

FORANE® 409A

Forane® 409A refrigerant (R-409A or FX-56) is a low ozone depleting blend of HCFC refrigerants R-22, R-124, and R-142b. R-409A is formulated to closely resemble the properties of R-12.

Application	Applications include many medium temperature refrigeration systems, vending machines, refrigerators, positive displacement chillers, humidifiers, and other systems using R-12 or R-500.
Properties & Performance	R-409A has properties and performance similar to R-12 and R-500. Low side pressures are similar to those of R-12, while high side pressures will typically be 15 to 25 psi higher. Equal or better heat transfer characteristics are usually obtained when retrofitting from R-12 to R-409A.
Lubrication	R-409A works well with the MO or AB found in R-12 or R-500 systems and typically does not require an oil change. For low temperature, mineral oil based R-12 applications (evaporator temperatures less than 0°F), a partial oil change (less than 30%) to alkylbenzene is recommended. R-409A is fully miscible with AB and POE oils.
Charging	Due to the zeotropic nature of R-409A, it should be charged as a liquid to prevent fractionation (changes in refrigerant composition due to vapor charging. See Definitions- Fractionation). In situations where vapor is normally charged into a system, a valve should be installed in the charging line to flash the liquid to vapor while charging. Charging weight ratios of R-409A are usually 85 - 90% of the charge weight of R-12.
Retrofit	R-409A is the recommended retrofit for R-12 and R-500 stationary DX systems, where an oil change to POE is not practical. R-409A is not recommended for use in automotive air conditioning system or systems that utilize a flooded evaporator (i.e. centrifugal chillers). For these systems, R-134a is the recommended retrofit product.

RETROFITTING PROCEDURE

1. Establish baseline performance. Note the oil type in use and any system operating data (if system is operating properly). Check for existing leaks and identify any needed repairs.
2. Recover the existing refrigerant charge (DO NOT vent to atmosphere). Weigh the amount of refrigerant removed.
3. Perform any repairs identified in step 1 and fix any leaks.
4. Replace the filter-drier and, if necessary, elastomeric seals (O-rings, sight glasses, etc.). Verify the condition of the system oil; replace if necessary.
5. Oil changes are typically not required for R-409A. For low temperature mineral oil based systems, a partial (greater than 30%) oil change to AB is recommended.
6. Evacuate the system (less than 500 microns) and ensure it maintains a vacuum. If vacuum is lost, it may indicate that leaks are present in the system.
7. Charge system with R-409A refrigerant. Remove refrigerant as liquid only from cylinder. The initial charge amount should be approximately 85 – 90% of the standard charge for R-12 for TXV systems and 80 % for cap tube systems.
8. Adjust TXV set point and/or refrigerant charge to achieve the desired superheat. Low side pressure control settings may also need to be adjusted.
9. Monitor oil levels in the compressor. If necessary, adjust oil amounts to attain normal operating level (mid sight glass).
10. Label system clearly, indicating the type and amounts of system refrigerant and oil.

PROPERTIES	R-409A
Average Molecular Weight (g/mol)	97.4
Normal Boiling Point (°F)	-30.1
Critical Temperature	224.2
ASHRAE Safety Group Classification	A1
Ozone Depletion Potential (ODP)	0.05
Global Warming Potential (GWP)	1,290

R-22 TRANSITION

Montreal Protocol HCFC Phase-out

Ongoing R-22 Reduction



R-22 is the most widely used HCFC refrigerant for HVACR applications, such as residential air conditioning, refrigeration, and other cooling applications. Although R-22 has been a good solution for many different applications, it is classified as an HCFC and is subject to phase-out according to the Montreal Protocol international treaty and the Clean Air Act in the United States.

In the USA, the Clean Air Act has met the requirements of the Montreal Protocol by limiting consumption of HCFC, including R-22, through a series of phase downs through 2030. Each step reduces R-22 consumption by reducing or eliminating R-22 in different market segments.

As part of this phase down, R-22 will not be permitted for use in new OEM HVACR equipment in 2010, reducing the R-22 demands into this sector and helping to meet the 75% reduction in ozone depleting substances.

In 2015, R-22 will have another step change reduction of 90% of the overall allowable consumption for servicing R-22 systems in the United States.

These step-downs will continue through 2030, when R-22 will be completely phased out in the United States.

