

CONTECComissão de Normalização
Técnica**SC-22**

Utilities Equipment

Steam Generator for Injection in Oil Well**2nd Amendment**

This is the 2nd Amendment to PETROBRAS N-2252 REV. D, incorporated the 1st amendment and it is used to alter the text of the Standard in the parts indicated below:

NOTE 1 The news pages with the performed amendments are placed in its corresponding positions.

NOTE 2 The amended pages, indicated the date of the amendment, are placed at the end of this standard, in chronological order, and shall not be used.

CONTENTS OF THE 1st AMENDMENT - 04/2014**- Section 2:**

Replace the ABNT NBR 8441 by ABNT [NBR IEC 60034-5](#).

- Subsection 9.8.11:

Alteration of the text.

- Subsection 13.4:

Alteration of the text.

CONTENTS OF THE 2nd AMENDMENT - 03/2016**- Section 2:**

Replace the PETROBRAS N-313 by PETROBRAS [N-2919](#).

Replace the PETROBRAS N-1278 by Manual de Sinalização para Ambientes Industriais e Marítimos da PETROBRAS.

Replace the PETROBRAS N-2668 by PETROBRAS [N-76](#).

Replace the ABNT NBR 5175 by ABNT [NBR 5175:2014](#).

Replace the ANP/INMETRO nº 1 de 19/06/2000 by Portaria ANP/INMETRO nº 1 de 10/06/2013.

Include of ABNT [NBR 15367:2006](#) and ABNT NBR [17094:2013](#).

- Subsection 10.5.6:

Alteration of the text.

Steam Generator for Injection in Oil Well

Specification

This Standard replaces and cancels its previous revision.

The CONTEC - Authoring Subcommittee provides guidance on the interpretation of this Standard when questions arise regarding its contents. The Department of PETROBRAS that uses this Standard is responsible for adopting and applying the sections, subsections and enumerates thereof.

Technical Requirement: A provision established as the most adequate and which shall be used strictly in accordance with this Standard. If a decision is taken not to follow the requirement ("non-conformity" to this Standard) it shall be based on well-founded economic and management reasons, and be approved and registered by the Department of PETROBRAS that uses this Standard. It is characterized by imperative nature.

Recommended Practice: A provision that may be adopted under the conditions of this Standard, but which admits (and draws attention to) the possibility of there being a more adequate alternative (not written in this Standard) to the particular application. The alternative adopted shall be approved and registered by the Department of PETROBRAS that uses this Standard. It is characterized by verbs of a nonmandatory nature. It is indicated by the expression: **[Recommended Practice]**.

Copies of the registered "non-conformities" to this Standard that may contribute to the improvement thereof shall be submitted to the CONTEC - Authoring Subcommittee.

Proposed revisions to this Standard shall be submitted to the CONTEC - Authoring Subcommittee, indicating the alphanumeric identification and revision of the Standard, the section, subsection and enumerate to be revised, the proposed text, and technical/economic justification for revision. The proposals are evaluated during the work for alteration of this Standard.

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Introduction

PETROBRAS Technical Standards are prepared by Working Groups - WG (consisting specialized of Technical Collaborators from Company and its Subsidiaries), are commented by Company Units and its Subsidiaries, are approved by the Authoring Subcommittees - SCs (consisting of technicians from the same specialty, representing the various Company Units and its Subsidiaries), and ratified by the Executive Nucleus (consisting of representatives of the Company Units and its Subsidiaries). A PETROBRAS Technical Standard is subject to revision at any time by its Authoring Subcommittee and shall be reviewed every 5 years to be revalidated, revised or cancelled. PETROBRAS Technical Standards are prepared in accordance with PETROBRAS Technical Standard [N-1](#). For complete information about PETROBRAS Technical Standards see PETROBRAS Technical Standards Catalog.

CONTEC

 Comissão de Normalização
Técnica

SC - 22

Utilities Equipment

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FOREWORD

This Standard is the English version (issued in 07/2012) of PETROBRAS N-2252 REV. D 10/2011. In case of doubt, the Portuguese version, which is the valid document for all intents and purposes, shall be used.

