PETROBRAS	TECHNICAL SPECIFICATION	Nº: I-ET-5000.00-2221-253-PEI-001	
	CLIENT: Refining		SHEET: 1 of 17
	JOB: General Technical Specifications		CC: -
	AREA: Fluid Catalytic Cracking Units		
SRGE	TITLE: **FCC EXPANSION JOINTS REQUIREMENTS**		-
			SRGE/ERGE

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INDEX OF REVISIONS

REV.	DESCRIPTION AND/OR REVISED SHEETS
0	ORIGINAL ISSUE
A	UPDATED THE SKIN TEMPERATURE SCHEME, INCLUDED PRESSURE SENSOR SCHEME AND ELSEWHERE INDICATED.
B	INCLUDED NON-METALLIC EXPANSION JOINT REQUIREMENTS.
C	WHERE INDICATED.

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	JUL/16/21	JUL/23/21	MAR/21/24	DEC/24/24					
DESIGN	EETC/EBET	EETC/EBET	EETC/EMT	EETC/EMT					
EXECUTION	BR15	BR15	BR15	BR15					
CHECK	CFT6	CFT6	UPSD	UPSD					
APPROVAL	CFT3	CFT3	UQT2	UQT2					

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FORM OWNED TO PETROBRAS N-0381 REV. L

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1 PURPOSES

1.1 This specification establishes the minimum conditions required for design and fabrication of packed metallic bellows expansion joints and non-metallic expansion joints for FCC Convertor Piping Systems to be installed at Catalytic Cracking Unit on PETROBRAS Refineries in Brasil.

1.2 This specification, together with the purchase order, expansion joint data sheets and drawings, covers the requirements for the fabrication, heat treatment, assembly, inspection and testing of carbon and alloy steel metal bellows type expansion joints.

1.3 The piping systems covered by this technical specification are:

1.3.1 Regenerated Catalyst Standpipe;

1.3.2 Spent Catalyst Standpipe;

1.3.3 Recycle Catalyst Standpipe;

1.3.4 External Riser;

1.3.5 Flue Gas Piping.

2 GENERAL CONDITIONS

2.1 In this document the user or the issuer of this specification will be referred as PURCHASER. The company responsible for the supply of the expansion joints will be referred as VENDOR.

2.2 All deviations and exceptions from the specification shall be clearly identified in the proposal and submitted for approval. Otherwise, the proposal will be considered as full acceptance of this specification.

2.3 Compliance with this specification does not exempt vendor from the responsibility of supplying any accessories suitable for the intended service.

2.4 Vendor shall guarantee that the equipment is free from defects of workmanship, materials, and design for a period of one year of operation or two years after shipment, whichever occurs first.

2.5 The manufacturer shall provide a supply list of similar applications in FCC units for petroleum industry, with, at least, five years of operation.

2.6 The manufacturer shall provide a recommended spare parts list with the proposal.

2.7 The schematic drawings shown in the ANNEX I, ANNEX II and ANNEX III are to be used as a reference. Vendors shall provide all the features considered necessary to achieve the minimum requirements established in this specification.

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2.8 The most stringent requirements shall govern if any conflict occur between the documents and standards referenced herein.

3 REFERENCE DOCUMENTS AND STANDARDS

3.1 ASME Boiler and Pressure Vessel Code - Section VIII - Div. 1.

3.2 ASME Boiler and Pressure Vessel Code - Section IX.

3.3 ASME B16.5 – Pipe Flanges and Flanged Fittings.

3.4 ASME B16.47 – Large Diameter Steel Flanges.

3.5 ASME B31.3 – Process Piping.

3.6 ASTM C795 – Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

3.7 EJMA STANDARDS.

3.8 Fluid Sealing Association Technical Handbook for Non-Metallic Expansion Joints.

3.9 PETROBRAS Standard NTP-133 – “Soldagem” (Welding).

3.10 PETROBRAS Standard NTP-550 – “Projeto de Isolamento Térmico a Alta temperatura” (Thermal Insulation Design for High Temperature).

3.11 PETROBRAS Standard NTP-1617 – Application of Refractory Castable.

3.12 PETROBRAS Standard NTP-1728 – Castable Refractory.

3.13 PETROBRAS Standard NTP-1910 – Castable Lining Design.

4 GENERAL REQUIREMENTS

4.1 Specific data for expansion joints mechanical design are presented in expansion joint data sheet, identified as follows: FD-5&&&.00-&2221-253-PEI-&&&, where 5&&&.00 identifies the refinery where the expansion is to be supplied; &2221 is related to the specific FCCU; and &&& is a sequential number.

4.2 The expansion joint model recommended and specified in this document is internally packed bellows type without steam injection and material bellows ASTM B443 alloy 625 LCF. The use of a different type with steam injection in the internal sleeve is allowed only when eventually specified by PETROBRAS in the data sheet item 4.1

4.3 The information to be obtained in the expansion data sheet are TAG number; operating, design and upset conditions; expansion joint type; installation position; end connections; expansion joints movements and other specific data for expansion joint mechanical design.

