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Elliott turbomachinery processes Sakhalin LNG

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Advanced compressor technology and project management expertise are key to the project's success

Natural gas is a driving force behind the world's economy. In addition to fueling businesses, powering electricity production and heating homes, natural gas also underpins international financial markets. Access to dependable supplies of natural gas has a direct bearing on the security, growth and development of many countries, large and small.

As the demand for natural gas grows, so does both the search for new supplies and more effective ways to transport it to locations where it is needed most. Energy companies are reaching out to the farthest corners of the earth with their exploration and production efforts. With the consumption of natural gas anticipated to increase by 20% globally over the next 10 years, it is vitally important for energy companies to find new reserves, and to design, build and efficiently operate new processing facilities. Elliott, a leading manufacturer of turbomachinery, is providing these global energy companies with equipment, technical support, and on-site expertise every step of the way.

Developing Russia's Gas Reserves

In the spring of 2009 one of the world's largest integrated oil and gas production facilities has gone into production in Russia, the home of the world's most extensive natural gas reserves. Located at the southern tip of Sakhalin Island in the town of Prigorodnoye, the new $22 billion plant – known as Sakhalin II – consists of of three offshore platforms, an on shore production facility, 1000km pipe line, a liquefied natural gas (LNG) plant, and an oil export terminal.

Owned by a Gazprom-led consortium, the Sakhalin LNG plant consists of two process trains, each having throughput capacity of 4.8 million tonnes of LNG per annum. This plant is the first of its kind in Russia. When fully operational later this year, it will provide about 5% of the world's total supply of LNG. Elliott served as the prime equipment contractor on the project, supplying the refrigerant compressor trains at the heart of the facility's LNG operations.

Advanced Technology for a Harsh Climate

Shell developed a new double mixed refrigerant (DMR) gas liquefaction process for the Sakhalin II LNG facility that takes advantage of the cold weather conditions at the site. This advanced technology was selected to ensure maximum production efficiency in the extreme cold of Sakhalin's winters, where temperatures are often low as -35°C, and more than 1.5 meters of snow accumulates annually. Sakhalin II LNG is the first plant in the world running on this process.

A Trusted Supplier for The "Heart" of Two-Train Design

The Sakhalin II LNG plant consists of two identical LNG trains. Each LNG train features two strings of compression equipment – a precooled mixed refrigerant (PMR) string and a mixed refrigerant (MR) string.

Elliott had complete technical responsibilities for the PMR and MR strings. Each PMR string comprised a Frame 7 (85MW) gas turbine, a 12MW motor/generator used as a helper motor, and an Elliott 88MB6-5 PRM compressor. The MR strings included a Frame 7 (85MW) gas turbine driving a low pressure MR axial compressor, a 12MW motor/generator used as a helper motor and an Elliott 60MB6I medium and high pressure MR compressor.

Sakhalin Energy selected Elliott as prime equipment contractor to design and manufacture the centrifugal compressors. Significant factors in Elliott's selection included:

• Elliott's long and successful history of supplying compressors for LNG production;
• Elliott's track record of providing highly reliable and efficient equipment on previous LNG projects;
• Advanced and proven refrigerant compression technology;
• World class manufacturing facilities and capability of conducting 75,000plus kW full-load string test; and
• Experiences of leading and managing complicated large-scale project.

An Innovative Approach To System Control

Sakhalin II LNG uses speed control to achieve smoother process control, rather than rely on torque control like many other LNG installations around the world. In the plant, the PMR and MR string typically run at 3,600 rpm. If process loads increase and the speed drops, the motor control system introduces power to the motor to bring the string back to rated speed. On the other hand, if the gas turbine is not running at maximum power, an operator can send a signal to the gas turbine controller to increase speed. This increase will also be detected by the motor controller, which will then generate power to slow the speed of the string back down to 3,600 rpm.

Since temperatures in Prigorodnoye are extremely low throughout most of the year, starting procedures for all equipment had to be carefully considered. Starting power for the equipment is provided by one variable frequency drive (VFD) supplying two motors. A single VFD is used to start each string of equipment independently. After each string is started, both motors can be connected to the drive. Excess power can be exported from a string and shared with the other string in the LNG train. Excess power may also be exported back to the customer power system through the VFD.

All of the equipment at Sakhalin II is housed inside a noise enclosure. Elliott was responsible for ensuring that all of the machinery fit inside of the compressor section of the structure. Working closely with the gas turbine supplier and the installation contractor, the Elliott team developed a strategy to contain all of the equipment inside the structure, while minimizing its size. In addition, the design addressed the full spectrum of health, safety and environmental considerations to provide a safe work environment for plant maintenance personnel.

