



**BUREAU
VERITAS**

**MARINE & OFFSHORE DIVISION
TYPE APPROVAL CERTIFICATE
E&P/12146A-C-15-001 Rev.00**

This is to confirm that the procedure for verification described in Appendix C has been satisfactorily applied, with respect to conformity of EXSTO design and manufacturing, control and test procedures, for the product below:

Designer and Manufacturer **EXSTO**
Product **Bend restrictors for static application (see drawings in appendix A)**

Description (see report E&P12146A-R-2015-001 for more details) Bend restrictors including:
➤ PU82D Polyurethane halves (Process datasheet FP PU82D-1-10)
➤ Metallic end-termination (S355, S235, A36, SS316L as typical)
➤ PU halves assembly bolts (UNS S32760 Super Duplex, Inconel 625 or 718, Titanium Grade 5 as typical)
➤ End-termination assembly bolts (ASTM A320/A193/A194 B7/L7 grade, ASTM A320/A193/A194 B7M/L7M grade as typical or equivalent)
➤ Cathodic protection (Impalloy 18XH and 13XH aluminium anodes, Aberdeen Foundries AFA-30F, AFA-36F or AFA-50F aluminium anodes or Sacor ACPE aluminium anodes)

Main parameters and ranges
➤ Design life 25 years
➤ Maximum ambient temperature 23°C
➤ Maximum flexible outer diameter Up to 450 mm
➤ Maximum bending moment Up to 150 kN.m
➤ Maximum shear force Up to 50 kN

Reference standards:

- ISO/DIS 13628-16 / API 17L1, 2013 – Specification for flexible pipe ancillary equipment
- ISO/DIS 13628-17 / API 17L2, 2013 – Guidelines for flexible ancillary equipment
- NORSOK M503 / DNV-RP-B401 / ISO 15589-2 – Cathodic protection design

The evaluation has been performed based on:

- A design dossier, documenting design methodology and the design criteria,
- A material dossier (including material qualification tests reports) for the different components,
- A testing program (ULOR measurement, FAT and full-scale test),
- Manufacturing activities
- QA/QC system has been confirmed as independently certified to ISO 9001.

Details on this evaluation together with the list of reviewed documents are given in the technical report E&P12146A-R-2015-001. The result of this evaluation being satisfactory, the present certificate of Type Approval is delivered and valid up to 05th November 2018, within the scope of the BUREAU VERITAS General Conditions of Service, to whom it may concern.

Paris, November 05th, 2015, Rev.00

For and on behalf of BUREAU VERITAS

A-L. GAIGNEUX / E. RULENCE / F. MIGEON
Project Engineers

L. VERNEY
SURFAS Jacket Unit Manager



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Appendix A – Typical bend restrictor design