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4.4 All pressure containing and structural parts shall be in accordance with the ASME B31.3. Mechanical calculation shall comply EJMA standard.

4.5 Technical proposal shall present:

4.5.1 Delivery plan and declaration of attendance of this technical specification and material requisition applicable.

4.5.2 Preliminary list of raw material required, including specifications, dimensions, and quantities.

4.5.3 Preliminary design drawing with the total weight and overall dimensions.

4.6 Vendor shall provide any necessary supporting device to expansion joint, informing the recommended clearances. Supporting device shall be designed for minimum and easy maintenance.

4.7 Expansion joint end connections shall comply with reference drawing or expansion joint data sheet. End connections shall be clearly shown in detail on the expansion joint drawings.

4.8 The criteria to establish the design allowable stress shall consider the accumulated creep damage due to upset temperatures. For upset temperatures and duration see expansion joint data sheet (see item 4.1).

4.9 Vendor shall supply installation manual with all necessary information to assure compatibility of final assembly.

4.10 Vendor shall provide all necessary data for mechanical assessment of piping systems considering expansion joint reaction, such as: spring rate, weight, bellows effective area or mean diameter of bellows corrugations and geometrical data.

4.11 Vendor shall also inform the rated movements and other expansion joint limitations.

4.12 The design life of each expansion joint shall be at least 1,000 cycles at the design condition.

4.13 Design movements shall be according to expansion joint data sheet (see item 4.1).

4.14 Internal sleeves shall be installed in such a way to prevent direct impingement of catalyst on the bellows or the opening between sleeves. It shall be sized to provide enough clearance between the OD of the sleeve and the ID of expansion joint shell, so as interferences caused by lateral deflections or rotations do not occur. The clearance shall be defined for upset temperature condition. The opening between the telescopic sleeves shall be centered to the bellows. See ANNEX I.

4.15 For hot wall joints, the design of attachments (ex. for tie rods) shall also prevent localized thermal stresses. Attachments shall not slip and detach from expansion joint center pipe. Provide limit stops if necessary.

4.16 Mechanical calculation of support lugs shall eventually include the weight of

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standpipe when informed by Petrobras.

4.17 Hinges, gimbals, and tie rods shall be designed to withstand the design and test pressure, weight of its components, as well as any other forces resulting from piping action. Torsion movements shall not be transferred to metallic bellows.

4.18 Expansion joints shall be provided with movement indicators. The indicator shall have a clear scale, shall be visible for both sides of the expansion joints and shall have enough resistance to avoid easy damage.

4.19 Bellows plies requirements.

4.19.1 Bellows minimum thickness: 1,27 mm.

4.19.2 Composite bellows plies are not allowed.

4.19.3 Expansion joint shall be provided with double testable ply. Each bellows ply shall be designed for the full design conditions. The redundant ply shall guarantee the performance and sealing of the expansion joint in case of primary ply failure.

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4.19.4 Each expansion joint bellows shall be provided with a pressure sensor between the plies for testing and detection of internal and external ply failure. Double redundant bellows plies shall be used for all metallic expansion joints at the convertor section under the scope of this technical specification (see item 1.3). Supplier shall design a proper attachment support for the pressure sensor to avoid vibration. As a reference, see Figure 7 of ANNEX IV.

4.19.5 Metallic bellows shall be protected by removable external covers with 6 mm minimum thickness.

4.19.6 Bellows' material shall be ASTM B443 alloy 625 LCF, except if specified a different material is allowed only when eventually specified by PETROBRAS in the data sheet item 4.1.

4.19.7 Skin points shall be installed to monitor temperature on external bellows. See Figure 6 of ANNEX III.

4.20 Packing and sealing requirements.

4.20.1 Metallic bellows skin temperature shall range from 300 °C to 450 °C. Manufacturer shall provide proper external and internal blanket thermal insulation to achieve this range. This blanket shall be shop applied.

4.20.2 The space between the internal sleeves and the metallic bellows shall be packed with ceramic fiber blanket insulation. The ceramic fiber insulation shall be installed in blanket form and shall be in accordance with ASTM Specification C795. The insulation dimensions shall be determined to avoid temperature above bellows material limits and catalyst impingement. Provide thermal calculation, to be included in the mechanical calculation report.

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4.20.3 An external protection of woven wire mesh covered with a layer of aluminized fiberglass or silica cloth shall be provided with the ceramic fiber blanket, for mechanical sealing and easy handling. Alternative methods may be accepted but shall be submitted for PETROBRAS approval.

4.20.4 For packed-metallic-bellows expansion joints, a heavy-duty liner seal shall be provided to retain the ceramic fiber blanket and keep large particles out of the bellows/liner cavity. This liner seal shall be made by a 309 SS knitted wire hope, covered with a 309 SS hose braid. The liner seal shall be one-piece continuous circular section provided with only one splice. For hot wall expansion joints, the liner seal should only be used if there is no risk of damage to the equipment in case of anchor failure.

