



**Certificate Number:** 15ABD10595 Rev. D  
**BV Job no.:** 20ABD9598607 and 20ABD9659851

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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 17L1: 1<sup>st</sup> Edition: 2013 (Errata 2: November 2015)  
 (Specification for Flexible Pipe Ancillary Equipment)


*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: 13/05/2025**

Issued by:  Bureau Veritas UK Limited Craigshaw Business Park Craigshaw Road AB12 3AR Aberdeen	Author: Michael Wilson Position: Graduate Design Verification Engineer	Approver: Rizwan Mohammed Position: Principal Verification Engineer
	Signature & Stamp 	Signature & Stamp 
	Date: 30/10/2020	Date: 30/10/2020

## Certificate Revision History

<u>Revision</u>	<u>Reason for Revision</u>
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

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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.

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

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

<b>Manufacturing Limits</b>	<b>Value</b>
Maximum Pumping Capacity (PU Material)	574L / 14min
<b>Design Limits</b>	<b>Value</b>
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	65 °C
Maximum Design Temperature (DRY Condition) – BC-PU-135	70 °C
Maximum Design Temperature (WET and DRY Condition)- BC-PU-164 Note 1	80 °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.

Bureau Veritas has assessed the bend restrictors which are documented by the following independent appraisal reports for which this Certificate of Type shall always be read in conjunction with these reports:

- (i) 15ABD10538 Rev. 0
- (ii) 17ABD10827 Rev. 0
- (iii) 17ABD10861 Rev. 0
- (iv) 19ABD10470 Rev. A
- (v) 20ABD10428 Rev. 0
- (vi) 20ABD10828 Rev. 0

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

Documentation from previously reviewed within the certificates 15ABD10595 Rev. A, 15ABD10595 Rev. B and 15ABD10595 Rev. C has been referred to in addition to new supplied documentation, all of which is listed below:

<b>Ref.</b>	<b>Title</b>	<b>Document number</b>	<b>Rev.</b>
1	Bend Restrictor Structural Calculation	14200-DC-1 Template No': 00002-DD-BR-DC-01-001-REV03	1
2	Bolted Mould Standardisation - FEA Report	14200-DR-1	1
3	Bend Restrictor General Assembly Drawing	14200-GA-1	1
4	Inspection and Test Plan	00002-PD-002-001	1
5	Quality Plan	14200-PD-005-001	1
6	Assembly Procedure	14200-PD-006-001	1
7	Handling and Storage Procedure	14200-PD-007-001	1
8	Qualification Test Report	14200-PD-009-001	1
9	Production Test Report	14200-PD-011-001	1
10	Bend Restrictor Design Basis	13029-DD-BR-DB-01-001	2

11	PU Interface Moulding (GA Drawing)	13029-DW-RC-DT-01-001	2
12	Bend Restrictor Inspection and Test Plan	13898-PD-002	2
13	Bend Restrictor Production Test Procedure	13898-PD-010	2
14	Material Data Sheet	BC-PU-109	3
15	Bend Restrictor Structural Calculation	70088-DD-BR-DC-01-001	1
16	Bolted Mould Standardisation - FEA Report	70088-DD-BR-DR-01-001	1
17	Bend Restrictor Standardisation	70088-DD-BR-QB-01-001	1
18	Bend Restrictor Standardisation	70088-DD-BR-QB-01-002	1
19	Bend Restrictor General Assembly	70088-DW-BR-GA-99-001	1
20	Reaction flange drawing	00002-DW-RC-DT-01-001	01
21	Test set up drawing	00002-DW-LTA-GA-01-001	01
22	Interface flange structural calculations	12460-DD-TS-DC-01-001	01
23	Long term bend radius derivation	00002-DD-BR-DC-01-003	01
24	Bend restrictor load test tension calculation	00002-DD-BR-DC-01-004	01
25	Bend restrictor load test arrangement calculations	00002-DD-LTA-DC-01-001	01
26	Reaction flange structural calculation	12460-DD-RC-DC-01-001	03
27	Material qualification test report for BC-PU-109	BGLR 2398	NC
28	Material qualification test report for BC-PU-135	BGLR 2319	NC
29	Reaction collar drawing	13029-DW-RC-DT-01-001	02
30	FAT procedure	12928-PD-010	02
31	Technical Laboratory Report for BC-PU-164	BGLR 75203	03
32	Hot Wet Ageing of BC PU 109 and BC PU 135 at 65 deg C	BGLR 2566 (Dated: 02/10/2020)	-

#### 4 Material Specifications:

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)

Balmoral Comtec Ltd shall demonstrate the qualification test records to ensure the compliance of material selected for bend restrictors to the requirement specified in API Specification 17L1: 1<sup>st</sup> Edition: 2013, Sections 4.4 and 6.4.

