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Priority Cool Refrigerant Study

Study Final Report

Greenway Solutions

Prepared for:

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Executive summary

This report demonstrates the energy savings potential of *Priority Cool* hydrocarbon based refrigerant over standard R22 refrigerant. Side by side tests run in both real world settings and a laboratory setting show significant energy savings in the refrigerant compressor electrical loads. While fan loads remain constant, the thermodynamic properties appear to improve performance on the air side of the refrigerant cycle with lower evaporator temperatures and higher moisture removal (latent load).

Compressor energy savings for each test is shown below;

Test Case #1 Lab test – 10%

Test Case #2 Field test – 18 to 19%

Test Case #3 Field test – 24%

The Priority Cool air handler in the lab test removed 27% more moisture from the air in a lab test.

It must be noted that Priority Cool refrigerant has not been registered with the U.S. Environmental Protection Agency (EPA). Similar hydrocarbon refrigerants have not been accepted for use in HVAC systems. These alternative refrigerants are acceptable in commercial refrigeration systems.

I. Purpose of the Report

The purpose of this report is to define the test results for comparing standard R22 refrigerant energy performance and *Priority Cool* hydrocarbon based replacement refrigerant in a side by side study. The testing was performed on air conditioners in a simulated laboratory test, and in a real world side by side comparison.

II. Systems Tested

For the lab tests, integrated testing was performed on a set of two matching direct expansion (DX) units located in the same space in this project. A data acquisition system was installed to monitor and collect data during the field test.

For the field testing, two matching roof top units were used serving offices spaces on the same floor of a commercial office building in Melville.

III. Team Data

Team Member	Company	Contact Info.
Lab Owner	Air Control Supply	Bob Mecca 516-241-2242
Engineering Provider	WSP Flack + Kurtz 512 Seventh Avenue New York, NY 10018	Paul Meyer, PE, CEM, LEEP AP, GBE paul.meyer@wspfk.com Office (212) 951-2662 Fax (212) 689-7489 Cell (917) 596-3191
Client	Priority Cool Refrigerants, Inc	Robert Conway 631-553-8538
Mechanical Contractor	Apollo HVAC Corp	Rudy Holesek 631-242-8787

IV. Laboratory Test Case #1

A laboratory test simulation was performed on two identical DX split units. The heat load was generated in the space with a separate heat source.

Flack + Kurtz scheduled functional tests through the contractor and owners. Flack + Kurtz witnessed and documented the integrated testing of the split units according to the approved Test Plan. The Mechanical Contractor executed the tests.

The test location was the training room at Air Control Supply, 1580 Lakeland Ave, Bohemia, NY 11716.

The room conditions were:

Room size: 22'-9" L x 20'-5" W x 18' H

Ceiling: None installed (exposed /insulated roof deck)

Glass: None (no exterior windows)

Outside Doors: (1) metal man door

Outside Walls: (1) approximately 20' x 16'

Interior lighting: approximately 1.25 wpf

The equipment under test was:

Quantity (2) Amana 2-ton air cooled condensing units – R-22 (specs attached)

(2) Amana 2-ton air handlers – R-22 (specs attached)

(2) Honeywell programmable thermostats

The test room had (1) Payne 45,000 btuh warm air furnace to supply sensible heat load into room. An unconditioned warehouse adjacent to the lab space supplied both sensible and latent heat load thru a large transfer grill.

Refrigeration piping of identical size and length was used to connect both systems

The condensing units were located on grade side by side immediately outside the space on the North side of the building. The air handlers were located side by side on the inside of the North wall for minimum refrigeration pipe run.

Suction and liquid line pressure gauges were installed inside for data monitoring.

The air handlers drew air from the testing room across the evaporator coils and discharged the air out of the building. Room air was made up by a transfer opening from adjoining warehouse space. The warehouse space was not conditioned.

The testing took place from October 13 to 24th, 2011.

The test procedure:

The data acquisition M & V sensors were calibrated and verified as accurate.

