MAKING MODERN LIVING POSSIBLE

Reliable System Performance
PM valves

REFRIGERATION &
AIR CONDITIONING DIVISION

Service guide

Contents **Page**

Introduction

Danfoss components are designed to give a high level of performance over an extended operating life.

When Danfoss develops its refrigeration components, deep consideration is given to functionality, operating performance, serviceability, and lifetime. Well-designed valves do not come by coincidence and experience counts.

Danfoss have more than 60 years of experience with design and manufacture of refrigeration valves, which assures reliable designs and a long operating life.

Mechanical components are subject to wear

Despite the best designs, it is well known that mechanical components experience wear. Operating conditions have a major influence on the expected life and performance of mechanical components.

The presence of system contaminants such as dirt, metal particles, moisture, and acids in refrigeration systems directly contribute to accelerated wear in mechanical components.

Wear can give reduced performance and reduced life
While the effects of normal wear are anticipated in valve design and construction, the presence of contaminants take effect depending on the type and concentration of contaminants over time.

Such contaminants will result in reduced valve performance and reduced life expectancy.

The value of preventive maintenance
The use of preventive maintenance procedures is an effective strategy for maintaing valve performance at a high level and assuring a full life expectancy.

Such procedures can include the appropriate use and cleaning of system filters and strainers. It can also include the use of moisture indicators and driers in systems succeptible to high water concentrations. These two procedures alone are significant steps towards protecting the system performance.

Maintaining a long lasting plant

Contaminants do not belong in refrigeration systems. However most refrigeration systems have some level of contamination and the level of contamination is important in determining required service intervals.

Water
Water is necessary for acid-salts to become active and aggressive. Strong acids can seriously damage the inside of valves and controls. Water in high concentations can freeze and clogg nozzles and filters. Water may enter into refrigeration systems when the system pressure is below the atmospheric pressure or when system are open during service or installation procedures.

Solid Contaminants
Solid contaminants found in refrigeration system can cause clogging of filters and nozzles. They can damage valve seats and sealing surfaces causing valve leakages.

They can even cause valves to fail by damaging finely machined working surfaces such as bearings and threads.

Contaminants in a refrigeration system may remain from the of original installation activities. For example, metal particles may be left behind from pipe grinding before welding or from pipes that were not properly cleaned before installation. Contaminants can also result from corrosion caused by water, acids or other chemicals in the system.

Experience shows that refrigeration systems free from contaminants are more reliable. Ideally all of these contaminants can be eliminated or prevented. Reality shows that few systems are completely clean and many have quite a high level of contamination.

Assuring long lasting performance

Danfoss recommends to always follow good installation practices and to create and use plant specific service manuals with indication of critical system components and service intervals.
Such routines keep the need for system service at a minimum level, and also minimise the cost of poor system performance and reduce the risk of system breakdowns.

A majority of installed refrigeration systems contain some level of contaminants. While these contaminants can be cleaned up and removed in many cases, it is possible that the refrigeration valves are not working at an optimal level. Sub-optimal valve performance can result in higher system operating costs, lower system performance, or higher risk of unexpected failures.

As a step in the preventive maintenance procedures, Danfoss recommends periodic valve inspection to insure optimal performance. The frequency of the valve inspection should directly consider the level of contamination in the system. This document contains some specific guidelines for evaluating service intervals.

Ultimately it is up to the refrigeration mechanic to diagnose the condition of the valves.
It is the refrigeration mechanic, who has the hands-on knowledge and experience to evaluate the condition of a system. The refrigeration mechanic should take the time to identify critical system components, with the purpose of making a plant specific service manual where inspection and service intervals are clearly defined.

Scheduling Service and Inspection
The ideal frequency of inspections and preventive maintenance intervals varies from system to system. However, experience shows that certain events or conditions influence the ideal length of time between inspections and service intervals.

These events or conditions are mentioned below:

- 3 months following a new system start-up
- Immediately prior to re-starting a system that has been idle for 6 months or more.
- Immediately prior to re-starting a system that has experienced a major component failure.
- Periodical inspection: Adjusted according to plant conditions.

Determining when inspection/service is needed

Use the tables below as a guide to determine the periodic intervals between valve inspections.

