## INDEX OF REVISIONS

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<tr>
<th>REV.</th>
<th>DESCRIPTION AND/OR REVISED SHEETS</th>
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<tbody>
<tr>
<td>0</td>
<td>This document supersedes and replaces document I-ET-0000.00-1500-290-P6B-004, rev. A.</td>
</tr>
</tbody>
</table>

**REV. 0**

<table>
<thead>
<tr>
<th>DATE</th>
<th>PROJECT</th>
<th>EXECUTION</th>
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<td>29/11/2017</td>
<td>EISE/EDR</td>
<td>TS8H</td>
<td>BF6I</td>
<td>CLZ2</td>
</tr>
</tbody>
</table>

THE INFORMATION CONTAINED IN THIS DOCUMENT IS PETROBRAS PROPERTY AND MAY NOT BE USED FOR PURPOSES OTHER THAN THOSE SPECIFICALLY INDICATED HEREIN. THIS FORM IS PART OF PETROBRAS N-381 REV. L.
1. EXECUTIVE SUMMARY

This technical specification documents the functional and technical requirements for the design, materials, manufacture, inspection, testing and delivery of the sour service SCR Tapered Stress Joints for field development.

The technical requirements detailed herein are the minimum requirements to ensure a quality product for service. Additional client requirements may be included if deemed desirable or necessary. All components and materials used for the Tapered Stress Joint have the specified requirement to be qualified for sour service. Though the design requirements for the SCRs are generally considered to be within normal requirements, this specification allows for qualification by either specialized testing or review and acceptance of previous testing programs which have used similar operational and environmental conditions.

2. INTRODUCTION

2.1. Work Scope

This technical specification defines the functional and technical requirements for the design, materials, manufacture, inspection, testing and delivery of an SCR Tapered Stress Joint for field development. Any additional criteria necessary as a consequence of the proposed method of installing, testing, and operating the hang-off system may be included. The system components selected to satisfy the requirements of this specification shall be determined by SUPPLIER. However, the SUPPLIER shall submit the designs and related design data to COMPANY for approval prior to start of manufacturing.

This specification covers the Tapered Stress Joint requirements for the use in 1 off 12” nominal both oil export or gas export sour services SCR.

Design parameter envelope for the above SCR’s services can be found in Table 6-1.

In general terms, it is anticipated that the supplied Tapered Stress Joint will consist of the following basic components:

Table 2–1: Scope of Supply (Breakdown)

<table>
<thead>
<tr>
<th>Item</th>
<th>Application</th>
<th>Description</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Transition Spool</td>
<td>Transitions of the galvanic interface between the titanium active taper/compact flange and the FPU steel spool above the stress joint.</td>
<td>01</td>
</tr>
<tr>
<td>1.1</td>
<td>Compact Flange</td>
<td>Connection between the active taper and the transition spool.</td>
<td>01</td>
</tr>
<tr>
<td>2</td>
<td>Steel Bushing</td>
<td>Component mounted on the upper end of the active taper (support cone) which reacts the SCR tension.(^{(1)})</td>
<td>01</td>
</tr>
</tbody>
</table>
### Titanium Stress Joint Specification

<table>
<thead>
<tr>
<th>No.</th>
<th>Component</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Active Taper</td>
<td>Cylindrical shaped component with tapered wall thickness to provide flexure for the stress joint.</td>
<td>01</td>
</tr>
<tr>
<td>4</td>
<td>Lower Pup Piece</td>
<td>Flanged extension which connects to the lower flange of the active taper and welds to the lower SCR pipe.</td>
<td>01</td>
</tr>
<tr>
<td>5</td>
<td>Handling Accessory</td>
<td>Flanged pullhead with seal ring, bolts and nuts</td>
<td>01</td>
</tr>
<tr>
<td>6</td>
<td>Construction Accessory</td>
<td>Sample of lower extension forging for WPQT</td>
<td>04</td>
</tr>
<tr>
<td>7</td>
<td>Construction Accessory</td>
<td>Sample of lower extension forging for FJC qualification</td>
<td>02</td>
</tr>
<tr>
<td>8</td>
<td>Technical Documentation</td>
<td>Documentation as required by product Document List in Table 2–2</td>
<td>01</td>
</tr>
</tbody>
</table>

#### TSJ Retrofit for an Existing Basket

An SCR stress joint will include an active taper section an upper support cone and steel bushing to react SCR tension, compact flange and transition spool for the SCR upper connection above the support cone, and the lower pup piece which can be welded to the top of the SCR pipe. Figures 1.1 and 1.2 present a general SCR stress joint illustration with the major elements labeled for reference.

![Figure 1–1: SCR Stress Joint Assembly](image)
The scope of services to be carried out by MANUFACTURER is the following:

- Material Qualification Tests (samples included)
- Process Qualification
- Factory acceptance tests
- Additional scope:
  - Technical assistance at lower hull construction site (optional)
  - Supervision during installation

The SUPPLIER is encouraged to propose systems that best meet or exceed the requirements of this document. While this document is intended to be specific, COMPANY encourages the SUPPLIER to bring to COMPANY’s attention any suggested improvements and/or note any errors or inconsistencies in this specification.

### 2.2. Documentation

At the time of contract award, MANUFACTURER shall provide the following information, as a minimum, in a Design Premises document:

- Design basis including design data, design codes and criteria;
- Design Brief detailing the design methodology and software to be used;
- Preliminary calculation note;
- Interface dimensions (e.g. flange height, rotation point elevation);
- Stiffness range.
Table 2-2 summarizes the documentation that shall be supplied by MANUFACTURER during contract execution, as a minimum:

<table>
<thead>
<tr>
<th>Titles of documents</th>
<th>Identification Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCR Stress Joint Design Report</td>
<td>TBD</td>
</tr>
<tr>
<td>SCR Stress Joint Design Methodology</td>
<td>TBD</td>
</tr>
<tr>
<td>Welding Specification (NDT included)</td>
<td>TBD</td>
</tr>
<tr>
<td>Welding Qualification Plan (NDT included)</td>
<td>TBD</td>
</tr>
<tr>
<td>Specifications of Materials</td>
<td>TBD</td>
</tr>
<tr>
<td>Factory Acceptance Test Procedure</td>
<td>TBD</td>
</tr>
<tr>
<td>Procedure for Coating Application</td>
<td>TBD</td>
</tr>
<tr>
<td>Specification for Preservation, Packaging, Handling, and Shipping</td>
<td>TBD</td>
</tr>
<tr>
<td>Quality Plan</td>
<td>TBD</td>
</tr>
<tr>
<td>Quality Control Specification</td>
<td>TBD</td>
</tr>
<tr>
<td>Stress Joint General Assembly Drawing</td>
<td>TBD</td>
</tr>
<tr>
<td>Manufacturing Drawing Package</td>
<td>TBD</td>
</tr>
<tr>
<td>Manufacturing Inspection Procedures</td>
<td>TBD</td>
</tr>
<tr>
<td>Data Book</td>
<td>TBD</td>
</tr>
</tbody>
</table>

3. DEFINITIONS AND ABBREVIATIONS

3.1. Definitions

COMPANY: PETRÓLEO BRASILEIRO S.A. – PETROBRAS

SUPPLIER: The organization providing the SCR stress joint under contract to the COMPANY.

PROJECT: P55 EXPORT SCR

SCR: Steel Catenary Riser, which mates with the lower end of the stress joint

Tapered Stress Joint: The entire assembly including the active taper section with support cone and steel bushing to react SCR tension, compact flange and transition spool for upper connection and the lower pup piece required to provide...
Titanium Stress Joint Specification

Requisition: A formal written request for supply of equipment or materials.

Receptacle: Structure that is welded to the porch on the semi-sub hull and where the Flexible Joint will be seated. It is used to transfer the forces and moments from the Flexible Joint to the semi-sub hull.

May: Is used where alternatives are equally acceptable

Shall: Indicates a mandatory requirement.

Should: Indicates a preferred course of action.

3.2. Abbreviations

The following abbreviations are used on the document:

ACAD AutoCad
DGPS Differential Global Positioning System
DP Dynamic Positioning
HIPAP High Precision Acoustic Positioning system
ITP Inspection and Test Plan
LBL Long Baseline
MRU Motion Reference Unit
MSV Multi Support Vessel
PLET Pipeline End Termination
ROV Remotely Operated Vehicle
SCR Steel Catenary Riser
TSJ Tapered Stress Joint
USBL Ultra Short Baseline
4. REFERENCES

All equipment supplied under the scope of this Specification shall be in conformance to the latest editions currently in effect at the time of award of contract of the design codes, standards, and COMPANY’s documents listed hereafter in this section.

Where the requirements of any documents are found to be in conflict with each other, or with the requirements of this Specification, the supplier shall request written clarification from COMPANY before continue the work. COMPANY’s decision shall be final regarding interpretation of requirements.

The Tapered Stress Joint shall be designed and manufactured in accordance with the regulations applicable for service offshore Brazil.