4.20.5 The diameter of the liner seal shall be 1½ times the specified clearance in the radial direction for the expansion joint in the cold position before preset.

4.20.6 The liner seal shall be anchored by means of a seal rod, that is a “U” shape clip. As an alternative two retaining rings could be used. These rings shall be made of 309 SS, to be annealed after forming.

5 SPECIFIC REQUIREMENTS

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5.1 METALLIC BELLOWS EXPANSION JOINTS

5.1.1 Manufacturer must justify whenever equalizing or reinforcing rings are not used.

5.1.2 There shall be at least three convolutions for each bellows.

5.2 UNIVERSAL TYPE EXPANSION JOINTS FOR CATALYST STANDPIPES

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5.2.1 Universal type expansion joints for catalyst standpipes in cold wall design shall be provided with refractory lining with the thickness and material indicated in expansion joint data sheet (see 4.1). The pipe material (shell) used on expansion joints ends and intermediate pipe shall be carbon steel shells according to specs ASTM A515 or ASTM A672 as per expansion joint data sheet. The class and grades to be used shall be compatible to the material of the connected pipes (see Figure 1 of ANNEX I)

5.2.2 Cold wall design expansion joints schematic protection for bellows is presented in Figure 1 of ANNEX I. Packing and sealing shall be according to item 4.14.

5.2.3 For cold wall expansion joints, the inner sleeve not supported in the cold box shall be connected to the shell by means of a conical transition with a 30° max. lateral angle.

5.2.4 Hot wall expansion joints for catalyst standpipes bellows shall be protected by internal sleeves according to Figure 2 of ANNEX I, provided with heavy-duty liner seal as per item 4.20.6.

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5.2.5 The universal type expansion joint for catalyst standpipes shall be provided with pantograph linkage (See Figure 4 of ANNEX II). If lateral movement out of the plane of the pantograph is foreseen, devices to allow for this lateral movement shall be provided (for example see Figure 5 of ANNEX II).

5.3 HOT WALL EXPANSION JOINTS FOR INLET AND OUTLET LINES OF TURBOEXPANDER

5.3.1 Expansion joints for inlet lines of turboexpander shall be hot wall design, as well as the expansion joint at the outlet line connected directly to turbo expander outlet nozzle. This is to avoid any risk of damage to the expander rotor due to the release of debris from refractory lining.

5.3.2 The bellows shall be protected by internal sleeves according to Figure 3 of ANNEX I. No heavy-duty liner seal should be used.

5.3.3 The applicable types of expansion joints for this service are gimbal, hinged, tied double gimbal, or tied double hinged, as indicated in the piping mechanical drawings and expansion joints data sheets.

5.3.4 The hardware shall be provided with special attachments, such as floating rings, to guarantee low thermal stresses on the expansion joint shell.

5.3.5 Pins of hinges and gimbals shall be provided with stellite hard facing to prevent galling.

B 5.4 NON-METALLIC EXPANSION JOINTS FOR LOW PRESSURE DUCTS

5.4.1 The fabric material tempearure limit shall be clearly specified on the drawings.

5.4.2 Manufacturer shall give reference of the use of fabric expansion joints on flue gas ducts according to item 2.4.

5.4.3 Fabric expansion joints internal insulation and construction details shall be according to ANNEX V.

5.5 Supplier shall prepare and deliver fabrication drawings, showing complete longitudinal section and cross-section, overall dimensions, bellows dimensions and details, expansion joint spring rates, cold clearances, and construction materials, component weight and total weight. Drawing shall contain a sketch with movements/rotations, cold and hot positions, and off-sets when applicable.

6 FABRICATION REQUIREMENTS

6.1 All welds shall be full penetration and smooth finish, with no undercut or lack of fusion.

6.2 All retaining pressure welds shall be submitted to 100% radiographic examination or, alternatively, 100% ultrasonic examination, where allowed by the ASME B31.3.

6.3 All internal welds, fillet and attachment welds shall be submitted to dye penetrant

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examination.

6.4 If applicable, vendor shall perform heat treatment procedures, considering the risk of sensitization and sigmatization of the austenitic stainless-steel parts.

6.5 Welding procedure and qualification certificate shall be submitted for PETROBRAS approval.

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6.6 Refractory lined expansion joints (cold wall design) requirements:

6.6.1 Expansion joints shall be painted according to PETROBRAS standard N-2, up to 76 mm from each end of the expansion joint. Special high temperature indicating painting according to condition 9 shall be used.

6.6.2 Refractory lining application shall be according to PETROBRAS standards N-1617 and N-1910.

6.6.3 Expansion joints shall be refractory lined according to Expansion Joint Data sheet requirements.

6.7 Mill test reports shall be submitted for all materials and weld consumable.

6.8 Expansion joints shall be tested at shop.

6.9 For 304 SS parts, the welds shall be with ER-308H electrodes 15/16 coating and ferrite control to be 3% to 8% FN Delong examination.