Please also refer to the inspection guide on issues to look for inside.

The findings of an inspection will result in a choice of which service set to use, provided any is needed.

- First the plant conditions table is used to determine the points.
  The points from each of the 5 questions are added.
- The plant condition points and water content level are then used in the table of recommended intervals together with the present moisture level.
  To determine the levels of moisture related to the refrigerant, please refer to the moisture reference table to get an idea of the water content level whether it is low, medium or high.

Recommended intervals given based on Danfoss experience and could be used as a general guideline. In each individual case different service intervals could applied, if necessary.

Plant condition table

Questions		Points	Application comment
1. Pulsations	None or low	0	Dry suction lines
	Moderate	2	Hot gas lines, Wet suction lines, pump lines, oil lines
	High	4	Economizer lines, Compressor discharge lines
2. Plant pressures	Above atm.pressure	0	
	Below atm.pressure	2	
3. Filtering	Mechanical filtering	1	
	Moisture removal	1	by molecular sieves or boiling off (air purger)
	No filtering	4	
4. Saturation	Dry gas	0	ex. dry suction line, hot gas line
	Pure liquid	1	ex. liquid line or condensate line
	Mixture of gas and liquid	2	ex. wet suction line
5. Stand still periods	Long >one month	4	Danger of rust formations
	Short <one month	2	Sediments occurs
	Continous operation	0	Valves remain quite clean inside

*Definition of water content *)*

		Low	Medium	High
R717	[%]	< 0.5	0.5 - 1	> 1
HFC	ppm	< 60	60-100	> 100
HCFC	ppm	< 30	30-100	> 100
CO_2	ppm	< 15	15-55	> 55

*) **Note:** PM valves are not recommended for hydrocarbons

Recommended intervals [years] between inspections

		Water		
		Low water content	Medium water content	High water content
Plant Conditions	1-6	5	4	3
	7-11	4	3	2
	12-16	3	2	1

Service kits

A	Inspection	Open/close - complete set of gaskets
B	Maintenance	Most worn parts
C	Overhaul	All wearparts
D	Replacement	Valve replacement

Example

Please refer to the principle drawing of a meat processing plant:

Two stage plant with pump circulation:

Refrigerant:	R22
Suction pressure:	–35°C
Pump separator liquid temperature:	–30°C
Intermediate suction pressure:	–10°C
Liquid temperature:	+35°C

After half a year the owner wants to determine when to service the critical system components, i.e. the PM valves in the system.

There are PM valves on two applications in the system:

- in the wet suction line, from the freezing tunnels (pos. 15)
- in the dry suction line to the economizer port (pos. 12).

The liquid temperature after the condenser is 35°C (95°F) and the colour of the SGN element shows an intermediate colour between green (dry) and yellow (wet) so from the SGN tables the moisture content must be in the range 40-160 ppm which corresponds to medium water content.

Because the liquid temperature is –30°C (-22°F) and the dry suction to the compressors are –35°C (-31°F) the plant pressure is higher than atmospheric pressure (R22 has a boiling point of –40.76°C (-41.37°F) at standard atm. pressure).

The plant has mechanical filtering, but no molecular sieves to remove moisture.

The plant is running continuously by the air coolers (in the process). The compressors have stand still periods to distribute running hours between them.

Based on this information it is now possible to fill in the tables as follows:

Refer to table on previous page	Valve type 1	Valve type 2
Q.1: Pulsations	0	4
Q.2: Plant pressures	0	0
Q.3: Filtering	1	1
Q.4: Saturation	2	0
Q.5: Stand still periods	0	2
Total points	3	7

