

seismic research

compressor systems for
seismic exploration



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your high pressure solution



company profile

LMF is the leading Austrian manufacturer of high-pressure piston compressor systems for air, natural gas, technical and industrial (process) gases.

These systems, with power rates from 20 to 6,200 kW (30 to 8,300 hp) and for pressures of up to 700 bar (10,150 psi), are designed and manufactured in accordance with internationally applicable standards.

LMF has over 60 years of experience in the production of compressors and offers its customers the benefits of the latest developments in design engineering, proven manufacturing methods, testing under full load, installation and after sales service, all from a single source.

GEOGRAPHICAL POSITION

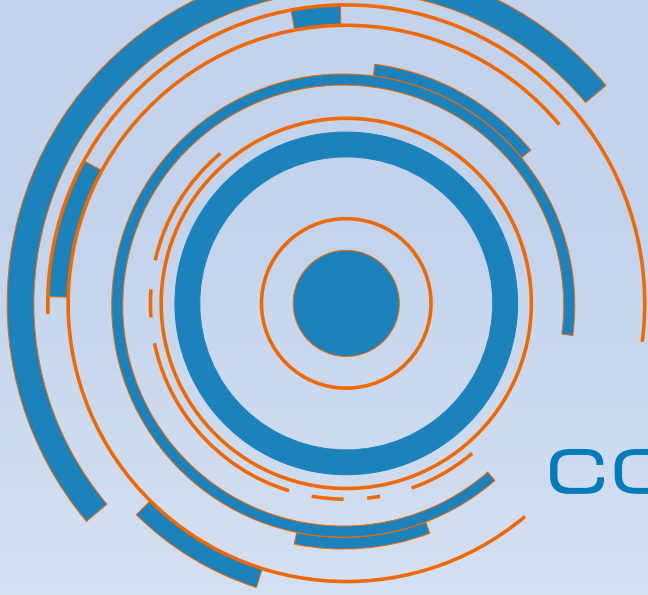
Leobersdorf is located approx. 30 km south of the capital of Austria, Vienna, and has direct access to the freeways, both to the city of Vienna and to the Vienna International Airport.

LMF Headquarters in Leobersdorf, Austria

LMF is well known worldwide as the manufacturer of:

- API 11P/API 618 Compressors (chemical and petrochemical industry)
- Compound compressor systems (mobile and stationary) for seismic research
- Compressors for many types of industrial applications
- CNG/CBG-systems





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basic designs

SEISMIC EXPLORATION

is provided with air-gun systems (offshore). As energy sources high pressure compressors are in use.

The requirements for the compressors are, besides efficient performance,

- low maintenance costs
- availability
- small dimensions and
- low weight

LMF offers a wide range of capacities up to 78 m³/min (2,755 cfm) and working pressures up to 350 bar (5,076 psi) in stationary, portable and mobile design for offshore operation with electric motor or diesel engine as prime mover.

2 TO 6 M³/MIN (70 TO 212 CFM)

CAPACITY:

Air-cooled piston compressors designed for continuous operation.

8 TO 20 M³/MIN (282 TO 706 CFM)

CAPACITY:

Water-cooled piston compressors in cross-head design, combined with blower type feed compressors for minimum space requirements of the complete package.

21 TO 78 M³/MIN (742 TO 2,755 CFM)

CAPACITY:

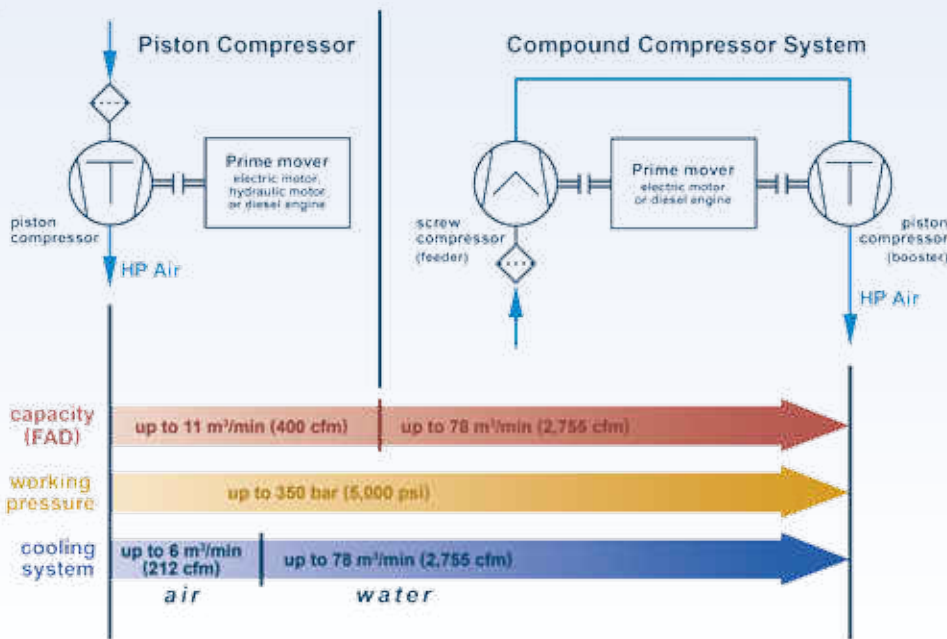
Compound systems as optimal solutions for highest capacities with smallest possible space requirements and weights.

A rotary screw compressor is used to feed the piston compressor with pre-compressed air. Both compressors are directly driven by a centrally located electric motor or diesel engine.

COOLING SYSTEM

Piston compressors with capacities up to approx. 6 m³/min (212 cfm) are available in air-cooled design. On request it is, however, possible to supply the inter- and after-coolers with water-cooling.

The prime mover can be air- or water-cooled. Larger piston compressors and compound compressor systems will be water-cooled. Prime movers (electric motors and diesel engines) are generally also water-cooled. It is a preferred modern design to have the compressor (piston or compound) cooled by a closed freshwater circuit with one fresh- / seawater heat exchanger (plate cooler). This system keeps the compressor unit „clean“ from seawater and makes a fast and easy heat exchanger maintenance possible.



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optional equipment



AUXILIARY EQUIPMENT

All additional components such as relief valves, filters, pressure reservoirs etc. can also be supplied and integrated into the pressure control of the units by **LMF** as part of an overall concept.

OPTION 1: CAPACITY CONTROL

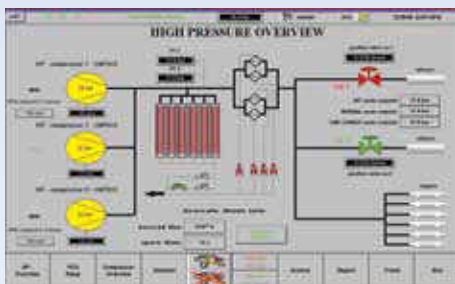
For larger capacities, e.g. 20m³/min (707 cfm) and more, it is relevant to adjust the compressor capacity during operation to the actual demand in order to avoid blow-off air and save energy (fuel or electric).

LMF has developed an electronic control system for stepless capacity control in the range between 50% and 100% load by means of

- frequency speed control of electric driven units or
- a combination of air inlet and engine speed control of diesel driven units (reduction of fuel consumption up to 40%, reduction of compressed air capacity 50%)

OPTION 2: LMF PRESSURE CONTROL SYSTEM (LMF-PCS)

Depending on the actual pressure in the high pressure reservoir, the system is controlling up to 4 compressor aggregates in an optimized way.



Pressure control: high pressure overview

OPTION 3: GUN ARRAY MANIFOLD

A manifold with all required locking and monitoring facilities is used to feed all airguns installed. In order to avoid pressure surges that might compromise operation safety, the locking fittings are operated pneumatically.

OPTION 4: PRESSURE RESERVOIR (BOTTLE RACK)

High pressure air receiver consisting of one high pressure vessel with a volume of 500 ltr. or 4 up to 18 high pressure bottles, 63 ltr. each. Compact design and skid mounted package for ready to use installation at the main high pressure supply line. Necessary air storage when using automatic pressure control system (LMF-PCS).

OPTION 5: HIGH PRESSURE FILTERS

2 double high pressure filters upstream to gun array manifold for clean high pressure supply to the air gun distribution. Rated pressure of high pressure filters: 250 bar.