6.10 Expansion Joint Movement Test.

6.10.1 The expansion joint shall be submitted to a movement test at factory, witnessed by a PETROBRAS technician or third part expert designated by PETROBRAS. The test consists of the application of movement for design and upset condition, monitoring the corresponding forces by means of a dynamometer or load cell.

6.10.2 Provide a mechanical calculation to estimate the expected forces, using the stiffness calculated by vendor.

6.10.3 The purpose is to evaluate the real cold stiffness factors and if there is any internal interference in the expansion joint. Measured stiffness factors shall comply with values informed at the expansion joint data sheet. The results shall be submitted to Petrobras approval.

6.10.4 Vendor shall submit a procedure for the movement test, to be approved by Petrobras.

7 INSTALATION REQUIREMENTS

7.1 All expansion joints shall be delivered with shipping devices for transportation and temporary supports for installation.

7.2 The expansion joint shall have a name plate informing tag number, service,

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operating and design conditions, pressure test, manufacturer, purchase order number, year of fabrication, total weight.

7.3 The expansion joint shall have the flow direction indicated on external shell, in two places 180° apart.

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8 SCOPE OF SUPPLY AND APPROVAL

8.1 The documents listed BELOW and the design of the expansion joint, as a whole, are subject to the PETROBRAS approval. However, approval by PETROBRAS, or the adoption of changes as recommended by PETROBRAS, shall not relieve CONTRACTOR of any of the above guarantees of his contractual obligations to PETROBRAS.

8.1.1 Mechanical drawings with main dimensions to support the detalied piping design. The mechanical drawing shall be provided with, at least, the following information:

a. Total length;
b. External diameter and thickness of each part of the expansion joint;
c. Hardware general width and height for piping arrangement and interference evaluation;
d. Materials of construction;
e. Bellows dimensions and number of corrugations;
f. Transportation lugs dimensions;
g. Supporting lugs (if necessary);
h. Expansion joints stiffness factors;
i. Total weight of Expansion joints;
j. Any other dimensions considered necessary for piping mechanical design evaluation;

8.1.2 Bellows calculation report, with the EJMA standards stress, life and stiffness factor calculations.

8.1.3 3D modelling of expansion joint, to be exported to the 3D modelling system used by PETROBRAS Industrial Team (E3D).

9 ANNEX

ANNEX I – INTERNAL SLEEVE;

ANNEX II – EXPANSION JOINT HARDWARE CONSIDERATIONS;

ANNEX III – SKIN POINT INSTALLATION;

ANNEX IV – PRESSURE SENSOR SCHEME;

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ANNEX V – NON METALLIC EXPANSION JOINT FOR FLUE GAS DUCT APPLICATIONS (LOW PRESSURE STREAMS).