4.1. Project Documents

<table>
<thead>
<tr>
<th>Ref. n°</th>
<th>Document number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ref. [1].</td>
<td>I-DE-3010.70-1500-940-PMU-001</td>
<td>SCR System Subsea Layout</td>
</tr>
<tr>
<td>Ref. [3].</td>
<td>I-RM-3010.70-6500-274-PMU-XXX</td>
<td>Material Requisition for P-55 SCR Tapered Stress Joint</td>
</tr>
<tr>
<td>Ref. [4].</td>
<td>I-FD-3010.70-6500-219-PMU-001</td>
<td>Clad Linepipe for Production and Water Injection SCRs</td>
</tr>
<tr>
<td>Ref. [5].</td>
<td>I-DE-3010.70-1321-141-EWV-005</td>
<td>SEMI-BR P-55: Receptacles for Steel Catenary Risers</td>
</tr>
<tr>
<td>Ref. [6].</td>
<td>I-FD-3010.70-1500-274-PMU-003</td>
<td>Risers and Umbilicals Top End Fitting Data Sheet (P-55)</td>
</tr>
<tr>
<td>Ref. [7].</td>
<td>ET-3549.00-9300-941-PUR-004</td>
<td>Características dos Fluidos Deslocados</td>
</tr>
</tbody>
</table>

4.2. COMPANY’s Standards

<table>
<thead>
<tr>
<th>Ref. n°</th>
<th>Document number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ref. [8].</td>
<td>I-ET-0000.00-6000-970-PSQ-001</td>
<td>Procedure and Personnel Qualification and Certification</td>
</tr>
<tr>
<td>Ref. [9].</td>
<td>ET-3000.00-1500-251-PAZ-001</td>
<td>Fixadores em Aço de Alta Resistência para Utilização Submarina</td>
</tr>
</tbody>
</table>

4.3. Industry Codes and Standards

<table>
<thead>
<tr>
<th>Ref. n°</th>
<th>Document number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ref. [10]</td>
<td>API 5L</td>
<td>Specification for Line Pipe</td>
</tr>
</tbody>
</table>
# Titanium Stress Joint Specification

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Specification/Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[12]</td>
<td>DNV OS F201</td>
<td>Dynamic Risers - Offshore standard</td>
</tr>
<tr>
<td>[14]</td>
<td>API RP 2RD</td>
<td>Design of Risers for Floating Production Systems or Tension-Leg Platforms</td>
</tr>
<tr>
<td>[15]</td>
<td>DNV RP C203</td>
<td>Fatigue Strength Analysis of Offshore Steel Structures DnV Recommended Practice</td>
</tr>
<tr>
<td>[16]</td>
<td>NACE MR0175/ISO 15156-3</td>
<td>Materials for Use in H₂S-Containing Environments in Oil and Gas Production</td>
</tr>
<tr>
<td>[17]</td>
<td>NACE TM0177</td>
<td>Laboratory testing of metals for resistance to specific forms of environmental cracking in H₂S environments</td>
</tr>
<tr>
<td>[18]</td>
<td>NACE TM0284</td>
<td>Evaluation of pipeline and pressure vessel steels for resistance to Hydrogen-Induced Cracking-2003</td>
</tr>
<tr>
<td>[21]</td>
<td>AMS 3156</td>
<td>Oil, Fluorescent Penetrant, Water Washable</td>
</tr>
<tr>
<td>[22]</td>
<td>AMS 2648</td>
<td>Radiographic Inspection of Titanium and Titanium Bar and Billets</td>
</tr>
<tr>
<td>[23]</td>
<td>AMS 2645</td>
<td>Fluorescent Penetrant Inspection</td>
</tr>
<tr>
<td>[24]</td>
<td>AMS 2631</td>
<td>Ultrasonic Inspection, Titanium and Titanium Alloy Bar and Billets</td>
</tr>
<tr>
<td>[25]</td>
<td>AMS 2630</td>
<td>Inspection, Ultrasonic Product over 0.5 Inch (12.7mm) Thick</td>
</tr>
<tr>
<td>[26]</td>
<td>AMS 2380</td>
<td>Approval and Control of Premium Quality Titanium Alloys</td>
</tr>
<tr>
<td>[27]</td>
<td>API RP 2RD</td>
<td>Specification for Design of Risers for Floating Production Systems and TLPs</td>
</tr>
<tr>
<td>[29]</td>
<td>ASTM E992</td>
<td>Kee Equivalent Energy Test Method</td>
</tr>
<tr>
<td>[31]</td>
<td>ASTM E8</td>
<td>Standard Test Methods for Tension Testing of</td>
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4.4. Other Documents

<table>
<thead>
<tr>
<th>Ref. n°</th>
<th>Document number</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>Ref. [34]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ref. [35]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ref. [36]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. GENERAL REQUIREMENTS

5.1. Material Supplied

All equipment and material manufactured and/or supplied under this Specification shall be new, of proven design, and in accordance with sound engineering fabrication and manufacturing practice. It is preferred to use existing designs or modifications that have been already accepted.

SUPPLIER shall be responsible for the selection of the materials. All materials shall be suitable for the intended service. The selected materials shall be in accordance with the relevant applicable codes, standards and specifications and be able to meet the requirements defined in Ref. [3].

The origin and manufacture of all materials used in the manufacture shall be clearly identified. SUPPLIER shall submit any required material manufacturing process details, tests, examinations, inspections, and acceptance criteria for review and approval by COMPANY.

5.2. SUPPLIER’s Responsibilities

SUPPLIER shall furnish all labor, consumables, tools, equipment and materials other than those explicitly identified as supplied by COMPANY required to manufacture, test and deliver. SUPPLIER shall perform all operations required for design, manufacture, inspection, testing and handling.

Nothing contained herein, or omitted from the following provisions shall be construed as relieving the SUPPLIER of the obligation to supply in accordance with functional requirements outlined herein, capable of functioning in an SCR system for the design period specified by COMPANY.

At SUPPLIER’s own expense, SUPPLIER shall furnish a written technical manual wherein procedures and necessary tools for storage, manipulation, and transportation of the Tapered Stress Joint be detailed described, with emphasis to prevent either labors from injury, or equipment and environment from damage. Such documentation shall include procedures and respective tools and consumables for inspection and maintenance during operational life of the Tapered Stress Joint, pointing out frequencies. Herein the term maintenance shall comprise all job related to cleaning, painting or applying protective coating, repairing etc. and assembling, disassembling and/or substitution of each component of the Tapered Stress Joint. Tests to be performed in order to ensure perfect assemblage shall be indicated. The
documentation shall list each single part of the Tapered Stress Joint and points out criteria to be observed in order to replace each one when applicable.

Also, the documentation shall indicate possible fail mode pointing to respective technique of inspection and remedial work.

SUPPLIER shall develop a written Manufacturing Plan/Procedure, which includes a Quality Control Plan, which shall be submitted to COMPANY for approval prior to commencement of material procurement and manufacturing.

A pre-production meeting shall be held between SUPPLIER, COMPANY and any third party inspection personnel involved. The purpose of the meeting is to ensure that all parties involved fully understand job requirements and resolve any outstanding issues prior to commencement of manufacturing.

COMPANY furnished Drawings and Specifications shall be checked by SUPPLIER immediately upon receipt, and SUPPLIER shall promptly notify COMPANY of any discrepancies therein.

For any requirement in question by SUPPLIER, it shall be SUPPLIER’s responsibility to:

Obtain clarification from COMPANY, which shall be final and binding;

Review and resolve conflicts with COMPANY prior to initiation of Work or continuation of Work.

SUPPLIER shall allow COMPANY full and unrestrained access to all areas concerned with design, manufacture, inspection and testing during all times while work is being performed for this order. SUPPLIER shall provide all reasonable facilities to COMPANY inspectors, without charge, to satisfy the inspector that product is manufactured in accordance with this Specification. Such facilities shall include, but not limited to, office equipment and telecommunication equipment. All inspection shall be made at the place of manufacture prior to shipment. If any inspection or testing reveals details not in accordance with this Specification, then SUPPLIER may demonstrate to COMPANY that the product still satisfies the design requirement. If SUPPLIER is unable to demonstrate this to COMPANY’s satisfaction, then the manufacturing and/or testing procedure shall be repeated until compliance is demonstrated. All such remedial work shall be performed at SUPPLIER’s cost.

In accordance with Section 14.1 (Procedures, Reports and Records) and at SUPPLIER’s own expense, SUPPLIER shall furnish all data generated during the design cycle of the Tapered Stress Joint including the results of the numerical analyses that will be carried out in order to fulfill the design requirements (Section 6 of the present specification) and design basis (reference [MD FJ]). This documentation shall be comprised of written report, in a layout defined by the COMPANY, and the electronic input and output files of the finite element analysis.

Equipment used for the manufacture shall be of proven design and in good operating condition.

Methods employed shall be in accordance with prudent engineering, fabrication and construction practice.

All costs including taxes are to the SUPPLIER account in undertaking the responsibilities.

Deviations from this Specification are not permitted. All proposed changes or modifications to this Specification shall be submitted in writing for COMPANY approval. Approved changes shall be incorporated into a revised, approved purchase specification. Disclaimers are not permitted.

5.3. Product Qualification
Qualification of the product for the intended service is essential. The qualification requirements shall include but not be limited to the following:

- SUPPLIER shall demonstrate that all materials proposed for the Stress Joint are compatible with and qualified for the design service conditions (including design temperatures, pressures and the chemical composition of the pipeline fluids).
- SUPPLIER shall demonstrate by analysis/tests that the designs meet allowable stresses and fatigue requirements.
- SUPPLIER shall produce data that substantiate the fatigue performance of welds and parent materials.
- SUPPLIER shall submit, or shall make available at SUPPLIER facilities, all documents related to the product qualification including a detailed plan, schedule and test program for COMPANY approval before the commencement of the work.

5.4. Unit of Measurements

All data shall be reported in primarily SI units; however, customary US units may also be reported for reference only.

