



Bus Climate Control
York, Pa USA

Drawing No. Z-293

Rev. A

Title:

**CONTAMINATION LIMITS FOR
FLUOROCARBON AND CO2 FRGT**

Date: 03-23-25

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1.0 Scope

This Engineering Requirement establishes maximum limits for water, non-condensable gases, liquid, and solid contaminants for fluorocarbon and CO₂ refrigerant - containing tubing, coils compressors, vessels and complete systems manufactured by Buss Climate Control Corporation. It also outlines referee check methods for determining if the component and system meets the intent of each individual requirement. At the end of the requirement is an appendix, which outlines some acceptable methods for obtaining desired levels of cleanliness.

1.1 Refrigerants and Oils

Refrigerants and oils charged into systems or components shall meet all the requirements of the applicable material specifications.

2.0 Moisture Content

Excessive moisture in a refrigerating system can cause ice formation in the expansion valves, capillary tubes, or evaporator. It can also induce corrosion of metals, copper plating, chemical degradation to motor materials, hydrolysis of lubricants, and sludge formation. The solubility of water in refrigerant varies with different refrigerants and with temperature.

2.1 Complete Systems (Including Split Systems)

Requirement - Moisture content of the refrigerant shall not exceed 50 ppm with single component refrigerants R-134a and CO₂, Zeotropic blends R-404A, R-407C and R-410A, and 60 ppm with R-22.

Referee Check Method - System shall be operated four hours at conditions that will load the system compressor to at least the full load amperes as stamped on the unit. After four hours a liquid sample will be collected in a dry evacuated cylinder, and sent to a certified laboratory for moisture determination.

2.2 System Components

2.2.2. Coils (RTPF Al/Cu & Al/Al, MCHX), Tubing, Pressure Vessels and Open Compressors

2.2.2.1 Those to be shipped with refrigerant holding charges as components for field assembly.

Requirement - Moisture content shall not exceed 25 ppm.

Referee Check Method – Moisture can be confirmed with a moisture monitor/meter by taking a reading when component is at room ambient and approximately 0 PSIG (101 kPa) or it can be sent to a certified testing laboratory.

2.2.2.2 Those shipped without refrigerant charge and intended to be purged with an inert gas (e.g. N₂) or otherwise evacuated in the field.

Referee Check Method - Gas within the device to be recirculated through a dew point meter until the dew point stabilizes. “Check Evacuation” is a satisfactory alternate method.

2.2.3 Hermetic Motor - Compressors

Requirement - Moisture content shall not exceed that given by the formula



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.6667 g = .10 (Tons)

Tons = Maximum rated compressor capacity in tons at ARI standard compressor rating conditions of
(Air Cooled) 45° TS/130° TC 65° Return/0° Sub-cooling
(Water Cooled) 45° TX/105° TC/55° Return/0° Sub-cooling

Referee Check Method - This shall be determined by collecting moisture in a dry ice cold trap (-90° to 100°F) with the compressor evacuated to pressure of 100 microns or lower for four hours. Compressor is to be maintained at a temperature of 240°F \pm 5° during this time.

3.0 Non-Condensable (For purposes of this Engineering Requirement, a non-condensable gas is defined as a gas that has a boiling point of -100°F (-73°C) or lower at atmospheric pressure.)

3.1 Complete Systems (Including Split Systems)

Requirement - Non-condensables shall not exceed 500 ppm (0.05%) by volume of the total system refrigerant charge.

Referee Check Method - A representative sample of the charge shall be removed after the system has been operated, and allowed to equilibrate for at least 2 hours after the system has been shut down. This will allow for molecular dispersion to occur. The sample of gas shall be evaluated by gas chromatography for non-condensables.

3.2 Components Intended for Field Assembly

3.2.1 Those shipped with refrigerant holding charge.

Requirement - Non-condensables shall not exceed 500 ppm (0.05%) by volume the holding charge.

Referee Check Method - A representative sample of the charge shall be removed after the system has been operated, and allowed to equilibrate for at least 2 hours after the system has been shut down. This will allow for molecular dispersion to occur. The sample of gas shall be evaluated by gas chromatography for non-condensables.

4.0 Liquid and Solid Contaminants

4.1 Complete Systems

Requirement - Solid contaminants shall not exceed 0.1 g and 0.25 cc (Compacted Volume) per nominal ton of system capacity.

