Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Low-GWP Alternative Refrigerants Evaluation Program (Low-GWP AREP)

TEST REPORT #4

System Drop-in Test of Refrigerant R-32 in Split System Heat Pump (with Addendum)

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This report has been made available to the public as part of the author company's participation in the AHRI's Low-GWP AREP.

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1. Introduction:

   This document reports performance testing conducted on a 3.5 Ton split-system heat pump, designed for operation with R410A, but tested with both R410A and R32 (difluoromethane). This testing occurred during August 2012 at the Lennox Product Development and Research Center in Carrollton, TX.
   The motivation for this work was to investigate the suitability of lower Global Warming Potential (GWP) refrigerants as candidate replacements for the HFC refrigerant: R410A. These two refrigerants have GWPs (AR4, 2007 Assessment) of:

   R410A – 2088
   R32 - 675

2. Details of Test Setup:

   a. <u>Description of System</u>

   The outdoor unit is designated as a 14HPX-042 (Lab Inventory Control # 29882). This R410A heat pump uses a scroll-type compressor and has a thermostatic expansion valve for refrigerant flow control in the heating mode. It uses POE oil. The calorimetered sample compressor was provided by Emerson Climate Technologies.

   The indoor unit is a multi-position coil-blower. The model number is CBX26UH-042 (Lab Inventory Control #29880). This air handler uses a PSC-type direct drive blower and was tested in the upflow configuration. The air flow was set for nominal 1400 CFM (normal for a 3 ½ ton air conditioner).

   The AHRI 210/240 Directory ratings for this system are:

   AHRI #5184649
   14HPX-042-230-18 + CBX26UH-042*+TDR
   Classification: HRCU-A-CB
   Cooling Capacity (Btuh): 42500
   EER Rating (Cooling): 12.00
   SEER Rating (Cooling): 14.00
   Heating Capacity (Btuh) @ 47 F: 45500
   Region IV HSPF Rating (Heating): 8.20
   Heating Capacity (Btuh) @ 17 F: 28200

This system tested 98% of "A" capacity, 103% of "A" EER and 105% of SEER.

b. Description of Modifications to System

A refrigerant flow meter was placed in the liquid line. Pressure taps were placed at the liquid service valve, on the compressor suction and discharge lines and on the liquid line at the inlet to the indoor expansion valve. Thermocouples were placed on the outside of refrigerant piping. Adjustable stems were placed on the expansion valves to enable some superheat adjustment.

c. Description of Tests Conducted

The heat pump was evaluated using a pair of psychrometric test chambers. The indoor portion of the heat pump was connected to an AMCA 210 Code Tester. There are dry bulb/wet bulb temperature samplers on the inlet and outlet air streams. This enables measurement of air side capacity. A coriolis-type flow meter is used to determine refrigerant mass flow rate. With temperature and pressure sensors to establish refrigerant thermodynamic states, the refrigerant capacity can also be measured. An energy balance is determined between the two capacity measurements. The psychrometric test facility is operated as a certified satellite facility and is under an annual calibration system traceable to NIST standards. All instruments were determined to be within accuracy specifications at the conclusion of testing.

The tests that have been conducted are the set of tests required to establish SEER and HSPF ratings according to AHRI 210/240. The test data from the steady-state tests are included in this report. The non-steady-state tests were also conducted but only the cyclic degradation values are included in the report.

The compressor used was one that was furnished to us with calorimeter data for the 50F/100F and 45F/130F test points. We found that the performance improved after a run-in period. All data presented is post run-in.

The approach taken was to charge the R410A system to achieve the subcooling and superheat values that matched production verification testing of this model's performance on the AHRI 210/240 "B" test (82F outdoor temperature). When we switched to R32, we charged the unit to achieve approximately the same subcooling on the "B" test. We found it necessary to adjust the setting of indoor expansion valve to get a similar superheat. We did not have to adjust the outdoor thermostatic expansion valve when we operated in heating mode. We did not exhaust the possible variations in charge and TXV settings to optimize performance. Some further efficiency gains might be possible.

