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NATIONAL IRANIAN OIL REFINING & DISTRIBUTION COMPANY
NATIONAL IRANIAN OIL ENGINEERING
& CONSTRUCTION COMPANY

NIOEC SP

NIOEC SPECIFICATION
FOR
STEAM METHANE REFORMER FURNACE
FIRST EDITION

JULY, 2005

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IN THE NAME OF GOD**FOREWORD**

By their very nature, technical Specifications are continuously subject to modifications and revisions. To strengthen their merit and usefulness, continuous improvements, addendum, deletion of disparate information and consequently provision of updated revisions are to be made in order to ascertain that such Specifications meet the current requirements, inclusive of Iranian Petroleum Standards (IPS) and the recognized and acceptable national and international Standards, as well as the optimal codes and practices based on the accumulated in-house know-how and plant knowledge and experiences.

However, in reality, due to several reasons, not to mention the complexity of the matter, the ultimate goal of continuous direct embedment of the required changes on the relevant Specifications may be far reaching. Therefore, in the interim periods between the officially issued revisions, the required changes will appear in other documents related to the engineering and design work of the ongoing projects.

In response to the initiative of the Design and Engineering Directorate, and considering that the task of the execution of several important and mega projects for the realization of the new oil refineries, pipelines and oil terminals as well as improvements of the existing facilities, has been assigned to NIOEC, it was decided to update the NIOEC Specifications and to issue new official revisions.

The Design and Engineering Directorate was itself entrusted to carry out this important task, and as such by forming several special technical committees, working in close co-operation and cohesion and sharing their expertise and knowledge, the updated and revised NIOEC Specifications were successfully prepared and complied.

These Specifications are intended to be used for Oil Refineries, Distribution Depots, Oil Terminals, Pipelines and Pump Stations within NIOEC's projects, and have been proven to be of high value for such purposes. It must however be appreciated that these Specifications represent the minimum requirements and should in no way be interpreted as a restriction on the use of better procedures, engineering and design practices or materials.

We encourage and highly appreciate the users and other clear sighted and experts to send their comments on the Specifications to the Design and Engineering Director of NIOEC for evaluation and approval.

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NOTES:

- 1) THIS SHEET IS A RECORD OF ALL REVISIONS TO THIS SPECIFICATION.
- 2) WHEN APPROVED EACH REVISION SHALL BE CONSIDERED AS A PART OF THE ORIGINAL DOCUMENT.
- 3) NUMBER OF PAGES EXCLUDES THIS SHEET AND THE COVER SHEET.

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INTRODUCTION

To satisfy the requirements of this NIOEC Specification, Iranian Petroleum Standard [IPS-ME-206](#)(Dec.2002)with the modifications as specified herein after shall be strictly followed.

Articles 0 through 3 of this document replace entirely the related articles in the referenced IPS Standard (all 3 parts).

1.SCOPE

- 1.1. This Specification covers the minimum requirements for the supply, design, materials, fabrication, inspection and testing for a steam methane reforming furnace for the production of hydrogen by reforming mixtures of C1 to C4⁺ hydrocarbon with steam at high temperature in the presence of catalyst.
- 1.2. The furnace shall include a convection section for waste heat recovery and shall be completely furnished , including all structural steel, refractories, burners, burner piping, tubes inlet and outlet manifolds, steam drum and related piping, flue gas ducts, stairways, platforms and stack.
- 1.3. For general requirements for furnaces reference is made to the [NIOEC-SP-45-03](#).
- 1.4. In case of conflict between this Specification and NIOEC-SP-45-03, the requirements of this Specification shall govern.
- 1.5. Resolution on cases not explicitly stipulated in this Specification, or on cases where conflicts may arise among the requirements of the referenced/relevant consent and approval of NIOEC.
- 1.6. Deviation from this specification will only be permitted on obtaining written approval from NIOEC.
- 1.7. This specification covers material and equipment standard for reformer furnaces is prepared in three parts as follows::

Part I: materials and equipment standard for reformer furnaces.

Part II: material standard for centrifugally cast reformer furnace tubes.

Part III: material standard for outlet manifold for reformer furnaces.

