
OnTrack

Liebherr-Transportation Systems Magazine
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LIEBHERR



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www.liebherr.com



Dear Reader,

This issue of our magazine focuses on the development of Liebherr's transportation activities, which are characterized by a lot of optimism, although our industry is confronted with many challenges.

Driven by mega trends like increasing urbanization, demographic change and environmental consciousness, the global railway market is considered to steadily grow in the years to come. Regarding technology, we see strong trends towards digitalization, decarbonization (e.g. replacement of diesel drives by environmentally friendly solutions based on batteries or hydrogen), increase of efficiency and use of natural refrigerants in air-conditioning applications, especially in Europe. In terms of low GWP HVAC systems, Liebherr is an industry leader with air cycle technology already in service and HVAC systems using CO₂ or propane as refrigerant about to enter series production. In addition, with airless braking technologies substantial first steps were taken towards pneumatic free trains.

To comply with the increasing demand, we are further strengthening our global footprint by more vertical integration at our best cost production sites in Marica (Bulgaria) and Pinghu (China). Further, our customers can rely on swift and sustainable product support. Excellence in maintenance, repair and overhaul services is our daily aspiration.

However, the positive outlook is clouded by challenges arising from geopolitical shifts, showing the fragility of our global supply chain. Although overall costs and lead times are normalizing, some commodities remain critical.

Liebherr-Aerospace and Transportation Systems is based on solid foundations, and we are continuously preparing the future of transport by investing above industry



average in innovative products, industrial capabilities and services as well as our employees. We accept the challenges on digital transformation and sustainability. Both will significantly change our operations along the whole product life cycle. Against the background of all these challenges, our corporate strategy is setting the path until the end of the decade and beyond, ensuring that we remain a strong and reliable partner for our customers.

transform.develop.sustain.

... is a strong slogan that supports our strategy, capturing its main messages: This decade will be a decade of transformation. We will develop our products and capabilities, adapting to the changing market requirements. Sustainability of our operations but also of the future transport system will drive our roadmap.

Expect to get excited by Liebherr-Aerospace and Transportation Systems as an attractive employer working on solutions for a sustainable transportation eco-system. Let's take the future into our hands and jointly re-shape our industry.
Now is the right time!

Best regards,

The Board of Liebherr-Aerospace & Transportation SAS

Alex Vlieland
Chief Customer Officer

François Lehmann
Chief Financial Officer

Martin Wandel
Chief Operating Officer

Dr. Klaus Schneider
Chief Technology Officer

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Impressions

Certified welders

Liebherr Transportation Systems (China) Co., Ltd. in Pinghu has successfully obtained the EN15085-2 CL1 welding certificate (TÜV Süd). Just seven months after applying, the team has established a well-developed welding control system.

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0 mm



3.35 mm

1 mm

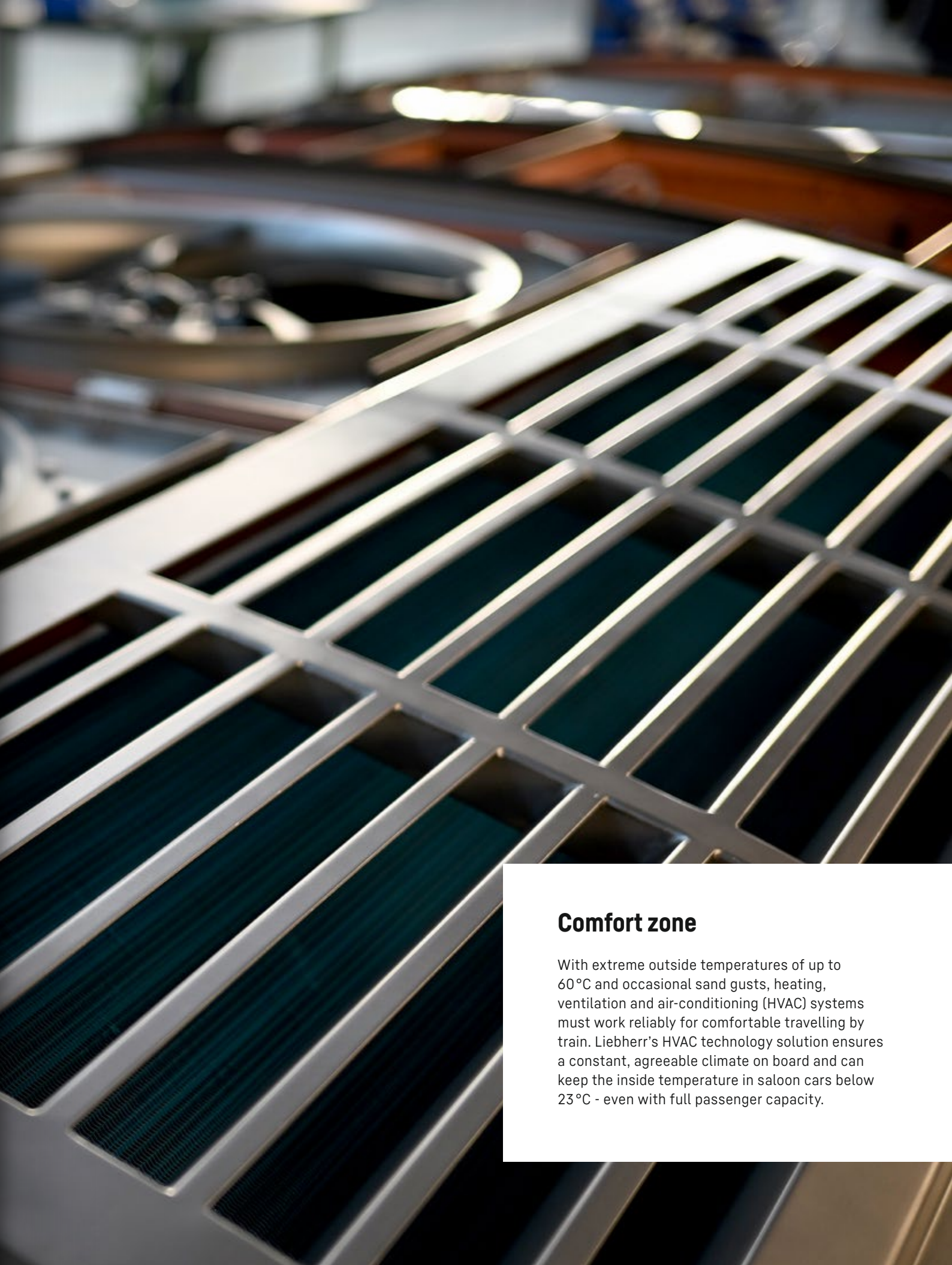




No bumpy rides

They make every ride stable and smooth: Liebherr dampers are the invisible helpers that ensure comfort and safety in rail and bus applications. The connection between the damper and the chassis or car body is formed by the so-called eyelet head. This component securely fixes the damper while providing the necessary flexibility. Like a joint in the human body, it enables controlled movements and absorbs forces to optimize the ride quality.





Comfort zone

With extreme outside temperatures of up to 60°C and occasional sand gusts, heating, ventilation and air-conditioning (HVAC) systems must work reliably for comfortable travelling by train. Liebherr's HVAC technology solution ensures a constant, agreeable climate on board and can keep the inside temperature in saloon cars below 23°C - even with full passenger capacity.