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ANNEX I – INTERNAL SLEEVE

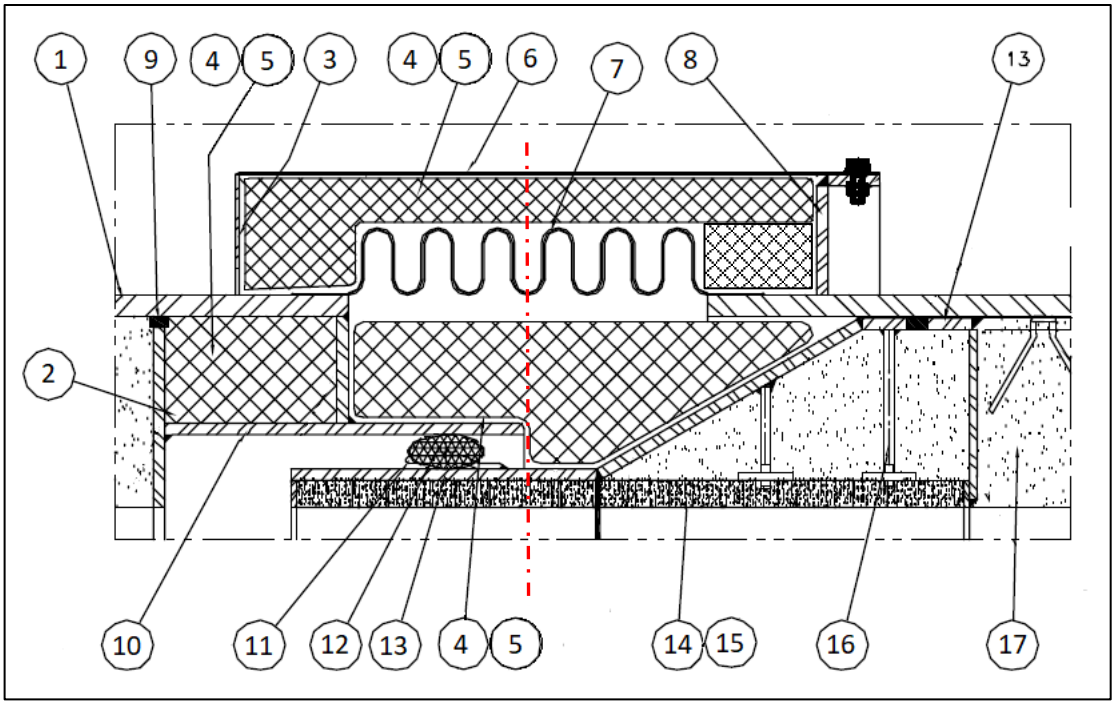


Figure 1 – Internal Sleeve for Cold Wall Design

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Table I – Material List for Cold Wall Design

POS.	DESCRIPTION	MATERIAL
1	EXPANSION JOINT PIPE	ACCORDING TO THE CONNECTED PIPING SYSTEM. SEE EXPANSION JOINT DATA SHEET.
2	COLD BOX	CERAMIC FIBER
3	COVER RING	ASTM A36
4	WOVEN WIRE MESH	AISI 309 + CERAMIC FIBER
5	BLANKET INSULATION	CERAMIC FIBER
6	REMOVABLE COVER	CARBON STEEL
7	BELLOWS	INCONEL 625 LCF (UNS N06626)
8	COVER SUPPORT	ASTM A36
9	STUFFING	CARDBOARD
10	INTERNAL SLEEVE	ASTM A240 Gr. 304H
11	LINER SEAL ANCHOR	AISI 309
12	LINER SEAL	309 SS KNITTED WIRE HOPE
13	INTERNAL SLEEVE	ASTM A240 Gr. 304H
14	25 mm REFRACTORY LINING	ANTIEROSIVE CLASS A ACCORDING TO NTP-1728

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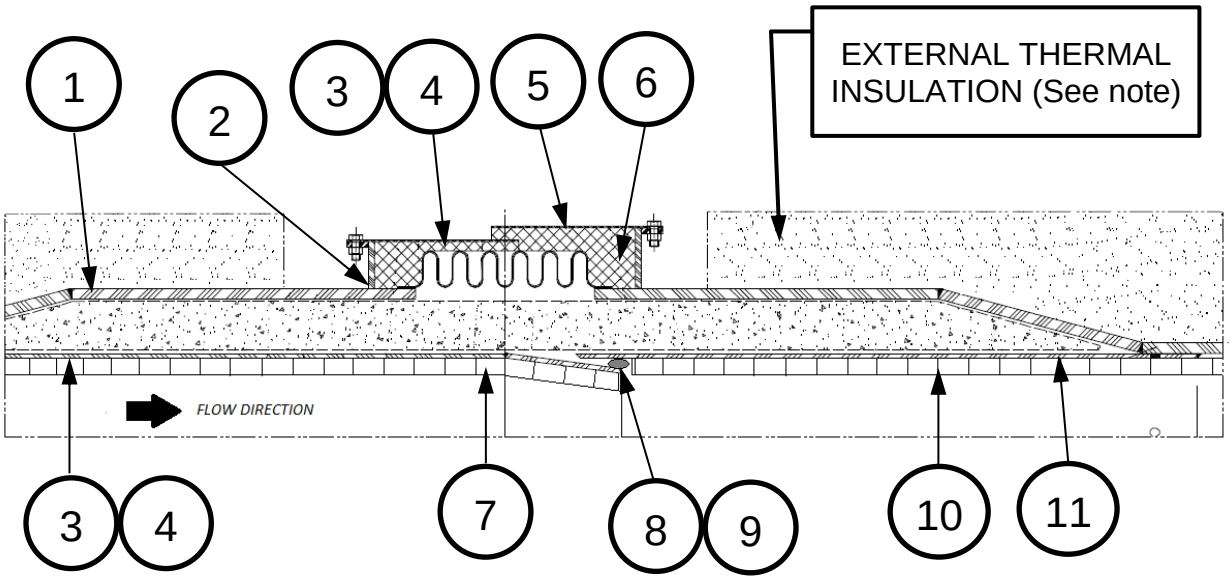


Figure 2 - Internal Sleeve for Hot Wall Design (not for turboexpander piping)

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Table II – Material List for Hot Wall Design (except turboexpander piping)

POS.	DESCRIPTION	MATERIAL
1	EXPANSION JOINT PIPE	According to the Connected Piping System. See Expansion Joint Data Sheet.
2	COVER SUPPORT	Compatible with expansion joint shell.
3	WOVEN WIRE MESH	AISI 309 + CERAMIC FIBER
4	BLANKET INSULATION	CERAMIC FIBER
5	REMOVABLE COVER	CARBON STEEL
6	BELLOWS	INCONEL 625 LCF (UNS N06626)
7	INTERNAL SLEEVE UPSTREAM	ASTM A240 Gr. 304H
8	LINER SEAL ANCHOR	AISI 309
9	LINER SEAL	309 SS KNITTED WIRE HOPE
10	INTERNAL SLEEVE DOWNSTREAM	ASTM A240 Gr. 304H
11	25 mm REFRACTORY LINING	ANTIEROSIVE CLASS A ACCORDING TO NTP-1728

Note:
Parts to be externally insulated shall be sized by vendor according to NTP-550 and clearly identified in the expansion joints drawing. The installation will be performed on field by PETROBRAS or EPC contractor.

