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THE AIR FORCE**

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Civil Engineering

**REFRIGERANT MANAGEMENT
PROGRAM**

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This publication supports Department of the Air Force Manual (DAFMAN) 32-7002, *Environmental Compliance and Pollution Prevention*, regarding the installation, management, maintenance, and operation of equipment containing regulated refrigerants. It provides information and guidance for managing refrigerants used in stationary equipment and does not apply to refrigerants used in motor vehicle air conditioning (MVAC), aircraft refrigeration systems, or mobile aerospace ground support equipment (AGE). Additionally, this pamphlet includes updates to address changes due to the American Innovation and Manufacturing (AIM) Act enacted in December 2020. This publication applies to all civilian employees and uniformed members of the Regular Air Force, the United States Space Force, the Air Force Reserve, the Air National Guard, and those with a contractual obligation to abide by the terms of DAF publications who develop, acquire, deliver, use, operate, or manage refrigerants used on DAF installations. In instances where the identified organizations and personnel are tenants to a non-DAF organization, those personnel will follow the requirements identified in applicable and enforceable agreements in accordance with Air Force Instruction (AFI) 25-201, *Intra-Service, Intra-Agency, and Inter-Agency Support Agreements Procedures*. Refer recommended changes and questions about this publication to the office of primary responsibility (OPR) using Department of the Air Force (DAF) Form 847, *Recommendation for Change of Publication*; route DAF Forms 847 from the field through the appropriate functional chain of command. Ensure all records generated as a result of processes prescribed in this publication adhere to Air Force Instruction (AFI) 33-322, *Records Management and Information Governance Program*, and are disposed in accordance with the Air Force Records Disposition Schedule, which is located in the Air Force Records Information Management System.

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Chapter 1

GENERAL INFORMATION

1.1. Introduction. The U.S. Environmental Protection Agency (EPA) initially promulgated regulations for the management of ozone-depleting substances (ODS) in 1992 under Title VI of the Clean Air Act (CAA). These regulations are contained within Title 40, Code of Federal Regulations (CFR), Part 82, *Protection of Stratospheric Ozone*.

1.1.1. ODS Refrigerants. ODS refrigerants are classified by their impact on stratospheric ozone as well as other factors, including chemical structure and risk to health and the environment. ODS refrigerants fall under two ODS categories, Class I and Class II. Class I ODS refrigerants include chlorofluorocarbons (CFCs) while Class II refrigerants include hydrochlorofluorocarbons (HCFCs). It is important to note that the Class I and Class II ODS categories also include substances other than refrigerants, such as halons, carbon tetrachloride, methyl chloroform, methyl bromide, and other brominated fluorocarbons. A full list of compounds that fall under both ODS categories can be found in Title 42, United States Code, Section 7671a (42 USC 7671a) and also in 40 CFR 82 (as Appendices A and B in Subpart A). Since this pamphlet only addresses refrigerants, a comprehensive listing of Class I and Class II ODS that could be used as refrigerants is included in [Tables A2.1](#) and [A2.2](#) in [Attachment 2](#).

1.1.2. Substitute Refrigerants. Compounds used to replace Class I or II refrigerants are subject to some of the same regulations as the compounds that they replace. Substitute refrigerants are evaluated by the EPA and managed under the Significant New Alternatives Policy (SNAP). A subset of substitute refrigerants is exempt from the venting prohibition and all other requirements under 40 CFR Part 82. A list of exempt substitute refrigerants and uses is included in [Table A2.3](#) in [Attachment 2](#).

1.1.3. Hydrofluorocarbon (HFC) Substitute Refrigerants. HFCs are a major category of substitute refrigerants under 40 CFR Part 82, but only certain provisions of the 40 CFR Part 82 refrigerant management regulations apply to HFCs. Specifically, the 40 CFR Part 82 technician certification requirements, safe disposal requirements, intentional venting prohibitions, reclamation standards, and requirements to use certified recovery equipment all apply equally to HFCs as they apply to ODS refrigerants (see [paragraphs 2.1, 2.2, 2.6, 2.7, and 2.8](#) of this DAFPAM). However, the 40 CFR Part 82 leak inspection, repair, and reporting requirements (discussed in [paragraphs 2.3, 2.4, 2.5, and 2.11](#)) do not apply to HFC stationary equipment. Additional mandates have been placed on hydrofluorocarbon substitute refrigerants under the AIM Act. The full list of additional mandates under the Act can be found in 42 USC § 7675 and was promulgated by the EPA in 40 CFR Part 84. The AIM Act was enacted with the goal of reducing emissions of HFC substitute refrigerants, of which many have high Global Warming Potentials (GWP). The most significant impact of the AIM Act is the phasedown of many HFCs, similar to the phaseout of Class I ODSs that started in 1994. Regulations implementing the AIM Act phasedown are at 40 CFR Part 84, *Phasedown of Hydrofluorocarbons*. Effective 1 January 2026, EPA will require leak inspection, repair, and reporting requirements for HFC stationary equipment similar to the current requirements for ODS refrigerants, although the refrigerant capacity threshold for HFC equipment (i.e., the threshold in which leak inspection/repair requirements must be met) will be 15 pounds, which

is less than the 50-pound threshold associated with ODS equipment. These HFC leak inspection/repair requirements are located in 40 CFR Part 84, Subpart C (specifically §§ 84.100 – 84.106; updated 10 December 2024) and are implemented to meet Subsection (h) of the AIM Act, which requires minimizing the release of regulated substances from equipment and ensuring the safety of technicians and consumers. In addition to leak inspection/repair, Subpart C to 40 CFR 84 also contains requirements for installing automatic leak detection system on certain HFC-containing compliances. Those include industrial process refrigeration or commercial refrigeration appliances with a full charge of 1,500 pounds or greater of a refrigerant that has a global warming potential greater than 53.

1.1.4.Overseas Installations. Overseas DAF installations should comply with applicable Final Governing Standards (FGS) or Overseas Environmental Baseline Guidance (OEBGD) as appropriate. This DAFPAM can be used to as a guide to assist in compliance with applicable requirements.

1.2. Purpose. The purpose of this pamphlet is to provide recommendations and best management practices for complying with Federal statutory requirements for Class I and Class II refrigerants and their non-ODS substitutes under Title VI of the CAA. All DAF installations, regardless of size, with refrigeration, comfort cooling, or industrial process equipment containing non-exempt refrigerants or refrigerant substitutes must manage and maintain equipment and refrigerant stockpiles in such a way as to ensure both mission success and compliance with applicable environmental regulations.

1.3. Intended Audience. This pamphlet is intended to assist personnel working on DAF installations who work with refrigerants and their substitutes, perform maintenance on, or are responsible for, facility design, planning, or environmental oversight and compliance activities for stationary equipment regulated under Title VI of the CAA (e.g., chillers, air conditioners, refrigeration units, or process equipment). This pamphlet provides recommendations to assist with regulatory compliance as well as best management practices for operations and maintenance activities. It acts as a guide for tenant organizations who do not receive equipment service support from installation Civil Engineering (CE) on how to comply with EPA regulations only and does not address specific policy or guidance from their native organization or DAF requirements within the framework of their host-tenant, or other support agreement(s).

1.4. Applicability. This pamphlet is intended to address stationary equipment containing refrigerants and their non-ODS substitutes installed on DAF installations used for the purposes of comfort cooling, commercial refrigeration, or industrial process cooling, regardless of who owns or operates the equipment. All installation-owned Air Conditioning/Refrigeration (AC/R) equipment and tenant- or contractor-operated AC/R equipment on a DAF installation is subject to the requirements of 40 CFR Part 82 or 40 CFR Part 84 identified in this pamphlet. As such, all personnel responsible for operating, maintaining, and managing AC/R equipment should follow the recommendations of this pamphlet unless it conflicts with Federal, State, or local regulation. **Note:** Refrigerants and non-ODS substitute refrigerants used in motor vehicle air conditioning (MVAC), aircraft refrigeration systems, or mobile aerospace ground support equipment (AGE) are managed by other programs and subject to different regulatory requirements and therefore are not included in the scope of this document.

1.5. Terminology. Common terminology is defined in [Attachment 1](#) of this DAFPAM.

1.6. Legal Drivers. Legal requirements for the management of refrigerants and non-ODS substitutes are defined in 40 CFR Part 82 and 40 CFR Part 84. 40 CFR Part 82 regulations were initially published in 1992 to implement Section 608 of the CAA and have been amended multiple times by the EPA, most recently in October 2024. DAF installations are subject to, and therefore must comply with, all provisions of the CAA; failure to comply can result in both civil and criminal penalties of up to \$59,114 to \$124,426 per non-compliance per day in 2025 (rate increases annually) (See 40 CFR § 19.4 Statutory civil monetary penalties, as adjusted for inflation, and tables). Major sections of Title VI of the CAA addressed in this pamphlet are listed in [Table 1.1](#) below. **Note:** This pamphlet provides recommendations to assist with regulatory compliance

Table 1.1. Major Applicable Sections of the Clean Air Act for Refrigerant Management.

| CAA Section | Title |
|-------------|---|
| 602 | Listing of Class I and Class II Substances |
| 603 | Monitoring and Reporting Requirements |
| 608 | National Recycling and Emission Reduction Program |
| 612 | Safe Alternatives Policy |

1.7. Scope of Requirements. The statutory and regulatory requirements identified in this pamphlet are applicable to all real property installed equipment (RPIE), real property similar equipment (RPSE) or any other stationary equipment containing refrigerant and/or non-ODS substitute refrigerants and the management of that equipment on DAF-owned or managed installations, including contractor operations and tenant organizations.

1.8. Department of the Air Force Refrigerant Management Program. This pamphlet is intended to function as a guide for complying with statutory requirements under Section 608 of the CAA as well as provide recommendations specific to operations maintenance best management practices. Unless otherwise required by State or local regulation, each installation is no longer required to develop and maintain individual refrigerant management plans. For guidance regarding hazardous material management and associated requirements, see AFMAN 32-7002, Chapter 3, *Hazardous Material Management*.

1.9. Phaseout of Class I and Class II Refrigerants. Based on United Nations Environment Programme (UNEP) protocols, phase out of Class I and Class II ODS's began in 1994 and 2003 respectively and will continue through the year 2030. Under the Montreal Protocol, CFC refrigerants were phased out by 1996, while HCFC refrigerants were to be reduced by 90 percent from their 1989 baseline by 2015. The initial schedule set the milestones of 99.5% reduction by 2020 with use of HCFCs being phased out by 2030. In 2020, the production of all new HCFC refrigerants ceased. In addition, manufacturing new equipment using HCFC refrigerants was banned beyond January 2010. The exception is HCFC-123. Equipment designed to use HCFC-123 could be produced until January 2020 (40 CFR 82.15(g)(5)(ii)). The refrigerant itself will be produced until 2030 and must be recovered or recycled starting January 1, 2021. [Table A2.4 in Attachment 2](#) provides an outline of the United States phaseout schedule.

1.10. Phasedown of HFC Refrigerants. Under the AIM Act, the EPA has implemented a phase-down timeline for non-ODS HFC refrigerants, which are used as replacements for Class I and Class II substances. Production and use of these refrigerants will be gradually reduced until 2036, after which only 15% of the production and consumption baseline (average from 2011 – 2013) will remain. It is therefore important that DAF installations manage this impending limited resource through responsible equipment maintenance and leak management. As discussed in Chapter 3, the process of transitioning to non-HFC or AIM-Act-compliant low-GWP-HFC equipment should occur through attrition by replacing existing stationary air conditioning equipment at the end of its routine service life with common equipment that is commercially available at the time of replacement. New equipment utilizing high-GWP refrigerants will be phased out and unavailable for different use sectors/subsectors starting 1 January 2025. This phase out will continue through 1 January 2028, at which time no high-GWP equipment will be available for purchase (see [paragraph 2.13.4](#)).

1.11. Acceptable Substitutes for Refrigeration Equipment. The EPA SNAP program generates and maintains a list of acceptable and unacceptable substitutes for equipment-specific uses. The SNAP program is intended to promote a smooth transition to safer alternatives. This list is updated periodically as the EPA assesses further information on refrigerant alternatives and should be reviewed regularly for changes. The official list of approved SNAP refrigerants and uses is maintained at the following EPA website: <https://www.epa.gov/snap>

Chapter 2

ENVIRONMENTAL REQUIREMENTS

2.1. Prohibition on Venting. Effective 13 June 2005, no person maintaining, servicing, repairing, or disposing of appliances may knowingly vent or otherwise release into the environment any appliance's Class I or II refrigerant or non-ODS substitute refrigerant (including HFCs, but excluding exempt substitutes). Knowingly releasing a refrigerant or non-exempt substitute (other than de minimis releases) is a violation of Federal law (40 CFR 82.154(a)) and is subject to civil and criminal fines and penalties. **Note:** DAF installations with a Title V Air Operating Permit are required to keep records for five years or as required by other governing regulation.

2.1.1. Exempt Substitute Refrigerants. Current exempt substitute refrigerants and allowable uses are listed in **Table A2.3** of **Attachment 2** of this DAFPAM. Refrigerants on this list are exempt from all regulations under Title VI of the CAA.

2.1.2. "De minimis Releases." As defined in 40 CFR 82.154(a)(2), releases associated with good faith attempts to recycle or recover Class I or II refrigerants or non-exempt substitutes are not subject to this prohibition.

2.2. Technician Certification. All technicians working on AC/R equipment containing Class I, Class II or non-exempt substitute refrigerant on DAF installations must satisfy EPA training and certification requirements imposed by Title VI of the CAA.

2.2.1. Requirements.

2.2.1.1. For the purpose of demonstrating compliance with Section 608 of the CAA, a technician is "any person who in the course of maintenance, service, or repair of an appliance could be reasonably expected to violate the integrity of the refrigerant circuit and therefore release refrigerants into the environment". Activities that fall under this definition include, but are not limited to; adding or removing refrigerant; adding or removing components; and cutting refrigerant lines. Activities such as painting the appliance, rewiring an external electrical circuit, replacing insulation on a length of pipe, or tightening nuts and bolts are not reasonably expected to violate the integrity of the refrigerant circuit.

2.2.1.2. All military and civil service technicians opening refrigerant appliances for maintenance, service, repair, or disposal must be certified as Universal technicians upon completion of the Air Force Specialty Code (AFSC) 3-level awarding technical school or upon hire into civil service.

2.2.1.3. Base Operations Support (BOS), other support or service contractors, and technicians servicing tenant-owned or operated refrigerant appliances for maintenance, service, repair, or disposal must be certified in accordance with applicable Federal, State, local regulations, or Final Governing Standards/Overseas Environmental Baseline Guidance Document (FGS/OEBGD) (as applicable) at overseas installations.

2.2.1.4. In accordance with 40 CFR 82.161(a)(2), apprentices (as defined in 40 CFR 82.152) do not require certification provided they are currently registered as an apprentice

in maintenance, service, repair, or disposal of appliances with the U.S. Department of Labor's Office of Apprenticeship (or a State Apprenticeship Council recognized by the Office of Apprenticeship) and are closely and continually supervised by a certified technician while performing any maintenance, service, repair, or disposal that could reasonably be expected to release refrigerant from appliances into the environment. It should be noted that an individual may only be an apprentice for two years from the date of first registration.

2.2.1.5. Technicians supervising apprentices are responsible for ensuring adherence with all compliance requirements.

2.2.2. Certification Types. All refrigerant technicians must be certified by an EPA-approved certification program in accordance with the following classifications and types:

2.2.2.1. Type I: Required for servicing small appliances.

2.2.2.2. Type II: Required for servicing or disposing of medium, high, and very high-pressure appliances, excluding small appliances, MVACs, and MVAC-like appliances

2.2.2.3. Type III: Required for servicing or disposing of low-pressure appliances.

2.2.2.4. Universal: Allows servicing all types of appliances.

Note: definitions for small appliance, medium-pressure appliance, high-pressure appliance, very high-pressure appliance, and low-pressure appliance can be found in [Attachment 1](#).

2.3. Equipment Subject to Regulations.

2.3.1. Equipment Containing Class I or Class II Refrigerants: The provisions of Section 608 of the CAA are currently applicable to all stationary refrigeration equipment containing a Class I or Class II refrigerant or a refrigerant blend containing a Class I or Class II refrigerant.

2.3.2. Maintenance and Leak Repair Requirements: Equipment having one or more refrigerant circuits that have a full charge capacity of 50 pounds or more of a refrigerant containing a Class I or Class II ODS or blend that contains a Class I or Class II refrigerant is subject to the maintenance and leak repair provisions of 40 CFR § 82.157. These provisions are summarized in [paragraphs 2.4.1](#) through [2.4.5](#) of this DAFPAM.

