BENNEX

Advanced Cable Termination

ACT

Subsea Electrical Termination

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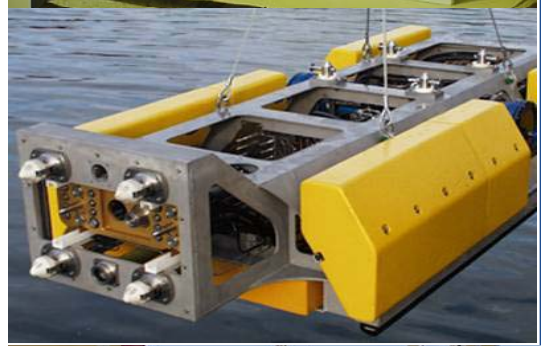
Key Business Areas

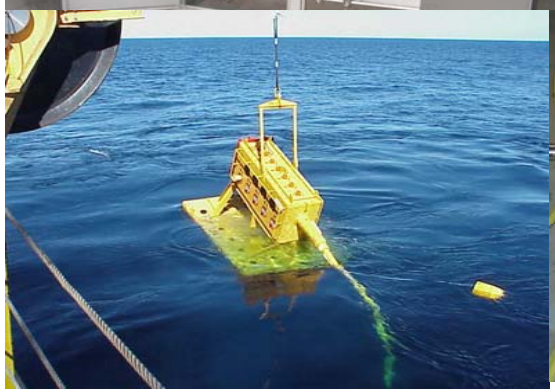
Seismic	ROV	Distribution & Monitoring	Umbilical Terminations	Process Monitoring	Valves
•Design	•Engineering	•Definition	•Definition	•Engineering	•Subsea valves
•Qualification	•Procurement	•Engineering	•Engineering	•Installation	•ON/OFF valves for offshore industry
•Production	•Pilot training	•Assembly	•Testing	•Testing	•Procurement
•Assembly	•Refurbishment	•Spares	•Assembly	•Service	•Project admin.
•Maintenance	•Spares	•SVC	•Service		•Expediting
	•Tooling design				•Follow-up.
					•Documentation.

BENNEX: A solution provider

BENNEX

PRODUCT LINE SAMPLES





A Transmark International company

Bennex Brief History :

- 1975 - Bennex established in Bergen, Norway
- 1978 - Bennico Ltd. in Aberdeen was formed.
- 1980 - Ametek's Scorpio ROV was introduced to the North Sea in 1980
- 1993 – Aquisition of Bennex AS by Transmark International
- 1996 – Aquisition of Bennex Omnitec
- 2001 - Expension to USA with Bennex Subsea Houston

Summary. In The Subsea business for 30 years (2005)

Bennex Umbilical Termination History :

Control umbilical terminations late 80's /early 90's done with penetrators typically ended in a 1 atmospheric chamber. Results: unbalanced system. => water ingress and short circuits

1992 Troll Oil umbilical Termination was developed and tested by Bennex and installed in 1993-1994 (qty = 169) . The terminations were a pressure balanced and compensated system.

1994 Bennex Omnitec delivered the 1st pressure balanced Anguila® system to Saga Petroleum on Snorre TLP.

System developed in Kongsberg and Bergen resulted in the 2nd generation termination (pass through, Pressure balanced, relief valve)

