



Our experience, your benefit
TYPE APPROVED EXPANSION
JOINTS FOR LPG-/LNG CARRIERS



EXPANSION JOINTS FOR LPG-/LNG CARRIERS

LPG-/LNG carriers are vessels, designed especially for transportation of Liquefied Petroleum Gas and Liquefied Natural Gas. LPG Carriers are designed mainly to carry butane, propane, butadiene, propylene, vinyl chloride-monomer and anhydrous ammonia, whereas LNG carriers are designed mainly to carry methane. There are primarily three different ways of transporting these liquefied gases. They are categorised as follows:

- Fully pressurised
- Fully refrigerated
- Semi-pressurised and refrigerated

Fully pressurized carriers

These ships carry the cargo in spherical or cylindrical steel tanks, normally designed for a working pressure of approx. 16 BarG, corresponding to the vapour pressure of propane at 45°C, which is also the maximum ambient temperature, in which the ship is likely to operate.

Semi-pressurised / refrigerated carriers

These vessels are fitted with a refrigeration plant that provides a fully refrigerated ability while having a high design pressure for the Cargo Tanks. Their construction is based on carrying propane at a pressure of approx. 8 BarG at a temperature of -10°C, normally designed for a temperature of -48°C though.

Fully refrigerated carriers

The vessels for such applications are generally designed for approx. 0,25 BarG at a temperature of -50°C, but for LNG Carriers the design temperature can be as low as 162°C depending on the cargo grade. As these gases are highly hazardous and flammable, a high level of safety is required when designing for LPG-/LNG Carriers. For example all ships are double hulled; in effect a double ship, that protects the cargo in the event of a collision or grounding.

APPLICATION & REQUIREMENTS

Application

All these ways of transporting the gas, set various demanding requirements for the tanks and the tank system design. Normally the gas onboard the Carriers are stored in cylindrical or spherical steel tanks.

The vessels usually are designed with 4-6 tanks along the centreline of the vessel. A combination of ballast tanks, cofferdams and voids are surrounding the tanks. Inside the tanks pumps are installed. All the cargo pumps are discharged into a common pipe which runs along the deck of the vessel. It branches off to either side of the vessel to the cargo manifolds used for loading or discharging. On the Carrier each gas tank is mounted at an anchoring, which allows the gas tank to move.

In order to absorb these movements an expansion joint is installed at each anchoring. The tank is supported around its circumference by the equatorial ring which is supported by a large circular skirt which takes the

weight of the tank down to the hull structure. This skirt allows the tank to expand and contract during cool down and warm-up operations. During cool down or warm-up the tank is able to expand or contract by 2 feet. Because of this expansion and contraction all piping enters into the tank via the top, and is connected to the ships' lines via flexible bellows, which will result in movements in the tank settlements.

Demanding requirements

Due to the demanding design parameters and the severe consequences, following a possible failure, the expansion joints used for such applications must also meet very high demands:

- The design phase is rather complex as the design must meet both requirements in the classification Society Rules (e.g. Bureau Veritas) and the International Rules for Gas Carriers (IGC Code)
- Every design has to pass a burst test of 5 times the design pressure, and the fatigue life of the expansion joint must be verified

- The mechanical properties of the materials used for the expansion joint must be verified through comprehensive testing, -especially the strength and ductility of the materials must be verified
- Every expansion joint has to pass a pressure test of 2 times the design pressure
- Special requirements regarding welding procedures and consumables are also applicable

All of these tests/documents must be witnessed and approved by a third party surveyor.

TYPE APPROVALS

Belman type approvals

We hold type approvals for IGC cargo and process piping up to DN 400 from:

- BV
- LR
- DNV
- ABS
- KRS

These type approvals can be forwarded on request.

See the Belman type approvals on our website: www.belman.com.



PRELUDE

REFERENCES

Clients for expansion joints for LNG/LPG include among others:

Drydocks World

Shell Prelude

Wärtsilä Oil & Gas

Hamworthy

Huyn dai Heavy Industries

DAEWOO E&C



FLNG

4514-07027, Australia

2 expansion joints made from Duplex and Superduplex. The two different size expansion joints are coated with special paint. The special paint (and also the paint on the bellow) was a special customer requirement.