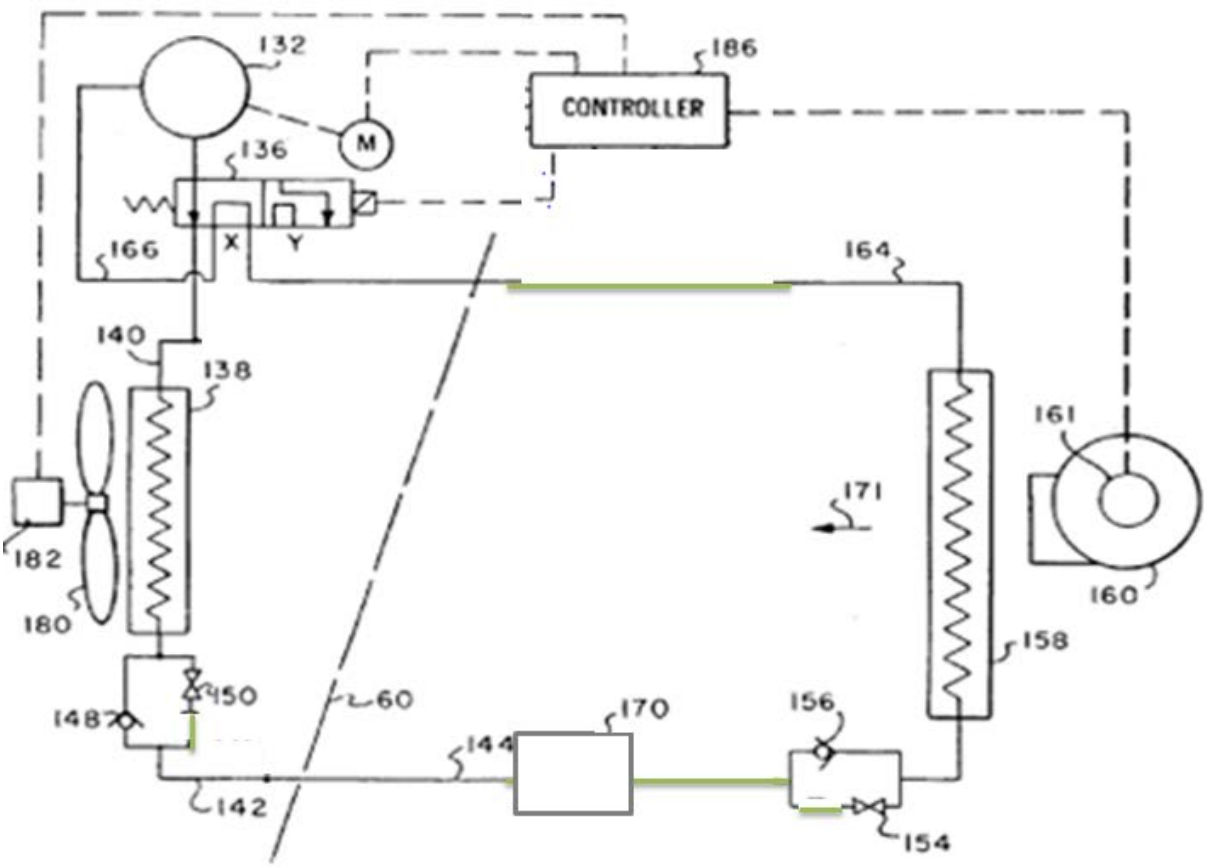


Figure 1. Diagram of Split-System Heat Pump

Legend:
- 60 – Separation line between outdoor and indoor components
- 132 – Compressor
- 136 – Reversing Valve
- 138 – Outdoor Heat Exchanger
- 140 – Vapor Line to Outdoor Heat Exchanger
- 142 – Location of Liquid Service Valve
- 144 – Liquid Line
- 148 – Outdoor Refrigerant Check Valve
- 150 - Outdoor Thermostatic Expansion Valve
- 154 – Indoor Thermostatic Expansion Valve
- 156 – Indoor Refrigerant Check Valve
- 158 – Indoor Heat Exchanger
- 160 – Indoor Blower
- 161 – Indoor Blower Motor
- 164 – Vapor Line to Indoor Heat Exchanger
- 166 – Compressor Discharge Line
- 170 – Coriolis-Effect Refrigerant Flow Meter
- 171- Conditioned Air Delivered to Air Flow Measuring Equipment
- 180 – Outdoor Fan
- 182 – Outdoor Fan Motor
- 186 – Low Voltage Control Panel

3. Results

This page provides information that relates to the heat pump system.

Subsequent pages provide information gathered from the cooling and heating mode tests.

Basic Information	
Alternative Refrigerant	R32
Alternative Lubricant	3MAF-POE
Baseline Refrigerant and Lubricant	R410A + 3MAF-POE
Make and Model of System	Lennox 14HPX-042 + CBX26UH-042
Nominal Capacity and Type of System	3.5 Ton Split Heat Pump

Other System Changes
indoor TXV superheat adjustment

System Data	**Base.**	**Alt.**	**Ratio**
Degradation Coefficient (Cooling) – Cd	0.044	0.028	0.64
Seasonal Energy Efficiency Ratio - SEER	14.68	14.60	0.99
Degradation Coefficient (Heating) – Cd	0.109	0.071	0.65
Heating Seasonal Performance Factor – HSPF (region IV, min DHR)	9.07	9.52	1.05

Test Data Form for Test: "A" Test
Type of System: Split HP Alternate Refrigerant: R32

Air Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	R410A	R32					
Flow Rate (air side)	39.84	39.96	m ^ 3/min	1407	1411	CFM	1.00
Inlet Temperature	26.67/19.44	26.67/19.5	C	80.0/67.0	80.0/67.1	F	
Outlet Temperature	15.33/14.28	15.56/14.22	C	59.6/57.7	60.0/57.6	F	
Condenser							
Heat Exchange Fluid	R410A	R32					
Flow Rate (air side)	123.1	123.1	m ^ 3/min	4347	4347	CFM	1.00
Inlet Temperature	35	35	C	95	95	F	
Outlet Temperature	not measured	not measured	C	not measured	not measured	F	
Net Air-Side Cooling Capacity			kW	41770	42738	BTUH	

Refrigerant Side Data Temperatures & Pressures	Baseline		Alternative		Baseline		Alternative	
	T (C)	P [kPa]	T (C)	P [kPa]	T [F]	P [psia]	T [F]	P [psia]
Compressor Suction	19.5	1067	22.8	1082	67.1	154.8	73.0	156.9
Compressor Discharge	69.4	2548	88.3	2653	157	369.6	191.0	384.8
Condenser Inlet	69.4	2548	88.3	2653	157	369.6	191.0	384.8
Condenser Outlet	38.7	2484	40.9	2616	101.7	360.2	105.6	379.4
Expansion Device Inlet	38.2	2444	40.2	2599	100.8	354.4	104.4	377
Subcooling, at expan. device	2.4		1.4		4.3		2.5	
Evaporator Inlet	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Evaporator Outlet	15.3	1083	16.5	1088	59.6	157	61.7	157.8
Evaporator Superheat	5.3		7.1		9.6		12.7	
Net Refrigerant-Side Cooling Capacity					42001 BTUH		42479 BTUH	

