

ROV INTERVENTION INTERFACES

Donald K Faulds
Tooling & Robotics Manager
Perry Slingsby Systems
Kirkbymoorside,
York, YO62 6EZ, UK



PSS 3-finger Manipulator Jaw.

ABSTRACT

The recent API 17H/ISO 13628-8 standards for ROV interfaces have brought a welcome clarity to subsea operations after many years of informal practice. Misunderstandings coupled with common misconceptions of ROV capabilities can lead to extended operation times. There are several common interfaces that remain outside the standard at present.

This paper gives practical examples of “best practice” interface design for subsea remote intervention and effective use of the work class ROV. Getting the interface right and using the ROV efficiently saves hours of valuable vessel time.

THE STANDARDS

The Remotely Operated Vehicle (ROV) has made oil field development practical in the depths beyond the reach of divers and has become so capable that most new subsea developments in diveable waters have been designed for ROV intervention as well.

ROVs depend on standardized interfaces much more than divers due to the limits of their manipulator dexterity; yet despite the huge growth in ROV

operations this standardization process has been relatively slow.

The API 17D standard for subsea wellhead equipment was released in 1992: the same year that the first guidelineless tree was installed in The Peterbras Marlim field – an operation that heralded the start of the ROV-only deepwater oilfields. Originally, 17D excluded guidelineless systems but this was changed in 1996. The 17D Appendix C of “candidate” ROV intervention fixtures was immediately adopted by ROV intervention designers as if they were firm standards, with most items adopted extensively. The remainder are rarely used and a pitfall to the unwary who will search long to find intervention tools to match. One major omission was the definition of the linear valve override interface.

The API 17H standard was intended to formalize and expand the interfaces. However, the deliberation took so long that unofficial drafts of the standard were in circulation and in use as if they were firm for at least four years before it was issued. The ISO 13628-8 version came in 2002 and finally API 17H was issued as an identical document in 2004.

The Norwegian NORSOK U-102 and U-007 standards provide valuable additional definition but are regional.

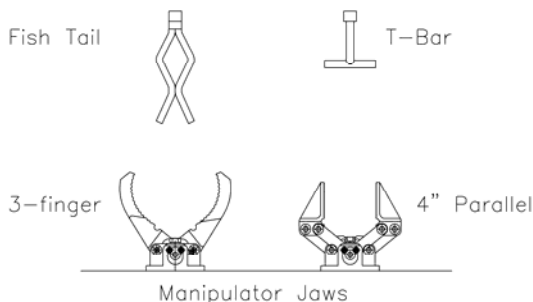
THE STANDARD ROV

There isn't one! An area that remains undefined at present is what space should be allowed for workclass ROVs to pass into subsea structures. The table of ROVs in API 17H Annex A has widths from 55" to 77" but it is relatively common to encounter subsea structures with gaps around 60". Length is usually less significant but height is often critical where ROVs have to pass under BOPs to position tools. There isn't an easy answer on this as vehicles have had to become much larger to accommodate the larger thrusters, power packs and buoyancy packages for deepwater applications.



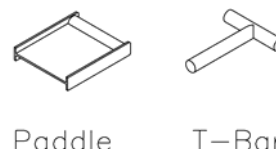
TXLS – typical deepwater workclass

ROV manipulator practice varies but the most common is to have a 5-function “grabber” on the left and a 7-function dexterous arm on the right. However, the practice divides sharply into the type of handles for the 7-function arm. The 4" parallel jaw is versatile and can grip T-bars but other operators prefer the 6" curved 3-finger jaw which grips the fish-tail best. When crossed over, the parallel jaw is poor with fish-tails and the 3-finger is poor with T-bars. Often the interfaces are set long before the ROV contractor is engaged and inefficient offshore operations with mismatched interfaces ensue.



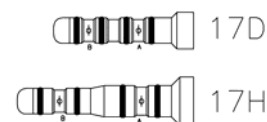
The absence of a standard definition for the fish-tail handle doesn't help.