1 SCOPE

1.1 This Standard establishes the required minimum conditions for supply of steam generators for injection in land oil wells. Other technical requirements which are needed for the specific supply of the steam generator shall be included in the equipment's Technical Specification.

1.2 A steam generator for injection in land oil wells is understood as being the watertube steam generator with a single pass and one or more coils, with forced circulation both of water and air, with one or more burners, mounted on a stationary or moving skid.

1.3 This Standard applies to provisions initiated as of the date of its issuance.

1.4 This Standard contains Technical Requirements and Recommended Practice.

2 NORMATIVE REFERENCES

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies.

Norma Regulamentadora nº 10 ([NR-10](#)) - Segurança em Instalações e Serviços em Eletricidade;

Norma Regulamentadora nº 13 ([NR-13](#)) - Caldeiras e Vasos de Pressão;

Norma Regulamentar nº 26 ([NR-26](#)) - Sinalização de Segurança;

Portaria ANP/INMETRO nº 1 de 19/06/2013 - Medição de Petróleo e Gás Natural;

Portaria INMETRO/MDIC 179 de 18/05/2010 - Requisitos de Avaliação da Conformidade de Equipamentos Elétricos e Eletrônicos para Atmosfera Explosivas;

Portaria INMETRO/MDIC 243 de 04/09/2009 - Requisitos de Avaliação da Conformidade para Motores Elétricos de Indução Trifásicos Rotor Gaiola de Esquilo;

Manual de Sinalização para Ambientes Industriais e Marítimos da PETROBRAS;

PETROBRAS [N-2](#) - Anticorrosive Coating of Industrial Equipment;

PETROBRAS [N-13](#) - Technical Requirements for Paintwork;

PETROBRAS [N-57](#) - Projeto Mecânico de Tubulações Industriais;

PETROBRAS [N-58](#) - Graphic Symbols for Process and Engineering Flowsheets;

PETROBRAS [N-59](#) - Símbolos Gráficos para Desenhos de Tubulação;

PETROBRAS [N-76](#) - Piping Materials for Refining and Transportation Plants;

PETROBRAS [N-115](#) - Fabricação e Montagem de Tubulações Metálicas;

PETROBRAS [N-116](#) - Sistemas de Purga de Vapor em Tubulações e Equipamentos;

PETROBRAS [N-250](#) - Installation of High Temperature Thermal Insulation;

PETROBRAS [N-279](#) - Design of Steel Structures;

PETROBRAS [N-293](#) - Manufacture and Assembly of Metallic Structures;

PETROBRAS [N-314](#) - Low-Voltage Panel Motor Control Center;

PETROBRAS [N-381](#) - Execution of Drawing and Other General Technical Documents;

PETROBRAS [N-442](#) - External Painting of Piping for Onshore Facilities;

PETROBRAS [N-550](#) - Design of High-Temperature Thermal Insulation;

PETROBRAS [N-898](#) - Símbolos Gráficos e Designações para Diagramas Elétricos;

PETROBRAS [N-1219](#) - Colors;

PETROBRAS [N-1438](#) - Terminologia Soldagem;

PETROBRAS [N-1521](#) - Identification of Industrial Equipment;

PETROBRAS [N-1522](#) - Identificação de Tubulações Industriais;

PETROBRAS [N-1550](#) - Metallic Structure Painting;

PETROBRAS [N-1617](#) - Application of Refractory Castable;

PETROBRAS [N-1618](#) - Thermal Insulation Material;

PETROBRAS [N-1665](#) - Burner - Data Sheet;

PETROBRAS [N-1674](#) - Projeto de Arranjo de Instalações Industriais Terrestres de Petróleo, Derivados, Gás Natural e Álcool;

PETROBRAS [N-1710](#) - Coding of Technical Engineering Documents;

PETROBRAS [N-1728](#) - Castable Refractory;

PETROBRAS [N-1735](#) - Painting of Electrical Equipment, Machines and Instruments;

PETROBRAS [N-1857](#) - Electrical Resistance Trace Heating System for Industrial Applications - Design, Installation, Inspection, and Maintenance Procedures;

PETROBRAS [N-1882](#) - Criteria for Development of Instrumentation Designs;

PETROBRAS [N-1883](#) - Presentation of Instrumentation/Automation Design;