Referee Check Method - System to be given standard shipping test and then operated for 80 hours at conditions, which will simulate the refrigerant flow rate and standard rating conditions. (An acceptable way to keep the suction and discharge saturated temperatures within \pm 5° of the pertinent values at the standard rating conditions.) The unit will be cycled alternately during this period for 55 minutes "on" and 5 minutes "off." The system strainers or filters will collect the residue during operation, by filtering the compressor oil charge (test filters should retain particles 5 microns in size or larger), and by flushing with a high purity suitable solvent (e.g. mineral spirits, petroleum naphtha, an alcohol, heptane) the compressor, accumulator and other components that may trap solids (Caution: These solvents are extremely flammable and a health hazard. Use proper personal protection equipment and ventilation when handling these solvents). With products having shell type components that are large volume and have low velocity refrigerant flow paths (such as certain water-cooled condensers) it may not be practical to open and flush out these

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devices. In these cases it will be satisfactory to run the unit for 200 hundred hours (instead of 80) and check the filters, the oil and flush the compressor only.

4.1.1 Liquids and Dissolved Solids

Requirement - These shall be limited to a level that will permit the oil to match the stability of the new compressor lubricant within 0.5% per ASHRAE Standard 97 "Sealed Glass Tube Method to Test the Chemical Stability of Materials for Use within Refrigerant Systems." (Ex. if new oil equals 2.5% refrigerant breakdown then the sample being checked should not exceed 3.0 %.)

Referee Checked Method - Remove oil and any entrained refrigerant charge from the compressor after the operation described in 4.1 above. The entrained refrigerant shall be evaporated from the oil and a representative sample or the oil will be checked for stability by the sealed tube test method. The stability of the sample shall be compared to the stability of a sample of the new oil taken at the time of charging.

4.2 Copper Contamination

Systems using MCHX or all aluminum RTPF heat exchanger, for components; every attempt should be made to limit or in best case, be free of copper particulates (chips, shavings, oxide flakes, etc.). Copper contamination cannot be tolerated in a system with an all aluminum heat exchanger. It is the responsibility of each Business Unit in consultation with MTG to determine the amount of copper contamination that can be tolerated in their systems.

Referee Check Method- Wash component with a suitable solvent (alcohol, heptanes) and collect on a filter media. Microscopically examine for the presence of copper. Further verification of the solids can be performed by SEM.

Note:

For systems using MCHX or all aluminum RTPF heat exchangers, it is recommended that a filter be designed into the system in the Liquid Line, upstream of the TXV Valve on the Evaporator side and in the Compressor Suction line. It is the responsibility of each Business Units in consultation with MTG, by product, to determine if this is required as well as the size of the filter. Driving factors that may drive this decision are variables such as moisture content, compressor type (i.e. reciprocating or Scroll) and system cleanliness.

4.3 Components (Either Field or Factory Assembly)

4.3.1 Coils (RTPF Al/Cu & Al/Al, MCHX), Tubing, Pressure Vessels and Compressors

Requirement - Contamination shall not exceed that in the following Table.

1. Component	2. Solids	3. Solids and Liquids	Liquids* & Dissolved Solids (B)
Coils	0.0035 g/ft. ² Internal Surface	Not more than a total of 0.0035 g/ft. ² for both per ASTM B-280 Buss Climate Control formed connecting Tubing Systems using all aluminum	0.0035 g/ft. ² Internal Surface (B)
Strait Tubing	0.0035 g/ft. ² Internal Surface		0.0035 g/ft. ² Internal Surface (B)
Pressure Vessel	0.0035 g/ft. ² Internal Surface		0.0035 g/ft. ² Internal Surface (B)

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Compressors	0.051 g/Nominal (Open & Hermetic) Ton (A)	HX- Components must limit or in "Best Case", eliminate copper contamination (Refer to Section 4.2.	0.005 g/ft. ² (B)
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* 0.0035mg/ft²= 3.5mg/ft²

*Buss Climate Control approved fluids are exempt from the limits.

Although 0.051 g/ton will be accepted as an upper limit, it is intended the compressor supplier take corrective action whenever more than 5% of shipments exceed 0.035 g/ton.

