VENT REQUIREMENTS

For Stocked Equipment

Manufacture Model		Cat I Dia.	Cat III Dia.	Cat III Mat'l.	Intake Dia.	Intake Mat'l.	Max. Lgth.	Max. 90's	Deduct for each 90	Min. Lgth.
Lennox										
LF24-30A, 45A		3	3	26 ga. Galv or SS	NA	NA	30	5	5	5
LF24-60A, 75A		4	4	26 ga. Galv or SS	NA	NA	30	5	5	5
1residential applications only max. length is 5'										
Lennox										
LF24-100A	1 Pipe	4	3	26 ga. Galv or SS	NA	NA	25	5	5	5
LF24-125A	1 Pipe	4	4	26 ga. Galv or SS	NA	NA	25	5	5	5
LF24-150A	1 Pipe	4	4	26 ga. Galv or SS	NA	NA	25	5	5	5
LF24-200A	1 Pipe	5	4	26 ga. Galv or SS	NA	NA	25	5	5	5
LF24-250A	1 Pipe	5	5	26 ga. Galv or SS	NA	NA	25	5	5	5
LF24-300A	1 Pipe	5	5	26 ga. Galv or SS	NA	NA	35	7	5	5
LF24-345A	1 Pipe	6	5	26 ga. Galv or SS	NA	NA	35	7	5	5
LF24-400A	1 Pipe	6	5	26 ga. Galv or SS	NA	NA	35	7	5	5
Lennox							**2" - 3"**		**2" - 3"**	
G51MP-***-045	1 or 2 Pipe	NA	2 or 3	PVC/ABS	2 or 3	PVC/ABS	55-70		5	15
G51MP-36B-070	1 or 2 Pipe	NA	2 or 3	PVC/ABS	2 or 3	PVC/ABS	55-70		5	15
G51MP-***-090	1 or 2 Pipe	NA	2 or 3	PVC/ABS	2 or 3	PVC/ABS	25-70		5	15
G51MP-***-110	1 or 2 Pipe	NA	2 or 3	PVC/ABS	2 or 3	PVC/ABS	15-70		5	15
G51MP-60C-135	1 or 2 Pipe	NA	3	PVC/ABS	3	PVC/ABS	na-55		5	15
Lennox							**2" - 3"**		**2" - 3"**	
G61MP-36B-045	1 or 2 Pipe	NA	2 or 3	PVC/ABS	2 or 3	PVC/ABS	55-70		5	15
G61MP-36B-070	1 or 2 Pipe	NA	2 or 3	PVC/ABS	2 or 3	PVC/ABS	55-70		5	15
G61MP-***-090	1 or 2 Pipe	NA	2 or 3	PVC/ABS	2 or 3	PVC/ABS	25-70		5	15
G61MP-***-110	1 or 2 Pipe	NA	2 or 3	PVC/ABS	2 or 3	PVC/ABS	15-70		5	15
G61MP-60C-135	1 or 2 Pipe	NA	3	PVC/ABS	3	PVC/ABS	na-55		5	15
Lennox							**2" - 3"**			
G61MPV-36B-070	1 or 2 Pipe	NA	2 or 3	PVC/ABS	2 or 3	PVC/ABS	55-70		5	15
G61MPV-***-090	1 or 2 Pipe	NA	2 or 3	PVC/ABS	2 or 3	PVC/ABS	25-70		5	15
G61MPV-60C-110	1 or 2 Pipe	NA	2 or 3	PVC/ABS	2 or 3	PVC/ABS	15-70		5	15
G61MPV-60D-135	1 or 2 Pipe	NA	3	PVC/ABS	3	PVC/ABS	na-55		5	15
Lennox							**2" - 3"**		**2" - 3"**	
GHR26Q2/3-50	2 Pipe	NA	2 or 3	PVC/ABS	2 or 3	PVC/ABS	55-130		5	15
GHR26Q3-75	2 Pipe	NA	2 or 3	PVC/ABS	2 or 3	PVC/ABS	55-130		5	15
GHR26Q**-100	2 Pipe	NA	2 or 3	PVC/ABS	2 or 3	PVC/ABS	25-130		5	15
GHR26Q4/5-120	2 Pipe	NA	3	PVC/ABS	3	PVC/ABS	15-120		5	15
Lennox										
HM61[1]		NA	2 or 3	PVC/ABS	2 or 3	PVC/ABS	125	6	5	6
1Based on 2" Concentric Termination										
NTI										
T150 Nat'l Gas	2 Pipe	NA	2 or 3	PVC/ABS	2 or 3	PVC/ABS	15-105		5	
T200 Nat'l Gas	2 Pipe	NA	3	PVC/ABS	3	PVC/ABS	105		5	
T150, 200 LP	2 Pipe	NA	3	PVC/ABS	3	PVC/ABS	50		5	
Weil McClain										
Ultra 80, 105, 155	2 Pipe		3	PVC/ABS	3	PVC/ABS	100		7	2
Ultra 230	2 Pipe		3 or 4	PVC/ABS	3 or 4	PVC/ABS	30-100		7	2
Ultra 310	2 Pipe		4	PVC/ABS	4	PVC/ABS	100		7	2
Weil McClain										
GV3-5	1 or 2 Pipe		3	Stainless	3		100		10	
GV-6	1 or 2 Pipe		3	Stainless	3		80`		10	

VENT REQUIREMENTS

For Stocked Equipment

Manfacturer	Model	Cat I Diameter	Cat III Diameter	Cat III Mat'l	Intake Diameter	Intake Mat'l	Max Length	Max 90's	Deduct per 90	Minimum Length
Rinnai										
	RHFE-263			OEM New			13	2		
	RHFE-431			OEM New			13	2		
	RHFE-551			OEM Old			13	2		
	RHFE-556			OEM New			13	2		
	RHFE-1001			OEM Old			13	2		
	RHFE-1004			OEM Old			13	2		
	REU-2532, 2520		4⅝ Concentric	OEM			23' (incl 3 90's) Max Total Equiv. Lgth 41'		6	
Empire										
	DV-*E			OEM			15		5	

VENT CATEGORY DEFINITIONS

Model #	Clearance to Opening	Clearance to Inside Corner
Lennox 2 Pipe	12"	
Lennox 1 Pipe	48"	
Lennox LF	48"	
W/M Sealed Comb.	12"	
W/M One Pipe	48"	
RHFE	9"	24"
REU	12"	12"

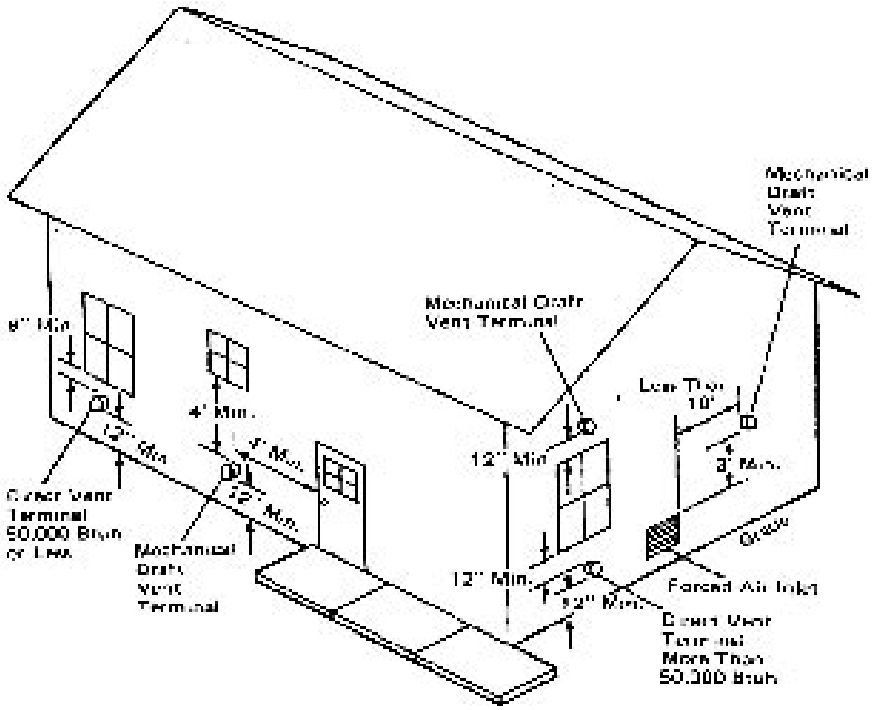
Cat. I Less the 87%—Chimney Vent. Non-positive vent pressure

Cat. III Positive pressure vent (typically sidewall). Low condensation less than 89%

Cat. IV Positive pressure vent; low temp. resulting in condensation 89% or higher

Direct Vent Terminal is a sealed combustion appliance which draws exterior combustion air

A Mechanical Draft Terminal is a power vented unit drawing combustion air from inside the structure



REFERENCE

B-VENT CAPACITY TABLE

Type B-Vent with B-Vent Connectors Serving a Single Appliance*
Common Sizes; Refer to Manufacturers Guide for Complete Table

B-Vent Diameter		3" B-Vent			4" B-Vent			5" B-Vent			6" B-Vent			7" B-Vent			8" B-Vent		
Vent	Lateral	Fan Assist		Nat	Fan Assist		Nat	Fan Assist		Nat	Fan Assist		Nat	Fan Assist		Nat	Fan Assist		Nat
Heigth		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
8	0	0	84	50	0	165	94	0	276	155	0	415	235	0	583	320	0	780	415
	5	23	53	38	32	103	71	42	171	114	53	252	173	70	356	237	83	473	313
15	0	0	94	58	0	191	112	0	327	187	0	502	285	0	716	390	0	970	525
	5	22	65	45	30	130	87	39	219	142	49	330	217	64	463	300	76	620	403
	10	29	59	41	40	121	82	51	206	135	64	315	208	84	445	288	99	600	386
20	0	0	97	61	0	202	119	0	349	202	0	540	307	0	776	430	0	1057	575
	5	21	71	48	29	143	96	38	242	160	47	367	241	62	519	337	73	697	460
	10	28	64	44	38	133	89	50	229	150	62	351	228	81	499	321	95	675	443
30	0	0	100	64	0	213	128	0	374	220	0	587	336	0	853	475	0	1173	650
	5	21	77	54	28	160	108	36	275	176	45	421	273	58	600	385	69	811	524
	10	27	70	50	37	150	102	48	262	171	59	405	261	77	590	271	91	788	507
50	0	0	101	67	0	216	134	0	397	232	0	633	363	0	932	518	0	1297	708
	5	20	82		27	177	119	35	312	200	43	487	308	55	702	438	65	960	605
	10	26	72		35	168	114	45	299	190	56	471	298	73	681	426	86	935	598

NFPA 54 1996 does NOT allow use of exterior masonry chimneys for venting gas appliances below -5º. Use of a single fan assisted appliance in any masonry chimney is severely restricted—check your application carefully.

B-VENT CAPACITY TABLE

Type B-Vent with Single Wall Connectors Serving a Single Appliance*
Common Sizes; Refer to Manufacturers Guide for Complete Table

B-Vent Diameter		3" B-Vent			4" B-Vent			5" B-Vent			6" B-Vent			7" B-Vent			8" B-Vent		
Vent	Lateral	Fan Assist		Nat	Fan Assist		Nat	Fan Assist		Nat	Fan Assist		Nat	Fan Assist		Nat	Fan Assist		Nat
Heigth		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
8	0	37	83	50	58	164	93	83	273	154	123	412	234	161	580	319	206	777	414
	5	nr	nr	37	77	102	69	107	168	114	151	252	171	193	352	235	245	470	311
15	0	36	93	57	56	190	111	80	325	186	116	325	186	153	713	388	195	966	523
	5	51	63	44	75	128	86	102	216	140	144	326	217	182	459	298	231	616	400
	10	nr	nr	39	95	116	79	128	201	131	182	308	203	228	438	284	284	592	381
20	0	35	96	60	54	200	118	78	346	201	114	537	306	149	772	428	190	1053	573
	5	50	68	47	73	140	94	100	239	158	141	363	239	144	528	344	224	692	457
	10	nr	nr	41	93	129	86	125	223	146	177	344	224	222	491	316	277	666	437
30	0	34	99	63	53	211	127	76	372	219	110	584	334	144	849	472	184	1168	647
	5	49	74	52	72	157	106	98	271	173	136	417	271	171	595	382	215	806	521
	10	nr	nr	nr	91	144	98	122	255	168	171	397	257	213	570	367	265	777	501
50	0	33	99	66	51	213	133	73	394	230	105	629	361	138	928	515	176	1292	704
	5	48	80	nr	70	174	117	94	308	198	131	482	305	164	692	435	204	953	602
	10	nr	nr	nr	89	160	nr	118	292	186	162	461	292	203	671	420	253	923	583

*B-Vent may be used on Category I Venting Systems ONLY. The use of B-Vent in Category III is not approved for any appliance. See vent tables for multiple appliance vent designs.

