SINES LNG Terminal: low cost/ fast track project but new technologies and an answer to EN 1473 new safety approach

by

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When the contract was awarded, in November 2000, by TRANSGAS ATLANTICO to the TRACTEBEL consortium, the execution of the project was faced as a real challenge.

The consortium, constituted with TRACTEBEL, ENTREPOSE Contracting and SOMAGUE, was winning this EPC contract in a very competitive market in front of strong international competitors. As result of this competition the SINES LNG terminal project was awarded for a very low price, less than 190 million Euros, and with a short delivery time, 37 months.

On top of this low cost/ fast track constrains the project had to be executed in a congested area, between a public road, a coal terminal, a container terminal and an industrial railways station, in an existing harbour still under development.

A few words about the Sines LNG Terminal.

Sines is a deep-water harbour in Portugal along the Atlantic Ocean, located 150 km South of Lisbon.

The terminal can unload ships ranging from 45 000 through 165 000 cum.

A 2000m 36" unloading line allows to unload LNG carriers at maximum 10 000 m^3/ h.

Two full containment storage tanks of 120 000 cum net capacity each, with possibility for a third one, receive the LNG whilst average and peak send out are respectively 300 000 and 450 000 Ncum/hr at 84 barg in the first phase. The peak send out was increased to900 000 Ncum/hr during the execution of the project.

In addition to this continuous send out truck loading facilities have been installed with capacity up to 3 000 trucks per year in the first phase.

To assist in this challenging work but also to promote a high quality and safety level, TRACTEBEL decided to take benefit of the last development of the technologies but also to apply the new health, safety and environment standards through the different phases of the project: design, construction and operation.

Hereafter are some of the new developments that were used by TRACTEBEL and its partners in the consortium.

During the design first:

- The schedule was an important parameter. As in all projects the circulation of the information, between partners in the consortium and between consortium and client, was considered primordial for the success of the project but also for the coordination and understanding between the parties. It was thus decided to organise the document circulation and the correspondence around the electronic mailing and electronic document management systems (EDMS).
- Sines being located in a seismic area, dynamic calculations were applied for all earthquake simulations in structures, foundations and piping systems.
- As result of the earthquake but also of the water hammer in the unloading lines the dynamic loads were reaching 180 T on the supports. Special

neoprene dampeners have been installed to absorb these dynamic loads and to reduce the real loads the anchor blocks.

- The layout of the central control room and related technical rooms and offices was the result of an ergonomic study. This ergonomic study allowed defining the correct lighting and control station arrangement whilst organising the rooms for direct access and interfaces. This study resulted in a better communication between actors in the control building and a faster response in case of alarm or emergency.
- The control and monitoring of the plant is usually ensured by different systems: process, safety, fire and gas detection, and security. All these systems have been integrated in one system covering these specific functionalities. This integration allows a better interface and complementarities. As an example in case of any detection the cameras will automatically focuse on the area where the detection occurs and so allows a faster reaction and answer from the operator.
- In a modern plant hundreds signals and data are continuously transferred. To allow it several loops of fiber optic cables have been installed to provide the information in real time to the processors. These fiber optic cables enabled to save kilometres of cupper cables whilst ensuring a perfect transfer through the redundancy of the loops.
- The iso 9000 Procedures were strictly followed at the different stages of the engineering requiring formal check approvals of documents, design reviews …
- TRACTEBEL operating experience in LNG shipping and receiving terminal was used in the design by integrating terminal operators at various stages of the project (design and commissioning)
- The communication in the plant is based upon a wireless telephonic system interconnected with the public networks, allowing direct access between the mobile phone and the external world.
- In order to limit overdesign and plant inefficiencies, the Sines LNG Terminal was designed for the most frequent process conditions such as average seawater flow/temperature average LNG composition, average pipeline pressure and a sensitivity study was done to appraise the performances of the plant in extreme operating range . The primary target of the designer was “a safe fit for purpose terminal.”

During the construction a full HSE policy was implemented on the field to ensure health, safety and environmental free impact. For this a specific structure with safety officers and environment inspector was allocated for a continuous monitoring. This structure and the safety minded policy allowed to reach 1 000 000 working hours on site without loss time accident. As part of the structure could be identified safety induction training (more than 3700) for all new incomers and refreshment on a regular basis, tool box meetings (more than 340 for more than 10 000 attendees) and field exercises.