Both units were charged with standard R-22 according to factory procedures. The units were run side by side to establish a baseline and to prove that the units performed identically. The data acquisition system was run during this phase of the testing. The units did draw the same power. Please see the appendices for this data.

The Apollo technicians evacuated unit #1 using standard EPA procedures for refrigerant reclaimation.

The unit #1 test system was charged with Priority Cool HC22a/502a refrigerant according to empirical data and manufacturers recommendations. Amount of the original R22 removed was 4 lbs 7 oz. The amount of HC22a/502a installed was

1 lb. 10 oz. One of the primary reasons for lower energy consumption of Priority Cool is the lower gas volume requires less compressor work.

Both units were operated under load and operating parameters were recorded using data acquisition system.

On the initial test day the outdoor weather conditions was heavy rain. The high humidity allowed for the testing of moisture removal capacity between the two refrigerants. Simultaneous condensate water collections were taken from both condensate drains. The Priority Cool (unit #1) discharged 14 fluid ounces of water. The R22 (unit #2) discharged 11 fluid ounces of water. The Priority Cool unit removed 27% more moisture from the conditioned air.

Test was run for 6 consecutive days with data collection. Data is available in the appendices for review.

Metering/Monitoring variables of the two HVAC units:

(i) Inside Space Temperature
(ii) Outdoor Temperature
(iii) Thermostat settings for each space and unit
(iv) Supply air temperature
(v) Return air temperature
(vi) Total kWH
(vii) Electrical Demand
(viii) Refrigerant Low side pressure
(ix) Refrigerant High side pressure
(x) Hours of operation

Team Member Responsibilities

Mechanical Contractor

i) Performed all recommended installation requirements on both split units. This included checking refrigerant charge, condenser and evaporator coils, filters and fans. Provided documentation that installation was completed and copies of the O&M manuals.

ii) Reclaimed the original R22 refrigerant from one of the split units using all required EPA procedures.

iii) Evacuated the refrigerant circuit with a vacuum pump.

iv) Charged the unit with the recommended amount of *Priority Cool* refrigerant according to the manufacturer's instructions.

v) Documented the services performed.

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1) Witnessed the contractor responsibilities shown above. Performed site inspection of split units after installation of Priority Cool refrigerant. Verified correct operation. Insured that all required installations had been performed on both test units.

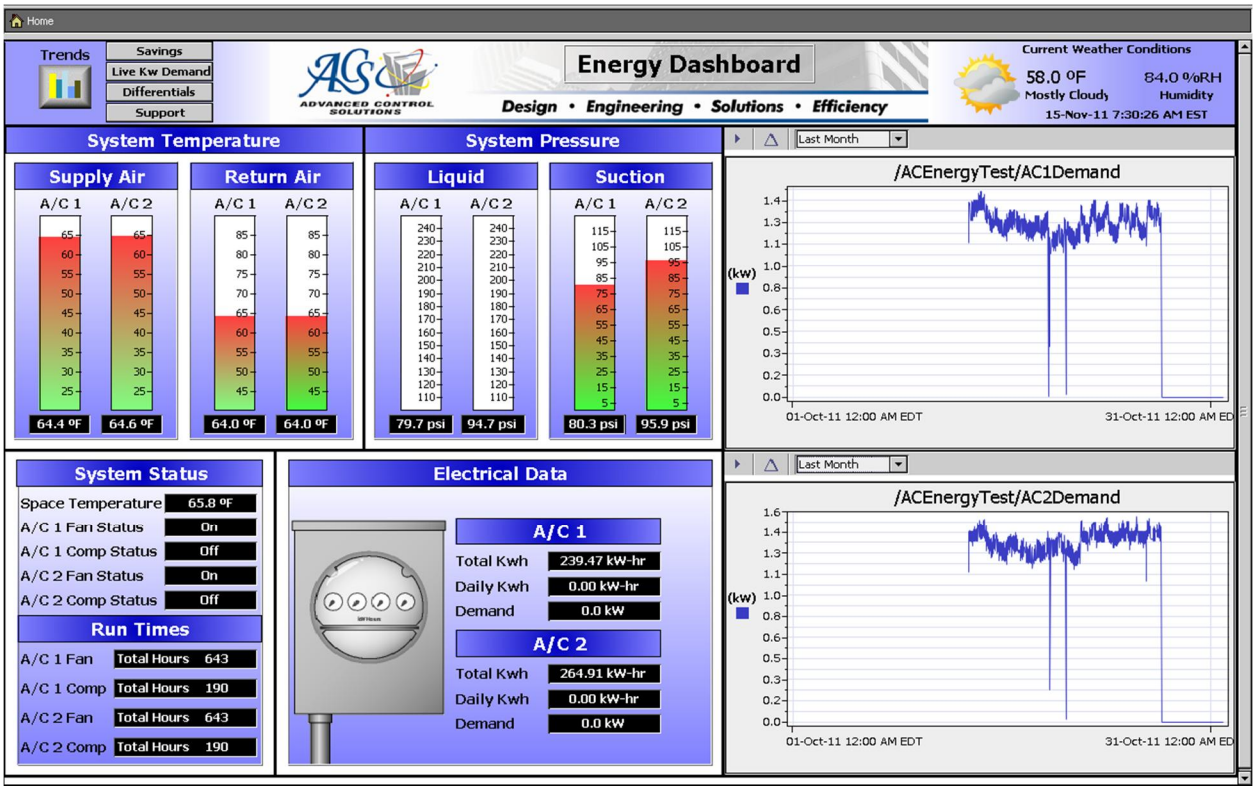
2) Verified data acquisition was recording correct values.

