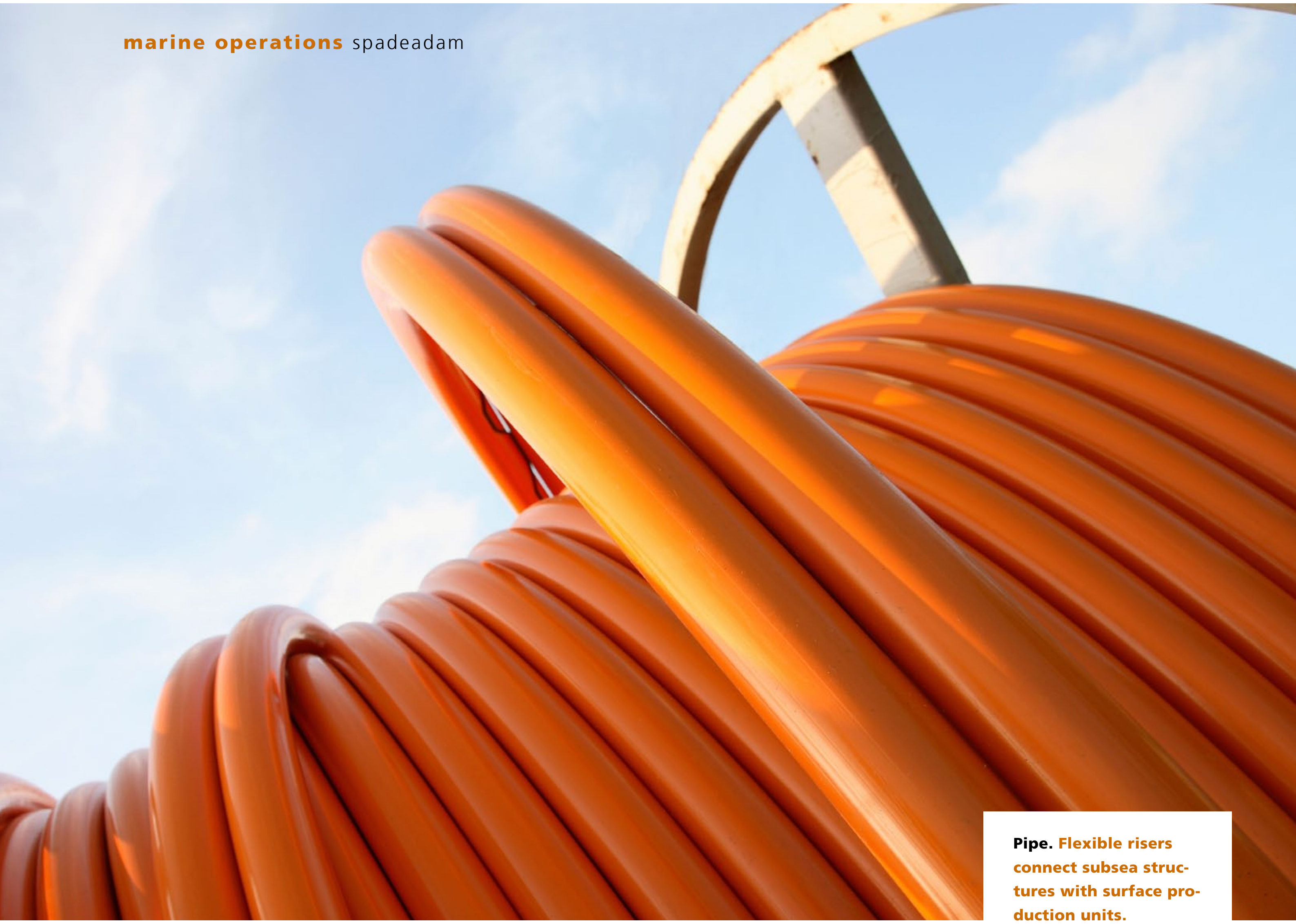

**Pipe.** **Flexible risers connect subsea structures with surface production units.**

The use of full-scale testing can prove to be impractical or prohibitively expensive, so it has become standard practice to use computer modelling based on theoretical predictions, mathematic calculations and laboratory scale experiments. Although this type of testing and hazard prediction has its place, it is still important from time to time to validate the predictions with full-scale testing. This is particularly important in new research and the long term development of theoretical modelling as many problems involve physical or chemical processes which are scale dependant.

