

TYPE APPROVAL CERTIFICATE

This is to certify:

That the Pipeline Isolation Plugs

with type designation(s)
SmartPlug®

Issued to

TDW Offshore Services A/S
Stavanger, Norway

is found to comply with

DNV-OS-F101 Submarine Pipeline Systems (2013)

ASME BPVC Section VIII Rules for Construction of Pressure Vessels Div. 2 (2013)

Application :

For use as isolation plug for oil and/or gas pipelines.

Conditions and limitations are given below and in reference documents.

Design to follow approved design documentation and test procedures given in the reference documents.

This Certificate is valid until **2019-12-31**.

Issued at **Høvik** on **2016-08-01**

DNV GL local station: **Stavanger**

Approval Engineer: **António Cartaxo**

for **DNV GL**

Afzal Hussain
Head of Section

This Certificate is subject to terms and conditions overleaf. Any significant change in design or construction may render this Certificate invalid.
The validity date relates to the Type Approval Certificate and not to the approval of equipment/systems installed.

Product description

The TDW SmartPlug® tool is a bi-directionally pig-able, remotely operated isolation tool, allowing isolation of a pipeline system at operating pressure.

Application/Limitation

This Type Approval Certificate (TAC) testifies that the methodology of the presented design documentation meets the requirements given in the specified codes and DNV GL's engineering judgement. This includes an assessment of possible failure modes, analyses and procedures which reduce the risk of these failures to occur. This TAC replaces the Type Approval Certificate number P-14141.

The SmartPlug® isolation tool is designed for pressure operations and consists of typical plug modules, pigging modules and a control system. The modules are typically connected by ball joints. The control system includes all electrical and hydraulic components needed to control the plug modules and provide through wall communication. The control system can be obtained in a single module, or be splitted up and partly be obtained in several modules, connected by hydraulic tubings or electrical cables. The maximum packer radial extrusion gap – in combination with operating temperature, design pressure, packer design and isolation time – shall, for each plugging operation, be documented by TDW Offshore Services (TDW) in the design documentation. This should be based on TDW documented experience and subject for approval by DNV GL. The calculation of the maximum extrusion gap shall include possible effects due to unsymmetrical plug locking and pipe expansion.

The materials used for the pressure containing parts of the SmartPlug® plug modules (i.e. pressure head, bowl and hydraulic cylinder) are not listed as pressure vessel materials approved by BPVC ASME VIII, Division 2; however, materials used for pressure containing parts have been evaluated by DNV GL and found equivalent to materials listed by ASME for this application (see reference documents for material list). The corrosive environment shall be evaluated for each operation and the recommendation to avoid risk by hydrogen embrittlement in parts subject to tension stresses shall be included in the operational procedures, when applicable.

Type Approval documentation

The reference documents specified below are related to a typical SmartPlug® operation and represent the typical design methods, being is also valid for different input parameters:

- [1] Design Premises, TDW Doc. No.: 150705-01-107-DEP-001, Rev. 03, 13th May 2015;
- [2] 36in SmartPlug D870, TDW Dwg. P100723, Rev. 1, 27th January 2011;
- [3] Elastic-Plastic Finite Element Analysis of a Pipeline Isolated with a SmartPlug® Tool, TDW template file;
- [4] Stress and Strain Analysis of a Pipeline Isolated with a SmartPlug® Tool – Isolation Load Case (Safety Class High), TDW template file;

The reference documents specified below are related to general plug module design and documentation method:

- [5] SmartPlug Pressure Containing Parts – Material List, TDW Doc. No. 117371, Rev. 3, 10th February 2016;
- [6] TDW Material Specification for Slips – Material Uddeholm Viking (Chipper), TDW Doc. No. 194850, Rev. 1, 29th April 2016;
- [7] TDW Material Specification for Slips – Material Uddeholm Dievar, TDW Doc. No. 194233, Rev. 1, 29th April 2016;
- [8] TDW Material Specification for Slips – Material Uddeholm Nimax, TDW Doc. No. 195795, Rev. 1, 24th June 2016;
- [9] 18in G1 Plug Module D385 HS – Design report, TDW Doc. No. 188709, Rev. 2, 23rd July 2015.

The reference document specified below represents the typical documentation and design method for the latter Plug module generation:

- [10] 29-in G1 Plug Module D650 Design Report Results Summary, TDW Doc. No. 183246, Rev. 2, 14th March 2014.

This certificate also covers Plug modules where the entire hydraulic control system is integrated into the Plug module. The documentation listed below represents the typical documentation and design method for the latter Plug module generation:

- [11] Assembly drawing 140961 16IN G3 plug module W370, Rev. 1, 27th January 2011;
[12] 120230 T3 hydraulic schematic no for G3 plug module, Rev. 3, 12th July 2010.

The referenced document as specified below are related to SmartPlug control systems. The document represents an additional contingency unsetting feature for a SmartPlug[®] tool:

- [13] Qualification of 170898 UMTM – Unsetting from Monitoring and Tracking Module, Doc. No.: 100710-04-108-REP-001, Rev. 01, 17th February 2012.