3) Analyzed recorded data and compared energy usage of both units.

4) Performed periodic field observation of DX units.

5) Issued this final engineering report.

Typical screen shot of the data acquisition system-



V. Field Test Case #2:

b. The RXR owned building at 68 South Service Rd. Melville, New York was used for a side by side field test of Priority Cool refrigerant. A 75-ton rooftop heat/cool unit was chosen for the test. The unit was a Trane Model #SFHFC754H777C9BD8D11ABCE0G00L00RT0Y8600, Serial # C05B01224. The unit was charged with R-22 refrigerant and was manufactured in 2006. The unit operates with (6) scroll compressors with circuits #1 and #2. Each circuit consists of (1) 15-ton and (2) 10-ton compressors. This unit serves a general office environment of the first floor that was fully occupied. The total area covered of the floor under test was 62,650 sq.ft., with 31,325 sq.ft. served by each RTU.

On August 17, 2011 the return air was measured at 74F db, the supply air was 55F db, and the outdoor temperature was 82F db.

In this test the entire unit was not shut down in an effort to not cause discomfort to the building occupants. Each circuit was independently shut down and the existing R-22 refrigerant was recovered. Each circuit was evacuated for a period of 45 minutes and the Priority Cool refrigerant was installed. The amount of existing R-22 recovered was 80 lbs in circuit #1 and 79 lbs on circuit #2. Priority Cool refrigerant installed was 37 lb-6 oz in circuit #1 and 36 lbs-3 oz in circuit #2, both weighed by the same electronic scale.

The compressor amperage in circuit #1 while running with the existing R-22 was measured at 26.3, 16.4 and 17.4 respectively on the 460 volt 3 phase circuits. After Priority Cool was installed the compressor amperage was measured at 21.1, 13.3 and 13.9 respectively. **This was a decrease of over 19%.**

The compressor amperage in circuit #2 while running with the existing R-22 was measured at 25.5, 16.9 and 17.2 respectively. After Priority Cool was installed the compressor amperage was measured at 21.4, 13.6 and 13.5 respectively. **This was a decrease of over 18%.** After stabilizing both circuits the supply air temperature leveled off at 52F db with a return air temperature of 76F db. The supply air temperature of Priority Cool was 3F lower than the original R22.

