



Suva[®]
refrigerants



ART-33

Retrofit Guidelines for Suva[®] 95 (R-508B)

Suva[®] 95 was developed by DuPont as a non-ozone-depleting replacement for R-503 and R-13 in the low side of very low temperature (VLT) applications using cascaded compressors. These applications typically operate with evaporator temperatures between -40°F and -150°F (-40°C and -100°C), and include environmental test chambers, constant (very low) temperature freezers, and process cooling. The production of R-503 and R-13 ceased at the end of 1995 as mandated by the Montreal Protocol and other legislation. Suva[®] 95 can be used to retrofit existing R-503 and most R-13 systems if the proper procedures are followed. Refer to DuPont's PFC Refrigerants Environmental Policy for guidelines on controlling emissions of Suva[®] 95.

VLT systems are often unique and sometimes complex in their design. Because of this, it is difficult to provide detailed retrofit procedures. The objective of this bulletin is to provide general retrofit guidelines and items for consideration when planning a conversion to Suva[®] 95. Original equipment manufacturers (OEMs) as well as compressor suppliers should always be consulted for their recommendations. Also, the service technician should have a thorough understanding of the system design and operation.

Properties

Suva[®] 95 is an azeotropic mixture of nonozone-depleting refrigerants. It is nonflammable and has zero ozone-depletion potential. Because of these properties, Suva[®] 95 is an excellent refrigerant for applications in VLT refrigeration (less than $-40^{\circ}\text{F}/^{\circ}\text{C}$) where safety and consistency of performance are required.

Table 1 lists the general properties of Suva[®] 95.

Table 1
General Properties of Suva[®] 95

Boiling Point, 1 atm	-126.5°F (-88°C)
Critical Temperature	56.7°F (13.7°C)
Critical Pressure	571 psia (3935 kPa)
Latent Heat of Vaporization at Boiling Point	72.4 Btu/lb (168.2 kJ/kg)
Saturated Vapor Density at -100°F (-73.3°C)	0.83 lb/ft ³ (13.25 kg/m ³)
Ozone Depletion Potential (R-12 = 1)	0
Flammability	Nonflammable
Exposure Limit* (8- and 12-hour time weighted average)	1000 ppm

*The exposure limit is a calculated limit determined from the DuPont AEL of the individual components. It is an airborne exposure limit established by DuPont to which nearly all workers can be repeatedly exposed during a working lifetime without adverse effects.

Operating Characteristics

Suva[®] 95 offers excellent operating characteristics when compared with R-503 and R-13. Capacity and efficiency values are nearly equivalent to R-503 and superior to R-13. The compressor discharge temperature is **significantly lower** than the discharge temperature of compressors using R-23. Lower discharge temperatures may equate to longer compressor life and better lubricant stability.

The estimated operating values of a cascade system running with Suva[®] 95 are shown in **Table 2**. R-503, R-13, and R-23 performance parameters are shown for comparison.

Table 2
Theoretical Performance of a Cascade System
Using R-13, R-503, R-23, or Suva® 95

	R-503	R-13	R-23	Suva® 95
Capacity	100	71	74	98
Efficiency	100	105	95	103
Discharge Pressure, psi (kPa)	145 (999)	104 (717)	123 (848)	147 (1013)
Suction Pressure, psi (kPa)	18 (124)	12 (83)	13 (90)	18 (124)
Discharge Temperature, °F (°C)	225 (107)	198 (92)	280 (138)*	186 (85)

Operating Conditions: -120°F (-84.4°C) evaporator; -31°F (-35°C) condenser; 10°F (5.6°C) subcooling; 0°F (-17.8°C) suction temperature; 70% isentropic compression efficiency; 4% volumetric clearance.

* Field tests have shown that the discharge temperature can be as high as 300°F (149°C) in some hermetic and semihermetic compressor systems.

General

- Suva® 95 is the best choice to replace R-13, R-23, and R-503 in the large majority of existing systems.
- When retrofitting to Suva® 95, follow an “HFC type” retrofit procedure (such as the Suva® HP62 procedure).
- Before beginning the retrofit, the unit should be in good operating condition. Suva® 95 will NOT correct preexisting problems. Baseline performance data should be recorded before and after retrofit.
- The existing oil should be replaced with a high-quality polyol ester (POE) lubricant, suitable for very low-temperature operation. Residual mineral oil should be less than 5%. This might require three or more lubricant flushes.
- Because POEs are better solvents than mineral oils, some accumulated sludge in the system may be dissolved into the refrigerant/oil stream (depending on the age and condition of the system). Filters may need to be changed more frequently during the initial runs after the retrofit.
- Driers should be replaced. Driers designed for R-13 and R-503 or Suva® 95 are acceptable.
- O-rings have not been changed in most retrofits monitored by DuPont. However, based on the age and condition of the O-rings, they are a possible leak source. A thorough leak test should be conducted before and after the retrofit. Any O-rings that are disturbed during retrofit should be replaced with new O-rings that are compatible with HFCs and POE lubricants.
- Recycle or recovery machines designed for use with R-13 or R-503 can be used with Suva® 95. However, avoid mixing refrigerants.

Expansion Tanks

• Regardless of the refrigerant being used, some VLT systems contain expansion tanks, others do not. When designing the system, the OEM determines if an expansion tank is needed based on a number of factors. A tank is normally included for two reasons:

- 1) To provide a reservoir to dump refrigerant during high load operation when compressor discharge pressure might increase significantly.
- 2) To provide adequate vapor space to prevent the formation of saturated liquid when the system is shut down for a period of time. When saturated liquid is present, very high pressure can develop. The expansion tank ensures that only superheated vapor will be present, limiting system pressure.