Test Data Form for Test: "A" Test
Type of System: Split HP Alternate Refrigerant: R32

Comparison Data			**Base.**	**Alt.**	**SI Units**	**Base.**	**Alt.**	**IP UNits**	**Ratio**
Mode (Heating/Cooling)			Cooling						
Compressor Type			scroll	scroll					
Compressor Displacement			0.122	0.122	M^3/min	4.32	4.32	Ft ^3/min	1.00
Nominal Motor Size			n/a	n/a	hp				
Motor Speed			3500	3500	rpm				1.00
Expansion Device Type			TXV	TXV					
Lubricant Charge			1.242	1.242	liters	42	42	fl. oz.	1.00
Refrigerant Charge			6.35	4.863	kg	14	10.72	lb	0.77
Refrigerant Mass Flow Rate*			273.4	185.1	kg/hr	602.8	408.1	lb/hr	0.68
Composition, at compr. Inlet if applicable				n/a	n/a				
Ambient Temps.	In - door	db	26.67	26.67	C	80.0	80.0	F	
		wb	19.44	19.5	C	67.0	67.1	F	
	Out - door	db	35	35	C	95.0	95.0	F	
		wb	n/a	n/a	C	n/a	n/a	F	
Total Capacity			12242	12526	W	41770	42738	Btu/hr	1.02
Sensible Capacity			9059	8893	W	30910	30344	Btu/hr	0.98
Total System Power Input			3376	3661	W	3376	3661	W	1.08
Compressor Power Input			2685	2963	W	2685	2963	W	1.10
Energy Efficiency Ratio (EER)			12.35	11.67	W/W	12.35	11.67	Btuh/W	0.94
Coeff. Of Performance* (COP)			3.62	3.42					0.94

Data Source(s) for Refrigerant Properties
NIST REFPROP Version 9

Submitted By:
Uselton / Crawford

Test Data Form for Test: "B" Test
Type of System: Split HP Alternate Refrigerant R32

Air Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	R410A	R32					
Flow Rate (air side)	39.87	39.76	m ^ 3/min	1408	1404	CFM	1.00
Inlet Temperature	26.67/19.44	26.67/19.5	C	80.0/67.0	80.0/67.1	F	
Outlet Temperature	14.94/13.83	14.88/13.72	C	58.9/56.9	58.8/56.7	F	
Condenser							
Heat Exchange Fluid	R410A	R32					
Flow Rate (air side)	123.1	123.1	m ^ 3/min	4347	4347	CFM	1.00
Inlet Temperature	27.78	27.78	C	82.0	82.0	F	
Outlet Temperature	n/a	n/a	C	n/a	n/a	F	
Net Air-Side Cooling Capacity			kW	44807	46210	BTUH	

Refrigerant Side Data Temperatures & Pressures	Baseline		Alternative		Baseline		Alternative	
	T (C)	P [kPa]	T (C)	P [kPa]	T [F]	P [psia]	T [F]	P [psia]
Compressor Suction	18.2	1044	21.0	1071	64.8	151.4	69.8	155.3
Compressor Discharge	59.4	2118	73.8	2213	139	307.2	164.8	321.0
Condenser Inlet	59.4	2118	73.8	2213	139	307.2	164.8	321.0
Condenser Outlet	30.7	2060	33.1	2175	87.2	298.8	91.6	315.5
Expansion Device Inlet	30.6	2022	32.9	2157	87.1	293.3	91.2	312.8
Subcooling, at expan. device	2.3		1.6		4.1		2.9	
Evaporator Inlet	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Evaporator Outlet	15.2	1059	16.7	1078	59.4	153.6	62	156.3
Evaporator Superheat	6.0		7.6		10.8		13.6	
Net Refrigerant-Side Cooling Capacity					44996 BTUH		45892 BTUH	

Test Data Form for Test: "B" Test
Type of System: Split HP Alternate Refrigerant R32

Comparison Data			**Base.**	**Alt.**	**SI Units**	**Base.**	**Alt.**	**IP Units**	**Ratio**
Mode (Heating/Cooling)			Cooling						
Compressor Type			scroll	scroll					
Compressor Displacement			0.122	0.122	M^3/min	4.32	4.32	Ft ^3/min	1.00
Nominal Motor Size			n/a	n/a	hp				
Motor Speed			3500	3500	rpm				1.00
Expansion Device Type			TXV	TXV					
Lubricant Charge			1.242	1.242	liters	42	42	fl. oz.	1.00
Refrigerant Charge			6.35	4.863	kg	14	10.72	lb	0.77
Refrigerant Mass Flow Rate*			174.4	121.4	kg/hr	595.0	414.2	lb/hr	0.70
Composition, at compr. Inlet if applicable				n/a	n/a				
Ambient Temps.	In - door	db	26.67	26.67	C	80.0	80.0	F	
		wb	19.44	19.5	C	67.0	67.1	F	
	Out - door	db	35	35	C	82.0	82.0	F	
		wb	n/a	n/a	C	n/a	n/a	F	
Total Capacity			13132	13543	W	44807	46210	Btu/hr	1.03
Sensible Capacity			9468	9345	W	32306	31884	Btu/hr	.99
Total System Power Input			2983	3119	W	2983	3119	W	1.05
Compressor Power Input			2287	2425	W	2287	2425	W	1.06
Energy Efficiency Ratio (EER)			15.02	14.82	W/W	15.02	14.82	Btuh/W	.99
Coeff. Of Performance (COP)			4.40	4.34					.99