- (A) Capacity 45°TS/130° TC/65° Return Gas/0° Sub-cooling - Air Cooled
Capacity 40°TS/105° TC/55° Return Gas/0° Sub-cooling - Water Cooled

- (B) Note: Compressors used in the system may contain assembly and/or run-in residual oil to a maximum of 5% of the system production oil charge if the oil is determined to be compatible or Buss Climate Control approved with the compressor lubricant and system refrigerant. If not approved, ASHRAE Standard 97 must be conducted adding 5% of the processing fluid to the compressor lubricant.

Referee Check Method - Contaminants to be collected by circulating or washing internally (to constant weight) with a high purity suitable solvent (e.g. mineral spirits, petroleum naphtha, an alcohol, heptane) filtering the solution to collect solids 5 microns or larger, and then evaporating the solution to determine the quantity of liquid or dissolved contaminants (Caution: These solvents are extremely flammable and a health hazard. Use proper personal protection equipment and ventilation when handling these solvents).

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APPENDIX

- 5 Following are some acceptable methods for obtaining the desired levels of cleanliness of internal surfaces and spaces of refrigerant containing parts. Alternate methods are satisfactory if they produce the results specified in this requirement.

5.3 Copper Tubing

5.3.1 Tubing as Received - Tubing accepted for fabrication into hairpins, return bends, coils, manifolds, connecting lines etc., should have refrigeration quality bright anneal internal finish. Good practice is as specified in ASTM B-280 (Latest Revision).

5.3.2 Tubing Fabrication - If fabrication into subassemblies such as hairpins, return bends and headers is accomplished without the use of lubricants, if chipless cutting and forming operations are used, and if storage of parts between steps of fabrication is provided in clean, sealed containers, no cleaning of finished parts should be necessary.

5.3.2.1 Cleaning of the tubing is not required if the lubricant used in the tubing fabrication operation meets the following requirements:

(A) The lubricant must be qualified by Buss Climate Control Engineering for System Compatibility.

(B) The tubing has met the requirements set forth in section 5.1.2 for chipless processing and storage.

Note: Any changes in refrigerant will require the lubricant to be re-qualified by Buss Climate Control Engineering for use with the new refrigerant.

5.1.2.2 If any of the above is not achieved, parts must be cleaned. One way of doing this is to pump a suitable cleaning solvent through the tubing at sufficient velocity to carry the contaminants through and out.

5.3.3 Tube Brazing - All soldered or brazed joints (except beyond pinch-offs) shall be made with an inert or reducing gas present on the refrigerant side. This is important to prevent oxidation and oxide flakes from dislodging from the wall surface.

5.3.3.1 Fluxless brazing shall be used wherever practical for making joints, and where fluxes must be used, the fabrication technique (and cleaning method, where necessary) used shall be such as to prevent residual flux on the refrigerant side of the joint.

5.3.4 Tube Cleaning - In the event it is necessary to clean the tubing prior to use, the following method is acceptable.

(A) Remove oil and grease by immersion in a hot aqueous cleaner.

(B) Rinse by immersion in clean overflowing water tank.

(C) Remove scale and oxidation products by immersion in a tank of hot oxidizing acidic solution.

(D) Rinse as in (B) above.

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- (E) Dry completely in an oven, remove trapped water by manipulation to drain and blow out with clean dry air if necessary.

5.4

Steel and Cast Iron Parts

- 5.4.1 Un-machined Castings - Casting before machining should be free of fused-on sand, core sand, wires and flash. An acceptable method of obtaining this condition is the use of shot or grit blasting and hand-chiseling if necessary.

5.4.2 Steel Parts and Compressor Components of Cast Iron

An acceptable method for the accomplishment of the required cleanliness level is the use of a three-stage pressure-spray washer followed by a forced circulation-drying oven. The three stages use the following materials.

(A) Low PH cleaner such as Oakite 86M at 150° - 160°F, approximately 3 - 5% volume.

(B) Water rinse, overflowing.

(C) Rust preventing solution (at 130° - 140°F) such as Oakite 98, 1 - 2% by volume.

Note: Rust preventive materials must be approved by Buss Climate Control per ASHRAE Standard 97.

5.5 Coils, Tubing, Pressure Vessels and Open Compressors to be Assembled and Evacuated in Subsequent Manufacturing Operations

- 5.5.1 For storage prior to assembly, the dew point of air in the component must be at least 10°F below the lowest ambient in which the component will be stored.

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