Full-Load Testing and On-Time Delivery

Due to the remote location of the Sakhalin II facility and the severe weather conditions that exist there for three quarters of the year, it was essential that all equipment shipped to the site be thoroughly tested and in working order prior to transport. This required transporting all of the components of a complete train to Elliott's facility in the USA for a full-load test. The motor, two transformers, the variable frequency drive, switchgear, and the axial compressor were shipped from Europe to the United States. The gas turbine parts were shipped from various locations to Elliott.

Using the recently expanded test facilities at its USA plant, Elliott moved the 88MB6-5 compressor – the largest vertically-split compressor ever built by Elliott, weighing 145 tonnes – directly from the assembly line onto the test stand. Once the compressor was in position, the gas turbine was moved into the test facility on a rail car and lifted into position to create the machinery string. Then all other auxiliary equipment was installed.

After all the equipment was secured, 37,280kW gas coolers linked to Elliott's permanent, on-site cooler farm were connected, along with valves, controls, electrical power and test instrumentation. Every component was evaluated using comprehensive testing protocols during nine weeks of testing attended by representatives from the various suppliers.

After testing was complete in May 2005, Trains 1 and 2 were loaded on rail cars at the USA facility and shipped to the port of Baltimore, Maryland. There cranes loaded the turbine and compressor equipment into the hold of a freighter. The total shipment of equipment consisted of approximately 200 crates, the largest measuring 2x4x10 metres.

Five weeks later, the ship reached Sakhalin Island. When it arrived, the team from Elliott was there, ready to receive the cargo. Within a narrow window of ice free weather, the equipment was quickly unloaded and transferred to the LNG facility construction site.

Responding To Challenges

As with any project of this magnitude, the construction of Sakhalin II was not without challenges. Material lost or damaged during shipping needed to be replaced as quickly as possible. In addition, on-site modifications were required to several major system components vital to the effective functioning of the equipment. When the client requested significant changes to the dry gas seals, Elliott design engineers and the project management team responded with an effective solution and without major disruption to the installation schedule. Whenever problems arose, Elliott and all other representatives cooperated closely to achieve successful, on time completion of the project.

As Elliott and its partners identified issues with the installation, it was often necessary to ship additional tools and parts to the site. Due to the isolation of the island, it was not unusual for it to take several weeks to order and receive tools or components. Careful planning on Elliott's part and meticulous coordination with its sub-vendors and with Russian Customs helped to minimized downtime and keep delivery and installation on schedule.

The extreme cold of the winters posed significant challenges for workers at the Sakhalin II jobsite. In the winter months when temperatures were often -35°C, all equipment was covered with snow and encased in a thick layer of ice. During the brief summer thaw, frozen ground quickly turned into ankle deep mud.

As the prime equipment contractor, Elliott was responsible for managing communications and troubleshooting problems from the project's initiation through its completion. Elliott managed translations among the various partners and also managed all of the sub-contractors, including visa, lodging, and travel arrangements for the manufacturer personnel and installation crews working on the site.

Elliott arranged for all equipment and project documentation submitted from vendors throughout the world to be translated into Russian for use by the end-users of the equipment. The documents were first completed in English, and when all technical details were approved by the installation contractor, a Russian version or a dual language version was produced.

All of Elliott's efforts have been highly recognized and appreciated by the client. As the Project Manager of Sakhalin LNG Project, Hilary Mercer said: "We are very positive regarding the performance of the Elliott organization. Specifically we appreciate the rapid response we got from both US and Japan when required, and the quality and cooperation of Elliott's representatives at the site.

A Bright Future For Russian Energy

Six years of intensive, focused work transformed the Sakhalin II project from technical drawings to an operating production facility. On February 18, 2009, Russian President Dimitry Medvedev officially inaugurated the LNG plant. At the time of the dedication, Train 1 was fully operational and Train 2 was undergoing precommissioning and nitrogen testing operations.

In recognition of the international impact that the plant will have on the worldwide supply of natural gas, UK's Prince Andrew, Duke of York, and Japanese Prime Minister Taro Aso joined President Medvedev at the opening ceremony. All parties present at the dedication understood the significant impact Sakhalin II will have on the world's natural gas supply. Thanks to Sakhalin Energy Investment Company's faith and trust in Elliott, the plant is sure to further strengthen Russia's position as a major energy supplier.

About Elliott

Elliott is a global leader in the design, manufacture and service of technically advanced centrifugal compressors and steam turbines used in the petrochemical, refining, oil & gas and process industries, as well as in power applications. The company employs 1,900 persons in 30 locations around the world. Elliott is a wholly owned subsidiary of Ebara Corporation, a major industrial conglomerate headquartered in Tokyo, Japan. Ebara employs 15,000 people and has sales of US $5.3 billion.