In the USA, these regulations may change in the future. Please visit www.forane-us.com.

R-22 users should be aware of the need to transition to other, more sustainable refrigerants meeting the application's requirements. Current HFC refrigerants listed in this Tech Digest meet these needs and are not under any phase-out restrictions.

DEFINITIONS

Bubble Point (Saturated Liquid Temperature)	The temperature (for a given pressure) at which the liquid of a refrigerant blend (any 400 or 500 series refrigerant) begins to evaporate or boil. This is similar to the saturated liquid temperature of a single component refrigerant.
Dew Point (Saturated Vapor Temperature)	The temperature (for a given pressure) at which the vapor of a given refrigerant blend (any 400 or 500 series refrigerant) begins to condense or liquefy. This is similar to the saturated vapor temperature of a single component refrigerant.
Fractionation	The change in composition of a refrigerant blend (any 400 or 500 series refrigerant) when it changes phase from liquid to vapor (evaporation) or from vapor to liquid (condensation). This behavior in blends explains the permanent changes to refrigerant composition from leaks, causing the blend to deviate outside the tolerances of the designed composition.
Glide	The difference in temperature between the evaporator outlet and inlet due to fractionation of the blend. Theoretically, this can be calculated by finding the difference between the dew and bubble temperatures at constant pressure. Actual measurements may differ slightly depending on the state of the liquid refrigerant at either end of the evaporator (or condenser). Pressure losses through the evaporator may also affect glide.
Normal Boiling Point (NBP)	The temperature at which a given refrigerant begins to boil while at atmospheric pressure (14.7 psia).
Abbreviations	AB – alkylbenzene GWP – global warming potential MO – mineral oil ODP – ozone depletion potential OEM – original equipment manufacturer POE – polyolester PAG – polyalkylene glycol

OTHER TOPICS

Refrigerant Lubricants

The phase-out of ozone depleting refrigerants has impacted air-conditioning and refrigeration equipment design in many ways. One of the most significant changes to these systems is the transition of the compressor lubricants. Use of an appropriate lubricant is important when servicing, installing, or retrofitting a system. The following information may be helpful as general background information on refrigerant lubricants; however, always follow OEM recommendations for proper lubricant selection.

Mineral Oil: Mineral oil has been the lubricant of choice for systems utilizing many of the CFC and HCFC refrigerants. Both the CFCs and HCFCs tend to have adequate miscibility with mineral oil, helping to ensure acceptable oil return under normal operating conditions. Sometimes a synthetic lubricant (i.e. AB or POE) is required under certain conditions, such as reduced miscibility with CFC retrofit blends or high discharge temperatures with products like R-22.

Alkylbenzene: Alkylbenzene is a synthetic refrigerant compressor lubricant used in new refrigeration systems and for retrofits from CFCs to HCFCs. Typically, Alkylbenzene has better miscibility with HCFCs than mineral oil, resulting in more reliable oil return. For retrofits of older CFC equipment, a partial oil change from mineral oil to alkylbenzene may be acceptable.

Polyolester: HFC refrigerants serve as the replacements for the ozone-depleting CFCs and HCFCs. However, both mineral oil and alkylbenzene have poor miscibility with HFCs, making oil return with these products unreliable in many systems. POEs are synthetic oils commonly used in new HFC systems and for retrofitting older CFC and HCFC equipment to HFC refrigerants. Special care must be taken when using POE oils due to their quick absorption of moisture when left exposed to the atmosphere (hygroscopic).

Polyalkylene Glycol: In addition to POE oils, polyalkylene glycol (PAG) lubricants are used with R-134a in automotive air-conditioning applications. Like POEs, PAGs are hygroscopic synthetic oils and must be treated with care to minimize exposure to moisture. While both POEs and PAGs are used with R-134a in automotive systems, the two oil types are not interchangeable and should not be mixed.

Material Compatibility

Whenever retrofitting an air-conditioning or refrigeration system, compatibility of system materials is always a concern. Items such as elastomers, hoses, and filter-driers respond differently to different refrigerants and oils. For these reasons, before performing any refrigerant retrofit, Arkema recommends contacting the OEM for specific recommendations. Arkema's Technical Service hotline can also be reached at (800) 738-7695.

