


“Lady of Victories”

This self-contained power generation barge is right at home in the Caspian sea

Francesco Gentile



It is 95 meters long and contains over 190 km of electrical and instrumentation cables. It has a total electricity output of 120 MW, is environmentally friendly and since April 2007, the Caspian Sea has been its home. Affectionately known as “Lady of Victories,” it is a self-contained power generation barge designed to serve the Kashagan offshore oil field in the Caspian Sea. This Power Generation barge is the result of over two years of fruitful collaboration between ABB and Rolls-Royce Power.

Extraction and generation

The Kashagan Field is not only the largest oil field discovered in the North Caspian Sea PSA contract area, but globally, it is the largest that has been discovered in the last 30 years. It is located approximately 80 km from Atyrau in Kazakhstan, and covers a surface area of about 3,400 km². It contains an estimated 38 billion barrels of oil, of which 13 billion are potentially recoverable in case of gas re-injection.

Given its size and other factors, the development of the Kashagan field represents one of the greatest challenges in the petroleum industry. These factors include: a deep, high-pressure reservoir; a high sulfur content – of the order 16 to 20 percent – combined with the hydrogen sulfide (H₂S) concentration in the oil to be extracted; shallow waters of between three and four meters that freeze between November and March; the sea-level is also known to fluctuate during the rest of the year; wide temperature variations of the order –30 °C to +40 °C are not uncommon; and finally an extremely sensitive environment

with a variety of internationally protected species of fauna and flora.

It was decided that the Kashagan field should be developed in three subsequent phases, and this would require the careful co-ordination of simultaneous operations, including development and production, construction of new plants, and the upgrading and expansion of already existing ones. During the three phases, production will increase from an initial level of 75,000 bpd (barrels per day) to a peak of 1.2 million bpd in the second half of the next decade. The proposed development will include both offshore and onshore processing facilities as well as the interconnecting of trunk lines.

ABB’s involvement began in the first development phases of the Kashagan field when it was awarded a contract in September 2004 by the sole oilfield operators, Agip KCO B.V., to design and construct a self-contained barge. In fact, ABB’s Power Generation Barge 8, completed in collaboration with Rolls-Royce, was to become the

first process module to be delivered to the Kashagan Field.

The Power Generation Module 8

The power generation barge is designed to provide and manage electrical power to the Block D offshore complex in the Kashagan field. The contract included engineering, procurement, fabrication, commissioning and start-up of the Power Generation Module No. 8.

ABB’s power generation barge is designed to provide and manage electrical power to the Block D offshore complex in the Caspian sea’s Kashagan field.

The barge weighs about 1,000 tons, is 95 meters long, 16 meters wide and 5.5 meters high, and the hull is made of low temperature carbon steel plates to accommodate the extreme weather conditions of the Caspian sea, as well as to comply with required marine standards¹⁾. These two factors also dictate the type of materials that should be used for other structural components to ensure that the barge equipment is properly preserved during navigation. For example, heat tracing and insulation has been extensively applied to all piping circuits. The barge is equipped with four 30MW Turbo-generators and auxiliary systems, gas conditioning skids, a Load Management System/Distributed Management System (LMS/DMS), step-up and step-down transformers, high-, medium- and low-voltage electrical distribution switchgears, and various topside structures. Passive Fire Protection (PFP) requirements for these structures have been met by utilizing special prefabricated panels (certified to “A60” class standard) which guarantee adequate resistance to fire.

A technical summary of ABB’s power generation barge is given in **Factbox 1**.

Factbox 1 The Power Generation Module 8 – a technical overview

Main equipment

- Four Rolls-Royce RB 211 6762 30 MW gas turbine generators. Each turbine generator is equipped with a DLE (Dry Low Emission) System. That is, each gas turbine comes with an inlet air filter house, exhaust stack and oil cooler
- Four fuel gas conditioning packages complete with four 60kW heating streams
- Three 2 MVA emergency diesel generators

Main electrical equipment

- High-voltage switchgear SF₆ Type – 35 kV 40.5 kV insulated voltage
- Medium-voltage switchboard Air Type – 6.6kV 7.2kV insulated voltage
- Four 10/35 kV 35MVA step-up transformers
- Two 35/6.6kV 25MVA step-down transformers
- Low-voltage MCC rated to 400V
- UPS 230 Vca, double redundant, rated up to 40kW
- DC Battery charger 110Vcc 20KW – double redundant
- Batteries – double redundant

I&C

- Load Management System/Distributed Management System LMS/DMS suitable for up to 3,100 inputs and outputs
- A fire and gas detection system

Topside buildings

- Steel structure buildings with a total weight of 300 tons
- Two blast-proof and fire-resistant gas turbine generator buildings (each covering 450m²) – A60 rated
- An A60 rated fire-resistant electrical building over two floors covering a total of 290m²
- Pipe racks
- Vent tower

Miscellaneous

- HVAC system:
 - Heating: Two 250 kW heating for gas turbine building plus 110 kW heating for main generation building
 - Cooling: 180 kW cooling for main generation building
- Fire fighting systems

Footnotes

¹⁾ A certificate from the Naval Authority is required as proof of compliance.

Extraction and generation

The power generation barge hull was fabricated in sections. The topside structures were prefabricated in a workshop before being transferred to the dry dock.



Sitting in the Malta fabrication yard, the 1,000 ton, 95 meter long, 16 meter wide and 5.5 meter high barge starts to take shape.