2. REFERENCES

The following standards, codes and specifications, to the extent specified hereinafter, shall constitute a part of this NIOEC specification. Latest edition of the undated referenced documents and the cited edition of the dated references shall apply. The applicability of changes made to the dated references after the cited date shall be agreed upon between NIOEC and the Vendor/Contractor.

API (AMERICAN PETROLEUM INSTITUTE)

API STANDARD530“Calculation of Heater-Tube Thickness in Petroleum Refineries”

API STANDARD 560 “Fired Heaters for General Refinery Service”

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

Section I	"Rules for Construction of Power Boilers"
Section II	"Materials"
Section V	"Non-Destructive Examination"
Section VIII	"Rules for Construction of Pressure Vessels"
Section IX	"Welding and Brazing Qualifications"
B 16.5	"Pipe Flanges and Flanged Fittings"
B 31.1	"Power Piping"
B 31.3	"Process Piping"
B 46.1	"Surface Texture"

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)

ASTM A-297	"Standard Specification for Steel Castings, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application"
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NIOEC-SP (NIOEC SPECIFICATIONS)

NIOEC-SP-00-10	"NIOEC Specification for Units"
NIOEC-SP-00-50	"NIOEC Specification for Design Criteria for Process and Mechanics"
NIOEC-SP-45-03	"NIOEC Specification for Fired Heaters"
NIOEC-SP-45-07	"NIOEC Specification for Refractory Linings"
NIOEC-SP-80-05	"NIOEC Specification for internal lining"

2.1. Equivalent to IPS Standard

Substitute the following IPS Standards as referred to throughout [IPS-M-ME-206](#) to relevant NIOEC's Specifications as follows:

<u>IPS Standard</u>	<u>Relevant NIOEC Specification</u>
IPS-G-ME-200	NIOEC-SP-45-03
IPS-M-TP-710	NIOEC-SP-45-07
IPS-E-GN-100	NIOEC-SP-00-10

3. UNITS

International system of units (SI) shall be used in accordance with NIOEC-SP-00-10, unless otherwise specified.

4. ADDENDUM TO IPS STANDARD IPS-M-ME-206

This addendum revises the below listed articles of the referenced standard as follows:

Substitute "... by the Company" to "... by the Contractor" throughout this standard.

PART I**4. Design(Modification)****4.11.(Addition)**

Process conditions are shown on attached Specification sheets which form a part of this Specification.

4.12.(Addition)

Steam-methane reaction shall have an approach to equilibrium of 7.22°C or less, based on end of run conditions.

4.13.(Addition)

The entire furnace shall be designed to permit firing at a turndown of 50% of design rate and also at 120% of design with 25% excess air.

5.Tubes(Modification)

5.4. Convection section tubes shall conform to the following specifications:

TUBE METAL DESIGN TEMP. °C	MATERIAL	ASTM NUMBER *
400	Carbon steel	SA-106 GR B,SA192 SA-209 T1 or SA-335 P1
427	Low alloy steel	SA-213 T11 or SA-335 P 11
593	Low alloy steel	SA-213 TP 304 or 316 or 321 SA-312 TP 304 or 316 or 321 , 347
704	Austenitic stainless steel	SA-376 TP 304 or 316 or 321, 347

* **Note:** For material selection of tube ,API 560 requirements shall be met.

8.REFRACTORIES AND INSULATIONS

8.1(Modification) Design temperature of the outside casing surface of the radiant and convection sections shall not exceed 60 °C (140 °F) at an ambient temperature of 15°C(60 °F) in still air.

The 60 °C (140 °F) casing temperature has been established for personnel protection reasons. If personnel protection is provided or the casing is not accessible during normal operation, then this casing temperature can be increased to 82 °C(180 °F).

8.2(Modification) End tube sheets shall be insulated with monolithic insulating concrete.

9. STRUCTURES AND APPURTENANCES (Modification)**9.5. (Addition)**

Two access doors each 610mm×610 mm (24" ×24 ") shall be provided in each radiant cell. These shall be arranged to provide access to both sides of the tube row.

9.6.(Addition)

An explosion door shall be provided in each heater cell. Explosion door shall be so located as to prevent injury to the operators when opening.