2.3.3. Equipment Containing only Substitute Refrigerants is currently exempt from the leak repair and recordkeeping provisions of Section 608 of the CAA. However, substitute refrigerants are still subject to the venting prohibition and evacuation provisions under 40 CFR § 82.156. Also, the EPA has incorporated leak repair requirements for HFC refrigerants into 40 CFR Part 84. See [paragraph 2.13.5](#).

2.3.4. Equipment Containing only Exempt Refrigerants is currently exempt from all requirements under Section 608 of the CAA. A list of exempt refrigerants is contained in [Table A2.3](#).

2.3.5. Appliances Containing Less than 50 Pounds of ODS Refrigerant: Equipment that does not have at least one refrigerant circuit containing 50 pounds or more of a refrigerant that is comprised in whole or in part of a Class I or Class II ODS is not subject to the leak repair provisions of 40 CFR 82.157. This equipment, however, is subject to the recovery and evacuation provisions of Table 1 of 40 CFR 82.156 and must have ODS refrigerants and non-exempt substitute refrigerants recovered as outlined in [paragraph 2.6](#) of this document prior to sending the equipment for disposal.

2.3.6. Equipment Categories:

2.3.6.1. Comfort Cooling: appliances used to provide cooling in order to control heat and/or humidity in occupied facilities including but not limited to residential, office, and commercial buildings. Comfort cooling appliances include but are not limited to chillers, commercial split systems, and packaged roof-top units.

2.3.6.2. Commercial Refrigeration: appliances used in the retail food and cold storage warehouse sectors. Retail food appliances include the refrigeration equipment found in supermarkets, convenience stores, restaurants, and other food service establishments. Cold storage includes the refrigeration equipment used to store meat, produce, dairy products, and other perishable goods.

2.3.6.3. Industrial Process Refrigeration: appliances that are directly linked to the processes used in, for example, the chemical, pharmaceutical, petrochemical, and manufacturing industries. This sector also includes industrial ice machines, appliances used directly in the generation of electricity, and ice rinks. Where one appliance is used for both industrial process refrigeration and other applications, it will be considered industrial process refrigeration equipment if 50 percent or more of its operating capacity is used for industrial process refrigeration.

2.3.6.4. Other: any stationary appliance which does not meet the definition of one of the other categories.

2.4. Equipment Repair and Maintenance. Equipment subject to the requirements of Section 608 of the CAA must be repaired in accordance with (IAW) applicable Federal, State, local regulations or FGS/OEBGD (as applicable) at overseas installations. Information regarding operations and maintenance best practices for equipment servicing and repairs can be found in Chapter 3 of this DAFPAM.

2.4.1. Leak Rate Action Thresholds. Equipment must be maintained so that it is leaking below the applicable 12-month leak rate repair threshold as defined by the EPA. These limits are contained in [Table 2.1](#) below.

Table 2.1. Leak Rate Thresholds.

| Appliance Category | Leak Rate Threshold |
|--------------------|---------------------|
| Comfort Cooling | 10% |

| Appliance Category | Leak Rate Threshold |
|----------------------------------|---------------------|
| Commercial Refrigeration | 20% |
| Industrial Process Refrigeration | 30% |
| Other | 10% |

2.4.2. Leak Rate Calculations. The leak rate must be calculated every time a regulated piece of equipment is serviced where the refrigerant circuit is opened, and refrigerant is added or removed. A record of both the leak rate and quantity of refrigerant added or removed must be maintained in accordance with applicable regulations. Leak rate calculations are performed automatically when service records are entered into the Air Force Air Program Information Management System (APIMS). These records are also automatically retained in the system and available for future compliance demonstrations and reporting as required by law.

2.4.2.1. Leak Rate Calculation Methods. EPA prescribes two methods to calculate equipment leak rate. Installation personnel can select either of the two methods; however, the same method must be used for all AC/R on the installation and cannot be switched for convenience.

Example calculations are included in [Attachment 3](#).

2.4.2.2. Loss Rate Percentage Annualizing Method (LR% Ann): expressed in terms of the percentage of the appliance’s full charge that would be lost over a 12-month period if the current rate of loss were to continue over that period.

Equation 2.1. Annualizing Leak Rate Equation

$$LR\%Ann = \frac{\text{pounds of refrigerant added}}{\text{pounds of refrigerant in full charge}} \times \frac{365 \text{ days/year}}{\text{shorter of: \# of days since refrigerant last added or 365 days}} \times 100\%$$

2.4.2.3. Loss Rate percentage Rolling Average Method (LR%Roll): aggregates the quantity of refrigerant added to the appliance over the past 365 days or since the last time repairs were made if that period is less than one year.

Equation 2.2 Rolling Average Leak Rate Equation.

$$LR\%Roll = \frac{\text{pounds of refrigerant added over past 365 days (or since the last successful follow-up verification test showing all identified leaks in the appliance were repaired, if that period is less than one year)}}{\text{pounds of refrigerant in full charge}} \times 100\%$$

2.4.3. Leak Identification. The EPA requires equipment owners or operators to promptly calculate the leak rate each time refrigerant is added to a refrigerant circuit containing 50

pounds or more of a refrigerant containing a Class I or II ODS. If the system is leaking in excess of the applicable threshold in [Table 2.1](#) it must be repaired.

2.4.4. Leak Repairs. Equipment having one or more refrigerant circuits containing 50 pounds or more of a Class I or Class II ODS with leaks that exceed the leak rate specified in [Table 2.1](#) must:

2.4.4.1. Be repaired by a technician who is properly certified for that kind of equipment.

2.4.4.2. Have refrigerant evacuated in accordance with the required levels in [Table A2.5](#) in [Attachment 2](#) of this DAFPAM.

2.4.4.3. Have the leak rate calculated and maintained with repair records.

2.4.4.4. Be repaired, mothballed, or have a plan to remove from service within 30 days of discovery. The date that the leak rate was calculated in the DAF APIMS will be considered the start of the 30-day repair and reporting clock.

2.4.4.5. Not continue leaking in excess of the leak rates in [Table 2.1](#).

2.4.4.6. Have all repairs properly documented in APIMS in accordance with all applicable regulations. See [paragraph 2.10](#) of this DAFPAM for additional information on recordkeeping requirements.

2.4.4.7. Have the initial, 30-day and any other mandated subsequent leak inspections completed and properly documented in accordance with [paragraph 2.5](#) of this DAFPAM.

2.4.5. Leaking Equipment That Cannot Be Repaired. The EPA imposes strict deadlines for compliance with repairing leaking equipment or retrofitting/retiring the equipment.

2.4.5.1. If the appliance cannot be repaired or mothballed within 30 days of discovering a leak greater than the applicable threshold in [Table 2.1](#), or within 30 days of a failed follow-up verification test, or after making a good-faith effort to repair the leaks, a one-year Retrofit or Retirement Plan for the leaking appliance must be developed IAW 40 CFR 82.157(h). The plan must be signed by an authorized official such as the Base Civil Engineer (BCE). The plan must be entered into APIMS and a copy of the plan must be maintained and available for review by the EPA upon request. Actions identified in the plan must be completed within 13 months.

2.4.5.2. All repair activities must be documented and retained in APIMS.

2.4.5.3. The EPA may grant additional time to repair leaks under certain circumstances. These circumstances include, but may not be limited to, the following:

2.4.5.3.1. If the refrigeration appliance is located in an area subject to radiological contamination or where shutting down the appliance will directly lead to radiological contamination.

2.4.5.3.2. If necessary parts are unavailable or if requirements of other applicable Federal, State, or local regulations make a repair within 30 or 120 (for cases requiring

industrial process shutdown) days impossible. Portions of the repair that do not need a time extension must be completed within 30 days.

2.4.5.3.3. Instances where an industrial process shutdown is needed to repair leaks from industrial process refrigeration equipment.

2.4.5.3.4. Equipment is “mothballed.” System mothballing means the intentional shutdown of a refrigeration appliance undertaken for an extended period by the owners or operators of that facility, where the refrigerant has been evacuated from the appliance or the affected isolated section of the appliance, to at least atmospheric pressure.

2.4.5.4. Equipment repair is unnecessary if a plan to retrofit or retire the equipment within a year is developed within 30 days after the leak is discovered (See [paragraph 2.4.5.1](#)). This provision also applies to a failed follow-up verification test or after making good-faith efforts to repair the leak(s).

2.5. Equipment Inspections. Equipment inspections are required as part of equipment maintenance, repair, and management regardless of ownership or who the servicing technician is. Requirements vary depending on equipment size, refrigerant(s) used and history of leak repairs. The following inspections are required for equipment containing 50 pounds or more of a Class I or Class II ODS or blend when it has been found to be leaking in excess of the applicable threshold in [Table 2.1](#). Additionally, records of these inspections must be maintained IAW Federal, State or Local regulations; see [paragraph 2.10](#) of this document for additional information.

2.5.1. Initial Verification Test. As soon as practical after completion of a repair to a piece of stationary equipment subject to leak repair requirements, the equipment must be checked for leaks prior to adding additional refrigerant and/or returning it to service. If the refrigerant charge was evacuated, the system (or isolated component(s) or portion of the repaired refrigerant circuit) must be checked to ensure that the repair was effective prior to replacing the refrigerant charge.

2.5.2. Follow-Up Verification Test. After returning a piece of stationary equipment to service, a follow-up or “30-day” verification must be performed. This verification test must be performed no later than 30 days after completion of the repair and returning the equipment to operation. Technicians are not required to wait 30-days, however, and can perform this assessment as soon as the equipment has reached normal operating conditions, i.e., temperatures, pressures, process rates, etc.

2.5.3. Recurring Leak Inspections. Stationary equipment that has exceeded its applicable leak rate threshold ([Table 2.1](#)) and was subsequently repaired and had its refrigerant charge replaced must be inspected IAW with the frequencies outlined in [Table 2.2](#) below.

2.5.4. Required Personnel for Leak Verifications and Inspections. Leak verifications and inspections must be conducted by a certified technician using method(s) determined by the technician to be appropriate for that appliance.

Table 2.2. Recurring Leak Inspection Requirements

| Equipment | Full Charge | Frequency of Leak Inspections |
|--|--------------------------|--|
| Commercial Refrigeration and Industrial Process Refrigeration | 50 to 500 pounds | Once per calendar year until the owner/operator can demonstrate through the leak rate calculations that the leak rate has not exceeded 20% (commercial refrigeration) or 30% (industrial process refrigeration or IPR) for one year. |
| | > 500 pounds | Once every three months until the owner/operator can demonstrate through leak rate calculations that the leak rate has not exceeded 20% (commercial refrigeration) or 30% (IPR) for four quarters in a row. |
| Comfort Cooling | 50 or more pounds | Once per calendar year until the owner/operator can demonstrate through the leak rate calculations that the leak rate has not exceeded 10% for one year. |

2.5.5. Appliance Components. All visible and accessible components of an appliance must be inspected, with the following exceptions:

2.5.5.1. Where components are insulated, under ice that forms on the outside of equipment, underground, behind walls, or are otherwise inaccessible;

2.5.5.2. Where personnel must be elevated more than two meters above a support surface; or

2.5.5.3. Where components are unsafe to inspect, as determined by site personnel.

2.5.6. Leak Inspection Exemptions. Quarterly or annual leak inspections are not required on appliances, or portions of appliances, continuously monitored by an automatic leak detection system that is audited or calibrated annually. An automatic leak detection system may directly detect refrigerant in air, monitor the area surrounding appliances in a manner other than solely detecting refrigerant concentrations in air, or monitor the operating conditions of the appliance.

2.5.6.1. For systems that directly detect the presence of a refrigerant in air, the system must: 1) only be used to monitor components located inside an enclosed building or structure; 2) have sensors or intakes placed so that they will continuously monitor the refrigerant concentrations in air in proximity to the compressor, evaporator, condenser, and other areas with a high potential for a refrigerant leak; 3) accurately detect a concentration level of 10 parts per million of vapor of the specific refrigerant or refrigerants used in the refrigeration appliance(s); and 4) alert the owner or operator when a refrigerant concentration of 100 parts per million of vapor of the specific refrigerant or refrigerants used in the refrigeration appliance(s) is reached.

2.5.6.2. For a system that monitors its surroundings in a manner other than detecting refrigerant concentrations in air or monitors conditions of the appliance, the system must automatically alert the owner or operator when measurements indicate a loss of 50 pounds of refrigerant or 10 percent of the full charge, whichever is less.

2.5.6.3. When automatic leak detection equipment is only being used to monitor portions of an appliance, the remainder of the appliance continues to be subject to any applicable leak inspection requirements.

2.6. Refrigerant Recovery.

2.6.1. Recovery, recycling, and reuse of Class I, Class II ODS and non-exempt substitute refrigerants will be accomplished to the maximum extent practicable to ensure responsible use and prevent losses to the atmosphere. All refrigerants must be recovered/recycled by removing the refrigerant using EPA-certified recovery equipment to the required evacuation levels and be stored in an approved container. Refrigerant recovery must be completed in accordance with the levels contained in [Table A2.5](#) of [Attachment 2](#) of this DAFPAM.

2.6.2. Anyone who opens a refrigerant circuit containing a Class I or II ODS and/or a non-exempt substitute refrigerant or disposes of AC/R equipment must recover the remaining refrigerant and/or verify that the refrigerant is evacuated to the levels required by the EPA as applicable for the equipment size, type, refrigerant and age. Required evacuation levels are specified in Table 1 of 40 CFR 82.156 and are included in [Table A2.5](#) of [Attachment 2](#) of this DAFPAM.

2.6.2.1. The EPA has established limited exceptions to its evacuation requirements for minor repairs and repairs of leaking equipment not followed by an equipment evacuation into the environment. If evacuation to the level in [Table A2.5](#) of [Attachment 2](#) of this DAFPAM is not attainable, or would significantly contaminate the recovered refrigerant, persons opening the appliance must isolate the leaking components from the non-leaking components whenever possible; evacuate non-leaking components to the required levels in [Table A2.5](#) and evacuate leaking components to the lowest level attainable that will not significantly contaminate the refrigerant (not to exceed 0 psig [pound per square inch gauge]).

2.6.2.2. If evacuation of the equipment to the environment will not be performed when repairs are complete, and if the repair is not major, then the appliance must be evacuated to at least 0 psig before it is opened if it is a medium, high pressure or very high-pressure appliance, or be pressurized to 0 psig before it is opened if it is a low-pressure appliance. Methods that require subsequent purging (e.g., nitrogen) cannot be used.

2.6.2.3. Major repairs include the removal of a compressor(s), condenser, evaporator, or auxiliary heat exchanger coil.

2.6.3. Small appliances containing less than 5 pounds of refrigerant; such as household refrigerators, household freezers, and water coolers, are required to recover 80 percent of the system refrigerant if the system's compressor is non-functional and 90 percent if the compressor is functional. Alternatively, equipment can be evacuated to four inches of mercury vacuum.

2.6.4. The EPA permits the return of recovered and/or recycled refrigerant to the same system or other systems owned by the same person without restriction. If refrigerant changes ownership, the refrigerant must be reclaimed. Reclamation must return the refrigerant to a state such that it meets the purity standards of the most current edition of the Air-Conditioning,

Heating, and Refrigeration Institute (AHRI) Standard 700-2019, *Specifications for Refrigerants*, and chemically analyzed to confirm it meets that standard.

2.6.5. Refrigerants must be reclaimed by an EPA-certified refrigerant reclaimer. A list of EPA-certified refrigerant reclaimers can be found on the following EPA website: <https://www.epa.gov/section608/epa-certified-refrigerant-reclaimers>

2.7. Refrigerant Recovery Equipment. All technicians who maintain, repair, or dispose of AC/R equipment on DAF installation that contains a Class I, II or non-exempt substitute refrigerant must use recovery and recycling equipment certified by an EPA-approved testing organization; e.g., the AHRI or Underwriters Laboratory (UL). This requirement extends not only to installation personnel and direct support contractors, but also to tenant organizations, their personnel, and contractors as well.

2.7.1. Equipment used to handle refrigerants during servicing must be capable of meeting the evacuation levels listed in **Table A2.5** of **Attachment 2** of this DAFPAM. For small appliances containing less than five pounds of refrigerant, recovery equipment must be capable of recovering 90 percent of the refrigerant charge when the compressor is operational, or 80 percent when it is not operational.

2.7.2. Recovery or recycling equipment must always be operated and maintained in accordance with the manufacturer's directions unless such directions conflict with the requirements of the EPA; in these cases, technicians must comply with EPA mandates.