6. DESIGN REQUIREMENT DATA

6.1. General

The design requirements applicable to the stress joint shall include, but not be limited to the following:

- The Stress Joint shall conform to the requirements specified in this document and accommodate the specified values of angular rotation, axial loads, the temperature/pressure/chemistry of fluids passing through the SCRs, plus any other parameters, including interface requirements for a service life of 25 years. The Stress Joint shall be designed for sour service per ISO 15156–3 (Ref. [16]) requirements.
- The Stress Joint shall transfer all loads at their maximum design limits without gross yielding, buckling, collapsing, or failing during the specified service life.
- The stress joint lower connection “pup piece” shall be designed to be compatible with the SCR riser pipe.
- The Stress Joint shall be designed to interface with the existing receptacle design.
- The Stress Joint shall accommodate the conditions specified in the fatigue spectrum to be provided after award of contract, when analyzed by accepted fatigue analysis techniques without failure for a factored fatigue life of greater than 25 years. The combined fatigue life shall include contributions due to installation and wave induced fatigue. SUPPLIER shall get approval from COMPANY regarding parameters, techniques, and programs used for the FEA and fatigue analysis prior to starting either FEA or fatigue analysis.
- SUPPLIER shall submit data that qualifies the fatigue performance of the specific welds (if any) that will be used in the design, and shall use industry-accepted standards for fatigue performance of welds and other materials.
- The Stress Joint configuration and materials shall be optimized. The fabrication of the Stress Joint shall be subject to scrutiny, inspection, verification, qualification, and documentation in accordance with COMPANY’s and industry standards.
- The SCR stress joint shall successfully pass the factory acceptance testing criteria set forth by the COMPANY.
- SUPPLIER shall submit a complete Design Report and appropriate drawings to the COMPANY for review and approval prior to commencement of production operations.
• Nothing contained in this specification or omitted from it shall be construed as relieving the SUPPLIER of the obligation to supply the Stress Joints in accordance with functional requirements contained herein, said Stress Joints to be capable of functioning properly in an SCR system for a minimum of 25 years without need for maintenance.

### 6.2. SCR Tapered Stress Joint Design Data

**Table 5–1: Design Data for SCR Tapered Stress Joint.**

<table>
<thead>
<tr>
<th>Data Description</th>
<th>Value</th>
<th>Units</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Riser Description</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Pipe ID</td>
<td>274.2</td>
<td>mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[23]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Pipe OD</td>
<td>12.75</td>
<td>inch</td>
<td>API size</td>
</tr>
<tr>
<td>4 Pipe Wall Thickness</td>
<td>24.85</td>
<td>mm</td>
<td>This value includes 3.2 mm of corrosion thickness at the top part of the SCR pipe</td>
</tr>
<tr>
<td>5 Material Grade</td>
<td>DNV</td>
<td>450</td>
<td></td>
</tr>
<tr>
<td><strong>External Connections</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Top Flange Type / Size</td>
<td>6BX-</td>
<td></td>
<td>Dimensions according API 6A, bore equal to pipe ID</td>
</tr>
<tr>
<td></td>
<td>5000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>/ 13-</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5/8”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Top Flange Elevation</td>
<td>See</td>
<td>[03]</td>
<td>The height of the Top Flange connection shall comply with Ref.</td>
</tr>
<tr>
<td>8 Extension Weld Prep</td>
<td>TBD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Extension and Attachment Flange</td>
<td>TBD</td>
<td>mm</td>
<td>Sealing surfaces with alloy 625, bore with corrosion thickness</td>
</tr>
<tr>
<td>internal corrosion protection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Receptacle Parameters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Basket Size</td>
<td>See</td>
<td>[02]</td>
<td></td>
</tr>
<tr>
<td><strong>Riser Corrosion Control</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Data Description

<table>
<thead>
<tr>
<th>Data Description</th>
<th>Value</th>
<th>Units</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 External Coating</td>
<td>3.2/5</td>
<td>mm</td>
<td>SCR is coated with 3-layer polypropylene based coating with an additional layer of solid polypropylene for thermal insulation.</td>
</tr>
<tr>
<td>12 Cathodic Protection</td>
<td>SCR Sacrificial anodes</td>
<td></td>
<td>MANUFACTURER shall assure the electrical continuity between the attachment flange of the platform and the riser through the Stress Joint.</td>
</tr>
</tbody>
</table>

### Fluid Data

<table>
<thead>
<tr>
<th>Data Description</th>
<th>Value</th>
<th>Units</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 Type of Fluid</td>
<td>Sour service</td>
<td></td>
<td>Max. 100ppm of H₂S, max XXX of CO₂</td>
</tr>
<tr>
<td>14 Fluid Flow Rate(2)</td>
<td>16,00</td>
<td>m³/da</td>
<td>Dead oil</td>
</tr>
<tr>
<td></td>
<td>3,500,000(max.)</td>
<td></td>
<td>Gas @ 1atm and 20°C</td>
</tr>
</tbody>
</table>

### Internal Pressure Data

<table>
<thead>
<tr>
<th>Data Description</th>
<th>Value</th>
<th>Units</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 Local Design Pressure</td>
<td>244</td>
<td>barg</td>
<td>242 + 2 = 244 barg at Flexible joint elevation TBC – Associated Temperature: 40°C</td>
</tr>
<tr>
<td>16 Local Incidental Pressure</td>
<td>269</td>
<td>barg</td>
<td>267 + 2 = 269 barg at Flexible joint elevation Associated Temperature: 65°C</td>
</tr>
<tr>
<td>17 Minimum Operating</td>
<td>&lt; 1</td>
<td>bara</td>
<td>Associated Temperature: 4 to 40°C</td>
</tr>
<tr>
<td>18 Local Maximum Operating(1)</td>
<td>209</td>
<td>barg</td>
<td>207 + 2 = 209 barg at Flexible joint elevation Associated Temperature: 15 to 40°C</td>
</tr>
<tr>
<td>19 Local Hydrotest</td>
<td>308</td>
<td>barg</td>
<td>303 + 5 = 308 barg at Flexible joint elevation Associated Maximum Temperature: 30°C</td>
</tr>
</tbody>
</table>

### External Pressure Data

<table>
<thead>
<tr>
<th>Data Description</th>
<th>Value</th>
<th>Units</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 Operating external pressure</td>
<td>2.3*</td>
<td>barg</td>
<td>*Pressure created by a 23 meters water depth</td>
</tr>
</tbody>
</table>

### Temperature Data

<table>
<thead>
<tr>
<th>Data Description</th>
<th>Value</th>
<th>Units</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>21 Design</td>
<td>90</td>
<td>ºC</td>
<td>TBC – Associated Pressure: 143 barg</td>
</tr>
<tr>
<td>22 Minimum design temperature</td>
<td>-20</td>
<td>ºC</td>
<td>TBC – Associated Pressure: HOLD</td>
</tr>
</tbody>
</table>
Titanium Stress Joint Specification

<table>
<thead>
<tr>
<th>Data Description</th>
<th>Value</th>
<th>Units</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>23 Maximum Operating</td>
<td>70 / 90°</td>
<td>°C</td>
<td>TBC – *90°C during 12.5% of service life</td>
</tr>
<tr>
<td>24 Minimum Operating</td>
<td>4</td>
<td>°C</td>
<td>TBC – Associated Pressure: HOLD</td>
</tr>
</tbody>
</table>

(1) During contract execution, PETROBRAS will detail the sustained pressure events with associated temperature and duration, to characterize the expected service over the design life of the Stress joint.

6.3. SCR Tapered Stress Joint Receptacle

Receptacle is not included in the scope of supply.

SUPPLIER, however, shall provide facility (e.g. Steel Bushing) to retrofit for the existing receptacle.

6.4. Design Loads

From the Xxxxx global riser analysis and environmental conditions, COMPANY will provide the SCR interface loads at the Stress Joint termination locations, including tension, bending moment, and fatigue spectrum, as required.

6.5. Loads During Installation

The base case for the SCR installation at this time is with the SCR Stress Joint pup piece welded to the riser at the end of the J-Lay process and is immediately installed into the receptacle. The main installation load associated with this method is the axial tension due to the weight of the riser with the associated bending moment due to the angular rotation of the Stress Joint during the installation process. The maximum angular rotation is relatively low, since the installation is normally performed under calm conditions. Installation loads will be provided to SUPPLIER prior to award of contract.

6.6. Loads During Service Life

A wide variety of static and dynamic loads may be imposed on the Stress Joint during its service life.

In most cases the static loads are limited to a few load cases based on anticipated events such as maximum design conditions for both near and far riser cases, normal operating, functional testing and accidental events. Each load case is typically defined by the internal pressure/temperature, axial tension, and absolute rotation. Loading case matrix and calculated values will be informed to SUPPLIER prior to award of contract.

6.7. Rotational Stiffness Requirements

The physical configuration and material properties of an SCR Stress Joint define its stiffness values.

SUPPLIER shall provide preliminary rotational stiffness values in the form of rotational stiffness versus angle variation for the Stress Joint under the full range of design conditions contained in this specification. During detail design of the Stress Joints, SUPPLIER shall characterize the stiffening effect of the Stress Joint design at both small and large angles and show that it is predictable and consistent.
SUPPLIER and COMPANY shall agree on the rotational stiffness values prior to contract award for the supply of the Stress Joints. Subsequent modification of the rotational stiffness values after contract award date shall not be permitted without COMPANY approval. The design rotational stiffness for different angle ranges shall be confirmed for the Stress Joint design in an FAT similar to that described in Section 7.0 herein. SUPPLIER shall submit proposed FAT to COMPANY for review and approval prior to initiation of testing. Final rotational stiffness values shall be provided once the SCR Stress Joint design has been completed.

6.8. Service and Fatigue Life

The service life for the Xxxxx Stress Joint is 25 years. The design fatigue life used in evaluation of an SCR Stress Joint is the specified service life with a FOS of 10, i.e. for the 25-year service life the design fatigue life would be 250 years.