Industry Information

Ice ice baby

In Liebherr-Transportation Systems' test chamber components are tested to demonstrate, for example, their thermal durability. Depending on the purpose of the test, the units are exposed to temperatures between plus 60°C and minus 40°C for hours or days and during this process test engineers monitor the behavior of the materials and functions under various conditions. Here, an engineer is spraying the cover of an air-conditioning unit with water vapor in order to test that the air openings do not get blocked when operating in freezing fog ambient conditions.



“For passengers to reach their destinations safely and comfortably”

Liebherr-Transportation Systems in Korneuburg (Austria) manufactures hydraulic systems for railway vehicles and buses in a workspace of around 11,000 m². The company has recently developed a new generation of hydraulic articulation dampers, which will be used in articulated buses produced by Hübner. Dieter Pflanzer introduces the new dampers.



Mr. Pflanzer, how are these new dampers used?

Dieter Pflanzer: Hübner integrates these types of dampers in their articulated buses. We have developed the dampers and they are installed in the so-called articulation point produced by Hübner as a complete unit. The articulation point connects the front and rear part of the bus and includes the joint with two Liebherr dampers and the folding bellows. Our dampers ensure that the articulated bus can manage cornering and straight travel safely and comfortably. This requires the damping to continually adjust depending on the driving situation. The adjustment is performed by the articulation control using a proportional valve on the damper.

Dieter Pflanzer has already worn several hats at Liebherr: After studying Mechanical Engineering – Management at TU Wien (Vienna University of Technology), he started at Liebherr-Transportation Systems in Korneuburg (Austria) as a project leader. After 2018 onwards he was Head of the Hydraulics Business Unit. Since April 2023, he has been Director Operations of Liebherr-Transportation Systems Marica EOOD (Bulgaria). He also holds the position of Director Operations at Liebherr-Transportation Systems GmbH & Co KG in Korneuburg.

“The dampers are able to withstand up to 500 bar of pressure, which is a remarkable feature!”

Dieter Pflanzer

Director Operations at Liebherr-Transportation Systems GmbH & Co KG and
Liebherr-Transportation Systems Marica EOOD

What in particular is required of these articulation dampers?

Dieter Pflanzer: The articulation dampers must withstand high pressure of up to 500 bar. They also have to function smoothly and, above all, safely under tough operating conditions for many years.

The dampers are assembled in Korneuburg. Which are the biggest production challenges and how big are the planned quantities?

Dieter Pflanzer: The production line comprises various machines, test devices, a paint line and the final inspection point. Several thousand dampers have been produced up to now at our Korneuburg site. To ensure the shortest possible manufacturing times, streamlined and precisely coordinated production procedures are essential for an annual production rate of 6,000 – 10,000 units. We constantly monitor quality and productivity, and continuously improve as we work. With these kind of quantities, any additional action could impact production.

Thus, on an articulated public bus, there is a very good chance that the articulation point is stabilized by Liebherr dampers?

Dieter Pflanzer: Correct. Almost all notable articulated buses operate using articulation systems from Hübner and these are almost all fitted with Liebherr dampers. For passengers to reach their destinations safely and comfortably, the dampers are essential components in an articulated bus.

From Marica to the world

A lot is happening at Liebherr-Transportation's site in Marica in the south of Bulgaria: Liebherr's entire series production of heating, ventilation and air-conditioning (HVAC) systems for the railway industry, takes place here on an area of around 10,000 m². Alstom, Siemens and Stadler are three examples of Liebherr's international customers base. To find out how the site is set up, how it has developed over the last years and how the search for skilled personnel looks like, we spoke to Ekaterina Stankova, Head of Human Resources.



Ekaterina Stankova has worked at Liebherr for already 22 years and is leading the HR department at Liebherr-Transportation Systems Marica EOOD since 2010. With a team of three, she is responsible for employee matters on site and for tackling the challenges of the recruiting process.

Mrs. Stankova, what kind of products are manufactured at Liebherr-Transportation Systems Marica EOOD?

Ekaterina Stankova: Our site encompasses a broad spectrum of activities: Predominant is the series production of all heating, ventilation and air-conditioning (HVAC) systems for rail vehicles. The colleagues of Liebherr-Transportation Systems GmbH & Co KG in Korneuburg in Austria develop

the prototypes, which we then manufacture at our site. This led to the production of 2,700 air-conditioning systems in 2023, which were delivered to various customers worldwide and which ranged from large projects with high unit numbers to small series of just 30 systems. Just recently, series production began of an HVAC system that offers an environmentally friendlier alternative to standard refrigerants through its use of the refrigerant R774, that is CO₂.

We also manufacture air-conditioning systems for construction machinery and transport refrigeration systems for trailers. Some of our design engineers are also part of the aviation development teams for landing gear and flight control systems at the Liebherr site in Lindenberg (Germany). We assemble valve actuators for aircraft air-conditioning systems for Liebherr-Aerospace Toulouse SAS based in France. We also manufacture various electronic components for Liebherr-Electronics and Drives GmbH in Lindau situated at Lake Constance, and we assemble control cabinets for Liebherr cranes and concrete technology.

How has the site developed since it was founded in 2004 and which milestones have been reached?

Ekaterina Stankova: Initially, we were accommodated in the factory building of Liebherr-Hausgeräte Marica EOOD. At that time, HVAC systems were manufactured on a workspace of just 300 m². In 2010, Liebherr-Transportation Systems Marica EOOD was founded. The construction of our own production hall ultimately enabled series production for our HVAC systems to take off.

Our site has continually evolved over the years. In addition to Operational Procurement, we have employees in Strategic Sourcing since several years. Since 2018 there is a Design Department on site that works closely with Liebherr-Aerospace in Lindenberg, in Germany, and that is involved in the development of landing gears and flight control systems. This department was successively developed and expanded.

Marica is an important site for the entire Liebherr Group. We collaborate closely with other Liebherr companies and benefit from synergies.

With all these different fields of activity, is it a big challenge to find qualified staff?

Ekaterina Stankova: It is certainly not easy because many large national and international companies are located in and around Marica thus offering numerous attractive employment opportunities. We provide an extensive training and development program as it is important to us that our employees are well trained. We also welcome experienced professionals seeking a career change. They can retrain internally and benefit from tailored training they need for their field of work.

Assembly hall of Liebherr-Transportation Systems in Marica, Bulgaria.





Knowledge of English also plays an important role because we are an international company and work closely with colleagues in Korneuburg, Lindenberg and Toulouse. We therefore offer to pay for all employees to attend language courses. Furthermore, we offer a wide variety of sport programs and additional health insurance. The health of our employees is very important to us.

It sounds like employees get a lot of benefits.

Ekaterina Stankova: We want our employees to feel good and enjoy coming to work. Once they have started working at Liebherr, they generally stay with us for a long time, so our fluctuation rate is comparatively low. This is also due to the fact that we are a solid company with a good reputation.

Is personnel development at the Marica site closely interconnected with other Liebherr sites?

Ekaterina Stankova: Very much so. Collaboration and contact with colleagues in Korneuburg are particularly close.

We also have a strong connection to the site in Lindenberg. Last year we were able for the first time to offer an exchange program between our sites for our apprentices and students on dual education. They spent several weeks at the respective other site and experienced working at Liebherr from another perspective. The project went very well, and we would like to continue this in the future.

Liebherr-Transportation Systems Marica EOOD – center of excellence for HVAC systems manufacturing

The Liebherr Group has had a foothold in the Bulgarian market for many years. Since 1999, Liebherr-Hausgeräte Marica EOOD in Radinovo in southern Bulgaria has produced high quality refrigerators and freezers.

