# Unexpected Projects and Equipment Requiring San Jose Fire Department Hazardous Materials Review

**Table 1: Hazardous Materials (Haz Mat) Review Summary Criteria**
**All projects identified below require the following (unless otherwise noted):**

- **Completion of *UN-35 Form San Jose Fire Department Building Occupancy Classification Inventory Information Form*,**
- **Add Hazardous Materials Architectural Review Process (Haz Mat Arch Review) as part of Building Permits, and**
- **Add Hazardous Materials Inspection Required on Info Field in Amanda**

**Criteria for requiring a Hazardous Materials Construction Permits (HZ Permits) is also indicated, where applicable. Listed are typical equipment with hazardous materials – not exhaustive and more hazardous materials may be on site than listed below.**

| Project Types | Potential Hazardous Materials Equipment and Minimum Thresholds |
|---|---|
| **1. Medium or large construction projects** | Any projects when there is no temporary electrical connection onsite for trailer and construction equipment.<br>☐ Diesel generators (any size) – (A temporary HZ Permit required if over the generator will be onsite for 30 days and the size of tank is 60+ gal) |
| **2. Fire Pumps, Emergency and Standby Power Systems and Cell Sites** | Many projects now require emergency or standby power systems and are included in checklists below for various types of projects where these systems are common. Review requirements for the various types of systems:<br>☐ Batteries/Inverters/UPS systems any interconnected battery system See Table 1A for review requirements<br>☐ Flammable Liquids (any size) – (HZ Permit required 60+ gal)<br>☐ Liquid Petroleum Gas (LPG, such as propane) if there is any gas storage that is bolted down cylinders or tanks. (HZ Permit required).<br>☐ Natural Gas if there is a gas storage cylinder or tank - NO Haz Mat review or inspection required if just plumbed from street natural gas line to generator.<br>☐ Others including fuel cells any size – Requires Review various requirements for HZ Permit |

| Project Types | Potential Hazardous Materials Equipment and Minimum Thresholds |
|---|---|
| **3. Large Properties:**<br>• **Hotels,**<br>• **Large Business Campus Offices**<br>• **High-Rises**<br>• **Private or Trade Schools, Colleges**<br>• **Shopping Malls (not individual tenant spaces)**<br>• **Gyms** | For any of these project types that contain any of the following:<br>☐ Has emergency or standby power systems - See Project Type #2<br>☐ Has grills, fire pits, or heaters for common area patios and separate stationary fuel tank or separate storage of any portable propane tanks (HZ Permit required for any bolted down LPG system)<br>☐ Contains maintenance shops (performs hot work)<br>☐ Has any water treatment chemicals or boilers, cooling towers and swimming pools used or stored onsite (HZ Permit required tanks 60+ gal)<br>☐ Has any bulk laundry onsite (not coin operated) and bulk storage of sanitizing chemicals (HZ Permit required tanks 60+ gal)<br>☐ Has a cafeteria, room service, bar, or restaurant – See Project Type #5<br><br>Watch out for phased deferrals for pools, generators, etc. make sure these deferrals include a hazardous materials review, easily missed! |
| **4. Retail** | ☐ All paint stores- Kelly Moore, Sherman Williams etc.<br>☐ All auto stores – waste oil tanks,<br>☐ All pool supply stores (may require a HZ-Permit if storage quantities require control area separation).<br>☐ All big box retail- e.g. Walmart, Home Depot, Target – Usually has a source of emergency or standby power system- See Project Type #2<br>☐ Looking at hazardous materials combustible storage height max is 6 feet if in display area and 8 feet if in storage (front of the store vs storage areas).<br>☐ Chemical Secondary Separation |
| **5. Food Service:**<br>• **Restaurants**<br>• **Food Service Facilities**<br>• **Coffee Bars**<br>• **Bars**<br>• **Wineries**<br>• **Breweries**<br>• **Marijuana Dispensaries Serving Food**<br>• **Grocery Stores** | If none of the below is true, then Haz Mat Arch Review Process and Haz Mat Inspection NOT required:<br>☐ Has emergency or standby power systems – See **Project Type #2**<br>☐ Has indoor cooking oil or oil waste tank or other aboveground process tanks 60+gal (HZ Permit Required)<br>☐ Has any beverage system, soda fountain dispensers, or beer taps with systems using or connected to 100+ pounds of Carbon Dioxide (HZ Permit required)<br>☐ Has any use and storage of helium or nitrogen (HZ Permit required if 6000+ cubic feet at Normal Temperature and Pressure (NTP))<br>☐ Has refrigeration rooms – see **Project Type #6 (next item)**<br>☐ 60+ gal plus sanitizing chemicals bulk storage tanks (HZ Permit also required)<br>☐ Has grills, fire pits, or heaters for common area patios and separate stationary fuel tank or separate storage of any portable propane tanks (HZ Permit required for any bolted down LPG system). |