Leak Detection

Leak checking should be a routine practice whenever performing maintenance on or servicing an air-conditioning or refrigeration system. As elastomers and other sealing components may react differently to new refrigerants and oils, leak checking should always be performed after any refrigerant retrofit.

Certain older style leak detectors have difficulty detecting newer refrigerants. It is important to verify whether or not your leak detector is rated for the type of refrigerant (CFC, HCFC, or HFC) you will be working with. Also, some refrigerant dyes are only compatible with specific refrigerant oils. Always check with the manufacturer before using a leak dye in an air-conditioning or refrigeration system.

Forane® Refrigerant Pressure Temperature Chart

PRESSURE (PSIG)																		
Sat. Temp (°F)	R-22	R-407C Liquid Pressure	R-407C Vapor Pressure	R-410A Liquid Pressure	R-427A Liquid Pressure	R-427A Vapor Pressure	R-407A Liquid Pressure	R-407A Vapor Pressure	R-123	R-12	R-134a	R-409A Liquid Pressure	R-409A Vapor Pressure	R-401A Liquid Pressure	R-401A Vapor Pressure	R-401B Liquid Pressure	R-401B Vapor Pressure	Sat. Temp (°C)
-50	6.2	2.9	11.4	5.3	3.8	11.9	0.8	9.0	29.2	15.4	18.7	12.4	17.2	13.5	17.9	12.2	16.8	-45.6
-45	2.7	0.4	8.5	8.0	0.1	9.0	1.7	5.7	29.0	13.3	16.9	9.7	15.2	11.1	16.0	9.6	14.7	-42.8
-40	0.5	2.5	5.2	11.0	1.9	5.9	3.9	2.0	28.9	11.0	14.8	6.8	13.1	8.4	13.8	6.7	12.4	-40.0
-35	2.6	4.8	1.5	14.2	4.1	2.4	6.4	1.0	28.7	8.4	12.5	3.5	10.7	5.3	11.4	3.4	9.7	-37.2
-30	4.9	7.3	1.3	17.8	6.6	0.8	9.2	3.3	28.4	5.5	9.8	0.0	8.1	2.0	8.7	0.1	6.8	-34.4
-25	7.4	10.1	3.6	21.8	9.3	2.9	12.2	5.8	28.1	2.3	6.9	2.0	5.1	0.8	5.6	2.0	3.5	-31.7
-20	10.1	13.1	6.1	26.1	12.2	5.3	15.6	8.5	27.8	0.6	3.7	4.1	1.9	2.9	2.2	4.1	0.1	-28.9
-15	13.2	16.5	8.8	30.8	15.4	7.9	19.2	11.5	27.4	2.4	0.1	6.5	0.8	5.1	0.7	6.5	2.0	-26.1
-10	16.5	20.1	11.9	35.9	18.9	10.8	23.2	14.9	27.0	4.5	1.9	9.0	2.8	7.5	2.8	9.1	4.2	-23.3
-5	20.0	24.0	15.2	41.5	22.8	14.0	27.5	18.5	26.5	6.7	4.1	11.8	4.9	10.1	5.0	11.9	6.6	-20.6
0	23.9	28.3	18.9	47.5	26.9	17.5	32.2	22.5	25.9	9.1	6.5	14.8	7.2	13.0	7.4	14.9	9.2	-17.8
5	28.2	33.0	22.9	54.1	31.4	21.2	37.3	26.9	25.3	11.8	9.1	18.1	9.7	16.1	10.1	18.2	12.1	-15.0
10	32.8	38.0	27.3	61.2	36.3	25.4	42.8	31.6	24.6	14.6	11.9	21.7	12.5	19.5	13.0	21.8	15.2	-12.2
15	37.7	43.5	32.0	68.8	41.5	29.9	48.7	36.7	23.7	17.7	15.0	25.5	15.4	23.1	16.2	25.7	18.6	-9.4
20	43.0	49.3	37.2	77.1	47.2	34.7	55.1	42.3	22.8	21.0	18.4	29.6	18.7	27.1	19.6	29.9	22.3	-6.7
25	48.7	55.7	42.7	86.0	53.3	40.0	62.0	48.3	21.8	24.6	22.1	34.0	22.2	31.4	23.4	34.4	26.3	-3.9
