The Adriatic LNG Terminal
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- Overview of the key aspects of the structural monitoring and the integrity programs for ALNG assets
From Concept to Reality

First proposal: 1997

First EIA: 1999

Permitting & Foundation Agreements: 2000-2005


Commissioning & Start-up: 2009
Terminal Function and Design

- First concrete Gravity Based Structure (GBS) offshore LNG import terminal
- First application of Modular LNG storage tank technology
- First application of specially adapted LNG offloading arms

- 375m long by 115m wide in 30m water depth
- 8 GSCM per year regasification capacity
Safety, Health and Environment

Put Safety First in All We Do

- Relentlessly pursue “Nobody Gets Hurt”
- Control risk with effective SHEMS Implementation
- Implemented Loss Prevention System (LPS)
- Safety and Major Incidents Prevention Policy (Seveso Law) issued after a consultation process
- Strong Process Safety program:
  - Loss of Primary Containment events down from 1 in 2010 to 0 in 2012
Safety, Health and Environment

Protect the Natural Environment

- Company operations environmental performance is strictly regulated

- No spills or regulatory exceedances have been recorded since start-up

- Environmental monitoring plans defined in Environmental Impact Assessment:
  - Regulatory agencies execute the plan in waters around the terminal
  - The chlorinated and cold plume confirmed to disperse within less than 100 m, not affecting the sea bed and with no measurable consequences for marine life

- All emissions (water and air) as well as waste are limited by Integrated Pollution Prevention & Control (IPPC) Permit:
  - NOx and CO concentration from Gas Turbine Generators stacks
  - Free active chlorine concentration from sea water discharge
  - Average sea water temperature difference (delta T) between inlet and outlet
Challenges and Achievements since startup

- From Cooldown to Design Capacity
- Post-startup works
- Weather Events
- Gas Emergency Situations
- Seismic Events
From Cooldown to Design Capacity (2009)

- **10 Aug**
  - The first LNG Carrier at the Terminal
  - Gradually cooled down piping and Tank 1 in preparation of introducing LNG

- **25 Aug**
  - Reach the Required Temperature
  - Commenced pumping the LNG cargo into Tank 1

- **28 Aug**
  - Completed LNG Discharge
  - Used the LNG in tank 1 to slowly cool Tank 2

- **6 Sept**
  - First Gas sendout (~3 MSCM/d)
  - Sendout maintained cycling through combination of pumps and vaporizers.
  - Rate gradually increased over the following weeks
  - In parallel, second LNG cargo unloaded into Tank 2

November 2009 - ALNG terminal accepted design number of LNG Carriers per month
Post-startup works

Significant items grouped and managed by an integrated project team

- Upgraded WHRV to enhance resistance to Stress Corrosion Cracking
- Modified lifeboat davits to avoid clashes with the GBS
- Modified tethering system of the 4 fenders
- Modified seawater inlet strainers to better withstand severe environmental conditions

Certification of topside systems from regulatory perspective

- Improved LNG custody transfer operations and implemented modification to gas measurement systems

Most of these works were completed in 2010 with no impact on operational reliability
Weather Events

- The terminal has no port infrastructure to protect it from exposure to severe weather.
- The Northern Adriatic climate is known for rapid changes in weather conditions.
- LNGC marine operations are limited by meteoocean criteria set by the Harbour Master.

Specific weather events tested the effectiveness of marine operations and associated meteoocean criteria:

- **Feb 2010.** Two tankers in quick succession mid-month then a reduction in send out to conserve inventory.
- **Jan 2011.** Prolonged weather event during which fender number 4 was lost.
- **Feb 2012.** Extremely cold weather in Europe bringing wind velocities and wave heights approaching the 100-year storm.
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Monthly gas re-delivery plans have not been significantly affected.
Gas Emergency Situations

ALNG worked with the Government and users to respond to the gas system needs to provide gas delivery flexibility
Seismic Events

- Significant seismic events occurred in May-June 2012 (epicenter about 100 km away)

- Assessed response compared with design predictions to verify structural integrity

- Evaluated the amplification factor between GBS bottom and top slab

- Determined natural frequencies and modal shapes of the GBS and its foundation
Seismic Events

Structural Assessment

- Verify for GBS (analysis of the SGSM)
  - Inclinometers: No rotations or distortion
  - Acceleration
  - Pore pressure: No changes in the subsoil
  - Long term settlement: No displacement

- Verify for LNG storage tanks
  - Strain Monitoring System: No anomalous structural response

No anomalies were detected by the seismic structural assessment.
Reliability

- Terminal throughput surpassed 20 bcm of natural gas from startup through 2012
- 249 LNG carriers have been received making it one of the busiest in Europe
- Equipment count, sizing and sparing are have enabled short-term “peaking” (120% of nominal capacity)
- Weather delays require large send-out rate swings to manage inventory levels
- The major equipment installed have either an installed or running spare
- Ten-year major equipment and facility maintenance and inspection plan
Unscheduled downtime in 2012: 0.3% (from 1.47% in 2010)

Major equipment maintenance / inspection campaigns accomplished

Structured measures in place to continuously reduce unplanned shutdowns which are primarily driven by Gas Turbine Generators and Distributed Control System (DCS)

The duration of unplanned downtime events have decreased
Integrity Management Program

- Developed and executing a comprehensive integrity management program which address condition monitoring, inspection and testing of critical equipment

- Program is based on a structural and geotechnical monitoring system and on a Risk Based Inspection (RBI)

- Objectives:
  - Monitor the corrosion protection system
  - Detect other defects

- The integrity programs cover:
  - Piping and pressure vessels
  - Pipeline
  - Concrete and steel structures
Inspection Program Results

Piping and Pressure Vessels:
- NDT base-line inspection completed
- Data uploaded in CIMS
- NDT mainly consists of wall thickness measurements
  Ultrasonic testing used as the main technique, while for cryogenic lines, radiographic analysis methods are used
- Future step includes the preparation of optimized inspection programs based on the results of risk assessments

Pipeline:
- In-line inspection campaign with MFL pig completed
- ROV underwater inspection aimed at checking:
  - The cathodic protection level
  - The burial status and the position
- No defects detected. Next inspection planned in 2016
### Inspection Program Results

#### Steel and concrete structures:
- **Objectives:** Confirm the terminal structures are free from construction defects and collect operational data in order to obtain static re-certification under Italian law.
- **Base-Line inspection plan:** Structured on a 5 year timeline (2010 – 2014).
- **Inspection plan:** Includes an annual general visual inspection and a series of more specific NDTs.

#### Underwater inspection:
- **Two underwater campaigns in 2010-2014.**
- **Each survey:** Consisted of a Level II and Level III survey.
- **Level III survey:** Includes close visual inspections and wall thickness measurements.
- **Inspection:** Carried out with ROV and anode consumption measurements.
- **Scour Protection:** Dedicated multibeam survey.
Conclusion

- The Adriatic LNG terminal is a unique facility with several industry firsts
- The terminal started up and reached design throughput in less than 3 months
- Significant punchlist items progressed post startup. Most completed in 2010.
- Reliability of LNGC berthing operations and fundamental design choices validated through weather events
- The facilities were not affected by the 2012 earthquakes
- Strategic role confirmed during national gas emergencies
Conclusion

- Reliable facility providing high quality dependable services to Italy
- Regasification reliability has continued to improve over time
- Effective Facilities Integrity Management is managed using a risk-based approach
- Quotaholder support in specific areas such as SHEMS, risk management, equipment and systems reliability
Thank You

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