Data Source(s) for Refrigerant Properties
NIST REFPROP Version 9

Submitted By:
Uselton/Crawford

Test Data Form for Test: "H1" Test
Type of System: Split HP Alternate Refrigerant R32

Air Side Data	**Base.**	**Alt.**	**SI Units**	**Base.**	**Alt.**	**IP Units**	**Ratio**
Evaporator							
Heat Exchange Fluid	R410A	R32					
Flow Rate (air side)	123.1	123.1	m ^ 3/min	4347	4347	CFM	1
Inlet Temperature	8.33/6.11	8.33/6.11	C	47.0/43.0	47.0/43.0	F	
Outlet Temperature	n/a	n/a	C	n/a	n/a	F	
Condenser							
Heat Exchange Fluid	R410A	R32					
Flow Rate (air side)	39.67	39.02	m ^ 3/min	1399	1378	CFM	0.98
Inlet Temperature	21.11	21.11	C	70.0	70.0	F	
Outlet Temperature	37.56	37.67	C	99.6	99.8	F	
Net Air-Side Heating Capacity				44625	44285	BTUH	

Refrigerant Side Data Temperatures & Pressures	**Baseline**		**Alternative**		**Baseline**		**Alternative**	
	T (C)	**P [kPa]**	**T (C)**	**P [kPa]**	**T [F]**	**P [psia]**	**T [F]**	**P [psia]**
Compressor Suction	8.3	838	9.6	865	47.7	121.3	49.2	125.5
Compressor Discharge	77.3	2830	87.4	2670	170.8	407.5	189.4	387.3
Condenser Inlet	73.9	2822	81.4	2661	164.7	406.2	178.5	386.0
Condenser Outlet	25.0	2779	28.0	2639	77.4	400.1	82.4	382.8
Expansion Device Inlet	23.4	2750	26.1	2619	74.7	395.7	79	379.8
Subcooling, at expan. device	20.9		14.6		36.8		26.3	
Evaporator Inlet	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Evaporator Outlet	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Evaporator Superheat	6.8		7.6		13.1		13.7	
Net Refrigerant-Side Heating Capacity					46214 BTUH		47260 BTUH	

Test Data Form for Test: "H1" Test
Type of System: Split HP Alternate Refrigerant R32

Comparison Data			**Base.**	**Alt.**	**SI Units**	**Base.**	**Alt.**	**IP UNits**	**Ratio**
Mode (Heating/Cooling)			Heating						
Compressor Type			scroll	scroll					
Compressor Displacement			0.122	0.122	M^3/min	4.32	4.32	Ft ^3/min	1.00
Nominal Motor Size			n/a	n/a	hp				
Motor Speed			3500	3500	rpm				1.00
Expansion Device Type			TXV	TXV					
Lubricant Charge			1.242	1.242	liters	42	42	fl. oz.	1.00
Refrigerant Charge			6.35	4.863	kg	14	10.72	lb	0.77
Refrigerant Mass Flow Rate*			210.2	151.1	kg/hr	463.6	333.2	lb/hr	0.72
Composition, at compr. Inlet if applicable				n/a	n/a				
Ambient Temps.	In - door	db	21.11	21.11	C	70.0	70.0	F	
		wb	n/a	n/a	C	n/a	n/a	F	
	Out - door	db	8.33	8.33	C	47.0	47.0	F	
		wb	6.11	6.11	C	43.0	43.0	F	
Total Capacity			13079	12979	W	44625	44285	Btu/hr	0.99
Sensible Capacity			13079	12979	W	44625	44285	Btu/hr	0.99
Total System Power Input			3704	3633	W	3704	3633	W	0.98
Compressor Power Input			2978	2918	W	2978	2918	W	0.98
Energy Efficiency Ratio (EER)			n/a	n/a	W/W	n/a	n/a	Btuh/W	n/a
Coeff. Of Performance (COP)			3.53	3.57					1.01

Data Source(s) for Refrigerant Properties
NIST REFPROP Version 9

Submitted By:
Uselton/Crawford

Test Data Form for Test: "H3" (17F Steady State Heating)
Type of System: Split HP Alternate Refrigerant: R32

Air Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	R410A	R32					
Flow Rate (air side)	123.1	123.1	m ^ 3/min	4347	4347	CFM	1.00
Inlet Temperature	-8.4	-8.4	C	17.0	17.0	F	
Outlet Temperature	n/a	n/a	C	n/a	n/a	F	
Condenser							
Heat Exchange Fluid	R410A	R32					
Flow Rate (air side)	39.5	40.35	m ^ 3/min	1395	1425	CFM	1.02
Inlet Temperature	21.11	21.11	C	70.0	70.0	F	
Outlet Temperature	32.22	32.00	C	90.0	89.6	F	
Net Air-Side Heating Capacity			kW	30032	30177	BTUH	

