



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

TEST REPORT #53

System Drop-in Test of Refrigerant Blend DR-55 in a Five-Ton R-410A Rooftop Packaged Unit

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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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List of Tested Refrigerant's Compositions (Mass%)

DR-55	R-32/R-125/R-1234yf (67/7/26)
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1. Introduction:

This document reports performance testing conducted on a 5 Ton rooftop packaged air-conditioner at high outdoor ambient temperatures. It was tested with R410A, and DR-55. This testing occurred during May and August 2015 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 for use in high ambient conditions.

A conventional R-410A rooftop unit was first tested, without modifications, at several high ambient conditions. The unit was then tested at the same test points with DR-55 at the same and several additional high ambient temperature conditions. The refrigerants have GWPs of:

R410A – 2088
DR-55 - 675 (T. Leck, Chemours, 2015)

2. Details of Test Setup:

a. Description of System

The base unit was an LGH060H4ESP built in 2007 (Lab Inventory Control # 28759). This R410A air conditioner used a scroll-type compressor with thermostatic expansion valve for refrigerant flow control. The production compressor (ZPS51K4E-PFV) used the POE oil that Emerson Climate Technologies provides with its scroll air conditioning compressors.

A refrigerant flow meter was placed in the liquid line. Pressure taps were placed at the liquid line at the condenser, on the compressor suction and discharge lines and on the liquid line at the inlet to the expansion valve. Thermocouples were placed on the outside of refrigerant piping. An adjustable stem was placed on the expansion valve to enable some superheat adjustment.

The air flow was set for nominal 1750 CFM.

The ratings for the baseline system were:

Cooling Capacity (BTUH): 60,000

EER Rating: 12.7

This system tested 107% of “A” capacity, and 104% of “A” EER.

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b. Description of Modifications to System

For the baseline test, the system was operated with its nameplate charge of R-410A. For alternate refrigerant testing, the adjustable stem was added to the expansion valve and our procedure was to match the superheat and subcooling measured with the baseline refrigerant at the “A” (95F outdoor temperature) test condition. The values for those “A” tests are provided below. There is a reason that the subcooling for DR-55 is not exactly equal to the baseline subcooling: addition of more charge induced pressure oscillations – the TXV was not able to control to a constant superheat. This is an example of compromises made when doing “drop-in” testing.

Refrigerant	Superheat (F)	Subcooling (F)
R-410A	14.0	14.2
DR-55	14.4	10.4

c. Description of Tests Conducted

The air conditioner was evaluated using a pair of psychrometric test chambers. The supply air outlet of the air conditioner was connected to an AMCA 210 Code Tester. The air is returned to the Indoor Room. The return air to the unit is drawn from the Indoor Room through a duct. There are dry bulb/wet bulb temperature samplers on the inlet and outlet conditioned air stream. 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 “air-side” capacity is always used for the reported capacity.

The psychrometric test facility is operated as a certified satellite facility and is under an annual calibration system traceable to NIST standards. All instruments (Test Room #7) had their calibration checked in August 2014 (R—410A) and July 2015 (DR-55). These are the principal instruments used for taking measurements:

- Critical T’couples: Type “T” - Moore Industries, Inc. M/N TIY T2
Accuracy: +/-0.35F (individually further calibrated to +/-0.20F)
- General T’couples: Type “T” - OPTO22 M/N AITM2-I
Accuracy: +/-01.38F (individually further calibrated to +/-0.20F)
- Air Flow Pressures: Validyne M/N CD-15
Accuracy: +/-0.25% of full scale (Range: +/-5.5 in. H2O)
- Refrigerant Pressures: Druck, Inc. M/N PTX610
Accuracy: +/-0.10% of full scale (Range: 0.0 – 800 psig)

Micro-Motion Sensor M/N CMF-025

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Refrigerant Flow Rate: Micro-Motion Transmitter M/N RFT9739
Accuracy: +/-0.10% of full scale (Range: 0 – 1200 lbs/hr)

Watt-Hr Meter: GE 700X3G215
Accuracy: +/- 2.0 % of reading

Watt Meter: Yokogawa WT500
Accuracy: +/-0.1% of reading +/-0.1% of full scale (Range: 0 – 7kW)

Three steady-state tests were conducted with each refrigerant. The indoor temperature was 80F dry bulb / 67F wet bulb. The three outdoor temperature test points were 95F, 115F and 125F. Testing was conducted to standards AHRI 210/240 and ASHRAE 37. There are two pages in this report for data from each of the tests.

AHRI received a request that AREP II tests be extended to several other high ambient conditions:

84F / 66F Indoor – 115F Outdoor
84F / 66F Indoor – 126F Outdoor
84F / 66F Indoor – 131F Outdoor

At the time the request was received, the R-410A testing had been completed. It was possible for the DR-55 testing to be extended to include these test points.

d. Test Facility Description

Figures 1 and 2 show, diagrammatically, the arrangement of the testing equipment and the test unit. The chassis of the rooftop unit is entirely in the outdoor room and the process air is ducted from the indoor room. An AMCA code tester is used to measure the process air volume flow rate to help determine the “air-side” cooling capacity. A refrigerant flow meter is used to measure the mass flow rate of the refrigerant. A “refrigerant-side” cooling capacity measurement is made using it. The two values of cooling capacity must agree within four percent for the test to be considered valid. Our testing at the 95 degree outdoor temperature did confirm that the test setup was good. (Note: At very high outdoor temperatures there is enough cabinet heat gain to reduce “air-side” capacity out of the 4% tolerance. We used our judgment with regard to the validity of these tests and will report “air-side” capacity as the official cooling capacity.)

