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NATIONAL IRANIAN OIL REFINING & DISTRIBUTION COMPANY

NATIONAL IRANIAN OIL ENGINEERING

& CONSTRUCTION COMPANY

NIOEC SP

NIOEC SPECIFICATION

FOR

DESIGN CRITERIA FOR PROCESS AND MECHANICS

SECOND EDITION

JANUARY, 2008

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IN THE NAME OF GOD

FOREWORD

By their very nature, technical standard 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 standard 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 standard 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 on going projects.

In response to the initiative of the Design Division of the Engineering and Construction 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 Division of the Engineering and Construction 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 Deputy of the Engineering Department of NIOEC for evaluation and consideration.

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NOTES:

1) THIS SHEET IS A RECORD OF ALL REVISIONS TO THIS SPECIFICATION.
2) REMARKS RELATED TO EACH REVISION SHOW A BRIEF DESCRIPTION. THESE REMARKS SHALL BE INTERPRETED IN CONJUNCTION WITH THE REVISED TEXT MARKED BY REVISION NUMBERS.
3) WHEN APPROVED EACH REVISION SHALL BE CONSIDERED AS A PART OF THE ORIGINAL DOCUMENT.
4) NUMBER OF PAGES EXCLUDES THIS SHEET AND THE COVER SHEET.

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0. INTRODUCTION

To satisfy the requirements of basic philosophies to be applied during design and engineering of all projects in the field of refinery/oil plant, distribution depots, pump stations and pipelines, this NIOEC Specification shall be used.

1. SCOPE

NIOEC specifications cover the general requirements for detailed engineering, procurements, testing, inspection & construction of refinery/ oil plant, distribution depots, pump stations and pipelines.

This Specification covers the minimum requirements for Process and Mechanics design criteria including essential instructions and points of noteworthy to be applied during implementation of process and/or utility units design and engineering activities.
The purpose of this Specification is to standardize the basis of design for all process and/or utility units.
In case of conflict between this Specification and other NIOEC's Specifications/engineering dossiers, the requirements as stipulated in this Specification are in first priority.

2. REFERENCES

Throughout this Specification, the following dated and undated standards/ codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard.
For undated references, the latest edition of the referenced document (including any supplements and amendments) applies. For dated references, the edition cited applies.
The applicability of changes in dated references that occur after the cited date shall mutually be agreed upon by NIOEC and the vendor/contractor.

API (AMERICAN PETROLEUM INSTITUTE)

Standard 610, 10th. Ed., "Centrifugal Pumps for General Refinery Services"

Standard 620, 10th. Ed., "Design and Construction of Large, Welded, Low-pressure Storage Tanks"

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

ASME Boiler and Pressure Vessel Code:

Section I: "Power Boilers"

Section VIII: "Pressure Vessels"

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ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)

ASTM Specification D- 396- 61 T

NFPA (NATIONAL FIRE PROTECTION ASSOCIATION)

NFPA 170, "Standard for Fire Safety Symbols"

NIOEC-SP (NIOEC SPECIFICATIONS)

NIOEC-SP-00-10 "NIOEC Specification for Units"

NIOEC-SP-00-11 "NIOEC Specification for Site Conditions"

NIOEC-SP-00-52 "NIOEC Specification for Process Flow Diagram"

NIOEC-SP-00-55 "NIOEC Specification for Piping & Instrumentation Diagram"

NIOEC-SP-00-62 "NIOEC Specification for Numbering System"

NIOEC-SP-00-75 "NIOEC Specification for Pressure and Vacuum Relief Devices"

NIOEC-SP-46-01 "NIOEC Specification for Centrifugal Pumps for General Refinery Services"

NIOEC-SP-46-12 "NIOEC Specification for Centrifugal Pumps for General Services"

NIOEC-SP-50-08 "NIOEC Specification for Winterizing & Heat Conservation"

NIOEC-SP-70-01 "NIOEC Specification for Instrumentation"

3. UNITS

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

4. PROCESS UNITS DESIGN BASIS

4.1 GENERAL

4.1.1 General legends and symbols for PFD, P&ID, electrical, instrumentation, HVAC, civil and structure drawings and abbreviations shall be in accordance with NIOEC standard drawings as specified herein below:

- PFD- Symbols and legends; "SD-00-0001-1/1"
- P&IDs –Symbols and legends (Piping) ; "SD-00-0100-1/4"
- P&IDs –Symbols and legends (Instrument) ; "SD-00-0100-2/4"
- P&IDs –Symbols and legends (Equipment) ; "SD-00-0100-3/4"
- P&IDs –Symbols and legends (Miscellaneous Equipment) ; "SD-00-0100-4/4"
- P&IDs –Abbreviation ; "SD-00-0101-1/1"
- Fire Safety Symbols : Refer to NFPA 170

4.1.2 The numbering of the equipment, drawing and all engineering documents shall be as per NIOEC-SP-00-62.

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4.1.3 The drafting procedure for process flow diagrams (PFDs) and piping & instrumentation diagrams (P & IDs) shall be as per "NIOEC-SP-00-52" and "NIOEC-SP-00-55 respectively.

