

# Industry collaboration— collaboration approach to get industry approval of Siemens Digi3

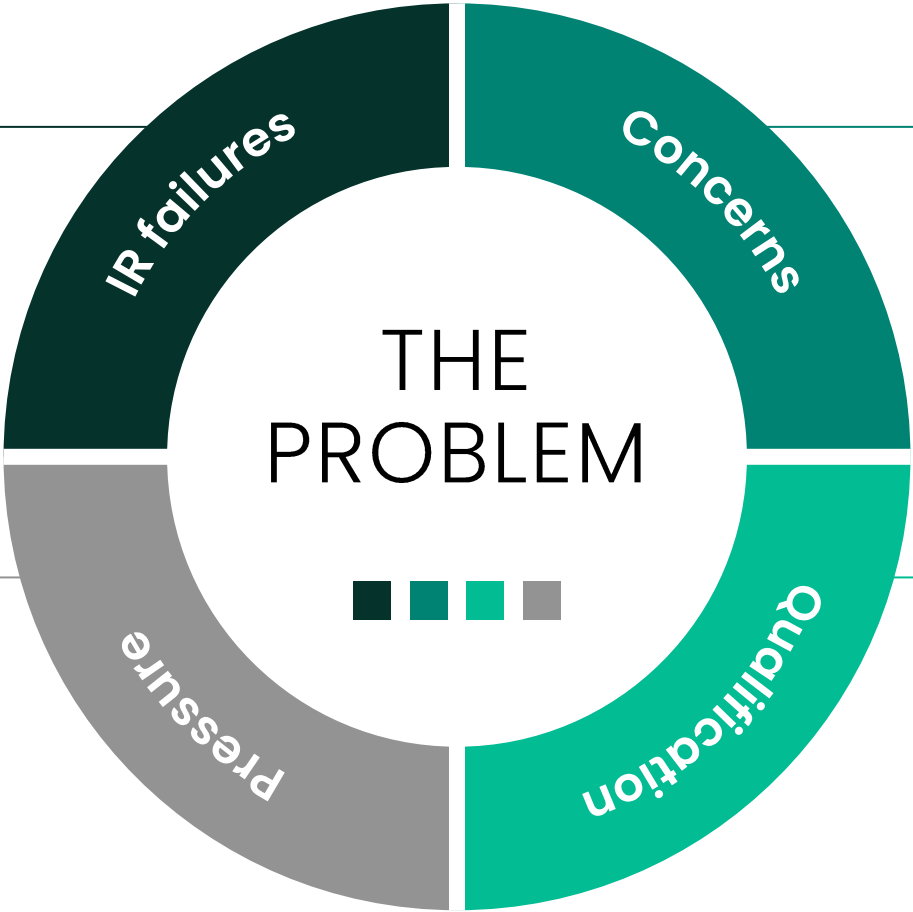
**James D'Arcy**

Senior Product Manager

# The problem statements

The Baker Hughes 3kV Distribution solution for a BP project was based on a delivered system which was suffering from deteriorating IR failures in service.

At the same time, Oceaneering and TFMC, contracted by Total were also planning on using a 3kV distribution system.

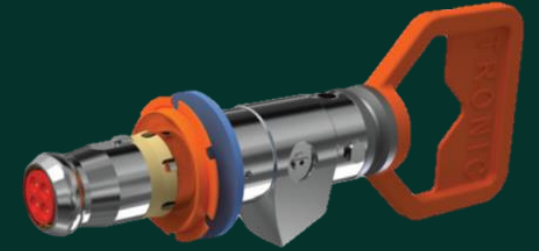


The 3kV products on the market were both 'new' to the Subsea Controls Industry and despite both being claimed to be qualified, our experience on this deployed project raised concern.

The 3kV Connector falls outside of API17F and SEPS and therefore a robust qualification program is undefined.

# DigiTRON3

- Siemens' intent was to design a 4-way higher voltage connector for long step outs
- 4-way controls connector based on the DigiTRON+ size 10 connector with a modified HV (Higher Voltage) cable, termination sleeve and cable management
- It is a 1,8/3 (3,6)kV wet mate single phase controls connector (IEC 3 phase categorisation adopted to match typical umbilical rating)
- Colour differentiators are used on the DigiTRON3 connectors as they share the same metal work as DigiTRON+
- Extended Electrical Qualification to TR2390 with power (SEPS) Voltage values applied



