SEAFOM – Promoting Fiber Optic Sensing in the Upstream Oil and Gas Industry

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SEAFOM Steering Committee Member
Weatherford
Introduction

SEAFOM exists to facilitate the growth of fiber optics sensing in subsea, dry tree, and land well applications as well as within subsea infrastructure.

Value drivers
- Knowledge sharing
- Networking
- Develop recommended practices for eventual adoption as industry standards
- Dissemination of today’s fiber optic technology & applications and its commercial applicability to the Oil & Gas Industry
SEAFOM – Member Benefits

SEAFOM’s value proposition is based around its unique membership base that allows consistent collaboration across a broad range of fiber optic providers and users.

- Develop and steer formation of recommended practices and testing procedures
- Operator supply chain engagement and technology influence
- Consistent focus on knowledge sharing and inter-company collaboration
- Key focus on addressing overall reliability of fiber optic systems intended for deployment in complex scenarios
- Bi-Annual SEAFOM™ “Industry Events” focused on marketing and promotion of the entire membership supply chain to a wide operator audience
- Promotion of closer collaboration and knowledge sharing across industry and the research and development activities within Academia*
- Supply chain support and stimulation, especially for the smaller / newer vendor members who enjoy access to a wide array of established end-users (Operators) and other potential vendor partners
- Active promotion of training related to the deployment of fiber optic technology within the Oil & Gas arena

*Academic members benefit from free membership
SEAFOM – Member Benefits

Oilfield Fiber Optic technologies and membership base solutions are promoted through special events, publications, and deployment surveys.

- Annual SEAFOM Industry Promotional Events promoting SEAFOM members to a wide number of End-Users
- Publication of a New Industry Primer detailing Fiber Optic Sensing for Downhole applications (2019)
- Publication of first ever deployment survey of global downhole Fiber Optic installations (2016)
About SEAFOM

SEAFOM meetings focus on knowledge sharing, progressing working group activities and promoting networking

- SEAFOM meetings take place over 2 consecutive days and occur 3 times/year (working group communication is ongoing)
- The location of SEAFOM alternates between the US (usually Houston) and Europe

<table>
<thead>
<tr>
<th></th>
<th>Day 1</th>
<th>Day 2</th>
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<tbody>
<tr>
<td>Morning</td>
<td>• Knowledge sharing presentations</td>
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<td>• Working groups</td>
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Typical SEAFOM meeting format
Current members

SEAFOM’s membership includes organizations across the supply chain.
Industry recommended practices

There are currently 7 SEAFOM recommended practices completed (or under development) that will ultimately be submitted to API in order to promote standardization and greater industry alignment.

<table>
<thead>
<tr>
<th>Ref</th>
<th>Name</th>
<th>Status</th>
<th>Publication / API submission date</th>
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<tbody>
<tr>
<td>MSP-02</td>
<td>DAS Parameter Definitions and Tests</td>
<td>Ongoing</td>
<td>Published Dec 2017</td>
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<tr>
<td>AWES-DIG</td>
<td>FBG based Monitoring Systems - Recommended Practice For the Qualification of Downhole Instrumentation / Sensors</td>
<td>Completed - AWES Collaboration</td>
<td>AWES publish 2nd rev Sept 2017</td>
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<tr>
<td>F&amp;C-01</td>
<td>Fiber and Cable in Harsh Environment - Recommended Testing Procedures</td>
<td>Completed</td>
<td>Published 2015</td>
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<tr>
<td>TSD-01</td>
<td>Functional Design and Test Specification for an Optical Feedthrough System used in Subsea Xmas Tree Installation</td>
<td>Completed</td>
<td>Planned update for 2018, API in 2018</td>
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<tr>
<td>TSD-02</td>
<td>Functional Design and Test Specification for Subsea electrical / optical connectors and jumpers</td>
<td>Completed</td>
<td>Completed Feb 2016, API in 2017</td>
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<tr>
<td>TSD-03</td>
<td>Functional Design and Test Specification for Downhole Electrical and Optical Connectors and Assemblies for in-well sensing applications</td>
<td>Ongoing</td>
<td>Publish April 19</td>
</tr>
<tr>
<td>AWES TEF</td>
<td>Tubing Encase Fiber document (developed in collaboration with AWES, the Advanced Well Equipment Standardization group)</td>
<td>Completed - AWES Collaboration</td>
<td>Published 2016</td>
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Note: Measurement Sensor Performance (MSP); Test Qualification Plan (TQP); Fiber & Cable (F&C)
Timeline: TQP-01