The purpose of the modelling and testing is to determine the material, component, assembly or process operational parameters and so predict and protect against possible failures. This cannot be done without a full understanding of the hazards, the four principal stages being:

- **the identification of possible failures through experience or foresight**
- **understanding the nature and mechanism of the failure and its potential consequences**
- **determining the probability and consequences of a failure**
- **establishing the means of preventing a failure as well as limiting and protecting against the consequences**

Although the probability of a failure can be managed and

# The Need for Full-scale Testing

**Computer modelling is the standard – but it is still important to validate the predictions with full-scale testing. A case for GL Noble Denton's Spadeadam test site**

minimised by the use of modelling and testing, the combination of a failure probability and its consequences must not give rise to an unacceptable risk. This can only be truly understood by full-scale testing especially when working on new technologies and processes where there is little or no existing information. A good example of full-scale testing producing unexpected results and identifying unanticipated potential hazards is that of a gas explosion in a congested area, as conducted by Germanischer Lloyd at its Spadeadam test site in Cumbria, UK. These full-scale tests resulted in an overpressure substantially higher than that predicted by modelling.

Wellstream (see page 37) have developed a modelling system called PipeMaker™ to predict the burst pressure for a given flexible pipe type. They have used this successfully for a number of years and have now confirmed that the data from testing at full-scale at Spadeadam is providing them with the confidence that their model predictions remain valid for their new range of flexible pipes.

## Factory Acceptance Testing and Burst Testing

As part of their quality control system, Wellstream carry out Factory Acceptance Testing (FAT) on all production runs and a burst test on a type test basis. This is to verify the quality of the product plus to acquire data to verify their PipeMaker™ software. The software is used to establish pipe mechanical properties based on analytical formulae supported by comprehensive empirical test data.

A test sample is taken from the end of a production run and fitted with standard production end fitting for use in a type test. This sample is then firstly subjected to a normal hydrostatic test or FAT. Upon successful completion of the FAT the same test sample is then taken through 10 pressure cycles before finally being hydrostatically burst tested.

For the FAT, the pipe is pressurised to the design pressure x 1.5 x 1.04 and held for a period of 24 hours. After successfully completing the FAT, the same test sample is taken through 10 pressurization cycles to the working pressure of the pipe. The pressurisation and depressurisation rates are controlled ▷


**ABSTRACT**

- Failure probability can only be truly understood by full-scale testing.
- Wellstream have developed a modelling system called PipeMaker to predict the burst pressure for a given flexible pipe type.
- They validate the results in the Spadeadam test site.


**Fountain.** **Underwater burst tests show weak spots.**

Photo: iStockphoto


**Widget.** GL Spadeadam has installed a 10,000 kN dynamic tension – tension testing rig for testing subsea pipes.

with a 10-minute hold period at the elevated pressure. As soon as the final pressurisation cycle has been successfully completed the test sample enters into a hydrostatic burst test. Again the pressurisation rate is controlled but this time the pressure is continually increased until a pipe failure is detected by the rapid depressurisation of the test sample. After completing the above tests the test sample is finally dissected to verify the condition of the internal layers post burst failure.

**KNOWLEDGE.** The team of scientists and engineers at Spadeadam possess a wealth of experience in carrying out full-scale testing.

## Tensile Testing

GL Spadeadam has recently installed a 10,000 kN dynamic tension - tension testing rig for testing subsea pipes and other equipment on behalf of Wellstream. The test rig is capable of housing pipes up to 24" in diameter and 12 m in length. The tests are fully automated allowing for 600 mm of extension on the sample and in excess of 2,000,000 cycles per test. A data acquisition system is set up to record 130 instruments although this can be increased if required.

Along with the dynamic tension - tension testing the facility can simultaneously hydrostatically pressurise or burst the test sample with up to 60,000 psi. The test pressure is controlled via a PLC allowing pressurisation and depressurisation rates to be pre-programmed into the system.

