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	CLIENT: REDUC - REFINARIA DUQUE DE CAXIAS					SHEET: 1 OF 9																																			
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	AREA: U-1250					-																																			
SRGE	TITLE: DESIGN CRITERIA - STATIC EQUIPMENT D-591 AND E-590					SRGE/SI-IV/IES																																			
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AP CONSULTORIA E PROJETOS LTDA.	FILE: WORD/V.2013/I-ET-5230.00-2221-500-APJ-001=A.doc			TECHNICAL RESPONSIBLE: TATO GALVÃO MORENO																																					
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SUMMARY 1. OBJECTIVE 2. SCOPE OF SUPPLY 3. APPLICABLE STANDARDS 4. DESIGN CRITERIA					

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1.

OBJECTIVE

This Technical Specification presents additional Design Criteria to those indicated in the PETROBRAS Standards to be considered for the supply of the Interstage Vessel (D-591) and Interstage Condenser (E-590) of Wet Gas Compressor, to be installed in the U-1250 - unit of REDUC located in the State of Rio de Janeiro, Brazil.

2.

SCOPE OF SUPPLY

2.1.

VENDOR shall be responsible for the supply of the complete interstage vessel (D-591) and Interstage Condenser (E-590) Package fully operational in accordance with the requirements of this Technical Specification, with all the necessary instruments to operate safely. A detailed Scope of Supply is outlined in the I-RM-5230.00-2221-321-APJ-002 – MATERIAL REQUISITION FOR WET GAS COMPRESSOR SUPPLY C-504.

2.2.

The VENDOR is responsible for all information required to design the foundation. The anchor bolts shall be supplied in accordance with PETROBRAS N-134 Standard.

3.

APPLICABLE STANDARDS

3.1.

Applicable Rules

3.1.1.

The Applicable Standards must be used in their latest revision as of the date of signature of the Contract.

3.1.2.

The codes, standards and technical specifications mentioned in the Applicable Standards are also applicable.

3.1.3.

This Technical Specification shall take precedence over the Applicable Standards.

3.1.4.

Codes, standards and technical specifications listed on the Contractual Annex of Applicable Standards and Documents shall also be used.

3.2.

PETROBRAS Standards

N-253

- Pressure Vessel Design

N-266

- Presentation of Pressure Vessel Design

N-268

- Fabrication of Pressure Vessel

N-269

- Pressure Vessel Assembly

N-466

- English – Design of Shell-and-Tube Heat Exchanger

N-1492

- Shell and Tube Heat Exchanger – Data Sheet

N-1500

- English – Pressure Vessel Drawing and Data Sheet Form

N-1706

- Additional Requirements for Pressure Vessel Subject to Wet H2S Service

N-1707

- Projeto de Vaso de Pressão com Revestimento Metálico

N-1710

- English - Coding of Technical Engineering Documents

N-2054

- English - Internal and External Accessories for Pressure Vessels

N-2064

- English – Issuance and Revision of Design Documents

N-2941

- Personal Competencies for Inspection Activities

N-0002

- Revestimento Anticorrosivo de Equipamento Industrial

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3.3. PETROBRAS Technical Specifications

I-ET-0000.00-0000-500-PEI-001 (Compliance with NR-13 Requirements for Pressure Vessels)

I-ET-0000.00-0000-500-PEI-003 (Procedure for Performing Stress Analysis by Means of Finite Element Method (FEM))

I-ET-0000.00-0000-500-PEI-004 (Rules to Calculate Wind Loading on Equipment)

I-ET-0000.00-0000-500-PEI-005 (Maximum Allowable Loads on Pressure Vessel Nozzles)

3.4. Brazilian Regulation and Standards

Brazilian Ministry of Economy Regulation no. NR-13 (Norma Regulamentadora de Caldeiras, Vasos de Pressão e Tubulações e Tanques Metálicos de Armazenamento)