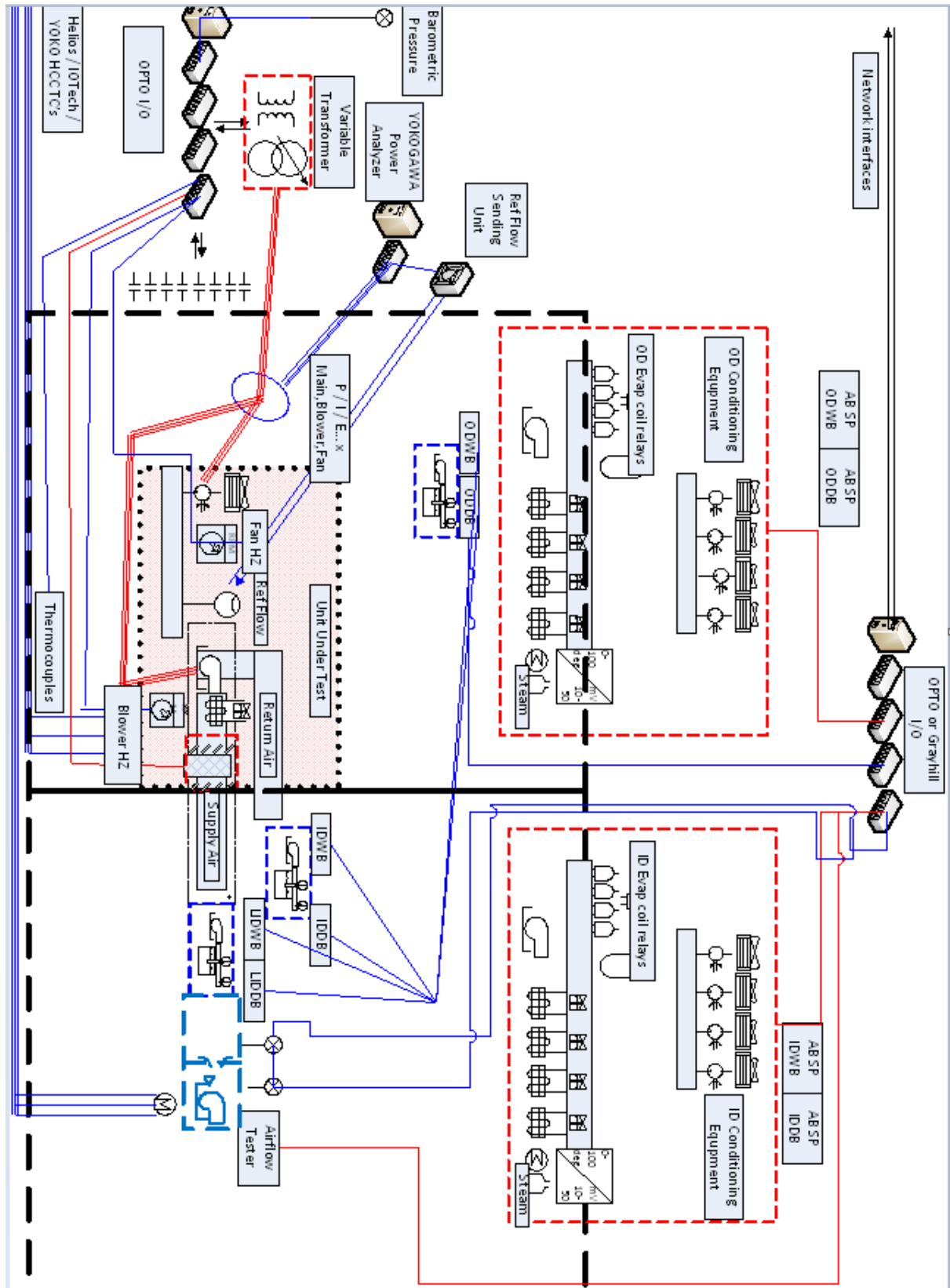


Figure 1. Diagram of Test Facility

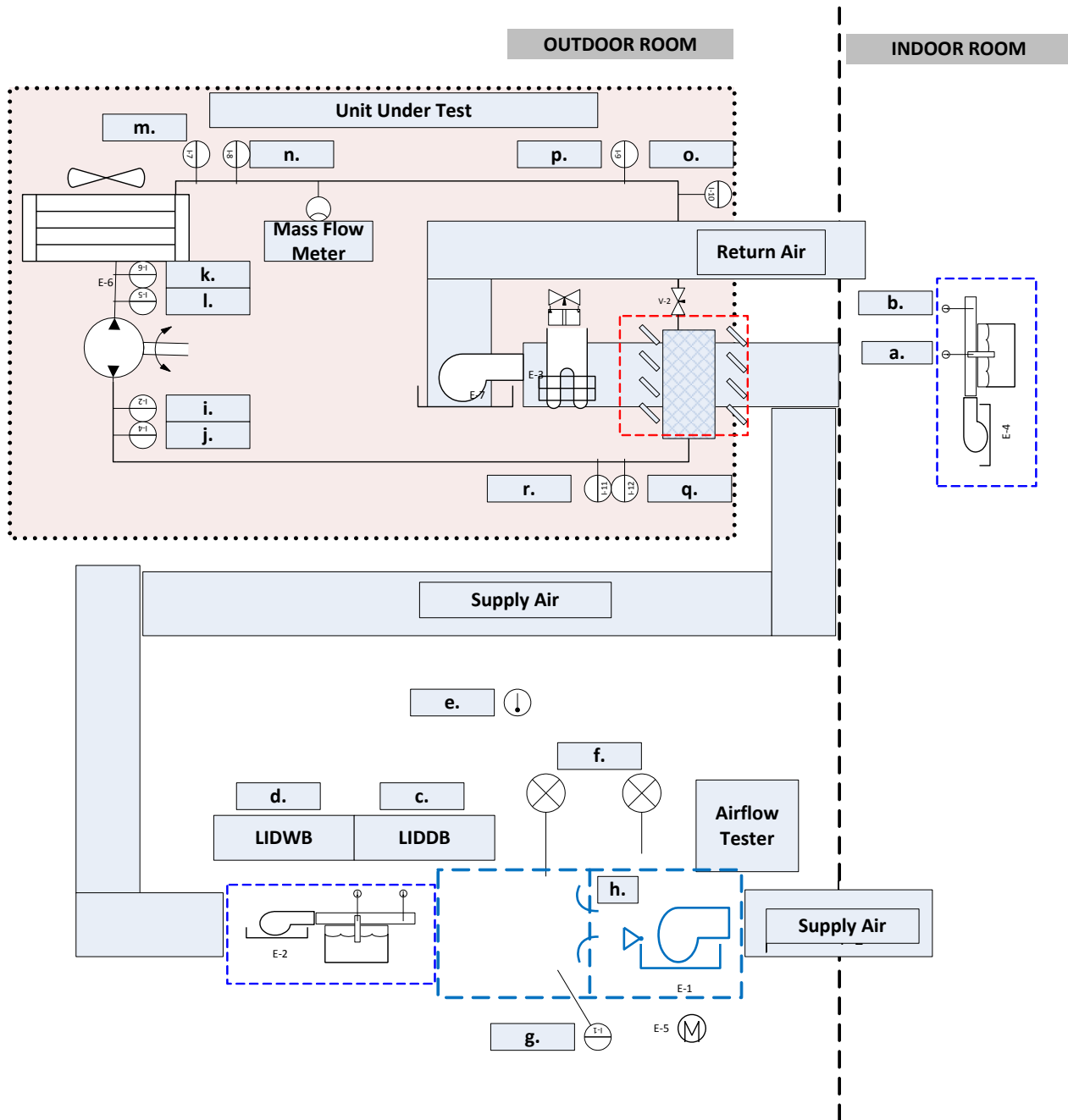


Figure 2. Schematic View of System Under Test

Legend for Instrumentation:

- a. Indoor Entering Dry Bulb Temp.
- b. Indoor Entering Wet Bulb Temp.
- c. Indoor Leaving Dry Bulb Temp.
- d. Indoor Leaving Wet Bulb Temp.
- e. Outdoor Dry Bulb Temp.
- f. Air Flow Tester Nozzle Differential Pressure

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- g. Temperature at Nozzle
- h. Nozzle Area
- i. Compressor Suction Temp.
