

*LETS (Life Extension of Technical Structures) Global has since 2005 been solving structural integrity challenges in the offshore industry. Here LETS' Malcolm Hedmar (malcolm.hedmar@lets-global.com) explains the process of peening, as the company expands in Brazil*

# Ultrasonic peening focuses heat on steel

**L**ETS Global uses its own developed and approved ultrasonic peening procedure to treat fatigue hot-spots on offshore installations. As a result the company has effectively been extending the service life of offshore installations on the North-Sea and Gulf of Mexico and due to the level of expertise which they have gathered they expanded their services to Brazil this year.

Ultrasonic peening, might sounds a lot like Ultrasonic Testing, which tends to mislead people into thinking that its some kind of inspection method. In fact, ultrasonic reefers to the utilised frequency, which happens to be in the ultrasonic spectrum which starts at 20 KHz, and the verb peening is derived from the hardened steel peen which works the steel surface.

So when performing ultrasonic peening, a hardend steel peen is oscillated or hammered against a weld-toe or steel surface at 20,000 times per second.

## The procedure

So what does it do? Well the LETS Global ultrasonic peening method can be broken down into two main aspects: both aspects occur simultaneously.

The first aspect is the groove formation at the weld-

toe; all uneven geometrical features of the weld toe will be removed with the oscillating peen. When the peen is pushed against and along the weld toe a groove will be formed, the peen hammers the steel surface at such a high rate that the groove seemingly effortless is created. As the groove is made, the uneven geometrical features and crack-like flaws in the weld-toe region will be removed. After the procedure this groove will have a radius of >2mm. The groove serves as a excellent transition between the deck plate and the weld, and it therefore very beneficial for the stress flow at the weld toe region.

The second aspect is the redistribution of residual stresses. Because the hammering has such small amplitude a shallow layer close to the metal surface will get compressed, this without removing too much material. As a result a layer with compressive stresses will form. Underneath the compressive layer a neutral layer will form. These two layers are created by the procedure and therefore the harmful tensile stresses will effectively be removed from the treated area. Tensile stresses play a big role in crack initiation during high cycle fatigue.

Thus using the Global Ultrasonic Peening Procedure you have the removal of crack-

like flaws, creation of a smooth transition between deck-plate and weld, a removal of tensile stresses and introduction of compressive stresses. This formula equals a tremendous improvement in endurance when it comes to high cycle fatigue, found in every structure on the sea; including FPSO's, TLP's, SPAR.

In (conservative) numbers the LETS Global ultrasonic peening procedure will make a welded attachment last 4-times longer than an untreated fatigue hot-spot.

Since the improvement of this procedure is so significant installations in the North-Sea, Gulf of Mexico and Brazil are starting to make more and more use of it.

## Limitations

All this might seem too good to be true. Well, as with any new method there will be limitations and obstacles. The procedure will only be significantly beneficial if the welds selected for the procedure is full penetration. Since only the surface of the weld and weld-toe is effected by the treatment a fillet weld will be left with a weak untreated area; the root. So the crack initiation at a fillet weld will start at the root instead of the weld-toe; limiting the full benefit of the method.

The second obstacle is finding the location for the treat-





Peening in action

ment. The method is more cost effective if the fatigue hot-spots in the structure have been located. Having said this LETS Global has gained a considerable amount of experience in this area, so finding the hot-spots is more like a finding an elephant in a haystack than a needle.

### FPSO structural integrity

FPSO-operators face a tough challenge; safeguard the structural integrity of the installation without disrupting the production of the installation. In the past structural integrity enhancement often meant adding steel to the structure. In essence putting more steel in a structure as an attempt to solve a weak spot is a bit like repairing a rubber hose with a steel pipe; it will fix the leakage but it will also create breaking points at the two ends of the steel pipe. As

many FPSO's originate from tanker hulls, they are designed to move with the waves. If steel is added to one section, it becomes stiffer. The stiffer section will most likely not fail, but the around located sections will become more vulnerable for fatigue cracking.

Ideally one would want to strengthen the weakest points of the vessel but without altering the stiffness of the vessel. This is exactly what the LETS Global Ultrasonic Peening Procedure does. In many ways an offshore structure is like a chain; the structure is no better than its weakest link. So if you can increase the strength of the weakest link, you will increase the durability of the whole chain, or in this case offshore installation.

The LETS Global Ultrasonic Peening Procedure has been used successfully on FPSOs.

One of the main reasons for this is that the procedure does not interrupt the production of the rig as the procedure does not produce any heat. Fatigue hot-spots which can be found in ballast tanks, cargo tanks and on pallet-stool brackets can limit the service life of FPSO's. If ultrasonic peening is applied before cracks have started to initiate it is a very powerful tool to safeguard the future integrity of the structure without disrupting the production of the rig. It is a win-win case since the ultrasonic peening is far cheaper than conventional hot-work.

### Effect on the industry

Weld-repair and/or strengthening offshore structures with extra welded steel have always been tricky business and most of all expensive. When strengthening an installation which is already in serv-

ice by adding additional steel, the rigidity of the structure will change, leaving the unmodified section of the structure more likely to develop fatigue hot-spots.

The real advantage of the ultrasonic peening procedure is that if it is used pro-active things such as weld-repair is a thing of the past; as strengthening is done without affecting the rigidity of the installation. Another big advantage is that the method does not disrupt the production of the rig.

The structural integrity of a producing or drilling installation should not be the limitation of an asset; it should not be a prime concern for an operator. The operator should focus on the goal; pumping or drilling. Thus using a service such as LETS Global with its in-house trained Ultrasonic Peening Technicians, service life of any offshore installation can be extended. ■