.7 psia)	3437
	4234 kPa (614.1 psia)	8401
density:	542 kg/m ³ (33.8 lb/cf)	3437
	544 kg/m ³ (34.0 lb/cf)	8401
specific volume:	1.84 L/kg (0.0294 cf/lb)	8401
	1.85 L/kg (0.0296 cf/lb)	3437
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.013 mass-weighted average (model-derived relative to R 11)	9501
	0.019 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	3000 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.51 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	A1/A1	8601
NFPA 704 degrees of hazard (H-F-R-S):	AlliedSignal: 2-0-0	MSDS
	health-flammability-reactivity [-special]: 0=no, 4=severe	
NPCA HMIS hazard ratings (H-F-R):	AlliedSignal: 2-0-0	MSDS
	DuPont: 1-0-1	MSDS
	health-flammability-reactivity 0=insignificant, 4=extreme	
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	DuPont: components are 1000 ppm v/v TWA for 8 hr/day and 40 hr/wk	MSDS

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

density, saturated liquid:	1171 kg/m ³ (73.11 lb/cf)	8401
density, saturated vapor:	50.95 kg/m ³ (3.181 lb/cf)	8401
specific volume, saturated liquid:	0.854 L/kg (0.0137 cf/lb)	8401
specific volume, saturated vapor:	19.6 L/kg (0.3144 cf/lb)	8401
velocity of sound, saturated liquid:	474 m/s (1556 ft/s)	8401
velocity of sound, saturated vapor:	146 m/s (480 ft/s)	8401
viscosity, saturated liquid:	157 μ Pa·s (0.157 cp)	8401
viscosity, saturated vapor:	12.7 μ Pa·s (0.0127 cp)	8401
thermal conductivity, saturated liquid:	0.0750 W/m·K (0.0434 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01216 W/m·K (0.00703 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	2852 kPa (413.7 psia)	8401
pressure, vapor (dew point):	2797 kPa (405.7 psia)	8401
heat of vaporization:	105.5 kJ/kg for liquid and vapor both at nominal composition (45.4 Btu/lb)	8401
	106.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (45.6 Btu/lb)	8401
· critical point -----		
temperature:	82.6 °C (180.7 °F)	3435
	83.0 °C (181.5 °F)	8401
pressure:	4445 kPa (644.8 psia)	3435
	4525 kPa (656.3 psia)	8401
density:	531 kg/m ³ (33.1 lb/cf)	3435
	536 kg/m ³ (33.5 lb/cf)	8401
specific volume:	1.86 L/kg (0.0299 cf/lb)	8401
	1.88 L/kg (0.0302 cf/lb)	3435
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.020 mass-weighted average (model-derived relative to R 11)	9501
	0.030 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	2580 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.44 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	A1/A1	8601
NFPA 704 degrees of hazard (H-F-R-S):	AlliedSignal: 2-0-0	MSDS
	health-flammability-reactivity [-special]: 0=no, 4=severe	
NPCA HMIS hazard ratings (H-F-R):	AlliedSignal: 2-0-0	MSDS
	DuPont: 1-0-1	MSDS
	health-flammability-reactivity 0=insignificant, 4=extreme	
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	DuPont: components are 1000 ppm v/v TWA for 8 hr/day and 40 hr/wk	MSDS

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

· emergency exposure limit -----
 Refrigerant Concentration Limit (RCL): 32,000 ppm v/v (preliminary
 value under review, based on
 draft ASHRAE 34aa)

· acute (short-term) toxicity -----
 LC50 (lethal concentration, 50%): rat, 4 hr, AlliedSig: >300,000 MSDS
 ppm (fatal concentration by
 inhalation for half of test
 animals)

cardiac sensitization threshold/LOEL: dog, AlliedSignal: 50,000 ppm MSDS
 v/v (lowest observed effect
 level in test animals)

· flammability -----
 LFL-UFL (flammability limits in air): none (nonflammable as tested) 3442
 heat of combustion (by ASHRAE 34-92): -1.6 MJ/kg (-672 Btu/lb) UL
 flash point: AlliedSig: gas, not applicable MSDS
 autoignition temperature: 641 °C (1186 °F) 5931
 autodecomposition temperature: AlliedSignal: >250°C (>482°F) MSDS
 former UL Classification: practically nonflammable 5931
 (withdrawn for revision of the
 classification system,
 category SBQT2)

· detection -----
 appearance: DuPont: clear, colorless MSDS
 odor: DuPont: slight ethereal MSDS

PRODUCTION

first commercial use as a refrigerant: 1992
 last year production allowed: 2029 based on refrigerant 22 8C01
 in developed countries under
 the Montreal Protocol

specific volume, saturated liquid:	0.875 L/kg (0.0140 cf/lb)	8814
specific volume, saturated vapor:	23.0 L/kg (0.3685 cf/lb)	8814
velocity of sound, saturated liquid:	508 m/s (1668 ft/s)	8814
velocity of sound, saturated vapor:	151 m/s (495 ft/s)	8814
viscosity, saturated liquid:	154 $\mu\text{Pa}\cdot\text{s}$ (0.154 cp)	8814
viscosity, saturated vapor:	12.6 $\mu\text{Pa}\cdot\text{s}$ (0.0126 cp)	8814
thermal conductivity, saturated liquid:	0.0765 W/m \cdot K (0.0442 Btu/hr \cdot ft $^{\circ}$ F)	8814
thermal conductivity, saturated vapor:	0.01176 W/m \cdot K (0.00680 Btu/hr \cdot ft $^{\circ}$ F)	8814
· 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	2526 kPa (366.4 psia)	8814
pressure, vapor (dew point):	2501 kPa (362.8 psia)	8814
heat of vaporization:	119.3 kJ/kg for liquid and vapor both at nominal composition (51.3 Btu/lb)	8814
	118.3 kJ/kg coexisting liquid and vapor at bubble-point pressure (50.9 Btu/lb)	8814
· critical point -----		
temperature:	91.2 $^{\circ}$ C (196.2 $^{\circ}$ F)	8814
pressure:	4686 kPa (679.6 psia)	8814
density:	508 kg/m ³ (31.7 lb/cf)	8814
specific volume:	1.97 L/kg (0.0315 cf/lb)	8814

ENVIRONMENTAL

ODP (ozone depletion potential):	0.026 mass-weighted average (model-derived relative to R 11)	9501
	0.038 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	3150 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	8.4 mass-weighted average relative to R 11 for infinite integration period	DW

SAFETY

· classification -----		
safety group (ASHRAE Standard 34):	A1/A1	8601
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	Rhône-Poulenc: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	1tr
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	29,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	3C02

PRODUCTION

last year production allowed:	2029 based on refrigerant 22 in developed countries under the Montreal Protocol	8C01
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R-403B

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----- REFRIERANT DATA SUMMARY -----
R-403B      R-290/22/218 (5.0/56.0/39.0)      see
zeotrope    ternary blend                        RDB#
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COMMON USE(S)

commercial and transport refrigeration; alternative for refrigerant 502

IDENTIFIERS

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common name(s):  R-403B; R403B; R 403B      4B71
                  HC/HCFC/FC-403B, not HCFC-403B
trade name(s):   Rhodia Isceon 69-L
historical name(s): Rhône-Poulenc Isceon 69-L
                  Rhône-Poulenc RX1
ARI container color / Pantone number: none, use light green grey/413 6601

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PHYSICAL

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· nominal blend formulation -----
  composition:      R-290/22/218              4B71
  component weight fractions: 5.0 / 56.0 / 39.0 % 4B71
  component weight tolerances: +0.2, -2.0 / ±2.0 / ±2.0 4B71
  component mole fractions: 11.708 / 66.873 / 21.418 % 8820
· properties -----
  molar mass:      103.25749 g/mol (0.227644 lb/mol) 8820
· normal boiling point -----
  bubble point temperature: -43.8 °C (-46.8 °F) 8414
  dew point temperature: -42.3 °C (-44.1 °F) 8414
  maximum temperature glide: 1.51 °C (2.7 °F) 8414
  density, saturated liquid: 1385 kg/m3 (86.47 lb/cf) 8414
  density, saturated vapor: 5.61 kg/m3 (0.350 lb/cf) 3A64
                        5.68 kg/m3 (0.354 lb/cf) 8414
  specific volume, saturated liquid: 0.722 L/kg (0.0116 cf/lb) 8414
  specific volume, saturated vapor: 176.2 L/kg (2.8223 cf/lb) 8414
  heat of vaporization: 191.0 kJ/kg (82.1 Btu/lb) 3A64
                        191.7 kJ/kg (82.4 Btu/lb) 8414
  velocity of sound, saturated liquid: 757 m/s (2484 ft/s) 8414
  velocity of sound, saturated vapor: 141 m/s (464 ft/s) 8414
  viscosity, saturated liquid: 317 µPa·s (0.317 cp) 8414
  viscosity, saturated vapor: 9.89 µPa·s (0.00989 cp) 8414
  thermal conductivity, liquid: 0.0939 W/m·K (0.0543 Btu/hr·ft°F) 8414
  thermal conductivity, vapor: 0.0076 W/m·K (0.0044 Btu/hr·ft°F) 8414
· normal pressure, 20 °C (68 °F) -----
  density, vapor: 4.366 kg/m3 (0.2726 lb/cf) 8414
· normal pressure, 21.1 °C (70 °F) ---
  density, vapor: 4.349 kg/m3 (0.2715 lb/cf) 8414
· 20 °C (68 °F) -----
  pressure, liquid (bubble point): 958.3 kPa (138.98 psia) 8814
  pressure, vapor (dew point): 938.2 kPa (136.07 psia) 8814
  density, saturated liquid: 1166 kg/m3 (72.78 lb/cf) 8414
  density, saturated vapor: 48.70 kg/m3 (3.040 lb/cf) 8414

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specific volume, saturated liquid:	0.858 L/kg (0.0137 cf/lb)	8414
specific volume, saturated vapor:	20.6 L/kg (0.3292 cf/lb)	8414
velocity of sound, saturated liquid:	460 m/s (1510 ft/s)	8414
velocity of sound, saturated vapor:	139 m/s (456 ft/s)	8414
viscosity, saturated liquid:	148 $\mu\text{Pa}\cdot\text{s}$ (0.148 cp)	8414
viscosity, saturated vapor:	12.7 $\mu\text{Pa}\cdot\text{s}$ (0.0127 cp)	8414
thermal conductivity, saturatd liquid:	0.0686 W/m \cdot K (0.0397 Btu/hr \cdot ft $^{\circ}$ F)	8414
thermal conductivity, saturated vapor:	0.01208 W/m \cdot K (0.00698 Btu/hr \cdot ft $^{\circ}$ F)	8414
• 25 $^{\circ}$ C (77 $^{\circ}$ F) -----		
pressure, saturated vapor:	1318.3 kPa (191.20 psia)	3A64
density, saturated liquid:	1150 kg/m ³ (71.79 lb/cf)	3A64
viscosity, saturated liquid:	224 $\mu\text{Pa}\cdot\text{s}$ (0.224 cp)	3A64
viscosity, vapor at 1 atm:	13.0 $\mu\text{Pa}\cdot\text{s}$ (0.0130 cp)	3A64
thermal conductivity, saturatd liquid:	0.0848 W/m \cdot K (0.0490 Btu/hr \cdot ft $^{\circ}$ F)	3A64
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	2486 kPa (360.5 psia)	8814
pressure, vapor (dew point):	2462 kPa (357.1 psia)	8814
heat of vaporization:	100.6 kJ/kg for liquid and vapor both at nominal composition (43.3 Btu/lb)	8414
	99.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (42.6 Btu/lb)	8414
• critical point -----		
temperature:	88.7 $^{\circ}$ C (191.6 $^{\circ}$ F)	8814
pressure:	4397 kPa (637.7 psia)	8814
density:	523 kg/m ³ (32.6 lb/cf)	8414
specific volume:	1.70 L/kg (0.0273 cf/lb)	3A64
	1.91 L/kg (0.0306 cf/lb)	8414
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.019 mass-weighted average (model-derived relative to R 11)	9501
	0.028 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	4420 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	16 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
• classification -----		
safety group (ASHRAE Standard 34):	A1/A1	8601
• long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	Rhône-Poulenc: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	1tr
• emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	34,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
• flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	3A65

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

PRODUCTION

last year production allowed: 2029 based on refrigerant 22 8C01
in developed countries under
the Montreal Protocol

density, vapor:	4.130 kg/m3 (0.2579 lb/cf)	8401
· normal pressure, 21.1 °C (70 °F) ---		
density, vapor:	4.114 kg/m3 (0.2568 lb/cf)	8401
· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	1102.2 kPa (159.86 psia)	8401
pressure, vapor (dew point):	1088.9 kPa (157.93 psia)	8401
density, saturated liquid:	1068 kg/m3 (66.70 lb/cf)	8401
density, saturated vapor:	56.40 kg/m3 (3.521 lb/cf)	8401
specific volume, saturated liquid:	0.936 L/kg (0.0150 cf/lb)	8401
specific volume, saturated vapor:	17.7 L/kg (0.2840 cf/lb)	8401
velocity of sound, saturated liquid:	411 m/s (1350 ft/s)	8401
velocity of sound, saturated vapor:	136 m/s (446 ft/s)	8401
viscosity, saturated liquid:	136 µPa·s (0.136 cp)	8401
viscosity, saturated vapor:	12.2 µPa·s (0.0122 cp)	8401
thermal conductivity, saturatd liquid:	0.0694 W/m·K (0.0401 Btu/hr·ft°F)	8401
thermal conductivity, saturated vapor:	0.01534 W/m·K (0.00887 Btu/hr·ft°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	2886 kPa (418.5 psia)	8401
pressure, vapor (dew point):	2871 kPa (416.4 psia)	8401
heat of vaporization:	82.2 kJ/kg for liquid and vapor both at nominal composition (35.3 Btu/lb)	8401
	82.1 kJ/kg coexisting liquid and vapor at bubble-point pressure (35.3 Btu/lb)	8401
· critical point -----		
temperature:	72.1 °C (161.7 °F)	3C04
	72.1 °C (161.9 °F)	8401
pressure:	3732 kPa (541.2 psia)	3C04
	3735 kPa (541.7 psia)	8401
density:	489 kg/m3 (30.5 lb/cf)	8401
specific volume:	2.05 L/kg (0.0328 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
	<0.00004 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	4540 mass-weighted average relative to CO2 for 100 yr integration	9501
HGWP (halocarbon GWP):	0.80 mass-weighted average relative to R 11 for infinite integration period	DW

SAFETY

· classification -----		
safety group (ASHRAE Standard 34):	A1/A1	8601
NFPA 704 degrees of hazard (H-F-R-S):	AlliedSignal: 1-0-1 health-flammability-reactivity [-special]: 0=no, 4=severe	MSDS
NPCA HMIS hazard ratings (H-F-R):	AlliedSignal: 1-0-1 DuPont: 1-0-1 health-flammability-reactivity 0=insignificant, 4=extreme	MSDS MSDS

R-405A

```

----- REFRI GERANT DATA SUMMARY -----
R-405A      R-22/152a/142b/C318 (45.0/7.0/5.5/42.5)      see
zeotrope    tetrary blend                                     RDB#
-----

```

COMMON USE(S)

service fluid to replace refrigerant 12 in mobile air conditioners
and refrigeration equipment; service fluid to replace refrigerant 500

IDENTIFIERS

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common name(s):  R-405A; R405A; R-405A      4B71
                  HCFC/HFC/HCFC/FC-405A
                  not HCFC-405A
trade name(s):   ATG R-405A
                  China Sun G2015
                  Greencool (Gu) G2015
name used in U.S. EPA SNAP Rule:  HCFC/HFC/Fluoroalkane Blend A
ARI container color / Pantone number:  none, use light green grey/413 6601

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PHYSICAL

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· nominal blend formulation -----
      composition:  R-22/152a/142b/C318      4B71
      component weight fractions:  45.0 / 7.0 / 5.5 / 42.5 %  4B71
      component weight tolerances:  ±2.0 / ±1.0 / ±1.0 / ±2.0 and  4B71
                                      sum of 152a and 142b +0.0,-2.0  4B71
      component mole fractions:  58.239/ 11.860/ 6.125/ 23.777  8820
                                      %
· properties -----
      molar mass:  111.90682 g/mol (0.246712      8820
                  lb/mol)
normal freezing/melting/triple point:  -62.0 °C (-79.6 °F)      MSDS
· normal boiling point -----
      bubble point temperature:  -32.9 °C (-27.2 °F)      8401
      dew point temperature:  -24.5 °C (-12.0 °F)      8401
      maximum temperature glide:  8.41 °C (15.1 °F)      8401
      density, saturated liquid:  1448 kg/m3 (90.38 lb/cf)      8401
      density, saturated vapor:  5.70 kg/m3 (0.356 lb/cf)      8401
      specific volume, saturated liquid:  0.691 L/kg (0.0111 cf/lb)      8401
      specific volume, saturated vapor:  175.6 L/kg (2.8121 cf/lb)      8401
      heat of vaporization:  196.0 kJ/kg (84.3 Btu/lb)      8401
velocity of sound, saturated liquid:  743 m/s (2438 ft/s)      8401
velocity of sound, saturated vapor:  667 m/s (2187 ft/s)      8401
      viscosity, saturated vapor:  10.27 µPa·s (0.01027 cp)      8401
      viscosity, saturated liquid:  354 µPa·s (0.354 cp)      8401
      thermal conductivity, liquid:  0.0913 W/m·K (0.0527      8401
                                      Btu/hr·ft°F)
      thermal conductivity, vapor:  0.0082 W/m·K (0.0047      8401
                                      Btu/hr·ft°F)
· normal pressure, 20 °C (68 °F) -----
      density, vapor:  4.750 kg/m3 (0.2965 lb/cf)      8401
· normal pressure, 21.1 °C (70 °F) ---
      density, vapor:  4.731 kg/m3 (0.2953 lb/cf)      8401
· 20 °C (68 °F) -----
      pressure, liquid (bubble point):  660.1 kPa (95.74 psia)      8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

pressure, vapor (dew point):	534.8 kPa (77.56 psia)	8401
density, saturated liquid:	1273 kg/m ³ (79.50 lb/cf)	8401
density, saturated vapor:	27.91 kg/m ³ (1.742 lb/cf)	8401
specific volume, saturated liquid:	0.785 L/kg (0.0126 cf/lb)	8401
specific volume, saturated vapor:	35.8 L/kg (0.5740 cf/lb)	8401
velocity of sound, saturated liquid:	515 m/s (1689 ft/s)	8401
velocity of sound, saturated vapor:	141 m/s (462 ft/s)	8401
viscosity, saturated liquid:	188 μ Pa·s (0.188 cp)	8401
viscosity, saturated vapor:	12.2 μ Pa·s (0.0122 cp)	8401
thermal conductivity, saturated liquid:	0.0723 W/m·K (0.0418 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01119 W/m·K (0.00647 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1784 kPa (258.7 psia)	8401
pressure, vapor (dew point):	1572 kPa (228.0 psia)	8401
heat of vaporization:	124.7 kJ/kg for liquid and vapor both at nominal composition (53.6 Btu/lb)	8401
	96.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (41.4 Btu/lb)	8401
· critical point -----		
temperature:	106.0 °C (222.8 °F)	8401
pressure:	4292 kPa (622.5 psia)	8401
density:	535 kg/m ³ (33.4 lb/cf)	8401
specific volume:	1.87 L/kg (0.0299 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.018 mass-weighted average (model-derived relative to R 11)	5301
	0.026 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	5750 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.17 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (application pending) components are A1,A2,A2,A1r	
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	Greencool AEL: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	MSDS
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	32,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	
flash point:	Greencool: none	MSDS
· detection -----		
appearance:	Greencool: clear, colorless	MSDS
odor:	Greencool: slight ethereal	MSDS

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

PRODUCTION

first commercial use as a refrigerant:	1995	mfr
last year production allowed:	2029 by refrigerants 22, 142b	8C01
	in developed countries under	
	the Montreal Protocol	

R-406A

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----- REFRIERANT DATA SUMMARY -----
R-406A      R-22/600a/142b (55.0/4.0/41.0)      see
zeotrope    ternary blend                          RDB#
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COMMON USE(S)

alternative for refrigerants 12 and 500, originally targeted for mobile air conditioning, the market focus has shifted to refrigeration; primarily for aftermarket use to service or retrofit existing equipment

IDENTIFIERS

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common name(s):  R-406A; R406A; R-406A          4B71
                  HCFC/HC/HCFC-406A          4B71
                  not HCFC-406A              4B71
trade name(s):   McMullen Oil McCool R-406A
                  Monroe Air Tech Autofrost-X3 8354
                  People's Welding Supply GHG-X3 8354
historical name(s): GHG Refrigerant-12 Substitute 4886
                  ICOR R-406A
                  Solvay Solkane(R) 406A      5128
ARI container color / Pantone number: none, use light green grey/413 6601
                                      with red / 185 band

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PHYSICAL

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· nominal blend formulation -----
      composition:  R-22/600a/142b          4B71
      component weight fractions: 55.0 / 4.0 / 41.0 % 4B71
      component weight tolerances: ±2.0 / ±1.0 / ±1.0 4B71
      component mole fractions: 57.156 / 6.184 / 36.660 % 8820
· properties -----
      molar mass: 89.85739 g/mol (0.198102 lb/mol) 8820
· normal boiling point -----
      bubble point temperature: -32.3 °C (-26.2 °F) 5127
                              -32.7 °C (-26.9 °F) 8401
      dew point temperature: -23.4 °C (-10.0 °F) 5127
                              -23.5 °C (-10.4 °F) 8401
      maximum temperature glide: 9.16 °C (16.5 °F) 8401
      density, saturated liquid: 1255 kg/m3 (78.35 lb/cf) 8401
      density, saturated vapor: 4.56 kg/m3 (0.285 lb/cf) 8401
      specific volume, saturated liquid: 0.797 L/kg (0.0128 cf/lb) 8401
      specific volume, saturated vapor: 219.6 L/kg (3.5178 cf/lb) 8401
      heat of vaporization: 241.5 kJ/kg (103.8 Btu/lb) 8401
      velocity of sound, saturated liquid: 836 m/s (2744 ft/s) 8401
      velocity of sound, saturated vapor: 159 m/s (522 ft/s) 8401
      viscosity, saturated liquid: 355 µPa·s (0.355 cp) 8401
      viscosity, saturated vapor: 9.32 µPa·s (0.00932 cp) 8401
      thermal conductivity, liquid: 0.0082 W/m·K (0.0047 Btu/hr·ft·°F) 8401
                                      0.1064 W/m·K (0.0615 Btu/hr·ft·°F) 8401
· normal pressure, 20 °C (68 °F) -----
      density, vapor: 3.813 kg/m3 (0.2380 lb/cf) 8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

· normal pressure, 21.1 °C (70 °F) ---		
density, vapor:	3.797 kg/m ³ (0.2371 lb/cf)	8401
· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	633.0 kPa (91.81 psia)	5127
	646.5 kPa (93.76 psia)	8401
pressure, vapor (dew point):	491.0 kPa (71.21 psia)	5127
	503.8 kPa (73.06 psia)	8401
density, saturated liquid:	1114 kg/m ³ (69.53 lb/cf)	8401
density, saturated vapor:	20.87 kg/m ³ (1.303 lb/cf)	8401
specific volume, saturated liquid:	0.898 L/kg (0.0144 cf/lb)	8401
specific volume, saturated vapor:	47.9 L/kg (0.7676 cf/lb)	8401
velocity of sound, saturated liquid:	601 m/s (1970 ft/s)	8401
velocity of sound, saturated vapor:	161 m/s (529 ft/s)	8401
viscosity, saturated liquid:	194 µPa·s (0.194 cp)	8401
viscosity, saturated vapor:	11.0 µPa·s (0.0110 cp)	8401
thermal conductivity, saturatd liquid:	0.0838 W/m·K (0.0484	8401
	Btu/hr·ft°F)	
thermal conductivity, saturated vapor:	0.01104 W/m·K (0.00638	8401
	Btu/hr·ft°F)	
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1703 kPa (247.0 psia)	5127
	1733 kPa (251.4 psia)	8401
pressure, vapor (dew point):	1435 kPa (208.1 psia)	5127
	1475 kPa (213.9 psia)	8401
heat of vaporization:	162.3 kJ/kg for liquid and	8401
	vapor both at nominal	
	composition (69.8 Btu/lb)	
	147.2 kJ/kg coexisting liquid	8401
	and vapor at bubble-point	
	pressure (63.3 Btu/lb)	
· critical point -----		
temperature:	114.5 °C (238.1 °F)	5127
	116.5 °C (241.7 °F)	8401
pressure:	4581 kPa (664.4 psia)	5127
	4883 kPa (708.2 psia)	8401
density:	456 kg/m ³ (28.4 lb/cf)	5127
	459 kg/m ³ (28.6 lb/cf)	8401
specific volume:	2.18 L/kg (0.0349 cf/lb)	8401
	2.19 L/kg (0.0352 cf/lb)	5127
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.036 mass-weighted average	9501
	(model-derived relative to R	
	11)	
	0.055 mass-weighted average	9501
	(semi-empirical relative to R	
	11)	
GWP (global warming potential):	1990 mass-weighted average	9501
	relative to CO ₂ for 100 yr	
	integration	
HGWP (halocarbon GWP):	0.34 mass-weighted average	DW
	relative to R 11 for infinite	
	integration period	
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	A1/A2	8601
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	25,000 ppm v/v (preliminary	

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

value under review, based on
draft ASHRAE 34aa)

· flammability -----
LFL-UFL (flammability limits in air): none (nonflammable as tested) 4886
worst fractionation flammable 4886
(12.8-20.7% in DIN51649 test) mfr

PRODUCTION

first commercial use as a refrigerant: March 1993 mfr
last year production allowed: 2029 by refrigerants 22, 142b 8C01
in developed countries under
the Montreal Protocol

R-407A

----- REFRIGERANT DATA SUMMARY -----
 R-407A R-32/125/134a (20.0/40.0/40.0) see
 zeotrope ternary blend RDB#

COMMON USE(S)

alternative for refrigerant 502 in new equipment and for retrofit of
 some existing systems

Note: The composition tolerances indicated for this refrigerant were
 originally $\pm 2/\pm 1/\pm 2$ (see RDB6101), but were subsequently changed in
 ASHRAE Standard 34-1992 addendum 34y to $\pm 2/\pm 2/\pm 2$ (see RDB7250).

IDENTIFIERS

common name(s): R-407A; R407A; R 407A 4B71
 HFC/HFC/HFC-407A, not HFC-407A 4B71
 trade name(s): ICI Klea(R) 407A MSDS
 ICI Klea(R) 60 4131
 ARI container color / Pantone number: lime green / 368 6601

PHYSICAL

· nominal blend formulation -----
 composition: R-32/125/134a 4B71
 component weight fractions: 20.0 / 40.0 / 40.0 % 4B71
 component weight tolerances: ± 2.0 / ± 2.0 / ± 2.0 4B71
 component mole fractions: 34.642 / 30.031 / 35.327 % 8820

· properties -----
 molar mass: 90.11001 g/mol (0.198659 8820
 lb/mol)

· normal boiling point -----
 bubble point temperature: -45.2 °C (-49.4 °F) 8401
 dew point temperature: -38.7 °C (-37.7 °F) 4130
 maximum temperature glide: 6.52 °C (11.7 °F) 8401
 density, saturated liquid: 1405 kg/m³ (87.70 lb/cf) 8401
 density, saturated vapor: 4.88 kg/m³ (0.305 lb/cf) 8401
 specific volume, saturated liquid: 0.712 L/kg (0.0114 cf/lb) 8401
 specific volume, saturated vapor: 204.8 L/kg (3.2807 cf/lb) 8401
 heat of vaporization: 234.4 kJ/kg (100.8 Btu/lb) 8401
 velocity of sound, saturated liquid: 791 m/s (2596 ft/s) 8401
 velocity of sound, saturated vapor: 153 m/s (503 ft/s) 8401
 viscosity, saturated liquid: 376 $\mu\text{Pa}\cdot\text{s}$ (0.376 cp) 8401
 viscosity, saturated vapor: 393.23 $\mu\text{Pa}\cdot\text{s}$ (0.39323 cp) 8401
 thermal conductivity, liquid: 0.1200 W/m·K (0.0693 8401
 Btu/hr·ft²·°F)
 thermal conductivity, vapor: 0.0086 W/m·K (0.0049 8401
 Btu/hr·ft²·°F)

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 3.811 kg/m³ (0.2379 lb/cf) 8401

· normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 3.795 kg/m³ (0.2369 lb/cf) 8401

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 1091.1 kPa (158.25 psia) 8401
 pressure, vapor (dew point): 944.1 kPa (136.93 psia) 8401
 density, saturated liquid: 1168 kg/m³ (72.93 lb/cf) 8401

density, saturated vapor:	42.68 kg/m ³ (2.665 lb/cf)	8401
specific volume, saturated liquid:	0.856 L/kg (0.0137 cf/lb)	8401
specific volume, saturated vapor:	23.4 L/kg (0.3753 cf/lb)	8401
velocity of sound, saturated liquid:	471 m/s (1545 ft/s)	8401
velocity of sound, saturated vapor:	151 m/s (494 ft/s)	8401
viscosity, saturated liquid:	159 μ Pa·s (0.159 cp)	8401
viscosity, saturated vapor:	12.6 μ Pa·s (0.0126 cp)	8401
thermal conductivity, saturated liquid:	0.0858 W/m·K (0.0496 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01328 W/m·K (0.00767 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	2894 kPa (419.8 psia)	8401
pressure, vapor (dew point):	2680 kPa (388.7 psia)	8401
heat of vaporization:	117.1 kJ/kg for liquid and vapor both at nominal composition (50.3 Btu/lb)	8401
	103.4 kJ/kg coexisting liquid and vapor at bubble-point pressure (44.4 Btu/lb)	8401
· critical point -----		
temperature:	81.9 °C (179.4 °F)	8401
pressure:	4487 kPa (650.8 psia)	8401
density:	531 kg/m ³ (33.2 lb/cf)	8401
specific volume:	1.88 L/kg (0.0302 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
	<0.00021 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	2340 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.40 mass-weighted average relative to R 11 for infinite integration period	DW

SAFETY

· classification -----		
safety group (ASHRAE Standard 34):	A1/A1	8601
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	ICI OEL: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	6B35
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	69,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	3A61
heat of combustion (by ASHRAE 34-92):	-3.4 MJ/kg (-1474 Btu/lb)	mfr
	-3.6 MJ/kg (-1538 Btu/lb)	UL
flash point:	ICI: does not flash	MSDS
autoignition temperature:	685 °C (1265 °F)	5931
former UL Classification:	practically nonflammable (withdrawn for revision of the classification system,	5931

R-407B

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----- REFRIERANT DATA SUMMARY -----
R-407B      R-32/125/134a (10.0/70.0/20.0)      see
zeotrope    ternary blend                          RDB#
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COMMON USE(S)

alternative for refrigerant 502 for retrofit of existing systems operating at high lift conditions (e.g., evaporating at -40 °C, -40 °F, and condensing at 40 °C, 105 °F, or higher) and in hermetic compressors where discharge temperature is limited; under consideration as an alternative for refrigerant 22 both in new equipment and as a service fluid

Note: The composition tolerances indicated for this refrigerant were originally $\pm 2/\pm 1/\pm 2$ (see RDB6101), but were subsequently changed in ASHRAE Standard 34-1992 addendum 34y to $\pm 2/\pm 2/\pm 2$ (see RDB7250).

IDENTIFIERS

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common name(s):  R-407B; R407B; R 407B          4B71
                  HFC/HFC/HFC-407B, not HFC-407B 4B71
trade name(s):   ICI Klea(R) 407B              MSDS
                  ICI Klea(R) 61                4133
ARI container color / Pantone number:  cream / 156 6601

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PHYSICAL

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· nominal blend formulation -----
  composition:      R-32/125/134a                4B71
  component weight fractions:  10.0 / 70.0 / 20.0 % 4B71
  component weight tolerances:  $\pm 2.0$  /  $\pm 2.0$  /  $\pm 2.0$  4B71
  component mole fractions:    19.787 / 60.036 / 20.178 % 8820
· properties -----
  molar mass:        102.93680 g/mol (0.226937    8820
                    lb/mol)
· normal boiling point -----
  bubble point temperature:    -46.8 °C (-52.2 °F)      8401
  dew point temperature:       -42.4 °C (-44.3 °F)      8401
  maximum temperature glide:   4.39 °C (7.9 °F)         8401
  density, saturated liquid:    1460 kg/m3 (91.13 lb/cf)    8401
  density, saturated vapor:     5.62 kg/m3 (0.351 lb/cf)    8401
  specific volume, saturated liquid: 0.685 L/kg (0.0110 cf/lb) 8401
  specific volume, saturated vapor: 176.3 L/kg (2.8244 cf/lb) 8401
  heat of vaporization:         200.0 kJ/kg (86.0 Btu/lb)    8401
  velocity of sound, saturated liquid: 750 m/s (2460 ft/s)    8401
  velocity of sound, saturated vapor: 141 m/s (463 ft/s)    8401
  viscosity, saturated liquid:   393  $\mu\text{Pa}\cdot\text{s}$  (0.393 cp)    8401
  viscosity, saturated vapor:    9.85  $\mu\text{Pa}\cdot\text{s}$  (0.00985 cp) 8401
  thermal conductivity, liquid:  0.1069 W/m·K (0.0618    8401
                    Btu/hr·ft·°F)
  thermal conductivity, vapor:   0.0087 W/m·K (0.0050    8401
                    Btu/hr·ft·°F)
· normal pressure, 20 °C (68 °F) -----
  density, vapor:               4.351 kg/m3 (0.2716 lb/cf) 8401
· normal pressure, 21.1 °C (70 °F) ---
  density, vapor:               4.334 kg/m3 (0.2706 lb/cf) 8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	1153.0 kPa (167.23 psia)	8401
pressure, vapor (dew point):	1055.4 kPa (153.07 psia)	8401
density, saturated liquid:	1197 kg/m ³ (74.70 lb/cf)	8401
density, saturated vapor:	55.99 kg/m ³ (3.496 lb/cf)	8401
specific volume, saturated liquid:	0.836 L/kg (0.0134 cf/lb)	8401
specific volume, saturated vapor:	17.9 L/kg (0.2861 cf/lb)	8401
velocity of sound, saturated liquid:	417 m/s (1368 ft/s)	8401
velocity of sound, saturated vapor:	136 m/s (446 ft/s)	8401
viscosity, saturated liquid:	156 µPa·s (0.156 cp)	8401
viscosity, saturated vapor:	12.9 µPa·s (0.0129 cp)	8401
thermal conductivity, saturated liquid:	0.0739 W/m·K (0.0427 Btu/hr·ft ² °F)	8401
thermal conductivity, saturated vapor:	0.01385 W/m·K (0.00800 Btu/hr·ft ² °F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	3039 kPa (440.8 psia)	8401
pressure, vapor (dew point):	2915 kPa (422.8 psia)	8401
heat of vaporization:	87.0 kJ/kg for liquid and vapor both at nominal composition (37.4 Btu/lb)	8401
	80.6 kJ/kg coexisting liquid and vapor at bubble-point pressure (34.6 Btu/lb)	8401
· critical point -----		
temperature:	74.4 °C (165.9 °F)	8401
pressure:	4083 kPa (592.2 psia)	8401
density:	562 kg/m ³ (35.1 lb/cf)	8401
specific volume:	1.78 L/kg (0.0285 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
	<0.00012 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	3070 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.52 mass-weighted average relative to R 11 for infinite integration period	DW

SAFETY

· classification -----		
safety group (ASHRAE Standard 34):	A1/A1	8601
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	ICI OEL: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	6B35
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	69,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	3A62
heat of combustion (by ASHRAE 34-92):	-1.5 MJ/kg (-653 Btu/lb)	mfr
	-1.8 MJ/kg (-775 Btu/lb)	UL
flash point:	ICI: does not flash	MSDS

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

R-407C

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----- REFRIGERANT DATA SUMMARY -----
R-407C      R-32/125/134a (23.0/25.0/52.0)      see
zeotrope    ternary blend                          RDB#
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COMMON USE(S)

alternative for refrigerant 22 in air conditioners and heat pumps for both new equipment and retrofit use for aftermarket service; generally not suitable in equipment with a flooded evaporator due to high glide: This refrigerant and its use in air conditioners and heat pumps may be covered by U.S. patents 5,370,811 and 5,438,849, respectively, issued to Y. Yoshida, K. Arita, and M. Funakura and assigned to Matsushita Electric Industrial Company, Limited (Osaka, Japan). Other U.S. and foreign patents may apply, including - but not limited to - European 430169, Japanese 1928524 and 1928525, and Korean 69627.

Note: The composition tolerances indicated for this refrigerant were originally $\pm 2/\pm 1/\pm 2$ (see RDB6101), but were subsequently changed in ASHRAE Standard 34-1992 addendum 34w to $\pm 2/\pm 2/\pm 2$ (see RDB6801).

IDENTIFIERS

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common name(s):  R-407C; R407C; R 407C      6101
                  HFC/HFC/HFC-407C, not HFC-407C 6101
trade name(s):   AlliedSignal Genetron(R) 407C  MSDS
                  Ausimont Meforex(R) M95      7726
                  Daikin R-407C                MSDS
                  DuPont Suva(R) 9000          MSDS
                  Elf Atochem Forane(R) 407C   6938
                  HRP (UK) HARP(R) 407C
                  ICI Klea(R) 407C            6B35
                  ICI Klea(R) 66              4135
                  Solvay Solkane(R) 407C
historical name(s): DuPont Suva(R) AC9000      4764
                   Hoechst Reclin(R) 407C     7855
                   Hoechst Reclin(R) HX3      7855
ARI container color / Pantone number: medium brown (brown) / 471 6601

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PHYSICAL

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· nominal blend formulation -----
  composition:      R-32/125/134a              6101
  component weight fractions: 23.0 / 25.0 / 52.0 % 6101
  component weight tolerances:  $\pm 2.0$  /  $\pm 2.0$  /  $\pm 2.0$  6101
  component mole fractions: 38.111 / 17.956 / 43.933 % 8820
· properties -----
  molar mass:      86.20283 g/mol (0.190045 lb/mol) 8820
· normal boiling point -----
  bubble point temperature: -43.6 °C (-46.4 °F) 4765
                           -43.6 °C (-46.5 °F) 5A31
                           -43.8 °C (-46.9 °F) 8401
  dew point temperature:  -36.7 °C (-34.1 °F) 8401
  maximum temperature glide: 7.09 °C (12.8 °F) 8401
  density, saturated liquid: 1382 kg/m3 (86.28 lb/cf) 8401

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density, saturated vapor:	4.63 kg/m ³ (0.289 lb/cf)	8401
specific volume, saturated liquid:	0.724 L/kg (0.0116 cf/lb)	8401
specific volume, saturated vapor:	216.0 L/kg (3.4592 cf/lb)	8401
heat of vaporization:	248.0 kJ/kg (106.6 Btu/lb)	8401
velocity of sound, saturated liquid:	806 m/s (2646 ft/s)	8401
velocity of sound, saturated vapor:	158 m/s (518 ft/s)	8401
viscosity, saturated liquid:	371 μPa·s (0.371 cp)	8401
viscosity, saturated vapor:	9.81 μPa·s (0.00981 cp)	8401
thermal conductivity, liquid:	0.1242 W/m·K (0.0718 Btu/hr·ft ² ·°F)	8401
thermal conductivity, vapor:	0.0086 W/m·K (0.0050 Btu/hr·ft ² ·°F)	8401
· normal pressure, 20 °C (68 °F) -----		
density, vapor:	3.647 kg/m ³ (0.2276 lb/cf)	8401
· normal pressure, 21.1 °C (70 °F) ---		
density, vapor:	3.632 kg/m ³ (0.2267 lb/cf)	8401
· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	1035.7 kPa (150.22 psia)	8401
pressure, vapor (dew point):	879.8 kPa (127.61 psia)	8401
density, saturated liquid:	1159 kg/m ³ (72.35 lb/cf)	8401
density, saturated vapor:	37.59 kg/m ³ (2.347 lb/cf)	8401
specific volume, saturated liquid:	0.863 L/kg (0.0138 cf/lb)	8401
specific volume, saturated vapor:	26.6 L/kg (0.4262 cf/lb)	8401
velocity of sound, saturated liquid:	495 m/s (1624 ft/s)	8401
velocity of sound, saturated vapor:	156 m/s (512 ft/s)	8401
viscosity, saturated liquid:	163 μPa·s (0.163 cp)	8401
viscosity, saturated vapor:	12.4 μPa·s (0.0124 cp)	8401
thermal conductivity, saturated liquid:	0.0904 W/m·K (0.0522 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01309 W/m·K (0.00756 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	2763 kPa (400.7 psia)	8401
pressure, vapor (dew point):	2524 kPa (366.1 psia)	8401
heat of vaporization:	130.9 kJ/kg for liquid and vapor both at nominal composition (56.3 Btu/lb) 113.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (48.7 Btu/lb)	8401
· critical point -----		
temperature:	86.1 °C (186.9 °F)	8401
	86.1 °C (187.0 °F)	4134
	86.7 °C (188.1 °F)	4765
	87.3 °C (189.1 °F)	5A31
pressure:	4634 kPa (672.1 psia)	8401
density:	513 kg/m ³ (32.0 lb/cf)	8401
specific volume:	1.95 L/kg (0.0312 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
	<0.00027 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1980 mass-weighted average relative to CO ₂ for 100 yr integration	9501

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

R-407D

----- REFRIGERANT DATA SUMMARY -----

R-407D	R-32/125/134a (15.0/15.0/70.0)	see
zeotrope	ternary blend	RDB#

COMMON USE(S)

alternative for refrigerant 500 in ultra-low temperature cascade and low-temperature (below -25 °C, -13 °F) systems, especially in biomedical applications

IDENTIFIERS

common name(s):	R-407D; R407D; R 407D	7250
	HFC/HFC/HFC-407D, not HFC-407D	2909
trade name(s):	ICI Klea(R) 407D	MSDS
historical name(s):	ICI Klea(R) 32/125/134a (15/15/70) blend	
ARI container color / Pantone number:	dark brown (chocolate) / 450	ARI

PHYSICAL

· nominal blend formulation -----		
composition:	R-32/125/134a	7250
component weight fractions:	15.0 / 15.0 / 70.0 %	7250
component weight tolerances:	±2.0 / ±2.0 / ±2.0	7250
component mole fractions:	26.227 / 11.368 / 62.405 %	8820
· properties -----		
molar mass:	90.96066 g/mol (0.200534 lb/mol)	8820
· normal boiling point -----		
bubble point temperature:	-39.4 °C (-39.0 °F)	8401
dew point temperature:	-32.7 °C (-26.8 °F)	8401
maximum temperature glide:	6.75 °C (12.2 °F)	8401
density, saturated liquid:	1384 kg/m ³ (86.41 lb/cf)	8401
density, saturated vapor:	4.81 kg/m ³ (0.300 lb/cf)	8401
specific volume, saturated liquid:	0.722 L/kg (0.0116 cf/lb)	8401
specific volume, saturated vapor:	208.1 L/kg (3.3331 cf/lb)	8401
heat of vaporization:	240.3 kJ/kg (103.3 Btu/lb)	8401
velocity of sound, saturated liquid:	792 m/s (2597 ft/s)	8401
velocity of sound, saturated vapor:	154 m/s (505 ft/s)	8401
viscosity, saturated liquid:	384 µPa·s (0.384 cp)	8401
viscosity, saturated vapor:	9.72 µPa·s (0.00972 cp)	8401
thermal conductivity, liquid:	0.1178 W/m·K (0.0681 Btu/hr·ft ² ·°F)	8401
thermal conductivity, vapor:	0.0088 W/m·K (0.0051 Btu/hr·ft ² ·°F)	8401
· normal pressure, 20 °C (68 °F) -----		
density, vapor:	3.853 kg/m ³ (0.2406 lb/cf)	8401
· normal pressure, 21.1 °C (70 °F) ---		
density, vapor:	3.838 kg/m ³ (0.2396 lb/cf)	8401
· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	879.8 kPa (127.61 psia)	8401
pressure, vapor (dew point):	750.0 kPa (108.77 psia)	8401
density, saturated liquid:	1182 kg/m ³ (73.76 lb/cf)	8401
density, saturated vapor:	33.20 kg/m ³ (2.073 lb/cf)	8401
specific volume, saturated liquid:	0.846 L/kg (0.0136 cf/lb)	8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

specific volume, saturated vapor:	30.1 L/kg (0.4824 cf/lb)	8401
velocity of sound, saturated liquid:	508 m/s (1666 ft/s)	8401
velocity of sound, saturated vapor:	153 m/s (502 ft/s)	8401
viscosity, saturated liquid:	178 $\mu\text{Pa}\cdot\text{s}$ (0.178 cp)	8401
viscosity, saturated vapor:	12.0 $\mu\text{Pa}\cdot\text{s}$ (0.0120 cp)	8401
thermal conductivity, saturated liquid:	0.0880 W/m \cdot K (0.0508 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01304 W/m \cdot K (0.00753 Btu/hr \cdot ft $^{\circ}$ F)	8401
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	2387 kPa (346.2 psia)	8401
pressure, vapor (dew point):	2179 kPa (316.1 psia)	8401
heat of vaporization:	135.8 kJ/kg for liquid and vapor both at nominal composition (58.4 Btu/lb)	8401
	118.3 kJ/kg coexisting liquid and vapor at bubble-point pressure (50.9 Btu/lb)	8401
• critical point -----		
temperature:	91.6 $^{\circ}$ C (196.8 $^{\circ}$ F)	8401
pressure:	4483 kPa (650.2 psia)	8401
density:	508 kg/m ³ (31.7 lb/cf)	8401
specific volume:	1.97 L/kg (0.0315 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
	<0.00036 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1820 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.31 mass-weighted average relative to R 11 for infinite integration period	DW

SAFETY

• classification -----		
safety group (ASHRAE Standard 34):	A1/A1	8601
NFPA 704 degrees of hazard (H-F-R-S):	ICI: 1-0-1	mfr
	health-flammability-reactivity [-special]: 0=no, 4=severe	
• long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	ICI OEL: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	6B35
• emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	65,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
• flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	
heat of combustion (by ASHRAE 34-92):	-4.3 MJ/kg (-1864 Btu/lb)	mfr
flash point:	ICI: none (does not flash)	MSDS
former UL Classification:	practically nonflammable (withdrawn for revision of the classification system, category SBQT2)	UL

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

· detection -----

appearance: ICI: colorless liquified gas MSDS
odor: ICI: faint ether-like odor MSDS

PRODUCTION

first commercial use as a refrigerant: 1994
last year production allowed: unrestricted 8C01

R-407E

----- REFRI GERANT DATA SUMMARY -----
 R-407E R-32/125/134a (25.0/15.0/60.0) see
 zeotrope ternary blend RDB#

COMMON USE(S)

under consideration - particularly in Japan - as an alternative for
 refrigerant 22, both in new equipment and as a service fluid, in
 window and packaged air conditioners

IDENTIFIERS

common name(s): R-407E; R407E; R 407E 34f
 R-32/125/134a (25/15/60)
 R32/125/134a (25/15/60)
 R 32/125/134a (25/15/60)
 HFC/HFC/HFC-407E; not HFC-407E 34f
 HFC-32/HFC-125/HFC-134a 2909
 (25/15/60)
 not HFC-32/125/134a (25/15/60) 2909
 trade name(s): ICI Klea(R) Blend 25/15/60 MSDS
 ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

• nominal blend formulation -----
 composition: R-32/125/134a 34f
 component weight fractions: 25.0 / 15.0 / 60.0 % 34f
 component weight tolerances: ±2.0 / ±2.0 / ±2.0 34f
 component mole fractions: 40.261 / 10.471 / 49.268 % 8820
 • properties -----
 molar mass: 83.78100 g/mol (0.184705 8820
 lb/mol)
 • normal boiling point -----
 bubble point temperature: -42.8 °C (-45.1 °F) 8401
 dew point temperature: -35.6 °C (-32.0 °F) 8401
 maximum temperature glide: 7.25 °C (13.0 °F) 8401
 density, saturated liquid: 1367 kg/m3 (85.34 lb/cf) 8401
 density, saturated vapor: 4.48 kg/m3 (0.280 lb/cf) 8401
 specific volume, saturated liquid: 0.732 L/kg (0.0117 cf/lb) 8401
 specific volume, saturated vapor: 223.3 L/kg (3.5768 cf/lb) 8401
 heat of vaporization: 256.9 kJ/kg (110.5 Btu/lb) 8401
 velocity of sound, saturated liquid: 816 m/s (2679 ft/s) 8401
 velocity of sound, saturated vapor: 172 m/s (564 ft/s) 8401
 viscosity, saturated liquid: 368 µPa·s (0.368 cp) 8401
 viscosity, saturated vapor: 9.76 µPa·s (0.00976 cp) 8401
 thermal conductivity, liquid: 0.1269 W/m·K (0.0733 8401
 Btu/hr·ft°F)
 thermal conductivity, vapor: 0.0086 W/m·K (0.0050 8401
 Btu/hr·ft°F)
 • normal pressure, 20 °C (68 °F) -----
 density, vapor: 3.545 kg/m3 (0.2213 lb/cf) 8401
 • normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 3.531 kg/m3 (0.2204 lb/cf) 8401
 • 20 °C (68 °F) -----
 pressure, liquid (bubble point): 999.8 kPa (145.01 psia) 8401

pressure, vapor (dew point):	843.3 kPa (122.32 psia)	8401
density, saturated liquid:	1152 kg/m ³ (71.94 lb/cf)	8401
density, saturated vapor:	34.78 kg/m ³ (2.171 lb/cf)	8401
specific volume, saturated liquid:	0.868 L/kg (0.0139 cf/lb)	8401
specific volume, saturated vapor:	28.8 L/kg (0.4606 cf/lb)	8401
velocity of sound, saturated liquid:	511 m/s (1675 ft/s)	8401
velocity of sound, saturated vapor:	160 m/s (524 ft/s)	8401
viscosity, saturated liquid:	165 μ Pa·s (0.165 cp)	8401
viscosity, saturated vapor:	12.3 μ Pa·s (0.0123 cp)	8401
thermal conductivity, saturated liquid:	0.0934 W/m·K (0.0540 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01298 W/m·K (0.00750 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	2679 kPa (388.5 psia)	8401
pressure, vapor (dew point):	2433 kPa (352.9 psia)	8401
heat of vaporization:	139.8 kJ/kg for liquid and vapor both at nominal composition (60.1 Btu/lb)	8401
	119.1 kJ/kg coexisting liquid and vapor at bubble-point pressure (51.2 Btu/lb)	8401
· critical point -----		
temperature:	88.8 °C (191.8 °F)	8401
pressure:	4734 kPa (686.6 psia)	8401
density:	500 kg/m ³ (31.2 lb/cf)	8401
specific volume:	2.00 L/kg (0.0320 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
	<0.00031 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1750 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.30 mass-weighted average relative to R 11 for infinite integration period	DW

SAFETY

· classification -----		
safety group (ASHRAE Standard 34):	A1/A1	34f
NFPA 704 degrees of hazard (H-F-R-S):	ICI: 1-0-1	mfr
	health-flammability-reactivity [-special]: 0=no, 4=severe	
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	ICI OEL: 1,000 ppm v/v TWA for MSDS 8 hr/day and 40 hr/wk	
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	69,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	ICI: nonflammable as tested	MSDS
heat of combustion (by ASHRAE 34-92):	-4.8 MJ/kg (-2084 Btu/lb)	mfr
flash point:	ICI: does not flash	MSDS

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

· detection -----

appearance:	ICI: colorless liquified gas	MSDS
odor:	ICI: faint ethereal	MSDS

PRODUCTION

first commercial use as a refrigerant:	projected: 1998	
last year production allowed:	unrestricted	8C01

R-408A

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----- REFRIGERANT DATA SUMMARY -----
R-408A      R-125/143a/22 (7.0/46.0/47.0)      see
zeotrope   ternary blend                          RDB#
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COMMON USE(S)

alternative for refrigerant 502, primarily for aftermarket use to service or retrofit existing low and medium temperature refrigeration equipment; under limited consideration as a blowing agent and aerosol propellant

IDENTIFIERS

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common name(s):  R-408A; R408A; R 408A      6101
                  HFC/HFC/HCFC-408A      6101
                  not HCFC-408A          6101
trade name(s):   Elf Atochem Forane(R) 408A  MSDS
                  HRP (UK) HARP(R) 408A
                  ICI Arcton(R) 408A      CSDS
historical name(s): Elf Atochem Forane(R) FX-10 4770
name used in U.S. EPA SNAP Rule: HCFC Blend Epsilon
ARI container color / Pantone number: medium purple / 248 6601

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PHYSICAL

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· nominal blend formulation -----
      composition:  R-125/143a/22          6101
      component weight fractions:  7.0 / 46.0 / 47.0 % 6101
      component weight tolerances: ±2.0 / ±1.0 / ±2.0 6101
      component mole fractions:    5.075 / 47.628 / 47.297 % 8820
· properties -----
      molar mass:    87.01468 g/mol (0.191835 lb/mol) 8820
· normal boiling point -----
      bubble point temperature:  -45.5 °C (-49.8 °F) 8401
      dew point temperature:     -45.0 °C (-49.0 °F) 8401
      maximum temperature glide: 0.46 °C (0.8 °F) 8401
      density, saturated liquid: 1293 kg/m3 (80.70 lb/cf) 8401
      density, saturated vapor:   4.85 kg/m3 (0.303 lb/cf) 8401
      specific volume, saturated liquid: 0.774 L/kg (0.0124 cf/lb) 8401
      specific volume, saturated vapor: 206.2 L/kg (3.3024 cf/lb) 8401
      heat of vaporization:       224.9 kJ/kg (96.7 Btu/lb) 8401
      velocity of sound, saturated liquid: 809 m/s (2653 ft/s) 8401
      velocity of sound, saturated vapor: 155 m/s (508 ft/s) 8401
      viscosity, saturated liquid: 318 µPa·s (0.318 cp) 8401
      viscosity, saturated vapor: 9.05 µPa·s (0.00905 cp) 8401
      thermal conductivity, liquid: 0.1058 W/m·K (0.0611 Btu/hr·ft°F) 8401
      thermal conductivity, vapor: 0.0078 W/m·K (0.0045 Btu/hr·ft°F) 8401
· normal pressure, 20 °C (68 °F) ----
      density, vapor: 3.678 kg/m3 (0.2296 lb/cf) 8401
· normal pressure, 21.1 °C (70 °F) ---
      density, vapor: 3.664 kg/m3 (0.2287 lb/cf) 8401
· 20 °C (68 °F) -----
      pressure, liquid (bubble point): 1050.7 kPa (152.39 psia) 8401

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pressure, vapor (dew point):	1042.7 kPa (151.23 psia)	8401
density, saturated liquid:	1076 kg/m ³ (67.17 lb/cf)	8401
density, saturated vapor:	46.63 kg/m ³ (2.911 lb/cf)	8401
specific volume, saturated liquid:	0.929 L/kg (0.0149 cf/lb)	8401
specific volume, saturated vapor:	21.4 L/kg (0.3435 cf/lb)	8401
velocity of sound, saturated liquid:	484 m/s (1587 ft/s)	8401
velocity of sound, saturated vapor:	151 m/s (497 ft/s)	8401
viscosity, saturated liquid:	144 μPa·s (0.144 cp)	8401
viscosity, saturated vapor:	12.0 μPa·s (0.0120 cp)	8401
thermal conductivity, saturatd liquid:	0.0764 W/m·K (0.0442 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01313 W/m·K (0.00759 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	2744 kPa (398.0 psia)	8401
pressure, vapor (dew point):	2733 kPa (396.4 psia)	8401
heat of vaporization:	112.7 kJ/kg for liquid and vapor both at nominal composition (48.4 Btu/lb)	8401
	112.5 kJ/kg coexisting liquid and vapor at bubble-point pressure (48.4 Btu/lb)	8401
· critical point -----		
temperature:	83.3 °C (182.0 °F)	8401
pressure:	4424 kPa (641.6 psia)	8401
density:	481 kg/m ³ (30.0 lb/cf)	8401
specific volume:	2.08 L/kg (0.0333 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.016 mass-weighted average (model-derived relative to R 11)	9501
	0.024 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	3640 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.64 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	A1/A1	8601
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	47,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	4770
heat of combustion (by ASHRAE 34-92):	5.7 MJ/kg (2435 Btu/lb)	UL
flash point:	Atochem: gas, not applicable	MSDS
autoignition temperature:	698 °C (1288 °F)	5931
former UL Classification:	practically nonflammable (withdrawn for revision of the classification system, category SBQT2)	6938
· detection -----		

appearance: Elf Atochem: clear, colorless MSDS
odor: Elf Atochem: faint ethereal MSDS

PRODUCTION

first commercial use as a refrigerant: circa 1994
last year production allowed: 2029 based on refrigerant 22 8C01
in developed countries under
the Montreal Protocol

R-409A

----- REFRIGERANT DATA SUMMARY -----
 R-409A R-22/124/142b (60.0/25.0/15.0) see
 zeotrope ternary blend RDB#

COMMON USE(S)

alternative for refrigerant 12, primarily for aftermarket use to service or retrofit low- and medium-temperature refrigeration systems; promoted where removal of residual mineral oil is difficult, preventing use of refrigerant 134a, such as those with small hermetic compressors (e.g., vending machines)

IDENTIFIERS

common name(s):	R-409A; R409A; R 409A	6101
	HCFC/HCFC/HCFC-409A	6101
	not HCFC-409A	6101
trade name(s):	AlliedSignal Genetron(R) 409A	MSDS
	Elf Atochem Forane(R) 409A	MSDS
	HRP (UK) HARP(R) 409A	
	ICI Arcton(R) 409A	CSDS
	Solvay R409A	
historical name(s):	Elf Atochem Forane(R) FX-56	4771
name used in U.S. EPA SNAP Rule:	HCFC Blend Gamma	
ARI container color / Pantone number:	medium brown (tan) / 465	6601

PHYSICAL

- nominal blend formulation -----
 - composition: R-22/124/142b 6101
 - component weight fractions: 60.0 / 25.0 / 15.0 % 6101
 - component weight tolerances: ±2.0 / ±2.0 / ±1.0 6101
 - component mole fractions: 67.609 / 17.848 / 14.543 % 8820
- properties -----
 - molar mass: 97.43345 g/mol (0.214804 lb/mol) 8820
- normal boiling point -----
 - bubble point temperature: -35.4 °C (-31.8 °F) 8401
 - dew point temperature: -26.1 °C (-15.0 °F) 4136
 - 27.5 °C (-17.6 °F) 8401
 - maximum temperature glide: 7.89 °C (14.2 °F) 8401
 - density, saturated liquid: 1395 kg/m3 (87.07 lb/cf) 8401
 - 5 kg/m3 (0.31 lb/cf) 8401
 - specific volume, saturated vapor: 199.4 L/kg (3.1944 cf/lb) 8401
 - heat of vaporization: 220.2 kJ/kg (94.7 Btu/lb) 8401
 - velocity of sound, saturated liquid: 806 m/s (2644 ft/s) 8401
 - velocity of sound, saturated vapor: 152 m/s (498 ft/s) 8401
 - viscosity, saturated liquid: 365 µPa·s (0.365 cp) 8401
 - viscosity, saturated vapor: 9.85 µPa·s (0.00985 cp) 8401
 - thermal conductivity, liquid: 0.1028 W/m·K (0.0594 Btu/hr·ft·°F) 8401
 - thermal conductivity, vapor: 0.0078 W/m·K (0.0045 Btu/hr·ft·°F) 8401
- normal pressure, 20 °C (68 °F) -----
 - density, vapor: 4.128 kg/m3 (0.2577 lb/cf) 8401
- normal pressure, 21.1 °C (70 °F) ---

	density, vapor:	4.112 kg/m ³ (0.2567 lb/cf)	8401
• 20 °C (68 °F) -----			
	pressure, liquid (bubble point):	725.2 kPa (105.17 psia)	8401
	pressure, vapor (dew point):	592.8 kPa (85.98 psia)	8401
	density, saturated liquid:	1223 kg/m ³ (76.34 lb/cf)	8401
	density, saturated vapor:	27.00 kg/m ³ (1.685 lb/cf)	8401
	specific volume, saturated liquid:	0.818 L/kg (0.0131 cf/lb)	8401
	specific volume, saturated vapor:	37.0 L/kg (0.5934 cf/lb)	8401
	velocity of sound, saturated liquid:	559 m/s (1833 ft/s)	8401
	velocity of sound, saturated vapor:	154 m/s (504 ft/s)	8401
	viscosity, saturated liquid:	193 µPa·s (0.193 cp)	8401
	viscosity, saturated vapor:	11.8 µPa·s (0.0118 cp)	8401
	thermal conductivity, saturated liquid:	0.0799 W/m·K (0.0462 Btu/hr·ft°F)	8401
	thermal conductivity, saturated vapor:	0.01080 W/m·K (0.00624 Btu/hr·ft°F)	8401
• 60 °C (140 °F) -----			
	pressure, liquid (bubble point):	1941 kPa (281.5 psia)	8401
	pressure, vapor (dew point):	1714 kPa (248.6 psia)	8401
	heat of vaporization:	141.6 kJ/kg for liquid and vapor both at nominal composition (60.9 Btu/lb)	8401
		125.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (54.0 Btu/lb)	8401
• critical point -----			
	temperature:	106.9 °C (224.4 °F)	8401
	pressure:	4499 kPa (652.5 psia)	4771
		4693 kPa (680.7 psia)	8401
	density:	508 kg/m ³ (31.7 lb/cf)	8401
	specific volume:	1.97 L/kg (0.0316 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	0.039 mass-weighted average (model-derived relative to R 11)	9501
	0.046 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1640 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.27 mass-weighted average relative to R 11 for infinite integration period	DW

SAFETY

• classification -----		
	safety group (ASHRAE Standard 34):	A1/A1 8601
	NFPA 704 degrees of hazard (H-F-R-S):	AlliedSignal: 2-0-0 MSDS
		health-flammability-reactivity [-special]: 0=no, 4=severe
	NPCA HMIS hazard ratings (H-F-R):	AlliedSignal: 2-0-0 MSDS
		health-flammability-reactivity 0=insignificant, 4=extreme
• long-term occupational limit -----		
	exposure limit consistent to OSHA PEL:	Solvay SAEL: 1,000 ppm v/v TWA MSDS for 8 hr/day and 40 hr/wk
• emergency exposure limit -----		

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

R-409B

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----- REFRIGERANT DATA SUMMARY -----
R-409B      R-22/124/142b (65.0/25.0/10.0)      see
zeotrope   binary blend                          RDB#
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COMMON USE(S)

alternative for refrigerants 12 and 500, primarily for aftermarket use to service or retrofit transport refrigeration

IDENTIFIERS

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common name(s):  R-409B; R409B; R-409B          6801
                  HCFC/HCFC/HCFC-409B          6801
                  not HCFC-409B                 2909
trade name(s):   Elf Atochem Forane(R) 409B
                  Elf Atochem Forane(R) FX-57   MSDS
ARI container color / Pantone number: none, use light green grey/413 6601