Dimension: **DN 100, DN 200** | Installation length: **294, 276 mm** | Design temperature: **-10/150°C** | Design pressure: **0,5 bar** | AX: **Up to +/-17 mm** | Bellows: **1.4462, 1.4410** | Flanges: **1.4462, 1.4501**

LPG Carrier

4710-07020, South Korea + Norway

Dimension: **DN 250** | Installation length: **500 mm** | Design temperature: **-50/50°C** | Design pressure: **5 bar** | AX: **+/-18 mm** | LA: **+/-7 mm** | Bellows: **1.4541** | Flanges: **1.4404** | Inner Sleeve: **1.4571** | Intermediate pipe: **1.4301**



REFERENCES



LPG carrier

4712-07021, South Korea + Norway

48 expansion joints were supplied according to customer specifications. They were installed in connection with valves on the deck of a LPG carrier. As the application was critical extensive testing and approvals were required by the customer. In this project our expansion joints were type approved by 3 different notified bodies; LR, ABS and DNV. The approvals obtained can be used also for future projects. Expansion joint design is a double bellow solution to absorb larger movements.

Dimension: **DN 250** | Installation length: **500 mm** | Medium: **Liquid petroleum gas** | Design temperature: **-50/50°C** | Design pressure: **5 bar** | AX: **+/-18 mm** | LA: **+/-7 mm** | Bellows: **1.4541** | Flanges: **1.4404** | Intermediate pipe: **1.4301**



LPG carrier

976-05001, UAE

5 expansion joints were installed on the gas tanks of a LPG carrier. The gas tanks were fixed on anchors, allowing a certain amount of movement. The expansion joints were installed in connection with each single anchor to compensate for this movement. The expansion joints were produced using stainless steel due to the low design temperature. Likewise the connection ends were manufactured from a special seamless pipe. All expansion joints underwent 100% X-ray tests.

Dimension: **DN 200-250** | Installation length: **800-1300 mm** | Medium: **Liquid petroleum gas** | Design temperature: **-20°C** | Design pressure: **16 bar** | AX: **+/-10 mm** | Bellows, inner sleeve: **1.4571** | Welding ends: **1.4404**

LNG carrier

4710-10015, Norway

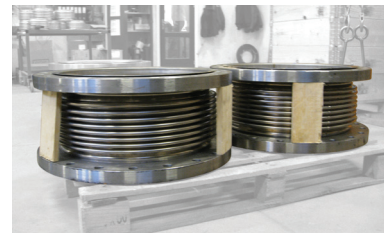
12 expansion joints installed in a LNG carrier.



Dimension: **DN 250** | Installation length: **500 mm** | Medium: **Liquid natural gas** | Design temperature: **-50/+45°C** | Design pressure: **5 bar** | AX: **+/-10 mm** | LA: **+/-25 mm** | All parts: **1.4404**

4710-10017, Norway

3 expansion joints for a LPG carrier. The expansion joints are for the scrubber systems (cleaning systems).



Dimension: **DN 500** | Installation length: **295 mm** | Medium: **Liquid petroleum gas** | Design temperature: **550°C** | Design pressure: **2,5 bar** | AX: **+/-58 mm** | Bellows: **2.4858** | Flanges: **1.0038** | Inner sleeve: **1.4571**

REFERENCES



For ductwork

4916-08031, Germany

These 18 expansion joints were installed in the ductwork on a LNG carrier.

Dimension: **DN 400 - DN 600** | Installation length: **1060-1335 mm** | Design temperature: **-165/50°C** | Design pressure: **2 bar** | AX: **Up to +/-100 mm** | LA: **Up to +/-20 mm** | Bellows: **1.4541** | Welding ends: **1.4404**

REFERENCES



LPG carrier

4713-02042, Norway

Dimension: **DN 250** | Installation length: **600 mm** | Design temperature: **-165/125°C** | Design pressure: **5 bar** | AX: **+/-10 mm** | LA: **+/-20 mm** | Bellows: **1.4541** | Flanges: **1.4404** | Intermediate pipe: **1.4301**



European raw materials

4712-04018, Norway

It was very important to the end customer that these expansion joints were manufactured from raw materials produced in Europe. Belman is familiar with such demands from its clients, so the request presented no difficulties.