4.1.4 Separate Process Flow Diagram(s) (PFDs) and respective Heat and Material Balance tables shall be prepared for each operation mode as well as regeneration in each unit.

4.1.5 The enthalpy reference conditions (temperature & pressure) shall be noted on all Heat & Material Balance Tables.

4.1.6 Integration of the process units shall be avoided unless otherwise specified. The design shall facilitate normal operation, start-up, shutdown, regeneration and turndown of the process units separately and individually.

4.1.7 The Licensor shall specify the composition as well as Cyanide content of the effluent sour water for licensed units.

4.1.8 Facilities shall be provided for the neutralization of the austenitic stainless steel piping and equipment during shutdown of the unit.

4.2 MACHINERY / DRIVERS SELECTION PHILOSOPHIES

4.2.1 Isolation facilities shall be provided for each machinery equipment.

4.2.2 The stand- by steam turbine drivers shall automatically be started up for low discharge pressure of the respective machinery.

4.2.3 No spare is required for centrifugal compressors.

4.2.4 Where, condensing steam turbine driver is specified, the drivers of the condensate pumps shall be back pressure steam turbine (MP to LP) type for main pump and electrical type for spare pump.

4.2.5 All pumps in continuous operation shall have individual spares. Spare pumps shall be provided as follows:

No. of Operating Pumps	No. of Spare Pumps
1	1
2	1

4.3 WINTERIZING AND HEAT CONSERVATION

4.3.1 Protection of the process and all associated equipment, lines and instruments against atmospheric temperatures which would cause congealing or freezing of contents, interfere with operation or cause damage to equipment shall be shown on the Piping & Instrumentation Diagrams (P&IDs).

However, steam or electrical tracing details shown on the diagrams are indicative and denote only the necessity of tracing in basic design stage.

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Type of tracing and insulation, use of thermal cement or otherwise numbers and size of steam traps will be determined at detail design stage. Protection described by standard nomenclature on the P & I Diagrams should be reviewed in detail engineering to insure that proper standards or requirements in this regard have been met.

4.3.2 The winterizing should be based on a winterizing temperature as specified in the site conditions of each project as per NIOEC-SP-00-11.

4.3.3 Protection of lines, instruments and equipment not shown on the P&I diagrams should be provided by the detail engineering to the extent and in accordance with NIOEC-SP-50-08.

4.3.4 Lines in Asphalt and liquid Sulfur services should be steam jacketed. Valves in these lines are generally steam jacketed wedge plugs.

4.3.5 The objective temperature for heat traced pipelines and equipment shall generally be the fluid pour point plus 22 ºC . The objective temperature for sour gases and reciprocating compressor suction lines and drum shall be minimum 22 ^{o}C above the fluid dew point.

Fuel gas system containing C3 & heavier materials and/or sour gas shall be traced for an objective temperature of 49 ºC.

Fuel oil supply and return lines shall be traced for an objective temperature of 120 ºC.

The minimum maintaining temperature for the specified commodities shall be according to the following Table A. The objective temperature shall be shown on P&IDs.

TABLE A

MINIMUM MAINTAINING TEMPERATURE

COMMODITY	TEMPERATURE, (ºC)
- Water Aqueous Solution	24
- Light Diesel	*
- Heavy Diesel	*
- Waxy Distillate	*
- Heavy vacuum slop	*
- Dewaxing Unit Feed	*
- Vacuum Residue	*
- Deasphaled Oil	*
- Fuel Gas	49
- Hot Slops	66
- Base Oil	60
- Fuel Oil (Supply & Return)	120
- Caustic Solution:	
* 50 Degree Baume	28
* 25 Degree Baume	11
* 4.5 Degree Baume	20

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- Slack wax 90
- Asphalt (*) (Steam Jacketed)
- Liquid Sulfur (*) (Steam Jacketed)

(*) Temperature will be determined in basic design phase.

5. EQUIPMENT DESIGN BASIS

5.1 DESIGN PRESSURE AND TEMPERATURE

5.1.1 Design Pressure for Individual Equipment Items

The design pressure is the maximum and / or minimum pressure for which the mechanical calculation shall be performed. The operating pressure is defined as the maximum/minimum (for vacuum services) anticipated normal operating pressure.

