

ACCELERATOR DIVISION ES&H PROCEDURE

ADSP-08-0201

CONTROL AND PHASEOUT OF OZONE-DEPLETING SUBSTANCES

RESPONSIBLE DEPARTMENT ES&H

PREPARED BY  DATE 6/29/09
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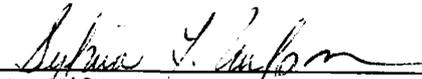
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1.0 PURPOSE AND SCOPE

This procedure sets forth the Accelerator Division (AD) responsibilities for complying with the Clean Air Act requirements to control and phase out emissions of ozone-depleting substances (ODS) such as chlorofluorocarbons (CFCs) and halons. Such substances (see Attachment 1 for a listing of class I and class II ODS) are used as the working fluid in appliances such as air conditioners, chillers, refrigerators, and dehumidifiers; in industrial process refrigeration equipment at the Central Helium Liquefier (CHL); as degreasers and parts cleaners in both liquid and aerosol forms; and as fire suppression agents. The procedure provides for complying with applicable regulations, inventorying AD equipment containing ODS and AD processes using ODS, developing inspection and preventative maintenance programs, tracking and reporting ODS usage, investigating the feasibility and cost of alternative substances or technologies, and planning for and carrying out phaseout of these substances. Analysis and planning in advance of statutory deadlines for cessation of ODS manufacturing are essential to prevent disruptions of system availability and control costs of recharging equipment.

This procedure does not cover requirements pertaining to the servicing of motor vehicle air conditioners (MVAC) and MVAC-like appliances because this activity is not carried out by AD personnel.

2.0 REFERENCES¹

- 2.1 Title VI, Clean Air Act, as amended, Title 42, United States Code 7401, *et seq.*
- 2.2 Title 40, Code of Federal Regulations (CFR) Part 82, Protection of Stratospheric Ozone
- 2.3 *An Assessment of Alternatives and Technologies for Replacing Ozone-Depleting Substances at DOE Facilities*, C.W. Purcell *et al.*, Battelle Pacific Northwest Laboratory, PNL-8222, October 1992
- 2.4 *Climbing Out of the Ozone Hole, A Preliminary Survey of Alternatives to Ozone-Depleting Chemicals*, Greenpeace International, October 1992, and February 1993 supplement, *Sources of Safer Alternatives to Ozone Depleting Chemicals (ODCs) by Use Sector and State by State in the US*
- 2.5 59 FR 44240, Notice of acceptability, August 26, 1994
- 2.6 60 FR 3318, Notice of acceptability, January 13, 1995

¹All references, including an up-to-date version of 40 CFR Part 82, which EPA amends frequently, are available upon request from the Environment, Safety and Health (ES&H) Department.

- 2.7 60 FR 38729, Acceptable Substitutes for the Significant New Alternatives Policy (SNAP) Program, Notice of acceptability, July 28, 1995
- 2.8 61 FR 4736, Notice of acceptability and clarification of June 13, 1995 final rule, January 8, 1996
- 2.9 62 FR 10700, Notice of acceptability, March 10, 1997
- 2.10 Environmental Protection Agency (EPA) Ozone Layer Depletion web area, <http://www.epa.gov/ozone/strathome.html>, which includes links to fact sheets on regulations and alternatives to ozone depleters.
- 2.11 62 FR 30275, Notice of acceptability, June 3, 1997
- 2.12 63 FR 9151, Notice of acceptability, February 24, 1998
- 2.13 63 FR 28251, Notice of acceptability, May 22, 1998
- 2.14 64 FR 30410, Notice of acceptability, June 8, 1999
- 2.15 64 FR 68039, Notice of acceptability, December 6, 1999
- 2.16 65 FR 19327, Notice of acceptability, April 12, 2000
- 2.17 65 FR 37900, Notice of acceptability, June 21, 2000
- 2.18 65 FR 78977, Notice of acceptability, December 18, 2000, as corrected at 66 FR 13655, March 7, 2001
- 2.19 66 FR 28379, Notice of acceptability, May 23, 2001
- 2.20 67 FR 13272, Notice of acceptability, March 22, 2002
- 2.21 67 FR 77927, Notice of acceptability, December 20, 2002, as corrected at 68 FR 16728, April 7, 2003
- 2.22 68 FR 50533, Notice of acceptability, August 21, 2003
- 2.23 69 FR 58903, Notice of acceptability, October 1, 2004
- 2.24 71 FR 15589, Notice of acceptability, March 29, 2006
- 2.25 71 FR 56884, Notice of acceptability, September 28, 2006
- 2.26 72 FR 30141, Listing of Substitutes for Ozone-Depleting Substances – n-Propyl Bromide in Solvent Cleaning, May 30, 2007
- 2.27 72 FR 56628, Notice of acceptability, October 4, 2007
- 2.28 74 FR 21, Notice of acceptability, January 2, 2009
- 2.29 Fermilab ES&H Manual Chapter 8081, Refrigeration [*sic*] Management

