



Certificate Number: 15ABD10595 Rev. E
BV Job no.: 21ABD11657554

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Certificate of Type Approval

This is to certify that the design methodology and the manufacturing processes for the product identified below was found to be in compliance with the stated Regulations and Standards



Product: Bend Restrictor (Static Application Only)

Manufactured by: Balmoral Comtec Limited
Balmoral Park
Loirston
Aberdeen
AB12 3GY
Scotland

Specified regulations and standards: API Specification 17L1: 2nd Edition: June 2021
(Specification for Ancillary Equipment for Flexible Pipes and Subsea Umbilicals)

We further certify that the manufacturer's arrangements for consistently manufacturing the product in accordance with the approved type have been assessed and found to be satisfactory.

This Type Approval Certificate is valid until: 29/05/2025

Issued by: Bureau Veritas UK Limited Craigshaw Business Park Craigshaw Road AB12 3AR Aberdeen	Author: Charles STEWART Position: Lead Engineer	Approver: Rizwan MOHAMMED Position: Certification Manager
	Signature & Stamp 	Signature & Stamp 
	Date: 15 th December 2021	Date: 15 th December 2021

Certificate Revision History

Revision	Reason for Revision
0	Initial Issue
A	Section 2 updated to highlight limitations for bend restrictor. General certificate text update
B	Scope expanded to include additional design option for the reaction collar.
C	Renewal and Extension with Additional Design
D	Scope extended to include new material and increase temperature limit for existing PU materials
E	Revision of Standard and increased maximum temperature



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Schedule of Approval

1 Product Description:

Bend restrictors are designed to limit over-bending at the interface between subsea umbilicals, risers and flowlines (SURF) and rigid structures.

The bend restrictor string is made up of a number of bend restrictor units, each comprising of two halves bolted together around the SURF. Each unit has a male (external) end and a female (internal) end, which interlock with the adjoining bend restrictor units when assembled.

2 Application/Limitations:

The bend restrictor is designed in such a way that there is a clearance between the interlocking male/female ends of each unit. The bend restrictor units initially move independent of one another as the SURF begins to bend. As the SURF approaches its minimum bend radius (MBR), the interlocking male/female profiles of the adjoining bend restrictor units begin to contact each other until the bend restrictor reaches its geometric locking radius (GMLR).

The bend restrictor reaches its GMLR at a point before the MBR of the SURF is reached, thus preventing over-bending.

A short, summarised, definition of a bend restrictor is given below:

"A bend restrictor is a mechanical device that functions as a mechanical stop which limits the local radius of curvature of the flexible pipe to a minimum value"

Design limitations are assessed using reference documents listed in section 3 of this report. Typical parameters are shown below to accompany design report for each product.

Typical Parameters	
Design Life	Installation Shear Force
Sea Water Density	Service Bending Moment
Deck Handling Air Temperature	Service Shear Force
Short Term Subsea Temperature	Bend Restrictor Element Material
Long Term Subsea Temperature	Fastener Material
Deck Handling Bending Moment	Reaction Flange/Collar Material
Deck Handling Shear Force	Interface Flange/Collar Material
Installation Bending Moment	Reaction Flange/Collar Fastener Material

The design of the bend restrictors verified by Bureau Veritas under this certificate are subject to the following limitations:

Manufacturing Limits	Value
Maximum Pumping Capacity (PU Material)	574L / 14min
Design Limits	Value
Maximum Design Temperature (WET Condition) – BC-PU-109	65°C
Maximum Design Temperature (DRY Condition) – BC-PU-109	65°C
Maximum Design Temperature (WET Condition) – BC-PU-135 ^{Note 1}	85°C
Maximum Design Temperature (DRY Condition) – BC-PU-135 ^{Note 1}	85°C
Maximum Design Temperature (WET and DRY Condition)- BC-PU-164 ^{Note 1}	90°C

Note 1: Creep Strain and Creep Rupture tests are unaged at 4, 23, 50 and 75 °C, accordingly the maximum temperature is limited to 75 °C when the BR is subjected to creep loading. This is not applicable to the high temperature contact region between the BR and pipe, which is subjected to low stress/strain levels and does not contribute to creep failure as a result..