Refrigerant Side Data Temperatures & Pressures	Baseline		Alternative		Baseline		Alternative	
	T (C)	P [kPa]	T (C)	P [kPa]	T [F]	P [psia]	T [F]	P [psia]
Compressor Suction	-8.6	524	-5.7	542	16.5	76.1	21.7	78.7
Compressor Discharge	77.9	2416	90.8	2263	172.3	350.4	195.5	328.2
Condenser Inlet	70.6	2410	77.3	2259	159.0	349.5	171.2	327.6
Condenser Outlet	22.2	2398	23.4	2250	72.0	347.9	74.2	326.4
Expansion Device Inlet	18.9	2384	19.9	2241	66.0	345.8	67.9	325.0
Subcooling, at expan. device	17.6		12.7		31.7		22.8	
Evaporator Inlet	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Evaporator Outlet	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Evaporator Superheat	3.8		6.3		6.9		11.4	
Net Refrigerant-Side Heating Capacity					30013 BTUH		30492 BTUH	

Test Data Form for Test: "H3" (17F Steady State Heating)
Type of System: Split HP Alternate Refrigerant: R32

Comparison Data			**Base.**	**Alt.**	**SI Units**	**Base.**	**Alt.**	**IP UNits**	**Ratio**
Mode (Heating/Cooling)			Heating						
Compressor Type			scroll	scroll					
Compressor Displacement			0.122	0.122	M^3/min	4.32	4.32	Ft ^3/min	1.00
Nominal Motor Size			n/a	n/a	hp				
Motor Speed			3500	3500	rpm				1.00
Expansion Device Type			TXV	TXV					
Lubricant Charge			1.242	1.242	liters	42	42	fl. oz.	1.00
Refrigerant Charge			6.35	4.863	kg	14	10.72	lb	0.77
Refrigerant Mass Flow Rate*			130.0	92.7	kg/hr	286.7	204.5	lb/hr	0.71
Composition, at compr. Inlet if applicable				n/a	n/a				
Ambient Temps.	In - door	db	21.11	21.11	C	70.0	70.0	F	
		wb	n/a	n/a	C	n/a	n/a	F	
	Out - door	db	-8.33	-8.33	C	17.0	17.0	F	
		wb	-9.39	-9.33	C	15.1	15.2	F	
Total Capacity			8802	8844	W	30032	30177	Btu/hr	1.00
Sensible Capacity			8802	8844	W	30032	30177	Btu/hr	1.00
Total System Power Input			3427	3314	W	3427	3314	W	1.00
Compressor Power Input			2698	2565	W	2698	2565	W	.95
Energy Efficiency Ratio (EER)			n/a	n/a	W/W	n/a	n/a	Btuh/W	n/a
Coeff. Of Performance (COP)			2.57	2.67					1.04

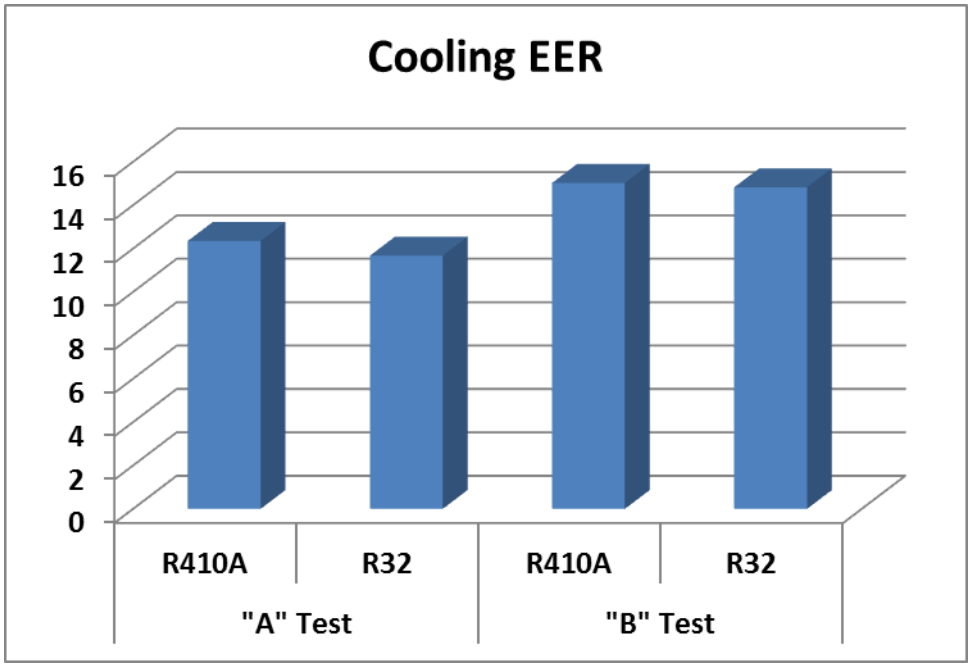
Data Source(s) for Refrigerant Properties
NIST REFPROP Version 9