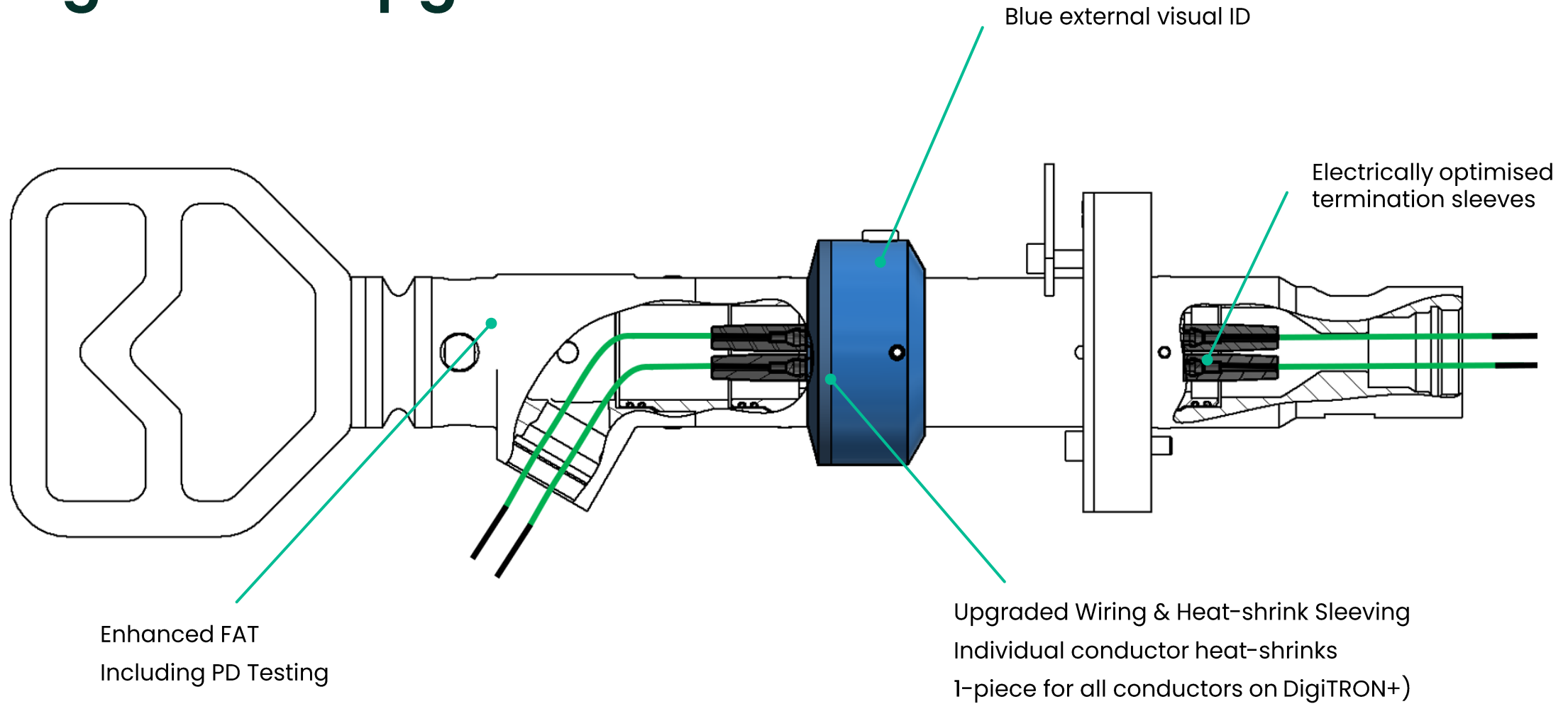
# Siemens DigiTRON3 deployed history

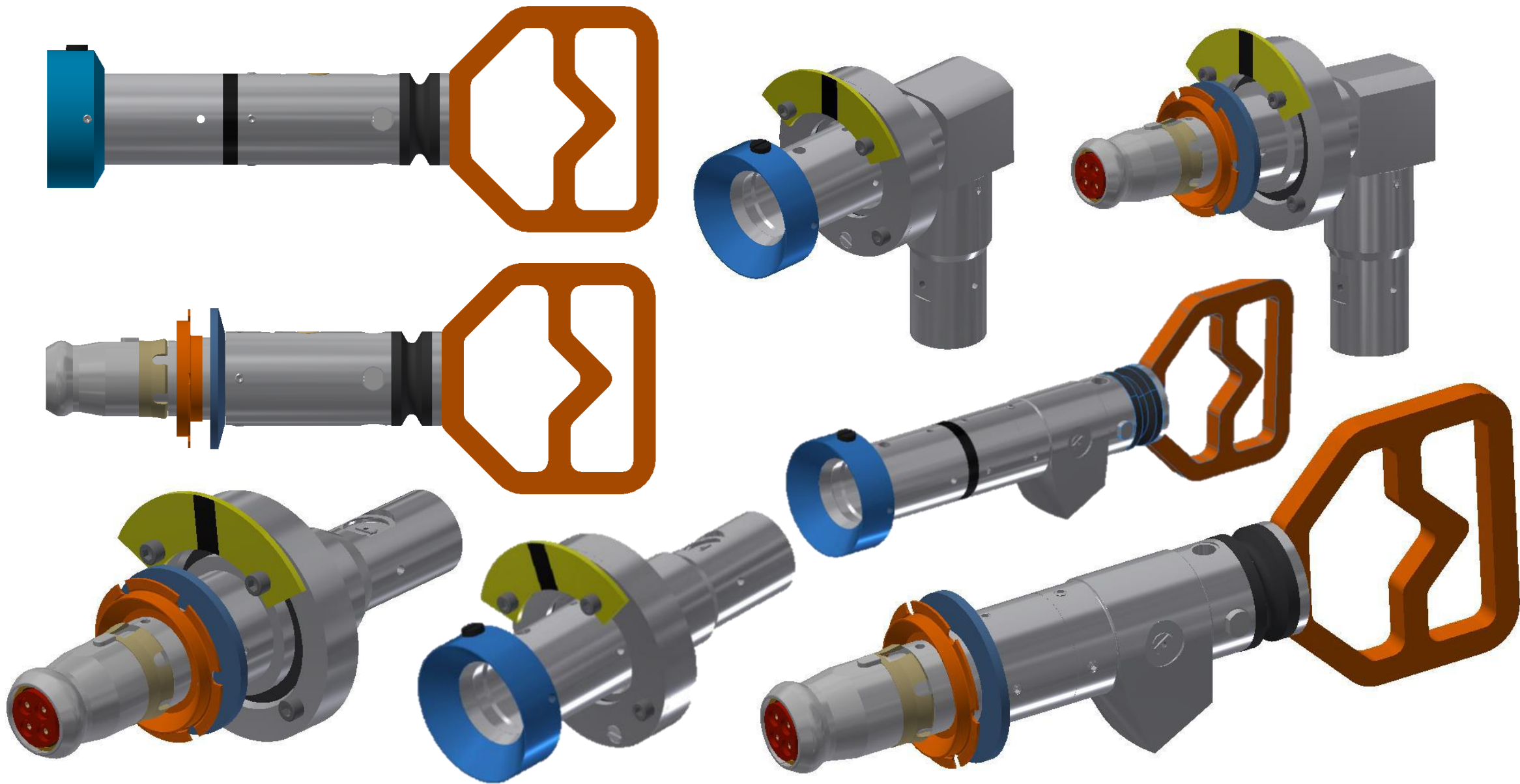
Year	Name	Location	Depth	Overview
2018	"LoVe" (Lofoten–Vesteralen) Cabled Ocean Observatory phase 1	North Sea	250	Phase 1- Umbilical installation with Subsea Distribution Units.  3kV hybrid termination head, receptacle connectors and loop-backs.
2019	"LoVe" (Lofoten–Vesteralen) Cabled Ocean Observatory phase 2	North Sea	1,600	Phase 2 - installation of observation nodes, hook-up to SDU's, and system commissioned.  Operational voltage 3kV single phase. One circuit per connector (2 pins used). Operational August 2019.  6 open-ended harnesses, plugs, receptacles, dummy plugs.