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PHYSICAL

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· nominal blend formulation -----
  composition:      R-22/124/142b                6801
  component weight fractions: 65.0 / 25.0 / 10.0 % 6801
  component weight tolerances: ±2.0 / ±2.0 / ±1.0 6801
  component mole fractions:  72.671 / 17.709 / 9.620 % 8820
· properties -----
  molar mass:      96.67323 g/mol (0.213128      8820
                  lb/mol)
· normal boiling point -----
  bubble point temperature: -36.5 °C (-33.7 °F)  8401
  dew point temperature:   -29.7 °C (-21.5 °F)  8401
  maximum temperature glide: 6.82 °C (12.3 °F)  8401
  density, saturated liquid: 1406 kg/m3 (87.79 lb/cf) 8401
  density, saturated vapor:  5.02 kg/m3 (0.313 lb/cf) 8401
  specific volume, saturated liquid: 0.711 L/kg (0.0114 cf/lb) 8401
  specific volume, saturated vapor:  199.2 L/kg (3.1916 cf/lb) 8401
  heat of vaporization:      219.6 kJ/kg (94.4 Btu/lb) 8401
  velocity of sound, saturated liquid: 807 m/s (2649 ft/s) 8401
  velocity of sound, saturated vapor:  156 m/s (513 ft/s) 8401
  viscosity, saturated liquid: 362 µPa·s (0.362 cp) 8401
  viscosity, saturated vapor:  9.88 µPa·s (0.00988 cp) 8401
  thermal conductivity, liquid: 0.1035 W/m·K (0.0598      8401
                  Btu/hr·ft°F)
  thermal conductivity, vapor: 0.0077 W/m·K (0.0044      8401
                  Btu/hr·ft°F)
· normal pressure, 20 °C (68 °F) -----
  density, vapor:          4.093 kg/m3 (0.2555 lb/cf) 8401
· normal pressure, 21.1 °C (70 °F) ---
  density, vapor:          4.077 kg/m3 (0.2545 lb/cf) 8401
· 20 °C (68 °F) -----
  pressure, liquid (bubble point): 758.5 kPa (110.01 psia) 8401
  pressure, vapor (dew point):     640.6 kPa (92.91 psia) 8401
  density, saturated liquid: 1227 kg/m3 (76.62 lb/cf) 8401
  density, saturated vapor:   29.16 kg/m3 (1.820 lb/cf) 8401
  specific volume, saturated liquid: 0.815 L/kg (0.0131 cf/lb) 8401
  specific volume, saturated vapor: 34.3 L/kg (0.5494 cf/lb) 8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

velocity of sound, saturated liquid:	554 m/s (1817 ft/s)	8401
velocity of sound, saturated vapor:	154 m/s (504 ft/s)	8401
viscosity, saturated liquid:	189 $\mu\text{Pa}\cdot\text{s}$ (0.189 cp)	8401
viscosity, saturated vapor:	12.0 $\mu\text{Pa}\cdot\text{s}$ (0.0120 cp)	8401
thermal conductivity, saturated liquid:	0.0800 W/m \cdot K (0.0462 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01081 W/m \cdot K (0.00624 Btu/hr \cdot ft $^{\circ}$ F)	8401
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	2028 kPa (294.1 psia)	8401
pressure, vapor (dew point):	1830 kPa (265.5 psia)	8401
heat of vaporization:	139.1 kJ/kg for liquid and vapor both at nominal composition (59.8 Btu/lb)	8401
	124.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (53.6 Btu/lb)	8401
• critical point -----		
temperature:	104.4 $^{\circ}$ C (219.9 $^{\circ}$ F)	8401
pressure:	4711 kPa (683.3 psia)	8401
density:	511 kg/m ³ (31.9 lb/cf)	8401
specific volume:	1.96 L/kg (0.0313 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.033 mass-weighted average (model-derived relative to R 11)	9501
	0.046 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1620 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.27 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
• classification -----		
safety group (ASHRAE Standard 34):	A1/A1	8601
• emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	20,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
• flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	4136
flash point:	Elf Atochem: not applicable	MSDS
autoignition temperature:	698 $^{\circ}$ C (1288 $^{\circ}$ F)	UL
former UL Classification:	practically nonflammable (withdrawn for revision of the classification system, category SBQT2)	UL
• detection -----		
appearance:	Elf Atochem: clear, colorless	MSDS
odor:	Elf Atochem: faint ethereal	MSDS
PRODUCTION		
first commercial use as a refrigerant:	1994	
last year production allowed:	2029 by components in	8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

developed countries under the
Montreal Protocol

R-410A

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----- REFRIGERANT DATA SUMMARY -----
R-410A      R-32/125 (50.0/50.0)                see
zeotrope    binary blend                          RDB#
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COMMON USE (S)

replacement for refrigerant 22 for new residential and light-commercial air conditioners and heat pumps, chillers, and commercial refrigeration; aftermarket use to retrofit existing chillers with components approved for high pressure; replacement for refrigerant 13B1 in industrial refrigeration; under consideration as a fire suppressant in aviation systems; may be covered by U.S. patent 4,978,467

IDENTIFIERS

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common name(s):  R-410A; R410A; R 410A           6101
                  HFC/HFC-410A; not HFC-410A     6101
trade name(s):   AlliedSignal Genetron(R) AZ-20  3A59
                  Carrier Puron(TM)              mfr
                  Daikin R-410A                  MSDS
                  DuPont Suva(R) 9100 (>May1996) MSDS
                  Elf Atochem Forane(R) 410A     MSDS
                  Solvay Solkane(R) 410         6101
                  Solvay Solkane(R) 410A
ARI container color / Pantone number:  rose / 507

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PHYSICAL

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· nominal blend formulation -----
      composition:  R-32/125                       6101
      component weight fractions:  50.0 / 50.0 %    6101
      component weight tolerances:  +0.5, -1.5 / +1.5, -0.5  6101
      component mole fractions:     69.762 / 30.238 %    8820
· properties -----
      molar mass:  72.58481 g/mol (0.160022 lb/mol)  8820
· normal boiling point -----
      temperature:  -52.7 °C (-62.9 °F)             5338
      bubble point temperature:  -51.6 °C (-60.9 °F)  8401
      dew point temperature:  -51.5 °C (-60.8 °F)    8401
      maximum temperature glide:  0.05 °C (0.1 °F)    8401
      density, saturated liquid:  1351 kg/m3 (84.33 lb/cf)  8401
      density, saturated vapor:   4.17 kg/m3 (0.261 lb/cf)  8401
                                   4.19 kg/m3 (0.262 lb/cf)  5338
      specific volume, saturated liquid:  0.740 L/kg (0.0119 cf/lb)  8401
      specific volume, saturated vapor:  239.6 L/kg (3.8377 cf/lb)  8401
      heat of vaporization:  256.7 kJ/kg (110.3 Btu/lb)  5338
                                   271.5 kJ/kg (116.7 Btu/lb)  8401
      velocity of sound, saturated liquid:  845 m/s (2773 ft/s)  8401
      velocity of sound, saturated vapor:  169 m/s (556 ft/s)  8401
      viscosity, saturated liquid:  314 µPa·s (0.314 cp)  8401
      viscosity, saturated vapor:  9.79 µPa·s (0.00979 cp)  8401
      thermal conductivity, liquid:  0.1454 W/m·K (0.0840 Btu/hr·ft·°F)  8401
      thermal conductivity, vapor:  0.0081 W/m·K (0.0047 Btu/hr·ft·°F)  8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

	Btu/hr·ft°F)	
· normal pressure, 20 °C (68 °F) -----		
density, vapor:	3.061 kg/m ³ (0.1911 lb/cf)	8401
· normal pressure, 21.1 °C (70 °F) ---		
density, vapor:	3.049 kg/m ³ (0.1903 lb/cf)	8401
· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	1442.7 kPa (209.25 psia)	8401
pressure, saturated vapor:	1439.4 kPa (208.77 psia)	5338
pressure, vapor (dew point):	1438.3 kPa (208.61 psia)	8401
density, saturated liquid:	1085 kg/m ³ (67.74 lb/cf)	8401
	1087 kg/m ³ (67.88 lb/cf)	5338
density, saturated vapor:	55.56 kg/m ³ (3.468 lb/cf)	5338
	56.53 kg/m ³ (3.529 lb/cf)	8401
specific volume, saturated liquid:	0.920 L/kg (0.0147 cf/lb)	5338
specific volume, saturated vapor:	18.0 L/kg (0.2883 cf/lb)	5338
velocity of sound, saturated liquid:	471 m/s (1546 ft/s)	8401
velocity of sound, saturated vapor:	164 m/s (538 ft/s)	8401
viscosity, saturated liquid:	129 µPa·s (0.129 cp)	8401
viscosity, saturated vapor:	13.6 µPa·s (0.0136 cp)	8401
thermal conductivity, saturatd liquid:	0.1013 W/m·K (0.0585	8401
	Btu/hr·ft°F)	
thermal conductivity, saturated vapor:	0.01444 W/m·K (0.00834	8401
	Btu/hr·ft°F)	
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	3833 kPa (555.9 psia)	8401
pressure, saturated vapor:	3817 kPa (553.6 psia)	5338
pressure, vapor (dew point):	3825 kPa (554.8 psia)	8401
heat of vaporization:	107.2 kJ/kg for liquid and	8401
	vapor both at nominal	
	composition (46.1 Btu/lb)	
	104.7 kJ/kg coexisting liquid	8401
	and vapor at bubble-point	
	pressure (45.0 Btu/lb)	
· critical point -----		
temperature:	70.2 °C (158.3 °F)	8401
	72.5 °C (162.5 °F)	3A59
pressure:	4770 kPa (691.8 psia)	8401
	4950 kPa (717.9 psia)	5338
density:	500 kg/m ³ (31.2 lb/cf)	3A59
	552 kg/m ³ (34.5 lb/cf)	8401
specific volume:	1.81 L/kg (0.0290 cf/lb)	8401
	2.00 L/kg (0.0320 cf/lb)	3A59
ENVIRONMENTAL		
ODP (ozone depletion potential):	<0.00002 mass-weighted average	9501
	(model-derived relative to R	
	11)	
GWP (global warming potential):	2340 mass-weighted average	9501
	relative to CO ₂ for 100 yr	
	integration	
HGWP (halocarbon GWP):	0.39 mass-weighted average	DW
	relative to R 11 for infinite	
	integration period	
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	A1/A1	8601
NFPA 704 degrees of hazard (H-F-R-S):	AlliedSignal: 2-0-1	MSDS
	health-flammability-reactivity	

NPCA HMIS hazard ratings (H-F-R): [-special]: 0=no, 4=severe
 AlliedSignal: 1-0-1 MSDS
 DuPont: 1-0-1 MSDS
 health-flammability-reactivity
 0=insignificant, 4=extreme

• long-term occupational limit -----
 exposure limit consistent to OSHA PEL: AlliedSignal OEL: 1,000 ppm 7110
 v/v TWA for 8 hr/day and 40
 hr/wk

• emergency exposure limit -----
 Refrigerant Concentration Limit (RCL): 55,000 ppm v/v (preliminary
 value under review, based on
 draft ASHRAE 34aa)

• flammability -----
 LFL-UFL (flammability limits in air): none (nonflammable as tested) 3A59
 heat of combustion (by ASHRAE 34-92): -4.4 MJ/kg (-1875 Btu/lb) UL
 flash point: AlliedSignal: not applicable MSDS
 DuPont: will not burn MSDS
 autoignition temperature: 732 °C (1350 °F) 5931
 AlliedSignal: >750°C (>1382°F) MSDS
 autodecomposition temperature: Elf Atochem: >427 °C (>800 °F) MSDS
 former UL Classification: practically nonflammable 6938
 (withdrawn for revision of the
 classification system,
 category SBQT2)

• detection -----
 appearance: DuPont: clear, colorless MSDS
 odor: AlliedSignal: faint ethereal MSDS

PRODUCTION
 last year production allowed: unrestricted 8C01

R-410B

----- REFRIGERANT DATA SUMMARY -----

R-410B	R-32/125 (45.0/55.0)	see
zeotrope	binary blend	RDB#

COMMON USE(S)

alternative for refrigerant 22 in new air conditioners and heat pumps
designed for higher discharge pressures

IDENTIFIERS

common name(s):	R-410B; R410B; R 410B	6101
	HFC/HFC-410B, not HFC-410B	
historical name(s):	before May 1996:	
	DuPont Suva(R) 9100	
ARI container color / Pantone number:	maroon / 194	6601

PHYSICAL

· nominal blend formulation -----		
composition:	R-32/125	6101
component weight fractions:	45.0 / 55.0 %	6101
component weight tolerances:	±1.0 / ±1.0	6101
component mole fractions:	65.369 / 34.631 %	8820
· properties -----		
molar mass:	75.57166 g/mol (0.166607 lb/mol)	8820
normal freezing/melting/triple point:	-95.3 °C (-139.6 °F)	
· normal boiling point -----		
bubble point temperature:	-51.5 °C (-60.7 °F)	8401
dew point temperature:	-51.4 °C (-60.6 °F)	8401
maximum temperature glide:	0.08 °C (0.1 °F)	8401
density, saturated liquid:	1367 kg/m ³ (85.31 lb/cf)	8401
density, saturated vapor:	4.34 kg/m ³ (0.271 lb/cf)	8401
specific volume, saturated liquid:	0.732 L/kg (0.0117 cf/lb)	8401
specific volume, saturated vapor:	230.2 L/kg (3.6878 cf/lb)	8401
heat of vaporization:	260.7 kJ/kg (112.1 Btu/lb)	8401
velocity of sound, saturated liquid:	833 m/s (2733 ft/s)	8401
velocity of sound, saturated vapor:	166 m/s (543 ft/s)	8401
viscosity, saturated liquid:	321 µPa·s (0.321 cp)	8401
viscosity, saturated vapor:	9.81 µPa·s (0.00981 cp)	8401
thermal conductivity, liquid:	0.1405 W/m·K (0.0812 Btu/hr·ft ² ·°F)	8401
thermal conductivity, vapor:	0.0081 W/m·K (0.0047 Btu/hr·ft ² ·°F)	8401
· normal pressure, 20 °C (68 °F) -----		
density, vapor:	3.187 kg/m ³ (0.1990 lb/cf)	8401
· normal pressure, 21.1 °C (70 °F) ---		
density, vapor:	3.174 kg/m ³ (0.1982 lb/cf)	8401
· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	1434.1 kPa (208.00 psia)	8401
pressure, vapor (dew point):	1428.2 kPa (207.14 psia)	8401
density, saturated liquid:	1097 kg/m ³ (68.48 lb/cf)	8401
density, saturated vapor:	58.49 kg/m ³ (3.651 lb/cf)	8401
specific volume, saturated liquid:	0.912 L/kg (0.0146 cf/lb)	8401
specific volume, saturated vapor:	17.1 L/kg (0.2739 cf/lb)	8401

velocity of sound, saturated liquid:	460 m/s (1509 ft/s)	8401
velocity of sound, saturated vapor:	160 m/s (524 ft/s)	8401
viscosity, saturated liquid:	130 $\mu\text{Pa}\cdot\text{s}$ (0.130 cp)	8401
viscosity, saturated vapor:	13.6 $\mu\text{Pa}\cdot\text{s}$ (0.0136 cp)	8401
thermal conductivity, saturated liquid:	0.0972 W/m \cdot K (0.0562 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01441 W/m \cdot K (0.00833 Btu/hr \cdot ft $^{\circ}$ F)	8401
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	3807 kPa (552.1 psia)	8401
pressure, vapor (dew point):	3798 kPa (550.8 psia)	8401
heat of vaporization:	101.0 kJ/kg for liquid and vapor both at nominal composition (43.4 Btu/lb)	8401
	98.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (42.2 Btu/lb)	8401
• critical point -----		
temperature:	69.5 $^{\circ}$ C (157.0 $^{\circ}$ F)	8401
	71.0 $^{\circ}$ C (159.9 $^{\circ}$ F)	5A51
pressure:	4665 kPa (676.6 psia)	8401
	4780 kPa (693.2 psia)	5A51
density:	495 kg/m 3 (30.9 lb/cf)	5A51
	561 kg/m 3 (35.0 lb/cf)	8401
specific volume:	1.78 L/kg (0.0285 cf/lb)	8401
	2.02 L/kg (0.0323 cf/lb)	5A51
ENVIRONMENTAL		
ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
GWP (global warming potential):	2490 mass-weighted average relative to CO $_2$ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.42 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
• classification -----		
safety group (ASHRAE Standard 34):	A1/A1	8601
NPCA HMIS hazard ratings (H-F-R):	DuPont: 1-0-1 health-flammability-reactivity 0=insignificant, 4=extreme	MSDS
• emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	58,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
• flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	MSDS
flash point:	DuPont: will not burn	MSDS
autoignition temperature:	725 $^{\circ}$ C (1337 $^{\circ}$ F)	5931
former UL Classification:	practically nonflammable (withdrawn for revision of the classification system, category SBQT2)	5931
• detection -----		
appearance:	DuPont: clear, colorless	MSDS
odor:	DuPont: slight ethereal	MSDS

PRODUCTION

last year production allowed: unrestricted

8C01

R-411A

----- REFRIGERANT DATA SUMMARY -----
 R-411A R-1270/22/152a (1.5/87.5/11.0) see
 zeotrope ternary blend RDB#

COMMON USE(S)

service fluid for aftermarket use to replace refrigerant 22

IDENTIFIERS

common name(s):	R-411A; R411A; R 411A	6101
	HC/HCFC/HFC-411A	6101
	not HCFC-411A	6101
trade name(s):	ATG R-411A	
	China Sun Group G2018a	
	Cool-Ex R411A	
	Greencool (Gu) G2018a	
ARI container color / Pantone number:	dark purple (violet) / 266	ARI
	with red / 185 band	ARI

PHYSICAL

· nominal blend formulation -----		
composition:	R-1270/22/152a	6101
component weight fractions:	1.5 / 87.5 / 11.0 %	6101
component weight tolerances:	+0.0, -1.0 / +2.0, -0.0 /	6101
	+0.0, -1.0	6101
component mole fractions:	2.936 / 83.347 / 13.717 %	8820
· properties -----		
molar mass:	82.36415 g/mol (0.181582	8820
	lb/mol)	
normal freezing/melting/triple point:	-120.0 °C (-184.0 °F)	MSDS
· normal boiling point -----		
bubble point temperature:	-39.7 °C (-39.4 °F)	8401
dew point temperature:	-37.2 °C (-35.0 °F)	8401
maximum temperature glide:	2.44 °C (4.4 °F)	8401
density, saturated liquid:	1328 kg/m ³ (82.87 lb/cf)	8401
density, saturated vapor:	4.41 kg/m ³ (0.276 lb/cf)	8401
specific volume, saturated liquid:	0.753 L/kg (0.0121 cf/lb)	8401
specific volume, saturated vapor:	226.6 L/kg (3.6290 cf/lb)	8401
heat of vaporization:	249.6 kJ/kg (107.3 Btu/lb)	8401
velocity of sound, saturated liquid:	865 m/s (2838 ft/s)	8401
velocity of sound, saturated vapor:	165 m/s (540 ft/s)	8401
viscosity, saturated liquid:	340 µPa·s (0.340 cp)	8401
viscosity, saturated vapor:	9.65 µPa·s (0.00965 cp)	8401
thermal conductivity, liquid:	0.1162 W/m·K (0.0671	8401
	Btu/hr·ft ² ·°F)	
thermal conductivity, vapor:	0.0074 W/m·K (0.0043	8401
	Btu/hr·ft ² ·°F)	
· normal pressure, 20 °C (68 °F) -----		
density, vapor:	3.481 kg/m ³ (0.2173 lb/cf)	8401
· normal pressure, 21.1 °C (70 °F) ----		
density, vapor:	3.467 kg/m ³ (0.2165 lb/cf)	8401
· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	860.3 kPa (124.77 psia)	8401
pressure, vapor (dew point):	820.0 kPa (118.93 psia)	8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

density, saturated liquid:	1146 kg/m ³ (71.51 lb/cf)	8401
density, saturated vapor:	32.65 kg/m ³ (2.038 lb/cf)	8401
specific volume, saturated liquid:	0.873 L/kg (0.0140 cf/lb)	8401
specific volume, saturated vapor:	30.6 L/kg (0.4907 cf/lb)	8401
velocity of sound, saturated liquid:	581 m/s (1907 ft/s)	8401
velocity of sound, saturated vapor:	166 m/s (545 ft/s)	8401
viscosity, saturated liquid:	172 μ Pa·s (0.172 cp)	8401
viscosity, saturated vapor:	12.1 μ Pa·s (0.0121 cp)	8401
thermal conductivity, saturated liquid:	0.0887 W/m·K (0.0513 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01144 W/m·K (0.00661 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	2296 kPa (333.0 psia)	8401
pressure, vapor (dew point):	2239 kPa (324.7 psia)	8401
heat of vaporization:	152.7 kJ/kg for liquid and vapor both at nominal composition (65.7 Btu/lb)	8401
	151.5 kJ/kg coexisting liquid and vapor at bubble-point pressure (65.1 Btu/lb)	8401
· critical point -----		
temperature:	99.1 °C (210.3 °F)	8401
pressure:	4954 kPa (718.5 psia)	8401
density:	488 kg/m ³ (30.4 lb/cf)	8401
specific volume:	2.05 L/kg (0.0329 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.030 mass-weighted average (model-derived relative to R 11)	9501
	0.044 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1680 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.28 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	A1/A2	8601
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	Greencool AEL: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	MSDS
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	28,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	MSDS
	worst fractionation flammable	mfr
flash point:	Greencool: none	MSDS
· detection -----		
appearance:	Greencool: clear, colorless	MSDS
odor:	Greencool: slight ethereal	MSDS

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

PRODUCTION

first commercial use as a refrigerant:	1996	mfr
last year production allowed:	2029 based on refrigerant 22 in developed countries under the Montreal Protocol	8C01

R-411B

----- REFRIGERANT DATA SUMMARY -----
 R-411B R-1270/22/152a (3.0/94.0/3.0) see
 zeotrope ternary blend RDB#

COMMON USE(S)

service fluid for aftermarket use to replace refrigerant 502 in
 commercial refrigeration and food warehouses

IDENTIFIERS

common name(s):	R-411B; R411B; R 411B	6101
	HC/HCFC/HFC-411B	6101
	not HCFC-411B	6101
trade name(s):	ATG R-411B	
	China Sun Group G2018b	
	Cool-Ex R411B	
	Greencool (Gu) G2018b	
ARI container color / Pantone number:	blue-green (teal) / 326	ARI
	with red / 185 band	ARI

PHYSICAL

· nominal blend formulation -----		
composition:	R-1270/22/152a	6101
component weight fractions:	3.0 / 94.0 / 3.0 %	6101
component weight tolerances:	+0.0,-1.0/+2.0,-0.0/+0.0,-1.0	6101
component mole fractions:	5.922 / 90.305 / 3.773 %	8820
· properties -----		
molar mass:	83.06897 g/mol (0.183136 lb/mol)	8820
normal freezing/melting/triple point:	-119.0 °C (-182.2 °F)	MSDS
· normal boiling point -----		
bubble point temperature:	-41.6 °C (-42.9 °F)	8401
dew point temperature:	-41.3 °C (-42.3 °F)	8401
maximum temperature glide:	0.31 °C (0.6 °F)	8401
density, saturated liquid:	1342 kg/m ³ (83.75 lb/cf)	8401
density, saturated vapor:	4.51 kg/m ³ (0.281 lb/cf)	8401
specific volume, saturated liquid:	0.745 L/kg (0.0119 cf/lb)	8401
specific volume, saturated vapor:	221.8 L/kg (3.5531 cf/lb)	8401
heat of vaporization:	243.4 kJ/kg (104.6 Btu/lb)	8401
velocity of sound, saturated liquid:	865 m/s (2837 ft/s)	8401
velocity of sound, saturated vapor:	163 m/s (536 ft/s)	8401
viscosity, saturated liquid:	339 µPa·s (0.339 cp)	8401
viscosity, saturated vapor:	9.63 µPa·s (0.00963 cp)	8401
thermal conductivity, liquid:	0.1164 W/m·K (0.0672 Btu/hr·ft ² ·F)	8401
thermal conductivity, vapor:	0.0073 W/m·K (0.0042 Btu/hr·ft ² ·F)	8401
· normal pressure, 20 °C (68 °F) -----		
density, vapor:	3.508 kg/m ³ (0.2190 lb/cf)	8401
· normal pressure, 21.1 °C (70 °F) ---		
density, vapor:	3.494 kg/m ³ (0.2181 lb/cf)	8401
· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	918.3 kPa (133.19 psia)	8401
pressure, vapor (dew point):	899.0 kPa (130.39 psia)	8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

density, saturated liquid:	1150 kg/m ³ (71.77 lb/cf)	8401
density, saturated vapor:	36.48 kg/m ³ (2.277 lb/cf)	8401
specific volume, saturated liquid:	0.870 L/kg (0.0139 cf/lb)	8401
specific volume, saturated vapor:	27.4 L/kg (0.4391 cf/lb)	8401
velocity of sound, saturated liquid:	571 m/s (1872 ft/s)	8401
velocity of sound, saturated vapor:	164 m/s (539 ft/s)	8401
viscosity, saturated liquid:	169 μ Pa·s (0.169 cp)	8401
viscosity, saturated vapor:	12.2 μ Pa·s (0.0122 cp)	8401
thermal conductivity, saturated liquid:	0.0876 W/m·K (0.0506 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01136 W/m·K (0.00656 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	2430 kPa (352.5 psia)	8401
pressure, vapor (dew point):	2406 kPa (348.9 psia)	8401
heat of vaporization:	145.0 kJ/kg for liquid and vapor both at nominal composition (62.3 Btu/lb)	8401
	143.4 kJ/kg coexisting liquid and vapor at bubble-point pressure (61.6 Btu/lb)	8401
· critical point -----		
temperature:	96.0 °C (204.7 °F)	8401
pressure:	4947 kPa (717.5 psia)	8401
density:	497 kg/m ³ (31.0 lb/cf)	8401
specific volume:	2.01 L/kg (0.0322 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.032 mass-weighted average (model-derived relative to R 11)	9501
	0.047 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1790 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.30 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	A1/A2	8601
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	Greencool AEL: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	MSDS
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	27,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested) worst fractionation flammable	MSDS mfr
	flash point:	Greencool: none MSDS
· detection -----		
appearance:	Greencool: clear, colorless	MSDS
odor:	Greencool: slight ethereal	MSDS

PRODUCTION

first commercial use as a refrigerant:	1996	mfr
last year production allowed:	2029 based on refrigerant 22 in developed countries under the Montreal Protocol	8C01

R-411C

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----- REFRIGERANT DATA SUMMARY -----
R-411C      R-1270/22/152a (3.0/95.5/1.5)      see
zeotrope    ternary blend                          RDB#
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COMMON USE(S)

alternative for refrigerants 12, 22, 500, and 502 in air-conditioning and refrigeration applications with evaporator temperatures of -20 to 10 °C (-4 to 50 °F) and condensing temperatures of 25 to 60 °C (77 to 140 °F)

Note: The designation, tolerances, and safety classification indicated for this refrigerant were proposed, with contingencies, by ASHRAE SSPC 34 on 1997.06.29; the contingencies were removed on 1998.01.18. The designation, tolerances, and classification are subject to a review and approval procedure; assignment will not occur until published in an addendum or revision to ANSI/ASHRAE Standard 34-1997.

IDENTIFIERS

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common name(s):  R-411C; R411C; R 411C
                  R-1270/22/152a (3.0/95.5/1.5)
                  R1270/22/152a (3.0/95.5/1.5)
                  R 1270/22/152a (3.0/95.5/1.5)
                  HC/HCFC/HFC-411C
                  not HCFC-411C
                  HC-1270/HCFC-22/HFC-152a      2909
                  (3.0/95.5/1.5)
                  not HCFC-1270/22/152a      2909
trade name(s):   China Sun Group G2018C
                  Greencool G2018C             MSDS
ARI container color / Pantone number: none, use light green grey/413 6601

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PHYSICAL

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· nominal blend formulation -----
      composition:  R-1270/22/152a
      component weight fractions:  3.0 / 95.5 / 1.5 %
      component weight tolerances:  +0.0,-0.5/+1.0,-0.0/+0.0,-0.5
      component mole fractions:     5.949 / 92.156 / 1.895 %      8820
· properties -----
      molar mass:    83.44068 g/mol (0.183955      8820
                    lb/mol)
normal freezing/melting/triple point: -119.0 °C (-182.2 °F)      MSDS
· normal boiling point -----
      bubble point temperature:  -41.8 °C (-43.3 °F)      8401
      dew point temperature:     -40.9 °C (-41.5 °F)      8401
      maximum temperature glide: 0.95 °C (1.7 °F)          8401
      density, saturated liquid:  1349 kg/m3 (84.21 lb/cf)    8401
      density, saturated vapor:   4.54 kg/m3 (0.283 lb/cf)    8401
      specific volume, saturated liquid: 0.741 L/kg (0.0119 cf/lb) 8401
      specific volume, saturated vapor:  220.3 L/kg (3.5284 cf/lb) 8401
      heat of vaporization:        241.6 kJ/kg (103.9 Btu/lb) 8401
velocity of sound, saturated liquid:  863 m/s (2833 ft/s)    8401
velocity of sound, saturated vapor:   163 m/s (534 ft/s)     8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

viscosity, saturated liquid:	339 $\mu\text{Pa}\cdot\text{s}$ (0.339 cp)	8401
viscosity, saturated vapor:	9.63 $\mu\text{Pa}\cdot\text{s}$ (0.00963 cp)	8401
thermal conductivity, liquid:	0.1162 W/m \cdot K (0.0671 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, vapor:	0.0072 W/m \cdot K (0.0042 Btu/hr \cdot ft $^{\circ}$ F)	8401
· normal pressure, 20 $^{\circ}$ C (68 $^{\circ}$ F) -----		
density, vapor:	3.524 kg/m 3 (0.2200 lb/cf)	8401
· normal pressure, 21.1 $^{\circ}$ C (70 $^{\circ}$ F) ---		
density, vapor:	3.509 kg/m 3 (0.2191 lb/cf)	8401
· 20 $^{\circ}$ C (68 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	926.8 kPa (134.42 psia)	8401
pressure, saturated vapor:	913.7 kPa (132.52 psia)	8401
density, saturated liquid:	1155 kg/m 3 (72.09 lb/cf)	8401
density, saturated vapor:	37.32 kg/m 3 (2.330 lb/cf)	8401
specific volume, saturated liquid:	0.866 L/kg (0.0139 cf/lb)	8401
specific volume, saturated vapor:	26.8 L/kg (0.4292 cf/lb)	8401
velocity of sound, saturated liquid:	569 m/s (1865 ft/s)	8401
velocity of sound, saturated vapor:	164 m/s (537 ft/s)	8401
viscosity, saturated liquid:	169 $\mu\text{Pa}\cdot\text{s}$ (0.169 cp)	8401
viscosity, saturated vapor:	12.3 $\mu\text{Pa}\cdot\text{s}$ (0.0123 cp)	8401
thermal conductivity, saturated liquid:	0.0872 W/m \cdot K (0.0504 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01132 W/m \cdot K (0.00654 Btu/hr \cdot ft $^{\circ}$ F)	8401
· 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	2451 kPa (355.5 psia)	8401
pressure, vapor (dew point):	2436 kPa (353.3 psia)	8401
heat of vaporization:	143.3 kJ/kg for liquid and vapor both at nominal composition (61.6 Btu/lb)	8401
	141.9 kJ/kg coexisting liquid and vapor at bubble-point pressure (61.0 Btu/lb)	8401
· critical point -----		
temperature:	95.5 $^{\circ}$ C (203.9 $^{\circ}$ F)	8401
pressure:	4951 kPa (718.1 psia)	8401
density:	501 kg/m 3 (31.3 lb/cf)	8401
specific volume:	2.00 L/kg (0.0320 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.032 mass-weighted average (model-derived relative to R 11)	9501
	0.048 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1820 mass-weighted average relative to CO $_2$ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.30 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (application pending)	
	A1/A1 proposed 18Jan98	34g
	components are A3, A1, and A2	8601

NFPA 704 degrees of hazard (H-F-R-S):	Greencool: 2-0-0	MSDS
	health-flammability-reactivity	
	[-special]: 0=no, 4=severe	
NPCA HMIS hazard ratings (H-F-R):	Greencool: 2-0-0	MSDS
	health-flammability-reactivity	
	0=insignificant, 4=extreme	
· long-term occupational limit ----- exposure limit consistent to OSHA PEL:	Greencool: components are 375, 1,000, and 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	MSDS
· emergency exposure limit ----- Refrigerant Concentration Limit (RCL):	27,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	MSDS
· flammability ----- LFL-UFL (flammability limits in air):	none (nonflammable as tested)	MSDS
	flash point:	MSDS
· detection ----- appearance:	Greencool: clear, colorless	MSDS
	odor:	MSDS
	sweetish odor	MSDS
PRODUCTION		
first commercial use as a refrigerant:	January 1996	mfr
last year production allowed:	2029 based on refrigerant 22 in developed countries under the Montreal Protocol	8C01

R-412A

----- REFRIGERANT DATA SUMMARY -----
 R-412A R-22/218/142b (70.0/5.0/25.0) see
 zeotrope ternary blend RDB#

COMMON USE(S)

replacement for refrigerant 500 in low- and medium-temperature refrigeration with hermetic (especially rotary vane) compressors, such as biomedical and pharmaceutical applications; high stage of cascaded systems for ultra-low temperatures, for example with refrigerant 508A in the low stage

IDENTIFIERS

 common name(s): R-412A; R412A; R 412A 6101
 HCFC/FC/HCFC-412A 6101
 not HCFC-412A 2909
 trade name(s): ICI Arcton(R) 412A MSDS
 ICI Arcton(R) TP5R MSDS
 ARI container color / Pantone number: none, use light green grey/413 6601
 with red / 185 band

PHYSICAL

· nominal blend formulation -----
 composition: R-22/218/142b 6101
 component weight fractions: 70.0 / 5.0 / 25.0 % 6101
 component weight tolerances: ±2.0 / ±2.0 / ±1.0 6101
 component mole fractions: 74.619 / 2.451 / 22.930 % 8820

· properties -----
 molar mass: 92.17363 g/mol (0.203208 8820
 lb/mol)
 normal freezing/melting/triple point: -153.0 °C (-243.4 °F) MSDS

· normal boiling point -----
 bubble point temperature: -36.4 °C (-33.6 °F) 8814
 dew point temperature: -28.8 °C (-19.9 °F) 8814
 maximum temperature glide: 7.62 °C (13.7 °F) 8814
 density, saturated liquid: 1362 kg/m3 (85.05 lb/cf) 8814
 density, saturated vapor: 4.77 kg/m3 (0.298 lb/cf) 8814
 specific volume, saturated liquid: 0.734 L/kg (0.0118 cf/lb) 8814
 specific volume, saturated vapor: 209.8 L/kg (3.3607 cf/lb) 8814
 heat of vaporization: 230.7 kJ/kg (99.2 Btu/lb) 8814
 velocity of sound, saturated liquid: 827 m/s (2713 ft/s) 8814
 velocity of sound, saturated vapor: 157 m/s (514 ft/s) 8814
 viscosity, saturated liquid: 359 µPa·s (0.359 cp) 8814
 viscosity, saturated vapor: 9.75 µPa·s (0.00975 cp) 8814
 thermal conductivity, liquid: 0.1069 W/m·K (0.0617 8814
 Btu/hr·ft°F)
 thermal conductivity, vapor: 0.0077 W/m·K (0.0045 8814
 Btu/hr·ft°F)

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 3.903 kg/m3 (0.2437 lb/cf) 8814

· normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 3.887 kg/m3 (0.2427 lb/cf) 8814

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 753.2 kPa (109.25 psia) 8814

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

pressure, vapor (dew point):	617.1 kPa (89.51 psia)	8814
density, saturated liquid:	1192 kg/m ³ (74.42 lb/cf)	8814
density, saturated vapor:	26.62 kg/m ³ (1.662 lb/cf)	8814
specific volume, saturated liquid:	0.839 L/kg (0.0134 cf/lb)	8814
specific volume, saturated vapor:	37.6 L/kg (0.6017 cf/lb)	8814
velocity of sound, saturated liquid:	572 m/s (1878 ft/s)	8814
velocity of sound, saturated vapor:	158 m/s (520 ft/s)	8814
viscosity, saturated liquid:	188 μ Pa·s (0.188 cp)	8814
viscosity, saturated vapor:	11.8 μ Pa·s (0.0118 cp)	8814
thermal conductivity, saturated liquid:	0.0827 W/m·K (0.0478 Btu/hr·ft ² ·°F)	8814
thermal conductivity, saturated vapor:	0.01083 W/m·K (0.00626 Btu/hr·ft ² ·°F)	8814
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	2008 kPa (291.3 psia)	8814
pressure, vapor (dew point):	1773 kPa (257.1 psia)	8814
heat of vaporization:	148.6 kJ/kg for liquid and vapor both at nominal composition (63.9 Btu/lb)	8814
	143.4 kJ/kg coexisting liquid and vapor at bubble-point pressure (61.7 Btu/lb)	8814
· critical point -----		
temperature:	107.5 °C (225.5 °F)	8814
pressure:	4883 kPa (708.2 psia)	8814
density:	499 kg/m ³ (31.2 lb/cf)	8814
specific volume:	2.00 L/kg (0.0321 cf/lb)	8814
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.035 mass-weighted average (model-derived relative to R 11)	9501
	0.052 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	2340 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	2.4 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	A1/A2	8601
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	ICI exposure limit: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	MSDS
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	26,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	mfr
	worst fractionation flammable	mfr
flash point:	ICI: does not flash	MSDS
· detection -----		
appearance:	ICI: colorless liquified gas	MSDS

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

odor: ICI: faint ether-like odor MSDS

PRODUCTION

first commercial use as a refrigerant:	circa 1997	mfr
last year production allowed:	2029 by refrigerants 22, 142b	8C01
	in developed countries under	
	the Montreal Protocol	

R-413A

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----- REFRIERANT DATA SUMMARY -----
R-413A      R-218/134a/600a (9.0/88.0/3.0)      see
zeotrope    ternary blend                          RDB#
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COMMON USE(S)

alternative for refrigerant 12 for commercial and transport
refrigeration and as a service fluid for domestic refrigerators and
freezers, mobile air conditioners, and vending machines

IDENTIFIERS

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common name(s):  R-413A; R413A; R 413A      34af
                  R-218/134a/600a (9/88/3)    2909
                  FC/HFC/HC-413A; not HFC-413A  34af
                  FC-218/HFC-134a/HC-600a      2909
                  (9/88/3)                      2909
                  not FC-218/134a/600a (9/88/3) 2909
                  not HFC-218/134a/600a (9/88/3) 2909
trade name(s):   Rhodia Isceon 49
historical name(s): Rhône-Poulenc Isceon 49
                  Rhône-Poulenc RX2
ARI container color / Pantone number: none, use light green grey/413 6601
                                          with red / 185 band

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PHYSICAL

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· nominal blend formulation -----
      composition:  R-218/134a/600a      34af
      component weight fractions:  9.0 / 88.0 / 3.0 %  34af
      component weight tolerances: ±1.0 / ±2.0 / +0.0,-1.0  34af
      component mole fractions:    4.976 / 89.658 / 5.366 %  8820
· properties -----
      molar mass:  103.95370 g/mol (0.229179  8820
                  lb/mol)
· normal boiling point -----
      bubble point temperature:  -29.3 °C (-20.7 °F)  8814
      dew point temperature:     -27.6 °C (-17.7 °F)  8814
      maximum temperature glide: 1.67 °C (3.0 °F)  8814
      density, saturated liquid:  1344 kg/m3 (83.89 lb/cf)  8814
      density, saturated vapor:   5.39 kg/m3 (0.337 lb/cf)  8814
      specific volume, saturated liquid: 0.744 L/kg (0.0119 cf/lb)  8814
      specific volume, saturated vapor: 185.4 L/kg (2.9700 cf/lb)  8814
      heat of vaporization:        210.6 kJ/kg (90.5 Btu/lb)  8814
      velocity of sound, saturated liquid: 734 m/s (2409 ft/s)  8814
      velocity of sound, saturated vapor: 143 m/s (471 ft/s)  8814
      viscosity, saturated liquid:  370 µPa·s (0.370 cp)  8814
      viscosity, saturated vapor:   9.46 µPa·s (0.00946 cp)  8814
      thermal conductivity, liquid: 0.0999 W/m·K (0.0577  8814
                  Btu/hr·ft°F)
      thermal conductivity, vapor: 0.0093 W/m·K (0.0054  8814
                  Btu/hr·ft°F)
· normal pressure, 20 °C (68 °F) -----
      density, vapor: 4.417 kg/m3 (0.2758 lb/cf)  8814
· normal pressure, 21.1 °C (70 °F) ---
      density, vapor: 4.399 kg/m3 (0.2746 lb/cf)  8814

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	619.0 kPa (89.78 psia)	8814
pressure, vapor (dew point):	603.3 kPa (87.50 psia)	8814
density, saturated liquid:	1184 kg/m ³ (73.91 lb/cf)	8814
density, saturated vapor:	30.13 kg/m ³ (1.881 lb/cf)	8814
specific volume, saturated liquid:	0.845 L/kg (0.0135 cf/lb)	8814
specific volume, saturated vapor:	33.2 L/kg (0.5317 cf/lb)	8814
velocity of sound, saturated liquid:	507 m/s (1665 ft/s)	8814
velocity of sound, saturated vapor:	142 m/s (467 ft/s)	8814
viscosity, saturated liquid:	194 µPa·s (0.194 cp)	8814
viscosity, saturated vapor:	11.4 µPa·s (0.0114 cp)	8814
thermal conductivity, saturated liquid:	0.0786 W/m·K (0.0454 Btu/hr·ft ² ·°F)	8814
thermal conductivity, saturated vapor:	0.01350 W/m·K (0.00780 Btu/hr·ft ² ·°F)	8814
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1770 kPa (256.7 psia)	8814
pressure, vapor (dew point):	1753 kPa (254.2 psia)	8814
heat of vaporization:	129.5 kJ/kg for liquid and vapor both at nominal composition (55.7 Btu/lb)	8814
	129.8 kJ/kg coexisting liquid and vapor at bubble-point pressure (55.8 Btu/lb)	8814
· critical point -----		
temperature:	101.4 °C (214.5 °F)	8814
pressure:	4237 kPa (614.5 psia)	8814
density:	501 kg/m ³ (31.3 lb/cf)	8814
specific volume:	2.00 L/kg (0.0320 cf/lb)	8814

ENVIRONMENTAL

ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
	<0.00044 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	2180 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	3.9 mass-weighted average relative to R 11 for infinite integration period	DW

SAFETY

· classification -----		
safety group (ASHRAE Standard 34):	A1/A2	34b
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	49,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	worst fractionation flammable	mfr
flash point:	Rhodia: not applicable	MSDS
· detection -----		
appearance:	Rhodia: colorless	MSDS
odor:	Rhodia: slightly ethereal	MSDS

PRODUCTION

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

first commercial use as a refrigerant:	circa 1996	mfr
last year production allowed:	unrestricted	8C01

R-414A

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----- REFRIGERANT DATA SUMMARY -----
R-414A      R-22/124/600a/142b (51.0/28.5/4.0/16.5)      see
zeotrope    tetrary blend                                           RDB#
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COMMON USE(S)

alternative for refrigerant 12, primarily for aftermarket use to service or retrofit existing automobile air conditioners, other mobile air-conditioning (MAC) systems, and commercial refrigeration; also marketed as a replacement for refrigerants 134a and 500 in commercial refrigeration

Note: The designation, tolerances, and safety classification indicated for this refrigerant were proposed by ASHRAE SSPC 34 on 1998.06.21. They are subject to a review and approval procedure that is now underway; assignment will not occur until published in an addendum or revision to ANSI/ASHRAE Standard 34-1997.

IDENTIFIERS

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common name(s):  R-414A; R414A; R 414A      34+
                  HCFC/HCFC/HC/HCFC-414A    34+
                  not HCFC-414A             2909
                  HCFC-22/HCFC-124/HC-600a/HCFC- 2909
                  142b (51.0/28.5/4.0/16.5)  2909
trade name(s):   GHG-X4; Autofrost-X4      8354
                  McMullen Oil Chill-It     8354
                  McMullen Oil McCool Chill-It
                  Monroe Air Tech Autofrost-X4 8354
historical name(s): GHG-X4 Refrig. 12 Substitute
name used in U.S. EPA SNAP Rule: HCFC Blend Xi
ARI container color / Pantone number: none, use light green grey/413 6601

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PHYSICAL

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· nominal blend formulation -----
      composition:  R-22/124/600a/142b      34+
      component weight fractions:  51.0 / 28.5 / 4.0 / 16.5 %  34+
      component weight tolerances:  ±2.0 / ±2.0 / ±0.5 / +0.5,-1.0  34+
      component mole fractions:     57.172/ 20.242/ 6.671/ 15.915  8820
                                     %
· properties -----
      molar mass:    96.93217 g/mol (0.213699      8820
                    lb/mol)
· normal boiling point -----
      bubble point temperature:  -34.0 °C (-29.3 °F)      8401
      dew point temperature:     -25.8 °C (-14.4 °F)      8401
      maximum temperature glide: 8.27 °C (14.9 °F)      8401
      density, saturated liquid:  1323 kg/m3 (82.56 lb/cf)  8401
      density, saturated vapor:   4.96 kg/m3 (0.309 lb/cf)  8401
      specific volume, saturated liquid: 0.756 L/kg (0.0121 cf/lb)  8401
      specific volume, saturated vapor:  201.7 L/kg (3.2311 cf/lb)  8401
      heat of vaporization:        222.3 kJ/kg (95.6 Btu/lb)  8401
      velocity of sound, saturated liquid: 805 m/s (2641 ft/s)  8401
      velocity of sound, saturated vapor:  152 m/s (499 ft/s)  8401
      viscosity, saturated liquid:  355 µPa·s (0.355 cp)  8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

viscosity, saturated vapor:	9.67 $\mu\text{Pa}\cdot\text{s}$ (0.00967 cp)	8401
thermal conductivity, liquid:	0.1013 W/m \cdot K (0.0585 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, vapor:	0.0081 W/m \cdot K (0.0047 Btu/hr \cdot ft $^{\circ}$ F)	8401
· normal pressure, 20 $^{\circ}$ C (68 $^{\circ}$ F) -----		
density, vapor:	4.111 kg/m ³ (0.2566 lb/cf)	8401
· normal pressure, 21.1 $^{\circ}$ C (70 $^{\circ}$ F) ---		
density, vapor:	4.095 kg/m ³ (0.2556 lb/cf)	8401
· 20 $^{\circ}$ C (68 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	681.4 kPa (98.83 psia)	8401
pressure, vapor (dew point):	550.4 kPa (79.83 psia)	8401
density, saturated liquid:	1165 kg/m ³ (72.72 lb/cf)	8401
density, saturated vapor:	24.84 kg/m ³ (1.551 lb/cf)	8401
specific volume, saturated liquid:	0.859 L/kg (0.0138 cf/lb)	8401
specific volume, saturated vapor:	40.3 L/kg (0.6448 cf/lb)	8401
velocity of sound, saturated liquid:	563 m/s (1848 ft/s)	8401
velocity of sound, saturated vapor:	153 m/s (503 ft/s)	8401
viscosity, saturated liquid:	189 $\mu\text{Pa}\cdot\text{s}$ (0.189 cp)	8401
viscosity, saturated vapor:	11.5 $\mu\text{Pa}\cdot\text{s}$ (0.0115 cp)	8401
thermal conductivity, saturatd liquid:	0.0791 W/m \cdot K (0.0457 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01107 W/m \cdot K (0.00639 Btu/hr \cdot ft $^{\circ}$ F)	8401
· 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	1824 kPa (264.5 psia)	8401
pressure, vapor (dew point):	1596 kPa (231.5 psia)	8401
heat of vaporization:	127.8 kJ/kg coexisting liquid and vapor at bubble-point pressure (54.9 Btu/lb)	8401
· critical point -----		
temperature:	110.7 $^{\circ}$ C (231.3 $^{\circ}$ F)	8401
pressure:	4696 kPa (681.1 psia)	8401
density:	484 kg/m ³ (30.2 lb/cf)	8401
specific volume:	2.07 L/kg (0.0331 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	0.032 mass-weighted average (model-derived relative to R 11)	9501
	0.044 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1530 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.26 mass-weighted average relative to R 11 for infinite integration period	DW

SAFETY

· classification -----		
safety group (ASHRAE Standard 34):	none (application pending) A1/A1 proposed 98Jun21 components are A1, A1, A3, A2	341 8601
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	Peoples Welding: 1000 ppm v/v TWA for 8 hr/day and 40 hr/wk	MSDS
· emergency exposure limit -----		

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

Refrigerant Concentration Limit (RCL): 19,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)

· flammability -----

heat of combustion (by ASHRAE 34-92):	3.6 MJ/kg (1533 Btu/lb)	UL
flash point:	Peoples Welding: none	MSDS
autoignition temperature:	Peoples Welding: ~500°C (932°F)	MSDS
autodecomposition temperature:	Peoples Welding: ≥204°C (400°F)	MSDS
former UL Classification:	practically nonflammable	UL
	(withdrawn for revision of the classification system, category SBQT2)	

PRODUCTION

first commercial use as a refrigerant:	January 1996	mfr
last year production allowed:	2029 by refig 22,124, and 142b	8C01
	in developed countries under the Montreal Protocol	

R-414B

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----- REFRIERANT DATA SUMMARY -----
R-414B      R-22/124/600a/142b (50.0/39.0/1.5/9.5)      see
zeotrope    tetrary blend                                       RDB#
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COMMON USE(S)

service alternative for refrigerants 12 and 134a, primarily for aftermarket use to retrofit automobile and other mobile air conditioning systems (MACS) and stationary refrigeration equipment

Note: The designation, tolerances, and safety classification indicated for this refrigerant were proposed by ASHRAE SSPC 34 on 1998.06.21. Designation and classification are subject to a review and approval procedure now underway; assignment will not occur until published in an addendum or revision to ANSI/ASHRAE Standard 34-1997.

IDENTIFIERS

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common name(s):  R-414B; R414B; R 414B           34m
                  HCFC/HCFC/HC/HCFC-414B       34m
                  HCFC-22/HCFC-124/HC-600a/     2909
                  HCFC-142b (50/39/1.5/9.5)    2909
                  not HCFC-22/124/600a/142b    2909
trade name(s):   AMI Automotive HOT SHOT(TM)
                  ESP (Canada) HOT SHOT
                  ICOR HOT SHOT
ARI container color / Pantone number:  medium blue (blue) / 2995  ARI

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PHYSICAL

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· nominal blend formulation -----
      composition:  R-22/124/600a/142b           34m
      component weight fractions:  50.0 / 39.0 / 1.5 / 9.5 %  34m
      component weight tolerances:  ±2.0 / ±2.0 / ±0.5 / +0.5,-1.0  34m
      component mole fractions:     58.744/ 29.031/ 2.622/ 9.603 % 8820
· properties -----
      molar mass:    101.58958 g/mol (0.223967 lb/mol)  8820
· normal boiling point -----
      bubble point temperature:  -34.4 °C (-29.9 °F)  8401
      dew point temperature:     -26.1 °C (-15.0 °F)  8401
      maximum temperature glide:  8.27 °C (14.9 °F)  8401
      density, saturated liquid:  1390 kg/m3 (86.80 lb/cf)  8401
      density, saturated vapor:   5.20 kg/m3 (0.325 lb/cf)  8401
      specific volume, saturated liquid:  0.719 L/kg (0.0115 cf/lb)  8401
      specific volume, saturated vapor:  192.2 L/kg (3.0791 cf/lb)  8401
      heat of vaporization:       212.7 kJ/kg (91.4 Btu/lb)  8401
      velocity of sound, saturated liquid:  789 m/s (2587 ft/s)  8401
      velocity of sound, saturated vapor:  148 m/s (486 ft/s)  8401
      viscosity, saturated liquid:  365 µPa·s (0.365 cp)  8401
      viscosity, saturated vapor:   9.87 µPa·s (0.00987 cp)  8401
      thermal conductivity, liquid:  0.0990 W/m·K (0.0572 Btu/hr·ft°F)  8401
      thermal conductivity, vapor:  0.0080 W/m·K (0.0046 Btu/hr·ft°F)  8401
· normal pressure, 20 °C (68 °F) -----

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

	density, vapor:	4.308 kg/m ³ (0.2689 lb/cf)	8401
· normal pressure, 21.1 °C (70 °F) ---			
	density, vapor:	4.290 kg/m ³ (0.2678 lb/cf)	8401
· 20 °C (68 °F) -----			
	pressure, liquid (bubble point):	693.9 kPa (100.64 psia)	8401
	pressure, vapor (dew point):	563.2 kPa (81.69 psia)	8401
	density, saturated liquid:	1222 kg/m ³ (76.27 lb/cf)	8401
	density, saturated vapor:	26.70 kg/m ³ (1.667 lb/cf)	8401
	specific volume, saturated liquid:	0.819 L/kg (0.0131 cf/lb)	8401
	specific volume, saturated vapor:	37.5 L/kg (0.5999 cf/lb)	8401
	velocity of sound, saturated liquid:	548 m/s (1797 ft/s)	8401
	velocity of sound, saturated vapor:	150 m/s (491 ft/s)	8401
	viscosity, saturated liquid:	193 µPa·s (0.193 cp)	8401
	viscosity, saturated vapor:	11.8 µPa·s (0.0118 cp)	8401
	thermal conductivity, saturatd liquid:	0.0773 W/m·K (0.0447 Btu/hr·ft·°F)	8401
	thermal conductivity, saturated vapor:	0.01092 W/m·K (0.00631 Btu/hr·ft·°F)	8401
· 60 °C (140 °F) -----			
	pressure, liquid (bubble point):	1860 kPa (269.7 psia)	8401
	pressure, vapor (dew point):	1637 kPa (237.5 psia)	8401
	heat of vaporization:	136.7 kJ/kg for liquid and vapor both at nominal composition (58.8 Btu/lb)	8401
		118.3 kJ/kg coexisting liquid and vapor at bubble-point pressure (50.9 Btu/lb)	8401
· critical point -----			
	temperature:	108.0 °C (226.4 °F)	8401
	pressure:	4588 kPa (665.4 psia)	8401
	density:	507 kg/m ³ (31.6 lb/cf)	8401
	specific volume:	1.97 L/kg (0.0316 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	0.031 mass-weighted average (model-derived relative to R 11)	9501
	0.041 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1410 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.23 mass-weighted average relative to R 11 for infinite integration period	DW

SAFETY

· classification -----		
safety group (ASHRAE Standard 34):	none (application pending) A1/A1 proposed 98Jun21 components are A1, A1, A3, A2	34m 8601
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	18,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	ICOR: none, will not burn	MSDS
flash point:	ICOR: will not burn	MSDS

autoignition temperature: ICOR: 632 °C (1170 °F) MSDS
former UL Classification: practically nonflammable UL
(withdrawn for revision of the
classification system,
category SBQT2)

PRODUCTION

first commercial use as a refrigerant: March 1996
last year production allowed: 2029 by refig 22,124, and 142b 8C01
in developed countries under
the Montreal Protocol

R-416A

----- REFRIGERANT DATA SUMMARY -----
 R-416A R-134a/124/600 (59.0/39.5/1.5) see
 ternary blend RDB#

COMMON USE(S)

replacement for refrigerant 12 for aftermarket use as a service fluid in mobile air conditioners, transport refrigeration equipment, and other applications

Note: The designation and safety classification indicated for this refrigerant as well as tolerances of (+½, -1 / +1, -½ / +0.0, -0.3) were proposed by ASHRAE SSPC 34 on 1997.11.21. Revised tolerances of (+½, -1 / +1, -½ / +0.1, -0.2) were proposed by ASHRAE SSPC 34 on 1998.06.21. They are subject to a review and approval procedure now underway; assignment will not occur until published in an addendum or revision to ANSI/ASHRAE Standard 34-1997. Publication was recommended on 1999.06.20. Early product literature for this blend (before September 1997) from InterCool Energy Corporation (ICE) showed the formulation to be R-134a/124/600 (59/39/2); the manufacturer has indicated that the formulation was not changed, but is now being shown more precisely as (59.0/39.5/1.5). This refrigerant may be covered by U.S. patents 5,360,566 and 5,425,890.

IDENTIFIERS

 common name(s): R-416A; R416A; R 416A 34an
 R-134a/124/600 (59/39.5/1.5)
 R134a/124/600 (59/39.5/1.5)
 R 134a/124/600 (59/39.5/1.5)
 HFC/HCFC/HC-416A 34an
 not HCFC-416A 34an
 HFC-134a/HCFC-124/HC-600 8601
 (59/39.5/1.5) 8601
 not HCFC-134a/124/600 8601
 (59/39.5/1.5) 8601
 trade name(s): IGC/ICE FRIGC(R) FR-12(TM) 5A41
 Pennzoil FRIGC(R) FR-12(TM) 6C06
 name used in U.S. EPA SNAP Rule: HCFC Blend Beta
 ARI container color / Pantone number: yellow-green (lime) / 381 ARI

PHYSICAL

· nominal blend formulation -----
 composition: R-134a/124/600 34an
 component weight fractions: 59.0 / 39.5 / 1.5 % 34an
 component weight tolerances: +0.5, -1.0/+1.0, -0.5/+0.0, -0.3 34an
 +0.5, -1.0/+1.0, -0.5/+0.1, -0.2 34+
 component mole fractions: 64.719 / 32.393 / 2.888 % 8820
 · properties -----
 molar mass: 111.92031 g/mol (0.246742 8820
 lb/mol)
 · normal boiling point -----
 bubble point temperature: -23.4 °C (-10.0 °F) 8401
 dew point temperature: -21.8 °C (-7.3 °F) 8401
 maximum temperature glide: 1.55 °C (2.8 °F) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

density, saturated liquid:	1387 kg/m ³ (86.60 lb/cf)	8401
density, saturated vapor:	5.67 kg/m ³ (0.354 lb/cf)	8401
specific volume, saturated liquid:	0.721 L/kg (0.0115 cf/lb)	8401
specific volume, saturated vapor:	176.4 L/kg (2.8253 cf/lb)	8401
heat of vaporization:	198.9 kJ/kg (85.5 Btu/lb)	8401
velocity of sound, saturated liquid:	719 m/s (2359 ft/s)	8401
velocity of sound, saturated vapor:	140 m/s (458 ft/s)	8401
viscosity, saturated liquid:	373 μ Pa·s (0.373 cp)	8401
viscosity, saturated vapor:	9.67 μ Pa·s (0.00967 cp)	8401
thermal conductivity, liquid:	0.0946 W/m·K (0.0547 Btu/hr·ft ² ·°F)	8401
thermal conductivity, vapor:	0.0094 W/m·K (0.0054 Btu/hr·ft ² ·°F)	8401
· normal pressure, 20 °C (68 °F) -----		
density, vapor:	4.765 kg/m ³ (0.2975 lb/cf)	8401
· normal pressure, 21.1 °C (70 °F) ---		
density, vapor:	4.746 kg/m ³ (0.2963 lb/cf)	8401
· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	504.8 kPa (73.22 psia)	8401
pressure, vapor (dew point):	479.8 kPa (69.58 psia)	8401
density, saturated liquid:	1248 kg/m ³ (77.93 lb/cf)	8401
density, saturated vapor:	25.14 kg/m ³ (1.570 lb/cf)	8401
specific volume, saturated liquid:	0.801 L/kg (0.0128 cf/lb)	8401
specific volume, saturated vapor:	39.8 L/kg (0.6371 cf/lb)	8401
velocity of sound, saturated liquid:	528 m/s (1731 ft/s)	8401
velocity of sound, saturated vapor:	140 m/s (458 ft/s)	8401
viscosity, saturated liquid:	215 μ Pa·s (0.215 cp)	8401
viscosity, saturated vapor:	11.3 μ Pa·s (0.0113 cp)	8401
thermal conductivity, saturated liquid:	0.0774 W/m·K (0.0447 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01273 W/m·K (0.00736 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1479 kPa (214.5 psia)	8401
pressure, vapor (dew point):	1426 kPa (206.8 psia)	8401
heat of vaporization:	132.8 kJ/kg for liquid and vapor both at nominal composition (57.1 Btu/lb) 127.0 kJ/kg coexisting liquid and vapor at bubble-point pressure (54.6 Btu/lb)	8401
· critical point -----		
temperature:	108.2 °C (226.8 °F)	8401
pressure:	4016 kPa (582.5 psia)	8401
density:	517 kg/m ³ (32.3 lb/cf)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.010 mass-weighted average (model-derived relative to R 11)	9501
	0.011 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1190 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.20 mass-weighted average relative to R 11 for infinite integration period	DW

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (application pending)
 A1/A1 recommended 99Jun20 34n
 components are A1, A1, and A3 8601
 NFPA 704 degrees of hazard (H-F-R-S): IGC/ICE: 2-0-0 MSDS
 health-flammability-reactivity
 [-special]: 0=no, 4=severe

· emergency exposure limit -----
 Refrigerant Concentration Limit (RCL): 22,000 ppm v/v (preliminary
 value under review, based on
 draft ASHRAE 34aa)

· acute (short-term) toxicity -----
 cardiac sensitization (CS) EC50: dog, 10 min: ≤90,000 ppm v/v 7407
 (effective concentration in
 half of test animals)
 cardiac sensitization threshold/LOEL: dog, 10 min, 2/6: ≤90,000 ppm 7407
 v/v (lowest observed effect
 level in test animals)
 dog, 10 min, ?/6: ≤70,000 ppm 7407
 v/v (lowest observed effect
 level in test animals)
 cardiac sensitization (CS) NOEL: dog, 10 min, 0/6: ≤50,000 ppm 7407
 v/v (no observed effect level
 in test animals)

· flammability -----
 heat of combustion (by ASHRAE 34-92): 7.8 MJ/kg (3370 Btu/lb) UL
 flash point: IGC/ICE: none MSDS
 autoignition temperature: 723 °C (1333 °F) UL

· detection -----
 appearance: clear, colorless gas MSDS
 odor: faint hydrocarbon odor MSDS

PRODUCTION

first commercial use as a refrigerant: May 1995
 last year production allowed: 2029 based on refrigerant 124 8C01
 in developed countries under
 the Montreal Protocol

R-729 (air)

----- REFRIGERANT DATA SUMMARY -----
R-729 air (78% v/v nitrogen, 21% oxygen, 1% argon)
inorganic zeotropic blend

Included in [volume 1](#)
with single-compound refrigerants
based on common designation.

R-1130

----- REFRIGERANT DATA SUMMARY -----
R-1130 blend of dichloroethene isomers

Included in [volume 1](#)
with single-compound refrigerants
based on common designation.