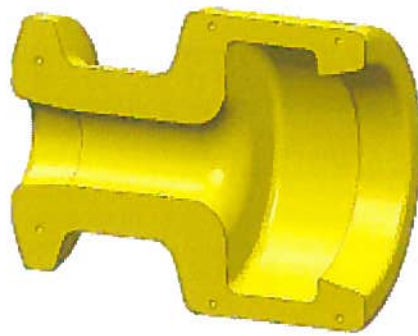


Figure 1: PU Bend Restrictor half element

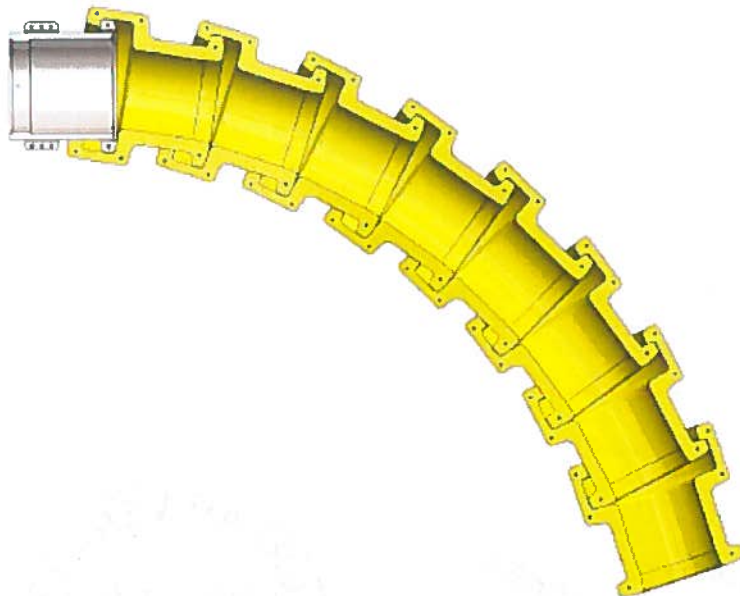


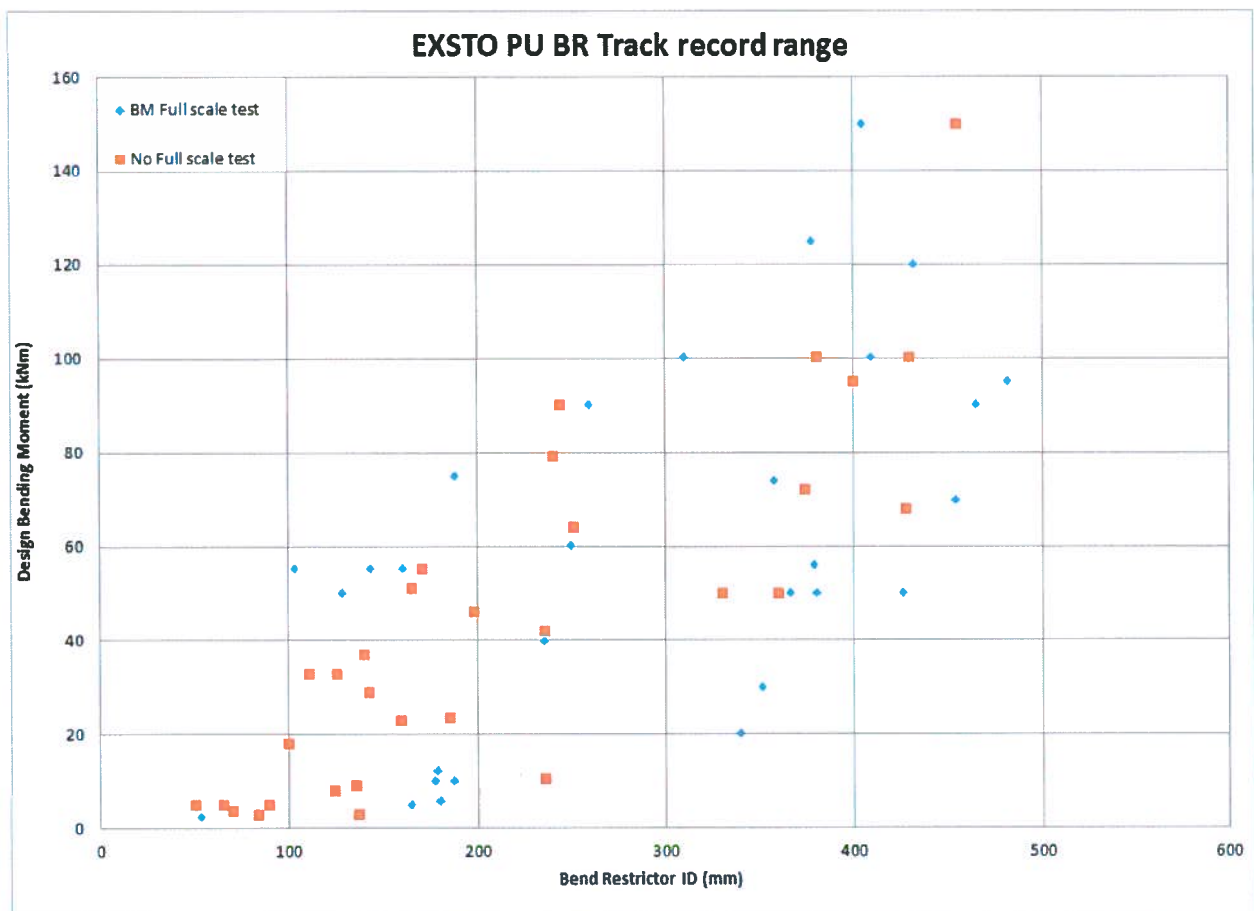
Figure 2: Section of Bend restrictor assembly showing interlocked Bend Restrictor elements



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Appendix B – EXSTO Bend Restrictor Experience