OPTION 6: CONTAINERIZATION

All compressor units are prepared to fit into containers, which are hot-zinc coated and painted. Additionally the containers are equipped with forced fan and all openings for proper operation on deck.

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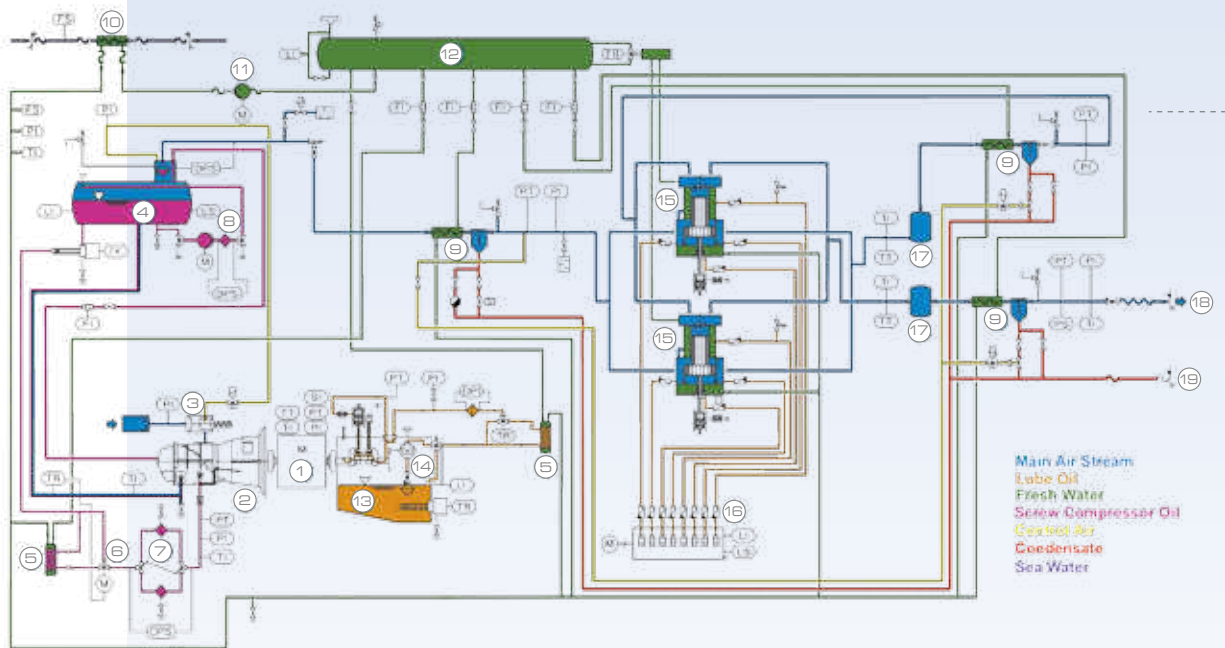
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compound system

GENERAL COMPRESSOR DESCRIPTION

A compound unit consists of a rotating (screw type) and a reciprocating (piston type) compressor, both coupled to a prime mover. Depending on the client's requirements the prime mover can be a diesel engine or an electric motor (AC).

Generally both the screw (single-stage) and the piston compressor are directly coupled to the prime mover. The screw block is equipped with an integrated gear giving the rotors their optimized speed range.



- (P) Pressure
- (T) Temperature
- (F) Flow rate
- (L) Level
- (I) Indicator
- (S) Alarm/Switch
- (R) Regulator
- (1) Prime mover
- (2) Screw compressor

- (3) Inlet control valve
- (4) Oil separation tank
- (5) Oil cooler
- (6) Oil temp. control valve
- (7) Main stream dual filter
- (8) Side stream filter system
- (9) Air cooler and separator
- (10) Seawater/freshwater cooler

- (11) Freshwater pump
- (12) Freshwater reservoir
- (13) Compressor skid
- (14) Gear type oil pump
- (15) Piston compressor unit
- (16) Cylinder lubricator
- (17) Spring pads
- (18) High pressure discharge
- (19) Condensate outlet

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benefits for clients

COMBINED ADVANTAGES

The compound compressor combines the advantages of both rotating and reciprocating systems. A screw block requires far less space than that taken by other low pressure systems. Single-stage oil-injected screw blocks replace two or three low pressure piston compressor stages. The piston compressor completes compression after the screw has reached the pressure limit imposed by its geometrical design. In this way, a single-stage screw combined with a two- or three-stage piston compressor for example, can substitute a conventional four- or five-stage reciprocating unit.