| Project Types | Potential Hazardous Materials Equipment and Minimum Thresholds |
|---|---|
| **6. Mechanical Systems:**<br>• **Refrigeration Room**<br>• **HVAC**<br>• **Chillers** | ☐ Refrigeration rooms (not just refrigerators) with A1 Group Refrigerants 220+ pounds or any other group 30+ pounds listed in attached Table 1D: 2019 California Mechanical Table 1102.3 Refrigerants Groups and Properties and allowable [ASHRAE 34: TABLE 4-1, TABLE 4-2] (A-1 Refrigerant highlighted in yellow) No HZ Permit required. |
| **7. Public Storage or Warehouses** | For any of these project types that contain any of the following:<br>☐ Has a source emergency or standby power systems- see **Project Type #2**<br>☐ Need to make sure what is stored is not hazardous materials. Need inventory of any chemical stored.<br>☐ Has any water treatment chemicals for boilers, cooling towers, and swimming pools used or stored onsite (HZ Permit required tanks 60+ gal)<br>☐ Performs hot work |
| **8. Auto Facilities**<br>• **Auto Repair Shops**<br>• **Carwashes**<br>• **Auto Showrooms**<br>• **Auto Wrecking Yards** | ☐ Storing any drums or tanks for used oil/used batteries, etc.<br>☐ Storing any cleaning or paint supplies<br>☐ Stores body work chemicals, paint, Bondo, spray booths or dipping, ovens<br>☐ Using any defueling or chemical<br>☐ Oil waste storage (any size) – (HZ Permit Required if 60+ gallons)<br>☐ Performs hot work<br>☐ Contains Spray Booths |
| **9. Maintenance and Government (NOT Federal, State or County) Corporation Yards** | For any facilities containing any of the following:<br>☐ Has emergency or standby power systems - see Project Type #2<br>☐ Any hydrogen, compressed natural gas, diesel, or gasoline fueling stations (HZ Permits 60+ gal – also see Tables 1B and 1C)<br>☐ Has any water treatment chemicals for boilers, cooling towers,or swimming pools used or stored onsite (HZ Permit Required tanks 60+ gal)<br>☐ Has any automobile or truck washing stations<br>☐ Has any chemicals or hazardous equipment stored outside<br>☐ Has used batteries, used oil, or chemical waste storage<br>☐ Performs hot work |

| Project Types | Potential Hazardous Materials Equipment and Minimum Thresholds |
|---|---|
| **10. Medical and Institutional**<br>• **Doctor's Office**<br>• **Dentist's Office**<br>• **Surgical Centers,**<br>• **Cryogenic Therapies**<br>• **Hospitals,**<br>• **Elderly Care Facilities,**<br>• **Other Institutional Care Facilities** | For any of these project types that contain any of the following:<br>☐ Has emergency or standby power systems - See Project Type #2<br>☐ Storing or using any medical gas e.g. oxygen, nitrogen, nitrous oxide gases or cryogenic fluids –See Tables 1B and 1C for when HZ Permit Required.<br>☐ Laboratories or fume hoods<br>☐ Has any water treatment chemicals for boilers, cooling towers, spas and swimming pools used or stored onsite (HZ Permit Required 60+ gal)<br>☐ Has any bulk laundry onsite (not coin operated) (HZ Permit required 60+ gal)<br>☐ Has bulk storage and delivery of sanitizing chemicals (HZ Permit required 60+ gal)<br>☐ Has a cafeteria, room service, bar, or restaurant – See Project Type #5<br>☐ Has grills, fire pits, or heaters for common area patios and separate stationary fuel tank or separate storage of any portable propane tanks (HZ Permit Required for any bolted down LPG system) |

