

## Checklist for the commissioning of R744 booster systems

<b>Check pressure strength and tightness, mount pressure relief valves: Pressure and tightness test only with dehydrated nitrogen, not with air or oxygen!</b>		
<ul style="list-style-type: none"> <li>▪ Compressor:               <ul style="list-style-type: none"> <li>– Was already subjected to a pressure strength test at the factory. A tightness test is sufficient.</li> <li>– Test pressures must not exceed the maximum values on the compressor name plate! Distinguish between the high and low pressure sides!</li> </ul> </li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Piping:               <ul style="list-style-type: none"> <li>– Pressure strength according to EN 378-2: MOP x 1.43 or min. 1.1 ( ≥ category II) // subsequent EN12799 (brazed joints), EN12517 (welded joints).</li> </ul> </li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Decouple, shut-off or isolate individual system sections, record (measure) pressure and temperature.</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Mount the pressure relief valves:               <ul style="list-style-type: none"> <li>– HP, MOP _____ Serial number(s): _____</li> <li>– MP, MOP _____ Serial number(s): _____</li> <li>– MT LP, MOP _____ Serial number(s): _____</li> <li>– LT LP, MOP _____ Serial number (s): _____</li> </ul> </li> </ul>		<input type="checkbox"/>
<b>Fill oil into oil separator and oil reservoir:</b>		
<ul style="list-style-type: none"> <li>▪ Use BSE85K (POE) or BSG68K (PAG) oil, do not mix POE and PAG oil!</li> <li>▪ BSE60K oil is not permitted for compressors in the low temperature compressor stage in booster systems!</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Document the oil type and oil charge.</li> </ul>		<input type="checkbox"/>
<b>Install filter drier cartridges:</b>		
<ul style="list-style-type: none"> <li>▪ Model 48-DM</li> </ul>		<input type="checkbox"/>
<b>Evacuate:</b>		
<ul style="list-style-type: none"> <li>▪ It is difficult to dry systems merely by evacuating. Evaporating water by evacuation is time-consuming. Therefore: Break the vacuum of 20 mbar 2–3 times with dehydrated nitrogen during the evacuation process.</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Avoid ice formation in the system (triple point) – no temperatures below 0°C!</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Recommendation for "standing" vacuum: Approx. 0.7 mbar (500 microns).</li> </ul>		<input type="checkbox"/>
<b>Switch on the oil heater(s): (Do not switch on the compressor!):</b>		
<ul style="list-style-type: none"> <li>▪ Oil sump temperature(s) should be at 35-40°C, but at least 20 K above the ambient temperature.</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Check the oil level in the compressor.</li> </ul>		<input type="checkbox"/>
<b>Break vacuum with gaseous R744:</b>		
<ul style="list-style-type: none"> <li>▪ Connect R744 refrigerant cylinder with pressure reducer and suitable filling lines to the system.</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Evacuate filling lines or flush with gaseous R744.</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Open the filling connection and break the vacuum with gaseous R744 up to approx. 10 bar (-40°C).</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Use pressure reducer while extracting gaseous R744 from cylinders (no extraction through dip pipe).</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ If the refrigerant cylinder cools down considerably, heat the cylinder in a water bath at max. 40°C!</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Close the discharge and suction gas shut-off valves of the compressors in the medium and low temperature compressor stages.</li> </ul>		<input type="checkbox"/>
<b>Check safety and control components:</b>		
<ul style="list-style-type: none"> <li>▪ Connect laptop to compound controller (FRIGO DATA, Plant Visor, Service Tool, etc.).</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Switch the compound control digitally to "on". Load circuits of the compressors remain switched off.</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Calibrate pressure transducer and temperature sensor.</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Signal tests on the analogue and digital inputs and outputs.</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Check temperature sensor assignment (cold spray).</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ If necessary, check arrangement of the wiring and electrical connections.</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Check correct mounting of the temperature sensor on the gas cooler.</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Check correct mounting of pressure transducers and temperature sensors on the evaporators.</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Check the rotation direction of the gas cooler fan.</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Check the rotation direction of the evaporator fan.</li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Check the parameters of the superheat controller at the evaporators.               <ul style="list-style-type: none"> <li>– Activate protection function "Close expansion valves at MOP and minimum superheat".</li> <li>– Set/check parameters for MOP.</li> <li>– Set/check parameter for minimum superheat.</li> </ul> </li> </ul>		<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Check the parameters of the suction pressure control on the compound regulator.               <ul style="list-style-type: none"> <li>– Allow for short time delays for the compressors during the initial commissioning phase.</li> </ul> </li> </ul>		<input type="checkbox"/>