This allows for considerable reductions in weight and space. It is usually possible to achieve a 50% decrease in the floor space required, further-more the number of compressor valves can be approximately reduced by half.

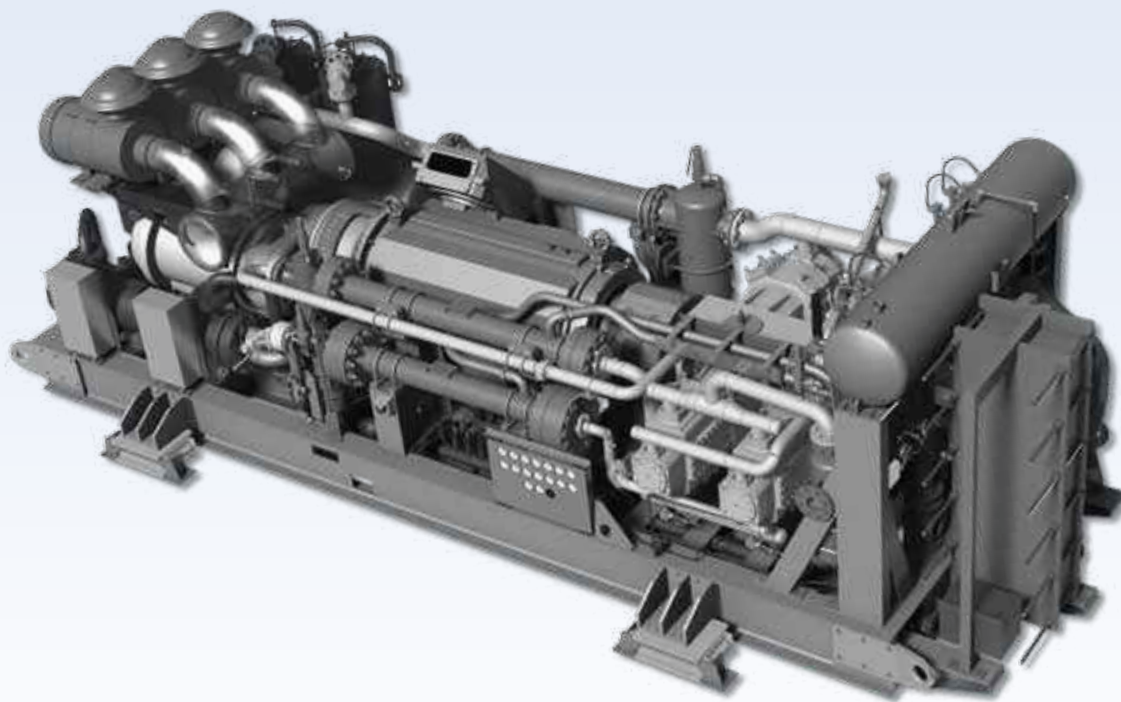
QUALITY AND COMPETENCE

Compound compressors are available for under deck installation or containerized for on-deck application. Compressor cooling is a closed, fresh water circuit with water (seawater) recooling. All machines are designed, manufactured and tested (under

full load) in accordance with the valid standards (such as DIN, DNV, VDI, VDE, IEC, ISO, etc.) and the **LMF** quality assurance system, which has been certified by BV (ISO 9001).

In addition, all units can be tested according to DNV, LRS, GL, BV, CCS etc., and relevant certificates (e.g. CE-certificates) are submitted if required.

All **LMF** compressors are optimized based on our experience in having built more than 650 units since 1980, for clients all over the world.