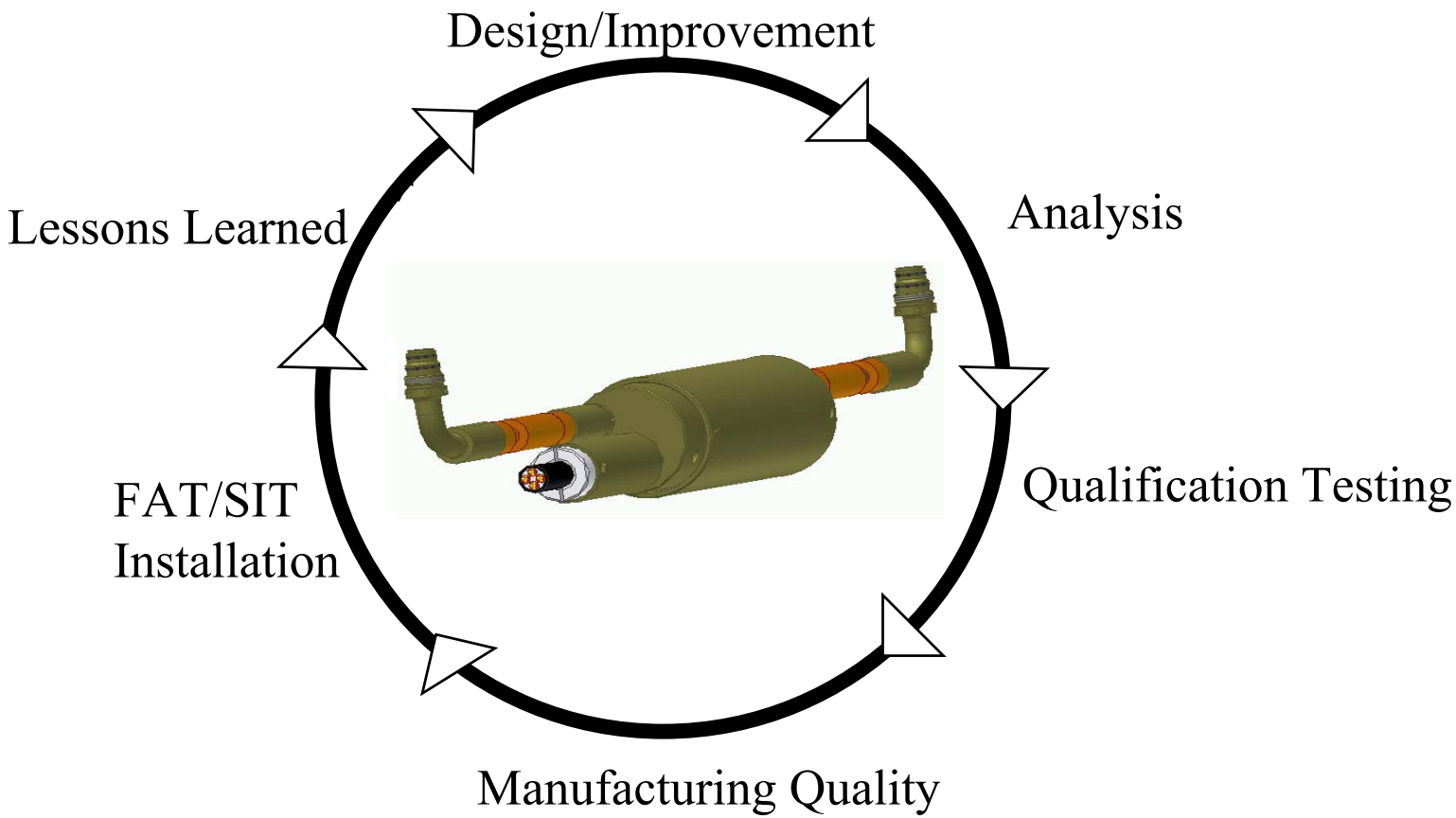
Bennex Umbilical Termination History :

Anguila® Cable Termination ACT is the 3rd generation system due to evolution of field requirements and experience from the field.

Redesign is with standard Anguila® components to reduce lead time, as well as allow configuration flexibility.

Redesign is evolving using Bennex Quality circle, and is a continuation of Bennex philosophy of working with pressure, not against it.

Bennex Quality Wheel



Advanced Cable Termination (Anguila ACT)

Tested and field proven design. (R)evolution of existing Bennex Electrical Cable Termination, incorporating latest lessons learned and customer requests:

- Keep basis design, as design is sound and proven
- Incorporate Lessons Learned/Continue Self recovery paths
- 3 Barriers or more as standard, while keeping a minimum of two barriers in self recovery mode. 4th barrier avail upon request
- Offer flexibility of Entry and Exit ports: same/opposite sides
- Make it Smaller - Reduce parts count - Reduce lead time
- Listen to and Incorporate what we want (!)

Advanced Cable Termination (Anguila ACT) Addressing Umbilical failures:

All internal Bennex design requirements plus listed inputs are incorporated making the ACT a field proven reliable termination of subsea control cables to electrical (fiber) connectors.

The ACT is an oil filled pressure and temperature compensated triple barrier tested to 450 bar (6,530 psi, 4,500 m sea depth, 15,000 ft sea water equivalent) and 25+ years design life, with self recovery features to accomodate umbilical failures/geometry changes.

Advanced Cable Termination (Anguila ACT)
Addressign umbilical failures

The system is a result of over a decade of continous improvements, field experience, validation testing, and thousands of Bennex umbilical terminations and Anguila® distribution systems installed.

