



LNG plant refrigeration train

Electrical motors used as starter / helper / generator
Bonny Island, Nigeria

The case

One of the world's largest LNG complexes

The project for Nigeria LNG Ltd based in Bonny Island, Nigeria utilizes the gas reserves of the eastern part of the Niger delta by converting them to liquefied natural gas for export to industrial customers in Europe and Turkey. The plant has seen substantial growth since start up 8 years ago and now has six liquefaction trains in operation. The capacity of each train is 4 million metric tons of LNG per year. In 2002, GE Power Conversion's business was chosen to supply the first two sets of a complete electrical system for the liquefaction of trains 4 and 5. Subsequently in 2004, Power Conversion was selected again for the electrical set for train 6.

Regarding the liquefaction in the LNG supply chain

The most economical transportation of natural gas for destinations upwards of 5,000 miles is through liquefaction. The patented liquefaction process reduces the volume by 600 times. Natural gas liquefaction occurs when the gas is cooled to -160°C (-260°F). Several processes are patented. It consists mainly of methane (C1), ethane (C2), propane (C3), butane (C4) and nitrogen (N2). The liquefaction system used at Bonny Island is a conventional process using a Propane Refrigeration (PR) pre-cooling step followed by a Mixed Refrigerant (MR) condensation cycle.



imagination at work



The challenge

The customer's requirements were very specific, with only two similar installation set-ups in the world. Power Conversion was able to meet the challenges of optimizing available energy for the customer by using their technical competencies and capabilities.

Original concept to reduce the number of equipment

For each train, a converter drives two 2-pole turbo synchronous machines of 13 MW each. One machine is dedicated to the 60 MW compressor of the propane cycle, and the other one to the 80 MW compressor of the MR cycle. The two 2-pole turbo synchronous machines are used as:

- **Starter:** to start the gas turbine by accelerating the shaft until the combustion enables the turbine to work alone
- **Helper:** to provide additional power to the gas turbine if required
- **Generator:** to regenerate the excess of power (automatic energy management)

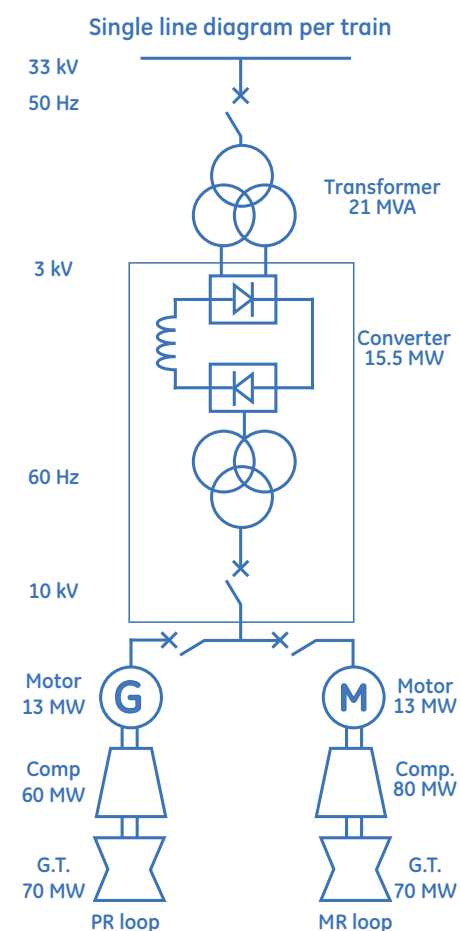
Dynamic stability studies

Responding to customer demand, Power Conversion performed time domain studies of the entire system dynamic behavior, including network, gas turbine and compressor shaft-lines. The studies analyzed different occurring events to confirm the stability of the whole process under any possible situations.

Our solution

3 complete electrical systems each comprised of:

- Harmonics filters 33 kV
- Network transformer 33 kV / 3 kV
- Frequency converter SD7000 15.5 MW
- Machine transformer 3 kV / 10 kV
- 10 kV switchboards
- 2 high-speed motors 3,600 rpm – 10 kV - Power 13 MW each
- Cooling systems
- Energy Management System



LCI converters bring high availability and increased reliability

Based on thyristor technology for synchronous motors, the SD7000 LCI drive allows speed control up to 100 MW.

Power Conversion's proven technology and high reliability, for processes requiring high availability, ensures continuous operation 365 days per year. In addition, the four-quadrant operation enables the regeneration of energy to the network with no additional costs.

The fully digital controller integrates all the components of an automation controller into a coherent unit: a mechanical structure for industrial environments, powerful CPUs, high-performance operating system, communication networks and industrial inputs/outputs.

Combining the thyristors advantages and the last generation of controllers, the SD7000 converter meets the compressor requirements in terms of:

- High overall efficiency (> 98.5%)
- High availability and reliability
- High network disturbance robustness
- High starting torque and throughout the speed range
- No upper limit of power
- Four-quadrant operation
- Reduced installation time and costs

Power regeneration for increased efficiency

During operation thanks to regeneration of excess power, whenever the need is for any loop to reach more or less power, a system balances the need from the power grid to a gas turbine, from a loop to the other one or from a gas turbine to the power grid. So in static mode, as well as in transitory mode, the gas turbine always performs at its optimal operating point.



Energy Management System for smooth operation

The Electrical Protection and Control Functionality (EPCF) system monitors energy flow and controls the energy requirements of each compressor (PR and MR). It also communicates the energy balance and status of each part of the electrical system through to the gas turbine control system and the plant's DCS.

Harmonic filters also improve power factor

Based on extensive experience, Power Conversion has studied and designed the suitable harmonic filters for the power grid to ensure reduced harmonics disturbance while improving the power factor of the whole grid.



Increase of availability through the interconnection of each train's supply

The power supply for trains 4, 5 and 6 are interconnected. In the event of breakdown, each converter train can function in back up mode for the neighboring train.

Vision

From the 33 kV network to the 13 MW synchronous motor shaft end, Power Conversion carried out all the studies, supplied and integrated the different electric components and commissioned the complete electrical system.

Trains 4 and 5 were commissioned and put into use during the first quarter of 2006 and train 6 in the first quarter of 2007, with all equipment in operation since initial installation.

10 kV switchboards: security in all situations

Up to nine 10 kV circuit breakers are installed to ensure proper operation and protection of the LNG trains during start up, continuous running and back up.

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