**Table 1A: Battery Technology and Minimum Capacity Review Criteria for Haz Mat Review**

| Battery Technology | Minimum Kilowatt hours for Haz Mat Arch Review and HZ Permit | Range for Haz Mat Inspection Only (No Haz Mat Plan Review) | No Haz Mat Review or Inspection |
|---|---|---|---|
| **Lead acid all types** | ***70+ kWh*** | ***<70 kWh and ≤10 kWh*** | ***<10 kWh*** |
| **Nickel-Cadmium (Ni-Cd)** | ***70+ kWh*** | ***<70 kWh and ≤10 kWh*** | ***<10 kWh*** |
| **Lithium, all types** | ***20+ kWh*** | ***<20 kWh and ≤10 kWh*** | ***<10 kWh*** |
| **Sodium: Ion** | ***70+ kWh*** | ***<70 kWh and ≤10 kWh*** | ***<10 kWh*** |
| **Solium: Non-ion** | ***20+ kWh*** | ***<20 kWh and ≤10 kWh*** | ***<10 kWh*** |
| **Total Flow batteries** | ***20+ kWh*** | ***<20 kWh and ≤10 kWh*** | ***<10 kWh*** |
| **Other Battery Types** | ***10+ kWh*** | ***NA*** | ***<10 kWh*** |

| Table 1B: Compressed Gas Minimum Permit Quantity Criteria for HZ Construction Permit from 2019 CFC Table 105.6.8 | |
|---|---|
| **Class of Gas** | **Amount (cubic feet at NTP)** |
| **Carbon dioxide used in carbon dioxide enrichment systems and beverage systems** | **874 (100 lbs.)** |
| **Corrosive** | **200** |
| **Flammable (except cryogenic fluids and liquified petroleum gases)** | **200** |
| **Highly Toxic** | **Any** |
| **Inert and simple asphyxiant** | **6000** |
| **Oxidizing (including Oxygen)** | **504** |
| **Pyrophoric** | **Any** |
| **Toxic** | **Any** |

| Table 1C: Cryogenic Fluids Minimum Permit Quantity Criteria for HZ Construction Permit from 2019 CFC Table 105.6.10 | | |
|---|---|---|
| **Class of Cryogenic Fluid** | **Inside Building Amount (gallons)** | **Outside Building Amount (gallons)** |
| **Flammable** | **Over 1** | **60** |
| **Inert** | **60** | **500** |
| **Oxidizing** | **10** | **50** |
| **Physical or Health Hazard Not indicated above** | **Any** | **Any** |

| Table 2: Good Reminders of Some Other Projects Types Frequently Needing Hazardous Materials Architectural Review and Permits | |
|---|---|
| ☐ Liquid Propane Gas<br>☐ Gas Stations,<br>☐ Plating Shops,<br>☐ Recycling Facilities<br>☐ Industrial Tool Installations Using and Storing Hazardous Materials<br>☐ Data Centers<br>☐ Dry Cleaning Businesses Installing New Machines<br>☐ Marijuana Laboratories, Grow and Processing Facilities | ☐ Paint Booths/ Spray Rooms<br>☐ Chemical Waste Handling Businesses<br>☐ Roofing Materials Storage Businesses<br>☐ Fumigation Businesses<br>☐ Fire Pumps<br>☐ Facilities Using Fume Hoods<br>☐ Compressed Gas or Liquid Gas Systems<br>☐ Wineries and Breweries |

| Table 1D: 2019 California Mechanical Code Table 1102.3<br>Refrigerant Groups, Properties, And Allowable Quantities [ASHRAE 34: Table 4-1, Table 4-2] | | | | | |
|---|---|---|---|---|---|
| **Refrigerant** | **Chemical Formula[3]** | **Chemical Name[1] (Composition For Blends)** | **Safety Group[7]** | **OEL[2] (Ppm)** | **Pounds Per 1000 Cubic Feet of Space** |
| R-11 | $CCl_3F$ | Trichlorofluoromethane | A1 | C1000 | 0.39 |
| R-12 | $CCl_2F_2$ | Dichlorodifluoromethane | A1 | 1000 | 5.6 |
| R-12B1 | $CBrClF_2$ | Bromochlorodifluoromethane | - | - | - |
| R-13 | $CClF_3$ | Chlorotrifluoromethane | A1 | 1000 | - |
| R-13B1 | $CBrF_3$ | Bromotrifluoromethane | A1 | 1000 | - |
| R-14 | $CF_4$ | Tetrafluoromethane (carbon tetrafluoride) | A1 | 1000 | 25 |
| R-21 | $CHCl_2F$ | Dichlorofluoromethane | B1 | - | - |
| R-22 | $CHClF_2$ | Chlorodifluoromethane | A1 | 1000 | 13 |
| R-23 | $CHF_3$ | Trifluoromethane | A1 | 1000 | 7.3 |
| R-30 | $CH_2Cl_2$ | Dichloromethane (methylene chloride) | B1 | - | - |
| R-31 | $CH_2ClF$ | Chlorofluoromethane | - | - | - |
| R-32 | $CH_2F_2$ | Difluoromethane (methylene fluoride) | A2L | 1000 | 4.8 |
| R-40 | $CH_3Cl$ | Chloromethane (methyl chloride) | B2 | - | - |
| R-41 | $CH_3F$ | Fluoromethane (methyl fluoride) | - | - | - |
| R-50 | $CH_4$ | Methane | A3 | 1000 | - |
| R-113 | $CCl_2FCClF_2$ | 1, 1, 2-trichloro-1, 2, 2 - trifluoro ethane | A1 | 1000 | 1.2 |
| R-114 | $CClF_2CClF_2$ | 1, 2-dichloro-1, 1, 2, 2 tetrafluoro ethane | A1 | 1000 | 8.7 |
| R-115 | $CClF_2CF_3$ | Chloropentafluoroethane | A1 | 1000 | 47 |
| R-116 | $CF_3CF_3$ | Hexafluoroethane | A1 | 1000 | 34 |
| R-123 | $CHCl_2CF_3$ | 2, 2-dichloro-1, 1, 1, - trifluoroethane | B1 | 50 | 3.5 |