Summary text

---|---|---|---|---|---|---
Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4

- Working group established
- Draft document produced
- Document review and iterations
- Issue final document
- Submit to API
- Review
Overview: MSP-01

Measurement Specification for Distributed Temperature Sensing

Objective

- To provide a guide, specifically focused on "Distributed Temperature Sensing" (DTS) which enables:
  - Every DTS customer to select a product based on comparable specifications derived from identical parameter definitions and comparable test procedures
  - Every DTS manufacturer to specify and test their instrument performance following the same parameter definitions and test procedures as anybody else

Deliverables

- A set of DTS performance parameter definitions, test setups and testing procedures, which are valid for any brand or model of a DTS system.
  - The document does not pose any requirements on the actual DTS performance, nor is it intended to actually define any specific acceptance criteria for any given application, nor to limit any user to use any brand of DTS with any desired/compatible fiber and cable.

Value contribution

- What does this document provide to the industry:
  - A harmonized definition of the key DTS performance parameters together with standardized procedures on how to test them.

- Intended end-users of the document?
  - Decision makers and technical buyers at oil service providers or operators
  - DTS equipment manufacturers
Overview: MSP-02

DAS Parameter Definitions and Tests

Objective
- Development of a guide to standardize parameter definitions, measurement metrics and recommend test and or characterization processes approaches to assess the performance of DAS Interrogators used in Oil and Gas applications such as cementing, completion, stimulation, production, logging, seismic, and other down hole measurements.

Deliverables
- Document MSP-02 aims to clearly define DAS measurement and performance parameters and identifies basic in-lab test processes to support evaluation of DAS Instruments as a means to verify capabilities.
- The aim of this document is to be a standard to support common language for end-user specification development, and a process means for verification.

Value contribution
- What does this document provide to the industry:
  - A set of standards to define DAS measurement and performance parameters
  - A reference for operators to support determination the suitability of DAS offerings to meet the intended measurement objectives of an operator
- Intended end-users of the document?
  - DAS Implementation operator personnel inclusive of those without optical measurement expertise.
Overview: AWES-DIG Rev 2

FBG Sensor Systems - Recommended Practice For the Qualification of Downhole Instrumentation / Sensors

Objective

• To agree a set of performance metrics and recommend test procedures to assess the performance of Downhole Instrumentation and Sensor systems used in Oil and Gas applications.
• Note: Work Group Collaborated with AWES to update the existing AWES-DIG document to appropriately include fiber based sensors downhole.

Deliverables

• Best Practice document covering specifications of downhole measurement systems and methods of validating those specifications.
• We are not recommending minimum or target values - these are up to the end-user to specify, according to the requirements of their application.

Value contribution

• What does this document provide to the industry:
  – A single point of reference for specifications and test methods. This will allow suppliers and operators to realise commercial and operational benefits by providing a single specification that all can qualify their products to and purchase against.
• Intended end-users of the document?
  – Technology developers, to give them a rigorous basis for testing, qualification and making good technical proposals.
  – Operators, to help assure them a product is fit for their application and to assist in requesting and checking suppliers’ proposals.
Overview: TSD-01

Functional Design and Test Specification for an Optical Feedthrough System used in Subsea Xmas Tree Installation

Objective

- To define a minimum performance specification for an optical feedthrough system (OFS) to be used in intelligent well applications through vertical or horizontal subsea Christmas (Xmas) Trees (XT)
- This document specifically addresses the interface between the subsea environment of the XT and the downhole or reservoir environment for transmission of optical data through the XT.

Deliverables

- Recommended practice document outlining
  - Specification of minimum design and functional requirements
  - Specification of minimum qualification and factory acceptance test requirements

Value contribution

- What does this document provide to the industry:
  - A consolidation of the various individual company Design and Test Specification documents allowing for significant cost reductions for suppliers and operators by providing a single specification that all can use and qualify their products to.