30	54.9	62.5	48.7	95.5	59.8	45.7	69.3	54.8	20.7	28.4	26.0	38.7	26.0	36.0	27.4	39.3	30.6	-1.1
35	61.5	69.8	55.2	105.7	66.8	51.9	77.2	61.8	19.5	32.5	30.3	43.8	30.1	40.9	31.8	44.5	35.2	1.7
40	68.5	77.6	62.1	116.6	74.3	58.7	85.6	69.4	18.1	36.9	35.0	49.2	34.5	46.2	36.5	50.1	40.2	4.4
45	76.0	86.0	69.5	128.3	82.3	65.6	94.6	77.4	16.6	41.6	40.0	54.9	39.2	51.8	41.6	56.0	45.6	7.2
50	84.0	94.9	77.5	140.8	90.8	73.3	104.2	86.1	15.0	46.7	45.4	61.0	44.3	57.9	47.0	62.4	51.4	10.0
55	92.5	104.5	86.0	154.1	99.9	81.5	114.4	95.3	13.1	52.0	51.1	67.6	49.8	64.3	52.8	69.2	57.5	12.8
60	101.6	114.6	95.1	168.2	109.6	90.3	125.2	105.2	11.2	57.7	57.3	74.5	55.6	71.2	59.0	76.5	64.1	15.6
65	111.2	125.4	104.8	183.2	119.9	99.6	136.7	115.7	9.0	63.7	63.9	81.8	61.9	78.5	65.7	84.2	71.2	18.3
70	121.4	136.9	115.2	199.2	130.8	109.6	148.8	127.0	6.6	70.2	71.0	89.5	68.6	86.3	72.8	92.3	78.7	21.1
75	143.6	149.1	126.2	216.1	142.4	120.3	161.7	138.9	4.0	76.9	78.6	97.7	75.8	94.5	80.3	101.0	86.7	23.9
80	143.6	162.1	137.8	234.0	154.6	131.6	175.3	151.6	1.2	84.1	86.6	106.4	83.4	103.2	88.4	110.2	95.2	26.7
85	155.7	175.8	150.2	253.0	167.6	143.7	189.7	165.1	0.9	91.7	95.1	115.5	91.5	112.4	96.9	119.8	104.2	29.4
90	168.4	190.2	163.4	273.0	181.2	156.4	204.8	179.3	2.5	99.7	104.2	125.2	100.2	122.2	106.0	130.1	113.8	32.2
95	181.8	205.5	177.4	294.1	195.6	170.0	220.8	194.4	4.2	108.2	113.8	135.3	109.4	132.5	115.6	140.9	123.9	35.0
100	195.9	221.6	192.1	316.4	210.8	184.4	237.6	210.4	6.1	117.1	124.1	146.0	119.2	143.3	125.7	152.3	134.7	37.8
105	210.7	238.5	207.8	339.9	226.8	199.6	255.3	227.4	8.1	126.5	134.9	157.2	129.6	154.8	136.5	164.3	146.0	40.6
110	226.3	256.4	224.4	364.6	243.6	215.7	273.9	245.2	10.3	136.4	146.3	169.0	140.6	166.8	147.8	176.9	158.0	43.3
115	242.7	275.1	241.9	390.5	261.2	232.7	293.5	264.1	12.6	146.7	158.4	181.4	152.3	179.4	159.8	190.1	170.6	46.1
120	259.9	294.7	260.5	417.7	279.7	250.6	314.0	284.0	15.1	157.6	171.1	194.4	164.7	192.7	172.4	204.0	183.9	48.9
125	277.9	315.2	280.1	446.3	299.1	269.5	335.4	305.0	17.7	169.0	184.5	208.0	177.8	206.6	185.7	218.6	197.9	51.7
130	296.8	336.7	300.9	476.3	319.4	289.5	357.9	327.1	20.6	180.9	198.7	222.3	191.6	221.2	199.7	233.9	212.6	54.4
135	316.5	359.2	322.9	507.6	340.7	310.5	381.5	350.5	23.6	193.5	213.6	237.2	206.3	236.5	214.5	250.0	228.1	57.2
140	337.2	382.6	346.2	540.5	362.9	332.6	406.2	375.1	26.8	206.5	229.3	252.9	221.8	252.5	229.9	266.7	244.3	60.0
145	358.8	407.0	370.8	574.8	386.1	355.9	431.9	401.0	30.2	220.2	245.7	269.3	238.2	269.3	246.2	284.3	261.4	62.8
150	381.5	432.4	396.9	610.6	410.3	380.4	458.9	428.3	33.8	234.5	263.0	286.4	255.5	286.8	263.2	302.6	279.3	65.6

