

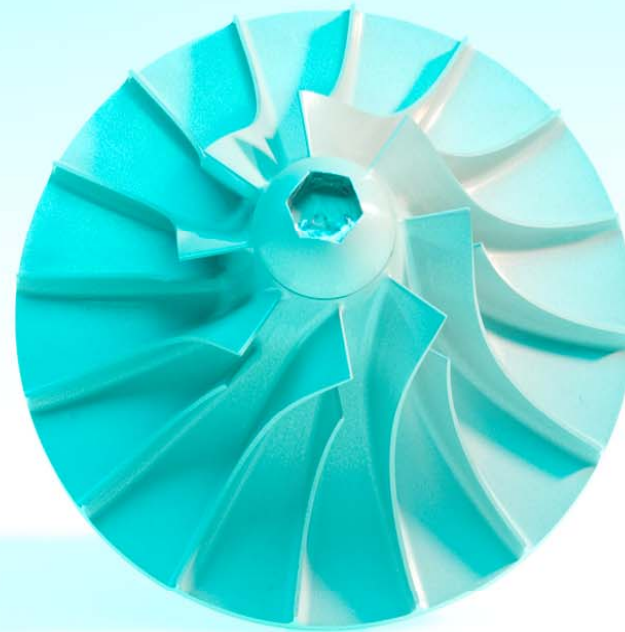
A Member of  
The Linde Group

**KRYOTECHNIK**

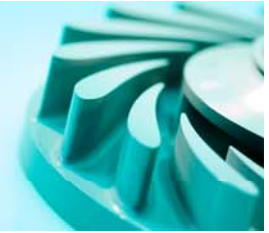
Linde Kryotechnik AG  
Ohlig / Clausen  
September 28<sup>th</sup>, 2009  
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Klaus Ohlig / Jürgen Clausen  
Berne, September 28, 2009