2019	Cooper Energy Sole	Australia	130	3-off 3kV ACT3 (Receptacle) and dummy plugs, 3kV Test Connectors.
2020	Murphy Oil Rotan	South China Sea	1,150	2-off 3kV REDU3, LTPCs 3kV ACT3, 3kV EFL (Plug to Receptacle), Test and parking connectors.

# DigiTRON3 key specifications

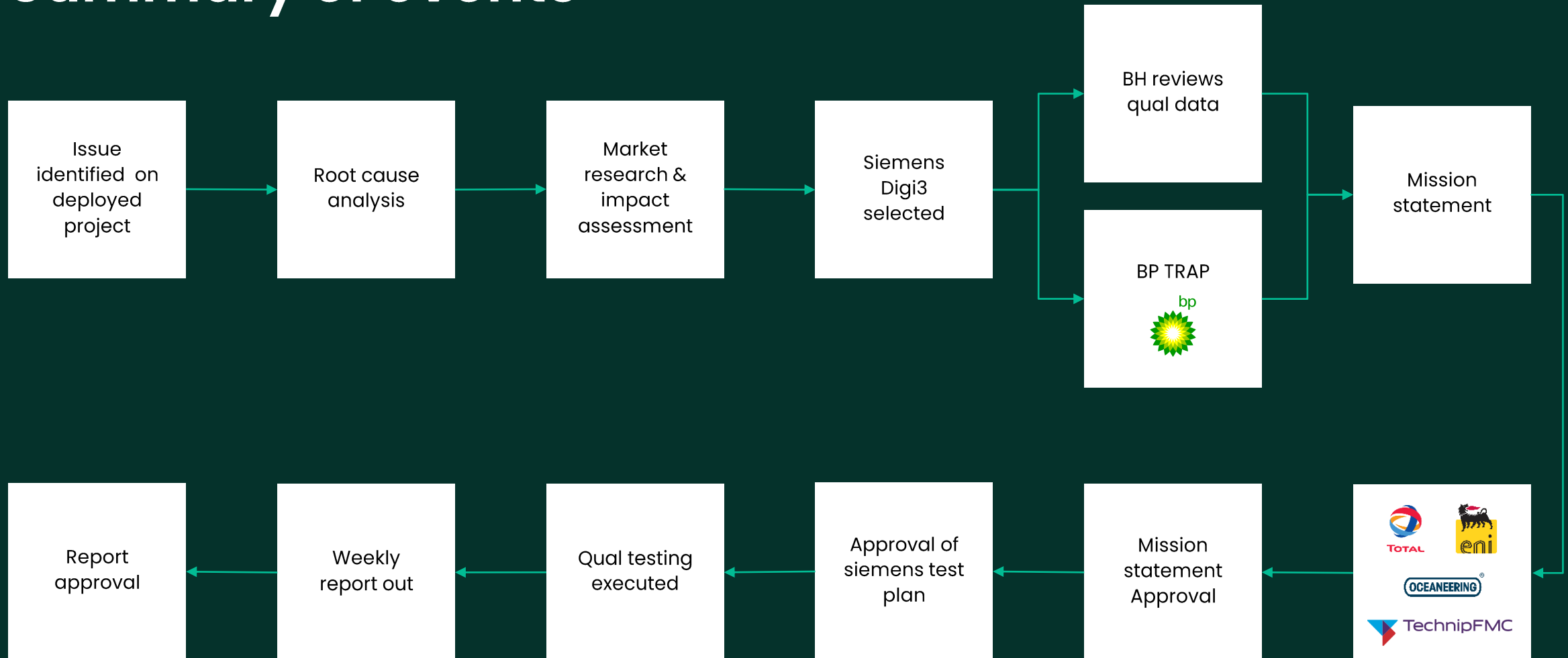
Parameter	Value	Unit
Rated voltage	1,8/3 (3,6)	kV
Rated current	30	A
Frequency	50-60	Hz
Minimum breakdown voltage ( $>8U_0$ )	14,4	kV
Number of contacts (pins)	4	
Design life	30	Years
Maximum water depth	4,000	m
Operational temperature	-5 to +30	°C
Storage temperature	-25 to +60	°C

