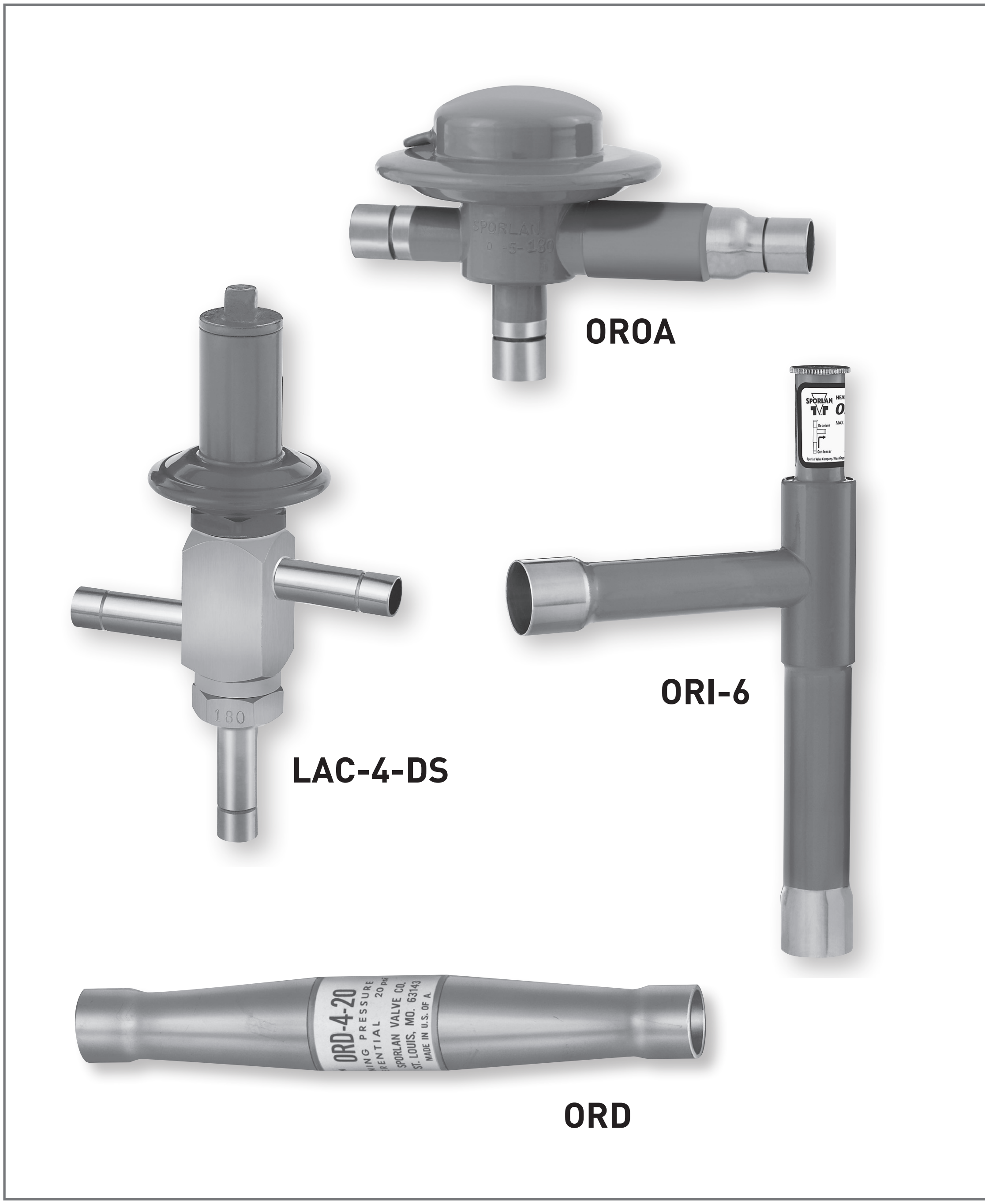
Head Pressure Control Charging Recommendations

ORI, ORD, OROA and LAC



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The design and operation of Sporlan Head Pressure Control Valves are discussed thoroughly in Bulletin 90-30. Installation and service is covered in Bulletin 90-31. This bulletin was prepared to provide complete charging instructions, from determining the correct amount of refrigerant to actually charging the system.

If the manufacturer of your equipment provides charging information it should be used. However, if it is not provided, the following procedure is suggested.

