

NIOEC-SP-70-10(3)							
DOCUMENT CODE						NO. OF PAGES: 9	
PLAN/PRJ/SUB	UNIT	PHASE	DISCIPLINE	DOCUMENT TYPE	SERIAL NO.	REV. NO.	DATE
NIOEC	000	EG	IN	SP	7010	A3	MARCH 2017



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

NIOEC SP

NIOEC SPECIFICATION FOR TANK GAUGING EQUIPMENT

SECOND EDITION

DECEMBER 2009

THIS STANDARD IS THE PROPERTY OF NATIONAL IRANIAN OIL ENGINEERING & CONSTRUCTION COMPANY. IT IS CONFIDENTIAL AND ALL RIGHTS RESERVED TO THE OWNER. NEITHER WHOLE NOR ANY PART OF THIS DOCUMENT MAY BE DISCLOSED TO ANY THIRD PARTY, REPRODUCED, STORED IN ANY RETRIEVAL SYSTEM OR TRANSMITTED IN ANY FORM OR BY ANY MEANS WITHOUT THE PRIOR WRITTEN CONSENT OF THE NATIONAL IRANIAN OIL ENGINEERING & CONSTRUCTION COMPANY.

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.

REVISION INDEX

REV. PAGE	1	2	3	4	5	REV. PAGE	1	2	3	4	5	REV. PAGE	1	2	3	4	5	REV. PAGE	1	2	3	4	5
1						26						51						76					
2	X	X	X			27						52						77					
3	X	X	X			28						53						78					
4	X	X	X			29						54						79					
5	X	X	X			30						55						80					
6	X	X	X			31						56						81					
7	X	X	X			32						57						82					
8			X			33						58						83					
9	X	X	X			34						59						84					
10						35						60						85					
11						36						61						86					
12						37						62						87					
13						38						63						88					
14						39						64						89					
15						40						65						90					
16						41						66						91					
17						42						67						92					
18						43						68						93					
19						44						69						94					
20						45						70						95					
21						46						71						96					
22						47						72						97					
23						48						73						98					
24						49						74						99					
25						50						75						100					

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.

6					
5					
4					
3	MARCH,2017	F.FAZLI	G.R. MOHSENI	M.R. FARZAM	M. KARGARNAJAFI
2	DECEMBER,2009	INST. DISC.	KHATIB	FARZAM	SAJEDI
1	APRIL, 2007	ORDOOBADI	ORDOOBADI	FARZAM	SAJEDI
REV.	DATE	PREPARED	CHECKED	APPROVED	AUTHORIZED

CONTENTS:	PAGE NO.
INTRODUCTION.....	2
1. SCOPE	2
2. REFERENCES.....	2
3. UNITS	3
4. ADDENDUM TO IPS-G-IN-300	4

INTRODUCTION

To satisfy the requirements of this NIOEC specification, Iranian Petroleum Standard IPS-G-IN-300(2) (2014), with the modifications as specified hereinafter shall be strictly followed.

Articles 1 through 3 of this document replace entirely the related articles in the referenced IPS Standard.

1. SCOPE

This specification defines NIOEC'S minimum requirements for tank gauging equipment used in various types of tanks and containers.

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 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.

API (AMERICAN PETROLEUM INSTITUTE)

API STD 2555	"Methods for Liquid Calibration of Tanks"
API MPMS CH. 1	"Manual of Petroleum Measurement Standards Chapter 1- Vocabulary"
API MPMS CH. 3.1A	"Manual of Petroleum Measurement Standards Chapter 3- Tank Gauging: Section 1A: Standard Practice for the Manual Gauging of Petroleum and Petroleum Products"
API MPMS CH. 3.1B	"Manual of Petroleum Measurement Standards Chapter 3-Tank Gauging: Section 1B: Standard Practice for Level Measurement of Liquid Hydrocarbons in Stationary Tanks by Automatic Tank Gauging"
API MPMS CH. 3.2	"Manual of Petroleum Measurement Standards Chapter 3- Tank Gauging: Section 2: Standard Practice for Gauging Petroleum and Petroleum Products in Tank Cars"
API MPMS CH. 3.3	"Manual of Petroleum Measurement Standards Chapter 3- Tank Gauging: Section 3: Standard Practice for Level Measurement of Liquid Hydrocarbons in Stationary Pressurized Storage Tanks by Automatic Tank Gauging"
API MPMS CH. 3.4	"Manual of Petroleum Measurement Standards Chapter 3- Tank Gauging: Section 4: Standard Practice for Level Measurement of Liquid Hydrocarbons on Marine Vessels by Automatic Tank Gauging"