Dimension: **DN 250** | Installation length: **500 mm** | Design temperature: **-50/50°C** | Design pressure: **5 bar** | AX: **+/-18 mm** | LA: **+/-7 mm** | Bellows: **1.4541** | Flanges: **1.4404** | Intermediate pipe: **1.4301**

LNG carrier

4712-07017, Norway

Dimension: **DN 250** | Installation length: **500 mm** | Design temperature: **-50/+50°C** | Design pressure: **5 bar** | AX: **+/-18 mm** | LA: **+/-7 mm** | Bellows: **1.4541** | Flanges: **1.4404** | Intermediate pipe: **1.4301**



4710-10017, Italy

24 expansion joints were installed on the exhaust of an LNG/LPG carrier.

Dimension: **DN 150** | Installation length: **258 mm** | Design temperature: **150°C** | Design pressure: **1 bar** | AX: **+/-61 mm** | LA: **+/-20 mm** | Bellows: **1.4541** | Flanges: **1.4404**





REFERENCES



LNG Expansion joint

4514-06050, Korea

Dimension: **DN 150** | Installation length: **258 mm** | Design temperature: **-20/150°C** | Design pressure: **1,5 bar** | AX: **+/-61 mm** | LA: **+/-21 mm** | AN: **+/-37,5°** | Bellows: **1.4541** | Flanges: **1.4404**



LPG-carrier

4714-03002, Norway

5 expansion joints were installed on the gas tanks of a LPG carrier.

Dimension: **DN 250** | Installation length: **600 mm** | Design temperature: **-165/125°C** | Design pressure: **5 bar** | AX: **+/-20 mm** | LA: **+/-40 mm** | Bellows: **1.4541** | Flanges: **1.4404**

LPG carrier

4714-03014, Norway

14 expansion joints installed in a LNG carrier.

Dimension: **DN 250** | Installation length: **500 mm** | Design temperature: **-50/+50°C** | Design pressure: **5 bar** | AX: **+/-36 mm** | LA: **+/-14 mm** | Bellows: **1.4541** | Flanges: **1.4404**



LNG carrier

4715-01020, Norway

9 expansion joints for a LNG carrier.

Dimension: **DN 150** | Installation length: **490 mm** | Design temperature: **-163/45°C** | Design pressure: **10 bar** | LA: **+/-50 mm** | Bellows: **1.4404** | Flanges: **1.4404**



QUALITY ASSURANCE

The delivery of high quality products and services has always been an integrated part of what we stand for. We strive to provide expansion joints and services of a consistently high quality which fully meet the expectations of our customers. The implementation and adherence to recognised quality assurance systems ensures that all processes are performed accurately. The project starts with the initial review of the submitted specifications, followed by the design, manufacture, testing and documentation, all in accordance with the customer's requirements.

The accreditations and certificates we possess enable us to shorten and optimise each project by performing

tests and inspection in-house. The Belman expansion joint design and production process makes use of state-of-the-art technologies. Accredited authorities perform regular controls and tests to confirm the efficient and professional continuity of Belman process management.

Company approvals

- EN ISO 9001:2008
- EN ISO 3834-2
- Pressure Equipment Directive PED 2014/68/EU (PED 97/23/EC)
- AD2000 Merkblatt HPO

- TR CU 032/2013 (GOST-R)
- Declaration of conformity (Russian Rostechnadzor)
- Mark transfer approval within EN 10204 3.1 PED/AD-M W
- DNV-GL type approval
- Bureau Veritas type approval
- LNG/LPG standard type approvals for LR, BV, DNV-GL, ABS and KRS
- EHEDG

Our latest approvals can be seen from our website.

OUR COMPANY ACCREDITATIONS

MANAGING RISK



WELDING & MATERIAL CONTROL

Welding

Our focus on quality assurance includes also welding and within this area, we follow both client requests, project requests, our own procedures, our own quality objectives and the requirements of the design codes.

A natural step for Belman has been to automatise the process of welding as much as possible to ensure that we have the right qualified welding procedure (WPS) for the project and also that we are using the right certified welders for the project. We hold a database with more than 200 different qualified WPS.

