

# From testing to knowing

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## Abstract

Ice factories, meat processing plants and breweries around the world rely on the refrigeration technology experts from GEA Refrigeration Germany GmbH. Based in Berlin, the company manufactures highly precise screw compressors, the heart of the cooling systems. In order to ensure and improve the quality and energy efficiency of its compressors, the company strives to permanently eliminate errors in design and production, and at its suppliers. Three ZEISS coordinate measuring machines, as well as ZEISS CALYPSO and ZEISS GEAR PRO software are helping the company come closer to its goals.

**KEYWORDS: highly precise screw compressors, cold temperatures, coordinate measuring machines, the source of errors**

Going skiing in August at temperatures over 100 degrees Fahrenheit in Dubai seems a little far-fetched. However, at the skiing center in Al Barsha, temperatures hover around the freezing point in the snow-covered 22,500 m<sup>2</sup> facility. The screw compressors from GEA Refrigeration Germany GmbH are a vital component in this undertaking. The company known and valued throughout the entire Eastern Bloc back in the days of the Cold War for its low-vibration cooling systems has belonged to GEA Refrigeration Technologies since 1994 and thus the GEA Group, a technology enterprise with around 24,000 employees around the globe. Since then, the company has continuously opened up new markets and regions with its constantly improved screw compressors.

It is now one of the market leaders in the industry. The solutions created by the 260 employees at GEA Refrigeration Germany GmbH ensure that the required cold temperatures are provided at one of the world's largest breweries in Mexico, one of the world's largest cooling houses in Mecca and, since recently, Curtis Island in Australia. The screw compressors are used there to liquefy natural gas. GEA Refrigeration Germany wants to be an even bigger player in this booming market. In order to serve new and promising markets, the company invested in a new measuring machine from ZEISS in 2013. The MMZ T gantry measuring machine is a super-sized coordinate measuring machine for which the measuring lab in Berlin had to be modified to provide the necessary ceiling height of six meters.



*Fig. 1. "Without highly precise measuring machines, we would be unable to manufacture with the precision that we now do," emphasizes Harald Wilke, Quality Department Manager*

## High tech for a new market

Natural gas must be cooled to minus 163 degrees Celsius to turn it into liquefied natural gas (LNG). As a result, its volume is reduced by a factor of 600, which allows it to be transported by ship without taking up much space. Sounds simple, however, it is anything but. The dimensions of such a compression system alone are enormous and therefore also the screw compressors. In order to enter this expanding market, the company recently developed and built an XXL screw compressor. It features two rotors that compress gases that will be used as coolants. While transforming back to its original gaseous state, the compressed and liquefied coolant removes heat from the surrounding area. The performance and energy efficiency of the cooling machines depends largely on the two screw-shaped rotors optimally interacting.



*Fig. 2. The screw-shaped rotors are the centerpiece of the screw compressors which compress the gas*

This requires highly precise manufacturing. The accepted tolerances lie between 0.02 and 0.01 millimeters and thus a value that is three-to-six times thinner as a human hair. "Without the appropriate measuring machines, this would not be possible," emphasizes Harlad Wilke, Quality Department Manager at GER Refrigeration Germany, pointing to the gantry machine from ZEISS that has been in operation since October 2013. It offers a measuring range of almost 16 square meters with measuring accuracy of just 2.8 micrometers. According to Wilke, "This machine is designed for the precise measurement of our complex and large parts." Nonetheless, the ZEISS MMZ in Berlin is not your everyday measuring machine. It is equipped with a rotary table and a tailstock specially developed for the company, which uses a bezel to very precisely hold the extremely large rotors in the axis. These rotors can weigh up to two tons, or as much as a fully loaded car. Thanks to the rotary table, the parts can be positioned so that the stylus on the coordinate measuring machine can capture the geometries from all sides.

## Tracking down errors

The ZEISS MMZ rising majestically in the front section of the company's air-conditioned measuring lab "gets peoples' attention just with its sheer size and quickly impresses them with its ease of use," states Carsten Göbel, the measuring technician responsible for the measuring lab at GEA Refrigeration Germany. Measurements are made here around the clock – no easy task considering the size of the rotors and the cast-iron housings. To demonstrate how easily the measuring machine can be loaded despite its enormous size, the average-size measuring technician moves quickly about the measuring table. From there, he steers the crane hanging over the measuring machine at a height of nearly six meters and easily positions a 600 kilogram rotor on the rotary table.