In 2004, the first HVAC systems for rail vehicles were manufactured in a small area of the production hall at the site. The founding of a separate production company enabled the then 300 m² workspace to be expanded to around 10,000 m². Around 290 employees currently work at the site. HVAC systems have been in series production in Marica since 2016. Liebherr-Transportation Systems Marica also manufactures various control cabinets and electronic components for Liebherr-Electronics and Drives GmbH.

Corporate Responsibility: From a solid C to a solid B

The Carbon Disclosure Project creates transparency to promote a more sustainable economy. Liebherr-Aerospace and Transportation Systems participated for the second time – and improved significantly compared to the previous year.

In 2023, the Aerospace and Transportation Systems segment of the Liebherr Group participated in the Carbon Disclosure Project (CDP) for the second time. The CDP score report allows companies to understand their score and ranking in the activity group (transportation equipment) and which categories require attention to reach higher scoring levels. This enables companies to progress towards environmental stewardship through benchmarking and continuous improvement.

Whereas Liebherr-Aerospace & Transportation SAS had achieved a solid C in 2022, which was already quite a success, it was now rewarded with a solid B. This improved ranking is the result of coordinated action taken on climate issues in the past compared to just knowing impacts on and of climate issues.

Liebherr-Aerospace and Transportation Systems' ambitious corporate action is more important than ever. It is not only about meeting the demands of customers, but also about to enhance corporate reputation, to stay competitive and to uncover risks and opportunities as well as to track and benchmark progress.

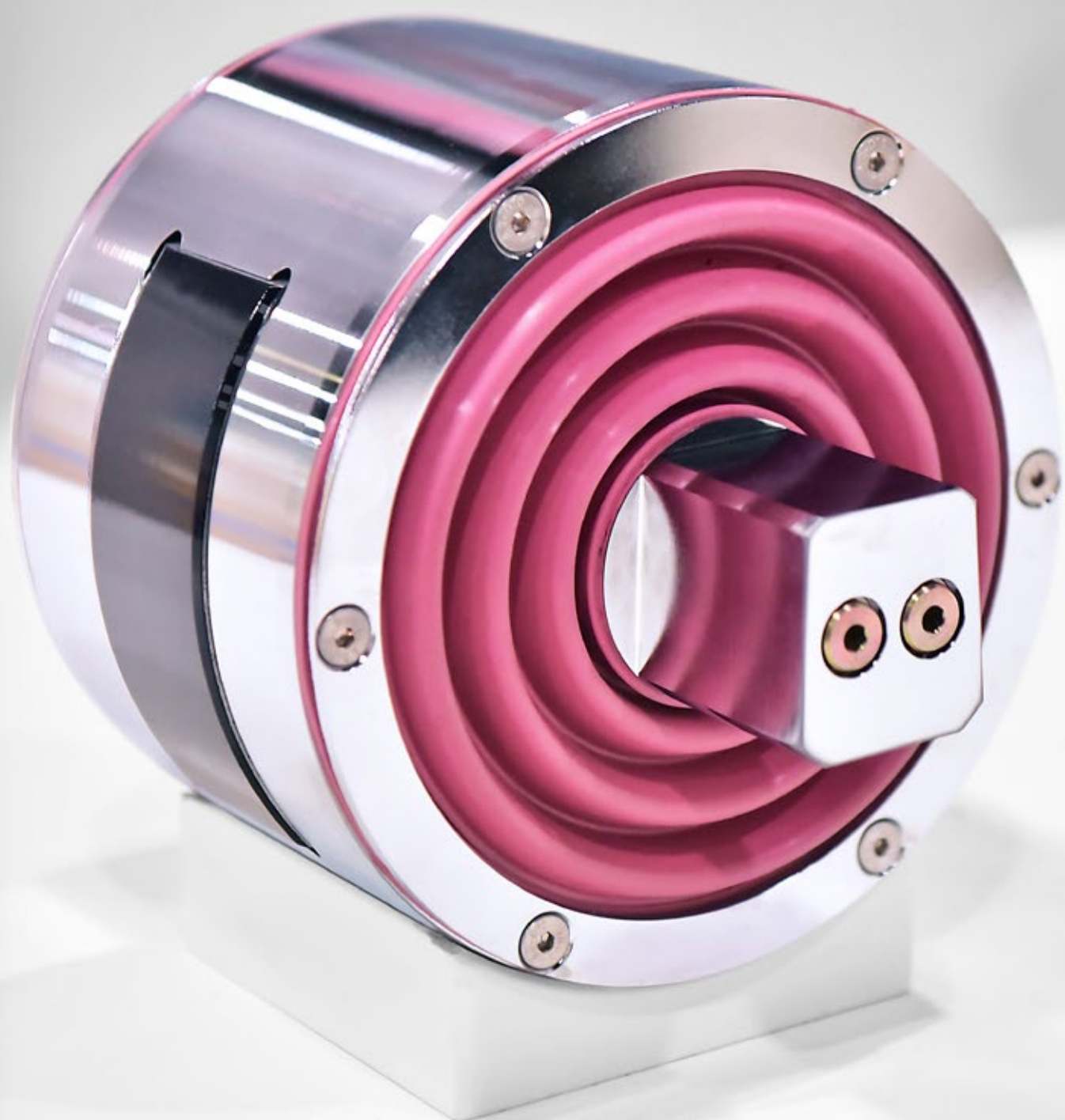


Liebherr's Corporate Responsibility Strategy embodies a sustainable and forward-looking approach.

Research & Development

Less wear on rails

Liebherr's Controlled Axle Steering "LiCAS" system significantly reduces wear and tear on the rails and wheels, while providing stability and control. It also reduces vibrations and noise levels and contributes to the longevity of rail infrastructure and the conservation of resources.



Naturally cool

In recent years, the rail industry has made significant strides towards making mobility more environmentally friendly. Liebherr-Transportation Systems has been working intensively to implement more climate-friendly alternatives compared to conventional refrigerants and to adapt heating, ventilation, and air-conditioning (HVAC) systems accordingly. Three technologies stand out in particular: the use of alternative refrigerants such as CO₂ or propane, and Liebherr's proven air-cycle technology.

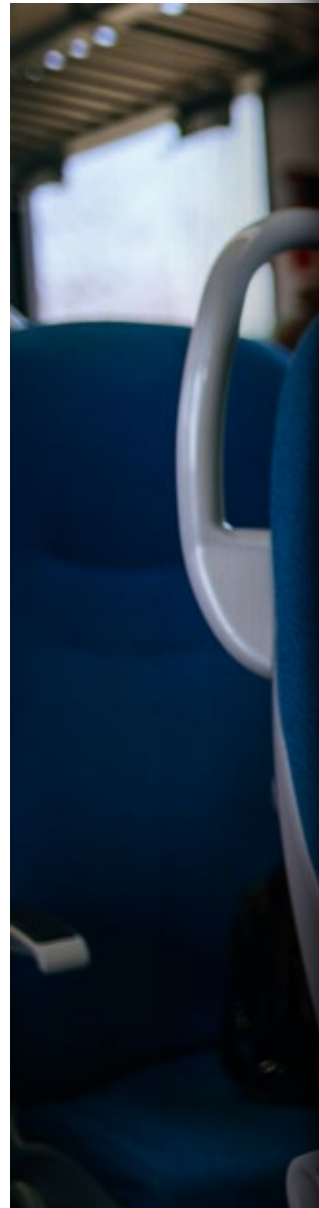
Energy efficient cooling with CO₂

What initially sounds contradictory is actually a climate-friendly alternative to conventional refrigerants: CO₂, also known as R744. With a Global-Warming-Potential (GWP) of 1, it not only has a very low greenhouse effect compared to conventional refrigerants, but it is also particularly energy-efficient in temperate climate zones and can heat very efficiently in heat pump operation. Moreover, the refrigerant is non-toxic and non-flammable. Since carbon dioxide occurs in large quantities in nature, it is cost-effective compared to synthetic refrigerants.