6.9. Fatigue Load Spectrum

The fatigue load spectrum is a summary of the loads, angles and associated cycle counts for the service life period, including the maximum operating pressure, maximum operating temperature and nominal torque at the SCR Stress Joint. Fatigue spectra will be provided for Stress Joint design after award of contract.

6.10. Maintenance

The Stress Joint shall be provided with adequate access for inspection and maintenance. The method of mating the SCR Stress Joint to the receptacle must allow for removal if repair to the riser or Stress Joint will be necessary. SUPPLIER shall provide a procedure for such an operation.

6.11. In-Service Inspection

SUPPLIER shall supply the procedure for the periodic inspection confirming the integrity of the Stress Joint and the related components during the service life of the field. SUPPLIER shall also supply the procedure for removing marine growth on the Stress joint and the related components prior to the inspection.

6.12. Pigging Requirements

6.12.1. Conventional Pig

The SCR Stress Joint shall be capable of passing disc-type (Mandrel / Solidcast) pigs equipped with wire brushes. SUPPLIER shall review the SCR Stress Joint design based on the overall design criteria and demonstrate to COMPANY’s satisfaction that this can be achieved.

SUPPLIER’s evaluation shall consider the dimension and operation of typical disc-type pigs and in particular the minimum pig length required for the pig to pass through the Stress Joint without losing its seal. SUPPLIER shall perform a drift test to demonstrate that the Stress Joint is suitable for pigging in both directions.

6.12.2. Inspection Pig

The Stress Joint shall be capable of passing an ultrasonic or magnetic type inspection pig in both directions at a 3-degree maximum misalignment angle. SUPPLIER must review the SCR stress joint design based on the overall design criteria to determine if the required angle for pigging is feasible. Any conflict must be resolved during the design process.

SUPPLIER shall provide to the manufacturer of the inspection pigs all information required to perform a simulation of the inspection pig passing through the Stress Joint.

6.13. Installation
SUPPLIER shall provide assistance to COMPANY during preparation of the Stress Joint and receptacle installation and handling procedure. SUPPLIER shall review the installation and handling procedures (to be developed by SCR installation contractor).


The top connection of the SCR Stress Joints shall include an attachment flange forged as an integral unit with the attach flange separate from the body. The attachment flange shall be designed to connect to the topside interface spool flange.

The attachment of the riser to the SCR Stress Joint extension (SCR pup piece) shall be a butt weld connection. SUPPLIER shall assure that the pup piece material and dimensions are compatible with the mating SCR components in accordance with Table 6–1.

SUPPLIER shall support weld qualification of the interface weld between the stress joint pup piece and the SCR riser pipe by providing material certificates and material samples of the pup piece as described in Table 2–1.

NOTE: SUPPLIER shall not be responsible for performing the weld between the stress joint pup piece and the SCR pipe.

NOTE: The weld test rings may be supplied from a separate forging, provided that the forging is from the same heat and heat-treated at the same time that the stress joint pup piece is heat-treated. Fatigue test rings

6.15. Corrosion Protection

Corrosion protection of the Stress Joint and the SCR shall be accomplished with a combination of a protective coating and cathodic protection.

The Stress Joint extensions shall be coated with a corrosion protection coating compatible with the corresponding SCR coating.

The outer surface of the Stress Joint body including all flanges and openly exposed surfaces (excluding face of flange) and any other wetted surfaces not openly exposed shall be coated with Thermal Sprayed Aluminum (TSA) in accordance with COMPANY specification. What about Rubber

Inconel 625 inlays shall be applied to the sealing surfaces of the flange faces.

All coatings and coating procedures used by SUPPLIER or SUBCONTRACTORS are subject to the COMPANY’s review and approval.

SUPPLIER shall assure electrical continuity between the Stress Joint body and the attachment flange. In addition to the above, SUPPLIER shall also assure electrical discontinuity between the attachment flange and the riser extension. Electrical isolation method design and performance shall be provided to COMPANY. Isolation gaskets from ceramic or load bearing non-metallics shall be used to isolate the titanium from the steel SCR with coatings applied to flange faces, fasteners, and other surfaces that may provide an electrical path between the titanium tapered Stress Joint and the steel SCR.

However, the Stress Joint shall be prepared to allow electrical connection with the hull by conductive straps at any time, if needed for SCR Cathodic protection.

6.16. Installation

COMPANY will supply all relevant details of the installation plans and requirements (developed by the installation CONTRACTOR) to SUPPLIER for review and comment regarding suitability for use with Stress Joint operational parameters. These details may include the following:

- General installation plans
• Commissioning details for the SCR stress joint and riser
• Special tool requirements for installation
• Requirement for an SCR stress joint mock-up

Based on the information provided, SUPPLIER shall provide assistance to COMPANY during preparation of the Stress Joint installation and handling procedure (to be developed by SCR installation CONTRACTOR).

6.17. Stress Joint Marking and Shipping

The Stress Joint must be stamped for permanent identification, including identifying features such as size, rating, and SUPPLIER’s assigned serial number. Additional marking for SCR tagging may be required by COMPANY. The Stress Joint must be crated by SUPPLIER for offshore shipment. The Stress Joint crate shall be clearly marked by paint stencil to identify the contents by size and serial number and C.G. The Stress Joint shall be protected against moisture/corrosion, assuming that it may be stored in an outside, unprotected area. Stress Joint delivery and shipping schedule will be mutually agreed prior to award of contract.

7. MANUFACTURING REQUIREMENTS

The definition of the functional requirements establishes specific guidelines for issues relating to the installation, operation and maintenance of the titanium Stress Joint.

The SCR titanium Stress Joint system must be designed to the applicable government and industrial standards in effect in the region of its use as advised by COMPANY. SUPPLIER shall seek not only to comply to the regulations and standards provided but shall endeavor to meet unstated standards which may come into play during the course of the project, including those from regulatory and certifying authorities.

Nothing contained herein, or omitted from this specification shall be construed as relieving the SUPPLIER of the obligation to supply the SCR Stress Joint in accordance with functional requirements outlined herein, capable of functioning in a SCR system for a minimum of 25 years.

7.1. Procurement and Fabrication

SUPPLIER shall furnish all labor, consumables, tools, equipment and materials (other than those explicitly identified as supplied by COMPANY) required to manufacture, test and deliver Stress Joint in a safely per the agreed schedule. SUPPLIER shall perform all operations required for manufacture, inspection, testing, handling, and shipping packaging of the systems as part of a documented and COMPANY approved quality plan specific for Stress Joint to be supplied for the Xxxxx field development. This manufacturing Quality Control Plan shall be prepared by SUPPLIER and reviewed and approved by COMPANY prior to commencing manufacture. Witness, Inspection and Hold points shall be identified in the plan along with a description of the non-conformance documentation and review process.

SUPPLIER may propose procedures or “in-house” specifications for fabrication and inspection processes by submitting same to COMPANY for review and approval. All fabrication and inspection procedures shall be approved by COMPANY in writing prior to use. For COMPANY approval of procedures or specifications deemed by SUPPLIER to be “proprietary”, COMPANY’s representative(s) may review such documents as required at SUPPLIER’s place of business.

SUPPLIER shall allow COMPANY full and unrestrained access to all areas concerned with manufacture, inspection and testing of the Stress Joint. If any inspection or testing reveals details not in accordance with this specification, then SUPPLIER may demonstrate to COMPANY that the product still satisfies the design requirement. If SUPPLIER is unable to demonstrate this to the COMPANY, then the manufacturing and/or testing procedure shall
be repeated until compliance is demonstrated. All such remedial work shall be performed at SUPPLIER’s cost.

Copies of material specifications, results of all mechanical properties tests, and mill test certificates of materials used in any components shall be provided to COMPANY. Material traceability to mill heat and/or heat treatment lot as applicable is required for all materials. Material that is not traceable, shall not be used.

7.2. Manufacturing Procedures

A manufacturing Quality Control Plan shall be prepared by SUPPLIER and reviewed by COMPANY prior to commencing manufacture. Witness, Inspection and Hold points shall be identified in the plan along with a description of the non-conformance review process.

7.3. Material Selection

All equipment and material manufactured and/or supplied under this Specification shall be new, of proven design, and produced in accordance with sound engineering fabrication and manufacturing practice. Use of, or modifications to, existing designs are preferred.

All materials used for the SCR Stress Joint shall be specified. Each part of the Stress Joint that shall be in contact with the product stream (specified in reference [2] RM) shall be made of materials that are compatible with the product. SUPPLIER shall describe the method of manufacture and all materials, which are to be used, including heat or other special treatments and the hardness limits of wearing surfaces.

SUPPLIER shall review COMPANY’s material selection and confirm compatibility with SUPPLIER’s Stress Joint design. SUPPLIER is responsible for ensuring the overall metallurgical compatibility of the SCR Stress Joint components, including compatibility with the pipe sections to be welded to the Stress Joint extension (pup piece). SUPPLIER shall detail all Stress Joint component materials for COMPANY review during SUPPLIER’s bid submission.

The COMPANY will specify to the best of their ability the relevant codes, standards, regulations and interface requirements which govern the selection of materials by the SUPPLIER. SUPPLIER shall be responsible for the selection of the SCR Stress Joint materials, which shall be approved for sour service per Ref. [16] (ISO 15156–3). All selected materials shall be suitable for service under all conditions, internal (pressure, temperature, fluid/solids composition, flow rates, etc.) and external (environmental conditions) as defined in this specification and any clarifications provided by COMPANY and shall be clearly identified.