2.7.3. Each piece of recycling or recovery equipment must have a visible label that shows that it has been tested and certified by a third-party EPA-approved testing organization to meet the requirements of 40 CFR 82.158. The label is also required to meet the following requirements and must:

2.7.3.1. Be in a readily visible or accessible location,

2.7.3.2. Be made of a material expected to last the lifetime of the equipment and present the required information in such a manner that it is likely to remain legible for the lifetime of the equipment.

2.7.3.3. Be affixed in such a manner that it cannot be removed from the equipment without damaging the label.

2.7.3.4. State the following; "THIS EQUIPMENT HAS BEEN CERTIFIED BY [APPROVED EQUIPMENT TESTING ORGANIZATION] TO MEET EPA'S MINIMUM REQUIREMENTS FOR RECYCLING OR RECOVERY EQUIPMENT INTENDED FOR USE WITH [APPROPRIATE CATEGORY OF APPLIANCE]."

2.7.3.5. Show the date of manufacture and the serial number (if applicable) of the equipment.

2.7.4. Grandfathered Equipment. Equipment manufactured before 15 November 1993, including homemade equipment, will be grandfathered (considered certified) if it is capable of achieving the level of evacuation specified in the second column of **Table A2.5** in **Attachment**

2 of this DAFPAM when tested using a properly calibrated pressure gauge. Third-party testing is not required for equipment manufactured before 15 November 1993. Equipment manufactured before 15 November 1993 that is used for small appliances containing less than 5 pounds of refrigerant will be grandfathered (considered certified) if capable of either recovering 80 percent of refrigerant in the system (regardless of if the system compressor is operational or not), or is capable of achieving a four-inch vacuum when tested using a properly calibrated pressure gauge.

2.7.5. Recovery or recycling equipment already used for CFC or HCFC equipment should not be used for other alternate/substitute refrigerants to avoid mixing different types of refrigerants.

2.7.6. Contracts to purchase recycling or recovery equipment for use on DAF facilities must require procurement of equipment certified by an EPA-approved equipment testing organization to meet the applicable requirements and standards of 40 CFR 82.158 including the evacuation level requirements in [Table A2.5](#) of [Attachment 2](#) of this DAFPAM.

2.7.7. Recovery Equipment Registration. The EPA no longer requires that entities/persons servicing stationary air-conditioning and refrigeration equipment certify that they have acquired refrigerant recovery or recycling equipment and that they are complying with the applicable requirements. Submitting and maintaining documentation of this notification to the EPA for this purpose is no longer required.

2.8. Equipment Disposal Requirements. Refrigeration equipment that has been slated for disposal must have its refrigerant evacuated in accordance with current EPA requirements.

2.8.1. Larger refrigeration equipment that is typically dismantled onsite before disposal (e.g., retail food refrigeration, cold storage warehouse refrigeration, chillers, or industrial process refrigeration) must have its refrigerant recovered according to the EPA's servicing and evacuation requirements prior to the refrigerant circuit(s) being opened.

2.8.2. Smaller equipment that typically enters the waste stream with the charge intact (e.g., household refrigerators, freezers, room air-conditioners) is subject to special safe disposal requirements and must have its charge removed prior to being sent for disposal as well.

2.8.3. Both disposable cylinders and reusable cylinders must have all refrigerant and refrigerant oils recovered and removed prior to disposal or return of empty reusable cylinders to Hazardous Material Pharmacy (HAZMART) for reuse through the installation vendor. Cylinders must be evacuated until empty (recover the refrigerant until the pressure is reduced to a vacuum). The container's valve should be closed and the container itself marked as empty; the container is now ready for disposal. It is recommended but not required that the cylinder valve be opened afterwards to allow air to enter. The cylinder valve is then broken off while the valve remains open, and the cylinder is punctured. This will prevent cylinder misuse by untrained individuals. Once the cylinder has been rendered useless as a refrigerant container, it can be disposed of as scrap metal. For details on disposal rules, refer to Department of Transportation (DOT) Specification 39, *Non-reusable (non-refillable) cylinders*, 49 CFR 178.65, and Defense Logistics Agency Instruction (DLAI) 4145.25, *Storage and Handling of Liquefied and Gaseous Compressed Gasses and Their Full and Empty Cylinders*.

2.8.4. Refrigerant recovery equipment used to remove refrigerant from appliances prior to final disposal must meet the same performance standards as EPA-certified refrigerant recovery equipment to normally service that kind of equipment.

2.9. Refrigerant and Refrigerant Oil Management and Disposal.

2.9.1. The installation Hazardous Material Management Process (HMMP) team is the focal point for the proper management and disposal of refrigerants. The installation Environmental Element is the authoritative source for determining the disposition of any excess or unusable refrigerants in accordance with Department of Defense (DoD) policy. AFMAN 32-7002, Chapter 3, *Hazardous Materials Management*, provides guidance on the disposition of Class I and Class II ODS.

2.9.2. Transfers and Defense Logistics Agency (DLA) Turn-ins.

2.9.2.1. Transfer of excess refrigerants managed by the DLA ODS Reserve to persons/entities outside the DAF is strictly regulated. ODS materials included in **Table 2.3** are managed by the DLA and cannot be sold or transferred outside of DoD. Information regarding turn in procedures, DLA points of contact, and a list of covered HFC materials are available at: <https://www.dla.mil/Aviation/Offers/ODS-Reserve/>. Excess HFC refrigerants may not be transferred out of government ownership without first being offered to DLA in accordance with the turn-in procedures. The term “excess” in the context of these turn-in requirements refers to bulk refrigerant held in storage cylinders on the installation or recovered by technicians in the course of decommissioning or completely purging equipment. “Excess” does not include small quantities of refrigerant captured by technicians in the course of routine equipment maintenance. Transfers of excess refrigerant to other bases is encouraged and should be arranged through the installation HAZMART.

Table 2.3. Materials Managed by the DLA ODS Reserve

| Common Name | Chemical Name |
|--------------|--|
| CFCs | |
| R-11 | Trichlorofluoromethane |
| R-12 | Dichlorodifluoromethane |
| R-114 | Dichlorotetrafluoroethane |
| R-500 | Azeotropic mixture of CFC-12 and HFC-152A (1,1 Difluoroethane) |
| R-502 | Azeotropic mixture of CFC-115 and HCFC-22 |
| HCFCs | |
| R-22 | Chlorodifluoromethane |

| Common Name | Chemical Name |
|-------------------|----------------------------|
| Halons | |
| Halon 1202 | Dibromodifluoromethane |
| Halon 1211 | Bromochlorodifluoromethane |
| Halon 1301 | Bromotrifluoromethane |
| Solvents | |
| Methyl Chloroform | 1,1,1 Trichloroethane |
| CFC-113 | Trichlorotrifluoroethane |

2.9.2.2. If the BCE identifies excess materials managed by the DLA ODS Reserve that cannot be utilized on the installation or reallocated within the MAJCOM or region, these supplies must be offered to the DLA ODS Defense Reserve Stockpile through the HAZMART. Unless directed by personnel at the DLA ODS Reserve, all such excess or unusable material must be shipped to the DLA ODS Reserve when it is no longer needed.

2.9.3. Refrigerant and Refrigerant-Contaminated Oil Disposal. The oil in a refrigeration appliance can contain large amounts of dissolved refrigerant. EPA requires a reduction in the pressure prior to an oil change to ensure that the bulk of the refrigerant contained in the oil is recovered.

2.9.3.1. Refrigerants and refrigerant-contaminated oils sent for recycling or reclamation are not classified as a hazardous waste under Federal law.

2.9.3.2. Refrigerant-contaminated oils are subject to refrigerant recycling and reclamation requirements and must have dissolved refrigerant recovered to no more than 5 psig prior to being exposed to the atmosphere. This can be accomplished either while the oil is still within the equipment, or after it has been removed and placed into a suitable container.

2.9.3.3. Refrigerant-contaminated oils are not to be mixed with used oils from other sources. Doing so can result in classification of the oil as a hazardous waste and therefore require additional management and disposal costs.

2.9.3.4. If refrigerants are not ultimately reclaimed from the oil, manage the oil IAW 40 CFR 279 requirements, or manage as solid [and potentially hazardous] waste IAW 40 CFR 261. For guidance, contact the installation Environmental Element.

2.9.3.5. Used oils containing CFCs after the CFC reclamation procedure are subject to specification limits for used oil fuels if they are not burned.

2.9.3.6. Any refrigerant contaminated by other refrigerants that cannot be reclaimed is considered to be a "solid waste." This waste refrigerant must, in turn, be characterized by

the installation Environmental Element to determine whether it is also classified as a hazardous waste. The Environmental Element may also use process knowledge to declare the refrigerant to be hazardous waste and then manage and ensure its proper disposal IAW AFMAN 32-7002, Chapter 5, *Hazardous Waste Management*, and any applicable Federal, State, or local regulation. For this reason, it is imperative that refrigerants are not mixed.

2.10. Recordkeeping. Refrigerant activities on DAF installations must be documented and retained in accordance with applicable Federal, State, local regulations or FGS/OEBGD (as applicable) at overseas installations. Federal law requires that records associated with refrigerant management be retained for a minimum of three years. The installation CE Environmental Element should be contacted to determine if any additional State, local or host nation requirements exist.

2.10.1. APIMS. The DAF Air Program Information Management System (APIMS) is the system of record for all refrigerant management compliance records per AFMAN 32-7002, 2.15.4. As such, all records required to demonstrate compliance with Federal, State or Local refrigerant regulations must be maintained in APIMS. This includes, but is not limited to; technician certifications, equipment inventories, service records and inspections.

2.10.1.1. APIMS is fully accredited and meets all applicable DAF Information Technology (IT) system requirements; as such, it is approved for use at all installations. It is web based and therefore does not require installation of any software or additional hardware beyond a standard computer with internet access and a Common Access Card (CAC) reader. The system is configured to allow multiple user levels (technician vs. manager) so as to limit data access and allow review of service records prior to final approval in the system.

2.10.1.2. To obtain an APIMS account, please contact the Air Quality Program Manager at your installation's Environmental Element or the Environmental Management Office at ANG installations.

2.10.1.3. APIMS can be accessed at the following link: <https://apims.af.mil>

2.10.1.4. Help with using APIMS can be obtained by contacting the Help Desk at: help@apims-support.com or calling (800) 274-4406.

2.10.2. Technician Certification.

2.10.2.1. Copies of technician certifications must be maintained in APIMS and be readily available for inspection. Technicians are not required to carry their certification card at all times; however, technicians must ensure they have provided a copy to the installation's Heating, Ventilation and Air Conditioning (HVAC) shop manager.

2.10.2.2. Service contractors, tenants and any other technician performing refrigerant work on DAF installations are required to provide copies of technician certifications to the Environmental Element when providing copies of refrigeration equipment maintenance records.

2.10.2.3. Managers storing technician certifications must ensure that no Personally Identifiable Information (PII) is stored as part of the training certification records.

Historically, certifications included a technician's Social Security Number; if a technician's certification includes this information, it must be redacted prior to entry into APIMS or storing a local copy at the installation.

2.10.3. Equipment Inventory. An up-to-date inventory of all HVAC equipment having one or more refrigerant circuits that contain 50 lbs or more of a Class I or Class II ODS must be maintained in APIMS at all DAF installations. Note, some State and local agencies have implemented regulations that expand on the Federal CAA requirements and require tracking of non-exempt substitute refrigerants. As such, installation Environmental Element personnel should be aware of additional State or local regulations and ensure that the HVAC shop is aware of and complying as necessary.

2.10.3.1. Full Charge Determinations. The equipment inventory must include a record of the full charge of each refrigerant circuit or system subject to environmental regulations, as well as the method used to make that determination, e.g., manufacturer's specification, actual measurement, or calculation of system capacity, etc.

2.10.4. Refrigerant Service Records. Records of refrigerant maintenance events for equipment having one or more refrigerant circuits containing 50 pounds or more of a Class I or Class II ODS must be retained in APIMS to be able to demonstrate compliance with environmental regulations. A record of service must be maintained any time refrigerant is added or removed from a piece of equipment.

2.10.4.1. Service records must include the amount and type of refrigerant added to or removed from a piece of equipment during service as well as the date service was performed, the name of the technician performing work and detailed notes regarding what work was accomplished on what specific piece of equipment.

2.10.4.2. Service contractors performing maintenance on stationary equipment located on a DAF installation must provide copies of all service records to the installation Environmental Element. These records must include all information necessary to demonstrate compliance with Federal, State, or local regulations as applicable per 2.10.4.1.

2.10.4.3. Equipment Leak Rates. Each time refrigerant is added or removed from a piece of equipment, the leak rate must be calculated, and a record maintained. See [paragraph 2.4.2](#) for additional information regarding leak rate calculations. So long as APIMS is utilized, leak rates are automatically calculated and retained as part of the electronic record.

2.10.4.4. Leak Verifications and Follow-Up Inspections. Records of all initial, 30-day and other follow-up leak verifications/inspections must be maintained in APIMS.

2.10.5. Refrigerant Purchase and Disposal Records. DAF installations must maintain records of refrigerant purchased and sent for reclamation or destruction. These records must include when, where, type and quantity of refrigerants purchased. Similarly, records must be maintained detailing what kinds of refrigerant were sent for reclamation or disposal, the quantity of material sent as well as the date, recipient, and final disposition of the material.

2.10.6. EPA Reporting. Installation Environmental Elements must maintain copies of reports submitted to EPA as well as and any responses from EPA. These records, as well as all other records required by Section 608 of the CAA must be retained for a minimum of three years.

2.11. Regulatory Reporting.

2.11.1. Required Reports for Repairs Requiring More Than 30 Days.

2.11.1.1. All of the following actions will be entered by the installation CE Environmental Element into APIMS as a record under the base-wide refrigerant management process and copy to the Air Quality POC at AFCEC/CZ, ANG or National Guard Bureau (NGB), Air Force Reserve Command (AFRC), or Space Force designated level, as applicable.

2.11.1.2. EPA Initial Report. An initial report must be submitted to the EPA regarding why more than 30 days are needed to complete repairs. This report must be submitted within 30 days of determining that the leak rate exceeded the applicable leak rate threshold in [Table 2.1](#) and include the following:

2.11.1.2.1. Identification of the facility;

2.11.1.2.2. Leak rate;

2.11.1.2.3. Method used to determine the leak rate and full charge;

2.11.1.2.4. Date a leak rate above the applicable leak rate threshold was discovered;

2.11.1.2.5. Location of leak(s) to the extent determined to date;

2.11.1.2.6. Any repair work completed thus far and the date that work was completed;

2.11.1.2.7. The reasons why more than 30 days are needed to complete the work and an estimate of when the work will be completed.

2.11.1.2.8. If changes from the original estimate of when work will be completed result in extending the completion date from the date submitted to the EPA, the reasons for these changes must be documented and submitted to the EPA within 30 days of discovering the need for the change.

2.11.2. Leak Repair Plans. The BCE must submit a plan to fix leaks for which repairs are planned, but cannot be completed, to achieve a rate below the applicable allowable leak rate prior to the 30- or 120-day point (in the cases when an industrial process shutdown is required). This plan is submitted only after the BCE has originally notified the EPA that the initial completion dates cannot be met.

2.11.3. EPA Final Report. The BCE must maintain records of the dates, types, and results of all initial and follow-up verification tests in APIMS for a minimum of three years. Upon completion of all repairs, perform an initial verification to confirm that the leak is fixed with a subsequent follow-up verification test. If there is still a leak, an interim report is sent to the EPA. A second report is due to the EPA 30 days from the date of the initial verification of the repair previously reported to the EPA. Each report must also include the following:

- 2.11.3.1. Identification of the facility;
- 2.11.3.2. Leak rate;
- 2.11.3.3. Method used to determine the leak rate and full charge;
- 2.11.3.4. Date leak rate above the applicable leak rate threshold was discovered;
- 2.11.3.5. Location of leak(s) to the extent determined to date;
- 2.11.3.6. Any repair work completed thus far and the date that work was completed.

2.11.4. **Chronically Leaking Equipment.** Equipment having at least one refrigerant circuit containing 50 pounds or more of a Class I or Class II ODS that has leaked in excess of 125% of its refrigerant charge in a year must be reported to the EPA. This report must be submitted not later than March 1 of the following year and describe efforts to identify and repair leaks in the appliance.

2.11.5. **EPA Report Submittal.** All reports provided to the EPA will be sent by the installation Environmental Element to ensure compliance with reporting and recordkeeping requirements. Installation Environmental Elements must maintain copies of reports submitted to EPA and any responses from EPA.