Water content	Low	Medium	High
HFC [ppm]	<60	60-100	>100

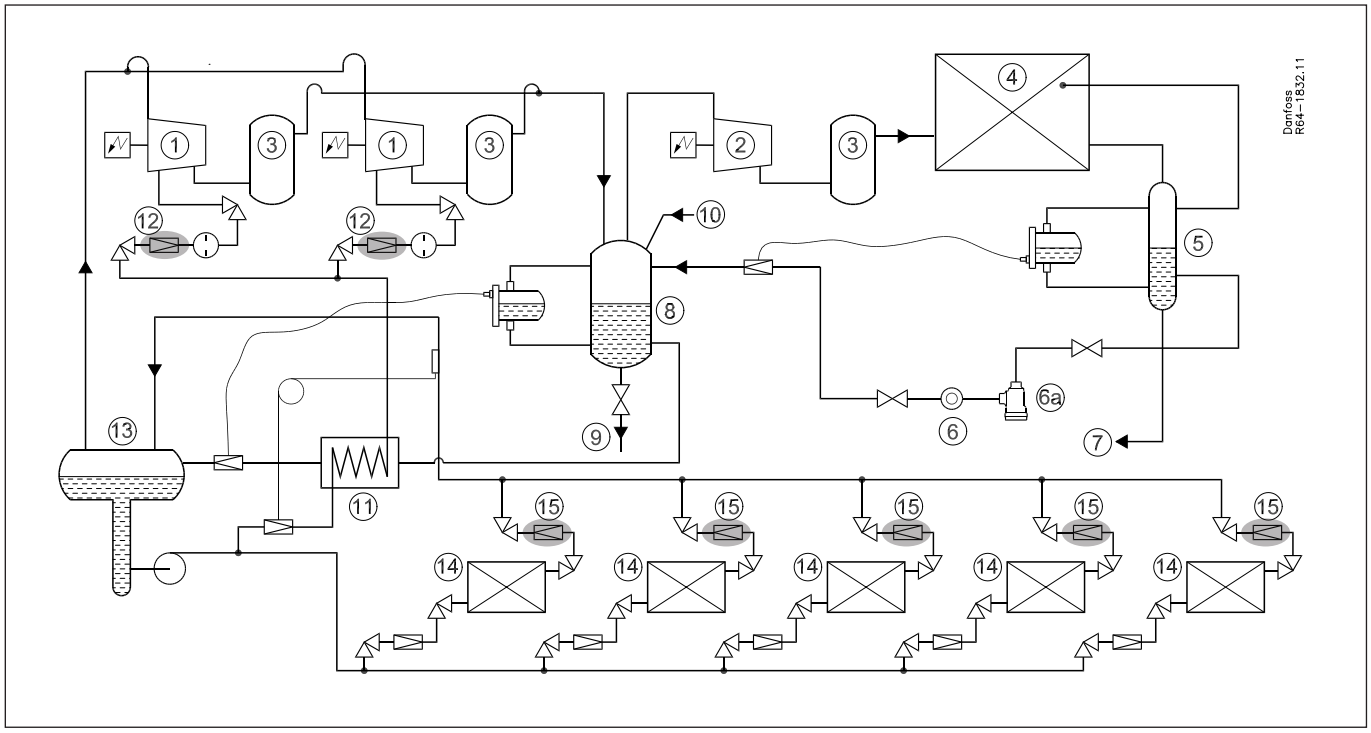
The table with recommended intervals then recommends an opening of valve type 1 after 4 years of total plant operation and valve type 2 after 3 years of compressor running (taken from the compressor hour counters).

If the valve(s) type 2 are submitted to a high level of vibrations by the other running compressors it could be a consideration to use the plant running hours instead of the compressor running hours. The issue being fretting corrosion inside the PMs.

1. LP-compressors
2. HP-compressors
3. Oil separators
4. Evaporative condenser
5. Liquid trap arrangement
6. SGN moisture indicator in MLI element