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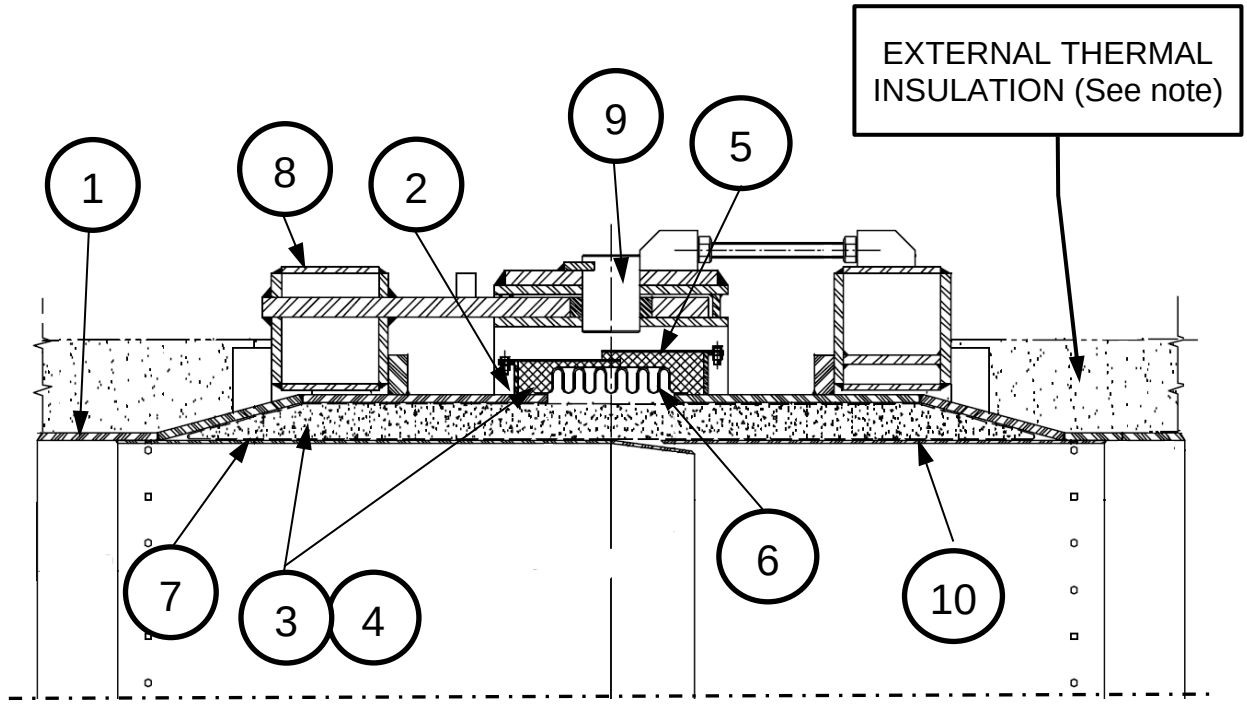


Figure 3 - Internal Sleeve for Hot Wall Design (typical hinged expansion joint)

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Table III - Material List for Hot Wall Design (hinged expansion joint)

POS.	DESCRIPTION	MATERIAL
1	EXPANSION JOINT PIPE	According to the Connected Piping System. See Expansion Joint Data Sheet.
2	COVER SUPPORT	Compatible with expansion joint shell.
3	WOVEN WIRE MESH	AISI 309 + CERAMIC FIBER
4	BLANKET INSULATION	CERAMIC FIBER
5	REMOVABLE COVER	CARBON STEEL
6	BELLOWS	INCONEL 625 LCF (UNS N06626)
7	INTERNAL SLEEVE UPSTREAM	ASTM A240 Gr. 304H
8	FLOATING RING	By Vendor
9	HINGE PIN	AISI 304/Stellite
10	INTERNAL SLEEVE DOWNSTREAM	ASTM A240 Gr. 304H

Note:
Parts to be externally insulated shall be sized by vendor according to NTP-550 and clearly identified in the expansion joints drawing. The installation will be performed on field by PETROBRAS or EPC contractor.

