Determining when a Refrigerant Detection System is applied

UL 60335-2-40 Summary

1. **When a single circuit containing R-454B has more than 4 pounds and less than 169 pounds an (RDS) *that energizes the indoor circulating fan* must be used in any of the following circumstances:**

   A. The R-454B refrigerant quantity is greater than 34 pounds
   B. The supply air discharge height from the floor to the diffuser is less than 2 feet
   C. The smallest ducted zone (room) area is smaller than allowed in Table 2. (See Tables 2 Listed)

2. **When the total applied area is smaller than the required value per #1 above. The mitigation strategy still requires an RDS, *as well as adding mechanical exhaust airflow to the space.* Therefore, the excessive amount of R-454B refrigerant that could accumulate in the space is diluted and exhausted before a hazardous condition can occur.**

   A. See Table 3 to see if total area is less than the required value per #1.
   B. If determined the total area is less than required see Table 4 to determine the minimum exhaust air

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Table 2
Minimum Applied Area to Apply R-454B Unit
(ft) No RDS Required

Maximum Single Circuit Charge (m_c)	Discharge Height (h_a) From Floor to Diffuser							
	ft	ft	ft	ft	ft	ft	ft	ft
lbs.	2.0	3.3	4.6	5.9	6.6	7.2	8.0	9.0
4	292.2	107.3	55.2	33.6	26.8	22.5	18.3	14.4
6	657.3	241.4	124.3	75.5	60.4	50.7	41.1	32.5
8	1168.6	429.2	220.9	134.3	107.3	90.2	73.0	57.7
10	1825.9	670.7	345.2	209.8	167.7	140.9	114.1	90.2
12	2629.4	965.8	497.0	302.1	241.4	202.9	164.3	129.8
16	4674.4	1717.0	883.6	537.1	429.2	360.7	292.2	230.8
18	5916.0	2173.0	1118.3	679.8	543.3	456.5	369.8	292.2
20	7303.8	2682.7	1380.7	839.3	670.7	563.6	456.5	360.7
22	8837.5	3246.1	1670.6	1015.5	811.5	681.9	552.3	436.4
24	10517.4	3863.1	1988.2	1208.6	965.8	811.5	657.3	519.4
26	12343.3	4533.8	2333.3	1418.4	1133.5	952.4	771.5	609.5
28	14315.4	5258.2	2706.1	1645.0	1314.5	1104.6	894.7	706.9
30	16433.5	6036.2	3106.5	1888.4	1509.0	1268.0	1027.1	811.5
32	18697.6	6867.8	3534.5	2148.5	1717.0	1442.7	1168.6	923.3
34	21107.9	7753.1	3990.1	2425.5	1938.3	1628.7	1319.2	1042.4

Table 2
Minimum Applied Area to Apply R-454B Unit
(m) No RDS Required

Maximum Single Circuit Charge (m_c)								
	m	m	m	m	m	m	m	m
kg	0.6	1.0	1.4	1.8	2.0	2.2	2.4	2.7
1.8	29.7	10.9	5.6	3.4	2.7	2.3	1.9	1.5
2.7	66.7	24.5	12.6	7.7	6.1	5.1	4.2	3.3
3.6	118.6	43.6	22.4	13.6	10.9	9.2	7.4	5.9
4.5	185.3	68.1	35.0	21.3	17.0	14.3	11.6	9.2
5.4	266.9	98.0	50.4	30.7	24.5	20.6	16.7	13.2
7.3	474.4	174.3	89.7	54.5	43.6	36.6	29.7	23.4
8.2	600.4	220.5	113.5	69.0	55.1	46.3	37.5	29.7
9.1	741.3	272.3	140.1	85.2	68.1	57.2	46.3	36.6
10.0	896.9	329.5	169.6	103.1	82.4	69.2	56.1	44.3
10.9	1067.4	392.1	201.8	122.7	98.0	82.4	66.7	52.7
11.8	1252.8	460.2	236.8	144.0	115.0	96.7	78.3	61.9
12.7	1452.9	533.7	274.7	167.0	133.4	112.1	90.8	71.7
13.6	1667.9	612.6	315.3	191.7	153.2	128.7	104.2	82.4
14.5	1897.7	697.0	358.7	218.1	174.3	146.4	118.6	93.7
15.4	2142.3	786.9	405.0	246.2	196.7	165.3	133.9	105.8

Simplified equation 1: $A_{min} = (8.546 \times m_c/h_a)^2$ (IP); Amin = $(1.83 \times m_c/h_a)^3$ (SI).