For the commissioning and operation the following tools were put available to the operators:

- A 3D electronic model with possibility to walk inside and thus to simulate the foreseen field interventions.
- A plant management system (PMS) based on SAP
- An interface between the DCS and the PMS, allowing to retrieve the process parameters, such as running man-hours, number of starts, operating conditions, and to download them in the PMS for the preventive and condition based maintenance organization.
- The asset management system, allowing to adjust the parameters of every transmitter from the control room.

Beside the already addressed constrains TRACTEBEL had to comply with the new European standard EN 1473 and to the new safety approach as developed by this standard. It was one of the first project for which this standard has been referred as the basis for the safety design.

This standard defines rules and guidelines to enable the designer to build-up the criteria and requirements that will allow reaching the minimum safety levels, instead of the prescriptive recommendations of widely used NFPA 59A.

This specific European approach is highlighted in the related section 4.4: hazard assessment.

For Sines, the assessment has been applied using both deterministic and probabilistic approaches.

The methodology could be summarized as follows:

- Identification of the potential hazards, from internal and external origins
- Determination of the consequences for each identified hazard
- Collection of failure rate data and determination of the frequency of each hazard
- Determination of the risk associated to each hazard, and allocation into a risk matrix, as per EN annex K
- Computation of all hazards into risk contours in order to classify the hazards with regard to their consequences in view of the level of risk definition, in accordance with EN annex L

The computation was subcontracted by TRACTEBEL to DNV.

During the works one specific issue was the validity of the failure rate data. The public available data are not related to cryogenic application or to the same quality level. The available statistical data base as used by the QRA specialists are therefore not fit for purpose and could lead to wrong or abusive conclusions. Therefore these data and the resulting risk assessment have been evaluated and corrected by extrapolation by reference to in-house data coming from big LNG operators.

In the class of consequence the threshold value was defined to be 50 t, instead of 6 m³ in the current revision of EN 1473 Annex, in agreement with the client and the authorities.

As result of this risk assessment some mitigation measures were implemented: protection barriers along rack at road crossing, safety distance at railway crossing and additional water monitors.

As part of the risk assessment is the seismicity in Sines. Portugal is a seismic area as it was demonstrated by the earthquake in Lisbon in 1755 .

It was therefore important to define the earthquake level, ground acceleration and spectra, and to define a seismic classification for the different systems of the installation based upon their functionalities and their importance on a safety point of view.

For the Sines design some principles have been proposed and agreed by the client:

- The plant will be shutdown after any earthquake which magnitude exceeds a portion of OBE acceleration value. This shutdown can be an operator decision or from the seismic detectors that have been installed.
- The plant will be fully inspected prior to resume operation to check operability, integrity and stability
- After SSE the plant will be brought to a safe conditions in the hours following the event to allow a safe control of the plant during the decommissioning if needed or during the implementation of the corrective actions.
- The Central Control Room will not receive all information after a SSE but the transfer of the critical data will be designed to guarantee the availability of these data in the control room even after SSE. These critical data such as tank pressure will be relayed by hard wiring that is not crossing elevated structures. The central control room will be the crisis centre in case of earthquake.
- Local small leaks are accepted after an earthquake provided that the plant could keep its integrity to avoid additional hazard.

The Sines classification has been organised in 4 classes:

A: items that are vital for operation, such as fire fighting equipment and system (for local operation), ESD valves, tank safety valves, UPS related to safety control systems

B: items which failure could bring additional hazards, such as all equipment and piping containing LNG and gas

C: items that should not collapse as the collapse could affect A or B classified items and consequently bring additional hazard.

D: all other items for which nothing is required.

All the here above defined items were foreseen to be operational after an OBE as per the OBE definition.

The completion of the Sines Terminal on time and within the budget is therefore an illustration that a high quality and safety level can be achieved at low cost and in a short period providing that Contractor takes benefit form the previous LNG expertise, from a proper organisation and considering the new technologies and codes.