PETROBRAS [N-1910](#) - Presentation of Instrumentation/Automation Design;

PETROBRAS [N-1997](#) - Electrical Networks in Cable Tray Systems - Design, Installation, and Inspection;

PETROBRAS [N-2040](#) - Preparation, Presentation and Management of Electrical Design Documents;

PETROBRAS [N-2154](#) - Classificação de Áreas para Instalações Elétricas em Regiões de Perfuração e Produção;

PETROBRAS [N-2547](#) - Frequency Converter for Speed Control of Electric Motor Up To 660 VAC;

PETROBRAS [N-2802](#) - Folhas de Dados de Instrumentação Coletânea;

PETROBRAS [N-2833](#) - Forms and Lists for Instrumentation Designs;

PETROBRAS [N-2919](#) - Motores Elétricos Trifásicos de Indução ou Síncronos;

ABNT [ISO/TS 29001](#) - Indústrias do Petróleo, Gás Natural e Petroquímica - Sistemas de Gestão da Qualidade Específicos do Setor - Requisitos para Organizações de Fornecimento de Produtos e Serviços;

ABNT [NBR 5175:2014](#) - Números das Funções dos Dispositivos de Manobra, Controle e Proteção de Sistemas de Potência;

ABNT [NBR 5410](#) - Instalações Elétricas de Baixa Tensão;

ABNT [NBR 5597](#) - Eletroduto de Aço-Carbono e Acessórios, com Revestimento Protetor e Rosca NPT;

ABNT [NBR 12177-2](#) - Caldeiras Estacionárias à Vapor - Inspeção de Segurança - Parte 2 - Caldeiras Aquatubulares;

ABNT [NBR 12313:2000](#) - Sistema de Combustão - Controle e Segurança para Utilização de Gases Combustíveis em Processos de Baixa e Alta Temperatura;

ABNT [NBR 13970](#) - Segurança de Máquinas - Temperatura de Superfícies Acessíveis - Dados Ergonômicos para Estabelecer os Valores Limites de Temperatura de Superfícies Aquecidas;

ABNT [NBR 14039](#) - Instalações Elétricas de Média Tensão de 1,0 kV a 36,2 kV;

ABNT [NBR 15367:2006](#) - Máquinas Elétricas Girantes - Motores de Indução - Marcação de Cabos Terminais e Sentido de Rotação;

ABNT [NBR 15827](#) - Válvulas Industriais para Instalações de Exploração, Produção, Refino e Transporte de Produtos de Petróleo;

ABNT [NBR 17094-1:2013](#) - Máquinas Elétricas Girantes - Motores de Indução Parte 1: Trifásicos;

ABNT [NBR IEC 60034-5](#) Máquinas Elétricas Girantes - Parte 5: Graus de Proteção Proporcionados pelo Projeto Completo de Máquinas Elétricas Girantes (Código IP);

ABNT [NBR IEC 60439-1](#) - Conjuntos de Manobra e Controle de Baixa Tensão Parte 1: Conjuntos com Ensaio de Tipo Totalmente Testados (TTA) e Conjuntos com Ensaio de Tipo Parcialmente Testados (PTTA);

ABNT [NBR IEC 60529](#) - Graus de Proteção para Invólucros de Equipamentos Elétricos (Código IP);

ABNT [NBR ISO 9001](#) - Sistemas de Gestão da Qualidade;

IEC [61131-1](#) - Programmable Controllers - Part 1: General Information;

IEC [61131-2](#) - Programmable Controllers - Part 2: Equipment Requirements and Tests;

IEC [61131-3](#) - Programmable Controllers - Part 3: Programming Languages;

IEC [61131-5](#) - Programmable Controllers - Part 5: Communications;

IEC [61508-1](#) - Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems - Part 1: General Requirements;

ANSI/ISA [5.1](#) - Instrumentation Symbols and Identification;

ANSI/ISA [7.0.01](#) - Quality Standard for Instrument Air;

API [RP 555](#) - Process Analyzers;

ASME BPVC [Section I](#) - Rules for Construction of Power Boilers;

ASME BPVC [Section VIII - Division 1](#) - Rules for Construction of Pressure Vessels;

ASME [PTC 4](#) - Fired Steam Generators;

ISA [18.1](#) - Annunciator Sequences and Specifications;

NFPA [85](#) - Boiler and Combustion Systems Hazards Code Effective.