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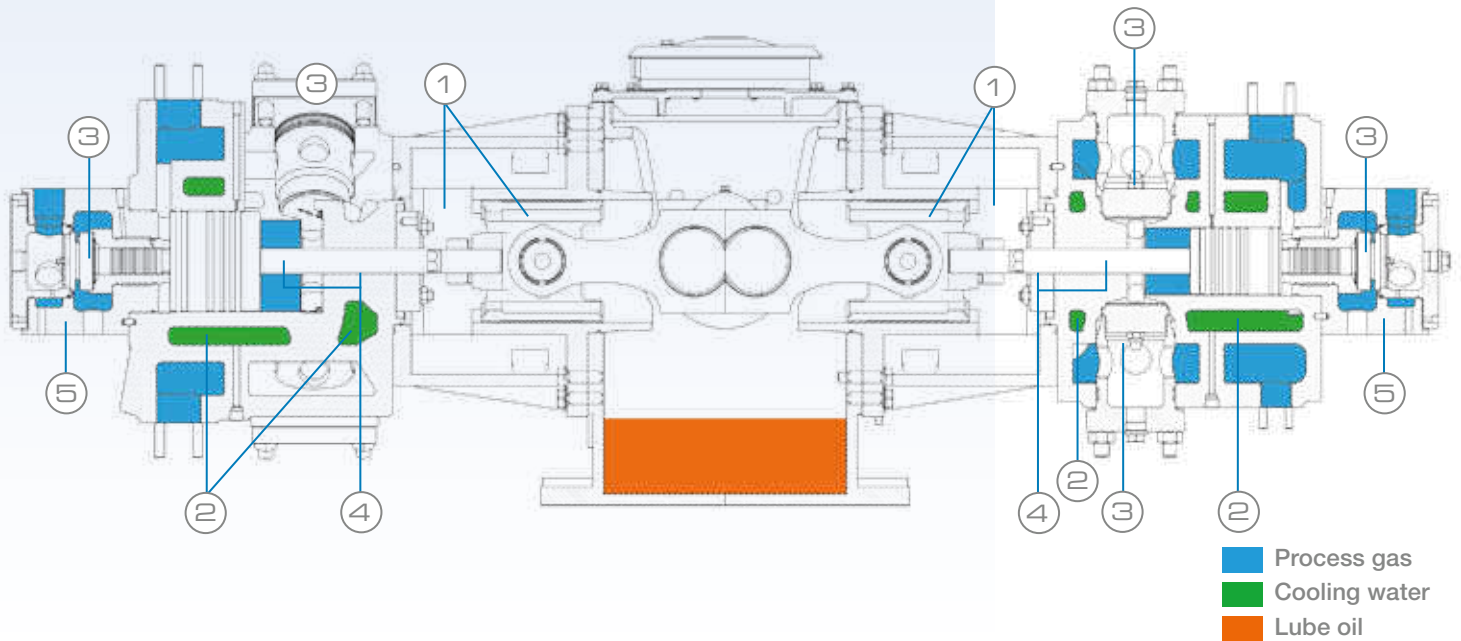
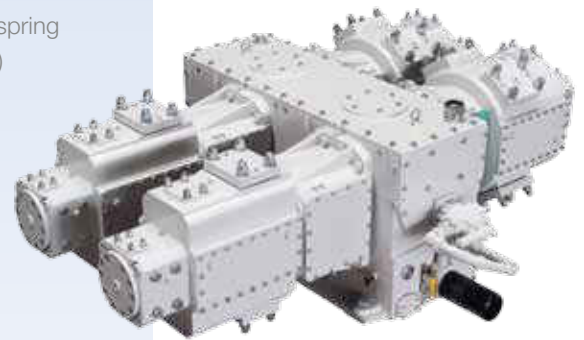
pressure solution

