Valve test tool with torque and angle control monitor.

Talking the torque

The accurate application of torque in both installation and maintenance of pipeline and wellhead assets is vital to ensuring equipment is fully operational in remote and hostile subsea locations. Norbar Torque Tools' technical manager **Mark Woodward** discusses recent advances in this sector.

Torque is the combination of tangential force acting at a distance from the axis of rotation. Incorrect torque application has a range of impacts on everyday life from trivial to critical, as anyone who has struggled to unscrew an over-tight bottle top or discovered a loose wheel nut on their vehicle will confirm.

In the early years of North Sea development, torque tools used in factories, refineries and offshore or subsea operations were generally modifications of standard models. Then Norwegian tooling specialist VerktØy Industri saw the opportunity for producing torque tools specifically for the oil & gas industry. Its expertise and support played a major part in Norbar's decision to develop a product range and engineered-to-order solutions for oil & gas industry applications.

ROV handling

A wide variety of torque tools are used for actuation and measurement at offshore and subsea locations, frequently manipulated using ROVs. Robotics has revolutionised the range and scope of projects that can be undertaken in a hostile deepwater environment such as the challenging undersea terrain encountered in the construction of the Langeled pipeline.

The 1200km pipeline links the Norwegian Ormen Lange gas field to the UK and can supply approx 2 billion cubic metres of gas annually when in full production. Ormen Lange was the first offshore gas field where all production stations were located on the seabed and the 1m diameter gas pipes cross an incredibly rough seabed terrain, requiring complex routing past underwater peaks, rockfields and gulleys.

At each junction, fasteners securing the pipe sections had to be tightened to a precise torque using a calibrated instrument. The specification required a torque multiplier that was sufficiently robust to work on pipeline connection points, each located at a terminator platform where the flow could be shut at need to repair the system.

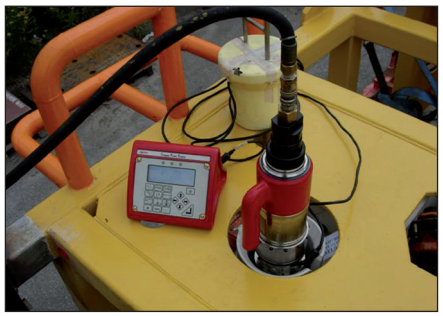
Working at extreme depths of up to 1500m and at sub-zero temperatures, the tool had to generate a high level of torque with total accuracy to actuate the wet pipe connector clamps. This would normally require a substantial steel-bodied instrument, but this was out of the question, since the device needed to be light enough to be carried by an ROV with a maximum payload of 60kg when immersed in sea water.

Minimising weight is a critical consideration in the manufacture of torque instruments for use by ROVs. Increases in weight mean that more buoyancy is required on the ROV, which leads to increased costs and impaired manoeuvrability. Materials therefore need to be chosen for lightness while being able to deliver on the required strength and torque.

The solution was to manufacture a customised torque multiplier, meeting the required torque up to 63,000Nm† and constructed of high strength aluminium to accommodate the weight limit for a standard ROV. Manipulator handles allow for both vertical and horizontal operation and the device has been successfully in service since 2005.

Torque tools for offshore and subsea applications are required to comply with the international oil and gas industry standard ISO 13628 -8:2002(E), which includes the rotary torque standard. As well as wet pipe connector clamp tools such as used for Langeled, Norbar's

† *Newton metre (Nm) = the level of torque resulting from the force of one Newton at a distance of one metre.*



Left: *PT 5 pneumatic torque multiplier used in valve testing.*

Right: *API Class 4 verification kit in waterproof and impact resistant Peli-case.*

portfolio includes valve intervention tools, wet intervention torque multipliers plus torque multipliers and transducers for use in intervention tools, including gearboxes with or without integral torque transducers.

Subsea trees are frequently joined to the structure with Fastlock clamp systems. There may be up to 50 valves on a christmas tree, ranging from Class 1 valves with maximum torques of up to 68Nm to Class 7 with torques up to 34,000Nm. Ensuring the correct torque is critical. Over-torque can break the valve with significant loss of production and revenues if replacement requires a shutdown.

It would be impractical to hold different torque tools for each value or to standardise on the largest tool to accommodate the occasional Class 7 valve. There are a large number of API Class 4 intervention tools on the market for use in the oil & gas sector and the gear adapter has become a frequently used method of extending a Class 4 tool, generating a maximum 2700Nm of torque, up to Class 7.

The problem has been that this method of extending Class 4 torque tools has led to inaccuracy in torque measurement.

This has now been overcome with the introduction of a High Accuracy Torque Multiplier for Wet Valve Actuation. For use with standard torque tools operated by ROVs, the device incorporates an innovative gear design which gets over inherent gearbox inefficiencies where the number of turns the input has to make to achieve one revolution of the output is not the same as the torque multiplication ratio.

The solution was to engineer each gear stage to give an exact velocity ratio to deliver the required torque multiplication while achieving accuracy better than ±5%.

Again, care was taken with the need to minimise weight and to ensure the device was robust enough to withstand the extremes of temperature and pressure in the subsea environment.

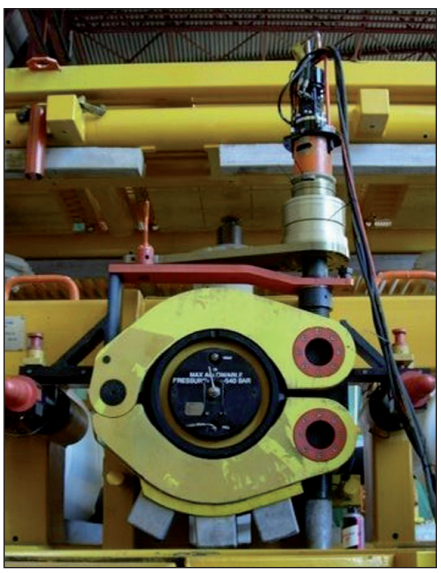
Calibration and accreditation

Testing for torque tools is carried out with electronic transducers and calibration equipment before they are taken subsea, to ensure that they are applying the correct torque. This may be carried out on the quayside or the equipment may be transported to support vessels and platforms via helicopter and ship. Testing devices need to be robust in order to function in harsh environments but also require the maximum protection during transit, which has made the waterproof and impact resistant Peli-case a useful aid.

The oil & gas industry has a strong interest in showing that high levels of accuracy in torque measurement and actuation are being achieved. This helps to demonstrate publicly that no corners are being cut in any area impacting on safety or the environment, which applications relating to torque plainly do. Recent oil spills have made the need to be seen to follow best practice particularly important.

The qualifications gained by suppliers to the oil & gas sector can be an element in this confidence building and in the case of torque the process begins at calibration laboratories. Their competence falls under the international standard ISO/IEC 17025:2005, which is an essential tool for laboratories to develop their management system for quality, administration and technical operations. The standard is used by accreditation bodies such as UKAS (United Kingdom Accreditation Service) as the basis for evaluation and customers recognise its importance as a qualification of a laboratory's competence to deliver technically valid results. OE

Pneumatic torque multiplier and reaction for wellhead connection clamps.



Torque multiplier specifically for actuating wet pipe connector clamps requiring torque of up to 63,000Nm.

Torque multiplier designed as adapter to allow API 17D Class 4 intervention tools to generate the torque required for Class 7 applications.