3.0 STATUTORY/REGULATORY BACKGROUND

3.1 PRODUCTION PHASEOUT

3.1.1 Production of halons (the worst ozone depleters) largely ceased on December 31, 1993. Production or importation of other class I substances, except for methyl bromide, was essentially banned as of December 31, 1995. Small quantities of some substances may continue to be produced or imported for exempted essential uses. Production and import restrictions on methyl bromide took effect on January 1, 2001. Phaseout of the production and importation of HCFC-141b (class II) began on January 1, 2003, and an HCFC allowance system to limit HCFC consumption to specific levels and to reduce it in a step-wise fashion began on January 21, 2003. Additional production restrictions, including one on HCFC-22, will be phased in 2010-2040. Export restrictions have now also been placed on certain ODS (see 40 CFR 82.4).

3.2 RECYCLING AND EMISSIONS REDUCTION

3.2.1 It is unlawful for any person, in the course of maintaining, servicing, repairing, or disposing of appliances or industrial process refrigeration equipment, to knowingly vent, release or dispose of class I or class II substances used as refrigerants in such equipment in a manner which allows the substance to enter the atmosphere. This prohibition also applies to substitutes for class I or II substances used in such equipment unless specifically exempted by EPA from the definition of refrigerant in 40 CFR §82.152. [Many substitutes contribute significantly to global warming and/or exacerbate local air quality problems.] No person testing, maintaining, servicing, repairing, or disposing of halon-containing equipment or using such equipment for technician training may knowingly vent or otherwise release into the environment any halons used in such equipment. Also, owners of halon-containing equipment are liable for releases of halon caused by failure to properly maintain the equipment.

3.2.1.1 Enforcement actions related to these prohibitions may result in fines of up to \$25,000 per day per violation plus criminal prosecution.

3.2.1.2 *De minimis* releases associated with good faith efforts to recycle or recover refrigerants and halons (defined in 40 CFR 82.154(a) and 82.270(b)) are exempted.

3.2.1.3 These prohibitions do not apply to non-refrigerant uses (e.g., parts cleaning) or fire suppression (i.e., discharge to fight an actual fire).

3.2.2 Anyone maintaining, servicing, repairing, or disposing of ODS-containing appliances is required to first evacuate the refrigerant therein to levels specified in §82.156, and verify attainment of those levels. Refrigerant may be transferred into a system receiver (unless disposing of the unit or maintaining, servicing, or repairing a unit that has a charge of greater than 15 pounds and that is not equipped with a

permanently attached pump-out unit) or a recovery or recycling machine certified for that type of appliance pursuant to §82.158. A list of certified equipment is available from EPA (see §82.158(i)).

- 3.2.2.1 Refrigerant may be returned directly (i.e., without being reclaimed) to the same equipment from which it is recovered, and recycling on site is allowed without restriction.
- 3.2.2.2 Unwanted used refrigerant generally must be purified to specified standards (Appendix A to subpart F) by a certified reclaimer before it can be sold to another party (§§82.154(g) and §82.164). There are recordkeeping requirements associated with such sales (§82.166). Normally, only certified technicians may purchase class I or class II substances for use as refrigerants (see §82.166(b) for an exception).
- 3.2.2.3 Persons maintaining, servicing, repairing, or disposing of ODS-containing appliances must first certify to EPA Region V that they have acquired and are properly using certified recycling or recovery equipment. Fermilab consolidated all of the divisions'/sections' certifications into one submittal to EPA when this requirement became effective (August 12, 1993). This certification must be amended if new equipment is purchased. See §82.162(a) or (d) for required contents of certification. The information should be provided to the Environment, Safety, and Health (ES&H) Department. Refrigerant recycling or recovery equipment may not be altered without recertification (§82.154(d)).
- 3.2.2.4 Technicians maintaining, servicing, or repairing an ODS-containing appliance (other than certain small appliances containing 5 pounds or less of refrigerant (see §82.152)) must be certified for that type of appliance. Apprentices working under certified technicians are exempted. Technician training or testing programs must be approved by EPA as meeting all of the standards in §82.161 and appendix D to 40 CFR 82, Subpart F. Technicians must keep a copy of their certificate on site (§82.166(l)). Technicians who test, maintain, service, repair, or dispose of halon-containing equipment are not required to be certified, but must be trained in halon emissions reduction.
- 3.2.3 Owners of appliances containing more than 50 pounds of refrigerant must have all leaks repaired within 30 days of discovery if the equipment is leaking at a rate such that the loss of refrigerant will exceed 15 percent of the total charge during a 12-month period (35 percent for industrial process refrigeration equipment). See definition of "full charge" in §82.152 and potentially applicable recordkeeping requirements in §82.166(q).
- 3.2.3.1 An additional 90 days is allowed for repair of industrial process refrigeration equipment if repair would require shutdown of the process. Other extensions may be granted if parts are unavailable or other regulatory requirements lengthen the time required for repair. As much of the repair as possible must be completed within the initial 30 (120)