"With the start of serial production of HVAC systems using CO₂ as a refrigerant in 2024, we have reached a major milestone on the road to more sustainable mobility," reports Reinhard Aigner, Coordinator of Research and Technology at Liebherr-Transportation Systems in Korneuburg (Austria). He has been intensively involved with air-conditioning systems and how they can become more environmentally friendly for many years. "Our HVAC systems are one of the first solutions of their kind to be used in rolling stock applications."

Maximum cooling performance with minimal energy consumption thanks to propane

Another major milestone for Liebherr is the start of serial production of propane-based HVAC units. The natural refrigerant, also known as R290, enables more sustainable cooling and, in terms of pressure, is very similar to the previously used refrigerant R134. With a GWP of 3, it provides a low greenhouse potential as well as maximum cooling performance with minimal energy consumption. This system also guarantees rail vehicle operators a reliable product solution with low downtime. The technical concept takes into account all relevant safety requirements.



Cooling with natural ambient air

A completely climate-friendly solution is Liebherr's air-cycle technology. The trick: it uses only natural ambient air for cooling – no refrigerant is needed.

"With air-cycle technology, ambient air is compressed, cooled, and expanded again to achieve the desired cooling effect," explains Reinhard Aigner. "Since the system consists of only a few components and the cooling circuit does not require pressure testing and evacuation after restoration, the air-based air-conditioning system is simple

and cost-effective to maintain. Additionally, the system is characterized by low operating costs and, due to efficient partial load control, low energy consumption."

Originally developed by Liebherr for the aviation industry, the air-cycle technology has been used for decades in aircraft air-condition systems. Given the significant advantages over conventional vapor cycle systems, Liebherr was one of the first companies to start using this technology in rail vehicles. The goals in both industries are the same: economy and passenger comfort.



Programs & Contracts

Reliable partner
Liebherr-Transportation Systems builds
long-term partnerships worldwide.



Braving the heat in Bangladesh

Even in Bangladesh's tropical climate, passengers can travel in comfort on board trains manufactured by Sung Shin RST. Heating, ventilation and air-conditioning (HVAC) systems from Liebherr ensure a pleasant indoor climate – no matter how hot the weather is outside.

Passenger trains in Bangladesh now run with HVAC systems from Liebherr-Transportation Systems. The units are installed in trains of the Korean locomotive and railway car builder Sung Shin Rolling Stock Technology (RST).

The project was implemented particularly quickly: After receiving the order for 118 units, the team was able to deliver the first units and perform the First Article Inspection (FAI) after just six months. "Despite the very short lead-time, we have engineered and tested the customized products with features such as multiple additional redundancy functions to always enable high availability in service," explains Andreas Walter, Executive Director of Liebherr Transportation Systems (China) Co., Ltd. In order to ensure proper operation of the HVAC systems and customer satisfaction, Liebherr also provides additional training to the end customer on the site of Sung Shin RST in Korea.

"The project in Bangladesh is an example of how we at Liebherr are expanding our engineering, production, and service facilities in Asia to serve our customers even better," adds Roland Friedrich, Deputy General Manager of Liebherr Transportation Systems (China) Co., Ltd. "We are therefore gradually expanding our presence in key markets such as the Middle East, the Indian subcontinent and South-east Asia, and are already using our existing facilities."



Liebherr equips each of the 59 railway coaches manufactured by Sung Shin RST for Bangladesh with two roof-mounted HVAC units.



Andreas Walter, General Manager (left), and Roland Friedrich, Deputy General Manager of Liebherr Transportation Systems (China) Co., Ltd., with an HVAC unit for a passenger railway coach.

Travelling at day and night in Kazakhstan

The rail vehicle manufacturer Stadler is producing trains for the state railroad company of Kazakhstan (KTZ) – with HVAC technology from Liebherr on board. The heating, ventilation and air-conditioning systems will ensure a comfortable journey in the sleeper and couchette passenger carriages.

Passengers on the Federal Railways of Kazakhstan will soon be able to travel and dream in comfort. 550 HVAC systems will be installed in sleeper and couchette passenger carriages of the train manufacturer Stadler Rail Group, where they will ensure optimum temperature and ventilation in the cars. The units will be manufactured and supplied by Liebherr Transportation Systems (China) Co., Ltd., based in Pinghu, and delivered until 2030.

The contract is a first milestone in the Kazakh railway market and also strengthens Liebherr's position on the international market. "We are very honored to have been selected for this project and to be able to contribute our

experience and technical solutions to this project," said Roland Friedrich, Deputy General Manager of Liebherr Transportation Systems (China) Co., Ltd. and Key Account Manager for Stadler Rail Group.



Liebherr supplies 550 HVAC systems for Stadler's sleeper and couchette passenger cars operated in Kazakhstan.

Propane based HVAC technology enters series production

Cooling in an environmentally friendly way: New heating, ventilation, and air-conditioning (HVAC) systems from Liebherr use the refrigerant propane. It is considered an environmentally friendly alternative to conventional refrigerants. The new HVAC systems have been ordered by the rail vehicle manufacturer Stadler Polska Sp. z o.o. and are marking the start of serial production.

The refrigerant propane, also known as R290, is a natural refrigerant. With a factor of 3, it has a significantly lower global warming potential than many synthetic refrigerants and is therefore considered a more climate-friendly alternative. Liebherr is now producing propane-based HVAC systems in series for the first time, offering a sustainable and efficient solution for vehicle manufacturers and operators.

The technical concept takes into account all relevant safety requirements. Propane, as a refrigerant, not only forms a natural alternative to conventional refrigerants but is also easy to maintain and guarantees a reliable product solution with minimal downtime.

Delivery to Stadler will take place from mid-September 2024 to the end of 2026 and comprises HVAC systems for 20 electric multiple units of FLIRT trains (Fast Light Inter-city and Regional Train), including 80 saloon HVAC units, 80 heat recovery units and 40 cab units.

The vehicles will be operated by the Finnish government-owned railway company VR-Group and will serve regional transportation in, for example, the regions of Helsinki, Tampere and Lahti. A FLIRT with four carriages can accommodate up to 800 passengers.



© Stadler Polska

Liebherr supplies Stadler's FLIRTs (here an illustration of a mock-up) with air-conditioning systems that use propane as a natural refrigerant.

Riding comfortably and saving money at the same time

The HVAC systems by Liebherr that are installed in the DT5 fleet of Hamburger Hochbahn have now been equipped with new software and hardware measures and tested on board the trains. The objective: to make them even more energy efficient.

The significantly rising electricity costs in the public transport sector are a challenge for both, the operators as well as the rail transport vehicle manufacturers. In order to provide a solution, Liebherr-Transportation Systems, train manufacturer Alstom and operator Hamburger Hochbahn have jointly developed a program to make Liebherr's existing advanced heating, ventilation and air-conditioning (HVAC) systems for the DT5 fleet even more energy efficient.

New software and hardware measures are installed in the DT5 trains for this purpose. The data generated during the heating and cooling period is analyzed in order to determine the economic and technical benefits for Hamburger Hochbahn in terms of riding comfort for the passengers and energy savings at the same time.