- j. Compressor Suction Pressure
- k. Compressor Discharge Temp.
- l. Compressor Discharge Pressure
- m. Condenser Outlet Temp.
- n. Condenser Outlet Pressure
- o. TXV Inlet Temp.
- p. TXV Inlet Pressure
- q. Evaporator Outlet Temp.
- r. Evaporator Outlet Pressure

3. Results

R-410A cooling capacity declines by 27% going from 95F ambient to 125F.

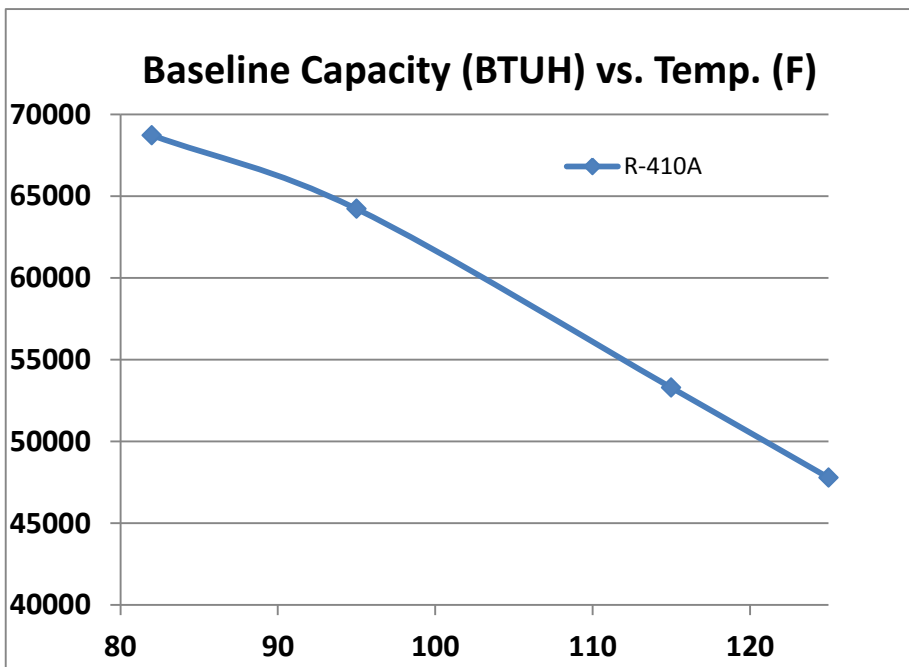


Figure 3. Base Unit Cooling Performance

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The EER declines 46% from 95F to 125F.