API MPMS CH. 3.6	"Manual of Petroleum Measurement Standards Chapter 3- Tank Gauging: Section 6: Measurement of Liquid Hydrocarbons by Hybrid Tank Measuring Systems"
API MPMS CH. 7	"Manual of Petroleum Measurement Standards Chapter 7- Temperature Determination"

IPS (IRANIAN PETROLEUM STANDARD)

IP-G-IN-300(2) (2014)	"Tank Gauging for Petroleum and Petroleum Products"
-----------------------	---

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

ISO 4266	"Petroleum and Liquid Petroleum Products- Measurement of Level and Temperature in Storage Tanks by Automatic Methods"
ISO 4269	"Petroleum and Liquid Petroleum Products- Tank Calibration by Liquid Measurement- Incremental Method Using Volumetric Meters"

NEMA (NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION)

NEMA 250	"Enclosures for Electrical Equipment (1000 Volts Maximum)"
----------	--

NIOEC-SIP (NIOEC SHOP INSPECTION PROCEDURE)

NIOEC-SIP-70-01	"Shop Inspection Procedure for Instruments"
-----------------	---

NIOEC SP (NIOEC SPECIFICATIONS)

NIOEC-SP-70-01	"NIOEC Specification for Instrumentation"
NIOEC-SP-00-10	"NIOEC Specification for Units"
NIOEC-SP-40-03	"NIOEC Specification for Spare Parts Requirement"

OIML (INTERNATIONAL ORGANIZATION OF LEGAL METROLOGY)

OIML R85	"Automatic Level Gauges for Measuring the Level of Liquid in Stationary Storage Tanks"
----------	--

3. UNITS

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

4. ADDENDUM TO IPS-G-IN-300

6.2.3 (SUBSTITUTION)

6.2.3.1 General

This section defines the requirements for Radar Tank Gauging (RTG) Instruments and Systems conforming to custody transfer and inventory accuracy. The section covers all hardware, software, software configuration, calibration and communication with host computer systems, as required, together with the auxiliary temperature, pressure and water bottom instrumentation associated with RTG systems.

6.2.3.2 System Requirements

The radar based tank gauging system shall consist of a total system solution; i.e., from tank mounted units to Operator Interface and external data communication.

The system shall be able to measure tank levels, temperature, pressure and water levels. Based on the measured values the system shall provide Inventory calculations (volumes, density and mass). The system shall be able to perform alarm and error handling for all system components.

The system shall provide for certain levels of redundancy. Critical system (devices) as the field data concentrators shall have the ability to operate in hot stand-by redundancy mode. The switching to redundant stand-by units shall be automatic.

All configurable devices shall have an optional hardware based write protection which can be sealed.

Radar tank gauging equipment shall be individually tested for accuracy over a distance from 1 to 20 meters. The test shall be performed in a test range approved by an international accredited institute.

6.2.3.3 Environmental Conditions

Unless otherwise stated by job specification, all tank and field-mounted equipment shall be designed for continuous operation in ambient temperature of -40°C to 80°C and relative humidity of 100%, condensing. For hot climates self-ventilating sun radiation protection shall be provided.

The control room equipment such as operator workstations and associated peripheral equipment shall be installed indoors, which shall be designed for operations at ambient temperature $23^{\circ}\text{C} \pm 3^{\circ}\text{C}$ and a relative humidity between 30% RH to 65% RH, non-condensing. For shipping and storage conditions, the temperature and humidity shall be considered as -20°C to 65°C and 0% RH to 100% RH.

Surge Protection: The field equipment shall be designed with galvanic isolation on communication and power connections. Transient suppression components shall include gas-discharge tubes and varistors. The radar equipment shall not generate microwave power levels hazardous to humans during normal operation, bench testing or field service. International health requirements stipulate that the radiated power shall be less than 2 mW EIRP (Equivalent Isotropic Radiation Power).