Liebherr technology makes the Hamburger Hochbahn DT5 rolling stock series from Alstom even more energy efficient.

Let's take the next step on the way to the trains of tomorrow

Cooling without refrigerants? This is the concept behind Liebherr's air cycle heating, ventilation and air-conditioning (HVAC) systems. This technology uses only natural ambient air for cooling and thus offers a climate-friendly alternative to conventional refrigerants. These HVAC systems are now also used by SNCF, the French national railroad company, for trains in the Occitania region.

291 heating, ventilation and air-conditioning (HVAC) systems from Liebherr-Transportation Systems are being supplied to SNCF, the French national railroad company. The special feature of the air-conditioning systems is that they are based on environmentally friendly air cycle technology and use only ambient air for cooling instead of conventional chemical refrigerants. The units will be installed in SNCF's Autorail à Grand Capacité (AGC) trains by Bombardier, which will be operated in the Occitania region (France). The air-conditioning system was tested very successfully by the Occitania region and SNCF in France within the frame of SNCF's "Eco-Clim" research program on an AGC TER train from 2015 to 2019.

"Our air cycle air-conditioning technology is the next step on the way to tomorrow's trains and we are proud to be able to contribute to eco-friendly travelling as well as to the comfort of the passengers on board Occitania AGC trains," said Dr. Klaus Schneider, Chief Technology Officer at Liebherr-Aerospace & Transportation SAS.

The units are manufactured at Liebherr-Transportation Systems Marica EOOD in Radinovo (Bulgaria). This is where the series production of HVAC systems is located, which are used in railway vehicles worldwide. Included in the scope of supply for SNCF: customer service over the entire life cycle.



The air cycle air-conditioning system by Liebherr works entirely without refrigerants.

Environmentally friendly technology

But how does the concept of air cycle air-conditioning work? The ambient air is first conducted through an open loop by a cooling turbine running at high speeds. The cooling turbine is a compact component consisting of a turbine stage, a compressor stage and an electrical motor, all of which are connected by a common shared shaft. First the air is depressurized to below atmospheric pressure at the turbine stage, which cools it considerably. This cold air then passes through a heat exchanger, where it absorbs the heat from the air streaming into the passenger compartment. During the last stage in the open circuit, the depressurized air is conducted through the compressor stage of the cooling turbine and compressed back to atmospheric pressure. During this process the air heats up significantly. That means the surroundings can be used highly effectively as a heat exchanger with 100% effectiveness. The entire air cycle air-conditioning system comprises only a few components and is therefore very easy to maintain.

Major advantages proven in field tests

Already in 2002, Liebherr-Transportation Systems fitted an ICE 3 train from German operator Deutsche Bahn AG (DB) with air cycle air-conditioning systems for test runs.

Additional fittings for the first model series and 13 eight-car trains of the second model series of the ICE 3 soon followed. In 2018, DB and Liebherr-Transportation Systems presented the very good results of a joint project comparing Liebherr's air cycle air-conditioning system with a traditional vapor cycle system operating with the refrigerant R134a.

The UBA, Germany's Federal Environmental Agency based in Dessau-Rosslau, supported the project because of its environmental advantages compared with traditional vapor cycle systems with fluorinated refrigerants.

Additionally, as the system only consists of a few components, it is not only of low weight, but also simple and inexpensive to service. It is characterized by very low operating costs and low energy consumption.



Liebherr's air-conditioning system was successfully tested on an AGC TER train from 2015 to 2019.

Customer Service

In best hands

From Canada to India:

Liebherr-Transportation Systems offers specialized and qualified customer service at numerous service and support facilities worldwide.



Smooth journeys ahead

In the bustling regions around Sofia and Plovdiv in Bulgaria, they roll daily through the landscape – the Desiro Classic electric multiple units from Siemens Mobility. These modern trains are equipped with air-conditioning systems developed and manufactured by Liebherr-Transportation Systems. However, even the most reliable systems occasionally require maintenance and care.

Liebherr-Transportation Systems has supplied spare parts for the maintenance of HVAC equipment (heating, ventilation and air-conditioning systems) for 82 passenger compartment and 48 driver's cab units to Alstom Transport SA, Sofia (Bulgaria). These were developed and manufactured by Liebherr and installed in 24 three- and four-part electric multiple units of the Desiro Classic type.

The entire maintenance was carried out by the Alstom service personnel in the Alstom Transport factory in Sofia. Liebherr not only supplied the necessary spare parts for the order but was also on site with qualified service personnel to support the work with hands-on training for the Alstom employees.

Liebherr-Transportation Systems GmbH & Co KG in Korneuburg near Vienna (Austria) develops, produces and services air-conditioning equipment and hydraulic actuation systems for many kinds of rail cars.



“In the summertime ...”

“...when the weather is high.” That’s when reliable air-conditioning systems are needed. This is exactly what Liebherr customer service provides in the Alstom Talent 3 trains of SWEG in Offenburg (Germany).

Passengers on the Alstom Talent 3 trains operated by SWEG Südwestdeutsche Landesverkehrs-GmbH in Offenburg (Germany) don’t have to sweat, even in summery outdoor temperatures. Liebherr service technicians have successfully serviced the heating, ventilation and air-conditioning (HVAC) systems in the electric trains. As part of this so-called “summer maintenance” a total of 43 passenger and 24 driver’s compartment air-conditioning systems were inspected and overhauled.

The regular check of the cooling cycle is an annual and legally prescribed inspection and an essential part of Liebherr’s customer service package. Skilled service technicians carry out a careful visual inspection of the HVAC units including refrigeration components. This involves cleaning the condensers, covering seals and replacing refrigerants or conspicuous components. With these measures, Liebherr guarantees that the air-conditioning systems perform flawlessly – no matter how hot it is outside.



© SWEG Südwestdeutsche Landesverkehrs-GmbH

Every year, Liebherr performs the “summer maintenance” of HVAC systems for SWEG’s Talent 3 trains.

Going strong in Toronto

When systems fail, this can quickly become expensive for operators. Regular inspections, on the other hand, can help to detect problems at an early stage and thus avoid breakdowns or at least keep them as short as possible. With this in mind, Liebherr was commissioned by the Toronto Transit Commission to maintain 40 HVAC systems for the Toronto Rocket subway fleet.

Every day, the Toronto Transit Commission (TTC) subways are in operation in the Canadian city of Toronto, reliably taking passengers from A to B. The Toronto Rocket trains have been in operation since 2008 and are equipped with heating, ventilation and air-conditioning (HVAC) systems from Liebherr. To ensure that the systems continue to work reliably, they are maintained and overhauled by Liebherr. From March 2024 to March 2025, 40 units will be serviced and technically inspected by Liebherr service technicians at Liebherr-Canada Ltd. in Burlington (Canada).

“We are proud that we have once again been able to gain the trust of our customer,” says Wolfgang Boettcher, Head of Customer Support at Liebherr-Transportation Systems in Korneuburg (Austria). “This follow-up order confirms our high service quality and the expertise of our employees.

We look forward to continuing our successful collaboration and making an important contribution to the energy efficiency of our customer's subway vehicles.”

This follow-up order includes extensive inspections, cleaning the systems, checking and replacing worn parts and those that are subject to the preventive actions in the maintenance manual as well as ensuring the efficient and trouble-free operation of the HVAC units. This not only helps to extend the products' life span, but also to reduce operating costs and improve the air quality in the passenger compartments. The units can continue to deliver a strong performance.