| Refrigerant | Chemical Formula[3] | Chemical Name[1] (Composition For Blends) | Safety Group[7] | OEL[2] (Ppm) | Pounds Per 1000 Cubic Feet of Space |
|---|---|---|---|---|---|
| R-124 | $CHClFCF_3$ | 2-chloro-1, 1, 2, 2 – tetrafluoroethane | A1 | 1000 | 3.5 |
| R-125 | $CHF_2CF_3$ | Pentafluoroethane | A1 | 1000 | 23 |
| R-134a | $CH_2FCF_3$ | 1, 1, 1, 2-tetrafluoroethane | A1 | 1000 | 13 |
| R-141b | $CH_3CCl_2F$ | 1, 1-dichloro- 1 -fluoroethane | - | 500 | 0.78 |
| R-142b | $CH_3CClF_2$ | 1-chloro-1, 1 -difluoroethane | A2 | 1000 | 5.1 |
| R-143a | $CH_3CF_3$ | 1, 1, 1-trifluoroethane | A2L | 1000 | 4.5 |
| R-152a | $CH_3CHF_2$ | 1, 1 -difluoroethane | A2 | 1000 | 2.0 |
| R-170 | $CH_3CH_3$ | Ethane | A3 | 1000 | 0.54 |
| R-E170 | $CH_3OCH_3$ | Methoxymethane(Dimethyl ether) | A3 | 1000 | 1.0 |
| R-218 | $CF_3CF_2CF_3$ | Octafluoropropane | A1 | 1000 | 43 |
| R-227ea | $CF_3CHFCF_3$ | 1, 1, 1, 2, 3, 3, 3-heptafluoropropane | A1 | 1000 | 36 |
| R-236fa | $CF_3CH_2CF_3$ | 1, 1, 1, 3, 3, 3-hexafluoropropane | A1 | 1000 | 21 |
| R-245fa | $CHF_2CH_2CF_3$ | 1, 1, 1, 3, 3-pentafluoropropane | B1 | 300 | 12 |
| R-290 | $CH_3CH_2CH_3$ | Propane | A3 | 1000 | 0.56 |
| R-C318 | $-(CF_2)_4-$ | Octafluorocyclobutane | A1 | 1000 | 41 |
| R-400 | Zoetrope | R-12/114 (50.0/50.0) | A1 | 1000 | 10 |
| R-400 | Zoetrope | R-12/114 (60.0/40.0) | A1 | 1000 | 11 |
| R-401A | Zoetrope | R-22/152a/124 (53.0/13.0/34.0) | A1 | 1000 | 6.6 |
| R-401B | Zoetrope | R-22/152a/124 (61.0/11.0/28.0) | A1 | 1000 | 7.2 |
| R-401C | Zoetrope | R-22/152a/124 (33.0/15.0/52.0) | A1 | 1000 | 5.2 |
| R-402A | Zoetrope | R-125/290/22 (60.0/2.0/38.0) | A1 | 1000 | 17 |
| R-402B | Zoetrope | R-125/290/22 (38.0/2.0/60.0) | A1 | 1000 | 15 |

