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:	Dynamic Bend Stiffener (BSR)
Manufactured by:	Balmoral Comtec Limited Balmoral Park Loirston Aberdeen AB12 3GY Scotland
Specified regulations and standards:	API 17L1: 1st 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: 28/05/2025

Issued by: Bureau Veritas UK Limited Craigshaw Business Park Craigshaw Road AB12 3AR Aberdeen	Author: Rahul Gopal Position: Equipment Certification Team Leader	Approver: Rizwan Mohammed Position: Principal Verification Engineer
	Signature & Stamp:	Signature & Stamp:
	Date: 28/05/2020	Date: 28/05/2020

Certificate Revision History

Revision	Reason for Revision
0	Initial Issue
A	Section 3 Updated with Additional Reference Document
B	Section 2 Updated to Highlight Limitations for Dynamic Bend Stiffener
C	Section 4 updated to Highlight Material Specification for BSR Spindle & Ring Assembly
D	Certificate Renewal

Schedule of Approval

1 Product Description:

Dynamic Bend Stiffeners are used to prevent the over-bending of a flexible pipe or umbilical under load.

There are three sections in Dynamic Bend Stiffeners:-

- The central active section, which is normally conical but may be modified to optimise the stiffness profile along the length. The diameter and length of the cone controls the loaded shape and bend radius of the stiffener and flexible/umbilical.
- An additional cylindrical section with a mounting flange and internal steelwork which joins the polyurethane cone to the end fitting. For dynamic BSRs, the end fitting has a combination of an inner tube to securely attach the polyurethane and an outer cage to provide extra support and reduce the stress on the polyurethane to steel bond at the mating flange face.
- A short straight section at the tip of the small end of the cone. This is to reinforce the thin area of the stiffener to inhibit tearing of the polyurethane.

Dynamic Bend Stiffener is designed as per requirement of API 17L1: 1st Edition: 2013.

2 Application/Limitations:

Flexible pipes or umbilicals carry a high risk of over-bending. Dynamic Bend Stiffeners act as a sleeve to these pipes/umbilicals to restrict the movement. The definition of a Dynamic Bend Stiffener can be summarised as shown below:

'Dynamic Bend Stiffener is a mechanical device consisting of a tapered elastomeric sleeve fitted over a flexible pipe, umbilical or cable to provide extra support and prevent overbending.''

Design Limitations are assessed using reference documents listed in Section 3 of this report. Typical parameters to accompany the design report for each product are shown below:

- Design Life
- Sea Water Density
- Service Temperature Range
- Global Bending Moment
- Global Shear Force
- Operation MBR (Minimum Bend Radius)
- Flexible/umbilical Bend Stiffness
- Bend Stiffener ID
- Active Length
- Maximum Tension Angle
- Dynamic Bend Stiffener – Central Active Section Material
- Mounting Flange and Internal Steelwork Material

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

Manufacturing Limits	**Value**
Maximum Pumping Capacity (PU Material)	11200 kg (800 kg/min for 14 mins)
Design Limits	**Value**
Maximum Design Contact Temperature (WET Condition) – BC-PU-108	55°
Maximum Design Contact Temperature (DRY Condition) – BC-PU-108	90°

Bureau Veritas has assessed the Dynamic Bend Stiffeners which are documented by the following independent appraisal reports for which this Certificate of Type Approval 15ABD10765 Rev. D (BV Job No. 20ABD7719631) shall always be read in conjunction with these reports:

(i) 15ABD10601 Rev. A
(ii) 17ABD10222 Rev. 0
(iii) 20ABD10511 Rev. 0

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

Documentation previously reviewed within the certificate 15ABD10765 Rev. C has been referred to in addition to newer projects supplied; the documentation for which is listed below:

Ref.	Title	Document n°	Rev.
1	PU Fatigue Calculation	14160-DC-3	01
2	Bend Stiffener Design Report	14160-DR-1	02
3	Bend Stiffener FEA Report	14160-DR-2	02
4	Dynamic Bend Stiffener – General Assembly	14160-GA-1	03
5	Bend Stiffener Inspection and Test Plan	14160-PD-002-001	03
6	Production Test Procedure	14160-PD-010-001	02
7	Dynamic Bend Stiffener – Steelwork Assembly	14264-SA-1	01
8	Bend Stiffener Design Basis	14160-DB-1	02
9	Bend Stiffener Design Calculation	14160-DC-01	03
10	Steelwork Fatigue Calculation	14160-DC-2	01
11	Flange and Tube Assembly	DBS-2-00000	02
12	Spindle and Ring Assembly	DBS-2-00001	01
13	Material Qualification Report	BGLR 2187	05
14	Half Scale Bond Test	00003-DD-BS-DR-00-101	01
15	Balmoral Bend Stiffener Flex Fatigue Testing	00003-DD-BS-DR-00-103	01

4 Material Specifications:

Dynamic Bend Stiffener assembly has the following materials used for each component:

Bend Stiffener Active Section	: Polyurethane (BC-PU-108)
Internal Steelwork	: Structural Steel (BS EN 10025-1 S355J2 + N, BS EN 10210 S355J2H + N, BS EN 10060 S355 H2N Hot Rolled Bar) Inconel 625 UNS N06625
Fasteners	: ASTM A320 Grade L7M (Studs) ASTM A194 Grade 7, 7M (Nuts)

Bureau Veritas have reviewed qualification test report BGLR 2187 submitted by Balmoral Comtec Ltd. Information provided in this report confirms the compliance against API 17L1: 1st Edition: 2013 – Tables 5 and 12.

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

5 Fabrication/Testing Procedures:

API 17L1: 1st Edition: 2013 – Section 5.7 states detailed procedures to follow while performing factory acceptance testing (FAT)s. Balmoral Comtec Ltd. document 14160-PD-010-001 Rev 02 specifies the production test procedures for bend stiffeners. Bureau Veritas reviewed this document and found it to be in compliance with the requirement.

6 Type Test reports/Laboratory Reports/Certificates:

Previous test report - BV-BAL-8632678-IR-001 Rev. 00, has been reviewed by Bureau Veritas against the requirements of API 17L1: 1st Edition: 2013 for the previous type approval certificate 15ABD10765 Rev. C and was found to be satisfactory.

7 Marking of Product:

Drawings provided for the dynamic bend stiffener design show the marking detail. They were found to be in compliance with the requirements of Section 4.8.1 and Section 5.8.2 of API 17L1: 1st 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 Dynamic Bend Stiffeners against the requirements stated in API Specification 17L1: 1st 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.

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.

End of certificate

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)	✓					✓
Assessor's initials	CW					

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 for next visit in agreement with the Client.
5. * check Part (B) for Additional Elements

Part (B) - Additional elements to be audited

Design 1: Dynamic Bend Stiffener (14160-GA-1 Rev. 03)

ITP Reference: 14160-PD-002-001 Rev. 03

Activity	ITP Activities 20-25
Witness Manufacturing Tests - Year 1 – Design 1	X
Witness Manufacturing Tests - Year 2 – Design 1	X
Witness Manufacturing Tests - Year 3 – Design 1	X
Witness Manufacturing Tests - Year 4 – Design 1	X
Witness Manufacturing Tests - Year 5 – Design 1	X

End of Appendix