Liebherr-Transportation Systems has once again been commissioned to maintain 40 HVAC systems on the Toronto Rocket Subway fleet.

Smooth driving in Budapest

Tram rides can sometimes be a bit bumpy as the tram travels over tracks or takes curves. Roll coupling components by Liebherr ensure a safe and smooth ride experience – as it is the case with the Combino low-floor trams in Budapest. These were recently equipped with new spare parts.

The Combino trams operating on line 4 and 6 in downtown Budapest (Hungary), have been equipped with new roll coupling components by Liebherr-Transportation Systems. The spare parts have been installed in the anti-buckling system of the trams, ensuring that the vehicles stay on track and do not have any dangerous inclinations or kinks. Liebherr supplied a total of 189 control cylinders and 39 damping cylinders for this purpose.

The hydraulic elements play an important role: in combination with electronic control, sensors and pneumatic elements, the control and damping cylinders react in real time to changes in the driving dynamics. Especially in modern

low-floor trams, the passenger compartment is positioned low above the rails, which makes the lateral rolling motion more noticeable. To avoid this effect, the cylinders of the roll coupling system enable precise and controlled movement. At the same time, they reliably dampen vibrations and shocks. The entire hydraulic system works passively, so that derailments due to computer errors are ruled out. The tram is therefore more stable on the tracks and passengers enjoy a smooth ride.



Liebherr technology on board: the Combino low-floor tram in Budapest.

Liebherr on board the installed base of rolling stock

Regional coverage

NAFTA

Products and solutions

Heating, ventilation and air-conditioning (HVAC) systems

- Roof mounted
- Under floor
- Modular air-conditioning systems (MACS)

Hydraulic systems

- Active, semi active and passive damper systems

Providing the following functions:

- Bogie steering
- Curve detection
- Electro-hydraulic brake actuator (EHBA)
- Levelling
- Liebherr Controlled Axle Steering (LiCAS)
- Roll coupling
- Running gear control

HVAC coolant solutions

- Conventional refrigerants
- CO₂
- Propane
- Air cycle

Europe

Asia/Pacific

Including countries applying GOST standards administered by the Euro-Asian Council for Standardization, Metrology and Certification (EASC)

Africa/Middle East

OEM and production sites
Korneuburg (Austria)
Marica (Bulgaria)
Pinghu (China)

Sales and service sites
Bangalore (India)
Gatwick (United Kingdom)
Laval (Canada)
Saline, Michigan (USA)
Mannheim (Germany)
Paris-Taverny (France)
Reiden (Switzerland)

Aerospace

Unfolding efficiency

Improved aerodynamics need longer wing spans and longer wings need to fold their wing tips to match with the airport gates. Liebherr provides reliable folding mechanisms for future more efficient aircraft platforms.



A 3D printed milestone

From the printer to the sky: For several years now aircraft have been flying with 3D-printed components from Liebherr-Aerospace. With the so-called additive manufacturing, increasingly complex components can now be produced, making the technology very interesting for aircraft construction. A new milestone has now been reached: both the aircraft manufacturer Airbus as well as EASA (European Aviation Safety Agency) have approved a flex shaft, a component of the flight control system produced by Liebherr using additive manufacturing for series production.

The conventionally manufactured flex shaft, which was also developed by Liebherr years ago, consisted of seven individual parts and has now been replaced by a single 3D-printed component. This not only increases reliability but also saves weight. The flex shaft is used in the high-lift system of the Airbus A350, where it is integrated into the active differential gearbox of the flap system. The flex shaft transmits the rotary movement to a position sensor and thus compensates for an angle and axis misalignment between gearbox and sensor. The component is significantly more complex compared to the 3D-printed parts previously developed and manufactured by Liebherr and thus represents the next step towards applications in highly integrated systems in aviation.

Liebherr is one of the leading companies in Europe in terms of technology and has been printing non-safety-critical parts of the highest quality for years, such as a sensor bracket for the nose landing gear of the Airbus A350.

Liebherr's goal is to build completely new components and systems that are lighter, smaller and cheaper to manufacture as an addition to the value chain. The development of 3D printing technology is rapid and Liebherr is right in the middle of it.



Ready for series production:
Liebherr's 3D printed flex shaft for the Airbus A350 high lift system.

Additive manufacturing – layer by layer

Additive manufacturing is the name given to a process which uses digital 3D design data to build up a component layer-by-layer by melting material. The term “3D printing” is used more and more often as a synonym for additive manufacturing. However, additive manufacturing is a better description, indicating that the process involved is a professional production process which differs significantly from conventional subtractive manufacturing methods. Instead of milling a part from a solid block, for example, additive manufacturing builds up components layer by layer from materials which come in fine-powder form. Materials available include a variety of different metals, plastics and composites.

Once the additively manufactured component is finished, the excess titanium powder is extracted and prepared for the next printing process.



Ambition and long-term vision

Liebherr-Aerospace Toulouse has acquired two companies: SIBI SAS and GIT Galvanoplastie Industrielle Toulousaine SAS (GIT SAS). Liebherr's center of excellence for environmental control and thermal management systems is thus expanding industrial capabilities and strengthening its competencies.

New capacities for sheet metal processing

In December 2023, Liebherr-Aerospace Toulouse SAS, has acquired the activities of SIBI SAS, a subsidiary of the Industrial Family Group KEP Technologies. A new Liebherr legal entity called "Liebherr-Aerospace Montauban SAS" has been created and all SIBI SAS employees were taken over.

The company is specialized in the industrialization and production of metal assemblies and a key player in precision mechanics for the aerospace industry, particularly in the sheet metal sector.

In 2022, it generated sales of around €11 million and employed over 120 people at its two sites in Montauban and Toulouse (France).

"With the acquisition of SIBI SAS, we wish to strengthen our operational and industrial performance by drawing on the skills of Liebherr-Aerospace Montauban's employees, who have acquired extensive experience in sheet metal working, machining of complex parts, aeronautical welding, and assembly," explained François Lehmann, Chief Financial Officer of Liebherr-Aerospace & Transportation SAS and Managing Director of Liebherr-Aerospace Toulouse SAS. "Our aim is to reinforce the company's industrial capabilities to meet the growing needs of the sector in context with the increasing aircraft production rates."

Aerial view of Liebherr-Aerospace Toulouse SAS



A key skill in surface treatment

In 2024, Liebherr-Aerospace Toulouse has acquired the company GIT Galvanoplastie Industrielle Toulousaine SAS (GIT SAS), a company with expertise in surface treatment of aerospace parts. The company has been renamed and registered as Liebherr-Aerospace Coatings SAS.

Based in Cugnaux, in the vicinity of Toulouse (France), the company specializes in surface treatment and the application of liquid paint on various materials for the aerospace industry. In 2023, GIT SAS achieved a turnover of €8 million and employed more than 80 people.

“With the acquisition of GIT Galvanoplastie Industrielle Toulousaine SAS, we have added a key skill, surface treatment, to our portfolio of industrial competencies

by drawing on the expertise of GITs, i.e. now the employees of Liebherr-Aerospace Coatings SAS,” said François Lehmann. “We are adding both an industrial capacity and new cutting-edge processes that will enable us to support our growth and that of our customers. This acquisition comes less than three months after the one of SIBI SAS. These two acquisitions testify to our ambition and long-term vision to meet the growing needs of the aerospace sector, and to consolidate our presence in the region of Occitania.”