Red Numerals (in bold and italics) - Inches Hg. Below 1 ATM

PRESSURE (PSIG)

Sat. Temp (°F)	R-502	R-408A Liquid Pressure	R-402A Liquid Pressure	R-402B Liquid Pressure	R-404A Liquid Pressure	R-507A	Sat. Temp (°C)
-50	<i>0.2</i>	<i>1.6</i>	2.5	1.1	0.6	1.1	-45.6
-45	1.9	1.1	4.9	3.2	2.7	3.3	-42.8
-40	4.1	3.3	7.4	5.6	5.0	5.7	-40.0
-35	6.5	5.6	10.3	8.2	7.6	8.3	-37.2
-30	9.2	8.2	13.4	11.1	10.4	11.2	-34.4
-25	12.1	11.0	16.7	14.2	13.4	14.3	-31.7
-20	15.3	14.1	20.4	17.6	16.8	17.8	-28.9
-15	18.8	17.5	24.5	21.4	20.5	21.6	-26.1
-10	22.6	21.2	28.8	25.4	24.5	25.7	-23.3
-5	26.7	25.2	33.6	29.8	28.8	30.1	-20.6
0	31.1	29.5	38.7	34.6	33.5	34.9	-17.8
5	35.9	34.2	44.2	39.8	38.6	40.2	-15.0
10	41.0	39.3	50.1	45.3	44.0	45.8	-12.2
15	46.5	44.8	56.5	51.3	49.9	51.8	-9.4
20	52.5	50.7	63.4	57.6	56.2	58.3	-6.7
25	58.8	57.0	70.7	64.5	63.0	65.3	-3.9
30	65.6	63.7	78.5	71.8	70.3	72.8	-1.1
35	72.8	71.0	86.9	79.6	78.1	80.8	1.7
40	80.5	78.7	95.8	88.0	86.4	89.3	4.4
45	88.7	87.0	105.3	96.9	95.2	98.4	7.2
50	97.4	95.8	115.4	106.3	104.7	108.1	10.0
55	106.6	105.1	126.1	116.3	114.7	118.5	12.8
60	116.4	115.1	137.4	127.0	125.3	129.4	15.6
65	126.7	125.6	149.4	138.2	136.6	141.1	18.3
70	137.6	136.8	162.1	150.1	148.6	153.4	21.1
75	149.1	148.7	175.5	162.7	161.2	166.4	23.9
80	161.2	161.2	189.7	176.0	174.6	180.2	26.7
85	174.0	174.4	204.6	189.9	188.8	194.8	29.4
90	187.4	188.4	220.2	204.7	203.7	210.1	32.2
95	201.4	203.1	236.8	220.2	219.4	226.3	35.0
100	216.2	218.7	254.2	236.5	235.9	243.4	37.8
105	231.7	235.4	272.4	253.6	253.4	261.3	40.6
110	247.9	252.1	291.6	271.6	271.7	280.2	43.3
115	264.9	270.2	311.7	290.5	290.9	300.0	46.1
120	282.7	289.1	332.8	310.3	311.1	320.8	48.9
125	301.4	308.9	354.9	331.0	332.3	342.6	51.7
130	320.8	329.7	378.1	352.7	354.5	365.5	54.4
135	341.2	351.5	402.4	375.4	377.8	389.4	57.2
140	362.6	374.3	427.8	399.2	402.2	414.5	60.0
145	385.0	398.1	454.4	424.0	427.7	440.7	62.8
150	408.4	423.0	482.3	450.0	454.4	468.1	65.6