CORRUGATED LINER CAPACITY

Single Category I Appliance

Vent Height	Lateral	Conn. Type	3" Flex		4" Flex		5" Flex		6" Flex		7" Flex		8" Flex	
			Fan	Nat	Fan	Nat	Fan	Nat	Fan	Nat	Fan	Nat	Fan	Nat
15	5	Double	52	36	104	70	175	114	264	174	370	240	496	322
	10		47	33	97	66	165	108	252	166	356	230	480	309
	5	Single	50	35	102	69	173	112	261	174	367	238	493	320
	10		nr	31	93	63	161	105	246	162	350	227	474	305
25	5	Double	59	41	121	82	207	134	315	206	448	289	603	394
	10		54	38	113	76	196	128	302	196	432	277	585	380
	5	Single	57	40	119	80	204	132	312	204	444	286	599	391
	10		nr	nr	109	74	191	126	296	192	424	273	577	375
35	5	Double	63	nr	131	89	227	146	350	225	500	319	679	435
	10		57	nr	124	84	217	141	337	216	484	308	660	422
	5	Single	60	nr	129	87	224	143	347	224	496	316	674	433
	10		nr	nr	118	nr	211	138	330	213	476	304	651	417
50	5	Double	66	nr	142	95	250	160	390	246	545	350	768	484
	10		61	nr	134	91	239	152	377	238	537	341	748	471
	5	Single	64	nr	139	94	246	158	386	244	557	348	762	482
	10		nr	nr	128	nr	234	149	369	234	537	336	738	466

TWO OR MORE CATEGORY I APPLIANCES

Vent Height	Conn. Type	4" Flex Liner			5" Flex Liner			6" B-Vent			7" Flex Liner			8" Flex Liner		
		Fan Assist		Nat	Fan Assist		Nat	Fan Assist		Nat	Fan Assist		Nat	Fan Assist		Nat
		Fan	Nat	Nat	Fan	Nat	Nat	Fan	Nat	Nat	Fan	Nat	Nat	Fan	Nat	Nat
15	Double	100	90	73	156	131	115	226	182	165	342	282	224	445	355	292
	Single	97	86	70	151	127	112	220	177	160	333	274	219	435	347	286
25	Double	115	104	88	184	157	138	270	221	198	409	341	268	536	434	350
	Single	110	100	84	176	152	134	262	213	192	398	332	260	524	423	342
35	Double	125	113	98	202	175	154	301	249	222	456	385	301	603	492	392
	Single	119	108	93	195	168	150	291	239	213	444	373	291	588	479	382
50	Double	134	122	107	223	195	171	337	282	248	513	438	338	683	565	440
	Single	127	116	102	214	186	166	325	270	237	498	423	328	666	549	428

AIR CONDITIONING CHARGING CALCULATOR FOR R22

Use this table to charge split air conditioning systems using R-22, and a cooling capillary tube and fixed orifice flow control.

1. Measure the indoor temperature ºF
2. Measure the outdoor temperature ºF
3. Read the Required superheat from Table 1.
4. Measure the suction line pressure. From Table 2 read the desired suction line temperature for your pressure reading.

Table 1

Indoor Temp. °F		Required Superheat °F for Measured Outdoor Temperature												
Dry Bulb	Wet Bulb[1]	55°	60°	65°	70°	75°	80°	85°	90°	95°	100°	105°	110°	115°
70°	58°	22°	17°	14°	10°	6°								
75°	63°	25°	22°	19°	16°	13°	11°	8°						
80°	67°	29°	27°	24°	22°	19°	17°	15°	12°	10°	7°			
85°	71°	33°	31°	29°	27°	25°	23°	20°	18°	16°	14°	12°	9°	7°
90°	75°	38°	36°	34°	32°	31°	29°	27°	25°	23°	22°	20°	18°	17°
95°	79°	42°	40°	39°	37°	36°	34°	33°	31°	29°	28°	26°	24°	23°

Table 2

Required	Correct Suction Line Temp. °F for Measured Suction Pressure PSI[3]									
Superheat °F[2]	50 PSI	55 PSI	60 PSI	65 PSI	70 PSI	75 PSI	80 PSI	85 PSI	90 PSI	95 PSI
5°	31°	35°	43°	46°	49°	52°	56°	58°	62°	67°
10°	36°	40°	44°	47°	51°	54°	57°	61°	63°	67°
15°	41°	45°	49°	52°	56°	59°	62°	66°	68°	72°
20°	46°	50°	54°	57°	61°	64°	67°	71°	73°	77°
25°	51°	55°	59°	62°	66°	69°	72°	76°	78°	82°
30°	56°	60°	64°	67°	71°	74°	77°	81°	83°	87°

Notes:

Use only superheat thermometers or digital thermocouple thermometers

[1] If humidity is above 70% or below 20% use wet bulb temperature.

[2] This is the required superheat obtained from table 1

[3] This is the temperature which you should read on your suction line thermometer. If your reading is not within ± 5º F adjust refrigerant charge.

REFRIGERATION SOLDERS AND BRAZING MATERIALS

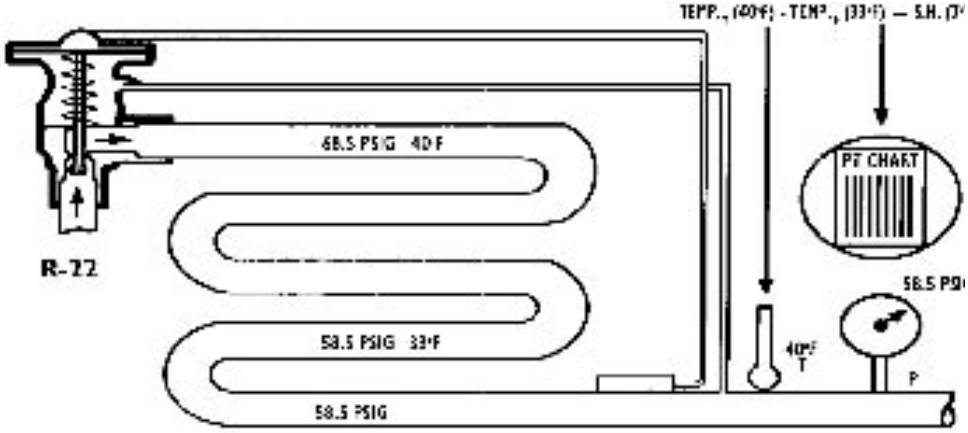
Materials having melting points below 700°F should not be used for air conditioning or refrigeration systems. For copper to copper connections Sil-Fos, Silverflow, or equal is probably best as it requires no flux. It should not be used for joints involving iron.

Material	Composition	Melting Temp. °F	Flow Temp. °F
Fifty Fifty	50% lead, 50% tin	360°	415°
Sixty Forty	60% lead, 40% tin	360°	459°
Stay-Brite			400°
Stay-Brite #8		430°	535°
Ninetyfive-Five		450°	465°
Silvabrite 100 (Engelhard)	95.5% tin, 4% copper, 0,5% silver	440°	500°
Silvabrite (Engelhard)	94% tin, 4% silver	430°	450°
Silverflow (Victor)	7% phosphorus, 93% copper	1310°	1471°
Easy-Flo (Hardy & Harman)	45% silver	1120°	1145°
Safety Silv 1200	75% silver		1145°
Stay-Silv 45	45% silver		1160°
Easy-Flow (Handy & Harman)	50% silver	1160°	1175°
Sil-Fos (Handy & Harman)	15% silver, 80% copper, 5% phosphorous	1185°	1300°
Pho-copper	93 copper, 7% phosphorous	1317°	1470°

Other materials not listed should be evaluated based on their melting points, and the use of flux.

REFRIGERANT PRESSURES

Measuring Superheat R22 & R410A



PSI R22	F°	PSI R410	PSI R22	F°	PSI R410
24.0	0	48.6	143.6	80	235.3
28.2	5	55.2	155.6	85	254.1
32.8	10	62.3	168.4	90	274.3
37.7	15	70.0	181.7	95	295.1
43.0	20	78.3	195.9	100	317.2
48.7	25	87.3	210.7	105	340.5
54.9	30	96.8	226.3	110	365.0
61.5	35	107.1	242.7	115	390.7
68.5	40	118.0	259.8	120	417.7
76.0	45	129.7	277.9	125	445.9
84.0	50	114.2	296.7	130	475.6
92.5	55	155.5	316.5	135	506.5
101.6	60	169.6	337.2	140	539.0
111.2	65	184.6	358.8	145	572.8
121.4	70	200.6	381.4	150	608.1
132.2	75	217.4			

MEASURING SUPERHEAT OUTPUT

1. Determine suction pressure with accurate gauge at evaporator outlet. For AC units measure pressure at Schraders found on suction line provided for this purpose.
2. From table at right determine the saturation temperature at observed suction pressure.
3. Measure temp. of suction gas. For split units measure this at suction line before the service device. For packaged units measure suction line 6" away from the compressor.
4. Subtract saturation temperature read from table in step 2 from temperature measured in step 3. Difference is superheat of suction gas.

SUCTION LINE CAPACITY R22

R22 Refrigerant Line Length and Capacity Reduction

			Equivalent Length of Run (ft.)						
Tons	**Tube Size**	**25' Ratings**	**40**	**60**	**80**	**100**	**120**	**140**	
1.0	1/2	-165	-150	-340	-530	-720	**-910**	**-1100**	
	5/8	0	-50	-100	-170	-230	-290	-350	-410
1.5	5/8	0	-140	-340	-540	-740	-940	**-1140**	**-1340**
	3/4	+165	-50	-115	-180	-245	-310	-375	-440
2.0	5/8	-360	-350	-800	-1250	**-1700**	**-2150**		
	3/4	0	-120	-290	-460	-630	-800	-970	-1140
	7/8	110	-80	-160	-240	-320	-400	-480	-560
2.5	5/8	-730	-675	-1575	**-2475**				
	3/4	0	-270	-570	-870	-1170	-1470	-1770	-2070
	7/8	225	-150	-240	-375	-510	-645	-780	-915
3.0	3/4	-360	-430	-950	-1470	-1990	**-2510**	**-3030**	**-3550**
	7/8	0	-180	-410	-640	-870	-1000	-1330	1560
	1-1/8	215	-45	-100	-155	-210	-265	-320	-375
3.5	3/4	-525	-565	-1325	-2085	**-2845**	**-3605**		
	7/8	0	-250	-670	-1090	-1510	-1930	-2350	**-2770**
	1-1/8	295	-85	-185	-285	-385	-485	-585	-685
4.0	3/4	-1345	-1440	-2210	**-2980**	**-3750**	**-4520**		
	7/8	-480	-380	-910	-1440	-1970	-2500	**-3030**	**-3560**
	1-1/8	0	-150	-320	-490	-660	-830	-1000	-1170
5.0	7/8	-870	-750	-1710	-2670	**-3630**	**-4590**	**-5550**	
	1-1/8	0	-180	-480	-780	-1080	-1380	-1680	-1980
	1-3/8	240	-75	-170	-265	-360	-455	-550	-645
6.0	1-1/8	0	-370	-860	-1350	-1840	-2330	-2820	-3310
	1-3/8	380	-100	-230	-360	-490	-620	-750	-880
7.5	1-1/8	-720	-675	-1575	-2475	-3375	-4275	-5175	**-6075**
	1-3/8	0	-240	-565	-890	-1215	-1540	-1865	-2190
	1-5/8	235	-100	-235	-370	-505	-640	-775	-910

REFRIGERANT LINE SIZING

1. The suction line size should be one of the sizes on the table left.
2. Use the recommended liquid line size unless the total pressure drop (friction loss plus liquid lift) exceeds 35 PSI.
3. **Bold** values at left are not recommended

Equivalent Length (ft)

Tube Size	Short 90	Log Rad. 90
1/2	4.7	3.2
5/8	5.7	3.9
3/4	6.5	4.5
7/8	2.7	1.9
1 1/8	2.7	1.9
1 3/8	3.2	2.2
1 5/8	3.8	2.6

R-410A - INTRODUCTION AND USE

Introduction:

R-22 contains HCFC's (hydrogen, chlorine, fluorine, and carbon) which have been deemed to be destructive to the environment. Alternatives to these refrigerants must be HCFC free and maintain high levels of efficiency.