6.2.3.4 General Radar Tank Gauge Design

Radar equipment shall use Frequency Modulated Continuous Wave (FMCW). Radar technology which measures level based on elapsed time between send/receive of a fixed frequency signal (pulse or time domain) shall not be used for high performance tank gauging. Incremental phase evaluation shall not be used since it can lead to large level gauging errors.

To avoid excessive temperature cycling the internal electronics in the level gauge shall be temperature stabilized.

The radar gauge shall have a digital reference to ensure accuracy and stability. Analogue delay lines suffer from temperature and aging effects and shall not be used.

The vendor shall provide calculations proving MTBF figures based on installed units in field service.

For high performance measurement the drift of measured level value shall be less than one (1) mm for the entire temperature range.

The system sub parts (antennas, electronics, housing etc.) shall be designed such that they can freely be interchanged without EEPROM change etc.

The radar gauge itself shall calculate the level rate value. The filtering of the level rate value shall be adjustable. The level rate value shall be available on the field bus as a standard parameter in the communication protocol. Host calculated level rate shall not be used since timing errors makes level rate unreliable.

The gauge shall operate in a stand-alone mode (single gauge installation) or in a network with an operator interface workstation in the control room. Level update time shall not exceed one (1) second in the field data concentrator.

The gauges shall communicate with the workstation via a vendor supplied field bus and also be able to be upgraded to fit common types of international standardized field busses. The radar tank gauging shall have the ability to connect direct to other types of tank gauging systems using built in communication adapters and protocol drivers.

The standard field bus communication shall have a baud rate of at least 4800 Baud.

The radar gauge shall have optional inputs for temperature, pressure, water bottom sensors and similar. To provide highest accuracy in hybrid systems the pressure inputs shall be able to receive digital as well as analogue signals.

The radar gauge shall have optional relay outputs, which are controlled by customer-selected variables like level and temperature. The relays can be used for control of pumps, valves etc. or indication of alarms. If the relays are used for High-High alarm the function shall be approved by authorizes notified body such as TÜV, etc for overfill protection.

The gauge shall optionally be provided with remote mounted, local, digital level and temperature indicators. The readout devices shall be user configurable in Metric units. The display digits shall have a height of at least 11 mm.

Local level indicator integral to the field control unit shall display exactly the same level as indicated in the control room operator console.

Level alarms shall be configurable from the software residing in the operator interface unit in the control room.

Wave integration time, i.e. time to inhibit the Radar response to transient level fluctuations, shall be adjustable in each gauge between 1 to 100 seconds.

The radar tank gauging shall be powered 230 Volt, 50Hertz.

6.2.3.5 Installation on Fixed Roof Tanks

If the radar tank gauging shall be installed on an existing tank opening then the radar beam shall be such that interfering echoes are avoided. The antenna design shall be such that minimum influence from the tank wall is provided. Both inclination and orientation of the antenna shall be adjustable.

The antenna design shall be made with sloping surfaces to ensure condensation drip-off. Therefore a horizontal, flat antenna surfaces in fixed roof tanks shall be avoided. (See API MPMS CH. 3.1B)

The material in the antenna shall be proven to be compatible for the chemical composition of the tank products.

The antenna design shall be rugged to withstand tank atmosphere.

6.2.3.6 Installation on Still-Pipes

The RTG shall be selected according to manufacture recommendation and relevant standard.

The antenna for still pipe gauges shall operate in the Low Loss-circular-symmetric transmission mode to prevent loss of accuracy due to slots, holes, rust and deposits.

The vendor shall identify any potential radar tank gauging accuracy or reliability affects associated with still pipe slot area, rust or hydrocarbon deposits, and still pipe inconsistencies or lack of straightness.

The radar tank gauging shall allow access to the still pipe for manual gauging, temperature dipping and sampling. The access to the still pipe shall be made such that no special tools or extra spool piece under the gauge are needed. During this procedure it shall not be necessary to power down the radar tank gauging.