We continued to monitor the performance of this test unit and a second 75-ton rooftop unit serving the general office area at this location. The Priority Cool test unit serves the south half of the building's first floor and the comparison R22 unit serves the north half of the same floor. The compressor amperage continued to be the same spread of between 15% and 19% throughout the test period of 2 months. The amount of condensate generated was not measured in this test.

Note that these 75-ton units are both Variable Air Volume (VAV) units with Variable Frequency Drives. The loads vary due to VAV throttling so the comparative amperage readings were taken during the morning pull-down cycle when the loads were at a maximum.

This test unit remains in operation with Priority Cool refrigerant to date.

VI. Field Test Case #3:

Another field test was performed on July 6, 2011 at the Apollo HVAC offices at 225 North Fehrway, Bay Shore, New York on a 5-ton rooftop heat/cool unit. The unit under test was a Rheem Model #RKKA-A060CK13E, Serial #2A5643ADAAF349911631, using R-22refrigerant and operates on 208 volt 3 phase power, the unit was manufactured in 1999 and uses a scroll compressor. This unit serves a general office environment. The return air was measured as 72F db, the supply air was 51F db, and the outdoor temperature was 84F db.

The unit was shut down and the existing R-22 was recovered. The unit was evacuated for a period of 30 minutes and the Priority Cool refrigerant was installed. The amount of existing R-22 recovered was 8 lb-0 oz and the Priority Cool refrigerant installed was 3 lb-4 oz both weighed by the same electronic scale.

The unit compressor amperage while running with R-22 was measured at 18.5 amps and after Priority Cool was installed the compressor amperage was measured at 13.9 amps. **This was a decrease in compressor amperage of over 24%.** The supply air temperature dropped from 51F db to 48F db.

Apollo continues to monitor the performance of the test unit and a second 5-ton rooftop unit serving the general office area at this location. The test unit serves the perimeter zone and the comparison unit serves the interior zone. The compressor amperage continued to be the same spread of between 20% and 24% throughout the summer test period of 2 months. In addition, the condensate drain water was measured and there was approximately 25% more moisture being removed by the Priority Cool unit.

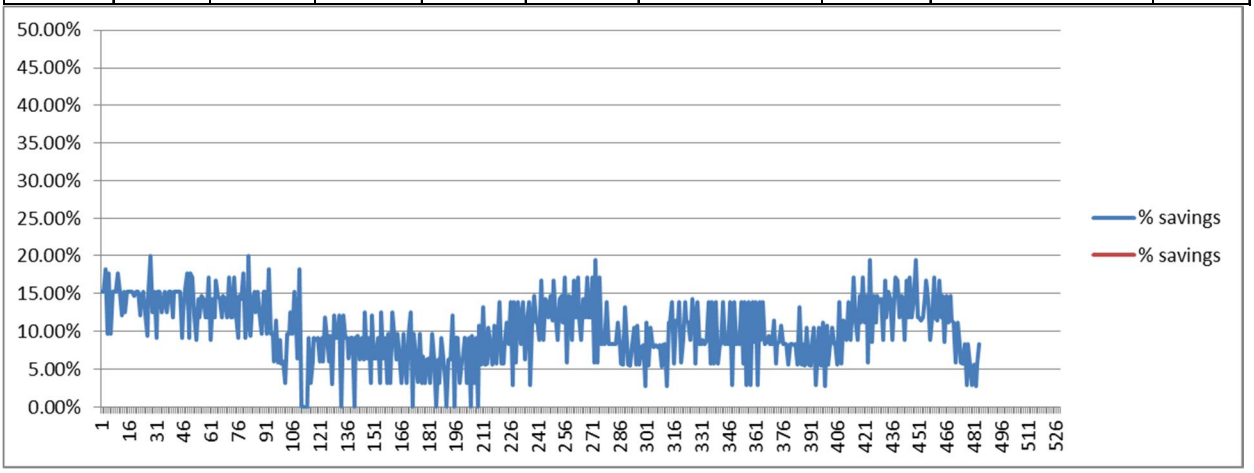
This test unit remains in operation with Priority Cool refrigerant to this date.