| Refrigerant | Chemical Formula[3] | Chemical Name[1] (Composition For Blends) | Safety Group[7] | OEL[2] (Ppm) | Pounds Per 1000 Cubic Feet of Space |
|---|---|---|---|---|---|
| R-403A | Zoetrope | R-290/22/218 (5.0/75.0/20.0) | A2 | 1000 | 7.6 |
| R-403B | Zoetrope | R-290/22/218 (5.0/56.0/39.0) | A1 | 1000 | 18 |
| R-404A | Zoetrope | R-125/143a/134a (44.0/52.0/4.0) | A1 | 1000 | 31 |
| R-405A | Zoetrope | R-22/152a/142b/C318 (45.0/7.0/5.5/42.5) | - | 1000 | 16 |
| R-406A | Zoetrope | R-22/600a/142b (55.0/4.0/41.0) | A2 | 1000 | 4.7 |
| R-407A | Zoetrope | R-32/125/134a (20.0/40.0/40.0) | A1 | 1000 | 19 |
| R-407B | Zoetrope | R-32/125/134a (10.0/70.0/20.0) | A1 | 1000 | 21 |
| R-407C | Zoetrope | R-32/125/134a (23.0/25.0/52.0) | A1 | 1000 | 18 |
| R-407D | Zoetrope | R-32/125/134a (15.0/15.0/70.0) | A1 | 1000 | 16 |
| R-407E | Zoetrope | R-32/125/134a (25.0/15.0/60.0) | A1 | 1000 | 17 |
| R-407F | Zoetrope | R-32/125/134a (30.0/30.0/40.0) | A1 | 1000 | 20 |
| R-407G | Zoetrope | R-32/125/134a (2.5/2.5/95.0) | A1 | 1000 | 13 |
| R-408A | Zoetrope | R-125/143a/22 (7.0/46.0/47.0) | A1 | 1000 | 21 |
| R-409A | Zoetrope | R-22/124/142b (60.0/25.0/15.0) | A1 | 1000 | 7.1 |
| R-409B | Zoetrope | R-22/124/142b (65.0/25.0/10.0) | A1 | 1000 | 7.3 |
| R-410A | Zoetrope | R-32/125 (50.0/50.0) | A1 | 1000 | 26 |
| R-410B | Zoetrope | R-32/125 (45.0/55.0) | A1 | - | 27 |
| R-411A[6] | Zoetrope | R-1270/22/152a (1.5/87.5/11.0) | A2 | 990 | 2.9 |
| R-411B[6] | Zoetrope | R-1270/22/152a (3.0/94.0/3.0) | A2 | 980 | 2.8 |
| R-412A | Zoetrope | R-22/218/142b (70.0/5.0/25.0) | A2 | 1000 | 5.1 |
| R-413A | Zoetrope | R-218/134a/600a (9.0/88.0/3.0) | A2 | 1000 | 5.8 |
| R-414A | Zoetrope | R-22/124/600a/142b (51.0/28.5/4.0/16.5) | A1 | 1000 | 6.4 |
| R-414B | Zoetrope | R-22/124/600a/142b (50.0/39.0/1.5/9.5) | A1 | 1000 | 6.0 |
| R-415A | Zoetrope | R-22/152a (82.0/18.0) | A2 | 1000 | 2.9 |

