



From TLQ to ALQ

Network

# extra

TECHNICAL SUPPLEMENT

Issue 2 2009

## Always thinking...

Our engineers are constantly being challenged to create innovative solutions to difficult problems, this issue unwraps some of their recent projects.

## Out of the box

Squeezing a large vessel into a small space.

## Living in a box

New alternative living quarters for offshore expansion.

## Boxing clever

Designing a repair for beams under a live pipeline in a busy port.

A group of our advanced integrity and pipe stressing experts under the control of our Central Engineering Group collaborated on a design to strengthen a cryogenic pipeline jetty on a busy Mediterranean port, where implementing the design would have to be carried out on a live pipe system and without blocking access to any part of the harbour area.

jetty  
BUSY

requires

careful approach

#### Work description

The port of Arzew is Algeria's largest gas export terminal. The single pass export jetty carries three cryogenic pipes, 18", 16" and 4", associated with LNG export operations. The pipes are supported by cantilevered beams normal to main jetty beams.

An overloading event had caused one of the pipe supporting beams to fail, which led to failures in four more beams. These failures left a 100mm permanent deflection and made ineffective the jetty's post tensioning cables. The area in need of repair had avoided catastrophic collapse but the system was in marginal equilibrium and minor changes in loading could have led to a structural collapse, the breaking of the cryogenic pipes and the risk of fire or blast caused by release of the LNG.

Pipe supports had rusted and could not tolerate the pipe expanding due to any change in temperature. It is planned to replace the pipe supports but this cannot take place prior to the structural repair, therefore the pipe has to be kept at its operating temperature of -180°C, throughout the repair. To keep the temperature low, LNG has to circulate within the system, therefore the design would have to allow for the structural repair to be carried out while the piping system was live.

Our customer asked us to repair the jetty, restoring it to its original level of structural safety.

#### Construction constraints

The repair operation had to proceed in small steps as our customer asked that it be halted whenever an LNG vessel was moored at the jetty. They also asked us to avoid any obstruction of access to the harbour or jetty area.

The beams do not have easy accessibility as they are cantilevered from the jetty primary structure and extend over seawater. The pipes block access from the top and the free board below the beams is not large enough to allow a medium size barge to operate safely from below. In their condition prior to repair, the cantilever beams could not be relied upon to support the extra weight of any scaffolding.

The new pipe supports had already been designed and fabricated. The repair work had to be compatible with both the existing and the new pipe supporting systems and enable the supports to be replaced soon after the beams regain their original strength.

The structure is post-tensioned and partially made up of pre-cast concrete. This type of construction puts additional constraint on an effective repair solution.

#### Repair options

After an initial study involving construction, our customers operations people and the Central Engineering design team, we devised seven repair options that fell into the following three categories:

- Designs to replace and/or repair failed items

- Designs to strengthen the beams to increase the strength and safety margin for the existing structure
- Designs to replace the failed beams with completely new beams.

We then ranked the seven options according to:

- Constructability
- Level of expertise to complete the job
- Manhours
- Strength
- Durability of new installation in a corrosive environment
- Reliability of new installation under extreme conditions
- Maintenance and repair

#### The solution

Our design solution overcomes the structural failures, safety concerns and construction restrictions. The first step is to provide a temporary support that lifts the pipes off their supports in the repair zone and supports the cantilever beams at either end. Road raising units would then be installed to keep the jetty accessible. At this point it would be possible to install scaffolding and align the beams. Beam repair could now be carried out and a new strengthening structure could be installed. Replacement of the pipe supports could then go ahead as planned and the temporary supports could be removed. At this point the jetty would be back to its original strength.