6a. FIA mechanical filter

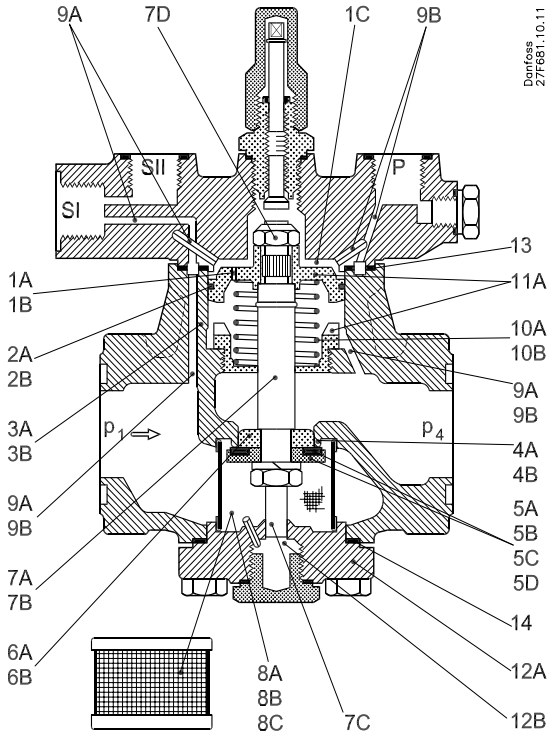
7. To oil compressor cooling
8. Intermediate pressure vessel
9. To intermediate pressure consumers (–10°C / 14°F)
10. From intermediate pressure consumers
11. Subcooler
12. PM valve type 2 - economizer port
13. Pump separator (–30°C / –22°F)
14. Freezing tunnel cooler
15. PM valve type 1 - wet suction line



The drawing is for explanatory purpose only

Inspection guide

The table below is useful as a checklist when performing PM valve inspections.
The primary checkpoints are listed along with different fault options that are known to occur by experience..
A picture of the component in new condition is shown as a reference. Varying degrees of deterioration are referenced.
If one of these conditions is observed the approriate service kit is shown in the top of the table.
For example, only the inspection kit is required for a valve found with acceptable conditions. On the other hand a valve found with damage to the lower seat, rebuild kit B is required.



			Kit to be used				
PM - part	Check for :	Pos. number on the drawing	A	B	C	D	Remark
Piston	Scoring	1A			Heavy		
	Rust	1B	Clean		Heavy		
	Blockage of bleed hole	1C	Clean				
Piston ring	Breakage	2A		X	X		
	Scoring	2B	Light-increase inspections	Heavy	Heavy		
Cylinder wall	Scoring	3A	Light-increase inspections			Heavy	Do not use sandpaper or similar
	Rust	3B	Light-clean carefully			Heavy	
Valve seat	Marks	4A				Heavy	
	Cavitation	4B	Light-increase inspections			Heavy	
Valve plate	Marks	5A	Machine using lathe	Heavy	Heavy		Results in leakage over seat
	Chips & particles	5B	Machine using lathe	Heavy	Heavy		Results in leakage over seat
	Fractures	5C		X	X		
	Deforming	5D		X	X		
Cone	Wear	6A	Light-increase inspections		Heavy		Looks like sand-blasting
	Cavitation	6B	Light-increase inspections		Heavy		Looks like very small holes - barely visible
Spindle (pushrod)	Wear	7A			Heavy		Looks like sand-blasting
	Cavitation	7B	Light-increase inspections		Heavy		Looks like very small holes - barely visible
	Bending	7C			Change		Measure using lathe
	Damage to thread	7D			Change		Bolt could also be damaged
Filter	Particles	8A	Clean				
	Deforming	8B			Change		
	Rust	8C	Clean		Heavy		
Pilot holes	Blockage	9A	Clean				
	Rust	9B	Clean				
Spring	Breakage	10A				X	
	Corrosion	10B	Clean			Heavy	
Intermediate plate	Rust	11A	Clean		Heavy		
Bottom plate	Particles	12A	Clean incl. house inside				
	Wear af guide hole	12B	Light-increase inspections			Heavy	

Inspection guide *(Continued)*

Inspection set A:

Consist of: Top gasket (13) Bottom gasket (14) Flange gaskets	Size	**Code no.** Both cone types
	5	027F3241
	10	
	15	
	20	
	25	
	32	027F3242
	40	027F3243
	50	027F3244
	65	027F3245
	80	027F3246
	100	027F3247
	125	027F3248

Maintenance set B:

Consist of: Top gasket (13) Bottom gasket (14) Flange gaskets Piston ring (2) Valve plate (5)	Size	**Code no.** Both cone types
	5	**027F3250**
	10	
	15	
	20	
	25	
	32	**027F3251**
	40	**027F3252**
	50	**027F3253**
	65	**027F3254**
	80	**027F3255**
	100	**027F3256**
	125	**027F3257**