2.11.6. **EPA Report Delivery.** All reports and notifications required for Class I and Class II ODS must be submitted electronically to 608reports@epa.gov unless the notification contains confidential business information. If the notification contains confidential business information, the information should be submitted to:

Section 608 Program Manager
Stratospheric Protection Division;
Mail Code: 6205T;
U.S. Environmental Protection Agency;
1200 Pennsylvania Avenue NW.,
Washington, DC 20460.

2.12. Enforcement. The EPA is continually performing random inspections, responding to tips, and pursuing violators. Under the CAA, EPA may assess civil administrative penalties of up to \$59,114 per day, per violation, as of the date of this publication, against federal agencies for noncompliance. The total penalty cannot exceed \$472,9014, as of the date of this publication, unless EPA and the Department of Justice determine a greater penalty is appropriate. EPA is required to update the potential fine amounts annually to account for inflation. Fees are updated at 40 CFR § 19.4 Statutory civil monetary penalties, as adjusted for inflation, and tables.

2.13. Impacts of AIM Act on Refrigerant Management. Although HFC refrigerants do not deplete the earth's ozone layer, many of them have high theoretical GWPs. The AIM Act of 2020 imparts restrictions on the quantity of HFCs that can be manufactured or imported into the United States and its territories.

- 2.13.1. Due to their high GWPs, the AIM Act requires the EPA to reduce emissions of those HFCs, including HFC refrigerants. This will be accomplished in three ways: 1) phase down

production and consumption of listed HFCs, 2) manage HFCs and their substitutes, and 3) facilitate transition to next-generation technologies. Although the AIM Act impacts HFC usage across all sectors, the information in this DAFPAM will only focus on the impacts to refrigerants.

2.13.2. Under the AIM Act, the United States will reduce production and consumption of HFC by 85% (based on GWP) by 2036. This baseline was established based primarily on average data from 2011 - 2013. **Table 2.4** below summarizes the phase down timeline.

Table 2.4. AIM Act HFC Phase Down Schedule

| Calendar Years | Percentage of Production Baseline ¹ | Percentage of Consumption Baseline ^{1,2} |
|---------------------|--|---|
| 2022 – 2023 | 90% | 90% |
| 2024 – 2028 | 60% | 60% |
| 2029 – 2033 | 30% | 30% |
| 2034 – 2035 | 20% | 20% |
| 2036 and thereafter | 15% | 15% |

¹ Baseline values were calculated by EPA in units of Metric Tons of Exchange Value Equivalent (MTEVe) or Million Metric Tons of Exchange Value Equivalent (MMTEVe).

² Consumption means production plus imports minus exports

2.13.2.1. Regulated HFCs. HFC substances regulated under the AIM Act are listed in **Table A2.7** in **Attachment 2**. Many HFC refrigerants are blended refrigerants, meaning that they are comprised of multiple components, some of which may be a regulated HFC. Although blended refrigerants are not specifically listed as HFCs, they are subject to the phase down of the AIM Act if they contain one or more regulated components (a regulated HFC). For example, R-410A is a blended refrigerant consisting of 50% HFC-32 and 50% HFC-125 by weight. Both these components are regulated HFCs. Since R-410A contains at least one regulated HFC substance, R-410A itself falls under the AIM Act.

2.13.2.2. HFC Allowances. For six specific end use application categories, the AIM Act drives the phase down of HFCs through use of “allowances.” These allowances are issued on an annual basis to manufacturers and importers of HFCs and limit the total amount of HFC substances that they can either produce or import in a given year. The quantity of allowances issued each year decreases during the phase down period resulting in lower quantities of HFCs available for use in the United States. One of the six end use application categories, which pertains directly to the DoD, is “Mission-Critical Military End Uses” (MCMEU). MCMEU is defined as, “*those uses of regulated substances by an agency of the Federal Government responsible for national defense which have a direct impact on mission capability, as determined by the U.S. Department of Defense (DOD), including,*

but not limited to uses necessary for development, testing, production, training, operation, and maintenance of Armed Forces vessels, aircraft, space systems, ground vehicles, amphibious vehicles, deployable/expeditionary support equipment, munitions, and command and control systems.”

2.13.2.3. MCMEUs. The DoD worked collaboratively with each Service Agency to determine historical usage of HFCs and estimate current and future needs to ensure mission success, while transitioning to newer, non-HFC refrigerants. MCMEU allocations will be centrally managed by the DLA to ensure proper use and tracking of mission-critical HFCs. The primary purpose of these allocations will be for weapon system sustainment.

2.13.2.4. Exchange Value and Exchange Value Equivalent. Each regulated HFC substance listed in [Table A2.7](#) has an assigned Exchange Value (EV). The EV is based on the substance’s GWP. For blended refrigerants that contain one or more regulated HFC substance, the EV of the blended refrigerant can be calculated based on the EV and weight percentage of each individual regulated HFC component. For example, R-410A contains 50% HFC-32 and 50% HFC-125 with the Exchange Values for HFC-32 and HFC-125 being 675 and 3,500, respectively. Therefore, the Exchange Value for R-410A can be calculated as follows: $EV_{R-410A} = 675(0.50) + 3,500(0.50) = 2,088$. Exchange Values for some common blended refrigerants are listed in [Table A2.8](#) in [Attachment 2](#). The Exchange Values allow for quantities of HFCs to be compared in a common unit of measure called Exchange Value Equivalent (EVe). EVe is determined by multiplying the mass of a regulated HFC by the Exchange Value of that HFC. For example, 50 kilograms of HFC-134a would be 71,500 kgEVe ($50 \times 1,430$). This can also be written as 71.5 MTEVe since 1,000 kilograms equals 1 metric ton.

2.13.2.5. Non-Mission-Critical HFC Usage. Unlike mission critical HFC usage, the kinds of use addressed in this pamphlet (facility AC/R equipment) are generally not covered under the MCMEU allocations. As such, HFC refrigerants for use in refrigeration and comfort cooling equipment will be subject to marketplace supply and demand pricing. It is thus important that DAF installations plan for equipment replacement during the normal life cycle management process to ensure that equipment is replaced prior to HFC refrigerants becoming prohibitively expensive.

2.13.3. EPA Regulations Associated with AIM Act. On 5 October 2021 the EPA issued a Final Rule to implement certain provisions of the AIM Act. This Final Rule included the creation of 40 CFR Part 84, *Phasedown of Hydrofluorocarbons*. Some of the more important sections of 40 CFR 84 include:

2.13.3.1. § 84.5 Prohibitions relating to regulated substances

2.13.3.2. § 84.13 Allocation of application-specific allowances

2.13.3.3. § 84.19 Transfers of allowances

2.13.3.4. § 84.29 Destruction of regulated substances

2.13.3.5. § 84.31 Recordkeeping and reporting

2.13.3.6. § 84.35 Administrative consequences

2.13.3.7. Subpart B Restrictions on the Use of Hydrofluorocarbons (§§ 84.50 - 84.64).

2.13.3.8 Subpart C Management of Regulated Substances (§§ 84.100 - 84.120)

2.13.4. Restrictions on the Use of Certain HFCs. Under 40 CFR Part 84, Subpart B (§§ 84.50 – 84.64), the EPA has issued restrictions on the use of higher-GWP HFCs in refrigeration, air conditioning, and heat pump (RACHP) equipment. These restrictions include prohibiting the manufacture and import of RACHP equipment that use higher-GWP HFCs; prohibiting the sale, distribution, and export of RACHP equipment that use higher-GWP HFCs; and prohibiting the installation of new RACHP equipment that use higher-GWP HFCs. These restrictions are implemented under Subsection (i) of the AIM Act.

2.13.4.1. Prohibition on the Manufacture and Import of HFC-Containing RACHP Equipment. The complete list of HFC-containing RACHP equipment for which there is a prohibition on the manufacture and import can be found in 40 CFR § 84.54(a). The list includes a description of the equipment, the threshold GWP for the HFC refrigerants the prohibition applies to, and the effective date of the prohibition. The following are just a few examples:

2.13.4.1.1. Effective January 1, 2025, self-contained residential and light commercial air conditioning and heat pump products using a regulated substance, or a blend containing a regulated substance, with a global warming potential of 700 or greater (See 40 CFR § 84.54(a)(1)).

2.13.4.1.2. Effective January 1, 2025, household refrigerators and freezers using a regulated substance, or a blend containing a regulated substance, with a global warming potential of 150 or greater (See 40 CFR § 84.54(a)(3)).

2.13.4.1.3. Effective January 1, 2025, retail food refrigeration – stand-alone units using a regulated substance, or a blend containing a regulated substance, with a global warming potential of 150 or greater (See 40 CFR § 84.54(a)(4)).

2.13.4.1.4. Effective January 1, 2025, chillers for comfort cooling using a regulated substance, or a blend containing a regulated substance, with a global warming potential of 700 or greater (See 40 CFR § 84.54(a)(10)(i)).

2.13.4.1.5. Effective January 1, 2026, chillers for industrial process refrigeration where the temperature of the fluid exiting the chiller is greater than -22 °F (-30 °C) using a regulated substance, or a blend containing a regulated substance, with a global warming potential of 700 or greater (See 40 CFR § 84.54(a)(10)(ii)).

2.13.4.1.6. Effective January 1, 2027, self-contained products in data center, information technology equipment facility, and computer room cooling using a regulated substance, or a blend containing a regulated substance, with a global warming potential of 700 or greater (See 40 CFR § 84.54(a)(11)).

2.13.4.2. Prohibition on the Sale, Distribution, and Export of RACHP Equipment. Per 40 CFR § 84.54(b), effective three years after the date the prohibition on the manufacture and import of HFC-containing RACHP equipment begins, no person may sell, distribute, offer for sale or distribution, make available for sale or distribution, purchase or receive for sale or distribution, or attempt to purchase or receive for sale or distribution, or export any equipment that uses a regulated substance as listed in 40 CFR § 84.54(a).

2.13.4.3. Prohibition on the Installation of New RACHP Equipment. The complete list of new HFC-containing RACHP equipment for which there is a prohibition on installation can be found in 40 CFR § 84.54(c). The list includes a description of the equipment, the threshold GWP for the HFC refrigerants the prohibition applies to, and the effective date of the prohibition. The following are just a few examples:

2.13.4.3.1. Effective January 1, 2025, residential or light commercial air conditioning or heat pump systems using a regulated substance, or a blend containing a regulated substance, with a global warming potential of 700 or greater, except for variable refrigerant flow air-conditioning and heat pump systems (See 40 CFR § 84.54(c)(1)).

2.13.4.3.2. Effective January 1, 2026, variable refrigerant flow systems for use as residential and light commercial air conditioning or heat pumps, using a regulated substance, or a blend containing a regulated substance, with a global warming potential of 700 or greater (See 40 CFR § 84.54(c)(2)).

2.13.4.3.3. Effective January 1, 2025, chillers for comfort cooling using a regulated substance, or a blend containing a regulated substance, with a global warming potential of 700 or greater (See 40 CFR § 84.54(c)(3)).

2.13.4.3.4. Effective January 1, 2026, chillers for industrial process refrigeration where the temperature of the fluid exiting the chiller is greater than -22 °F (-30 °C) using a regulated substance, or a blend containing a regulated substance, with a global warming potential of 700 or greater (See 40 CFR § 84.54(c)(5)).

2.13.5. HFC Leak Repair and Detection. Under 40 CFR Part 84, Subpart C—Management of Regulated Substances (§§ 84.100 – 84.120), the EPA has issued requirements effective January 1, 2026, for leak repair of refrigerant-containing appliances with a full charge of 15 or more pounds of refrigerant that contains a regulated substance (as defined in § 84.3) or contains a substitute for a regulated substance that has a global warming potential greater than 53. The leak repair requirements do not apply to appliances (as defined in 40 CFR § 82.152) containing solely an ozone-depleting substance as listed in 40 CFR Part 82, Subpart A, or to refrigerant-containing appliances used in the residential and light commercial air conditioning and heat pump subsector (See 40 CFR § 84.106(a)) [Note, leak repair requirement for ODS refrigerants are addressed in § 2.4 of this AFPAM]. Owners and operators of refrigerant-containing appliances used for industrial process refrigeration or commercial refrigeration, which are installed after January 1, 2026, must install and use an automatic leak detection system if the appliances hold a full charge of 1,500 pounds or greater of a refrigerant containing a regulated substance or a substitute for a regulated substance with a global warming potential greater than 53. Equipment installed after January 1, 2026 must install automatic leak detection equipment within 30 days of installation. Owners and operators of the described type of industrial process

or commercial appliances installed on or after January 1, 2017, and before January 1, 2026, must install and use an automatic leak detection system by January 1, 2027 (See 40 CFR § 84.108). These HFC management requirements are implemented under Subsection (h) of the AIM Act, and 40 CFR Part 84 Subpart C should be read closely to determine the impact at each DAF installation.

2.13.5.1. § 84.106 Leak repair. Contains requirements for persons (owners or operators) adding or removing refrigerant from appliances, to include: leak rate calculation methodology; requirements to address leaks through repair, or retrofitting or retiring a refrigerant-containing appliance; appliance repair requirements; verification tests on repair work; extensions to appliance repair deadlines; leak inspections; creation of retrofit and retirement plans; extensions to the one-year retrofit or retirement schedule; additional requirements applicable to chronically leaking appliances (i.e., those with a leak rate of 125 percent or more of the full charge in a calendar year); special provisions for purged refrigerant; recordkeeping requirements; and reporting requirements. Leak rate calculations must be performed using one of the two methods (annualizing method or rolling average method) specified under the definition of “Leak rate” found in § 84.102. These methods are similar to the methods used for ODS refrigerants (reference [paragraph 2.4.2](#) of this DAFPAM). Leak repairs are mandatory for any appliance with a leak rate that equals or exceeds a threshold listed in § 84.106(c) to include 30 percent for industrial process refrigeration appliances; 20 percent for commercial refrigeration appliances; and 10 percent for comfort cooling appliances, refrigerated transport appliances, or other refrigerant-containing appliances (not already listed) with a full charge of 15 or more pounds of refrigerant.

2.13.5.2. § 84.108 Automatic leak detection systems. Applies only to refrigerant-containing appliances used for industrial process refrigeration or commercial refrigeration with a full charge of 1,500 pounds or greater that were installed on or after January 1, 2017. The refrigerant must contain a regulated substance (as defined in § 84.3) or contain a substitute for a regulated substance that has a global warming potential greater than 53. § 84.108 contains details on the installation, auditing, and calibration of systems; system requirement to monitor components inside an enclosed building or structure; required system features to continuously monitor refrigerant concentrations, detect a concentration level of 10 parts per million, and alert the owner or operator when a refrigerant concentration of 100 parts per million of vapor of the specific refrigerant(s) used in the appliance(s) is reached; and requirements to maintain recordkeeping for at least three years, to include records on installation of the automatic leak detection system, auditing and calibration of the system, triggered alerts, and location of leaks.

2.13.6. DoD Policy. On 18 July 2022, the DoD issued a policy memorandum titled “*Establishment of Department of Defense Hydrofluorocarbon Allowance Management and Allocation Process per the American Innovation and Manufacturing Act.*” The memorandum states that the Department must transition to non-HFCs or lower exchange value HFCs where those alternatives can provide safe, suitable, and reliable national defense capabilities, recognizing some applications will not have such alternatives currently available. The memorandum also lists several actions the Department will need to take to comply with

requirements of the AIM Act and related EPA rule. Some of those items which may require installation-level involvement/input include, but are not limited to:

- 2.13.6.1. Coordinate with domestic manufacturers, importers, and suppliers to continually assess supply chain risk to mission-critical capabilities;
 - 2.13.6.2. Evaluate HFC quantities required to support of operational surge requirements and reduce supply chain risks that could result from single points of failure or dependence on foreign sources. Where appropriate, stockpile material for critical and strategic needs;
 - 2.13.6.3. Specify requirements for new equipment where HFC alternatives or lower exchange value HFCs can provide safe, suitable and reliable mission capabilities;
 - 2.13.6.4. Transition to non-HFC or lower exchange value HFC alternatives in existing equipment and military systems when those alternatives meet mission requirements, are cost effective, and are available from the domestic and allied industrial base;
 - 2.13.6.5. Prioritize the use of recycled and reclaimed HFCs instead of new production material, whenever economically, technically, and logistically feasible;
 - 2.13.6.6. Conserve existing installed HFCs by taking actions to reduce leakage and accidental discharge, and by recovering HFCs and making them available for reclamation and reuse.
- 2.13.7. 2016 Kigali Amendment to Montreal Protocol. The Kigali Amendment to the Montreal Protocol is an international agreement to gradually reduce the production and consumption of HFCs. The Kigali Amendment was adopted on 15 October 2016 (in Kigali, Rwanda) and became effective on 1 January 2019. On 31 October 2022 the United States became the 138th country to ratify the Kigali Amendment. The Amendment requires a phase down on the production and consumption of HFCs that is similar to the AIM Act.