## **ITER For Swiss Industry** Linde Kryotechnik AG's Expertise & Involvement

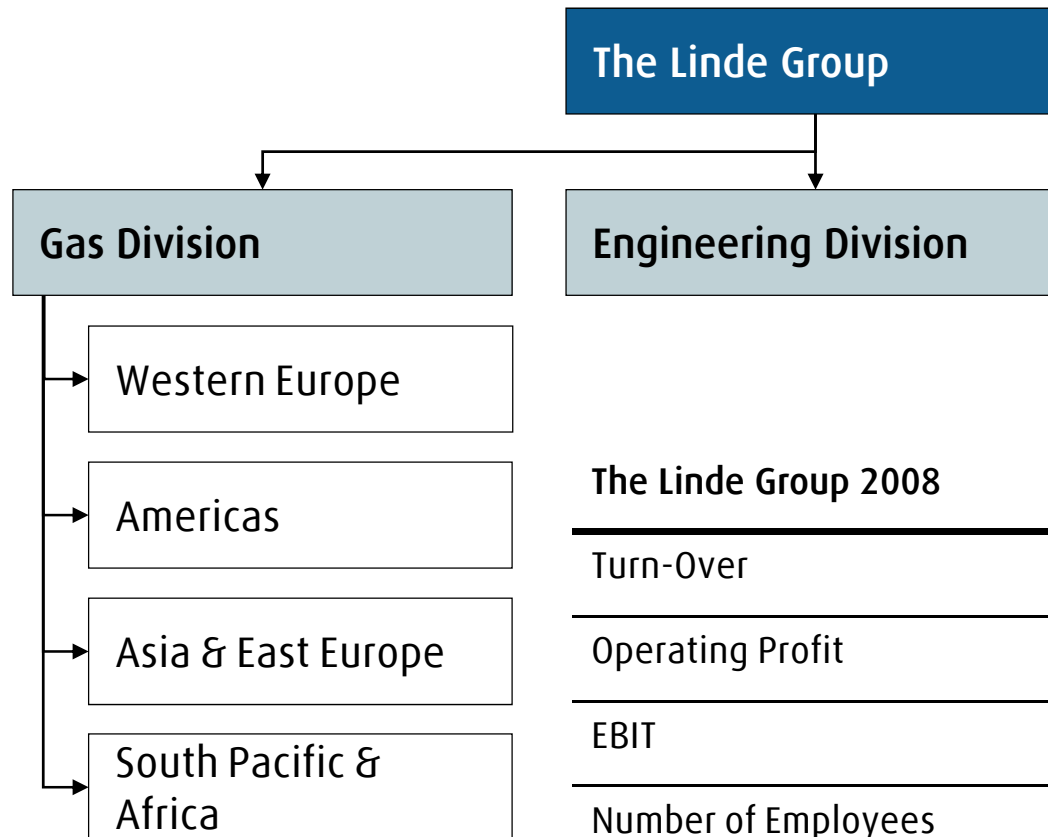


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# The Linde Group



## The Linde Group 2008

Turn-Over	12,663	€ million
Operating Profit	2,555	€ million
EBIT	1,391	€ million
Number of Employees	51,908	



### Olefine Plants

- Ethylene
- Propylene
- Butadiene
- Aromatics
- Polymers



### Natural Gas Plants

- LNG
- NGL
- IFC
- Helium



### Air Separation Plants

- Oxygen
- Nitrogen
- Rare Gases



### Hydrogen and Synthesis Gas Plants

- H<sub>2</sub>/CO/Synthesis Gas
- Gas Separation
- Gas Purification

Linde Kryotechnik AG, Switzerland,  
is a member of  
Linde Engineering

# Linde Kryotechnik AG

## Product Range



### Helium Solutions

Purification - Liquefaction -  
Reliquefaction - Refrigeration Systems



### Hydrogen Solutions

Purification - Liquefaction



### Special Solutions

Special Cryogenic Plant Engineering



### Storage and Distribution Solutions

Distribution Systems - Storage Tanks -  
Dewars

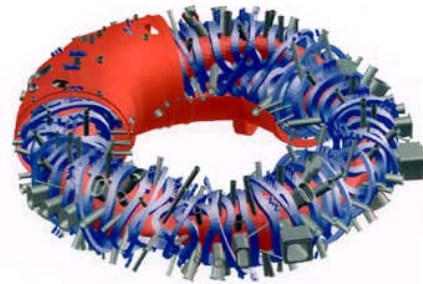


### Customer Service Solutions

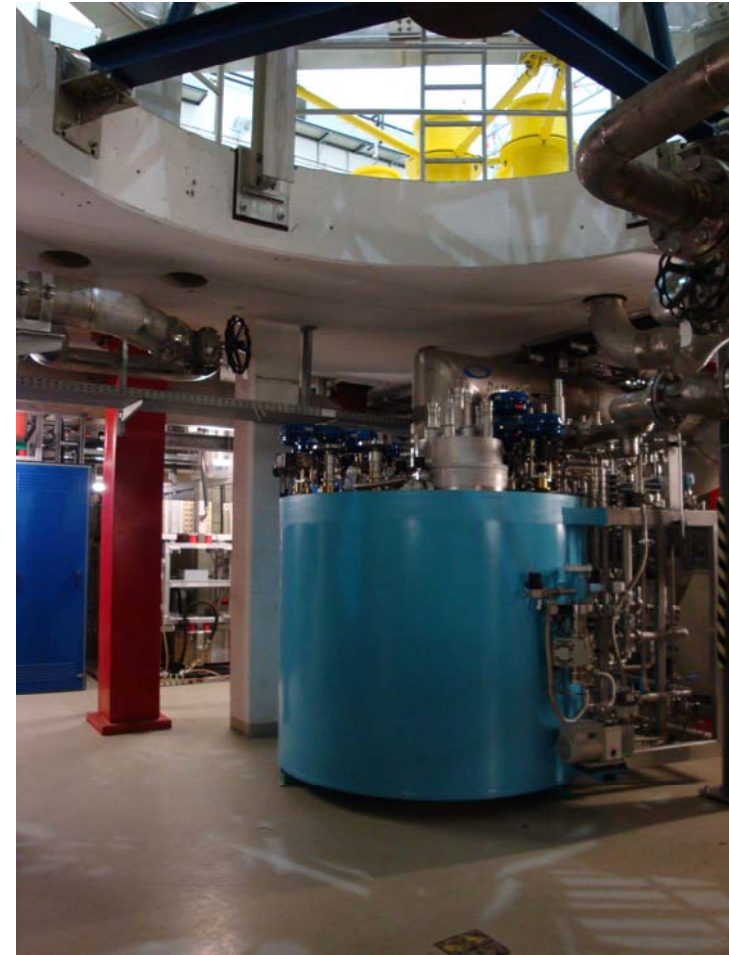
Installation & Maintenance - System Operation-  
Refurbishment - Spare Parts