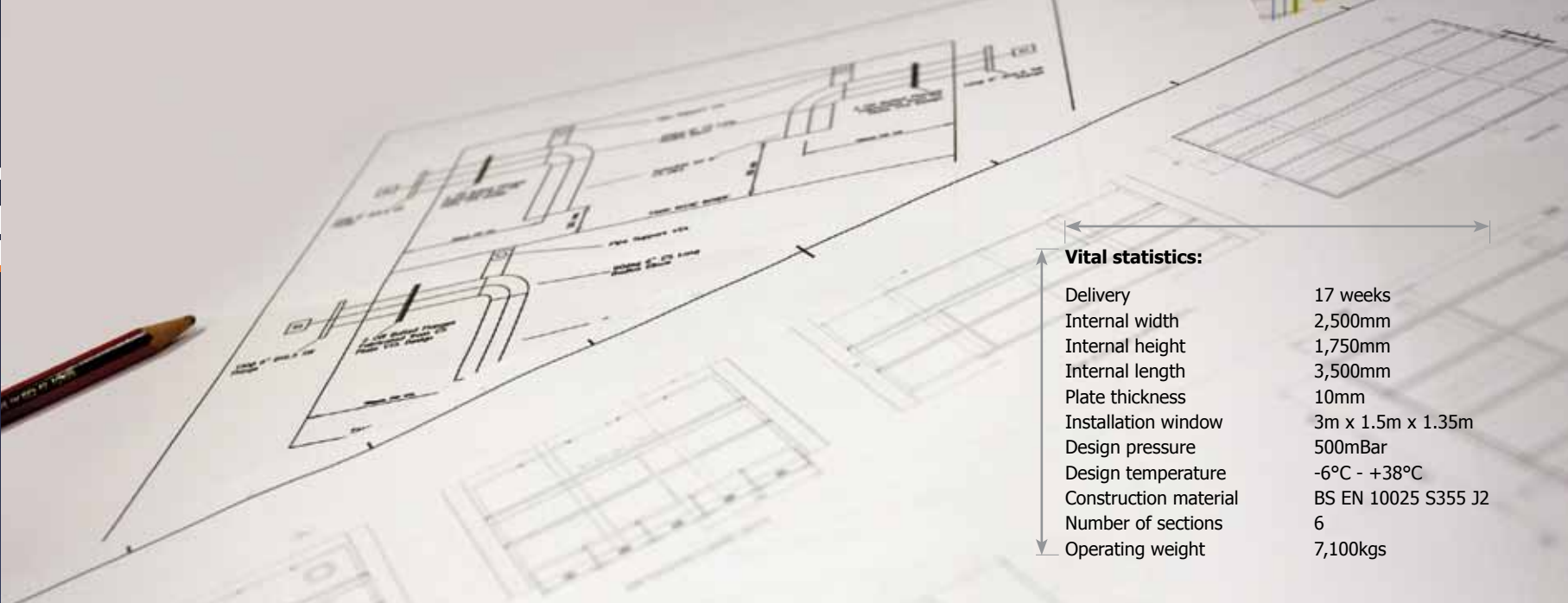
Workpacks have been completed and issued to the PSN construction team on site to allow progression of the scope in December 2009.



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**Vital statistics:**

Delivery	17 weeks
Internal width	2,500mm
Internal height	1,750mm
Internal length	3,500mm
Plate thickness	10mm
Installation window	3m x 1.5m x 1.35m
Design pressure	500mBar
Design temperature	-6°C - +38°C
Construction material	BS EN 10025 S355 J2
Number of sections	6
Operating weight	7,100kgs

# Ingenious tight squeeze sump tank

**Sectional tanks with a 500mBar design pressure are rare. Sectional tanks in more than three pieces are almost unheard of. Our customer needed just such a tank that would also fit through an installation window less than the practical width and height of the tank. Bill Gibson, our vessels technical authority, likes a challenge.**

"Our customer was refurbishing the oily water disposal system on a platform in the Northern North Sea" says Bill.

**The challenge**

"We were requested to provide a new oily water sump tank with a volume of 15m³. To minimize installation costs, the proposed tank location was restricted to an area with an installation envelope of just 3m x 1.5m x 1.3m. A design pressure of 500mBar would be required to allow venting to a low pressure flare. Atmospheric tanks are a common sight in the oil and gas industry, sectional tanks in two or three sections are a less common sight. Sectional tanks with 500mBar design pressures are rarer still and sectional tanks in more than three pieces are almost unheard of. Central

Engineering's Vessel Group were set the task of providing a sectional tank with a design pressure of 500mBar that would have to fit through an installation window less than the practical width and height of the tank."

**Our solution**

Initially, Bill and his team discussed producing a sectional panel tank with a number of vendors but no vendor was able to meet the required design conditions.

"With no existing solution to the problem," says Bill, "we had to develop a bespoke design. Concerns existed over the ability to seal a sectional panel design at the required design pressure. A traditional sectional tank in three sections with girth flanges would not be able to meet the required installation envelope. We developed an innovative six section design, which would meet the requirements of the installation window and also included detachable girders to prevent deformation and welded stiffeners to provide sufficient stiffness to the flat plate of the tank exterior.

"One of the most impressive elements of the design was the offset of sealing joints to improve the sealing ability of the tank at the design pressure. An innovative sealing system was developed with the girth flanges that connect

sections of the tank being designed to allow the flanges to make the transition into the plastic region of deformation when the bolting was pre-loaded to the required bolt stress."

Bill points out that at 500mBar the tank was excluded from the European Pressure Equipment Directive (PED) with Sound Engineering Practice (SEP) guiding design along with API 650 Welded Steel Tanks for Oil Storage. However, stress analysis was completed with adherence to Roark's Formulas for Stress and Strain.