NOTE For documents referred in this Standard and for which only the Portuguese version is available, the PETROBRAS department that uses this Standard should be consulted for any information required for the specific application.

3 SUBMITTAL OF THE TECHNICAL PROPOSAL AND THE DESIGN

3.1 General

All technical documents shall be coded in accordance with PETROBRAS [N-1710](#) and shall be submitted in accordance with PETROBRAS [N-58](#), [N-59](#), [N-381](#), [N-898](#), [N-1438](#), [N-1521](#), [N-1522](#), [N-1883](#) and [N-2040](#), ABNT [NBR 5175:2014](#) and [NBR 15827](#).

3.2 Documents of the Technical Proposal

A technical proposal shall be provided in three copies, containing, among other documents, the complete list of the imported and the nationalized parts, indicating the material and its respective sub-providers, and requiring the acceptance tests made by classification company.

NOTE 1 Sub-providers shall be listed on the PETROBRAS Registry and, in case they are not, they shall be ranked by the vendor as per the criteria established by PETROBRAS.

NOTE 2 The foreigner and national sub-providers' Quality Management System shall adhere to the requirements established by ABNT [ISO/TS 29001](#) and shall meet ABNT [NBR ISO 9001](#).

3.3 Design Documents

3.3.1 The required documents for approval of the design shall be submitted in three copies. Two copies shall be provided certified, and the other shall be electronic.

3.3.2 At least the following documents shall be submitted in order for the design to be approved:

- a) list of the design documents;
- b) Fully completed Data Sheet of the steam generator;
- c) Data Sheet - equipment, instruments and piping;
- d) Data Sheet of the burner, completed as in PETROBRAS [N-1665](#);
- e) Data Sheet of electric induction engines, completed as in PETROBRAS [N-2919](#).
- f) Data Sheets of frequency converters, completed as in PETROBRAS [N-2547](#);
- g) Data Sheets of instruments, control valves, safety valves and relief valves, completed as in PETROBRAS [N-2802](#);
- h) process flowchart;
- i) engineering flowchart;



- j) process description;
- k) area classification plant;
- l) arrangement plant;
- m) piping plant;
- n) instrument location plant;
- o) table with the summary of the variables with their respective set-points;
- p) calculation memories;
- q) burner design;
- r) dimensional drawing: views, sections and details of the steam generator;
- s) drawings of the finned tubes;
- t) set of drawings of refractories;
- u) assembly drawings;
- v) instrument list (as in PETROBRAS [N-2833](#));
- w) basic interconnection scheme for instruments;
- x) wiring diagram;
- y) functional diagram;
- z) diagrams of the automatic control grids;
- aa) listing of analog and digital Inlets/Outputs;
- ab) description of logic and automation with a logic diagram and a cause & effect diagram;
- ac) drawing of the steam generator's monitoring architecture, automatic control, safety and automation;
- ad) dimensional drawing and bill of materials of the local control panel;
- ae) software of the programmable equipment;
- af) key one line electric diagram;
- ag) dimensional drawing and bill of materials of the "Engines Control Center" (CCM) electrical panel;
- ah) scheme for assembly and final interconnection where it will be installed.

3.4 Design Books

These shall contain copies of every design document which has been approved by PETROBRAS, certified by the manufacturer and as built. This book shall be provided in two hard copies and in an electronic third copy.

3.5 Book of Technical Manufacturing Documents

It should contain all quality certificates of the materials used, the chemical and mechanical tests, the compliance certificates for work in explosive atmospheres (Ordinance INMETRO / [MDIC 179/2010](#)) or the statement of the Product Certification Office (PCO) accredited by INMETRO of all equipment, accessories, and electric and electronic instruments for potentially explosive atmospheres under conditions of flammable vapors and gases, a compliance certificate to be used to mark high-yield engines (Ordinance INMETRO/[MDIC 243/2009](#)), reports of visual inspection, dimensional inspection and non-destructive tests, application procedure of the refractory and painting procedure, also indicating location of weld repairs, qualification of welders and welding procedures, inspection plans, tests and others. This book shall be provided in two hard copies and in one electronic one copy.