Both, Liebherr-Aerospace Montauban SAS and Liebherr-Aerospace Coating SAS, are a 100 %-owned subsidiary of Liebherr-Aerospace Toulouse SAS. They are managed by Guillaume Deltombe, former production manager at Liebherr-Aerospace Toulouse SAS.



GIT, a 100%-owned subsidiary of Liebherr-Aerospace Toulouse SAS, has now a new name: Liebherr-Aerospace Coatings SAS.

The World with Liebherr

Aiming high

Designed for projects up high: the luffing jib cranes 280 HC-L 12/24 and 542 HC-L 18/36 from Liebherr at work on an impressive construction project in Auckland (New Zealand). Measuring 187 m in height, the "Seascape" skyscraper will be the tallest residential building in New Zealand when completed.





Interview with the family shareholders



Stéfanie Wohlfarth and Jan Liebherr, vice president and president of the administrative board of Liebherr-International AG, share their thoughts.

Mrs Wohlfarth, Mr Liebherr, the Group is celebrating its 75th anniversary in 2024. Your grandfather, the founder of the company, Hans Liebherr was known for his pioneering spirit. What do you think he would have liked in particular about the group of companies today? Where does his pioneering spirit live on?

Jan Liebherr: We have enjoyed healthy, sustainable and organic growth from the foundation of the company to the present day. Our grandfather would certainly be impressed if he could see how the products that he introduced have been developed and how the range of products has increased.

Stéfanie Wohlfarth: He would also be happy that the second generation continued to build up the Group, expanded it immensely and handed it over successfully to us as the third generation. And he would be very pleased about the diverse range of technology that we now offer. His pioneering spirit can still be felt in every Liebherr product in some way, as innovation and progress continue to be at the heart of our company.



Which moments or successes in the company's history have been particularly significant from your perspective?

Stéfanie Wohlfarth: The first ten years of the company's existence were definitely decisive. They were shaped by some groundbreaking new products. In my opinion, the early internationalisation of our company was a brave and pioneering step. Our grandfather already expanded to South Africa and Ireland back in the late 1950s. Many of the foundations for our current product segments were laid at this time. It was also important that the Group grew organically, from its own strength and own ideas – a principle to which we remain faithful. This goes hand in hand with the fact that we have always been able to successfully overcome periods of economic weakness throughout our company's history.

Jan Liebherr: It's equally worth noting that we developed our own expertise in component development at an early stage, which enabled us to offer our customers tailor-made solutions. The efficiency and environmental friendliness of products have also played an important role in our company for a long time. The early introduction of CFC-free domestic appliances in 1993 is a good example of this. Our entire Group – as we know it today – was also shaped by the restructuring into product areas in 2002.

How does the past influence the company today?

Jan Liebherr: Our past achievements are undoubtedly the basis for our current success. They have got us to where we are today. And they have a significant impact on what we stand for and our ability to position ourselves in the market. The pioneering spirit of our early years is alive everywhere in the company. Our history inspires us to also take on future challenges.

You both completed your first year as vice president and president of the administrative board of Liebherr-International AG in 2023. What were the highlights for you?

Stéfanie Wohlfarth: The last year took us to many of our sites around the world. This not only gave us a good insight into the current developments on the ground, but often gave us the valuable opportunity to talk to people in person. We were particularly pleased with the exceptionally positive response at Conexpo, North America's biggest construction trade show. It was a striking confirmation of our strong market position and our great customer satisfaction. Equally noteworthy for me was the inauguration of the "Haus Montafon" extension at the Löwen Hotel in Schruns.

Jan Liebherr: Our partnership with Fortescue, to develop emissions-free solutions for the mining sector, made significant progress last year. The first T 264 mining trucks from the major contract have already been delivered and the integration of the zero-emissions battery and fuel cell technology into the T 264 is in full swing. And we achieved another milestone with the delivery of the 2,000th crane in one year from our plant in Ehingen.

Stéfanie Wohlfarth: We also achieved major things in aerospace in 2023, securing the contract to supply electro-mechanic actuators for the flight control system of the electric eVTOL aircraft from Eve. The actuators with fully integrated electronics are among the first in the world to be used for primary flight control. And these are just some of the milestones from last year.

What were your greatest challenges last year?

Jan Liebherr: Although we managed to stabilise the supply chains to some extent, they continued to pose difficulties in some of our divisions. There were also declines in demand



in some product segments and the global political situation is still creating uncertainty. Despite these challenges, we remained on course overall and navigated our company through these changeable times.

Let's take a look at the figures. How would you rate the last business year in this regard?

Stéfanie Wohlfarth: Our overall assessment is very positive. Despite the occasionally challenging environment, we were able to increase both our revenue and our operating result. The revenue growth shows that our products and services are in demand and that we can adapt effectively and quickly to market changes. We are managing to succeed in challenging times such as these because we are well positioned with our diversified, international structure, our excellent proximity to our customers and our dedicated employees.

Digitalisation, alternative drives, autonomy and automation have been your priorities in technology in recent years. What progress have you made here?

Jan Liebherr: In the area of digitalisation, we continued to develop our digital platforms with the aim of further increasing the efficiency and safety of operating our machines. Concrete examples of this include the integration of the Tower Crane Portal into our MyLiebherr customer portal and the development of useful applications such as MyNotifier, which supplies crane drivers with important operating data.

Stéfanie Wohlfarth: Progress is also being made with autonomy and automation. One example is our work on the automated disassembly of battery systems. This will allow more vehicle batteries to be recycled in the future.

Jan Liebherr: We made remarkable progress in alternative drives, including with the development of machines with electric drives. Our first battery-electric L 507 E wheel loader and the electric material handling machine LH 80 M High Rise Industry are two examples of new innovations. As part of our open-technology approach, we have continued to work with alternative energy sources.

Let's take a look at the current business year. What are your predictions for 2024?

Jan Liebherr: Although the overall forecasts for the global economy are relatively cautious and the conditions and uncertainties we have mentioned will have an impact, we are confident. A solid order backlog and good demand in many industries give us reason to be optimistic. Due to our high level of diversification and international orientation, we are well placed to absorb declines in individual product segments and countries and maintain our successful course.

Given that you are celebrating the company's 75th anniversary, what are Liebherr's goals for the next decades?

Stéfanie Wohlfarth: We will continue to focus on healthy growth as a long-term goal for the years and decades to come. We want to achieve this by attracting people who are enthusiastic about technology and want to responsibly help shape the world of tomorrow and beyond with their ideas.

Thank you for sharing your thoughts!

This is an extract from the interview conducted in March 2024 as part of the 2023 annual report.

How it all began



Recognising the signs of the times

After the Second World War ended, the priority in Germany was to rebuild the bombed-out cities. By inventing the mobile tower crane, Hans Liebherr helped to speed up the reconstruction work and laid the foundations for the Group that exists today.

However, success was a little slow in coming. In the first year, he did not sell a single one of his cranes. However, his unswerving belief in his invention proved him right. The prototype crane was used to rebuild the town hall in Wiesbaden (Germany) and was a great success. The Upper Swabian company was about to make history.

When the first TK 10 tower crane left the plant in Kirchdorf an der Iller (Germany), the local highway authority refused let it cross the bridge there, saying it was too heavy. Hans Liebherr disagreed and got in the driver's seat himself and manoeuvred the truck with the crane across. The bridge held firm. A new structural analysis taking account of the large wheelbase of the truck and the more advantageous weight distribution later theoretically proved that Hans Liebherr had been right.

Milestones in the company's history

Hans Liebherr develops the world's first mobile tower crane, which speeds up the rebuilding of Germany.



