

# Wet-spot welding

A new system that enables high quality wet welds to be obtained in poor visibility without recourse to specialist welder-divers is described here by international welding technologist David Keats.

Speciality Welds Ltd develops solutions to the long-standing problems associated with underwater wet welding and in particular the skills required to produce high quality welds in poor and/or nil visibility. Its new system, which it has called Hammerhead (in keeping with the company's 'fish' brand), addresses problems in obtaining high quality wet welds in nil visibility, without the need for experienced (skilled) welder-divers.

By removing the individual welding skills from the operation, there is no need for the diver-welder to control parameters that affect quality, such as travel speed, electrode angle, arc length, accurate deposition, etc. Because the operator no longer needs to control these parameters, it is not essential to have good visibility. So, even in nil visibility conditions, high quality repeatable welds can be produced time after time.

In removing the skills necessary to carry out underwater wet welding, the company modified the fundamental approach to how 'stick' welding is carried out. Its system allows the operator a far more simplified role.

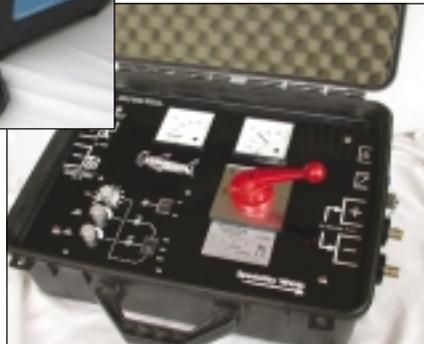
How is all this achieved? In simple terms, by creating a spot/plug weld rather than having to deposit a fillet weld within a specified joint.

By removing the need for a fillet weld deposit Speciality Welds has also simplified the joint configuration (simple lap joint) and all the preparation that goes with it, while also removing the need for extensive cleaning of the joint area, chipping off meters of slag prior to additional passes, etc. In fact there is no need for additional passes as the process is designed as a 'one-shot' approach, ie one electrode produces one spot/plug weld.

Other than the control system/electrodes, all other equipment is exactly as conventional 'stick' welding. The control unit is connected to



Control system housed in its standard 400A safety switch/control unit.



the welding power source via the remote control facility and is powered by 110V supply. All welding leads pass through our 400A Piranha safety switch before going to the diver.

## The control unit

The control system manages and manipulates:

- a timer;
- first peak/high current setting; and
- second background/low current setting.

The first high current setting allows the electrode to pierce through the materials, thereby, creating a hole through which both materials are joined together. The role of the timer is to limit the depth of this penetration, so as to avoid bursting through the base (back) material.

After the first weld cycle is completed and depth of penetration achieved, the second, lower current is automatically initiated and it's this current that fills the hole, creating a spot/plug weld that has penetrated both sections of material, creating a weld nugget.



Plate shows this piercing effect and the hole created by the 1st high current.

During the operation the diver or indeed robot need only apply sufficient pressure to the electrode to push it through the material while welding.

The guidelines shown below provide basic benchmark settings for selecting current and timer. The operator can then make any minor adjustments as are seen necessary to ensure adequate weld quality. Presently only one size of electrode is available, namely 3.2mm (1/8in) but this covers a wide range of material thickness:

3.2mm (1/8in) electrode	Timer	High current	Low current
Plate thickness 8-8mm (16mm) 5/16in	4-6 sec	250-260	150-160
10-10mm (20mm) 3/4in	5-8 sec	260-270	150-170
12-12mm (24mm) 1in	7-9 sec	270-280	160-180

## Weld strength properties

The size of a given weld and therefore the number of welds required is based on the following principle. (Area of a circle with 'd' as the diameter of the weld).

$$\frac{\pi d^2}{4}$$

Therefore, a single spot weld can offer the following theoretical strength properties.

$$\text{Max load} = \frac{\pi d^2}{4} \times \text{shear strength.}$$

(Neglecting any bending moment).