The design pressure shall be established according to the following criteria except in special cases approved by the Company. In addition, where, process fluid static head or other appropriate loads significantly increase the internal pressure, the design pressure shall be increased accordingly for the vessel section concerned.

A) For maximum normal operating pressure less than 1.5 barg (except item "G" below): Whichever is greater:

- 3.5 bar gage, or
- Flare design pressure if the vessel is connected to flare.

B) For maximum normal operating pressures between 1.5 and 20 barg, use the maximum normal operating gage pressure +2 bar.

C) For maximum normal operating pressures between 20 and 80 barg, use 110% of the maximum normal operating gage pressure.

D) For maximum normal operating pressures between 80 and 140 barg, use the maximum normal operating gage pressure +8 bar (see Note 2).

E) For maximum normal operating pressures above 140 barg, use the maximum normal operating gage pressure + 5% (see Note 2).

F) Equipment normally operated under vacuum shall be designed for full vacuum and for the highest pressure which the equipment can experience in case of vacuum system failure, (see Note 3).
Full vacuum shall be specified for isolable equipment containing fluid having a vapor pressure lower than atmospheric pressure at ambient temperature.
For equipment operated under vacuum, minimum internal pressure shall be 3.5 barg.
For vacuum rating designation, pressure shall be noted as external.

G) For equipment operating under Atmospheric pressure, use hydrostatic (water) pressure + 50 mm Water column (see Note 4).
For Atmospheric storage tanks operated under blanketed gas:

- For seal pressure lower than 100 mm of H2O tank design pressure shall be hydrostatic Pressure considering the tank full of liquid plus 150 mm of H2O,
- For seal pressure not higher than 400 mm of H2O, tank design pressure shall be according to API 620.

NOTES: The following design notes shall be taken into consideration for establishing design pressure :

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1) In case of equipment connected in series, without block valves in between, the design pressure for the upstream equipment shall be the same as the design pressure for the downstream equipment (equipped with safety valve) increased by 120% of the pressure drop foreseen between the two equipment, under safety valve discharge accordingly.

2) When design pressure lower than 110% max. operating pressure is specified, safety valves blow down shall be selected accordingly .

3) Design for vacuum :

a) Steam drums shall be designed for full vacuum conditions.

b) Vacuum design conditions shall not be required as consequence of equipment block-in after steam out operation. However, vacuum conditions shall be studied during start-up, shut-down and regeneration and shall be considered for equipment design where applicable.

c) Due consideration shall be taken to establish external design pressure for vessels subject to internal pressure but connected to the suction of compressor or other evacuating equipment .

d) Exchangers operating under a vacuum shall be designed for full vacuum.

e) Low pressure vessels that may be affected by decreasing in ambient temperature which cause vacuum condition in the vessel shall be designed for such vacuum conditions. As an example, main column overhead receiver which is operating at low pressure and receive feed from air cooled exchanger.

f) Vacuum design shall be specified for vessels which normally operate liquid full and can be blocked in and cooled down.

g) Vacuum design shall be specified for fractionators and associated equipment that can undergo a vacuum condition through the loss of heat input.

4) Same criteria are applied for the design of atmospheric storage tanks (without gas blanketing).

5) The set pressure of the relief valve must be lower than or equal to the equipment design pressure.

6) In case of fractionators and towers:

- Design pressure of the main column and connected side strippers shall be calculated based on the column bottom maximum normal operating pressure. Bottom maximum normal operating pressure shall include allowance for hydrostatic head (HHL Level) and pressure drop across trays and / or internals.
- Design pressure of the overhead condenser and reflux drum shall be calculated based on the column top maximum normal operating pressure.
- Design pressure of the bottom reboiler shall be calculated based on the column bottom maximum normal operating pressure plus static head.

7) Design pressure of the fired heater coils shall be calculated considering the design pressure of the downstream vessel plus fouling allowance (if any) plus 120% of the allowable pressure drop in clean conditions.

5.1.2. Design Pressure for Complete Systems

When several pieces of equipment are protected by the same relief valve, each piece of equipment shall be designed, at least, for the pressure imposed by the discharge conditions of the relief valve in case of emergency (see Note-1 under 5.1.1 above).