Database of qualified WPS



Clamp meters

All welding activity is carefully inspected under supervision of our own inspectors (IWS and IWIS).

As well as we have 100% traceability on all materials, we also have full traceability on all filler materials. 3.1 certificate can be provided for all of them. All documentation are kept in our files for minimum 10 years, which means that we can always find the needed documentation for the client in case it is required.



Penetrant inspection



Visual inspection



Weld measuring gauge

Material control

To ensure a short and accurate delivery time, we have an extensive stock of raw materials. For the bellow material, we stock various steel types in both sheets and coil. These are qualities such as different types of common stainless steel, all 300 series and special alloys being Inconel, Incoloy, Hastelloy, titanium, nickel etc. As quality is important to us and to our customers, we have comprehensive control at goods reception. We check all incoming raw materials according to our QA procedures and policies and that means, among others, that we check the material thickness, certificates, marking of the steel, if the goods are as ordered etc. We have a quarantine stock for goods not approved by the inspector. To ensure a consistent quality on our subsupplies and raw materials, we

audit our suppliers and we set also high demands for them in terms of having the same approvals, procedures and experience as we do. 3.1 certificates is a must and we are certified to mark transfer when the sheet and coil are used for several orders.

Selection of the suitable material for the expansion joint that suits the project/application is crucial. To ensure this with considerations of all applicable norms and standards, we have build an extensive material database.