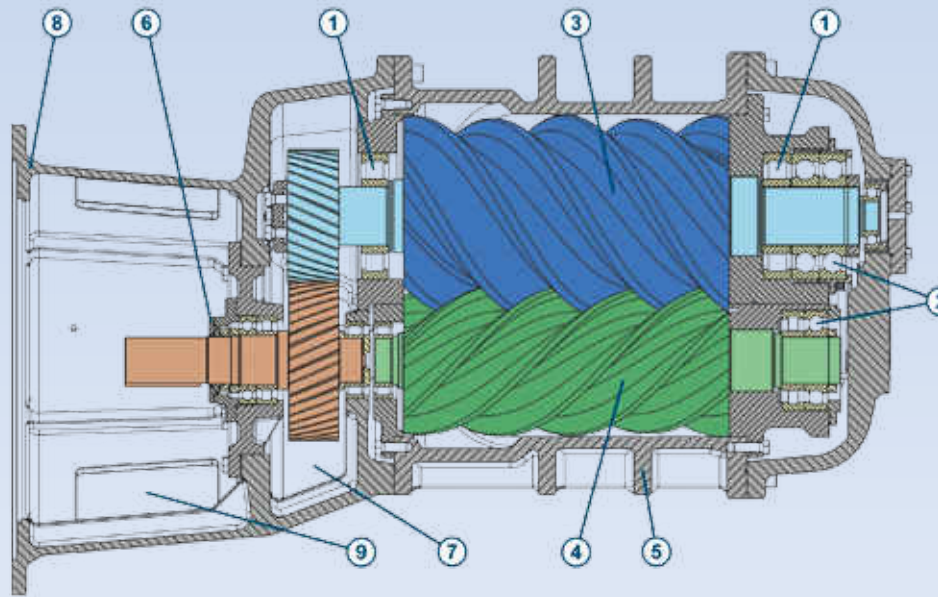
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proven main components

PISTON COMPRESSOR

- Low-vibration and extremely compact design due to totally balanced "Boxer" design
- High efficiency at low compression temperatures due to crosshead (1) design and water-cooled cylinders (2)
- Direct coupling with prime mover up to 1800 rp
- Three-stage compression in 2 or 4 cylinder units at final pressures rates of 137 bar (2,000 psi) / 207 bar (3,000 psi)
- Minimal oil consumption and wear of piston rings due to high pressure mini-lubrication of the PTFE piston rings and guide rings
- Maximum possible lifetime of compressor valves (3), ensured by high quality PEEK plates
- Long working life of stuffing box packings, as not exposed to compressor final pressure
- Extremely long periods between gear oil changes due to high efficiency of oil cooling system
- Uncomplicated valve service with no dismantling of gas or water pipes
- Simple piston ring change due to easily removable high pressure cylinder units (4)
- Complete unit mounted on spring elements (four-point version)





SCREW COMPRESSOR

- Single-stage, oil-injected unit
- Simple, highly robust design
- No wear and tear parts required
- Working life of bearings at least 30,000 hours (at a final pressure rate of 15 bar/218 psi)
- Roller bearings (1) absorb the radial forces, inclined ball bearings (2) the axial forces
- Superior efficiency through asymmetrical Sigma
- Profile of rotors; male rotor (3) five-lobed, smaller female rotor (4) six-lobed, oil-flooded
- Compressor housing (5) and shaft seal (6) pressure tight up to 15 bar (218 psi)
- Integrated single stage gear box (7); smoothness of running and low noise
- guaranteed by ground and inclined gear wheels
- Generously proportioned transmission housing (8) suitable for coupling assembly; large inspection openings (9)
- Suction control valve ensures very easy regulation of start, gas flow and pressure
- Automatic control of operating temperature by temperature control valve in oil circuit
- Maximum periods between oil changes due to additional, extremely fine filters (side-stream filtration system), also operable during compressor shutdown

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applications

- wherever it is important to combine
- large capacity
up to 78 m³/min fad (2,755 cfm) - and
- high pressure
up to 350 bar (5,076 psi) - with
- small dimensions and
- low weight
in comparison to all other presently available compressor designs
- LMF compound compressor units will provide the best solution!

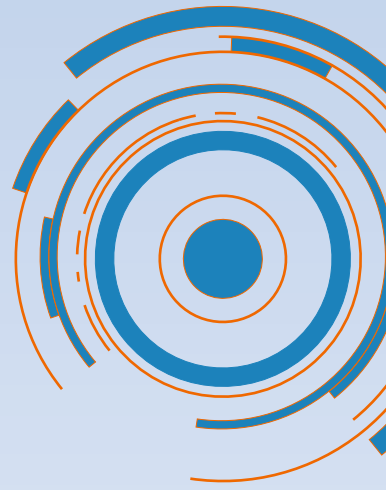
COMPOUND COMPRESSOR UNIT LMF 51s/138-207 E

