

## Supporting documentation for non-default M<sub>R</sub> values

### Background

Norrenergi's handling of refrigerants seeks to minimize the environmental impact regarding ozone depletion and greenhouse gas effect. Norrenergi phased out refrigerants harmful to the ozone layer. Current the greenhouse gas effect from refrigerant emissions continues to

### Example

Below is an example of an executed refrigerant discharge of heat pump VP1 at Norrenergi's plant Solnaverket in Solna 2018-08-13.

Emptying VP1					
Date/time	Heat pump pressure	Refrigerant tank pressure	Tank weight	Comment	Refrigerant left in heat pump (kg)
	Mpa(a)	Mpa(a)	Kg		kg
2018-08-13					
06:30	0,57	0,51	2600	Start	
06:45	0,51	0,51	2750	Pressure equalized	
07:00	0,51	0,51	2750	Start emptying liquid	
08:00	0,51	0,51	8950		
09:00	0,51	0,51	15150		
10:00	0,51	0,51	21300	Start emptying gas phase	
11:00	0,40	0,60	20400		
12:00	0,30	0,63	20600		
13:00	0,25	0,68	20700		
14:00	0,21	0,72	20800		
15:00	0,17	0,75	20900		
16:00	0,14	0,76	21300		
17:00	0,11	0,76	22550		
18:00	0,08	0,70	22590		200
19:00	0,06	0,68	22638		152
20:00	0,04	0,66	22688		102
21:00	0,03	0,65	22712		78

22:00	0,02	0,64	22734		56
23:00	0,01	0,63	22760		30
2018-08-14	0,009	0,60	22765		25
01:00	0,007	0,60	22770		20
02:00	0,005	0,60	22775		15
03:00	0,003	0,60	22781		9,5
04:00	0,002	0,60	22784		6,3
05:00	0,001	0,60	22787		3,4
06:00	0,0005	0,60	22790	Emptying complete	1,9

### Conclusion

The residual amount of refrigerant after emptying is very small due to the very low pressure in the heat pump at the end of the discharge operation. At 0,005 Mpa (0,05 bar) only 1,9 kg of refrigerant remains in the heat pump. 1,9 kg represents only 0,01 percent of total refrigerant installed in the system.