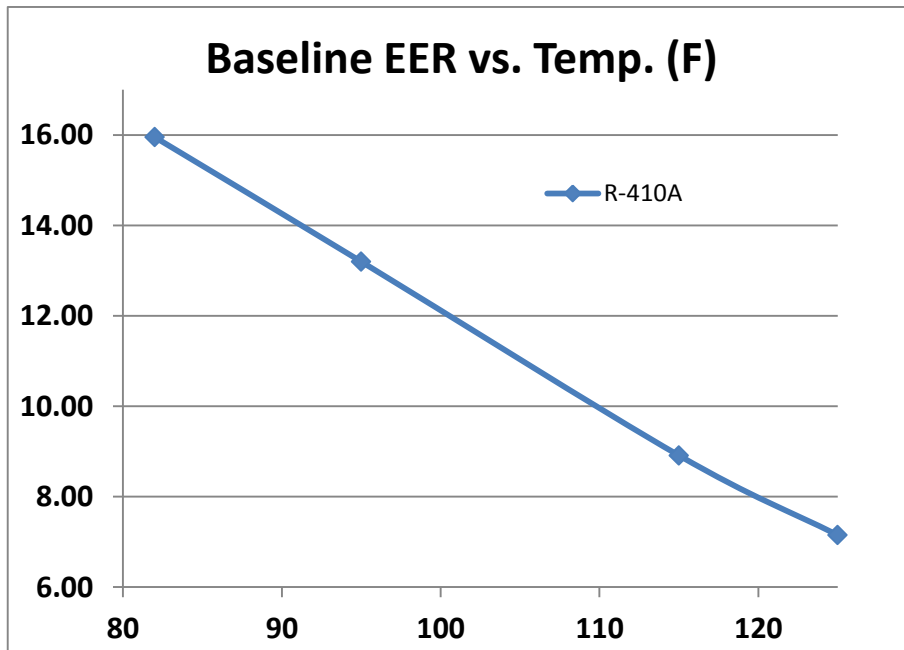


Figure 4. Base Unit Cooling EER

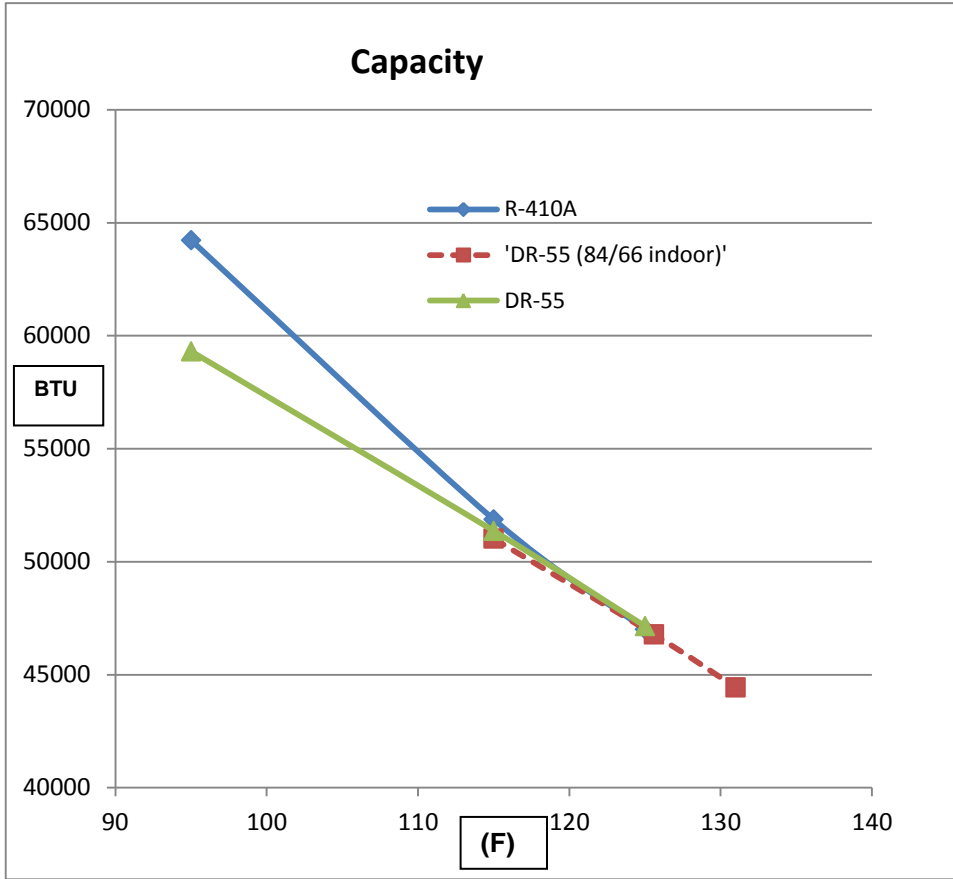


Figure 5. Comparison of Capacities (BTUH) for R-410A and DR-55 at high ambient temperatures (F)

From the above plot, it is clear that DR-55 maintains capacity better than R-410A going from the “A” test rating condition to higher outdoor ambient temperatures.

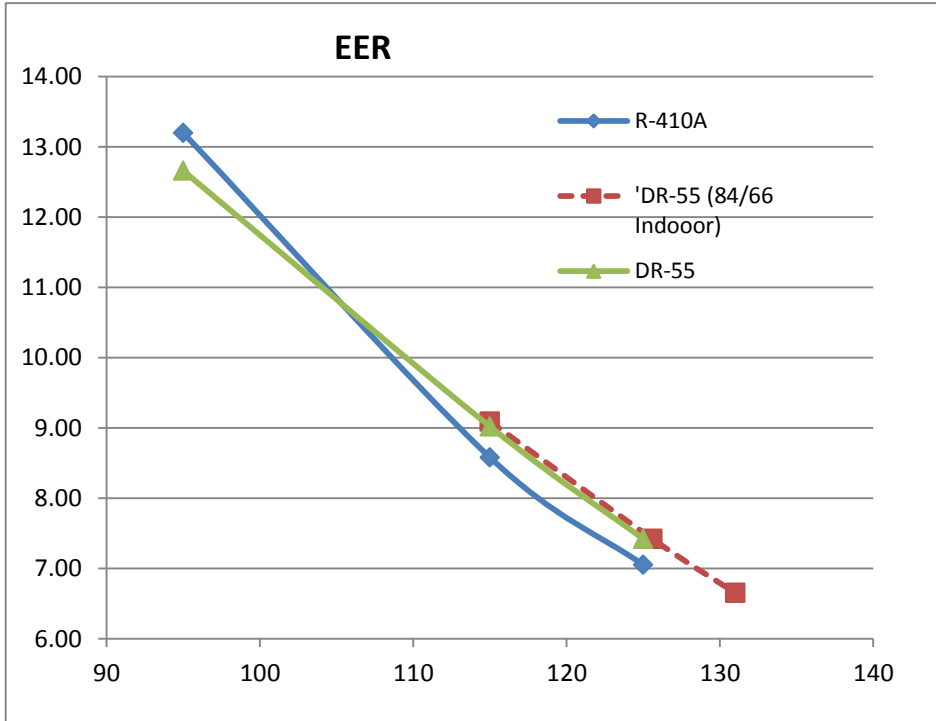


Figure 6. Comparison of efficiencies for R-410A and DR-55 at high ambient temperatures

DR-55 has somewhat higher efficiency at high ambient temperatures, compared to R-410A.