Refrigerant Profiles: Azeotropic Blends with Assigned Designations

	Btu/hr·ft°F)	
thermal conductivity, vapor:	0.0076 W/m·K (0.0044 Btu/hr·ft°F)	8401
· normal pressure, 20 °C (68 °F) -----		
density, vapor:	4.213 kg/m3 (0.2630 lb/cf)	8401
· normal pressure, 21.1 °C (70 °F) ---		
density, vapor:	4.196 kg/m3 (0.2619 lb/cf)	8401
· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	670.6 kPa (97.26 psia)	8401
pressure, vapor (dew point):	668.8 kPa (97.00 psia)	8401
density, saturated liquid:	1158 kg/m3 (72.32 lb/cf)	8401
density, saturated vapor:	32.02 kg/m3 (1.999 lb/cf)	8401
specific volume, saturated liquid:	0.863 L/kg (0.0138 cf/lb)	8401
specific volume, saturated vapor:	31.2 L/kg (0.5003 cf/lb)	8401
velocity of sound, saturated liquid:	528 m/s (1732 ft/s)	8401
velocity of sound, saturated vapor:	148 m/s (485 ft/s)	8401
viscosity, saturated liquid:	172 µPa·s (0.172 cp)	8401
viscosity, saturated vapor:	11.4 µPa·s (0.0114 cp)	8401
thermal conductivity, saturatd liquid:	0.0744 W/m·K (0.0430 Btu/hr·ft°F)	8401
thermal conductivity, saturated vapor:	0.01178 W/m·K (0.00681 Btu/hr·ft°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1809 kPa (262.4 psia)	8401
pressure, vapor (dew point):	1801 kPa (261.2 psia)	8401
heat of vaporization:	129.7 kJ/kg for liquid and vapor both at nominal composition (55.8 Btu/lb)	8401
	127.1 kJ/kg coexisting liquid and vapor at bubble-point pressure (54.6 Btu/lb)	8401
· critical point -----		
temperature:	102.1 °C (215.8 °F)	8401
pressure:	4173 kPa (605.2 psia)	8401
density:	492 kg/m3 (30.7 lb/cf)	8401
specific volume:	2.03 L/kg (0.0326 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.605 mass-weighted average (model-derived relative to R 11)	9501
	0.664 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	7870 mass-weighted average relative to CO2 for 100 yr integration	9501
HGWP (halocarbon GWP):	2.0 mass-weighted average relative to R 11 for infinite integration period	7214
	2.2 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	A1	8601
NFPA 704 degrees of hazard (H-F-R-S):	ARI recommendation: 2-0-0 health-flammability-reactivity	3A15

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

NPCA HMIS hazard ratings (H-F-R):	[-special]: 0=no, 4=severe AlliedSignal: 2-0-0 DuPont: 1-0-1 health-flammability-reactivity 0=insignificant, 4=extreme	MSDS MSDS
UL Comparative Hazard to Life Group:	5(a) in absence of flame or hot objects	0036
• short-term occupational limit ----- ARI "IDLH" recommendation:	50,000 ppm v/v for 30 min	3A15
• long-term occupational limit ----- exposure limit consistent to OSHA PEL:	ARI: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	3A15
• emergency exposure limit ----- Refrigerant Concentration Limit (RCL):	36,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
• flammability ----- LFL-UFL (flammability limits in air):	none (nonflammable as tested)	0036
flash point:	AlliedSignal: no flash point AlliedSignal: nonflammable8411 DuPont: will not burn	MSDS MSDS MSDS
autoignition temperature:	386 °C (727 °F)	5931
autodecomposition temperature:	DuPont: <445 °C (<833 °F) Elf Atochem: >427 °C (>800 °F)	MSDS MSDS
former UL Classification:	practically nonflammable (withdrawn for revision of the classification system, category SBQT2)	6938
• detection ----- appearance:	DuPont: clear, colorless	MSDS
odor:	AlliedSignal: faint ethereal	MSDS
PRODUCTION		
first commercial use as a refrigerant:	circa 1950	
last year production allowed:	1995 based on refrigerant 12 in developed countries under the Montreal Protocol	8C01

R-501

----- REFRIGERANT DATA SUMMARY -----
 R-501 R-22/12 (75.0/25.0) see
 azeotrope binary blend RDB#

IDENTIFIERS

common name(s): R-501; R501; R 501 2909
 HCFC/CFC-501 2909
 not CFC-501 or HCFC-501 2909
 ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

· nominal blend formulation -----
 composition: R-22/12 2909
 component weight fractions: 75.0 / 25.0 % 2909
 component mole fractions: 80.751 / 19.249 % 8820
 azeotropic temperature: -41.0 °C (-41.8 °F) 2909

· properties -----
 molar mass: 93.09844 g/mol (0.205247 8820
 lb/mol)

· normal boiling point -----
 bubble point temperature: -40.5 °C (-40.9 °F) 8401
 dew point temperature: -40.3 °C (-40.6 °F) 8401
 maximum temperature glide: 0.13 °C (0.2 °F) 8401
 density, saturated liquid: 1428 kg/m3 (89.15 lb/cf) 8401
 density, saturated vapor: 5.06 kg/m3 (0.316 lb/cf) 8401
 specific volume, saturated liquid: 0.700 L/kg (0.0112 cf/lb) 8401
 specific volume, saturated vapor: 197.7 L/kg (3.1670 cf/lb) 8401
 heat of vaporization: 214.9 kJ/kg (92.4 Btu/lb) 8401
 velocity of sound, saturated liquid: 818 m/s (2685 ft/s) 8401
 velocity of sound, saturated vapor: 153 m/s (503 ft/s) 8401
 viscosity, saturated liquid: 345 µPa·s (0.345 cp) 8401
 viscosity, saturated vapor: 9.67 µPa·s (0.00967 cp) 8401
 thermal conductivity, liquid: 0.1061 W/m·K (0.0613 8401
 Btu/hr·ft°F)
 thermal conductivity, vapor: 0.0070 W/m·K (0.0040 8401
 Btu/hr·ft°F)

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 3.934 kg/m3 (0.2456 lb/cf) 8401

· normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 3.918 kg/m3 (0.2446 lb/cf) 8401

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 881.0 kPa (127.77 psia) 8401
 pressure, vapor (dew point): 873.1 kPa (126.63 psia) 8401
 density, saturated liquid: 1228 kg/m3 (76.63 lb/cf) 8401
 density, saturated vapor: 39.71 kg/m3 (2.479 lb/cf) 8401
 specific volume, saturated liquid: 0.815 L/kg (0.0130 cf/lb) 8401
 specific volume, saturated vapor: 25.2 L/kg (0.4034 cf/lb) 8401
 velocity of sound, saturated liquid: 542 m/s (1779 ft/s) 8401
 velocity of sound, saturated vapor: 154 m/s (506 ft/s) 8401
 viscosity, saturated liquid: 175 µPa·s (0.175 cp) 8401
 viscosity, saturated vapor: 12.3 µPa·s (0.0123 cp) 8401
 thermal conductivity, saturatd liquid: 0.0800 W/m·K (0.0462 8401
 Btu/hr·ft°F)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

thermal conductivity, saturated vapor:	0.01079 W/m·K (0.00623 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	2333 kPa (338.3 psia)	8401
pressure, vapor (dew point):	2314 kPa (335.7 psia)	8401
heat of vaporization:	129.1 kJ/kg for liquid and vapor both at nominal composition (55.5 Btu/lb)	8401
	126.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (54.5 Btu/lb)	8401
· critical point -----		
temperature:	96.2 °C (205.2 °F)	8401
pressure:	4764 kPa (691.0 psia)	8401
density:	527 kg/m ³ (32.9 lb/cf)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.231 mass-weighted average (model-derived relative to R 11)	9501
	0.263 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	4080 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.98 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	A1	8601
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	27,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	2909
autoignition temperature:	637 °C (1179 °F)	5906
PRODUCTION		
last year production allowed:	1995 based on refrigerant 12 in developed countries under the Montreal Protocol	8C01

R-502

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----- REFRIERANT DATA SUMMARY -----
R-502          R-22/115 (48.8/51.2)          see
azeotrope     binary blend                  CAS number 39432-81-0      RDB#
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COMMON USE(S)

low-temperature commercial, industrial, and transport refrigeration;
 high stage of multistage, cascaded systems for extremely low
 temperatures; limited use in appliances; limited use in air-source
 heat pumps, particularly those that are heating only hydronic

IDENTIFIERS

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common name(s):  R-502; R502; R 502          2909
                  HCFC/CFC-502             2909
                  not CFC-502 or HCFC-502    2909
CAS number:      39432-81-0 Chemical Abstracts
                  Service Registry Number
trade name(s):   AlliedSignal Genetron(R) 502  MSDS
                  Asahi Glass Fron AF-502
                  Daikin Daiflon(R) 502
                  DuPont Freon(R) 502        MSDS
                  Elf Atochem Forane(R) 502   MSDS
                  HRP (UK) HARP(R) 502
                  Hoechst Frigen(R) 502
                  ICI Arcton(R) 502          MSDS
                  ZCIRI Kehua (PRC) R-502
ARI container color / Pantone number:  light purple (lavender) / 251  6601

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PHYSICAL

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· nominal blend formulation -----
  composition:      R-22/115                2909
  component weight fractions:  48.8 / 51.2 %  2909
  component mole fractions:    62.999 / 37.001 %  8820
  azeotropic temperature:     19.0 °C (66.2 °F)  2909
· properties -----
  molar mass:         111.62783 g/mol (0.246097  8820
                      lb/mol)
· normal boiling point -----
  bubble point temperature:    -45.3 °C (-49.5 °F)  8401
  dew point temperature:       -45.0 °C (-49.0 °F)  8401
  maximum temperature glide:   0.04 °C (0.1 °F)  8401
  density, saturated liquid:    1485 kg/m3 (92.72 lb/cf)  8401
  density, saturated vapor:     6.21 kg/m3 (0.388 lb/cf)  8401
  specific volume, saturated liquid: 0.673 L/kg (0.0108 cf/lb)  8401
  specific volume, saturated vapor: 161.0 L/kg (2.5795 cf/lb)  8401
  heat of vaporization:         173.3 kJ/kg (74.5 Btu/lb)  8401
  velocity of sound, saturated liquid: 728 m/s (2387 ft/s)  8401
  velocity of sound, saturated vapor: 136 m/s (445 ft/s)  8401
  viscosity, saturated liquid:  340 µPa·s (0.340 cp)  8401
  viscosity, saturated vapor:   9.73 µPa·s (0.00973 cp)  8401
  thermal conductivity, liquid: 0.0906 W/m·K (0.0523  8401
                      Btu/hr·ft°F)
  thermal conductivity, vapor:  0.0070 W/m·K (0.0041  8401
                      Btu/hr·ft°F)

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

· normal pressure, 20 °C (68 °F) -----		
density, vapor:	4.718 kg/m3 (0.2945 lb/cf)	8401
· normal pressure, 21.1 °C (70 °F) ---		
density, vapor:	4.699 kg/m3 (0.2934 lb/cf)	8401
· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	1015.1 kPa (147.23 psia)	8401
pressure, vapor (dew point):	1014.6 kPa (147.16 psia)	8401
density, saturated liquid:	1237 kg/m3 (77.20 lb/cf)	8401
density, saturated vapor:	57.93 kg/m3 (3.616 lb/cf)	8401
specific volume, saturated liquid:	0.809 L/kg (0.0130 cf/lb)	8401
specific volume, saturated vapor:	17.3 L/kg (0.2765 cf/lb)	8401
velocity of sound, saturated liquid:	429 m/s (1406 ft/s)	8401
velocity of sound, saturated vapor:	132 m/s (433 ft/s)	8401
viscosity, saturated liquid:	152 µPa·s (0.152 cp)	8401
viscosity, saturated vapor:	12.7 µPa·s (0.0127 cp)	8401
thermal conductivity, saturatd liquid:	0.0649 W/m·K (0.0375 Btu/hr·ft°F)	8401
thermal conductivity, saturated vapor:	0.01150 W/m·K (0.00665 Btu/hr·ft°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	2630 kPa (381.4 psia)	8401
pressure, vapor (dew point):	2630 kPa (381.4 psia)	8401
heat of vaporization:	86.0 kJ/kg for liquid and vapor both at nominal composition (37.0 Btu/lb)	8401
	86.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (37.0 Btu/lb)	8401
· critical point -----		
temperature:	80.7 °C (177.3 °F)	8401
pressure:	4018 kPa (582.8 psia)	8401
density:	569 kg/m3 (35.5 lb/cf)	8401
specific volume:	1.76 L/kg (0.0282 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	0.221 mass-weighted average (model-derived relative to R 11)	9501
	0.229 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	6200 mass-weighted average relative to CO2 for 100 yr integration	9501
HGWP (halocarbon GWP):	19 mass-weighted average relative to R 11 for infinite integration period	DW
	3.75 relative to R 11 for infinite integration period	4510

SAFETY

· classification -----		
safety group (ASHRAE Standard 34):	A1	8601
NFPA 704 degrees of hazard (H-F-R-S):	ARI recommendation: 2-0-0 health-flammability-reactivity [-special]: 0=no, 4=severe	3A15
NPCA HMIS hazard ratings (H-F-R):	AlliedSignal: 2-0-0 DuPont: 1-0-1 health-flammability-reactivity	MSDS MSDS

	0=insignificant, 4=extreme	
UL Comparative Hazard to Life Group:	5(a) in absence of flame or hot objects	0036
• short-term occupational limit -----		
ARI "IDLH" recommendation:	50,000 ppm v/v for 30 min	3A15
• long-term occupational limit -----		
NIOSH REL (recommended exposure limit):	none, components 1,000/1,000 ppm v/v TWA for 10 hr/day and 40 hr/wk	5204
ACGIH TLV-TWA (time-weighted average):	none, components 1,000/1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	9504
exposure limit consistent to OSHA PEL:	ARI: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	3A15
• emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	35,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
• acute (short-term) toxicity -----		
LC50 (lethal concentration, 50%):	rat, 4 hr, AlliedSig: ≥300,000 ppm (fatal concentration by inhalation for half of test animals)	MSDS
ALC (approximate lethal concentration):	rat, 2 hr, 0/4: > 200,000 ppm (lowest exposure tested with one or more deaths by inhalation)	6272
cardiac sensitization (CS) EC50:	dog, 10 min: 100,000-200,000 ppm v/v (effective concentration in half of test animals)	6274
cardiac sensitization threshold/LOEL:	dog, 5 min, 5/12: 100,000 ppm v/v (lowest observed effect level in test animals)	5644
cardiac sensitization (CS) NOEL:	dog, 10 min, 0/6: 50,000 ppm v/v (no observed effect level in test animals)	6274
• flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	2525
flash point:	AlliedSignal: no flash point	MSDS
autoignition temperature:	ICI: does not flash	MSDS
autodecomposition temperature:	704 °C (1299 °F)	3960
former UL Classification:	Elf Atochem: >427 °C (>800 °F)	MSDS
	practically nonflammable (withdrawn for revision of the classification system, category SBQT2)	5931
• detection -----		
appearance:	DuPont: clear, colorless	MSDS
odor:	AlliedSignal: faint ethereal	MSDS
PRODUCTION		
first commercial use as a refrigerant:	1961	5C39
last year production allowed:	1995 based on refrigerant 115 in developed countries under the Montreal Protocol	8C01

R-503

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----- REFRIGERANT DATA SUMMARY -----
R-503          R-23/13 (40.1/59.9)          see
azeotrope     binary blend                  RDB#
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COMMON USE(S)

extremely low temperature industrial refrigeration, primarily for the low stage of cascade systems, as well as very low temperature commercial and industrial refrigeration

IDENTIFIERS

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common name(s):  R-503; R503; R 503          2909
                  HFC/CFC-503              2909
                  not CFC-503 or HCFC-503  2909
trade name(s):   AlliedSignal Genetron(R) 503  MSDS
                  DuPont Freon(R) 503        MSDS
                  Elf Atochem Forane(R) 503  MSDS
                  Hoechst Frigen(R) 503
                  ICI Arcton(R) 503         MSDS
ARI container color / Pantone number:  blue-green (aqua) / 3268  6601

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PHYSICAL

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· nominal blend formulation -----
      composition:  R-23/13                  2909
      component weight fractions:  40.1 / 59.9 %  2909
      component mole fractions:    49.970 / 50.030 %  8820
      azeotropic temperature:     -88.7 °C (-127.6 °F)  3960
· properties -----
      molar mass:  87.24658 g/mol (0.192346 lb/mol)  8820
· normal boiling point -----
      bubble point temperature:  -87.5 °C (-125.5 °F)  8401
      dew point temperature:     -87.5 °C (-125.5 °F)  8401
      maximum temperature glide:  0.02 °C (0.0 °F)  8401
      density, saturated liquid:  1487 kg/m3 (92.82 lb/cf)  8401
      density, saturated vapor:   5.98 kg/m3 (0.373 lb/cf)  8401
      specific volume, saturated liquid:  0.673 L/kg (0.0108 cf/lb)  8401
      specific volume, saturated vapor:  167.2 L/kg (2.6789 cf/lb)  8401
      heat of vaporization:       179.1 kJ/kg (77.0 Btu/lb)  8401
      velocity of sound, saturated liquid:  739 m/s (2426 ft/s)  8401
      velocity of sound, saturated vapor:  143 m/s (470 ft/s)  8401
      viscosity, saturated liquid:  357 µPa·s (0.357 cp)  8401
      viscosity, saturated vapor:   8.73 µPa·s (0.00873 cp)  8401
      thermal conductivity, liquid:  0.1021 W/m·K (0.0590 Btu/hr·ft·°F)  8401
      thermal conductivity, vapor:  0.0060 W/m·K (0.0035 Btu/hr·ft·°F)  8401
· normal pressure, 20 °C (68 °F) -----
      density, vapor:  3.657 kg/m3 (0.2283 lb/cf)  8401
· normal pressure, 21.1 °C (70 °F) ---
      density, vapor:  3.643 kg/m3 (0.2274 lb/cf)  8401
· critical point -----
      temperature:  18.4 °C (65.2 °F)  8401
      pressure:    4265 kPa (618.6 psia)  8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

density: 552 kg/m3 (34.4 lb/cf) 8401
 specific volume: 1.81 L/kg (0.0290 cf/lb) 8401

ENVIRONMENTAL

ODP (ozone depletion potential): 0.599 mass-weighted average 9501
 (model-derived relative to R 11)
 GWP (global warming potential): 14,300 mass-weighted average 9501
 relative to CO2 for 100 yr
 integration
 HGWP (halocarbon GWP): 14 mass-weighted average DW
 relative to R 11 for infinite
 integration period

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 NFPA 704 degrees of hazard (H-F-R-S): AlliedSignal: 1-0-1 MSDS
 health-flammability-reactivity
 [-special]: 0=no, 4=severe
 NPCA HMIS hazard ratings (H-F-R): AlliedSignal: 1-0-1 MSDS
 DuPont: 1-0-1 MSDS
 health-flammability-reactivity
 0=insignificant, 4=extreme
 UL Comparative Hazard to Life Group: 6 in absence of flame or hot 5931
 objects
 · long-term occupational limit -----
 exposure limit consistent to OSHA PEL: ICI provisional OEL: 1,000 ppm 5A24
 v/v TWA for 8 hr/day and 40
 hr/wk
 · flammability -----
 LFL-UFL (flammability limits in air): none (nonflammable as tested) 3208
 flash point: AlliedSignal: no flash point MSDS
 ICI: does not flash MSDS
 autoignition temperature: >750 °C (>1382 °F) 5931
 autodecomposition temperature: DuPont: >760 °C (>1400 °F) MSDS
 former UL Classification: nonflammable (withdrawn for 5931
 revision of the classification
 system, category SBQT2)
 · detection -----
 appearance: DuPont: clear, colorless MSDS
 odor: Allied: practically odorless MSDS
 ICI: faint ether-like odor MSDS

PRODUCTION

last year production allowed: 1995 based on refrigerant 13 8C01
 in developed countries under
 the Montreal Protocol

thermal conductivity, saturated vapor:	0.01531 W/m·K (0.00885 Btu/hr·ft ² ·°F)	8401
· critical point -----		
temperature:	62.1 °C (143.9 °F)	8401
pressure:	4439 kPa (643.8 psia)	8401
density:	505 kg/m ³ (31.5 lb/cf)	8401
specific volume:	1.98 L/kg (0.0317 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.207 mass-weighted average (model-derived relative to R 11)	9501
GWP (global warming potential):	5760 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	19 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	41,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	3208
PRODUCTION		
last year production allowed:	1995 based on refrigerant 115 in developed countries under the Montreal Protocol	8C01

R-506

----- REFRIGERANT DATA SUMMARY -----
 R-506 R-31/114 (55.1/44.9) see
 azeotrope binary blend RDB#

COMMON USE(S)

withdrawn from commercial use with identification of refrigerant 31
 as carcinogenic; formerly used in applications with high condensing
 temperatures, such as for overhead crane cabs in steel mills

IDENTIFIERS

 common name(s): R-506; R506; R 506
 HCFC/CFC-506
 not CFC-506 or HCFC-506
 ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

· nominal blend formulation -----
 composition: R-31/114 2909
 component weight fractions: 55.1 / 44.9 % 2909
 component mole fractions: 75.388 / 24.612 % 8820
 azeotropic temperature: 18.0 °C (64.4 °F) 2909
 · properties -----
 molar mass: 93.69111 g/mol (0.206554 8820
 lb/mol)
 · normal boiling point -----
 temperature: -12.3 °C (9.9 °F) 0036
 heat of vaporization: 239.4 kJ/kg (102.9 Btu/lb) 0036
 · critical point -----
 temperature: 142.2 °C (288.0 °F) 1136
 pressure: 5164 kPa (749.0 psia) 1136
 density: 541 kg/m3 (33.7 lb/cf) 1136
 specific volume: 1.85 L/kg (0.0296 cf/lb) 1136

ENVIRONMENTAL

ODP (ozone depletion potential): 0.387 mass-weighted average 9501
 (model-derived relative to R
 11)

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 UL Comparative Hazard to Life Group: 5 in absence of flame or hot 0036
 objects
 · flammability -----
 LFL-UFL (flammability limits in air): none (nonflammable as tested) 0036

PRODUCTION

last year production allowed: 1995 based on refrigerant 114 8C01
 in developed countries under
 the Montreal Protocol

	density, vapor:	4.166 kg/m ³ (0.2601 lb/cf)	8401
• 20 °C (68 °F) -----			
	pressure, liquid (bubble point):	1127.5 kPa (163.53 psia)	8401
	pressure, vapor (dew point):	1126.4 kPa (163.37 psia)	8401
	density, saturated liquid:	1073 kg/m ³ (66.97 lb/cf)	8401
	density, saturated vapor:	59.58 kg/m ³ (3.720 lb/cf)	8401
	specific volume, saturated liquid:	0.932 L/kg (0.0149 cf/lb)	8401
	specific volume, saturated vapor:	16.8 L/kg (0.2688 cf/lb)	8401
	velocity of sound, saturated liquid:	403 m/s (1322 ft/s)	8401
	velocity of sound, saturated vapor:	134 m/s (440 ft/s)	8401
	viscosity, saturated liquid:	135 µPa·s (0.135 cp)	8401
	viscosity, saturated vapor:	12.3 µPa·s (0.0123 cp)	8401
	thermal conductivity, saturated liquid:	0.0684 W/m·K (0.0395 Btu/hr·ft ² ·°F)	8401
	thermal conductivity, saturated vapor:	0.01542 W/m·K (0.00891 Btu/hr·ft ² ·°F)	8401
• 60 °C (140 °F) -----			
	pressure, liquid (bubble point):	2950 kPa (427.9 psia)	8401
	pressure, vapor (dew point):	2948 kPa (427.6 psia)	8401
	heat of vaporization:	77.0 kJ/kg for liquid and vapor both at nominal composition (33.1 Btu/lb)	8401
		77.6 kJ/kg coexisting liquid and vapor at bubble-point pressure (33.4 Btu/lb)	8401
• critical point -----			
	temperature:	70.8 °C (159.4 °F)	8401
		70.9 °C (159.6 °F)	3A60
	pressure:	3715 kPa (538.8 psia)	8401
		3793 kPa (550.2 psia)	3A60
	density:	493 kg/m ³ (30.7 lb/cf)	8401
		500 kg/m ³ (31.2 lb/cf)	3A60
	specific volume:	2.00 L/kg (0.0321 cf/lb)	3A60
		2.03 L/kg (0.0325 cf/lb)	8401
ENVIRONMENTAL			
	ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
	GWP (global warming potential):	4600 mass-weighted average relative to CO ₂ for 100 yr integration	9501
	HGWP (halocarbon GWP):	0.81 mass-weighted average relative to R 11 for infinite integration period	DW
		0.96 relative to R 11 for infinite integration period	4683
SAFETY			
• classification -----			
	safety group (ASHRAE Standard 34):	A1	8601
	NFPA 704 degrees of hazard (H-F-R-S):	AlliedSignal: 2-0-0 health-flammability-reactivity [-special]: 0=no, 4=severe	MSDS
	NPCA HMIS hazard ratings (H-F-R):	AlliedSignal: 2-0-0 health-flammability-reactivity 0=insignificant, 4=extreme	MSDS
• emergency exposure limit -----			
	Refrigerant Concentration Limit (RCL):	69,000 ppm v/v (preliminary)	

1.75 L/kg (0.0281 cf/lb) 8401

ENVIRONMENTAL

ODP (ozone depletion potential): <0.00019 mass-weighted average 9501
(model-derived relative to R
11)
GWP (global warming potential): 13,000 mass-weighted average 9501
relative to CO2 for 100 yr
integration
HGWP (halocarbon GWP): 115 mass-weighted average DW
relative to R 11 for infinite
integration period

SAFETY

· classification -----
safety group (ASHRAE Standard 34): A1/A1 8601
NPCA HMIS hazard ratings (H-F-R): DuPont: 1-0-1 MSDS
health-flammability-reactivity
0=insignificant, 4=extreme
· long-term occupational limit -----
exposure limit consistent to OSHA PEL: DuPont: 1,000 ppm v/v TWA for 5909
8 hr/day and 40 hr/wk
· emergency exposure limit -----
Refrigerant Concentration Limit (RCL): 52,000 ppm v/v (preliminary
value under review, based on
draft ASHRAE 34aa)
· flammability -----
LFL-UFL (flammability limits in air): none (nonflammable as tested) 5909
flash point: none (nonflammable as tested) mfr
autoignition temperature: >750 °C (>1382 °F) 5C10
former UL Classification: nonflammable (withdrawn for 5C10
revision of the classification
system, category SBQT2)
· detection -----
appearance: DuPont: clear, colorless MSDS
odor: DuPont: slight ethereal MSDS

PRODUCTION

first commercial use as a refrigerant: 1996
last year production allowed: unrestricted 8C01

R-509A

```

----- REFRIERANT DATA SUMMARY -----
R-509A      R-22/218 (44.0/56.0)          see
azeotrope   binary blend                  RDB#
-----

```

COMMON USE(S)

very low temperature refrigeration with hermetic compressors in the range of approximately -40 to -30 °C (-40 to -22 °F), especially for biomedical and pharmaceutical uses; replacement for refrigerant 502 in these applications

IDENTIFIERS

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common name(s):  R-509A; R509A; R 509A      6801
                  also R-509; R509; R 509   6101
                  HCFC/HFC 509A, not HCFC-509A 6801
                  also HCFC/FC-509, not HCFC-509 6101
                  not FC-509A or FC-509      6101
trade name(s):   ICI Arcton(R) 509          MSDS
                  ICI Arcton(R) TP5R2       MSDS
ARI container color / Pantone number: none, use light green grey/413 6601

```

PHYSICAL

```

· nominal blend formulation -----
      composition:  R-22/218                6101
component weight fractions:  44.0 / 56.0 %  6101
component mole fractions:    63.079 / 36.921 % 8820
azeotropic temperature:     0.0 °C (32.0 °F)  4C51
· properties -----
      molar mass:    123.96188 g/mol (0.273289 8820
                    lb/mol)
normal freezing/melting/triple point: -173.0 °C (-279.4 °F)  MSDS
· normal boiling point -----
      bubble point temperature: -40.4 °C (-40.8 °F)  8814
      dew point temperature:    -40.4 °C (-40.7 °F)  8814
      maximum temperature glide: 0.06 °C (0.1 °F)    8814
                                       0.40 °C (0.7 °F)    mfr
      density, saturated liquid: 1522 kg/m3 (95.03 lb/cf) 8814
      density, saturated vapor:  6.77 kg/m3 (0.423 lb/cf) 8814
      specific volume, saturated liquid: 0.657 L/kg (0.0105 cf/lb) 8814
      specific volume, saturated vapor: 147.6 L/kg (2.3645 cf/lb) 8814
      heat of vaporization:       160.9 kJ/kg (69.2 Btu/lb) 8814
velocity of sound, saturated liquid: 685 m/s (2246 ft/s) 8814
velocity of sound, saturated vapor: 128 m/s (420 ft/s) 8814
      viscosity, saturated vapor: 10.09 µPa·s (0.01009 cp) 8814
      viscosity, saturated liquid: 332 µPa·s (0.332 cp) 8814
      thermal conductivity, liquid: 0.0816 W/m·K (0.0472 8814
                                       Btu/hr·ft²F)
      thermal conductivity, vapor: 0.0074 W/m·K (0.0043 8814
                                       Btu/hr·ft²F)
· normal pressure, 20 °C (68 °F) ----
      density, vapor: 5.248 kg/m3 (0.3276 lb/cf) 8814
· normal pressure, 21.1 °C (70 °F) ---
      density, vapor: 5.227 kg/m3 (0.3263 lb/cf) 8814
· 20 °C (68 °F) -----

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

pressure, liquid (bubble point):	877.6 kPa (127.28 psia)	8814
pressure, vapor (dew point):	1103.0 kPa (159.98 psia)	mfr
	875.0 kPa (126.91 psia)	8814
density, saturated liquid:	1289 kg/m ³ (80.45 lb/cf)	8814
density, saturated vapor:	54.59 kg/m ³ (3.408 lb/cf)	8814
specific volume, saturated liquid:	0.776 L/kg (0.0124 cf/lb)	8814
specific volume, saturated vapor:	18.3 L/kg (0.2934 cf/lb)	8814
maximum temperature glide:	0.02 °C (0.0 °F)	mfr
velocity of sound, saturated liquid:	417 m/s (1369 ft/s)	8814
velocity of sound, saturated vapor:	125 m/s (409 ft/s)	8814
viscosity, saturated liquid:	157 µPa·s (0.157 cp)	8814
viscosity, saturated vapor:	12.9 µPa·s (0.0129 cp)	8814
thermal conductivity, saturated liquid:	0.0608 W/m·K (0.0351 Btu/hr·ft ² ·°F)	8814
thermal conductivity, saturated vapor:	0.01160 W/m·K (0.00670 Btu/hr·ft ² ·°F)	8814
• 60 °C (140 °F) -----		
pressure, liquid (bubble point):	2319 kPa (336.3 psia)	8814
pressure, vapor (dew point):	2314 kPa (335.6 psia)	8814
	2602 kPa (377.4 psia)	mfr
heat of vaporization:	83.8 kJ/kg for liquid and vapor both at nominal composition (36.0 Btu/lb)	8814
	82.9 kJ/kg coexisting liquid and vapor at bubble-point pressure (35.6 Btu/lb)	8814
• critical point -----		
temperature:	87.2 °C (188.9 °F)	8814
pressure:	4027 kPa (584.1 psia)	8814
density:	578 kg/m ³ (36.1 lb/cf)	8814
specific volume:	1.73 L/kg (0.0277 cf/lb)	8814

ENVIRONMENTAL

ODP (ozone depletion potential):	0.015 mass-weighted average (model-derived relative to R 11)	9501
	0.022 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	5650 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	23 mass-weighted average relative to R 11 for infinite integration period	DW

SAFETY

classification -----		
safety group (ASHRAE Standard 34):	A1	8601
long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	ICI exposure limit: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	MSDS
emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	38,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
flammability -----		
LFL-UFL (flammability limits in air):	ICI: none (nonflammable atSTP)	MSDS

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

flash point:	ICI: does not flash	MSDS
autoignition temperature:	ICI: not applicable	MSDS
· detection -----		
appearance:	ICI: colorless liquified gas	MSDS
odor:	ICI: faint ether-like odor	MSDS

PRODUCTION

first commercial use as a refrigerant:	circa 1994	
last year production allowed:	2029 based on refrigerant 22 in developed countries under the Montreal Protocol	8C01

Refrigerant Profiles: Blends without Assigned Designations

Refrigerant Database

R-12/40

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-12/40 (??/??) see
 zeotrope binary blend RDB#

COMMON USE(S)

proposed as a substitute for refrigerant 12 to respond to wartime
 shortages in 1944 and 1945

IDENTIFIERS

common name(s): R-12/40 (??/??)
 R12/40 (??/??)
 R 12/40 (??/??)
 CFC-12/HCC-40 (??/??)
 not CFC-12/40 (??/??)
 ARI container color / Pantone number: none, use light green grey/413 6601
 possibly with red / 185 band

PHYSICAL

· nominal blend formulation -----
 composition: R-12/40
 component weight fractions: fomulation must be indicated %

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 components are A1 and B2 8601
 · flammability -----
 LFL-UFL (flammability limits in air): nonflammable for $\geq 35\%$ m/m R12 6633

PRODUCTION

first commercial use as a refrigerant: 1944
 last year production allowed: 1995 based on refrigerant 12 8C01
 in developed countries under
 the Montreal Protocol

R-12/764 (92.0/8.0)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-12/764 (92.0/8.0) see
 zeotrope blend RDB#

COMMON USE(S)

developmental blend, proposed in the 1930s, to facilitate leak
 detection for refrigerant 12 in its early years; not known to have
 been used commercially

IDENTIFIERS

common name(s): R-12/764 (92.0/8.0)
 R12/764 (92.0/8.0)
 R 12/764 (92.0/8.0)
 trade name(s): Frigidaire DL-8 2113

PHYSICAL

· nominal blend formulation -----
 composition: R-12/764
 component weight fractions: 92.0 / 8.0 %
 component mole fractions: 83.782 / 16.218 % 8820
 · properties -----
 molar mass: 111.69324 g/mol (0.246241 8820
 lb/mol)

ENVIRONMENTAL

ODP (ozone depletion potential): 0.640 (model-derived relative 9501
 to R 11)
 0.702 (semi-empirical relative 9501
 to R 11)

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized 2113
 last year production allowed: 1995 based on refrigerant 12 8C01
 in developed countries under
 the Montreal Protocol

R-22/12 (90.0/10.0)

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----- REFRIERANT DATA SUMMARY -----
unassigned   R-22/12 (90.0/10.0)
azeotrope    binary blend
                                                    see
                                                    RDB#
-----

```

COMMON USE(S)

field mixture to improve oil return in systems with flooded evaporators, especially built-up systems with evaporator temperatures below -20 °C (-4 °F); also used to lower condensing pressures and temperatures

IDENTIFIERS

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common name(s):  R-22/12 (90/10)
                  R22/12 (90/10)
                  R 22/12 (90/10)
                  HCFC-22/CFC-12
                  not CFC-22/12 or HCFC-22/12
                  candidate for R-501_ series
ARI container color / Pantone number: none, use light green grey/413 6601

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PHYSICAL

```

· nominal blend formulation -----
      composition:  R-22/12
      component weight fractions:  90.0 / 10.0 %
      component weight tolerances:  ±5.0 / ±5.0
      component mole fractions:    92.639 / 7.361 %
· properties -----
      molar mass:    89.00361 g/mol (0.196219 lb/mol)
· normal boiling point -----
      bubble point temperature:  -41.3 °C (-42.3 °F)
      dew point temperature:     -41.2 °C (-42.2 °F)
      maximum temperature glide: 0.05 °C (0.1 °F)
      density, saturated liquid: 1409 kg/m3 (87.96 lb/cf)
      density, saturated vapor:  4.84 kg/m3 (0.302 lb/cf)
      heat of vaporization:       225.6 kJ/kg (97.0 Btu/lb)
· normal pressure, 20 °C (68 °F) -----
      density, vapor:             3.759 kg/m3 (0.2347 lb/cf)
· normal pressure, 21.1 °C (70 °F) -----
      density, vapor:             3.744 kg/m3 (0.2337 lb/cf)
· 20 °C (68 °F) -----
      pressure, liquid (bubble point): 913.5 kPa (132.49 psia)
      pressure, vapor (dew point):     913.5 kPa (132.49 psia)
      density, saturated liquid:       1209 kg/m3 (75.48 lb/cf)
      density, saturated vapor:        39.69 kg/m3 (2.478 lb/cf)
      specific volume, saturated liquid: 0.827 L/kg (0.0132 cf/lb)
      specific volume, saturated vapor: 25.2 L/kg (0.4037 cf/lb)
      velocity of sound, saturated vapor: 159 m/s (523 ft/s)
      viscosity, saturated liquid:     183 µPa·s (0.183 cp)
      viscosity, saturated vapor:      12.8 µPa·s (0.0128 cp)
      thermal conductivity, saturatd liquid: 0.0863 W/m·K (0.0499 Btu/hr·ft°F)
      thermal conductivity, saturated vapor: 0.01310 W/m·K (0.00757 Btu/hr·ft°F)

```


R-22/12/142b (25.0/15.0/60.0)

```

----- REFRIGERANT DATA SUMMARY -----
unassigned   R-22/12/142b (25.0/15.0/60.0)           see
zeotrope     ternary blend                                     RDB#
-----

```

COMMON USE(S)

limited aftermarket use as an alternative for refrigerants 12, 22, 500, and 502, primarily as a service fluid claimed to improve performance, circa 1983-1994

Note: The trade name "R-176" was derived from the sum of 22, 12, and 142 from the component designations.

IDENTIFIERS

```

common name(s):  R-22/12/142b (25.0/15.0/60.0)
                  HCFC-22/CFC-12/HCFC-142b
                  not CFC-22/12/142b (25/15/60)
                  not HCFC-22/12/142b (25/15/60)
historical name(s): Alaskan Cool "R-176"
                    AlaskanAirConditioning "R-176"
                    Arctic Chill "R-176"           2A20
                    Arctic Cool "R-176"
                    Kalie-Chemie "R-176"          MSDS
                    Pennwalt Isotron "142b/22/12  MSDS
                    Blend 60/25/15"              MSDS
ARI container color / Pantone number: none, use light green grey/413 6601
                                         with red / 185 band

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PHYSICAL

```

· nominal blend formulation -----
                        composition:  R-22/12/142b
component weight fractions: 25.0 / 15.0 / 60.0 %
component mole fractions:  28.620 / 12.280 / 59.100 %   8820
· properties -----
                        molar mass:  98.98772 g/mol (0.218231   8820
                                         lb/mol)
normal freezing/melting/triple point: -149.6 °C (-237.3 °F)   2A20
· normal boiling point -----
  bubble point temperature: -26.9 °C (-16.5 °F)           8814
  dew point temperature:   -17.7 °C (0.1 °F)              8814
  maximum temperature glide: 9.19 °C (16.5 °F)           8814
  density, saturated liquid: 1288 kg/m3 (80.39 lb/cf)     8814
  density, saturated vapor:  4.91 kg/m3 (0.307 lb/cf)     8814
  specific volume, saturated liquid: 0.777 L/kg (0.0124 cf/lb) 8814
  specific volume, saturated vapor: 203.6 L/kg (3.2614 cf/lb) 8814
  heat of vaporization:      214.5 kJ/kg (92.2 Btu/lb)     2A20
                           223.9 kJ/kg (96.3 Btu/lb)     8814
velocity of sound, saturated liquid: 798 m/s (2619 ft/s)   8814
velocity of sound, saturated vapor: 152 m/s (499 ft/s)    8814
  viscosity, saturated liquid: 370 µPa·s (0.370 cp)       8814
  viscosity, saturated vapor:  9.23 µPa·s (0.00923 cp)    8814
  thermal conductivity, liquid: 0.0991 W/m·K (0.0573   8814
                                         Btu/hr·ft°F)
  thermal conductivity, vapor: 0.0084 W/m·K (0.0049   8814

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

	Btu/hr·ft°F)	
· normal pressure, 20 °C (68 °F) -----		
density, vapor:	4.212 kg/m3 (0.2630 lb/cf)	8814
· normal pressure, 21.1 °C (70 °F) ---		
density, vapor:	4.195 kg/m3 (0.2619 lb/cf)	8814
· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	516.8 kPa (74.96 psia)	8814
pressure, vapor (dew point):	403.7 kPa (58.56 psia)	8814
density, saturated liquid:	1164 kg/m3 (72.67 lb/cf)	8814
density, saturated vapor:	18.20 kg/m3 (1.136 lb/cf)	8814
specific volume, saturated liquid:	0.859 L/kg (0.0138 cf/lb)	8814
specific volume, saturated vapor:	0.1 L/kg (0.0009 cf/lb)	8814
velocity of sound, saturated liquid:	601 m/s (1970 ft/s)	8814
velocity of sound, saturated vapor:	154 m/s (505 ft/s)	8814
viscosity, saturated liquid:	215 µPa·s (0.215 cp)	8814
viscosity, saturated vapor:	10.7 µPa·s (0.0107 cp)	8814
thermal conductivity, saturatd liquid:	0.0804 W/m·K (0.0464	8814
	Btu/hr·ft°F)	
thermal conductivity, saturated vapor:	0.01083 W/m·K (0.00625	8814
	Btu/hr·ft°F)	
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1410 kPa (204.5 psia)	8814
pressure, vapor (dew point):	1206 kPa (174.8 psia)	8814
heat of vaporization:	157.8 kJ/kg for liquid and	8814
	vapor both at nominal	
	composition (67.8 Btu/lb)	
	152.1 kJ/kg coexisting liquid	8814
	and vapor at bubble-point	
	pressure (65.4 Btu/lb)	
· critical point -----		
temperature:	123.2 °C (253.8 °F)	8814
	129.4 °C (265.0 °F)	2A20
pressure:	4528 kPa (656.7 psia)	8814
	5102 kPa (740.0 psia)	2A20
density:	471 kg/m3 (29.4 lb/cf)	8814
specific volume:	2.12 L/kg (0.0340 cf/lb)	8814
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.157 mass-weighted average	9501
	(model-derived relative to R	
	11)	
	0.187 mass-weighted average	9501
	(semi-empirical relative to R	
	11)	
GWP (global warming potential):	3450 mass-weighted average	9501
	relative to CO2 for 100 yr	
	integration	
HGWP (halocarbon GWP):	0.77 mass-weighted average	DW
	relative to R 11 for infinite	
	integration period	
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
	components are A1, A1, and A2	8601
NFPA 704 degrees of hazard (H-F-R-S):	Pennwalt: 2-1-0	MSDS
	health-flammability-reactivity	
	[-special]: 0=no, 4=severe	
· long-term occupational limit -----		

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

exposure limit consistent to OSHA PEL:	Pennwalt: 1,000 ppm v/v TWA	MSDS
	for 8 hr/day and 40 hr/wk	
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	2A20
	worst fractionation flammable	MSDS
	flash point:	
· detection -----	Elf Atochem: nonflammable	MSDS
	appearance:	
	Elf Atochem: clear, colorless	MSDS
	odor:	
	Kali-Chemie: faint ethereal	MSDS

PRODUCTION

first commercial use as a refrigerant:	1983 by AlaskanAirConditioning	
last year production allowed:	1995 based on refrigerant 12	8C01
	in developed countries under	
	the Montreal Protocol	

R-22/124/600 (50.0/47.0/3.0)

----- REFRIGERANT DATA SUMMARY -----

unassigned	R-22/124/600 (50.0/47.0/3.0)	see
zeotrope	tetrary blend	RDB#

COMMON USE(S)

alternative for refrigerant 12, primarily for aftermarket use to service or retrofit existing medium temperature refrigeration equipment without a lubricant change (not suited for use with centrifugal compressors or flooded evaporators)

IDENTIFIERS

common name(s):	R-22/124/600 (50/47/3)	
	R22/124/600 (50/47/3)	
	R 22/124/600 (50/47/3)	
	HCFC-22/HCFC-124/HC-600	2909
	(50/47/3)	
	not HCFC-22/124/600 (50/47/3)	2909
trade name(s):	Ausimont Meforex(R) DI-36	7202
ARI container color / Pantone number:	none, use light green grey/413	6601

PHYSICAL

· nominal blend formulation -----		
composition:	R-22/124/600	
component weight fractions:	50.0 / 47.0 / 3.0 %	
component mole fractions:	59.353 / 35.349 / 5.298 %	8820
· properties -----		
molar mass:	102.64340 g/mol (0.226290 lb/mol)	8820
· normal boiling point -----		
bubble point temperature:	-34.8 °C (-30.6 °F)	8401
dew point temperature:	-26.9 °C (-16.4 °F)	8401
maximum temperature glide:	7.90 °C (14.2 °F)	8401
density, saturated liquid:	1393 kg/m3 (86.93 lb/cf)	8401
density, saturated vapor:	5.27 kg/m3 (0.329 lb/cf)	8401
specific volume, saturated liquid:	0.718 L/kg (0.0115 cf/lb)	8401
specific volume, saturated vapor:	189.7 L/kg (3.0379 cf/lb)	8401
heat of vaporization:	209.9 kJ/kg (90.2 Btu/lb)	8401
velocity of sound, saturated liquid:	784 m/s (2572 ft/s)	8401
velocity of sound, saturated vapor:	147 m/s (482 ft/s)	8401
viscosity, saturated liquid:	357 µPa·s (0.357 cp)	8401
viscosity, saturated vapor:	9.94 µPa·s (0.00994 cp)	8401
thermal conductivity, liquid:	0.0982 W/m·K (0.0567 Btu/hr·ft°F)	8401
thermal conductivity, vapor:	0.0080 W/m·K (0.0046 Btu/hr·ft°F)	8401
· normal pressure, 20 °C (68 °F) -----		
density, vapor:	4.352 kg/m3 (0.2717 lb/cf)	8401
· normal pressure, 21.1 °C (70 °F) ----		
density, vapor:	4.334 kg/m3 (0.2706 lb/cf)	8401
· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	704.6 kPa (102.19 psia)	8401
pressure, vapor (dew point):	578.7 kPa (83.93 psia)	8401
density, saturated liquid:	1221 kg/m3 (76.20 lb/cf)	8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

density, saturated vapor:	27.81 kg/m ³ (1.736 lb/cf)	8401
specific volume, saturated liquid:	0.819 L/kg (0.0131 cf/lb)	8401
specific volume, saturated vapor:	36.0 L/kg (0.5759 cf/lb)	8401
velocity of sound, saturated liquid:	540 m/s (1773 ft/s)	8401
velocity of sound, saturated vapor:	148 m/s (486 ft/s)	8401
viscosity, saturated liquid:	188 μ Pa·s (0.188 cp)	8401
viscosity, saturated vapor:	11.9 μ Pa·s (0.0119 cp)	8401
thermal conductivity, saturated liquid:	0.0766 W/m·K (0.0442 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01102 W/m·K (0.00637 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1887 kPa (273.7 psia)	8401
pressure, vapor (dew point):	1675 kPa (242.9 psia)	8401
heat of vaporization:	133.4 kJ/kg for liquid and vapor both at nominal composition (57.4 Btu/lb)	8401
	126.9 kJ/kg coexisting liquid and vapor at bubble-point pressure (54.5 Btu/lb)	8401
· critical point -----		
temperature:	102.6 °C (216.7 °F)	8401
pressure:	4559 kPa (661.2 psia)	8401
density:	460 kg/m ³ (28.7 lb/cf)	7202
	507 kg/m ³ (31.7 lb/cf)	8401
	507 kg/m ³ (31.7 lb/cf)	8401
specific volume:	1.97 L/kg (0.0316 cf/lb)	8401
	2.17 L/kg (0.0348 cf/lb)	7202
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.029 mass-weighted average (model-derived relative to R 11)	9501
	0.037 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1240 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.20 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	Ausimont AEL: 900 ppm v/v TWA for 8 hr/day and 40 hr/wk	7202
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	27,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	7202
PRODUCTION		
first commercial use as a refrigerant:	1996	
last year production allowed:	2029 by refrigerants 22, 124	8C01

in developed countries under
the Montreal Protocol

R-22/124/600a/142b (55.0/24.0/3.0/18.0)

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----- REFRIGERANT DATA SUMMARY -----
unassigned R-22/124/600a/142b (55.0/24.0/3.0/18.0) see
zeotrope tetrary blend RDB#
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COMMON USE(S)

service alternative for refrigerants 12 and 134a, primarily for aftermarket use to retrofit automobile and other mobile air conditioning systems (MACS)

This blend was marketed by ICOR International, Incorporated (Indianapolis, IN, USA) and others from late 1995 through March 1996 under the name "HOT SHOT." This product was reformulated to settle a claim of patent infringement.

IDENTIFIERS

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common name(s): R-22/124/600a/142b(55/24/3/18) 2909
                R22/124/600a/142b (55/24/3/18) 2909
                R 22/124/600a/142b(55/24/3/18) 2909
                candidate for R-414 series
                HCFC-22/HCFC-124/HC-600a/ 2909
                  HCFC-142b (55/24/3/18)
                not HCFC-22/124/600a/142b 2909
historical name(s): before March 1996:
                    AMI Automotive KAR KOOL(TM)
                    ESP (Canada) KAR KOOL
                    ICOR HOT SHOT
name used in U.S. EPA SNAP Rule: HCFC Blend Omicron
ARI container color / Pantone number: none, use light green grey/413 6601

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PHYSICAL

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· nominal blend formulation -----
    composition: R-22/124/600a/142b
    component weight fractions: 55.0 / 24.0 / 3.0 / 18.0 %
    component weight tolerances: ±1.5 / ±1.5 / ±1.0 / ±1.0
    component mole fractions: 61.005/ 16.866/ 4.950/ 17.179 8820
    %
· properties -----
    molar mass: 95.90880 g/mol (0.211443 8820
                lb/mol)
· normal boiling point -----
    bubble point temperature: -34.5 °C (-30.1 °F) 8401
    dew point temperature: -26.4 °C (-15.4 °F) 8401
    maximum temperature glide: 8.17 °C (14.7 °F) 8401
    density, saturated liquid: 1333 kg/m3 (83.24 lb/cf) 8401
    density, saturated vapor: 4.92 kg/m3 (0.307 lb/cf) 8401
    specific volume, saturated liquid: 0.750 L/kg (0.0120 cf/lb) 8401
    specific volume, saturated vapor: 203.5 L/kg (3.2590 cf/lb) 8401
    heat of vaporization: 224.2 kJ/kg (96.4 Btu/lb) 8401
    velocity of sound, saturated liquid: 810 m/s (2657 ft/s) 8401
    velocity of sound, saturated vapor: 153 m/s (502 ft/s) 8401
    viscosity, saturated liquid: 357 µPa·s (0.357 cp) 8401
    viscosity, saturated vapor: 9.69 µPa·s (0.00969 cp) 8401
    thermal conductivity, liquid: 0.1025 W/m·K (0.0592 8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

	Btu/hr·ft ^{°F})	
thermal conductivity, vapor:	0.0080 W/m·K (0.0046 Btu/hr·ft ^{°F})	8401
· normal pressure, 20 °C (68 °F) -----		
density, vapor:	4.066 kg/m ³ (0.2538 lb/cf)	8401
· normal pressure, 21.1 °C (70 °F) ---		
density, vapor:	4.050 kg/m ³ (0.2528 lb/cf)	8401
· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	659.9 kPa (95.71 psia)	8401
pressure, vapor (dew point):	563.2 kPa (81.69 psia)	8401
density, saturated liquid:	1173 kg/m ³ (73.21 lb/cf)	8401
density, saturated vapor:	25.18 kg/m ³ (1.572 lb/cf)	8401
specific volume, saturated liquid:	0.853 L/kg (0.0137 cf/lb)	8401
specific volume, saturated vapor:	39.7 L/kg (0.6363 cf/lb)	8401
velocity of sound, saturated liquid:	566 m/s (1855 ft/s)	8401
velocity of sound, saturated vapor:	155 m/s (507 ft/s)	8401
viscosity, saturated liquid:	190 µPa·s (0.190 cp)	8401
viscosity, saturated vapor:	11.6 µPa·s (0.0116 cp)	8401
thermal conductivity, saturatd liquid:	0.0799 W/m·K (0.0462 Btu/hr·ft ^{°F})	8401
thermal conductivity, saturated vapor:	0.01099 W/m·K (0.00635 Btu/hr·ft ^{°F})	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1862 kPa (270.0 psia)	8401
pressure, vapor (dew point):	1631 kPa (236.6 psia)	8401
heat of vaporization:	145.4 kJ/kg for liquid and vapor both at nominal composition (62.5 Btu/lb)	8401
	129.5 kJ/kg coexisting liquid and vapor at bubble-point pressure (55.7 Btu/lb)	8401
· critical point -----		
temperature:	109.9 °C (229.8 °F)	8401
pressure:	4729 kPa (685.9 psia)	8401
density:	487 kg/m ³ (30.4 lb/cf)	8401
specific volume:	2.05 L/kg (0.0329 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.033 mass-weighted average (model-derived relative to R 11)	9501
	0.046 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1610 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.27 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (requested January 1996, withdrawn March 1996)	
	components are A1, A1, A3, A2	8601
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	ICOR: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

• flammability -----
LFL-UFL (flammability limits in air): ICOR: will not burn MSDS
autoignition temperature: ICOR: 632 °C (1170 °F) MSDS

• detection -----
appearance: ICOR: colorless, liquified gas MSDS
odor: ICOR: faint ethereal odor MSDS

PRODUCTION

first commercial use as a refrigerant: late 1995
last year production allowed: 2029 by refig 22,124, and 142b 8C01
in developed countries under
the Montreal Protocol

R-22/134a/21 (65.0/15.0/20.0)

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----- REFRIGERANT DATA SUMMARY -----
unassigned  R-22/134a/21 (65.0/15.0/20.0)          see
zeotrope    ternary blend                          RDB#
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COMMON USE(S)

alternative for refrigerant 12, primarily in Russia, tested since 1996 as a service fluid for domestic refrigerators and commercial refrigeration

IDENTIFIERS

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common name(s):  R-22/134a/21 (65.0/15.0/20.0)
                  R22/134a/21 (65.0/15.0/20.0)
                  R 22/134a/21 (65.0/15.0/20.0)
                  HCFC-22/HFC-134a/HCFC-21      8601
                  (65/15/20)
                  not HCFC-22/134a/21 (65/15/20) 8601
                  (Russia) C10M2, in C10M series
                  (Russia) S10-M2
trade name(s):   Astor (Russia) "ASTRON-12"
ARI container color / Pantone number: none, use light green grey/413 6601

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PHYSICAL

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· nominal blend formulation -----
      composition:  R-22/134a/21
component weight fractions:  65.0 / 15.0 / 20.0 %
component mole fractions:    68.772 / 13.450 / 17.778 %      8820
· properties -----
      molar mass:   91.48651 g/mol (0.201693 lb/mol)      8820
· normal boiling point -----
  bubble point temperature:  -35.9 °C (-32.7 °F)          8814
  dew point temperature:     -22.5 °C (-8.4 °F)           8814
  maximum temperature glide: 13.45 °C (24.2 °F)           8814
  density, saturated liquid: 1415 kg/m3 (88.32 lb/cf)      8814
  density, saturated vapor:  4.60 kg/m3 (0.287 lb/cf)      8814
  specific volume, saturated liquid: 0.707 L/kg (0.0113 cf/lb) 8814
  specific volume, saturated vapor: 217.6 L/kg (3.4859 cf/lb) 8814
  heat of vaporization:      240.9 kJ/kg (103.6 Btu/lb)    8814
  velocity of sound, saturated liquid: 837 m/s (2745 ft/s) 8814
  velocity of sound, saturated vapor: 160 m/s (525 ft/s)  8814
  viscosity, saturated vapor: 10.10 µPa·s (0.01010 cp)    8814
  viscosity, saturated liquid: 386 µPa·s (0.386 cp)       8814
  thermal conductivity, liquid: 0.1126 W/m·K (0.0651 Btu/hr·ft·°F) 8814
  thermal conductivity, vapor: 0.0079 W/m·K (0.0046 Btu/hr·ft·°F) 8814
· normal pressure, 20 °C (68 °F) -----
  density, vapor: 3.874 kg/m3 (0.2418 lb/cf)              8814
· normal pressure, 21.1 °C (70 °F) ----
  density, vapor: 3.858 kg/m3 (0.2408 lb/cf)              8814
· 20 °C (68 °F) -----
  pressure, liquid (bubble point): 743.4 kPa (107.82 psia) 8814
  pressure, vapor (dew point):    532.5 kPa (77.23 psia)  8814

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

density, saturated liquid:	1243 kg/m ³ (77.60 lb/cf)	8814
density, saturated vapor:	22.30 kg/m ³ (1.392 lb/cf)	8814
specific volume, saturated liquid:	0.804 L/kg (0.0129 cf/lb)	8814
specific volume, saturated vapor:	44.8 L/kg (0.7184 cf/lb)	8814
velocity of sound, saturated liquid:	590 m/s (1935 ft/s)	8814
velocity of sound, saturated vapor:	163 m/s (534 ft/s)	8814
viscosity, saturated liquid:	203 μ Pa·s (0.203 cp)	8814
viscosity, saturated vapor:	11.8 μ Pa·s (0.0118 cp)	8814
thermal conductivity, saturatd liquid:	0.0877 W/m·K (0.0507 Btu/hr·ft ² ·°F)	8814
thermal conductivity, saturated vapor:	0.01041 W/m·K (0.00602 Btu/hr·ft ² ·°F)	8814
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1991 kPa (288.8 psia)	8814
pressure, vapor (dew point):	1629 kPa (236.3 psia)	8814
heat of vaporization:	157.6 kJ/kg for liquid and vapor both at nominal composition (67.8 Btu/lb)	8814
	150.0 kJ/kg coexisting liquid and vapor at bubble-point pressure (64.5 Btu/lb)	8814
· critical point -----		
temperature:	111.0 °C (231.8 °F)	8814
pressure:	5101 kPa (739.8 psia)	8814
density:	521 kg/m ³ (32.5 lb/cf)	8814
specific volume:	1.92 L/kg (0.0308 cf/lb)	8814

ENVIRONMENTAL

ODP (ozone depletion potential):	0.030 mass-weighted average (model-derived relative to R11)	9501
	0.041 mass-weighted average (semi-empirical relative to R11)	9501
GWP (global warming potential):	1520 mass-weighted average relative to CO ₂ for 100 yr integration	9501

SAFETY

· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending) components are A1, A1, and B1	8601 8601

PRODUCTION

last year production allowed:	2029 by refrigerants 21 and 22 in developed countries under the Montreal Protocol	8C01
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R-22/142b (40.0/60.0)

----- REFRIGERANT DATA SUMMARY -----

unassigned R-22/142b (40.0/60.0) see
 zeotrope binary blend RDB#

COMMON USE(S)

under consideration as a refrigerant, blowing agent, and aerosol
 propellant

IDENTIFIERS

common name(s): R-22/142b (40.0/60.0)
 R22/142b (40.0/60.0)
 R 22/142b (40.0/60.0)
 HCFC-22/HCFC-142b (40/60)
 not HCFC-22/142b (40/60)

trade name(s): AlliedSignal Genetron(R) MSDS
 22/142b Blend

ARI container color / Pantone number: none, use light green grey/413 6601
 with red / 185 band

PHYSICAL

· nominal blend formulation -----
 composition: R-22/142b
 component weight fractions: 40.0 / 60.0 %
 component mole fractions: 43.656 / 56.344 % 8820

· properties -----
 molar mass: 94.37129 g/mol (0.208053 8820
 lb/mol)

· normal boiling point -----
 bubble point temperature: -27.9 °C (-18.3 °F) 8401
 dew point temperature: -18.3 °C (-1.0 °F) 8401
 maximum temperature glide: 9.61 °C (17.3 °F) 8401
 density, saturated liquid: 1280 kg/m3 (79.88 lb/cf) 8401
 density, saturated vapor: 4.69 kg/m3 (0.293 lb/cf) 8401
 specific volume, saturated liquid: 0.781 L/kg (0.0125 cf/lb) 8401
 specific volume, saturated vapor: 213.2 L/kg (3.4156 cf/lb) 8401
 heat of vaporization: 236.1 kJ/kg (101.5 Btu/lb) 8401
 velocity of sound, saturated liquid: 819 m/s (2688 ft/s) 8401
 velocity of sound, saturated vapor: 156 m/s (512 ft/s) 8401
 viscosity, saturated liquid: 372 µPa·s (0.372 cp) 8401
 viscosity, saturated vapor: 9.29 µPa·s (0.00929 cp) 8401
 thermal conductivity, liquid: 0.1035 W/m·K (0.0598 8401
 Btu/hr·ft°F)
 thermal conductivity, vapor: 0.0084 W/m·K (0.0049 8401
 Btu/hr·ft°F)

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 4.013 kg/m3 (0.2505 lb/cf) 8401

· normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 3.997 kg/m3 (0.2495 lb/cf) 8401

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 543.6 kPa (78.84 psia) 8401
 pressure, vapor (dew point): 414.9 kPa (60.18 psia) 8401
 density, saturated liquid: 1154 kg/m3 (72.02 lb/cf) 8401
 density, saturated vapor: 17.82 kg/m3 (1.113 lb/cf) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

specific volume, saturated liquid:	0.867 L/kg (0.0139 cf/lb)	8401
specific volume, saturated vapor:	56.1 L/kg (0.8988 cf/lb)	8401
velocity of sound, saturated liquid:	614 m/s (2013 ft/s)	8401
velocity of sound, saturated vapor:	158 m/s (520 ft/s)	8401
viscosity, saturated liquid:	214 $\mu\text{Pa}\cdot\text{s}$ (0.214 cp)	8401
viscosity, saturated vapor:	10.7 $\mu\text{Pa}\cdot\text{s}$ (0.0107 cp)	8401
thermal conductivity, saturatd liquid:	0.0837 W/m \cdot K (0.0483 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01087 W/m \cdot K (0.00628 Btu/hr \cdot ft $^{\circ}$ F)	8401
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	1485 kPa (215.3 psia)	8401
pressure, vapor (dew point):	1243 kPa (180.3 psia)	8401
heat of vaporization:	165.6 kJ/kg for liquid and vapor both at nominal composition (71.2 Btu/lb)	8401
	158.9 kJ/kg coexisting liquid and vapor at bubble-point pressure (68.3 Btu/lb)	8401
• critical point -----		
temperature:	123.1 $^{\circ}$ C (253.6 $^{\circ}$ F)	8401
pressure:	4723 kPa (685.0 psia)	8401
density:	466 kg/m ³ (29.1 lb/cf)	8401
specific volume:	2.15 L/kg (0.0344 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.039 mass-weighted average (model-derived relative to R 11)	9501
	0.060 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	2140 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.37 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
• classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
	components are A1 and A2	8601
NFPA 704 degrees of hazard (H-F-R-S):	AlliedSignal: 2-4-0	MSDS
	health-flammability-reactivity [-special]: 0=no, 4=severe	
NPCA HMIS hazard ratings (H-F-R):	AlliedSignal: 2-1-0	MSDS
	health-flammability-reactivity 0=insignificant, 4=extreme	
• flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	0520
	worst fractionation flammable	MSDS
flash point:	AlliedSignal: not applicable	MSDS
	none (nonflammable as tested)	0520
autoignition temperature:	AlliedSignal: ~630 $^{\circ}$ C (~1166 $^{\circ}$ F)	MSDS
• detection -----		
appearance:	Elf Atochem: clear, colorless	MSDS
odor:	AlliedSignal: faint ethereal	MSDS

PRODUCTION

last year production allowed: 2029 by components in 8C01
developed countries under the
Montreal Protocol

R-22/142b (60.0/40.0)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-22/142b (60.0/40.0) see
 zeotrope binary blend RDB#

COMMON USE(S)

examined (circa 1993) as a refrigerant

IDENTIFIERS

common name(s): R-22/142b (60.0/40.0)
 R22/142b (60.0/40.0)
 R 22/142b (60.0/40.0)
 HCFC-22/HCFC-142b (60/40)
 not HCFC-22/142b (60/40)
 historical name(s): Elf Atochem Forane(R) FX-55
 ARI container color / Pantone number: none, use light green grey/413 6601
 with red / 185 band

PHYSICAL

· nominal blend formulation -----
 composition: R-22/142b
 component weight fractions: 60.0 / 40.0 %
 component mole fractions: 63.548 / 36.452 % 8820

· properties -----
 molar mass: 91.58113 g/mol (0.201902 8820
 lb/mol)

· normal boiling point -----
 bubble point temperature: -33.4 °C (-28.1 °F) 8401
 dew point temperature: -24.0 °C (-11.2 °F) 8401
 maximum temperature glide: 9.37 °C (16.9 °F) 8401
 density, saturated liquid: 1321 kg/m3 (82.48 lb/cf) 8401
 density, saturated vapor: 4.65 kg/m3 (0.290 lb/cf) 8401
 specific volume, saturated liquid: 0.757 L/kg (0.0121 cf/lb) 8401
 specific volume, saturated vapor: 215.2 L/kg (3.4477 cf/lb) 8401
 heat of vaporization: 237.4 kJ/kg (102.1 Btu/lb) 8401
 velocity of sound, saturated liquid: 833 m/s (2732 ft/s) 8401
 velocity of sound, saturated vapor: 158 m/s (519 ft/s) 8401
 viscosity, saturated liquid: 366 µPa·s (0.366 cp) 8401
 viscosity, saturated vapor: 9.52 µPa·s (0.00952 cp) 8401
 thermal conductivity, liquid: 0.1070 W/m·K (0.0618 8401
 Btu/hr·ft°F)
 thermal conductivity, vapor: 0.0080 W/m·K (0.0046 8401
 Btu/hr·ft°F)

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 3.884 kg/m3 (0.2425 lb/cf) 8401

· normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 3.868 kg/m3 (0.2415 lb/cf) 8401

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 667.5 kPa (96.82 psia) 8401
 pressure, vapor (dew point): 516.6 kPa (74.92 psia) 8401
 density, saturated liquid: 1171 kg/m3 (73.07 lb/cf) 8401
 density, saturated vapor: 21.81 kg/m3 (1.361 lb/cf) 8401
 specific volume, saturated liquid: 0.854 L/kg (0.0137 cf/lb) 8401
 specific volume, saturated vapor: 45.9 L/kg (0.7346 cf/lb) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

velocity of sound, saturated liquid:	596 m/s (1956 ft/s)	8401
velocity of sound, saturated vapor:	160 m/s (526 ft/s)	8401
viscosity, saturated liquid:	199 $\mu\text{Pa}\cdot\text{s}$ (0.199 cp)	8401
viscosity, saturated vapor:	11.3 $\mu\text{Pa}\cdot\text{s}$ (0.0113 cp)	8401
thermal conductivity, saturated liquid:	0.0842 W/m \cdot K (0.0487 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01080 W/m \cdot K (0.00624 Btu/hr \cdot ft $^{\circ}$ F)	8401
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	1792 kPa (259.9 psia)	8401
pressure, vapor (dew point):	1518 kPa (220.2 psia)	8401
heat of vaporization:	159.3 kJ/kg for liquid and vapor both at nominal composition (68.5 Btu/lb)	8401
	152.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (65.6 Btu/lb)	8401
• critical point -----		
temperature:	114.8 $^{\circ}$ C (238.6 $^{\circ}$ F)	8401
pressure:	4899 kPa (710.5 psia)	8401
density:	482 kg/m ³ (30.1 lb/cf)	8401
specific volume:	2.08 L/kg (0.0333 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.038 mass-weighted average (model-derived relative to R 11)	9501
	0.056 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	2060 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.35 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
• classification -----		
safety group (ASHRAE Standard 34):	none (no application pending) components are A1 and A2	8601 8601
• flammability -----		
LFL-UFL (flammability limits in air):	Atochem: nonflammable as tested	MSDS
flash point:	Elf Atochem: nonflammable	MSDS
• detection -----		
appearance:	Elf Atochem: clear, colorless	MSDS
odor:	Elf Atochem: faint ether-like	MSDS
PRODUCTION		
last year production allowed:	2029 by components in developed countries under the Montreal Protocol	8C01

R-22/142b/21 (65.0/20.0/15.0)

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----- REFRIGERANT DATA SUMMARY -----
unassigned   R-22/142b/21 (65.0/20.0/15.0)           see
zeotropic    ternary blend                               RDB#
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COMMON USE(S)

alternative for refrigerant 12, primarily in Russia, tested since 1996 as a service fluid for domestic refrigerators and commercial refrigeration

IDENTIFIERS

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common name(s):  R-22/142b/21 (65.0/20.0/15.0)
                  R22/142b/21 (65.0/20.0/15.0)
                  R 22/142b/21 (65.0/20.0/15.0)
                  HCFC-22/HCFC-142b/HCFC-21      8601
                  (65/20/15)
                  not HCFC-22/142b/21 (65/20/15)
                  (Russia) C10M1, in C10M series
                  (Russia) S10-M1
trade name(s):   Astor (Russia) "ASTRON-12"
ARI container color / Pantone number: none, use light green grey/413 6601

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PHYSICAL

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· nominal blend formulation -----
      composition:  R-22/142b/21
      component weight fractions:  65.0 / 20.0 / 15.0 %
      component mole fractions:    68.558 / 18.150 / 13.292 %      8820
· properties -----
      molar mass:    91.20109 g/mol (0.201064 lb/mol)      8820
· normal boiling point -----
      bubble point temperature:  -34.5 °C (-30.0 °F)      8814
      dew point temperature:     -21.2 °C (-6.2 °F)      8814
      maximum temperature glide: 13.23 °C (23.8 °F)      8814
      density, saturated liquid:  1371 kg/m3 (85.57 lb/cf)  8814
      density, saturated vapor:    4.56 kg/m3 (0.285 lb/cf)  8814
      specific volume, saturated liquid:  0.730 L/kg (0.0117 cf/lb)  8814
      specific volume, saturated vapor:  219.2 L/kg (3.5106 cf/lb)  8814
      heat of vaporization:        242.1 kJ/kg (104.1 Btu/lb)  8814
      velocity of sound, saturated liquid:  845 m/s (2774 ft/s)  8814
      velocity of sound, saturated vapor:  160 m/s (526 ft/s)  8814
      viscosity, saturated liquid:  381 µPa·s (0.381 cp)  8814
      viscosity, saturated vapor:    9.88 µPa·s (0.00988 cp)  8814
      thermal conductivity, liquid:  0.1107 W/m·K (0.0640 Btu/hr·ft²F)  8814
      thermal conductivity, vapor:   0.0079 W/m·K (0.0046 Btu/hr·ft²F)  8814
· normal pressure, 20 °C (68 °F) ----
      density, vapor:              3.865 kg/m3 (0.2413 lb/cf)  8814
· normal pressure, 21.1 °C (70 °F) ---
      density, vapor:              3.849 kg/m3 (0.2403 lb/cf)  8814
· 20 °C (68 °F) -----
      pressure, liquid (bubble point):  692.4 kPa (100.43 psia)  8814
      pressure, vapor (dew point):     487.5 kPa (70.70 psia)  8814

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

density, saturated liquid:	1213 kg/m ³ (75.74 lb/cf)	8814
density, saturated vapor:	20.25 kg/m ³ (1.264 lb/cf)	8814
specific volume, saturated liquid:	0.824 L/kg (0.0132 cf/lb)	8814
specific volume, saturated vapor:	49.4 L/kg (0.7912 cf/lb)	8814
velocity of sound, saturated liquid:	607 m/s (1991 ft/s)	8814
velocity of sound, saturated vapor:	163 m/s (536 ft/s)	8814
viscosity, saturated liquid:	206 $\mu\text{Pa}\cdot\text{s}$ (0.206 cp)	8814
viscosity, saturated vapor:	11.5 $\mu\text{Pa}\cdot\text{s}$ (0.0115 cp)	8814
thermal conductivity, saturatd liquid:	0.0871 W/m \cdot K (0.0503 Btu/hr \cdot ft $^{\circ}$ F)	8814
thermal conductivity, saturated vapor:	0.01032 W/m \cdot K (0.00596 Btu/hr \cdot ft $^{\circ}$ F)	8814
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	1847 kPa (267.9 psia)	8814
pressure, vapor (dew point):	1477 kPa (214.3 psia)	8814
heat of vaporization:	162.9 kJ/kg for liquid and vapor both at nominal composition (70.0 Btu/lb)	8814
	154.8 kJ/kg coexisting liquid and vapor at bubble-point pressure (66.5 Btu/lb)	8814
• critical point -----		
temperature:	116.0 $^{\circ}$ C (240.8 $^{\circ}$ F)	8814
pressure:	5073 kPa (735.8 psia)	8814
density:	502 kg/m ³ (31.3 lb/cf)	8814
specific volume:	1.99 L/kg (0.0319 cf/lb)	8814
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.037 mass-weighted average (model-derived relative to R11)	9501
	0.052 mass-weighted average (semi-empirical relative to R11)	9501
GWP (global warming potential):	1730 mass-weighted average relative to CO ₂ for 100 yr integration	9501
SAFETY		
• classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
	components are A1, A1, and B1	8601
PRODUCTION		
last year production allowed:	2029 by components in developed countries under the Montreal Protocol	8C01

R-22/152a

```

----- REFRIGERANT DATA SUMMARY -----
unassigned   R-22/152a (formulation not disclosed)      see
zeotrope     binary blend                                     RDB#
-----

```

COMMON USE(S)

interim alternative for refrigerant 12 in refrigerator-freezers in China

The following information is preliminary and may be incomplete or incorrect. Data on this blend may be available from Tsinghua University (Beijing, Peoples Republic of China), Hangzhou First Chemical Company, Limited (Hangzhou, Zhejiang, Peoples Republic of China), and other refrigerant manufacturers. The blend is described as a near-azeotropic blend.

IDENTIFIERS

```

common name(s):  R-22/152a (??/??)
                  R22/152a (??/??)
                  R 22/152a (??/??)
trade name(s):   (China) THR01
                  Hangzhou (China) First-12      8331

```

PHYSICAL

```

· nominal blend formulation -----
  composition:  R-22/152a

```

ENVIRONMENTAL

```

ODP (ozone depletion potential): <0.03 (model-derived relative 8331
to R 11)
GWP (global warming potential):  0.3 (probably 0.3x3800 = 1140) 8331
relative to CO2 for 100 yr
integration
probably intended: 1140      8331
relative to CO2 for 100 yr
integration

```

SAFETY

```

· classification -----
  safety group (ASHRAE Standard 34): none (no application pending) 8601
                                      components are A1 and A2      8601

```

PRODUCTION

```

first commercial use as a refrigerant: circa 1997 in China
last year production allowed:         2029 based on refrigerant 22 8C01
in developed countries under
the Montreal Protocol

```

R-22/152a

```

----- REFRIGERANT DATA SUMMARY -----
unassigned   R-22/152a (formulation not disclosed)      see
zeotrope     binary blend                                     RDB#
-----

```

COMMON USE(S)

used as a replacement for refrigerant 12 in refrigerator-freezers in China

The following information is preliminary and may be incomplete or incorrect. Data on this blend may be available from the Zhejiang Chemical Industry Research Institute (Hangzhou, Zhejiang, Peoples Republic of China) and refrigerant manufacturers. The blend formulation has not been disclosed and data inconsistencies preclude precise determination; it appears to be approximately R-22/152a (23/77).

IDENTIFIERS

```

common name(s):  R-22/152a (??/??)
                  R22/152a (??/??)
                  R 22/152a (??/??)
trade name(s):   Zhejiang (China) ZC-1                8B15

```

PHYSICAL

```

· nominal blend formulation -----
      composition:  R-22/152a
      component mole fractions: 18.7 / 81.3 estimated %      8820
· properties -----
      molar mass:   69.9 estimated g/mol (0.154103 lb/mol)  8820
· normal boiling point -----
      temperature:  -28.4 °C (-19.1 °F)                    8B15

```

ENVIRONMENTAL

```

ODP (ozone depletion potential): 0.008 estimated mass average 9501
                                   (model-derived relative to R
                                   11)
                                   0.01 (model-derived relative 8B15
                                   to R 11)
                                   0.012 estimated mass average 9501
                                   (semi-empirical relative to R
                                   11)
GWP (global warming potential): 456 relative to CO2 for 100 yr 8B15
                                   integration
                                   590 estimated mass average 9501
                                   relative to CO2 for 100 yr
                                   integration

```

SAFETY

```

· classification -----
  safety group (ASHRAE Standard 34): none (no application pending) 8601
                                       components are A1 and A2      8601
· long-term occupational limit -----
  exposure limit consistent to OSHA PEL: 1000 ppm v/v TWA for 8 hr/day 8B15

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

· flammability ----- and 40 hr/wk
LFL (lower flammability limit in air): 6.6 % v/v 8B15

PRODUCTION

first commercial use as a refrigerant: circa 1995 in China 8B15
last year production allowed: 2029 based on refrigerant 22 8C01
in developed countries under
the Montreal Protocol

R-22/152a

```

----- REFRIERANT DATA SUMMARY -----
unassigned   R-22/152a (formulation not disclosed)      see
zeotrope     binary blend                                     RDB#
-----

```

COMMON USE(S)

used as a replacement for refrigerant 12 in refrigerator-freezers in China

The following information is preliminary and may be incomplete or incorrect. Data on this blend may be available from the Zhejiang Chemical Industry Research Institute (Hangzhou, Zhejiang, Peoples Republic of China) and refrigerant manufacturers. The blend formulation has not been disclosed and data inconsistencies preclude precise determination; it appears to be approximately R-22/152a (58/42).