ACT design also addresses and prevents recent umbilical termination failures identified as:

- Collapse of the umbilical core
- Underbalanced system in the front end of the termination

Advanced Cable Termination (Anguila ACT)

TECHNICAL DATA.

- Umbilical electrical termination, for most common subsea cables up to 16 mm^2 (5 AWG) and 30 mm outer sheath diameter.
- Waterblocking via in-line splice
- A safety ”weak link” prevents the collapse of the ACT unit, or bird nesting of the subsea cable wires in the event of a loss of internal pressure.
- Integrated ACT Junction box: splicing and distributing the electric conductors for specific project requirements

Advanced Cable Termination (Anguila ACT)

TECHNICAL DATA.

- ACT system uses the Anguila pressure compensating hose(s) with MKII interfaces (Over 6,000 Anguila MKII systems installed)

- Compensating medium: Dielectric Fluid.

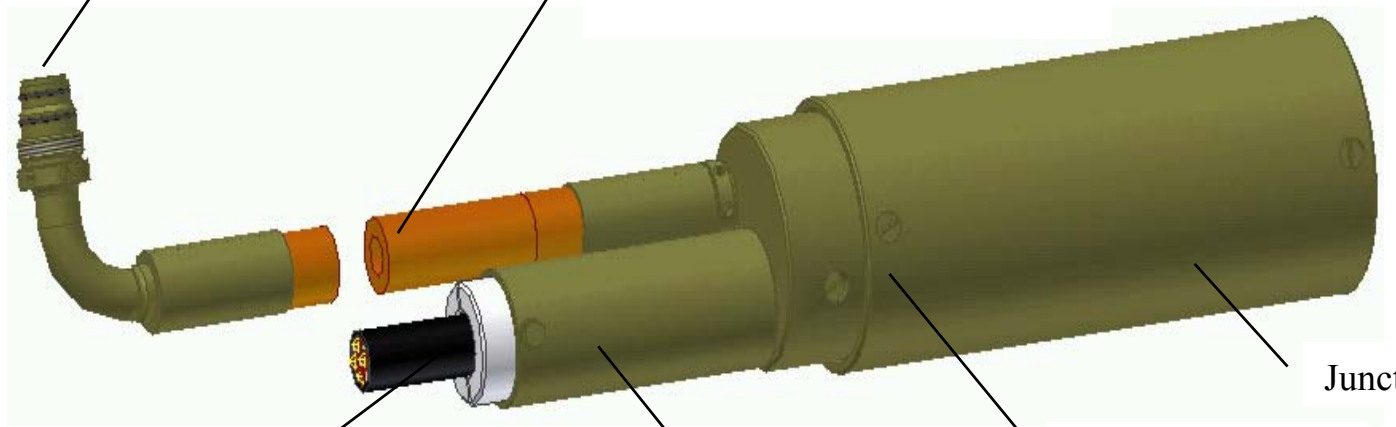
- Tested to 450 bar (6,530 psi, 4,500 m sea depth, 15,000 ft sea water equivalent)

- Design life 25 years.

- Temperature ratings.: Storage –40 ^{o}C/+70^{o}C; -40 ^{o}F to + 158 ^{o}F
  Working.:-5 ^{o}C/+50 ^{o}C; 23 ^{o}F/ 122 ^{o}F

Advanced Cable Termination (Anguila ACT)

TERMINOLOGY.



Advanced Cable Termination (Anguila ACT)
Addressing Potential umbilical failures

Umbilical core collapse remediation:

- As the umbilical is lowered subsea, the umbilical cores and air in the insertices are at 1 atmosphere.
- As the umbilical is lowered air trapped inside the core, or insertices is compressed, putting the umbilical cores at risk of collapsing or at least creating a geometry shift of the cores due to ambient pressure.
- In the event of an umbilical core geometry change such as seen during a collapse, the front end dynamic break out boot seals self adjust to the new umbilical core sizes. This is avoiding any type of leakage or delamination if there was a static potted system
- **Result:** Termination is unafected and preserved.