R-410A is a mixture or R-32 and R-125. It is NOT a "drop in" replacement for R-22 systems. R-410A requires different lubricating oils, driers, and TXV's than R-22.

R-410A cylinders are ROSE colored and must never be stored above 125º F.

R-410A boils at -62.9º F which is 20º F colder than R-22 when released to atmosphere. Therefore there is a serious danger of frostbite when servicing R-410A systems.

R-410A vapor pressures are 50 - 70% higher than R-22.

R-22 oil is mineral based. R-410A oil is a synthetic called POLYESTER (POE). This oil must be kept in sealed containers because it absorbs moisture when exposed to the atmosphere. This oil is damaging to roofing materials.

SUCTION LINE CAPACITY R-410A

Refrigerant Line Length and Capacity Reduction

Equivalent Length of Run (ft.)									
Tons	**Tube Size**	**40**	**60**	**80**	**100**	**120**	**140**	**160**	**200**
1.0	1/2*	-70	-160	-250	-340	-430	-520	-610	**-790**
	5/8	-20	-50	-73	-100	-130	-155	-180	-235
1.5	1/2*	-173	-410	-640	-875	-1110	-1340	-1575	**-2040**
	5/8	-50	-120	-185	-250	-320	-385	-450	-585
	3/4	-20	-45	-70	-95	-125	-150	-175	-225
2.0	5/8*	-115	-270	-430	-585	-740	-895	-1050	-1360
	3/4	-45	-100	-160	-215	-275	-330	-390	-505
	7/8	-20	-45	-70	-95	-125	-150	-175	-225
2.5	5/8*	-220	-515	-810	-1110	-1400	-1695	-1990	-2585
	3/4	-80	-190	-295	-405	-515	-620	-730	-945
	7/8	-35	-80	-130	-175	-220	-270	-315	-410
3.0	5/8	-380	-885	-1390	-1895	-2400	-2905	-3410	**-4425**
	3/4*	-140	-325	-510	-700	-880	-1070	-1255	1625
	7/8	-60	-145	-225	-310	-390	-470	-555	-720
3.5	3/4*	-220	-510	-805	-1095	-1390	-1680	-1975	-2560
	7/8	-95	-220	-345	-475	-600	-725	-850	-1105
4.0	3/4	-320	-745	-1170	-1600	-2025	-2450	-2875	-3730
	7/8*	-140	-325	-510	-690	-1060	-1245	-1430	-1615
	1 1/8	-40	-90	-145	-195	-245	-300	-350	-455
5.0	3/4	-620	-1450	-2280	-3105	-3935	-4760	-5590	**-7245**
	7/8*	-265	-615	-970	-1325	-1675	-2030	-2380	-3080
	1 1/8	-70	-165	-255	-350	-445	-540	-630	-820
6.0	3/4	-1070	-2495	-3920	-5345	-6770	**-8195**	**-9625**	
	7/8	-455	-1060	-1665	-2270	-2875	-3480	-4080	-5290
	1 1/8	-115	-270	-430	-585	-740	-895	-1050	-1360
7.5	7/8	-875	-2040	-3210	-4375	-5540	-6750	-7875	**-9040**
	1 1/8	-225	-530	-830	-1135	-1435	-1740	-2040	-2645
	1 3/8	-80	-190	-300	-405	-515	-620	-730	-945

REFRIGERANT LINE SIZING

1. The suction line size should be one of the sizes on the table left.
2. Use the recommended liquid line size unless the total pressure drop (friction loss plus liquid lift) exceeds 50 PSI.
3. **Bold** values at left are not recommended

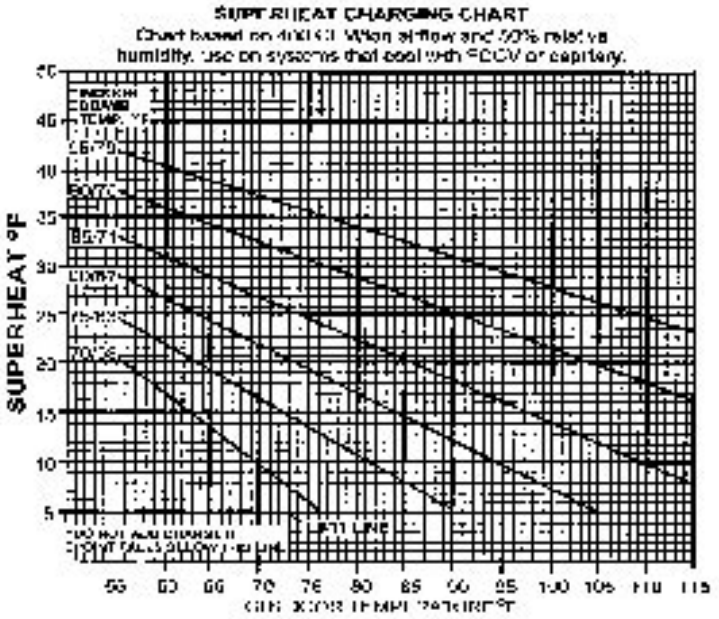
Tube Size	Short Elbow	Long Rad.Elb.
1/2	4.7	3.2
5/8	5.7	3.9
3/4	6.5	4.5
7/8	2.7	5.3
1 1/8	2.7	1.9
1 3/8	3.2	2.2
1 5/8	3.8	2.6

Tube Size	Charge Adj Ft Lbs.
1/4 -5/8	0.016
5/16 - 3/4	0.027
5/16 -7/8	0.029
3/8 - 3/4	0.033
3/8 - 7/8	0.040
3/8 - 1 1/8	0.045
1/2 - 7/8	0.068
1/2 - 1 1/8	0.073
1/2 - 1 3/8	0.080
5/8 - 1 3/8	0.119

AIR CONDITIONING CHARGING CALCULATOR FOR R410A

Use this table to charge split air conditioning systems using R-410A, and a cooling capillary tube or a fixed orifice flow control.

1. Measure the indoor temperature ºF
2. Measure the outdoor temperature ºF
3. Find the outdoor air temperature recorded at the bottom of the superheat charging chart. Plot a vertical line to the point that it intersects with the indoor air temperature line for your application. Then plot a horizontal line left to read the desired superheat from the left edge of the graph.
4. If suction line temperature is not with 5 ºF of the suction line pressure reading:
   - Add charge to decrease line temperature
   - Remove charge to increase line temperature



Notes:

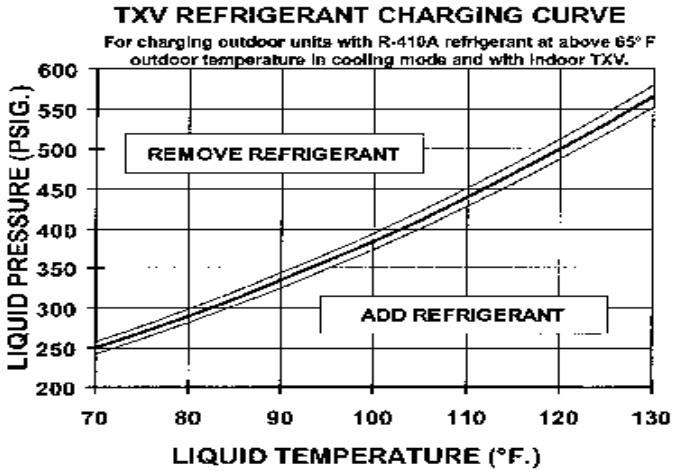
Use only superheat thermometers or digital thermocouple thermometers

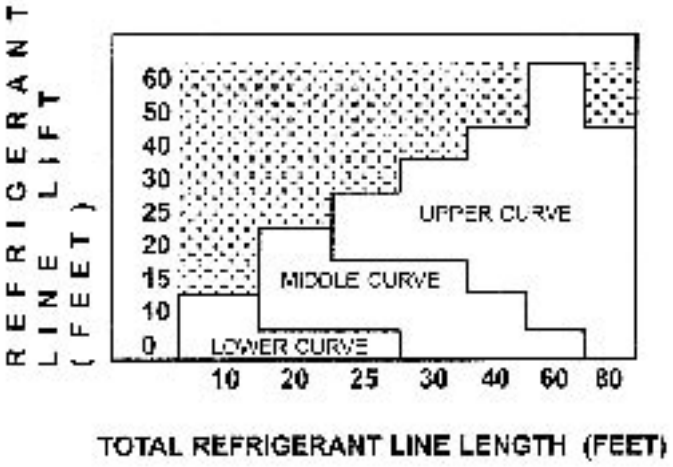
1. If humidity is above 70% or below 20% use wet bulb temperature.
2. This is the required superheat obtained from table 1
3. This is the temperature which you should read on your suction line thermometer. If your reading is not within ± 5ºF adjust refrigerant charge.

AIR CONDITIONING CHARGING CALCULATOR FOR R410A

Use this table to charge split air conditioning systems using R-410A, and a TXV refrigerant control.

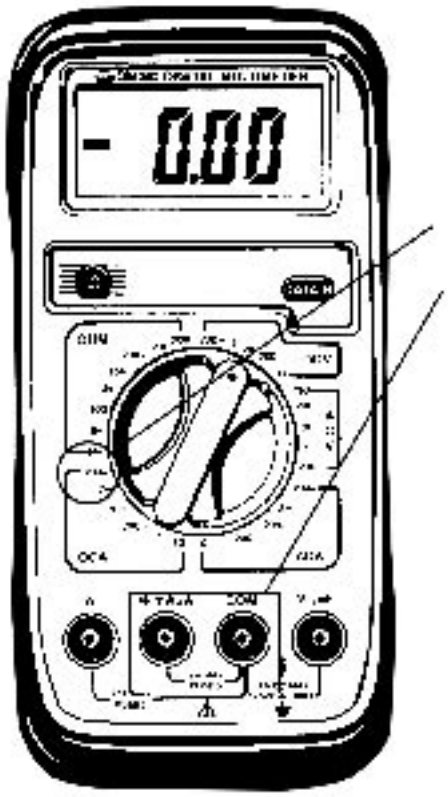
1. Measure liquid line temperature ºF
2. Measure refrigerant pressure at the service valves.
3. Determine total refrigerant pipe length and height if the indoor section is above the outdoor unit. Plot the intersection of the two points on the curve selection chart below right to determine which charging curve to use.
4. Plot your observed measurements on the TXV Refrigerant Charging Curve (right). If they intersect above the curve remove refrigerant. If they intersect below the curve add refrigerant.
5. Whenever charge is added or removed, allow the system to stabilize before additional adjustments are made.