days. Documentation and notification requirements apply. See §§82.156(i)(2) and (3) and §82.166(n).

- 3.2.3.2 Repairs must bring the annual leak rate to under 15 percent (35 percent for industrial process refrigeration equipment).
- 3.2.3.3 Repairs may be postponed if the owner/operator develops within 30 days a one-year retrofit or retirement plan (§82.156(i)(6)). Under certain circumstances, EPA may grant additional time beyond the one-year period for retrofit/replacement of certain types of equipment (§§82.156(i)(7), (8) and (10) and §82.166(o)).
- 3.2.3.4 After a repair involving industrial process refrigeration equipment, an initial verification test must be conducted at the conclusion of the repairs. Equipment that was taken off line for repair may not be brought back on line until such a test indicates the repair was successful (unless the owner/operator opts to prepare a retrofit/retirement plan). A follow-up test must be completed within 30 days of completing the repairs or (if the process was shut down) bringing the plant back on line. The follow-up test must usually be conducted under normal operating conditions. Equipment that fails the follow-up test must undergo another repair/verification test cycle within 30 days (or 120 days, if process shutdown is involved) unless the owner/operator opts to prepare a one-year retrofit/retirement plan or brings the leak rate within the allowable annual limit within 180 days by repairing other parts of the system. Notice, incorporating information specified in §82.166(n), must be provided to EPA within 30 days of any of the following events: initial failure of follow-up verification test, successful follow-up test after a second repair effort, and determination that the leak rate has been brought within allowable annual limits as a result of other repairs. (§82.156(i)(3))
- 3.2.3.5 Owners of appliances containing more than 50 pounds of refrigerant must keep servicing records documenting the date and type of service, as well as any quantity of refrigerant added, including amounts purchased and added by in-house technicians as well as their date of purchase and addition (§82.166(k)). Records must be kept for at least 3 years (§82.166(m)).

3.3 PROCUREMENT

- 3.3.1 Active or new contracts involving service, repair, or disposal of appliances or industrial process refrigeration equipment must include or be modified to include a condition requiring the contractor to ensure compliance with the recycling and emissions reduction requirements.
- 3.3.2 Proper labeling under 40 CFR 82, Subpart E shall be a specification for the purchase of any product containing ODS.

3.4 SUBSTITUTES FOR ODS

- 3.4.1 EPA has created a program for evaluating and regulating

substitutes for ODS. The "Significant New Alternatives Policy" (SNAP) program rules are found in Subpart G of 40 CFR 82.