The TK 10 set new benchmarks in the construction industry as the first mobile tower crane and laid the foundations of Liebherr's success.

1949



1950



Crane production starts in Kirchdorf an der Iller (Germany) and is later moved to Biberach an der Riss (Germany), when the company starts manufacturing its own components.

When Hans Liebherr is unable to find product components on the market, he quickly starts making them himself.



The demand for cranes increases rapidly and there is a shortage of gear wheels. This prompts Hans Liebherr to go into a new area of business as he develops a gear hobbing machine.

1952



Hans Liebherr develops Europe's first hydraulic excavator, the L300, which is four times lighter than conventional machines.



Low weight plus high performance equals success for Liebherr hydraulic excavators.

1954



1954



Liebherr builds its own refrigerator factory Ochsenhausen (Germany) and starts producing fridges.



Non-stop refrigerators: Hans Liebherr recognized demand at an early stage.

1955



Liebherr widens its range of construction machines to include concrete mixers and starts manufacturing in Bad Schussenried (Germany).



The first reverse drum mixer – still a pre-series model here – becomes a bestseller.

The company expands abroad and builds a plant in Ireland to produce tower cranes and special cranes.

Tower cranes, and later also special and maritime cranes, are produced in Killarney in the Southwest of Ireland.



The "Europe" in Killarney is the first Liebherr hotel. Today, the Group runs six first-class hotels: three in Ireland, two in Austria and one in Germany.

1958



At the same time as the Irish subsidiary, a Liebherr plant is also being built in South Africa.



Did you know that ...

... the first Liebherr subsidiary outside Europe was established in South Africa?

The demand for high-quality construction machinery was high, but intercontinental transport was expensive. Hans Liebherr expanded to Springs in South Africa in 1958 and was able to supply neighbouring countries from there, too. There are now several subsidiaries in South Africa that cater to the local construction, civil engineering and mining industries and offer back-up service and spare parts for Liebherr machines and equipment.

1960



Liebherr establishes a plant in Lindenberg (Germany) and enters the aerospace industry.



The aerospace division grows from a repair firm into a world-leading system supplier to the aerospace industry.

1961



Liebherr opens a crawler excavator production plant in Colmar (France) and later expands the product programme.



The RT 1000 crawler excavator produced in Colmar has an operating weight of 20 tonnes.

The establishment of the plant in Ehingen (Germany) heralds the start of the journey to become the global market leader for mobile and crawler cranes.

The LTM 1025 is the world's first all-terrain mobile crane and combines on-road and off-road operation.



With the launch of the LTM 1025, Liebherr sets new standards with the world's first all-terrain mobile crane.

Liebherr begins series production of diesel engines, which makes it less dependent on external suppliers.



Bestseller from Ehingen (Germany): the AUK 40T-60 with its 24-metre telescopic boom and fully hydraulic crane drive.

1969



1977



1984



1970-1976



Liebherr expands to North and South America as well as in Europe and invests in new production sites.

1983



The new wheel loaders have virtually wear-free brakes.

The L 531 and L 541 wheel loaders are launched. Their hydrostatic travel drive reduces fuel consumption. The stepless transmission is ideal for commercial vehicles and the brakes are practically wear-free.

"We still continue to challenge ourselves to be at the forefront of technology. Technology is not an end in itself – it is always about greater benefits and solutions for our customers, with appropriate value for money."

Hans Liebherr, 1985

Hans Liebherr stayed true to his principles his whole life – they continue to shape the company and live on in the Group's core values.



The second generation of the Liebherr family seamlessly continues Hans Liebherr's success and pushes ahead into new markets.

1993



1996



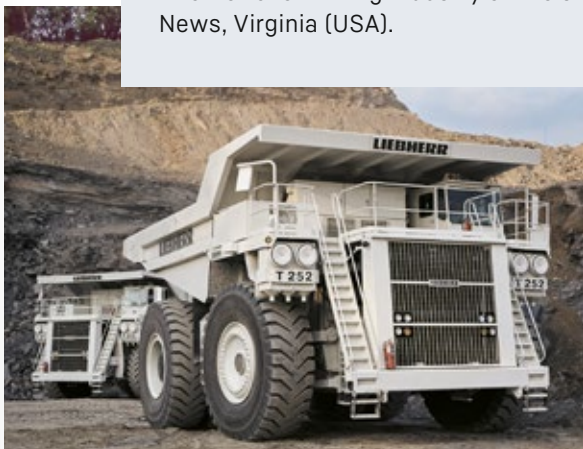
1995



1997



Liebherr begins producing mining trucks for the international mining industry at the site in Newport News, Virginia (USA).

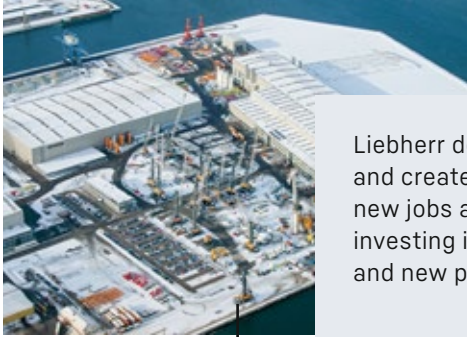


The T 252 mining truck is the first model to be produced in Newport News, Virginia (USA).

Liebherr-Mietpartner GmbH is founded in order to standardise and expand the rental business.

Digitalisation, automation, networking and alternative drives are important areas of research.

Maritime crane production on the Baltic Sea: Liebherr opens a plant in Rostock (Germany) for mobile harbour cranes, ship cranes and offshore cranes in 2005.



Liebherr doubles its revenue and creates thousands of new jobs around the world by investing in site expansions and new production facilities.

The construction of the largest crane in the company's history begins: the HLC 295000 Heavy Lift offshore crane with a lift capacity of up to 5,000 tonnes.

2003-
2008



Since
2016



2018

2012



2017



The first members of Liebherr's third generation join the Group's management team.



The HLC 295000 Heavy Lift offshore crane with a lift capacity of up to 5,000 tonnes.

There is a world premiere in the aerospace product area when an Airbus A380 flies with a 3D-printed spoiler actuator valve block for the first time.

In the area of climate-friendly energy sources, Liebherr relies on the alternative fuel HVO, which is obtained from cooking oil waste, fat residues, waste fats and vegetable oil.



The majority of the Group's construction machinery, cranes and mining equipment can be fuelled with HVO.

2021



2019



With the LB 16 unplugged the Group showcases the world's first rotary drilling rig that can be operated by battery without any restrictions compared to a conventional drive.



All quiet on the building site: Liebherr opens a new chapter with the LB 16 unplugged.

2022



The first Liebherr hydrogen engine, the H966, also offers great potential for the future and is used in the R 9XX H2 crawler excavator.

2023



The Group has made quantum leaps in energy efficiency and circularity in the area of refrigeration and freezing, with the innovative patented BluRoX technology. Liebherr is the only manufacturer in the world to insulate its appliances with a vacuum combined with perlite – a finely ground lava rock with very low thermal conductivity.



Launch of the first BluRoX models: the revolutionary technology uses lava rock for cooling and freezing – a quantum leap in energy efficiency.

Liebherr has already influenced the history of technology in many industries and will continue to shape the world of the future with its pioneering spirit.

The Rail Express

The A 922 Rail Litronic railroad excavator

A perfectly tuned hydraulic concept combined with the Liebherr LIKUFIX coupling system turn this railroad excavator into a flexible and steady top performer on any construction site.

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Railroad excavator