6.2.3.7 Pressurized Storage Tank Gauges

For high accuracy applications, an optional pressure transducer for vapor space pressure measurement shall be incorporated into the RTG. The pressure input shall be used for automatic compensation of the level indication due to changes in vapor density.

The vendor shall provide at least one reference pin for the still pipe to permit on-line field verification of the liquid level. Multiple reference pins shall be provided as an option. The reference pin(s) shall be made visible to the radar tank gauging only during the verification procedure to avoid unwanted influence of the level reading.

The vendor shall provide an optional isolation valve at the gauge head to provide increased safety.

6.2.3.8 Temperature System

Spot and averaging temperature elements shall be of Pt100 type (RTD). The RTD system measurement accuracy shall be $\pm 0.5^{\circ}\text{C}$ or better. The field electronics shall be capable of automatically determining a true average from the submerged RTDs. In case of non-cylindrical tanks, weighting factors shall be possible to use for correct average product temperature calculations.

Averaging temperature elements shall include a specified number of RTD elements of graduated lengths housed in a common flexible metal thermo-well. The distance between the individual elements shall not exceed 3 meter.

The spot or multipoint temperature RTDs shall be wired directly into the radar tank gauging or to the Data Acquisition Unit and the temperature values shall be transmitted to the remote workstation/Field Data Concentrator via the common communications bus.

6.2.3.9 Performance Criteria

The intrinsic or bench tested accuracy of the level gauge shall be equal to or better than $\pm 3\text{ mm}$ over the entire measuring range of the radar tank gauging for inventory applications.

The vendor shall on request provide accuracy certification documentation for each individual gauge. The test procedure shall be traceable to national standards.

The radar tank gauging shall deliver stated instrument accuracy from the initial adjustment on the tank. The instrument must not need emptying or filling operations for calibration. Automatic correction or "self learning" must not be utilized.

The radar tank gauging must operate under the same instrument accuracy under both static and dynamic process conditions i.e. moving or steady levels.

6.2.3.10 Human Machine Interface (HMI)

The HMI shall consist of a PC based, user configurable graphical interface. It shall perform calculations, system management, alarm handling, configuration and data storage. Personal computer shall conform to the current technology and shall be equipped with appropriate parts required for the process control system. Optional network adapter may be required.

The Operator interface graphics shall be designed for normal plant operation information and the relevant HMI shall provide the following general categories of standard functions as a minimum:

- All standard windows shall be able to customize on demand.
- The HMI shall have the ability to accommodate local languages.
- The HMI software shall have the ability to interface to all common DCS, PLC, SCADA systems or similar. The interfaces shall either be serial links or OPC-database format.
- The HMI software shall be able to act as a master for other type tank gauging systems.
- An alarm log shall be provided which displays all current acknowledged and cleared alarms. An alarm inhibit function shall be provided by which a single or group of associated alarms could be de-activated. The ability to inhibit any alarm shall be multi level password protected.
- A group configuration function shall be provided which permits the plant operator(s) to define the groupings of tanks for display on the group view screen and the group Inventory screen. A similar function shall be available for alarms.
- A value entry function shall be provided which permits the plant operator(s) to manually enter process values and operating parameters for each tank. It shall be possible to configure tanks in the system which not is equipped with radar tank gauging.
- An engineering function interface shall be provided for system configuration and set-up. All configuration changes shall be password protected.

6.2.3.11 Tank Inventory Management

The HMI shall be able to calculate tank inventory values according to API. All values in the calculation process shall be displayed.

The system shall have an input for ambient air temperature. The system shall be able to use this temperature value combined with the product temperature, for compensation of thermal tank shell expansion.

The system shall be capable of storing unique volume tables and correction factors, with at least 1000 strapping points for each storage tank. These tables will provide level to volume conversion of the tank.

Leakage Alarm: The system shall generate leak alarms based on the change in level or the Net Standard Volume of the products in the storage tanks.

Rate of Change Computations (Flow): The system shall provide a calculated volume rate of change based on the true level rate from the radar tank gauging and the tank capacity table.

Alarming Capabilities: The system shall generate multiple High, Low, and Safe alarms for level, temperature, pressure and water bottom level. Configurable time delays shall be provided for each process variable to minimize nuisance alarms.