Bureau Veritas has assessed the Bend Restrictors which are documented by the complementary independent appraisal report for which this Certificate of Type shall always be read in conjunction with:

21ABD10731 Rev. 0

Complimentary Independent Appraisal Report

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3 Design Calculations, Design Methodology, Drawings, Documentation and Specifications:

Ref.	Title	Reference n°	Rev.
1	Bend Restrictor General Assembly	14375-GA-01	06
2	Bend Restrictor Load Test Arrangement	14375-GA-02	03
3	Bend Restrictor Design Report	14375-DR-01	03
4	Bend Restrictor Structural Calculation	14375-DC-01	03
5	BR Short Term Locking Radius Calculation	14375-DC-02	03
6	BR Long Term Locking Radius Calculation	14375-DC-03	02
7	BR Load Test Arrangement Calculation	14375-DC-05	03
8	Bend Restrictor Locking Radius Calculation	14375-DC-06	-
9	Bend Restrictor Design Basis	14375-DB-01	03
10	PU Bend Restrictor General Arrangement	13029-DW-BR-GA-01-001	04
11	Load Test Arrangement	13029-DW-LTA-GA-01-001	03
12	Bend Restrictor Design Basis	13029-DD-BR-DB-01-001	02
13	Bend Restrictor Structural Calculation	13029-DD-BR-DC-01-001	04
14	BR Locking Radius Calculation - Short Term	13029-DD-BR-DC-01-002	02
15	BR Locking Radius Calculation - Long Term	13029-DD-BR-DC-01-003	02
16	Load Test Arrangement Calculation	13029-DD-BR-DC-01-004	02
17	Bend Restrictor Design Basis	13029-DD-BR-DB-01-001	02
18	Inspection Test Plan	13029-PD-002	04
19	Bend Restrictor General Assembly	00136-DW-BR-GA-01-001	01
20	Bend Restrictor Structural Calculation (WIP)	70088-DD-BR-DC-01-001	01
21	Bolted Mould Standardisation - FEA Report	70088-DD-BR-DR-01-001	01
22	BR Qualification Basis Summary	70088-DD-BR-QB-01-002	01
23	BR Standardisation Qualification Basis	70088-DD-BR-QB-01-001	01
24	Inspection and Test Plan	70123-PD-002-001	01
25	Inspection and Test Plan	14375-PD-002-001	02
26	Production Test Report	13029-PD-011	01
27	Production Test Report	14375-PD-011-001	01
28	Production Test Report	70123-PD-011-001	01
29	Technical Laboratory Report	BGLR 75239	00
30	Technical Laboratory Report	BGLR 75203	06

Bureau Veritas' approval of the above documents are detailed in the complementary Independent Appraisal Report (21ABD10731 Rev. 0).

4 Material Specifications:

Balmoral Comtec Limited shall produce records of tests demonstrating that the material selected for a specific application meet the functional requirements specified for the ancillary equipment, for the service life for storage, transport, installation, and operation conditions.

Materials detailed below have been reviewed against the requirements of API Specification 17L1: 2nd Edition.

The bend restrictor assembly has the following materials used for each component:

Bend Restrictor Element	: Polyurethane (BC-PU-109, BC-PU-135 or BC-PU-164)
Reaction Flange/Collar	: Structural Steel (BS EN 10025-1 S355J2 + N) / Polyurethane (BC-PU-109, BC-PU-135 or BC-PU-164)
Fasteners	: Super Duplex (UNS S32670)/ ASTM A276M (bolts and nuts) Super Duplex (UNS S32670) / ASTM A240M (washer)

Test Procedures for Polymer materials to be according to standards specified in Table 5 API Specification 17L1: 2nd Edition.

Balmoral Comtec Ltd shall demonstrate the qualification test records to ensure the compliance of material selected for bend restrictors to the requirement specified in Sections 4.4 and 6.4 of API Specification 17L1: 2nd Edition.

5 Fabrication/Testing Procedures:

API Specification 17L1: 2nd Edition, provides detailed procedures for performing factory acceptance tests (FAT)s. Balmoral Comtec Ltd documents 13029-PD-002 Rev. 04, 14375- PD-001 Rev. 02 and 70123-PD-002-001 Rev.01 specify the production test procedures for Bend Restrictor assemblies. Bureau Veritas have reviewed these documents and found them to be in compliance with the requirement.

6 Type Test Reports/Laboratory Reports/Certificates:

Bureau Veritas has witnessed a sample of production tests for the approved type and all the applicable requirements of API Specification 17L1: 2nd Edition were found to be met. Bureau Veritas' involvement is detailed in the following inspection report:

21ABD10739 Rev. 0

Witness Inspection Report

7 Marking of Product:

Marking of product shall comply with minimum requirements of section 4.8.1 of API Specification 17L1: 2nd Edition.

8 Certificate Retention:

The Type Approval Certificate is valid only if the Surveillance plan in Appendix A of this Certificate is followed.