REFERENCE

FLAME CURRENT TESTING



µ DC MICROAMPS

Flame current on ANY gas fired equipment that is not standing pilot is measure in DC microamps. This is a critical measurement to aid you in diagnosing "nuisance" lockouts. This is how you would set up a typical meter:

• Set meter here: 200 microamp scale

• Place probes here: common and microamps

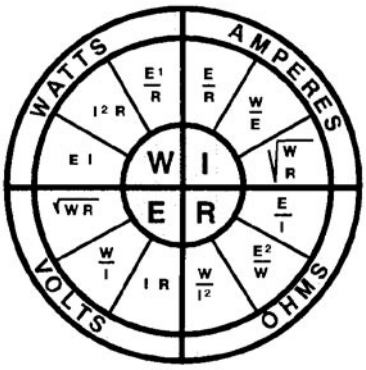
Flame current is measured by placing the meter in series to measure the amount of current being conducted by the flame from the flame current source (normally a flame sensor, HS ignitor, intermittent pilot, or direct ignitor) to ground. You measure flame current by either of the following:

1. Disconnect the wire lead to the flame probe and place the meter in series by connecting one lead to the sensor and the other to the sensor wire.
2. If the system does not have an independent flame probe, or it is not conveniently placed, you can locate where the ignition module grounds and place the meter in series between the module and it ground point. This is normally done by disconnecting the wire marked "ground" on the module and connecting the leads to the ground wire and it's ground point.

Model	Manufacturer	Min. Flame Current	Module Make	Normal Flame Current	Where to Connect	Notes
All Furnaces	Lennox	1.0	White Rodgers	2.5 - 3.5+	Flame probe or ground off model	HSI w/flame probe
LF24	Lennox	0.5	Fenwal	3 -5+		Direct Spark
All Gas Boilers	Weil McClain	1.0	OEM-W/M	3 - 5+	Ground wire off module	
RHFE-1001, 1004	Rinnai	1.0	OEM-Rinnai	5 -7 +	Flame probe	3 flame probes!!
RHFE-551				2 - 4 1st stg 5 - 8 2nd stg		2stg on 1 probe
RHFE-263, 431,556				3.5 - 8+		
Continuum	Rinnai	1.0	OEM-Rinnai	3-8	Flame Rod	

OHM'S LAW

This Wheel shows the equation for calculating any one of the basic factors of electricity: Watts (W), Amperes (I), Volts (E), or Ohms (R), when any two of these factors are known. The elements to be calculated are on the rim of the wheel. Each quadrant shows three equations for solving the unknown.



Example: A 2400 watt heater is connected to a 240v circuit. What is the Amp. Draw?
Solution: W/E = I or 2400 w /240v = 10 amps
What is the watt draw?

I x E = W 10 amps x 240 volts = 2400 watts

ESTIMATING ENERGY CONSUMPTION

In order to determine annual fuel usage, the Degree Day standard for the area is used in the following equation:

$$F = \frac{HL \times 24 \times DD}{E \times P \times T.D.}$$

Where:
HL = Design Heat Load (BTUH)
DD = Degree Day
24 = hours per day
E = AFUE of Heating System
P = BTU content of fuel
T.D. = Design Temperature Difference

Example:75000 BtuH load in Portland, ME 85% furnace

$$\frac{75000 \times 24 \times 7570}{.85 \times 139000 \times 90} = 1281 \text{ Gal. \#2 fuel oil per year}$$

Degree Days

Maine		New Hampshire	
Bangor	8220	Berlin	8270
Portland	7570	Concord	7570

CONVERSION TABLES

Multiply	By	To Obtain
°C	1.8 plus 32°	°F
°F - 32	.5555	°C
Specific Gravity	Natural Gas	0.62
	LP Gas	1.52
Boiler Horse Power	33,475	BTU/Hr.
BTU	.000393	Horse Power
Tons of Refrigeration	12,000	BTU/Hr.
Gallons of Water	8.345	Lbs. of Water
Cubic Feet of Water	7.48	Gallons of Water
Inches of Water	.03613	Lbs. per Sq. In.
PSI	27.67	Inches Water
Meters	3.28	Feet
Feet	0.3048	Meters

Energy Conversion	
Natural Gas	
1 cu. ft. Nat'l. Gas	1,000 BTU
LP Gas	
1 cubic foot	2,550 BTU
1 lb.	21,650 BTU
1 gallon	91,500 BTU
Oil	
1 gal. kerosene	134,000 BTU
1 gal. #2 fuel oil	139,000 BTU
Electric	
1 KWH	3,412 BTU

BRANCH CIRCUIT WIRE SIZING

Distance (Power to Supply Load) in Feet (208 230V)

Amps ***	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
10															
15		12 AWG Copper													
20															
25			10 AWG Copper												
30															
35				8 AWG Copper											
40															
45						6 AWG Copper									
50											4 AWG Copper				
55															
60															

*** Required Branch Circuit Ampacity

Suitable for 1 ph or 3 ph circuits. Based on 60°C Insulation, 30°C ambient Temp (86°F), no more than three conductors per raceway.

HEATING & COOLING CAPACITY

	Heating BTUH at outlet based on outlet temperature				Cooling BTUH at outlet		
CFM	**120°**	**140°**	**160°**	**180°**	**65°**	**60°**	**55°**
40	2175	3045	3915	4785	640	855	1070
60	3260	4565	5870	7170	960	1280	1600
80	4350	6090	7825	9565	1280	1710	2135
100	5435	7610	9785	11955	1600	2135	2670
125	6795	9515	12230	14945	2000	2670	3335
150	8155	11415	14675	17930	2400	3200	4000
175	9515	13320	17120	20920	2800	3735	4670
200	10870	15220	19570	23920	3200	4270	5340
225	12230	17125	22015	26910	3600	4805	6005
250	13590	19025	24460	29900	4000	5340	6670
275	14950	20930	26905	32885	4405	5870	7340
300	16310	22830	29350	35875	4805	6405	8005
325	17665	24735	31800	38865	5205	6940	8670
350	19025	26635	34245	41855	5605	7470	9240
375	20385	28540	36690	44845	6005	8005	10005
400	21745	30440	39135	47835	6405	8540	10675
450	24460	34245	44030	53815	7205	9605	12010
500	27180	38050	48920	59795	8005	10675	13345
600	32615	45660	58705	71755	9605	12810	16010
700	38050	53270	68490	83715	11210	14945	18680
800	43490	60880	78270	95670	12810	17080	21350
900	48925	68490	88055	107630	14410	19215	24015
1000	54360	76100	98740	119590	16010	21350	26685
1200	65230	91320	117410	143510	19215	25620	32025
1400	76105	106540	136975	167425	22415	29890	37360
1600	86975	121760	156545	191345	25620	34160	42700
1800	97850	136980	176110	215260	28820	38430	48035
2000	108720	152200	195680	239180	32025	42700	53370
2200	119590	167420	215260	263095	35225	46970	58710
2400	130460	182640	234830	287010	38430	51235	64045

THERMOCOUPLE & THERMOPILE SERVICE

Thermocouple Testing:

1. Remove thermocouple connection from the gas valve.
2. Connect the thermocouple leads to a multimeter on the millivolt scale.
3. Turn gas valve control knob to pilot/ignition position and press in
4. Light the pilot.
5. Continue to hold the control knob down for 30 seconds. Voltage should read 11 millivolts or higher.

Thermopile Testing:

1. Set multimeter to the millivolt scale. Connect to the TP and TH/TP terminals on the gas valve.
2. Light the pilot & hold down the control knob in the pilot/ignition position. Voltage output should exceed 500 millivolts open circuit after 90 seconds.
3. Turn control knob to ON position. Turn on the main burner. Voltage should be greater than 100 millivolts closed circuit.

CONTROL TRANSFORMER SERVICE

VA Rating:

Control transformers are sized by their VA rating. The VA rating of a transformer is determined by multiplying the secondary voltage by the secondary current (amps).

Example: A 50VA transformer with a 24 volt secondary can operate at 24 volts x 2.08 amps without overloading the transformers capacity.

Troubleshooting:

Control transformers burnout when the load placed on them exceeds their VA rating. To troubleshoot a transformer that is tripping its fuse (in some units) or burning out follow these steps:

1. Check to see that primary voltage is present.
2. If secondary voltage is present, but the control devices do not operate, connect a clamp-on ammeter in the secondary circuit. Energize the circuit and observe the secondary amp draw. Do not operate the transformer more than 10 seconds if the amp draw exceeds the VA rating: the transformer will burn out!
3. Disconnect one control device at a time until the secondary voltage draw is less than the transformer VA rating to determine the defective component.

HEAT ANTICPATORS

General Information:

In a typical heating system, when the thermostat calls, the heater begins warming up the area. By the time the heat gets to the thermostat and warms it up enough to turn off the furnace or boiler, the unit has put out too much heat and the ambient temperature may be much too high. The heat anticipator compensates for this overshoot by causing the thermostat to turn off the burner(s) prematurely. A common type of heat anticipator is a resistive wire inside the thermostat strung near the bimetallic coil that is the temperature sensor. A slider can be moved along this wire, adjusting how much of the wire will have current flowing through it when the unit is calling for heat. When the thermostat calls for heat, the resistive wire generates a small (and adjustable) amount of heat that will soon artificially lower the temperature at which the thermostat ceases its call for heat.

In general, the larger the heat anticipator number, the longer the heating unit will run. Smaller heat anticipator numbers will cause the unit to cycle more frequently.

Setting the Anticipator:

Usually the heat anticipator is set to the current draw of the gas valve or oil burner primary control. This information can frequently be found on the valve or control.

If the current draw is not available it can be measured. With a clamp on ammeter, wrap 10 (ten) turns of the thermostat circuit wire around the pick up, read the current, and divide by 10. Example: 6 amps =600MA or .6 amps. Set the scale on your thermostat to this number.

GAS LINE SIZING

Black Iron Pipe

Natural Gas 5"-7" WC

Length/Ft.	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"
10	132	278	520	1050	1600	3050
20	93	190	350	730	1100	2100
30	73	152	285	590	890	1650
40	63	130	245	500	760	1450
50	56	115	215	440	670	1270
60	50	105	195	400	60	1150
80	43	90	170	350	530	990
100	38	79	150	320	460	870
125	34	72	130	275	410	780
150	31	64	120	250	380	710
200	26	55	100	210	320	610

LP Gas 11"-13" WC

Length/Ft.	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"
10	275	565	1070	2200	3300	6250
20	187	392	730	1500	2300	4320
30	153	315	590	1210	1860	3460
40	127	268	500	1040	1550	3000
50	115	237	450	915	1410	2640
60	102	218	410	835	1270	2380
80	77	163	345	725	1090	2060
100	70	145	308	625	975	1810
125	62	132	275	565	865	1600
150	62	132	252	512	795	1500
200	55	112	213	440	675	1260

COPPER TUBE SIZING

LP gas 11" wc 0.5" Pressure Drop

Lgth. in Ft.	3/8" OD MBtuH	1/2" OD MBtuH	5/8" OD MBtuH	3/4" OD MBtuH
10	49	110	206	348
20	34	76	141	239
30	27	61	114	192
40	23	52	97	164
50	20	46	86	146
60	19	42	78	132
80	16	36	67	113
100	14	32	59	100
125	12	28	52	89
150	11	26	48	80
200	10	22	41	69
250	9	19	36	61
300	8	18	33	55
350	7	16	30	51
400	7	15	28	47

GAS ORIFICE CAPACITY

Drill Size	BtuH Nat'l. Gas @ 3 1/2" wc	BtuH LP Gas @ 11.0"
60	4650	13000
59	4900	13750
58	5150	14450
57	5400	15150
56	6300	17600
55	7900	22000
54	8800	24750
53	10400	28800
52	11750	33000
51	13000	36700
50	14250	40000
49	15500	43500
48	16750	47200
47	17900	50200
46	19000	53500

Drill Size	BtuH Nat'l. Gas @ 3.5" wc	BtuH LP Gas @ 11.0"
45	19500	55000
44	21500	60050
43	23000	
42	25250	
41	26750	
40	27800	
39	28600	
38	29900	
37	31100	
36	33000	

EXPANSION TANK SIZING CHART AT 200°F

Boiler BTUH	Fine Tube Radiation	Unit Heaters	Cast Iron Radiators	Cast Iron Baseboard
25,000	15	15	15	15
50,000	15	15	30	30
75,000	30	30	30	60
100,000	30	30	60	60
125,000	30	60	60	90
150,000	30	60	90	90
175,000	60	60	SX-30V	SX-30V
200,000	60	60	SX-30V	SX-30V
250,000	60	90	SX-30V	SX-40V
300,000	90	SX-30V	SX-30V	SX-40V
350,000	SX-30V	SX-30V	SX-40V	SX60V
400,000	SX-30V	SX-40V	SX-40V	SX-60V

Sizing based on • Fill Pressure 12 psig • Relief Pressure 30 psig • Average System Temperature 200ºF

SIMPLIFIED DUCT SIZING

For Residential Applications

CFM*	Round Duct Diameter	Rectangular Duct Size	Oval Size	CFM*	Round Duct Diameter	Rectangular Duct Size
50	5	6x3	5	600	12	8x14
75	6	8x3	6	700	12	8x16
100	6	3¼x12	6	800	14	8x18
125	7	3¼x12	7	900	14	8x20
150	7	3¼x14	7	1000	14	8x24
200	8	8x6		1200	16	8x26** 12x20
250	9	8x8		1400	16	8x30** 12x20
300	9	8x8		1600	18	12x20**
400	10	8x12		1800	18	12x22**
500	12	8x12		2000	20	12x24**

*CFM based on .08" friction per 100' of ductwork. This corresponds to a velocity of 450 FPM. This is an appropriate criteria for residential duct sizing with normal room dimensions. Higher pressures are possible (and may be desirable in some applications) but would result in higher noise levels.