3.5. References Documents

DE-5230.00-2221-944-APJ-002 (Fluxograma de Engenharia – Separadores)

I-RM-5230.00-2221-321-APJ-002 (Material Requisition for Wet Gas Compressor Supply C-504)

3.6. Codes

NACE Std MR103 / ISO 17495-1 (Petroleum, petrochemical and natural gas industries - Metallic materials resistant to sulfide stress cracking in corrosive petroleum refining environments)

NACE Std MR0175 / ISO 15156-1 (Petroleum and natural gas industries— Materials for use in H2S-containing Environments in oil and gas production)

ASME Seção VIII, Divisão 1 (Boiler and Pressure Vessel Code)

ASME B16.5 (Pipe Flanges and Flanged Fittings)

ASTM (American Society for Testing and Materials)

TEMA (Standards Of Tubular Exchanger Manufacturer Association)

WRC 107/297 (Local Stresses in Spherical and Cylindrical Shells Due to External Loadings)

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4. DESIGN CRITERIA

4.1. General

4.1.1. The static equipment D-591 and E-590 shall be designed and constructed in accordance with ASME-VIII Div. 1, supplied with the ASME U Stamp.

4.1.2. The VENDOR shall be responsible for performing detailed engineering in accordance with PETROBRAS design specifications NI-253, NI-466, and NI-1706, which shall serve as the basis for the design, fabrication, and testing of static equipment D-591 and E-590.

4.1.3. In the event that the VENDOR engages subcontractor(s) for the design, fabrication, and testing of static equipment, the VENDOR shall be responsible for ensuring that such subcontractors comply with the technical requirements of PETROBRAS standards NI-253, NI-466, and NI-1706.

4.1.4. Minimum conditions required for E-590 Heat Exchanger

- Water cooled heat exchangers shall have the water located into the tubes.
- Cooling water deposit coefficient is 0.0004 m².°C.h/kcal.
- Minimum cooling water velocity on tube side is 1.0 m/s.
- The use of U-tubes for cooling water is not allowed.

4.1.5. Minimum Material specification for Heat Exchanger, Pressure Vessel and Internals

4.1.5.1 Vessel D-591

Special Service	Wet H ₂ S – NI-1706 Category 1
Corrosion Allowance	6mm
PWHT	Yes (Wet H ₂ S Service)
MATERIALS	
Shell	Carbon Steel SA-516 Gr. 60
Nozzle Necks	Carbon Steel SA-106 Gr. B
Nozzles	Carbon Steel SA-105 / SA-106 Gr. B/ SA-516 Gr. 60
Internals (removable and welded)	Carbon Steel SA-516 Gr. 60
Demister	Stainless Steel 304/304L

Special Service: Wet H₂S - For base material, design and fabrication additional requirements, see PETROBRAS NI-1706 - Category 1.

4.1.5.2 Heat Exchanger E-590

	Shell side	Tube side
Special Service	Wet H ₂ S – NI-1706 Category 1	-
Corrosion Allowance	6mm	3mm
PWHT	Yes (Wet H ₂ S Service)	-
MATERIALS		
Shell	Carbon Steel SA-516 + 6mm c.a.	
Tubes	Duplex Stainless Steel SA-789 UNS S31803 (seamless)	
Channel	Carbon Steel SA-516 + 3mm c.a.	
Tubesheet	Carbon Steel SA-516 + 6mm c.a. shell side + 3mm clad SS304L tube side	
Baffles	Stainless Steel 304/304L	

Special Service: Wet H₂S - For base material, design and fabrication additional requirements, see PETROBRAS NI-1706 - Category 1.

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4.1.6. The equipment lifting devices as tailing lugs, trunnions and lifting lugs, including welds, shall be designed to withstand the equipment weight considering a minimum impact factor multiplier of 1.5 and the allowable stress used in the design calculations of lifting devices shall be 67% of the material yield stress, unless otherwise specified on mechanical drawing.