Bureau Veritas has reviewed qualification test report 14200-PD-009-001 Rev. 01 and technical laboratory report GBLR 75203 Rev. 03 and BGLR 2566 (02/10/2020) submitted by Balmoral Comtec Ltd. Information provided in this report confirms the compliance against API Specification 17L1: 1<sup>st</sup> Edition: 2013, Tables 5 and 15.

Metallic material used for ancillary equipment and fasteners shall comply with the requirements of API Specification 17L1: 1<sup>st</sup> Edition: 2013 Tables 6 and 7. Material data sheets provided by Balmoral Comtec Ltd satisfy the requirement.



**5 Fabrication/Testing Procedures:**

API Specification 17L1: 1<sup>st</sup> Edition: 2013, Section 6.7, provides detailed procedures for performing factory acceptance tests (FAT)s. Balmoral Comtec Ltd documents 14200-PD-011-001 Rev. 01, and 13898-PD-010 Rev. 02 specify the production test procedures and production test reports for each bend restrictor design. Bureau Veritas have reviewed these documents and found them to be in compliance with the requirement.

**6 Type Test reports/Laboratory Reports/Certificates:**

Previous test reports BV-BAL-8471093-IR-001 Rev. 01 and 19ABD10750 Rev. A have been reviewed against the requirements of API 17L1: 1<sup>st</sup> Edition and have approved the testing required for previously approved design. Testing for the new design of Bend Restrictor has not been witnessed by Bureau Veritas, refer to section 8.

**7 Marking of Product:**

Drawings provided for the bend restrictor designs show the marking detail. They were found to be in compliance with the requirements of Section 4.8.1 of API Specification 17L1: 1<sup>st</sup> Edition: 2013.

**8 Certificate Retention:**

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

**9 Documentation to accompany each product:**


- i. Design Premise
- ii. Design Report
- iii. Manufacturing Quality Plan
- iv. Installation Procedures
- v. As-Built Documentation (supplied by end client for ancillary equipment)
- vi. Detailed Engineering Drawings
- vii. Material Specifications
- viii. Manufacturing Record Book

**10 Comments:**

10.1 Bureau Veritas has reviewed the design methodology for bend restrictors against the requirements stated in API Specification 17L1: 1<sup>st</sup> Edition: 2013. This design methodology was found to be in compliance.

10.2 Balmoral Comtec Ltd. shall demonstrate all relevant documents including design reports and calculations on a case-by-case basis for each project specific product. Design reports shall also document limitations stated in section 2 of this Certificate of Type Approval.

10.3 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.

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10.4 The material qualification testing for the increase of the temperature range of BC-PU-135 and BC-PU-109 and the addition new PU material BC-PU-164 has not been witnessed by Bureau Veritas, however the test reports, procedures and calibration records have been reviewed and deemed to meet the requirements of API Specification 17L1: 1<sup>st</sup> Edition: 2013.

10.5 This certificate is issued based on the current data provided for the age testing of the BC-PU-164.

***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)	✓					✓
Purchasing / Verification of Purchased Product (8.4)	✓					✓
<b>Assessor's initials</b>	CW					



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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.
4. Highlight suggested areas of surveillance plan for next visit in agreement with the Client.
5. \* check Part (B) for Additional Elements

**Part (B) Additional elements to be audited**

Design 1: Standard PU Bend Restrictor (BR) with Reaction Flange (14200-GA-1 Rev. 1)

Design 2: BR PU as the interface connecting to the adaptor plate in the client groove (13029-DW-RC-DT-01-001 Rev. 2)

Design 3: New Bend Restrictor with increased active length (Box section) (70088-DW-BR-GA-99-001 Rev. 1)

ITP Reference: 14200-PD-002-001 Rev. 01 and XXXXX-PD-002-001 Rev. 01

Activity	ITP 24-30	ITP 20-23
First Batch of Design 3	X	X
Witness Manufacturing Tests - Year 1 – Design 1,2 or 3	X	X
Witness Manufacturing Tests - Year 2 – Design 1,2 or 3	X	X
Witness Manufacturing Tests - Year 3 – Design 1,2 or 3	X	X
Witness Manufacturing Tests - Year 4 – Design 1,2 or 3	X	X
Witness Manufacturing Tests - Year 5 – Design 1,2 or 3	X	X

***End of Appendix***