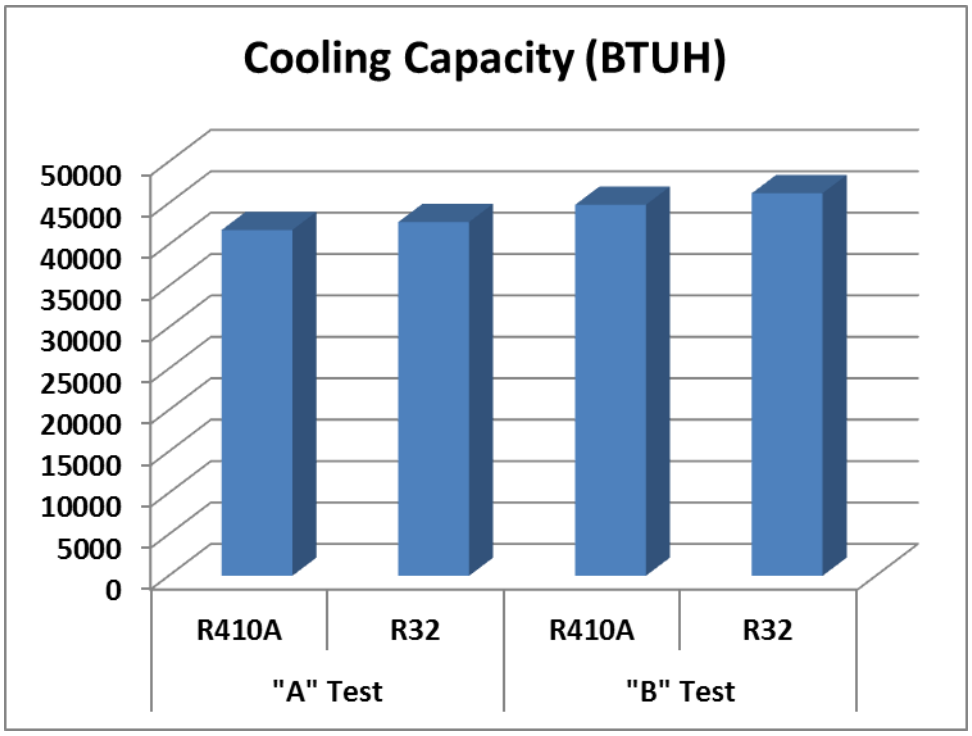
Submitted By:
Uselton/Crawford

4. Conclusions

The alternate refrigerant worked in this R410A system without significant equipment modifications. (Long-term reliability has not been established.) During testing, it was necessary to take precautions for protection of personnel and our facility since R32 is mildly flammable, having an ASHRAE A2L refrigerant designation.

For R32 testing, steady-state cooling efficiencies dropped and the heating efficiencies went up. The SEERs were more comparable (due to a low Cd measured with R32). The HSPF was higher. The cooling capacity went up slightly and the heating capacity stayed about the same.




Cooling Capacity (BTUH)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
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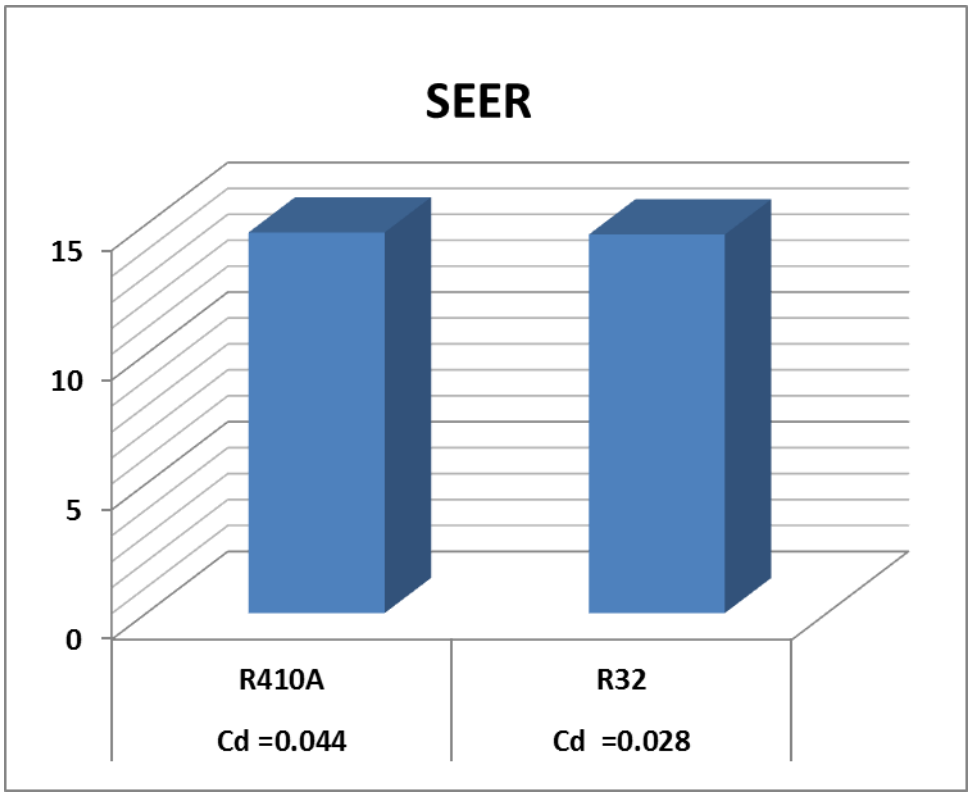
R410A
R32
R410A
R32
"A" Test
"B" Test