| Refrigerant | Chemical Formula[3] | Chemical Name[1] (Composition For Blends) | Safety Group[7] | OEL[2] (Ppm) | Pounds Per 1000 Cubic Feet of Space |
|---|---|---|---|---|---|
| R-415B | Zoetrope | R-22/152a (25.0/75.0) | A2 | 1000 | 2.1 |
| R-416A[6] | Zoetrope | R-134a/124/600 (59.0/39.5/1.5) | A1 | 1000 | 3.9 |
| R-417A[6] | Zoetrope | R-125/134a/600 (46.6/50.0/3.4) | A1 | 1000 | 3.5 |
| R-417B | Zoetrope | R-125/134a/600 (79.0/18.3/2.7) | A1 | 1000 | 4.3 |
| R-417C | Zoetrope | R-125/134a/600 (19.5/78.8/1.7) | A1 | 1000 | 5.4 |
| R-418A | Zoetrope | R-290/22/152a (1.5/96.0/2.5) | A2 | 1000 | 4.8 |
| R-419A | Zoetrope | R-125/134a/E170 (77.0/19.0/4.0) | A2 | 1000 | 4.2 |
| R-419B | Zoetrope | R-125/134a/E170 (48.5/48.0/3.5) | A2 | 1000 | 4.6 |
| R-420A | Zoetrope | R-134a/142b (88.0/12.0) | A1 | 1000 | 12 |
| R-421A | Zoetrope | R-125/134a (58.0/42.0) | A1 | 1000 | 17 |
| R-421B | Zoetrope | R-125/134a (85.0/15.0) | A1 | 1000 | 21 |
| R-422A | Zoetrope | R-125/134a/600a (85.1/11.5/3.4) | A1 | 1000 | 18 |
| R-422B | Zoetrope | R-125/134a/600a (55.0/42.0/3.0) | A1 | 1000 | 16 |
| R-422C | Zoetrope | R-125/134a/600a (82.0/15.0/3.0) | A1 | 1000 | 18 |
| R-422D | Zoetrope | R-125/134a/600a (65.1/31.5/3.4) | A1 | 1000 | 16 |
| R-422E | Zoetrope | R-125/134a/600a (58.0/39.3/2.7) | A1 | 1000 | 16 |
| R-423A | Zoetrope | R-134a/227ea (52.5/47.5) | A1 | 1000 | 19 |
| R-424A[6] | Zoetrope | R-125/134a/600a/600/601a (50.5/47.0/0.9/1/.0/0.6) | A1 | 970 | 6.2 |
| R-425A | Zoetrope | R-32/134a/227ea (18.5/69.5/12.0) | A1 | 1000 | 16 |
| R-426A[6] | Zoetrope | R-125/134a/600/601a (5.1/93.0/1.3/0.6) | A1 | 900 | 5.2 |
| R427A | Zoetrope | R-32/125/143a/134a (15.0/25.0/10.0/50.0) | A1 | 1000 | 18 |
| R428A | Zoetrope | R-125/143a/290/600a (77.5/20.0/0.6/1.9) | A1 | 1000 | 23 |
| R429A | Zoetrope | R-E170/152a/600a (60.0/10.0/30.0) | A3 | 1000 | 0.81 |

| Refrigerant | Chemical Formula[3] | Chemical Name[1] (Composition For Blends) | Safety Group[7] | OEL[2] (Ppm) | Pounds Per 1000 Cubic Feet of Space |
|---|---|---|---|---|---|
| R430A | Zoetrope | R-152a/600a (76.0/24.0) | A3 | 1000 | 1.3 |
| R431A | Zoetrope | R-290/152a (71.0/29.0) | A3 | 1000 | 0.69 |
| R432A | Zoetrope | R-1270/E170 (80.0/20.0) | A3 | 700 | 0.13 |
| R433A | Zoetrope | R-1270/290 (30.0/70.0) | A3 | 880 | 0.34 |
| R433B | Zoetrope | R-1270/290 (5.0/95.0) | A3 | 950 | 0.54 |
| R433C | Zoetrope | R-1270/290 (25.0/75.0) | A3 | 790 | 0.41 |
| R434A | Zoetrope | R-125/141a/134a/600a (63.2/18.0/16.0/2.8) | A1 | 1000 | 20 |
| R435A | Zoetrope | R-E170/152a (80.0/20.0) | A3 | 1000 | 1.1 |
| R436A | Zoetrope | R-290/600a (56.0/44.0) | A3 | 1000 | 0.50 |
| R436B | Zoetrope | R-290/600a (52.0/48.0) | A3 | 1000 | 0.51 |
| R-437A | Zoetrope | R-125/134a/600/601 (19.5/78.5/1.4/0.6) | A1 | 990 | 5.0 |
| R-438A | Zoetrope | R-32/125/134a/600/601a (8.5/45.0/44.2/1.7/0.6) | A1 | 990 | 4.9 |
| R-439A | Zoetrope | R-32/125/600a (50.0/47.0/3.0) | A2 | 990 | 4.7 |
| R-440A | Zoetrope | R-290/134a/152a (0.6/1.6/97.8) | A2 | 1000 | 1.9 |
| R-441A | Zoetrope | R-170/290/600a/600 (3.1/54.8/6.0/36.1) | A3 | 1000 | 0.39 |
| R-442A | Zoetrope | R-32/125/134a/152a/227ea (31.0/31.0/30.0/3.0/5.0) | A1 | 1000 | 21 |
| R-443A | Zoetrope | R-1270/290/600a (55.0/40.0/5.0) | A3 | 580 | 0.19 |
| R-444A | Zoetrope | R-32/152a/1234ze(E) (12.0/5.0/83.0) | A2L | 850 | 5.1 |
| R-444B | Zoetrope | R-32/152a/1234ze(E) (41.5/10.0/48.5) | A2l | 890 | 4.3 |
| R-445A | Zoetrope | R-744/134a/1234ze(E) (6.0/9.0/85.0) | A2L | 930 | 4.2 |
| R-446A | Zoetrope | R-32/1234ze(E)/600 (68.0/29.0/3.0) | A2L | 960 | 2.5 |
| R-447A | Zoetrope | R-32/125/1234ze(E) (68.0/3.5/28.5) | A2L | 900 | 2.6 |