DETERMINING AMOUNT OF CHARGE – When "refrigerant side" head pressure control is utilized on a system, one of the most important factors is determining the total system refrigerant charge. While on most packaged units the amount of charge is listed on the unit, the required charge for a field built-up system cannot be listed by the manufacturer. Charge is usually added when the system is started up until "proper" system performance is reached. However, this is not satisfactory and if the system is to function properly **year-round,** the correct amount of extra charge must be calculated ahead of time.

RETROFIT PRECAUTIONS – When changing refrigerants on a retrofit, be sure to calculate the refrigerant charge required for the new refrigerant. The density of the alternate refrigerants varies considerably from their CFC predecessors. In other words, if you remove 10 pounds of R-12 from a system being retrofitted to R-401A do not charge the system with 10 pounds of R-401A. Typically, an R-401A system would only need approximately 90% of the R-12 previously required.

There are two methods of calculating the extra charge necessary to flood the condenser if the condenser manufacturer does not publish this data.

1 – COMPLETELY FLOODED CONDENSER:
The easiest method is to calculate the **volume** of the condenser coil and then use the density factor of the refrigerant shown in Table 1 to figure the pounds of refrigerant necessary to **completely** flood the condenser coil at the appropriate ambient. The factors involved in calculating the extra pounds of refrigerant are:

- **a. Length of tubing and return bends in condenser**
- **b. Minimum ambient temperature at which systems will be required to function**
- **c. Tubing size and wall thickness**
- **d. Refrigerant**

The primary point to remember in selecting the proper density factor is that when the liquid drain valve (ORI, OROA, or LAC) is throttling, the refrigerant temperature will be at the same temperature as the ambient.

EXAMPLE: Calculate the extra refrigerant charge necessary for a Refrigerant 22, roof-top, air conditioning unit (40°F evaporator and a minimum condensing temperature of 90°F) with compressor unloading to 33-1/3% of full compressor capacity. To determine the equivalent length of tubing in a condenser proceed as follows: First, count the number of tubes and multiply this by their length.

Example: 150 tubes x 7.55 feet = 1132.5 feet

Next, count the return bends and multiply them by the factor shown in Table 1.

Example: 150 bends x .250 for 1/2 inch bends = 37.5 feet

Then add this 37.5 feet to the 1132.5 feet for a total of 1170 feet

The system uses a 30 hp condensing unit with a condenser coil containing 1170 equivalent feet of 1/2 inch tubing (tubes and return bends). Assume a design temperature of minus 20°F minimum ambient. From Table 1 we find the density factor necessary to calculate the pounds of extra refrigerant to **completely** flood the condenser at minus 20°F: 1170 feet x .102 pounds/foot = 119 pounds.

2 – PARTIALLY FLOODED CONDENSER:
On many systems it isn't necessary to **completely** flood the condenser to maintain sufficient operating head pressure (equivalent to approximately 90°F condensing temperature) because of a milder climate than Method 1 assumes. Therefore, a second method is available. The additional information found in Tables 2 and 3 can be used to figure more closely the charge necessary to properly flood the condenser for sufficient head pressure at various minimum ambient temperatures. (The multipliers are applied to the extra refrigerant charge that was calculated in Method 1 to **completely** flood the condenser.)

EXAMPLE: Our example calls for a compressor equipped with unloaders. Since the compressor would unload at the low ambients this must be taken into consideration. This is necessary

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since as the compressor unloads, the condenser's capacity increases and additional flooding is required. Using the same roof-top unit as in the earlier example (40°F evaporator and minus 20°F minimum ambient), a multiplier of .79 is shown in Table 2. And since we have unloaders (33-1/3%), this .79 is used to enter Table 3 to find a multiplier of .95. This final multiplier is applied to the 119 pounds calculated earlier to arrive at the final extra charge requirement: 119 x .95 = 113 pounds. This is added to the normal system charge to arrive at a total system charge.

Since the majority of "low and medium suction" condensing units are already flooded 75% or more for any minimum ambient temperatures below 20°F, no data is supplied for these units even when they use unloaders. The normal procedure is to recommend flooding from 90 to 100% for these units when they have unloaders.

REFRIGERANT CHARGING PROCEDURES – Normally this information is supplied by the equipment manufacturer. And when it is available, it should be followed. When it is not available from the equipment manufacturer, the following suggestions are recommended.

Once the amount of extra refrigerant charge is calculated, care must be taken in charging the system to ensure the proper total amount of refrigerant getting into the system. This is especially true if the ambient temperature is below 70°F and the liquid drain valve (ORI, OROA, or LAC) is throttling the refrigerant flow from the condenser. A step-by-step procedure is given below for the two possible situations that can exist. And depending on the ambient temperature at the time the system is charged, each should be carefully followed to ensure proper system operation in both summer and winter. In either case, a liquid seal must be established in the receiver before the system can start to function correctly.