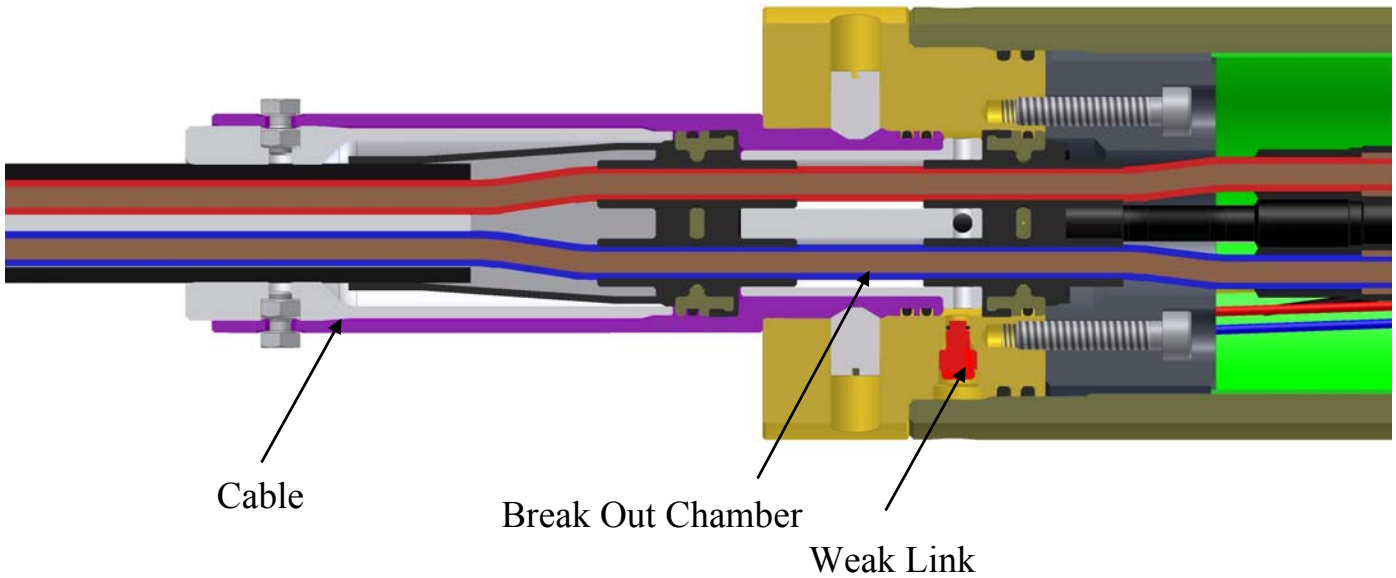
Advanced Cable Termination (Anguila ACT)
Addressign Potential umbilial failures

Identified umbilical failure and remediation: Underbalanced system in termination front end

- In the event the front end break out boot seal fails, there is a risk of dielectric fluid leaking back up inside the umbilical insertices.
- This can and will create an underbalanced situation in the front end of the termination which the umbilical termination self adjustign piston will compensate as much as possible to re-establish neutral delta P.
- This is done until until its dielectric reservoir is exhausted.
- When this happens, the front end of the termination is subject to a delta P, which is corrected by the weak link.
- **Result:** Termination is preserved with 2 sealing beariers present between the now opened weak ling and splice

Advanced Cable Termination (Anguila ACT)