The design shall be performed considering the equipment in horizontal and vertical position.

The lifting weight shall be defined as shop weight plus insulation, ladders, platforms, main pipelines and fireproofing. The internal packing or trays shall be excluded in lifting weight.

4.1.7. In addition to the requirements indicated in the applicable PETROBRAS Standards, the items presented below shall be observed.

4.2. Pressure Vessels

4.2.1. Facilities shall be provided for the removal of the packing, catalyst and appurtenances (manholes, platforms, etc.) for maintenance purpose.

4.2.2. For all equipment designed in accordance with the ASME Code, Section VIII, Division 1 or 2, the designer shall demonstrate, in the calculation sheets, the evaluation for impact test requirements of each vessel component based on its individual material classification, thickness and the rated minimum design metal temperature (MDMT).

4.2.3. For horizontal vessels with slope, the nozzle location shall comply with the sketch showed as FIGURE 1. Despites the slope, all nozzles shall be in vertical position.

4.2.4. For horizontal vessels and heat exchangers, with operating weight exceeding 20 tons, PTFE (Polytetrafluoroethylene) plates shall be provided in the sliding saddle.

The compression strength and deformation of PTFE (Polytetrafluoroethylene) plates, due to compression load on the slide saddle, shall be evaluated in order to avoid contact between metallic plates.

4.2.5. Vortex breakers shall be removable (not welded to the equipment shell), in order to make easy inspection and cleaning.

4.2.6. The circumferential weld of Ring-Type Flanges designed and fabricated according to Appendix 2, Figure (11) of ASME BPVC Section VIII Division 1 shall be UT examined.

4.2.7. The stresses analysis of nozzles junctions on the shell and heads due to external piping loads is equipment manufacturer’s responsibility.

4.3. Heat Exchangers

4.3.1. TEMA Class R - Type AJS.

4.3.2. Tube bundles shall be identified in the back area of fixed tube-sheet, by three mark spaced 120 degrees apart. The marks shall be done with a ½” steel punch.

a) *Heat exchangers with one tube bundle:*

FP-2001-1 - tube bundle of P-2001

FP-2001-2 - spare tube bundle of P-2001

b) *Heat exchangers with interchangeable tube bundles:*

FP-2002-1 and FP-2002-2 - interchangeable tube bundles of P-2002 A/B

FP-2002-3 - spare tube bundles of P-2002 A/B

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c) *Heat exchangers with interchangeable two at two tube bundles:*

FP-2003 A/B-1 and FP-2003 A/B-2 - interchangeable tube bundles of P-2003 A/B

FP-2003 A/B-3 - spare tube bundle of P-2003 A/B

FP-2003 C/D-1 and FP-2003 C/D-2 - interchangeable tube bundles of P-2003 C/D

FP-2003 C/D-3 - spare tube bundle of P-2003 C/D

The respective equipment tags shall also identify all parts of heat exchangers.

4.3.3. The following heat exchanger components shall be marked with a 1/2” steel punch:

- Channel cover;
- Channel;
- Floating head cover;
- Bonnet;
- Floating head backing-device and splice plates;
- Test ring and test flange.

4.3.4. The installation of nameplates on covers channels or any other removable parts shall be avoided. Preference shall be given to a visible place on the shell.

4.3.5. All heat exchangers shall be supplied with a test ring and/or a test flange. For those operating in parallel (interchangeable units), a number of one test ring /flange shall be supplied for each set with less than 4 (four) heat exchanges, and for greater set, two test rings for each set with 4 (four) heat exchanges.

4.3.6. Two spare sets of gaskets and 10% of the bolts of the heat exchangers main flanges shall be supplied.

4.3.7. The floating head configuration shall be in accordance with TEMA item RCB-5. The length projections indicated on Figure RCB-5.141 of TEMA as “OPTIONAL” shall be mandatory. The STYLE “D” configuration on Figure RCB-5.141 of TEMA is not permitted.