| Refrigerant | Chemical Formula[3] | Chemical Name[1] (Composition For Blends) | Safety Group[7] | OEL[2] (Ppm) | Pounds Per 1000 Cubic Feet of Space |
|---|---|---|---|---|---|
| R-447B | Zoetrope | R-32/125/1234ze(E) (68.0/8.0/24.0) | A2L | 970 | 23 |
| R-448A | Zoetrope | R-32/125/1234yf/134a/1234ze(E)(26.0/26.0/20.0/21.0/7.0) | A1 | 890 | 24 |
| R-449A | Zoetrope | R-32/125/1234yf/134a(24.3/24.7/25.3/25.7) | A1 | 830 | 23 |
| R-449B | Zoetrope | R-32/125/1234yf/134a(25.2/24.3/23.2/27.3) | A1 | 850 | 23 |
| R-449C | Zoetrope | R-32/125/1234yf/134a(20.0/20.0/31.0/29.0) | A1 | 800 | 23 |
| R-450A | Zoetrope | R-134a/1234ze(E) (42.0/58.0) | A1 | 880 | 20 |
| R-451A | Zoetrope | R-1234yf/134a (89.8/10.2) | A2L | 520 | 5.3 |
| R-451B | Zoetrope | R-1234yf/134a (88.8/11.2) | A2L | 530 | 5.3 |
| R-452A | Zoetrope | R-32/125/1234yf (11.0/59.0/30.0) | A1 | 780 | 27 |
| R-452B | Zoetrope | R-32/125/1234yf (67.0/7.0/26.0) | A2L | 870 | 23 |
| R-452C | Zoetrope | R-32/125/1234yf (12.5/61.0/26.a) | A1 | 800 | 27 |
| R-453A | Zoetrope | R-32/125/134a/227ea/600/601a(20.0/20.0/53.8/5.0/0.6/0.6) | A1 | 1000 | 7.8 |
| R-454A | Zoetrope | R-32/1234vf (35.0/65.0) | A2L | 690 | 28 |
| R-454B | Zoetrope | R-32/1234yf (68.9/31.1) | A2L | 850 | 22 |
| R-454C | Zoetrope | R-32/1234yf (21.5/78.5) | A2L | 620 | 29 |
| R-455A | Zoetrope | R-744/32/1234vf (3.0/21.5/75.5) | A2L | 650 | 23 |
| R-456A | Zoetrope | R-32/134a/1234ze(E) (6.0/45.0/49.0) | A1 | 900 | 20 |
| R-457A | Zoetrope | R-32/1234yf/152a (18.0/70.0/12.0) | A2L | 650 | 25 |
| R-458A | Zoetrope | R-32/125/134a/227ea/236fa(20.5/4.0/61.4/13.5/0.6) | A1 | 1000 | 18 |
| R-500 | azeotrope3 | R-12/152a (73.8/26.2) | A1 | 1000 | 7.6 |

| Refrigerant | Chemical Formula[3] | Chemical Name[1] (Composition For Blends) | Safety Group[7] | OEL[2] (Ppm) | Pounds Per 1000 Cubic Feet of Space |
|---|---|---|---|---|---|
| R-501 | azeotrope3 | R-22/12 (75.0/25.0)4 | A1 | 1000 | 13 |
| R-502 | azeotrope3 | R-22/115 (48.8/51.2) | A1 | 1000 | 21 |
| R-503 | azeotrope3 | R-23/13 (40.1/59.9) | - | 1000 | - |
| R-504 | azeotrope3 | R-32/115 (48.2/51.8.) | - | 1000 | 28 |
| R-505 | azeotrope3 | R-12/31 (78.0/22.0)4 | - | - | - |
| R-506 | azeotrope3 | R-31/114 (55.1/44.9) | - | - | - |
| R-507A[5] | azeotrope3 | R-125/143a (50.0/50.0) | A1 | 1000 | 32 |
| R-508A | azeotrope3 | R-23/116 (39.0/61.0) | A1 | 1000 | 14 |
| R-508B | azeotrope3 | R-23/116 (46.0/54.0) | A1 | 1000 | 13 |
| R-509A[5] | azeotrope3 | R-22/218 (44.0/56.0) | A1 | 1000 | 24 |
| R-510A | azeotrope3 | R-E170/600a (88.0/12.0) | A3 | 1000 | 0.87 |
| R-511A | azeotrope3 | R-290/E170 (95.0/5.0) | A3 | 1000 | 0.59 |
| R-512A | azeotrope3 | R-134a/152a (5.0/95.0) | A2 | 1000 | 1.9 |
| R-513A | azeotrope3 | R-1234yf/134a (56.0/44.0) | A1 | 650 | 20 |
| R-513B | azeotrope3 | R-1234yf/134a (58.5/41.5) | A1 | 640 | 21 |
| R-514A | azeotrope3 | R-1336mzz(Z)/1130 (E) (74.7/25.3) | B1 | 320 | .86 |
| R-515A | azeotrope3 | R-1234ze(E)/227ea (88.0/12.0) | A1 | 810 | 19 |
| R-600 | CH3CH2CH2CH3 | Butane | A3 | 1000 | 0.15 |
| R-600a | CH(CH3)2CH3 | 2-methylpropane (isobutane) | A3 | 1000 | 0.59 |
| R-601 | CH3CH2CH2CH2CH3 | Pentane | A3 | 600 | 0.18 |
| R-601a | (CH3)2CHCH2CH3 | 2-methylbutane (isopentane) | A3 | 600 | 0.18 |