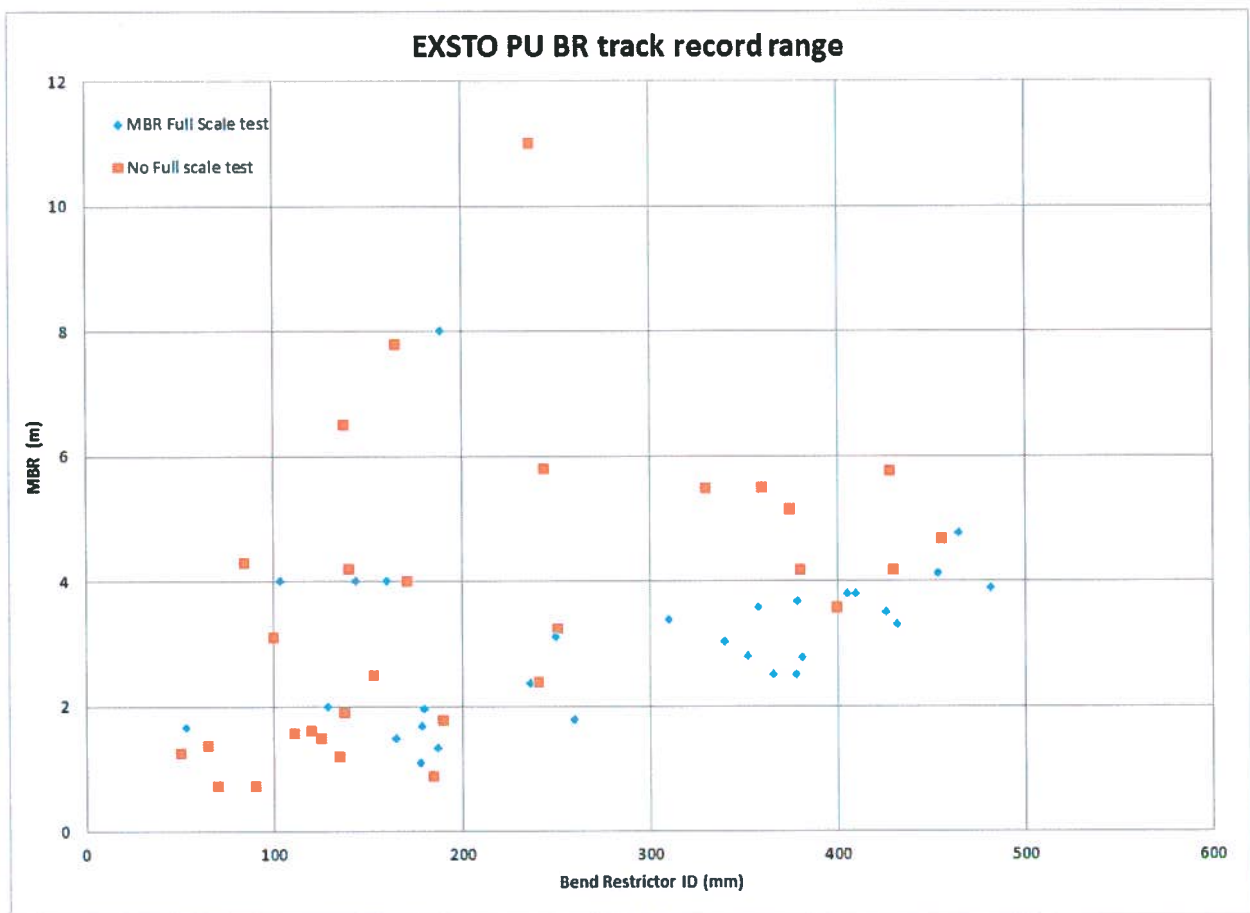




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Appendix B – EXSTO Bend Restrictor Experience





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Appendix C – BV’s Certification Scheme

The certification scheme consists in three phases:

PHASE 1 : Type approval, where the calculation tools, the design rules, the basic material dossier, the fabrication and QA/QC procedures are fully investigated and performance tests are carried out to correlate with prediction values for the complete family of components intended for fabrication. When satisfactorily completed, these assessment leads to a **Type Approval Certificate (TAC)**, valid for one company, one factory and one type of product.

PHASE 2 : Independent reviews, where the proposed design is investigated for a given project and application, against the content of type approval certification, the client's specifications and other applicable codes and standards. This leads to an **Independent Review Certificate (IRC)**, valid for one bend restrictor design (factory, diameter, number and type), and one application (diameter, MBR, external loads).

PHASE 3 : Survey during fabrication, for a given application, to confirm the conformity with the reviewed design, with the expected properties of procured materials and with the approved fabrication and control procedures. A **Certificate of Conformity (COC)** is then issued, valid for one bend restrictor structure already covered by an IRC.