# DigiTRON3 upgrades





# Summary of events

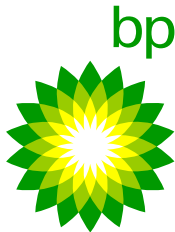




# The solution

Mission statement outlines the rigors that an umbilical termination, wet-mate connector and electrical flying lead might experience in their life post-delivery from the supplier.

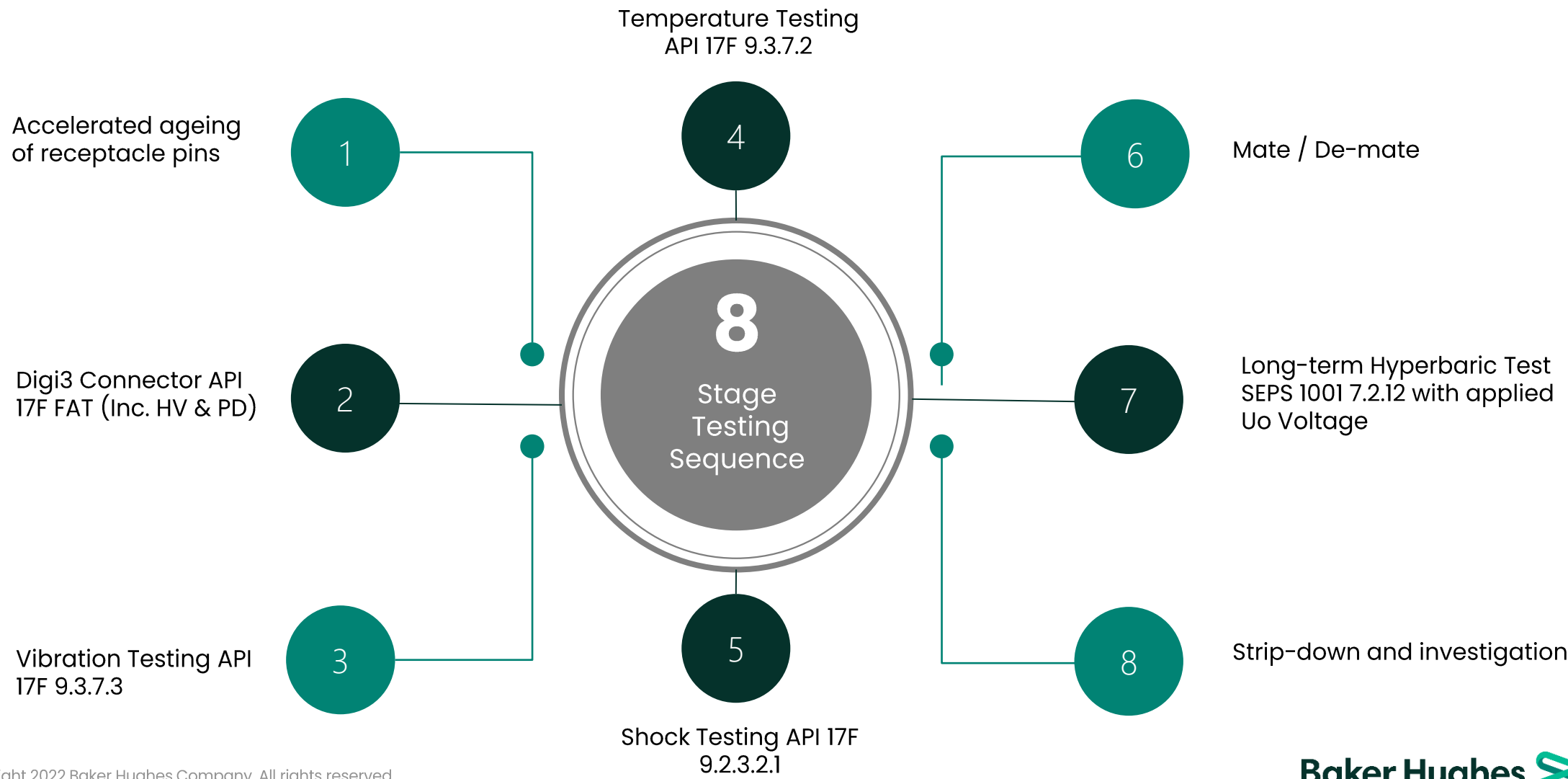
## Reviewed and commented on by:



## Testing regime was based on SEPS Section 7.2.12 with connector pairs:

- Built and tested as per any other connector
- Have been through representative ESS testing (shock, vibration, temperature)
- Have experienced surface & subsea mating/de-mating activities congruent with operational expectations
- Under continual electrical stress during extended hyperbaric test
- At elevated temperature or frequency to artificially accelerate the simulated time of the connector subsea

# Digi3 30—years testing sequence



# The solution



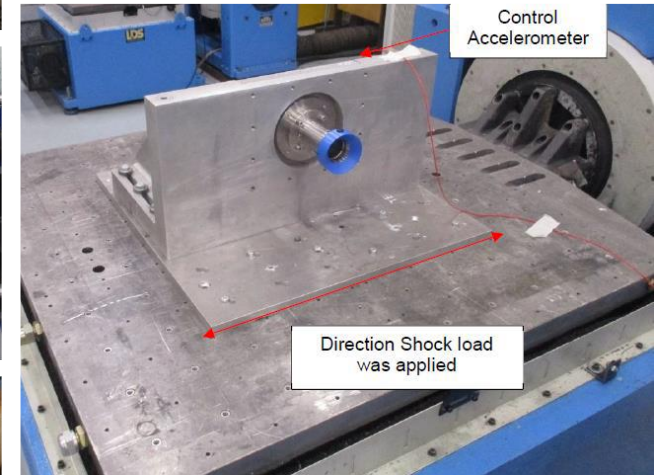
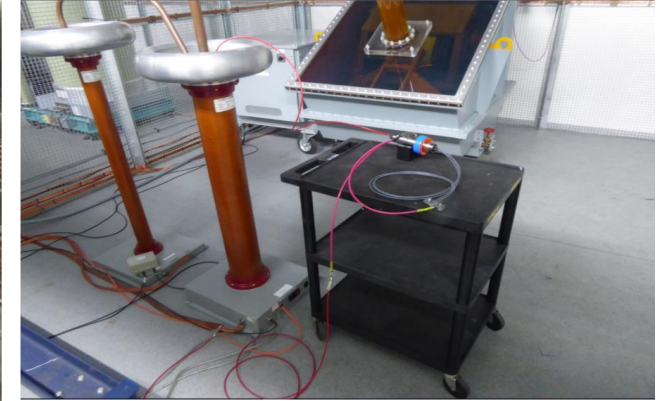
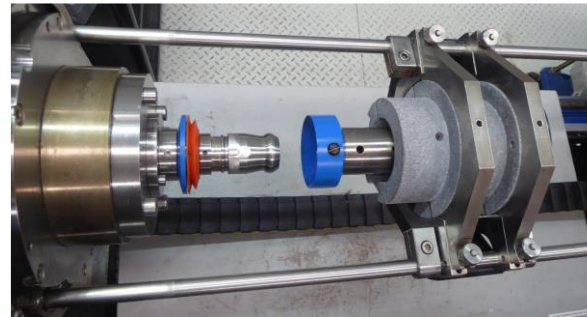
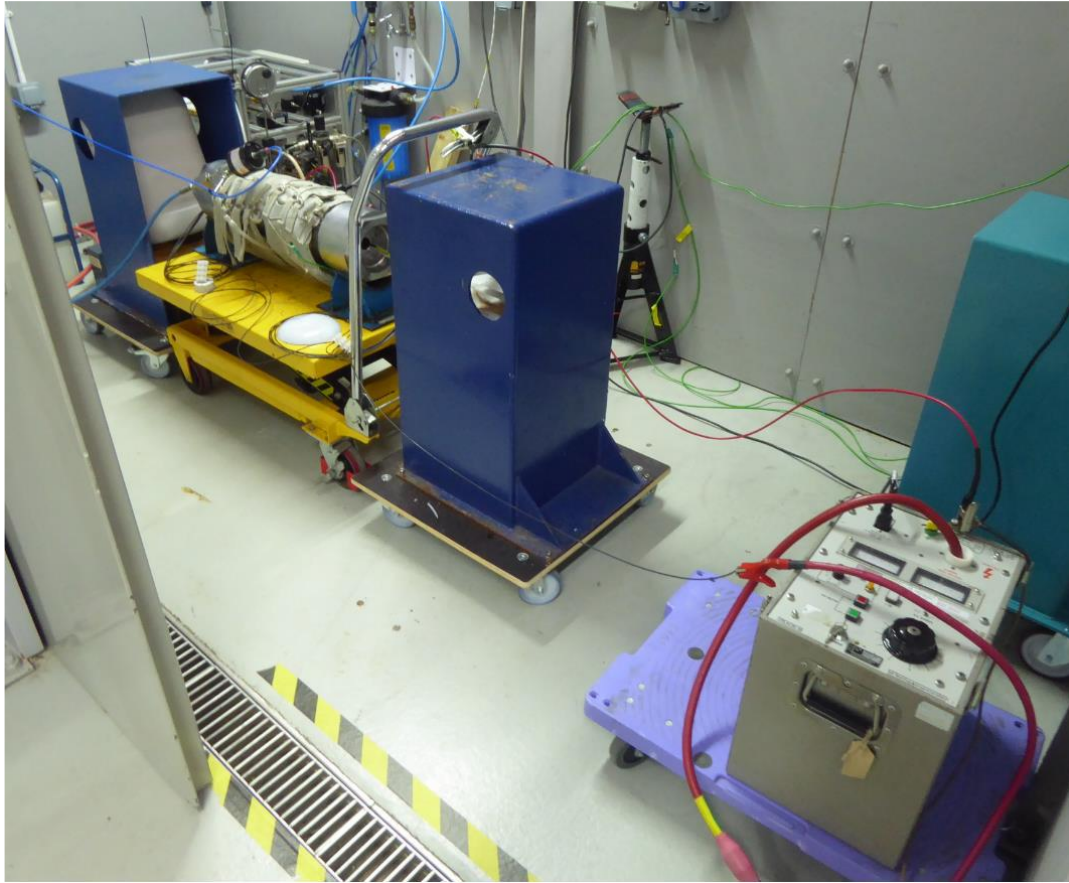
- One set of critical components was artificially aged with heat outside of the connector assembly
- Plug was aged in Mineral oil. Receptacle in seawater