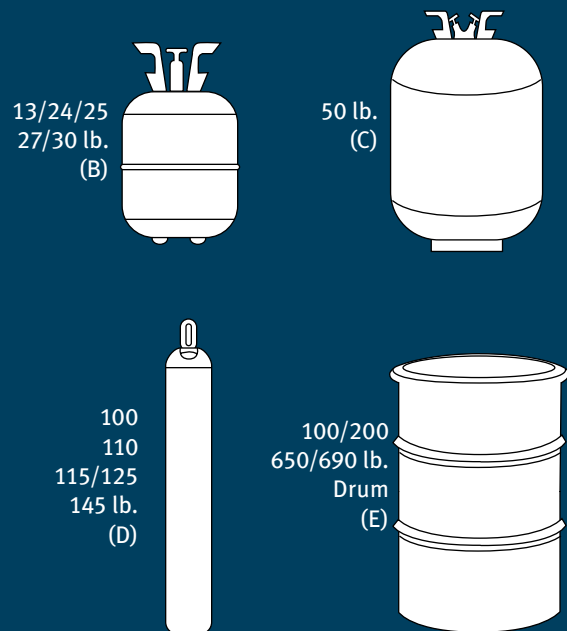
Red Numerals (in bold and italics) - Inches Hg. Below 1 ATM

Forane® Refrigerant Cylinder Identification

Type	Color Code	Sizes (Net lbs.)	
R-12	CFC	White	30 (B), 50 (C), 145 (D), 2000
R-502	CFC	Lavender	30 (B), 125 (D)
R-22	HCFC	Light Green	30 (B), 50 (C), 125 (D), 1000, 1750
R-123	HCFC	Light Blue Grey	100 (E), 200 (E)
R-401A	HCFC	Pinkish Red	30 (B), 125 (D)
R-401B	HCFC	Mustard	30 (B), 125 (D)
R-402A	HCFC	Sand	27 (B), 110 (D)
R-402B	HCFC	Olive	13 (B)
R-408A	HCFC	Medium Purple	24 (B), 100 (D), 1300
R-409A	HCFC	Tan	30 (B), 125 (D), 1800
R-134a	HFC	Light Blue	30 (B), 125 (D), 1000, 1750
R-404A	HFC	Orange	24 (B), 100 (D), 1300 tons
R-407A	HFC	Lime Green	25 (B), 115 (D)
R-407C	HFC	Brown	25 (B), 115 (D), 1000, 1600
R-427A	HFC	Green	25 (B) 110 (D)
R-410A	HFC	Rose	25 (B), 100 (D), 850, 1350
R-507A	HFC	Teal	25 (B), 100 (D), 800, 1400

Container Types

Size not to scale



Forane® Refrigerant Basic Property Data Chart

Properties	R-410A	R-427A	R-407A	R-407C	R-134a	R-404A	R-507A	R-22	R-408A	R-409A	R-123
Average Molecular Weight (g/mol)	72.6	90.4	90.1	86.2	102.0	97.6	98.8	86.5	87.0	97.4	152.9
Normal Boiling Point (NBP) (°F)	-61.9	-44.8	-49.0	-46.1	-14.9	-51.5	-52.8	-41.3	-47.9	-30.1	82.1
Latent Heat of Vaporization at NBP (BTU/lb)	116.7	102.0	101.3	107.4	92.8	86.0	84.3	100.5	97.6	94.6	73.7
Critical Temp (°F)	162.0	185.6	180.1	187.2	214.1	161.6	159.8	204.8	182.6	224.2	362.7
Critical Pressure (psia)	717.9	637.1	654.9	670.1	590.3	539.5	539.5	722.3	629.5	667.2	532.9
Density of Saturated Vapor @ NBP (lb/ft³)	0.26	0.30	0.30	0.29	0.33	0.34	0.34	0.29	0.30	0.31	0.40
Density of Saturated Liquid at 77°F (lb/ft³)	66.3	71.9	71.5	71.1	75.3	65.2	65.0	74.5	66.3	75.9	91.3
Specific Heat of Saturated Vapor at NBP (BTU/lb °R)	0.17	0.18	0.18	0.17	0.19	0.18	0.18	0.14	0.16	0.15	0.16
Specific Heat of Saturated Liquid at 77°F (BTU/lb °R)	0.44	0.38	0.36	0.38	0.34	0.39	0.39	0.30	0.37	0.30	0.23
Ozone Depletion Potential (ODP) (CFC-11 = 1.0)	0	0	0	0	0	0	0	0.055	0.026	0.05	0.02
ASHRAE Safety Group Classification	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	B1
Occupational Exposure Limits (8 hr time/wt. Avg.) (ppm)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	50
Global Warming Potential (GWP)	2,100	2,130	2,100	1,800	1,430	3,900	4,000	1,810	2,650	1,290	77

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