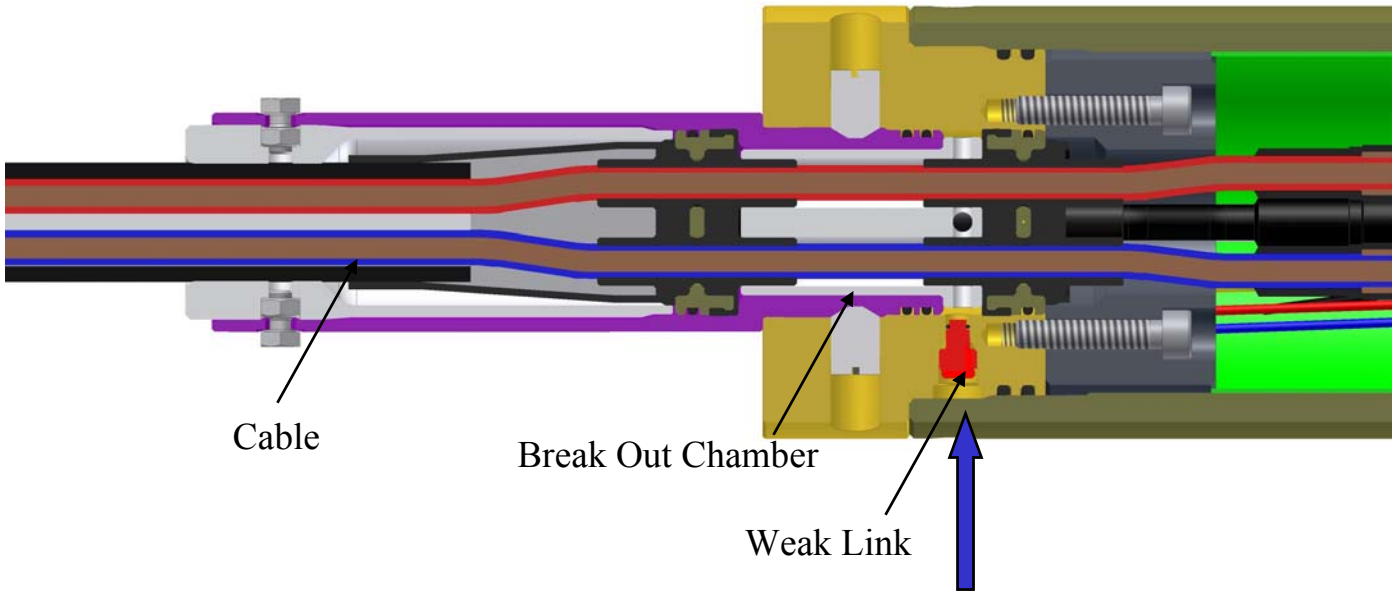
DETAIL OF THE WEAK LINK



In the event of a under-pressure in the break out chamber, the ”Weak-link” system ensures that the termination is preserved.

Advanced Cable Termination (Anguila ACT)

DETAIL OF THE WEAK LINK



Weak link opens, re-establishing a balanced pressure between the 1st chamber and the 2nd chamber. 2 sealing barriers still exist between termination spice and opened weak ling.