SUPPLIER shall detail all component materials in SUPPLIER’s submission for COMPANY’s review and approval. SUPPLIER shall also submit any required material manufacturing process details, tests, examinations, inspections and acceptance criteria for each selected material to the COMPANY for review and approval prior to purchase of materials. Materials specifications shall include fabrication techniques, chemical composition, target chemistry with allowable chemistry ranges, fracture toughness, forging/sizing procedures. The chemical composition specification and material properties selected shall be approved by COMPANY. COMPANY shall also approve all material fabrication sub-suppliers and fabrication facilities for the seamless tubular or forgings to be used for the Xxxx stress joints. COMPANY shall review and approve SUPPLIER’s material selection and confirm compatibility with SUPPLIER’s design and shall approve any materials fabrication sub-suppliers.

The forging ratio at the critical section shall be a minimum of 5 to 1. Ingots shall be triple remelted for heavy wall pipe and flanged components or with approval of COMPANY, double melted from premium ingots. Mechanical testing for the stress joint shall be from a prolongation or sacrificial forging undergoing the same manufacturing process as the
material to be supplied. The prolongation size and dimensions shall be described fully in the MPS requirements.

Titanium pipe, fasteners, and components shall be produced by the sponge refining technique or alternate high quality process to minimize hydrogen and interstitial elements such as oxygen to produce an extra low interstitial (ELI) grade. Processing standard shall conform to AMS 2380 and ASTM B 265, Type 29.

Repair welding by the heavy-wall seamless-tubular product or forging sub-supplier is not allowed.

8. TESTING REQUIREMENTS

8.1. Qualification of Stress Joints

Prior to commencing the manufacturing of Stress Joint, the SUPPLIER shall verify to the COMPANY’s total satisfaction that the SUPPLIER’s proposed designs will meet all the requirements as specified in this document. This shall be done by manufacturing/testing prototypes and/or other verification procedures, depending upon the concept for the Stress Joint. Verification procedure(s) to be proposed by the SUPPLIER, and submitted to COMPANY for review and approval. Prototype testing, if required, will be additional scope and should be priced as an option.

SUPPLIER will also submit a FAT testing program for review by the COMPANY prior to the completion of production operations. The testing program shall include appropriate tests to assure qualification of the materials, processes for the completed SCR Stress Joint assembly. All testing procedures are subject to both internal and external Quality Control oversight and verification. The following areas of testing shall be considered a minimum requirement for acceptance of the SCR Stress Joint assembly. The Stress Joint will also require a fit-up test to demonstrate the appropriate mating of the Stress Joint to the hang-off receptacle basket (to be supplied by others).

8.2. Material Qualification

All materials used in the fabrication of the SCR Stress Joint shall successfully submit to qualification testing in accordance with either accepted standards or approved SUPPLIER procedures prior to use in fabrication of the stress joints. SUPPLIER shall include acceptance criteria (mechanical test values, material compositions, etc) for each material to be supplied for the Stress Joint to the COMPANY for review and approval prior to procurement. The COMPANY shall have access to the material test results for verification prior to commencement of production operations. SUPPLIER may propose results of previous testing of identical materials for acceptance by COMPANY for the purposes of material qualification. Previous tests shall only be proposed where the test conditions (temperature, pressure, fluid composition) are characteristic of those identified herein.

Mill Test Certificates shall be supplied for metallic materials and shall include the following information:

- Steel or non-ferrous metal-making process, heat number, and name of metal supplier.
- Yield and ultimate tensile strength and elongation percentage.
- Chemical analysis (including carbon equivalent and Pcm for carbon steel).
- Charpy V-notch, hardness and percentage shear.
- CTOD test results

Documentation of existing data, conformance tests, and detailed inspection procedures shall be submitted to COMPANY for review and approval and shall include the following minimum items:
a) Dimensional checks to ensure compliance with standards, specifications, and project drawings.

b) Vickers Hardness Survey (testing method to be proposed by SUPPLIER). Results of all hardness determinations, including failures, shall be reported in the documentation package.

c) Tensile tests on base metal in accordance with ASTM E8.

d) Fracture toughness testing shall be performed on all tubular/forged components per the requirements of ASTM E992-84. All fracture toughness appearance results, including failures, shall be provided in the documentation package. Test methods and acceptance criteria to be proposed by SUPPLIER for COMPANY review and approval.

e) CTOD Fracture Toughness Testing. CTOD fracture toughness testing shall be performed. A set of 3 longitudinal specimens shall be extracted from the QTS and tested to evaluate the fracture toughness of each forging heat treatment lot. CTOD specimen dimensions, fatigue pre-cracking, and testing shall be in accordance with ASTM E1290.

f) Each forging shall be ultrasonically examined in accordance with AMS 2630 and AMS 2630.

g) All machined forgings shall be fluorescent penetrant inspected in accordance with AMS 2645 or AMS 3156.

SUPPLIER may propose alternate means which meet or exceed the listed requirements in this section to COMPANY for review and approval in the form of a deviation request.

A test report and/or a quality assurance inspection report shall be written for each test performed and issued to COMPANY for review within two weeks of test completion.

8.3. Process Qualification

All material processing and component/assembly fabrication shall be subject to inspection and/or non-destructive test (NDT) procedures to verify that quality standards are maintained. Specific inspection/testing required to verify product quality shall be detailed in the manufacturing quality plan to be reviewed and approved by COMPANY. Tests of this type shall include ultrasonic inspection, magnetic particle inspection, metal hardness at any welds, X-ray analysis of welds and dimensional conformance.

All forgings shall be UT tested in accordance with AMS 2631, Class I (3/64 flat bottom hole) after all forming and heat treatment but prior to shipment from the tubular/forging sub-supplier. Volumetric coverage shall be 100%, preferably with straight-beam from three mutually orthogonal directions if possible. When straight beam scanning from three mutually orthogonal directions is not possible; angle-beam may be utilized to effect 100% volumetric coverage. All UT procedures and scan maps shall be approved by COMPANY. Acceptance criteria shall be in accordance with AMS 2631, Class 1. All flaws that appear to be cracks shall be rejected regardless of size or orientation.

All tubulars and forgings which have finished machining specified shall be examined by wet-fluorescent or wet-visible contrast PT in accordance with AMS 2645H after all heat-treatment operations but prior to shipment from the tubular/forging sub-supplier. Surface coverage shall be 100% of finish machined surfaces with magnetization in at least two mutually orthogonal directions (for cylinders and tubulars – circumferential and longitudinal). All PT procedures shall be in accordance with AMS 3156 and approved by COMPANY prior to use.

9. INSPECTION AND MATERIAL TESTING

The manufacturing quality, Inspection and Test Plan (ITP) shall include proposals for COMPANY Witness, Hold, and Monitor points. The ITP shall be submitted for COMPANY review and approval prior to the start of manufacturing operations. The testing program shall include appropriate tests to assure qualification of materials, processes, and the completed
Stress Joint assembly. All testing procedures are subject to both internal (SUPPLIER) and external (COMPANY or COMPANY’s representative) Quality Control oversight and verification.

SUPPLIER shall be responsible to issue notification for inspection (NFI) to COMPANY’s designated inspection department within 20 days prior to the starting of the inspection point as per approved ITP.

9.1. Test Reports
Each test performed shall result in a test report and a quality assurance inspection report, which shall be issued to COMPANY within two weeks of test completion.

9.2. Minimum Inspection and Testing Requirements for Stress Joint Pup Piece
All testing shall be performed in the final heat treated conditions. Documentation of existing data, conformance tests, and detailed inspection procedures shall be submitted to COMPANY for review and shall include the following minimum items:

1. Dimensional checks to ensure compliance with standards, specifications, and project drawings.

2. Fitting dimensions shall be in accordance with ANSI B16.9 (for fittings smaller than 406.4 mm (16 inches) in diameter) or MSS-SP-75 (for fittings larger than 406.4 mm (16 inches) in diameter). Flange dimensions and rating shall be in accordance with ANSI B16.5.

3. The following exceptions shall apply to the tolerances given in ANSI B16.9 and MSS-SP-75:
   - The average OD shall be between plus 0.8% or minus 0.5% of the specified OD. The allowable OD range and the target (aim) OD shall be identified in the MPS. Determinations of average OD shall be made at each end and in the middle of each tubular.
   - For a distance of 152.4-mm (6-inch) from the ends of each tubular, the average ID shall be within 0.25-mm (0.01-inch) of the target ID. The allowable ID range and the target (aim) ID shall be identified in the MPS. Other requirements for machined surface finish shall be in accordance with reference [4].

4. Material hardness survey in accordance with ASTM E 10 shall be performed on base metal as near as practical to the center of at least two (2) of the heat-treated surfaces. Hardness shall not exceed 235HB and shall not be less than 156HB. Hardness readings shall be taken on representative forgings at locations proposed by SUPPLIER and approved by COMPANY.

5. Longitudinal Tensile Tests:
Two tensile tests on base metal in the final heat-treated condition shall be performed in accordance with ASTM E8 at room temperature. No subsequent heat treatment is allowed without retesting. The longitudinal centerline of specimens shall be within ¼ Tf of the mid-wall location, and the entire gauge length of all specimens shall be no closer than 1 Tf to any quenched ends and no closer than ¼ Tf to welds between test sample and thermal buffers. Tf is the finished machined wall thickness across the designated critical section for mechanical properties. Specimen orientation shall be parallel to the primary grain flow direction. Standard 12.7 mm (0.5 inch) round specimens per ASTM E8 Figure 8, shall be used. Test results shall comply with the requirement listed in Table 9-1.

Table 9–1: Tensile Properties Requirements
6. Charpy V-Notch Impact Test:
Charpy V-Notch impact tests shall be performed on the base metal, fusion line and fusion line + 2mm and weld deposit for each component in accordance with ASTM A 370. The test temperature shall be 10°C below the minimum design temperature. The minimum values for absorbed energy (joule) and fracture appearance (% shear area), for both base metal and weld deposits, are listed in Table 9–2.