Chapter 3

OPERATIONS MANAGEMENT

3.1. Equipment Replacement. There is no reason to make equipment replacement decisions based solely on the type of refrigerant used in an item of equipment; however, other factors must be considered when determining whether to retain or select equipment with a particular refrigerant. The most important selection criteria include equipment efficiency and condition. Based on past refrigerant phase-outs, refrigerant inventory and availability should not be an issue if existing refrigerants are recovered and reused as equipment is decommissioned. Therefore, with common refrigerants still available today, selection criteria should be heavily weighted towards equipment efficiency and condition factors.

3.1.1. AIM Act Impact on Equipment Replacement. Due to the planned phase down of HFCs, CE personnel responsible for planning for new or replacement equipment replacement should evaluate use of non-regulated refrigerants (non-ODS, non-HFC or ones with low exchange values) when selecting new or replacement units. Although the AIM Act does not currently prohibit certain kinds of refrigerants, the planned phase down of HFCs will drive prices for those substances higher as supplies decrease.

3.2. Refrigerant Leak Detection. Refrigerant leak detection is a key component of minimizing losses to the atmosphere. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 15-2022 requires appropriate detection in storage areas to protect the health of employees working in that mechanical space. Leaks are usually found in tubing, flanges, O-rings, and other connections. Gasket and O-ring improvements and better manufacturing techniques have significantly reduced leaks in AC/R equipment. An ongoing program for detecting leaks is the best solution for managing refrigerant losses during normal operations. This section introduces refrigerant leak-detection equipment and techniques.

3.2.1. The BCE must develop a leak detection program that matches individual AC/R equipment with a specific type of leak detection. The BCE should also develop an equipment leak-check schedule based on the equipment type and leak history and include it with the equipment's recurring work plan requirements. As more leaks occur, equipment checks need to be increased accordingly.

3.2.2. All leaks must be scheduled for repair. Leaks that exceed EPA-required action levels must be repaired within 30 days of discovery. Additional information and requirements for leak repairs is included in this DAFPAM (See [paragraph 2.4](#)).

3.2.3. The EPA now requires additional recurring leak inspections for equipment that has leaked. Adherence to this inspection schedule is required by law; information regarding these inspections can be found in this DAFPAM (See [paragraph 2.5](#)).

3.2.4. Leak Detection Tools. There are several methods available to pinpoint refrigerant leaks, ranging from soap bubbles, simple fluorescent dye, to sophisticated electronic sensors/detectors.

3.2.4.1. Fluorescent Dyes. Fluorescent dyes are used in refrigeration systems to detect leaks visible under ultraviolet (UV) light. Fluorescent dyes are available for all refrigerants

in use today. The dyes are placed in the refrigeration lubricant when the system is serviced. Select a dye compound compatible with the lubricating oil in the refrigeration system. Contact the refrigerant supplier for recommendations on appropriate dyes to ensure compatibility with the refrigerant. Leaks are detected by using a UV light to search for dye that has escaped from the system. The color of the dye when subjected to UV light is normally an easily visible bright green or yellow. Fluorescent dyes work very well because large areas can be rapidly checked by a single individual.

3.2.4.2. Electronic Detection Equipment with Sensors. The primary use of refrigerant detection using sensor-based systems is for life, safety, & health purposes. All common refrigerants are heavier than air and most are odorless. Released in a sufficient quantity, they can displace the air in a space and pose an asphyxiation hazard. Electronic refrigerant detection with alarms can warn occupants of this danger. A secondary use of electronic refrigerant detection systems is for use in EPA leak rate compliance. However, exercise caution before installing refrigerant detection systems for this purpose. In highly ventilated areas such as the outside environment or a mechanical room, the maximum refrigerant concentrations are likely to be lower than the sensor detection limit. Recommend an engineering analysis using the ASHRAE 62.1 IAQ procedure before installing refrigerant sensor systems for EPA leak rate compliance purposes. Electronic detection equipment belongs in one of the following categories according to selectivity criteria: (1) nonselective; (2) halogen-selective; (3) compound-specific.

3.2.4.2.1. Nonselective Sensors. These equipment sensors can detect any emission or vapor present, regardless of its chemical composition. Detectors in this category are based on electrical ionization, thermal conductivity, ultrasonic, or metal-oxide semiconductors. These detectors are simple to use, very rugged, and typically inexpensive. Nonselective sensors excel at pinpointing leak locations.

3.2.4.2.2. Halogen-Selective Sensors. Halogen-selective sensors use a specialized sensor that allows the monitor to detect compounds containing fluoride, chloride, bromide, and iodide without interference from other chemicals. These sensors reduce the number of false alarms generated by non-refrigerant compounds such as paint or gas fumes. These durable detectors are easy to use and have a higher sensitivity than nonselective detectors (detection limits are typically less than 5 parts per million [ppm]). The detector's partial specificity makes calibration easy.

3.2.4.2.3. Compound-Specific Sensors. Compound-specific sensors are complex and expensive. They can detect a single variety without suffering interference from other compounds. Compound-specific sensors are Infrared (IR)-based. Newer types are based on infrared-photo acoustic spectroscopy (IR-PAS). These have detection limits around 1 ppm, depending upon the compound detected.

3.2.4.3. Sensitivity. Most monitors will detect all halogen-based refrigerants, but their sensitivity varies with the specific refrigerant type. When calibrating monitors, choose the refrigerant for which the detector has the lowest sensitivity. For example, if the unit is monitoring a room that has both R-12 and R-22, choose R-12 when calibrating. Commonly used refrigerants can be divided into four groups based on their sensitivity levels:

3.2.4.3.1. Highest sensitivity: R-11, -22, -123

3.2.4.3.2. Moderate sensitivity: R-502

3.2.4.3.3. Low sensitivity: R-12, -500, -114

3.2.4.3.4. Lowest sensitivity: R-134a

3.2.4.4. Continuous Duty Area Monitors. Electronic detection equipment - used as area monitors - checks the refrigerant vapor level continuously in an equipment room or other locations where exposure is possible. Monitoring happens for several reasons: to protect personnel health and safety, conserve refrigerant, and protect valuable refrigeration equipment.

3.2.4.5. Monitor Characteristics. If a monitor continuously samples air inside an equipment room, it should have several capabilities that short-term or leak-checking monitors do not require. These include low 0-drift or an auto-zeroing capability and outputs for triggering external alarms that alert appropriate personnel. Long-term monitoring devices should remain stable inside the temperature, voltage, humidity, and barometric pressure ranges they will encounter. Continuous monitors should be refrigerant-specific to prevent nuisance alarms generated by untargeted compounds. Monitors with poor selectivity will react to compounds other than refrigerants, including cleaning agents or paints. They should require minimal maintenance.

3.2.4.6. Considerations for Sensor Selection. Typically, sensors last approximately two to five years from the installation date before a new sensor is required. As refrigerant detection takes place, the sensor loses some of its ability to detect refrigerant again. Sensor life is mostly determined by how much refrigerant it senses over time. Choose a sensor with a built-in calibration leak detector (a pre-programmed leak for a large selection of gases) to quickly verify the unit's calibration status. Recalibrate when necessary. To ensure accuracy, the calibrated leak is adjusted with unique electronics programmed into the sensor that correct for leak rate changes created by temperature fluctuations. Several sensor types are used in refrigerant-detection devices, but they can generally detect a wide range of refrigerants. Monitor sensitivity is tuned best for detecting a specific refrigerant. Even after tuning, a monitor will be sensitive to other common refrigerants. Manufacturers often publish cross-sensitivity charts that show how the monitor will react to various chemicals, including other refrigerants, if it is tuned to a specific refrigerant. If you know which refrigerants will be inside the equipment room, it is possible to choose a monitor calibration that will generate alarms at or below those refrigerants' threshold limit value – time-weighted average (TLV-TWA). If a proper calibration setting cannot be found, multiple detectors are needed. For example, a monitor set that detects R-123 would also detect R-134a at a level that would generate alarms for both refrigerants below their respective TLV-TWA.

3.2.5. Comparing Sensors and Fluorescent Dyes. [Table 3.1](#) provides considerations when comparing sensors and fluorescent dyes for selecting leak detection options.

Table 3.1. Comparison of Refrigerant Sensors and Fluorescent Dyes.

| Comments | Nonselective | Halogen-Selective | Compound-Specific | Fluorescent Dyes |
|-----------------------|--|---|---|--|
| Advantages | Simplicity Ruggedness | Simple/rugged Can be calibrated Good sensitivity Low maintenance | Low interference level Can be calibrated Good sensitivity | Low price Rapid detection |
| Disadvantages | Low detection limit Cross-sensitive Limited calibrated | Not compound-specific Detector lifetime Stability | Complex maintenance Stability questionable High price | Lube compatibility No sunlight use Not for area monitoring |
| Refrigerants detected | All CFCs HCFCs HFCs Blends (410A, 406, 407C) | All CFCs HCFCs HFCs Blends (410A, 406, 407C) | All CFCs HCFCs HFCs Blends (410A, 406, 407C) | All currently available refrigerants |
| Other | None | For single refrigerant use In moderately clean equipment rooms | Degraded in dirty environments Preferred type for multi-refrigerant environments | Potential lubricant compatibility issues |

3.3. Maintenance Practices and Equipment to Minimize Refrigerant Leaks From Air-Conditioning and Refrigeration Systems.

3.3.1. Compliance with Environmental Regulations. Compliance with environmental regulations is mandatory. Failure to comply with environmental regulations can result in civil or criminal penalties and fines being levied on both the installation as well as technicians. As of the date of this publication, the EPA is authorized to issue fines up to \$59,114 per non-compliance, per day (rate increases annual to account for inflation) and the total penalty cannot exceed \$472,901 unless EPA and the Department of Justice determine a greater penalty is appropriate. Information and recommendations for complying with EPA regulations is included in Chapter 2 of this DAFPAM.

3.3.2. Low-loss Fittings. Must be installed on all refrigeration servicing equipment used to connect to service ports on refrigeration equipment; e.g., gauges, recovery equipment, etc.

3.3.3. Refrigerant Recovery. Recovery is mandatory if the system will be opened to the atmosphere. If an equipment component that requires service is isolated, only the isolated equipment section needs to be evacuated. Information and recommendations on complying

with the associated environmental requirements is contained in this DAFPAM (See [paragraph 2.6](#)).

3.3.4. Refrigerant Reclamation. Refrigerant reclamation from a system undergoing repairs is not required in most cases. Reclamation is required if, for example, free water stands in the system due to a tube failure or because a motor burned out. Recovered refrigerants from the equipment must be reclaimed if ownership is transferred for use outside of the DAF. The DAF is considered a single owner, so reclamation is not necessary when performing inter-base transfers. If reclamation is required, the installation HAZMART will provide guidance on proper handling. Additional information specific to refrigerant reclamation can be found in this DAFPAM (See [paragraph 2.6.4](#)).

3.3.5. Refrigerant Recycling. Recycling means to extract and clean refrigerant from an appliance for reuse without meeting all the requirements for reclamation. In general, recycled refrigerant is refrigerant that is cleaned using oil separation and single or multiple passes through devices such as replaceable core filter-driers, which reduce moisture, acidity, and particulate matter. These procedures are usually implemented at the field job site. Recycling can be useful for drying refrigerants that contain moisture instead of water or for removing particulate matter prior to reuse.

3.4. Recovery Equipment. Appropriate and compliant recovery equipment must be utilized to meet the requirements of the inspection or maintenance task. Equipment must be certified and capable of meeting the levels of evacuation in [Table A2.5](#) of [Attachment 2](#) of this DAFPAM. Additional information regarding recovery equipment is included in this DAFPAM (See [paragraph 2.7](#)).

3.4.1. Equipment used to recover or transfer refrigerant between refrigeration units and storage cylinders must be operated in accordance with and meet the requirements contained in this DAFPAM (See [paragraph 2.7](#)).

3.4.2. New Equipment Evaluation Criteria. If the equipment cannot reach required evacuation levels or maintain purge-loss limits of less than 3 percent refrigerant/Non-Condensable Gas (NCG) for the total amount being recycled, it should be replaced with new equipment and the following criteria should be evaluated to acquire the appropriate item.

3.4.2.1. UL or AHRI certification.

3.4.2.2. Safety. Look for high-pressure, low-pressure, and high-temperature sensors for system safety shutdowns or lockouts.

3.4.2.3. Job function versatility.

3.4.2.4. Capacity of the container that holds the refrigerant during servicing.

3.4.2.5. Recovery rate (one hour maximum).

3.4.2.6. Fitting designed for low-loss.

3.4.2.7. Tanks: proprietary or non-proprietary.

3.4.2.8. Filter replacement prices.

3.5. Inspection and Maintenance Concepts.

3.5.1. Inspection Practices and Techniques.

3.5.1.1. Particulate Evaluation. Oil filters in refrigeration equipment are an important source of information. Technicians can spot debris trapped on the filter material, remove it, and send it to the spectrographic oil analysis laboratory to identify the sediments and further evaluate the system's condition. This evaluation can be just as important as testing the liquid oil sample. When laboratory analysis of chiller oil is required, select a qualified laboratory that can perform a full range of tests.

3.5.1.1.1. Dielectric strength measures a fluid's insulating ability. A low value can indicate water or other conducting compounds.

3.5.1.1.2. A fluid's color can indicate contaminants and system operating conditions.

3.5.1.1.3. The interfacial tension analysis indicates whether compounds with a strong affinity for water are present.

3.5.1.2. Spectrographic Oil Analysis. Laboratory analysis of chiller oil is a method of analyzing the mechanical condition of equipment and pinpoints locations when tear-down and visual inspections are required. A spectrographic oil analysis is inexpensive and typically has a quick turn-around time. Before obtaining an oil sample for analysis, a chiller must operate for at least one hour; otherwise, any metals in the oil will not have enough time to be re-entrained from the machine bottom and will go undetected during analysis. With a complete and accurate laboratory oil analysis, testing system correction recommendations will become more reliable.

3.5.1.2.1. Analysis of Metal Content. Chiller oil spectrographic analysis shows the oil's metal content and should indicate the possible source of the metal. Elements typically discovered during analyses and available sources are listed in [Table 3.2](#).

3.5.1.2.2. Recording Analysis Results. Oil analysis results should be included in the maintenance history. In many cases, rapid changes in values may indicate more problems than the value's magnitude at any given point in time. In fact, the real strength of spectrographic analysis is the ability to spot excessive wear rates indicated by rapidly increasing concentrations of the elements listed in [Table 3.2](#) relative to the number of operating hours between samples. To properly spot these trends, the analytical laboratory performing the tests must have historical test data.

Table 3.2. Oil Analysis Elements Possible and Sources.

| Element | Possible Sources |
|-------------------|------------------------------------|
| Iron | Shell/supports/cylinder/tube sheet |
| Chromium | Rings/cylinder/crankshaft |
| Nickel | Tubes/crankshaft |
| Aluminum | Pistons/bearings/impeller |
| Lead/tin | Bearings |
| Copper | Bearings/tubes/oil lines |
| Silver | Solder/cooler |
| Silicon | Dirt/sealant/coolant |
| Boron | Additive/coolant |
| Sodium | Brine/coolant |
| Potassium | Additive |
| Zinc | Anti-wear additive |
| Calcium/Magnesium | Brine/detergent additive |
| Barium | Detergent additive |

3.5.1.2.3. Eddy Current Tube-Testing. Eddy current tube testing measures the thickness of the tube as the probe passes from one end to the other. This method can identify potential leak areas before they occur. It can prevent unscheduled chiller downtime, lost production, lost cooling, major chiller damage, and refrigerant charge contamination. Refrigerant contaminated with water in-leak requires reclamation. To protect the refrigerant charge, a chiller requires eddy current tube-testing at least once every three years.

3.5.2. Service Practices.

3.5.2.1. Before opening a system, technicians should clearly understand the type of service work required. Previous service records should be part of the work order package but can be obtained from the service records or operating logs. This information should be used to develop a work plan that ensures refrigerant losses are minimal and identifies areas to check for possible leaks.