**These duct sizes are available by special order only, or can be field fabricated.

QUICK SIZING TABLE FOR FURNACES

Output Capacity MBtuH	Min CFM	Supply Duct @ 800fpm	Minimum Square Inches	Min # 6" Supply Runs @ 115CFM	Min # 7 Supply Runs @ 155CFM ea.	Min RA Duct (800fpm)	Min RA Grill (500fpm)
45-50	500	14x8 or 12"Rd.	100	5	4	14x8 or 12"Rd.	12x12
60-70	700	18x8 or 14"Rd.	140	6	5	18x8 or 14"Rd.	24x10
75-85	800	22x8 or 14"Rd.	170	7	5	22x8 or 14"Rd.	24x12
95-105	900	24x8 or 16"Rd.	190	8	6	24x8 or 14"Rd.	24x12
105-115	1100	22x10 or 16"Rd.	220	10	7	22x10 or 16"Rd.	30x12
125-150	1400	24x12 or 18"Rd.	280	12	9	24x12 or 18"Rd.	30x14
150-160	1600	1-35x10, 20"Rd. or 2-22x8	360	14	10	32x10 or 20"Rd.	30x18

CFM—TEMPERATURE MEASUREMENT

$$CFM = \frac{\text{BTU Output}}{\text{Delta T x 1.08}} \qquad \frac{\text{75000 BTU input x 80\% eff.}}{\text{50 dF DT x 1.08}} = 1111 \text{ CFM}$$

Where BTU Output = BTU input x steady state eff. %
Delta T = Temperature rise through furnace

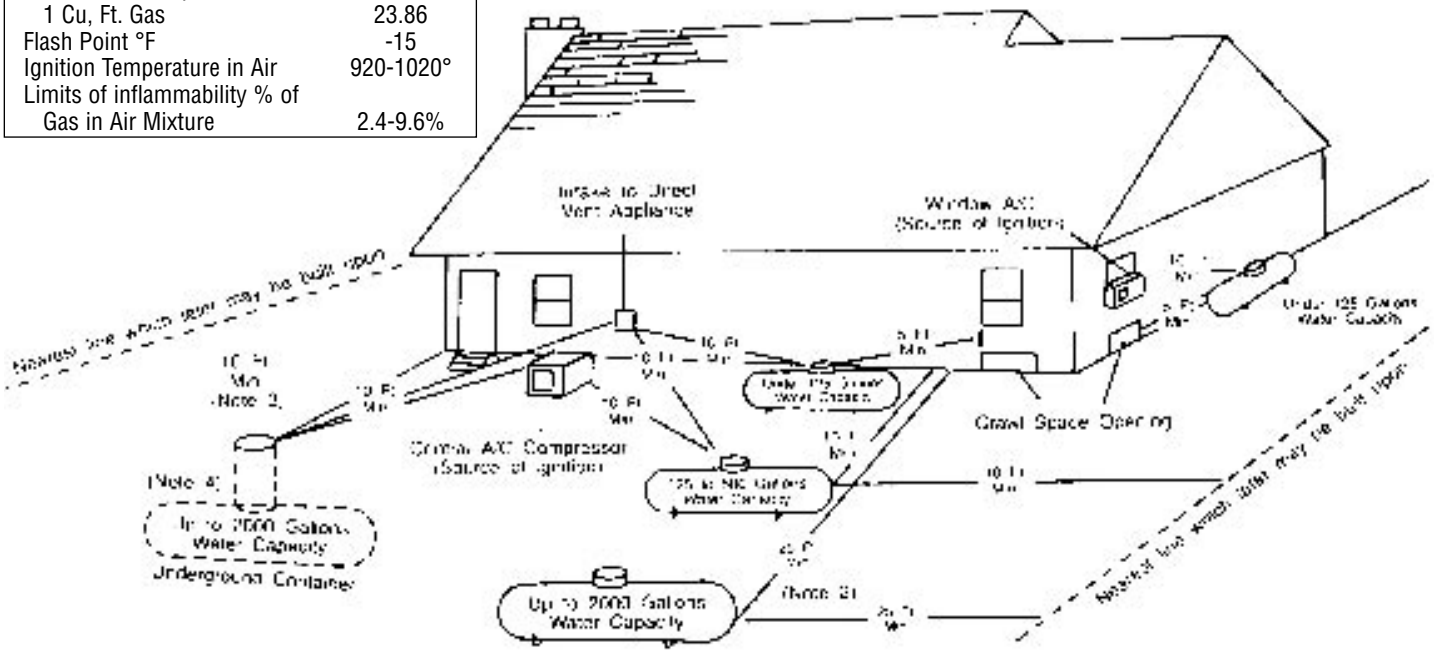
LP GAS INFORMATION - TANK SIZING

Tank Capacity	Diameter	Length	Tank Weight	20°F MBtuH	60° MBtuH
120	24	68	288	235.0	417.8
150	24	84	352	290.3	516.1
200	30	79	463	341.3	606.7
250	30	94	542	406.1	721.9
325	30	119	672	514.1	937.9
500	37	119	1062	634.0	1127.1
1000	41	192	1983	1088.5	1978.1

Based on American Welding & Tank information and products

Temp	PSI	Temp.	PSI
130°	257	40°	63
120°	225	30°	51
110°	197	20°	40
100°	172	10°	31
90°	149	0°	23
80°	128	-10°	16
70°	109	-20°	10
60°	92	-30°	5
50°	77	-40°	1

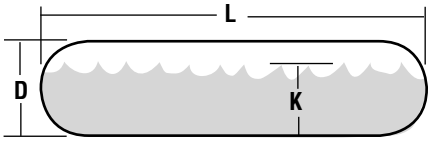
Propane Properties	
Formula	C_3H_6
Boiling Point °F	-44
Specific Gravity Gas	1.53
Specific Gravity Liquid	0.51
Lbs / Gal. Liquid @ 60°	4.24
Cu. Ft. of Air Required to Burn 1 Cu, Ft. Gas	23.86
Flash Point °F	-15
Ignition Temperature in Air	920-1020°
Limits of inflammability % of Gas in Air Mixture	2.4-9.6%



DETERMINING PROPANE VAPORIZATION CAPACITY

Vaporizing Capacities For Other Air Temperatures

Multiply the results obtained with the other formula, by one of the following factors for the prevailing air temperature.



Where
D =Outside diameter in inches
L = Overall length in inches
K = Constant for percent volume of liquid in container

Prevailing Air Temperature	Multiplier	Prevailing Air Temperature	Multiplier
-15°F	0.25	+5°F	1.25
-10°F	0.50	+10°F	1.50
-5°F	0.75	+15°F	1.75
-0°F	1.00	+20°F	2.00

Percentage Container Filled	K Equals	*Propane Vaporization Capacity at 0°F (in BTU/Hr.)
60	100	DxLx100
50	90	DxLx90
40	80	DxLx80
30	70	DxLx70
20	60	DxLx60
10	45	DxLx45

*These formulae allow for the temperature of the liquid to refrigerate to -20°F (below zero), producing a temperature differential of 20°F for the transfer of heat from the air to the container's "wetted" surface and then into the liquid. The vapor space area of the vessel is not considered. Its effect is negligible.

PIPE CAPACITY IN MBTUH

Pipe Size	MBTUH Capacity @ 580BTU/Ft	Ft Radiation Head Ft./100'	Friction Loss TD	GPM at 20°
1/2"	17	29'	4.2'	1.7
3/4"	39	67'	4.2	3.9
1"	71	122'	4.2	7.1
1 1/4"	160	275'	4.2	16.0
1 1/2"	240	413'	4.2	24.0
2"	450	775'	4.2	45.0

- In order for a pump to move the GPM listed it must overcome a friction head of 4.2' per 100' of pipe (total equivalent length)
- Example: If one wants to carry 16 GPM in a 1-1/4" pipe through a 300' loop (TEL) the pipe must overcome a friction head of 4.2' x 3 or 12.6 ft. In other words, the pump specification would be to pump 16 GPM against a 12.6' friction head

WEBBER STOCKED BOILER WATER CONTENT

Manufacturer Model	Water Cont. Gal. Less Coil
Weil McLain	
Ultra 80	095
Ultra 105	1.07
Ultra 155	1.2
Ultra 230	1.6
Ultra 310	2.1
GV3	3.3
GV4	4.2
GV5	5.1
GV6	6.0
AHE45	
AHE60	
CGs3	1.5
CGs4	2.1
CGs5	2.7
CGs6	3.3
CG*25	1.5
CG*3	2.1
CG*4	2.7
CG*5	2.2
CG*6	3.3
CG*7	3.8
CG*8	4.4
WGO2	11.0
WGO3	14.9
WG04	13.4
WG05	15.9
WG06	18.4
WG07	20.8
WG08	23.3
WG09	25.8

Manufacturer Model	Water Cont. Gal. Less Coil
Buderus	
G115-21	8.7
G115-28	10.8
G115-34	12.9
G215-3	12.9
G215-4	16.1
G215-5	19.3
G215-6	22.5
G215-7	25.6
G124x18	2.5
G124x25	3.0
G124x32	3.5
Viessmann	
VR2-18	7.1
VR2-22	9.2
VR2-27, 33	11.6
VR2-40	12.7
VR2-50	16.1
VR2-63	19.3
VB2-18	18.5
VB2-22	23.2
VB2-33	31.2
VB2-40	37.0
VB2-50	52.6
VB2-63	59.0
WB2-6	1.1
WB2-8	1.2
WB2-11	3.1
WB2-15	3.1

Manufacturer Model	Water Cont. Gal. Less Coil
NTI	
CT80, 95, 100	3.6
CT120,150, 180	5.4
CT215, 230, 250	7.3
Caprice Series	15.0
T150	3.9
T200	5.1
VS Series	15.0
Triton Series	18.0
Superior	
SB083	12
SB121	14
SB148	14
SB196	16
SB257	18
Solaria	
SL375	3.6
SL4100	4.3
SL5125	5.1
SL6120	5.8

WATER CONTENT & ANTIFREEZE

Type "L" Copper Tubing		Standard Steel Pipe	
Nominal Size (inches)	US Gallons per 100 Feet	Nominal Size (inches)	US Gallons per 100 Feet
3/8	.075	3/8	1.0
1/2	1.21	17/32	1.6
5/8	1.81	3/4	2.8
3/4	2.51	1	4.5
1	4.28	1 1/4	6.3
1 1/4	6.52	1 1/2	10.2
1 1/2	9.25	2	17.0
2	6.06	3	39.0
3	35.37	4	69.0

Propylene of Propylene Glycol	Burst Temp dF	Flow Temp dF
100%	-100	-50
75%	-80	-35
50%	-60	-15
40%	-50	0

To calculate the amount of boiler antifreeze required for a system, determine the total water content of the system from the tables above. Then calculate the percentage of antifreeze desired from the Freeze Protection Table. Antifreeze should be checked annually to ensure continued protection.