- 3.4.1.1 Substitutes judged *acceptable* may be used without restriction for the specified end-use.
- 3.4.1.2 Substitutes judged *acceptable subject to use conditions* may be used only if specified conditions of use are met to minimize risk to human health and the environment. Potential users must first make reasonable efforts to ascertain that other alternatives are not feasible due to safety, performance, or technical reasons. Documentation of these assessments is required and must be kept on file. See §82.180(b)(2) for required content of records.
- 3.4.1.3 Substitutes judged *acceptable subject to narrowed use limits* are allowed in some cases because of a lack of alternatives for specialized applications. Potential users must first make reasonable efforts to ascertain that other alternatives are not technically feasible. Documentation of these assessments is required and must be kept on file. See §82.180(b)(3) for required content of records.
- 3.4.1.4 Substitutes judged *unacceptable* may not be used except as noted below in paragraph 3.4.3.1. EPA has determined that these substitutes may have adverse effects on human health or the environment and has identified other alternatives in particular industrial use sectors that, on an overall basis, reduce risk to human health and the environment and are currently or potentially available.
- 3.4.2 Safe alternatives to class I or class II substances shall be substituted to the maximum extent practicable, except that substitution is not required for class II substances identified as safe.
- 3.4.3 Appendices to 40 CFR 82, Subpart G list substitutes for refrigeration, foam blowing, solvent cleaning, and fire suppression and explosion protection streaming and total flooding agents that EPA has judged to be either unacceptable or acceptable subject to narrowed use limits or use conditions. Substitutes that have been judged acceptable for use without limitations are not part of the rule itself, but are listed in the preambles to the various Subpart G rule-making notices (59 FR 13044, March 18, 1994, 60 FR 31092, June 13, 1995, 61 FR 25585, May 22, 1996, 64 FR 22982, April 28, 1999, 67 FR 4185, January 29, 2002, and 67 FR 47703, July 22, 2002) and references 2.5 through 2.9 and 2.11 through 2.28. In addition to the above use categories, these references also list substitutes judged acceptable for air conditioning, aerosols, adhesives and coatings, and other applications. References 2.8, 2.15, 2.18, and 2.20 through 2.28 list acceptable substitutes for various refrigerant applications of such class II substances as HCFC-22.

- 3.4.3.1 Existing supplies of substitutes listed as unacceptable or acceptable subject to narrowed use limits may be used up if they were in the possession of the user as of March 18, 1994.
- 3.4.3.2 Substitutes must be used in accordance with any stated use restrictions.
- 3.4.3.3 Aerosol products that contain class I, groups I and III, and/or class II substances (see Attachment 1 of this procedure), either as propellants or as active ingredients, are generally banned from sale under 40 CFR 82 Subpart C as non-essential products. However, see §§82.66(d)(2) and 82.70(a)(2) for exemptions, which include some cleaners, lubricants and mold release agents.

4.0 RESPONSIBILITIES

4.1 DEPARTMENT HEADS

- a. Ensure that all operations under their cognizance are conducted in compliance with applicable prohibitions and requirements in EPA regulations pertaining to maintaining, servicing, repairing, and disposing of ODS-containing equipment (see section 3.2 and reference 2.2) and use of substitutes (see section 3.4 and reference 2.2),
- b. Establish and maintain required records (see section 3),
- c. Replace department-owned equipment containing a class I or class II refrigerant with a new unit using a non-ozone-depleting refrigerant, whenever a unit fails in a way that results in loss of the charge or otherwise requires costly repairs,
- d. Inform the AD Environmental Officer (EO) and, if applicable, the FESS Refrigerant Manager, promptly about any releases from ODS-containing equipment, repair said equipment within 14 days, and report results of post-repair leak checks to the EO and Refrigerant Manager within 30 days.
- e. Provide the ES&H Department with any requested information for tracking departmental inventory and usage of ODS-containing equipment and ODS-containing chemicals, and
- f. Establish preventative maintenance programs for selected inventoried equipment containing ODS (in coordination with the Facilities Engineering Services Section (FESS), as applicable).

4.2 ES&H DEPARTMENT

- a. Verifies compliance with applicable requirements during pertinent tripartite self-assessments,
- b. Maintains AD inventory of ODS-containing chemicals in the AD Chemical Inventory database,

- c. Ensures, through staff ES&H review of purchase requisitions under ADSP-08-0601, that appropriate alternatives have been considered when chemicals, vehicles, etc. containing ODS are being procured,
- d. Assists department heads in identifying substitutes for ODS-containing chemicals and acts as a resource for information on substitutes to ODS,
- e. Coordinates with the Fermilab Environmental Protection Subcommittee on ODS issues, and
- f. In coordination with FESS to avoid double-counting, provides data on ODS releases to the ES&H Section for incorporation into annual Toxic Release Inventory report.

4.3 BUILDING MANAGERS

- a. Establish preventative maintenance programs for building utility equipment containing ODS (in coordination with FESS, as applicable),
- b. Inform the AD Environmental Officer and, if applicable, the FESS Refrigerant Manager, promptly about any releases from ODS-containing equipment, repair said equipment within 14 days, and report results of post-repair leak checks to the EO and Refrigerant Manager within 30 days, and
- c. When repairing or replacing ODS-containing equipment, evaluate opportunities for converting to systems employing non-ODS and select them whenever technically and economically feasible.