An important characteristic for an air conditioner designed for high ambient operation is the compressor discharge temperature. High discharge temperatures can degrade the compressor oil that is circulating with the refrigerant. In the 125F test, the discharge temperature was 206F for R-410A and 230F for DR-55.

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4. Test Data

This is the “A” test data.

Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM				Test:	"A"				
				Alt. Refrig.:	DR-55				
Manufacturer: Lennox Industries Inc.			Manufacturer's Notation: LGH060H4ESP						
Basic Information									
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)			DR-55						
Alternative Lubricant Type and ISO Viscosity			3MAF-POE						
Baseline Refrigerant and Lubricant			R-410A, 3MAF-POE						
Make and Model of System			Lennox, LGH060H4ESP						
Nominal Capacity and Type of System			5 Ton, Rooftop Air Conditioning Unit						
Comparison Data									
		Base.	Alt.	SI Units	Base.	Alt.	Base.	Ratio	
Mode (Heating/Cooling)		Cooling							
Compressor Type		scroll	scroll						
Compressor Displacement		0.229	0.229	m ³ /min			ft ³ /min	1	
Nominal Motor Size		4.5	4.5	hp				1	
Motor Speed		3500	3500	rpm				1	
Expansion Device Type		TXV	TXV						
Lubricant Charge		1.66	1.66	liter	56	56	ounce	1	
Refrigerant Charge		6.72	6.27	kg	14.82	13.825	lb	0.93	
Refrigerant Mass Flow Rate		396.18	323.98	kg/hr	873.6	714.4	lb/hr	0.82	
Composition, at compr. inlet if applicable			n/a	% wt					
Ambient Temps.	Indoor	db	26.7	26.7	C	79.99	79.99	F	
		wb	19.5	19.4	C	67.02	66.95	F	
	Outdoor	db	35.0	35.0	C	95.00	95.00	F	
		wb	n/a	n/a	C	n/a	n/a	F	
Total Capacity		18819	17378	W	64230	59312	Btu/hr	0.92	
Sensible Capacity		12889	12611	W	43989	43041	Btu/hr	0.98	
Total System Power Input		4867	4687	W	4867	4687	W	0.96	
Compressor Power Input		4062	3879	W	4062	3879	W	0.95	
Energy Efficiency Ratio (EER)		n/a	n/a	W/W	13.20	12.66	Btuh/W	0.96	
Coeff. Of Performance (CCOP)		3.87	3.71					n/a	
Other System Changes									
System Data*									
Degradation Coefficient – Cd					Base.	Alt.	Ratio		
Seasonal Energy Efficiency Ratio - SEER									
Heating Seasonal Performance Factor - HSPF									
* Only Steady-State Cooling Tests Conducted									

Lennox Testing Report

Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM

"A" Test page 2

Type of System: R-410A Single Package AC Unit Alternate Refrigerant:

Air Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air						
Flow Rate (gas)	49.63	50.73	m ³ /min	1753	1791	ft ³ /min	
Flow Rate (liquid)	n/a	n/a	L/min	n/a	n/a	gal/min	n/a
Inlet Temperature*	*	*	C	*	*	F	
Outlet Temperature*	*	*	C	*	*	F	
Condenser							
Heat Exchange Fluid	Air	Air					
Flow Rate (gas)	135.9	135.9	m ³ /min	4800	4800	ft ³ /min	
Flow Rate (liquid)	n/a	n/a	L/min	n/a	n/a	gal/min	n/a
Inlet Temperature	35.0	35.0	C	95.0	95.0	F	
Outlet Temperature	(notmeasured)	(notmeasured)	C	(notmeasured)	(notmeasured)	F	
* see previous page							

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	17.0	1082	18.4	1038	63	157	65	151
Compressor Discharge	73.0	2744	76.6	2572	163	398	170	373
Condenser Inlet	73.0	2744	76.6	2572	163	398	170	373
Condenser Outlet	37.5	2670	37.4	2516	99	387	99	365
Expansion Device Inlet	35.9	2640	36.9	2516	97	383	98	365
Subcooling, at expan. device	7.9		5.8		14		10	
Evaporator Inlet	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)
Evaporator Outlet	18.0	1089	19.4	1056	64	158	67	153
Evaporator Superheat	7.8		8.0		14		14	

Data Source(s) for Refrigerant Properties
NIST REFPROP v. 9, and Alt. Refrigerant Manufacturer

Additional Notes

Submitted by: RBU Lennox Industries Inc.

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Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM			Test: "115F"					
			Alt. Refrig.: DR-55					
Manufacturer: Lennox Industries Inc.			Manufacturer's Notation: LGH060H4ESP					
Basic Information								
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)			DR-55					
Alternative Lubricant Type and ISO Viscosity			3MAF-POE					
Baseline Refrigerant and Lubricant			R-410A, 3MAF-POE					
Make and Model of System			Lennox, LGH060H4ESP					
Nominal Capacity and Type of System			5 Ton, Rooftop Air Conditioning Unit					
Comparison Data								
Mode (Heating/Cooling)			Base.	Alt.	SI Units	Base.	Alt.	Base.
Compressor Type			scroll	scroll				
Compressor Displacement			0.229	0.229	m ³ /min			ft ³ /min 1
Nominal Motor Size			4.5	4.5	hp			1
Motor Speed			3500	3500	rpm			1
Expansion Device Type			TXV	TXV				
Lubricant Charge			1.66	1.66	liter	56	56	ounce 1
Refrigerant Charge			6.72	6.27	kg	14.82	13.825	lb 0.93
Refrigerant Mass Flow Rate			403.6	326.2	kg/hr	890.0	719.2	lb/hr 0.81
Composition, at compr. inlet if applicable				n/a	% wt			
Ambient Temps.	Indoor	db	26.7	26.7	C	80.02	79.99	F
		wb	19.4	19.4	C	66.99	66.98	F
	Outdoor	db	46.1	46.1	C	115.01	114.97	F
		wb	n/a	n/a	C	n/a	n/a	F
Total Capacity			15199	15050	W	51874	51367	Btu/hr 0.99
Sensible Capacity			12673	11445	W	43253	39063	Btu/hr 0.90
Total System Power Input			6047	5692	W	6047	5692	W 0.94
Compressor Power Input			5227	4871	W	5227	4871	W 0.93
Energy Efficiency Ratio (EER)			n/a	n/a	W/W	8.58	9.02	Btuh/W 1.05
Coeff. Of Performance (COP)			2.51	2.64				n/a
Other System Changes								
System Data*						Base.	Alt.	Ratio
Degradation Coefficient – Cd								
Seasonal Energy Efficiency Ratio - SEER								
Heating Seasonal Performance Factor - HSPF								
* Only Steady-State Cooling Tests Conducted								