Documentation

Documentation for each plug size that shall be available at the manufacturer:

- Design premises;
- Description;
- Assembly drawing with parts list;
- Calculations;
- Machine drawings;
- Materials specifications;
- Pipeline exposure from the plug and pressure stress calculations;
- Inspection and test plan;
- Test reports containing compliance with test procedures.

Conditions

- Before re-use of any plug, sufficient service, inspection and re-tests to prove full functionality shall be performed and documented;
- Prior to each operation: Structural Test (if not done before) at min 1.43 x planned isolation pressure and in max pipe ID + Factory Acceptance Test at same conditions as planned operation. All executed operations are mapped in a TDW SmartPlug[®] Experience List where data like isolation pressure and pipeline medium is recorded;
- Factory Acceptance Testing (FAT) or equivalent shall document the following: seal function of the largest possible diameter; locking system function by teeth grip onto the pipe. The latter shall be inspected after the test and show that the teeth have given plastic indentation marks into the pipe wall. Further it shall be documented that the hardness of the tested pipe is, at least, equivalent to the actual pipe;
- For SmartPlug systems with two Plug modules, the annulus pressure shall be monitored during actual operation to verify double block functionality;
- A NDT (Non Destructive Test) of all structural parts of a plug module is performed after each structure test and periodically each 4th year to verify the parts are free from cracks and other imperfections.

Tests carried out

- Packer Heat and SmartPlug Long Term Single Isolation, Plugging Specialists International A/S Test. Doc. No.: 980606-047, Rev. 1, December 18th, 1998;
- Packer testing at:
 - 9% extrusion and 501 bar pressure. Refer to DNV GL Product Certificate No. STG-14-743M5441-32-181133-01 for 32in Plug Module UID 181127;
 - 10% extrusion and 358 bar pressure. Refer to DNV GL Product Certificate No. STG-14-743M5441-29-179488-01 for 29in Plug Module UID 179505;

- Structural Test includes:
 - A seal test against defined pipe internal surface discontinuities (ugly weld). Refer to Structure Test Rig drawing UID181323 as an example;
 - Measuring self-lock pressure of each plug module. The self-lock pressure is the minimum differential pressure required for a plug module to be pressure energized (without being hydraulically locked). Refer to Structure Test document no. 101-B02-179488-59575-201213 as an example;
- Strain gauge measurements of a pipe to verify that the level of strain is within the elastic limit of the pipe material and to verify FEA calculation method. Refer to DNV Test Report No. 2007-3412;
- Testing of slips teeth penetration into pipe wall to investigate the combination of different material hardness of slips and pipe and the wear of the slips teeth after multiple use. Refer to TDW Test Report No. 810112-E-MC-0003;
- Influence of Slips teeth penetration on pipeline integrity and pipeline hardness which could compromise the ability of sour medium service. Refer to Test Report No. 130807-01-108-TER-001 performed for a client;

Marking of product

For traceability to this type approval, the final products are to be marked with:

- Manufacturer's identification;
- Serial/Part No. of pressure head;
- NV-stamp (for future product certification, if applicable).

Periodical assessment

In connection with product audits as required by DNV Standard for Certification 1.2, January 2013, a DNV GL engineer shall perform a survey every second year and before expire date of this certificate to verify that the conditions of the type approval are complied with. If any changes to the type approved product are implemented, DNV GL shall be informed in writing.

Product Certificate

Each Plug module produced shall be subject to DNV GL witness during manufacturing and FAT, as well as check of the actual documentation corresponding to the type approved documentation as listed above. This forms the basis for the 'Product Certificate' issued by DNV GL, including stamping of the product.

Revision Record

- First issue dated 2004-12-17.
- The first rev. 1 increased the size range of SmartPlugs down to 6".
- The rev. 2 (2009) was issued due to change in company name from Plugging Specialist International to TDW Offshore Services. Further, the second revision was updated to refer and comply with the latest revisions of DNV-OS-F101 (2007) and ASME VIII division 2 (2007). The required hydrostatic pressure test level was changed from 1.25 to 1.43 times the design pressure, in the 2007 revision of ASME VIII division 2.
- The 2011 revision of the TA certificate, i.e. certificate P-13989, was updated to reflect the 2011 revision of given reference documents.
- This 2012 revision of the TA certificate, i.e. certificate P-14141, is updated to include SmartPlug sizes up to and including 48". Further, the UTM (Unsetting from Monitoring and Tracking module) through a new solenoid valve has been implemented providing an additional option to unset the tool.
- The 2015 revision updates the new editions of the reference codes, the range of dimensions of the SmartPlug® and updates the reference for Standard for Certification. The reference to SmartPlug Compact was removed. Update to new DNV-GL template. Product description and tests carried out were included.
- The 2016 revision includes verification of slips (gripping segments) materials specifications.

END OF CERTIFICATE