SEER
15
10
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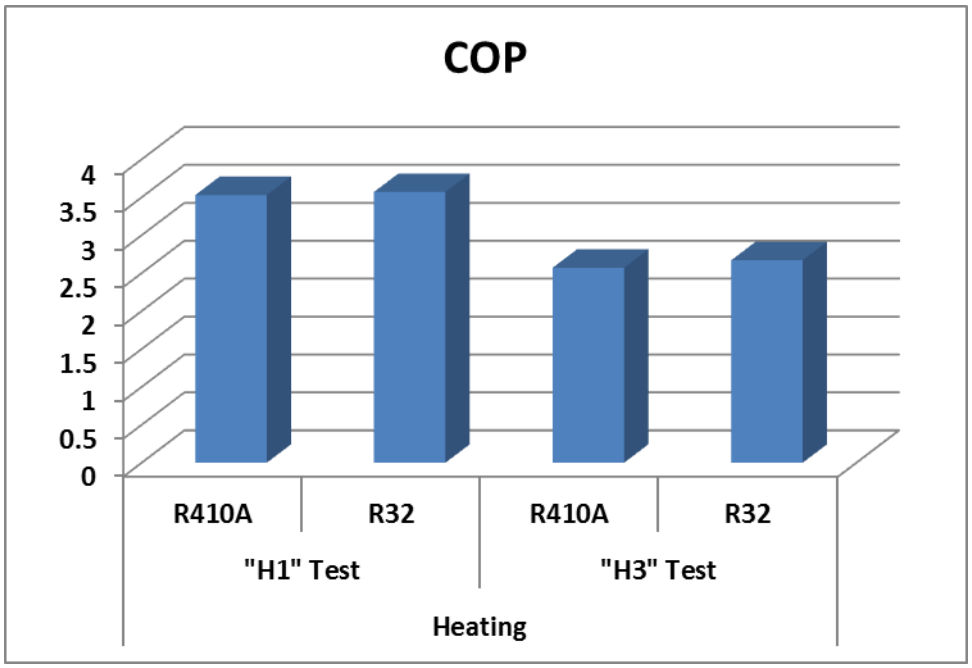
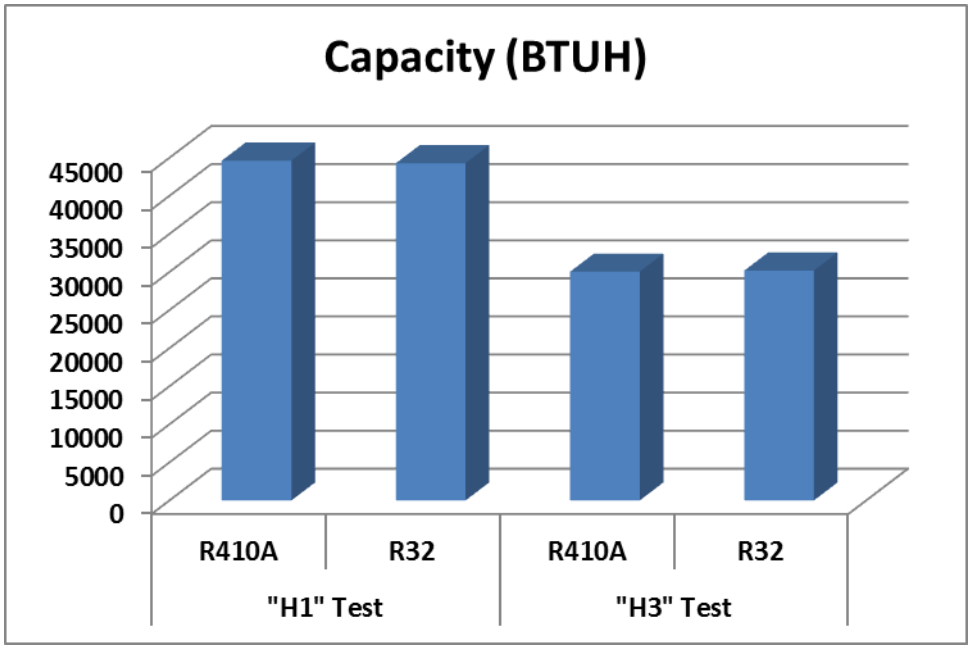
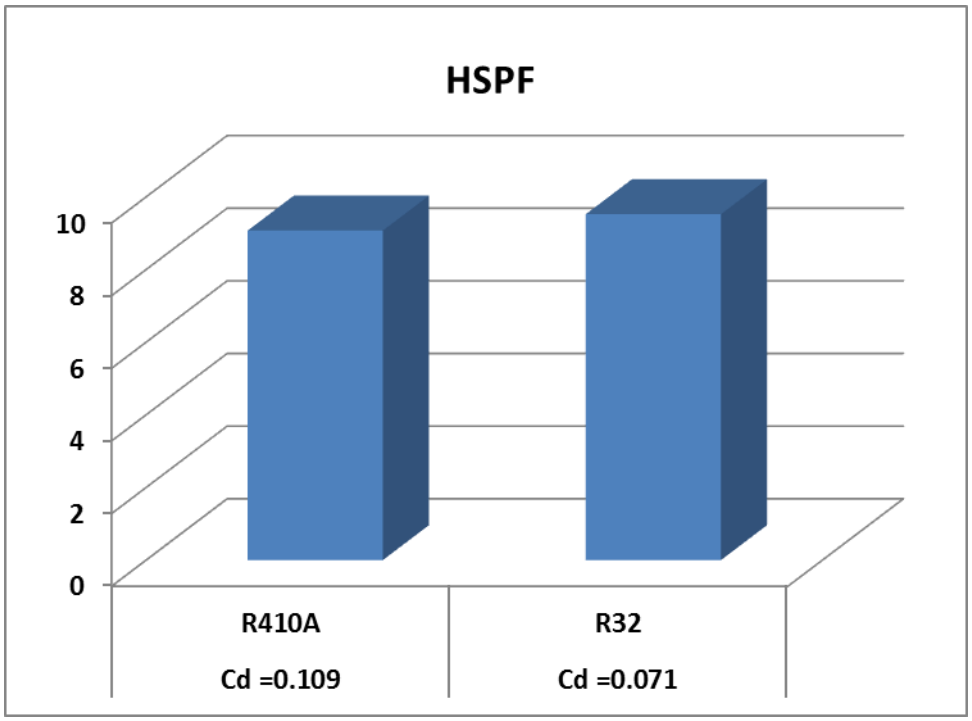
R410A
Cd =0.044
R32
Cd =0.028