IDENTIFIERS

```

common name(s):  R-22/152a (??/??)
                  R22/152a (??/??)
                  R 22/152a (??/??)
trade name(s):   Zhejiang (China) ZC-2                8B15

```

PHYSICAL

```

· nominal blend formulation -----
      composition:  R-22/152a
      component mole fractions:  51.0 / 49.0 estimated %      8820
· properties -----
      molar mass:    76.5 estimated g/mol (0.168654 lb/mol)  8820
· normal boiling point -----
      temperature:   -24.1 °C (-11.4 °F)                    8B15

```

ENVIRONMENTAL

```

ODP (ozone depletion potential):  0.020 estimated mass average  9501
                                   (model-derived relative to R
                                   11)
                                   0.029 (model-derived relative  8B15
                                   to R 11)
                                   0.029 estimated mass average  9501
                                   (semi-empirical relative to R
                                   11)
GWP (global warming potential):    925 relative to CO2 for 100  8B15
                                   yr integration
                                   1180 estimated mass average  9501
                                   relative to CO2 for 100 yr
                                   integration

```

SAFETY

```

· classification -----
  safety group (ASHRAE Standard 34):  none (no application pending)  8601
                                       components are A1 and A2        8601
· long-term occupational limit -----
  exposure limit consistent to OSHA PEL:  1000 ppm v/v TWA for 8 hr/day  8B15

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

· flammability ----- and 40 hr/wk
LFL-UFL (flammability limits in air): none 8B15

PRODUCTION

first commercial use as a refrigerant: circa 1995 in China 8B15
last year production allowed: 2029 based on refrigerant 22 8C01
in developed countries under
the Montreal Protocol

R-22/152a/114 (36.0/24.0/40.0)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-22/152a/114 (36.0/24.0/40.0) see
 zeotrope ternary blend RDB#

COMMON USE(S)

developmental formulation of an alternative to refrigerant 12, primarily for aftermarket use to service or retrofit existing equipment; tested circa 1989 pending commercial availability and Toxic Substances Control Act (TSCA) listing of refrigerant 124 for successor blends, such as KCD-9433

The following information is preliminary and may be incomplete or incorrect. Data may be available from DuPont Chemicals (Wilmington, DE, USA) and other refrigerant manufacturers.

IDENTIFIERS

common name(s): R-22/152a/114 (36/24/40)
 HCFC-22/HFC-152a/CFC-114
 not CFC-22/152a/114
 not HCFC-22/152a/114
 trade name(s): DuPont KCD-9430 2206

PHYSICAL

· nominal blend formulation -----
 composition: R-22/152a/114
 component weight fractions: 36.0 / 24.0 / 40.0 %

ENVIRONMENTAL

HGWP (halocarbon GWP): 1.61 relative to R 11 for 0535
 infinite integration period

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized

R-22/152a/124 (31.0/24.0/45.0)

```

----- REFRIGERANT DATA SUMMARY -----
unassigned R-22/152a/124 (31.0/24.0/45.0) see
zeotrope ternary blend RDB#
-----

```

COMMON USE(S)

developmental formulation for mobile air-conditioning (MAC) systems, primarily for aftermarket use to service or retrofit existing automobile air conditioners and other equipment as an alternative for refrigerant 12; tested circa 1990; largely superseded by other blends including refrigerant 401C

IDENTIFIERS

```

common name(s): R-22/152a/124 (31/24/45)
                 candidate for R-401 series
                 HCFC-22/HFC-152a/HCFC-124
                 not HCFC-22/152a/124
trade name(s):  DuPont KCD-9452                2206

```

PHYSICAL

```

· nominal blend formulation -----
  composition: R-22/152a/124
  component weight fractions: 31.0 / 24.0 / 45.0 %
  component mole fractions: 34.092 / 34.553 / 31.355 %      8820
· properties -----
  molar mass: 95.09283 g/mol (0.209644 lb/mol)              8820
· normal boiling point -----
  bubble point temperature: -29.6 °C (-21.3 °F)              8401
  dew point temperature: -24.1 °C (-11.5 °F)                 8401
  maximum temperature glide: 5.44 °C (9.8 °F)                 8401
  density, saturated liquid: 1318 kg/m3 (82.31 lb/cf)         8401
  density, saturated vapor: 4.85 kg/m3 (0.302 lb/cf)          8401
  specific volume, saturated liquid: 0.759 L/kg (0.0122 cf/lb) 8401
  specific volume, saturated vapor: 206.4 L/kg (3.3060 cf/lb) 8401
  heat of vaporization: 230.2 kJ/kg (99.0 Btu/lb)              8401
  velocity of sound, saturated liquid: 796 m/s (2611 ft/s)    8401
  velocity of sound, saturated vapor: 153 m/s (503 ft/s)      8401
  viscosity, saturated liquid: 349 µPa·s (0.349 cp)           8401
  viscosity, saturated vapor: 9.79 µPa·s (0.00979 cp)         8401
  thermal conductivity, liquid: 0.1024 W/m·K (0.0592 Btu/hr·ft°F) 8401
  thermal conductivity, vapor: 0.0085 W/m·K (0.0049 Btu/hr·ft°F) 8401
· normal pressure, 20 °C (68 °F) -----
  density, vapor: 4.040 kg/m3 (0.2522 lb/cf)                   8401
· normal pressure, 21.1 °C (70 °F) ----
  density, vapor: 4.023 kg/m3 (0.2512 lb/cf)                   8401
· 20 °C (68 °F) -----
  pressure, liquid (bubble point): 596.4 kPa (86.50 psia)     8401
  pressure, vapor (dew point): 520.2 kPa (75.44 psia)         8401
  density, saturated liquid: 1173 kg/m3 (73.25 lb/cf)         8401
  density, saturated vapor: 23.09 kg/m3 (1.441 lb/cf)         8401
  specific volume, saturated liquid: 0.852 L/kg (0.0137 cf/lb) 8401

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

specific volume, saturated vapor:	43.3 L/kg (0.6939 cf/lb)	8401
velocity of sound, saturated liquid:	573 m/s (1879 ft/s)	8401
velocity of sound, saturated vapor:	154 m/s (507 ft/s)	8401
viscosity, saturated liquid:	191 $\mu\text{Pa}\cdot\text{s}$ (0.191 cp)	8401
viscosity, saturated vapor:	11.6 $\mu\text{Pa}\cdot\text{s}$ (0.0116 cp)	8401
thermal conductivity, saturated liquid:	0.0826 W/m \cdot K (0.0477 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01195 W/m \cdot K (0.00690 Btu/hr \cdot ft $^{\circ}$ F)	8401
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	1654 kPa (239.9 psia)	8401
pressure, vapor (dew point):	1523 kPa (220.9 psia)	8401
heat of vaporization:	153.1 kJ/kg for liquid and vapor both at nominal composition (65.8 Btu/lb)	8401
	148.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (63.7 Btu/lb)	8401
• critical point -----		
temperature:	110.4 $^{\circ}$ C (230.7 $^{\circ}$ F)	8401
pressure:	4433 kPa (643.0 psia)	8401
density:	477 kg/m ³ (29.8 lb/cf)	8401
specific volume:	2.10 L/kg (0.0336 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.022 mass-weighted average (model-derived relative to R 11)	9501
	0.027 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	910 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.14 relative to R 11 for infinite integration period	2206
	0.14 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
• classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
PRODUCTION		
first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	2029 by refrigerants 22, 124 in developed countries under the Montreal Protocol	8C01

R-22/152a/124 (36.0/24.0/40.0)

----- REFRIERANT DATA SUMMARY -----
 unassigned R-22/152a/124 (36.0/24.0/40.0) see
 zeotrope ternary blend RDB#

COMMON USE(S)

developmental formulation of an alternative to refrigerant 12,
 primarily for aftermarket use to service or retrofit existing
 equipment; tested circa 1989; largely superseded by other blends,
 such as refrigerants 401A, 401B, 401C, and MP33

IDENTIFIERS

common name(s): R-22/152a/124 (36/24/40)
 candidate for R-401_ series
 HCFC-22/HFC-152a/CFC-124
 not HCFC-22/152a/124
 trade name(s): DuPont KCD-9433 2206

PHYSICAL

· nominal blend formulation -----
 composition: R-22/152a/124
 component weight fractions: 36.0 / 24.0 / 40.0 %
 component mole fractions: 38.809 / 33.871 / 27.321 % 8820

· properties -----
 molar mass: 93.21470 g/mol (0.205503 8820
 lb/mol)

· normal boiling point -----
 bubble point temperature: -30.7 °C (-23.2 °F) 8401
 dew point temperature: -25.3 °C (-13.6 °F) 8401
 maximum temperature glide: 5.33 °C (9.6 °F) 8401
 density, saturated liquid: 1315 kg/m3 (82.11 lb/cf) 8401
 density, saturated vapor: 4.77 kg/m3 (0.298 lb/cf) 8401
 specific volume, saturated liquid: 0.760 L/kg (0.0122 cf/lb) 8401
 specific volume, saturated vapor: 209.6 L/kg (3.3579 cf/lb) 8401
 heat of vaporization: 233.5 kJ/kg (100.4 Btu/lb) 8401
 velocity of sound, saturated liquid: 804 m/s (2637 ft/s) 8401
 velocity of sound, saturated vapor: 155 m/s (508 ft/s) 8401
 viscosity, saturated liquid: 347 µPa·s (0.347 cp) 8401
 viscosity, saturated vapor: 9.77 µPa·s (0.00977 cp) 8401
 thermal conductivity, liquid: 0.1039 W/m·K (0.0600 8401
 Btu/hr·ft°F)
 thermal conductivity, vapor: 0.0084 W/m·K (0.0049 8401
 Btu/hr·ft°F)

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 3.958 kg/m3 (0.2471 lb/cf) 8401

· normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 3.942 kg/m3 (0.2461 lb/cf) 8401

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 620.1 kPa (89.94 psia) 8401
 pressure, vapor (dew point): 543.1 kPa (78.77 psia) 8401
 density, saturated liquid: 1167 kg/m3 (72.85 lb/cf) 8401
 density, saturated vapor: 23.69 kg/m3 (1.479 lb/cf) 8401
 specific volume, saturated liquid: 0.857 L/kg (0.0137 cf/lb) 8401
 specific volume, saturated vapor: 42.2 L/kg (0.6761 cf/lb) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

velocity of sound, saturated liquid:	574 m/s (1884 ft/s)	8401
velocity of sound, saturated vapor:	156 m/s (512 ft/s)	8401
viscosity, saturated liquid:	189 $\mu\text{Pa}\cdot\text{s}$ (0.189 cp)	8401
viscosity, saturated vapor:	11.6 $\mu\text{Pa}\cdot\text{s}$ (0.0116 cp)	8401
thermal conductivity, saturatd liquid:	0.0834 W/m \cdot K (0.0482 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01190 W/m \cdot K (0.00688 Btu/hr \cdot ft $^{\circ}$ F)	8401
· 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	1712 kPa (248.4 psia)	8401
pressure, vapor (dew point):	1582 kPa (229.4 psia)	8401
heat of vaporization:	154.2 kJ/kg for liquid and vapor both at nominal composition (66.3 Btu/lb)	8401
	149.4 kJ/kg coexisting liquid and vapor at bubble-point pressure (64.2 Btu/lb)	8401
· critical point -----		
temperature:	109.3 $^{\circ}$ C (228.7 $^{\circ}$ F)	8401
pressure:	4492 kPa (651.5 psia)	8401
density:	475 kg/m ³ (29.7 lb/cf)	8401
specific volume:	2.10 L/kg (0.0337 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	0.023 mass-weighted average (model-derived relative to R 11)	9501
	0.028 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	980 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.16 relative to R 11 for infinite integration period	0535
	0.16 mass-weighted average relative to R 11 for infinite integration period	DW

SAFETY

· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601

PRODUCTION

first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	2029 by refrigerants 22, 124 in developed countries under the Montreal Protocol	8C01

R-22/152a/124 (40.0/17.0/43.0)

```

----- REFRIERANT DATA SUMMARY -----
unassigned   R-22/152a/124 (40.0/17.0/43.0)           see
zeotrope     ternary blend                                   RDB#
-----

```

COMMON USE(S)

developmental formulation of an alternative to refrigerants 12 and 500, primarily for aftermarket use to service or retrofit existing equipment; tested circa 1990

IDENTIFIERS

```

common name(s):  R-22/152a/124 (40/17/43)
                  R22/152a/124 (40/17/43)
                  R 22/152a/124 (40/17/43)
                  candidate for R-401 series
                  HCFC-22/HFC-152a/HCFC-124
                  (40/17/43)
                  not HCFC-22/152a/124
trade name(s):   DuPont Suva(R) MP33
ARI container color / Pantone number:  none, use light green grey/413 6601

```

PHYSICAL

```

· nominal blend formulation -----
      composition:  R-22/152a/124
component weight fractions:  40.0 / 17.0 / 43.0 %
component mole fractions:    44.693 / 24.866 / 30.440 %      8820
· properties -----
      molar mass:   96.61336 g/mol (0.212996 lb/mol)      8820
· normal boiling point -----
      bubble point temperature:  -28.8 °C (-19.8 °F)      2A19
                                   -31.9 °C (-25.4 °F)      8401
      dew point temperature:     -25.8 °C (-14.4 °F)      8401
      maximum temperature glide: 6.09 °C (11.0 °F)      8401
      density, saturated liquid:  1353 kg/m3 (84.44 lb/cf)  8401
      density, saturated vapor:   4.95 kg/m3 (0.309 lb/cf)  8401
      specific volume, saturated liquid:  0.739 L/kg (0.0118 cf/lb)  8401
      specific volume, saturated vapor:  202.0 L/kg (3.2360 cf/lb)  8401
      heat of vaporization:        224.9 kJ/kg (96.7 Btu/lb)  8401
      velocity of sound, saturated liquid:  796 m/s (2610 ft/s)  8401
      velocity of sound, saturated vapor:   152 m/s (499 ft/s)  8401
      viscosity, saturated liquid:  354 µPa·s (0.354 cp)  8401
      viscosity, saturated vapor:   9.86 µPa·s (0.00986 cp)  8401
      thermal conductivity, liquid:  0.1020 W/m·K (0.0589 Btu/hr·ft°F)  8401
      thermal conductivity, vapor:  0.0083 W/m·K (0.0048 Btu/hr·ft°F)  8401
· normal pressure, 20 °C (68 °F) -----
      density, vapor:  4.100 kg/m3 (0.2560 lb/cf)  8401
· normal pressure, 21.1 °C (70 °F) ----
      density, vapor:  4.084 kg/m3 (0.2549 lb/cf)  8401
· 20 °C (68 °F) -----
      pressure, liquid (bubble point):  644.2 kPa (93.43 psia)  8401
      pressure, vapor (dew point):     554.2 kPa (80.38 psia)  8401

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

density, saturated liquid:	1196 kg/m ³ (74.65 lb/cf)	8401
density, saturated vapor:	25.07 kg/m ³ (1.565 lb/cf)	8401
specific volume, saturated liquid:	0.836 L/kg (0.0134 cf/lb)	8401
specific volume, saturated vapor:	39.9 L/kg (0.6390 cf/lb)	8401
velocity of sound, saturated liquid:	562 m/s (1845 ft/s)	8401
velocity of sound, saturated vapor:	153 m/s (502 ft/s)	8401
viscosity, saturated liquid:	190 μ Pa·s (0.190 cp)	8401
viscosity, saturated vapor:	11.8 μ Pa·s (0.0118 cp)	8401
thermal conductivity, saturated liquid:	0.0812 W/m·K (0.0469 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01160 W/m·K (0.00670 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1764 kPa (255.8 psia)	8401
pressure, vapor (dew point):	1612 kPa (233.8 psia)	8401
heat of vaporization:	146.9 kJ/kg for liquid and vapor both at nominal composition (63.2 Btu/lb)	8401
	141.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (60.9 Btu/lb)	8401
· critical point -----		
temperature:	108.3 °C (226.9 °F)	8401
pressure:	4497 kPa (652.2 psia)	8401
density:	490 kg/m ³ (30.6 lb/cf)	8401
specific volume:	2.04 L/kg (0.0327 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.025 mass-weighted average (model-derived relative to R 11)	9501
	0.031 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1060 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.17 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	19,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	2A19
heat of combustion (by ASHRAE 34-92):	-3.7 MJ/kg (-1598 Btu/lb)	UL
flash point:	DuPont, TOC: will not burn	MSDS
autoignition temperature:	678 °C (1252 °F)	5931
former UL Classification:	practically nonflammable (withdrawn for revision of the classification system, category SBQT2)	5931
· detection -----		
appearance:	DuPont: clear, colorless	MSDS

odor: DuPont: slight ethereal MSDS

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized
last year production allowed: 2029 by refrigerants 22, 124 8C01
in developed countries under
the Montreal Protocol

R-22/152a/124 (52.0/15.0/33.0)

```

----- REFRIERANT DATA SUMMARY -----
unassigned   R-22/152a/124 (52.0/15.0/33.0)           see
zeotrope     ternary blend                               RDB#
-----

```

COMMON USE(S)

developmental formulation of an alternative for refrigerant 12, primarily for aftermarket use to service or retrofit existing, medium-temperature, commercial refrigeration equipment and home refrigerators; tested circa 1990-1995

IDENTIFIERS

```

common name(s):  R-22/152a/124 (52/15/33)
                  R22/152a/124 (52/15/33)
                  R 22/152a/124 (52/15/33)
                  candidate for R-401 series
                  HCFC-22/HFC-152a/HCFC-124
                  (52/15/33)
                  not HCFC-22/152a/124
historical name(s):  before 1995: DuPont Suva(R)      MSDS
                   MP39 (later reformulated)        MSDS
ARI container color / Pantone number:  none, use light green grey/413 6601

```

PHYSICAL

```

· nominal blend formulation -----
      composition:  R-22/152a/124
      component weight fractions:  52.0 / 15.0 / 33.0 %
      component mole fractions:    56.189 / 21.219 / 22.592 %      8820
· properties -----
      molar mass:    93.43352 g/mol (0.205986 lb/mol)      8820
· normal boiling point -----
      bubble point temperature:    -34.1 °C (-29.4 °F)      8814
      dew point temperature:       -28.7 °C (-19.6 °F)      8814
      maximum temperature glide:   5.45 °C (9.8 °F)      8814
      density, saturated liquid:   1356 kg/m3 (84.64 lb/cf)      8814
      density, saturated vapor:    4.84 kg/m3 (0.302 lb/cf)      8814
      specific volume, saturated liquid:  0.738 L/kg (0.0118 cf/lb)      8814
      specific volume, saturated vapor:  206.6 L/kg (3.3101 cf/lb)      8814
      heat of vaporization:        229.3 kJ/kg (98.6 Btu/lb)      8814
      velocity of sound, saturated liquid:  810 m/s (2656 ft/s)      8814
      velocity of sound, saturated vapor:  155 m/s (507 ft/s)      8814
      viscosity, saturated liquid:   351 µPa·s (0.351 cp)      8814
      viscosity, saturated vapor:    9.84 µPa·s (0.00984 cp)      8814
      thermal conductivity, liquid:  0.1048 W/m·K (0.0606 Btu/hr·ft°F)      8814
      thermal conductivity, vapor:   0.0080 W/m·K (0.0046 Btu/hr·ft°F)      8814
· normal pressure, 20 °C (68 °F) -----
      density, vapor:  3.961 kg/m3 (0.2472 lb/cf)      8814
· normal pressure, 21.1 °C (70 °F) ---
      density, vapor:  3.945 kg/m3 (0.2462 lb/cf)      8814
· 20 °C (68 °F) -----
      pressure, liquid (bubble point):  700.3 kPa (101.57 psia)      8814

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

pressure, vapor (dew point):	614.2 kPa (89.08 psia)	8814
density, saturated liquid:	1191 kg/m ³ (74.32 lb/cf)	8814
density, saturated vapor:	27.06 kg/m ³ (1.689 lb/cf)	8814
specific volume, saturated liquid:	0.840 L/kg (0.0135 cf/lb)	8814
specific volume, saturated vapor:	37.0 L/kg (0.5919 cf/lb)	8814
velocity of sound, saturated liquid:	564 m/s (1849 ft/s)	8814
velocity of sound, saturated vapor:	156 m/s (511 ft/s)	8814
viscosity, saturated liquid:	186 μ Pa·s (0.186 cp)	8814
viscosity, saturated vapor:	11.9 μ Pa·s (0.0119 cp)	8814
thermal conductivity, saturated liquid:	0.0824 W/m·K (0.0476 Btu/hr·ft ² ·°F)	8814
thermal conductivity, saturated vapor:	0.01146 W/m·K (0.00662 Btu/hr·ft ² ·°F)	8814
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1902 kPa (275.9 psia)	8814
pressure, vapor (dew point):	1760 kPa (255.3 psia)	8814
heat of vaporization:	147.2 kJ/kg for liquid and vapor both at nominal composition (63.3 Btu/lb)	8814
	142.5 kJ/kg coexisting liquid and vapor at bubble-point pressure (61.3 Btu/lb)	8814
· critical point -----		
temperature:	105.7 °C (222.3 °F)	8814
pressure:	4615 kPa (669.4 psia)	8814
density:	491 kg/m ³ (30.6 lb/cf)	8814
specific volume:	2.04 L/kg (0.0326 cf/lb)	8814
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.026 mass-weighted average (model-derived relative to R 11)	9501
	0.035 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1220 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.20 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
· flammability -----		
LFL-UFL (flammability limits in air):	Elf Atochem: nonflammable	MSDS
flash point:	Elf Atochem: will not burn	MSDS
autodecomposition temperature:	Elf Atochem: >427 °C (>800 °F)	MSDS
· detection -----		
appearance:	Elf Atochem: clear, colorless	MSDS
odor:	Elf Atochem: slight ethereal	MSDS
PRODUCTION		
first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	2029 by refrigerants 22, 124 in developed countries under the Montreal Protocol	8C01

R-22/152a/124 (60.0/13.0/27.0)

```

----- REFRIGERANT DATA SUMMARY -----
unassigned   R-22/152a/124 (60.0/13.0/27.0)           see
zeotrope     ternary blend                                     RDB#
-----

```

COMMON USE(S)

developmental formulation of an alternative to refrigerants 12 and 500, primarily for aftermarket use to service or retrofit existing, low-temperature equipment; tested circa 1990-1992

IDENTIFIERS

```

common name(s):  R-22/152a/124 (60/13/27)
                  R22/152a/124 (60/13/27)
                  R 22/152a/124 (60/13/27)
                  candidate for R-401 series
                  HCFC-22/HFC-152a/HCFC-124
                  (60/13/27)
                  not HCFC-22/152a/124
historical name(s):  before 1993: DuPont Suva(R)      MSDS
                    MP66 (later reformulated)       MSDS
ARI container color / Pantone number:  none, use light green grey/413 6601

```

PHYSICAL

```

· nominal blend formulation -----
  composition:      R-22/152a/124
  component weight fractions:  60.0 / 13.0 / 27.0 %
  component mole fractions:    63.745 / 18.081 / 18.174 %      8820
· properties -----
  molar mass:       91.86488 g/mol (0.202527 lb/mol)      8820
· normal boiling point -----
  bubble point temperature:    -35.4 °C (-31.8 °F)      8814
  dew point temperature:       -30.6 °C (-23.0 °F)      8814
  maximum temperature glide:   4.87 °C (8.8 °F)      8814
  density, saturated liquid:    1362 kg/m3 (85.00 lb/cf)      8814
  density, saturated vapor:     4.79 kg/m3 (0.299 lb/cf)      8814
  specific volume, saturated liquid:  0.734 L/kg (0.0118 cf/lb)      8814
  specific volume, saturated vapor:  208.6 L/kg (3.3421 cf/lb)      8814
  heat of vaporization:         231.0 kJ/kg (99.3 Btu/lb)      8814
  velocity of sound, saturated liquid:  817 m/s (2682 ft/s)      8814
  velocity of sound, saturated vapor:  156 m/s (511 ft/s)      8814
  viscosity, saturated liquid:    350 µPa·s (0.350 cp)      8814
  viscosity, saturated vapor:    9.84 µPa·s (0.00984 cp)      8814
  thermal conductivity, liquid:   0.1064 W/m·K (0.0615 Btu/hr·ft°F)      8814
  thermal conductivity, vapor:    0.0078 W/m·K (0.0045 Btu/hr·ft°F)      8814
· normal pressure, 20 °C (68 °F) -----
  density, vapor:               3.891 kg/m3 (0.2429 lb/cf)      8814
· normal pressure, 21.1 °C (70 °F) ----
  density, vapor:               3.876 kg/m3 (0.2419 lb/cf)      8814
· 20 °C (68 °F) -----
  pressure, liquid (bubble point):  736.4 kPa (106.81 psia)      8814
  pressure, vapor (dew point):     656.2 kPa (95.17 psia)      8814

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

density, saturated liquid:	1191 kg/m ³ (74.33 lb/cf)	8814
density, saturated vapor:	28.57 kg/m ³ (1.784 lb/cf)	8814
specific volume, saturated liquid:	0.840 L/kg (0.0135 cf/lb)	8814
specific volume, saturated vapor:	35.0 L/kg (0.5606 cf/lb)	8814
velocity of sound, saturated liquid:	564 m/s (1850 ft/s)	8814
velocity of sound, saturated vapor:	157 m/s (515 ft/s)	8814
viscosity, saturated liquid:	183 μPa·s (0.183 cp)	8814
viscosity, saturated vapor:	12.0 μPa·s (0.0120 cp)	8814
thermal conductivity, saturated liquid:	0.0831 W/m·K (0.0480 Btu/hr·ft·°F)	8814
thermal conductivity, saturated vapor:	0.01136 W/m·K (0.00656 Btu/hr·ft·°F)	8814
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1992 kPa (288.9 psia)	8814
pressure, vapor (dew point):	1862 kPa (270.0 psia)	8814
heat of vaporization:	146.6 kJ/kg for liquid and vapor both at nominal composition (63.0 Btu/lb)	8814
	142.5 kJ/kg coexisting liquid and vapor at bubble-point pressure (61.3 Btu/lb)	8814
· critical point -----		
temperature:	104.0 °C (219.2 °F)	8814
pressure:	4686 kPa (679.6 psia)	8814
density:	494 kg/m ³ (30.8 lb/cf)	8814
specific volume:	2.03 L/kg (0.0325 cf/lb)	8814
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.027 mass-weighted average (model-derived relative to R 11)	9501
	0.037 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1330 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.22 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
· flammability -----		
LFL-UFL (flammability limits in air):	DuPont: none (not flammable as tested)	MSDS
	flash point: DuPont, TOC: will not burn	MSDS
· detection -----		
appearance:	DuPont: clear, colorless	MSDS
odor:	DuPont: slight ethereal	MSDS
PRODUCTION		
first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	2029 by refrigerants 22, 124 in developed countries under the Montreal Protocol	8C01

R-22/227ea/600a/142b (41.0/40.0/4.0/15.0)

```

----- REFRIGERANT DATA SUMMARY -----
unassigned   R-22/227ea/600a/142b (41.0/40.0/4.0/15.0)      see
zeotrope     tetrary blend                                           RDB#
-----

```

COMMON USE (S)

alternative for refrigerants 12 and 134a for centrifugal chillers, primarily for aftermarket use to service or retrofit existing equipment

The following information is preliminary and may be incomplete or incorrect. Further data may be available from GHG Dev Labs (West Lafayette, IN, USA) or refrigerant manufacturers.

IDENTIFIERS

```

common name(s):  R-22/227ea/600a/142b
                  R22/227ea/600a/142b
                  R 22/227ea/600a/142b
                  (41/40/4/15)
                  HCFC/HFC/HC/HCFC-
                  22/227ea/600a/142b
                  (41/40/4/15)
                  not HCFC-22/227ea/600a/142b
                  (41/40/4/15)
trade name(s):  Autofrost-X5
                  GHG-X5

```

8354

PHYSICAL

```

· nominal blend formulation -----
      composition:  R-22/227ea/600a/142b
      component weight fractions:  41.0 / 40.0 / 4.0 / 15.0 %
      component mole fractions:    51.123/ 25.364/ 7.420/ 16.093  8820
                                   %
· properties -----
      molar mass:    107.81679 g/mol (0.237695  8820
                    lb/mol)
· normal boiling point -----
      bubble point temperature:  -32.4 °C (-26.3 °F)  8401
      dew point temperature:     -24.8 °C (-12.6 °F)  8401
      maximum temperature glide: 7.62 °C (13.7 °F)  8401
      density, saturated liquid: 1354 kg/m3 (84.53 lb/cf)  8401
      density, saturated vapor:   5.51 kg/m3 (0.344 lb/cf)  8401
      specific volume, saturated liquid: 0.738 L/kg (0.0118 cf/lb)  8401
      specific volume, saturated vapor: 181.6 L/kg (2.9093 cf/lb)  8401
      heat of vaporization:       203.7 kJ/kg (87.6 Btu/lb)  8401
      velocity of sound, saturated liquid: 737 m/s (2417 ft/s)  8401
      velocity of sound, saturated vapor: 142 m/s (467 ft/s)  8401
      thermal conductivity, liquid: 0.0927 W/m·K (0.0535  8401
                                   Btu/hr·ft°F)
      thermal conductivity, vapor: 0.0083 W/m·K (0.0048  8401
                                   Btu/hr·ft°F)
· normal pressure, 20 °C (68 °F) -----
      density, vapor: 4.579 kg/m3 (0.2859 lb/cf)  8401
· normal pressure, 21.1 °C (70 °F) ---

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

	density, vapor:	4.561 kg/m ³ (0.2847 lb/cf)	8401
• 20 °C (68 °F) -----			
	pressure, liquid (bubble point):	647.2 kPa (93.86 psia)	8401
	pressure, vapor (dew point):	537.9 kPa (78.02 psia)	8401
	density, saturated liquid:	1193 kg/m ³ (74.48 lb/cf)	8401
	density, saturated vapor:	27.19 kg/m ³ (1.697 lb/cf)	8401
	velocity of sound, saturated liquid:	513 m/s (1683 ft/s)	8401
	velocity of sound, saturated vapor:	143 m/s (469 ft/s)	8401
• 60 °C (140 °F) -----			
	pressure, liquid (bubble point):	1748 kPa (253.5 psia)	8401
	pressure, vapor (dew point):	1566 kPa (227.1 psia)	8401
	heat of vaporization:	127.7 kJ/kg for liquid and vapor both at nominal composition (54.9 Btu/lb)	8401
		109.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (47.1 Btu/lb)	8401
• critical point -----			
	temperature:	108.2 °C (226.8 °F)	8401
	pressure:	4366 kPa (633.2 psia)	8401
	density:	500 kg/m ³ (31.2 lb/cf)	8401
	specific volume:	2.00 L/kg (0.0320 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	0.020 mass-weighted average (model-derived relative to R 11)	9501
	0.030 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	2640 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.47 mass-weighted average relative to R 11 for infinite integration period	DW

SAFETY

• classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
	components are A1, ??, A3, A2	8601

PRODUCTION

first commercial use as a refrigerant:	circa 1997	mfr
last year production allowed:	2029 by refrigerants 22, 142b in developed countries under the Montreal Protocol	8C01

R-22/600a/142b (55.0/8.0/37.0)

```

----- REFRIGERANT DATA SUMMARY -----
unassigned   R-22/600a/142b (55.0/8.0/37.0)           see
zeotrope     ternary blend                                   RDB#
-----

```

COMMON USE(S)

this blend was a developmental version of what evolved into GHG Refrigerant 12 Substitute (R-406A), with a revised formulation, as a service fluid to replace refrigerant 12; further data may be available from GHG Dev Labs and refrigerant manufacturers

IDENTIFIERS

```

common name(s):  R-22/600a/142b (55/8/37)
                  R22/600a/142b (55/8/37)
                  R 22/600a/142b (55/8/37)
                  candidate for R-406 series
                  HCFC-22/HC-600a/HCFC-142b
                  HCFC/HC/HCFC-22/600a/142b
historical name(s): GHG-X3

```

PHYSICAL

```

· nominal blend formulation -----
                        composition:  R-22/600a/142b
component weight fractions: 55.0 / 8.0 / 37.0 %
component mole fractions:  55.703 / 12.054 / 32.243 %      8820
· properties -----
                        molar mass:  87.57396 g/mol (0.193068      8820
                        lb/mol)

```

ENVIRONMENTAL

```

ODP (ozone depletion potential): 0.035 mass-weighted average      9501
                                   (model-derived relative to R
                                   11)
                                   0.052 mass-weighted average      9501
                                   (semi-empirical relative to R
                                   11)
GWP (global warming potential):  1900 mass-weighted average      9501
                                   relative to CO2 for 100 yr
                                   integration
HGWP (halocarbon GWP):          0.32 mass-weighted average      DW
                                   relative to R 11 for infinite
                                   integration period

```

SAFETY

```

· classification -----
safety group (ASHRAE Standard 34): none (no application pending) 8601

```

PRODUCTION

```

first commercial use as a refrigerant: May 1992 (until March 1993) mfr
last year production allowed:         2029 by refrigerants 22, 142b 8C01
                                       in developed countries under
                                       the Montreal Protocol

```

R-22/600a/142b (65.0/4.0/31.0)

```

----- REFRI GERANT DATA SUMMARY -----
unassigned  R-22/600a/142b (65.0/4.0/31.0)          see
zeotrope    ternary blend                            RDB#
-----

```

COMMON USE(S)

alternative for refrigerant 12 primarily for aftermarket use to service or retrofit existing automobile air conditioners and other mobile air-conditioning (MAC) systems in hot and humid climates (not a drop in fluid, requires installation of a high-pressure cut-out switch and possibly a defrost timer); also for commercial refrigeration to increase capacity in low-temperature equipment with oversized motors

The following information is preliminary and may be incomplete or incorrect. Further data may be available from GHG Dev Labs (West Lafayette, IN, USA) or refrigerant manufacturers.

IDENTIFIERS

```

common name(s):  R-22/600a/142b (65/4/31)
                  R22/600a/142b (65/4/31)
                  R 22/600a/142b (65/4/31)
                  candidate for R-406_ series
                  HCFC/HC/HCFC-22/600a/142b
                  (65/4/31)
                  not HCFC-22/600a/142b (65/4/31)
trade name(s):   GHG High Performance
                  GHG-HP                                8354
historical name(s): GHG-HP Refrig. 12 Substitute
name used in U.S. EPA SNAP Rule: HCFC Blend Lambda

```

PHYSICAL

```

· nominal blend formulation -----
composition:      R-22/600a/142b
component weight fractions: 65.0 / 4.0 / 31.0 %
component mole fractions:  66.582 / 6.096 / 27.322 %      8820
· properties -----
molar mass:       88.57268 g/mol (0.195269 lb/mol)      8820
· normal boiling point -----
bubble point temperature: -35.0 °C (-30.9 °F)            8401
dew point temperature:   -26.7 °C (-16.1 °F)            8401
maximum temperature glide: 8.25 °C (14.8 °F)             8401
density, saturated liquid: 1274 kg/m3 (79.54 lb/cf)      8401
density, saturated vapor:  4.54 kg/m3 (0.284 lb/cf)      8401
specific volume, saturated liquid: 0.785 L/kg (0.0126 cf/lb) 8401
specific volume, saturated vapor: 220.1 L/kg (3.5257 cf/lb) 8401
heat of vaporization:    241.4 kJ/kg (103.8 Btu/lb)      8401
velocity of sound, saturated liquid: 841 m/s (2760 ft/s) 8401
velocity of sound, saturated vapor:  160 m/s (525 ft/s) 8401
viscosity, saturated liquid: 351 µPa·s (0.351 cp)        8401
viscosity, saturated vapor:  9.45 µPa·s (0.00945 cp)      8401
thermal conductivity, liquid: 0.1080 W/m·K (0.0624 Btu/hr·ft·°F) 8401

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

thermal conductivity, vapor:	0.0080 W/m·K (0.0046 Btu/hr·ft ² ·°F)	8401
· normal pressure, 20 °C (68 °F) -----		
density, vapor:	3.754 kg/m ³ (0.2343 lb/cf)	8401
· normal pressure, 21.1 °C (70 °F) ----		
density, vapor:	3.739 kg/m ³ (0.2334 lb/cf)	8401
· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	706.7 kPa (102.50 psia)	8401
pressure, vapor (dew point):	567.0 kPa (82.24 psia)	8401
density, saturated liquid:	1122 kg/m ³ (70.02 lb/cf)	8401
density, saturated vapor:	23.35 kg/m ³ (1.458 lb/cf)	8401
specific volume, saturated liquid:	0.892 L/kg (0.0143 cf/lb)	8401
specific volume, saturated vapor:	42.8 L/kg (0.6859 cf/lb)	8401
velocity of sound, saturated liquid:	592 m/s (1942 ft/s)	8401
velocity of sound, saturated vapor:	162 m/s (532 ft/s)	8401
viscosity, saturated liquid:	187 µPa·s (0.187 cp)	8401
viscosity, saturated vapor:	11.3 µPa·s (0.0113 cp)	8401
thermal conductivity, saturated liquid:	0.0841 W/m·K (0.0486 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01102 W/m·K (0.00637 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1886 kPa (273.5 psia)	8401
pressure, vapor (dew point):	1638 kPa (237.5 psia)	8401
heat of vaporization:	168.6 kJ/kg for liquid and vapor both at nominal composition (72.5 Btu/lb)	8401
	152.5 kJ/kg coexisting liquid and vapor at bubble-point pressure (65.6 Btu/lb)	8401
· critical point -----		
temperature:	112.2 °C (234.0 °F)	8401
pressure:	4950 kPa (717.9 psia)	8401
density:	467 kg/m ³ (29.1 lb/cf)	8401
specific volume:	2.14 L/kg (0.0343 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.035 mass-weighted average (model-derived relative to R 11)	9501
	0.053 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1950 mass-weighted average relative to CO ₂ for 100 yr integration	6695
HGWP (halocarbon GWP):	0.33 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending) components are A1, A3, and A2	8601
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	25,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		

LFL-UFL (flammability limits in air): worst fractionation flammable

PRODUCTION

first commercial use as a refrigerant:	1997	mfr
last year production allowed:	2029 by refrigerants 22, 142b	8C01
	in developed countries under	
	the Montreal Protocol	

R-23/22 (10.0/90.0, 15.0/85.0, and 20.0/80.0)

```

----- REFRIGERANT DATA SUMMARY -----
unassigned R-23/22 (10.0/90.0, 15.0/85.0, and 20.0/80.0)      see
zeotrope   binary blend                                         RDB#
-----

```

COMMON USE(S)

considered as an alternative for refrigerant 22, especially for heat pumps, in the early 1980s to improve performance

Data may be available from the Institut Français du Pétrole (IFP, Rueil Malmaison, France), Elf Atochem (Levallois-Perret, France), and other refrigerant manufacturers.

IDENTIFIERS

trade name(s): Elf Atochem Frimip
ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

· nominal blend formulation -----
composition: R-23/22
component weight fractions: 10.0/90.0, 15.0/85.0, and %
20.0/80.0 %

SAFETY

· classification -----
safety group (ASHRAE Standard 34): none (no application pending) 8601
components are both A1 8601

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized
last year production allowed: 2029 based on HCFC component 8C01
in developed countries under
the Montreal Protocol

R-23/22/152a (5.0/65.0/30.0)

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----- REFRIGERANT DATA SUMMARY -----
unassigned   R-23/22/152a (5.0/65.0/30.0)           see
zeotrope     ternary blend                                     RDB#
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COMMON USE(S)

under consideration as a replacement for refrigerant 12, primarily for aftermarket use to retrofit commercial and transport refrigeration systems

The following information is preliminary and may be incomplete or incorrect. Data on this blend may be available from Moncton Refrigerants Incorporated (Toronto, ON, Canada) and refrigerant manufacturers.

IDENTIFIERS

```

common name(s):  R-23/22/152a (5/65/30)           6742
                  R23/22/152a (5/65/30)
                  R 23/22/152a (5/65/30)
                  HFC-23/HCFC-22/HFC-152a       6742
                   (5/65/30)
                  not HCFC-23/22/152a
trade name(s):   Moncton Refrigerants NARM-12
name used in U.S. EPA SNAP Rule: HCFC Blend Kappa
ARI container color / Pantone number: none, use light green grey/413 6601

```

PHYSICAL

```

· nominal blend formulation -----
  composition:      R-23/22/152a
  component weight fractions: 5.0 / 65.0 / 30.0 %
  component mole fractions:  5.591 / 58.851 / 35.558 %      8820
· properties -----
  molar mass:       78.28782 g/mol (0.172595           8820
                    lb/mol)
· normal boiling point -----
  bubble point temperature: -44.8 °C (-48.7 °F)         8401
  dew point temperature:   -33.2 °C (-27.8 °F)         8401
  maximum temperature glide: 11.57 °C (20.8 °F)         8401
  density, saturated liquid: 1281 kg/m3 (79.97 lb/cf)    8401
  density, saturated vapor:  4.13 kg/m3 (0.258 lb/cf)    8401
  specific volume, saturated liquid: 0.781 L/kg (0.0125 cf/lb) 8401
  specific volume, saturated vapor: 242.3 L/kg (3.8806 cf/lb) 8401
  heat of vaporization:      276.2 kJ/kg (118.7 Btu/lb)  8401
  velocity of sound, saturated liquid: 898 m/s (2947 ft/s) 8401
  velocity of sound, saturated vapor: 170 m/s (557 ft/s) 8401
  viscosity, saturated liquid: 376 µPa·s (0.376 cp)     8401
  viscosity, saturated vapor:  9.52 µPa·s (0.00952 cp)   8401
  thermal conductivity, liquid: 0.1211 W/m·K (0.0699      8401
                    Btu/hr·ft°F)
  thermal conductivity, vapor: 0.0078 W/m·K (0.0045      8401
                    Btu/hr·ft°F)
· normal pressure, 20 °C (68 °F) -----
  density, vapor:           3.312 kg/m3 (0.2068 lb/cf)   8401
· normal pressure, 21.1 °C (70 °F) ---

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

Refrigerant Database

	density, vapor:	3.299 kg/m ³ (0.2059 lb/cf)	8401
· 20 °C (68 °F) -----			
	pressure, liquid (bubble point):	924.8 kPa (134.14 psia)	8401
	pressure, vapor (dew point):	727.1 kPa (105.45 psia)	8401
	density, saturated liquid:	1096 kg/m ³ (68.40 lb/cf)	8401
	density, saturated vapor:	27.15 kg/m ³ (1.695 lb/cf)	8401
	specific volume, saturated liquid:	0.913 L/kg (0.0146 cf/lb)	8401
	specific volume, saturated vapor:	36.8 L/kg (0.5900 cf/lb)	8401
	velocity of sound, saturated liquid:	589 m/s (1932 ft/s)	8401
	velocity of sound, saturated vapor:	171 m/s (562 ft/s)	8401
	viscosity, saturated liquid:	170 µPa·s (0.170 cp)	8401
	viscosity, saturated vapor:	11.8 µPa·s (0.0118 cp)	8401
	thermal conductivity, saturated liquid:	0.0908 W/m·K (0.0525 Btu/hr·ft ² ·°F)	8401
	thermal conductivity, saturated vapor:	0.01210 W/m·K (0.00699 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----			
	pressure, liquid (bubble point):	2353 kPa (341.2 psia)	8401
	pressure, vapor (dew point):	2054 kPa (297.9 psia)	8401
	heat of vaporization:	166.8 kJ/kg for liquid and vapor both at nominal composition (71.7 Btu/lb)	8401
		160.1 kJ/kg coexisting liquid and vapor at bubble-point pressure (68.8 Btu/lb)	8401
· critical point -----			
	temperature:	100.8 °C (213.4 °F)	8401
	pressure:	4951 kPa (718.1 psia)	8401
	density:	459 kg/m ³ (28.7 lb/cf)	8401
	specific volume:	2.18 L/kg (0.0349 cf/lb)	8401
ENVIRONMENTAL			
	ODP (ozone depletion potential):	0.022 mass-weighted average (model-derived relative to R 11)	9501
		0.033 mass-weighted average (semi-empirical relative to R 11)	9501
	GWP (global warming potential):	2030 mass-weighted average relative to CO ₂ for 100 yr integration	9501
	HGWP (halocarbon GWP):	0.63 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY			
· classification -----			
	safety group (ASHRAE Standard 34):	none (no application pending)	8601
		components are A1, A1, and A2	8601
PRODUCTION			
	first commercial use as a refrigerant:	not known to be commercialized	
	last year production allowed:	2029 by HCFC component in developed countries under the Montreal Protocol	8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

R-23/22/152a (5.0/80.0/15.0)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-23/22/152a (5.0/80.0/15.0) see
 zeotrope ternary blend RDB#

COMMON USE(S)

under consideration as a replacement for refrigerant 22

IDENTIFIERS

common name(s): HFC-23/HCFC-22/HFC-152a
 not HCFC-23/22/152a (5/80/15)
 alternative chemical names/formulae: R-23/22/152a (5/80/15)
 R23/22/152a (5/80/15)
 R 23/22/152a (5/80/15)
 trade name(s): Moncton Refrigerants NARM-22 MSDS
 ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

· nominal blend formulation -----
 composition: R-23/22/152a
 component weight fractions: 5.0 / 80.0 / 15.0 %
 component weight tolerances: ±2.0 / ±2.0 / +0.0, -1.0
 component mole fractions: 5.836 / 75.606 / 18.558 % 8820

· properties -----
 molar mass: 81.71861 g/mol (0.180159 lb/mol) 8820

· normal boiling point -----
 bubble point temperature: -47.0 °C (-52.7 °F) 8401
 dew point temperature: -36.7 °C (-34.1 °F) 8401
 -37.5 °C (-35.6 °F) mfr
 maximum temperature glide: 10.30 °C (18.5 °F) 8401
 density, saturated liquid: 1351 kg/m³ (84.31 lb/cf) 8401
 density, saturated vapor: 4.37 kg/m³ (0.273 lb/cf) 8401
 specific volume, saturated liquid: 0.740 L/kg (0.0119 cf/lb) 8401
 specific volume, saturated vapor: 229.0 L/kg (3.6674 cf/lb) 8401
 heat of vaporization: 259.2 kJ/kg (111.5 Btu/lb) 8401
 velocity of sound, saturated liquid: 887 m/s (2910 ft/s) 8401
 velocity of sound, saturated vapor: 166 m/s (543 ft/s) 8401
 viscosity, saturated liquid: 375 µPa·s (0.375 cp) 8401
 viscosity, saturated vapor: 9.71 µPa·s (0.00971 cp) 8401
 thermal conductivity, liquid: 0.1193 W/m·K (0.0689 Btu/hr·ft²·°F) 8401
 thermal conductivity, vapor: 0.0074 W/m·K (0.0043 Btu/hr·ft²·°F) 8401

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 3.453 kg/m³ (0.2156 lb/cf) 8401

· normal pressure, 21.1 °C (70 °F) ----
 density, vapor: 3.439 kg/m³ (0.2147 lb/cf) 8401

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 1010.2 kPa (146.52 psia) 8401
 pressure, vapor (dew point): 819.8 kPa (118.90 psia) 8401
 density, saturated liquid: 1145 kg/m³ (71.48 lb/cf) 8401
 density, saturated vapor: 32.28 kg/m³ (2.015 lb/cf) 8401
 specific volume, saturated liquid: 0.873 L/kg (0.0140 cf/lb) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

specific volume, saturated vapor:	31.0 L/kg (0.4962 cf/lb)	8401
velocity of sound, saturated liquid:	569 m/s (1867 ft/s)	8401
velocity of sound, saturated vapor:	167 m/s (548 ft/s)	8401
viscosity, saturated liquid:	169 $\mu\text{Pa}\cdot\text{s}$ (0.169 cp)	8401
viscosity, saturated vapor:	12.2 $\mu\text{Pa}\cdot\text{s}$ (0.0122 cp)	8401
thermal conductivity, saturated liquid:	0.0881 W/m \cdot K (0.0509 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01161 W/m \cdot K (0.00671 Btu/hr \cdot ft $^{\circ}$ F)	8401
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	2552 kPa (370.2 psia)	8401
pressure, vapor (dew point):	2271 kPa (329.4 psia)	8401
heat of vaporization:	151.8 kJ/kg for liquid and vapor both at nominal composition (65.3 Btu/lb)	8401
	140.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (60.5 Btu/lb)	8401
• critical point -----		
temperature:	97.2 $^{\circ}$ C (206.9 $^{\circ}$ F)	8401
pressure:	5036 kPa (730.4 psia)	8401
density:	488 kg/m ³ (30.5 lb/cf)	8401
specific volume:	2.05 L/kg (0.0328 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	0.027 mass-weighted average (model-derived relative to R 11)	9501
	0.040 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	2290 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.67 mass-weighted average relative to R 11 for infinite integration period	DW

SAFETY

• classification -----		
safety group (ASHRAE Standard 34):	none (no application pending) components are A1, A1, and A2	8601
• long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	Moncton AEL: 1,000 ppm v/v TWA 1tr for 8 hr/day and 40 hr/wk	
• emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	29,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
• flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested) worst fractionation flammable	MSDS 34
	flash point:	Univ Moncton: will not burn MSDS
• detection -----		
appearance:	University of Moncton: clear, colorless	MSDS MSDS
odor:	Univ Moncton: slight ethereal	MSDS

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized
last year production allowed: 2029 by refrigerant 22 in 8C01
developed countries under the
Montreal Protocol

R-23/22/152a (5.0/90.0/5.0)

----- REFRIGERANT DATA SUMMARY -----

unassigned	R-23/22/152a (5.0/90.0/5.0)	see
zeotrope	ternary blend	RDB#

COMMON USE(S)

under consideration as a replacement for refrigerant 502, primarily for aftermarket use to retrofit commercial and transport refrigeration systems

IDENTIFIERS

common name(s):	R-23/22/152a (5/90/5)	
	R23/22/152a (5/90/5)	
	R 23/22/152a (5/90/5)	
	HFC-23/HCFC-22/HFC-152a	
	(5/90/5)	
	not HCFC-23/22/152a (5/90/5)	
trade name(s):	Moncton Refrigerants NARM-502	MSDS
name used in U.S. EPA SNAP Rule:	HCFC Blend Iota	
ARI container color / Pantone number:	none, use light green grey/413	6601

PHYSICAL

· nominal blend formulation -----		
composition:	R-23/22/152a	
component weight fractions:	5.0 / 90.0 / 5.0 %	
component weight tolerances:	±2.0 / ±2.0 / ±1.0	
component mole fractions:	6.012 / 87.616 / 6.372 %	8820
· properties -----		
molar mass:	84.17789 g/mol (0.185580 lb/mol)	8820
· normal boiling point -----		
bubble point temperature:	-48.4 °C (-55.2 °F)	8401
dew point temperature:	-38.9 °C (-38.1 °F)	8401
	-40.3 °C (-40.6 °F)	
maximum temperature glide:	8.51 °C (15.3 °F)	8401
density, saturated liquid:	1401 kg/m3 (87.44 lb/cf)	8401
density, saturated vapor:	4.56 kg/m3 (0.285 lb/cf)	8401
specific volume, saturated liquid:	0.714 L/kg (0.0114 cf/lb)	8401
specific volume, saturated vapor:	219.3 L/kg (3.5135 cf/lb)	8401
heat of vaporization:	247.2 kJ/kg (106.3 Btu/lb)	8401
velocity of sound, saturated liquid:	878 m/s (2880 ft/s)	8401
velocity of sound, saturated vapor:	163 m/s (533 ft/s)	8401
viscosity, saturated liquid:	373 µPa·s (0.373 cp)	8401
viscosity, saturated vapor:	9.77 µPa·s (0.00977 cp)	8401
thermal conductivity, liquid:	0.1178 W/m·K (0.0681 Btu/hr·ft°F)	8401
thermal conductivity, vapor:	0.0072 W/m·K (0.0042 Btu/hr·ft°F)	8401
· normal pressure, 20 °C (68 °F) -----		
density, vapor:	3.554 kg/m3 (0.2219 lb/cf)	8401
· normal pressure, 21.1 °C (70 °F) ---		
density, vapor:	3.540 kg/m3 (0.2210 lb/cf)	8401
· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	1073.4 kPa (155.68 psia)	8401

pressure, vapor (dew point):	907.6 kPa (131.64 psia)	8401
density, saturated liquid:	1180 kg/m ³ (73.65 lb/cf)	8401
density, saturated vapor:	37.22 kg/m ³ (2.324 lb/cf)	8401
specific volume, saturated liquid:	0.848 L/kg (0.0136 cf/lb)	8401
specific volume, saturated vapor:	26.9 L/kg (0.4304 cf/lb)	8401
velocity of sound, saturated liquid:	554 m/s (1818 ft/s)	8401
velocity of sound, saturated vapor:	164 m/s (537 ft/s)	8401
viscosity, saturated liquid:	169 μ Pa·s (0.169 cp)	8401
viscosity, saturated vapor:	12.4 μ Pa·s (0.0124 cp)	8401
thermal conductivity, saturated liquid:	0.0860 W/m·K (0.0497 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01132 W/m·K (0.00654 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	2704 kPa (392.2 psia)	8401
pressure, vapor (dew point):	2465 kPa (357.5 psia)	8401
heat of vaporization:	140.8 kJ/kg for liquid and vapor both at nominal composition (60.5 Btu/lb)	8401
	130.5 kJ/kg coexisting liquid and vapor at bubble-point pressure (56.1 Btu/lb)	8401
· critical point -----		
temperature:	94.4 °C (201.8 °F)	8401
pressure:	5095 kPa (739.0 psia)	8401
density:	511 kg/m ³ (31.9 lb/cf)	8401
specific volume:	1.96 L/kg (0.0314 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.031 mass-weighted average (model-derived relative to R 11)	9501
	0.045 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	2460 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.70 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending) components are A1, A1, and A2	8601
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	Moncton AEL: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	ltr
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	27,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	MSDS
flash point:	Moncton: will not burn	MSDS
· detection -----		
appearance:	Moncton: clear, colorless	MSDS
odor:	Moncton: slight ethereal odor	MSDS

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

Refrigerant Database

PRODUCTION

first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	2029 by refrigerant 22 in	8C01
	developed countries under the	
	Montreal Protocol	

R-23/32/134a (4.5/21.5/74.0)

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----- REFRIGERANT DATA SUMMARY -----
unassigned   R-23/32/134a (4.5/21.5/74.0)           see
zeotrope     ternary blend                                   RDB#
-----

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COMMON USE(S)

considered (circa 1993-1995) as an alternative for refrigerant 22

IDENTIFIERS

```

common name(s):  R-23/32/134a (4.5/21.5/74.0)
                  R23/32/134a (4.5/21.5/74.0)
                  R 23/32/134a (4.5/21.5/74.0)
                  HFC-23/HFC-32/HFC-134a
                  (4.5/21.5/74.0)
                  not HFC-23/32/134a
                  (4.5/21.5/74.0)
historical name(s): Elf Atochem Forane(R) FX-220   3A28

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PHYSICAL

```

· nominal blend formulation -----
      composition:  R-23/32/134a
component weight fractions:  4.5 / 21.5 / 74.0 %
component mole fractions:   5.344 / 34.359 / 60.298 %   8820
· properties -----
      molar mass:   83.13801 g/mol (0.183288           8820
                    lb/mol)
· normal boiling point -----
      bubble point temperature:  -42.2 °C (-44.0 °F)   3A28
      dew point temperature:    -33.4 °C (-28.1 °F)   3A28
      density, saturated vapor:  4.10 kg/m3 (0.256 lb/cf) 3A28
      heat of vaporization:     292.0 kJ/kg (125.5 Btu/lb) 3A28
· 25 °C (77 °F) -----
      pressure, saturated vapor: 1150.0 kPa (166.79 psia) 3A28
      density, saturated liquid: 1130 kg/m3 (70.54 lb/cf) 3A28
· critical point -----
      temperature:  89.0 °C (192.2 °F)           3A28
      pressure:    4900 kPa (710.7 psia)         3A28

```

ENVIRONMENTAL

```

ODP (ozone depletion potential): <0.00003 mass-weighted average 9501
                                  (model-derived relative to R
                                  11)
                                  <0.00039 mass-weighted average 9501
                                  (semi-empirical relative to R
                                  11)
GWP (global warming potential):  2040 mass-weighted average 9501
                                  relative to CO2 for 100 yr
                                  integration
HGWP (halocarbon GWP):          0.61 mass-weighted average DW
                                  relative to R 11 for infinite
                                  integration period

```

SAFETY

```

· classification -----

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

safety group (ASHRAE Standard 34): none (no application pending) 8601
 components are A1, A2, and A1 8601

• emergency exposure limit -----
 Refrigerant Concentration Limit (RCL): 69,000 ppm v/v (preliminary
 value under review, based on
 draft ASHRAE 34aa)

• flammability -----
 LFL-UFL (flammability limits in air): none (nonflammable as tested) 3A28

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized
 last year production allowed: unrestricted 8C01

R-23/125/143a (20.0/36.0/44.0)

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----- REFRIERANT DATA SUMMARY -----
unassigned   R-23/125/143a (20.0/36.0/44.0)           see
zeotrope     ternary blend                                   RDB#
-----

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COMMON USE(S)

very low temperature applications, including industrial refrigeration, primarily for aftermarket use to retrofit existing systems as an alternative for refrigerant 13B1

Note: Conversion from refrigerant 13B1 to this refrigerant may require changing to a polyolester lubricant.