The test rig building was completed in 16 weeks from concept to commissioning including the design and manufacture of the test rig itself. Within that time scale the site was cleared with the construction of a roadway, parking together with a floating foundation allowing a further two rigs to be built if required. The facility has been designed to enable the test samples to be installed through the roof of the building with the entire operations run through a remote control room over 60 m away. Wellstream are also able to monitor their tests from the comfort of their offices in Newcastle with all

**Location.** The facilities at the GL Spadeadam Test Site.

the data and CCTV systems streamed live over the Internet. Wellstream are developing new products to work in ever more demanding environments where operating parameters such as pressure, water depth, temperature and fluid characteristics become even more challenging. As these new designs mature, the tailored facilities at the GL Spadeadam test site are ideally placed to carry out the necessary development and proof testing.

## Looking to the Future

The permanent team of scientists and engineers at Spadeadam possess a wealth of experience in carrying out full-scale testing and this knowledge along with the large investment in equipment and services has provided GL Spadeadam with the infrastructure to successfully complete full-scale testing for many of the major oil and gas companies including Wellstream.

As technology and innovation moves forward, GL will continue to design and develop the means to test the resulting products on a full-scale basis. This will ensure that the hazards and risks continue to be identified and managed successfully. The GL Spadeadam team are now investigating the feasibility of installing a larger tensile testing rig to compliment the range of tests required for subsea pipes and other equipment. The machine is to be rated to 16,000 kN capable of housing a 20 m test sample with the added features of torque measurement and application. The entire facility will allow a pipe sample to be tested under tensile and torsional loadings whilst being hydrostatically pressurised at elevated temperatures. This will capture data which will more accurately represent the increasingly challenging operational conditions found in the field. □ **DB**

**GL NOBLE DENTON EXPERT:**
David Brown, General Manager
Spadeadam Test Site & GL Flow Centre
Phone: +44 1697 749138
E-Mail: david.brown@gl-group.com

# Wellstream: A Profile

Wellstream was founded in 1983 in Panama City, Florida (USA), where they established themselves as a niche market manufacturer supplying products to the global offshore oil and gas industry. In 1995 Wellstream was acquired by Dresser Industries and began to emerge as a **SIGNIFICANT MARKET PLAYER**, securing the largest flexible pipe contract ever awarded to that date from Norsk Hydro in 1995 as part of the Troll Ojle and Gas development offshore Norway. This was followed by the opening of a state-of-the-art manufacturing facility in Newcastle upon Tyne, UK, in 1997.

Wellstream became a part of Halliburton in 1998, and continued to improve its position with continued product development; Wellstream becoming the first company to qualify products to operate in 2,000-m water depth following many years of technical cooperation with Petrobras in Brazil. In 2003 the company was acquired by Candover Investment Partners together with a management buy-in, this led to the commercialization of FlexSteelTM onshore systems and the decision to site a second manufacturing facility in Brazil, confirming Wellstream's position as a world leader for these products.

## Offshore Products

Wellstream's **UNBONDED DYNAMIC FLEXIBLE RISERS AND STATIC FLOWLINES** are a key integrating technology in connecting subsea structures with the surface. Working alongside installation companies, Wellstream ensures that its increasing product envelope fits well with new offshore systems as they develop, including hybrid riser systems. **HIGH PRESSURE/HIGH TEMPERATURE PRODUCTS**: 1,034 bar (15,000 psi)/54 ˚C (130 ˚F) are stock items for well servicing applications and deliverable worldwide. Their spoolable deployment, improved pumping efficiency and longevity are ideal for the extreme operating environments of the drilling industry.

## Onshore Products

**FLEXSTEEL™** – Wellstream's latest innovation, FlexSteelTM, challenges the dominance of onshore rigid steel solutions. This product brings together the advantages of rigid and flexible pipe technologies. Major Canadian onshore operators have already adopted FlexSteelTM for fluid transfer and pipeline rehabilitation: its ease of installation being just one advantage over other solutions in harsh tundra conditions.