# Selected References

## Fusion Experiment Wendelstein 7-X



Fusion Experiment Wendelstein 7-X



# Selected References

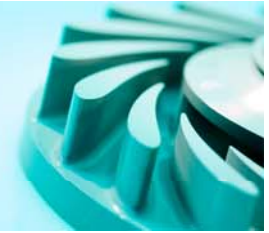
## Wendelstein 7-X



MPI Greifswald - Wendelstein 7-X		MPI Greifswald - Wendelstein 7-X	
<b>General information of project</b>		<b>Process Data</b>	
<ul style="list-style-type: none"> <li>Technical feasibility study Linde Start 1997</li> <li>Placing the order at Linde End of 2003</li> <li>Scope of work Turnkey</li> <li>Scheduled handover Mid of 2009</li> <li>Present state of project Commissioning</li> </ul>		<ul style="list-style-type: none"> <li><b>General</b></li> <li>Exergetic equivalent refrigeration capacity 7 kW @ 4.5 K</li> <li>Max. electrical power consumption 1.64 MW</li> <li>Consumers of cryogenic power in W7-X               <ul style="list-style-type: none"> <li>Coils</li> <li>Coil support structure</li> <li>Current leads</li> <li>Heat radiation shield of the W7-X cryostat</li> <li>Divertor cryo-vacuum pumps</li> <li>Shields for the divertor cryo-vacuum pumps</li> </ul> </li> <li>Automation level / Main operation modes               <ul style="list-style-type: none"> <li>Standard refrigeration</li> <li>Peak power refrigeration</li> <li>Short standby refrigeration</li> <li>Long standby refrigeration with/without liquefaction</li> <li>Warming up cold plant</li> <li>Warming up W7-X</li> </ul> </li> <li>Cool-down time of W7-X from ambient temperature &lt; 2 weeks</li> </ul>	
<b>Technical equipment</b>		<b>Compressor unit</b>	
<b>Machines 14</b>		<ul style="list-style-type: none"> <li>Max. 1st stage compressor shaft power 600 kW</li> <li>Max. 2nd stage compressor shaft power 1250 kW</li> <li>1st stage compressor discharge pressure 5.35 bara (peak power refrigeration mode)</li> <li>2nd stage compressor discharge pressure 17.5 bara (short standby refrigeration mode)</li> </ul>	
<ul style="list-style-type: none"> <li>Warm screw compressors 2</li> <li>Expansion turbines 7</li> <li>Cold compressors 2</li> <li>Cold circulators 4</li> </ul>		<b>Plate fin heat exchanger</b>	
<b>Plate fin heat exchangers 10</b>		<ul style="list-style-type: none"> <li>Min. heat transfer rate of one plate fin heat exch. 0.94 kW (cooling from 5.4 to 4.5 K) *</li> <li>Max. heat transfer rate of one plate fin heat exch. 686 kW (cooling from ambient temp. to 93 K) *</li> <li>* standard refrigeration mode</li> </ul>	
<ul style="list-style-type: none"> <li>Max. block length / volume / weight 4.75 m / 3.56 m<sup>3</sup> / 4'100 kg</li> </ul>		<b>Helium process</b>	
<b>Measuring device 404</b>		<ul style="list-style-type: none"> <li>Lowest Helium temperature 3.3 K (supercritical Helium)</li> <li>Helium separators temperature 3.3 K @ 0.366 bara</li> <li>3.8 K @ 0.662 bara</li> <li>4.4 K @ 1.19 bara</li> <li>Helium filling capacity 2.7 tons (@ 15 bara in buffer-tanks)</li> </ul>	
<ul style="list-style-type: none"> <li>Temperature sensors 166</li> <li>Pressure &amp; differential pressure sensors 201</li> <li>Flowmeasurement 37</li> </ul>			
<b>Valves 998</b>			
<ul style="list-style-type: none"> <li>Warm &amp; cold manual on/off valves 758</li> <li>Warm pneumatic control &amp; on/off valves 92</li> <li>Cold pneumatic control valves 80</li> <li>Safety valves 68</li> </ul>			
<b>Coldboxes 4 (+2 testboxes)</b>			
<ul style="list-style-type: none"> <li>Coldbox 1 ø 3.2 m, length 5.6 m / 45 m<sup>3</sup></li> <li>Coldbox 2 ø 3.2 m, length 6.2 m / 50 m<sup>3</sup></li> <li>Sub-cooler box ø 2.3 m, length 6.5 m / 27 m<sup>3</sup></li> <li>Magnet valve box ø 2.0 m, length 1.6 m / 5 m<sup>3</sup></li> </ul>			
Helium purification-system with 3 coalescers in serial, 1 oil adsorber			
2 alternating adsorbers for moisture (dryer)			
2 alternating adsorbers @ 80 K, 1 adsorber @ 20 K			
Transferlines 5 lines, the longest with ca. 54 m / DN400			
Quenchline ca. 134 m / DN 200			