IDENTIFIERS

```

common name(s):  R-23/125/143a (20.0/36.0/44.0)
                  R23/125/143a (20.0/36.0/44.0)
                  R 23/125/143a (20.0/36.0/44.0)
                  HFC-23/HFC-125/HFC-143a
                  (20/36/44)
                  not HFC-23/125/143a (20/36/44)
trade name(s):  Dehon Service Mixiflon ES20      mfr

```

PHYSICAL

```

· nominal blend formulation -----
      composition:  R-23/125/143a
      component weight fractions:  20.0 / 36.0 / 44.0 %
      component weight tolerances:  ±1.0 / ±1.0 / ±1.0      mfr
      component mole fractions:    25.754 / 27.043 / 47.203 %  8820
· properties -----
      molar mass:    90.15816 g/mol (0.198765      8820
                  lb/mol)
· normal boiling point -----
      bubble point temperature:  -63.0 °C (-81.4 °F)      MSDS
                               -64.8 °C (-84.6 °F)      8401
      dew point temperature:    -52.3 °C (-62.1 °F)      8401
      maximum temperature glide: 12.50 °C (22.5 °F)      8401
      density, saturated liquid: 1354 kg/m3 (84.52 lb/cf)  8401
      density, saturated vapor:  5.19 kg/m3 (0.324 lb/cf)  8401
      specific volume, saturated liquid: 0.739 L/kg (0.0118 cf/lb) 8401
      specific volume, saturated vapor: 192.8 L/kg (3.0876 cf/lb) 8401
      heat of vaporization:      219.5 kJ/kg (94.4 Btu/lb) 8401
      velocity of sound, saturated liquid: 796 m/s (2611 ft/s) 8401
      velocity of sound, saturated vapor: 149 m/s (488 ft/s) 8401
      viscosity, saturated liquid: 377 µPa·s (0.377 cp) 8401
      viscosity, saturated vapor:  9.17 µPa·s (0.00917 cp) 8401
      thermal conductivity, liquid: 0.1083 W/m·K (0.0626      8401
                  Btu/hr·ft°F)
      thermal conductivity, vapor: 0.0083 W/m·K (0.0048      8401
                  Btu/hr·ft°F)
· normal pressure, 20 °C (68 °F) -----
      density, vapor: 3.803 kg/m3 (0.2374 lb/cf) 8401
· normal pressure, 21.1 °C (70 °F) ---
      density, vapor: 3.788 kg/m3 (0.2365 lb/cf) 8401
· 20 °C (68 °F) -----

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

pressure, liquid (bubble point): 1785.0 kPa (258.89 psia) MSDS
 1818.7 kPa (263.78 psia) 8401
 pressure, vapor (dew point): 1440.4 kPa (208.91 psia) 8401
 density, saturated liquid: 1025 kg/m3 (64.01 lb/cf) 8401
 density, saturated vapor: 71.12 kg/m3 (4.440 lb/cf) 8401
 specific volume, saturated liquid: 0.975 L/kg (0.0156 cf/lb) 8401
 specific volume, saturated vapor: 14.1 L/kg (0.2252 cf/lb) 8401
 velocity of sound, saturated liquid: 358 m/s (1174 ft/s) 8401
 velocity of sound, saturated vapor: 140 m/s (460 ft/s) 8401
 viscosity, saturated liquid: 116 µPa·s (0.116 cp) 8401
 viscosity, saturated vapor: 12.8 µPa·s (0.0128 cp) 8401
 thermal conductivity, saturatd liquid: 0.6708 W/m·K (0.3876 Btu/hr·ft°F) 8401
 thermal conductivity, saturated vapor: 0.01564 W/m·K (0.00903 Btu/hr·ft°F) 8401
 · critical point -----
 temperature: 59.2 °C (138.6 °F) 8401
 67.3 °C (153.1 °F) MSDS
 pressure: 4025 kPa (583.8 psia) 8401
 density: 493 kg/m3 (30.8 lb/cf) 8401
 specific volume: 2.03 L/kg (0.0325 cf/lb) 8401

ENVIRONMENTAL

ODP (ozone depletion potential): <0.00009 mass-weighted average 9501
 (model-derived relative to R 11)
 GWP (global warming potential): 6700 mass-weighted average 9501
 relative to CO2 for 100 yr integration
 HGWP (halocarbon GWP): 2.3 mass-weighted average DW
 relative to R 11 for infinite integration period

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 components are A1, A1, and A2 8601
 · flammability -----
 flash point: Dehon: not applicable MSDS
 · detection -----
 appearance: Dehon: colorless MSDS
 odor: Dehon: faint MSDS

PRODUCTION

first commercial use as a refrigerant: 1994
 last year production allowed: unrestricted 8C01

R-32/125 (32.0/68.0)

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----- REFRIERANT DATA SUMMARY -----
unassigned R-32/125 (32.0/68.0) see
zeotrope binary blend RDB#
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COMMON USE(S)

replacement for refrigerant 13B1 for very low temperature
refrigeration

IDENTIFIERS

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common name(s): R-32/125 (32/68)
                R32/125 (32/68)
                R 32/125 (32/68)
                candidate for R-410 series
                HFC-32/HFC-125 (32/68)
                not HFC-32/125 (32/68)
trade name(s): Elf Atochem Forane(R) FX-80 MSDS
ARI container color / Pantone number: none, use light green grey/413 6601

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PHYSICAL

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· nominal blend formulation -----
      composition: R-32/125
      component weight fractions: 32.0 / 68.0 %
      component mole fractions: 52.054 / 47.946 % 8820
· properties -----
      molar mass: 84.62572 g/mol (0.186568 lb/mol) 8820
· normal boiling point -----
      bubble point temperature: -51.1 °C (-60.0 °F) 8814
      dew point temperature: -50.9 °C (-59.7 °F) 8814
      maximum temperature glide: 0.17 °C (0.3 °F) 8814
      density, saturated liquid: 1408 kg/m3 (87.91 lb/cf) 8814
      density, saturated vapor: 4.85 kg/m3 (0.303 lb/cf) 8814
      specific volume, saturated liquid: 0.710 L/kg (0.0114 cf/lb) 8814
      specific volume, saturated vapor: 206.1 L/kg (3.3008 cf/lb) 8814
      heat of vaporization: 232.6 kJ/kg (100.0 Btu/lb) 8814
      velocity of sound, saturated liquid: 787 m/s (2581 ft/s) 8814
      velocity of sound, saturated vapor: 155 m/s (509 ft/s) 8814
      viscosity, saturated liquid: 342 µPa·s (0.342 cp) 8814
      viscosity, saturated vapor: 9.88 µPa·s (0.00988 cp) 8814
      thermal conductivity, liquid: 0.1272 W/m·K (0.0735 Btu/hr·ft°F) 8814
      thermal conductivity, vapor: 0.0082 W/m·K (0.0047 Btu/hr·ft°F) 8814
· normal pressure, 20 °C (68 °F) -----
      density, vapor: 3.570 kg/m3 (0.2229 lb/cf) 8814
· normal pressure, 21.1 °C (70 °F) ---
      density, vapor: 3.556 kg/m3 (0.2220 lb/cf) 8814
· 20 °C (68 °F) -----
      pressure, liquid (bubble point): 1401.8 kPa (203.31 psia) 8814
      pressure, vapor (dew point): 1391.3 kPa (201.79 psia) 8814
      density, saturated liquid: 1129 kg/m3 (70.49 lb/cf) 8814
      density, saturated vapor: 64.03 kg/m3 (3.997 lb/cf) 8814
      specific volume, saturated liquid: 0.886 L/kg (0.0142 cf/lb) 8814

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

specific volume, saturated vapor:	15.6 L/kg (0.2502 cf/lb)	8814
velocity of sound, saturated liquid:	429 m/s (1407 ft/s)	8814
velocity of sound, saturated vapor:	148 m/s (486 ft/s)	8814
viscosity, saturated liquid:	134 $\mu\text{Pa}\cdot\text{s}$ (0.134 cp)	8814
viscosity, saturated vapor:	13.5 $\mu\text{Pa}\cdot\text{s}$ (0.0135 cp)	8814
thermal conductivity, saturated liquid:	0.0866 W/m \cdot K (0.0501 Btu/hr \cdot ft $^{\circ}$ F)	8814
thermal conductivity, saturated vapor:	0.01422 W/m \cdot K (0.00822 Btu/hr \cdot ft $^{\circ}$ F)	8814
· 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	3716 kPa (539.0 psia)	8814
pressure, vapor (dew point):	3701 kPa (536.8 psia)	8814
heat of vaporization:	84.0 kJ/kg for liquid and vapor both at nominal composition (36.1 Btu/lb)	8814
	83.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (35.8 Btu/lb)	8814
· critical point -----		
temperature:	67.7 $^{\circ}$ C (153.8 $^{\circ}$ F)	8814
pressure:	4397 kPa (637.7 psia)	8814
density:	581 kg/m ³ (36.3 lb/cf)	8814
specific volume:	1.72 L/kg (0.0276 cf/lb)	8814
ENVIRONMENTAL		
ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
GWP (global warming potential):	2870 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.49 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending) components are A2 and A1	8601 8601
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	69,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· detection -----		
appearance:	Elf Atochem: colorless	CSDS
odor:	Elf Atochem: ether-like (slightly)	CSDS CSDS
PRODUCTION		
first commercial use as a refrigerant:	1997	
last year production allowed:	unrestricted	8C01

R-32/125 (48.0/52.0)

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----- REFRIGERANT DATA SUMMARY -----
unassigned   R-32/125 (48.0/52.0)                see
zeotrope     binary blend                          RDB#
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COMMON USE(S)

under consideration as an alternative for refrigerant 22 in new air conditioners and heat pumps designed for higher discharge pressures

IDENTIFIERS

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common name(s):  R-32/125 (48/52)
                  R32/125 (48/52)
                  R 32/125 (48/52)
                  candidate for R-410 series
                  HFC-32/HFC-125 (48/52)
                  not HFC-32/125 (48/52)
trade name(s):   Asahi Glass Asahiklin 32/125
ARI container color / Pantone number: none, use light green grey/413 6601

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PHYSICAL

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· nominal blend formulation -----
      composition:  R-32/125
component weight fractions:  48.0 / 52.0 %
component mole fractions:    68.047 / 31.953 %      8820
· properties -----
      molar mass:   73.75076 g/mol (0.162593 lb/mol)      8820
· normal boiling point -----
      bubble point temperature:  -51.6 °C (-60.8 °F)      8401
      dew point temperature:     -51.5 °C (-60.7 °F)      8401
      maximum temperature glide:  0.06 °C (0.1 °F)          8401
      density, saturated liquid:  1357 kg/m3 (84.73 lb/cf)   8401
      density, saturated vapor:   4.24 kg/m3 (0.265 lb/cf)   8401
      specific volume, saturated liquid:  0.737 L/kg (0.0118 cf/lb) 8401
      specific volume, saturated vapor:  235.8 L/kg (3.7776 cf/lb) 8401
      heat of vaporization:        267.2 kJ/kg (114.9 Btu/lb) 8401
      velocity of sound, saturated liquid:  840 m/s (2757 ft/s)   8401
      velocity of sound, saturated vapor:  168 m/s (551 ft/s)   8401
      viscosity, saturated liquid:  317 µPa·s (0.317 cp)      8401
      viscosity, saturated vapor:   9.80 µPa·s (0.00980 cp)   8401
      thermal conductivity, liquid:  0.1435 W/m·K (0.0829 Btu/hr·ft°F) 8401
      thermal conductivity, vapor:   0.0081 W/m·K (0.0047 Btu/hr·ft°F) 8401
· normal pressure, 20 °C (68 °F) -----
      density, vapor:  3.110 kg/m3 (0.1942 lb/cf)      8401
· normal pressure, 21.1 °C (70 °F) ---
      density, vapor:  3.098 kg/m3 (0.1934 lb/cf)      8401
· 20 °C (68 °F) -----
      pressure, liquid (bubble point):  1439.4 kPa (208.77 psia) 8401
      pressure, vapor (dew point):     1434.5 kPa (208.06 psia) 8401
      density, saturated liquid:       1090 kg/m3 (68.03 lb/cf) 8401
      density, saturated vapor:        57.31 kg/m3 (3.577 lb/cf) 8401
      specific volume, saturated liquid:  0.918 L/kg (0.0147 cf/lb) 8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

specific volume, saturated vapor:	17.5 L/kg (0.2795 cf/lb)	8401
velocity of sound, saturated liquid:	467 m/s (1531 ft/s)	8401
velocity of sound, saturated vapor:	162 m/s (532 ft/s)	8401
viscosity, saturated liquid:	130 $\mu\text{Pa}\cdot\text{s}$ (0.130 cp)	8401
viscosity, saturated vapor:	13.6 $\mu\text{Pa}\cdot\text{s}$ (0.0136 cp)	8401
thermal conductivity, saturated liquid:	0.0997 W/m \cdot K (0.0576 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01443 W/m \cdot K (0.00834 Btu/hr \cdot ft $^{\circ}$ F)	8401
· 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	3823 kPa (554.5 psia)	8401
pressure, vapor (dew point):	3815 kPa (553.3 psia)	8401
heat of vaporization:	104.7 kJ/kg for liquid and vapor both at nominal composition (45.0 Btu/lb)	8401
	102.1 kJ/kg coexisting liquid and vapor at bubble-point pressure (43.9 Btu/lb)	8401
· critical point -----		
temperature:	69.9 $^{\circ}$ C (157.8 $^{\circ}$ F)	8401
pressure:	4728 kPa (685.7 psia)	8401
density:	556 kg/m ³ (34.7 lb/cf)	8401
specific volume:	1.80 L/kg (0.0288 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
GWP (global warming potential):	2400 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.40 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending) components are A2 and A1	8601 8601
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	56,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	
PRODUCTION		
last year production allowed:	unrestricted	8C01

R-32/125 (60.0/40.0)

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----- REFRI GERANT DATA SUMMARY -----
unassigned R-32/125 (60.0/40.0) see
azeotrope binary blend RDB#
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COMMON USE(S)

examined in early 1990s as a potential replacement for refrigerant 22, especially for residential air conditioners; this blend was a developmental version of AlliedSignal Genetron(R) AZ-20 (subsequently reformulated) and may be covered by U.S. patent 4,978,467; considered as a fire suppressant in aviation systems

IDENTIFIERS

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common name(s): R-32/125 (60/40)
                R32/125 (60/40)
                R 32/125 (60/40)
                candidate for R-410 series
                HFC-32/HFC-125 (60/40)
                not HFC-32/125 (60/40)

ARI container color / Pantone number: none, use light green grey/413 6601

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PHYSICAL

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· nominal blend formulation -----
      composition: R-32/125
      component weight fractions: 60.0 / 40.0 %
      component mole fractions: 77.581 / 22.419 %      8820
· properties -----
      molar mass: 67.26752 g/mol (0.148299 lb/mol)      8820
· normal boiling point -----
      bubble point temperature: -51.7 °C (-61.1 °F)      8401
      dew point temperature: -51.7 °C (-61.1 °F)      8401
      maximum temperature glide: 0.01 °C (0.0 °F)      8401
      density, saturated liquid: 1321 kg/m3 (82.45 lb/cf)      8401
      density, saturated vapor: 3.87 kg/m3 (0.242 lb/cf)      8401
      specific volume, saturated liquid: 0.757 L/kg (0.0121 cf/lb)      8401
      specific volume, saturated vapor: 258.4 L/kg (4.1390 cf/lb)      8401
      heat of vaporization: 293.3 kJ/kg (126.1 Btu/lb)      8401
      velocity of sound, saturated liquid: 869 m/s (2853 ft/s)      8401
      velocity of sound, saturated vapor: 866 m/s (2840 ft/s)      8401
      viscosity, saturated liquid: 302 µPa·s (0.302 cp)      8401
      viscosity, saturated vapor: 9.74 µPa·s (0.00974 cp)      8401
      thermal conductivity, liquid: 0.1550 W/m·K (0.0895 Btu/hr·ft°F)      8401
      thermal conductivity, vapor: 0.0081 W/m·K (0.0047 Btu/hr·ft°F)      8401
· normal pressure, 20 °C (68 °F) -----
      density, vapor: 2.836 kg/m3 (0.1770 lb/cf)      8401
· normal pressure, 21.1 °C (70 °F) ---
      density, vapor: 2.825 kg/m3 (0.1763 lb/cf)      8401
· 20 °C (68 °F) -----
      pressure, liquid (bubble point): 1455.8 kPa (211.15 psia)      8401
      pressure, vapor (dew point): 1453.6 kPa (210.83 psia)      8401
      density, saturated liquid: 1062 kg/m3 (66.30 lb/cf)      8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

density, saturated vapor:	52.83 kg/m ³ (3.298 lb/cf)	8401
specific volume, saturated liquid:	0.942 L/kg (0.0151 cf/lb)	8401
specific volume, saturated vapor:	18.9 L/kg (0.3032 cf/lb)	8401
velocity of sound, saturated liquid:	494 m/s (1620 ft/s)	8401
velocity of sound, saturated vapor:	172 m/s (566 ft/s)	8401
viscosity, saturated liquid:	127 μ Pa·s (0.127 cp)	8401
viscosity, saturated vapor:	13.5 μ Pa·s (0.0135 cp)	8401
thermal conductivity, saturated liquid:	0.1093 W/m·K (0.0631 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01450 W/m·K (0.00838 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	3872 kPa (561.5 psia)	8401
pressure, vapor (dew point):	3868 kPa (561.0 psia)	8401
heat of vaporization:	120.0 kJ/kg for liquid and vapor both at nominal composition (51.6 Btu/lb)	8401
	118.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (50.8 Btu/lb)	8401
· critical point -----		
temperature:	71.6 °C (160.9 °F)	8401
	73.2 °C (163.8 °F)	3219
pressure:	4974 kPa (721.4 psia)	8401
	5055 kPa (733.2 psia)	3219
density:	479 kg/m ³ (29.9 lb/cf)	3219
	532 kg/m ³ (33.2 lb/cf)	8401
specific volume:	1.88 L/kg (0.0301 cf/lb)	8401
	2.09 L/kg (0.0334 cf/lb)	3219
ENVIRONMENTAL		
ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
GWP (global warming potential):	2050 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.34 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
	components are A2 and A1	8601
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	3219
PRODUCTION		
first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	unrestricted	8C01

R-32/125 (75.0/25.0)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-32/125 (75.0/25.0) see
 azeotrope binary blend RDB#

COMMON USE(S)

under consideration circa 1999 as a potential replacement for
 refrigerant 22, especially for residential air conditioners; this
 blend may be covered by U.S. patent 4,978,467

IDENTIFIERS

common name(s): R-32/125 (75.0/25.0)
 R32/125 (75.0/25.0)
 R 32/125 (75.0/25.0)
 candidate for R-410 series
 HFC-32/HFC-125 (75.0/25.0)
 not HFC-32/125 (75.0/25.0)
 ARI container color / Pantone number: none, use light green grey/413 6601
 with red / 185 band

PHYSICAL

· nominal blend formulation -----
 composition: R-32/125
 component weight fractions: 75.0 / 25.0 %
 component mole fractions: 87.376 / 12.624 % 8820
 · properties -----
 molar mass: 60.60769 g/mol (0.133617 lb/mol) 8820
 · normal boiling point -----
 bubble point temperature: -51.8 °C (-61.2 °F) 8401
 dew point temperature: -51.8 °C (-61.2 °F) 8401
 maximum temperature glide: 0.00 °C (0.0 °F) 8401
 density, saturated liquid: 1278 kg/m3 (79.78 lb/cf) 8401
 density, saturated vapor: 3.49 kg/m3 (0.218 lb/cf) 8401
 specific volume, saturated liquid: 0.783 L/kg (0.0125 cf/lb) 8401
 specific volume, saturated vapor: 286.8 L/kg (4.5944 cf/lb) 8401
 heat of vaporization: 326.2 kJ/kg (140.2 Btu/lb) 8401
 velocity of sound, saturated liquid: 907 m/s (2976 ft/s) 8401
 velocity of sound, saturated vapor: 189 m/s (619 ft/s) 8401
 viscosity, saturated liquid: 289 µPa·s (0.289 cp) 8401
 viscosity, saturated vapor: 9.61 µPa·s (0.00961 cp) 8401
 thermal conductivity, liquid: 0.1686 W/m·K (0.0974 Btu/hr·ft°F) 8401
 thermal conductivity, vapor: 0.0082 W/m·K (0.0047 Btu/hr·ft°F) 8401
 · normal pressure, 20 °C (68 °F) -----
 density, vapor: 2.554 kg/m3 (0.1595 lb/cf) 8401
 · normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 2.544 kg/m3 (0.1588 lb/cf) 8401
 · 20 °C (68 °F) -----
 pressure, liquid (bubble point): 1467.7 kPa (212.87 psia) 8401
 pressure, vapor (dew point): 1029.9 kPa (149.37 psia) 8401
 density, saturated liquid: 1030 kg/m3 (64.29 lb/cf) 8401
 density, saturated vapor: 47.82 kg/m3 (2.985 lb/cf) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

specific volume, saturated liquid:	0.971 L/kg (0.0156 cf/lb)	8401
specific volume, saturated vapor:	20.9 L/kg (0.3350 cf/lb)	8401
velocity of sound, saturated liquid:	528 m/s (1732 ft/s)	8401
velocity of sound, saturated vapor:	185 m/s (607 ft/s)	8401
viscosity, saturated liquid:	125 $\mu\text{Pa}\cdot\text{s}$ (0.125 cp)	8401
viscosity, saturated vapor:	13.3 $\mu\text{Pa}\cdot\text{s}$ (0.0133 cp)	8401
thermal conductivity, saturated liquid:	0.1209 W/m \cdot K (0.0698 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01455 W/m \cdot K (0.00841 Btu/hr \cdot ft $^{\circ}$ F)	8401
· 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	3908 kPa (566.8 psia)	8401
pressure, vapor (dew point):	3907 kPa (566.7 psia)	8401
heat of vaporization:	140.0 kJ/kg for liquid and vapor both at nominal composition (60.2 Btu/lb)	8401
	139.9 kJ/kg coexisting liquid and vapor at bubble-point pressure (60.1 Btu/lb)	8401
· critical point -----		
temperature:	74.0 $^{\circ}$ C (165.1 $^{\circ}$ F)	8401
pressure:	5274 kPa (764.9 psia)	8401
density:	499 kg/m ³ (31.2 lb/cf)	8401
specific volume:	2.00 L/kg (0.0321 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	<0.00001 mass-weighted average (model-derived relative to R 11)	9501
GWP (global warming potential):	660 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.27 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending) components are A2 and A1	8601 8601
· flammability -----		
LFL-UFL (flammability limits in air):	probably flammable	
PRODUCTION		
first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	unrestricted	8C01

R-32/125/134a (30.0/10.0/60.0)

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----- REFRIGERANT DATA SUMMARY -----
unassigned   R-32/125/134a (30.0/10.0/60.0)           see
zeotrope     ternary blend                               RDB#
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COMMON USE(S)

under consideration as an alternative for refrigerant 22 both in new equipment and as a service fluid; developmental formulation for both DuPont Suva(R) AC9000 and ICI Klea(R) 66 (subsequently reformulated)

IDENTIFIERS

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common name(s):  R-32/125/134a (30/10/60)
                  R32/125/134a (30/10/60)
                  R 32/125/134a (30/10/60)
                  candidate for R-407 series
                  HFC-32/HFC-125/HFC-134a
                  (30/10/60)
                  not HFC-32/125/134a (30/10/60) 2909
historical name(s): before 1996:
                    DuPont Suva(R) AC9000
                    ICI Klea(R) 66                3A83
ARI container color / Pantone number: none, use light green grey/413 6601

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PHYSICAL

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· nominal blend formulation -----
  composition:      R-32/125/134a
  component weight fractions: 30.0 / 10.0 / 60.0 %
  component mole fractions:  46.206 / 6.676 / 47.118 %      8820
· properties -----
  molar mass:      80.125676 g/mol (0.176647 lb/mol)      8820
· normal boiling point -----
  bubble point temperature: -43.4 °C (-46.1 °F)           8401
  dew point temperature:   -36.1 °C (-33.1 °F)           8401
  maximum temperature glide: 7.26 °C (13.1 °F)           8401
  density, saturated liquid: 1352 kg/m3 (84.42 lb/cf)      8401
  density, saturated vapor:  4.29 kg/m3 (0.268 lb/cf)      8401
  specific volume, saturated liquid: 0.739 L/kg (0.0118 cf/lb) 8401
  specific volume, saturated vapor: 233.0 L/kg (3.7315 cf/lb) 8401
  heat of vaporization:      267.8 kJ/kg (115.1 Btu/lb)     8401
  velocity of sound, saturated liquid: 830 m/s (2725 ft/s) 8401
  velocity of sound, saturated vapor: 165 m/s (541 ft/s)  8401
  viscosity, saturated liquid: 360 µPa·s (0.360 cp)        8401
  viscosity, saturated vapor:  9.47 µPa·s (0.00947 cp)     8401
  thermal conductivity, liquid: 0.1318 W/m·K (0.0762 Btu/hr·ft°F) 8401
  thermal conductivity, vapor: 0.0085 W/m·K (0.0049 Btu/hr·ft°F) 8401
· normal pressure, 20 °C (68 °F) -----
  density, vapor:           3.389 kg/m3 (0.2116 lb/cf)      8401
· normal pressure, 21.1 °C (70 °F) ----
  density, vapor:           3.376 kg/m3 (0.2107 lb/cf)      8401
· 20 °C (68 °F) -----
  pressure, liquid (bubble point): 1024.7 kPa (148.62 psia) 8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

pressure, vapor (dew point):	863.7 kPa (125.27 psia)	8401
density, saturated liquid:	1138 kg/m ³ (71.04 lb/cf)	8401
density, saturated vapor:	34.11 kg/m ³ (2.130 lb/cf)	8401
specific volume, saturated liquid:	0.879 L/kg (0.0141 cf/lb)	8401
specific volume, saturated vapor:	29.3 L/kg (0.4696 cf/lb)	8401
velocity of sound, saturated liquid:	520 m/s (1706 ft/s)	8401
velocity of sound, saturated vapor:	164 m/s (538 ft/s)	8401
viscosity, saturated liquid:	162 μ Pa·s (0.162 cp)	8401
viscosity, saturated vapor:	12.3 μ Pa·s (0.0123 cp)	8401
thermal conductivity, saturated liquid:	0.0971 W/m·K (0.0561 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01294 W/m·K (0.00748 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	2743 kPa (397.9 psia)	8401
pressure, vapor (dew point):	2489 kPa (361.0 psia)	8401
heat of vaporization:	145.8 kJ/kg for liquid and vapor both at nominal composition (62.7 Btu/lb)	8401
	136.9 kJ/kg coexisting liquid and vapor at bubble-point pressure (58.9 Btu/lb)	8401
· critical point -----		
temperature:	89.1 °C (192.3 °F)	8401
pressure:	4873 kPa (706.8 psia)	8401
density:	490 kg/m ³ (30.6 lb/cf)	8401
specific volume:	2.04 L/kg (0.0327 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
	<0.00031 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1600 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.27 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
	components are A2, A1, and A1	8601
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	66,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	3A63
	worst fractionation flammable	
PRODUCTION		
first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	unrestricted	8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

R-32/125/143a (10.0/45.0/45.0)

```

----- REFRI GERANT DATA SUMMARY -----
unassigned   R-32/125/143a (10.0/45.0/45.0)           see
zeotrope     ternary blend                               RDB#
-----

```

COMMON USE(S)

considered (circa 1993-1997) as an alternative for refrigerant 502 and possibly also as a blowing agent and aerosol propellant

IDENTIFIERS

```

common name(s):  R-32/125/143a (10.0/45.0/45.0)
                  R32/125/143a (10.0/45.0/45.0)
                  R 32/125/143a (10.0/45.0/45.0)
                  HFC-32/HFC-125/HFC-143a
                  (10/45/45)
                  not HFC-32/125/143a (10/45/45)
historical name(s): Elf Atochem Forane(R) FX-40      2A06

```

PHYSICAL

```

· nominal blend formulation -----
  composition:      R-32/125/143a
  component weight fractions: 10.0 / 45.0 / 45.0 %
  component mole fractions:  17.433 / 34.004 / 48.563 %      8820
· properties -----
  molar mass:      90.69381 g/mol (0.199946 lb/mol)      8820
· normal boiling point -----
  bubble point temperature: -48.4 °C (-55.1 °F)           4136
  dew point temperature:   -47.8 °C (-54.0 °F)           4136
  maximum temperature glide: 0.60 °C (1.1 °F)              2A06
  density, saturated vapor: 5.06 kg/m3 (0.316 lb/cf)      2A06
  heat of vaporization:    221.0 kJ/kg (95.0 Btu/lb)      4136
· 25 °C (77 °F) -----
  pressure, saturated vapor: 1410.0 kPa (204.50 psia)     4136
  density, saturated liquid: 1040 kg/m3 (64.93 lb/cf)     4136
· critical point -----
  temperature:         71.3 °C (160.3 °F)                 3330
                      72.0 °C (161.6 °F)                 4136
  pressure:           4050 kPa (587.4 psia)               4136

```

ENVIRONMENTAL

```

ODP (ozone depletion potential): <0.00002 mass-weighted average 9501
                                   (model-derived relative to R
                                   11)
GWP (global warming potential): 4230 mass-weighted average 9501
                                   relative to CO2 for 100 yr
                                   integration
HGWP (halocarbon GWP): 0.74 mass-weighted average DW
                                   relative to R 11 for infinite
                                   integration period
                                   0.89 relative to R 11 for 4136
                                   infinite integration period

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 components are A2, A1, and A2 8601

· emergency exposure limit -----
 Refrigerant Concentration Limit (RCL): 29,000 ppm v/v (preliminary
 value under review, based on
 draft ASHRAE 34aa)

· flammability -----
 LFL-UFL (flammability limits in air): none (nonflammable as tested) 4136
 flash point: Elf Atochem: nonflammable MSDS
 autodecomposition temperature: Elf Atochem: >427 °C (>800 °F) MSDS

· detection -----
 appearance: Elf Atochem: clear, colorless MSDS
 odor: Elf Atochem: faint ethereal MSDS

PRODUCTION

last year production allowed: unrestricted 8C01

R-32/125/143a/134a (2.0/41.0/50.0/7.0)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-32/125/143a/134a (2.0/41.0/50.0/7.0) see
 zeotrope tetrinary blend RDB#

COMMON USE(S)

developmental blend (circa 1994-1996) as an alternative for
 refrigerant 502 in low-temperature refrigeration

IDENTIFIERS

common name(s): R-32/125/143a/134a (2/41/50/7)
 R32/125/143a/134a (2/41/50/7)
 R 32/125/143a/134a (2/41/50/7)
 HFC-32/HFC-125/HFC-143a/
 HFC-134a (2/41/50/7)
 not HFC-32/125/143a/134a 8601
 (2/41/50/7)
 historical name(s): Elf Atochem Forane(R) FX-48B MSDS

PHYSICAL

· nominal blend formulation -----
 composition: R-32/125/143a/134a
 component weight fractions: 2.0 / 41.0 / 50.0 / 7.0 %
 component mole fractions: 3.684/ 32.733/ 57.009/ 6.574 % 8820

· properties -----
 molar mass: 95.82137 g/mol (0.211250 8820
 lb/mol)

· normal boiling point -----
 temperature: -45.8 °C (-50.4 °F) MSDS
 bubble point temperature: -46.8 °C (-52.2 °F) 8401
 dew point temperature: -45.2 °C (-49.3 °F) 8401
 maximum temperature glide: 1.61 °C (2.9 °F) 8401
 density, saturated liquid: 1307 kg/m³ (81.61 lb/cf) 8401
 density, saturated vapor: 5.36 kg/m³ (0.335 lb/cf) 8401
 specific volume, saturated liquid: 0.765 L/kg (0.0123 cf/lb) 8401
 specific volume, saturated vapor: 186.4 L/kg (2.9860 cf/lb) 8401
 heat of vaporization: 205.2 kJ/kg (88.2 Btu/lb) 8401
 velocity of sound, saturated liquid: 752 m/s (2466 ft/s) 8401
 velocity of sound, saturated vapor: 145 m/s (476 ft/s) 8401
 viscosity, saturated liquid: 330 µPa·s (0.330 cp) 8401
 viscosity, saturated vapor: 9.11 µPa·s (0.00911 cp) 8401
 thermal conductivity, liquid: 0.1009 W/m·K (0.0583 8401
 Btu/hr·ft²·°F)
 thermal conductivity, vapor: 0.0089 W/m·K (0.0052 8401
 Btu/hr·ft²·°F)

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 4.055 kg/m³ (0.2531 lb/cf) 8401

· normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 4.038 kg/m³ (0.2521 lb/cf) 8401

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 1111.3 kPa (161.18 psia) 8401
 pressure, vapor (dew point): 1080.6 kPa (156.73 psia) 8401
 density, saturated liquid: 1068 kg/m³ (66.68 lb/cf) 8401
 density, saturated vapor: 54.69 kg/m³ (3.414 lb/cf) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

specific volume, saturated liquid:	0.936 L/kg (0.0150 cf/lb)	8401
specific volume, saturated vapor:	18.3 L/kg (0.2929 cf/lb)	8401
velocity of sound, saturated liquid:	418 m/s (1370 ft/s)	8401
velocity of sound, saturated vapor:	138 m/s (453 ft/s)	8401
viscosity, saturated liquid:	136 $\mu\text{Pa}\cdot\text{s}$ (0.136 cp)	8401
viscosity, saturated vapor:	12.2 $\mu\text{Pa}\cdot\text{s}$ (0.0122 cp)	8401
thermal conductivity, saturated liquid:	0.0709 W/m \cdot K (0.0410 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01515 W/m \cdot K (0.00875 Btu/hr \cdot ft $^{\circ}$ F)	8401
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	2905 kPa (421.3 psia)	8401
pressure, vapor (dew point):	2869 kPa (416.1 psia)	8401
heat of vaporization:	85.8 kJ/kg for liquid and vapor both at nominal composition (36.9 Btu/lb)	8401
	84.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (36.2 Btu/lb)	8401
• critical point -----		
temperature:	72.9 $^{\circ}$ C (163.3 $^{\circ}$ F)	8401
pressure:	3809 kPa (552.4 psia)	8401
density:	489 kg/m ³ (30.5 lb/cf)	8401
specific volume:	2.05 L/kg (0.0328 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
	<0.00005 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	4390 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.77 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
• classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
	components are A2, A1, A2, A1	8601
• flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	MSDS
flash point:	Elf Atochem: nonflammable	MSDS
autodecomposition temperature:	Elf Atochem: >427 $^{\circ}$ C (>800 $^{\circ}$ F)	MSDS
• detection -----		
appearance:	Elf Atochem: clear, colorless	MSDS
odor:	Elf Atochem: faint ethereal	MSDS
PRODUCTION		
first commercial use as a refrigerant:	circa 1994	
last year production allowed:	unrestricted	8C01

R-32/125/143a/134a (10.0/33.0/36.0/21.0)

```

----- REFRIGERANT DATA SUMMARY -----
unassigned R-32/125/143a/134a (10.0/33.0/36.0/21.0) see
zeotropic tetrinary blend RDB#
-----

```

COMMON USE(S)

formerly marketed (circa 1994-1996), primarily in Germany, as an alternative for refrigerants 22 and 502 in medium- and low-temperature refrigeration

IDENTIFIERS

```

common name(s): R-32/125/143a/134a
                 (10/33/36/21)
                 R32/125/143a/134a
                 (10/33/36/21)
                 R 32/125/143a/134a
                 (10/33/36/21)
                 HFC-32/HFC-125/HFC-143a/
                 HFC-134a (10/33/36/21)
                 not HFC-32/125/143a/134a
historical name(s): Hoechst Reclin(R) HX4 4778
                   Solvay Solkane(R) HX4
ARI container color / Pantone number: none, use light green grey/413 6601

```

PHYSICAL

```

· nominal blend formulation -----
  composition: R-32/125/143a/134a
  component weight fractions: 10.0 / 33.0 / 36.0 / 21.0 %
  component mole fractions: 17.453/ 24.965/ 38.894/ 18.688 8820
  %
· properties -----
  molar mass: 90.79703 g/mol (0.200173 8820
              lb/mol)
· normal boiling point -----
  bubble point temperature: -49.4 °C (-56.9 °F) 4778
  maximum temperature glide: 5.00 °C (9.0 °F) 4778
  heat of vaporization: 181.0 kJ/kg (77.8 Btu/lb) 4778
· 20 °C (68 °F) -----
  pressure, liquid (bubble point): 1105.1 kPa (160.28 psia) 4778
  pressure, vapor (dew point): 1021.7 kPa (148.19 psia) 4778
  density, saturated liquid: 1092 kg/m3 (68.17 lb/cf) 4778
· 60 °C (140 °F) -----
  pressure, liquid (bubble point): 2891 kPa (419.3 psia) 4778
  pressure, vapor (dew point): 2790 kPa (404.7 psia) 4778
· critical point -----
  temperature: 77.5 °C (171.5 °F) 4778
  pressure: 4010 kPa (581.6 psia) 4778
  density: 490 kg/m3 (30.6 lb/cf) 4778

```

ENVIRONMENTAL

```

ODP (ozone depletion potential): <0.00002 mass-weighted average 9501
                                  (model-derived relative to R
                                  11)
                                  <0.00012 mass-weighted average 9501

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

	(semi-empirical relative to R 11)	
GWP (global warming potential):	3620 mass-weighted average relative to CO2 for 100 yr integration	9501
HGWP (halocarbon GWP):	0.64 mass-weighted average relative to R 11 for infinite integration period	DW

SAFETY

· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
	components are A2, A1, A2, A1	8601
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	4778

PRODUCTION

first commercial use as a refrigerant:	circa 1994, ceased circa 1996	
last year production allowed:	unrestricted	8C01

R-32/125/290/134a (20.0/55.0/5.0/20.0)

```

----- REFRIERANT DATA SUMMARY -----
unassigned   R-32/125/290/134a (20.0/55.0/5.0/20.0)      see
zeotrope     tetrary blend                                           RDB#
-----

```

COMMON USE(S)

under consideration as an alternative for refrigerant 22 both in new equipment and as a service fluid

IDENTIFIERS

```

common name(s):  R-32/125/290/134a (20/55/5/20)
                  R32/125/290/134a (20/55/5/20)
                  R 32/125/290/134a (20/55/5/20)
                  HFC-32/HFC-125/HC-290/HFC-134a
                  (20/55/5/20)
                  not HFC-32/125/290/134a

```

PHYSICAL

```

· nominal blend formulation -----
      composition:  R-32/125/290/134a
      component weight fractions:  20.0 / 55.0 / 5.0 / 20.0 %
      component mole fractions:    33.369/ 39.775/ 9.842/ 17.014  8820
                                     %
· properties -----
      molar mass:    86.79777 g/mol (0.191356      8820
                    lb/mol)
· critical point -----
      temperature:   80.3 °C (176.5 °F)

```

ENVIRONMENTAL

```

ODP (ozone depletion potential):  <0.00002 mass-weighted average 9501
                                   (model-derived relative to R
                                   11)
                                   <0.00012 mole-weighted average 9501
                                   (semi-empirical relative to R
                                   11)
GWP (global warming potential):   1930 mass-weighted average      2590
                                   relative to CO2 for 100 yr
                                   integration
HGWP (halocarbon GWP):            0.44 mass-weighted average      DW
                                   relative to R 11 for infinite
                                   integration period

```

SAFETY

```

· classification -----
  safety group (ASHRAE Standard 34):  none (no application pending)  8601
                                       components are A2,A1,A3,andA1  8601

```

PRODUCTION

```

first commercial use as a refrigerant:  not known to be commercialized
last year production allowed:           unrestricted      8C01

```

R-32/134a (25.0/75.0)

----- REFRIERANT DATA SUMMARY -----
 unassigned R-32/134a (25.0/75.0) see
 zeotrope binary blend RDB#

COMMON USE(S)

under consideration as a replacement for refrigerant 22

IDENTIFIERS

common name(s): R-32/134a (25.0/75.0)
 R32/134a (25.0/75.0)
 R 32/134a (25.0/75.0)
 HFC-32/HFC-134a (25/75)
 not HFC-32/134a (25/75)

PHYSICAL

· nominal blend formulation -----
 composition: R-32/134a
 component weight fractions: 25.0 / 75.0 %
 component mole fractions: 39.531 / 60.469 % 8820

· properties -----
 molar mass: 82.26224 g/mol (0.181357 lb/mol) 8820

· normal boiling point -----
 bubble point temperature: -40.3 °C (-40.6 °F) 8401
 dew point temperature: -33.2 °C (-27.8 °F) 8401
 maximum temperature glide: 7.06 °C (12.7 °F) 8401
 density, saturated liquid: 1350 kg/m³ (84.27 lb/cf) 8401
 density, saturated vapor: 4.36 kg/m³ (0.272 lb/cf) 8401
 specific volume, saturated liquid: 0.741 L/kg (0.0119 cf/lb) 8401
 specific volume, saturated vapor: 229.6 L/kg (3.6778 cf/lb) 8401
 heat of vaporization: 265.0 kJ/kg (113.9 Btu/lb) 8401
 velocity of sound, saturated liquid: 824 m/s (2704 ft/s) 8401
 velocity of sound, saturated vapor: 163 m/s (535 ft/s) 8401
 viscosity, saturated liquid: 367 µPa·s (0.367 cp) 8401
 viscosity, saturated vapor: 9.66 µPa·s (0.00966 cp) 8401
 thermal conductivity, liquid: 0.1281 W/m·K (0.0740 Btu/hr·ft·°F) 8401
 thermal conductivity, vapor: 0.0086 W/m·K (0.0050 Btu/hr·ft·°F) 8401

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 3.483 kg/m³ (0.2174 lb/cf) 8401

· normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 3.469 kg/m³ (0.2166 lb/cf) 8401

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 914.4 kPa (132.62 psia) 8401
 pressure, vapor (dew point): 770.8 kPa (111.80 psia) 8401
 density, saturated liquid: 1150 kg/m³ (71.82 lb/cf) 8401
 density, saturated vapor: 30.85 kg/m³ (1.926 lb/cf) 8401
 specific volume, saturated liquid: 0.869 L/kg (0.0139 cf/lb) 8401
 specific volume, saturated vapor: 32.4 L/kg (0.5192 cf/lb) 8401
 velocity of sound, saturated liquid: 532 m/s (1746 ft/s) 8401
 velocity of sound, saturated vapor: 163 m/s (534 ft/s) 8401
 viscosity, saturated liquid: 172 µPa·s (0.172 cp) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

viscosity, saturated vapor:	12.0 $\mu\text{Pa}\cdot\text{s}$ (0.0120 cp)	8401
thermal conductivity, saturated liquid:	0.0961 W/m \cdot K (0.0555 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01285 W/m \cdot K (0.00742 Btu/hr \cdot ft $^{\circ}$ F)	8401
· 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	2478 kPa (359.4 psia)	8401
pressure, vapor (dew point):	2243 kPa (325.3 psia)	8401
heat of vaporization:	151.6 kJ/kg for liquid and vapor both at nominal composition (65.2 Btu/lb)	8401
	142.3 kJ/kg coexisting liquid and vapor at bubble-point pressure (61.2 Btu/lb)	8401
· critical point -----		
temperature:	93.7 $^{\circ}$ C (200.7 $^{\circ}$ F)	8401
pressure:	4830 kPa (700.5 psia)	8401
density:	481 kg/m 3 (30.0 lb/cf)	8401
specific volume:	2.08 L/kg (0.0333 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
	<0.00038 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1420 mass-weighted average relative to CO $_2$ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.24 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending) components are A2 and A1	8601 8601
· long-term occupational limit -----		
AIHA WEEL (workplace envl exp limit):	components are both 1000 ppm v/v TWA for 8 hr/day and 40 hr/wk	9503
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	67,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	worst fractionation flammable	
PRODUCTION		
first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	unrestricted	8C01

R-32/134a (30.0/70.0)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-32/134a (30.0/70.0) see
 zeotrope binary blend RDB#

COMMON USE(S)

under consideration, especially in Japan, as an alternative for
 refrigerant 22 both in new equipment and as a service fluid

IDENTIFIERS

common name(s): R-32/134a (30.0/70.0)
 R32/134a (30.0/70.0)
 R 32/134a (30.0/70.0)
 HFC-32/HFC-134a (30/70)
 not HFC-32/134a (30/70)
 trade name(s): Daikin Daiflon(R) 32/134a
 ARI container color / Pantone number: none, use light green grey/413 6601
 with red / 185 band

PHYSICAL

· nominal blend formulation -----
 composition: R-32/134a
 component weight fractions: 30.0 / 70.0 %
 component mole fractions: 45.668 / 54.332 % 8820
 · properties -----
 molar mass: 79.19347 g/mol (0.174592 8820
 lb/mol)
 · normal boiling point -----
 bubble point temperature: -41.8 °C (-43.3 °F) 8401
 dew point temperature: -34.6 °C (-30.2 °F) 8401
 maximum temperature glide: 7.25 °C (13.0 °F) 8401
 density, saturated liquid: 1341 kg/m3 (83.73 lb/cf) 8401
 density, saturated vapor: 4.22 kg/m3 (0.263 lb/cf) 8401
 specific volume, saturated liquid: 0.746 L/kg (0.0119 cf/lb) 8401
 specific volume, saturated vapor: 237.2 L/kg (3.8001 cf/lb) 8401
 heat of vaporization: 273.4 kJ/kg (117.5 Btu/lb) 8401
 velocity of sound, saturated liquid: 836 m/s (2742 ft/s) 8401
 velocity of sound, saturated vapor: 166 m/s (546 ft/s) 8401
 viscosity, saturated liquid: 360 µPa·s (0.360 cp) 8401
 viscosity, saturated vapor: 9.67 µPa·s (0.00967 cp) 8401
 thermal conductivity, liquid: 0.1325 W/m·K (0.0766 8401
 Btu/hr·ft°F)
 thermal conductivity, vapor: 0.0086 W/m·K (0.0050 8401
 Btu/hr·ft°F)
 · normal pressure, 20 °C (68 °F) -----
 density, vapor: 3.351 kg/m3 (0.2092 lb/cf) 8401
 · normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 3.338 kg/m3 (0.2084 lb/cf) 8401
 · 20 °C (68 °F) -----
 pressure, liquid (bubble point): 968.1 kPa (140.41 psia) 8401
 pressure, vapor (dew point): 813.3 kPa (117.96 psia) 8401
 density, saturated liquid: 1137 kg/m3 (70.97 lb/cf) 8401
 density, saturated vapor: 31.50 kg/m3 (1.966 lb/cf) 8401
 specific volume, saturated liquid: 0.880 L/kg (0.0141 cf/lb) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

specific volume, saturated vapor:	31.8 L/kg (0.5086 cf/lb)	8401
velocity of sound, saturated liquid:	534 m/s (1752 ft/s)	8401
velocity of sound, saturated vapor:	166 m/s (544 ft/s)	8401
viscosity, saturated liquid:	166 $\mu\text{Pa}\cdot\text{s}$ (0.166 cp)	8401
viscosity, saturated vapor:	12.1 $\mu\text{Pa}\cdot\text{s}$ (0.0121 cp)	8401
thermal conductivity, saturated liquid:	0.0989 W/m \cdot K (0.0571 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01285 W/m \cdot K (0.00742 Btu/hr \cdot ft $^{\circ}$ F)	8401
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	2609 kPa (378.4 psia)	8401
pressure, vapor (dew point):	2358 kPa (342.0 psia)	8401
heat of vaporization:	153.8 kJ/kg for liquid and vapor both at nominal composition (66.1 Btu/lb)	8401
	127.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (54.9 Btu/lb)	8401
• critical point -----		
temperature:	92.4 $^{\circ}$ C (198.3 $^{\circ}$ F)	8401
pressure:	4942 kPa (716.8 psia)	8401
density:	477 kg/m 3 (29.8 lb/cf)	8401
specific volume:	2.10 L/kg (0.0336 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
	<0.00035 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1380 mass-weighted average relative to CO $_2$ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.24 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
• classification -----		
safety group (ASHRAE Standard 34):	none (requested May 1995, withdrawn June 1997)	
	components are A2 and A1	8601
• long-term occupational limit -----		
AIHA WEEL (workplace envl exp limit):	components are both 1000 ppm v/v TWA for 8 hr/day and 40 hr/wk	9503
exposure limit consistent to OSHA PEL:	Daikin AEL: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	MSDS
• flammability -----		
LFL-UFL (flammability limits in air):	worst fractionation flammable	
• detection -----		
appearance:	colorless, transparent	
PRODUCTION		
first commercial use as a refrigerant:	projected: 1998-2000	
last year production allowed:	unrestricted	8C01

R-32/134a (33.8/66.2)

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----- REFRIERANT DATA SUMMARY -----
unassigned R-32/134a (33.8/66.2) see
zeotrope binary blend RDB#
-----

```

COMMON USE(S)

under consideration as an alternative for refrigerant 22

IDENTIFIERS

```

common name(s): R-32/134a (33.8/66.2)
                R32/134a (33.8/66.2)
                R 32/134a (33.8/66.2)
                HFC-32/HFC-134a (33.8/66.2)
                not HFC-32/134a (33.8/66.2)
                R-32/134a (33.7695/66.2305)
                R-32/134a (33.77/66.23)
                R-32/134a (34/66)
                R-32/134a (50/50 molar)
                R-32/134a equimolar

```

ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

```

· nominal blend formulation -----
      composition: R-32/134a
      component weight fractions: 33.8 / 66.2 %
      component mole fractions: 50.000 / 50.000 %      8820
· properties -----
      molar mass: 77.02714 g/mol (0.169816 lb/mol)      8820
· normal boiling point -----
      bubble point temperature: -42.8 °C (-45.1 °F)      8401
      dew point temperature: -35.6 °C (-32.0 °F)      8401
      maximum temperature glide: 7.26 °C (13.1 °F)      8401
      density, saturated liquid: 1335 kg/m3 (83.32 lb/cf)      8401
      density, saturated vapor: 4.12 kg/m3 (0.257 lb/cf)      8401
      specific volume, saturated liquid: 0.749 L/kg (0.0120 cf/lb)      8401
      specific volume, saturated vapor: 243.0 L/kg (3.8922 cf/lb)      8401
      heat of vaporization: 279.6 kJ/kg (120.2 Btu/lb)      8401
      velocity of sound, saturated liquid: 844 m/s (2770 ft/s)      8401
      velocity of sound, saturated vapor: 169 m/s (554 ft/s)      8401
      viscosity, saturated liquid: 354 µPa·s (0.354 cp)      8401
      viscosity, saturated vapor: 9.68 µPa·s (0.00968 cp)      8401
      thermal conductivity, liquid: 0.1359 W/m·K (0.0785 Btu/hr·ft°F)      8401
      thermal conductivity, vapor: 0.0085 W/m·K (0.0049 Btu/hr·ft°F)      8401
· normal pressure, 20 °C (68 °F) -----
      density, vapor: 3.258 kg/m3 (0.2034 lb/cf)      8401
· normal pressure, 21.1 °C (70 °F) ---
      density, vapor: 3.245 kg/m3 (0.2026 lb/cf)      8401
· 20 °C (68 °F) -----
      pressure, liquid (bubble point): 1006.6 kPa (146.00 psia)      8401
      pressure, vapor (dew point): 846.2 kPa (122.72 psia)      8401
      density, saturated liquid: 1127 kg/m3 (70.34 lb/cf)      8401

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

Refrigerant Database

density, saturated vapor:	31.99 kg/m ³ (1.997 lb/cf)	8401
specific volume, saturated liquid:	0.888 L/kg (0.0142 cf/lb)	8401
specific volume, saturated vapor:	31.3 L/kg (0.5008 cf/lb)	8401
velocity of sound, saturated liquid:	536 m/s (1758 ft/s)	8401
velocity of sound, saturated vapor:	168 m/s (552 ft/s)	8401
viscosity, saturated liquid:	163 μ Pa·s (0.163 cp)	8401
viscosity, saturated vapor:	12.2 μ Pa·s (0.0122 cp)	8401
thermal conductivity, saturated liquid:	0.1011 W/m·K (0.0584 Btu/hr·ft·°F)	8401
thermal conductivity, saturated vapor:	0.01286 W/m·K (0.00743 Btu/hr·ft·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	2704 kPa (392.1 psia)	8401
pressure, vapor (dew point):	2446 kPa (354.8 psia)	8401
heat of vaporization:	155.5 kJ/kg for liquid and vapor both at nominal composition (66.8 Btu/lb)	8401
	145.5 kJ/kg coexisting liquid and vapor at bubble-point pressure (62.6 Btu/lb)	8401
· critical point -----		
temperature:	91.4 °C (196.5 °F)	8401
pressure:	5020 kPa (728.1 psia)	8401
density:	474 kg/m ³ (29.6 lb/cf)	8401
specific volume:	2.11 L/kg (0.0338 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	<0.00001 mass-weighted average (model-derived relative to R 11)	9501
	<0.00034 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1360 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.23 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
	components are A2 and A1	8601
· long-term occupational limit -----		
AIHA WEEL (workplace envl exp limit):	components are both 1000 ppm v/v TWA for 8 hr/day and 40 hr/wk	9503
· detection -----		
appearance:	colorless, transparent	
PRODUCTION		
first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	unrestricted	8C01

R-32/152a

----- REFRIGERANT DATA SUMMARY -----

unassigned	R-32/152a (formulation not disclosed)	see
zeotrope	binary blend	RDB#

COMMON USE(S)

used as a replacement for refrigerant 12 in refrigerator-freezers in China

The following information is preliminary and may be incomplete or incorrect. Data on this blend may be available from the Zhejiang Chemical Industry Research Institute (Hangzhou, Zhejiang, Peoples Republic of China) and refrigerant manufacturers. The blend formulation has not been disclosed and data inconsistencies preclude precise determination; it appears to be approximately R-32/152a (5.5/94.5).

IDENTIFIERS

common name(s):	R-32/152a (??/??)	
	R32/152a (??/??)	
	R 32/152a (??/??)	
trade name(s):	Zhejiang (China) ZC-3	8B15

PHYSICAL

· nominal blend formulation -----		
	composition: R-32/152a	
· properties -----	component mole fractions: 6.9 / 93.1 estimated %	8820
	molar mass: 65.1 estimated g/mol (0.143521 lb/mol)	8820

ENVIRONMENTAL

ODP (ozone depletion potential):	0.000 estimated mass average (model-derived relative to R 11)	9501
	0.000 estimated mass average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	230 estimated mass average relative to CO2 for 100 yr integration	9501

SAFETY

· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
	components are A2 and A2	8601
· flammability -----		
LFL-UFL (flammability limits in air):	probably flammable	

PRODUCTION

first commercial use as a refrigerant:	circa 1995 in China	8B15
last year production allowed:	unrestricted	8C01

R-32/227ea (35.0/65.0)

```

----- REFRIGERANT DATA SUMMARY -----
unassigned   R-32/227ea (35.0/65.0)           see
zeotrope     binary blend                    RDB#
-----
    
```

COMMON USE(S)

under consideration as an alternative for refrigerant 22

The following information is preliminary and may be incomplete or incorrect. Data on this blend are available from Great Lakes Chemicals (Lafayette, IN, USA) and other refrigerant manufacturers.

IDENTIFIERS

```

common name(s):  R-32/227ea (35.0/65.0)
                  R32/227ea (35.0/65.0)
                  R 32/227ea (35.0/65.0)
trade name(s):  Great Lakes Chemical FM series
    
```

PHYSICAL

```

· nominal blend formulation -----
      composition:  R-32/227ea
component weight fractions:  35.0 / 65.0 %
component mole fractions:    62.935 / 37.065 %           8820
· properties -----
      molar mass:   95.76166 g/mol (0.211118           8820
                  lb/mol)
· normal boiling point -----
      bubble point temperature:  -45.8 °C (-50.5 °F)           8401
      dew point temperature:     -33.9 °C (-28.9 °F)           8401
      maximum temperature glide:  11.96 °C (21.5 °F)           8401
      density, saturated liquid:  1432 kg/m3 (89.37 lb/cf)       8401
      density, saturated vapor:   5.04 kg/m3 (0.314 lb/cf)       8401
      specific volume, saturated liquid:  0.699 L/kg (0.0112 cf/lb) 8401
      specific volume, saturated vapor:  198.6 L/kg (3.1809 cf/lb) 8401
      heat of vaporization:        228.3 kJ/kg (98.1 Btu/lb)     8401
      velocity of sound, saturated liquid:  727 m/s (2386 ft/s)   8401
      velocity of sound, saturated vapor:  150 m/s (493 ft/s)   8401
      viscosity, saturated vapor:   10.30 µPa·s (0.01030 cp)     8401
      viscosity, saturated liquid:   377 µPa·s (0.377 cp)       8401
      thermal conductivity, liquid:  0.1122 W/m·K (0.0648           8401
                  Btu/hr·ft°F)
      thermal conductivity, vapor:   0.0086 W/m·K (0.0050           8401
                  Btu/hr·ft°F)
· normal pressure, 20 °C (68 °F) -----
      density, vapor:  4.014 kg/m3 (0.2506 lb/cf)           8401
· normal pressure, 21.1 °C (70 °F) ---
      density, vapor:  3.998 kg/m3 (0.2496 lb/cf)           8401
· 20 °C (68 °F) -----
      pressure, liquid (bubble point):  1090.3 kPa (158.13 psia) 8401
      pressure, vapor (dew point):     843.4 kPa (122.33 psia) 8401
      density, saturated liquid:       1185 kg/m3 (73.96 lb/cf) 8401
      density, saturated vapor:        39.79 kg/m3 (2.484 lb/cf) 8401
      specific volume, saturated liquid:  0.844 L/kg (0.0135 cf/lb) 8401
      specific volume, saturated vapor:  25.1 L/kg (0.4026 cf/lb) 8401
    
```

velocity of sound, saturated liquid:	431 m/s (1415 ft/s)	8401
velocity of sound, saturated vapor:	147 m/s (483 ft/s)	8401
viscosity, saturated liquid:	156 $\mu\text{Pa}\cdot\text{s}$ (0.156 cp)	8401
viscosity, saturated vapor:	12.9 $\mu\text{Pa}\cdot\text{s}$ (0.0129 cp)	8401
thermal conductivity, saturatd liquid:	0.0825 W/m \cdot K (0.0477 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01256 W/m \cdot K (0.00726 Btu/hr \cdot ft $^{\circ}$ F)	8401
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	2835 kPa (411.2 psia)	8401
pressure, vapor (dew point):	2472 kPa (358.6 psia)	8401
heat of vaporization:	109.9 kJ/kg for liquid and vapor both at nominal composition (47.2 Btu/lb)	8401
	96.6 kJ/kg coexisting liquid and vapor at bubble-point pressure (41.5 Btu/lb)	8401
• critical point -----		
temperature:	87.1 $^{\circ}$ C (188.7 $^{\circ}$ F)	8401
pressure:	4720 kPa (684.6 psia)	8401
density:	514 kg/m ³ (32.1 lb/cf)	8401
specific volume:	1.95 L/kg (0.0312 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.000 (model-derived relative to R 11)	
GWP (global warming potential):	2770 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.50 mass-weighted average relative to R 11 for infinite integration period	8101
SAFETY		
• classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601

R-32/600 (95.0/5.0)

----- REFRIERANT DATA SUMMARY -----
 unassigned R-32/600 (95.0/5.0) see
 azeotrope binary blend RDB#

COMMON USE(S)

under consideration, especially in Japan, circa 1999 as an
 alternative for refrigerant 22 both in new equipment and as a service
 fluid

IDENTIFIERS

common name(s): R-32/600 (95.0/5.0)
 R32/600 (95.0/5.0)
 R 32/600 (95.0/5.0)
 HFC-32/HC-600 (95.0/5.0)
 not HFC-32/600 (95.0/5.0)
 R-32/600 (95/5)
 ARI container color / Pantone number: none, use light green grey/413 6601
 with red / 185 band

PHYSICAL

· nominal blend formulation -----
 composition: R-32/600
 component weight fractions: 95.0 / 5.0 %
 component mole fractions: 95.501 / 4.499 % 8820

· properties -----
 molar mass: 52.29777 g/mol (0.115297 8820
 lb/mol)

· normal boiling point -----
 bubble point temperature: -51.4 °C (-60.6 °F) 8401
 dew point temperature: -51.3 °C (-60.3 °F) 8401
 maximum temperature glide: 0.17 °C (0.3 °F) 8401
 density, saturated liquid: 1155 kg/m3 (72.10 lb/cf) 8401
 density, saturated vapor: 3.00 kg/m3 (0.187 lb/cf) 8401
 specific volume, saturated liquid: 0.866 L/kg (0.0139 cf/lb) 8401
 specific volume, saturated vapor: 333.2 L/kg (5.3377 cf/lb) 8401
 heat of vaporization: 377.4 kJ/kg (162.3 Btu/lb) 8401
 velocity of sound, saturated liquid: 964 m/s (3164 ft/s) 8401
 velocity of sound, saturated vapor: 206 m/s (674 ft/s) 8401
 viscosity, saturated liquid: 274 µPa·s (0.274 cp) 8401
 viscosity, saturated vapor: 9.03 µPa·s (0.00903 cp) 8401
 thermal conductivity, liquid: 0.1816 W/m·K (0.1049 8401
 Btu/hr·ft°F)
 thermal conductivity, vapor: 0.0083 W/m·K (0.0048 8401
 Btu/hr·ft°F)

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 2.204 kg/m3 (0.1376 lb/cf) 8401

· normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 2.195 kg/m3 (0.1371 lb/cf) 8401

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 1443.0 kPa (209.29 psia) 8401
 pressure, vapor (dew point): 1420.1 kPa (205.97 psia) 8401
 density, saturated liquid: 936 kg/m3 (58.40 lb/cf) 8401
 density, saturated vapor: 39.47 kg/m3 (2.464 lb/cf) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

specific volume, saturated liquid:	1.069 L/kg (0.0171 cf/lb)	8401
specific volume, saturated vapor:	25.3 L/kg (0.4058 cf/lb)	8401
velocity of sound, saturated liquid:	577 m/s (1893 ft/s)	8401
velocity of sound, saturated vapor:	203 m/s (667 ft/s)	8401
viscosity, saturated liquid:	122 $\mu\text{Pa}\cdot\text{s}$ (0.122 cp)	8401
viscosity, saturated vapor:	12.4 $\mu\text{Pa}\cdot\text{s}$ (0.0124 cp)	8401
thermal conductivity, saturated liquid:	0.1321 W/m \cdot K (0.0763 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01460 W/m \cdot K (0.00844 Btu/hr \cdot ft $^{\circ}$ F)	8401
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	3828 kPa (555.2 psia)	8401
pressure, vapor (dew point):	3783 kPa (548.7 psia)	8401
heat of vaporization:	173.7 kJ/kg for liquid and vapor both at nominal composition (74.7 Btu/lb)	8401
	172.3 kJ/kg coexisting liquid and vapor at bubble-point pressure (74.1 Btu/lb)	8401
• critical point -----		
temperature:	81.4 $^{\circ}$ C (178.6 $^{\circ}$ F)	8401
pressure:	5991 kPa (868.9 psia)	8401
density:	407 kg/m 3 (25.4 lb/cf)	8401
specific volume:	2.46 L/kg (0.0394 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.000 mass-weighted average (model-derived relative to R 11)	9501
GWP (global warming potential):	840 mass-weighted average relative to CO $_2$ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.13 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
• classification -----		
safety group (ASHRAE Standard 34):	none (no application pending) components are A2 and A3	8601 8601
• long-term occupational limit -----		
ACGIH TLV-TWA (time-weighted average):	components: R-600 is 800 ppm v/v TWA for 8 hr/day and 40 hr/wk	9504
AIHA WEEL (workplace envl exp limit):	components: R-32 is 1000 ppm v/v TWA for 8 hr/day and 40 hr/wk	5C14
• flammability -----		
LFL-UFL (flammability limits in air):	flammable	9834
• detection -----		
appearance:	colorless, transparent	
PRODUCTION		
first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	unrestricted	8C01

R-41/744

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-41/744 (various compositions) see
 zeotrope binary blend RDB#

COMMON USE(S)

under consideration to replace refrigerants 13 and 503

IDENTIFIERS

common name(s): R-41/744 (??/??)
 HFC-41/C-744 (??/??)

ENVIRONMENTAL

ODP (ozone depletion potential): 0.000 mass-weighted average 5301
 (model-derived relative to R
 11)

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized
 last year production allowed: unrestricted 8C01

R-123/141b/602/?polymers? (40.0/50.0/5.0/5.0)

----- REFRIGERANT DATA SUMMARY -----

unassigned R-123/141b/602/?polymers? (40.0/50.0/5.0/5.0) see
 tetrary blend RDB#

COMMON USE(S)

not known to be used as a refrigerant; replacement for fluorochemical
 11 as a blowing agent for rigid urethane, spray, froth, and pour foam
 systems

The following information is preliminary and may be incomplete or
 incorrect. Additional data on this blend may be available from
 InterCool Energy Corporation (ICE, Latham, NY, USA, a subsidiary of
 Intermagnetics General Corporation, IGC, Allentown, PA, USA) and
 other refrigerant manufacturers. This blend may be covered by
 pending patents. The fourth component is described as a proprietary
 polymer.

IDENTIFIERS

common name(s): R-123/141b/602/??? (40/50/5/?)
 R123/141b/602/??? (40/50/5/?)
 R 123/141b/602/??? (40/50/5/?)
 HCFC-123/HCFC-141b/HC-602/???
 not HCFC-123/141b/602/???
 (40/50/5/?)
 trade name(s): IGC/ICE FRIGC(R) FR-11(TM) MSDS
 ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

· normal boiling point -----
 temperature: IGC/ICE: >30 °C (>86 °F) MSDS

ENVIRONMENTAL

ODP (ozone depletion potential): IGC/ICE: 0.07 (model-derived mfr
 relative to R 11)
 GWP (global warming potential): IGC/ICE: 350 relative to CO2 mfr
 for 100 yr integration

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 · acute (short-term) toxicity -----
 anesthetic concentration: rat, deep anesthesia: 140,000 MSDS
 ppm v/v
 · flammability -----
 LFL-UFL (flammability limits in air): IGC/ICE: nonflammable MSDS
 flash point: IGC/ICE: not applicable MSDS
 · detection -----
 appearance: clear liquid MSDS

PRODUCTION

first commercial use as a refrigerant: 1997
 promotion begun October 1996
 last year production allowed: 2029 by refrigerant 123, 141b 8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

in developed countries under
the Montreal Protocol

R-124/123

```

----- REFRIGERANT DATA SUMMARY -----
unassigned   R-124/123 formulations vary, typically (42.0/58.0)      see
zeotrope     binary blend                                           RDB#
-----

```

COMMON USE(S)

industrial use in applications with high condensing temperatures, such as air conditioners for overhead crane cabs in steel mills, as a service fluid for retrofit of systems designed for refrigerant 114

Note: The hoses commonly used in systems designed for refrigerant 114 are not compatible with the R-124/123 blend.

IDENTIFIERS

```

common name(s):  R-124/123 (??/??)
                  R124/123 (??/??)
                  R 124/123 (??/??)
alternative chemical names/formulae:  incorrectly: R-123/124 (??/??)
ARI container color / Pantone number:  none, use light green grey/413 6601

```

PHYSICAL

```

· nominal blend formulation -----
      composition:  R-124/123
component weight fractions:  formulation must be indicated
                             %

```

SAFETY

```

· classification -----
  safety group (ASHRAE Standard 34):  none (no application pending)  8601
                                       components are A1 and B1         8601

```

PRODUCTION

```

first commercial use as a refrigerant:  circa 1995
last year production allowed:  2029 by refrigerants 123, 124  8C01
                               in developed countries under
                               the Montreal Protocol

```

R-124/123 (42.0/58.0)

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----- REFRIGERANT DATA SUMMARY -----
unassigned   R-124/123 (42.0/58.0)           see
zeotrope     binary blend                          RDB#
-----

```

COMMON USE(S)

industrial use in applications with high condensing temperatures, such as air conditioners for overhead crane cabs in steel mills, as a service fluid for retrofit of systems designed for refrigerant 114

Note: The hoses commonly used in systems designed for refrigerant 114 are not compatible with the R-124/123 blend.