Batch handling: The system shall provide importing and exporting flow indications based on volume movements in the tank. Indications of “estimated end time of batch” shall be provided based on user set points. The Batch Handling shall be able to handle multiple destinations and sources. The Batch function shall generate printable batch reports.

Report functions: The system shall be able to generate reports in different formats. All reports shall be publishable on printers, via e-mail or as a file. All reports shall be generated manually or automatic by user defined schedules. Minimum required reports are:

- Tank reports
- Inventory balance reports
- Alarm reports

6.2.3.12 System Diagnostics

The system diagnostics shall be capable of performing self-checks on each tank gauge and data collection or control units. As a minimum, the following features shall be included:

All field inputs, including level, temperature, pressure and water bottom signals shall be monitored for faults. All faults shall be annunciated and logged. The error indications shall be categorized such as communication failure, gauge failure or software failure.

All diagnostic information shall be displayed, alarmed, stored in historical files and included in reports. This diagnostic information shall include details of all types of failures, system status and configuration modifications. All diagnostic alarms shall be presented locally or distributed via e-mail.

6.2.3.13 System Security

It shall be possible to metrologically seal the HMI to prevent unauthorized tampering of the system. The method of sealing shall be approved by the NMI (the Netherlands) and the PTB (Germany).

The HMI and resident application software shall have a minimum of four levels of password protection. The security level of certain function shall be changeable. All functions shall have a pre-set security password level.

It shall be possible to set up individual user accounts with unique passwords and security levels for each operator. This shall enable tracking of system changes recorded in a log-file. The system administrator with the highest level of authority and password handles the assigning of user accounts.

6.2.3.14 System and Data Recovery

The tank gauging software shall be capable of data backup of all system configuration and process parameters. The system shall also be capable of retrieving all configuration parameters once a system failure has cleared.

8. TESTING, CALIBRATION AND INSPECTION (ADDITION)

- a) As a minimum, all instruments and instrument systems shall be tested in accordance with the Manufacturer's standard and, if applicable, as demanded by local authorities and standards. If shop inspection is specified the inspector representing NIOEC shall have right of entry to the plants

including sub-vendor's plants where work on or testing of the equipment and instruments are being performed. All tests and inspections shall be performed in accordance with the relevant NIOEC inspection and test procedures including Shop Inspection Procedure (NIOEC-SIP-70-01).

- b) The vendor shall perform all necessary operational tests (defined by the instrument characteristics) on completed systems so as to assure performance with the requirements of this specification.
- c) Certified test reports shall be provided for each instrument.
- d) If shop inspection is specified the inspector representing NIOEC shall have right of entry to the plants including sub-vendor's plants where work on or testing of the equipment and instruments are being performed.

9. SPARE PARTS (ADDITION)

9.1 Construction, Pre-commissioning and Commissioning Spare Parts

Vendor shall recommend the spares for construction, pre-commissioning, commissioning and construction allowance, which will be purchased together with the equipment, and include the cost of spares in the quotation.

9.2 Spare Parts for Two Years of Operation

Vendor shall recommend the spares required for 2 years of operation and provide a price list. NIOEC-SP-40-03 shall be followed.

Client may purchase the spares listed in vendor's recommended spare part list after review. Validity of spare parts proposal shall be 12 months.

10. GUARANTEES AND WARRANTIES (ADDITION)

Vendors shall guarantee that he is able to support and supply spare parts for the supplied hardware, software and firmware for at least 10 years from the date of shipment.

If the vendor believes that parts of the system will be withdrawn from sale after 10 years, he shall provide a statement detailing the equipment to be withdrawn, the timing and how updated parts can replace the withdrawn parts.

The vendor shall also guarantee that the equipment supplied is free from fault in design, workmanship and material, and is of adequate design and proper material to fulfill satisfactorily the specified operating conditions.

Should any failure or defect in design, material, workmanship or operating characteristics develop under the start-up and commissioning periods or during the first 12 months of operation, but not later than 24 months from the date of shipment, the vendor shall make all required repairs, alterations or replacements of the defective equipment, free of charge, and shall pay transportation fees involved to and from NIOEC's site.