Appendices

Lab test data –

	Energy Test						10-19 10-23				
		AC-1		AC-2							
Hours		119		119		KWH Savings					
KWH		146.47		163.22		16.75					
KWH Delta											
						Savings					
Savings		$30.77		$34.28		$3.51					

Date	Time	KWH	Daily KWH	KWH	Daily KWH	Daily KWH Savings	Daily %	Comp Loads S-R C			% Delta
10/19/2011	12:00 PM	0.05		0.03			12 Hours				
10/19/2011	11:45 PM	13.33	13.28	15.52	15.49	2.21	14.27%	AC-1	AC-2		
								4.10	4.10	0.00%	
10/20/2011	12:00 AM	13.61		15.86			24 Hours	4.23	3.84	9.22%	
10/20/2011	11:45 PM	40.92	27.31	46.44	30.58	3.27	10.69%	5.10	5.96	14.43%	3.74%
10/21/2011	12:00 AM	41.22		46.77			24 Hours	AC-1 Measured Amps			
10/21/2011	11:45 PM	70.06	28.84	77.95	31.18	2.34	7.50%	Volts	Amps	Watts	KWH
								202	5.1	1030.2	1.0302
10/22/2011	12:00 AM	70.38		78.31			24 Hours	24 Hour X KWH=			24.7248
10/22/2011	11:45 PM	100.64	30.26	112.06	33.75	3.49	10.34%				
								AC-2 Measured Amps			
10/23/2011	12:00 AM	100.97		112.41			24 Hours	Volts	Amps	Watts	KWH
10/23/2011	11:45 PM	131.59	30.62	146.28	33.87	3.25	9.60%	202	5.96	1203.92	1.20392
								24 Hour X KWH=			28.89408
10/24/2011	12:00 AM	131.89		146.64			11 Hours				
10/24/2011	1:00 PM	147.94	16.05	164.75	18.11	2.06	11.37%	Fan Measured Amps			
								Volts	Amps	Watts	KWH
								202	0.56	113.12	0.11312
Total HWH			146.36		162.98	16.62	10.20%	24 Hour X KWH=			2.71488



RXR office field test data-

RTU-1A		model #SFHFC754H777C9BD8D11ABCE0G00L00RT0Y8600	
68 South Service Road		serial #C05B01224	
Melville, NY 11747		75 tons	85 lbs r-22 per circuit
Circuit #1			
Compressor "A"	m#CSHA150K0D00	s#05C10005	15 ton
Compressor "B"	m#CSHA100K0E00	S#05C07016	10 ton
Compressor "C"	m#CHSA100K0E00	s#05C09060	10 ton
R-22	recovered 80 lbs		
HC-22a	recharged 38 lbs	(44% rated charge)	
R-22	270/65 pressures	84 deg OAT	suction temp 58 deg
	Comp "A"	24.3 amps	
	Comp "B"	14.9 amps	
	Comp "C"	15.8 amps	
HC-22a	210/65 pressures	82 deg OAT	suction temp 57 deg
	Comp "A"	22.1 amps	
	Comp "B"	14.3 amps	
	Comp "C"	14.9 amps	
Circuit #2			
Compressor "A	m#CSHA150K0D00	S#05C10002	15 TON
Compressor "B"	m#CSHA100K0E00	s#05C09054	10 TON
Compressor "C"	m#CSHA100K0R00	s#05C09055	10 TON
R-22	recovered 75 lbs		
HC-22a	recharged 36 lbs	(42% rated charge)	
R-22	281/68 pressures	82 deg OAT	suction temp 58 deg
	Comp "A"	24.5 amps	
	Comp "B"	14.9 amps	
	Comp "C"	15.2 amps	
HC-22a	250/66 pressures	84 deg OAT	suction temp 56 deg
	Comp "A"	21.5 amps	
	Comp "B"	14.2 amps	
	Comp "C"	14.5 amps	
Note:	2nd stage condenser coil needs cleaning		