3.6 Instruction Manuals for Installation, Operation and Maintenance

3.6.1 It shall contain the description of the process, the start-up and stoppage sequences, emergency stoppage, operation and pre-operation procedures, logs of the sub-providers, instructions for maintenance of the steam generator itself and others.

3.6.2 All electrical instruments shall be fitted with their respective electronic schematic diagrams and service manuals (maintenance). For programmable devices, in addition to these documents, the application program shall also be provided.

3.6.3 These manuals shall be provided in three hard copies and in one electronic copy. Manuals shall be written in Portuguese. For foreign suppliers, in addition to the Portuguese version (except for logs of sub-providers) the English version shall be provided .

4 Design and Operation Conditions

4.1 Capacity

The following capacities are standardized:

- a) 4,4 MW (15 MMBtu/h);
- b) 7,3 MW (25 MMBtu/h);
- c) 14,6 MW (50 MMBtu/h);
- d) 29,2 MW (100 MM/Btu/h).

NOTE Whenever necessary, different capacities may be specified on the equipment's Technical Specification.

4.2 Maximum Working Pressure

The following pressures (manometric) are standardized:

- a) 10 340 kPa (1 500 psi);
- b) 17 230 kPa (2 500 psi).

NOTE Whenever necessary, different pressures may be specified on the equipment's Technical Specification.

4.3 Minimum Thermal Efficiency

A thermal efficiency of at least 88 % shall be used, as in ASME [PTC 4](#).

4.4 Life Cycle

A life cycle of at least 25 years is established.

4.5 Capacity, maximum steam pressure, steam quality, the type of fuel, electrical feeds, feeding water quality and the work schedule shall be determined on the technical specification.

NOTE The generator's minimum capacity shall be between 25 % and 30 % of the rated capacity.

4.6 Design Standards

The steam generator shall be designed as in ASME BPVC [Section I](#).

5 Equipment Description

5.1 The steam generator (see Annex A) is made up of at least:

- a) convection zone;
- b) radiation zone;

- c) auxiliary systems;
- d) power and control panels.

5.2 The set shall be mounted on a skid and at least split (when stationary) with lifting eyes in order to facilitate handling and maintenance. All piping (drain, electric piping, instrument air and others) shall preferably be mounted on the outer part of the skid, in order to facilitate maintenance.

6 Convection Zone

6.1 The convection zone shall be designed for horizontal or vertical flow of gases and countercurrent flow of water. For each coil, input and output connections individually flanged shall be provided.

6.2 It is recommended installing facilities for launching and receiving pig for internal cleaning of each coil. It is suggested the installation of an adapter according to Figure 1, which consists of a "T" that has, at one end, an internal diameter greater than the internal diameter of the steam generator piping (chamber with overdiameter) and is closed with a blank flange. **[Recommended Practice]**

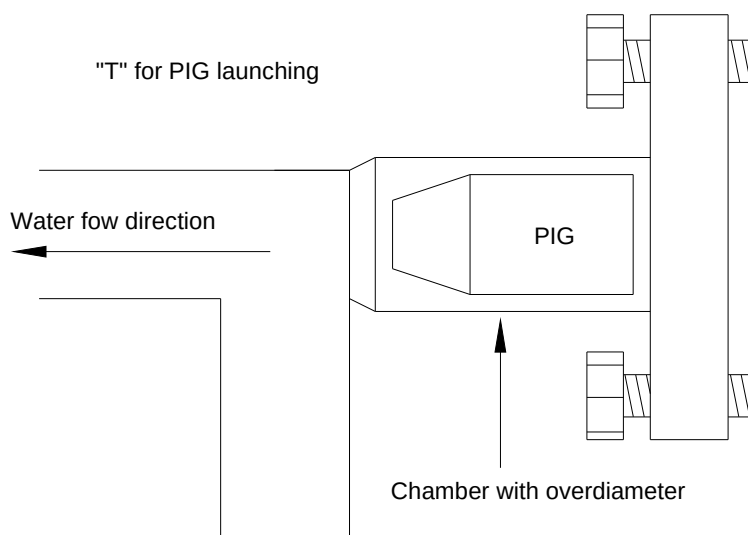


Figure 1 - Adapter for Pig Launching and Receiving

6.3 It is recommended that the convection zone is formed by horizontal, plain and finned tubes connected in series by means of 180° curves, with ASTM A234 WPB specification. **[Recommended Practice]**