<table>
<thead>
<tr>
<th>Minimum Average Value</th>
<th>Single Minimum Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>66 (50)</td>
<td>54 (40)</td>
</tr>
<tr>
<td>50</td>
<td>40</td>
</tr>
</tbody>
</table>

7. Drop-Weight Tear Test
Two standard P-3 Type Drop-Weight Tear Test (DWT) specimens shall be extracted from the Qualification Test Sample (QTS) in the final heat-treated condition and tested in accordance with ASTM E208. No subsequent hot work or heat treatment is allowed without re-testing. The longitudinal centerline of DWT specimens shall be no more than ¼T from the mid-wall location of the thickest section of the QTS, where T is the full thickness.

The test temperature shall be the minimum design temperature. Both specimens shall exhibit ‘no break' performance. If only one of the two specimens exhibits “break” performance, then two additional specimens may be extracted from material immediately adjacent to that of the failed specimen and re-tested as above. Both of the additional specimens shall exhibit 'no-break” performance for acceptance. Results of all drop-weight tests, including failures, shall be included in the documentation package.

8. CTOD Fracture Toughness Testing
CTOD fracture toughness testing shall be performed on the Flexible Joint Extension and Attach Flange. A set of 3 longitudinal specimens shall be extracted from the QTS and tested to evaluate the fracture toughness of each forging heat treatment lot. Specimens shall be taken at equal distances around the circumference of the forging (i.e. every 120 degrees) CTOD specimen dimensions, fatigue pre-cracking, and testing shall be in accordance with ASTM E1290.

Either SE(B) or C(T) type specimens may be utilized. SE(B) specimens shall be Bx2B for thicknesses less than 63.5 mm (2.5-inch) but may be BxB for thicknesses greater than or equal to 63.5 mm (2.5-inch).

CTOD specimen orientation shall be such that the long axis of SE(B) specimens is oriented parallel to the tubular axis and the machined notch is oriented perpendicular to tubular external and internal surfaces.

The test temperature shall be the minimum design temperature.
After testing, all specimens shall be subjected to the validity checks of ASTM E1290.
Significance of pop-ins shall be assessed as described in ASTM E1290 Paragraph 9.1.3.

There is no provision for retests of specimens unless it can be shown that base metal
defects/laminations/segregation interfered with the test. A replacement specimen shall be
prepared and tested for each invalidated specimen. Retest of invalidated specimens shall
only be with COMPANY approval.

The CTOD value shall be greater than or equal to 0.38mm.

9. Ultrasonic Examination
Each forging shall be ultrasonically examined in accordance with ASTM A 707 paragraph 13,
Ultrasonic Examination plus Supplemental Requirement S8, Additional Ultrasonic Test
Requirements and the following exceptions and additional requirements:

- Calibration for through-wall inspection shall be a 3.2mm diameter flatbottom hole (FBH).
- Calibration for angle-beam inspection shall be 3% notch.
- Acceptance criteria shall be based on 3.2mm diameter FBH rather than a 6.4mm FBH
  specified in paragraph 13.3 of ASTM A707.

10. Magnetic Particle Inspection
All forgings, for which finish machining has been specified, shall be examined by wet
magnetic particle (MP) in accordance with ASME Boiler and Pressure Vessel Code, Section
V. DC magnetizing probes shall not be allowed. Examination shall be performed after final
heat treatment and machining processes.

Surface coverage shall be 100 percent of finish-machined surfaces with magnetization in at
least two mutually perpendicular directions (circumferential and longitudinal for hollow
cylinders or tubulars).

Examination shall be conducted after all heat treatment operations (excluding stress relief)
have been completed.

MP procedures and magnetization plans shall be approved by COMPANY.

Remnant magnetic field strength (residual magnetism) shall not exceed 800A/m subsequent
to MP.

Acceptance criteria shall be in accordance with ASME Section V and MIL-STD-1907 Grade
B.

11. Visual Examination
All forgings shall receive visual examination (VE) with 100% surface coverage of all
accessible surfaces, to ensure that it is free from visible laps, cold shuts, cracks, porosity,
slag, excessive scale, and other surface imperfections.

10. FACTORY ACCEPTANCE TEST
Before the final release and packaging, the Stress Joint will undergo final testing and review
to assure all pertinent aspects of the design and fabrication are in compliance with both the
COMPANY’s specifications and SUPPLIER’s design and production requirements.

SUPPLIER shall propose a factory acceptance test program for COMPANY acceptance to
be carried out in detail on the Stress Joint and a fit-up procedure to demonstrate mating to
the receptacles. The factory acceptance test program will include as a minimum requirement
the steps outlined in hereunder and shall accomplish the following goals:
Titanium Stress Joint Specification

- Demonstrate compliance with performance requirements described in the SCR Stress Joint Specification.

- Detect any unit that fails to meet required performance levels and reject them for release unless the non-conformance can be eliminated through re-qualification or mutual written consent from the COMPANY.

The factory acceptance test program shall include as a minimum requirement the steps outlined in hereunder:

- Dimensional check
- Hydrostatic test (as detailed in Section 9.1)
- Maximum Angular Deflection to the maximum design rotation angle. The test shall be performed at ambient temperature, with and without the associated internal pressure and maximum axial loads as specified in Data Sheet 2 in reference [1]. Addition of equivalent internal pressure to simulate the axial load is acceptable.
- Axial Stiffness. The test shall be performed with zero angular rotation and with internal pressure, at ambient temperature. Measure record axial load and axial displacement for a number of load steps up to the maximum axial load specified in Data Sheet 2 of reference [1]. Addition of equivalent internal pressure to simulate the axial load is acceptable.
- Rotational Stiffness. The test shall be performed at ambient temperature, and with internal pressure and axial load. Measure and record rotational moment applied and angular rotation for a number of load steps up to and the maximum design angular deflection. Sufficient resolution shall be achieved at small angular deflection where rotation stiffness varies significantly with angular deflection. Addition of equivalent internal pressure to simulate the axial load is acceptable.
- Electrical Isolation Test of the coating.

SUPPLIER shall submit to COMPANY a Factory Acceptance Testing (FAT) specification including test conditions, procedures, measurements to be taken, and acceptance criteria specifically for the Stress Joint to be manufactured. The FAT specification for the Stress Joint shall provide all requirements (including angular increments for rotational stiffness test and hold times for hydrostatic testing) for the hydrostatic test, fatigue test and/or analysis, the axial stiffness test, the rotational stiffness test, and internal drift test. The FAT specification shall be reviewed and approved by COMPANY prior to initiation of factory acceptance testing.

10.1. Acceptance Criteria.

As a condition of acceptance, the Stress Joint shall meet the following minimum requirements:

- Full documentation for each SCR stress joint that all items in the assembly have been checked and are in compliance, including complete materials traceability documentation.
- A complete dimensional verification, including internal drift test
- A hydrotest of Stress Joint to the pressure specified in Table 5–1.
- Rotational stiffness test
- Large angle deflection capacity test
- Small angle stiffness test

These steps constitute the factory acceptance program, which must be reviewed and accepted by the COMPANY. Failure to meet the factory acceptance standards will result in
the issuance of a non-conformance report, which must be resolved before the product is released to the COMPANY.

10.2. Hydrostatic Pressure Test

Internal hydrostatic tests of the SCR Stress Joints shall be performed at the pressure specified in Table 5–1 and prior to delivery. Agreement shall be obtained with COMPANY’s representative that pressure stabilization has occurred before proceeding with the hold period of the pressure test. In addition to the specified test pressure, the Stress Joint shall also be subject to the maximum axial load and a static angular deflection of 4 degrees. Axial load may be simulated for this test by the application of the equivalent additional internal pressure. Test duration for all tests shall be a minimum of four (4) hours after pressure stabilization. All components shall be visually inspected for leaks throughout the test period. The test shall be performed in air to allow visual inspection.

Tests shall be performed with end caps installed on both ends of the SCR Stress Joints. Pressure recorders and charts shall be utilized. Following the completion of the test, SUPPLIER shall be responsible for removing the end cap and the associated heat-affected zone (HAZ) from the lower end of the extension, leaving a clean straight edge ready for beveling.

The fluid media shall be city tap water (fresh water) and the test temperature shall be ambient (outside approx. 20°C).

10.2.1. Test Documentation

Internal pressure test reports shall include, but not necessarily be limited to, the following information:

a. Detailed description of test equipment with diagram of test hook-up, and test procedures.
b. Test temperature records.
c. Test pressure records.
d. Test equipment calibration certificates.
e. Test results and interpretation.
f. Dead weight Pressure Test records.

Calibration certificates (valid within the previous 6 months) shall be supplied for the temperature recorder, the pressure recorder, and the dead weight tester.

11. PROCESS OF MANUFACTURE AND CHEMICAL COMPOSITION

Titanium pipe, fasteners, and components shall be produced by the sponge refining technique or alternate high quality process to minimize hydrogen and interstitial elements such as oxygen to produce an extra low interstitial (ELI) grade. Processing standard shall conform to AMS 2380 and ASTM B 265 Type 29.

Ingots shall be triple re-melted for heavy wall pipe and flanged components or with approval of COMPANY double melted from premium ingots.

11.1. Pipe and Flange Component Macro-structure

Pipe and flange component macro-structures shall be examined on the lead and trailing end of each extrusion or flanged end of forging at three locations equally spaced around the axis of revolution as per to AMS 2380.

11.1.1. Etching
The etching shall be performed for a sufficient time to develop a well-defined macrostructure and shall show no imperfections such as unhealed pipe, cracks, porosity, laps, folds, pitted areas, segregation, or inclusions detrimental to usage of the material.