3.5.2.2. Proper servicing practices require that refrigerants be isolated from the environment to the greatest extent possible. The following actions must happen at every servicing:

3.5.2.2.1. Detailed descriptions of service practices required by law are contained in Chapter 2 of this DAFPAM.

3.5.2.2.2. Equipment must be evacuated in accordance with the requirements outlined in **paragraph 2.5** of this DAFPAM. Required evacuation levels are contained in **Table A2.5** of **Attachment 2** of this DAFPAM.

3.5.2.2.3. Upon completion of servicing and maintenance, return the unit to proper operating charge level.

3.5.2.2.4. Document in detail actions taken during service as required in this DAFPAM (See **paragraph 2.10**).

3.5.2.3. Low-Pressure System Maintenance. Because low-pressure systems can be under a vacuum when they are not in operation, the EPA requires those systems undergoing minor servicing, such as oil changes, to be pressurized to atmospheric pressure. One of the following systems must be utilized to achieve proper pressure.

3.5.2.3.1. Blanket Heater. The most common pressurization system is an electric-resistant blanket heater installed between the evaporator's outer shell and its insulation jacket. Because it is mounted on the underside of the shell, it is commonly known as a belly heater. Typically, temperature or pressure sensors monitor the condenser conditions and control the blanket heater. To prevent system over-pressurization and refrigerant loss, temperature and pressure sensors should be checked before energizing the blanket heater.

3.5.2.3.2. Water Heater/Pump. This system type uses a small electric water heater and circulating pump package. It heats and circulates water through the evaporator tubes to raise the refrigerant temperature and system pressure. Before beginning the heating process, isolate the evaporator from the distribution piping system. The heat added to the water is typically controlled by monitoring the water temperature once it has left the evaporator. To prevent system over-pressurization and any resulting refrigerant loss, the temperature sensor should be checked before starting the water heater/pump system.

3.5.2.4. Servicing Purge Systems.

3.5.2.4.1. Most purge systems require regular service: purge tanks and oil separators must be cleaned; gasket materials must be renewed; purge compressors must be overhauled. Servicing should be performed according to the purge system manufacturer's guidelines. To open the purge system for service, isolate it from the chiller refrigeration system and recover the refrigerant from the purge unit. To provide a convenient, efficient means of accomplishing this on an ongoing basis, permanent access and isolation valves should be installed in the system whenever a new high-efficiency unit is introduced.

3.5.2.4.2. Purge runtime should be monitored and recorded. Many manufacturers suggest that purge systems operating in excess of one hour of runtime per week indicate excessive loss.

3.5.2.5. Isolate equipment subcomponents for service and repair by installing isolation valves. Replace missing system connections and refrigerant cylinder caps.

3.5.2.6. Oil should not be changed arbitrarily; instead, oil samples should be checked for contamination on a regular, scheduled basis. If contamination is present, it may indicate the need for oil and filter change. These tasks must be completed with minimal refrigerant loss. An oil sample port and isolation valves should be installed around the filter when the unit is first serviced. Change oil filters at intervals more frequently than required by manufacturers' recommendations or as indicated by spectrographic oil analyses.

3.5.2.7. Refrigeration gauge sets should be rebuilt, if necessary, with new seals, valve seats, and packing to reduce refrigerant losses. Additional features that reduce refrigerant loss include:

3.5.2.7.1. Quick-connect/low loss hose fittings.

3.5.2.7.2. Four-valve manifolds to reduce hose and manifold refrigerant purging amounts.

3.5.2.7.3. Quality, high-strength hoses to prevent ruptures.

3.5.2.7.4. Separate refrigeration gauge sets for each refrigerant that will prevent cross-contamination.

3.5.2.8. A vital element of a successful preventive maintenance program that minimizes emissions is a regularly scheduled chiller tube-testing program. It ensures tube integrity and efficiency and can provide early warnings.

3.5.3. Refrigerant Exposure. Refrigerants handled in accordance with the manufacturer's recommended exposure limits pose no acute or chronic inhalation toxicity hazard. For questions, contact your local Bioenvironmental Engineering or Safety Office as appropriate. ASHRAE 34 defines two safety classifications for toxicity. Class A denotes refrigerants of lower toxicity, and class B denotes refrigerants of higher toxicity. The toxicity class codes for select refrigerants are listed in the refrigerant physical properties table in [Attachment 2 \(Table A2.6\)](#).

3.5.4. Flammability Precautions.

3.5.4.1. Typical AC/R refrigerants are nonflammable and non-explosive. However, mixing refrigerants with liquids or gases that are oxidizers (such as air) can result in a flammable mixture. Therefore, refrigerants should never be mixed with any oxidizing gas or liquid. Additionally, refrigerants should not be exposed to open flames or electrical heating elements. Though most refrigerants are not flammable at ambient temperatures and atmospheric pressure, tests have shown some types to be combustible at pressures as low as 5.5 psig at 351 °F when mixed with air at volumetric concentrations of generally more than 60 percent air. At lower temperatures, higher pressures are required for combustibility. Refrigerants should not be used or allowed to be present with high concentrations of air above atmospheric pressure. Refrigerants that are considered flammable are assigned one of the following ASHRAE 34 class codes: 2L (lower flammability - mild), 2 (lower

flammability), or 3 (higher flammability). The flammability class codes for select refrigerants are listed in the refrigerant physical properties table in [Attachment 2 \(Table A2.6\)](#).

3.5.4.2. Several of the expected replacements for current HFC stationary equipment are rated as ASHRAE 34 class 2L (lower flammability - mild). When installing this replacement equipment, building codes may require minimum square footage, leak monitoring, or ventilation requirements for the mechanical room that did not apply to the legacy HFC equipment.

3.5.4.3. When storing Safety Group A2, B2, A3, and B3 refrigerants, the room must meet requirements of the National Fire Protection Association (NFPA) 70, National Electrical Code (NEC), Class I, Division I. Per ASHRAE 15-2022, the total of all Groups A2, B2, A3, and B3 refrigerants other than R-717 (ammonia), must not exceed 1100 pounds without approval by the authority having jurisdiction.

3.6. Disposable and Reusable Refrigerant Cylinders. Refrigerants are contained in disposable and reusable shipping containers or cylinders. Since the refrigerant-containing cylinders can be pressurized, they are considered pressure vessels. They must comply with Federal and State laws regulating transportation and usage of such containers. Specific guidance on the storage and handling of refrigerant cylinders is found in DLAI 4145.25, *Storage and Handling of Liquefied and Gaseous Compressed Gasses and their Full and Empty Cylinders*. Coordinate all movements with the installation HAZMART for current guidance on shipping and disposal procedures.

3.6.1. Identifying Containers. 2017 revisions to AHRI Guideline N, *Assignment of Refrigerant Container Colors*, specified that all refrigerant containers should have one uniform paint color, a light-green/grey (RAL 7044), and that existing individually assigned container paint colors should be transitioned to the new standard color by 2020. Guideline N previously stipulated that specific paint colors be used for refrigerant containers as an additional means of refrigerant identification. However, with the increasing number of refrigerants approved for use, there was concern over the potential misidentification of similarly colored containers. Refrigerant users should be aware that the label will now serve as the primary means of positively identifying the type of refrigerant in a cylinder or drum. Flammable refrigerants must continue to include a red band on the top of the container.

3.6.2. Disposable Refrigerant Cylinders. Disposable cylinders will be stored in dry locations to prevent corrosion and transported carefully to prevent abrasion of painted surfaces. They are not to be refilled. When the cylinder is empty, ensure all pressure is released to 0 psi. The cylinders should be rendered useless for any purpose by breaking off the valve or puncturing the cylinder. After the cylinder has been rendered incapable of containing any compressed gas under pressure, it must be disposed of as scrap metal. See [paragraph 2.9](#) of this DAFPAM for additional information regarding material disposal.

3.6.3. Transportation, Labels, and Markings (DOT Requirements). Questions regarding proper transportation, labeling, and markings of refrigerant cylinders can be answered by the installation Environmental Element.

3.7. Replacement and Disposal of Refrigerant and Refrigerant Oils. Refrigerants and refrigerant oils must be managed in accordance with EPA requirements. See [paragraph 2.9](#) of this DAFPAM for recommendations on complying with those legal requirements.

3.7.1. Oil Replacement. When oil analysis indicates that the refrigerant oil should be replaced, use the appropriate recovery system to remove the refrigerant for reuse in accordance with [paragraph 2.9](#) of this DAFPAM. It is a violation of Federal law to perform an oil change on a refrigeration system that has a pressure of greater than 5 psig. Used refrigerant oil must be properly managed and may or may not require disposal as a hazardous waste. Coordinate all disposal actions with the installation Environmental Element.

3.7.2. Refrigerant Replacement. Non-contaminated refrigerant remaining on the installation can be returned to any AC/R equipment on the installation with no other action. Any contaminated refrigerants must be coordinated through the installation HAZMART and Environmental Element for proper recycling, reclamation, or disposal, as appropriate for the level of contamination. Records of refrigerant sent for reclamation or disposal must be retained in accordance with [paragraph 2.10](#) of this DAFPAM.

3.8. Documentation. During and after service and inspections of equipment technicians, must record all data required for the work order, including the amount of refrigerant serviced, amount reused, amount of refrigerant added, observations of the overall condition of system equipment, and potential leak areas. Ensure all refrigerant actions are properly documented and entered into APIMS. See [paragraph 2.10](#) of this DAFPAM for information regarding recordkeeping requirements.

Record cost of any material expensed within the approved AF IT System (e.g., NexGen IT). When managed by Actual Time Accounting (ATA) Workgroup members, record their labor as appropriate within the AF IT System.

3.9. Physical Properties of Refrigerants. A table of physical properties for select refrigerants has been included as [Table A2.6](#) in [Attachment 2](#) of this DAFPAM for reference.

3.10. Additional References. Additional references are provided as suggested sources where more in-depth information can be found: AHRI 740-2016, *Performance Rating of Refrigerant Recovery Equipment and Recovery/Recycling Equipment*; 40 CFR Part 82, Subpart F, *Recycling and Emissions Reduction*; ANSI/ASHRAE Standard 147-2019, *Reducing the Release of Halogenated Refrigerants from Refrigerating and Air-Conditioning Equipment and Systems*.

Attachment 1**GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION*****References***

42 USC §§ 7401-7671q, *Clean Air Act (CAA)*

42 USC § 7675, *American Innovation and Manufacturing Act of 2020*

Public Law 116-260, *Consolidated Appropriations Act, 2021*, Section 103, *American Innovation and Manufacturing Act of 2020*

40 CFR Part 82, *Protection of Stratospheric Ozone*

40 CFR Part 84, *Phasedown of Hydrofluorocarbons*

49 CFR § 178.65, *Specification 39 non-reusable (non-refillable) cylinders*

Department of Defense policy memorandum, *Establishment of Department of Defense Hydrofluorocarbon Allowance Management and Allocation Process per the American Innovation and Manufacturing Act*, 18 July 2022

Department of Defense procedure memorandum, *Department of Defense Ozone Depleting Substances Customer Turn-in Procedures*, December 2023

AFPD 32-10, *Installations and Facilities*, 20 July 2020

AFPD 32-70, *Environmental Considerations in Air Force Programs and Activities*, 30 July 2018

AFI 25-201, *Intra-Service, Intra-Agency, and Inter-Agency Support Agreements Procedures*, 18 October 2013

AFI 33-322, *Records Management and Information Governance Program*, 23 March 2020

DAFI 90-160, *Publications and Forms Management*, 14 April 2022

DAFMAN 90-161, *Publishing Processes and Procedures*, 18 Oct 2023

AFMAN 32-7002, *Environmental Compliance and Pollution Prevention*, 4 February 2020

DLAI 4145.25, *Storage and Handling of Liquefied and Gaseous Compressed Gasses and Their Full and Empty Cylinders*, 16 June 2000

AHRI 700-2019, *Specification for Refrigerants*, 2019

AHRI 740-2016, *Performance Rating of Refrigerant Recovery Equipment and Recovery/Recycling Equipment*, 2016

AHRI Guideline N-2017, *Assignment of Refrigerant Container Colors*, 2017

ANSI/ASHRAE Standard 147-2019, *Reducing the Release of Halogenated Refrigerants from Refrigerating and Air-Conditioning Equipment and Systems*, 2019

ANSI/ASHRAE Standard 15-2022, *Safety Standard for Refrigeration Systems*, 2022

ANSI/ASHRAE Standard 34-2022, *Designation and Safety Classification of Refrigerant*, 2022

NFPA 70, *National Electrical Code (NEC)*, 2023

Prescribed Forms

None

Adopted Forms

None

Abbreviations and Acronyms

AC/R—Air-conditioning and refrigeration

AFCEC—Air Force Civil Engineer Center

AFIMSC—Air Force Installation and Mission Support Center

AFMAN—Air Force Manual

AFPD—Air Force Policy Directive

AFRC—Air Force Reserve Command

AFSC—Air Force Specialty Code

AHRI—Air-Conditioning, Heating, and Refrigeration Institute (formerly ARI)

AIM Act—American Innovation and Manufacturing Act of 2020

ANG—Air National Guard

ANSI—American National Standards Institute

APIMS—Air Program Information Management System

ARI—Air-Conditioning and Refrigeration Institute or American Refrigeration Institute (now AHRI)

ASHRAE—American Society of Heating, Refrigerating and Air-Conditioning Engineers

BCE—Base Civil Engineer

BEE—Bioenvironmental Engineering

BOS—Base operations support

CAA—Clean Air Act

CAAA—Clean Air Act Amendments

CAC—Common Access Card

CAS—Chemical Abstracts Service

CE—Civil Engineering

CFC—Chlorofluorocarbon

CFR—Code of Federal Regulations

CO₂—carbon dioxide

DAFI—Department of the Air Force Instruction

DAFPAM—Department of the Air Force Pamphlet

°C / °F—degrees Celsius / degrees Fahrenheit

DLA—Defense Logistics Agency

DLAI—Defense Logistics Agency Instruction

DoD—Department of Defense

DOT—Department of Transportation

EPA—Environmental Protection Agency

EV— Exchange Value

EVe—Exchange Value Equivalent

FGS—Final Governing Standards

GOCO—Government Owned Contractor Operated

GSUs—Geographically-Separated Units

GWP— Global Warming Potential

HAZMART—Hazardous Materials Pharmacy

HC—Hydrocarbon

HCFC—Hydrochlorofluorocarbon

HFC—Hydrofluorocarbon

Hg—Mercury

HMMP—Hazardous Materials Management Program

HVAC—heating, ventilating, and air-conditioning

IAW—In Accordance With

IDLH—Immediately Dangerous to Life and Health

IPR—Industrial Process Refrigeration

IR—Infrared

IR-PAS—Infrared-photo acoustic spectroscopy

IT—Information Technology

kgEVe—Kilograms of Exchange Value Equivalent

lb/yr—pound per year

lb—pound

LR/LR%Ann/LR%Roll—Loss Rate; Loss Rate percentage annualized; Loss Rate percentage rolling average

MAJCOM—Major Command

MCMEU— Mission-Critical Military End Uses

mm—millimeter

MMTEVe—Million Metric Tons of Exchange Value Equivalent

MTEVe—Metric Tons of Exchange Value Equivalent

MVAC—Motor Vehicle Air-Conditioning

NCG—non-condensable Gas

NEC—National Electric Code

NFPA—National Fire Protection Association

O&M—Operation & Maintenance

ODP—Ozone Depletion Potential

ODS—ozone-depleting substances

OEBGD—Overseas Environmental Baseline Guidance Document

OEL—Occupational Exposure Limit

OSHA—Occupational Safety and Health Administration

PII—Personally Identifiable Information

ppm—parts per million

psi—pounds per square inch

psia—pounds per square inch absolute

psig—pound per square inch gauge

PSU—Primary Subordinate Unit

RACHP—Refrigeration, Air Conditioning, and Heat Pump

RPIE—real property installed equipment

RPSE—real property similar equipment

SDS—Safety Data Sheet

SNAP—Significant New Alternatives Policy

STEL—Short-Term Exposure Limit

TLV—Threshold Limit Value

TLV-TWA—Threshold Limit Value – Time-Weighted Average

UL—Underwriters' Laboratory

UNEP—United Nations Environment Programme

USNO—United States Naval Observatory

UV—ultraviolet

wt—weight

Office Symbols

AF/A4C—HQ USAF, Deputy Chief of Staff for Logistics, Engineering, and Force Protection, Directorate of Civil Engineers

AFCEC/CZ—Air Force Civil Engineer Center, Environmental Directorate

AFRC/A4CA—Air Force Reserve Command, Environmental and Asset Accountability Branch

Terms

Appliance—Any device that contains and uses a refrigerant and is used for household or commercial purposes, including any air conditioner, refrigerator, chiller, or freezer. For a system with multiple circuits, each independent circuit is considered a separate appliance for the purposes of environmental compliance (Also see 40 CFR § 82.152 Definitions.).

