



Refrigeration Consulting Services

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Conversion Evaluation

R-22 to R-453A (R 44B)

Storage Refrigeration System

For

**Advanced Refrigerant Technologies (ART)
1613 Highway 3, South
League City, TX 77573**

For

**Del Monte Fresh Produce
Piers 16 & 18
Galveston, TX**

Project No. 201635

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Texas Engineering Firm F-2055



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1.0 Introduction:

The Storage Refrigeration System at Del Monte Fresh Produce, Piers 16 & 18, in Galveston, TX was inspected and evaluated to determine its suitability for converting the system to operation on R-453A (RS 44B) from its present operation on R-22 in order to avoid the rapidly increasing cost of R-22 due to its scheduled phase out in 2020. The Del Monte System underwent a thorough upgrade during 2007- 2011 and has been operating adequately since then. The refrigeration system is used to refrigerate bananas, pineapples, and melons stored at the facility at three temperatures: bananas, 52°F, pineapples at 45°F, and melons at 38°F.

The evaluation was done to identify any performance differences (capacity gain or loss and power increase or loss) for the system, to determine any capacity deficiencies for the components and piping, and to determine the need for modification or changing system components.

The refrigeration system is an industrial, central refrigeration system consisting of 6 Frick rotary screw refrigeration compressors, 3 evaporative condensers, 2 high pressure receivers, 2 shell and tube refrigerant sub coolers, and 4 suction accumulators, installed in an engine room at the facility. The storage spaces consist of 5 storage coolers, 4 of them containing 8 evaporators (air units), 1 containing 6 air units, and 2 Docks, each containing 6 air units.

All of the evaporators operate DX with the cooler units having 2 thermostatic expansion valves (TXVs) each and the Dock units with one TXV each. All refrigerant piping to and from the evaporators is installed on the roof of the facility. Please refer to the refrigeration drawings for the facility (available at Del Monte) for complete refrigeration system details.

The design refrigeration loads are shown on 201635-PFD1 prepared for the conversion evaluation (copy in Appendix). The total refrigeration estimated design load is 689 tons at the normal operating conditions (on R-22) of 26°F (50 psig) and 95°F condensing temperature. Del Monte stated that only 3 compressors are normally needed throughout the year, therefore, the percent utilization used for this evaluation was estimated conservatively at 65% of the available capacity from the compressors. This utilization rate then determined the normal capacity available from the compressors when operating with R-453A.

Section 2.0 is an executive summary of the results of the evaluation. Section 3.0 provides a discussion of the evaluation's findings and any recommended changes that were found to be necessary. The Appendix contains the spreadsheet showing the evaluation calculations and supporting documentation including compressor rating results. The spreadsheet contains the detailed findings supporting the conversion.

2.0 Executive Summary:

The results of the evaluation show that the R-22 refrigeration system appears to be a good candidate for conversion to R-453A (RS 44B). The spreadsheet evaluation shows that compressor capacity will be reduced by about 6% and the power required increased by about 1.5%. However, because of the available excess capacity, this should be of little concern since there will be adequate excess capacity available for both unusual and unexpected larger loads might they occur, and for backup capacity for all compressors. The evaluation shows that total available capacity on R-453A will be 715.7 tons or 250.5 tons of excess capacity for 465.2 tons required for loads at 65% utilization. The available capacity will also satisfy the total estimate design loads of 689 tons, allowing 27.7 tons of excess, but that load level has not reached even near that level during the last 5 years of operation,.

Operation on R-453A will require operating the compressors at 47.3 psig to maintain the average 26°F evaporating temperature due to the refrigerant glide for R-453A. This accounts for the reduced capacity. The average temperature due to glide is an estimate and some additional capacity may be available if the evaporating pressure can be adjusted a bit higher and still provide the required storage temperatures for the facility.

Additionally, R-453A requires a slightly lower mass flow rate, about 3% lower than for R-22. The total mass flow for R-453A is 126,381 lb/hr compared to 130,122 lb/hr for R-22. This means that piping will be adequate for the conversion. The lower mass flow also means that control valves, evaporator pressure regulators and expansion valves, should have adequate capacity. However, set points on the pressure regulators will have to be checked and likely changed and superheats on the TVVs will require checking and readjustment to achieve optimum system performance.

The evaluation did not reveal the need for changing any of the other components. Evaporators, condensers, refrigerant sub coolers, and suction accumulators should be adequate, due to the lower mass flow rates and based on statements made by the refrigerant manufacturer (results of some case studies) that claim minimal performance differences as compared to R-22.

Be aware that changes in system set points will be required and some adjustments will need to be made to achieve best performance from the system.

It should be noted that although the Frick rating shows a change in oil from Frick #2 to Frick #13 for R-453A, the refrigerant manufacturer states that R-453A is compatible with most refrigeration oils. It is recommended that Frick be consulted regarding the oil, but it appears an oil change may not be necessary.

It should be understood that R-453A is a blend and is subject to composition change due to leakage. Therefore, judicious leak checking and repair will be a necessary requirement to ensure good performance from R-453A. Also, regular analysis of the blend composition, with the potential replenishment of individual component addition, if available, will minimize the concern for composition variation due to leaks.

Conversion will require recovery of the R-22 in compliance with 40CFR, Part 82, Subpart F, and any repairs or other maintenance requirements should be considered for completion during the conversion. It is also recommended that the system is evacuated to at least 1,000 microns Hg absolute pressure and checked for moisture before adding new R-453A.

Because this is an existing system with some components older than 5 years, and because there appears to be minimum experience with R-453A in large systems, there can be no guarantee of adequate performance of the system on R-453A.

3.0 Evaluation Details

The details and results of the conversion evaluation are provide on the spreadsheet 201635-Htbal-1 in the Appendix. The spreadsheet provides the details of the evaluation and any recommendations, but the following provides some explanation of the results.

Note the flow rates for R-453A are lower than for R-22, as shown on the Frick runs in the Appendix. The rates are based on operation of the system at an estimated 65% utilization of the available compressor capacity (normally 3 compressors operating) show as 465.2 tons for R-453A. The calculations are based on 201635-PFD-1 process flow diagram, copy in the Appendix.

The compressor capacity results are included in Section II with the total heat rejection shown for the condenser. Section III shows the available condenser capacity compared to the required capacity at 65% utilization (7,454 MBH). Note that at 65%, 6,546 MBH excess condenser capacity is available over the total capacity of 14,000 MBH.

Section IV A provides a discussion of the adequacy of the evaporator pressure regulators. Note that adjustment will be necessary for all storage spaces. Section IV B discusses the thermostatic expansion valves. Superheats for all TXVs will be required.

Section V discusses the 3% lower flow rate that indicates the mass flow rates for R-453A vs. R-22. Adjustment of operating suction pressure may be necessary to achieve optimum performance.

In conclusion, it appears that conversion to R-453A should provide adequate performance for the system, with consideration of the results of this evaluation.

Appendix

201635-PFD-1 Process Flow Diagram

201635 Htbal-1 Evaluation Spreadsheet

Frick Compressor Ratings

RWBII-76 R-453A (2 installed)
RWBII-76 R-22 (2 installed)

RXF-68 R-453A (2 installed)
RXF-68 R-22 (2 installed)

RXF-50 R-453A (1 installed)
RXF-50 R-22 (1 installed)

RXF-30 R-453A (1 installed)
RXF-30 R-22 (1 installed)