RADIATOR RATINGS

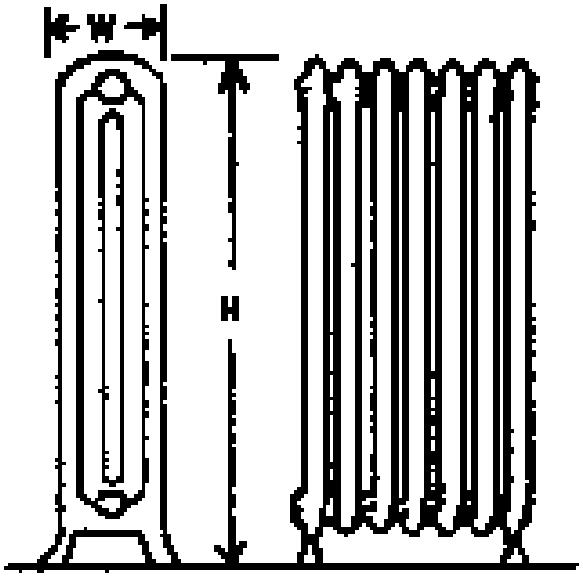
To determine the square feet of direct radiation and BTU capacity of a radiator:
1. Identify the style of radiator in the figure below.
2. Measure the height and width of the radiator.
3. Count the number of tubes in a section.
4. Count the number of sections.
5. Determine the square feet of radiation per section from the tables below and multiply by the number of sections.
6. Refer to the BTU/Hr. per square foot of radiation. Multiply the number of square feet calculated above by the BTU's per square foot to obtain the total output in BTU/hr.

Old Style Column Radiators

Columns:	1	2	3	4	5	6
Width:	4½	7½	9	11½	12½	12½
Height	**Sq. Ft. of Radiation Per Section**					
45"	3.5	5	6	10		
38"	3	4	5	8	10	
32"	2.5	3.33	4.5	6.5	8.5	
26"	2	2.67	3.75	5	7	7
23"	1.67	2.33	3.25	4.5		
22"	1.67	2.25	3	4	6	6
20"	1.5	2	2.75	3.5	5	5
18"	1.33	1.75	2.25	3	5	4.33
17"						4
16"					4	3.75
15"		1.5				
14"					4	3
13"					3	3

Heat Emission at 70°F Room Temperature

Aver. Water Temp.	160°	170°	180°	190°	200°	210°
BTU Out / Sq. Ft.	130	150	170	190	210	230



Tube Type Radiators

Tubes:	3	4	5	6	7
Width:	7½	9	11½	12½	12½
Height	**Sq. Ft. of Radiation Per Section**				
38"	3.5	4.25	5	6	
36"	3.5	4.25	5	6	7
32"	3	3.5	4.33	5	6
26"	2.33	2.75	3.5	4	5
23"	2	2.5	3	3.5	4.5
22"					4.5
20"	1.75	2.25	2.67	3	3.67
18"					3.5

Thin Tube Radiators

Tubes:	2	3	4	5	6
Width:	4½	7½	9	11½	12½
Height	**Sq. Ft. of Radiation Per Section**				
38"	2.5	2.6			
32"	2	2.4			3.7
26"			2.4	3	3
25"	1.6	1.6	2.0		3
23"				2.1	
22"	1.3	1.4	1.8		
20"			1.8		2.3
19"	1.1	1.2	1.6		2.3
17"				2.0	

DHW HEATER DESIGN

Heater Specifications

Thermal Expansion—Increase in Volume of 40 Gallons of Water When Raised From 39°

Pressure PSI	0	10	30	50
Boiling Point of Water	212°	240°	275°	298°

Boiling Point of Water
Boiling Point Increases with Increased Pressure

Temperature	39°	80°	160°	200°	280°
Volume	40g	40.1g	40.5g	41.5	43.1

Residential Sizing

Storage + Heat Input = Heated Water Available

Table 1. Gallons Required per Peak Hour	Gallons of 140° Required
Ist Person	20
2nd Person	20
Gallons per Person After the First 2	5
Gallon For Each Full Bath After the First	10
Gallons For Dish Washer	10
Gallons For Clothes Washer	20

Tank Storage:

- The draw efficiency of a tank is considered to be 70%. Therefore, the recovery available from storage in the first hour is 70% of the tanks rated volume

Table 2. Input Rating	GPH Recovery @ 70° Rise	GPH Recovery @ 90° Rise
Gas Input MBTuH		
30,000	39.0	30.3
35,000	42.9	35.4
40,000	51.9	40.4
50,000	64.9	50.5
70,000	90.9	70.7
100,000	129.9	101.0
Element Watts Electric		
1500	8.8	6.8
2500	14.6	11.4
4500	23.4	20.5

Table 3. Recommended Storage Tank Size. Application:	Tank Required	Usable Recovery
One Full Bath Residence	30g	21g
Two Bath or One Bath w/ Washer	40g	28g
Three Baths or Two Baths w/ Washer	50g	35g
See Whirlpool Table For Sizing of Application with Large Tubs		

Tub Capacity to Overflow	Total Min. Tank Size for Residence @ 140°
80	65
90	71
100	80
110	89
120	98
130	108
140	117
150	125

DHW HEATER SIZE EXAMPLE

Example: Family of 4, 2 Full Baths, with Washer & Dishwasher

Calculation of Example	Gallons Available
Total Gallons Required in Peak 2 Hours	90
Tank Size:	
According to Table 3 Tank Size is	
50 Gallon. Usable Hot Water From Storage Is:	35
Gal. To Be Produced By Heat Input 2 Hrs.	55
Gallons / Hour Needed From Input	27.5
From Table 2:	
Gas Heater : 30 MBtuh will Produce 30.3/ Hr	60.6
Total Gallons Available 30 MBtuh Gas	91.1
Electric 4500w will Produce 20.5g	41
Therefore Tank Size Will be Increased	
to 80 Gal. x .70=56g From Storage	56
Total Gallons Available Electric 80 Gal.	97

Item	Gallons Needed
2 People @ 20 Gal.	40
2 People @ 5 Gal.	10
Second Full Bath	10
Dishwasher	10
Cloths Washer	20
Total Two Hour Peak Requirement	90
Gallons Required per Hour	45

Rinnai

TROUBLESHOOTING GUIDE RINNAI RHFE-551FA

Before checking resistance readings, turn off power switch and then isolate item to be checked from circuit (unplug it). You must be a qualified service person to proceed with these tests!

	Manifold Pressure	Air Shutter Setting	Orifice Size	Bypass Restrictor
LP	9.4" WC	7 Notches Showing	1.00 mm (0.039")	1.15 mm
Nat'l	3.5" WC	2 Notches Showing	1.70 mm (0.067")	3.55 mm

(TR2) ES-14025-1X01 Transformer (upper)

Read Voltage Across	VAC	Resistance Ohms
Red-Red	100 primary	38-44
Yellow-Yellow	220 secondary	1250-1440
White-White	15 secondary	1.9-2.3

(SV1, SV2, SV3) Gas Valve Solenoids

Read Voltage Across	VDC	Resistance Ohms
SV1 Purple-Yellow	90 lo fire	1200-1800
SV2 Purple-Peach	90 hi fire	1200-1800
SV3 Purple-Yellow	90 redundant Coil	1200-1800

(FL) ES-02043X01 Convection Fan Motor

Read Voltage Across	VAC	Resistance Ohms
Wht-Blu: Lo Speed	95-105	230-290
Wht-Red: Hi Speed	95-105	100-125

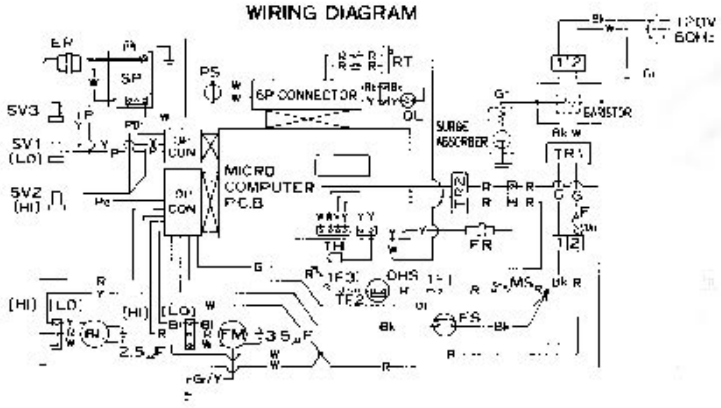
(TR1) ES-14026 Transformer (lower)

Read Voltage Across	VAC	Resistance Ohms
Blk-Wht	110-125 primary	16-21 ohms
Red-Black	98-105 secondary	24-29 ohms

(PS) ES-13003 Pressure Switch

Read Voltage Across	VDC	
Wht-Grd	9-12	To test – jump out switch. If unit functions, replace switch.
Chk both white wires to Ground to ensure circuit		

WIRING DIAGRAM



(SP) E1K-1X01 Speaker

Read Voltage Across:
+ Brown
85-90 VDC
- Purple

(BL) ES-02042 Combustion Blower

Read Voltage Across	VAC	Resistance Ohms
Wht-Ylw: Lo Spd	95-105	200-300
Wht-Red: Hi Spd	95-105	120-180

(RT)550F-0802 Slide Temperature Control

Set meter to the 200k ohm scale. Read across the red wires. Ohm reading should be 0 to 30k from high to low.

(TH) 550F-0807X02 Thermistor Assembly

Set meter to 200k ohm scale. As heat is applied to thermistor bulb, resistance will decrease. Apply ice to bulb and resistance should increase. Sample readings:

41°F = 91k ohms 68°F = 39k ohms
50°F = 65k ohms 86°F = 23k ohms

(FR) 550F-0510 Flame Rod

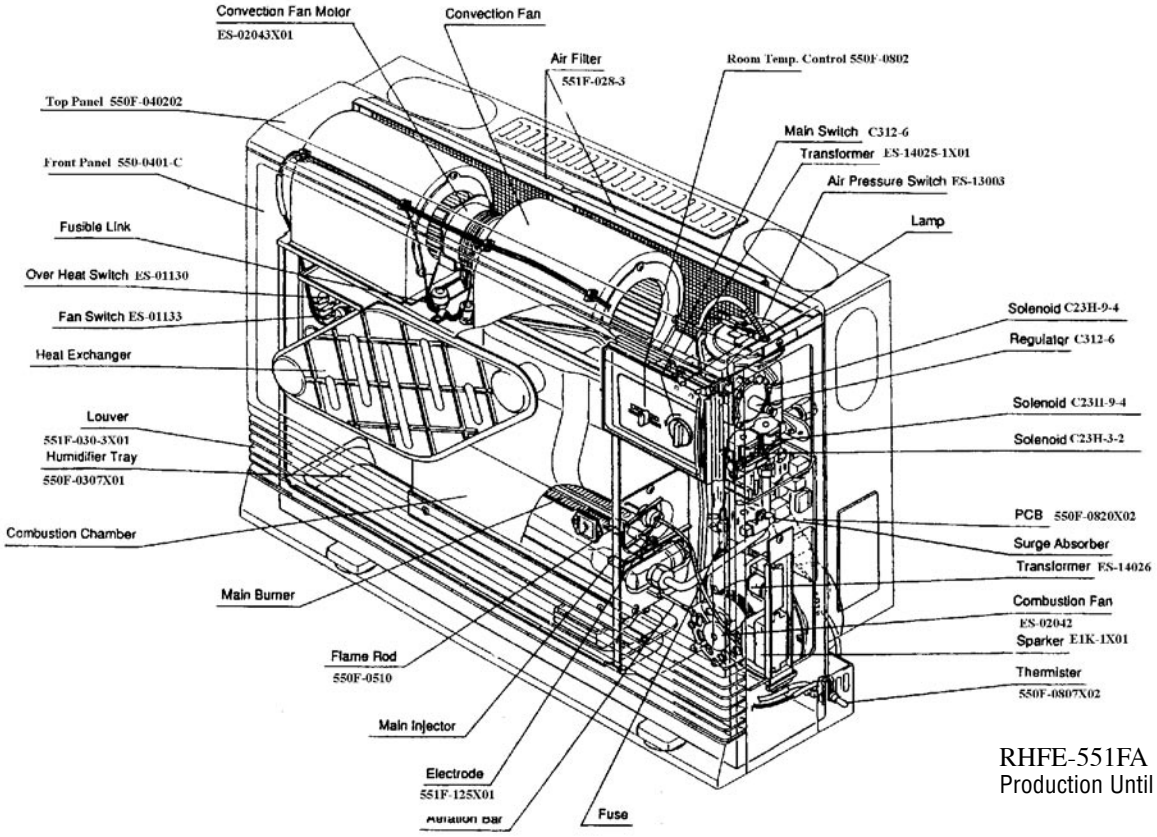
Flame current lo 2 - 4 micro amps DC
(see page 81)
Flame current hi 3 - 8 micro amps DC