**Design and procurement**

Our extensive experience of pressure vessel and tank manufacturers was critical in selecting a fabricator capable of producing a tank to the required standard. Bill continues: "We produced a full suite of tender documentation, including a mechanical specification, a mechanical data sheet and a Supplier Document Requirements Listing (SDRL). Included in the datasheet were general arrangement drawings and 3-D sketches outlining the required dimensions, materials and thicknesses calculated in-house. We conducted a full technical evaluation of four carefully selected fabricators, which included a full set of clarifications to ensure that costs could be accurately quoted for prior to any order being placed."

**Project management**

PSN was enlisted as project managers. Bill: "We held a clarification meeting prior to the start of fabrication to address any concerns from both parties and ensure that the fabricators were aware of our expectations. A timescale was agreed upon that met client requirements and was realisable by the vendor. We finalized the design and enlisted an independent third party to carry out inspections. I performed inspections prior to the commencement of welding and to witness hydrotesting required before and after the internal lining was applied."





The oily water sump tank was completed and delivered on time and on budget on Tuesday 6th of October 2009.

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## Hear more from our experts

Our technical experts are widely regarded as leaders in their fields and regularly attend industry events to present their innovative engineering solutions.

26th Nov, 2009	Optimising Operations and Maintenance in Late Field Life	Ian McKay	Annual IChemE Seminar Treetops Hotel, Aberdeen	
28th Jan, 2010	CO2: Threat or Opportunity?	John Hargreaves	Institute of ChemEng AGM University of Aberdeen	
4th Feb, 2010	After dinner presentation	Bob Keiller	Annual IChemE Dinner Carmelite Hotel, Aberdeen	
22nd - 24th Mar, 2010	Co-chair, SPE Applied Technology Workshop	John Hargreaves	Reservoir / Facilities Interface Treetops Hotel, Aberdeen	

# A place to lay down

**PSN recently project managed the design and installation of an additional living quarters project in the Southern North Sea. Trevor Woodhead, project manager, provides the details.**

## **The project**

Our customer's platform in the Southern North Sea is used as a gas storage facility, injecting gas during periods of low demand then exporting when demand is high. The platform's living quarters consist of a 74 bed Permanent Living Quarters (PLQ) and a 56 bed Temporary Living Quarters (TLQ), which is located on the roof of the PLQ. The TLQ had exceeded its expected life and the decision had been made to replace it with an Additional Living Quarters (ALQ).

## **The design**

PSN carried out a feasibility study for installing a 24 bed ALQ and recommended that it be placed on the deck previously used for drill pipe storage. We also recommended that the ALQ be linked to the PLQ at level 1 and that as this is within the crane radius, dropped object protection should be provided over the ALQ and that the dropped object protection should double as an additional laydown area. We prepared a basis of design, scope of requirements, functional specification and invitation to tender, which was issued by our customer.

## **Innovation**

The structural design consultant engaged by the module fabricator injected some innovation into the design by specifying that the additional laydown area be made of corrugated plate, which absorbs and dissipates the energy of dropped objects, deforms upon major impact and is made up of panels that can be replaced with minimum disruption to operations. This replaced elastomeric bearings which are traditionally used in the design of dropped object protection structures. Quick fix ISO connectors, used to secure containers during transit, were used to locate and tie down the modules to the support frame. Additionally, Wavistrong™ GRE materials were used for black and grey water pipework to a piping specification prepared by PSN. Laser surveys were used to finally position the structural foundations offshore using the footprint from a trial build onshore.

## **Execution**

Detailed design started in January 2009 and the successful contractor designed, fabricated and managed the installation of the accommodation, support frame and laydown area; these were trial built onshore and factory acceptance tested prior to shipping. Mechanical experts from PSN provided support during fabrication and inspection, including regular visits to the contractor's premises. Our customer chartered marine transport and all modules set sail on schedule, on June 16th. PSN project managed and designed the structural foundations, piping and electrical and instruments tie-ins. We also provided a project representative offshore during the construction phase of the project. All orders for materials were placed to PSN's specification and we managed project documentation using our customer's numbering procedures. We worked with technical authorities in providing comments on the design and we facilitated the constructability reviews.

## **Commissioning**

All modules were lifted and installed without incident. Some minor rework was carried out offshore to achieve compliance with design. A parallel project for upgrading the fire and gas system for the platform incorporated the ALQ and the installation of the PLQ panel was accelerated to accommodate commissioning. Breakthrough and architectural finishes were carried out on completion of site acceptance test and commissioning.

## **Decommissioning of TLQ**

On completion of the ALQ the TLQ was isolated for decommissioning. PSN prepared the workpacks for the demolition work, which is to commence after the current wirelining program. A new helicopter transit office will be located on the PLQ roof in the space created by demolishing the TLQ. A temporary erection and installation frame is to be supplied for skidding and installation of HTO modules under the helideck.

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