The T-bar style is not as easy to use as its widespread use would suggest. The T-bar sits in grooves in the parallel jaw but it needs the manipulator to grasp within 1/4" to properly swallow the bar into the slots. This is quite difficult to do. An easier handle interface to grip is the “paddle” which is fabricated from plate but with a round bar on the outer edge - but this is not part of any standard.



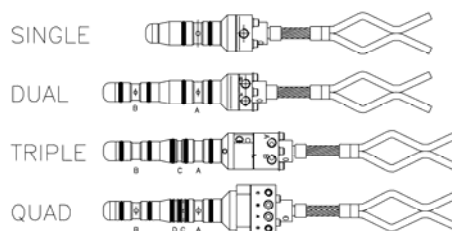
FLUID CONNECTIONS

One ROV interface that has been more thoroughly developed than any other is the 17H Hot Stab Type A. The interface defined in 17D was acceptable as a start, and is still in use by some operators, but those stabs can be damaged during insertion, resulting in seizure. The Deepstar project in 1994 extensively tested all the designs available and proposed the Type A stab for universal adoption, releasing detail drawings for the industry to share and adopted in 17H 10 years later. The key improvement in the geometry is the stepped diameter that gives progressive alignment, reducing the manipulator skill required.



One aspect not specified directly - but invaluable for the stab life - is the use of non-galling materials and low friction coatings. PSS use different grades of stainless for the male and female and Xylan™ coating of the male.

Variants within the Type A geometry have included ports up to 3/4" size. PSS has provided its own variations adding 3rd and 4th ports but maintaining interface compatibility with Type A 2-port standard.



TORQUE TOOL INTERFACE

There are usually more torque tool interventions than any other. API 17H figure 18 classes 1-4 are the most common. They are also the source of most interface problems. The standard defines the receptacle interface. The receptacle ought to be ± 0.02 " on all dimensions but this is often not properly controlled. In addition, the buckets are usually cast and some suppliers fail to clean-up the cast surfaces. The thickness of paint is often ignored but obviously affects the tool fit: in one project the interface was 0.15" undersize on the main bore diameter.

System integration tests are always the right place to check the interfaces. Using a heavy ROV torque tool with hydraulics hook-up to check every structure is time consuming so PSS have supplied a hand "gauging" tool with an accurate head representation, including working latches allowing interfaces to be correctly and rapidly checked.



Full Torque tool



Gauging tool

Often omitted is the latching wing clearance under the figure 18 bucket even though it is clearly shown in 17H (unspecified in 17D).

A simple feature that could be engineered into all torque interfaces on valves (but rarely is) is robust motion stops. Many hours are consumed offshore ensuring that the ROV torque tools are only applying certain torque levels to valve interface with attention to breakout, running and closing torque figures.

On a recent project where PSS supplied all the subsea valves, all interfaces were designed to accept class 4 maximum torque of 2000 ftlbs. This was applied to valves ranging from 1-1/2" up to 12". This cost very little to provide on the hardware yet was extremely beneficial in the operations phase with just one torque tool setting for all interventions in all positions.



12" & 1.5" – same operating torque

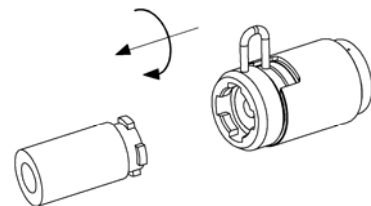
LINEAR OVERRIDE INTERFACE

The Type A interface is commonly used for override of powerful valve springs. This can be for operational reasons where the normal fluid control is not functioning or where a valve has to be locked open for a downhole intervention.

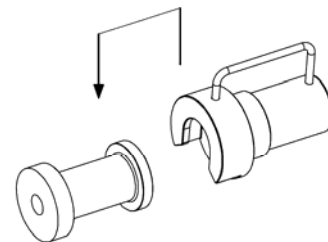


Type A interface and tool

This interface is used by subsea hardware designers because the bayonet twist operation gives the closest packing density. Although tool installation is a relatively easy task for divers (where the interface was first used) it is always a challenging task using ROVs with manipulators or other deployment tools because the override tool engagement needs precise alignment and the rotary action is not simple.