- delivery 51 m³/min (1,800 cfm) FAD at 138 bar (2,000 psi) and 207 bar (3,000 psi);
- driven by electric motor with 950 kW (1,274 hp) at 1,500 rpm;
- the DNV-certified unit is water-cooled by closed fresh water circuit (including electric motor and frequency converter) with fresh- /seawater heat exchanger and equipped with a control system for automatic operation in the stepless range between 50 % and 100 % capacity by frequency control;
- used for under-deck installation of seismic research vessels



COMPOUND COMPRESSOR UNIT LMF 21s/138-207 D

- containerized (24.6 ft container), including HP-air receiver and HP-control valve;
- delivery 21 m³/min (742 cfm) FAD at 138 bar (2,000 psi) and 207 bar (3,000 psi);
- driven by 12-cylinder diesel engine with 448 kW (600 hp) at 1,600 rpm;
- the DNV-certified unit is water-cooled by closed fresh-water circuit with fresh-/seawater heat exchanger and equipped with a control system for automatic operation in the stepless range between 50 % and 100 % capacity with a reduction of fuel consumption of 40 %;
- used for on-deck installation of seismic research vessels



PORTABLE COMPOUND COMPRESSOR UNIT LMF V19 / 5621 L20.7 D

- containerized (14.7 ft container), including HP-air receiver, HP-control valve and 16-channel HP-manifold;
- delivery 5.2 m³/min (183 cfm) FAD at 207bar (3,000 psi);
- driven by 6-cylinder water-cooled diesel engine with 152 kW (203 hp) at 2,200 rpm;
- used for on-deck installation of seismic research vessels as well as for shallow-water exploration

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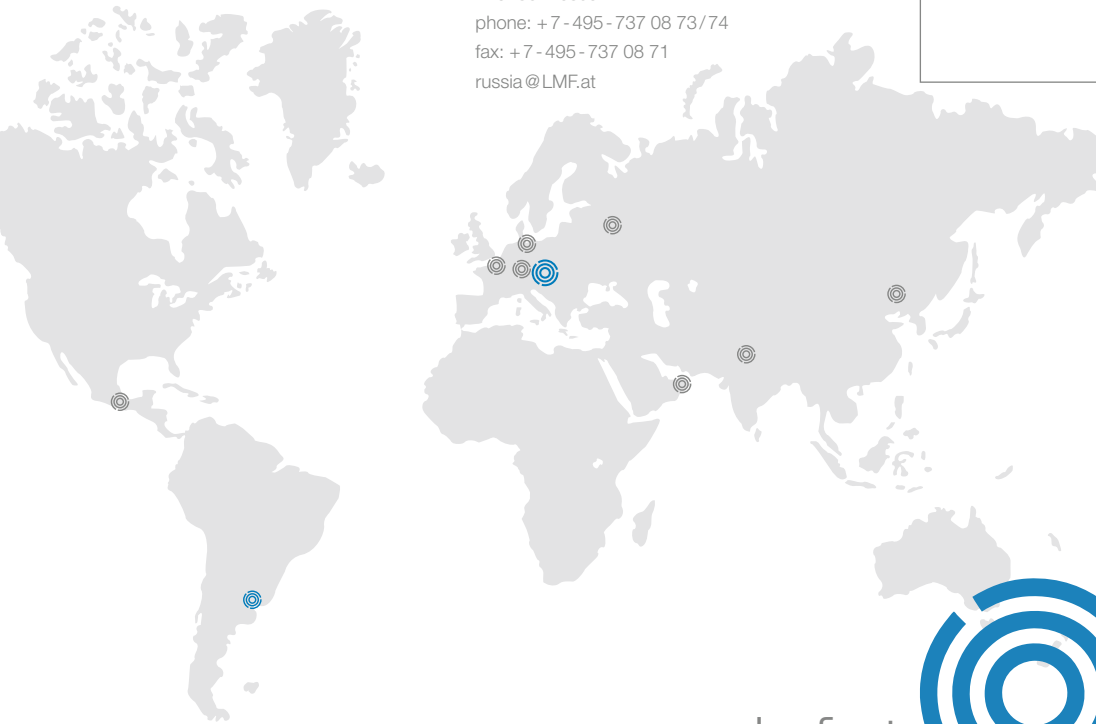
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