6.3.1 It is recommended that the three rows of finned tubes subjected to higher temperatures of the exhaust gases are provided with stainless steel fins. **[Recommended Practice]**

6.3.2 For finned tubes, there must be contact of, at least, 95 % between each fin and the tube, ensuring an adequate heat transfer to the thermal efficiency set forth in this Standard.

6.4 The maximum temperature outside the chamber, and the method and criteria for its measurement, shall meet PETROBRAS N-550, ABNT NBR 12177-2 and ABNT NBR 13970.

6.5 If the convection zone is vertical, there shall be two side doors, one on each side for access to allow cleaning operations. The doors are lined with ceramic fiber mat, according to PETROBRAS N-1618.

6.5.1 These doors are sealed with gaskets to prevent leakage of gases, and the primary seal is applied through internal inclined surfaces.

6.5.2 The stationary generators shall be provided with a device that facilitates the opening, with lifting eyes on its upper part and suspended by pulleys on the chamber structure, to allow the displacement of the doors towards the horizontal axis of the chamber (retractable door).

6.6 The interconnection curves of the tubes shall be outside the zone of heat exchange, i.e., the zone of gas flow. Points must be provided with Ø 3/4" plug for internal inspection, in a curve of each group of tubes layer of the convection zone (at least at four points).

6.7 It is recommended that the coupling of the convection zone to the interconnection pipeline or to the radiation zone is done by means of screws in the structure, and mounting sleeves and high temperature resistant gaskets. **[Recommended Practice]**

6.8 It is recommended that the lining of the convection chamber mirror is made of class A refractory concrete insulation. **[Recommended Practice]**

NOTE If that recommendation is implemented, PETROBRAS [N-1617](#), [N-1728](#) and [N-1910](#) shall be adopted.

6.9 Two doors shall be provided at the ends to allow access to the curves. These doors shall be screwed, lined with ceramic fiber and provided with a device to facilitate the opening and lifting eyes on its upper part.

NOTE It is recommended that the generators with vertical convection chamber are provided with a device that facilitates the opening, with lifting eyes on its upper part and suspended by pulleys on the chamber structure, to allow the displacement of the doors towards the direction transverse to the chamber. **[Recommended Practice]**

6.10 A gas exhaust stack shall be provided bolted to the structure of the convection zone (with high temperature resistant gasket), consisting of pipes and steel plates welded and reinforced and protected against the ingress of rainwater. It shall be provided a sampling tube of the stack gases in an easily accessible location, which makes it possible to collect from the skid.

7 Radiation Zone

7.1 The radiation zone (furnace) shall consist of a horizontal carbon steel cylinder, thermally lined preferably with ceramic fiber. ASTM A106B steel horizontal tubes, whether straight or plain, shall be placed longitudinally to the zone, along its entire internal perimeter and connected in series at their ends by 180° curves (which are within the radiation area) of short radius, of ASTM A 234 WPB steel. The pipes must be supported along its length by cast alloy steel brackets. The burner(s) shall be mounted at the end of the furnace, providing a horizontal flame.

7.2 It is recommended installing facilities for launching and receiving pig for internal cleaning of each coil. It is suggested the installation of the same adapter as described in 6.2 of this Standard. **[Recommended Practice]**

NOTE If the steam generator does not have pre-heater, it is not necessary to install that adapter before the radiation zone, being permitted the installation of only one before the convection zone, according to 6.2.

7.3 It is recommended that the burner refractory block is segmented into refractory castable. **[Recommended Practice]**

NOTE If that recommendation is implemented, PETROBRAS [N-1617](#), [N-1728](#) and [N-1910](#) shall be adopted.

7.4 The maximum temperature outside the chamber, and the method and criteria for its measurement, shall meet PETROBRAS [N-550](#), ABNT [NBR 12177-2](#) and ABNT [NBR 13970](#).

