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

NIOEC SP

NIOEC SPECIFICATION FOR PROCESS DESIGN OF HOT OIL & TEMPERED WATER CIRCUITS

SECOND EDITION

JUNE 2017

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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 on going 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-E-PR-410 May 2003 with the modifications as specified herein after shall be strictly followed.

Articles 1 and 2 of this document replace entirely the related articles in the referenced IPS Standard.

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 NIOEC Specification is intended to cover the minimum requirements and recommendations deem necessary to be considered in process design of "Hot Oil" and "Tempered Water" systems.

The scope is covered in two parts as:

Part I "Process Design of Hot Oil System"

Part II "Process Design of Tempered Water System"

Deviations from this Specification will only be permitted on obtaining written approval from NIOEC.

Resolution on cases not explicitly stipulated in this Specification, or on cases where conflicts may arise among the requirements of the referenced/relevant IPS and the international standards, shall be made through written consent and approval of NIOEC.

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 mutually agreed upon between NIOEC and the vendor/contractor

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

"ASME Code", Section VIII, Division 1

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-PR-410	"Engineering Standard for Process Design of Hot Oil & Tempered Water Circuits"
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NIOEC-SP (NIOEC SPECIFICATIONS)

NIOEC-SP-00-10	"NIOEC Specification for Units"
NIOEC-SP-00-50	"NIOEC Specification for Process & Mechanics Design Criteria"
NIOEC-SP-00-53	"NIOEC Specification for Layout & Spacing"
NIOEC-SP-44-01	"NIOEC Specification for Shell and Tube Heat Exchangers"

NIOEC-SP-44-02	"NIOEC Specification for Air Cooled Heat Exchangers"
NIOEC-SP-45-03	"NIOEC Specification for Fired Heaters"

2.1. Equivalent to IPS Standards

Substitute the following IPS Standards as referred to throughout IPS-E-PR-410 for the relevant NIOEC's Specifications as follows:

<u>IPS Standard</u>	<u>Relevant NIOEC Specification</u>
IPS-E-GN-100	NIOEC-SP-00-10
IPS-E-PR-190	NIOEC-SP-00-53
IPS-E-PR-440	NIOEC-SP-00-50
IPS-E-PR-771	NIOEC-SP-44-01
IPS-E-PR-785	NIOEC-SP-44-02
IPS-E-PR-810	NIOEC-SP-45-03
IPS-E-PR-850	NIOEC-SP-00-50

3. UNITS (Modification)

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

4. ADDENDUM TO IPS-E-PR-410

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

5. SYMBOLS AND ABBREVIATIONS (MODIFICATION)

DM WATER	=	DEMINERALIZED WATER
HO	=	HOT OIL

5.1. Definitions and Terminology (Modification)

Expansion vessel: A vessel to accommodate expanded volume and surge of the hot oil.

Heater: The heat energy producer in the system, either a furnace or a waste heat recovery unit (WHRU).

Hot oil: A mineral oil product stream used for heat transfer purposes.

Maximum allowable bulk temperature: The maximum bulk temperature of the HO allowed anywhere in the circuit, as specified by the manufacturer.

Maximum film temperature: The maximum temperature to which the HO may be subjected in the system. This highest temperature is on the tube inner wall of the heater skin and is determined by the heat flux and heat transfer coefficient.

Maximum operating temperature: The maximum HO bulk temperature at which the system is designed to operate and measured at the outlet of the heat source.

Minimum allowable bulk temperature: The minimum bulk temperature of the HO allowed anywhere in the circuit, as specified by the HO manufacturer.

Minimum operating temperature: The lowest HO bulk temperature at which the system is designed to start up. It should always be higher than the pumpability limit (fluid maximum viscosity is 150 cm²/s).

Return temperature: The temperature at which the HO returns to the heat source.

Tempered Water: the DM water as a cooling medium for solutions that would freeze or crystallize at usual cooling water temperatures is a common practice.

6.2.2. Disadvantages (Modification)

Low heat transfer properties

6.4.1. Heater Design (Modification)

6.4.1.12. Heaters shall be designed for uniform heat distribution. Multi pass heaters shall be designed for hydraulic symmetry of all passes.

6.4.1.13. The number of passes for vaporizing fluids shall be minimized. Each pass shall be single from inlet to outlet.

6.4.1.14. To provide sufficient operational flexibility and, in the case of organic fluids, allow for the slowest possible degree of fluid ageing, the location of maximum HO film temperature and peak heat flux should not coincide.

6.4.4. Heater Control and Instrumentation (Modification)

- e) Stack low temperature alarm
- h) Low/High draft alarm
- High combustible in stack alarm
- Loss of flame alarm
- Tube skin high temperature alarm

6.4.5. Hot Oil Surge Tank Design (Modification)

Purpose

The surge tank allows for thermal expansion of the HO and for venting low boiling components generated in the HO during its ageing process, and is used to minimize the consequences of upsets in the HO system operation. The designer shall take into account the following:

6.4.5.4. The surge tank shall be provided complete with the following: (Addition)

- h) DP gage and alarm

6.4.5.5. The need to accommodate the thermal expansion of the HO heated from minimum to maximum operating temperature;

6.4.5.6. The need to maintain the required Net Positive Suction Head (NPSH) for the HO circulating pumps under all operational scenarios;