5.1.2.1. <u>Exchangers, vessels and other equipment on the discharge of a pump</u>

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Equipment which could have to bear the shut-off pressure of a pump in case of a valve closing (either control valve or block valve) shall have a design pressure equal to or higher than the shut-off pressure of the pump. Pump shut-off pressure shall be estimated according to the following criteria, whichever is greater:

a) Design pressure of the suction vessel plus liquid height at vessel HLL at pump suction + pump differential pressure at rated flow of the pump.
b) Normal suction pressure plus liquid height at vessel HLL at pump suction + 120% of pump differential pressure at rated flow of the pump.

Shut off pressure of the centrifugal pumps shall be rechecked when Vendor's characteristic curves of selected pumps are available. If it exceeds the estimated pump shut-off pressure, the design pressure of downstream equipment shall be revised accordingly.

5.1.2.2. Exchangers which are not subject to pump shut-off

If no control or block valve is installed downstream the heat exchanger, the design pressure shall be calculated as the design pressure of the downstream equipment at the inlet point plus 1.2 times the pressure drop of the circuit between the heat exchanger inlet and the inlet point of the downstream equipment plus static head (if any).

5.1.2.3. Process system similar to that of a reactor - recycle gas-loop

In this case, Licensor's design philosophy and/or the recommendations given in the API Recommended Practice 520 and API recommended Practice 521, last editions shall be followed "settle out pressure".

5.1.3. Design Temperature

a) Unless otherwise specified , equipment design temperature shall be established according to the following criteria :

Operating Temperature(OT)	Design Temperature (DT), Min./ Max.
- Less than – 100 ºC	- Min. oper. temp./ 85 ºC min.
- Between – 40 ºC and –100 ºC	- 100 ºC/85 ºC min.
- Between – 30 ºC and – 39 ºC	- 45 ºC/85 ºC min.
- Between – 29 ºC and +60 ºC	- Min. oper. temp. / 85 ºC
- Between + 60 ºC and 343 ºC	- Max . oper. temp. +25 ºC.
- Above 343 ºC	- To be specified according to the selected material and process requirement .

b) The design temperature is determined for the maximum temperature coincident with the design pressure as determined above. Indicate any higher temperatures as alternate design conditions.
c) When, due to the possible loss of flow of the cooling medium in coolers, the tubes, tubes sheets and floating heads may be subject to the full inlet temperature, it shall be

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indicated on the individual process data sheet and these components shall be designed for the maximum anticipated operating temperature of the hotter medium.

d) The design temperatures for multiple exchangers in series shall be selected in accordance with the maximum temperatures likely to occur on each exchanger in both clean and fouled condition. The design temperature indicated in the process data sheet is the temperature of the hottest exchanger.
Intermediate design temperatures shall be calculated assuming the highest heat transfer coefficient with fouled surface and the lowest heat transfer coefficient with fouled surface for the colder and hotter sections respectively.
The irregular heat profiles shall be indicated on the process data sheet.
All calculations shall be based on the information noted on the process data sheet for worse conditions.

e) For fixed tube sheet exchangers without expansion joints, the differential between the average shell metal temperature and the average metal temperature of any one tube pass shall not exceed 28 ºC. When temperature differentials exceed 28 ºC an expansion joint shall be furnished.
For two pass shell exchangers the differential between the inlet and the outlet temperature of the shell side fluid shall not exceed 194 ºC.

f) The overhead receivers and relevant pumps casing shall be designed for operating temperature plus 25 ºC or the overhead maximum operating temperature of upstream columns, whichever is greater.

g) Columns with fired feed heater with / without side cut strippers in the zone between the drawoff trays of two adjacent side cuts, the design temperature shall be the drawoff temperature of the heavier side cut plus 25 ºC. In the zone between the heaviest side cut drawoff tray and the bottom of the column, the design temperature shall be the flash zone temperature plus 25 ºC.

h) For the fractionators with reboiler, the design temperature shall be the reboiler return temperature plus 25 ºC.

5.1.4. Purging Equipment with Steam

For equipment subject to steam purging at start – up or shutdown indication shall be given on the specification sheet.

5.1.5. Cyclic Operating Conditions

For equipment subject to pressure and temperature swings, the magnitude and frequency of these swing will be given on the specification sheet.

5.2 CORROSION ALLOWANCE (for equipment and lines)

5.2.1. Carbon steel (including low Alloy <5% Cr. Steels)

Whichever is greater:
- Corrosion allowance calculated for 20 years of service for equipment and 10 years of service for piping.
- Corrosion allowance of 1.0 mm. for piping and 3.0 mm for equipment.

Note (1): For removable carbon steel parts of internals, a minimum of 1.5 mm of corrosion allowance on each side in contact with the operating fluid shall be given.

Note (2): The corrosion allowance to be considered for any equipment and line should not be greater than 6 mm. Should in specific cases, a corrosion allowance greater

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