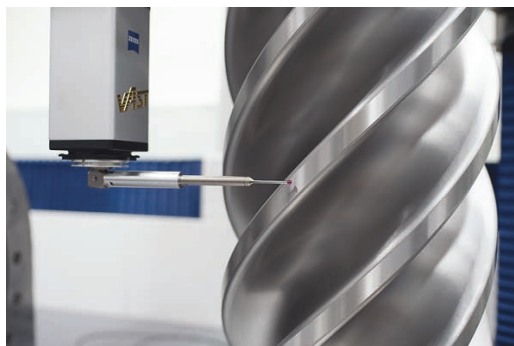
**Fig. 3.** "Thanks to the high-precision manufacturing processes, the screw compressors from GEA Refrigeration Germany are very energy efficient," explains measuring technician Carsten Göbel

In addition to Göbel, who is currently the only one measuring rotors on the ZEISS MMZ, five trained employees from production use the machine to measure their own housing components. “If they determine that the measured values, e.g. of the boreholes, exceed tolerance, they automatically look for the cause of the problems,” says Quality Manager Wilke. Thanks to ZEISS CALYPSO measuring software, they can quickly and, above all reliably, decide if they have to change the tool, correct the machine or stop production.



*Fig. 4. The measuring technician easily places a 750 kilo-gram rotor on the rotary table of the ZEISS MMZ T*

In the future, production employees will also be able to independently measure the rotors on the high-tech system. They will also receive support from ZEISS. With ZEISS GEAR PRO software, which is specially designed to measure gear wheels, operators can easily read and understand the printouts. “This is a major benefit of GEAR PRO,” summarizes Wilke, proudly stating that several important ideas for the development of the software originated with his company.



*Fig. 5. The ZEISS MMZ coordinate measuring machine measures a super-sized rotor*



*Fig. 6. Carsten Göbel and Harald Wilke discuss the measurement of a rotor on the ZEISS MMZ in the GEA Refrigeration Germany measuring lab*

## A good tradition

When it came time to find a measuring machine, the Berlin-based company, which by its own accounts is known the world over for the energy efficiency of its screw compressors, set the bar high. However, it came as a surprise that a measuring machine manufacturer backed away from these requirements. That another ZEISS measuring machine was chosen in the end came as no surprise. After all, the company had already had good experiences with their coordinate measuring machines from ZEISS. There is just something about decades of good quality. They have had a ZEISS UMC 850 coordinate measuring machine since their East Germany days. “Thanks to our persistence,” emphasizes Wilke, who has been ensuring the quality of the compressors in the company for decades.

For almost eight years, the company submitted one request after another to the Foreign Trade Minister of the former East Germany to obtain a highly precise coordinate measuring machine to ensure the quality of its products. Their requests were answered in 1988 just before the fall of the Berlin Wall. Since then, they have been using the ZEISS UMC 850 to measure their housings. ZEISS GEAR PRO software was introduced in 2012 to measure their smaller rotors. According to Wilke, “This is just as precise as the MMZ, if not quite as fast.”





*Fig. 7. The measuring technician checks the position of the rotor on the MMZ. The tailstock developed by ZEISS for GEA Refrigeration Germany reliably holds the rotor in place on the rotary table*

## Coupling was so yesterday

Ever since the company with manufacturing sites in Berlin and Halle began measuring its rotors with the two coordinate measuring machines, its coupling brackets have been gathering dust in the measuring lab. Because each rotor in a series at GEA Refrigeration Germany is the same as the others, the technicians no longer have to couple them in a time-consuming process. This means that the process of identifying the two rotors from production that have to fit together within the specified tolerances is now a thing of the past. According to Wilke, this procedure is still commonplace at many manufacturers of screw compressors. Many of them still manually check the fit of the rotors on coupling brackets using feeler gauges in the form of steel strips.

In addition to the reliability of quality assurance depending strongly on the individual tester, Wilke sees another key drawback to this approach: quality assurance takes a back seat to design and production. Thanks to its measuring machines, ZEISS CALYPSO and ZEISS GEAR PRO, GEA Refrigeration Germany now determines the source of errors at the push of a button and can initiate the elimination of problems wherever they may be. Wilke's summary: "As quality managers, we are now more than just checkers, we are knowers and controllers – and this makes our entire company that much stronger."

## References

[1] Innovation – The Magazine from Carl Zeiss Industrielle Messtechnik GmbH. Issue 18, p. 34-39, May 2015.