11.1.2. Acceptance Criteria

The acceptance criteria of the macro-grain structure shall be AMS 2380 Level 30 or finer.

11.1.3. Photographic Record

A photographic record of all sections shall be provided as part of the MPS and shall be traceable to the specific extrusion or forging.

11.2. Pipe and Flange Component Microstructure

Pipe and flange component microstructures shall be examined on the lead and trailing end of each extrusion or flanged end of forging in the transverse and longitudinal directions at the ID, mid-wall, and OD locations. Photomicrographs shall be prepared from specimens cut from each end of each extrusion/forging in both the longitudinal and transverse directions at OD, mid-wall and ID locations at 100 X magnification.

11.2.1. Examination Locations

Locations shall approximate the finished dimensions of the pipe and not the as-forged part. The microstructure shall be a fully transformed beta structure and free from inter-metallic phases and precipitates.

11.2.2. Grain Boundary Alpha

Grain boundary alpha is acceptable only when the percentage is not blocky or under 5% by volume. The surface shall be free of alpha case.

11.2.3. Photographic Record

A photographic record of all sections shall be provided as part of the MPS and shall be traceable to the specific extrusion or forging.

11.3. Fastener Microstructure

Fastener microstructure shall be tested and shall comply with the requirements of the bar specification AMS 4931. A photographic record of all sections shall be provided as part of the MPS and traceable to the specific bar stock used for fastener manufacture in final heat treatment condition.

11.4. Chemical Composition

Chemical composition for extrusions, forgings and fasteners shall conform to AMS 4931 with specific requirements for extra-low interstitial control for high fracture toughness and Ru addition or ASTM B 265 Type 23 or 29.

11.5. Repair

Repair welding by the heavy-wall seamless-tubular product or forging MANUFACTURER is not allowed.

12. NON-DESTRUCTIVE EXAMINATION

All components shall be visually, ultrasonically, and liquid penetrant inspected in accordance with the following requirements. In additional, visual inspection shall be done on all components and assembled equipment for conformance to COMPANY approved drawings.

12.1. Dimensional and Visual Inspection

All components shall be dimensionally and visually inspected prior to delivery. Rework or modifications shall not be allowed without COMPANY approval. All products and forgings
shall receive VT with 100% surface coverage of all accessible surfaces to be free from visible laps, cold shuts, cracks, porosity, slag, excessive scale, and other surface imperfections.

12.1.1. Dimensional Inspection

Pipe sections shall be dimensionally inspected or, each end and at the approximate center location for compliance to the COMPANY APPROVED. Flanges shall also be dimensionally inspected for compliance to the approved drawing. Reports detailing the actual dimensions shall be provided as part of the MPS.

12.1.2. Drift Testing

Pipe, flanges and weldments shall be drift tested in accordance with standard API procedures as per the COMPANY approved drift size specified on the approved drawing.

12.1.3. Visual Inspection

Pipe, flanges and weldments shall be 100% visually inspected on the entire OD and accessible ID surfaces. Any abnormalities, local grind-outs, etc. shall be recorded and documented. This applies even if the area is within the dimensional tolerances. The relative location, length, width and depth shall be recorded.

12.1.4. Hydrostatic Testing

Hydrostatic testing is not required for individual components. Hydrostatic testing shall be performed after fabrication on the assembly to demonstrate function and integrity.

12.1.5. Fasteners

Fasteners shall be 100% visually inspected and dimensionally inspected to COMPANY APPROVED drawing by the manufacturer or contractor, as per Ref. [9]

12.2. Ultrasonic Examination (UT) of Forgings/Extrusions and Pipe

All forgings shall receive UT in accordance with AMS 2631 Class I (3/64 flat bottom hole) prior to shipment from the heavy-wall seamless-tubular product or forging facility.

Volumetric coverage shall be 100% with straight-beam from three mutually orthogonal directions whenever practicable. When scanning with straight-beam from three mutually orthogonal directions is not practicable; angle-beam may be utilized to effect 100% volumetric coverage.

UT procedures and scan plans shall be approved by COMPANY.

Acceptance criteria shall be in accordance with AMS 2631 Class I. Flaws interpreted to be cracks shall be rejectable regardless of size.

12.3. Ultrasonic Examination (UT) of Heavy-Wall Seamless-Tubular Products

12.3.1. UT Procedure Specifications

Written UT procedure specifications shall be developed showing scan plans, techniques required, accuracy, equipment performance requirements, technique to be employed, and information required to reproduce test results independently. Procedures are subject to the approval of COMPANY.

12.3.2. Heat Treatment

UT shall be performed after all tubular forming and post-forming heat treatment (except stress relief).

12.3.3. Inspector Level
UT may be conducted by Level I, II, or III inspectors as per Ref. [8], however, evaluation of indications shall be performed by Level II or Level III certified inspectors.

12.3.4. Inspections Required

The full length of each heavy-wall seamless-tubular product shall be examined from the OD for longitudinally and circumferentially oriented defects with angle-beam transducers. In addition, the full length of each heavy-wall seamless-tubular product shall be examined from the OD with straight beam transducers to verify wall thickness.

12.3.5. Equipment Description

As appropriate for each inspection facility, the inspection equipment description shall include:

- General description of the physical equipment (e.g., shape, size, capacity, layout of sensors, multi-channel/multiplexed description, power supply, special accessories, etc.);
- General equipment operation (e.g., fixed or rotational motions, approximate speeds, frequency response, etc.);
- Test bench electronics, method of detecting and recording discontinuities, and alarm systems;
- Types of sensors and couplants;
- Areas and percentages of material to be inspected (such as ID or OD or both surfaces, full wall, and areas which cannot be fully inspected); and
- Testing location within the facility including the work environment (i.e., lighting, safety, protection from weather, etc.).

12.3.6. Straight-Beam Thickness Monitors

Straight-beam thickness monitors shall have a digital display that reads at least to 1/1000inch or 1/50-mm and shall have a demonstrated accuracy capability of ±0.002-inches (±0.05-mm) within a 1-inch (25-mm) testing range.

12.3.7. Reference Standards

Reference standards shall have the same nominal diameter, surface finish, and wall thickness as the heavy-wall seamless-tubular products being inspected and shall be made of acoustically similar material. Reference standards shall contain the following:

- Thickness Steps: Two thickness steps shall be machined into the inside surface of the reference standard to represent wall thicknesses of 95% of specified wall and 100% of specified wall. These thickness steps shall be used to verify accuracy and sensitivity of the straight-beam thickness monitor.
- Rectangular Reference Notches: Four rectangular reference notches shall be machined into the reference standard to represent wall thicknesses of 95% of specified wall and 100% of specified wall. These thickness steps shall be used to verify accuracy and sensitivity of the straight-beam thickness monitor.

12.3.8. Calibration Method

- Automatic Inspection

Reference gain levels for angle-beam transducers shall be set such that response levels from the appropriate ID and OD reference notches are equal to or greater than 80% of full screen height or full scale of chart.

A dynamic calibration check shall be performed prior to each inspection run, at least once every 8-hour shift during an inspection run, and at the end of each inspection run.
• Manual Inspection

All reference reflectors shall produce clear and distinct responses.

The appropriate reference notch shall be used to set a reference gain level and reference amplitude for the type of inspection to be performed (i.e. longitudinal ID notch for longitudinal defects located at or near the ID surface, etc.). Reference gain levels shall be set such that the response level from the reference reflector of interest is at least 80% of full screen height or full scale of chart.

A distance amplitude correction (DAC) curve shall be established on the CRT for each reference notch.

A calibration check shall be performed prior to examination, at least once every eight-hour shift, and at the end of each inspection run.

A calibration check shall be performed after any interruption of power, a change of batteries, a change of operating personnel, replacement of a system component, or adjustment of any electrical or mechanical control.

12.3.9. Operating Procedure

• Automatic Inspection

The location and position of angle-beam transducers shall be specified to introduce the sound beam at the optimum angle for maximum response from reference reflectors and inherent defects. Inspection angles within the part shall be between 30 and 70 degrees.

This may require separate channels or multiple inspections for ID and OD inspection in order to ensure 100% volumetric inspection.

Straight-beam transducers shall be positioned at least 50% of the near field distance away from OD surface, whenever practicable.

Flaw gates shall be set to provide 100% coverage of the wall thickness.

Scanning shall be in the same direction and at the same speed as for the calibration check.

Maximum allowable rotational scanning speed shall be set such that each transducer pulses at least once per each 0.040-inch (1.0-mm) of tubular circumference scanned.

Linear scanning speed or indexing shall be limited in order to ensure a minimum of 100% coverage by all inspection directions and methods using the effective beam width dimension.

Scanning shall be performed at a sensitivity level at least two times the reference gain level (+6 dB).

Alarm level amplitude thresholds shall be no more than 50% of full screen height or full scale of chart.

Note: Noise may prohibit an alarm gate set at 50% of reference. In such a case, the alarm level may be raised just above the noise level, but no greater than 56% of full screen height.

Indications whose amplitudes exceed the alarm level amplitude threshold may either be declared defects or shall require further evaluation by manual ultrasonic methods, at the option of the heavy-wall seamless tubular product MANUFACTURER.

• Manual Inspection

Wedges shall be contoured to the curvature of the material.

For indication locating, scanning sensitivity levels shall be at least two times the reference gain level (+6dB) or set at the background noise level caused by grain size scatter.

Indications shall be evaluated at the reference gain level.
Indications shall be evaluated after maximizing response by probe manipulation. Indications whose amplitudes exceed 50% of the DAC curve shall be mapped for position, length, and size. Discontinuities larger than the sound beam may be mapped using the ½ amplitude method.