5.0 INSTRUCTIONS

5.1 CHEMICAL INVENTORY TRACKING

- 5.1.1 The AD Chemical Inventory database will be used to record the following information: product name, manufacturer, material safety data sheet (MSDS) number, container size, number of containers, ODS constituents, ODS class(es), and use category.
- 5.1.2 The ES&H Department will update the chemical inventory database approximately biennially. Personnel responsible for chemical storage cabinets should provide updated inventories of ODS in their cabinets whenever requested by the ES&H Department.
- 5.1.3 When entering data for newly obtained chemicals, be sure to use the most recent MSDS number for that product. Manufacturers have been reformulating their products to substitute class II substances for class I substances or eliminate ODS altogether. An outdated MSDS number will cause the inventory to overstate the amount of ODS on hand.

5.2 MAINTENANCE

- 5.2.1 Except for *de minimis* releases, all class I and class II substances used as refrigerants and all halons must be recovered for reuse, reclamation, or appropriate disposal when a system containing them is opened. Technicians (whether in-house or subcontractor employees) performing this operation on refrigerant-containing equipment must be certified to work on the specific type of equipment involved through an EPA-approved training program. Technicians (whether in-house or subcontractor employees) performing this operation on halon-containing equipment must be trained in halon emissions reduction.
- 5.2.1.1 Refrigerant recovery and recycling equipment must be certified pursuant to 40 CFR 82.158. A form (OMB #2060-0256) for making this certification is available from the ES&H Department.
- 5.2.1.2 Refrigerant must be evacuated to the levels specified in §82.156 for the equipment on which maintenance is being performed.
- 5.2.1.3 Refrigerant should be returned to the same equipment or recycled on site whenever possible.
- 5.2.1.4 Unwanted refrigerant or halon, if it cannot be used elsewhere on site, must be disposed of via the ES&H Section using the same procedures as for other regulated chemical waste. Used refrigerants and halons that will be reclaimed off site are special (not hazardous) wastes.
- 5.2.1.5 Refrigerant being added to a system during maintenance, regardless of whether the activity is being performed by in-house technicians or service subcontractor, must be obtained through the FESS Refrigerant Manager or designee at Site 39 using the procedures in FESHM Chapter 8081 (Ref. 2.29).
- 5.2.2 Departments with systems containing large charges of ODS should review the use of rupture disks and evaluate the feasibility of replacing them with rupture disk/relief valve combinations which reclose after pressure has dropped, preventing loss of the entire charge of refrigerant.
- 5.2.3 Departments with systems containing large charges of ODS should conduct (in coordination with FESS, as appropriate) quarterly leak tests of major systems.
- 5.2.4 When purchasing refrigerant recovery and recycling equipment, ensure that the manufacturer has appropriately certified the equipment as meeting the standards in §82.158.

5.3 PHASEOUT PLANNING AND IMPLEMENTATION

5.3.1 Existing Chemicals and Equipment

- 5.3.1.1 Existing supplies of chemicals containing class I substances may generally be used up. Groups that have such products in their inventories but no longer have a use for them should notify the ES&H Department so the excess can be advertised and

a new user found. Groups that are still actively using these products are encouraged to investigate alternatives for their application now rather than waiting until existing supplies are exhausted. It may take some time to locate a new product that performs to your satisfaction.

- 5.3.1.2 Existing supplies of chemicals containing class I substances that are no longer suitable for use by anyone, e.g., past expiration date, clogged spray nozzle, etc., should be properly disposed of using the AD regulated chemical waste procedure (ADSP-08-0202).
- 5.3.1.3 Equipment containing class I substances that is operating reliably may remain in service. Remember, however, that maintenance costs may rise sharply as stocks of refrigerants that are no longer manufactured are depleted. It may be advisable to review the equipment inventory to identify candidates for conversion/retrofitting to use alternative substances or replacement, get cost estimates, develop schedules, etc. Replacement cost of R-22 will also eventually become a factor as that class II is phased out, beginning in 2010.
- 5.3.2 Procurement of New Chemicals and Equipment
 - 5.3.2.1 No purchases of new chemicals or equipment containing class I substances may be made without approval of the AD Environmental Officer and Senior Safety Officer. Lack of availability normally will automatically enforce this prohibition, since most such products may no longer be offered for sale. Manufacturers have substituted class II substances or non-ODS in their formulations. Existing stocks of most products containing class I substances have now been depleted and the stockroom should be issuing appropriately reformulated alternatives.
 - 5.3.2.2 Existing written specifications that call for the use of a certain chemical or equipment for a particular application should be reviewed and amended if that chemical/equipment contains a class I or class II substance. New specifications should require use of non-ODS.
 - 5.3.2.3 Resources for identifying substitutes include references 2.3 and 2.4, the ES&H Department, manufacturers, and coworkers and staff at other laboratories that have similar applications. Prior to procurement of a substitute, its acceptability for the application in question must be verified by consulting 40 CFR 82, Subpart G, the preambles to the rule (59 FR 13044, March 18, 1994, 60 FR 31092, June 13, 1995, 61 FR 25585, May 22, 1996, 64 FR 22982, April 28, 1999, 65 FR 24387, April 26, 2000, 67 FR 4185, January 29, 2002 (as corrected at 67 FR 12874, March 20, 2002), 67 FR 47703, July 22, 2002, and 68 FR 4004, January 27, 2003 (as corrected at 68 FR 16729, April 7, 2003)), or references 2.5 through 2.9 and 2.11 through 2.28. This is true for class II as well as class I substances. This verification may be done with the assistance of the ES&H Department in conjunction with the ES&H review process under ADSP-08-0601.