Comfort Cooling—Per 40 CFR § 82.152, air-conditioning appliances used to provide cooling in order to control heat and/or humidity in occupied facilities including but not limited to residential, office, and commercial buildings. Comfort cooling appliances include but are not limited to chillers, commercial split systems, and packaged roof-top units.

Commercial Refrigeration—Per 40 CFR § 82.152, commercial refrigeration means the refrigeration appliances used in the retail food and cold storage warehouse sectors. Retail food appliances include the refrigeration equipment found in supermarkets, convenience stores, restaurants and other food service establishments. Cold storage includes the refrigeration equipment used to store meat, produce, dairy products, and other perishable goods.

Consumption Rate (CR)—The annual rate at which a refrigerant is lost to leaks and emissions, typically expressed in pounds per year (lb/yr).

De minimis Refrigerant Release—Releases associated with good-faith attempts to recycle or recover refrigerants or non-exempt substitutes as defined in 40 CFR § 82.154(a)(2) and are not subject to the intentional venting prohibition.

Disposal—(1) The process leading to appliance disassembly where the appliance components are reused; (2) The disassembly of any appliance for discharge, deposit, dumping, or placing of its discarded component parts into or on any land or water; (3) The discharge, deposit, dumping, or placing of any discarded appliance into any land or water (Also see 40 CFR § 82.152 Definitions).

Exchange Value—The value assigned to a regulated substance in accordance with AIM Act subsections (c) and (e), as applicable.

Exchange Value Equivalent—A term used by the EPA to provide a common unit of measure between HFCs. Exchange Value Equivalent is determined by multiplying the mass of a regulated substance by the exchange value of that substance. For example, 50 kilograms of HFC-134a would be 71,500 kgEVe ($50 \times 1,430$). This can also be written as 71.5 metric tons of exchange value equivalent (MTEVe) since 1,000 kilograms equals 1 metric ton.

Exempt Substitute Refrigerant—As defined in 40 CFR § 82.154(a)(1), an exempt substitute refrigerant is a substance that is not subject to the venting prohibition or any other provision of Section 608 of the Clean Air Act. A list of exempt substitute refrigerants is contained in [Attachment 2, Table A2.3](#) of this DAFPAM.

Follow-up Verification Test—Per 40 CFR § 82.156(i), tests that involve checking the repairs to an appliance after a successful initial verification test and after the appliance has returned to normal operating characteristics and conditions to verify that the repairs were successful. Potential methods for follow-up verification tests include, but are not limited to, the use of soap bubbles as appropriate, electronic, or ultrasonic leak detectors, pressure, or vacuum tests, fluorescent dye, and black light, infrared or near infrared tests, and handheld gas detection devices.

Full Charge— Per 40 CFR § 82.152, the amount of refrigerant required for normal operating characteristics and conditions of the appliance as determined by using one or a combination of the following four methods: (1) Use the equipment manufacturer's determination of the correct full charge for the equipment; (2) Determine the full charge by making appropriate calculations based on component sizes, density of refrigerant, volume of piping, and other relevant considerations; (3) Use actual measurements of the amount of refrigerant added or evacuated from the appliance; and/or (4) Use an established range based on the best available data regarding the normal operating characteristics and conditions for the appliance, where the midpoint of the range will serve as the full charge and where records are maintained.

High-Pressure Appliance—Per 40 CFR § 82.152, an appliance that uses a refrigerant with a liquid phase saturation pressure between 170 psia [pounds per square inch absolute] and 355 psia

at 104 °F. Examples include but are not limited to appliances using R-22, R-407A, R-407C, R-410A, and R-502.

Household Refrigeration—Refrigerators and freezers intended primarily for household/small work center use. This equipment may be used outside the home and can be found in shops and work centers.

Industrial Process Refrigeration—Per 40 CFR § 82.152, complex customized appliances directly linked to the processes used in, for example, the chemical, pharmaceutical, petrochemical, and manufacturing industries. This sector also includes industrial ice machines, appliances used directly in the generation of electricity, and ice rinks. Where one appliance is used for both industrial process refrigeration and other applications, it will be considered industrial process refrigeration equipment if 50 percent or more of its operating capacity is used for industrial process refrigeration.

Industrial Process Shutdown— Per 40 CFR § 82.152, when an industrial process or facility temporarily ceases to operate or manufacture whatever is being produced at that facility.

Initial Verification Test—Per 40 CFR § 82.152, leak tests conducted after the repair is finished to verify that a leak or leaks have been repaired before refrigerant is added back to the appliance.

Leak Inspection—Per 40 CFR § 82.152, means the examination of an appliance to determine the location of refrigerant leaks. Potential methods include, but are not limited to, ultrasonic tests, gas-imaging cameras, bubble tests as appropriate, or the use of a leak detection device operated and maintained according to manufacturer guidelines. Methods that determine whether the appliance is leaking refrigerant but not the location of a leak, such as standing pressure/vacuum decay tests, sight glass checks, viewing receiver levels, pressure checks, and charging charts, must be used in conjunction with methods that can determine the location of a leak.

Leak Rate—The rate at which an appliance is losing refrigerant, measured between refrigerant charges. See [paragraph 2.4.1](#) of this DAFPAM for additional information.

Low-Loss Fitting— Per 40 CFR § 82.152, any device intended to establish a connection between hoses, AC/R equipment, or recovery or recycling equipment that will close automatically or must be manually closed before disconnecting, thereby minimizing the release of refrigerant to the atmosphere.

Low-Pressure Appliance— Per 40 CFR § 82.152, an appliance that uses a refrigerant with a liquid phase saturation pressure below 45 psia at 104 °F. This definition includes, but is not limited to, appliances using R-11, R-123, and R-113.

Major Maintenance, Service, or Repair— Per 40 CFR § 82.152, any maintenance, service, or repair that involves removing the compressor, condenser, evaporator, or auxiliary heat exchanger coil; or any maintenance, service, or repair that involves uncovering an opening of more than 4 square inches of “flow area” for more than 15 minutes.

Medium-pressure Appliance— Per 40 CFR § 82.152, an appliance that uses a refrigerant with a liquid phase saturation pressure between 45 psia and 170 psia at 104 °F. This definition includes, but is not limited to, appliances using R-114, R-124, R-134a, R-12, and R-500.

Mission-Critical Military End Uses (MCMEU)—One of six applications for which the AIM Act requires end users to obtain HFC allowance allocations. Mission-Critical Military End Uses are those uses of regulated substances by an agency of the Federal Government responsible for national defense which have a direct impact on mission capability, as determined by the U.S. Department of Defense (DOD), including but not limited to uses necessary for development, testing, production, training, operation, and maintenance of Armed Forces vessels, aircraft, space systems, ground vehicles, amphibious vehicles, deployable/expeditionary support equipment, munitions, and command and control systems.

Non-condensable Gas (NCG)—Gases, which are primarily air, other than the refrigerant in the cooling system. DAF cooling equipment uses purge units to automatically purge NCGs when the acceptable level is exceeded.

Non-Exempt Substitute Refrigerant—A refrigerant that does not contain a Class I or Class II substance and has not been exempted from regulation by the EPA.

Opening an Appliance— Per 40 CFR § 82.152, means any maintenance, service, repair, or disposal of an appliance that would release any refrigerant in the appliance to the atmosphere. Connecting and disconnecting hoses and gauges to measure pressures, add refrigerant, or recover refrigerant from the appliance are not considered “opening an appliance.”

Purge Units—Purge units are used with low-pressure chillers and refrigerant recovery equipment to remove non-condensable material that entered the system. All low-pressure chillers (R-11 or R-123) should have high-efficiency purges, with capability to process discharges of 0.7 to 1 pound-refrigerant per pound-NCG. High-efficiency purge units allow non-condensable material to be vented while leaking very little refrigerant.

Reclaim Refrigerant—To reprocess, purify, test, and certify used refrigerant to all of the specifications in Appendix A of 40 CFR Part 82, Subpart F (based on AHRI Standard 700-2019, *Specifications for Refrigerants*), that are applicable to that refrigerant and to verify that the refrigerant meets these specifications using the analytical methodology prescribed in Section 5 of Appendix A of 40 CFR Part 82, Subpart F (Also see 40 CFR § 82.152 Definitions).

Recover Refrigerant—To remove refrigerant in any condition from an appliance and to store it in an external container without necessarily testing or processing it in any way (Also see 40 CFR § 82.152 Definitions).

Recycle Refrigerant—To extract and clean refrigerant from an appliance for reuse without meeting all of the requirements for reclamation. In general, recycled refrigerant is refrigerant that is cleaned using oil separation and single or multiple passes through devices such as replaceable core filter-driers, which reduce moisture, acidity, and particulate matter. These procedures are usually implemented at the field job site (Also see 40 CFR § 82.152 Definitions).

Refrigerant—Any substance consisting in part or whole of a Class I or Class II ODS or an EPA-approved substitute, used in a heat cycle that undergoes a phase change between gas and liquid to provide a cooling effect; as in refrigerators, air conditioners, etc., (Also see 40 CFR § 82.152 Definitions).

Refrigerant Circuit— Per 40 CFR § 82.152, parts of an appliance that are normally connected to each other (or are separated only by internal valves) and are designed to contain refrigerant.

Self-contained Recovery Equipment— Per 40 CFR § 82.152, refrigerant recovery or recycling equipment that is capable of removing the refrigerant from an appliance without the assistance of components contained in the appliance.

Small Appliance— Per 40 CFR § 82.152, any appliance that is fully manufactured, charged, and hermetically sealed in a factory with 5 pounds or less of a Class I, Class II substance or substitute refrigerant, including, but not limited to, refrigerators and freezers (designed for home, commercial, or consumer use), medical or industrial research refrigeration equipment, room air conditioners (including window air conditioners and packaged terminal air heat pumps), dehumidifiers, under-the-counter ice makers, vending machines, and drinking water coolers.

Substitute Refrigerant—Any chemical or product, whether existing or new, used by any person as an EPA-approved replacement for a Class I or II ODS in a given refrigeration or air-conditioning end-use (Also see 40 CFR § 82.152 Definitions).

Technician— Per 40 CFR § 82.152, any person who maintains, services, or repairs AC/R equipment that could reasonably be expected to release refrigerants to the atmosphere. Must be certified by the EPA.

Very High-Pressure Appliance—Per 40 CFR § 82.152, AC/R equipment that uses a refrigerant with a critical temperature below 104 °F or with a liquid phase saturation pressure above 355 psia at 104 °F. This definition includes, but is not limited to, appliances using R-13, R-23, R-503, R-508A, and R-508B.

Attachment 2

REFRIGERANT TABLES

Table A2.1. Listing of Class I Compounds Used as Refrigerants.

| Name | Chemical Formula | Technical Name | CAS Number |
|---------|---|--------------------------------|------------|
| CFC-11 | CCl ₃ F | Trichlorofluoromethane | 75-69-4 |
| CFC-12 | CCl ₂ F ₂ | Dichlorodifluoromethane | 75-71-8 |
| CFC-113 | C ₂ F ₃ Cl ₃ | 1,1,2-Trichlorotrifluoroethane | 76-13-1 |
| CFC-114 | C ₂ F ₄ Cl ₂ | Dichlorotetrafluoroethane | 76-14-2 |
| CFC-115 | C ₂ F ₅ Cl | Monochloropentafluoroethane | 76-15-3 |
| CFC-13 | CF ₃ Cl | Chlorotrifluoromethane | 75-72-9 |
| CFC-111 | C ₂ FCl ₅ | Pentachlorofluoroethane | 354-56-3 |
| CFC-112 | C ₂ F ₂ Cl ₄ | Tetrachlorodifluoroethane | 76-12-0 |
| CFC-211 | C ₃ FCl ₇ | Heptachlorofluoropropane | 422-78-6 |
| CFC-212 | C ₃ F ₂ Cl ₆ | Hexachlorodifluoropropane | 3182-26-1 |
| CFC-213 | C ₃ F ₃ Cl ₅ | Pentachlorotrifluoropropane | 165977 |
| CFC-214 | C ₃ F ₄ Cl ₄ | Tetrachlorotetrafluoropropane | 29255-31-0 |
| CFC-215 | C ₃ F ₅ Cl ₃ | Trichloropentafluoropropane | 4259-43-2 |
| CFC-216 | C ₃ F ₆ Cl ₂ | Dichlorohexafluoropropane | 661-97-2 |
| CFC-217 | C ₃ F ₇ Cl | Chloroheptafluoropropane | 422-86-6 |

Table A2.2. Listing of Class II Compounds Used as Refrigerants.

| Name | Chemical Formula | Technical Name | CAS Number |
|-----------|--|-----------------------------|------------|
| HCFC-21 | CHFCl ₂ | Dichlorofluoromethane | 75-43-4 |
| HCFC-22 | CHF ₂ Cl | Monochlorodifluoromethane | 75-43-6 |
| HCFC-31 | CH ₂ FCl | Monochlorofluoromethane | 593-70-4 |
| HCFC-121 | C ₂ HFCl ₄ | Tetrachlorofluoroethane | 354-14-3 |
| HCFC-122 | C ₂ HF ₂ Cl ₃ | Trichlorodifluoroethane | 354-21-2 |
| HCFC-123 | C ₂ HF ₃ Cl ₂ | Dichlorotrifluoroethane | 306-83-2 |
| HCFC-124 | C ₂ HF ₄ Cl | Monochlorotetrafluoroethane | 2837-89-0 |
| HCFC-131 | C ₂ H ₂ FCl ₃ | Trichlorofluoroethane | 359-28-4 |
| HCFC-132b | C ₂ H ₂ F ₂ Cl ₂ | Dichlorodifluoroethane | 1649-08-7 |
| HCFC-133a | C ₂ H ₂ F ₃ Cl | Monochlorotrifluoroethane | 75-88-7 |
| HCFC-141b | C ₂ H ₃ FCl ₂ | Dichlorofluoroethane | 1717-00-6 |
| HCFC-142b | C ₂ H ₃ F ₂ Cl | Monochlorodifluoroethane | 75-68-3 |
| HCFC-221 | C ₃ HFCl ₆ | Hexachlorofluoropropane | 422-26-4 |
| HCFC-222 | C ₃ HF ₂ Cl ₅ | Pentachlorodifluoropropane | 422-49-1 |
| HCFC-223 | C ₃ HF ₃ Cl ₄ | Tetrachlorotrifluoropropane | 422-52-6 |
| HCFC-224 | C ₃ HF ₄ Cl ₃ | Trichlorotetrafluoropropane | 422-54-8 |

| Name | Chemical Formula | Technical Name | CAS Number |
|-------------|-------------------------|------------------------------|-------------------|
| HCFC-225ca | C3HF5Cl2 | Dichloropentafluoropropane | 422-56-0 |
| HCFC-225cb | C3HF5Cl2 | Dichloropentafluoropropane | 507-55-1 |
| HCFC-226 | C3HF6Cl | Monochlorohexafluoropropane | 431-87-8 |
| HCFC-231 | C3H2FCl5 | Pentachlorofluoropropane | 421-94-3 |
| HCFC-232 | C3H2F2Cl4 | Tetrachlorodifluoropropane | 460-89-9 |
| HCFC-233 | C3H2F3Cl3 | Trichlorotrifluoropropane | 7125-84-0 |
| HCFC-234 | C3H2F4Cl2 | Dichlorotetrafluoropropane | 425-94-5 |
| HCFC-235 | C3H2F5Cl | Monochloropentafluoropropane | 460-92-4 |
| HCFC-241 | C3H3FCl4 | Tetrachlorofluoropropane | 666-27-3 |
| HCFC-242 | C3H3F2Cl3 | Trichlorodifluoropropane | 460-63-9 |
| HCFC-243 | C3H3F3Cl2 | Dichlorotrifluoropropane | 460-69-5 |
| HCFC-244 | C3H3F4Cl | Monochlorotetrafluoropropane | 134190-50-4 |
| HCFC-251 | C3H4FCl3 | Monochlorotetrafluoropropane | 421-41-0 |
| HCFC-252 | C3H4F2Cl2 | Dichlorodifluoropropane | 819-00-1 |
| HCFC-253 | C3H4F3Cl | Monochlorotrifluoropropane | 460-35-5 |
| HCFC-261 | C3H5FCl2 | Dichlorofluoropropane | 420-97-3 |
| HCFC-262 | C3H5F2Cl | Monochlorodifluoropropane | 421-02-03 |
| HCFC-271 | C3H6FCl | Monochlorofluoropropane | 430-55-7 |

Table A2.3. Current Exempt Substitute Refrigerants and Approved Uses (Also see 40 CFR § 82.154(a)(1) for updates to exempt end-uses).¹

| Substitute Refrigerant | Exempt End-uses |
|--|---|
| Carbon dioxide (CO ₂) | Any application |
| Nitrogen (N ₂) | Any Application |
| Water (H ₂ O) | Any Application |
| Ammonia (NH ₃) | Commercial or industrial process refrigeration or in absorption units |
| Chlorine (Cl ₂) | Industrial process refrigeration (processing of chlorine and chlorine compounds) |
| Hydrocarbons (HC) | Industrial process refrigeration (processing of hydrocarbons) |
| Ethane, R-170 (C ₂ H ₆) | Very low temperature refrigeration equipment and equipment for non-mechanical heat transfer |
| Propane, R-290 (C ₃ H ₈) | Retail food refrigerators and freezers (stand-alone units only); household refrigerators, freezers, and combination refrigerators and freezers; self-contained room air conditioners for residential and light commercial air-conditioning and heat pumps; vending machines; and effective January 3, 2017, self-contained commercial ice machines, very low temperature refrigeration equipment, and water coolers |
| Isobutane, R-600a (HC(CH ₃) ₃) | Retail food refrigerators and freezers (stand-alone units only); household refrigerators, freezers, and combination refrigerators and freezers; and vending machines |
| R-441A | Retail food refrigerators and freezers (stand-alone units only); household refrigerators, freezers, and combination refrigerators and freezers; self-contained room air conditioners for residential and light commercial air-conditioning; heat pumps; and vending machines |

¹ This list is based on the list from EPA at the time of publication. This list may change, and installations must comply with the most up-to-date list.