- A test period of 7.5 weeks was adopted in order to simulate a replicative 25 years' service before being built back into Connector halves
- Arrhenius Principal Adopted – taking into account operational temperatures in all stakeholders' deployment locations
- Test temperature was 90°C
- These then joined 'virgin parts' for remainder of the FAT and long-term hyperbaric testing program

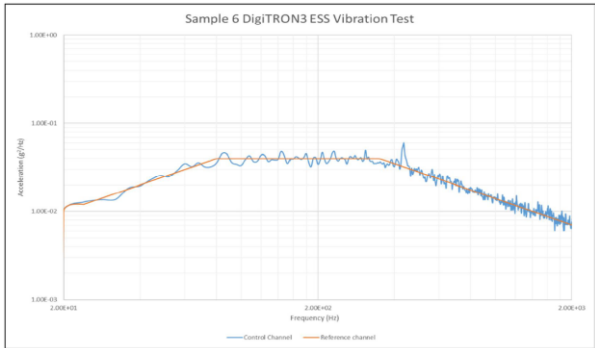


# Testing

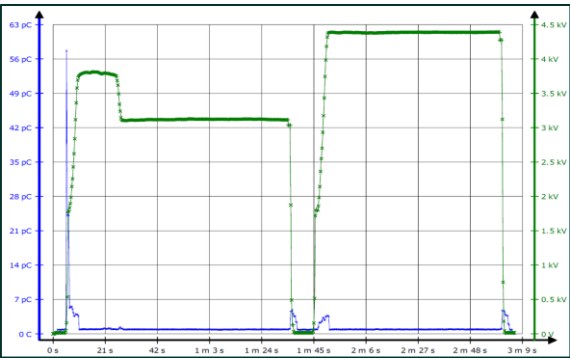


# Testing

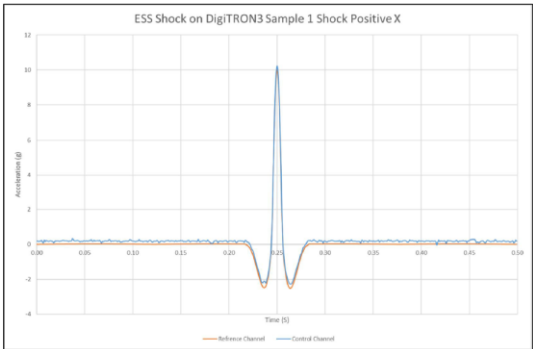
## ESS vibration



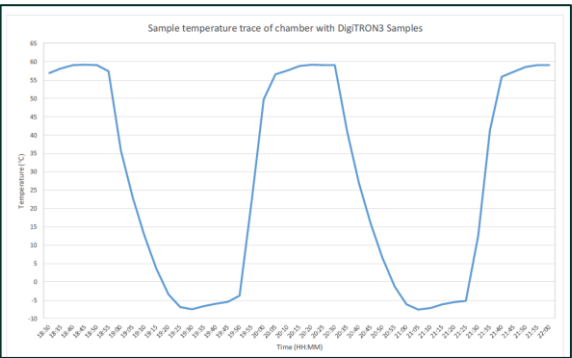
## PD testing



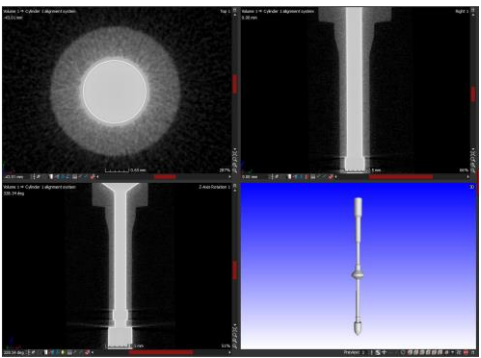
## ESS shock testing



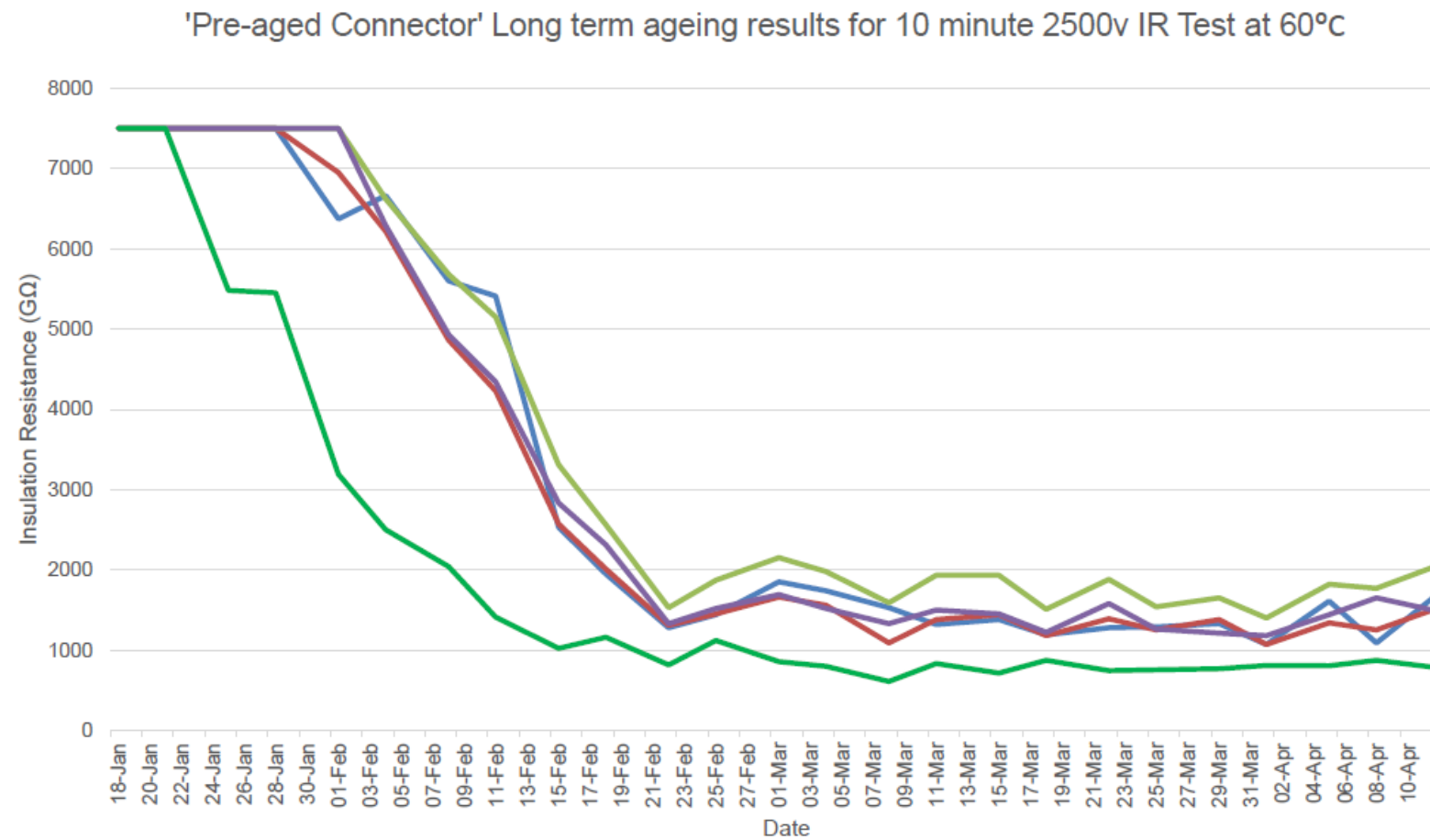
## Temperature cycling



## CT scanning of pins

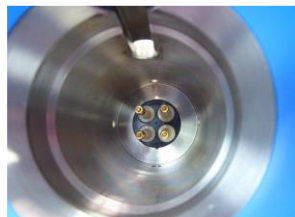
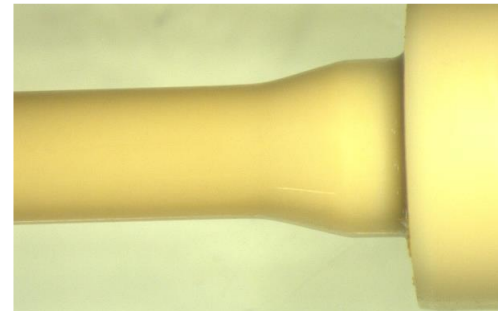
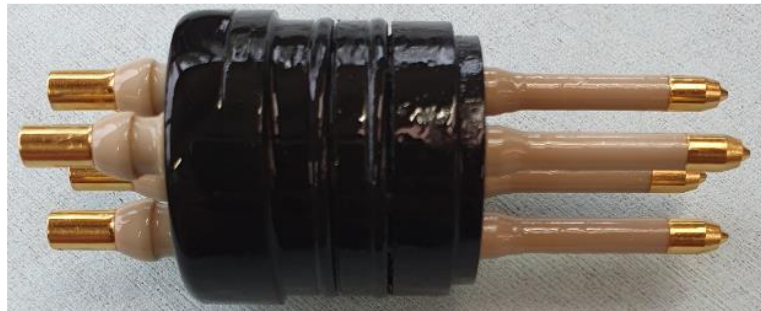