5.3.2.4 Personnel electing to use substitutes that EPA has judged acceptable subject to use conditions or narrowed use limits must consult with the ES&H Department to ensure that the choices are adequately justified and documented.

6.0 DISTRIBUTION

6.1 An electronic controlled copy of this procedure is maintained at <http://www-bdnew.fnal.gov/esh/adsp/ADSP-08-0601.pdf>.

6.2 The Main Control Room and the AD ES&H Department have controlled hardcopies of this procedure.

OZONE-DEPLETING SUBSTANCES

A. Class I

1. Group I:
 - CFCl₃ - Trichlorofluoromethane (CFC-11)
 - CF₂Cl₂ - Dichlorodifluoromethane (CFC-12)
 - C₂F₃Cl₃ - Trichlorotrifluoroethane (CFC-113)
 - C₂F₄Cl₂ - Dichlorotetrafluoroethane (CFC-114)
 - C₂F₅Cl - Monochloropentafluoroethane (CFC-115)
 - All isomers of the above chemicals

2. Group II:
 - CF₂ClBr - Bromochlorodifluoromethane (Halon-1211)
 - CF₃Br - Bromotrifluoromethane (Halon-1301)
 - C₂F₄Br₂ - Dibromotetrafluoroethane (Halon-2402)
 - All isomers of the above chemicals

3. Group III:
 - CF₃Cl - Chlorotrifluoromethane (CFC-13)
 - C₂FCl₅ - CFC-111
 - C₂F₂Cl₄ - CFC-112
 - C₃FCl₇ - CFC-211
 - C₃F₂Cl₆ - CFC-211
 - C₃F₃Cl₅ - CFC-213
 - C₃F₄Cl₄ - CFC-214
 - C₃F₅Cl₃ - CFC-215
 - C₃F₆Cl₂ - CFC-216
 - C₃F₇Cl - CFC-217
 - All isomers of the above chemicals

4. Group IV:
 - CCl₄ - Carbon Tetrachloride

5. Group V:
 - C₂H₃Cl₃ - 1,1,1-Trichloroethane (Methyl chloroform)
 - All isomers of the above chemical except 1,1,2-trichloroethane

6. Group VI:
 - CH₃Br - Bromomethane (Methyl bromide)

7. Group VII:
 - CHFBr₂
 - CHF₂Br (HBFC-22B1)
 - CH₂FBr
 - C₂HFBr₄
 - C₂HF₂Br₃
 - C₂HF₃Br₂
 - C₂HF₄Br
 - C₂H₂FBr₃
 - C₂H₂F₂Br₂
 - C₂H₂F₃Br

C₂H₃FBr₂
C₂H₃F₂Br
C₂H₄FBr
C₃HFBr₆
C₃HF₂Br₅
C₃HF₃Br₄
C₃HF₄Br₃
C₃HF₅Br₂
C₃HF₆Br
C₃H₂FBr₅
C₃H₂F₂Br₄
C₃H₂F₃Br₃
C₃H₂F₄Br₂
C₃H₂F₅Br
C₃H₃FBr₄
C₃H₃F₂Br₃
C₃H₃F₃Br₂
C₃H₃F₄Br
C₃H₄FBr₃
C₃H₄F₂Br₂
C₃H₄F₃Br
C₃H₅FBr₂
C₃H₅F₂Br
C₃H₆FBr

8. Group VIII:

CH₂BrCl (Chlorobromomethane)