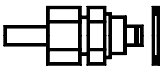
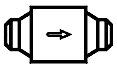
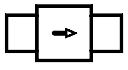
Overhaul set C:

Consist of: Top gasket (13) Bottom gasket (14) Flange gaskets Piston (1) Piston ring (2) Pushrod complete (4-7) Spring (10) Gaskets and o-rings for pilot valves (3 sets)	Size	**Code no.** Standard cone	**Code no.** V-cone
	5	**-**	027F3259
	10	**-**	027F3260
	15	**-**	027F3261
	20	**027F3262**	-
	25	**027F3263**	-
	32	**027F3264**	027F3271
	40	**027F3265**	027F3272
	50	**027F3266**	027F3273
	65	**027F3267**	027F3274
	80	**027F3268**	027F3275
	100	**027F3269**	027F3276
	125	**027F3270**	027F3277

The set of o-rings (027F1004) for the pilot valves is not included in to kits A and B and should be ordered separately.

Replacement Valve set D:

Set "D" Consist of: Valve complete Flange gaskets	Size	**Code no.** PM 1, std cone	**Code no.** PM 1, V-cone	**Code no.** PM 3, std cone	**Code no.** PM 3, V-cone
	5	**-**	**027F3001**	**-**	**027F3010**
	10	**-**	**027F3002**	**-**	**027F3011**
	15	**-**	**027F3003**	**-**	**027F3012**
	20	**027F3004**	**-**	**027F3013**	**-**
	25	**027F3005**	**-**	**027F3014**	**-**
	32	**027F3006**	**027F1936**	**027F3015**	**027F1945**
	40	**027F3007**	**027F1937**	**027F3016**	**027F1946**
	50	**027F3008**	**027F1938**	**027F3017**	**027F1947**
	65	**027F3009**	**027F1939**	**027F3018**	**027F1948**
	80	**-**	**-**	**027F1271**	**027F1930**
	100	**-**	**-**	**027F1272**	**027F1931**
	125	**-**	**-**	**027F1273**	**027F1932**

Accessories for PMC		Description	Qty	Code no.
		**External pilot connector** Weld, PM 5 to 65, ID 12.7 mm/OD 18 mm Weld, PM 80 to 125, ID 12.7 mm/OD 18 mm $^1/_4$ NPT, PM 5 to 65 $^1/_4$ NPT, PM 80 to 125		
		Nipple assembly	1	**027F1048**
		Damping orifice, dia. 1.0 mm	1	**027F1049**
		O-ring	1	**027B2065**
		Gasket	1	**027B2066**
		**Seal kit for external pilot connector**		**027F1004**
		Alu gasket	4	
		Gasket	4	
		O-ring	4	
		**Blanking plug**		**027F1046**
		Plug	1	
		Stop plug	1	
		O-ring	1	
		Gasket	1	
		**Pressure gauge connector**, solder/weld		**027F2035**
		Nipple assembly	1	
		Alu gasket	1	
		**Seal kit** for solder/weld pressure gauge connector		**027B2029**
		Alu gasket	10	
		Alu gasket	10	
		**Pressure gauge connector** cutting ring connector		
		6 mm	1	**027B2063**
		10 mm	1	**027B2064**
		**Pressure gauge connector**, $^1/_4$ NPT	1	**027B2062**
		**Pressure gauge connector**, flare		**027B2041**
		(Must not be used in ammonia systems!)		
		Nipple	1	
		Schraeder valve	1	
		Cap	1	
		Alu gasket	1	
		**Function indicator** for PM/PMC 1 and 3, sizes 5 to 65		**027F0085**
		Function indicator assembly	1	
		Gasket	1	
		**CVH pilot valve body** weld ID 12.7 mm/OD 18 mm	1	**027F1047**
		**CVH pilot valve body** G $^1/_4$ (ISO 228-1)	1	**027F1160**
		CVH pilot valve body G $^1/_4$ (USAS B2.1-1960)	1	**027F1159**
		**„Strong" spring** for PM 1 and 3, sizes 5 to 25, approx. 45% more closing force	1	**027F0662**
		Manual opening device for PM and ICS25-65 (stainless steel, square), including cap	1	**027F2130**