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9 Documentation to accompany each product:

The following Project Specific documentation shall accompany each product:

- a) Design Premise
- b) Design Report
- c) Manufacturing Quality Plan
- d) Installation Procedures
- e) As-built documentation – with supplied ancillary equipment
- f) Detailed engineering drawings

10 Comments:

- 10.1 Balmoral Comtec Ltd. shall demonstrate all relevant documents including design reports and calculations on a case-by-case basis for each project specific product.
- 10.2 This Type Approval certifies that the design methodology and the manufacturing processes for the Approved Type were found to be in compliance with the stated regulations and standards. When in-service this product shall be subject to Verification and Examination and comply with the applicable shelf state requirements.
- 10.3 This certificate is issued based on the current data provided for the age testing of BC-PU-164 & BC-PU-135.

End of Certificate



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Appendix A – Surveillance Plan

Part (A) - Implementation of Quality Management System

* Mandatory Elements all Visits	SURVEILLANCE All activities & Processes must be audited at least once over each 5 year period					
ELEMENTS TO BE EXAMINED	Initial	Surv. 1	Surv. 2	Surv. 3	Surv. 4	Re Cert
	April 2020	April 2021	April 2022	April 2023	April 2024	April 2025
*QMS / Manual / Policy / Objectives (4.4, 5.2, 6.2)	✓	✓	✓	✓	✓	✓
*Management Review (9.3)	✓	✓	✓	✓	✓	✓
*Internal Audit (9.2)	✓	✓	✓	✓	✓	✓
*Improvement / Internal NCR Process (10)	✓	✓	✓	✓	✓	✓
*Customer Satisfaction /Requirements (9.1.2)	✓	✓	✓	✓	✓	✓
*Roles, Responsibilities Competency, & Training (5.3, 7.2)	✓	✓	✓	✓	✓	✓
Resource Management (7.1.1, 7.1.2, 7.1.3, 7.1.4)	✓					✓
Design & Development (8.3)	✓	✓				✓
Control of Documents (7.5)	✓					✓
Control of Records (7.5)	✓					✓
Customer Property (8.5.3)	✓					✓
Identification & Traceability (8.5.2)	✓					✓
Control of Product & Service Provision (8.5.1) (Process Control)	✓					✓
Inspection and Testing (8.3.4) #	✓	✓				✓
Control of Monitoring & Measuring Equipment (7.1.5) (Calibration)	✓					✓
Operational Planning & Control (8.1, 8.2)	✓	✓				✓
Control of Non-Conforming Product (8.7)	✓					✓
Preservation of Product (8.5.4)	✓					✓
Control of externally provided processes, products and services (8.4)	✓					✓
Responsibilities, Authority & Communication (5.3, 7.4)	✓					✓
Assessor's initials	CW	CES	CES			



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1. In the Initial Assessment column, confirm by the use of a (✓) that all specified clauses have been audited.
2. In the Surveillance Audit columns, indicate by the use of a (✓), all of the clauses that have been audited during that Surveillance Audit and get agreement by the Client on the day of the Audit
3. In both Initial Assessment and Surveillance Audit columns, when Non Conformance, Opportunity for Improvement or Best Practice has been raised, identify by marking with abbreviated Serial Number accordingly.

Part (B) - Additional Elements (Witness Manufacturing Tests)

Design: ~~Distributed Buoyancy Module~~ ^{CES} *BEND RESTRICTOR (STATIC APPLICATION)*

ITP References: 13029-PD-002 Rev. 04, 14375-PD-001 Rev. 02 & 70123-PD-002-001 Rev.01

Year	Activity	ITP Activities
1 (2021)	Witness/Review Manufacturing Tests of Bend Restrictor designs 1-3	Hardness Check, Fit-Up, Locking Radius Test & Load Test to 1 & 1.3 Time design load
2 (2022)	Witness/Review Manufacturing Tests of Bend Restrictor designs 1-3	Hardness Check, Fit-Up, Locking Radius Test & Load Test to 1 & 1.3 Time design load
3 (2023)	Witness/Review Manufacturing Tests of Bend Restrictor designs 1-3	Hardness Check, Fit-Up, Locking Radius Test & Load Test to 1 & 1.3 Time design load
4 (2024)	Witness/Review Manufacturing Tests of Bend Restrictor designs 1-3	Hardness Check, Fit-Up, Locking Radius Test & Load Test to 1 & 1.3 Time design load

<p>Surveyor Y1: <i>Michael WILSON</i></p>   <p>BV Report No.: 21ABD10739 Rev. 0 Date: 04/10/21</p>	<p>Surveyor Y2:</p>   <p>BV Report No.: 22ABD10630 Rev. 0 Date: 14/7/22</p>	<p>Surveyor Y3:</p> <p>BV Report No.: Date:</p>	<p>Surveyor Y4:</p> <p>BV Report No.: Date:</p>
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To maintain the validity of this Certificate of Type Approval, quality management surveillance and endorsements of the witness manufacturing tests to be performed annually by a BUREAU VERITAS Surveyor.

End of Appendix