Lennox Testing Report

Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM

Type of System: R-410A Single Package AC Unit

Alternate Refrigerant:

Test: 115 F

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Air Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air						
Flow Rate (gas)	49.7	50.6	m ³ /min	1756	1788	ft ³ /min	1.02
Flow Rate (liquid)	n/a	n/a	L/min	n/a	n/a	gal/min	n/a
Inlet Temperature*	*	*	C	*	*	F	
Outlet Temperature*	*	*	C	*	*	F	
Condenser							
Heat Exchange Fluid	Air	Air					
Flow Rate (gas)	135.92	135.92	m ³ /min	4800	4800	ft ³ /min	
Flow Rate (liquid)	n/a	n/a	L/min	n/a	n/a	gal/min	n/a
Inlet Temperature	46.1	46.1	C	115	115	F	
Outlet Temperature	(not measured)	(not measured)	C	(not measured)	(not measured)	F	
* see previous page							

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	1131	19.8	1075	67	164	68	156
Compressor Discharge	88.6	3458	92.1	3244	191	501	198	470
Condenser Inlet	88.6	3458	92.1	3244	191	501	198	470
Condenser Outlet	47.8	3379	46.1	3190	118	490	115	463
Expansion Device Inlet	46.0	3379	47.9	3190	115	490	118	463
Subcooling, at expan. device	8.0		5.2		14		9	
Evaporator Inlet	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)
Evaporator Outlet	19.9	1136	20.5	1093	68	165	69	159
Evaporator Superheat	7.8		7.9		15		14	

Data Source(s) for Refrigerant Properties

NIST REFPROP v. 9, and Alt. Refrigerant Manufacturer

Additional Notes

Submitted by: RBU Lennox Industries Inc.

Lennox Testing Report

Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM				Test:	" 125F"				
				Alt. Refrig.:	DR-55				
Manufacturer: Lennox Industries Inc.			Manufacturer's Notation: LGH060H4ESP						
Basic Information									
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)			DR-55						
Alternative Lubricant Type and ISO Viscosity			3MAF-POE						
Baseline Refrigerant and Lubricant			R-410A, 3MAF-POE						
Make and Model of System			Lennox, LGH060H4ESP						
Nominal Capacity and Type of System			5 Ton, Rooftop Air Conditioning Unit						
Comparison Data									
Mode (Heating/Cooling)		Base.	Alt.	SI Units	Base.	Alt.	Base.	Ratio	
Compressor Type		scroll	scroll						
Compressor Displacement		0.229	0.229	m ³ /min			ft ^3min	1	
Nominal Motor Size		4.5	4.5	hp				1	
Motor Speed		3500	3500	rpm				1	
Expansion Device Type		TXV	TXV						
Lubricant Charge		1.66	1.66	liter	56	56	ounce	1	
Refrigerant Charge		6.72	6.27	kg	14.82	13.825	lb	0.93	
Refrigerant Mass Flow Rate		406.1	327.1	kg/hr	895.5	721.3	lb/hr	0.81	
Composition, at compr. inlet if applicable			n/a	% wt					
Ambient Temps.	Indoor	db	26.7	26.7	C	79.99	80.01	F	
		wb	19.4	19.4	C	67.00	67.00	F	
	Outdoor	db	51.7	51.6	C	125.06	124.95	F	
		wb	n/a	n/a	C	n/a	n/a	F	
Total Capacity		13773	13815	W	47008	47149	Btu/hr	1.00	
Sensible Capacity		12420	10991	W	42389	37513	Btu/hr	0.88	
Total System Power Input		6663	6353	W	6663	6353	W	0.95	
Compressor Power Input		5227	5532	W	5227	5532	W	1.06	
Energy Efficiency Ratio (EER)		n/a	n/a	W/W	7.05	7.42	Btuh/W	1.05	
Coeff. Of Performance (COP)		2.07	2.17					n/a	
Other System Changes									
System Data*					Base.	Alt.	Ratio		
Degradation Coefficient – Cd									
Seasonal Energy Efficiency Ratio - SEER									
Heating Seasonal Performance Factor - HSPF									

* Only Steady-State Cooling Tests Conducted

Lennox Testing Report

Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM

Type of System: R-410A Single Package AC Unit

Alternate Refrigerant: DR-55

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Test: 125

Air Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air						
Flow Rate (gas)	49.8	50.5	m ³ /min	1757	1785	ft ³ /min	1.02
Flow Rate (liquid)	n/a	n/a	L/min	n/a	n/a	gal/min	n/a
Inlet Temperature*	*	*	C	*	*	F	
Outlet Temperature*	*	*	C	*	*	F	
Condenser							
Heat Exchange Fluid	Air	Air					
Flow Rate (gas)	135.92	135.92	m ³ /min	4800	4800	ft ³ /min	1.00
Flow Rate (liquid)	n/a	n/a	L/min	n/a	n/a	gal/min	n/a
Inlet Temperature	51.7	51.6	C	125	125	F	
Outlet Temperature	(not measured)	(not measured)	C	(not measured)	(not measured)	F	
* see previous page							