IDENTIFIERS

```

common name(s):  R-124/123 (42.0/58.0)
                  R124/123 (42.0/58.0)
                  R 124/123 (42.0/58.0)
                  incorrectly R-123/124 (58/42)
                  incorrectly R123/124 (58/42)
                  incorrectly R 123/124 (58/42)
                  HCFC-124/HCFC-123 (42/58)           2909
                  not: HCFC-124/123 (42/58)           2909

ARI container color / Pantone number:  none, use light green grey/413 6601

```

PHYSICAL

```

· nominal blend formulation -----
      composition:  R-124/123
      component weight fractions:  42.0 / 58.0 %
      component mole fractions:    44.795 / 55.205 %           8820
· properties -----
      molar mass:    145.55918 g/mol (0.320903           8820
                  lb/mol)

· normal boiling point -----
      bubble point temperature:  0.3 °C (32.6 °F)           8401
      dew point temperature:     15.3 °C (59.5 °F)           8401
      maximum temperature glide: 14.93 °C (26.9 °F)           8401
      density, saturated liquid: 1484 kg/m3 (92.64 lb/cf)      8401
      density, saturated vapor:  6.40 kg/m3 (0.400 lb/cf)      8401
      specific volume, saturated liquid: 0.674 L/kg (0.0108 cf/lb) 8401
      specific volume, saturated vapor: 156.2 L/kg (2.5022 cf/lb) 8401
      heat of vaporization:       180.0 kJ/kg (77.4 Btu/lb)     8401
      velocity of sound, saturated liquid: 712 m/s (2336 ft/s)      8401
      velocity of sound, saturated vapor: 130 m/s (426 ft/s)      8401
      viscosity, saturated vapor: 10.56 µPa·s (0.01056 cp)      8401
      viscosity, saturated liquid: 428 µPa·s (0.428 cp)         8401
      thermal conductivity, liquid: 0.0790 W/m·K (0.0457           8401
                  Btu/hr·ft°F)
      thermal conductivity, vapor: 0.0097 W/m·K (0.0056           8401
                  Btu/hr·ft°F)

· normal pressure, 20 °C (68 °F) -----
      density, vapor: 6.283 kg/m3 (0.3922 lb/cf)           8401
· normal pressure, 21.1 °C (70 °F) ---
      density, vapor: 6.256 kg/m3 (0.3905 lb/cf)           8401
· 20 °C (68 °F) -----

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

pressure, liquid (bubble point):	203.1 kPa (29.46 psia)	8401
pressure, vapor (dew point):	121.6 kPa (17.63 psia)	8401
density, saturated liquid:	1429 kg/m ³ (89.22 lb/cf)	8401
density, saturated vapor:	7.60 kg/m ³ (0.474 lb/cf)	8401
specific volume, saturated liquid:	0.700 L/kg (0.0112 cf/lb)	8401
specific volume, saturated vapor:	131.6 L/kg (2.1080 cf/lb)	8401
velocity of sound, saturated liquid:	635 m/s (2082 ft/s)	8401
velocity of sound, saturated vapor:	130 m/s (427 ft/s)	8401
viscosity, saturated liquid:	337 μ Pa·s (0.337 cp)	8401
viscosity, saturated vapor:	10.7 μ Pa·s (0.0107 cp)	8401
thermal conductivity, saturatd liquid:	0.0732 W/m·K (0.0423 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.00996 W/m·K (0.00576 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	632 kPa (91.6 psia)	8401
pressure, vapor (dew point):	447 kPa (64.9 psia)	8401
heat of vaporization:	142.5 kJ/kg for liquid and vapor both at nominal composition (61.3 Btu/lb)	8401
	124.4 kJ/kg coexisting liquid and vapor at bubble-point pressure (53.5 Btu/lb)	8401
· critical point -----		
temperature:	156.2 °C (313.2 °F)	8401
pressure:	3835 kPa (556.2 psia)	8401
density:	554 kg/m ³ (34.6 lb/cf)	8401
specific volume:	1.80 L/kg (0.0289 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.018 mass-weighted average (model-derived relative to R 11)	9501
	0.023 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	330 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.05 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
	components are A1 and B1	8601
· flammability -----		
LFL-UFL (flammability limits in air):	expected to be nonflammable	
PRODUCTION		
first commercial use as a refrigerant:	circa 1995	
last year production allowed:	2029 by refrigerants 123, 124 in developed countries under the Montreal Protocol	8C01

R-125/22 (70.0/30.0)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-125/22 (70.0/30.0) see
 zeotrope binary blend RDB#

COMMON USE(S)

considered (circa 1992-1996) as an alternative for refrigerant 502

IDENTIFIERS

common name(s): R-125/22 (70.0/30.0) MSDS
 R125/22 (70.0/30.0) MSDS
 R 125/22 (70.0/30.0) MSDS
 historical name(s): Elf Atochem Forane(R) FX-20 2A06
 ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

· nominal blend formulation -----
 composition: R-125/22
 component weight fractions: 70.0 / 30.0 %
 component mole fractions: 62.701 / 37.299 % 8820

· properties -----
 molar mass: 107.50629 g/mol (0.237011 lb/mol) 8820

· normal boiling point -----
 bubble point temperature: -47.4 °C (-53.4 °F) 8401
 dew point temperature: -47.1 °C (-52.7 °F) 8401
 maximum temperature glide: 0.20 °C (0.4 °F) 2A06
 0.36 °C (0.6 °F) 8401
 density, saturated liquid: 1483 kg/m3 (92.58 lb/cf) 8401
 density, saturated vapor: 6.04 kg/m3 (0.377 lb/cf) 8401
 specific volume, saturated liquid: 0.674 L/kg (0.0108 cf/lb) 8401
 specific volume, saturated vapor: 165.5 L/kg (2.6515 cf/lb) 8401
 heat of vaporization: 183.4 kJ/kg (78.8 Btu/lb) 8401
 velocity of sound, saturated liquid: 745 m/s (2446 ft/s) 8401
 velocity of sound, saturated vapor: 137 m/s (449 ft/s) 8401
 viscosity, saturated liquid: 385 µPa·s (0.385 cp) 8401
 viscosity, saturated vapor: 9.74 µPa·s (0.00974 cp) 8401
 thermal conductivity, liquid: 0.0985 W/m·K (0.0569 Btu/hr·ft°F) 8401
 thermal conductivity, vapor: 0.0079 W/m·K (0.0046 Btu/hr·ft°F) 8401

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 4.541 kg/m3 (0.2835 lb/cf) 8401

· normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 4.523 kg/m3 (0.2823 lb/cf) 8401

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 1159.4 kPa (168.16 psia) 8401
 pressure, vapor (dew point): 1149.2 kPa (166.68 psia) 8401
 specific volume, saturated liquid: 0.824 L/kg (0.0132 cf/lb) 8401
 specific volume, saturated vapor: 15.5 L/kg (0.2480 cf/lb) 8401
 velocity of sound, saturated liquid: 409 m/s (1342 ft/s) 8401
 velocity of sound, saturated vapor: 132 m/s (432 ft/s) 8401
 viscosity, saturated liquid: 155 µPa·s (0.155 cp) 8401
 viscosity, saturated vapor: 13.0 µPa·s (0.0130 cp) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

thermal conductivity, saturatd liquid:	0.0677 W/m·K (0.0391 Btu/hr·ft°F)	8401
thermal conductivity, saturated vapor:	0.01311 W/m·K (0.00757 Btu/hr·ft°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	3027 kPa (439.1 psia)	8401
pressure, vapor (dew point):	3013 kPa (436.9 psia)	8401
heat of vaporization:	78.1 kJ/kg for liquid and vapor both at nominal composition (33.6 Btu/lb)	8401
	79.1 kJ/kg coexisting liquid and vapor at bubble-point pressure (34.0 Btu/lb)	8401
· critical point -----		
temperature:	73.7 °C (164.7 °F)	8401
pressure:	4036 kPa (585.4 psia)	8401
density:	563 kg/m3 (35.1 lb/cf)	8401
specific volume:	1.78 L/kg (0.0285 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.010 mass-weighted average (model-derived relative to R 11)	9501
	0.015 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	3230 mass-weighted average relative to CO2 for 100 yr integration	9501
HGWP (halocarbon GWP):	0.55 relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending) components are both A1	8601 8601
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	2A06
flash point:	Elf Atochem: none	MSDS
autodecomposition temperature:	Elf Atochem: >427 °C (>800 °F)	MSDS
PRODUCTION		
first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	2029 based on refrigerant 22 in developed countries under the Montreal Protocol	8C01

R-125/134a/600 (46.5/50.0/3.5)

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----- REFRIGERANT DATA SUMMARY -----
unassigned   R-125/134a/600 (46.5/50.0/3.5)           see
zeotrope     ternary blend                                       RDB#
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COMMON USE(S)

alternative for refrigerant 22, for air conditioners, chillers, and refrigeration, and possibly also refrigerant 502, for low- and medium-temperature refrigeration, primarily for aftermarket use to retrofit existing equipment; developmental formulation for Rhodia Isceon 59 (subsequently reformulated)

The following information is preliminary and may be incomplete or incorrect. Data may be available from Rhodia Limited (Avonmouth, Bristol, UK) and other refrigerant manufacturers. Product literature indicates that compressor discharge temperatures and condensing pressures are lower than with refrigerant 22 and that the blend is suitable for use with existing lubricants.

IDENTIFIERS

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common name(s):  R-125/134a/600 (46.5/50.0/3.5) mfr
                  R125/134a/600 (46.5/50.0/3.5) mfr
                  R 125/134a/600 (46.5/50.0/3.5) mfr
historical name(s): Rhône-Poulenc RX3                6708

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PHYSICAL

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· nominal blend formulation -----
  composition:      R-125/134a/600                    mfr
  component weight fractions: 46.5 / 50.0 / 3.5 %      mfr
  component weight tolerances: ±1.0 / ±1.0 / +0.0,-0.5 mfr
  component mole fractions:  41.317 / 52.261 / 6.422 %  8820
· properties -----
  molar mass:      106.64430 g/mol (0.235110          8820
                  lb/mol)
· normal boiling point -----
  bubble point temperature: -38.0 °C (-36.3 °F)      8414
                          -41.8 °C (-43.2 °F)      mfr
  dew point temperature:  -32.8 °C (-27.1 °F)      8414
                          -36.3 °C (-33.3 °F)      mfr
  maximum temperature glide: 5.14 °C (9.2 °F)        8414
  density, saturated liquid: 1381 kg/m3 (86.21 lb/cf) 8414
  density, saturated vapor:  5.64 kg/m3 (0.352 lb/cf) 8414
  specific volume, saturated liquid: 0.724 L/kg (0.0116 cf/lb) 8414
  specific volume, saturated vapor: 177.2 L/kg (2.8380 cf/lb) 8414
  heat of vaporization:      201.9 kJ/kg (86.8 Btu/lb) 8414
  velocity of sound, saturated liquid: 741 m/s (2431 ft/s) 8814
  velocity of sound, saturated vapor: 140 m/s (460 ft/s) 8814
  viscosity, saturated liquid: 388 µPa·s (0.388 cp) 8414
  viscosity, saturated vapor:  9.63 µPa·s (0.00963 cp) 8414
  thermal conductivity, liquid: 0.1006 W/m·K (0.0581
                                Btu/hr·ft·°F)      8414
  thermal conductivity, vapor: 0.0093 W/m·K (0.0054
                                Btu/hr·ft·°F)      8414
· normal pressure, 20 °C (68 °F) -----

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

	density, vapor:	4.522 kg/m ³ (0.2823 lb/cf)	8414
· normal pressure, 21.1 °C (70 °F) ---			
	density, vapor:	4.504 kg/m ³ (0.2812 lb/cf)	8414
· 20 °C (68 °F) -----			
	pressure, liquid (bubble point):	822.3 kPa (119.27 psia)	8814
	pressure, vapor (dew point):	731.1 kPa (106.03 psia)	8814
	density, saturated liquid:	1180 kg/m ³ (73.67 lb/cf)	8414
	density, saturated vapor:	38.17 kg/m ³ (2.383 lb/cf)	8414
	specific volume, saturated liquid:	0.847 L/kg (0.0136 cf/lb)	8414
	specific volume, saturated vapor:	26.2 L/kg (0.4197 cf/lb)	8414
	velocity of sound, saturated liquid:	464 m/s (1524 ft/s)	8814
	velocity of sound, saturated vapor:	138 m/s (453 ft/s)	8814
	viscosity, saturated liquid:	178 µPa·s (0.178 cp)	8414
	viscosity, saturated vapor:	11.9 µPa·s (0.0119 cp)	8414
	thermal conductivity, saturatd liquid:	0.0747 W/m·K (0.0432 Btu/hr·ft°F)	8414
	thermal conductivity, saturated vapor:	0.01392 W/m·K (0.00804 Btu/hr·ft°F)	8414
· 60 °C (140 °F) -----			
	pressure, liquid (bubble point):	2225 kPa (322.7 psia)	8814
	pressure, vapor (dew point):	2087 kPa (302.6 psia)	8814
	heat of vaporization:	110.4 kJ/kg for liquid and vapor both at nominal composition (47.5 Btu/lb)	8414
		108.8 kJ/kg coexisting liquid and vapor at bubble-point pressure (46.8 Btu/lb)	8414
· critical point -----			
	temperature:	90.1 °C (194.1 °F)	8414
		90.5 °C (194.9 °F)	mfr
	pressure:	3860 kPa (559.8 psia)	mfr
		4101 kPa (594.8 psia)	8814
	density:	519 kg/m ³ (32.4 lb/cf)	8414
	specific volume:	1.93 L/kg (0.0308 cf/lb)	8414
ENVIRONMENTAL			
	ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
		<0.00027 mass-weighted average (semi-empirical relative to R 11)	9501
	GWP (global warming potential):	2570 mass-weighted average relative to CO ₂ for 100 yr integration	9501
	HGWP (halocarbon GWP):	0.44 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY			
· classification -----			
	safety group (ASHRAE Standard 34):	none (no application pending)	8601
· flammability -----			
	LFL-UFL (flammability limits in air):	nonflammable	6708
PRODUCTION			
	first commercial use as a refrigerant:	June 1996	6708
	last year production allowed:	unrestricted	8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

R-125/134a/600 (46.6/50.0/3.4)

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----- REFRIGERANT DATA SUMMARY -----
unassigned   R-125/134a/600 (46.6/50.0/3.4)           see
zeotrope     ternary blend                                     RDB#
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COMMON USE(S)

alternative for refrigerant 22, for air conditioners, chillers, and refrigeration, and possibly also refrigerant 502, for low- and medium-temperature refrigeration, primarily for aftermarket use to retrofit existing equipment

The following information is preliminary and may be incomplete or incorrect. Data may be available from Rhodia Limited (Avonmouth, Bristol, UK) and other refrigerant manufacturers. Product literature indicates that compressor discharge temperatures and condensing pressures are lower than with refrigerant 22 and that the blend is suitable for use with existing lubricants.

IDENTIFIERS

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common name(s):  R-125/134a/600 (46.6/50.0/3.4) mfr
                  R125/134a/600 (46.6/50.0/3.4) mfr
                  R 125/134a/600 (46.6/50.0/3.4) mfr
trade name(s):   Rhodia Isceon 59
historical name(s): Rhône-Poulenc Isceon 59      mfr

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PHYSICAL

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· nominal blend formulation -----
  composition:      R-125/134a/600                mfr
  component weight fractions: 46.6 / 50.0 / 3.4 %    mfr
  component weight tolerances: ±1.1 / ±1.0 / +0.1, -0.4 mfr
  component mole fractions: 41.445 / 52.310 / 6.244 % 8820
· properties -----
  molar mass:       106.74531 g/mol (0.235333        8820
                    lb/mol)
· normal boiling point -----
  bubble point temperature: -38.0 °C (-36.4 °F)      8414
  dew point temperature:   -32.9 °C (-27.2 °F)      8414
  maximum temperature glide: 5.14 °C (9.2 °F)       8414
  density, saturated liquid: 1383 kg/m3 (86.33 lb/cf) 8414
  density, saturated vapor:  5.65 kg/m3 (0.353 lb/cf) 8414
  specific volume, saturated liquid: 0.723 L/kg (0.0116 cf/lb) 8414
  specific volume, saturated vapor:  177.0 L/kg (2.8349 cf/lb) 8414
  heat of vaporization:      201.7 kJ/kg (86.7 Btu/lb) 8414
  velocity of sound, saturated liquid: 741 m/s (2430 ft/s) 8814
  velocity of sound, saturated vapor:  140 m/s (460 ft/s) 8814
  viscosity, saturated liquid: 389 µPa·s (0.389 cp) 8414
  viscosity, saturated vapor:  9.64 µPa·s (0.00964 cp) 8414
  thermal conductivity, liquid: 0.1006 W/m·K (0.0581
                    Btu/hr·ft°F) 8414
  thermal conductivity, vapor: 0.0093 W/m·K (0.0054
                    Btu/hr·ft°F) 8414
· normal pressure, 20 °C (68 °F) -----
  density, vapor:          4.526 kg/m3 (0.2826 lb/cf) 8414
· normal pressure, 21.1 °C (70 °F) ---

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	density, vapor:	4.508 kg/m3 (0.2814 lb/cf)	8414
· 20 °C (68 °F) -----			
	pressure, liquid (bubble point):	823.4 kPa (119.43 psia)	8814
	pressure, vapor (dew point):	732.3 kPa (106.21 psia)	8814
	density, saturated liquid:	1182 kg/m3 (73.76 lb/cf)	8414
	density, saturated vapor:	38.27 kg/m3 (2.389 lb/cf)	8414
	specific volume, saturated liquid:	0.846 L/kg (0.0136 cf/lb)	8414
	specific volume, saturated vapor:	26.1 L/kg (0.4185 cf/lb)	8414
	velocity of sound, saturated liquid:	464 m/s (1522 ft/s)	8814
	velocity of sound, saturated vapor:	138 m/s (452 ft/s)	8814
	viscosity, saturated liquid:	178 µPa·s (0.178 cp)	8414
	viscosity, saturated vapor:	11.9 µPa·s (0.0119 cp)	8414
	thermal conductivity, saturatd liquid:	0.0746 W/m·K (0.0431 Btu/hr·ft°F)	8414
	thermal conductivity, saturated vapor:	0.01392 W/m·K (0.00804 Btu/hr·ft°F)	8414
· 60 °C (140 °F) -----			
	pressure, liquid (bubble point):	2228 kPa (323.1 psia)	8814
	pressure, vapor (dew point):	2090 kPa (303.1 psia)	8814
	heat of vaporization:	110.2 kJ/kg for liquid and vapor both at nominal composition (47.4 Btu/lb)	8414
		108.6 kJ/kg coexisting liquid and vapor at bubble-point pressure (46.7 Btu/lb)	8414
· critical point -----			
	temperature:	89.9 °C (193.9 °F)	8414
	pressure:	3860 kPa (559.8 psia)	mfr
		4096 kPa (594.1 psia)	8814
	density:	520 kg/m3 (32.5 lb/cf)	8414
	specific volume:	1.92 L/kg (0.0308 cf/lb)	8414

ENVIRONMENTAL

ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
	<0.00027 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	2570 mass-weighted average relative to CO2 for 100 yr integration	9501
HGWP (halocarbon GWP):	0.44 mass-weighted average relative to R 11 for infinite integration period	DW

SAFETY

· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
· emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	49,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
· flammability -----		
LFL-UFL (flammability limits in air):	nonflammable	6708

PRODUCTION

first commercial use as a refrigerant:	June 1996	6708
last year production allowed:	unrestricted	8C01

R-125/143a (45.0/55.0)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-125/143a (45.0/55.0) see
 azeotrope binary blend RDB#

COMMON USE(S)

under consideration as a replacement for refrigerant 502 especially for low-temperature commercial refrigeration, such as supermarket display cases and ice machines; this blend may be covered by U.S. patent 5,211,867 and was a developmental version of AlliedSignal Genetron(R) AZ-50 (subsequently reformulated)

IDENTIFIERS

common name(s): R-125/143a (45/55)
 R125/143a (45/55)
 R 125/143a (45/55)
 candidate for R-507 series
 HFC-125/HFC-143a (45/55)
 not HFC-125/143a (45/55)

PHYSICAL

· nominal blend formulation -----
 composition: R-125/143a
 component weight fractions: 45.0 / 55.0 %
 component mole fractions: 36.423 / 63.577 % 8820

· properties -----
 molar mass: 97.14584 g/mol (0.214170 lb/mol) 8820

· normal boiling point -----
 bubble point temperature: -47.1 °C (-52.7 °F) 8401
 dew point temperature: -47.1 °C (-52.7 °F) 8401
 maximum temperature glide: 0.00 °C (0.0 °F) 8401
 density, saturated liquid: 1302 kg/m3 (81.28 lb/cf) 8401
 density, saturated vapor: 5.49 kg/m3 (0.343 lb/cf) 8401
 specific volume, saturated liquid: 0.768 L/kg (0.0123 cf/lb) 8401
 specific volume, saturated vapor: 182.2 L/kg (2.9178 cf/lb) 8401
 heat of vaporization: 199.2 kJ/kg (85.6 Btu/lb) 8401
 velocity of sound, saturated liquid: 745 m/s (2444 ft/s) 8401
 velocity of sound, saturated vapor: 143 m/s (470 ft/s) 8401
 viscosity, saturated liquid: 322 µPa·s (0.322 cp) 8401
 viscosity, saturated vapor: 9.04 µPa·s (0.00904 cp) 8401
 thermal conductivity, liquid: 0.0982 W/m·K (0.0567 Btu/hr·ft°F) 8401
 thermal conductivity, vapor: 0.0090 W/m·K (0.0052 Btu/hr·ft°F) 8401

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 4.110 kg/m3 (0.2566 lb/cf) 8401

· normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 4.094 kg/m3 (0.2556 lb/cf) 8401

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 1123.6 kPa (162.96 psia) 8401
 pressure, vapor (dew point): 1122.7 kPa (162.83 psia) 8401
 density, saturated liquid: 1060 kg/m3 (66.15 lb/cf) 8401
 density, saturated vapor: 58.36 kg/m3 (3.643 lb/cf) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

specific volume, saturated liquid:	0.944 L/kg (0.0151 cf/lb)	8401
specific volume, saturated vapor:	17.1 L/kg (0.2745 cf/lb)	8401
velocity of sound, saturated liquid:	407 m/s (1335 ft/s)	8401
velocity of sound, saturated vapor:	136 m/s (445 ft/s)	8401
viscosity, saturated liquid:	133 $\mu\text{Pa}\cdot\text{s}$ (0.133 cp)	8401
viscosity, saturated vapor:	12.2 $\mu\text{Pa}\cdot\text{s}$ (0.0122 cp)	8401
thermal conductivity, saturated liquid:	0.0689 W/m \cdot K (0.0398 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01548 W/m \cdot K (0.00894 Btu/hr \cdot ft $^{\circ}$ F)	8401
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	2938 kPa (426.2 psia)	8401
pressure, vapor (dew point):	2937 kPa (425.9 psia)	8401
heat of vaporization:	79.0 kJ/kg for liquid and vapor both at nominal composition (34.0 Btu/lb)	8401
	79.6 kJ/kg coexisting liquid and vapor at bubble-point pressure (34.2 Btu/lb)	8401
• critical point -----		
temperature:	71.0 $^{\circ}$ C (159.9 $^{\circ}$ F)	8401
	71.3 $^{\circ}$ C (160.3 $^{\circ}$ F)	3222
pressure:	3702 kPa (537.0 psia)	3512
	3721 kPa (539.7 psia)	8401
density:	486 kg/m ³ (30.3 lb/cf)	8401
	490 kg/m ³ (30.6 lb/cf)	3222
specific volume:	2.04 L/kg (0.0327 cf/lb)	3222
	2.06 L/kg (0.0330 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
GWP (global warming potential):	4680 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.83 mass-weighted average relative to R 11 for infinite integration period	DW
	0.98 relative to R 11 for infinite integration period	3330

SAFETY

• classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
	components are A1 and A2	8601
• flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	3222

PRODUCTION

first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	unrestricted	8C01

R-125/143a/290/22 (42.0/6.0/2.0/50.0)

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----- REFRIGERANT DATA SUMMARY -----
unassigned   R-125/143a/290/22 (42.0/6.0/2.0/50.0)      see
zeotrope     tetry blend                                           RDB#
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COMMON USE(S)

alternative for refrigerant 502, primarily for aftermarket use to service or retrofit existing low and medium temperature refrigeration equipment without a lubricant change

IDENTIFIERS

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common name(s):  R-125/143a/290/22 (42/6/2/50)
                  R125/143a/290/22 (42/6/2/50)
                  R 125/143a/290/22 (42/6/2/50)
                  HFC-125/HFC-143a/HC-290/           2909
                  HCFC-22 (42/6/2/50)
                  not HCFC-125/143a/290/22           2909
                  "R-22/125/143a/290"
                  "R22/R125/R143a/R290"
trade name(s):   Ausimont Meforex(R) DI-44           7203
ARI container color / Pantone number: none, use light green grey/413 6601

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PHYSICAL

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· nominal blend formulation -----
      composition:  R-125/143a/290/22
      component weight fractions:  42.0 / 6.0 / 2.0 / 50.0 %
      component mole fractions:    33.489/ 6.832/ 4.341/ 55.338 % 8820
· properties -----
      molar mass:   95.69968 g/mol (0.210982           8820
                  lb/mol)
· normal boiling point -----
      bubble point temperature:  -45.6 °C (-50.1 °F)           7203
                              -47.7 °C (-53.9 °F)           8401
      dew point temperature:    -44.6 °C (-48.3 °F)           7203
                              -45.7 °C (-50.3 °F)           8401
      maximum temperature glide: 2.03 °C (3.6 °F)           8401
      density, saturated liquid: 1396 kg/m3 (87.12 lb/cf)   8401
      density, saturated vapor:  5.34 kg/m3 (0.333 lb/cf)   8401
      specific volume, saturated liquid: 0.717 L/kg (0.0115 cf/lb) 8401
      specific volume, saturated vapor: 187.4 L/kg (3.0015 cf/lb) 8401
      heat of vaporization:       206.7 kJ/kg (88.8 Btu/lb) 8401
      velocity of sound, saturated liquid: 796 m/s (2612 ft/s) 8401
      velocity of sound, saturated vapor: 147 m/s (483 ft/s) 8401
      viscosity, saturated liquid: 354 µPa·s (0.354 cp)     8401
      viscosity, saturated vapor:  9.61 µPa·s (0.00961 cp) 8401
      thermal conductivity, liquid: 0.1044 W/m·K (0.0603           8401
                              Btu/hr·ft²·°F)
      thermal conductivity, vapor: 0.0076 W/m·K (0.0044           8401
                              Btu/hr·ft²·°F)
· normal pressure, 20 °C (68 °F) -----
      density, vapor: 4.041 kg/m3 (0.2523 lb/cf)           8401
· normal pressure, 21.1 °C (70 °F) ---
      density, vapor: 4.025 kg/m3 (0.2513 lb/cf)           8401
· 20 °C (68 °F) -----

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

pressure, liquid (bubble point):	1127.5 kPa (163.53 psia)	8401
pressure, vapor (dew point):	1091.0 kPa (158.24 psia)	8401
density, saturated liquid:	1152 kg/m ³ (71.94 lb/cf)	8401
density, saturated vapor:	53.50 kg/m ³ (3.340 lb/cf)	8401
specific volume, saturated liquid:	0.868 L/kg (0.0139 cf/lb)	8401
specific volume, saturated vapor:	18.7 L/kg (0.2994 cf/lb)	8401
velocity of sound, saturated liquid:	458 m/s (1502 ft/s)	8401
velocity of sound, saturated vapor:	144 m/s (472 ft/s)	8401
viscosity, saturated liquid:	152 μ Pa·s (0.152 cp)	8401
viscosity, saturated vapor:	12.7 μ Pa·s (0.0127 cp)	8401
thermal conductivity, saturated liquid:	0.0732 W/m·K (0.0423 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01261 W/m·K (0.00728 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	2910 kPa (422.0 psia)	8401
pressure, vapor (dew point):	2865 kPa (415.5 psia)	8401
heat of vaporization:	99.1 kJ/kg for liquid and vapor both at nominal composition (42.6 Btu/lb)	8401
	99.5 kJ/kg coexisting liquid and vapor at bubble-point pressure (42.8 Btu/lb)	8401
· critical point -----		
temperature:	81.0 °C (177.7 °F)	8401
pressure:	4448 kPa (645.1 psia)	8401
density:	529 kg/m ³ (33.0 lb/cf)	8401
specific volume:	1.89 L/kg (0.0303 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.017 mass-weighted average (model-derived relative to R 11)	9501
	0.025 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	2870 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.49 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	Ausimont AEL: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	7203
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	7203
PRODUCTION		
first commercial use as a refrigerant:	1996	
last year production allowed:	2029 by refrigerant 22 in developed countries under the Montreal Protocol	8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

R-125/152a/227ea (40.0/5.0/55.0)

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----- REFRIGERANT DATA SUMMARY -----
unassigned   R-125/152a/227ea (40.0/5.0/55.0)           see
zeotrope     ternary blend                                       RDB#
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COMMON USE(S)

alternative for refrigerant 134a for automobile air conditioners and other mobile air-conditioning (MAC) systems to increase cooling capacity, primarily for aftermarket use to service or retrofit marginally performing existing equipment

The following information is preliminary and may be incomplete or incorrect. Further data may be available from GHG Dev Labs (West Lafayette, IN, USA) or refrigerant manufacturers. Product literature indicates that this zeotropic blend of hydrofluorocarbons (HFCs) is a high performance refrigerant that will result in a 6 °C (10 °F) colder duct temperature. The description indicates that the blend is not miscible in mineral oils and requires a polyalkylene glycol (PAG) or polyolester (POE) lubricant.

IDENTIFIERS

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common name(s):  R-125/152a/227ea
                  (40.0/5.0/55.0)
                  R125/152a/227ea
                  (40.0/5.0/55.0)
                  R 125/152a/227ea
                  (40.0/5.0/55.0)
                  HFC-125/HFC-152a/HFC-227ea
                  (40.0/5.0/55.0)
                  not HFC-125/152a/227ea
                  "R-227ea/152a/125 (55/5/40)"      mfr
                  R-125/152a/227ea (40/5/55)
trade name(s):   Autofrost GHG X7
                  MonroeAirTech Autofrost X7(TM)
                  Peoples Welding Supply GHG-X7
ARI container color / Pantone number: none, use light green grey/413 6601

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PHYSICAL

```

· nominal blend formulation -----
      composition:  R-125/152a/227ea           mfr
      component weight fractions: 40.0 / 5.0 / 55.0 %      mfr
      component weight tolerances: not indicated
      component mole fractions: 45.501 / 10.335 / 44.163 %  8820
· properties -----
      molar mass: 136.52832 g/mol (0.300993 lb/mol)      8820
· normal boiling point -----
      bubble point temperature: -34.4 °C (-29.9 °F)      MSDS
                               -38.6 °C (-37.4 °F)      8401
      dew point temperature: -27.8 °C (-18.0 °F)         8401
      maximum temperature glide: 10.79 °C (19.4 °F)       8401
      density, saturated liquid: 1509 kg/m3 (94.17 lb/cf)  8401
      density, saturated vapor: 7.08 kg/m3 (0.442 lb/cf)  8401
      specific volume, saturated liquid: 0.663 L/kg (0.0106 cf/lb) 8401

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specific volume, saturated vapor:	141.2 L/kg (2.2613 cf/lb)	8401
heat of vaporization:	165.4 kJ/kg (71.1 Btu/lb)	8401
velocity of sound, saturated liquid:	646 m/s (2119 ft/s)	8401
velocity of sound, saturated vapor:	123 m/s (405 ft/s)	8401
viscosity, saturated liquid:	446 $\mu\text{Pa}\cdot\text{s}$ (0.446 cp)	8401
viscosity, saturated vapor:	9.94 $\mu\text{Pa}\cdot\text{s}$ (0.00994 cp)	8401
thermal conductivity, liquid:	0.0801 W/m \cdot K (0.0463 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, vapor:	0.0096 W/m \cdot K (0.0055 Btu/hr \cdot ft $^{\circ}$ F)	8401
• normal pressure, 20 $^{\circ}$ C (68 $^{\circ}$ F) -----		
density, vapor:	5.802 kg/m 3 (0.3622 lb/cf)	8401
• normal pressure, 21.1 $^{\circ}$ C (70 $^{\circ}$ F) ---		
density, vapor:	5.778 kg/m 3 (0.3607 lb/cf)	8401
• 20 $^{\circ}$ C (68 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	805.5 kPa (116.83 psia)	8401
pressure, vapor (dew point):	636.1 kPa (92.25 psia)	8401
density, saturated liquid:	1282 kg/m 3 (80.01 lb/cf)	8401
density, saturated vapor:	42.15 kg/m 3 (2.631 lb/cf)	8401
specific volume, saturated liquid:	0.780 L/kg (0.0125 cf/lb)	8401
specific volume, saturated vapor:	23.7 L/kg (0.3801 cf/lb)	8401
velocity of sound, saturated liquid:	394 m/s (1294 ft/s)	8401
velocity of sound, saturated vapor:	121 m/s (396 ft/s)	8401
viscosity, saturated liquid:	190 $\mu\text{Pa}\cdot\text{s}$ (0.190 cp)	8401
viscosity, saturated vapor:	12.1 $\mu\text{Pa}\cdot\text{s}$ (0.0121 cp)	8401
thermal conductivity, saturated liquid:	0.0597 W/m \cdot K (0.0345 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01336 W/m \cdot K (0.00772 Btu/hr \cdot ft $^{\circ}$ F)	8401
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	2121 kPa (307.6 psia)	8401
pressure, vapor (dew point):	1874 kPa (271.8 psia)	8401
heat of vaporization:	83.8 kJ/kg for liquid and vapor both at nominal composition (36.0 Btu/lb)	8401
	78.5 kJ/kg coexisting liquid and vapor at bubble-point pressure (33.8 Btu/lb)	8401
• critical point -----		
temperature:	87.2 $^{\circ}$ C (189.0 $^{\circ}$ F)	8401
pressure:	3577 kPa (518.8 psia)	8401
density:	560 kg/m 3 (35.0 lb/cf)	8401
specific volume:	1.78 L/kg (0.0286 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
GWP (global warming potential):	3620 mass-weighted average relative to CO $_2$ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.64 mass-weighted average relative to R 11 for infinite integration period	DW

SAFETY

• classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
	components are A1, A2, and	8601

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

	unclassified	8601
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	GHG: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	MSDS
· flammability -----		
LFL-UFL (flammability limits in air):	GHG: nonflammable	MSDS
flash point:	GHG: none	MSDS
autoignition temperature:	GHG: ~260°C (~500°F)	MSDS
autodecomposition temperature:	GHG: ≥204 °C (≥400 °F)	MSDS
· detection -----		
appearance:	GHG: colorless liquified gas	MSDS
odor:	GHG: faint etherial odor	MSDS
PRODUCTION		
first commercial use as a refrigerant:	circa 1999	
last year production allowed:	unrestricted	3C05

R-125/290/218

----- REFRIGERANT DATA SUMMARY -----

unassigned R-125/290/218 (formulation not disclosed) see
zeotrope blend RDB#

COMMON USE(S)

alternative for refrigerant 13B1 in both existing and new equipment for very low temperature refrigeration, including that for process use, thermal shock systems, environmental test chambers, and freeze drying

Note: The following information is preliminary and may be incomplete or incorrect. Data may be available from Rhodia Limited (Avonmouth, Bristol, UK), Star Refrigeration (Glasgow, Scotland, UK), and other refrigerant manufacturers. Preliminary data show the pressures of this blend to be similar, but slightly lower than for refrigerant 13B1 with a small increase in efficiency and small decrease in capacity under identical conditions.

IDENTIFIERS

common name(s): R-125/290/218 (??/??/??)
HFC-125/HC-290/FC-218 (??/??/??)
trade name(s): Rhodia Isceon 89
historical name(s): Rhône-Poulenc Isceon 89
ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

• nominal blend formulation -----
composition: R-125/290/218
component weight fractions: formulation must be indicated
%

• normal boiling point -----
bubble point temperature: -54.6 °C (-66.3 °F) mfr
density, saturated vapor: 5.10 kg/m3 (0.318 lb/cf) mfr
heat of vaporization: 176.1 kJ/kg (75.7 Btu/lb) mfr

• 20 °C (68 °F) -----
pressure, liquid (bubble point): 1328.8 kPa (192.73 psia) mfr
pressure, vapor (dew point): 1244.0 kPa (180.43 psia) mfr
density, saturated liquid: 1168 kg/m3 (72.93 lb/cf) mfr
density, saturated vapor: 77.10 kg/m3 (4.813 lb/cf) 3209
specific volume, saturated liquid: 0.883 L/kg (0.0141 cf/lb) mfr
specific volume, saturated vapor: 13.0 L/kg (0.2078 cf/lb) mfr

• 60 °C (140 °F) -----
pressure, liquid (bubble point): 3284 kPa (476.2 psia) mfr
pressure, vapor (dew point): 3135 kPa (454.7 psia) mfr

• critical point -----
temperature: 70.1 °C (158.2 °F) mfr
pressure: 3650 kPa (529.4 psia) mfr

ENVIRONMENTAL

ODP (ozone depletion potential): 0.000 (model-derived relative to R 11)
HGWP (halocarbon GWP): 0.98 relative to R 11 for infinite integration period mfr

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

R-134a/124/600 (59.0/39.0/2.0)

```

----- REFRIGERANT DATA SUMMARY -----
unassigned R-134a/124/600 (59.0/39.0/2.0) see
ternary blend RDB#
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COMMON USE(S)

considered as a replacement for refrigerant 12 for aftermarket use as a service fluid in mobile air conditioners, transport refrigeration equipment, and other applications

This refrigerant may be covered by U.S. patents 5,360,566 and 5,425,890.

IDENTIFIERS

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common name(s): R-134a/124/600 (59/39/2)
                R134a/124/600 (59/39/2)
                R 134a/124/600 (59/39/2)
                candidate for R-416 series
                HFC-134a/HCFC-124/HC-600
                (59/39/2)
                not HCFC-134a/124/600
                (59/39/2)
trade name(s): Ausimont Meforex(R) DI-24
ARI container color / Pantone number: none, use light green grey/413 6601

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PHYSICAL

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· nominal blend formulation -----
      composition: R-134a/124/600
component weight fractions: 59.0 / 39.0 / 2.0 %
component mole fractions: 64.363 / 31.807 / 3.830 %      8820
· properties -----
      molar mass: 111.30506 g/mol (0.245386 lb/mol)      8820
· normal boiling point -----
  bubble point temperature: -23.4 °C (-10.1 °F)      8401
  dew point temperature: -21.8 °C (-7.3 °F)      8401
  maximum temperature glide: 1.56 °C (2.8 °F)      8401
  density, saturated liquid: 1378 kg/m3 (86.01 lb/cf)      8401
  density, saturated vapor: 5.64 kg/m3 (0.352 lb/cf)      8401
  specific volume, saturated liquid: 0.726 L/kg (0.0116 cf/lb)      8401
  specific volume, saturated vapor: 177.3 L/kg (2.8406 cf/lb)      8401
  heat of vaporization: 199.8 kJ/kg (85.9 Btu/lb)      8401
  velocity of sound, saturated liquid: 721 m/s (2365 ft/s)      8401
  velocity of sound, saturated vapor: 140 m/s (459 ft/s)      8401
  viscosity, saturated liquid: 371 µPa·s (0.371 cp)      8401
  viscosity, saturated vapor: 9.65 µPa·s (0.00965 cp)      8401
  thermal conductivity, liquid: 0.0948 W/m·K (0.0548 Btu/hr·ft°F)      8401
  thermal conductivity, vapor: 0.0094 W/m·K (0.0055 Btu/hr·ft°F)      8401
· normal pressure, 20 °C (68 °F) -----
  density, vapor: 4.739 kg/m3 (0.2958 lb/cf)      8401
· normal pressure, 21.1 °C (70 °F) ---
  density, vapor: 4.719 kg/m3 (0.2946 lb/cf)      8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	505.0 kPa (73.24 psia)	8401
pressure, vapor (dew point):	479.7 kPa (69.58 psia)	8401
density, saturated liquid:	1240 kg/m ³ (77.39 lb/cf)	8401
density, saturated vapor:	25.00 kg/m ³ (1.561 lb/cf)	8401
specific volume, saturated liquid:	0.807 L/kg (0.0129 cf/lb)	8401
specific volume, saturated vapor:	40.0 L/kg (0.6407 cf/lb)	8401
velocity of sound, saturated liquid:	529 m/s (1735 ft/s)	8401
velocity of sound, saturated vapor:	140 m/s (459 ft/s)	8401
viscosity, saturated liquid:	213 µPa·s (0.213 cp)	8401
viscosity, saturated vapor:	11.3 µPa·s (0.0113 cp)	8401
thermal conductivity, saturated liquid:	0.0776 W/m·K (0.0448 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01277 W/m·K (0.00738 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1478 kPa (214.4 psia)	8401
pressure, vapor (dew point):	1425 kPa (206.6 psia)	8401
heat of vaporization:	133.4 kJ/kg for liquid and	8401
	vapor both at nominal	
	composition (57.4 Btu/lb)	
	127.8 kJ/kg coexisting liquid	8401
	and vapor at bubble-point	
	pressure (54.9 Btu/lb)	
· critical point -----		
temperature:	108.6 °C (227.5 °F)	8401
pressure:	4042 kPa (586.2 psia)	8401
density:	513 kg/m ³ (32.1 lb/cf)	8401
specific volume:	1.95 L/kg (0.0312 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	0.010 mass-weighted average	9501
	(model-derived relative to R	
	11)	
	0.010 mass-weighted average	9501
	(semi-empirical relative to R	
	11)	
GWP (global warming potential):	1190 mass-weighted average	9501
	relative to CO ₂ for 100 yr	
	integration	
HGWP (halocarbon GWP):	0.20 mass-weighted average	DW
	relative to R 11 for infinite	
	integration period	

SAFETY

· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
	components are A1, A1, and A3	8601
NFPA 704 degrees of hazard (H-F-R-S):	IGC/ICE: 2-0-0	MSDS
	health-flammability-reactivity	
	[-special]: 0=no, 4=severe	
· acute (short-term) toxicity -----		
cardiac sensitization threshold/LOEL:	dog: 70,000 ppm v/v (lowest	4C58
	observed effect level in test	
	animals)	
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	6C06
	worst fractionation flammable	
flash point:	IGC/ICE: none	MSDS

· detection -----

appearance: IGC/ICE: clear, colorless gas MSDS
odor: IGC/ICE: faint hydrocarbon MSDS

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized
last year production allowed: 2029 based on refrigerant 124 8C01
in developed countries under
the Montreal Protocol

R-134a/142b (80.0/20.0)

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----- REFRIGERANT DATA SUMMARY -----
unassigned   R-134a/142b (80.0/20.0)                see
zeotrope     binary blend                                RDB#
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COMMON USE(S)

service fluid to replace refrigerant 12, for aftermarket use to retrofit existing automobile air conditioners and other mobile air-conditioning (MAC) systems

The following information is preliminary and may be incomplete or incorrect. Data may be available from Technical Chemical Company (TCC, Dallas, TX, USA), and other refrigerant manufacturers.

Note: This refrigerant also is sold as a "ternary blend" containing a small amount, up to 3%, of lubricant. Unconfirmed information indicates that the lubricant component may be a polyolester.

IDENTIFIERS

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common name(s):  R-134a/142b (80/20)
                  R134a/142b (80/20)
                  R 134a/142b (80/20)
                  HFC-134a/HCFC-142b (80/20)
                  not HCFC-134a/142b (80/20)
trade name(s):  TCC Johnsen's Freeze 12(TM)      8355
                 TCC Sercon Freeze 12(TM)       8355

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PHYSICAL

```

· nominal blend formulation -----
      composition:  R-134a/142b
component weight fractions:  80.0 / 20.0 %
component mole fractions:    79.756 / 20.244 %      8820
· properties -----
      molar mass:   101.71191 g/mol (0.224236      8820
                    lb/mol)
· normal boiling point -----
      bubble point temperature:  -24.1 °C (-11.4 °F)      8401
      dew point temperature:     -22.7 °C (-8.9 °F)      8401
      maximum temperature glide: 1.39 °C (2.5 °F)        8401
      density, saturated liquid: 1336 kg/m3 (83.42 lb/cf) 8401
      density, saturated vapor:  5.17 kg/m3 (0.323 lb/cf) 8401
      specific volume, saturated liquid: 0.748 L/kg (0.0120 cf/lb) 8401
      specific volume, saturated vapor: 193.4 L/kg (3.0983 cf/lb) 8401
      heat of vaporization:       218.7 kJ/kg (94.0 Btu/lb) 8401
      velocity of sound, saturated liquid: 748 m/s (2456 ft/s) 8401
      velocity of sound, saturated vapor: 147 m/s (482 ft/s) 8401
      viscosity, saturated liquid: 380 µPa·s (0.380 cp) 8401
      viscosity, saturated vapor:  9.33 µPa·s (0.00933 cp) 8401
      thermal conductivity, liquid: 0.1016 W/m·K (0.0587      8401
                    Btu/hr·ft°F)
      thermal conductivity, vapor: 0.0093 W/m·K (0.0054      8401
                    Btu/hr·ft°F)
· normal pressure, 20 °C (68 °F) ----
      density, vapor: 4.328 kg/m3 (0.2702 lb/cf)      8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

· normal pressure, 21.1 °C (70 °F) ---		
density, vapor:	4.310 kg/m ³ (0.2691 lb/cf)	8401
· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	522.9 kPa (75.84 psia)	8401
pressure, vapor (dew point):	498.0 kPa (72.22 psia)	8401
density, saturated liquid:	1201 kg/m ³ (74.96 lb/cf)	8401
density, saturated vapor:	23.75 kg/m ³ (1.483 lb/cf)	8401
specific volume, saturated liquid:	0.833 L/kg (0.0133 cf/lb)	8401
specific volume, saturated vapor:	42.1 L/kg (0.6744 cf/lb)	8401
velocity of sound, saturated liquid:	550 m/s (1804 ft/s)	8401
velocity of sound, saturated vapor:	147 m/s (483 ft/s)	8401
viscosity, saturated liquid:	216 µPa·s (0.216 cp)	8401
viscosity, saturated vapor:	11.0 µPa·s (0.0110 cp)	8401
thermal conductivity, saturated liquid:	0.0825 W/m·K (0.0477 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01286 W/m·K (0.00743 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1535 kPa (222.7 psia)	8401
pressure, vapor (dew point):	1481 kPa (214.9 psia)	8401
heat of vaporization:	146.3 kJ/kg for liquid and vapor both at nominal composition (62.9 Btu/lb)	8401
	144.9 kJ/kg coexisting liquid and vapor at bubble-point pressure (62.3 Btu/lb)	8401
· critical point -----		
temperature:	107.5 °C (225.5 °F)	8401
pressure:	4119 kPa (597.4 psia)	8401
density:	498 kg/m ³ (31.1 lb/cf)	8401
specific volume:	2.01 L/kg (0.0322 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.010 mass-weighted average (model-derived relative to R 11)	5301
	0.014 mass-weighted average (semi-empirical relative to R 11)	5301
GWP (global warming potential):	1400 mass-weighted average relative to CO ₂ for 100 yr integration	6695
HGWP (halocarbon GWP):	0.30 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending) components are A1 and A2	8601 8601
PRODUCTION		
first commercial use as a refrigerant:	1996	
last year production allowed:	2029 based on HCFC component in developed countries under the Montreal Protocol	8C01

R-134a/142b (80.0/20.0) plus lubricant additive

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----- REFRIGERANT DATA SUMMARY -----
unassigned  R-134a/142b (80.0/20.0) plus lubricant additive      see
zeotrope    binary blend                                         RDB#
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COMMON USE(S)

service fluid to replace refrigerant 12 for aftermarket use to retrofit existing automobile air conditioners, other mobile air-conditioning (MAC) systems, and stationary refrigeration systems

The following information is preliminary and may be incomplete or incorrect. Data may be available from Refrigerant Gases Incorporated (Bedford, TX) and other refrigerant manufacturers. This refrigerant was promoted and/or distributed by American National Corporation (Cocoa Beach, FL, USA), Cool EZ, Incorporated (New Orleans, LA, USA), Patriot Consumer Products (Metairie, LA, USA), and Technical Chemical Company (TCC, Dallas).

Notes: This refrigerant also is sold as a "ternary blend" containing a small amount of lubricant; the nominal formulation is "79/19/2," where the 2% implies the lubricant fraction. Unconfirmed information identifies the lubricant as an additized, naphthenic mineral oil (Royco 783). The trade name "RB-276" was derived from "Refrigerant Blend" and the sum of 134 and 142 from the component designations. The U.S. Air Force conducted tests of this refrigerant in two motor vehicles at Eglin AFB, FL.

IDENTIFIERS

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common name(s):  R-134a/142b (80/20)
                  R134a/142b (80/20)
                  R 134a/142b (80/20)
                  HFC-134a/HCFC-142b (80/20)
                  not HCFC-134a/142b (80/20)
trade name(s):   RGI Free Zone(TM) RB-276
historical name(s): American Natl FreeZone(TM)
                  Cool EZ RB-276
                  Patriot FreeZone(TM)
                  TCC Sercon FreeZone(TM)
name used in U.S. EPA SNAP Rule: HCFC Blend Delta