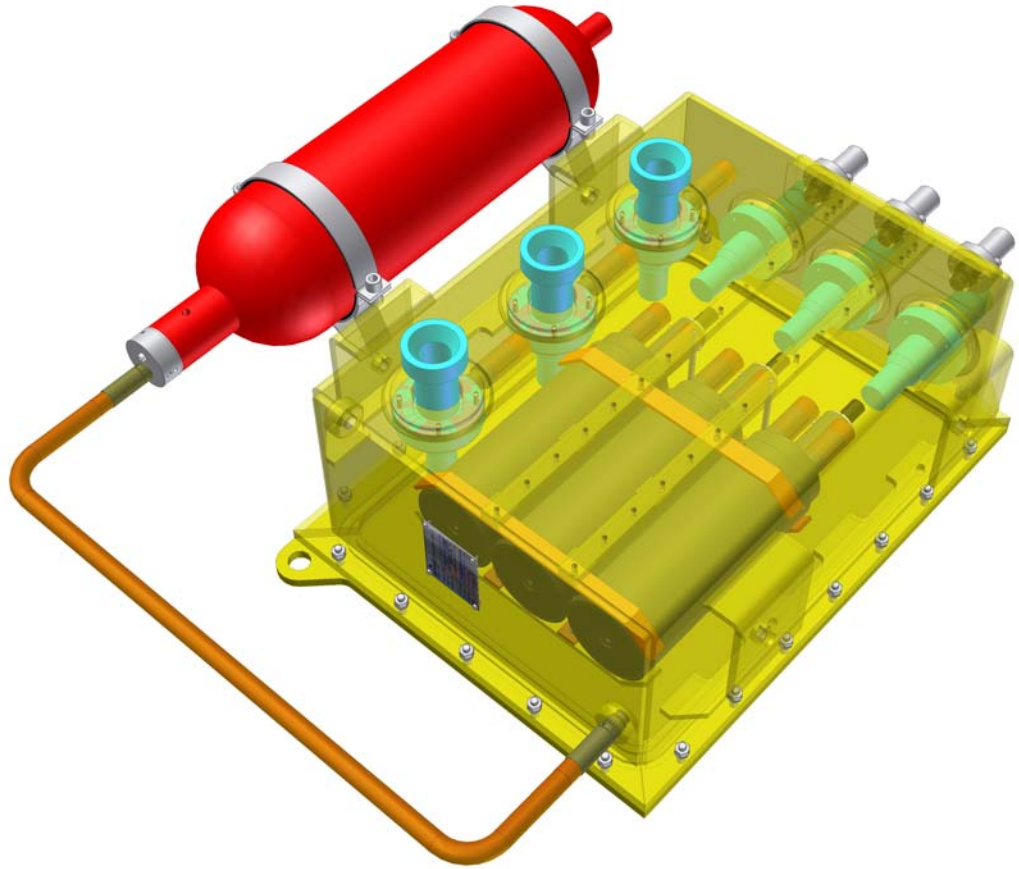
Termination is preserved

Advanced Cable Termination (Anguila ACT)
3rd Barrier

Bennex provides engineered solutions for 3rd barrier packaging

Example of ACT with additional barrier connected to external oil reservoir

Reservoir can be serviced by ROV



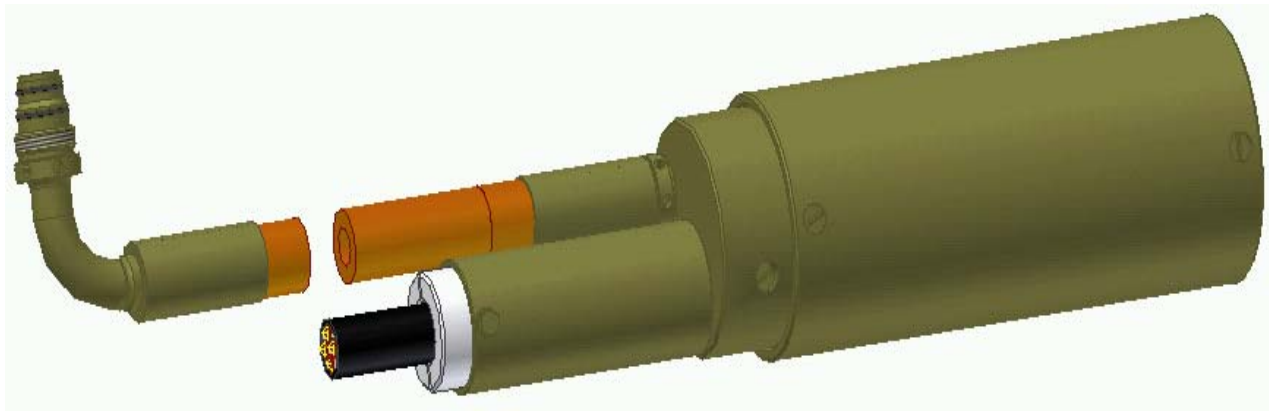
Advanced Cable Termination (Anguila ACT)
Typical configuration examples

1 in – 2 out

2 in – 1 out

3 in – 6 out

Typical 1 in –1 out



Anguila Cable Termination (ACT)

Configuration:
1 Quad in – 1 Hose out

Notice size of ACT vs. size of ROV connector

Subsea Electrical

RECONFIGURABLE

Anguila Cable Termination

(REACT)

Reconfigurable ACT Cable Termination (REACT)