| Refrigerant | Chemical Formula[3] | Chemical Name[1] (Composition For Blends) | Safety Group[7] | OEL[2] (Ppm) | Pounds Per 1000 Cubic Feet of Space |
|---|---|---|---|---|---|
| R-610 | CH3CH2 OCH2CH 3 | Ethoxyethane (ethyl ether) | - | 400 | - |
| R-611 | HCOOCH 3 | Methyl formate | B2 | 100 | - |
| R-702 | H2 | Hydrogen | A3 | - | - |
| R-704 | He | Helium | A1 | - | - |
| R-717 | NH3 | Ammonia | B2L | 25 | 0.014 |
| R-718 | H2O | Water | A1 | - | - |
| R-720 | Ne | Neon | A1 | - | - |
| R-728 | N2 | Nitrogen | A1 | - | - |
| R-732 | O2 | Oxygen | - | - | - |
| R-740 | Ar | Argon | A1 | - | - |
| R-744 | CO2 | Carbon dioxide | A1 | 5000 | 4.5 |
| R-744A | N2O | Nitrous oxide | - | - | - |
| R-764 | SO2 | Sulfur dioxide | B1 | - | - |
| R-1130(E) | CHCl=CH Cl | Trans-1,2-dichloroethene | B1 | 200 | 0.25 |
| R-1150 | CH2=CH2 | Ethene (ethylene) | A3 | 200 | - |
| R-1233zd(E) | CF3CH=C HCl | Trans- 1 -chloro- 3, 3, 3-trifluoro- 1 - propane | A1 | 800 | 5.3 |
| R-1234yf | CF3CF=C H2 | 2, 3, 3, 3-tetrafluoro- 1 -propane | A2L | 500 | 4.7 |
| R-1234ze(E) | CF3CH=C HF | Trans-1, 3, 3, 3- tetrafluoro- 1- propene | A2L | 800 | 4.7 |
| R-1270 | CH3CH= CH2 | Propene (propylene) | A3 | 500 | 0.11 |
| 1336rnzz(Z) | CF3CHC HCF3 | Cis-1, 1, 1,4,4,4-hexaflouro-2-butene | A1 | 500 | 5.4 |

For SI units: 1 pound = 0.453 kg, 1 cubic foot = 0.0283 m3

**Notes:**

1 The preferred name is followed by the popular name in parenthesis.
2 The OEL are 8-hour TWA; a C designation denotes a ceiling limit.
3 Azeotropic refrigerants exhibit some segregation of components at conditions of temperature and pressure other than those at which they were formulated. The extent of segregation depends on the azeotrope and hardware system configuration.
4 The exact composition of this azeotrope is in question and additional experimental studies are needed.
5 R-507, R-508, and R-509 shall be permitted as alternative designations for R-507A, R-508A, and R-509A due to a change in designations after assignment of R-500 through R-509. Corresponding changes were not made for R-500 through R-506.
6 The RCL values for these refrigerant blends are approximated in the absence of adequate data for a component comprising Jess than 4 percent m/m of the blend and expected to have a small influence in an acute, accidental release
7 Refrigerant flammability classification of Class 2L shall comply with the requirements for flammability classification or Class 2.
8 In accordance with Section 1102.2, ammonia refrigeration systems are not regulated by this chapter. R-717 (ammonia) is included in this table because the table is extracted from ASHRAE 34 and is not capable of being modified.