NOTE: While charging any system with head pressure control, the outdoor ambient temperature must be known. And if the system has compressor unloaders, it is important to know if they are functioning during the charging procedure. To keep this procedure as simple as possible, it is recommended that the unloaders be locked out (compressor fully loaded) during charging.

Charging of Systems with Sporlan Head Pressure Control in Ambients ABOVE 70°F (After normal evacuation procedures)

BEFORE STARTING SYSTEM

1 - Connect refrigerant cylinder to a charging or gauge port on the receiver outlet valve.

2 - Open the receiver valve approximately one-half way (so receiver and liquid line are connected to charging or gauge port).

3 - Charge liquid refrigerant into the high side of the system. Weighing the charge is recommended with the initial charge consisting of approximately 2.5 pounds per system ton.

4 - Remove the refrigerant drum and connect it to the suction side of the compressor.

5 - Charge refrigerant vapor into the low side until the pressure is above atmospheric pressure. Do not admit **liquid** refrigerant into the low side.

6 - Start the system.

7 - Observe **See•All moisture and liquid indicator** (at receiver outlet) to see if system is properly charged for normal refrigeration cycle. CAUTION: Bubbles in the **See•All** can be caused by flashing due to pressure drop from pipe or accessory losses, etc.

8 - If the **See•All** shows bubbles, more refrigerant should be added, while allowing sufficient time for the refrigerant to stabilize and clear the **See•All.**

9 - The extra refrigerant charge for head pressure control should be weighed in now by admitting liquid refrigerant to the high side.

Charging of Systems with Sporlan Head Pressure Control in Ambients BELOW 70°F (After normal evacuation procedures)

NOTE: When charging in ambients below 70°F the procedure is very critical. Be sure to adhere to the following steps without fail. Failure to do so will result in overcharging the system.

1 - Follow instructions 1 through 7 above.

2 - If the ORI, OROA, or LAC valve setting is correct for the system being charged, it is quite likely that some refrigerant will be backed up into the condenser and the **See•All** will indicate bubbles in the liquid line.

3 - Add more refrigerant, while allowing sufficient time for the refrigerant to stabilize and clear the **See•All**.

4 - At this point the system is correctly charged for this type of head pressure control **at the ambient temperature that exists while the charging procedure is taking place**.

5 - If the system is designed to operate at ambients below the ambient that exists during charging, additional charge will have to be added now.

6 - To calculate the additional charge required, follow the examples outlined under "Refrigerant Charge" **except** remember that the "head pressure control charge" is partially charged already. Refer to Tables 2 and 3. The difference in percentages between the minimum **design** ambient temperature and the ambient temperature at the time the system is charged gives the percent of **extra** charge still needed in the system. E.g., if this system was charged at an ambient of 50°F, we have approximately 40% of the **extra** charge in the system. This holds true as long as the compressor unloaders were not operating during charging. Therefore, the additional charge required is 95 minus 40 or 55% of the total **extra** charge calculated previously. This is .55 x 119 or 65 pounds.

Since good system performance during low ambient operation depends on proper refrigerant charge, it is very important that this phase of the installation procedure be done carefully. Many times, poor system performance will be due to too little or too much charge. And in many cases this will be the last item suspected.