Improper setup can cause a carbon build up on the flame sensor. If this occurs, you must confirm manifold pressure, air shutter settings, by-pass restrictor screw size, and proper orifice size

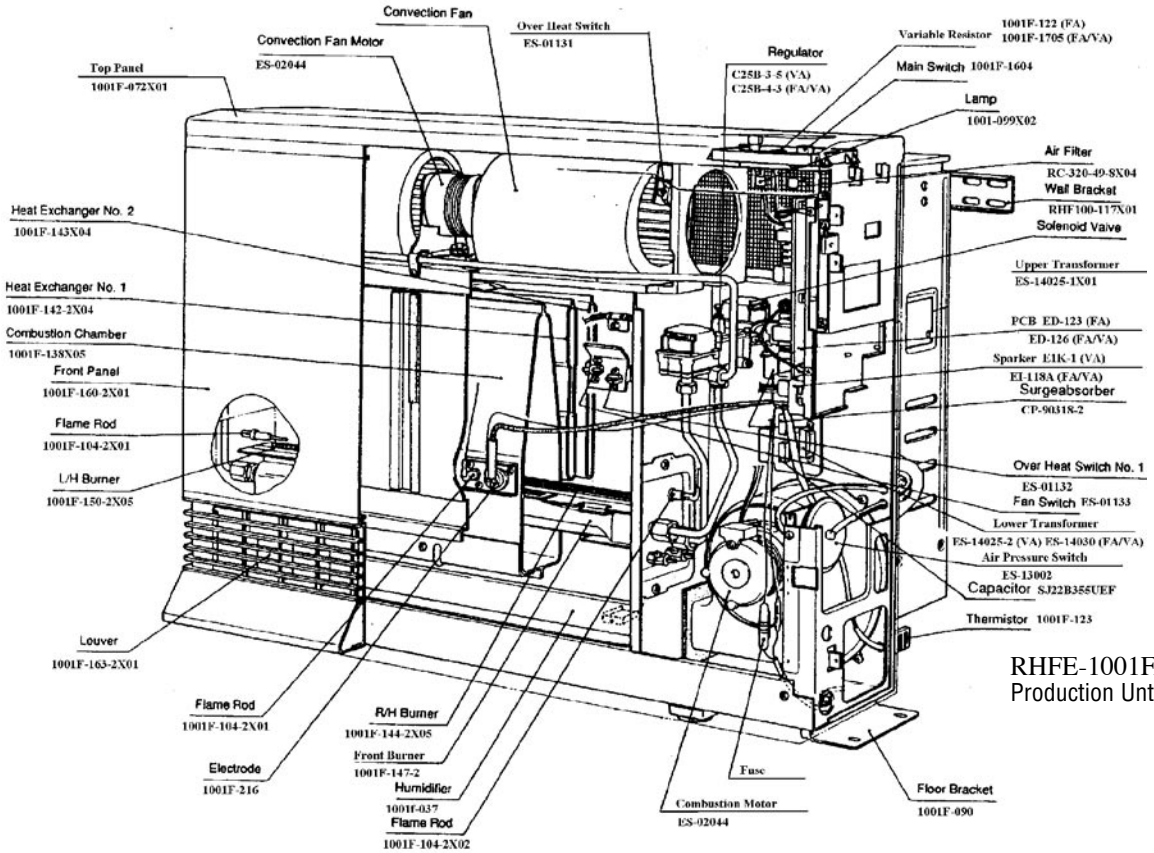
Safety Circuit Symbol	Part Number	Description
PCB	550F-0820X02	PC Board
TF1	551F-1453	Thermal Fuse Front
TF2	551F-1453	Thermal Fuse Back
TF3		Thermal Fuse
OHS	ES-01130	Over Heat Switch
MS	C312-6	Main Switch

To Test Safety Circuit:
Unplug black & red wire from TR1. Unplug 9 pin connector next to PCB. Measure continuity from gray wire connection of the 9 pin plug to the black wire ant TR1 connection. Turn the control knob to "ON". You should read continuity through this circuit. If not, confirm which safety switch is open and replace.

EXPLODED VIEW RHFE-1001FA & RHFE-551FA



RHFE-551FA
Production Until 1995



RHFE-1001FA & FA/VA
Production Until 1996

Rinnai

TROUBLESHOOTING GUIDE RINNAI RHFE-1001FA & RHFE-1001FA/VA

Before checking resistance readings, turn off power switch and then isolate item to be checked from circuit (unplug it). You must be a qualified service person to proceed with these tests!

	Manifold Pressure	Air Shutter Setting	Orifice Size
LP	10.5" WC	0 Notches Showing 1.15 m (0.045") Front	1.05 mm (0.041") Back
Nat'l	3.8" WC	5 Notches Showing Back Burners 3 Notches Front Right Burner	1.90 mm (0.074") Back 1.80 mm (0.71") Front

(TR2) ES-14027 Transformer (upper)

Read Voltage Across	VAC	Resistance Ohms	Pin #
Red-Red	98-105 primary	39-44	21-22
Ylw-Ylw	208-224 sec'dary	490-510	19-20
Wht-Wht	10-15 secondary	2.5-3.1	17-18

(SV1, SV2, SV3) PC-108 (FA) Gas Valve Solenoids

PC-108A (FA/VA)

Read Voltage Across	VDC	Resistance Ohms	Pin #
SV1 Gray-Blk	85-90 Coil	1400-1800	33-36
SV2 Gray-Blu	85-90 lo fire	1200-1600	34-36
SV3 Gray-Wht	85-90 hi fire	1200-1600	35-36

(FM) ES-02045X01 Convection Fan Motor

Read Voltage Across	VAC	Resistance Ohms	Pin #
Wht-Red lo spd	95-105	100-140	26-28
Wht-Blk hi spd	95-105	42-62	27-28

(TR1) ES-14025-2 (FA) Transformer (lower) ES-14030 (FA/VA)

Read Voltage Across	VAC	Resistance Ohms	Pin #
Blk-Wht	110-125 primary 19-20 FA/VA	100-140 FA	26-28
Gry-Gry	95-105 sec'dary 19-20 FA/VA	42-62 FA	27-28

(PS) ES-13002 Pressure Switch

Read Voltage Across	VDC	Resistance	Pin #
Wht-Grd (FA) Brn-Grd (FA-VA) Chk both white wires To ground to ensure Circuit is complete.	9-12 (FA) 13-18(FA/VA)	To test – jump out switch. If unit functions, replace switch.	4-5FA 6-7FA/VA

Safety Circuit Symbol	Part #	Description
OHS1	ES-01131	Limit on Upper Fan
OHS2	ES-01132	Limit in Heat Exchanger
TF1 & TF2		Between FM blowers

(SP) E1K-1 Sparker

Read Voltage Across:
+ Grey
85 - 90 VDC Pin 37 - 38
- Blue

(BL) ES-02044 Combustion Fan Motor

Read Voltage Across	VAC	Resistance Ohms	Pin #
Wht-Org lo spd	95-105	200-300	26-38 FA 29-31FA/VA
Wht-Blk hi spd	95-105	120-180	27-28 FA 30-31 FA/VA

(RT) 1001F-1705 (FA)Variable Resistor Temp. Control 1001F-1705 (FA/VA)
Set meter to the 200k ohm scale. Read across the red wires. Ohm reading should be 0 to 30k from high to low.

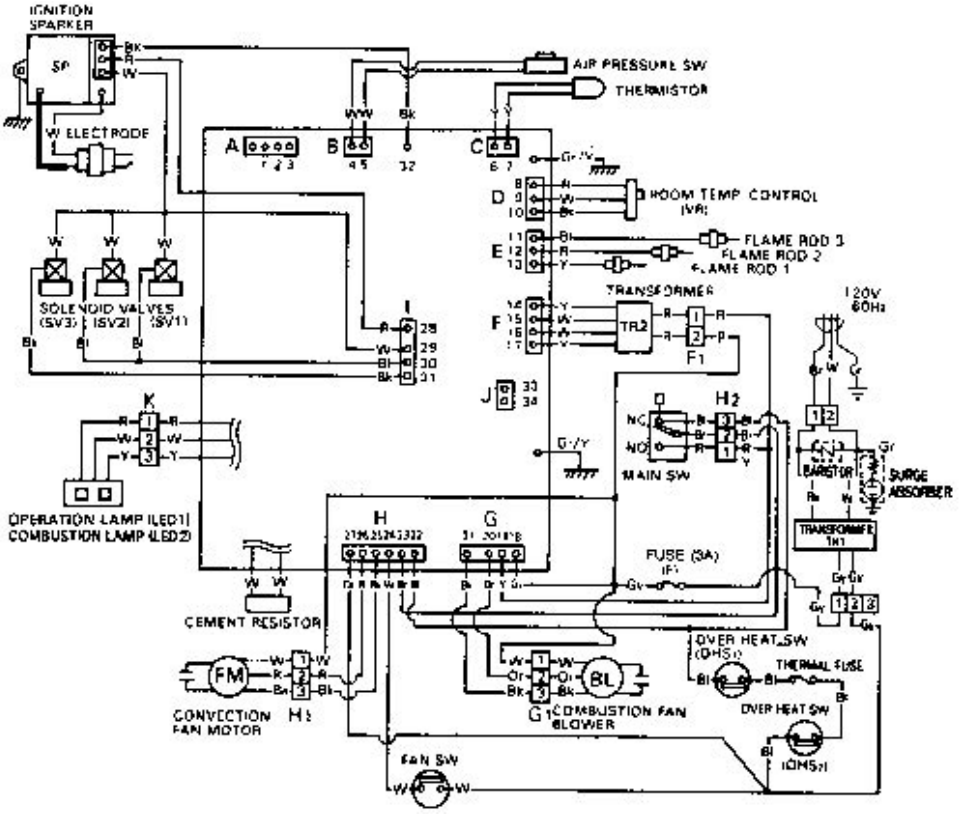
(TH) 1001F-123 Thermistor Assembly
Set meter to 200k ohm scale. As heat is applied to thermistor bulb, resistance will decrease. Apply ice to bulb and resistance should increase. Sample readings:

41°F = 91k ohms 68°F = 39k ohms
50°F = 65k ohms 86°F = 23k ohms

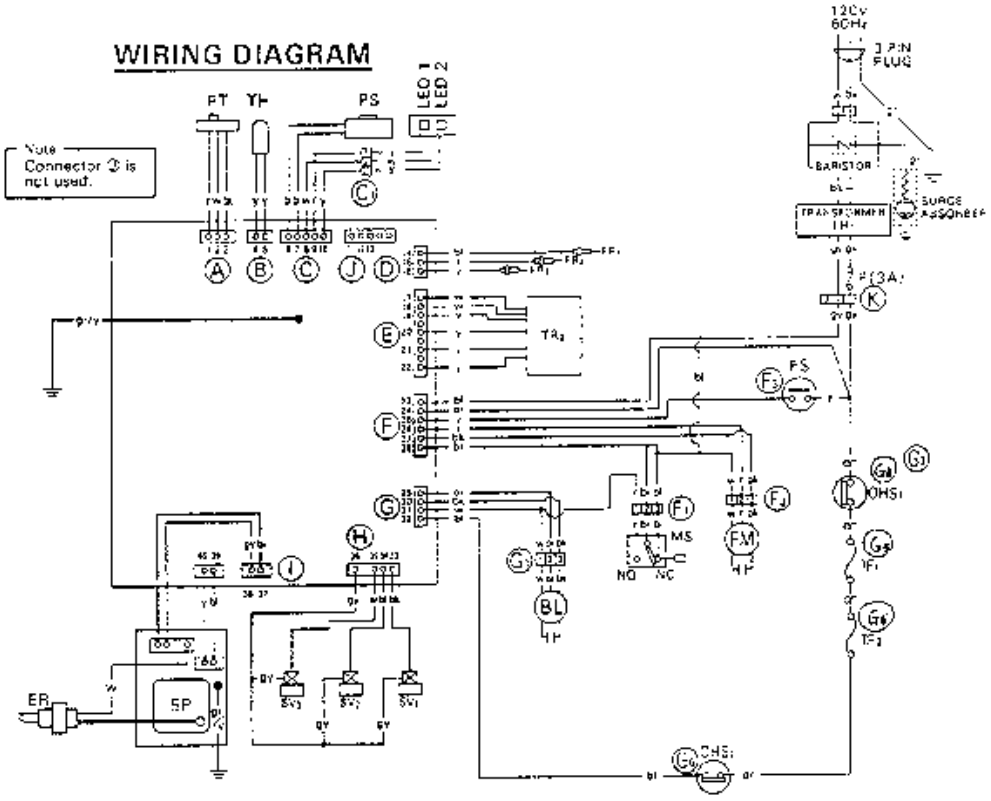
(FR) 1001F-104-2X01 Flame Rod
Flame current lo 2 - 4 micro amps DC
(see page 81)
Front Flame Rod Only
Flame current hi 3 - 8 micro amps DC
Measure at each of 3 flame rods
Improper setup can cause a carbon build up on the flame sensor. If this occurs, you must confirm manifold pressure, air shutter settings, by-pass restrictor screw size, and proper orifice size

Safety Circuit Test
Check continuity by reading from pin #22 blue wire to pin #27 orange wire (FA), (or pin #24 org. to #32 blue FA/VA). If the circuit is open isolate and replace the defective component

WIRING DIAGRAM RHFE-1001 FA



WIRING DIAGRAM RHFE-1001FA/VA



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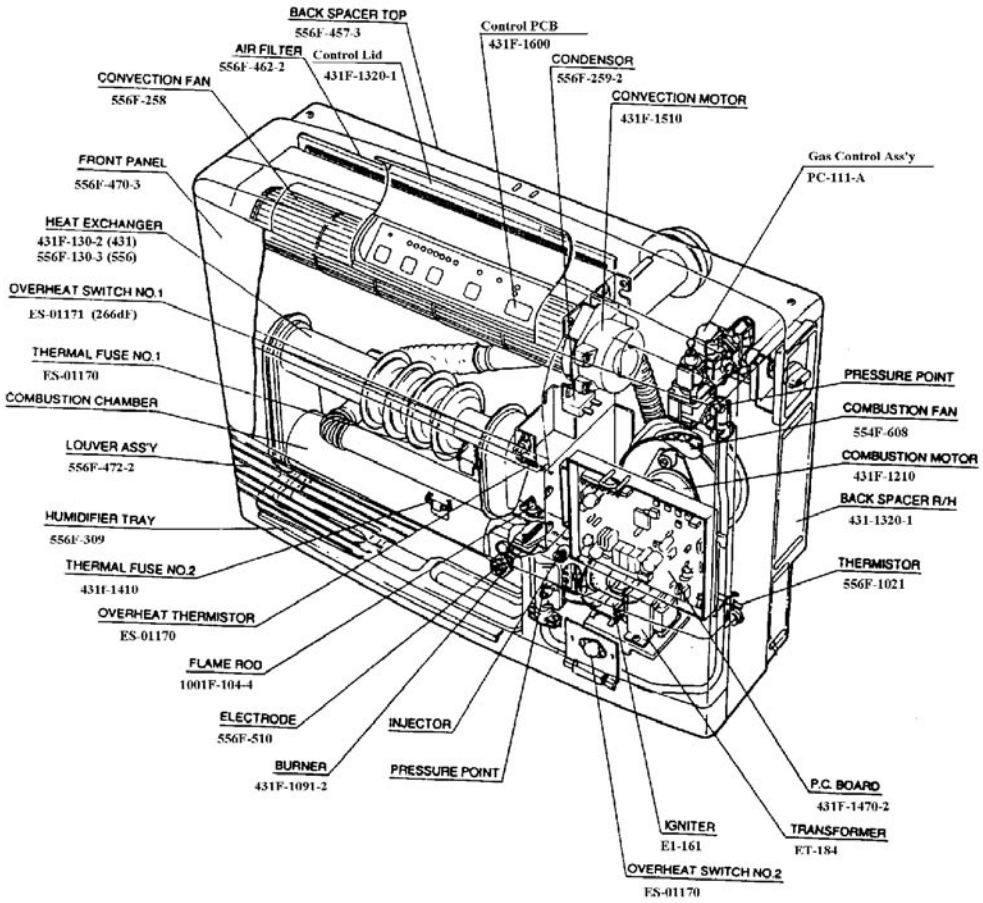

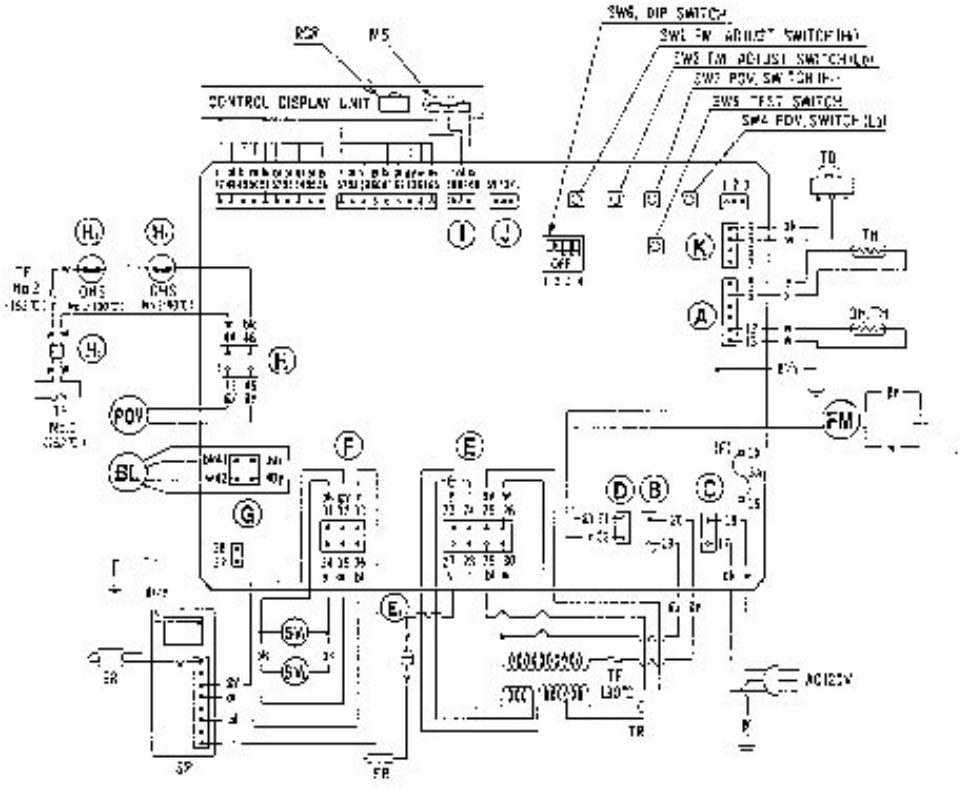

Gas Type Selection:

1. Set dip switches SW6 to the appropriate gas type. See following page for proper dip switch positions

Setting Gas Pressure:

1. Attach differential manometer to the two 1/8" test ports. Turn the unit on and wait for it to establish flame.
2. Press SW5. This will allow you to set the low pressure differential If low pressure needs adjustment press ▲ or ▼ arrow keys as needed. When desired pressure is reached, press SW4 button again to lock in the change.
3. Now press SW3.This will allow you to set the high pressure differential. Adjust this pressure with the ▲ and ▼ keys and press SW3 again to lock in the change.
4. Press the SW5 button again to exit the programing mode.

TROUBLE SHOOTING GUIDE RHFE-431FA'S AND RHFE-556FA/WTA'S

Before checking resistance readings, turn off power switch and then isolate item to be checked from circuit (unplug it). You must be a qualified service person to proceed with these tests!

****WARNING****

When setting gas pressures, refer to the Owner's Manual for the unit you are trouble shooting. You must measure differential pressure (not manifold pressure), and must have the complete model number down to the roman numerals.

Unit Settings Model Number	Press. NG High Fire	Press. NG Low Fire	Dip Switch Setting NG	Pressure LP High Fire	Pressure LP Low Fire	Dip Switch Setting
RHFE-431FA	2.1	0.4	off, on, on, on	4.4	1.0	on, off, on, on
RHFE431FAII	3.5	0.8	off, on, on, on	4.4	1.0	on, off, on, on
RHFE431FAIII	2.4	0.7	off, off, on, on	2.8	0.8	on, on, on, on
RHFE556FA/WTA	3.8	0.7	off, on, off, off	4.5	0.8	on, off, off, off
RHFE556FA/TRAIII	3.8	0.7	off, off, off, off	4.5	0.8	on, on, off, off

(TR) ET-184 Transformer Read Voltage Across	VAC	Resistance Ohms	Pin #
Wht-Wht	98-105	6-19	26-30
Red-Red	28-50	1-3	24-28
Blk-Blu	10-15	0.5-2	25-29
Blu-Ylw	130-185	200-400	23-29
Gry-Gry	110-120	10-14	19-20

(POV, SV1, SV2) C36D-5 Gas Solenoids Read Voltage Across	VDC	Resistance Ohms	Pin#
Gry-Gry	4.5 lo fire, 11.5 high	80-100	43-45
Blk-Ylw	85-90	1300-2000	31-34

(FM) 431F-1510 Convection Fan Motor Read Voltage Across	VAC	Resistance Ohms	Pin #
Red-Gry	80-94 lo fire, 95-104 hi	90-180	21-22

(FR) 1001F-104-4 Flame Rod

Flame current lo 3 - 8 micro amps DC
(see page 81)

Flame current hi 3 - 8 micro amps DC

Improper setup can cause a carbon build up on the flame sensor. If this occurs, you must confirm manifold pressure, air shutter settings, and proper orifice size

(H1, H2, H3) Safety Circuit

Check for continuity across pins 44 and 46 at terminal H on PC board. If circuit is open, find and replace defective switch / thermal fuse.

(TB) Terminal Block

This terminal is located on the right rear upper portion of the unit. On direct vent the jumper should be across terminals 2 and 3. On units with vent extensions over 4', this jumper should be across terminals 1 and 2.

(SP)E1-161 Sparker Board Read Voltage Across	VDC	Resistance Ohms	Pin #
Blu-Red	85-100	see below	33-36

Set meter to 400k scale & unplug the 5 pin connector on the sparker board. Reading across lugs for the red and blue wires, you should read 100 - 120k ohms resistance. When checking spark sensing circuit, check across orange (pin 35) and gray (pin 32). You should read 4 - 5 VDC. During spark this voltage should drop to 0 VDC

(BL) 431F-1210 Combustion Fan Motor Read Voltage Across	VDC	Resistance Ohms	Pin#
Red-Ylw	1-2 lo fire, 7.6-18 hi	1.2-1.8 meg	39-40
Blk-Wht	N/A	9.4-9.9K	41-42

(TH) 1001F-123 Thermistor Assembly

Set meter to 200k ohm scale. As heat is applied to thermistor bulb, resistance will decrease. Apply ice to bulb and resistance should increase. Sample readings:

41°F = 91k ohms 68°F = 39k ohms
50°F = 65k ohms 86°F = 23k ohms

(OH - TH) Overheat Thermistor

Check resistance across pins 12 and 13 at terminal A on the PC board. Proper readings should be 0.6k and 523k. A reading below 0.6k ohms indicates a short and a reading above 523k indicates an open circuit.

Information about previous faults is stored in the PCB and can be recalled during servicing. To do so, press the temperature control < and > buttons, and the economy button at the same time.