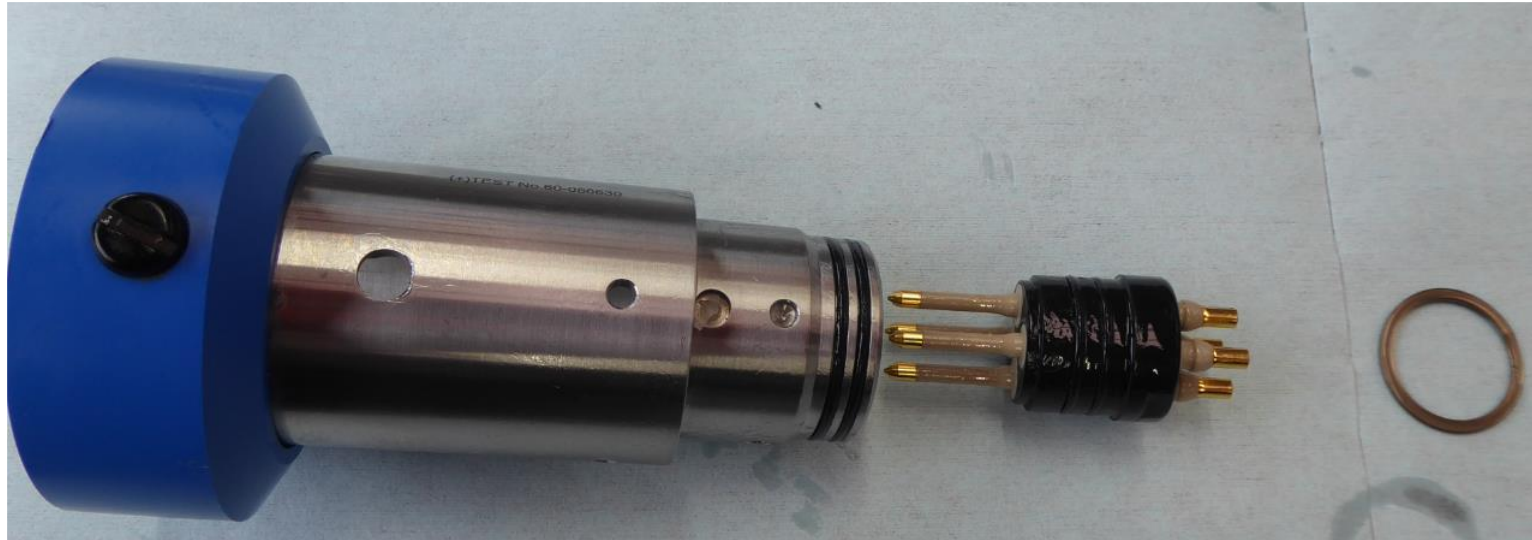


# Twice-weekly IR readings

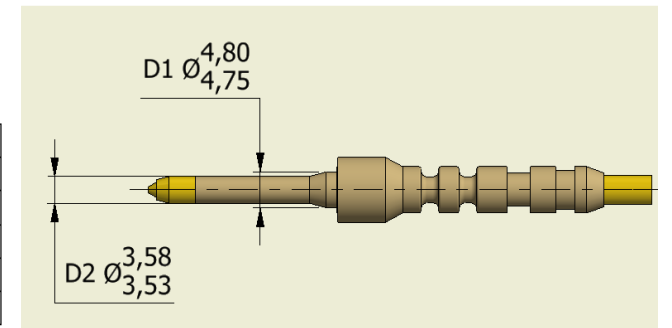








Pre-aged (30 years aged) Receptacle Pin Inspection (Ref DWG T11948-3)				
	D1 Allowable	D1 Measured	D2 Allowable	D2 Measure
Pin 1	Ø 4.80 / 4.75	4.75	Ø 3.58/3.53	3.55
Pin 2	Ø 4.80 / 4.75	4.75	Ø 3.58/3.53	3.56
Pin 3	Ø 4.80 / 4.75	4.76	Ø 3.58/3.53	3.56
Pin 4	Ø 4.80 / 4.75	4.75	Ø 3.58/3.53	3.55





# Summary

## Does 'qualified' really mean qualified?

Qualification is subjective especially when a product doesn't fall exactly within a specification or when a product is based on one that is historically qualified.

1

## Industry collaboration is possible

Weekly meetings with people from multiple time zones

Multiple Operators, competitive SPS Vendors, and suppliers all met and came together to achieve a common goal.

2

## SPS Vendors act as a 'shield' to tier 1 suppliers – BH aim to break this down

Siemens, perhaps did not have enough visibility into the life of their products outside of their factory. This needs to change.

3

"Great working with the entire team and very pleased with the results. Looking forward to getting these connectors subsea!"

"This work has gone some way to give us a high degree of confidence in the connector performance for Tortue and future projects."

"Once again and on behalf of Siemens Energy, I would like to thank everyone involved in this initiative for the collaborative and efficient manner in which we as a group conducted this project from start to finish, and for your regular attendance to our weekly discussions to help this process run as smoothly as possible. I personally have very much enjoyed this open team approach and it has been a pleasure working with you all."

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