Table 1

DATA TO CALCULATE REFRIGERANT TO FLOOD CONDENSER AND ASSOCIATED PIPING

REFRIGERANT	MINIMUM AMBIENT °F	EQUIVALENT LENGTH OF TUBING FOR EACH RETURN BEND — FEET			DENSITY FACTOR POUNDS PER FOOT OF TUBING — TUBING OD and WALL THICKNESS — Inches					
		3/8"	1/2"	5/8"	3/8 (.016)	1/2 (.017)	5/8 (.018)	7/8 (.045)	1-1/8 (.050)	1-3/8 (.055)
12	-40	.200	.250	.300	0.061	0.112	0.179	0.318	0.543	0.826
	-20				0.060	0.110	0.175	0.312	0.532	0.809
	0				0.058	0.107	0.172	0.305	0.520	0.792
	20				0.057	0.105	0.168	0.298	0.508	0.773
	40				0.054	0.102	0.163	0.290	0.495	0.753
	60				0.054	0.100	0.159	0.282	0.482	0.733
	70				0.053	0.098	0.157	0.278	0.474	0.722
22	-40	.200	.250	.300	0.056	0.104	0.167	0.296	0.505	0.769
	-20				0.055	0.102	0.163	0.289	0.493	0.750
	0				0.054	0.100	0.159	0.282	0.481	0.732
	20				0.052	0.097	0.154	0.274	0.468	0.712
	40				0.051	0.094	0.150	0.267	0.454	0.692
	60				0.049	0.091	0.145	0.258	0.440	0.670
	70				0.048	0.089	0.143	0.254	0.433	0.659
134a	-40	.200	.250	.300	0.057	0.105	0.167	0.297	0.507	0.772
	-20				0.055	0.102	0.164	0.291	0.496	0.755
	0				0.054	0.100	0.160	0.284	0.484	0.736
	20				0.053	0.097	0.156	0.276	0.471	0.718
	40				0.051	0.095	0.151	0.269	0.458	0.698
	60				0.050	0.092	0.147	0.261	0.444	0.677
	70				0.049	0.090	0.144	0.256	0.437	0.666
401A	-40	.200	.250	.300	0.056	0.103	0.164	0.292	0.497	0.758
	-20				0.055	0.101	0.161	0.286	0.487	0.742
	0				0.053	0.098	0.157	0.279	0.475	0.724
	20				0.052	0.096	0.153	0.272	0.463	0.705
	40				0.050	0.093	0.149	0.264	0.450	0.685
	60				0.049	0.090	0.144	0.255	0.435	0.663
	70				0.048	0.088	0.141	0.251	0.428	0.651
401B	-40	.200	.250	.300	0.056	0.103	0.165	0.293	0.499	0.760
	-20				0.055	0.101	0.161	0.286	0.488	0.744
	0				0.053	0.099	0.157	0.280	0.477	0.726
	20				0.052	0.096	0.153	0.272	0.464	0.707
	40				0.050	0.093	0.149	0.264	0.450	0.686
	60				0.049	0.090	0.144	0.255	0.436	0.663
	70				0.048	0.088	0.141	0.251	0.428	0.651
402A	-40	.200	.250	.300	0.056	0.104	0.166	0.295	0.504	0.767
	-20				0.055	0.101	0.162	0.288	0.490	0.747
	0				0.053	0.098	0.157	0.279	0.476	0.725
	20				0.052	0.095	0.152	0.270	0.460	0.701
	40				0.050	0.092	0.146	0.260	0.443	0.675
	60				0.047	0.088	0.140	0.249	0.424	0.646
	70				0.046	0.086	0.137	0.243	0.414	0.630
402B	-40	.200	.250	.300	0.056	0.103	0.164	0.292	0.498	0.758
	-20				0.054	0.100	0.160	0.285	0.486	0.740
	0				0.053	0.098	0.156	0.277	0.472	0.720
	20				0.051	0.095	0.151	0.269	0.458	0.698
	40				0.050	0.091	0.146	0.259	0.442	0.674
	60				0.048	0.088	0.140	0.249	0.425	0.647
	70				0.047	0.086	0.137	0.244	0.415	0.633