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ANNEX II – EXPANSION JOINT HARDWARE CONSIDERATIONS

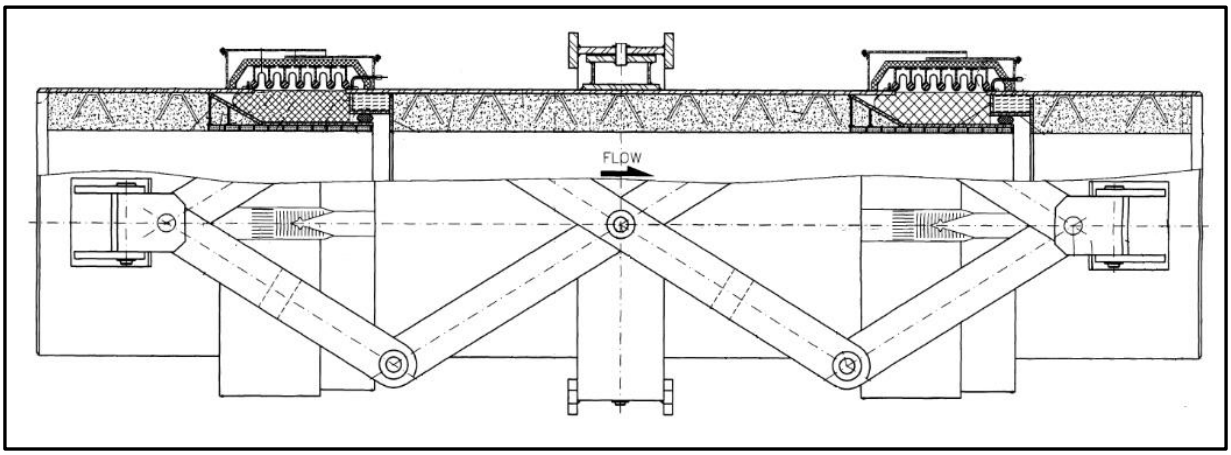


Figure 4 – Pantograph Linkage

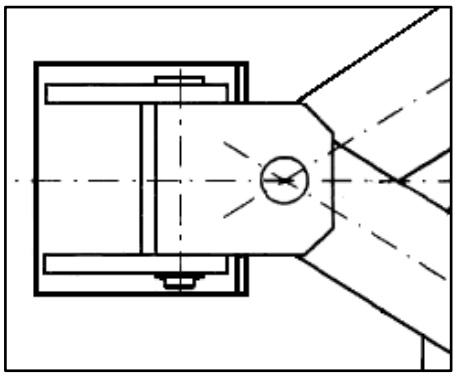
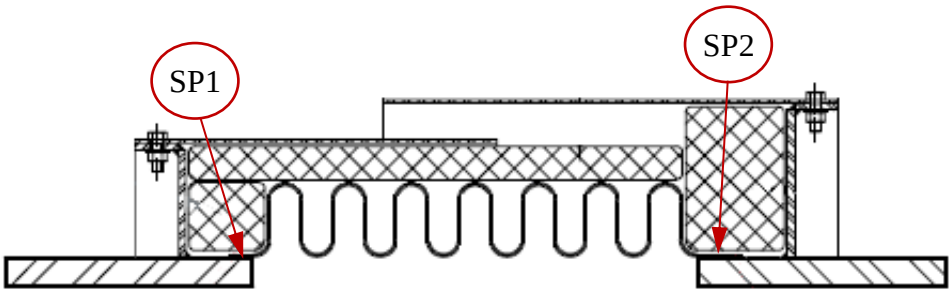


Figure 5 – Out of plane Pantograph Hinge

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ANNEX III – SKIN POINT INSTALLATION



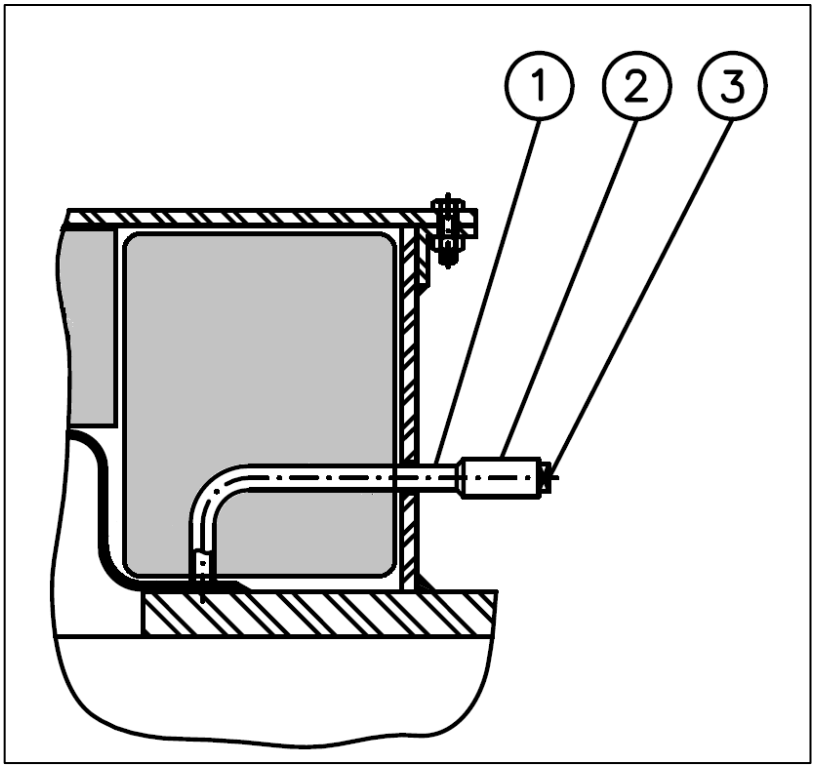
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Figure 6 – Skin Point Connection Position