Simplified equation 2: $A_{min} = (108.236 \times m_c/h_a)^2$ (IP); Amin = $(6.75 \times m_c/h_a)^3$ (SI).

m_c = refrigerant charge in lbs. or kg, h_a = discharge height from the entry point in the room to the floor in feet or meters.

Table equations sourced from UL-60335-2-40 Annex GG, Section 2.0.

Table 3
Refrigerant Detector Required
Total Applied Area and Air Circulation Rates for R-454B HVAC System

Maximum Single Circuit Refrigerant Charge (m_c)		Minimum Applied Area (TA) Minimum Air Circulation Rate (Q) Range: 4-169 lbs. of refrigerant			
		$TA_{min} = 15.0 \times m_c$ $Q_{min} = 27.1 \times m_c$		$TA_{min} = 3.1 \times m_c$ $Q_{min} = 101.4 \times m_c$	
lbs.	kg	ft²	CFM	m²	m³/h
4	1.8	60.0	108	5.6	184
6	2.7	90.0	163	8.4	276
8	3.6	120.0	217	11.2	368
10	4.5	150.0	271	14.1	460
12	5.4	180.0	325	16.9	552
16	7.3	240.0	434	22.5	736
18	8.2	270.0	488	25.3	828
20	9.1	300.0	542	28.1	920
22	10.0	330.0	596	30.9	1012
24	10.9	360.0	650	33.7	1104
26	11.8	390.0	705	36.6	1196
28	12.7	420.0	759	39.4	1288
30	13.6	450.0	813	42.2	1380
32	14.5	480.0	867	45.0	1472
34	15.4	510.0	921	47.8	1564
35	15.9	525.0	949	49.2	1610
40	18.1	600.0	1084	56.2	1840
45	20.4	675.0	1220	63.3	2070
50	22.7	750.0	1355	70.3	2300
60	27.2	900.0	1626	84.4	2760
70	31.8	1050.0	1897	98.4	3220
80	36.3	1200.0	2168	112.5	3680
90	40.8	1350.0	2439	126.6	4139
100	45.4	1500.0	2710	140.6	4599
110	49.9	1650.0	2981	154.7	5059
120	54.4	1800.0	3252	168.7	5519
130	59.0	1950.0	3523	182.8	5979

Equations #3 and #4:
TA = Total minimum applied area of the product, where height is a constant 7.2 ft/2.2 m.
m_c = Refrigerant charge in lbs. or kg.
h_c = Discharge height from the entry point in the room to the floor in feet or meters.
Q = Minimum ventilation airflow rate.
Table equations sourced from UL-60335-2-40 Annex GG, Section 2.0.

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Table 4
R-454B HVAC Units Where $m_c > m_{max}$
RDS and Exhaust Air Flow Required

Maximum Single Circuit Charge ($m_c - m_{max}$)		(Refrigerant charge greater than allowed by room area per UL-60335-2-40 Annex 2.1 and 2.2) Minimum Air Circulation (Q) and Exhaust Airflow Rates (EA)			
		$Q\ (cfm) = 54.1 \times (m_c - m_{max})$ $EA\ (cfm) = 0.43 \times (m_c - m_{max})$		$Q\ (m^3/h) = 202.7 \times (m_c - m_{max})$ $EA\ (m^3/h) = 1.6 \times (m_c - m_{max})$	
lbs.	kg	Q_{CFM}	EA_{CFM}	$Q_{m3/h}$	$EA_{m3/h}$
1	0.45	54	0.4	10966	0.7
2	0.91	108	0.9	21932	1.5
3	1.36	162	1.3	32898	2.2
4	1.81	216	1.7	43864	2.9
5	2.27	271	2.2	54830	3.6
6	2.72	325	2.6	65796	4.4
7.5	3.40	406	3.2	82246	5.4
10	4.54	541	4.3	109661	7.3
12	5.44	649	5.2	131593	8.7
14	6.35	757	6.0	153525	10.2
16	7.26	866	6.9	175457	11.6
18	8.16	974	7.7	197389	13.1
20	9.07	1082	8.6	219321	14.5
22	9.98	1190	9.5	241254	16.0
24	10.89	1298	10.3	263186	17.4
26	11.79	1407	11.2	285118	18.9
28	12.70	1515	12.0	307050	20.3
30	13.61	1623	12.9	328982	21.8