Table A2.4. U.S. Actions to Meet the Montreal Protocol Phaseout Schedule.

| Year to Be Implemented | Implementation of HCFC Phaseout through Clean Air Act Regulations | Year to Be Implemented | Percent Reduction in HCFC Consumption and Production from Baseline |
|-------------------------------|---|-------------------------------|---|
| 2003 | No production or import of HCFC-141b | 2004 | 35% |
| 2010 | No production or import of HCFC-142b and HCFC-22, except for use in equipment manufactured before January 1, 2010 | 2010 | 75% |
| 2015 | No production or import of any other HCFCs, except as refrigerants in equipment manufactured before January 1, 2020 | 2015 | 90% |
| 2020 | No production or import of HCFC-142b and HCFC-22 | 2020 | 99.5% |
| 2030 | No production or import of any HCFCs | 2030 | 100% |

Table A2.5. Required Levels of Evacuation for Appliances.¹

| Type of Appliance | Inches of Hg Vacuum ² | |
|--|--|---|
| | Equipment ³ Manufactured Before 15 Nov 93 | Equipment ³ Manufactured After 15 Nov 93 |
| Very high-pressure appliance | 0 | 0 |
| High-pressure appliance or isolated component, normally containing 200 pounds refrigerant | 0 | 0 |
| High-pressure appliance or isolated component, normally containing 200 pounds or more refrigerant | 4 | 10 |
| Medium-pressure appliance or isolated component normally containing less than 200 pounds refrigerant | 4 | 10 |
| Medium-pressure appliance or isolated component normally containing 200 pounds or more refrigerant | 4 | 15 |
| Low-pressure appliance | 25 ⁴ | 25 ⁴ |
| <p>¹ Data from Table 1 of 40 CFR 82.156 does not apply to small appliances, see additional information below</p> <p>² Relative to standard atmospheric pressure of 29.9 inches Hg</p> <p>³ Recovery/reclamation equipment must be certified per 40 CFR 82.158 requirements</p> <p>⁴ Measurement in mm Hg absolute, not relative to standard atmospheric pressure</p> | | |
| <p>Small Appliances (equipment containing < 5 pounds of refrigerant)</p> <p>Before opening a small appliance or when disposing of a small appliance, persons must recover refrigerant, using a recovery and/or recycling machine certified pursuant to 40 CFR 82.158, according to the following conditions:</p> <ul style="list-style-type: none"> • Recover 90 percent of the refrigerant in the appliance when the compressor in the appliance is functioning, or 80 percent of the refrigerant in the appliance when the compressor in the appliance is not functioning; or • Evacuate the appliance to four inches of mercury vacuum. | | |

Table A2.6. Physical Properties of Refrigerants.

| Refrigerant | Name | Chemical Formula | Boiling Point (°C / °F) | TLV (ppm) | STEL (ppm) | IDLH (ppm) | OEL (ppm) |
|--|--|--|---|--------------|---------------|---------------|--------------|
| <i>ASHRAE 34 Safety Group A1</i> This grouping signifies least toxic and least flammable | | | | | | | |
| CFC-11 | Trichlorofluoromethane | CCl ₃ F | 23.9/75 | 1,000 | -- | 10,000 | 1,000 |
| CFC-12 | Dichlorodifluoromethane | CCl ₂ F ₂ | -30/-22 | 1,000 | -- | 50,000 | 1,000 |
| CFC-13 | Chlorotrifluoromethane | CClF ₃ | -82/-115 | -- | -- | 50,000 | 1,000 |
| R-13B1 | Bromotrifluoromethane | CBrF ₃ | -57.8/-72 | 1,000 | -- | -- | 1,000 |
| R-14 | Tetrafluoromethane (carbon tetrafluoride) | CF ₄ | -128/-198 | -- | -- | -- | 1,000 |
| HCFC-22 | Chlorodifluoromethane | CHClF ₂ | -40.6/-41 | 1,000 | 1,250 | -- | 1,000 |
| CFC-113 | Trichlorotrifluoroethane | CCl ₂ FCClF ₂ | 47.8/118 | 1,000 | 1,250 | 4,500 | 1,000 |
| CFC-114 | Dichlorotetrafluoroethane | CClF ₂ CClF ₂ | 3.3/38 | 1,000 | -- | 50,000 | 1,000 |
| CFC-115 | Chloropentafluoroethane | CClF ₂ CF ₃ | -38.9/-38 | 1,000 | -- | -- | 1,000 |
| HFC-134a | 1,1,1,2-Tetrafluoroethane | CH ₂ FCF ₃ | -26/-15.2 | -- | -- | -- | 1,000 |
| CFC-400 | R-12 and R-114 | CCl ₂ F ₂ /C ₂ Cl ₂ F ₄ | Boiling point changes with pressure | 1,000 | -- | 50,000 | 1,000 |
| HCFC-401a | R-22/R-152a/R-124 (53%/13%/34% by wt) | CHClF ₂ /CH ₃ CHF ₂ /CHClFCF ₃ | -32.8/-27 | -- | -- | -- | 1,000 |
| HCFC-401b | R-22/R-152a/R-124 (61%/11%/28% by wt) | CHClF ₂ /CH ₃ CHF ₂ / CHClFCF ₃ | -35/-30.5 | -- | -- | -- | 1,000 |
| HCFC-402a | R-22/R-125/R-290 (30%/60%/2% by wt) | CHClF ₂ /C ₃ H ₈ / CHF ₂ CF ₃ C ₂ HF ₅ | -49/-56.6 | -- | -- | -- | 1,000 |
| HCFC-402b | R-22/R-125/R-290 (60%/38%/2% by wt) | CHClF ₂ /C ₃ H ₈ / CHF ₂ CF ₃ C ₂ HF ₅ | -47/-53.3 | -- | -- | -- | 1,000 |
| HFC-404a | R-143a/R-125/R-134a (52%/44%/4% by wt) | CH ₃ CF ₃ /CHF ₂ CF ₃ / CH ₂ FCF ₃ | -46.7/-52 | -- | -- | -- | 1,000 |
| CFC-500 | R-12/152a (73.8%/26.2% by wt) | CCl ₂ F ₂ /CH ₃ CHF ₃ | -33.3/-28 | 1,000 | -- | -- | 1,000 |
| CFC-502 | R-22/115 (48.8%/51.2% by wt) | CHClF ₂ /CClF ₂ CF ₃ | -45/-49.7 | 1,000 | -- | -- | 1,000 |
| CFC-503 | R-23/13 (40.1%/59.9% by wt) | CHF ₃ /CClF ₃ | -88/-126 | -- | -- | -- | 1,000 |
| HFC-507 | R-125/R-143a (50%/50% by wt) | CHF ₂ CF ₃ /CH ₃ CF ₃ | -46.7/-52 | -- | -- | -- | 1000 |
| R-718 | Water | H ₂ O | 100/212 | -- | -- | -- | -- |
| R-744 | Carbon Dioxide | CO ₂ | -78/-109 | 5,000 | 30,000 | 50,000 | -- |

| Refrigerant | Name | Chemical Formula | Boiling Point (°C / °F) | TLV (ppm) | STEL (ppm) | IDLH (ppm) | OEL (ppm) |
|--|---|-----------------------------------|----------------------------|--------------|---------------|---------------|--------------|
| ASHRAE 34 Safety Group A2 This grouping signifies least toxic but more flammable | | | | | | | |
| CFC-142b | 1-Chloro-1,1,- Difluoroethane | CH ₃ CClF ₂ | -10/14 | -- | -- | -- | 1000 |
| HFC-152a | 1,1-Difluoroethane | CH ₃ CHF ₂ | -25/-13 | -- | -- | -- | 1000 |
| ASHRAE 34 Safety Group A3 This group signifies least toxic but most flammable | | | | | | | |
| R-170 | Ethane | C ₂ H ₆ | -89/-128 | -- | -- | -- | 1000 |
| R-290 | Propane | C ₃ H ₈ | -42.2/-44 | 1,000 | -- | 20,000 | 1000 |
| R-600 | Butane | C ₄ H ₁₀ | -0.6/31 | 800 | -- | -- | 1000 |
| R-600a | 2-Methylpropane (Isobutane) | CH(CH ₃) ₃ | -11.7/11 | -- | -- | -- | 1000 |
| R-1150 | Ethene (Ethylene) | C ₂ H ₄ | -104/-155 | -- | -- | -- | 200 |
| R-1270 | Propene (Propylene) | C ₃ H ₆ | -47.8/-54 | -- | -- | -- | 500 |
| ASHRAE 34 Safety Group B1 This grouping signifies more toxicity but least flammable | | | | | | | |
| HCFC-123 | 2,2-Dichloro-1,1,1- Tri-fluoroethane | CHCl ₂ CF ₃ | 27.6/81.7 | -- | -- | -- | 50 |
| R-764 | Sulfur Dioxide | SO ₂ | -10/14 | 2 | 5 | 100 | -- |
| ASHRAE 34 Safety Group B2 This grouping signifies most toxic but more flammable | | | | | | | |
| R40 | Chloromethane (Methyl chloride) | CH ₃ Cl | -24.4/-12 | 50 | 100 | 10,000 | -- |
| R-611 | Methyl formate | HCOOCH ₃ | 31.7/89 | 100 | 150 | 5,000 | 100 |
| R-717 | Ammonia | NH ₃ | -33.3/-28 | 25 | 35 | 500 | 25 |

Table A2.7. Listing of HFC Substances Regulated under the AIM Act.¹

| Common Name | Chemical Formula | Exchange Value |
|--------------------|---|-----------------------|
| HFC-134 | CHF ₂ CHF ₂ | 1,100 |
| HFC-134a | CH ₂ FCF ₃ | 1,430 |
| HFC-143 | CH ₂ FCHF ₂ | 353 |
| HFC-245fa | CHF ₂ CH ₂ CF ₃ | 1,030 |
| HFC-365mfc | CF ₃ CH ₂ CF ₂ CH ₃ | 794 |
| HFC-227ea | CF ₃ CHFCF ₃ | 3,220 |
| HFC-236cb | CH ₂ FCF ₂ CF ₃ | 1,340 |
| HFC-236ea | CHF ₂ CHFCF ₃ | 1,370 |
| HFC-236fa | CF ₃ CH ₂ CF ₃ | 9,810 |
| HFC-245ca | CH ₂ FCF ₂ CHF ₂ | 693 |
| HFC-43-10mee | CF ₃ CHFCHFCF ₂ CF ₃ | 1,640 |
| HFC-32 | CH ₂ F ₂ | 675 |
| HFC-125 | CHF ₂ CF ₃ | 3,500 |
| HFC-143a | CH ₃ CF ₃ | 4,470 |
| HFC-41 | CH ₃ F | 92 |
| HFC-152 | CH ₂ FCH ₂ F | 53 |
| HFC-152a | CH ₃ CHF ₂ | 124 |
| HFC-23 | CHF ₃ | 14,800 |

¹ This table includes all isomers of the substances above, regardless of whether the isomer is explicitly listed on its own. This table is maintained in Appendix A to 40 CFR 84.

Table A2.8. Exchange Values of Common Blended Refrigerants Containing HFCs.¹

| Blended Refrigerant Name | Exchange Value |
|---------------------------------|-----------------------|
| R-401A | 16 |
| R-404A | 3,922 |
| R-407C | 1,774 |
| R-410A | 2,088 |
| R-448A | 1,386 |
| R-449A | 1,396 |
| R-449B | 1,411 |
| R-507A | 3,985 |

¹The blended refrigerants in this table contain one or more regulated HFC substances. For example, R-410A contains 50% HFC-32 and 50% HFC-125.

Attachment 3
EXAMPLE LEAK RATE CALCULATIONS

Example A3.1. Sample Annualizing Leak Rate Calculations.

An office building is cooled by a 200-ton rotary chiller containing a 400-pound HCFC R-22 refrigerant charge. 35 pounds of HCFC R-22 was added at the first servicing and a leak repair was made. 15 pounds of HCFC R-22 were added at the following servicing. The system was put into service 5 May 2023.

Service Records

| Calendar Date | Julian Date¹ | Refrigerant Added |
|----------------------|--------------------------------|--------------------------|
| 5 May 2022 | 125 | 0 lb |
| 1 Oct 2023 | 274 | 35 lbs |
| 4 Dec 2023 | 338 | 15 lbs |

1. Determine the leak rate for the service on 1 Oct 2023:

2. Determine the leak rate for the service on 4 Dec 2023:

Notes ¹Julian date calculated by USNO Julian date converter:

<https://aa.usno.navy.mil/data/JulianDate>

Date shown in Julian date field taken from calendar but needs to account for 365/366 days when calculating multi-calendar years.

Solution:

For 1 Oct 2023 Service

Step 1: Divide the quantity of refrigerant added on 1 Oct 2023 by the circuit full charge.

$$\frac{\text{Pounds of refrigerant added (35 lbs)}}{\text{Refrigerant full charge (400 lbs)}} = \mathbf{0.0875}$$

Step 2: Calculate the number of days between the 1 Oct 2023 service event and the previous service event, in this case the day the unit was put into service.

$$\text{Number of days in 2022 (365)} - \text{Julian date of first service (125)} + \text{Julian date of 1 Oct 2023 (274)} \\ = \mathbf{514 \text{ days}}$$

Step 3: Divide 365 days/year by the shorter of the result from Step 2 or 365 days (in this case it will be 365 days).

$$\frac{365 \text{ days/year}}{365 \text{ days}} = \mathbf{1/yr}$$

Step 4: Multiply the result from Step 1 by the result from Step 3 and then by 100%

$$0.0875 \times 1/yr \times 100\% = \mathbf{8.75\% \text{ per year}}$$

Result: This unit IS NOT leaking in excess of the EPA allowable leak rate for comfort cooling equipment of 10%.

Example A3.2 Sample Rolling Leakage Rate Calculations.

An office building is cooled by a 200-ton rotary chiller containing a 400-pound HCFC R-22 refrigerant charge. 150 pounds of HCFC R-22 were added at the first servicing and a leak repair was made. 5 pounds of HCFC R-22 were added at the following servicing. The system was put into service 5 May 2022.

| Service Records Calendar Date | Refrigerant Added |
|-------------------------------|-------------------|
| 5 May 2022 | 0 lbs |
| 1 Oct 2023 | 150 lbs |
| 4 Dec 2023 | 5 lbs |

1. Determine the LR_{Roll} for the fill on 1 Oct 2023

$$LR_{\%Roll} = \frac{150 \text{ lbs Added}}{400 \text{ lbs Total}} \times 100 = 37.5 \%$$

2. Determine the $LR_{\%Roll}$ for the fill on 4 Dec 2023

$$LR_{\%Roll} = \frac{5 \text{ lbs Added since last repair}}{400 \text{ lbs Total}} \times 100 = 1.25 \%$$