- Intended end-users of the document?
  - Personnel involved in technology development, fabrication and delivery of referenced connectors, project planners and project executioners utilizing these connectors in their projects

Image Source: SEAFOM Architecture Diagrams
Overview: TSD-02

Functional Design and Test Specification for Subsea electrical/optical connectors and jumpers

Objective

- To define the minimum requirements for design, fabrication, testing and qualification of the following types seawater exposed dry-mate and wet-mate subsea connectors and jumper assemblies for subsea production equipment
  - Electrical
  - Electrical / Optical - Hybrid
  - Optical

Deliverables

- Recommended practice document outlining
  - Specification of minimum design and functional requirements
  - Specification of minimum factory acceptance test requirements
- The Ethernet testing described is relevant for communication links utilising Ethernet subsea, even if parts of the link is not seawater exposed i.e. internal to instruments or subsea control modules.

Value contribution

- What does this document provide to the industry:
  - One common specification which merges and improves on the various requirements from all available subsea connector and jumper specifications, whilst removing cost driving disparate requirements.
- Intended end-users of the document?
  - Personnel involved in technology development, fabrication and delivery of referenced connectors, project planners and project executioners utilizing these connectors in their projects
Overview: TSD-03

Functional Design and Test Specification for Downhole Electrical and Optical Connectors and Assemblies for in-well sensing applications

Objective
- To provide a consolidation of the various Vendor Design and Test Specification documents allowing for a Recommended Practice document which outlines the minimum design and functional requirements, and the minimum qualification and factory acceptance test requirements for a In-well Optical/Electrical Connector and Penetrator assemblies and their associated TEF/TEC interface to be used in intelligent well applications

Deliverables
- Recommended practice document outlining
  - Specification of minimum design and functional requirements
  - Specification of minimum qualification and factory acceptance test requirements

Value contribution
- What does this document provide to the industry:
  - A consolidation of the various individual company Design and Test Specification documents allowing for significant cost reductions for suppliers and operators by providing a single specification that all can use and qualify their products to.
- Intended end-users of the document?
  - Personnel involved in technology development, fabrication and delivery of referenced connectors, project planners and project executioners utilizing these connectors in their projects

Image Source: Baker Hughes
Overview: F&C-01

Fiber and Cable in Harsh Environment - Recommended Testing Procedures

Objective

- To recommend test procedures for the key parameters of optical fibers and cables used in Oil and Gas applications such as Distributed Temperature Sensing, Logging and other down hole measurements.
- Provide a series of recommended practices to assess the performance of fiber and cable, and not specify values for the various parameters to be met by the manufacturer.

Deliverables

- In light of the absence of official standards for harsh environment fiber optic cables, users of these fibers and cables created this document as a first step toward having a common set of procedures in order to assess performance in these environments.
- While exact environmental conditions vary between each application, the intention is that this document be a discussion point between the manufacturer and the customer.

Value contribution

- What does this document provide to the industry:
  - Framework to structure testing
  - A common starting point
  - Flexibility to customize to proprietary needs
  - Guideline for Operators to select relevant tests
- Intended end-users of the document?
  - Manufacturers of fibers and cables
  - Integrators of fiber sensing systems
SEAFOM Deployment Survey

- Presented last year
- Data collected through 2016
  - Both operator and service company
- Breakdown of installations by region and tree location
- Expect follow-on survey with data through 2018
Current Activities

- DAS WG – Document Published MSP-02
  - Potential Pipeline Monitoring WG
- Connectors WG – Review TSD-01 for required updates
- Umbilical and Terminations WG – Need Representatives
- Bragg Grating WG – Working with IEEE on instrumentation MSP document
- Fiber Optic System Design Manual
  - From planning to execution for in-well monitoring
SEAFOM Industry Primer

- SEAFOM Fiber Optic Sensing for Downhole Oil & Gas Applications - An Industry Primer
  - Written in coordination with industry experts and edited by Dennis Dria
- Two part document covering basic fiber optic sensing background and in-well monitoring applications
- Extensive reference list
OTM 101 Course

- One day course covering upstream optical fiber sensing technologies and applications
- Course instructors are industry experts from operator and service companies
- Recently conducted 8 November 2018 in Houston
- Next course scheduled for 11 April 2019 in Amsterdam
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