<b>Further charging with refrigerant</b> (small to medium-sized systems) → Not for systems with large capacities and long piping distances between evaporators and compressors.	
▪ Set the evaporators digitally to "off".	<input type="checkbox"/>
▪ Close the shut-off valves at the outlet of the intermediate pressure vessel.	<input type="checkbox"/>
▪ Continue charging the system with liquid R744 into the intermediate pressure vessel. Do <u>not</u> use a pressure reducer when removing liquid R744 from cylinders! If necessary, switch on standstill cooling.	<input type="checkbox"/>
▪ Before the first evaporator goes into operation, the minimum liquid level in the intermediate pressure vessel must be reached.	<input type="checkbox"/>
▪ Stop filling the intermediate pressure vessel at 30 bar (depending on the design (MOP) of the system at this pressure level) and ensure that the pressure remains below the set point for the flash gas bypass valve.	<input type="checkbox"/>
<b>Commissioning:</b>	
▪ Open the discharge, suction and oil shut-off valves of the compressors, switch on the compressor load circuit.	<input type="checkbox"/>
▪ Switch the compressor to "automatic mode" ready for operation.	<input type="checkbox"/>
▪ Slowly open the liquid line shut-off valve from the intermediate pressure vessel.	<input type="checkbox"/>
▪ Start up the evaporators of the medium temperature application one after the other in "automatic mode".	<input type="checkbox"/>
– Note the capacity of the evaporator(s) in relation to the capacity of the compressor! Switch on the load in 3 to 5 steps in proportion to the nominal evaporator capacity.	<input type="checkbox"/>
– After commissioning the evaporator(s), wait to see how the control parameters change and adjust.	
– Observe the following parameters: High pressure Intermediate pressure Suction pressure of medium temperature compressor stage Suction pressure of low temperature compressor stage Suction gas temperature of medium temperature compressor stage Discharge gas temperature of medium temperature compressor stage Opening degree of high pressure control valve Opening degree of flash gas bypass valve Superheat and opening degree at the evaporators	<input type="checkbox"/>
– Reduce the room/refrigerated display cabinet temperature to approx. 10° to 8°C before the next group of evaporators is switched on.	<input type="checkbox"/>
▪ Start up the low temperature application evaporators one after the other. Process is the same as that previously described.	<input type="checkbox"/>
– Reduce the room/refrigerated display cabinet temperature to approx. -5°C° to -10°C° before the next group of evaporators is switched on.	<input type="checkbox"/>
→ Adjust/supplement refrigerant charge as required.	<input type="checkbox"/>
<b>After successful commissioning of the system, check the operating data and create a data protocol:</b>	
▪ Operating temperatures.	<input type="checkbox"/>
▪ Evaporation and condensing temperatures.	<input type="checkbox"/>
▪ Suction gas temperature.	<input type="checkbox"/>
▪ Discharge gas temperature > 50°C (40°C).	<input type="checkbox"/>
▪ Oil temperature > 30°C (20°C).	<input type="checkbox"/>
▪ Cycling rate.	<input type="checkbox"/>
▪ Medium temperature compressor stage: Min. time for one start-up and shut-off: 10 min.	<input type="checkbox"/>
▪ Low temperature compressor stage: Min. Operating time: 2 min.	<input type="checkbox"/>
▪ Maximum number of compressor starts per hour:	<input type="checkbox"/>
– Medium temperature compressor stage: 6	
– Low temperature compressor stage: 8	
▪ Voltage and operating current in all three phases.	<input type="checkbox"/>
▪ Filter change:	
– Suction gas filter and filter dryer after max. 200 h.	<input type="checkbox"/>
– Oil separator after 24..48 h.	<input type="checkbox"/>

To avoid heavy contaminations in the systems observe the following instructions after commissioning:	
<ul style="list-style-type: none"> <li>▪ Coalescence filter elements of oil separators are fine separators and replaced elements should be checked for contamination. To do this, cut off the end caps of the elements on one side and cut through the center of the cartridge to assess residues in the individual filter layers.</li> </ul>	<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ If the coalescence filter elements are heavily soiled, repeat the process after 24 to 48 hours.</li> </ul>	<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ The degree of contamination of the suction gas filters or filter drier inserts used on the suction side of the systems should not be assessed on the basis of a lowered evaporation temperature, as the pressure levels at R744 are high and the mesh size of the wire meshes are usually between 250 and 100 <math>\mu\text{m}</math>.</li> </ul>	
<ul style="list-style-type: none"> <li>▪ The use of newly developed suction filter inserts with a small mesh size is helpful to reduce the degree of contamination in the systems.</li> </ul>	<input type="checkbox"/>
<ul style="list-style-type: none"> <li>▪ Particularly in the case of large, widely branched pipe networks, residues are only returned from the system via the suction side after the first phases under full load.</li> </ul>	
<ul style="list-style-type: none"> <li>▪ For all filter elements used, a high degree of contamination leads to a significant drop in pressure and can lead to the destruction of the filter element!</li> </ul>	
<ul style="list-style-type: none"> <li>▪ In ISO 4406, all particles that are equal to or larger than 4 <math>\mu\text{m}</math> are cumulated and counted per 100 ml. The defined classification of all particles is based on particle sizes <math>\geq 4 \mu\text{m}</math>, <math>\geq 6 \mu\text{m}</math>, <math>\geq 14 \mu\text{m}</math>. The turbine oil category is generally used for compressors in refrigeration technology. The key of this category is 20 / 17 / 14 and results in accordance with ISO 4406 to:               <ul style="list-style-type: none"> <li>- max. 500.000 .. 1.000000 <math>\geq 4 \mu\text{m}</math></li> <li>- max. 64.000 .. 130.000 <math>\geq 6 \mu\text{m}</math></li> <li>- max. 8.000 .. 160.000 <math>\geq 14 \mu\text{m}</math></li> </ul> </li> </ul>	