Recordable indications are: those exceeding 50% of the DAC curve (not due to back surface), any indication continuous on the same plane and found over an axial or circumferential distance greater than 1/8-inch, and indications 50% or greater of reference amplitude if they travel, are continuous, or appear as clusters.

Planar indications shall be considered to be defects if they have a measured axial or circumferential length that is greater than 1/8-inch and are either: a) evaluated to be cracklike or b) evaluated to have a radial dimension greater than 3% of specified wall thickness.

Indications evaluated to be internal inclusions shall be considered to be defects if they are either: a) evaluated to have an axial or circumferential length exceeding 1/8-inch and their amplitude exceeds the DAC curve or b) evaluated to have an axial or circumferential length exceeding 1/8-inch and their evaluated radial dimension exceeds 3% of specified wall thickness, or c) evaluated to result in a remaining effective wall thickness less than 95% of specified wall thickness.

Any planar indication whose amplitude exceeds the DAC curve and whose measured axial or circumferential length exceeds 1/8-inch shall be considered a defect.

12.3.10. Defect Remedy

Heavy-wall seamless-tubular products containing defects shall be either completely rejected or, at the option of the tubular MANUFACTURER, shall have defective segments removed, provided length requirements are met. However, if the defect is located on the OD surface, or ID surface where accessible, grinding and subsequent manual ultrasonic inspection in accordance with Section 12.3 or fluorescent dye penetrant inspection in accordance with Section 12.4 may be performed to remove the defect and verify a remaining wall thickness equal to or greater than specified wall thickness in order to accept the tubular. ID surface defects which are evaluated by visual methods (e.g. borescope) to be either pits, round-bottom gouges, or plug scores shall not be cause for rejection provided remaining wall thickness equal to or greater than specified wall thickness is verified.

12.3.11. Results Documentation

Results of all ultrasonic inspections shall be included in the documentation package.

12.4. Fluorescent Dye Penetrant Examination (PT) of Finish-Machined Surfaces

All heavy-wall seamless-tubular products and forgings for which finish machining has been specified shall be examined by wet-fluorescent or wet-visible contrast PT in accordance with AMS 2645H prior to shipment from the heavy-wall seamless-tubular product or forging facility.

Surface coverage shall be 100 percent of finish machined surfaces with magnetization in at least two mutually perpendicular directions (circumferential and longitudinal for hollow cylinders or tubulars). Examination shall be conducted after all heat-treatment operations (excluding stress relief).

PT procedures shall comply with AMS 3156 and all visual examination plans shall be approved by COMPANY.

Acceptance criteria shall be in accordance with MIL-STD-1907 Grade A or ASME Code V Section 1220.

12.5. NDT Results Documentation
The results of all NDT shall be reported in the documentation package for all heavy-wall seamless tubular products and forgings.

13. EXTERNAL COATINGS AND ELECTRICAL ISOLATION

A COMPANY approved method to isolate the assembled titanium TSJ from the mating steel flange of the steel catenary riser (SCR) shall be provided. Electrical isolation using various non-conducting materials shall be provided and design basis and performance provided to COMPANY.

13.1. External Coatings

External coatings such as chlorobutyl rubber shall be used on 100% of the exposed surface area to afford electrical isolation and galvanic shielding from steel components to which the Stress Joint is connected in service.

13.2. Isolation Gaskets

Isolation gaskets from ceramic or load bearing non-metallic shall be used to isolate the titanium from the steel SCR with coatings applied to flange faces, fasteners and other surfaces affording an electrical path between the titanium Stress Joint and the steel SCR.

14. QUALITY ASSURANCE / HSE

This section defines the quality assurance requirements to be observed in performance of the procedures defined by this specification.

Quality is a prime consideration for ensuring the structural integrity of the stress joints. Inspection of the stress joints in service may not be possible and removal of the SCR to repair or replace the stress joint would be extremely costly. SUPPLIER shall demonstrate to COMPANY’s satisfaction that a quality system is in place to ensure that the stress joints will be manufactured per this specification.

Quality management procedures will be routinely performed in every phase of design and manufacture in accordance with the Quality System Manual. Internal quality standards will comply with ISO 9001.

14.1. Procurement, Fabrication, and Procedures, Reports and Records

Records will be maintained to sufficiently document the performance of each operation required by this specification and to identify all materials used in the processing. These records will be formal documentation (MIPs) containing manufacturing and quality control sign offs for each step of the process. These records are available to the COMPANY upon request and are retained by SUPPLIER for a minimum of 7 years (length of time to be confirmed by COMPANY prior to award of contract).

The following procedures, reports and records shall be provided to COMPANY for review.

- QA/QC procedures; to be submitted to COMPANY for review prior to start of design and production work. The plans and procedures shall include, as a minimum, the following elements:
  - Monitoring and Inspection Plan
  - Material and Process Qualification Plan
  - Inspection and Test Reports to be provided including all reports defined in this Specification
  - NDE Procedures
  - Hydrostatic Test Procedures
  - Document Control Procedures
Traceability Plan
- Design Basis (DB) to be submitted to COMPANY for review prior to start of design and production work, as a minimum, includes the following:
  - Design Parameters
  - Design methodology including FEA tools to be used as agreed by COMPANY.
  - Proposed material specifications
  - Chemical composition and mechanical properties of steel components (yield strength, tensile strength, percent elongation, area reduction and other required properties).
  - Component material lists and descriptions, including any “in-house” material specifications, which shall be made available at SUPPLIER facilities.
- List of Design Drawing to be provided.
- Design calculations and reports for each element to be provided.
- Manufacturing Procedure Specification (MPS) to be submitted to COMPANY for review prior to start of design and production work, as a minimum, includes the following:
  - Procedures including process control plans
  - Testing and Inspection Plan with monitoring points identified
  - Factory Acceptance Testing
  - The QA/QC, DP and MPS shall be written specifically for the PURCHASE ORDER and shall be approved by COMPANY prior to commencement of manufacturing operations.
  - SUPPLIER shall notify COMPANY of any changes in these practices for COMPANY review/approval prior to implementation.
  - Design calculations and reports of the SCR Stress Joint shall be issued to COMPANY for review prior to the manufacturing.
  - Inspection and test reports.
  - Certified as-built drawings or certified as-built dimensional reports.
  - Inspection and test records, and procedures as defined by this Specification.
- Nonconformity reports shall be issued to COMPANY within 5 working days. The copies shall be submitted to COMPANY and shall include all nonconformity reports initiated, dispositioned, or completed during the month. COMPANY reserves the right to review nonconformity dispositions and to require revised dispositions when the nonconformity was not resolved by a method or procedure that was reviewed by COMPANY. Common repair procedures and potential applications shall be submitted to COMPANY for review in advance of their use.
  - All nonconformity reports, including concession requests, shall be submitted to COMPANY for review.

14.2. Health, Safety & Environment

All work performed on the Xxxxx project shall strictly adhere to the COMPANY’s HSE principles and policies. COMPANY shall review and approve use of SUPPLIER’s in-house HSE program. SUPPLIER is responsible for effectively communicating and implementing the designated HSE philosophy to all personnel in its facilities and those of its sub-suppliers.
SUPPLIER shall submit a detailed HSE Plan within two weeks of Purchase Order award for COMPANY review and approval.

14.3. Responsibility
The manager of quality control is responsible for verifying compliance with the requirements of this specification.

14.4. Inspection
The SUPPLIER Quality Department is responsible for inspection and monitoring of these procedures to ensure conformance with the requirements of this specification. If specified, a third party inspection and verification agency can also be used to ensure conformance.

14.5. Approval of Drawings
Prior to start of manufacture of the stress joint, the final assembly drawings shall be supplied to COMPANY for review and approval. Subsequent revisions shall also be issued to COMPANY for review and approval. The drawings shall include the following as a minimum:
   a) Overall dimensions (diameter, length), including details of tapered sections.
   b) Total weights of each assembly (certificates).
   c) Material identification and source part number.
   d) Details of handling attachments.
   e) Weld maps for identifying NDE and other inspection requirements for welds, if welds will be required.

14.6. Project Management
- Kick-Off Meeting - SUPPLIER shall schedule a kickoff meeting within two weeks of receipt of Purchase Order.
- HSE/PEP Plans - SUPPLIER shall submit a detailed HSE Plan within two weeks of Purchase Order award, and shall submit a detailed Project Execution Plan (PEP) within four weeks of Purchase Order award, for COMPANY approval. SUPPLIER's PEP shall be designed to achieve all deliveries in line with COMPANY's requirements. SUPPLIER shall also submit a Manufacturing Quality Plan detailing all procurement, manufacturing, and inspection processes and activities for COMPANY approval within 30 days of contract award.
- Status Report - SUPPLIER shall submit a full status report at least monthly. Additional brief updates at more frequent intervals may be required as needed during design, fabrication, and testing of Stress Joint components.
- Organization and Key Personnel - SUPPLIER shall assign key engineering and service personnel to manage and control the WORK from start through to final delivery. Such personnel shall not be changed without COMPANY approval. Within 2 weeks of receipt of Purchase Order, SUPPLIER shall submit an organization chart defining the reporting structure and shall provide resumes of the proposed key candidates, with others on request, for COMPANY approval.
- The SUPPLIER shall confirm compliance with all the requirements of this document, and the referenced documents during the review of the manufacturing quality plan. Any deviation from the requirements of this document shall be highlighted and forwarded to COMPANY for review and approval. In the event of any disparity of information given in this document with any referenced document or standard, written clarification shall be sought from COMPANY before proceeding with design and/or fabrication of the Stress Joints.