7.5 It is recommended that the radiation zone is provided with two rectangular peep holes, allowing the vision with both eyes of the profile of the main flame and with, at least, one eye of the profile of the pilot flame. These peep holes shall be installed on the front part for monitoring the furnace. **[Recommended Practice]**

7.6 It is recommended that a drain nozzle with threaded cap shall be installed on the bottom of the radiation chamber. Drain pipes with globe valve shall be installed on the coil. **[Recommended Practice]**

7.7 The design of the radiation chamber shall consider that, in case of need of repair of a tube, the removal of the burner, or the furnace tube bundle, is not necessary.

8 Transition Zone

It is recommended that the transition zone (interconnection pipeline), if any, meets the requirements mentioned in 8.1 to 8.7. **[Recommended Practice]**

8.1 Be made of steel plate and lined with ceramic fiber, according to PETROBRAS [N-1618](#) **[Recommended Practice]**.

8.2 Be bolted to the convection zone and to the radiation zone. **[Recommended Practice]**

8.3 Be provided with water drainage and manhole for the inspection of down pipes of the convection zone and the access to the radiation zone. **[Recommended Practice]**

8.4 Be provided with a rectangular peep hole, allowing the inspection (with both eyes) of the internal part of the radiation zone, with minimum dimensions of 10 cm x 10 cm so that the thermographic inspection may be performed in the Radiation coils. They shall be positioned in such a way that that it allows to inspect 100 % of the Radiation coils. **[Recommended Practice]**

8.5 Be provided with a metal platform, on its top part, with antiskid plate floor, joint to the structure, with metal handrail and stairs up to the ground. **[Recommended Practice]**

8.6 Be provided with drain nozzle, bronze gate valve, of quick release. **[Recommended Practice]**

8.7 Be provided with a manhole with minimum dimension of 500 mm, internally insulated with ceramic fiber, according to PETROBRAS [N-1618](#), with the same wall thickness, fixed with screws and davit. **[Recommended Practice]**

9 Auxiliary Systems

The main auxiliary systems that compose the equipment are:

- a) feed water system;
- b) steam system;
- c) fuel conditioning system;
- d) compressed air generation system.

9.1 Feed Water System

The water feed is made in the skid limit of the steam generator. It shall be designed to overcome the back pressure equal to the maximum steam outlet pressure in addition to the system load losses. The flow rate shall be consistent with the capacity of the generator and with the maximum amount of heat released by the burner.

9.1.1 When there is feed pump, it is recommended that it presents the following characteristics:
[Recommended Practice]

- a) positive displacement type;
- b) alternative without forced lubrication of the pistons, with gaskets suitable for local conditions of the water;
- c) multiple belt coupling with tension adjustment;
- d) protection for the belts with access door allowing the exchange of the belts without removing of protector;
- e) driven by electric motor;
- f) pulsation dampeners for suction and discharge;
- g) flanged connections and Pressure Safety and Relief Valve (PSV);
- h) the shutters of the feed pump valves are provided in a suitable material to preserve their seating;
- i) the feed pump head is made of aluminum bronze and the pistons are made of ceramic material;
- j) the pulsation dampener of the pump discharge is spherical, with no moving parts and without the need for damping fluid.

NOTE When necessary, the electric motor shall be controlled by frequency converter specified according to PETROBRAS [N-2547](#).

9.1.2 A check valve shall be installed and an automatic shut-off valve system shall be installed in series with the check valve to prevent the steam from returning to the feed water system, due to unscheduled shutdowns, mainly for power shortage. If there is any pump, the valve shall be installed on its discharge side.

9.1.3 The internal materials of the check valves and the discharge valves of the feed pump shall be suitable to prevent the steam from returning from the generator at any moment.

9.2 Water Pre-Heater

9.2.1 The equipment shall be equipped with a pre-heater when there is need to raise the temperature of the generator feedwater before the convection section, so that its tubes are at an outside temperature above the dew point of the flue gases.

9.2.2 The pre-heater shall be thermally insulated, according to PETROBRAS [N-250](#), [N-550](#) and [N-1618](#).