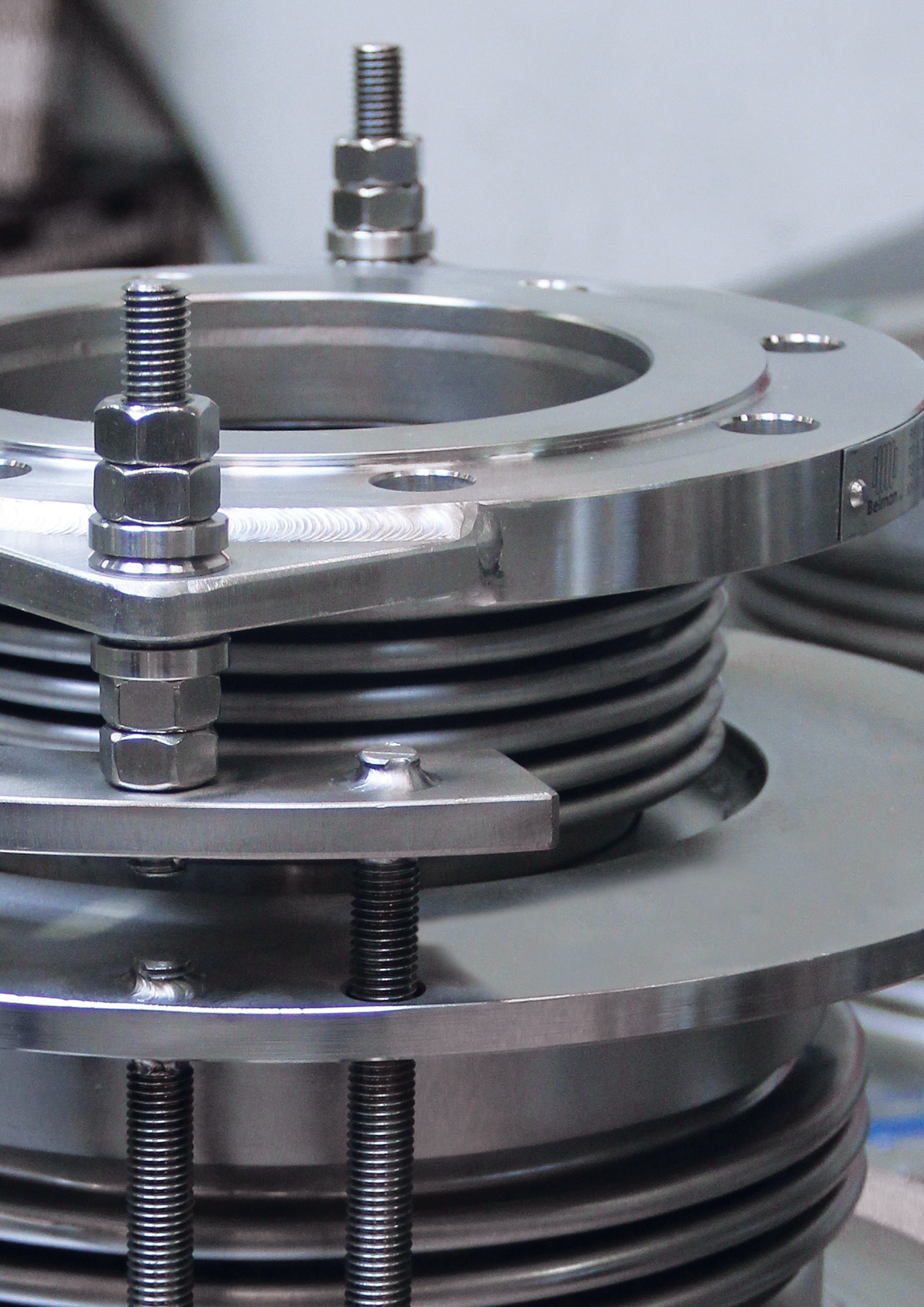


Sliding gauge



Caliper gauge

Material database



DOCUMENTATION

Not only does Belman concentrate on the quality and finish of its products, the same careful attention is also applied to the associated documentation.

Belman has developed its own special software which manages the material traceability on each project. It is also integrated with our design software to ensure the integrity of all materials used against the design code. Documentation is provided with every project. As we are able to execute tests and inspections in-house, our documentation is generated quickly and depending on the client's request, documentation can be supplied with the goods or sent separately. This ability to quickly generate documents ensures that no time is lost when our products arrive at the destination, allowing the installation to be immediately executed with the absolute minimum of downtime. Due to our strength in document management, we are repeatedly chosen by clients.

For the expansion joints specified in this catalogue and for our customised solutions, we can provide the complete documentation packages needed. Documentary requirements are determined by the project specifications, the application and the customer, industry and design code.

Some projects require just a few certificates while other projects, such as those for e.g. the nuclear power industry, require thousands of pages of documentation. No matter what the requirements may be, Belman has the experience to ensure compliance.

Typically, we offer our customers the following documentation:

Calculations

- Bellow calculations
- Flange calculations
- Finite Element Analysis (FEA)
- Tie rods calculations
- Pipe calculations
- Hinge calculations
- Lug and lifting lugs calculations
- Natural frequency calculations
- Inner sleeve calculations
- Bolt torque calculations
- Seismic calculations
- Pressure drop calculations
- External hardware calculations

Welding documentation

- WPS (15600 series (PED), AD2000, ASME IX)
- WPQR (15600 series (PED), AD2000, ASME IX)
- Welders certificates (EN/ISO 9606, EN/ISO 14732, AD2000, ASME IX)
- Welding lists (Belman layout, custom layout)
- Weld drawings
- Filler material certificates (minimum 2.2, EN 10204)
- Welding inspection reports (before, during and after)
- Production tests according to AD 2000
- Tests according to NORSOK
- As-build drawing

Other documentation

- Inspection certificate

- Material certificates according to EN 10204 3.1
- DoC – Declaration of Conformity
- CoC – Certificate of Conformity
- VT, PT, TP, RT, UT, MPI, PMI reports
- NDT operator certificate (EN 473/ISO 9712)
- Pressure- and tightness test report and procedure
- Pressure gauge calibration certificate
- ITP – Inspection and Test Plan
- Measuring report
- Paint report incl. datasheets
- ISO certificates (EN ISO 9001, EN ISO 3834-2)
- Type approval certificate
- Cleaning certificate and procedure
- Supplier EN ISO 9001 certificate
- Installation instruction

3rd party documents

- Witness pressure test
- Calculation approval
- Design approval
- Final inspection
- According to type approval
- Destructive testing

Other related documents

- According to nuclear specifications
- According to NORSOK specifications
- According to Oil/energy specifications
- According to special customer specifications/requirements


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For more information about our sales and production entities as well as our cooperative partners please refer to our website (WebLink: 14401) or contact us.

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