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PHYSICAL

```

· nominal blend formulation -----
      composition:  R-134a/142b
component weight fractions:  80.0 / 20.0 %
component mole fractions:    79.756 / 20.244 %      8820
· properties -----
      molar mass:   101.71991 g/mol (0.224254      8820
                  lb/mol)
· normal boiling point -----
      bubble point temperature:  -24.1 °C (-11.4 °F)      8401
      dew point temperature:     -22.7 °C (-8.9 °F)      8401
      maximum temperature glide:  1.39 °C (2.5 °F)      8401
      density, saturated liquid:  1336 kg/m3 (83.42 lb/cf)  8401
      density, saturated vapor:   5.17 kg/m3 (0.323 lb/cf)  8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

specific volume, saturated liquid:	0.748 L/kg (0.0120 cf/lb)	8401
specific volume, saturated vapor:	193.4 L/kg (3.0983 cf/lb)	8401
heat of vaporization:	218.7 kJ/kg (94.0 Btu/lb)	8401
velocity of sound, saturated liquid:	748 m/s (2456 ft/s)	8401
velocity of sound, saturated vapor:	147 m/s (482 ft/s)	8401
viscosity, saturated liquid:	380 μ Pa \cdot s (0.380 cp)	8401
viscosity, saturated vapor:	9.33 μ Pa \cdot s (0.00933 cp)	8401
thermal conductivity, liquid:	0.1016 W/m \cdot K (0.0587 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, vapor:	0.0093 W/m \cdot K (0.0054 Btu/hr \cdot ft $^{\circ}$ F)	8401
· normal pressure, 20 $^{\circ}$ C (68 $^{\circ}$ F) -----		
density, vapor:	4.328 kg/m ³ (0.2702 lb/cf)	8401
· normal pressure, 21.1 $^{\circ}$ C (70 $^{\circ}$ F) ---		
density, vapor:	4.310 kg/m ³ (0.2691 lb/cf)	8401
· 20 $^{\circ}$ C (68 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	522.9 kPa (75.84 psia)	8401
pressure, vapor (dew point):	498.0 kPa (72.22 psia)	8401
density, saturated liquid:	1201 kg/m ³ (74.96 lb/cf)	8401
density, saturated vapor:	23.75 kg/m ³ (1.483 lb/cf)	8401
specific volume, saturated liquid:	0.833 L/kg (0.0133 cf/lb)	8401
specific volume, saturated vapor:	42.1 L/kg (0.6744 cf/lb)	8401
velocity of sound, saturated liquid:	550 m/s (1804 ft/s)	8401
velocity of sound, saturated vapor:	147 m/s (483 ft/s)	8401
viscosity, saturated liquid:	216 μ Pa \cdot s (0.216 cp)	8401
viscosity, saturated vapor:	11.0 μ Pa \cdot s (0.0110 cp)	8401
thermal conductivity, saturated liquid:	0.0825 W/m \cdot K (0.0477 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01286 W/m \cdot K (0.00743 Btu/hr \cdot ft $^{\circ}$ F)	8401
· 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	1535 kPa (222.7 psia)	8401
pressure, saturated vapor:	1435 kPa (208.1 psia)	4101
pressure, vapor (dew point):	1481 kPa (214.9 psia)	8401
heat of vaporization:	146.3 kJ/kg for liquid and vapor both at nominal composition (62.9 Btu/lb)	8401
	144.9 kJ/kg coexisting liquid and vapor at bubble-point pressure (62.3 Btu/lb)	8401
· critical point -----		
temperature:	107.5 $^{\circ}$ C (225.5 $^{\circ}$ F)	8401
pressure:	4119 kPa (597.4 psia)	8401
density:	498 kg/m ³ (31.1 lb/cf)	8401
specific volume:	2.01 L/kg (0.0322 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.009 mass-weighted average (model-derived relative to R 11)	5301
	0.014 mass-weighted average (semi-empirical relative to R 11)	5301
GWP (global warming potential):	1740 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.30 mass-weighted average relative to R 11 for infinite integration period	DW

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

SAFETY

· classification -----
safety group (ASHRAE Standard 34): none (no application pending) 8601
components are A1 and A2 8601

PRODUCTION

first commercial use as a refrigerant: 1996
last year production allowed: 2029 based on HCFC component 8C01
in developed countries under
the Montreal Protocol

R-134a/152a (20.0/80.0)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-134a/152a (20.0/80.0) see
 zeotrope binary blend RDB#

COMMON USE(S)

considered (circa 1990-1995) as a replacement for refrigerant 12

described as a quasi-azeotropic blend - one that maintains uniform composition of the liquid and vapor phases coexisting in equilibrium within the entire concentration interval for the range -43 to 87 °C (-46 to 188 °F) (see RDB 7732)

IDENTIFIERS

common name(s): R-134a/152a (20.0/80.0) 2909
 R134a/152a (20.0/80.0) 2909
 R 134a/152a (20.0/80.0) 2909
 ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

· nominal blend formulation -----
 composition: R-134a/152a
 component weight fractions: 20.0 / 80.0 %
 component mole fractions: 13.929 / 86.071 % 8820

· properties -----
 molar mass: 71.06193 g/mol (0.156665 8820
 lb/mol)

· normal boiling point -----
 bubble point temperature: -24.1 °C (-11.4 °F) 8401
 dew point temperature: -24.1 °C (-11.4 °F) 8401
 maximum temperature glide: 0.01 °C (0.0 °F) 8401
 density, saturated liquid: 1065 kg/m3 (66.49 lb/cf) 8401
 density, saturated vapor: 3.63 kg/m3 (0.227 lb/cf) 8401
 specific volume, saturated liquid: 0.939 L/kg (0.0150 cf/lb) 8401
 specific volume, saturated vapor: 275.2 L/kg (4.4075 cf/lb) 8401
 heat of vaporization: 307.5 kJ/kg (132.2 Btu/lb) 8401
 velocity of sound, saturated liquid: 862 m/s (2829 ft/s) 8401
 velocity of sound, saturated vapor: 178 m/s (584 ft/s) 8401
 viscosity, saturated liquid: 308 µPa·s (0.308 cp) 8401
 viscosity, saturated vapor: 8.64 µPa·s (0.00864 cp) 8401
 thermal conductivity, liquid: 0.1179 W/m·K (0.0681 8401
 Btu/hr·ft°F)
 thermal conductivity, vapor: 0.0094 W/m·K (0.0054 8401
 Btu/hr·ft°F)

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 2.983 kg/m3 (0.1862 lb/cf) 8401

· normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 2.971 kg/m3 (0.1855 lb/cf) 8401

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 517.7 kPa (75.08 psia) 8401
 pressure, vapor (dew point): 517.4 kPa (75.04 psia) 8401
 density, saturated liquid: 959 kg/m3 (59.88 lb/cf) 8401
 density, saturated vapor: 17.30 kg/m3 (1.080 lb/cf) 8401
 specific volume, saturated liquid: 1.043 L/kg (0.0167 cf/lb) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

specific volume, saturated vapor:	57.8 L/kg (0.9259 cf/lb)	8401
velocity of sound, saturated liquid:	648 m/s (2125 ft/s)	8401
velocity of sound, saturated vapor:	179 m/s (587 ft/s)	8401
viscosity, saturated liquid:	176 $\mu\text{Pa}\cdot\text{s}$ (0.176 cp)	8401
viscosity, saturated vapor:	10.3 $\mu\text{Pa}\cdot\text{s}$ (0.0103 cp)	8401
thermal conductivity, saturated liquid:	0.0977 W/m \cdot K (0.0564 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01410 W/m \cdot K (0.00815 Btu/hr \cdot ft $^{\circ}$ F)	8401
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	1518 kPa (220.1 psia)	8401
pressure, vapor (dew point):	1517 kPa (220.0 psia)	8401
heat of vaporization:	211.6 kJ/kg for liquid and vapor both at nominal composition (91.0 Btu/lb)	8401
	211.8 kJ/kg coexisting liquid and vapor at bubble-point pressure (91.0 Btu/lb)	8401
• critical point -----		
temperature:	384.2 $^{\circ}$ C (723.6 $^{\circ}$ F)	8401
pressure:	4395 kPa (637.4 psia)	8401
density:	375 kg/m ³ (23.4 lb/cf)	8401
specific volume:	2.67 L/kg (0.0427 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	<0.00001 mass-weighted average (model-derived relative to R 11)	9501
	<0.0001 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	470 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.07 mass-weighted average relative to R 11 for infinite integration period	DW

SAFETY

• classification -----		
safety group (ASHRAE Standard 34):	none (no application pending) components are A1 and A2	8601 8601
• flammability -----		
LFL-UFL (flammability limits in air):	probably flammable	

PRODUCTION

first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	unrestricted	8C01

R-134a/152a (85.0/15.0)

----- REFRIGERANT DATA SUMMARY -----

unassigned	R-134a/152a (85.0/15.0)	see
azeotrope	binary blend	RDB#

COMMON USE(S)

considered (circa 1990-1995) as an alternative for refrigerant 12; the following information is preliminary and may be incomplete or incorrect; data on this blend are available from chemical manufacturers

IDENTIFIERS

common name(s): R-134a/152a (85.0/15.0)
 R134a/152a (85.0/15.0)
 R 134a/152a (85.0/15.0)
 HFC-134a/HFC-152a (85/15)
 not HFC-134a/152a (85/15)

PHYSICAL

· nominal blend formulation -----		
composition:	R-134a/152a	
component weight fractions:	85.0 / 15.0 %	
component mole fractions:	78.579 / 21.421 %	8820
· properties -----		
molar mass:	94.32344 g/mol (0.207948 lb/mol)	8820
· normal boiling point -----		
bubble point temperature:	-25.4 °C (-13.8 °F)	8401
dew point temperature:	-25.4 °C (-13.7 °F)	8401
maximum temperature glide:	0.06 °C (0.1 °F)	8401
density, saturated liquid:	1301 kg/m3 (81.23 lb/cf)	8401
density, saturated vapor:	4.85 kg/m3 (0.303 lb/cf)	8401
specific volume, saturated liquid:	0.769 L/kg (0.0123 cf/lb)	8401
specific volume, saturated vapor:	206.2 L/kg (3.3035 cf/lb)	8401
heat of vaporization:	234.2 kJ/kg (100.7 Btu/lb)	8401
velocity of sound, saturated liquid:	767 m/s (2515 ft/s)	8401
velocity of sound, saturated vapor:	152 m/s (499 ft/s)	8401
viscosity, saturated liquid:	361 µPa·s (0.361 cp)	8401
viscosity, saturated vapor:	9.39 µPa·s (0.00939 cp)	8401
thermal conductivity, liquid:	0.1073 W/m·K (0.0620 Btu/hr·ft°F)	8401
thermal conductivity, vapor:	0.0093 W/m·K (0.0054 Btu/hr·ft°F)	8401
· normal pressure, 20 °C (68 °F) -----		
density, vapor:	4.011 kg/m3 (0.2504 lb/cf)	8401
· normal pressure, 21.1 °C (70 °F) ---		
density, vapor:	3.994 kg/m3 (0.2493 lb/cf)	8401
· 20 °C (68 °F) -----		
pressure, liquid (bubble point):	555.1 kPa (80.50 psia)	8401
pressure, vapor (dew point):	553.6 kPa (80.30 psia)	8401
density, saturated liquid:	1162 kg/m3 (72.55 lb/cf)	8401
density, saturated vapor:	24.79 kg/m3 (1.548 lb/cf)	8401
specific volume, saturated liquid:	0.861 L/kg (0.0138 cf/lb)	8401
specific volume, saturated vapor:	40.3 L/kg (0.6461 cf/lb)	8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

velocity of sound, saturated liquid:	554 m/s (1818 ft/s)	8401
velocity of sound, saturated vapor:	152 m/s (499 ft/s)	8401
viscosity, saturated liquid:	201 $\mu\text{Pa}\cdot\text{s}$ (0.201 cp)	8401
viscosity, saturated vapor:	11.2 $\mu\text{Pa}\cdot\text{s}$ (0.0112 cp)	8401
thermal conductivity, saturated liquid:	0.0869 W/m \cdot K (0.0502 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01350 W/m \cdot K (0.00780 Btu/hr \cdot ft $^{\circ}$ F)	8401
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	1633 kPa (236.8 psia)	8401
pressure, vapor (dew point):	1630 kPa (236.4 psia)	8401
heat of vaporization:	153.0 kJ/kg for liquid and vapor both at nominal composition (65.8 Btu/lb)	8401
	153.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (65.9 Btu/lb)	8401
• critical point -----		
temperature:	102.9 $^{\circ}$ C (217.2 $^{\circ}$ F)	8401
pressure:	4082 kPa (592.0 psia)	8401
density:	474 kg/m ³ (29.6 lb/cf)	8401
specific volume:	2.11 L/kg (0.0338 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
	<0.0005 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1390 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.24 mass-weighted average relative to R 11 for infinite integration period	DW

PRODUCTION

first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	unrestricted	8C01

R-134a/152a/13I1 (26.4/22.8/50.8)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-134a/152a/13I1 (26.4/22.8/50.8) see
 zeotrope ternary blend RDB#

COMMON USE(S)

developmental blend, examined circa 1994, as an alternative for
 refrigerant 12

The designations "Ikon-12D" and "R-12D" were trade names and not
 refrigerant numbers conforming to ASHRAE Standard 34.

IDENTIFIERS

common name(s):	R-134a/152a/13I1	4831
	R134a/152a/13I1	4831
	R 134a/152a/13I1	4831
	(26.4/22.8/50.8)	
historical name(s):	Ikon(R) 12D	4831

PHYSICAL

· nominal blend formulation -----		
	composition: R-134a/152a/13I1	4831
	component weight fractions: 26.4 / 22.8 / 50.8 %	
	component mole fractions: 29.974 / 39.988 / 30.038 %	8820
	30 / 40 / 30 %	4831
· properties -----		
	molar mass: 115.84256 g/mol (0.255389 lb/mol)	8820

ENVIRONMENTAL

ODP (ozone depletion potential):	0.0042 mass-weighted average (model-derived relative to R 11)	9501
	0.0042 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	470 mass-weighted average relative to CO2 for 100 yr integration	9501

SAFETY

· flammability -----		
LFL-UFL (flammability limits in air):	Ikon: nonflammable	4831

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized

R-134a/152a/13I1

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-134a/152a/13I1 (formulation not disclosed) see
 zeotrope ternary blend RDB#

COMMON USE (S)

under consideration as a replacement for refrigerants 12 and 134a in medium-temperature, commercial refrigeration systems and other applications

The following information is preliminary and may be incomplete or incorrect. Data may be available from ETEC (Albuquerque, NM, USA), Ikon Corporation (c/o Dole Foods, Boynton Beach, FL, USA), and refrigerant manufacturers.

IDENTIFIERS

common name(s): R-134a/152a/13I1 (??/??/??) mfr
 R134a/152a/13I1 (??/??/??) mfr
 R 134a/152a/13I1 (??/??/??) mfr
 trade name(s): Ikon(R) B
 name used in U.S. EPA SNAP Rule: "Ikon(R) 12"
 ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

• nominal blend formulation -----
 composition: R-134a/152a/13I1 mfr
 component weight tolerances: not disclosed mfr
 • properties -----
 normal freezing/melting/triple point: ETEC: <-100 °C (<-148 °F) MSDS
 • normal boiling point -----
 temperature: -25.0 °C (-13.0 °F) MSDS

SAFETY

• classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 components A1/A2/unclassified 8601
 NFPA 704 degrees of hazard (H-F-R-S): ETEC: 2-0-1 MSDS
 health-flammability-reactivity
 [-special]: 0=no, 4=severe
 • short-term occupational limit -----
 exposure limit consistent OSHA STEL: ETEC tentative: 2,000 ppm v/v MSDS
 TWA for 15 min
 • long-term occupational limit -----
 exposure limit consistent to OSHA PEL: ETEC tentative AEL: 170 ppm MSDS
 v/v TWA for 8 hr/day and 40
 hr/wk
 • flammability -----
 flash point: ETEC: nonflammable MSDS
 • detection -----
 appearance: ETEC: colorless gas MSDS
 odor: ETEC: slight ethereal MSDS

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized

last year production allowed: unrestricted

8C01

R-134a/152a/13I1

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-134a/152a/13I1 (formulation not disclosed) see
 zeotrope ternary blend RDB#

COMMON USE(S)

developmental blend, examined circa 1994, as an alternative for
 refrigerant 22

The designations "Ikon-22C" and "R-22A" were trade names and not
 refrigerant numbers conforming to ASHRAE Standard 34.

IDENTIFIERS

historical name(s): Ikon(R) 22A 4831

SAFETY

· flammability -----
 LFL-UFL (flammability limits in air): Ikon: nonflammable 4831

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized

R-134a/600a (80.0/20.0)

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----- REFRI GERANT DATA SUMMARY -----
unassigned   R-134a/600a (80.0/20.0)           see
azeotrope    binary blend                       RDB#
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COMMON USE(S)

under consideration as an alternative for refrigerants 12 and 134a in domestic refrigerators as well as refrigerant 22 in air conditioners and heat pumps

Note: The following information is preliminary and may be incomplete or incorrect. Further data may be available from Electrolux Compressors and refrigerant manufacturers.

IDENTIFIERS

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common name(s):  R-134a/600a (80.0/20.0)
                  R134a/600a (80.0/20.0)
                  R 134a/600a (80.0/20.0)
                  HFC-134a/HC-600a (80/20)
                  not HFC-134a/600a (80/20)
trade name(s):   Electrolux Compressors RC
ARI container color / Pantone number: none, use light green grey/413 6601
                                          with red / 185 band

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PHYSICAL

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· nominal blend formulation -----
  composition:      R-134a/600a
  component weight fractions: 80.0 / 20.0 %
  component mole fractions: 69.499 / 30.501 %           8820
· properties -----
  molar mass:      88.63843 g/mol (0.195414           8820
                  lb/mol)
· normal boiling point -----
  bubble point temperature: -29.5 °C (-21.0 °F)           8401
  dew point temperature:   -29.4 °C (-21.0 °F)           8401
  maximum temperature glide: 0.00 °C (0.0 °F)             8401
  density, saturated liquid: 1088 kg/m3 (67.90 lb/cf)      8401
  density, saturated vapor:  4.64 kg/m3 (0.290 lb/cf)      8401
  specific volume, saturated liquid: 0.919 L/kg (0.0147 cf/lb) 8401
  specific volume, saturated vapor: 215.6 L/kg (3.4534 cf/lb) 8401
  heat of vaporization:     237.8 kJ/kg (102.2 Btu/lb)      8401
  velocity of sound, saturated liquid: 782 m/s (2567 ft/s) 8401
  velocity of sound, saturated vapor: 155 m/s (508 ft/s)  8401
  viscosity, saturated liquid: 316 µPa·s (0.316 cp)         8401
  viscosity, saturated vapor:  8.61 µPa·s (0.00861 cp)      8401
  thermal conductivity, liquid: 0.1028 W/m·K (0.0594           8401
                  Btu/hr·ft°F)
  thermal conductivity, vapor: 0.0096 W/m·K (0.0055           8401
                  Btu/hr·ft°F)
· normal pressure, 20 °C (68 °F) -----
  density, vapor:          3.676 kg/m3 (0.2295 lb/cf)       8401
· normal pressure, 21.1 °C (70 °F) ---
  density, vapor:          3.752 kg/m3 (0.2342 lb/cf)       8401
· 20 °C (68 °F) -----

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

pressure, liquid (bubble point):	612.6 kPa (88.84 psia)	8401
pressure, vapor (dew point):	606.7 kPa (87.99 psia)	8401
density, saturated liquid:	959 kg/m ³ (59.86 lb/cf)	8401
density, saturated vapor:	25.91 kg/m ³ (1.618 lb/cf)	8401
specific volume, saturated liquid:	1.043 L/kg (0.0167 cf/lb)	8401
specific volume, saturated vapor:	38.6 L/kg (0.6181 cf/lb)	8401
velocity of sound, saturated liquid:	544 m/s (1785 ft/s)	8401
velocity of sound, saturated vapor:	153 m/s (503 ft/s)	8401
viscosity, saturated liquid:	168 μ Pa·s (0.168 cp)	8401
viscosity, saturated vapor:	10.5 μ Pa·s (0.0105 cp)	8401
thermal conductivity, saturated liquid:	0.0803 W/m·K (0.0464 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01418 W/m·K (0.00819 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1725 kPa (250.1 psia)	8401
pressure, vapor (dew point):	1702 kPa (246.8 psia)	8401
heat of vaporization:	148.2 kJ/kg for liquid and vapor both at nominal composition (63.7 Btu/lb)	8401
	148.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (63.7 Btu/lb)	8401
· critical point -----		
temperature:	111.3 °C (232.3 °F)	8401
pressure:	4806 kPa (697.1 psia)	8401
density:	408 kg/m ³ (25.4 lb/cf)	8401
specific volume:	2.45 L/kg (0.0393 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	<0.00002 mass-weighted average (model-derived relative to R 11)	9501
	<0.0004 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1280 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.22 mass-weighted average relative to R 11 for infinite integration period	6739
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending) components are A1 and A3	8601 8601
· flammability -----		
LFL-UFL (flammability limits in air):	3.9-13.3 % v/v	6432
PRODUCTION		
first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	unrestricted	8C01

R-134a with alcohol, hydrocarbon, and weak alkaline

----- REFRIGERANT DATA SUMMARY -----
 unassigned R 134a (98%), alcohol, hydrocarbon, weak alkaline see
 zeotrope tetrary blend RDB#

COMMON USE(S)

additized version of refrigerant 134a to provide miscibility with mineral oils and other lubricants for use as a replacement for refrigerant 12 in domestic and commercial refrigeration, automobile air conditioners, and transport refrigeration

The following information is preliminary and may be incomplete or incorrect. Further information may be available from Kanao Metal Manufacturing Company (Japan) or Solpower Australia Pty Limited (Chattenham, Australia). The blend is described as 98% refrigerant 134a with 2% unspecified alcohol, hydrocarbon, and weak alkaline. A description claims the same performance and characteristics as refrigerant 134a plus compatibility with mineral oil, polyalkylene glycol (PAG), and polyolester (POE) lubricants.

IDENTIFIERS

trade name(s): Kanao Metal 134a-E

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601

PRODUCTION

first commercial use as a refrigerant: circa 1997

R-143a/22 (55.0/45.0)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-143a/22 (55.0/45.0) see
 zeotrope binary blend RDB#

COMMON USE(S)

under consideration as an alternative for refrigerant 502 and possibly also as a blowing agent and aerosol propellant; developmental and initial formulation for Atochem FX10 (subsequently reformulated)

IDENTIFIERS

common name(s): R-143a/22 (55.0/45.0)
 R143a/22 (55.0/45.0)
 R 143a/22 (55.0/45.0)
 HFC-143a/HCFE-22 (55/45)
 not HCFC-143a/22 (55/45)
 historical name(s): Elf Atochem Forane(R) FX-10 4136
 until 8 May 1994 4B16

PHYSICAL

· nominal blend formulation -----
 composition: R-143a/22
 component weight fractions: 55.0 / 45.0 %
 component mole fractions: 59.375 / 40.625 % 8820
 · properties -----
 molar mass: 90.72503 g/mol (0.200014 lb/mol) 8820
 · normal boiling point -----
 bubble point temperature: -44.5 °C (-48.1 °F) 2A06
 dew point temperature: -44.0 °C (-47.2 °F) 4136
 maximum temperature glide: 0.50 °C (0.9 °F) 2A06
 density, saturated vapor: 4.67 kg/m3 (0.292 lb/cf) 4136
 heat of vaporization: 235.0 kJ/kg (101.0 Btu/lb) 4136
 · 25 °C (77 °F) -----
 pressure, saturated vapor: 1180.0 kPa (171.14 psia) 4136
 density, saturated liquid: 1040 kg/m3 (64.93 lb/cf) 4136
 · critical point -----
 temperature: 83.0 °C (181.4 °F) 4136
 pressure: 4300 kPa (623.7 psia) 4136

ENVIRONMENTAL

ODP (ozone depletion potential): 0.019 mass-weighted average 9501
 (model-derived relative to R 11)
 0.030 mass-weighted average 9501
 (semi-empirical relative to R 11)
 GWP (global warming potential): 4010 mass-weighted average 9501
 relative to CO2 for 100 yr integration
 HGWP (halocarbon GWP): 0.72 mass-weighted average DW
 relative to R 11 for infinite integration period

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

SAFETY

· classification -----
safety group (ASHRAE Standard 34): none (no application pending) 8601
components are A2 and A1 8601

· flammability -----
LFL-UFL (flammability limits in air): none (nonflammable as tested) 3A40

PRODUCTION

last year production allowed: 2029 based on refrigerant 22 8C01
in developed countries under
the Montreal Protocol

R-152a/13I1 (25.0/75.0)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-152a/13I1 (25.0/75.0) see
 zeotrope binary blend RDB#

COMMON USE(S)

developmental blend, examined circa 1994, as an alternative for
 refrigerant 12

The designations "Ikon-12C" and "R-12C" were trade names and not
 refrigerant numbers conforming to ASHRAE Standard 34.

IDENTIFIERS

common name(s):	R-152a/13I1 (75/25)	4831
	R152a/13I1 (75/25)	4831
	R 152a/13I1 (75/25)	4831
historical name(s):	Ikon(R) 12C	4831
name used in U.S. EPA SNAP Rule:	Blend Zeta (possibly a revised formulation) "HCFC" Blend Zeta (incorrect)	

PHYSICAL

· nominal blend formulation -----		
composition:	R-152a/13I1	4831
component weight fractions:	75.0 / 25.0 %	4831
component mole fractions:	49.716 / 50.284 %	8820
	52 / 48 %	4831
· properties -----		
molar mass:	131.34918 g/mol (0.289575 lb/mol)	8820

ENVIRONMENTAL

ODP (ozone depletion potential):	0.006 (model-derived relative to R 11)	9501
	0.006 (semi-empirical relative to R 11)	9501
GWP (global warming potential):	50 mass-weighted average relative to CO2 for 100 yr integration	9501

SAFETY

· flammability -----		
LFL-UFL (flammability limits in air):	Ikon: nonflammable	4831

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized

R-152a/13I1

```

----- REFRIGERANT DATA SUMMARY -----
unassigned   R-152a/13I1 (formulation not disclosed)      see
zeotrope     binary blend                                       RDB#
-----

```

COMMON USE(S)

under consideration as an alternative for refrigerant 12

The following information is preliminary and may be incomplete or incorrect. Data on this blend may be available from ETEC (Albuquerque, NM, USA), Ikon Corporation (c/o Dole Foods, Boynton Beach, FL, USA), and refrigerant manufacturers.

The historical designation "Ikon 12" was a trade name and not a refrigerant number conforming to ASHRAE Standard 34.

IDENTIFIERS

```

common name(s):  R-152a/13I1 (??/??)      mfr
                  R152a/13I1 (??/??)      mfr
                  R 152a/13I1 (??/??)      mfr
trade name(s):   Ikon(R) A
historical name(s): "Ikon 12"          mfr
ARI container color / Pantone number: none, use light green grey/413 6601

```

PHYSICAL

```

· nominal blend formulation -----
      composition:  R-152a/13I1          mfr
      component weight tolerances: not disclosed      mfr
· normal boiling point -----
      temperature:  -22.5 °C (-8.5 °F)      MSDS

```

SAFETY

```

· classification -----
  safety group (ASHRAE Standard 34): none (no application pending) 8601
                                       components A2/unclassified      8601
NFPA 704 degrees of hazard (H-F-R-S): ETEC: 2-0-1                MSDS
                                       health-flammability-reactivity
                                       [-special]: 0=no, 4=severe
· long-term occupational limit -----
  exposure limit consistent to OSHA PEL: ETEC tentative AEL: 170 ppm      MSDS
                                       v/v TWA for 8 hr/day and 40
                                       hr/wk
· acute (short-term) toxicity -----
  LC50 (lethal concentration, 50%):  rat, 15 min, ETEC: 274,000 ppm MSDS
                                       (fatal concentration by
                                       inhalation for half of test
                                       animals)
cardiac sensitization threshold/LOEL:  dog, ETEC: 4,000 ppm v/v      MSDS
                                       (lowest observed effect level
                                       in test animals)
cardiac sensitization (CS) NOEL:       dog, ETEC: 2,000 ppm v/v (no      MSDS
                                       observed effect level in test
                                       animals)
· flammability -----

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

· detection -----	flash point:	ETEC: nonflammable	MSDS
	appearance:	ETEC: colorless gas	MSDS
	odor:	ETEC: slight ethereal	MSDS

PRODUCTION

first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	unrestricted	8C01

R-152a/227ea (25.0/75.0)

```

----- REFRIGERANT DATA SUMMARY -----
unassigned   R-152a/227ea (25.0/75.0)           see
zeotrope     binary blend                             RDB#
-----

```

COMMON USE(S)

under consideration as an alternative for refrigerant 12 for retrofit of refrigerators and freezers

The following information is preliminary and may be incomplete or incorrect. Data on this blend may be available from Great Lakes Chemicals (Lafayette, IN, USA) and other refrigerant manufacturers.

IDENTIFIERS

```

common name(s):  R-152a/227ea (75.0/25.0)
                  R152a/227ea (75.0/25.0)
                  R 152a/227ea (75.0/25.0)
trade name(s):  Great Lakes Chemical FM series

```

PHYSICAL

```

· nominal blend formulation -----
      composition:  R-152a/227ea
component weight fractions:  25.0 / 75.0 %
component mole fractions:    46.181 / 53.819 %           8820
· properties -----
      molar mass:   122.01030 g/mol (0.268987           8820
                  lb/mol)
· normal boiling point -----
      bubble point temperature:  -20.7 °C (-5.2 °F)
· critical point -----
      temperature:  107.8 °C (226.0 °F)
      pressure:     2834 kPa (411.0 psia)
      density:      485 kg/m3 (30.3 lb/cf)
      specific volume:  2.06 L/kg (0.0330 cf/lb)

```

ENVIRONMENTAL

```

ODP (ozone depletion potential):  0.000 (model-derived relative
to R 11)
GWP (global warming potential):   2210 mass-weighted average           9501
relative to CO2 for 100 yr
integration
HGWP (halocarbon GWP):           0.52 relative to R 11 for           8101
infinite integration period

```

SAFETY

```

· classification -----
safety group (ASHRAE Standard 34):  none (no application pending)  8601

```

PRODUCTION

```

first commercial use as a refrigerant:  not known to be commercialized
last year production allowed:           unrestricted                   8C01

```

R-152a/227ea (80.0/20.0)

```

----- REFRIGERANT DATA SUMMARY -----
unassigned   R-152a/227ea (80.0/20.0)           see
zeotrope     binary blend                             RDB#
-----

```

COMMON USE(S)

under consideration as an alternative for refrigerant 12

The following information is preliminary and may be incomplete or incorrect. Data on this blend are available from Great Lakes Chemicals and other refrigerant manufacturers.

IDENTIFIERS

```

common name(s):  R-152a/227ea (80.0/20.0)
                  R152a/227ea (80.0/20.0)
                  R 152a/227ea (80.0/20.0)
trade name(s):   Great Lakes Chemical FM series

```

PHYSICAL

```

· nominal blend formulation -----
                        composition:  R-152a/227ea
component weight fractions:  80.0 / 20.0 %
component mole fractions:    91.148 / 8.852 %           8820
· properties -----
                        molar mass:    75.25410 g/mol (0.165907      8820
                        lb/mol)

```

ENVIRONMENTAL

```

ODP (ozone depletion potential):  0.000 (model-derived relative
to R 11)
GWP (global warming potential):   910 mass-weighted average           9501
relative to CO2 for 100 yr
integration
HGWP (halocarbon GWP):           0.15 relative to R 11 for           8101
infinite integration period

```

SAFETY

```

· classification -----
safety group (ASHRAE Standard 34): none (no application pending)  8601

```

PRODUCTION

```

first commercial use as a refrigerant: not known to be commercialized
last year production allowed:         unrestricted                   8C01

```

R-152a/600a (70.0/30.0)

```

----- REFRIGERANT DATA SUMMARY -----
unassigned   R-152a/600a (70.0/30.0)           see
azeotrope    binary blend                       RDB#
-----

```

COMMON USE(S)

under consideration in the Russian Federation (since 1996) as an alternative for refrigerant 12, in both existing and new equipment, for domestic refrigerators

IDENTIFIERS

```

common name(s):  R-152a/600 (70.0/30.0)
                  R152a/600 (70.0/30.0)
                  R 152a/600 (70.0/30.0)
                  HFC-152a/HC-600a (70/30)
                  not HFC-152a/600a (70/30)
                  (Russia) "C1"

```

```

ARI container color / Pantone number: none, use light green grey/413 6601
                                        with red / 185 band

```

PHYSICAL

```

· nominal blend formulation -----
      composition:  R-152a/600
      component weight fractions:  70.0 / 30.0 %
      component mole fractions:    67.248 / 32.752 %           8820
· properties -----
      molar mass:    63.45348 g/mol (0.139891 lb/mol)       8820
· normal boiling point -----
      bubble point temperature:  -26.5 °C (-15.7 °F)         8401
      dew point temperature:     -26.4 °C (-15.6 °F)         8401
      maximum temperature glide: 0.07 °C (0.1 °F)            8401
      density, saturated liquid:  834 kg/m3 (52.06 lb/cf)     8401
      density, saturated vapor:   3.28 kg/m3 (0.205 lb/cf)   8401
      specific volume, saturated liquid: 1.199 L/kg (0.0192 cf/lb) 8401
      specific volume, saturated vapor: 304.8 L/kg (4.8829 cf/lb) 8401
      heat of vaporization:        329.7 kJ/kg (141.8 Btu/lb) 8401
      velocity of sound, saturated liquid: 910 m/s (2984 ft/s) 8401
      velocity of sound, saturated vapor: 186 m/s (610 ft/s) 8401
      viscosity, saturated liquid: 265 µPa·s (0.265 cp)      8401
      viscosity, saturated vapor: 7.46 µPa·s (0.00746 cp)     8401
      thermal conductivity, liquid: 0.1138 W/m·K (0.0658 Btu/hr·ft°F) 8401
      thermal conductivity, vapor: 0.0098 W/m·K (0.0056 Btu/hr·ft°F) 8401
· normal pressure, 20 °C (68 °F) -----
      density, vapor: 2.701 kg/m3 (0.1686 lb/cf)             8401
· normal pressure, 21.1 °C (70 °F) ---
      density, vapor: 2.689 kg/m3 (0.1679 lb/cf)             8401
· 20 °C (68 °F) -----
      pressure, liquid (bubble point): 537.0 kPa (77.88 psia) 8401
      pressure, vapor (dew point):    531.2 kPa (77.05 psia) 8401
      density, saturated liquid:      747 kg/m3 (46.63 lb/cf) 8401
      density, saturated vapor:       15.98 kg/m3 (0.997 lb/cf) 8401

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

specific volume, saturated liquid:	1.339 L/kg (0.0214 cf/lb)	8401
specific volume, saturated vapor:	62.6 L/kg (1.0026 cf/lb)	8401
velocity of sound, saturated liquid:	670 m/s (2197 ft/s)	8401
velocity of sound, saturated vapor:	186 m/s (610 ft/s)	8401
viscosity, saturated liquid:	151 $\mu\text{Pa}\cdot\text{s}$ (0.151 cp)	8401
viscosity, saturated vapor:	9.0 $\mu\text{Pa}\cdot\text{s}$ (0.0090 cp)	8401
thermal conductivity, saturated liquid:	0.0926 W/m \cdot K (0.0535 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01481 W/m \cdot K (0.00856 Btu/hr \cdot ft $^{\circ}$ F)	8401
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	1512 kPa (219.3 psia)	8401
pressure, vapor (dew point):	1492 kPa (216.3 psia)	8401
heat of vaporization:	223.2 kJ/kg for liquid and vapor both at nominal composition (96.0 Btu/lb)	8401
	222.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (95.5 Btu/lb)	8401
• critical point -----		
temperature:	120.3 $^{\circ}$ C (248.5 $^{\circ}$ F)	8401
pressure:	4933 kPa (715.5 psia)	8401
density:	309 kg/m 3 (19.3 lb/cf)	8401
specific volume:	3.24 L/kg (0.0519 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.000 (model-derived relative to R 11)	3B12
GWP (global warming potential):	140 mass-weighted average relative to CO $_2$ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.011 relative to R 11 for infinite integration period	5964
SAFETY		
• classification -----		
safety group (ASHRAE Standard 34):	none (no application pending) components are A2 and A3	8601 8601
• flammability -----		
LFL-UFL (flammability limits in air):	probably highly flammable	
PRODUCTION		
first commercial use as a refrigerant:	1998	
last year production allowed:	unrestricted	8C01

R-170/22/115

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-170/22/115 (formulation must be indicated) see
 zeotrope ternary blend RDB#

COMMON USE (S)

field mixture to improve oil return in ultra-low temperature systems,
 especially for blood refrigeration in hospitals with evaporator
 temperatures of approximately -60 °C (-76 °F)

IDENTIFIERS

common name(s): R-170/22/115; R170/22/115;
 R 170/22/115 (??/??/??)
 HC-170/HCFC-22/CFC-115
 not CFC-170/22/115
 "R-170/502"
 R-502 with ethane

PHYSICAL

· nominal blend formulation -----
 composition: R-170/22/115

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 components are A3, A1, and A1 8601
 · long-term occupational limit -----
 exposure limit consistent to OSHA PEL: none, all components are 1,000
 ppm v/v TWA for 8 hr/day and
 40 hr/wk

PRODUCTION

last year production allowed: 1995 based on refrigerant 115 8C01
 in developed countries under
 the Montreal Protocol

R-170/290 (6.0/94.0)

```

----- REFRIGERANT DATA SUMMARY -----
unassigned   R-170/290 (6.0/94.0)                see
zeotrope     binary blend                             RDB#
-----

```

COMMON USE(S)

candidate replacement for refrigerants 22 and 502, primarily as a service fluid in aftermarket use for retrofits, in commercial, industrial, and transport refrigeration

The following information is preliminary and may be incomplete or incorrect. Data may be available from Esanty Refrigerants / Boral Energy (Victoria, Australia) and other refrigerant manufacturers.

IDENTIFIERS

```

common name(s):  R-170/290 (6.0/94.0)
                  R170/290 (6.0/94.0)
                  R 170/290 (6.0/94.0)
                  HC-170/HC-290 (6/94)
                  not HC-170/290 (6/94)
trade name(s):   Boral Energy (Australia) ER22  mfr
                  Esanty Refrigerants ER22/502  mfr
ARI container color / Pantone number:  none, use light green grey/413 6601
                                          with red / 185 band

```

PHYSICAL

```

· nominal blend formulation -----
      composition:  R-170/290
      component weight fractions:  6.0 / 94.0 %
      component mole fractions:    8.559 / 91.441 %      8820
· properties -----
      molar mass:    42.89504 g/mol (0.094567      8820
                    lb/mol)
· normal boiling point -----
      temperature:   -50 to 0 °C (-58 to 32 °F)      mfr
      bubble point temperature:  -52.8 °C (-63.0 °F)      8401
      dew point temperature:     -43.9 °C (-47.0 °F)      8401
      maximum temperature glide:  8.88 °C (16.0 °F)      8401
      density, saturated liquid:  588 kg/m3 (36.72 lb/cf)      8401
      density, saturated vapor:   2.37 kg/m3 (0.148 lb/cf)      8401
      specific volume, saturated liquid:  1.699 L/kg (0.0272 cf/lb)      8401
      specific volume, saturated vapor:  422.5 L/kg (6.7673 cf/lb)      8401
      heat of vaporization:        447.3 kJ/kg (192.3 Btu/lb)      8401
      velocity of sound, saturated liquid:  1212 m/s (3978 ft/s)      8401
      velocity of sound, saturated vapor:  221 m/s (726 ft/s)      8401
      viscosity, saturated liquid:  211 µPa·s (0.211 cp)      8401
      viscosity, saturated vapor:   6.24 µPa·s (0.00624 cp)      8401
      thermal conductivity, liquid:  0.1372 W/m·K (0.0793      8401
                    Btu/hr·ft°F)
      thermal conductivity, vapor:  0.0115 W/m·K (0.0066      8401
                    Btu/hr·ft°F)
· normal pressure, 20 °C (68 °F) -----
      density, vapor:  1.812 kg/m3 (0.1131 lb/cf)      8401
· normal pressure, 21.1 °C (70 °F) ---

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

	density, vapor:	1.805 kg/m ³ (0.1127 lb/cf)	8401
· 20 °C (68 °F) -----			
	pressure, liquid (bubble point):	1050.6 kPa (152.38 psia)	8401
	pressure, vapor (dew point):	903.8 kPa (131.08 psia)	8401
	density, saturated liquid:	493 kg/m ³ (30.75 lb/cf)	8401
	density, saturated vapor:	19.10 kg/m ³ (1.192 lb/cf)	8401
	specific volume, saturated liquid:	2.030 L/kg (0.0325 cf/lb)	8401
	specific volume, saturated vapor:	52.4 L/kg (0.8389 cf/lb)	8401
	velocity of sound, saturated liquid:	734 m/s (2407 ft/s)	8401
	velocity of sound, saturated vapor:	220 m/s (721 ft/s)	8401
	viscosity, saturated liquid:	97 µPa·s (0.097 cp)	8401
	viscosity, saturated vapor:	8.0 µPa·s (0.0080 cp)	8401
	thermal conductivity, saturated liquid:	0.0954 W/m·K (0.0551 Btu/hr·ft ² ·°F)	8401
	thermal conductivity, saturated vapor:	0.01876 W/m·K (0.01084 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----			
	pressure, liquid (bubble point):	2490 kPa (361.1 psia)	8401
	pressure, vapor (dew point):	2295 kPa (332.8 psia)	8401
	heat of vaporization:	250.8 kJ/kg for liquid and vapor both at nominal composition (107.8 Btu/lb)	8401
		232.3 kJ/kg coexisting liquid and vapor at bubble-point pressure (99.9 Btu/lb)	8401
· critical point -----			
	temperature:	91.2 °C (196.1 °F)	8401
	pressure:	4286 kPa (621.6 psia)	8401
	density:	220 kg/m ³ (13.7 lb/cf)	8401
	specific volume:	4.55 L/kg (0.0729 cf/lb)	8401
ENVIRONMENTAL			
	ODP (ozone depletion potential):	0.000 mass-weighted average (model-derived relative to R 11)	5301
	GWP (global warming potential):	unknown, but very low: ~21 relative to CO ₂ for 100 yr integration	
	HGWP (halocarbon GWP):	<0.01 mass-weighted average relative to R 11 for infinite integration period	
SAFETY			
· classification -----			
	safety group (ASHRAE Standard 34):	none (no application pending)	8601
		components are both A3	8601
· flammability -----			
	LFL-UFL (flammability limits in air):	Esanty: 1.9-9.5 % v/v	mfr
	flash point:	-104 to 60 °C (-155 to 140 °F)	mfr
	autoignition temperature:	Esanty: 550 °C (1022 °F)	mfr
· detection -----			
	odor:	rotton cabbage-like odor	mfr
PRODUCTION			
	first commercial use as a refrigerant:	circa 1998	
	last year production allowed:	unrestricted	8C01

R-170/290

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-170/290 (formulation not disclosed) see
 zeotrope binary blend RDB#

COMMON USE(S)

service fluid for refrigerant 502 in commercial, industrial, and
 transport refrigeration

While the manufacturer indicates this blend is R-170/290, it has not
 disclosed the formulation. One study addressing it (see RDB9822)
 determined the formulation by gas chromatography as R-170/1270/290
 (3.95/1.0/95.0), so the nominal formulation may be approximately
 R-170/290 (5/95). The following information is preliminary and may
 be incomplete or incorrect. Further data may be available from Calor
 Gas Refrigeration (Slough, UK) and other refrigerant manufacturers.

IDENTIFIERS

common name(s): R-170/290 (??/??)
 R170/290 (??/??)
 R-170/1270/290 (4.0/1.0/95.0) 9822
 HC-170/HC-290 (??/??)
 not HC-170/290 (??/??)
 trade name(s): Calor Gas (UK) CARE 50 5B12
 Calor Gas (UK) CARE R290/R170 5B12
 Ecozone BV (NL) Ecoool-PET
 ARI container color / Pantone number: none, use light green grey/413 6601
 with red / 185 band

PHYSICAL

· nominal blend formulation -----
 composition: R-170/290
 component weight fractions: formulation must be indicated
 %
 · normal boiling point -----
 temperature: -49.0 °C (-56.2 °F) 5B12

ENVIRONMENTAL

ODP (ozone depletion potential): 0.000 (model-derived relative
 to R 11)
 GWP (global warming potential): unknown, but very low: ~20
 relative to CO2 for 100 yr
 integration

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 components are both A3 8601
 · flammability -----
 LFL-UFL (flammability limits in air): 2.2-10.2 % v/v 5B12

PRODUCTION

first commercial use as a refrigerant: November 1994
 last year production allowed: unrestricted 8C01

R-170/1270

```

----- REFRIGERANT DATA SUMMARY -----
unassigned R-170/1270 (formulation must be indicated) see
zeotrope binary blend RDB#
-----

```

COMMON USE(S)

under consideration as a replacement for refrigerant 13B1 both in new equipment and as a service fluid; use is constrained by high flammability

IDENTIFIERS

```

common name(s): R-170/1270 (??/??)
                R170/1270 (??/??)
                R 170/1270 (??/??)
                formulation must be indicated
                HC-170/HC-1270 (??/??)
                not HC-170/1270
ARI container color / Pantone number: none, use light green grey/413 6601
                                        with red / 185 band

```

PHYSICAL

```

· nominal blend formulation -----
                                composition: R-170/1270
                                component weight fractions: formulation must be indicated
                                                                %

```

SAFETY

```

· classification -----
  safety group (ASHRAE Standard 34): none (no application pending) 8601
                                        components are both A3      8601
· long-term occupational limit -----
  exposure limit consistent to OSHA PEL: none, all components are 1,000
                                        ppm v/v TWA for 8 hr/day and
                                        40 hr/wk

```

PRODUCTION

```

first commercial use as a refrigerant: circa 1996
last year production allowed: unrestricted 8C01

```

R-218/134/600 (32.7/62.8/4.5)

```

----- REFRIGERANT DATA SUMMARY -----
unassigned   R-218/134/600 (32.7/62.8/4.5)           see
azeotrope    ternary blend                               RDB#
-----
  
```

COMMON USE(S)

under consideration (since 1996) in the Russian Federation as an alternative for refrigerant 12, in both existing and new equipment, for domestic refrigerators

There is uncertainty whether the CMI blend in Russia is R-218/134/600 (32.7/62.8/4.5) or R-218/134a/600 (32.7/62.8/4.5).

IDENTIFIERS

```

common name(s):  R-218/134/600 (32.7/62.8/4.5)
                  R218/134/600 (32.7/62.8/4.5)
                  R 218/134/600 (32.7/62.8/4.5)
                  (Russia) "CMI"
                  (Russia) "SM1"
ARI container color / Pantone number:  none, use light green grey/413 6601
  
```

PHYSICAL

```

· nominal blend formulation -----
      composition:  R-218/134/600
      component weight fractions:  32.7 / 62.8 / 4.5 %
      component mole fractions:    20.063 / 71.005 / 8.932 %      8820
· properties -----
      molar mass:    115.36138 g/mol (0.254328      8820
                       lb/mol)
  
```

ENVIRONMENTAL

```

ODP (ozone depletion potential):  0.000 mass-weighted average      5301
                                   (model-derived relative to R
                                   11)
GWP (global warming potential):   3570 mass-weighted average      9501
                                   relative to CO2 for 100 yr
                                   integration
HGWP (halocarbon GWP):           13 relative to R 11 for          6739
                                   infinite integration period
  
```

SAFETY

```

· classification -----
  safety group (ASHRAE Standard 34):  none (no application pending)  8601
  
```

PRODUCTION

```

first commercial use as a refrigerant:  not known to be commercialized
last year production allowed:           unrestricted                8C01
  
```

R-218/134a/600 (32.7/62.8/4.5)

----- REFRIGERANT DATA SUMMARY -----

unassigned	R-218/134a/600 (32.7/62.8/4.5)	see
azeotrope	ternary blend	RDB#

COMMON USE(S)

under consideration (since 1996) in the Russian Federation as an alternative for refrigerant 12, in both existing and new equipment, for domestic refrigerators

There is uncertainty whether the CM1 blend in Russia is R-218/134/600 (32.7/62.8/4.5) or R-218/134a/600 (32.7/62.8/4.5).

IDENTIFIERS

common name(s): R-218/134a/600 (32.7/62.8/4.5)
 R218/134a/600 (32.7/62.8/4.5)
 R 218/134a/600 (32.7/62.8/4.5)
 (Russia) "CM1"
 (Russia) "SM1"

PHYSICAL

· nominal blend formulation -----
 composition: R-218/134a/600
 component weight fractions: 32.7 / 62.8 / 4.5 %
 component mole fractions: 20.063 / 71.005 / 8.932 % 8820

· properties -----
 molar mass: 115.36138 g/mol (0.254328 lb/mol) 8820

· normal boiling point -----
 bubble point temperature: -31.4 °C (-24.6 °F) 8814
 dew point temperature: -29.0 °C (-20.2 °F) 8814
 maximum temperature glide: 2.44 °C (4.4 °F) 8814
 density, saturated liquid: 1367 kg/m3 (85.31 lb/cf) 8814
 density, saturated vapor: 6.03 kg/m3 (0.376 lb/cf) 8814
 specific volume, saturated liquid: 0.732 L/kg (0.0117 cf/lb) 8814
 specific volume, saturated vapor: 186.7 L/kg (2.9913 cf/lb) 8814
 heat of vaporization: 186.7 kJ/kg (80.3 Btu/lb) 8814
 velocity of sound, saturated liquid: 696 m/s (2284 ft/s) 8814
 velocity of sound, saturated vapor: 135 m/s (442 ft/s) 8814
 viscosity, saturated liquid: 346 µPa·s (0.346 cp) 8814
 viscosity, saturated vapor: 9.65 µPa·s (0.00965 cp) 8814
 thermal conductivity, liquid: 0.0898 W/m·K (0.0519 Btu/hr·ft° F) 8814
 thermal conductivity, vapor: 0.0093 W/m·K (0.0054 Btu/hr·ft° F) 8814

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 4.904 kg/m3 (0.3061 lb/cf) 8814

· normal pressure, 21.1 °C (70 °F) ----
 density, vapor: 4.884 kg/m3 (0.3049 lb/cf) 8814

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 654.7 kPa (94.96 psia) 8814
 pressure, vapor (dew point): 620.8 kPa (90.04 psia) 8814
 density, saturated liquid: 1194 kg/m3 (74.51 lb/cf) 8814
 density, saturated vapor: 34.71 kg/m3 (2.167 lb/cf) 8814

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

specific volume, saturated liquid:	0.838 L/kg (0.0134 cf/lb)	8814
specific volume, saturated vapor:	28.8 L/kg (0.4615 cf/lb)	8814
velocity of sound, saturated liquid:	464 m/s (1523 ft/s)	8814
velocity of sound, saturated vapor:	133 m/s (435 ft/s)	8814
viscosity, saturated liquid:	177 $\mu\text{Pa}\cdot\text{s}$ (0.177 cp)	8814
viscosity, saturated vapor:	11.8 $\mu\text{Pa}\cdot\text{s}$ (0.0118 cp)	8814
thermal conductivity, saturated liquid:	0.0702 W/m \cdot K (0.0406 Btu/hr \cdot ft $^{\circ}$ F)	8814
thermal conductivity, saturated vapor:	0.01364 W/m \cdot K (0.00788 Btu/hr \cdot ft $^{\circ}$ F)	8814
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	1828 kPa (265.2 psia)	8814
pressure, vapor (dew point):	1766 kPa (256.2 psia)	8814
heat of vaporization:	109.8 kJ/kg for liquid and vapor both at nominal composition (47.2 Btu/lb)	8814
	110.5 kJ/kg coexisting liquid and vapor at bubble-point pressure (47.5 Btu/lb)	8814
• critical point -----		
temperature:	99.8 $^{\circ}$ C (211.6 $^{\circ}$ F)	8814
pressure:	4145 kPa (601.2 psia)	8814
density:	514 kg/m 3 (32.1 lb/cf)	8814
specific volume:	1.95 L/kg (0.0312 cf/lb)	8814

ENVIRONMENTAL

ODP (ozone depletion potential):	<0.00001 mass-weighted average (model-derived relative to R 11)	5301
	<0.00032 mass-weighted average (semi-empirical relative to R 11)	5301
GWP (global warming potential):	3110 relative to CO $_2$ for 100 yr integration	6694
HGWP (halocarbon GWP):	13 relative to R 11 for infinite integration period	6739

SAFETY

• classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
	components are A1, A1, and A3	8601

PRODUCTION

first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	unrestricted	8C01

R-218/134a/600 (33.0/62.0/5.0)

----- REFRIGERANT DATA SUMMARY -----

unassigned	R-218/134a/600 (33.0/62.0/5.0)	see
azeotrope	ternary blend	RDB#

COMMON USE(S)

under consideration (since 1996) in the Russian Federation as an alternative for refrigerant 12, in both existing and new equipment, for domestic refrigerators

developmental formulation of the CM1 blend in Russia

IDENTIFIERS

common name(s): R-218/134a/600 (33.0/62.0/5.0)
 R218/134a/600 (33.0/62.0/5.0)
 R 218/134a/600 (33.0/62.0/5.0)

PHYSICAL

· nominal blend formulation -----
 composition: R-218/134a/600
 component weight fractions: 33.0 / 62.0 / 5.0 %
 component mole fractions: 20.193 / 69.910 / 9.897 % 8820

· properties -----
 molar mass: 115.04850 g/mol (0.253639 lb/mol) 8820

· normal boiling point -----
 bubble point temperature: -31.4 °C (-24.5 °F) 8814
 dew point temperature: -28.9 °C (-20.0 °F) 8814
 maximum temperature glide: 2.46 °C (4.4 °F) 8814
 density, saturated liquid: 1358 kg/m³ (84.80 lb/cf) 8814
 density, saturated vapor: 6.01 kg/m³ (0.375 lb/cf) 8814
 specific volume, saturated liquid: 0.736 L/kg (0.0118 cf/lb) 8814
 specific volume, saturated vapor: 166.4 L/kg (2.6660 cf/lb) 8814
 heat of vaporization: 187.1 kJ/kg (80.5 Btu/lb) 8814
 velocity of sound, saturated liquid: 697 m/s (2287 ft/s) 8814
 velocity of sound, saturated vapor: 135 m/s (442 ft/s) 8814
 viscosity, saturated liquid: 344 µPa·s (0.344 cp) 8814
 viscosity, saturated vapor: 9.63 µPa·s (0.00963 cp) 8814
 thermal conductivity, liquid: 0.0898 W/m·K (0.0519 Btu/hr·ft²°F) 8814
 thermal conductivity, vapor: 0.0094 W/m·K (0.0054 Btu/hr·ft²°F) 8814

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 4.891 kg/m³ (0.3053 lb/cf) 8814

· normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 4.871 kg/m³ (0.3041 lb/cf) 8814

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 652.7 kPa (94.67 psia) 8814
 pressure, vapor (dew point): 617.4 kPa (89.54 psia) 8814
 density, saturated liquid: 1187 kg/m³ (74.09 lb/cf) 8814
 density, saturated vapor: 34.40 kg/m³ (2.147 lb/cf) 8814
 specific volume, saturated liquid: 0.843 L/kg (0.0135 cf/lb) 8814
 specific volume, saturated vapor: 29.1 L/kg (0.4657 cf/lb) 8814
 velocity of sound, saturated liquid: 465 m/s (1527 ft/s) 8814

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

velocity of sound, saturated vapor:	133 m/s (436 ft/s)	8814
viscosity, saturated liquid:	176 $\mu\text{Pa}\cdot\text{s}$ (0.176 cp)	8814
viscosity, saturated vapor:	11.7 $\mu\text{Pa}\cdot\text{s}$ (0.0117 cp)	8814
thermal conductivity, saturated liquid:	0.0702 W/m \cdot K (0.0406 Btu/hr \cdot ft $^{\circ}$ F)	8814
thermal conductivity, saturated vapor:	0.01367 W/m \cdot K (0.00790 Btu/hr \cdot ft $^{\circ}$ F)	8814
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	1822 kPa (264.2 psia)	8814
pressure, vapor (dew point):	1766 kPa (256.2 psia)	8814
heat of vaporization:	110.2 kJ/kg for liquid and vapor both at nominal composition (47.4 Btu/lb)	8814
	111.0 kJ/kg coexisting liquid and vapor at bubble-point pressure (47.7 Btu/lb)	8814
• critical point -----		
temperature:	100.2 $^{\circ}$ C (212.4 $^{\circ}$ F)	8814
pressure:	4159 kPa (603.2 psia)	8814
density:	511 kg/m 3 (31.9 lb/cf)	8814
specific volume:	1.96 L/kg (0.0313 cf/lb)	8814
ENVIRONMENTAL		
ODP (ozone depletion potential):	<0.00001 mass-weighted average (model-derived relative to R 11)	9501
	<0.00031 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	3830 mass-weighted average relative to CO $_2$ for 100 yr integration	6694
HGWP (halocarbon GWP):	14 mass-weighted average relative to R 11 for infinite integration period	6739
SAFETY		
• classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
	components are A1, A1, and A3	8601
PRODUCTION		
first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	unrestricted	8C01

R-218/152a (83.5/16.5)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-218/152a (83.5/16.5) see
 azeotrope binary blend RDB#

COMMON USE (S)

under consideration as an alternative for refrigerants 12, 22, and 502 in commercial and transport refrigeration and in domestic refrigerators and freezers; may be covered by USSR patent 1362739; consideration constrained by high global warming potential of component refrigerant 218

IDENTIFIERS

common name(s): R-218/152a (83.5/16.5)
 R218/152a (83.5/16.5)
 R 218/152a (83.5/16.5)
 FC-218/HFC-152a (83.5/16.5)
 not HFC-218/152a (83.5/16.5)
 "R507" (not by Standard 34) 4A07

PHYSICAL

· nominal blend formulation -----
 composition: R-218/152a
 component weight fractions: 83.5 / 16.5 %
 component mole fractions: 64.000 / 36.000 % 8820

· properties -----
 molar mass: 144.11004 g/mol (0.317708 lb/mol) 8820

· normal boiling point -----
 bubble point temperature: -34.8 °C (-30.7 °F) 8814
 dew point temperature: -33.7 °C (-28.6 °F) 8814
 maximum temperature glide: 1.17 °C (2.1 °F) 8814
 density, saturated liquid: 1471 kg/m³ (91.84 lb/cf) 8814
 density, saturated vapor: 1.71 kg/m³ (0.107 lb/cf) 8814
 specific volume, saturated liquid: 0.680 L/kg (0.0109 cf/lb) 8814
 specific volume, saturated vapor: 129.8 L/kg (2.0784 cf/lb) 8814
 heat of vaporization: 142.2 kJ/kg (61.1 Btu/lb) 8814
 velocity of sound, saturated liquid: 615 m/s (2018 ft/s) 8814
 velocity of sound, saturated vapor: 118 m/s (386 ft/s) 8814
 viscosity, saturated vapor: 10.00 µPa·s (0.01000 cp) 8814
 viscosity, saturated liquid: 308 µPa·s (0.308 cp) 8814
 thermal conductivity, liquid: 0.0697 W/m·K (0.0403 Btu/hr·ft·°F) 8814
 thermal conductivity, vapor: 0.0089 W/m·K (0.0052 Btu/hr·ft·°F) 8814

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 6.129 kg/m³ (0.3826 lb/cf) 8814

· normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 6.104 kg/m³ (0.3811 lb/cf) 8814

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 717.0 kPa (103.99 psia) 8814
 pressure, saturated vapor: 961.0 kPa (139.38 psia) 4A07
 pressure, vapor (dew point): 703.8 kPa (102.07 psia) 8814
 density, saturated liquid: 1246 kg/m³ (77.79 lb/cf) 4A07

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

	1260 kg/m ³ (78.67 lb/cf)	8814
density, saturated vapor:	50.88 kg/m ³ (3.176 lb/cf)	8814
	73.53 kg/m ³ (4.590 lb/cf)	4A07
specific volume, saturated liquid:	0.794 L/kg (0.0127 cf/lb)	8814
specific volume, saturated vapor:	19.7 L/kg (0.3148 cf/lb)	8814
velocity of sound, saturated liquid:	378 m/s (1241 ft/s)	8814
velocity of sound, saturated vapor:	113 m/s (372 ft/s)	8814
viscosity, saturated liquid:	148 μ Pa·s (0.148 cp)	8814
viscosity, saturated vapor:	12.4 μ Pa·s (0.0124 cp)	8814
thermal conductivity, saturatd liquid:	0.0546 W/m·K (0.0315 Btu/hr·ft ² ·°F)	8814
thermal conductivity, saturated vapor:	0.01393 W/m·K (0.00805 Btu/hr·ft ² ·°F)	8814
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1938 kPa (281.1 psia)	8814
pressure, saturated vapor:	2536 kPa (367.8 psia)	4A07
pressure, vapor (dew point):	1925 kPa (279.2 psia)	8814
heat of vaporization:	73.4 kJ/kg for liquid and vapor both at nominal composition (31.6 Btu/lb)	8814
	74.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (31.9 Btu/lb)	8814
· critical point -----		
temperature:	86.8 °C (188.2 °F)	8814
pressure:	3382 kPa (490.5 psia)	8814
density:	562 kg/m ³ (35.1 lb/cf)	8814
specific volume:	1.78 L/kg (0.0285 cf/lb)	8814
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.000 mass-weighted average (model-derived relative to R 11)	5301
GWP (global warming potential):	7210 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	34 mass-weighted average relative to R 11 for infinite integration period	DW
PRODUCTION		
first commercial use as a refrigerant:	not known to be commercialized	
last year production allowed:	unrestricted	8C01

R-225ca/225cb (45.0/55.0)

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----- REFRI GERANT DATA SUMMARY -----
unassigned R-225ca/225cb (45.0/55.0) see
azeotrope binary blend CAS number 127564-92-5 RDB#
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COMMON USE(S)

replacement for chlorofluorocarbon 113 as an industrial cleaning solvent, particularly for electronic circuit boards

blends of AK-225 also are marketed as solvents (e.g., with ethanol as Asahiklin AES and with methanol as Flux Remover AMS)

IDENTIFIERS

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common name(s): R-225ca/225cb (45/55)
                R225ca/225cb (45/55)
                R 225ca/225cb (45/55)
                HCFC-225ca/HCFC-225cb (45/55)
                not HCFC-225ca/225cb (45/55)
CAS number:    127564-92-5 Chemical Abstracts
                Service Registry Number
trade name(s): Asahi Glass Asahiklin AK-225

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PHYSICAL

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· nominal blend formulation -----
  component weight tolerances: Tech Spray: ±5.0 / ±5.0      MSDS
· properties -----
  molar mass: 202.937456 g/mol (0.447401 lb/mol)          8820
  normal freezing/melting/triple point: -131.0 °C (-203.8 °F)  MSDS
· normal boiling point -----
  temperature: 54.0 °C (129.2 °F)                          MSDS

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SAFETY

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· classification -----
  safety group (ASHRAE Standard 34): none (no application pending) 8601
· long-term occupational limit -----
  exposure limit consistent to OSHA PEL: Asahi Glass AEL: 50 ppm v/v  MSDS
                                         TWA for 8 hr/day and 40 hr/wk
· acute (short-term) toxicity -----
  cardiac sensitization threshold/LOEL: 15,000 ppm v/v (lowest      5C39
                                         observed effect level in test
                                         animals)
· flammability -----
  LFL-UFL (flammability limits in air): Tech Spray: none as tested  MSDS
                                         flash point: TCC, Tech Spray: none  MSDS
· detection -----
  appearance: Tech Spray: clear water-white  MSDS
  odor:       Tech Spray: mild                MSDS

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R-245ca/338mcc

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-245ca/338mcc see
 azeotrope binary blend RDB#

COMMON USE(S)

under consideration as a replacement for refrigerants 11 and 123

Note: This blend was conceived to inert the flammability of the single-compound refrigerant 245ca.

IDENTIFIERS

common name(s): R 245ca/338mcc (??/??)
 R-245ca/338mcc (??/??)
 R245ca/338mcc (??/??)
 HFC-245ca/HFC-338mcc (??/??)
 not HFC-245ca/338mcc (??/??)

PHYSICAL

· nominal blend formulation -----
 composition: R-245ca/338mcc

ENVIRONMENTAL

ODP (ozone depletion potential): 0.000 (model-derived relative to R 11)

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 components not classified 8601

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized
 last year production allowed: unrestricted 8C01

R-C270/134a (35.0/65.0)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-C270/134a (35.0/65.0) see
 azeotrope binary blend RDB#

COMMON USE(S)

under consideration as an alternative for refrigerant 22

IDENTIFIERS

common name(s): R-C270/134a (35/65)
 RC270/134a (35/65)
 R C270/134a (35/65)
 HC-C270/HFC-134a (35/65)
 not HFC-C270/134a (35/65)
 ARI container color / Pantone number: none, use light green grey/413 6601
 with red / 185 band

PHYSICAL

· nominal blend formulation -----
 component mole fractions: 56.628 / 43.372 % 8820
 · properties -----
 molar mass: 68.08204 g/mol (0.150095 8820
 lb/mol)

ENVIRONMENTAL

ODP (ozone depletion potential): <0.00001 mass weighted average 9501
 (model-derived relative to R
 11)
 <0.00033 mass weighted average 9501
 (semi-empirical relative to R
 11)
 GWP (global warming potential): 1050 mass-weighted average 9501
 relative to CO2 for 100 yr
 integration
 HGWP (halocarbon GWP): 0.18 mass-weighted average 6739
 relative to R 11 for infinite
 integration period

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 components are A3 and A1 8601
 · flammability -----
 LFL-UFL (flammability limits in air): probably flammable

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized
 last year production allowed: unrestricted 8C01

R-290/22/124 (3.0/40.0/57.0)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-290/22/124 (3.0/40.0/57.0) see
 zeotrope ternary blend RDB#

COMMON USE(S)

air conditioners operating at high condensing temperatures, such as those in steel mills, primarily for aftermarket use to retrofit existing systems as an alternative for refrigerant 12

IDENTIFIERS

common name(s): R-290/22/124 (3.0/40.0/57.0)
 R290/22/124 (3.0/40.0/57.0)
 R 290/22/124 (3.0/40.0/57.0)
 HC-290/HCFC-22/HCFC-124
 (3/40/57)
 not HC-290/22/124 (3/40/57)
 not HCFC-290/22/124 (3/40/57)
 trade name(s): Dehon Service Mixiflon DP40 mfr

PHYSICAL

· nominal blend formulation -----
 composition: R-290/22/124
 component weight fractions: 3.0 / 40.0 / 57.0 %
 component weight tolerances: ±1.0 / ±1.0 / ±1.0 mfr
 component mole fractions: 7.174 / 48.782 / 44.043 % 8820

· properties -----
 molar mass: 105.45309 g/mol (0.232484 lb/mol) 8820

normal freezing/melting/triple point: Dehon: <-100 °C (<-148 °F) MSDS

· normal boiling point -----
 bubble point temperature: -37.0 °C (-34.6 °F) 8401
 dew point temperature: -26.0 °C (-14.8 °F) 8401
 maximum temperature glide: 11.02 °C (19.8 °F) 8401
 density, saturated liquid: 1400 kg/m3 (87.42 lb/cf) 8401
 density, saturated vapor: 5.40 kg/m3 (0.337 lb/cf) 8401
 specific volume, saturated liquid: 0.714 L/kg (0.0114 cf/lb) 8401
 specific volume, saturated vapor: 185.3 L/kg (2.9680 cf/lb) 8401
 heat of vaporization: 206.6 kJ/kg (88.8 Btu/lb) 8401

velocity of sound, saturated liquid: 779 m/s (2556 ft/s) 8401
 velocity of sound, saturated vapor: 145 m/s (475 ft/s) 8401
 viscosity, saturated liquid: 366 µPa·s (0.366 cp) 8401
 viscosity, saturated vapor: 9.96 µPa·s (0.00996 cp) 8401
 thermal conductivity, liquid: 0.0963 W/m·K (0.0557 Btu/hr·ft°F) 8401
 thermal conductivity, vapor: 0.0083 W/m·K (0.0048 Btu/hr·ft°F) 8401

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 4.472 kg/m3 (0.2792 lb/cf) 8401

· normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 4.454 kg/m3 (0.2780 lb/cf) 8401

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 732.5 kPa (106.24 psia) 8401
 pressure, vapor (dew point): 569.3 kPa (82.56 psia) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

	687.3 kPa (99.68 psia)	MSDS
density, saturated liquid:	1214 kg/m ³ (75.79 lb/cf)	mfr
	1220 kg/m ³ (76.17 lb/cf)	8401
density, saturated vapor:	28.08 kg/m ³ (1.753 lb/cf)	8401
specific volume, saturated liquid:	0.820 L/kg (0.0131 cf/lb)	8401
specific volume, saturated vapor:	36.6 L/kg (0.5866 cf/lb)	8401
velocity of sound, saturated liquid:	527 m/s (1728 ft/s)	8401
velocity of sound, saturated vapor:	146 m/s (478 ft/s)	8401
viscosity, saturated liquid:	186 µPa·s (0.186 cp)	8401
viscosity, saturated vapor:	11.9 µPa·s (0.0119 cp)	8401
thermal conductivity, saturated liquid:	0.0741 W/m·K (0.0428 Btu/hr·ft ² ·°F)	8401
thermal conductivity, saturated vapor:	0.01532 W/m·K (0.00885 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----		
pressure, liquid (bubble point):	1924 kPa (279.1 psia)	8401
pressure, vapor (dew point):	1665 kPa (241.5 psia)	8401
heat of vaporization:	128.3 kJ/kg for liquid and vapor both at nominal composition (55.2 Btu/lb)	8401
	101.9 kJ/kg coexisting liquid and vapor at bubble-point pressure (43.8 Btu/lb)	
· critical point -----		
temperature:	105.1 °C (221.2 °F)	8401
	112.5 °C (234.5 °F)	mfr
pressure:	4457 kPa (646.4 psia)	8401
density:	511 kg/m ³ (31.9 lb/cf)	8401
specific volume:	1.96 L/kg (0.0313 cf/lb)	8401
ENVIRONMENTAL		
ODP (ozone depletion potential):	0.028 mass-weighted average (model-derived relative to R 11)	9501
	0.035 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	1110 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.18 mass-weighted average relative to R 11 for infinite integration period	DW
SAFETY		
· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending) components are A3, A1, and A1	8601 8601
· long-term occupational limit -----		
exposure limit consistent to OSHA PEL:	Dehon Service: 500-1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk	MSDS
· flammability -----		
LFL-UFL (flammability limits in air):	Dehon: nonflammable	MSDS
flash point:	Dehon: not applicable	MSDS
· detection -----		
appearance:	Dehon: colorless	MSDS
odor:	Dehon: faintly ethereal	MSDS

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

PRODUCTION

first commercial use as a refrigerant: 1994
last year production allowed: 2029 by refrigerants 22, 124 8C01
in developed countries under
the Montreal Protocol

R-290/124/123 (3.0/40.0/57.0)

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----- REFRIGERANT DATA SUMMARY -----
unassigned R-290/124/123 (3.0/40.0/57.0) see
zeotrope ternary blend RDB#
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COMMON USE(S)

industrial use in applications with high condensing temperatures, such as air conditioners for overhead crane cabs in steel mills, primarily as a service fluid for retrofit of systems designed for refrigerant 114

Note: The hoses commonly used in systems designed for refrigerant 114 are not compatible with the R-290/124/123 blend.