9.7.(Addition)

Sufficient peepholes shall be provided and located to permit optical pyrometer measurements on both sides of all tubes over their entire fired lengths.

9.8.(Addition)

A draft gauge of the inclined manometer type, having a range suitable for operating conditions and located near the damper operating mechanism, shall be supplied by the Purchaser with flexible connections to the following points:

- a) One point at floor level in each combustion chamber.
- b) One point at entrance to convection section.
- c) One point at outlet of convection section.
- d) One point on the stack side of damper.

10.STACK (Modification)**10.2.(Addition)**

The stack shall be self-supporting and shall have a minimum allowance for corrosion from the inside of 3mm (1/8 inch). The design shall consider the possibility of oscillation at critical wind velocities.

10.3.(Addition)

Stack shall be completely lined with a gunnited insulating concrete lining of 38mm (1-1/2") minimum thickness. Lining shall be reinforced with a carbon steel wire fabric welded to the stack on a minimum of 228.5 mm (9") centers.

10.4.(Addition)

Stack shall be of welded construction and have a minimum thickness of 6.5 mm. (1/4 inch).

10.5.(Addition)

For minimum stack height NIOEC-SP-00-50 requirements shall be followed..

10.6.(Addition)

Material of stack dampers shall be selected according to API560.s.

10.7.(Addition)

Stack dampers shall be provided complete with external position indicator and with chain or lever operators accessible from an operating platform or from grade.

10.8.(Addition)

An access opening for internal inspection at the base of each stack shall be provided.

10.9.(Addition)

The stack shall be equipped with a painter's trolley, trolley ring and rigging.

10.10.(Addition)

In order to measure stack emissions, a suitable flanged connection (commonly 6") shall be maintained below the damper.

12. STEAM GENERATION SYSTEM (Modification)**12.3.(Addition)**

Process design conditions for the waste heat boiler shall be included in the specified Data Sheets. Boiler drum shall include the following connections.

Feed Water Inlet	Low Level Alarm
Circulating Water Outlets	Continuous Blow down
Water and Steam Inlets	Intermittent Blow down
Steam Outlet	Pressure Gauge
Relief Valves	Drain
Level Gauge	Vent
High Level Alarm	Chemical Feed Inlet
and others indicated by Contractor.	

12.4.(Addition)

Boiler Drum shall be designed to handle a specified total steam quantity, part of which is produced in the convection zone boiler of this furnace, and part of which is produced in a waste heat boiler or boilers external to the furnace.

The latter boilers and connecting piping will be provided by Contractor.

15.INSPECTION AND TESTING (Modification)

15.9. requirements of NIOEC-SP-80-05 shall be followed. **(Substitution)**

16.GUARANTEES(Substitution)

The whole articles shall be modified as follows:

In addition to the guarantee specified in the Conditions of Contract the following shall be included in the performance guarantee:

16.1. (Addition)

During a 3 day test run when the furnace is supplied with feed gas and steam, fuel and catalyst as specified on the Data Sheet, that the thermal efficiency will be as specified and the performance of the heater will be as follows:

Carbon Monoxide plus Hydrogen

Produced lbmols/hr (in accordance with design)min.

Methane produced, lbmols/hr (in accordance with design)max.

Total pressure loss, psig (in accordance with design)max.

Requirements applying to capacity, thermal efficiency , outlet gas composition, total pressure drop, tube metal and refractory temperatures shall apply simultaneously.

16.2. That all equipment will operate satisfactorily and that design conditions may be maintained when stream rates are reduced to a minimum of 50% turndown.

16.3. Heaters will provide the specified performance without exceeding suppliers specified maximum tubewall or refractory temperatures when temperature is measured with an infrared pyrometer.

Location of peepholes to be used for guarantee test shall be marked on Vendors drawing. The use of pyrometers or thermocouples for this check shall be at the option of the Purchaser.

16.4. Heater tubes will be completely free of all flame impingement.

16.5. All parts which prove defective under operating use within one year from start of operation because of design, workmanship or materials used will be repaired or replaced with all charges of Freight, Site Labor, and Supervision to be paid for by supplier.