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	20.4	1161	22.2	1107	69	168	72	161
Compressor Discharge	96.6	3837	102.3	3614	206	557	216	524
Condenser Inlet	96.6	3837	102.3	3614	206	557	216	524
Condenser Outlet	53.6	3762	53.4	3559	128	546	128	516
Expansion Device Inlet	51.5	3762	53.9	3559	125	546	129	516
Subcooling, at expan. device	7.3		4.2		13		7	
Evaporator Inlet	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)
Evaporator Outlet	20.2	1166	22.7	1123	68	169	73	163
Evaporator Superheat	7.8		9.2		14		16	

Data Source(s) for Refrigerant Properties
 NIST REFPROP v. 9, and Alt. Refrigerant Manufacturer

Additional Notes

Submitted by: RBU Lennox Industries Inc.

Lennox Testing Report

These are the tests run with 84F / 66F indoor conditions and 115F, 126F and 131F outdoor temperatures. Only DR-55 was tested at these conditions in the drop-in testing program.

Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM				Test:	"115F"	84F / 66F Indoor		
				Alt. Refrig.:	DR-55			
Manufacturer: Lennox Industries Inc.			Manufacturer's Notation: LGH060H4ESP					
Basic Information								
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)			DR-55					
Alternative Lubricant Type and ISO Viscosity			3MAF-POE					
Baseline Refrigerant and Lubricant			N/A					
Make and Model of System			Lennox, LGH060H4ESP					
Nominal Capacity and Type of System			5 Ton, Rooftop Air Conditioning Unit					
Comparison Data								
		Base.	Alt.	SI Units	Base.	Alt.	IP Unit	Ratio
Mode (Heating/Cooling)		Cooling						
Compressor Type			scroll					
Compressor Displacement			0.229	m ³ /min			ft ³ /min	
Nominal Motor Size			4.5	hp				
Motor Speed			3500	rpm				
Expansion Device Type			TXV					
Lubricant Charge			1.66	liter		56	ounce	
Refrigerant Charge			6.27	kg		13.825	lb	
Refrigerant Mass Flow Rate			318.7	kg/hr		702.7	lb/hr	
Composition, at compr. inlet if applicable			n/a	% wt				
Ambient Temps.	Indoor	db		28.9	C		84.01	F
		wb		18.9	C		66.02	F
	Outdoor	db		46.1	C		115.03	F
		wb		n/a	C		n/a	F
Total Capacity			14948	W		51018	Btu/hr	
Sensible Capacity			13791	W		47067	Btu/hr	
Total System Power Input			5656	W		5656	W	
Compressor Power Input			4837	W		4837	W	
Energy Efficiency Ratio (EER)			n/a	W/W		9.02	Btuh/W	
Coeff. Of Performance (COP)			2.64					n/a
Other System Changes								
System Data*								
Degradation Coefficient – Cd					Base.	Alt.	Ratio	
Seasonal Energy Efficiency Ratio - SEER								
Heating Seasonal Performance Factor - HSPF								
* Only Steady-State Cooling Tests Conducted								

Lennox Testing Report

Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM

Type of System: R-410A Single Package AC Unit Alternate Refrigerant: DR-55 page 2
 test: 115F -- 84F/66F Indoor

Air Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air						
Flow Rate (gas)		50.7	m ³ /min		1792	ft ³ /min	
Flow Rate (liquid)		n/a	L/min		n/a	gal/min	n/a
Inlet Temperature*	*	*	C	*	*	F	
Outlet Temperature*	*	*	C	*	*	F	
Condenser							
Heat Exchange Fluid		Air					
Flow Rate (gas)		135.92	m ³ /min		4800	ft ³ /min	
Flow Rate (liquid)		n/a	L/min		n/a	gal/min	n/a
Inlet Temperature		46.1	C		115	F	
Outlet Temperature	(not measured)	(not measured)	C	(not measured)	(not measured)	F	
* see previous page							

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			20.5	1058			69	153
Compressor Discharge			93.0	3234			199	469
Condenser Inlet			93.0	3234			199	469
Condenser Outlet			46.7	3181			116	461
Expansion Device Inlet			47.6	3181			118	461
Subcooling, at expan. device			5.4				10	
Evaporator Inlet	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)
Evaporator Outlet			20.5	1072			69	156
Evaporator Superheat			8.5				15	

Data Source(s) for Refrigerant Properties
Alt. Refrigerant Manufacturer

Additional Notes

Submitted by: RBU Lennox Industries Inc.

Lennox Testing Report

Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM			Test: "126F" 84F / 66F Indoor				
			Alt. Refrig.: DR-55				
Manufacturer: Lennox Industries Inc.			Manufacturer's Notation: LGH060H4ESP				
Basic Information							
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)			DR-55				
Alternative Lubricant Type and ISO Viscosity			3MAF-POE				
Baseline Refrigerant and Lubricant			N/A				
Make and Model of System			Lennox, LGH060H4ESP				
Nominal Capacity and Type of System			5 Ton, Rooftop Air Conditioning Unit				
Comparison Data							
		Base.	Alt.	SI Units	Base.	Alt.	IP Unit
Mode (Heating/Cooling)		Cooling					
Compressor Type			scroll				
Compressor Displacement			0.229	m ³ /min			ft ³ /min
Nominal Motor Size			4.5	hp			
Motor Speed			3500	rpm			
Expansion Device Type			TXV				
Lubricant Charge			1.66	liter		56	ounce
Refrigerant Charge			6.27	kg		13.825	lb
Refrigerant Mass Flow Rate			323.8	kg/hr		714.1	lb/hr
Composition, at compr. inlet if applicable			n/a	% wt			
Ambient Temps.	Indoor	db	28.9	C		84.00	F
		wb	18.9	C		65.99	F
	Outdoor	db	52.2	C		125.99	F
		wb	n/a	C		n/a	F
Total Capacity			13705	W		46777	Btu/hr
Sensible Capacity			13415	W		45784	Btu/hr
Total System Power Input			6359	W		6359	W
Compressor Power Input			5536	W		5536	W
Energy Efficiency Ratio (EER)			n/a	W/W		7.36	Btuh/W
Coeff. Of Performance (COP)			2.16				n/a
Other System Changes							
System Data*							
Degradation Coefficient – Cd					Base.	Alt.	Ratio
Seasonal Energy Efficiency Ratio - SEER							
Heating Seasonal Performance Factor - HSPF							
* Only Steady-State Cooling Tests Conducted							