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REFRIGERANT	MINIMUM AMBIENT °F	EQUIVALENT LENGTH OF TUBING FOR EACH RETURN BEND — FEET			DENSITY FACTOR POUNDS PER FOOT OF TUBING — TUBING OD and WALL THICKNESS — Inches					
		3/8"	1/2"	5/8"	3/8 (.016)	1/2 (.017)	5/8 (.018)	7/8 (.045)	1-1/8 (.050)	1-3/8 (.055)
404A	-40	.200	.250	.300	0.052	0.095	0.152	0.271	0.462	0.703
	-20				0.050	0.093	0.149	0.264	0.450	0.686
	0				0.049	0.090	0.145	0.257	0.438	0.667
	20				0.047	0.088	0.140	0.249	0.424	0.646
	40				0.046	0.084	0.135	0.240	0.409	0.622
	60				0.044	0.081	0.129	0.230	0.392	0.596
	70				0.043	0.079	0.126	0.224	0.382	0.582
407C	-40	.200	.250	.300	0.053	0.098	0.156	0.277	0.472	0.719
	-20				0.052	0.095	0.152	0.270	0.460	0.701
	0				0.050	0.092	0.148	0.262	0.447	0.682
	20				0.049	0.090	0.143	0.254	0.433	0.660
	40				0.047	0.086	0.138	0.245	0.418	0.636
	60				0.045	0.083	0.132	0.235	0.400	0.610
	70				0.044	0.081	0.129	0.229	0.391	0.595
408A	-40	.200	.250	.300	0.061	0.112	0.179	0.318	0.543	0.826
	-20				0.060	0.110	0.175	0.312	0.532	0.809
	0				0.058	0.107	0.172	0.305	0.520	0.792
	20				0.057	0.105	0.168	0.298	0.508	0.773
	40				0.054	0.102	0.163	0.290	0.495	0.753
	60				0.054	0.100	0.159	0.282	0.482	0.733
	70				0.053	0.098	0.157	0.278	0.474	0.722
409A	-40	.200	.250	.300	0.057	0.105	0.168	0.298	0.508	0.774
	-20				0.056	0.103	0.164	0.292	0.497	0.758
	0				0.054	0.100	0.160	0.285	0.486	0.740
	20				0.053	0.098	0.157	0.278	0.474	0.722
	40				0.052	0.095	0.153	0.271	0.462	0.703
	60				0.050	0.093	0.148	0.263	0.449	0.684
	70				0.050	0.091	0.146	0.259	0.442	0.673
410A	-40	.200	.250	.300	0.053	0.097	0.155	0.275	0.470	0.715
	-20				0.051	0.094	0.151	0.268	0.456	0.695
	0				0.050	0.091	0.146	0.260	0.443	0.674
	20				0.048	0.088	0.141	0.251	0.428	0.652
	40				0.046	0.085	0.136	0.242	0.412	0.628
	60				0.044	0.082	0.130	0.232	0.395	0.601
	70				0.043	0.080	0.127	0.226	0.386	0.587
507	-40	.200	.250	.300	0.051	0.095	0.151	0.269	0.458	0.697
	-20				0.050	0.092	0.147	0.261	0.445	0.678
	0				0.048	0.089	0.142	0.253	0.431	0.657
	20				0.047	0.086	0.138	0.245	0.417	0.635
	40				0.045	0.083	0.133	0.236	0.402	0.612
	60				0.043	0.080	0.127	0.226	0.385	0.587
	70				0.042	0.078	0.124	0.221	0.376	0.573

Table 2

PERCENTAGE OF CONDENSER TO BE FLOODED

Condensing units with no compressor cylinder unloading

MINIMUM AMBIENT TEMPERATURE °F	LOW SUCTION CONDENSING UNITS				MEDIUM SUCTION CONDENSING UNITS				HIGH SUCTION CONDENSING UNITS			
	EVAPORATING TEMPERATURE — °F											
	-35°	-25°	-15°	-5°	0°	10°	20°	30°	35°	40°	45°	50°
80°	27	15	0	0	0	0	0	0	0	0	0	0
75°	46	33	18	0	0	0	0	0	0	0	0	0
70°	62	49	35	15	40	24	0	0	0	0	0	0
65°	70	57	46	32	52	36	20	0	12	5	0	0
60°	76	65	56	45	60	47	33	17	26	20	10	4
55°	80	71	63	54	66	54	43	30	36	31	24	18
** 50°	83	75	68	60	70	60	50	38	45	40	33	28
45°	85	78	72	65	73	64	55	45	50	46	41	35
40°	86	80	74	68	76	68	60	50	56	52	46	42
35°	87	82	76	72	78	70	63	55	60	56	52	47
30°	88	84	79	74	80	73	66	59	64	60	55	51
25°	89	85	81	76	82	75	69	61	66	63	59	55
20°	90	86	82	78	83	77	72	65	69	66	62	59
10°	91	88	84	80	85	80	75	69	73	70	66	64
0°	92	89	86	82	87	83	78	73	76	73	70	68
-10°	93	90	87	84	89	85	80	75	78	76	73	71
*- 20°	94	91	88	86	91	87	82	77	80	79	76	73
-30°	96	93	91	87	93	88	83	78	82	80	77	75
-40°	97	94	92	90	94	89	84	79	83	81	79	77

* Example, Page 1
** Example, Page 2

Table 3

PERCENTAGE OF CONDENSER TO BE FLOODED

Condensing units with compressor cylinder unloading (High suction condensing units ONLY)

CONDENSER FLOODING WITH NO UNLOADING %	PERCENT OF FULL COMPRESSOR CAPACITY			
	66-2/3%	50%	33-1/3%	20%
05	37	50	67	80
10	42	53	70	81
15	46	57	73	83
20	49	60	75	84
25	52	63	77	85
30	56	66	79	86
35	58	69	81	87
40	62	72	83	88
45	65	74	84	89
50	68	76	86	90
55	71	79	87	91
60	73	81	88	92
65	77	83	89	93
70	80	86	91	94
75	85	88	93	95
* 79	87	91	95	96
80	88	92	96	97
85	93	96	98	100

* Example, Page 1

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