If an expansion tank is not included, the system is normally designed with enough vapor space in the various components to avoid situation #2 mentioned above. Likewise, high discharge pressures during system operation are handled by other control methods.

- **When retrofitting from R-503 or R-23 to Suva® 95;** existing expansion tanks do not have to be replaced.
- **When retrofitting from R-13 to Suva® 95;** an expansion tank may need to be installed or replaced. In many retrofits already performed, installation of a tank, or tank replacement, has *not* been required.

For a given system, the lower vapor density of Suva® 95 suggests that a slightly larger expansion tank would be required. This is not always the case, however, because less Suva® 95 charge is required and the original system often is designed with more than the minimum required vapor space. Consult with the OEM for their recommendation.

R-503 Conversions to Suva® 95

- The capacity, energy efficiency, and pressure for Suva® 95 are very similar to those for R-503. Compressor discharge temperature is significantly lower. For these reasons, there are very few changes required during retrofit. Replacing the lubricant with a high-quality POE is the most important change (see “Lubricant Selection”).
- The systems are typically charged to a certain pressure. As a general rule, the static charge pressure for Suva® 95 will be about 8% lower than for R-503 (see **Table 3**).

R-13 Conversions to Suva® 95

- Use a high-quality POE lubricant; residual mineral oil should be less than 5%.

- The static charge pressure for Suva® 95 should be about 7% higher than for R-13 (see **Table 3**). After starting up the system, the charge size should be optimized by adding small amounts and monitoring system performance. Adjustments to charge size after start-up should be monitored carefully because overcharging could result in overpressure of the system during the shut-down mode.
 - For most applications, the expansion tank does not have to be replaced. Suva® 95 has a slightly higher pressure and a higher specific volume than R-13; but a smaller weight of refrigerant is charged into the system. This combination should result in adequate expansion capacity when the system is shut down. In very high ambient conditions, the pressure rating of the expansion tank should be checked for adequacy.
 - Because Suva® 95 has higher discharge pressure, the high-pressure valve (frequently called the dump valve) will have to be adjusted. For Suva® 95, it should be adjusted to about 290 psi (2000 kPa) initially. Further adjustments may be required.
 - In some systems, the existing expansion valve will be adequate. If it must be replaced, an R-503 expansion valve with the same tonnage rating is suggested. You may also want to check with your parts supplier to see if expansion valves designed specifically for Suva® 95 are available.
 - The theoretical cooling capacity of Suva® 95 is about 30% greater than that of R-13, which may affect the operation of the cascade system. Modifications may be required. The heat exchangers, expansion devices, and compressor motor should be evaluated to ensure that they can handle any additional load on the system. We believe Suva® 95 can replace R-13 in the majority of existing systems.
 - In some R-13 systems, Suva® 95 may not be able to satisfy the design requirements, or the expansion device or cap tube may be inaccessible. In these cases, we recommend that you consider the use of R-23 because its capacity is only about 5% higher than that of R-13. Keep in mind that R-23 will have significantly higher discharge temperature, which could negatively impact system reliability.
- If a POE lubricant is being used with the R-23, it does NOT have to be replaced when converting to Suva® 95.
 - The static charge pressure of Suva® 95 will be about 25% LESS than that of R-23 (see **Table 3**).
 - The expansion tank will not have to be replaced. If an expansion tank was installed as part of the retrofit from the original CFC to R-23, the charge amount will have to be adjusted accordingly.
 - Due to the higher operating pressure of Suva® 95, the dump valve setting should be increased to about 290 psig.
 - If the system is equipped with liquid injection, the valves will need to be “throttled back” to reduce the flow.
 - Because Suva® 95 has about 25% higher capacity, the TXV may need to be adjusted or replaced. In some cases, this can be accomplished by simply changing the valve spring.
- Note:** If the system contains a cap tube that is difficult to access, it may not make economic sense to convert to Suva® 95 if the cap tube has to be adjusted or replaced.

Table 3
Typical Static Charges

Original Refrigerant		Suva® 95	Static Charge Ratio
Type	Static Charge (psia)	Static Charge* (psia)	
R-13	125	134	1.07
R-503	125	115	0.92
R-23	125	94	0.75

Test Conditions: Evap: -70°F (-57°C)
Cond.: -25°F (-32°C)

*These are provided as a general guideline; charge optimization may be required.

Lubricant Selection

The criteria used for selecting a lubricant for use with Suva® 95 in an existing VLT system should include the following: refrigerant/lubricant miscibility, chemical stability, materials compatibility, and refrigeration system design. OEMs and compressor suppliers should be consulted. In the past, mineral oils and alkylbenzene have been proven to work well with R-13 and R-503 in cascade systems even though they have limited miscibility. The refrigeration systems were designed to take this limited miscibility into consideration. The miscibility of Suva® 95 with certain polyol esters is slightly better than that of R-13 and R-503 with mineral oil and alkylbenzene. This should help oil circulation at the low evaporator temperatures.

R-23 Conversions to Suva® 95

Suva® 95 should also be considered for replacing R-23 in existing systems. Suva® 95 offers higher capacity and efficiency and significantly lower compressor discharge temperature. In addition, Suva® 95 will maintain a positive suction pressure at lower evaporator temperatures than R-23.

Example: At -120°F (-84°C), the suction pressure for R-23 will be 3.9 inHg vacuum (90 kPa). The pressure for Suva® 95 will be 3 psig (122 kPa).

Certain POEs, designed for use in very low-temperature systems, have been used successfully with Suva® 95 in equipment retrofits. As men-

tioned, OEMs and compressor suppliers should be consulted before making a final decision on the lubricants.

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