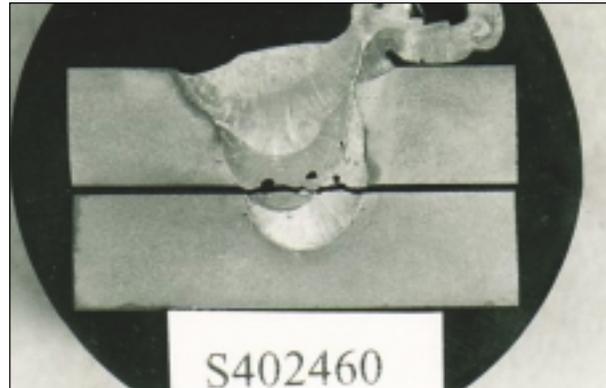
Typically the shear strength for plain carbon steel is generally assumed to be 4/5 the ultimate tensile strength. The Hammerhead electrode offers a tensile strength of 650N/mm<sup>2</sup>

## About the author



David Keats is managing director of Speciality Welds, the company he formed in June 2002 following a management buyout from MOS International. Involved in the welding industry since the early 1970s, Keats is an acknowledged authority on underwater wet-welding and is qualified both as a commercial diver and a senior welding inspector.

His first book, *The Professional Diver's Manual on Wet Welding*, was published by Woodhead (TWI) in 1990 and he completed the second edition, entitled *A Welder's Mate* (Troubador), last year.



Shows a wet-spot weld and 'flash' (excess material) cut through the centre and macro polished (x2 magnification)

(94ksi) and therefore, will offer a shear strength of approx. 520N/mm<sup>2</sup> (75ksi). Therefore, a 10.0mm (<sup>3</sup>/<sub>8</sub>in) diameter weld nugget will produce a max load capability of 40.840kN (9181lb/f) per spot. > overleaf

Using the following principle to calculate the overall stress acting on weld (G2.2 as shown above, see report S402460) ie

$$\text{Stress (UTS)} = \frac{\text{Force}}{\text{Area}} = \frac{606 \text{ N/mm}^2}{65.62\text{mm}^2} = \frac{39.8\text{kN}}{65.62\text{mm}^2}$$

The spot weld shown took 40kN to fracture and had a total area of 65mm<sup>2</sup>. The UTS was 606N/mm<sup>2</sup>. Compare this to a defect free multipass fillet weld (D2.2) fracturing at 259kN, but having a total area of 746mm<sup>2</sup> with a UTS of 347N/mm<sup>2</sup>.

The spot weld offers nearly twice the UTS capability for a fraction of the deposited weld metal. So when the time saved in deposited weld metal, cleaning, preparation and ease of use is considered, as well as the ability to weld in nil visibility, the benefits are considerable.

The weld offers strength improvements over normal ferritic steel electrodes and generally the heat-affected zone (HAZ) hardness is improved.

The specially formulated electrodes, which have a 27.5Cr and 14.45Ni equivalent, thereby, allowing for high percentage dilutions, of up to 50%.

### Conclusions

The process clearly remains a manual welding operation and is not defect free. Trials were limited to flat bar/plate stock welded in the flat and vertical positions.

However, the welding skills necessary for a diver to produce a weld have been removed, as have much of the material preparations and need for good visibility. Of course, there is a period in which the operator will need to familiarise with the process, but this can be achieved in a very short period. A good diver would be expected to produce an acceptable weld within a matter of minutes rather than hours, or days.

The process does offer solutions to welding in poor visibility without the need for skilled welders. So all in all, Speciality Welds believes this process offers a serious alternative to this long-standing problem.

As an added bonus, the system also works extremely well for welding above water. CE

● A full and detailed report has been published following the Smart Award trials and is available to download from [www.specialwelds.com](http://www.specialwelds.com)

This article is based on a presentation by David Keats to the Underwater Intervention (UI 2005) conference in New Orleans earlier this year.