B. Class II

CHFC₁₂ - Dichlorofluoromethane (HCFC-21)
CHF₂Cl - Chlorodifluoromethane (HCFC-22)
CH₂FCl - Chlorofluoromethane (HCFC-31)
C₂HFCl₄ - Tetrachlorofluoroethane (HCFC-121)
C₂HF₂Cl₃ - Trichlorodifluoroethane (HCFC-122)
C₂HF₃Cl₂ - Dichlorotrifluoroethane (HCFC-123)
C₂HF₄Cl - Monochlorotetrafluoroethane (HCFC-124)
C₂H₂FCl₃ - Trichlorofluoroethane (HCFC-131)
C₂H₂F₂Cl₂ - Dichlorodifluoroethane (HCFC-132b)
C₂H₂F₃Cl - Monochlorotrifluoroethane (HCFC-133a)
C₂H₃FCl₂ - Dichlorofluoroethane (HCFC-141b)
C₂H₃F₂Cl - Monochlorodifluoroethane (HCFC-142b)
C₂H₄FCl - Chlorofluoroethane (HCFC 151)
C₃HFCl₆ - Hexachlorofluoropropane (HCFC-221)
C₃HF₂Cl₅ - Pentachlorodifluoropropane (HCFC-222)
C₃HF₃Cl₄ - Tetrachlorotrifluoropropane (HCFC-223)
C₃HF₄Cl₃ - Trichlorotetrafluoropropane (HCFC-224)
C₃HF₅Cl₂ - Dichloropentafluoropropane (HCFC-225ca)
C₃HF₅Cl₂ - Dichloropentafluoropropane (HCFC-225cb)
C₃HF₆Cl - Monochlorohexafluoropropane (HCFC-226)

C₃H₂FCl₅ - Pentachlorofluoropropane (HCFC-231)
C₃H₂F₂Cl₄ - Tetrachlorodifluoropropane (HCFC-232)
C₃H₂F₃Cl₃ - Trichlorotrifluoropropane (HCFC-233)
C₃H₂F₄Cl₂ - Dichlorotetrafluoropropane (HCFC-234)
C₃H₂F₅Cl - Monochloropentafluoropropane (HCFC-235)
C₃H₃FCl₄ - Tetrachlorofluoropropane (HCFC-241)
C₃H₃F₂Cl₃ - Trichlorodifluoropropane (HCFC-242)
C₃H₃F₃Cl₂ - Dichlorotrifluoropropane (HCFC-243)
C₃H₃F₄Cl - Monochlorotetrafluoropropane (HCFC-244)
C₃H₄FCl₃ - Trichlorofluoropropane (HCFC-251)
C₃H₄F₂Cl₂ - Dichlorodifluoropropane (HCFC-252)
C₃H₄F₃Cl - Monochlorotrifluoropropane (HCFC-253)
C₃H₅FCl₂ - Dichlorofluoropropane (HCFC-261)
C₃H₅F₂Cl - Monochlorodifluoropropane (HCFC-262)
C₃H₆FCl - Monochlorofluoropropane (HCFC-271)
All isomers of the above chemicals

OZONE-DEPLETING SUBSTANCES

A. Class I

1. Group I:
 - CFCl₃ - Trichlorofluoromethane (CFC-11)
 - CF₂Cl₂ - Dichlorodifluoromethane (CFC-12)
 - C₂F₃Cl₃ - Trichlorotrifluoroethane (CFC-113)
 - C₂F₄Cl₂ - Dichlorotetrafluoroethane (CFC-114)
 - C₂F₅Cl - Monochloropentafluoroethane (CFC-115)
 - All isomers of the above chemicals
2. Group II:
 - CF₂ClBr - Bromochlorodifluoromethane (Halon-1211)
 - CF₃Br - Bromotrifluoromethane (Halon-1301)
 - C₂F₄Br₂ - Dibromotetrafluoroethane (Halon-2402)
 - All isomers of the above chemicals
3. Group III:
 - CF₃Cl - Chlorotrifluoromethane (CFC-13)
 - C₂FCl₅ - CFC-111
 - C₂F₂Cl₄ - CFC-112
 - C₃FCl₇ - CFC-211
 - C₃F₂Cl₆ - CFC-211
 - C₃F₃Cl₅ - CFC-213
 - C₃F₄Cl₄ - CFC-214
 - C₃F₅Cl₃ - CFC-215
 - C₃F₆Cl₂ - CFC-216
 - C₃F₇Cl - CFC-217
 - All isomers of the above chemicals
4. Group IV:
 - CCl₄ - Carbon Tetrachloride
5. Group V:
 - C₂H₃Cl₃ - 1,1,1-Trichloroethane (Methyl chloroform)
 - All isomers of the above chemical except 1,1,2-trichloroethane
6. Group VI:
 - CH₃Br - Bromomethane (Methyl bromide)
7. Group VII:
 - CHFBr₂
 - CHF₂Br (HBFC-22B1)
 - CH₂FBr
 - C₂HFBr₄
 - C₂HF₂Br₃
 - C₂HF₃Br₂
 - C₂HF₄Br
 - C₂H₂FBr₃
 - C₂H₂F₂Br₂
 - C₂H₂F₃Br