IDENTIFIERS

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common name(s): R-290/124/123 (3.0/40.0/57.0)
                R290/124/123 (3.0/40.0/57.0)
                R 290/124/123 (3.0/40.0/57.0)
                not: R-123/124/290 (57/40/3)
                not: R123/124/290 (57/40/3)
                not: R 123/124/290 (57/40/3)
                HC-290/HCFC-124/HCFC-123      2909
                  (3/40/57)                    2909
                not: HCFC-290/124/123        2909
                  (3/40/57)                    2909

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PHYSICAL

```

· nominal blend formulation -----
      composition: R-290/124/123
      component weight fractions: 3.0 / 40.0 / 57.0 %
      component mole fractions: 9.271 / 39.939 / 50.790 %      8820
· properties -----
      molar mass: 136.26833 g/mol (0.300420 lb/mol)      8820
· normal boiling point -----
      bubble point temperature: -15.3 °C (4.4 °F)      8401
      dew point temperature: 6.0 °C (42.8 °F)      8401
      maximum temperature glide: 21.34 °C (38.4 °F)      8401
      density, saturated liquid: 1445 kg/m3 (90.21 lb/cf)      8401
      density, saturated vapor: 6.02 kg/m3 (0.376 lb/cf)      8401
      specific volume, saturated liquid: 0.692 L/kg (0.0111 cf/lb)      8401
      specific volume, saturated vapor: 166.0 L/kg (2.6587 cf/lb)      8401
      heat of vaporization: 200.1 kJ/kg (86.0 Btu/lb)      8401
      velocity of sound, saturated liquid: 771 m/s (2530 ft/s)      8401
      velocity of sound, saturated vapor: 134 m/s (440 ft/s)      8401
      viscosity, saturated vapor: 10.55 µPa·s (0.01055 cp)      8401
      viscosity, saturated liquid: 461 µPa·s (0.461 cp)      8401
      thermal conductivity, liquid: 0.0853 W/m·K (0.0493 Btu/hr·ft°F)      8401
      thermal conductivity, vapor: 0.0101 W/m·K (0.0058 Btu/hr·ft°F)      8401
· normal pressure, 20 °C (68 °F) ----
      density, vapor: 5.865 kg/m3 (0.3661 lb/cf)      8401
· normal pressure, 21.1 °C (70 °F) ---

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

	density, vapor:	5.840 kg/m ³ (0.3646 lb/cf)	8401
· 20 °C (68 °F) -----			
	pressure, liquid (bubble point):	311.4 kPa (45.16 psia)	8401
	pressure, vapor (dew point):	132.3 kPa (19.19 psia)	8401
	density, saturated liquid:	1351 kg/m ³ (84.32 lb/cf)	8401
	density, saturated vapor:	7.74 kg/m ³ (0.483 lb/cf)	8401
	specific volume, saturated liquid:	0.740 L/kg (0.0119 cf/lb)	8401
	specific volume, saturated vapor:	12.9 L/kg (0.2069 cf/lb)	8401
	velocity of sound, saturated liquid:	628 m/s (2060 ft/s)	8401
	velocity of sound, saturated vapor:	135 m/s (442 ft/s)	8401
	viscosity, saturated liquid:	299 µPa·s (0.299 cp)	8401
	viscosity, saturated vapor:	10.8 µPa·s (0.0108 cp)	8401
	thermal conductivity, saturated liquid:	0.0742 W/m·K (0.0429 Btu/hr·ft ² ·°F)	8401
	thermal conductivity, saturated vapor:	0.01054 W/m·K (0.00609 Btu/hr·ft ² ·°F)	8401
· 60 °C (140 °F) -----			
	pressure, liquid (bubble point):	842 kPa (122.1 psia)	8401
	pressure, vapor (dew point):	487 kPa (70.6 psia)	8401
	heat of vaporization:	145.5 kJ/kg for liquid and vapor both at nominal composition (62.6 Btu/lb)	8401
		87.4 kJ/kg coexisting liquid and vapor at bubble-point pressure (37.6 Btu/lb)	8401
· critical point -----			
	temperature:	151.1 °C (304.0 °F)	8401
	pressure:	3985 kPa (578.0 psia)	8401
	density:	530 kg/m ³ (33.1 lb/cf)	8401
	specific volume:	1.89 L/kg (0.0302 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	0.017 mass-weighted average (model-derived relative to R 11)	9501
	0.022 mass-weighted average (semi-empirical relative to R 11)	9501
GWP (global warming potential):	320 mass-weighted average relative to CO ₂ for 100 yr integration	9501
HGWP (halocarbon GWP):	0.05 mass-weighted average relative to R 11 for infinite integration period	DW

SAFETY

· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending) components are A3, A1, and B1	8601 8601

PRODUCTION

first commercial use as a refrigerant:	circa 1995	
last year production allowed:	2029 by refrigerants 123, 124 in developed countries under the Montreal Protocol	8C01

R-290/134a

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-290/134a (??/??) see
 azeotrope binary blend RDB#

COMMON USE (S)

under consideration as an alternative for refrigerants 12 and 134a to
 enable use of mineral oil lubricants

IDENTIFIERS

common name(s): R-290/134a (??/??)
 R290/134a (??/??)
 R 290/134a (??/??)
 HC-290/HFC-134a (??/??)
 not HFC-290/134a (??/??)
 ARI container color / Pantone number: none, use light green grey/413 6601
 with red / 185 band

PHYSICAL

· nominal blend formulation -----
 composition: R-290/134a

ENVIRONMENTAL

ODP (ozone depletion potential): 0.000 (model-derived relative
 to R 11)

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 components are A3 and A1 8601

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized
 last year production allowed: unrestricted 8C01

R-290/134a/ethanol (??/98.0/??)

----- REFRIGERANT DATA SUMMARY -----

unassigned	R-290/134a/ethanol (??/98.0/??)	see
zeotrope	ternary blend	RDB#

COMMON USE(S)

additized version of refrigerant 134a to provide miscibility with mineral oils and other lubricants for use as a replacement for refrigerant 12 in domestic and commercial refrigeration, automobile air conditioners, and transport refrigeration

The following information is preliminary and may be incomplete or incorrect. Further information may be available from Seco Technologies, Incorporated (Los Angeles, CA, USA) or Solpower Australia Pty Limited (Chattenham, Australia). The blend is described as 98% refrigerant 134a with 2% pharmaceutical grade refrigerant 290 (propane) and ethanol. A description claims that this blend is up to 25% more efficient than refrigerant 134a, offers higher capacities with lower head pressures, and is compatible all systems designed for refrigerants 12 and 134a, and is compatible with mineral oil, polyalkylene glycol (PAG), and polyolester (POE) lubricants. This blend appears to be a revised formulation of R-134a-E.

IDENTIFIERS

trade name(s): Solpower Australia Pty SP34E

PHYSICAL

· properties -----			
	molar mass:	102.0 g/mol (0.224872 lb/mol)	mfr
· normal boiling point -----			
	temperature:	-26.1 °C (-15.1 °F)	mfr
· 20 °C (68 °F) -----			
	pressure, saturated vapor:	476.6 kPa (69.13 psia)	mfr
· 60 °C (140 °F) -----			
	pressure, saturated vapor:	1586 kPa (230.0 psia)	mfr
· critical point -----			
	temperature:	101.0 °C (213.9 °F)	mfr

ENVIRONMENTAL

ODP (ozone depletion potential):	0.000 (model-derived relative to R 11)	mfr
HGWP (halocarbon GWP):	0.24-0.29 relative to R 11 for infinite integration period	mfr

SAFETY

· classification -----			
	safety group (ASHRAE Standard 34):	none (application pending)	
· flammability -----			
	LFL-UFL (flammability limits in air):	nonflammable as tested % v/v	mfr
· detection -----			
	appearance:	colorless gas	mfr
	odor:	ethanol odor	mfr

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

PRODUCTION

first commercial use as a refrigerant: circa 1998

R-290/152a/13I1 (formulation not disclosed)

```

----- REFRIGERANT DATA SUMMARY -----
unassigned  R-290/152a/13I1 (formulation not disclosed)      see
zeotrope    ternary blend                                     RDB#
-----

```

COMMON USE(S)

under consideration as an alternative for refrigerants 12 and 134a

The following information is preliminary and may be incomplete or incorrect. Data on this blend may be available from Tsinghua University (Beijing, Peoples Republic of China) and refrigerant manufacturers.

The blend consists of refrigerant 13I1, a hydrofluorocarbon (HFC) with a low global warming potential, and hydrocarbon (HC). Papers on the blend indicate that the HFC and HC are both flammable, but that the blend is not. Although unpublished, the composition was identified as R-290/152a/13I1 at a presentation in November 1997, but the formulation was not disclosed.

IDENTIFIERS

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common name(s):  R-290/152a/13I1 (??/??/??)
                  R290/152a/13I1 (??/??/??)
                  R 290/152a/13I1 (??/??/??)
trade name(s):   (China) THR02                               5B03

```

PHYSICAL

```

· nominal blend formulation -----
  composition:      R-290/152a/13I1
  component weight fractions:  formulation must be indicated
  %
· normal boiling point -----
  maximum temperature glide:  1.00 °C (1.8 °F)                5B03

```

ENVIRONMENTAL

```

ODP (ozone depletion potential):  ~0. (model-derived relative to 5B03
R 11)
GWP (global warming potential):   ~50. relative to CO2 for 100  5B03
yr integration

```

SAFETY

```

· classification -----
  safety group (ASHRAE Standard 34):  none (no application pending)  8601
                                       components are A1, A3, and        8601
                                       unclassified                       8601
· flammability -----
  LFL-UFL (flammability limits in air):  none (nonflammable as tested)  5B03

```

PRODUCTION

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first commercial use as a refrigerant:  not known to be commercialized  5B03
last year production allowed:           unrestricted                    3C05
                                       unrestricted                       8C01

```


R-290/600 (60.0/40.0 by liquid volume)

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----- REFRIGERANT DATA SUMMARY -----
unassigned   R-290/600 (60.0/40.0 by liquid volume)      see
zeotrope     binary blend                                       RDB#
-----

```

COMMON USE(S)

service fluid for refrigerant 12 and 134a in such uses as mobile air conditioning, refrigerators, and ice makers; flammability has spurred restrictions in locations including Florida; while the National Highway Traffic Safety Administration and the U.S. Environmental Protection Agency are investigating potential risks, the manufacturer asserts that OZ-12 poses no unusual danger

The following information is preliminary and may be incomplete or incorrect. Data may be available from OZ Technology, Incorporated (Rathdrum, ID, USA) and other refrigerant manufacturers.

IDENTIFIERS

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common name(s):  R-290/600 (60/40)
                  R290/600 (60/40)
                  R 290/600 (60/40)
                  HC-290/HC-600 (60/40)
                  not HC-290/600 (60/40)           2909
trade name(s):   ES112R
                  ES12R
historical name(s): OZ Technology OZ-12
name used in U.S. EPA SNAP Rule: Hydrocarbon Blend A
ARI container color / Pantone number: none, use light green grey/413 6601
                                      with red / 185 band

```

PHYSICAL

```

· nominal blend formulation -----
                        composition:  R-290/600
component weight fractions:  60.0 / 40.0 %
component mole fractions:    66.411 / 33.589 %           8820
· properties -----
                        molar mass:   48.80704 g/mol (0.107601  8820
                                      lb/mol)

```

ENVIRONMENTAL

```

ODP (ozone depletion potential):  0.000 mass-weighted average
                                   (model-derived relative to R
                                   11)
GWP (global warming potential):   unknown, but very low: ~20
                                   relative to CO2 for 100 yr
                                   integration

```

SAFETY

```

· classification -----
safety group (ASHRAE Standard 34): none (no application pending)  8601
                                      components are both A3        8601
· emergency exposure limit -----
Refrigerant Concentration Limit (RCL): 4,600 ppm v/v (preliminary
                                      value under review, based on

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

draft ASHRAE 34aa)

PRODUCTION

first commercial use as a refrigerant:	circa 1993	
last year production allowed:	unrestricted	8C01

R-290/600 or R-290/600a

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-290/600 or R-290/600a, formulation not disclosed see
 zeotrope binary blend RDB#

COMMON USE(S)

service fluid for refrigerant 12 in such uses as mobile air conditioning, refrigerators, and ice makers

The following information is preliminary and may be incomplete or incorrect. Data may be available from Esanty Refrigerants / Boral Energy (Victoria, Australia) and other refrigerant manufacturers.

Product literature describes this refrigerant as "manufactured from a blend of purified hydrocarbons." It further identifies the blend as consisting of refrigerants 290 (propane) and 600a (isobutane), but shows the ingredients by Chemical Abstracts Service (CAS) registry numbers as consisting of 74-98-6 (propane) and 106-97-8 (n-butane). The product sheet shows the each components proportion as "0 to 50%", for which the only mathematical solution, without another component, is 50/50.

IDENTIFIERS

common name(s): R-290/600 or R-290/600a(??/??)
 R290/600 or R290/600a(??/??)
 R 290/600 or R 290/600a(??/??)
 HC-290/HC-600 (??/??) or
 HC-290/HC-600a (??/??)
 not HC-290/600 (??/??) or
 HC-290/600a (??/??) or
 trade name(s): Boral Energy (Australia) ER12 mfr
 Esanty Refrigerants ER12 mfr
 ARI container color / Pantone number: none, use light green grey/413 6601
 with red / 185 band

PHYSICAL

· normal boiling point -----
 temperature: -30 to 0 °C (-22 to 32 °F) mfr
 · 20 °C (68 °F) -----
 pressure, saturated vapor: 591.0 kPa (85.72 psia) mfr

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 components are both A3 8601
 · flammability -----
 LFL-UFL (flammability limits in air): 1.9-9.5 % v/v mfr
 flash point: -104 to 60 °C (-155 to 140 °F) mfr
 autoignition temperature: 550 °C (1022 °F) mfr
 · detection -----
 odor: rotton cabbage-like odor mfr

PRODUCTION

first commercial use as a refrigerant: circa 1998

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

last year production allowed: unrestricted

8C01

R-290/600a (50.0/50.0)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-290/600a (50.0/50.0) see
 zeotropic blend RDB#

COMMON USE(S)

alternative for refrigerant 12 in refrigerators, commercial refrigeration, mobile air conditioning, and ice makers; constrained by high flammability, though accepted in some countries, notably Germany, in systems with small charges

IDENTIFIERS

common name(s): R-290/600a (50.0/50.0)
 R290/600a (50.0/50.0)
 R 290/600a (50.0/50.0)
 HC/HC-290/600a (50/50)
 not HC-290/600a (50/50)
 ARI container color / Pantone number: none, use light green grey/413 6601
 with red / 185 band

PHYSICAL

· nominal blend formulation -----
 composition: R-290/600a
 component weight fractions: 50.0 / 50.0 %
 component mole fractions: 56.861 / 43.139 % 8820

· properties -----
 molar mass: 50.14653 g/mol (0.110554 lb/mol) 8820

· normal boiling point -----
 bubble point temperature: -32.8 °C (-27.0 °F) 8401
 dew point temperature: -24.1 °C (-11.4 °F) 8401
 maximum temperature glide: 8.68 °C (15.6 °F) 8401
 density, saturated liquid: 592 kg/m³ (36.97 lb/cf) 8401
 density, saturated vapor: 2.55 kg/m³ (0.159 lb/cf) 8401
 specific volume, saturated liquid: 1.688 L/kg (0.0270 cf/lb) 8401
 specific volume, saturated vapor: 392.0 L/kg (6.2797 cf/lb) 8401
 heat of vaporization: 412.8 kJ/kg (177.5 Btu/lb) 8401
 velocity of sound, saturated liquid: 1105 m/s (3625 ft/s) 8401
 velocity of sound, saturated vapor: 210 m/s (688 ft/s) 8401
 viscosity, saturated liquid: 222 µPa·s (0.222 cp) 8401
 viscosity, saturated vapor: 6.35 µPa·s (0.00635 cp) 8401
 thermal conductivity, liquid: 0.1233 W/m·K (0.0712 Btu/hr·ft·°F) 8401
 thermal conductivity, vapor: 0.0123 W/m·K (0.0071 Btu/hr·ft·°F) 8401

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 2.130 kg/m³ (0.1330 lb/cf) 8401

· normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 2.122 kg/m³ (0.1325 lb/cf) 8401

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 590.4 kPa (85.63 psia) 8401
 pressure, vapor (dew point): 477.1 kPa (69.20 psia) 8401
 density, saturated liquid: 528 kg/m³ (32.93 lb/cf) 8401
 density, saturated vapor: 11.05 kg/m³ (0.690 lb/cf) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

specific volume, saturated liquid:	1.896 L/kg (0.0304 cf/lb)	8401
specific volume, saturated vapor:	90.5 L/kg (1.4501 cf/lb)	8401
velocity of sound, saturated liquid:	790 m/s (2593 ft/s)	8401
velocity of sound, saturated vapor:	211 m/s (693 ft/s)	8401
viscosity, saturated liquid:	125 $\mu\text{Pa}\cdot\text{s}$ (0.125 cp)	8401
viscosity, saturated vapor:	7.5 $\mu\text{Pa}\cdot\text{s}$ (0.0075 cp)	8401
thermal conductivity, saturated liquid:	0.0966 W/m \cdot K (0.0558 Btu/hr \cdot ft $^{\circ}$ F)	8401
thermal conductivity, saturated vapor:	0.01708 W/m \cdot K (0.00987 Btu/hr \cdot ft $^{\circ}$ F)	8401
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	1520 kPa (220.4 psia)	8401
pressure, vapor (dew point):	1328 kPa (192.6 psia)	8401
heat of vaporization:	279.6 kJ/kg for liquid and vapor both at nominal composition (120.2 Btu/lb)	8401
	253.4 kJ/kg coexisting liquid and vapor at bubble-point pressure (109.0 Btu/lb)	8401
• critical point -----		
temperature:	114.8 $^{\circ}$ C (238.6 $^{\circ}$ F)	8401
pressure:	4042 kPa (586.2 psia)	8401
density:	218 kg/m ³ (13.6 lb/cf)	8401
specific volume:	4.59 L/kg (0.0735 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	0.000 mass-weighted average (model-derived relative to R 11)
GWP (global warming potential):	unknown, but very low: ~20 relative to CO ₂ for 100 yr integration
HGWP (halocarbon GWP):	<0.01 mass-weighted average relative to R 11 for infinite integration period

SAFETY

• classification -----		
safety group (ASHRAE Standard 34):	none (no application pending) components are both A3	8601 8601
• emergency exposure limit -----		
Refrigerant Concentration Limit (RCL):	4,800 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)	
• flammability -----		
LFL-UFL (flammability limits in air):	2-10 % v/v	8356

PRODUCTION

first commercial use as a refrigerant:	late 1800s, revived circa 1993	
last year production allowed:	unrestricted	8C01

R-290/600a

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-290/600a (formulation not disclosed) see
 zeotrope binary blend RDB#

COMMON USE(S)

service fluid for refrigerant 12 in such uses as mobile air
 conditioning, refrigerators, and ice makers

The following information is preliminary and may be incomplete or
 incorrect. Data may be available from Calor Gas Refrigeration
 (Slough, UK), and other refrigerant manufacturers.

IDENTIFIERS

common name(s): R-290/600a (??/??)
 HC-290/HC-600a (??/??)
 not HC-290/600a (??/??)
 trade name(s): Calor Gas (UK) CARE 30 5B12
 Ecozone BV (NL) Ecool-PIB
 ARI container color / Pantone number: none, use light green grey/413 6601
 with red / 185 band

PHYSICAL

· nominal blend formulation -----
 composition: R-290/600a
 component weight fractions: formulation must be indicated
 %
 · normal boiling point -----
 temperature: 31.5 °C (88.7 °F) 5B12

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 components are both A3 8601
 · flammability -----
 LFL-UFL (flammability limits in air): 1.95-9.1 % v/v 5B12

PRODUCTION

first commercial use as a refrigerant: June 1994
 last year production allowed: unrestricted 8C01

R-290/600a/600 (17.1/80.4/2.5)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-290/600a/600 (17.1/80.4/2.5) see
 HC ternary blend RDB#

COMMON USE(S)

not known to be used as a refrigerant; common aerosol propellant

IDENTIFIERS

common name(s): R-290/600a/600 (17.1/80.4/2.5) 6569
 R290/600a/600 (17.1/80.4/2.5) 6569
 R 290/600a/600 (17.1/80.4/2.5) 6569
 A-46 (also A46) 6569
 ARI container color / Pantone number: none, use light green grey/413 6601
 with red / 185 band

PHYSICAL

· nominal blend formulation -----
 composition: R-290/600a/600
 component weight fractions: 17.1 / 80.4 / 2.5 %
 component mole fractions: 21.377 / 76.252 / 2.371 % 8820
 · properties -----
 molar mass: 55.12379 g/mol (0.121527 8820
 lb/mol)

ENVIRONMENTAL

ODP (ozone depletion potential): 0.000 (model-derived relative
 to R 11)
 GWP (global warming potential): unknown, but very low: ~20
 relative to CO2 for 100 yr
 integration
 HGWP (halocarbon GWP): <0.01 relative to R 11 for
 infinite integration period

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 all components are A3 8601
 · flammability -----
 LFL-UFL (flammability limits in air): highly flammable

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized
 (as aerosol propellant 1970s)
 last year production allowed: unrestricted 8C01

R-600a/600 (50.0/50.0)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-600a/600 (50.0/50.0) see
 zeotrope binary blend RDB#

COMMON USE(S)

used in small refrigeration systems including household refrigerators in the 1920s and early 1930s; re-emerged in the 1990s as an alternative to refrigerants 12

The commercial formulation of this blend is subject to wide variation and typically includes other hydrocarbons as minor components. Accordingly, the specific physical and safety data for a given sample may differ from that shown.

IDENTIFIERS

common name(s): R-600a/600 (50/50)
 R600a/600 (50/50)
 R 600a/600 (50/50)
 HC-600a/HC-600 (50/50)
 not HC-600a/600 (50/50)
 isobutane/butane
 ARI container color / Pantone number: none, use light green grey/413 6601
 with red / 185 band

PHYSICAL

· nominal blend formulation -----
 composition: R-600a/600
 component weight fractions: 50 / 50 %
 component mole fractions: 50.000 / 50.000 % 8820

· properties -----
 molar mass: 58.12220 g/mol (0.128138 8820
 lb/mol)

· normal boiling point -----
 bubble point temperature: -6.5 °C (20.3 °F) 8401
 dew point temperature: -5.4 °C (22.3 °F) 8401
 maximum temperature glide: 1.12 °C (2.0 °F) 8401
 density, saturated liquid: 598 kg/m³ (37.34 lb/cf) 8401
 density, saturated vapor: 2.76 kg/m³ (0.172 lb/cf) 8401
 specific volume, saturated liquid: 1.672 L/kg (0.0268 cf/lb) 8401
 specific volume, saturated vapor: 362.3 L/kg (5.8033 cf/lb) 8401
 heat of vaporization: 378.6 kJ/kg (162.8 Btu/lb) 8401
 velocity of sound, saturated liquid: 1024 m/s (3359 ft/s) 8401
 velocity of sound, saturated vapor: 199 m/s (652 ft/s) 8401
 viscosity, saturated liquid: 216 µPa·s (0.216 cp) 8401
 viscosity, saturated vapor: 6.32 µPa·s (0.00632 cp) 8401
 thermal conductivity, liquid: 0.1149 W/m·K (0.0664 8401
 Btu/hr·ft²·°F)
 thermal conductivity, vapor: 0.0131 W/m·K (0.0076 8401
 Btu/hr·ft²·°F)

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 2.491 kg/m³ (0.1555 lb/cf) 8401

· normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 2.481 kg/m³ (0.1549 lb/cf) 8401

• 20 °C (68 °F) -----		
pressure, liquid (bubble point):	254.1 kPa (36.85 psia)	8401
pressure, vapor (dew point):	246.2 kPa (35.71 psia)	8401
density, saturated liquid:	568 kg/m ³ (35.46 lb/cf)	8401
density, saturated vapor:	6.36 kg/m ³ (0.397 lb/cf)	8401
specific volume, saturated liquid:	1.761 L/kg (0.0282 cf/lb)	8401
specific volume, saturated vapor:	157.3 L/kg (2.5191 cf/lb)	8401
velocity of sound, saturated liquid:	881 m/s (2890 ft/s)	8401
velocity of sound, saturated vapor:	201 m/s (658 ft/s)	8401
viscosity, saturated liquid:	164 µPa·s (0.164 cp)	8401
viscosity, saturated vapor:	6.9 µPa·s (0.0069 cp)	8401
thermal conductivity, saturated liquid:	0.1036 W/m·K (0.0599 Btu/hr·ft°F)	8401
thermal conductivity, saturated vapor:	0.01554 W/m·K (0.00898 Btu/hr·ft°F)	8401
• 60 °C (140 °F) -----		
pressure, liquid (bubble point):	751 kPa (108.9 psia)	8401
pressure, vapor (dew point):	737 kPa (106.9 psia)	8401
heat of vaporization:	303.8 kJ/kg for liquid and vapor both at nominal composition (130.6 Btu/lb)	8401
	303.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (130.4 Btu/lb)	8401
• critical point -----		
temperature:	143.6 °C (290.5 °F)	8401
pressure:	3727 kPa (540.6 psia)	8401
density:	227 kg/m ³ (14.1 lb/cf)	8401
specific volume:	4.41 L/kg (0.0707 cf/lb)	8401

ENVIRONMENTAL

ODP (ozone depletion potential):	0.000 (model-derived relative to R 11)	
GWP (global warming potential):	unknown, but very low: ~20 relative to CO ₂ for 100 yr integration	
HGWP (halocarbon GWP):	~0 relative to R 11 for infinite integration period	

SAFETY

• classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
	components are both A3	8601
NFPA 704 degrees of hazard (H-F-R-S):	Texaco: 1-4-1	MSDS
	health-flammability-reactivity [-special]: 0=no, 4=severe	
NPCA HMIS hazard ratings (H-F-R):	Texaco: 1-4-1	MSDS
	health-flammability-reactivity 0=insignificant, 4=extreme	
• flammability -----		
LFL-UFL (flammability limits in air):	Texaco: 1.8-8.4 % v/v	MSDS
flash point:	Texaco: <-51 °C (<-60 °F)	MSDS
• detection -----		
appearance:	Texaco: colorless	MSDS
odor:	Texaco: odorless	MSDS

PRODUCTION

first commercial use as a refrigerant:	1920s	
last year production allowed:	unrestricted	8C01

R-610/217ca11

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-610/217ca11 (formulation not disclosed) see
 zeotrope binary blend RDB#

COMMON USE(S)

developmental blend, examined circa 1994, as an alternative for
 refrigerant 11

The designations "Ikon-11A" and "R-11A" were trade names and not
 refrigerant numbers conforming to ASHRAE Standard 34.

IDENTIFIERS

historical name(s): Ikon(R) 11A 4831

SAFETY

· flammability -----
 LFL-UFL (flammability limits in air): Ikon: nonflammable 4831

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized

R-717/E170 (60/40)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-717/E170 (60/40) see
 azeotrope binary blend RDB#

COMMON USE(S)

candidate refrigerant to exploit the thermodynamic properties of refrigerant 717 (ammonia) and offer at least partial miscibility with common lubricants, reduced compressor discharge temperature, and high performance; targeted for air-cooled refrigeration systems with capacities of up to 25 kW (7 ton), but constrained by flammability and toxicity considerations

The designation "R723" does not conform to ASHRAE Standard 34. The blend appears eligible for a designation in the R-5xx series.

IDENTIFIERS

common name(s): R-717/E170 (60.0/40.0)
 R717/E170 (60.0/40.0)
 R 717/E170 (60.0/40.0)
 "R723"
 NH3/DME; ammonia/DME
 ARI container color / Pantone number: none, use light green grey/413 6601
 with red / 185 band

PHYSICAL

• nominal blend formulation -----
 composition: R-717/E170 9850
 component weight fractions: 60.0 / 40.0 % 9850
 component mole fractions: 80.228 / 19.772 % 8820
 • properties -----
 molar mass: 22.77203 g/mol (0.050204 8820
 lb/mol)

ENVIRONMENTAL

ODP (ozone depletion potential): 0.000 (model-derived relative
 to R 11)
 GWP (global warming potential): unknown, but very low: <1
 relative to CO2 for 100 yr
 integration

SAFETY

• classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 components are B2 and 8601
 unclassified 8601
 • flammability -----
 LFL (lower flammability limit in air): 6.0 % v/v 9850

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized
 last year production allowed: unrestricted 8C01

R-744/32/134a (7/31/62)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-744/32/134a (7/31/62) see
 zeotrope ternary blend RDB#

COMMON USE(S)

candidate refrigerant for refrigerant 22

IDENTIFIERS

common name(s): R-744/32/134a (7.0/31.0/62.0)
 R744/32/134a (7.0/31.0/62.0)
 R 744/32/134a (7.0/31.0/62.0)
 ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

· nominal blend formulation -----
 composition: R-744/32/134a 9321
 component weight fractions: 7.0 / 31.0 / 62.0 % 9322
 component mole fractions: 11.673 / 43.731 / 44.596 % 8820
 · properties -----
 molar mass: 73.38903 g/mol (0.161795 8820
 lb/mol)

ENVIRONMENTAL

ODP (ozone depletion potential): 0.000 (model-derived relative
 to R 11)
 GWP (global warming potential): >1260 relative to CO2 for 100 9501
 yr integration
 HGWP (halocarbon GWP): 0.22 relative to R 11 for DW
 infinite integration period

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 components are A1, A2, and A1 8601

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized
 last year production allowed: unrestricted 8C01

R-1132a/134a (5.0/95.0)

```

----- REFRI GERANT DATA SUMMARY -----
unassigned  R-1132a/134a (5.0/95.0)          see
zeotrope    binary blend                      RDB#
-----

```

COMMON USE(S)

under consideration as a replacement for refrigerant 22

IDENTIFIERS

```

common name(s):  R-1132a/134a (5/95)
                  R1132a/134a (5/95)
                  R 1132a/134a (5/95)
                  HFC-1132a/HFC-134a (5/95)
                  not HFC-1132a/134a (5/95)      2909
trade name(s):  Solvay VF2/134a (5/95)          7849

```

PHYSICAL

```

· nominal blend formulation -----
      composition:  R-1132a/134a
component weight fractions:  5.0 / 95.0 %
      component mole fractions:  7.737 / 92.263 %      8820
· properties -----
      molar mass:  99.09094 g/mol (0.218458      8820
                  lb/mol)

```

ENVIRONMENTAL

```

ODP (ozone depletion potential):  <0.00002 mass-weighted average 9501
                                   (model-derived relative to R
                                   11)
                                   <0.00048 mass-weighted average 9501
                                   (semi-empirical relative to R
                                   11)
GWP (global warming potential):  1520 mass-weighted average      7849
                                   relative to CO2 for 100 yr
                                   integration

```

SAFETY

```

· classification -----
  safety group (ASHRAE Standard 34):  none (no application pending) 8601

```

PRODUCTION

```

first commercial use as a refrigerant:  not known to be commercialized
                                           promoted 1995 by Solvay      7849
last year production allowed:  unrestricted      8C01

```

R-1216/600a/600 (98.0/1.0/1.0)

```

----- REFRIGERANT DATA SUMMARY -----
unassigned   R-1216/600a/600 (98.0/1.0/1.0)           see
zeotrope     ternary blend                                     RDB#
-----
    
```

COMMON USE(S)

alternative for refrigerant 12 for aftermarket use to service or retrofit existing automobile air conditioners, other mobile air-conditioning (MAC) systems, transport refrigeration, vending machines, and water coolers

The following information is preliminary and may be incomplete or incorrect. Further data may be available from TACIP International, Incorporated (Mobile, AL, USA), or refrigerant manufacturers. This ternary blend is believed to be the base for TACIP's ADAK-29 blend, which also contains an undisclosed component described as a "friction modifier."

IDENTIFIERS

```

common name(s):  R-1216/600a/600 (98.0/1.0/1.0)
                  R1216/600a/600 (98.0/1.0/1.0)
                  R 1216/600a/600 (98.0/1.0/1.0)
    
```

PHYSICAL

```

· nominal blend formulation -----
                        composition:  R-1216/600a/600
                        component weight fractions:  98.0 / 1.0 / 1.0 %
                        component mole fractions:    94.996 / 2.502 / 2.502 %           8820
· properties -----
                        molar mass:    145.42376 g/mol (0.320605           8820
                                      lb/mol)
    
```

ENVIRONMENTAL

```

ODP (ozone depletion potential):  0.000 mass-weighted average
                                   (model-derived relative to R
                                   11)
GWP (global warming potential):   2.0 relative to CO2 for 100 yr 7C31
                                   integration
    
```

SAFETY

```

· classification -----
  safety group (ASHRAE Standard 34):  none (no application pending)  8601
    
```

PRODUCTION

```

last year production allowed:  unrestricted           8C01
    
```

R-1216/600a/600/undisclosed (97.5/1.0/1.0/0.5)

----- REFRIGERANT DATA SUMMARY -----

unassigned	R-1216/600a/600/undisclosed (97.5/1.0/1.0/0.5)	see
zeotrope	tetrinary blend	RDB#

COMMON USE(S)

alternative for refrigerant 12 for aftermarket use to service or retrofit existing automobile air conditioners, other mobile air-conditioning (MAC) systems, transport refrigeration, vending machines, and water coolers

The following information is preliminary and may be incomplete or incorrect. Further data may be available from TACIP International, Incorporated (Mobile, AL, USA), or refrigerant manufacturers. The undisclosed component is described as a "friction modifier" having a CAS registry number of 64742-53-6, believed to be made of a treated light petroleum distillate. Product literature describes this refrigerant as "a blend of inert gases and hydrocarbons" and further indicates that it also contains a "nonflammable inert gas lubricating oil, known as HIGH-TECH 2." The literature asserts that the boiling points of these components bracket that of the hydrocarbon, making the refrigerant "nonflammable when leakage occurs." The literature states that synthetic lubricant used with refrigerant 134a must be removed, but does not indicate whether this refers to polyalkylene glycols, polyolesters, or both.

IDENTIFIERS

trade name(s):	TACIP International ADAK-29
historical name(s):	TACIP International ADAK-12
name used in U.S. EPA SNAP Rule:	Blend Mu

PHYSICAL

· normal boiling point -----		
bubble point temperature:	-32.0 °C (-25.5 °F)	mfr
dew point temperature:	-30.5 °C (-22.8 °F)	mfr
maximum temperature glide:	1.50 °C (2.7 °F)	mfr
· 20 °C (68 °F) -----		
pressure, vapor (dew point):	652.7 kPa (94.67 psia)	mfr
· 60 °C (140 °F) -----		
pressure, vapor (dew point):	1492 kPa (216.4 psia)	mfr
· critical point -----		
temperature:	94.9 °C (202.7 °F)	mfr
specific volume:	1.81 L/kg (0.0290 cf/lb)	mfr

ENVIRONMENTAL

ODP (ozone depletion potential):	TACIP: 0.000 (model-derived relative to R 11)
----------------------------------	---

SAFETY

· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
· flammability -----		
LFL-UFL (flammability limits in air):	TACIP: nonflammable gas	MSDS
heat of combustion (by ASHRAE 34-92):	449.4 MJ/kg (193212 Btu/lb)	MSDS

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

flash point: TACIP: nonflammable as tested MSDS
autoignition temperature: TACIP: 310 °C (590 °F) MSDS
· detection -----
appearance: TACIP: colorless, transparent MSDS
odor: TACIP: slight odor MSDS

PRODUCTION

first commercial use as a refrigerant: projected 1998
last year production allowed: unrestricted

R-1270/290 (98.0/2.0)

----- REFRIGERANT DATA SUMMARY -----
 unassigned R-1270/290 (98.0/2.0) see
 azeotrope binary blend RDB#

IDENTIFIERS

common name(s): R-1270/290 (98.0/2.0)
 R1270/290 (98.0/2.0)
 R 1270/290 (98.0/2.0)
 HC-1270/HC-290 (98/2)
 not HC-1270/290 (98/2)
 mappolene
 propene/propane
 propylene/propane
 ARI container color / Pantone number: none, use light green grey/413 6601
 with red / 185 band

PHYSICAL

· nominal blend formulation -----
 composition: R-1270/290
 component weight fractions: 98.0 / 2.0 %
 component weight tolerances: ±2.0 / ±2.0
 component mole fractions: 98.090 / 1.910 % 8820

· properties -----
 molar mass: 42.11825 g/mol (0.092855 lb/mol) 8820

· normal boiling point -----
 bubble point temperature: -47.7 °C (-53.9 °F) 8814
 dew point temperature: -47.7 °C (-53.9 °F) 8814
 maximum temperature glide: 0.00 °C (0.0 °F) 8814
 density, saturated liquid: 608 kg/m3 (37.98 lb/cf) 8814
 density, saturated vapor: 2.36 kg/m3 (0.147 lb/cf) 8814
 specific volume, saturated liquid: 1.644 L/kg (0.0263 cf/lb) 8814
 specific volume, saturated vapor: 423.7 L/kg (6.7875 cf/lb) 8814
 heat of vaporization: 438.6 kJ/kg (188.6 Btu/lb) 8814
 velocity of sound, saturated liquid: 1168 m/s (3832 ft/s) 8814
 velocity of sound, saturated vapor: 224 m/s (734 ft/s) 8814
 viscosity, saturated liquid: 243 µPa·s (0.243 cp) 8814
 viscosity, saturated vapor: 5.86 µPa·s (0.00586 cp) 8814
 thermal conductivity, liquid: 0.1566 W/m·K (0.0905 Btu/hr·ft°F) 8814
 thermal conductivity, vapor: 0.0104 W/m·K (0.0060 Btu/hr·ft°F) 8814

· normal pressure, 20 °C (68 °F) -----
 density, vapor: 1.778 kg/m3 (0.1110 lb/cf) 8814

· normal pressure, 21.1 °C (70 °F) ---
 density, vapor: 1.771 kg/m3 (0.1105 lb/cf) 8814

· 20 °C (68 °F) -----
 pressure, liquid (bubble point): 1019.7 kPa (147.90 psia) 8814
 pressure, vapor (dew point): 1019.7 kPa (147.90 psia) 8814
 density, saturated liquid: 512 kg/m3 (31.99 lb/cf) 8814
 density, saturated vapor: 21.46 kg/m3 (1.340 lb/cf) 8814
 specific volume, saturated liquid: 1.951 L/kg (0.0313 cf/lb) 8814
 specific volume, saturated vapor: 46.6 L/kg (0.7464 cf/lb) 8814

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

Refrigerant Database

velocity of sound, saturated liquid:	727 m/s (2384 ft/s)	8814
velocity of sound, saturated vapor:	222 m/s (730 ft/s)	8814
viscosity, saturated liquid:	106 $\mu\text{Pa}\cdot\text{s}$ (0.106 cp)	8814
viscosity, saturated vapor:	7.7 $\mu\text{Pa}\cdot\text{s}$ (0.0077 cp)	8814
thermal conductivity, saturated liquid:	0.1108 W/m \cdot K (0.0640 Btu/hr \cdot ft $^{\circ}$ F)	8814
thermal conductivity, saturated vapor:	0.01723 W/m \cdot K (0.00995 Btu/hr \cdot ft $^{\circ}$ F)	8814
• 60 $^{\circ}$ C (140 $^{\circ}$ F) -----		
pressure, liquid (bubble point):	2532 kPa (367.2 psia)	8814
pressure, vapor (dew point):	2532 kPa (367.2 psia)	8814
heat of vaporization:	249.2 kJ/kg for liquid and vapor both at nominal composition (107.1 Btu/lb)	8814
	249.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (107.1 Btu/lb)	8814
• critical point -----		
temperature:	92.5 $^{\circ}$ C (198.5 $^{\circ}$ F)	8814
pressure:	4670 kPa (677.3 psia)	8814
density:	223 kg/m 3 (13.9 lb/cf)	8814
specific volume:	4.48 L/kg (0.0717 cf/lb)	8814

ENVIRONMENTAL

ODP (ozone depletion potential):	0.000 mass-weighted average (model-derived relative to R 11)
GWP (global warming potential):	unknown, but very low: ~20 relative to CO $_2$ for 100 yr integration
HGWP (halocarbon GWP):	~0 relative to R 11 for infinite integration period

SAFETY

• classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
	components are A3 and A3	8601
	components are B3 and A3	pend
NFPA 704 degrees of hazard (H-F-R-S):	BOC Gases: 1-4-0	MSDS
	health-flammability-reactivity [-special]: 0=no, 4=severe	
NPCA HMIS hazard ratings (H-F-R):	BOC Gases: 1-4-0	MSDS
	health-flammability-reactivity 0=insignificant, 4=extreme	
• flammability -----		
LFL-UFL (flammability limits in air):	BOC Gases: 2.0-11.1 % v/v	MSDS
flash point:	BOC Gases: <-104 $^{\circ}$ C (<-162 $^{\circ}$ F)	MSDS
• detection -----		
appearance:	BOC Gases: colorless	MSDS
odor:	BOC Gases: natural gas odor	MSDS

PRODUCTION

first commercial use as a refrigerant:	not known to be commercialized
last year production allowed:	unrestricted 8C01

caoutchoucine

----- REFRIGERANT DATA SUMMARY -----
 unassigned solvent distillate of rubber see
 zeotrope blend RDB#

COMMON USE(S)

the first refrigerant used in a vapor-compression machine (1830s),
 "the volatile liquid arising from destructive distillation of
 caoutchouc" (French for rubber, also a contemporary name for India
 rubber); formerly used as an industrial solvent in printing and
 engraving

IDENTIFIERS

historical name(s): caoutchoucine 2113

PRODUCTION

first commercial use as a refrigerant: 1834 by J. Perkins, associates 2113

gasoline

----- REFRIGERANT DATA SUMMARY -----

unassigned	gasoline: complex mixture of volatile hydrocarbons	see
organic	blend	RDB#
	CAS number 8006-61-9	----

COMMON USE(S)

experimental use as a refrigerant in the 1920s; transportation fuel

IDENTIFIERS

common name(s):	gasoline
	motor fuel, petrol
CAS number:	8006-61-9 Chemical Abstracts Service Registry Number
NIOSH RTECS number:	LX3300000 (Registry of Toxic Effects of Chemical Substances)
historical name(s):	motor spirits

PHYSICAL

· properties -----		
	molar mass:	approximately 72 g/mol (0.000000 lb/mol) 5204
· normal boiling point -----		
	temperature:	38.8 °C (101.8 °F) 5204

SAFETY

· classification -----		
	NIOSH caution:	potential occupational carcinogen (limit exposures to lowest feasible) 5204
	ACGIH carcinogenicity category:	A3, animal carcinogen 9504
· occupational exposure warnings -----		
	substance under study:	ACGIH 8810
· short-term occupational limit -----		
	ACGIH TLV-STEL (short-term exp limit):	500 ppm v/v TWA for 15 min 9504
· long-term occupational limit -----		
	ACGIH TLV-TWA (time-weighted average):	300 ppm v/v TWA for 8 hr/day and 40 hr/wk 9504
· flammability -----		
	LFL-UFL (flammability limits in air):	1.4-7.6 % v/v 5204
	flash point:	-43 °C (-45 °F) 5204
	autoignition temperature:	280 °C (536 °F) 4B64

PRODUCTION

first commercial use as a refrigerant:	1923 by U.S. Bureau of Mines	2113
last year production allowed:	unrestricted	8C01

undisclosed blend: AZ-LT

----- REFRIGERANT DATA SUMMARY -----
 unassigned composition not disclosed see
 blend blend RDB#

COMMON USE(S)

replacement for refrigerant 503; extremely low temperature
 refrigeration as in freezers for biological, medical, and
 pharmaceutical use

The following information is preliminary and may be incomplete or
 incorrect. Data on this blend may be available from AlliedSignal
 Incorporated (Morristown, NJ, USA) and other refrigerant
 manufacturers.

IDENTIFIERS

trade name(s): AlliedSignal Genetron(R) AZ-LT

ENVIRONMENTAL

ODP (ozone depletion potential): 0.000 (model-derived relative
 to R 11)

undisclosed blend: EC-12a

----- REFRIGERANT DATA SUMMARY -----
 unassigned hydrocarbon blend, composition not disclosed see
 zeotrope blend blend RDB#

COMMON USE(S)

service fluid to replace refrigerant 12 in such uses as mobile air conditioning, refrigerators, ice makers, and industrial refrigeration; marketed as a "second-generation replacement" for refrigerant 134a and other non-ozone-depleting substitutes; flammability concerns have constrained acceptance

The following information is preliminary and may be incomplete or incorrect. Data may be available from OZ Technology, Incorporated (Rathdrum, ID, USA), DURACOOL Limited (Edmonton, Alberta, Canada, and Brisbane, Australia), and other refrigerant manufacturers. OZ Technology describes the composition as a compressed hydrocarbon mixture with "HC Friction Fighters" that contain "no graphite, paraffin, or Teflon." Unconfirmed data suggest that the blend contains refrigerants 290 (propane), 600 (butane), 600a (isobutane), and other components.

"HC-12a" and variants with other prefixes are trade names; they are not refrigerant designations conforming to ASHRAE Standard 34.

IDENTIFIERS

trade name(s): DURACOOL(TM) 12a
 Enviro-Cold EC-12a
 HR Technology EC-12a
 OZ Technology HC-12a(R)
 name used in U.S. EPA SNAP Rule: Hydrocarbon Blend B
 ARI container color / Pantone number: none, use light green grey/413 6601
 with red / 185 band

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 · flammability -----
 LFL-UFL (flammability limits in air): HR Technology: 3.0-9.7 % v/v MSDS
 OZ Technology: 1.9-8.5 % v/v MSDS
 autoignition temperature: OZ Technology: 810°C (1490°F) MSDS
 · detection -----
 appearance: HR: colorless gas MSDS
 OZ Technology: colorless gas MSDS
 odor: OZ: natural gas odor MSDS
 OZ: contains mercaptan odorant

PRODUCTION

first commercial use as a refrigerant: 1994
 last year production allowed: unrestricted 8C01

undisclosed blend: EC-22a, OZ HC-22

```

----- REFRIGERANT DATA SUMMARY -----
unassigned hydrocarbon blend, composition not disclosed      see
zeotrope    blend                                           RDB#
-----

```

COMMON USE(S)

service fluid to replace refrigerant 22; marketed as a "second-generation replacement" for refrigerant 134a and other non-ozone-depleting substitutes

The following information is preliminary and may be incomplete or incorrect. Data may be available from OZ Technology, Incorporated (Rathdrum, ID, USA), DURACOOOL (Edmonton, Alberta, Canada, and Brisbane, Australia), and other refrigerant manufacturers. OZ Technology describes the composition as "a compressed hydrocarbon mixture" with "HC Friction Fighters" that contain "no graphite, paraffin, or Teflon."

"HC-22a" and variants with other prefixes are trade names; they are not refrigerant designations conforming to ASHRAE Standard 34.

IDENTIFIERS

```

trade name(s):  DURACOOOL(TM) 22a
                Enviro-Cold EC-22a
                HR Technology EC-22a
                OZ Technology HC-22(R)
ARI container color / Pantone number:  none, use light green grey/413 6601
                                        with red / 185 band

```

SAFETY

```

· classification -----
  safety group (ASHRAE Standard 34):  none (no application pending)  8601
· flammability -----
  LFL-UFL (flammability limits in air):  HR Technology: 3.0-9.7 % v/v  MSDS
· detection -----
  appearance:  HR: colorless gas  MSDS
  odor:  HR: contains mercaptan odorant

```

PRODUCTION

```

first commercial use as a refrigerant:  1995
last year production allowed:  unrestricted  8C01

```

undisclosed blend: EC-502a, OZ HC-502a

----- REFRIGERANT DATA SUMMARY -----

unassigned	hydrocarbon blend, composition not disclosed	see
zeotrope	blend	RDB#

COMMON USE(S)

service fluid to replace refrigerant 502; marketed as a "second-generation replacement" for refrigerant 404A, 507A, and other non-ozone-depleting substitutes

The following information is preliminary and may be incomplete or incorrect. Data may be available from OZ Technology, Incorporated (Rathdrum, ID, USA), DURACOOL (Edmonton, Alberta, Canada, and Brisbane, Australia), and other refrigerant manufacturers. OZ Technology describes the composition as "a compressed hydrocarbon mixture" with "HC Friction Fighters" that contain "no graphite, paraffin, or Teflon."

"HC-502a" and variants with other prefixes are trade names; they are not refrigerant designations conforming to ASHRAE Standard 34.

IDENTIFIERS

trade name(s):	DURACOOL(TM) 502a	
	Enviro-Cold EC-502a	
	HR Technology EC-502a	
	OZ Technology HC-502a(TM)	
ARI container color / Pantone number:	none, use light green grey/413 6601	
	with red / 185 band	

SAFETY

· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
· flammability -----		
LFL-UFL (flammability limits in air):	HR Technology: 3.0-9.7 % v/v	MSDS
· detection -----		
appearance:	HR: colorless gas	MSDS
odor:	HR: contains mercaptan odorant	MSDS

PRODUCTION

first commercial use as a refrigerant:	circa 1997	
last year production allowed:	unrestricted	8C01

undisclosed blend: ES-12

----- REFRIGERANT DATA SUMMARY -----
 unassigned hydrocarbon blend, composition not disclosed see
 zeotrope blend RDB#

COMMON USE(S)

service fluid for refrigerant 12 in such uses as mobile air conditioning, refrigerators, ice makers, and industrial refrigeration; flammability concerns may constrain acceptance

The following information is preliminary and may be incomplete or incorrect. Data may be available from Intervest Environmental Incorporated (USA) and other refrigerant manufacturers.

The designation "ES-12" is a trade name and not a refrigerant number conforming to ASHRAE Standard 34.

IDENTIFIERS

trade name(s): Intervest Environmental ES-12
 ARI container color / Pantone number: none, use light green grey/413 6601 with red / 185 band

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601

PRODUCTION

first commercial use as a refrigerant: 1994
 last year production allowed: unrestricted 8C01

undisclosed blend: FX-21

----- REFRIGERANT DATA SUMMARY -----

unassigned	composition not disclosed	see
zeotrope	blend	RDB#

COMMON USE(S)

under consideration as an alternative for refrigerant 502

The following information is preliminary and may be incomplete or incorrect. Further data may be available from Elf Atochem (Philadelphia, PA, USA) or other refrigerant manufacturers.

IDENTIFIERS

trade name(s):	Elf Atochem Forane(R) FX-21	2A06
----------------	-----------------------------	------

PHYSICAL

· normal boiling point -----		
bubble point temperature:	-49.4 °C (-56.9 °F)	2A06
maximum temperature glide:	0.00 °C (0.0 °F)	2A06
density, saturated vapor:	6.35 kg/m3 (0.396 lb/cf)	2A06
heat of vaporization:	173.0 kJ/kg (74.4 Btu/lb)	2A06
· critical point -----		
temperature:	73.0 °C (163.4 °F)	2A06
pressure:	3800 kPa (551.1 psia)	2A06

ENVIRONMENTAL

ODP (ozone depletion potential):	0.05 (model-derived relative to R 11)	2A06
----------------------------------	---------------------------------------	------

SAFETY

· classification -----		
safety group (ASHRAE Standard 34):	none (no application pending)	8601
· flammability -----		
LFL-UFL (flammability limits in air):	none (nonflammable as tested)	2A06

PRODUCTION

first commercial use as a refrigerant:	not known to be commercialized
--	--------------------------------

undisclosed blend: FX-30

----- REFRIGERANT DATA SUMMARY -----
 unassigned composition not disclosed see
 zeotrope blend RDB#

COMMON USE(S)

under consideration as an alternative for refrigerant 502

The following information is preliminary and may be incomplete or incorrect. Further data may be available from Elf Atochem (Philadelphia, PA, USA) or other refrigerant manufacturers.

IDENTIFIERS

trade name(s): Elf Atochem Forane(R) FX-30 2A06

PHYSICAL

· normal boiling point -----
 bubble point temperature: -46.7 °C (-52.1 °F) 2A06
 maximum temperature glide: 0.00 °C (0.0 °F) 2A06
 density, saturated vapor: 5.40 kg/m³ (0.337 lb/cf) 2A06
 heat of vaporization: 205.0 kJ/kg (88.1 Btu/lb) 2A06
 · critical point -----
 temperature: 70.0 °C (158.0 °F) 2A06
 pressure: 3700 kPa (536.6 psia) 2A06

ENVIRONMENTAL

ODP (ozone depletion potential): 0.000 (model-derived relative to R 11) 2A06

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 · flammability -----
 LFL-UFL (flammability limits in air): none (nonflammable as tested) 2A06

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized

undisclosed blend: FX-50

----- REFRIGERANT DATA SUMMARY -----
 unassigned composition not disclosed see
 zeotrope blend RDB#

COMMON USE (S)

under consideration as an alternative for refrigerant 502

The following information is preliminary and may be incomplete or incorrect. Further data may be available from Elf Atochem (Philadelphia, PA, USA) or other refrigerant manufacturers.

IDENTIFIERS

trade name(s): Elf Atochem Forane(R) FX-50 2A06

PHYSICAL

· normal boiling point -----
 bubble point temperature: -44.3 °C (-47.7 °F) 2A06
 maximum temperature glide: 0.90 °C (1.6 °F) 2A06
 density, saturated vapor: 4.51 kg/m³ (0.282 lb/cf) 2A06
 heat of vaporization: 248.0 kJ/kg (106.6 Btu/lb) 2A06
 · critical point -----
 temperature: 83.0 °C (181.4 °F) 2A06
 pressure: 4500 kPa (652.7 psia) 2A06

ENVIRONMENTAL

ODP (ozone depletion potential): 0.05 (model-derived relative to R 11) 2A06

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 · flammability -----
 LFL-UFL (flammability limits in air): none (nonflammable as tested) 2A06

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized

undisclosed blend: FX-71

----- REFRIGERANT DATA SUMMARY -----
 unassigned composition not disclosed see
 zeotropic blend RDB#

COMMON USE(S)

under consideration as an alternative for refrigerant 502

The following information is preliminary and may be incomplete or incorrect. Data may be available from Elf Atochem (Philadelphia, PA, USA) or other refrigerant manufacturers.

IDENTIFIERS

trade name(s): Elf Atochem Forane(R) FX-71 2A06

PHYSICAL

· normal boiling point -----
 bubble point temperature: -45.7 °C (-50.3 °F) 2A06
 maximum temperature glide: 1.20 °C (2.2 °F) 2A06
 density, saturated vapor: 5.63 kg/m³ (0.351 lb/cf) 2A06
 heat of vaporization: 197.0 kJ/kg (84.7 Btu/lb) 2A06
 · critical point -----
 temperature: 71.0 °C (159.8 °F) 2A06
 pressure: 3700 kPa (536.6 psia) 2A06

ENVIRONMENTAL

ODP (ozone depletion potential): 0.000 (model-derived relative to R 11) 2A06

SAFETY

· classification -----
 safety group (ASHRAE Standard 34): none (no application pending) 8601
 · flammability -----
 LFL-UFL (flammability limits in air): none (nonflammable as tested) 2A06

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized

undisclosed blend: Isceon 39TC, RX5

----- REFRIGERANT DATA SUMMARY -----

unassigned	composition not disclosed	see
blend	binary zeotrope	RDB#

COMMON USE(S)

alternative for refrigerant 12 for centrifugal chillers for
aftermarket use to retrofit existing equipment

The following information is preliminary and may be incomplete or incorrect. Data may be available from Rhodia Limited (Avonmouth, Bristol, UK) and other refrigerant manufacturers. Rhodia describes this refrigerant as a near-azeotropic blend of two hydrofluorocarbons (HFCs) designed for use "without the need for engineering modification ... or oil change" and offering performance "comparable to R 12 even without changes to the impellor or gear". A product bulletin indicates that the blend is compatible with mineral oil, alkylbenzene, and ester-based lubricants. Although the composition has not been disclosed, unconfirmed information on the blend suggests that it may be R-134a/227ea in approximately a (60/40) formulation. If so, suitability for use with mineral oil may warrant verification.

IDENTIFIERS

trade name(s):	Rhodia Isceon 39 TC	
	Rhodia Isceon 39TC	
historical name(s):	Rhodia Isceon RX5	CSDS
ARI container color / Pantone number:	none, use light green grey/413	6601

PHYSICAL

· properties -----		
	molar mass:	121.4 g/mol (0.267641 lb/mol) mfr
· normal boiling point -----		
	bubble point temperature:	-24.7 °C (-12.5 °F) mfr
	dew point temperature:	-24.1 °C (-11.4 °F) mfr
	maximum temperature glide:	0.60 °C (1.1 °F) mfr
	heat of vaporization:	181.5 kJ/kg (78.0 Btu/lb) mfr
· 25 °C (77 °F) -----		
	pressure, saturated vapor:	619.0 kPa (89.78 psia) mfr
	density, saturated liquid:	1280 kg/m ³ (79.91 lb/cf) mfr
	viscosity, saturated liquid:	220 µPa·s (0.220 cp) mfr
· critical point -----		
	temperature:	110.6 °C (231.1 °F) mfr
	pressure:	37 kPa (5.4 psia) mfr

ENVIRONMENTAL

ODP (ozone depletion potential):	0.000 (model-derived relative to R 11)	mfr
----------------------------------	--	-----

SAFETY

· classification -----		
	safety group (ASHRAE Standard 34):	none (no application pending) 8601
· flammability -----		
	LFL-UFL (flammability limits in air):	nonflammable mfr
	flash point:	Rhodia: nonflammable CSDS

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

· detection -----

appearance: colorless
odor: slightly ethereal

CSDS
CSDS

PRODUCTION

first commercial use as a refrigerant: 1998

undisclosed blend: MT-31

```

----- REFRIGERANT DATA SUMMARY -----
unassigned    composition not disclosed          see
zeotrope      binary blend                        RDB#
-----

```

COMMON USE(S)

alternative for refrigerant 12 for aftermarket use for retrofit and service of stationery and transport refrigeration equipment

The following information is preliminary and may be incomplete or incorrect. Further data may be available from Millennia Tech Corporation (Decatur AL and/or South Haven MS USA) or other refrigerant manufacturers. The Material Safety Data Sheet (MSDS) describes the blend as "a nontoxic, nonflammable and noncorrosive homogeneous blend of Fluorocarbons and Hydrochlorofluorocarbons." A product data sheet indicates that the it "is a nonflammable, homogeneous blend of natural organic fluorocarbon, hydrochlorofluorocarbon and hydrocarbon gases." These descriptions are inconsistent with indications in product data sheets that the ozone depletion potential (ODP) is zero. Although the composition has not been disclosed, the limited information available suggests a near-azeotropic, binary blend of a hydrofluorocarbon - possibly R 1216 - and a hydrocarbon. The manufacturer indicates that the refrigerant is miscible with both mineral oil (MO) and alkylbenzene (AB) lubricants, but is not compatible with polyalkylene glycol (PAG), polyalphaolefin (PAO), or polyolester (POE) lubricants.

IDENTIFIERS

trade name(s): Millennia Tech MT-31

PHYSICAL

```

· properties -----
  normal freezing/melting/triple point: -180.3 °C (-292.6 °F)      mfr
· normal boiling point -----
      temperature: -35.0 °C (-31.0 °F)          mfr
      density, saturated liquid: 1221 kg/m3 (76.20 lb/cf)      mfr
      heat of vaporization: 210.3 kJ/kg (90.4 Btu/lb)          mfr
· 20 °C (68 °F) -----
      pressure, saturated vapor: 668.8 kPa (97.00 psia)      MSDS
· 60 °C (140 °F) -----
      pressure, saturated vapor: 724 kPa (105.0 psia)        MSDS
· critical point -----
      temperature: 120.2 °C (248.3 °F)          mfr
                  129.1 °C (264.3 °F)          mfr
      pressure: 4011 kPa (581.7 psia)          mfr
      density: 221 kg/m3 (13.8 lb/cf)          mfr
      specific volume: 4.52 L/kg (0.0725 cf/lb)      mfr

```

ENVIRONMENTAL

```

average atmospheric lifetime (τatm): Millennia Tech: <1 yr      mfr
ODP (ozone depletion potential): Millennia Tech: 0              mfr
                                (model-derived relative to R
                                11)
GWP (global warming potential): Millennia Tech: 8 relative to mfr

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

CO2 for 100 yr integration

SAFETY

```

· classification -----
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  NFPA 704 degrees of hazard (H-F-R-S): Millennium Tech: 2-0-0      MSDS
                                         health-flammability-reactivity
                                         [-special]: 0=no, 4=severe

· flammability -----
  LFL-UFL (flammability limits in air): Millennium Tech: "nonflammable" mfr
  autoignition temperature: Millennium Tech: "nonflammable" mfr

· detection -----
  appearance: Millennium Tech: colorless      MSDS
  odor: Millennium Tech: slight natural MSDS
  gas odor
    
```

PRODUCTION

first commercial use as a refrigerant: 1997

undisclosed blend: MT-31-1

```

----- REFRIGERANT DATA SUMMARY -----
unassigned    composition not disclosed          see
zeotrope      binary blend                        RDB#
-----

```

COMMON USE(S)

alternative for refrigerant 22 for aftermarket use for retrofit and service of commercial refrigeration equipment, air conditioners, and chillers

The following information is preliminary and may be incomplete or incorrect. Further data may be available from Millennia Tech Corporation (Decatur AL and/or South Haven MS USA) or other refrigerant manufacturers. The Material Safety Data Sheet (MSDS) describes the blend as "a nontoxic, nonflammable and noncorrosive homogeneous blend of Fluorocarbons and Hydrochlorofluorocarbons." A product data sheet indicates that it "is a nonflammable, homogeneous blend of natural organic fluorocarbon and hydrochlorofluorocarbon gases." These descriptions are inconsistent with indications in product data sheets that the ozone depletion potential (ODP) is zero. Although the composition has not been disclosed, the limited information available suggests a near-azeotropic, binary blend of a hydrofluorocarbon - possibly R 1216 - and a hydrocarbon. The manufacturer indicates that the refrigerant is miscible with both mineral oil (MO) and alkylbenzene (AB) lubricants, but not compatible with polyalkylene glycol (PAG), polyalphaolefin (PAO), and polyolester (POE) lubricants.

IDENTIFIERS

trade name(s): Millennia Tech MT-31-1

PHYSICAL

```

· properties -----
  normal freezing/melting/triple point:  -180.3 °C (-292.6 °F)      mfr
· normal boiling point -----
  temperature:                            -39.4 °C (-39.0 °F)      mfr
  density, saturated liquid:              1357 kg/m3 (84.70 lb/cf)   mfr
  heat of vaporization:                   210.3 kJ/kg (90.4 Btu/lb) mfr
· 20 °C (68 °F) -----
  pressure, saturated vapor:              703.3 kPa (102.01 psia)  MSDS
· critical point -----
  temperature:                            97.8 °C (208.0 °F)      mfr
  pressure:                               5029 kPa (729.4 psia)   mfr
  density:                                221 kg/m3 (13.8 lb/cf)   mfr
  specific volume:                       4.52 L/kg (0.0725 cf/lb) mfr

```

SAFETY

```

· classification -----
  safety group (ASHRAE Standard 34):      none (no application pending) 8601
  NFPA 704 degrees of hazard (H-F-R-S):  Millennia Tech: 2-0-0        MSDS
  health-flammability-reactivity
  [-special]: 0=no, 4=severe
· flammability -----
  LFL-UFL (flammability limits in air):  Millennia Tech: "nonflammable" mfr

```


autoignition temperature: Millennia Tech: "nonflammable" mfr
· detection -----
appearance: Millennia Tech: colorless MSDS
odor: Millennia Tech: slight natural MSDS
gas odor

PRODUCTION

first commercial use as a refrigerant: 1997

first commercial use as a refrigerant: circa 1994
last year production allowed: 1995 for CFC components in 8C01
developed countries under the
Montreal Protocol
? 2029 based on HCFC component 8C01
in developed countries under
the Montreal Protocol

undisclosed blend: Polycold Flammable CFC-Free

```

----- REFRIGERANT DATA SUMMARY -----
unassigned multiple blends, compositions not disclosed see
zeotrope blend blend RDB#
-----

```

COMMON USE(S)

commercial, industrial, and specialty refrigeration systems

The following information is preliminary and may be incomplete or incorrect. Further data may be available from Polycold Systems International (San Rafael, CA, USA) or refrigerant manufacturers. Material Safety Data Sheets (MSDSs) from Polycold dated 18 August 1995 identify multiple blends. This summary addresses those identified as "flammable CFC-free refrigerants shipped after January 1, 1995." It is described as a "mixture of halocarbons, hydrocarbons, and inert gases" with an indication that the formulation is deemed a trade secret.

Based on identified decomposition products and stability data, the blend appears to contain both chlorinated and fluorinated components, possibly including hydrochlorofluorocarbons (HCFCs) or hydrofluorocarbons (HFCs). Limited toxicity data suggest that the components may include refrigerants 22 and 123, but these possibilities have not been confirmed.

IDENTIFIERS

trade name(s): Polycold Flammable CFC-Free

SAFETY

```

. classification -----
  safety group (ASHRAE Standard 34): none (no application pending) 8601
. short-term occupational limit -----
  recommended short-term exposure limit: Polycold EEL: 1000 ppm (brief) MSDS
                                           Polycold: possible asphyxiant MSDS
. long-term occupational limit -----
  exposure limit consistent to OSHA PEL: Polycold AEL: 30 ppm v/v TWA MSDS
                                           for 8 hr/day and 40 hr/wk
. acute (short-term) toxicity -----
  cardiac sensitization threshold/LOEL: component, Polycold: ≥20,000 MSDS
                                           ppm v/v (lowest observed
                                           effect level in test animals)
. flammability -----
                                           flash point: Polycold: not determined MSDS
                                           autoignition temperature: Polycold: not determined MSDS
. detection -----
                                           appearance: Polycold: clear and colorless MSDS
                                           odor: Polycold: slight ethereal or MSDS
                                           foul odor

```

PRODUCTION

```

first commercial use as a refrigerant: circa 1995
last year production allowed: ? 2029 based on HCFC component 8C01
                               in developed countries under
                               the Montreal Protocol

```

SEE DATA LIMITATIONS AND NOTES ON PAGE 2

undisclosed blend: Polycold Nonflammable CFC-Free

```

----- REFRIGERANT DATA SUMMARY -----
unassigned   multiple blends, compositions not disclosed   see
zeotrope     blend                                                RDB#
-----

```

COMMON USE(S)

commercial, industrial, and specialty refrigeration systems

The following information is preliminary and may be incomplete or incorrect. Further data may be available from Polycold Systems International (San Rafeal, CA, USA) or refrigerant manufacturers. Material Safety Data Sheets (MSDSs) from Polycold dated 18 August 1995 identify multiple blends. This summary addresses those identified as "non-flammable CFC-free refrigerants shipped after January 1, 1995." It is described as a "mixture of halocarbons, hydrocarbons, and inert gases" with an indication that the formulation is deemed a trade secret.

Based on identified decomposition products and stability data, the blend appears to contain both chlorinated and fluorinated components, possibly including hydrochlorofluorocarbons (HCFCs) or hydrofluorocarbons (HFCs). Limited toxicity data suggest that the components may include refrigerants 22 and 123, but these possibilities have not been confirmed.

IDENTIFIERS

trade name(s): Polycold Nonflammable CFC-Free

SAFETY

```

· classification -----
  safety group (ASHRAE Standard 34): none (no application pending) 8601
· short-term occupational limit -----
  recommended short-term exposure limit: Polycold EEL: 1000 ppm (brief) MSDS
                                           Polycold: possible asphyxiant  MSDS
· long-term occupational limit -----
  exposure limit consistent to OSHA PEL: Polycold AEL: 30 ppm v/v TWA  MSDS
                                           for 8 hr/day and 40 hr/wk
· acute (short-term) toxicity -----
  cardiac sensitization threshold/LOEL: component, Polycold: ≥20,000  MSDS
                                           ppm v/v (lowest observed
                                           effect level in test animals)
· flammability -----
  LFL-UFL (flammability limits in air): Polycold: varies with mixture  MSDS
                                           flash point: Polycold: not determined  MSDS
                                           autoignition temperature: Polycold: not determined  MSDS
· detection -----
                                           appearance: Polycold: clear and colorless  MSDS
                                           odor: Polycold: slight ethereal  MSDS

```

PRODUCTION

```

first commercial use as a refrigerant: circa 1995
last year production allowed: ? 2029 based on HCFC component 8C01
                               in developed countries under
                               the Montreal Protocol

```


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