4.3.8. When two gaskets are compressed by the same bolting, as in the design of flange pairs used to contain a tubesheet, for both side, shall be used the same gasket material, suitable for the more critical condition (see also TEMA paragraph R-6.2/CB-6.2 and ASME BPVC Section VIII – item 2.5.(a) (2), for Division 1 and item 4.16.2.4, for Division 2).

4.3.9. The circumferential weld of Ring-Type Girth Flanges designed and fabricated according to Appendix 2, Figure (11) of ASME Code shall be UT examined.

4.3.10. Heat exchanger guarantee shall include thermal and mechanical performances.

4.3.11. In case of heat exchangers located at elevation upper than 3 meters shall be provided extra facilities to easy removal of the tube bundle.

4.3.12. When the tube to tube-sheet joints are specified for full strength welding, the full strength weld shall be specified and calculated in accordance with paragraph UW-20.4 of ASME BPVC Section VIII Division 1. The tube to tubesheet joint welds shall be leak tested (leak tightness) as per EEMUA Pub 143, item 12.4 (Freon). The manufacturer shall also provide the test procedure.

4.3.13. The stud, bolts and nuts of heat exchanger girth flanges shall comply with applicable piping specification for equipment nozzles.

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4.4. Wind Loads

4.4.1. Wind loads on the equipment shall be calculated by using the PETROBRAS Specification I-ET-0000.00-0000-500-PEI-004 and the Brazilian Standard ABNT NBR-6123.

4.5. NR-13 Requirements

4.5.1. The CONTRACTOR shall comply with the Brazilian Ministry of Labor Regulation no. NR-13 requirements, according to the Technical Specifications I-ET-0000.00-0000-500-PEI-001 and ET-0000.00-0000-510-PEI-001, through the production and organization of the necessary technical documentation (Manuals, Reports, Installation, Design, etc.) required in the Technical Specification above. This job shall be performed by the Licensed Professional approved by PETROBRAS.

4.6. Equipment Subject to H₂S Service

4.6.1. Equipment subject to H₂S Service shall comply with the requirements of the PETROBRAS Standard NI-1706.

4.7. Stress Analysis by the Finite Element Method

4.7.1. The requirements of Stress Analysis by the Finite Element Method shall be according to PETROBRAS Specification I-ET-0000.00-0000-500-PEI-003 (Procedure for Performing Stress Analysis by Means of Finite Element Method) and paragraph 5.4 of N-266.

4.8. Loads on Nozzles and Clips

4.8.1. The local stresses on nozzles due to external loads shall be according to PETROBRAS Specification I-ET-0000.00-0000-500-PEI-005 (Maximum Allowable Loads on Pressure Vessel Nozzles). Alternatively, the use of Finite Element Method for stress evaluation is allowed, according to the item 3.14 requirements.

4.9. Anchor Bolts

4.9.1. The resistant area to be considered in the calculation of the anchor bolts to pressure vessels shall be the minor valued between the root area (threaded part) and the corroded part (external diameter minus corrosion allowance of the anchor bolt).

4.9.2. The corrosion allowance to be considered shall be 2.0 mm on the radius of the anchor bolt.

4.9.3. When not previously specified, the material for the anchor bolt shall be ASTM-F-1554 Grade 36 (formerly ASTM A 307 Grade C).

4.10. Insulation Requirements

4.10.1. Vessel D-591 shall not have thermal insulation.

4.10.2. Heat Exchanger E-590:

- **Shell side:** Personal protection.
- **Tube side:** No thermal insulation

4.11. Painting Requirements

4.11.1. Equipment surfaces with thermal insulation shall be coated in accordance with PETROBRAS procedure N-0002P, under condition 7.

4.11.2. Equipment surfaces without thermal insulation shall be coated in compliance with PETROBRAS procedure N-0002P, under condition 1.