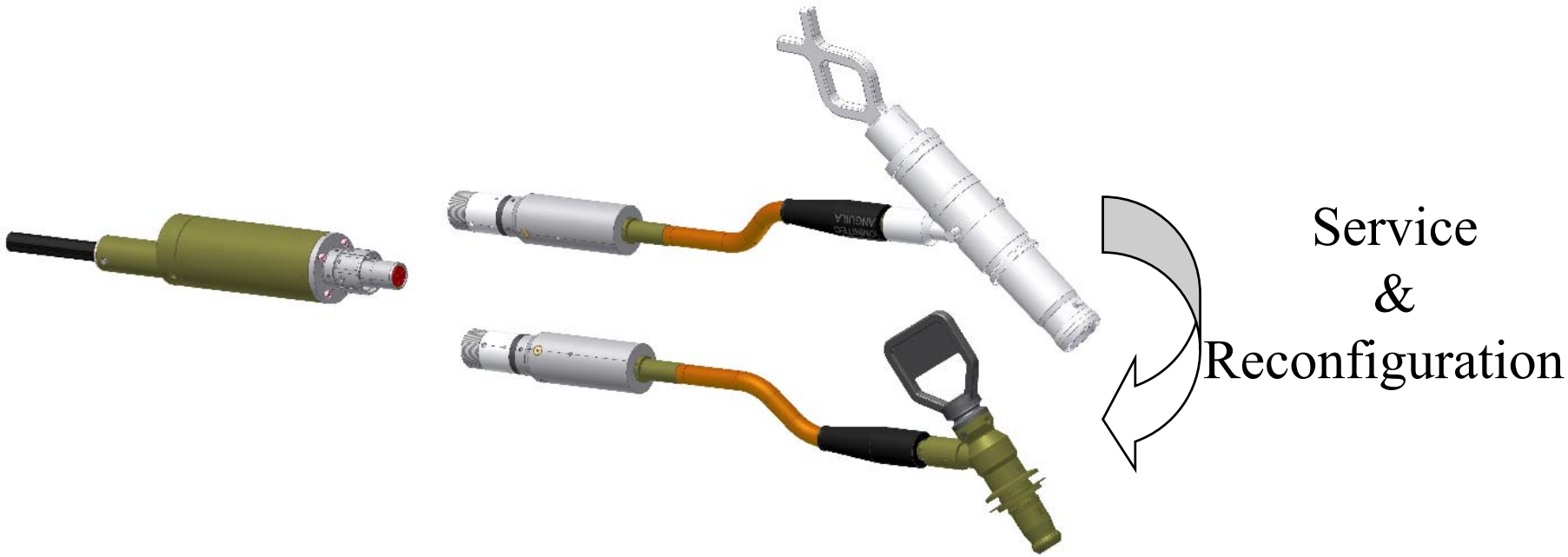
Base design is the ACT, but it is reconfigurable => REACT

Flexibility allows using the same umbilical termination with various end connector(s), including none (Hydraulics mode) => Modular design for different specific project requirements

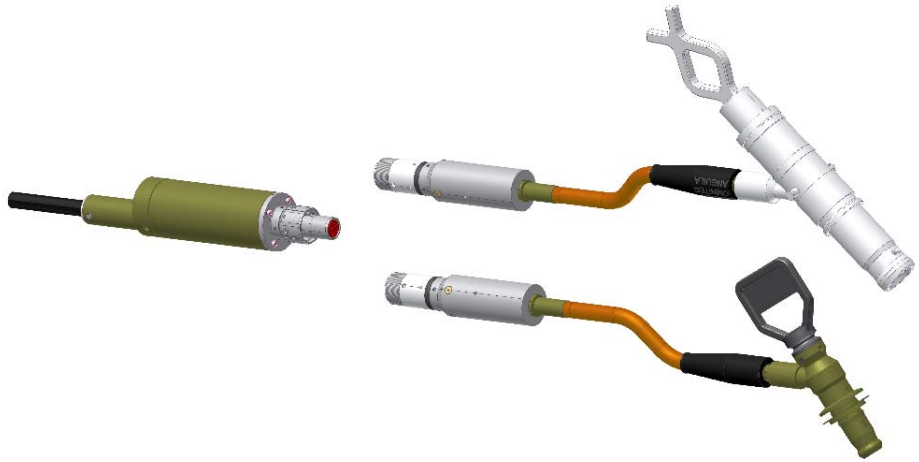
Design offers flexilibity without having to reterminate the umbilical for different jobs requirements => Cost saving, reconfiguration time saving

Emergency reconfiguration possible on site under 30min

Reconfigurable Anguila Cable Termination (REACT)



Bennex REACT Offers/Support



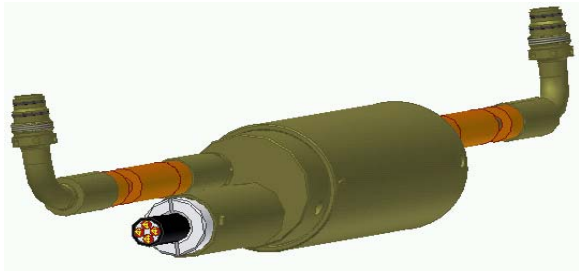
Train your Service organization for:

a) Reconfiguration work
b) Troubleshoot and repair at return of umbilical or when on site

Support your Service organization by:

a) Repair/Refurbish termination
b) Be ready to ship Emergency orders if/when needed

Bennex Umbilical Termination Summary



Anguila Cable Termination is a:

- **Evolution of previous generation termination.**
- **Continuation of Field Proven design philosophy (700+ installations)**
- **3rd generation design. Simplified, Smaller, Faster, Cost effective, yet incorporates all internal Bennex requirements**
- **Incorporation of customer wants and needs**