COP
4
3.5
3
2.5
2
1.5
1
0.5
0
R410A
R32
R410A
R32
"H1" Test
"H3" Test
Heating


Capacity (BTUH)
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
R410A
R32
R410A
R32
"H1" Test
"H3" Test



Mass flow rates are lower when using R32.

We found that the setting on the indoor expansion valve needed adjustment to achieve superheat and subcooling similar to the R410A values.

The compressor discharge temperature on the “A” test (95F outdoor temperature) was 26F higher when using R32 refrigerant.

The charge quantity for R-32 was 77% of the charge quantity for R-410A. The GWP of R-32 is 675, 32% of the GWP of R-410A which is 2088. In a TEWI calculation the direct warming contribution with R-32 will be reduced to 0.77 x 0.32 or 25% of the contribution from R-410A for the tested system.

ADDENDUM

Note: Participating companies have the option to perform additional tests at high ambient operating conditions, appropriately selected according to the equipment type. This data was collected for cooling operation at 115F (46.1C) outdoor ambient.

Type of System: Split HP Alternate Refrigerant: R32

Air Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	R410A	R32					
Flow Rate (air side)	39.84	39.96	m ^ 3/min	1407	1411	CFM	1.00
Inlet Temperature	26.7/19.4	26.7/ 19.5	C	80.0/67.0	80.0/67.1	F	
Outlet Temperature	16.0 / 14.8	16.3 / 14.72	C	60.8/58.7	61.3/58.5	F	
Condenser							
Heat Exchange Fluid	R410A	R32					
Flow Rate (air side)	123.1	123.1	m ^ 3/min	4347	4347	CFM	1.00
Inlet Temperature	46.1	46.2	C	115.0	115.1	F	
Outlet Temperature	not measured	not measured	C	not measured	not measured	F	
Net Air-Side Cooling Capacity			kW	37217	37889	BTUH	

Refrigerant Side Data Temperatures & Pressures	Baseline		Alternative		Baseline		Alternative	
	T (C)	P [kPa]	T (C)	P [kPa]	T [F]	P [psia]	T [F]	P [psia]
Compressor Suction	50.4	1103	26	1110	122.8	160	78.8	161
Compressor Discharge	85.8	3269	109	3400	186.4	474	229	493
Condenser Inlet	79.4	3269	97	3400	175	474	207	493
Condenser Outlet	49.9	3200	52	3358	121.8	464	125	487
Expansion Device Inlet	49.1	3158	50.6	3347	120.3	458	123	485
Subcooling, at expan. device	2.3		2.2		4.1		3.9	
Evaporator Inlet	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Evaporator Outlet	16.2	1117	17.2	1117	61.2	162	62.9	162
Evaporator Superheat	5.2		6.9		9.4		12.4	
Net Refrigerant-Side Cooling Capacity					BTUH		BTUH	

Test Data Form for Test: 115F Test
Type of System: Split HP Alternate Refrigerant: R32

Comparison Data			**Base.**	**Alt.**	**SI Units**	**Base.**	**Alt.**	**IP UNits**	**Ratio**
Mode (Heating/Cooling)			Cooling						
Compressor Type			scroll	scroll					
Compressor Displacement			0.122	0.122	M^3/min	4.32	4.32	Ft ^3/min	1.00
Nominal Motor Size			n/a	n/a	hp				
Motor Speed			3500	3500	rpm				1.00
Expansion Device Type			TXV	TXV					
Lubricant Charge			1.242	1.242	liters	42	42	fl. oz.	1.00
Refrigerant Charge			6.35	4.863	kg	14	10.72	lb	0.77
Refrigerant Mass Flow Rate*			27.6	184	kg/hr	607.4	405.6	lb/hr	
Composition, at compr. Inlet if applicable				n/a	n/a				
Ambient Temps.	In - door	db	26.67	26.67	C	80.0	80.0	F	
		wb	19.44	19.44	C	67.0	67.0	F	
	Out - door	db	46.1	46.2	C	115.0	115.1	F	
		wb	n/a	n/a	C	n/a	n/a	F	
Total Capacity			10908	11104	W	37217	37889	Btu/hr	1.02
Sensible Capacity			8521	8219	W	29075	28043	Btu/hr	0.96
Total System Power Input			4115	4418	W	4115	4418	W	1.07
Compressor Power Input			3429	3740	W	3429	3740	W	1.09
Energy Efficiency Ratio (EER)			n/a	n/a	W/W	9.01	8.54	Btuh/W	0.95
Coeff. Of Performance* (COP)			2.64	2.50					0.95

Data Source(s) for Refrigerant Properties
NIST REFPROP Version 9

Submitted By:
Uselton / Crawford