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ANNEX IV – PRESSURE SENSOR SCHEME



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Figure 7 – Pressure sensor connection for monitoring pressure in double plie interface

Table IV – Materials list for pressure sensor connections

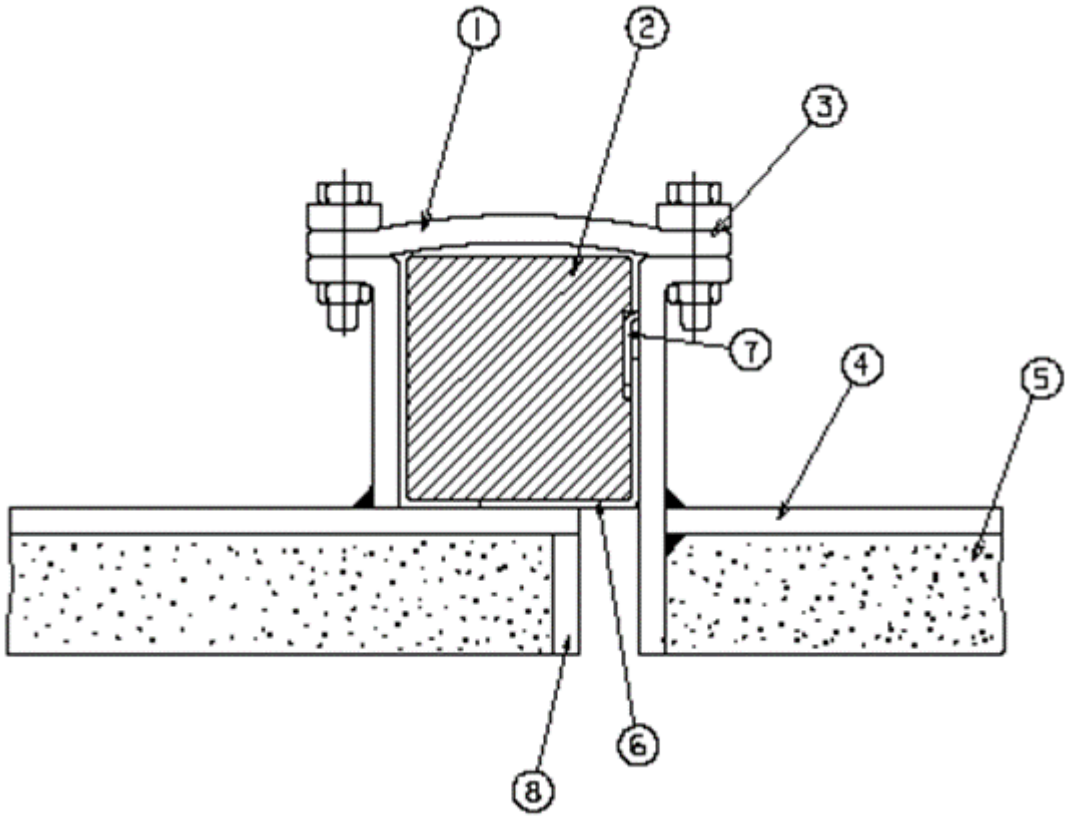
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POS.	DESCRIPTION	MATERIAL
1	TUBING	AISI 316
2	COUPLING	AISI 316
3	PLUG	AISI 316

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ANNEX V – NON METALLIC EXPANSION JOINT FOR FLUE GAS DUCT APPLICATIONS (LOW PRESSURE STREAMS)



MATERIALS LIST

POS.	DESCRIPTION	MATERIAL
1	Fabric belt	Resilient material to withstand design pressure and temperature.
2	Insulation box	Ceramic fiber blanket covered with a woven mesh and a layer of aluminized fiberglass.
3	Bolting	ASTM A193 Gr. B7 studs and ASTM A194 Cl. 2H nuts.
4	Duct	ASTM A672 Gr. B60 Cl. 12
5	125 mm thk refractory lining	Same as connected piping, according to pipe specs (see note) and PETROBRAS standard N-1728.
6	Internal sleeve	ASTM A240 Gr. 304H
7	Guide	ASTM A240 Gr. 304H
8	Retaining ring	ASTM A240 Gr. 304H

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