C₂H₃FBr₂
C₂H₃F₂Br
C₂H₄FBr
C₃HFBr₆
C₃HF₂Br₅
C₃HF₃Br₄
C₃HF₄Br₃
C₃HF₅Br₂
C₃HF₆Br
C₃H₂FBr₅
C₃H₂F₂Br₄
C₃H₂F₃Br₃
C₃H₂F₄Br₂
C₃H₂F₅Br
C₃H₃FBr₄
C₃H₃F₂Br₃
C₃H₃F₃Br₂
C₃H₃F₄Br
C₃H₄FBr₃
C₃H₄F₂Br₂
C₃H₄F₃Br
C₃H₅FBr₂
C₃H₅F₂Br
C₃H₆FBr

8. Group VIII:
CH₂BrCl (Chlorobromomethane)

B. Class II

CHFC₁₂ - Dichlorofluoromethane (HCFC-21)
CHF₂Cl - Chlorodifluoromethane (HCFC-22)
CH₂FC₁ - Chlorofluoromethane (HCFC-31)
C₂HFCl₄ - Tetrachlorofluoroethane (HCFC-121)
C₂HF₂Cl₃ - Trichlorodifluoroethane (HCFC-122)
C₂HF₃Cl₂ - Dichlorotrifluoroethane (HCFC-123)
C₂HF₄Cl - Monochlorotetrafluoroethane (HCFC-124)
C₂H₂FC₁₃ - Trichlorofluoroethane (HCFC-131)
C₂H₂F₂Cl₂ - Dichlorodifluoroethane (HCFC-132b)
C₂H₂F₃Cl - Monochlorotrifluoroethane (HCFC-133a)
C₂H₃FC₁₂ - Dichlorofluoroethane (HCFC-141b)
C₂H₃F₂Cl - Monochlorodifluoroethane (HCFC-142b)
C₂H₄FC₁ - Chlorofluoroethane (HCFC 151)
C₃HFCl₆ - Hexachlorofluoropropane (HCFC-221)
C₃HF₂Cl₅ - Pentachlorodifluoropropane (HCFC-222)
C₃HF₃Cl₄ - Tetrachlorotrifluoropropane (HCFC-223)
C₃HF₄Cl₃ - Trichlorotetrafluoropropane (HCFC-224)
C₃HF₅Cl₂ - Dichloropentafluoropropane (HCFC-225ca)
C₃HF₅Cl₂ - Dichloropentafluoropropane (HCFC-225cb)
C₃HF₆Cl - Monochlorohexafluoropropane (HCFC-226)

C₃H₂FCl₅ - Pentachlorofluoropropane (HCFC-231)
C₃H₂F₂Cl₄ - Tetrachlorodifluoropropane (HCFC-232)
C₃H₂F₃Cl₃ - Trichlorotrifluoropropane (HCFC-233)
C₃H₂F₄Cl₂ - Dichlorotetrafluoropropane (HCFC-234)
C₃H₂F₅Cl - Monochloropentafluoropropane (HCFC-235)
C₃H₃FCl₄ - Tetrachlorofluoropropane (HCFC-241)
C₃H₃F₂Cl₃ - Trichlorodifluoropropane (HCFC-242)
C₃H₃F₃Cl₂ - Dichlorotrifluoropropane (HCFC-243)
C₃H₃F₄Cl - Monochlorotetrafluoropropane (HCFC-244)
C₃H₄FCl₃ - Trichlorofluoropropane (HCFC-251)
C₃H₄F₂Cl₂ - Dichlorodifluoropropane (HCFC-252)
C₃H₄F₃Cl - Monochlorotrifluoropropane (HCFC-253)
C₃H₅FCl₂ - Dichlorofluoropropane (HCFC-261)
C₃H₅F₂Cl - Monochlorodifluoropropane (HCFC-262)
C₃H₆FCl - Monochlorofluoropropane (HCFC-271)
All isomers of the above chemicals