17. PREPARATION FOR SHIPMENT(Addition)

Add the following articles:

Heater manufacturer shall properly prepare the heaters or heater parts for shipment to the jobsite.

17.1. Outside exposed metal surfaces shall be prepared and painted for ocean shipment with a zinc chromate base paint.

- 17.2. Flange faces and machined surfaces shall be cleaned and coated with corrosion preventive or waterproof grease. Flange faces shall be protected with 6.35 mm (1/4") full face metal covers, gasketed and securely fastened with 4 bolts.
- 17.3. All threads of loose bolts and nuts shall be coated with a metallic base waterproof lubricant to prevent galling and then shipped in water tight barrels. All threads of bolts, including exposed parts of prefabricated items shall be coated with a metallic base waterproof lubricant and covered with metal protectors.
- 17.4. Suitable bracing and supports shall be provided to prevent damage during shipment. Any damage during shipment that occurs because of insufficient or loose bracing shall be the responsibility of the Vendor. Particular care shall be taken in wooden frame packaging of furnace tube sections.
- 17.5. Each reformer and stack section shall be equipped with lifting lugs and structural bracing designed and positioned by Vendor to permit handling during shipment and lifting for erection without damage to the reformer.
- 17.6. High nickel components shall not be painted or coated with any materials.

18. INFORMATION REQUIRED AFTER AWARD (Addition)

Add the following paragraph:

Vendor drawings and data requested by the Purchaser shall be furnished within one month after award of Purchase Order.

PART II

2. REFERENCES(Modification)

Substitute ASTM A-297 instead of ASTM A-608 as following:

A-297(Addition)

"Standard Specification for Steel Castings, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application"

4. MATERIAL (Modification)

4.1 (Sub.) Tubes shall be centrifugally cast as per ASTM A-297 grade HP and shall be fabricated only by suppliers with prior successful experience in centrifugally casting and fabricating such tubes.

(Note: Information supplied in Appendix A for material IN-519 and A-608 Modified HP shall be omitted.)

5. DESIGN(Modification)

Add the following article:

5.2.3. The corrosion allowance (if specified) shall be added to the inside wall after establishing the minimum wall thickness. The tube supplier shall guarantee that the

minimum wall thickness is sound metal, that is, that all micro-porosity has been removed.

6.4. Welding (Modification)

Add the following article:

6.4.8. The weld area shall be completely cleaned and degreased for a distance of at least 150 mm each side of the weld joint and on both the inside and outside surface of the tube sections. All oils, crayon marks, paint or other foreign matter shall be removed.

7.5.2.1. (Modification)

requirements of NIOEC-SP-80-05 shall be followed..

PART III

4. MATERIAL (Modification)

Add the following article:

4.7. Instrument connections shall be provided as required.

7. WELDING (Modification)

Add the following article:

7.8. All circumferential butt welds shall be 100% radiographically examined. Interpretation shall be according to para.UW-51 ASME code section VIII high contrast fine grain films shall be used.

8. INSPECTION AND TEST (Modification)

8.1. All material and work, including the work of sub-suppliers shall be subject to inspection by the Purchaser. Inspector shall have free access to the plants at all times when work on the contract is performed. Any rejections made by him will be final. However, inspection and/or witnessing of tests shall in no way release the supplier from guarantees as to materials, apparatus, and workmanship. Waiver of any phase of inspection must be obtained in writing from Purchaser.

9. DRAWINGS AND DOCUMENTATION (Modification)

9.2. Vendor shall provide three copies of photo micrographs showing grain size of each individual piece of material, except couplings, to Purchaser. Coupling material shall be mill certified as to grain size to Purchaser in three copies.

10. PREPARATION FOR SHIPMENT (Addition)

Add the following articles:

All materials and equipment shall be packed according to standard commercial export packing acceptable to steamship carriers. Packing and protective measures shall be subject to inspection and rejection at the point of manufacture.

- 10.1.** Alloy components shall not be painted or coated with corrosion preventive or waterproof grease.
- 10.2.** Suitable bracing and supports shall be provided to prevent damage during shipment.
- 10.3.** Metal closures shall be provided on ends beveled for field welds.