Construction overview

ABB PS&S (Process Solutions and Services) **Factbox 2**, situated in Milan, was responsible for the engineering, procurement, fabrication and commissioning of the complete Power Generation Module, while Rolls-Royce supplied the four fully assembled and factory tested Turbo-generators.

Over 190 km of electrical and instrumentation cables (and relevant cable ways) lie in special segregated areas throughout the barge.

Structural analysis was used to dimension the key components of the hull and topside structures. This analysis also took into consideration the possible dynamic loads during navigation. Pipe and cable routing was determined using 3D modeling, which also helped to supply the construction details for the pipe spools and supports to be fabricated. In all, a total of 100,000 engineering man-hours was required to develop all the engineering details. An experienced and fully equipped company, Malta Shipyards Ltd (MSL), was subcontracted to work on the barge construction.

The barge hull was fabricated in sections, starting with standard steel

plates that were then assembled in a dedicated dry dock. The topside structures were prefabricated in a workshop before being transferred to the dry dock for final installation. The entire fabrication process was subject to continuous reviews by DNV (Det Norske Veritas)²⁾, which then issued a formal "Statement of Compliance" to certify that the quality of the completed work was in accordance with the required international standards.

Over 190 km of electrical and instrumentation cables (and relevant cable ways) lie in special segregated areas throughout the barge, while fire and gas detection devices are positioned

all over to allow for constant monitoring. Marshalling panels have been designed to interface with the main plant DCS (Distribution and Control System) and these activate appropriate action when fire or gas has been detected.

Footnotes

²⁾ Det Norske Veritas (DNV) is an independent foundation whose "core competence is to identify, assess, and advise on how to manage risk. Whether we classify a ship, certify an automotive company's management system, or advise on how to best maintain an aging oil platform, our focus is to safely and responsibly improve business performance." (Extract taken from <http://www.dnv.com>, November 2007).

Factbox 2 ABB Process Solutions & Services (ABB PS&S)

ABB Process Solutions & Services (ABB PS&S), is an Italian-based company belonging to the ABB Group. It delivers turn-key solutions for the Oil & Gas industry, power plants and electrical and automation systems throughout the world. With an annual turnover of almost \$500 million, the company operates through a dedicated Center of Excellence which is situated in Sesto San Giovanni (Milan). The company delivers integrated services including engineering, procurement, construction, commissioning and start-up, as well as a global maintenance service.

The power generation barge contains over 190 km of electrical and instrumentation cables. It has a total electricity output of 120 MW.



Extraction and generation

Officially named "Lady of Victories," the barge was handed over to Agip KCO by ABB PS&S and Rolls-Royce in April 2007. "Lady of Victories" was finally launched on the 22nd of April.



Once the barge was mechanically complete, marine tests were successfully carried out in December 2006 to check and certify the barge's navigation stability. These tests were witnessed and formally accepted by international Agencies, such as DNV and Noble Denton³.

Safety, especially at the fabrication yard in Malta, was a priority throughout the entire project. At the beginning of the project, an ambitious goal of zero accidents was set. When an initial target of 500,000 man-hours without any Lost Time Incident (LTI) was reached at the Malta Yard, a ceremony was hosted by representatives of the Maltese Government to celebrate this achievement. In all, out of total of 900,000 man-hours spent at Malta fabrication yard, an impressive 700,000 were without LTI. Safety integration aspects were dealt with at dedicated HAZOP, SIL, and SAFOP workshops and reviews. These workshops were held throughout the course of the project, and were attended by those directly involved in the project, as well as third party consultants.

The complete design was judged by ATEX (The International standards for Hazardous Areas) and SOLAS (Safety Of Life At Sea – International stan-

dards that define safety for marine vessels) – to be in accordance with the required benchmarks that ensure PFP. Additionally, the barge fully complies with the required marine standards.

The end result is a power generation plant that meets the highest safety standards, and which is fully compliant with the strictest environmental protection policies.

Critical issues

Certain challenges were faced during the course of the project with respect to the efficient and effective integration of all the various systems on a single unit, while remaining fully compliant with the required industrial and safety standards.

This floating power generation plant meets the highest safety standards and is fully compliant with the strictest environmental protection policies.

The engineering team had to overcome dimensional constraints imposed on the barge because of specific standardization requirements of the Kashagan field. These constraints influenced where and how the equipment and systems on the barge were placed and configured. Three-dimen-

sional modeling was key in handling this issue, as it was used to verify interfaces between different areas, as well as the overlapping of various systems. In addition, it was used to define the most effective layout and routing for piping systems, and power and instrumentation cables. Besides its use in the engineering process, 3D modeling was consistently implemented during the production stage.

Another challenge was the constraints imposed by transit regulations through the various canals leading to the Kashagan field. Even though the barge was fully assembled and tested prior to delivery, these constraints meant that specific components had to be temporarily dismantled after final testing in the construction yard.

A recipe for success

The barge was mechanically completed and pre-commissioned in March 2007 at the Malta yard. In April 2007, it was officially named "Lady of Victories" and was handed over to Agip KCO by ABB PS&S and Rolls-Royce. "Lady of Victories" was finally launched on the 22nd of April.

This remarkable achievement in terms of technology and workmanship would not have been possible without the effective teamwork within the project organization, and the proactive involvement of qualified and reliable sub-suppliers. Seamless integration between the engineering, procurement and construction phases was possible because of the co-operation, knowledge and enthusiasm of each member of the project team. This combination also contributed to the timely and efficient manner in which the barge was completed, and is most definitely, a recipe for success.

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Footnotes

³ <http://www.nobledenton.com/> (November 2007)