Lennox Testing Report

Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM

Type of System: R-410A Single Package AC Unit Alternate Refrigerant: DR-55 page 2
 test: 126F -- 84F/66F Indoor

Air Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air						
Flow Rate (gas)		50.6	m ³ /min		1788	ft ³ /min	
Flow Rate (liquid)		n/a	L/min		n/a	gal/min	n/a
Inlet Temperature*	*	*	C	*	*	F	
Outlet Temperature*	*	*	C	*	*	F	
Condenser							
Heat Exchange Fluid		Air					
Flow Rate (gas)		135.92	m ³ /min		4800	ft ³ /min	
Flow Rate (liquid)		n/a	L/min		n/a	gal/min	n/a
Inlet Temperature		52.2	C		126	F	
Outlet Temperature	(not measured)	(not measured)	C	(not measured)	(not measured)	F	
* see previous page							

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			21.8	1097			71	159
Compressor Discharge			102.6	3648			217	529
Condenser Inlet			102.6	3648			217	529
Condenser Outlet			53.9	3594			129	521
Expansion Device Inlet			54.2	3594			130	521
Subcooling, at expan. device			4.3				8	
Evaporator Inlet	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)
Evaporator Outlet			21.4	1113			71	161
Evaporator Superheat			8.2				15	

Data Source(s) for Refrigerant Properties
Alt. Refrigerant Manufacturer

Additional Notes

Submitted by: RBU Lennox Industries Inc.

Lennox Testing Report

Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM			Test:	"131F"	84F / 66F Indoor			
			Alt. Refrig.:	DR-55				
Manufacturer: Lennox Industries Inc.			Manufacturer's Notation: LGH060H4ESP					
Basic Information								
Alternative Refrigerant (If not proprietary, composition as Charged, % wt)			DR-55					
Alternative Lubricant Type and ISO Viscosity			3MAF-POE					
Baseline Refrigerant and Lubricant			N/A					
Make and Model of System			Lennox, LGH060H4ESP					
Nominal Capacity and Type of System			5 Ton, Rooftop Air Conditioning Unit					
Comparison Data								
		Base.	Alt.	SI Units	Base.	Alt.	IP Unit	Ratio
Mode (Heating/Cooling)		Cooling						
Compressor Type			scroll					
Compressor Displacement			0.229	m ³ /min			ft ³ /min	
Nominal Motor Size			4.5	hp				
Motor Speed			3500	rpm				
Expansion Device Type			TXV					
Lubricant Charge			1.66	liter		56	ounce	
Refrigerant Charge			6.27	kg		13.825	lb	
Refrigerant Mass Flow Rate			321.8	kg/hr		709.6	lb/hr	
Composition, at compr. inlet if applicable			n/a	% wt				
Ambient Temps.	Indoor	db	28.9	C		83.99	F	
		wb	18.9	C		66.00	F	
	Outdoor	db	55.1	C		131.23	F	
		wb	n/a	C		n/a	F	
Total Capacity			13021	W		44439	Btu/hr	
Sensible Capacity			12983	W		44311	Btu/hr	
Total System Power Input			6722	W		6722	W	
Compressor Power Input			5913	W		5913	W	
Energy Efficiency Ratio (EER)			n/a	W/W		6.61	Btuh/W	
Coeff. Of Performance (COP)			1.94					n/a
Other System Changes								
System Data*								
Degradation Coefficient – Cd					Base.	Alt.	Ratio	
Seasonal Energy Efficiency Ratio - SEER								
Heating Seasonal Performance Factor - HSPF								
* Only Steady-State Cooling Tests Conducted								

Lennox Testing Report

Low-GWP AREP SYSTEM DROP-IN TEST DATA FORM

Type of System: R-410A Single Package AC Unit Alternate Refrigerant: DR-55 page 2
 test: 131F -- 84F/66F Indoor

Air Side Data	Base.	Alt.	SI Units	Base.	Alt.	IP Units	Ratio
Evaporator							
Heat Exchange Fluid	Air						
Flow Rate (gas)		51.0	m ³ /min		1800	ft ³ /min	
Flow Rate (liquid)		n/a	L/min		n/a	gal/min	n/a
Inlet Temperature*	*	*	C	*	*	F	
Outlet Temperature*	*	*	C	*	*	F	
Condenser							
Heat Exchange Fluid		Air					
Flow Rate (gas)		135.92	m ³ /min		4800	ft ³ /min	
Flow Rate (liquid)		n/a	L/min		n/a	gal/min	n/a
Inlet Temperature		55.1	C		131	F	
Outlet Temperature	(not measured)	(not measured)	C	(not measured)	(not measured)	F	
* see previous page							

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			22.5	1108			72	161
Compressor Discharge			107.2	3866			225	561
Condenser Inlet			107.2	3866			225	561
Condenser Outlet			58.6	3817			138	554
Expansion Device Inlet			56.7	3817			134	554
Subcooling, at expan. device			4.6				8	
Evaporator Inlet	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)	(not measured)
Evaporator Outlet			22.5	1126			73	163
Evaporator Superheat			8.8				16	

Data Source(s) for Refrigerant Properties
Alt. Refrigerant Manufacturer

Additional Notes

Submitted by: RBU Lennox Industries Inc.