TYPE A – INSERT & TWIST



TYPE B – HOOK-OVER

By contrast, the Type B interface, where the tool is simply hooked over a flange, is a much simpler operation, well suited to the ROV but not as widely adopted. The small amount of extra space required on the tree face is worth it for the ease of operation and the ROV tools to match are less expensive.

ROV WEIGHT, PAYLOAD, FRAME LIFT

These simple terms are universally understood among ROV suppliers but often misunderstood elsewhere.

Weight. ROVs have to fly at near-neutral weight in water. Any weight it picks up has to be counteracted by the vertical thrusters. High vertical thrust stirs up the seabed. As a rule of thumb, large work class ROVs can pick up tooling objects of up to 100 lbs (weight in water) and readily fly and maneuver them using manipulators. Lighter is always better. As weights approach 200 lbs, thrust becomes excessive and special planning is required.

With many of the latest deepwater work-class ROVs having masses of over 4 tons and horizontal thrust capacity up to 1 ton, the design forces suggested in the standards are light, reflecting the capacity of a previous generation of ROVs.

Payload. This is the amount of additional buoyancy of the ROV and normally represented by lead weights. As extra equipment is added to the ROV, lead is removed. Large work class ROVs typically have 300 lbs or more of payload.

Thru-frame Lift. This is the strength of the frame of the ROV to lift workskids, usually underneath. Work skids need to have their own buoyancy so that the net effect on the ROV weight in water is neutral. There have been projects where this was not understood! An ROV with an extra 1/2 ton of wet weight will just not fly. Large work class ROVs typically have 4000 lbs or more of spare thru frame lift.

GETTING IT RIGHT

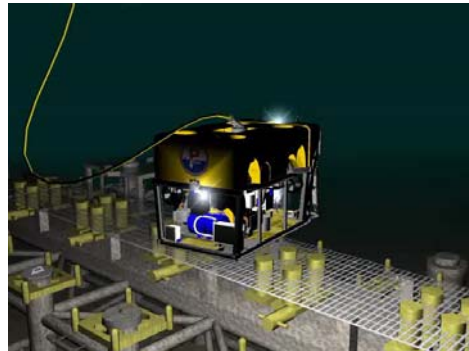
Designing for the smallest installed cost means considering the end operations from the start. The API/ISO/NORSOK standards are helpful and a major improvement over the previously informal approaches but there is no substitute for giving full consideration to the total ROV operations, not just picking a detail from a standard. This can be familiarization training of design staff and involvement of offshore personnel. Simple changes, such as described for standardized torque tool

REFERENCES

1. ISO 13628-8:2002 Remotely Operated Vehicle (ROV) Interfaces on Subsea Production Systems
2. ANSI/API Recommended Practice 17H, 1st Edition, July 2004
3. NORSOK U-102 Remotely Operated Vehicle Services, Rev 1, Oct 2003
4. NORSOK U-007 Subsea Intervention Systems, Rev 2, June 1998

interface, can make a major difference to the offshore operations.

This starts with correct use of the interfaces. 3-D computer models can be built and operations rehearsed using ROV simulators. (Perry Slingsby Systems now provides this facility with its ROV systems). With the latest “physics” software engines giving objects weights, stiffnesses and full ocean environment simulation the experience is as realistic as possible without the consequences of errors!



Simulated operations – highly effective

System integration tests should always include a full check through of all the interfaces, ideally with the actual tools.

Traditionally, this has always included access tests with mock-up (sometimes real) ROV deployed in air by crane. Adequate simulation can omit this though checking the tools fit into the interfaces should never be omitted.

Offshore operations always have the highest hourly operating cost so more time should be spent on the earlier stages for best offshore results.

SUMMARY

Perry Slingsby Systems, as a major supplier of intervention tooling, is continually developing new ways of providing cost effective remote intervention: either by tooling innovations or by promoting better design for operations. API 17H has been a big improvement in standardization but, as its introduction states, there is no substitute for “sound engineering judgment”.