- 6.4.5.7.** The need to reduce the risk of HO loss into the flare system. In the event of a tube rupture inside heat transfer equipment operating at process pressures above that of the HO circuit, sudden displacement of fluid from the system into the vessel can result in HO loss into the flare system.
- 6.4.5.8.** Possible presence of water in the circuit during start-up;
- 6.4.5.9.** The need for sufficient HO inventory to allow filling of equipment and during recommissioning after shut down for maintenance.
- 6.4.5.10.** The vessel and its piping should be designed for the full flow of the HO through the vessel.
- 6.4.5.11.** For operation at high temperatures, particularly approaching or exceeding the boiling point of the HO, a positive pressure of at least 1 bar to 2 bar above the vapor pressure of the HO (at this temperature) should be maintained.
- 6.4.5.12.** The nitrogen supply shall be equipped with a split-range controller and a non-return valve, which will regulate the nitrogen supply and its relief to flare.
- 6.4.5.13.** A dead pressure zone is required between nitrogen supply pressure and relief to flare set pressure. In this dead zone, the pressure is not controlled and is allowed to float freely while the nitrogen supply and relief-to-flare valves are both closed. This dead zone will reduce nitrogen consumption.
- 6.4.5.14.** At a certain controller output, the relief-to-flare valve should be prevented from starting to open while the nitrogen supply valve is not yet fully closed. (This could easily be the case due to small valve misalignments.)
- 6.4.5.15.** The non-return valve shall prevent HO and nitrogen back-flow into the nitrogen system in the event of pressure increase in the vessel.
- 6.4.5.16.** Low boiling degradation products shall be vented periodically. If regular venting of vapours is unavoidable, the vent line should be routed through a condenser to the collecting drum and flare, for further incineration or safe disposal.
- 6.4.5.17.** The vessel shall be equipped with a safety relief arrangement capable of protecting the system against over-pressure caused by fluid degradation, contamination, maloperation, overheating or tube failure in equipment.
- 6.4.5.18.** To allow for the pressure rise during steaming-out or purging the heater coils, relief valve(s) shall be sized to accommodate a flow of steam or purge nitrogen equivalent to a vapour velocity of 15 m/s in the heater coils. If necessary, the purge flow may be limited by installing a restriction orifice in the common supply line.
- 6.4.5.19.** If the ambient temperature can fall below the fluid's or its degradation products' freezing points, or if accumulated high boilers can plug the lines, nitrogen, vent-back-pressure and safety relief lines and valves shall be heat traced in order to prevent plugging.
- 6.4.5.20.** If the ambient temperature can fall below the HO's pumpability limit, heating the expansion vessel should be considered. In order to eliminate the risk of HO contamination in the event of coil rupture, either electrical heating or external heat tracing should be applied.
- 6.4.5.21.** Heating with steam or hot water should be avoided in order to minimize HO contamination.

NOTE: The possibility to evacuate the total HO inventory would eliminate the need for a special heating device for the vessel.

- 6.4.5.22.** The expansion vessel shall be insulated.

6.4.9. Storage Tank (Addition)

HO storage tank shall have sufficient capacity to hold the full inventory of the system, plus an additional 10% volume to accommodate make-up of losses caused by venting and mechanical leaks.

The minimum fluid level in the tank shall be set to ensure sufficient NPSH for the make-up pump. If the ambient temperature can fall below the HO minimum pump ability temperature, the tank should be heated, preferably electrically, and the suction line to the pump should be heat-traced and insulated. The storage tank shall be equipped with a dry nitrogen blanket to serve as a barrier between the fluid and the atmosphere to limit degradation and moisture ingress. Sudden drainage of the hot HO to the storage tank (in case of emergency evacuation of a part of or the whole fluid inventory) could result in excessive vapour release inside the tank.

That shall be avoided either by installing a drop volume cooler (expensive option) or by feeding the hot HO to the tank through a perforated pipe submerged in the cold fluid. The latter option shall be designed so that there is thorough mixing of the hot fluid, giving rise to rapid cooling and elimination of, or sufficient reduction in, vapour production. For the latter option, this amount of cold HO shall be added to the minimum tank capacity as defined above.

6.4.10. Piping (Addition)

6.4.10.1. Piping design and installation must include consideration to minimize vapor traps and to relieve expansion and contraction stresses.

6.4.10.2. The number of flanges in a hot oil system should be minimized. To minimize the possibility of leakage, the connections shall be welded as far as possible.

6.4.10.3. For systems with heaters arranged in parallel, sampling facilities shall be provided to allow evaluation of hot oil degradation in the parallel loops.

6.4.11. Heat Exchangers (Consumers) (Addition)

6.4.11.1. If designed and operated properly, HO systems can be considered to be non-fouling, so U-tube type heat exchangers may be applied if the HO flows inside the tubes. This is cheaper than floating head type heat exchangers and significantly reduces the risk of leakage and, consequently, contamination of the HO or process fluid.

6.4.11.2. To ensure proper design of the heat exchangers, the requisition sheet shall clearly mention the type of HO to be used, or its trade name. For the design specification of HO systems a fouling resistance of 0.00017 m²/kW shall be used.

6.4.11.3. If leakage of the HO into the process side (liquid or gas) could lead to hazardous situations, the equipment design pressure shall be at least twice the highest working pressure of the HO system. Flanged connections shall be avoided where possible.

6.4.11.4. All heat exchangers should be equipped with drains and vents to allow the HO to be drained into a collection system from where it can be pumped back to the storage tank (e.g. to allow maintenance of the system). To speed up the evacuation, a nitrogen purge point may be considered.