# Selected References

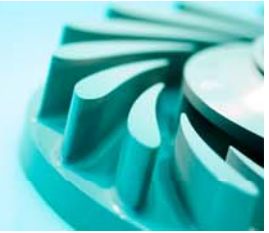
## CERN LHC Linde Helium Plants





# Selected References

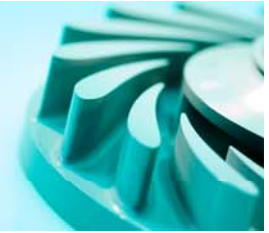
## CERN LHC Linde 18 kW He Refrigerator Plant






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# ITER Cryogenics Procurement Package Cryo Plants



34 - CRYOPLANT & CRYODISTRIBUTION		
2	Cryolines	
3	Cryodistribution Components	
34-1	Cryoplant	

## Linde interest in:

- Procurement package 34-1 Cryoplants

## Example: 4 boxes



### Supply of Cryo Plants for the ITER project is characterized by:

- TKLS approach, i.e. engineering, supply & installation
- total contract volume in the range of approx. € 150 to 200 million

### Linde Kryotechnik AG is a company with

- an annual sales of approx. € 40 million,
- excellent expertise in cryogenics, but
- limited TKLS capability for project with size of ITER Cryo-plants

### Special and dedicated approach to project execution required reflecting

- cryogenic expertise of Linde Kryotechnik AG
- TKLS expertise of experienced engineering company
- construction expertise of contractor

# ITER Cryogenics

## Linde Kryotechnik Scope of Supply



### Cryo Plants

- Conceptual design
- Process design
- Basic and detailed plant engineering
- Fabrication of cryogenic coldboxes
- Procurement of compressors & auxiliary systems
- Supply of cryogenic refrigeration/liquefaction systems
- Erection and installation supervision
- Commissioning and start-up
- Operation and maintenance

# Linde Kryotechnik AG

## Contact



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Ohlig / Clausen  
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**Thank you for your attention.**

