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

NIOEC SP

NIOEC SPECIFICATION
FOR
INSTRUMENTATION

FIRST EDITION

DECEMBER, 2006

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 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 and Construction Director of NIOEC for evaluation and consideration.

S. R. KASAEIZADEH


EXECUTIVE DIRECTOR

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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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1. SCOPE

1.1 This specification defines NIOEC's general requirements for the design of field instrumentation, control and safeguarding systems.

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

1.2 Specific specifications for major instrumentation equipment, instrument installation, material and P&ID abbreviations, legends and symbols are covered in the following NIOEC specifications:

<u>NIOEC-SP-70-02</u>	NIOEC SPECIFICATION FOR INSTRUMENT INSTALLATION
<u>NIOEC-SP-70-03</u>	NIOEC SPECIFICATION FOR INSTRUMENT INSTALLATION MATERIAL
<u>NIOEC-SP-70-04</u>	NIOEC SPECIFICATION FOR ELECTRIC MOTOR OPERATED VALVES
<u>NIOEC-SP-70-05</u>	NIOEC SPECIFICATION FOR INSTRUMENTATION CONTROL CABLES, CABLE TRAYS, CONDUITS, JUNCTION BOXES AND CABLE GLANDS
<u>NIOEC-SP-70-06</u>	NIOEC SPECIFICATION FOR BIDIRECTIONAL METER PROVERS
<u>NIOEC-SP-70-07</u>	NIOEC SPECIFICATION FOR INSTRUMENTATION & CONTROL SYSTEM CALIBRATION, INSPECTION AND TESTS
<u>NIOEC-SP-70-08</u>	NIOEC SPECIFICATION FOR PROCESS CONTROL SYSTEM (PCS)
<u>NIOEC-SP-70-09</u>	NIOEC SPECIFICATION FOR SAFEGUARDING SYSTEMS
<u>NIOEC-SP-70-10</u>	NIOEC SPECIFICATION FOR TANK GAUGING EQUIPMENT
<u>NIOEC-SP-70-11</u>	NIOEC SPECIFICATION FOR INSTRUMENTS OF FIRE-FIGHTING AND DETECTION EQUIPMENT
<u>NIOEC-SP-70-12</u>	NIOEC SPECIFICATION FOR VOLUMETRIC LIQUID MEASUREMENT METHODS
<u>NIOEC-SP-70-13</u>	NIOEC SPECIFICATION FOR ELECTRICAL POWER SUPPLY AND DISTRIBUTION SYSTEMS
<u>NIOEC-SP-70-14</u>	NIOEC SPECIFICATION FOR CONTROL PANELS AND SYSTEM CABINETS
<u>NIOEC-SP-70-15</u>	NIOEC SPECIFICATION FOR CONTROL CENTRES
<u>NIOEC-SP-70-16</u>	NIOEC SPECIFICATION FOR GENERAL INSTRUMENTATION FACTORY INSPECTION AND TESTING OF INSTRUMENTS AND INSTRUMENT SYSTEMS
<u>NIOEC-SP-70-17</u>	NIOEC SPECIFICATION FOR INSTRUMENT PROTECTION
<u>NIOEC-SP-70-18</u>	NIOEC SPECIFICATION FOR PIPELINE INSTRUMENTATION
<u>NIOEC-SP-70-19</u>	NIOEC SPECIFICATION FOR MISCELLANEOUS INSTRUMENTS
<u>NIOEC-SP-70-20</u>	NIOEC SPECIFICATION FOR PIPELINE AUTOMATIC LEAK DETECTION SYSTEM

NIOEC-SP-70-21 NIOEC SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLERS

[NIOEC-SD-0100-1 to 4](#) "Standard Drawing for P&ID Symbols and Legends",

[NIOEC-SD-0101-1/1](#) "Standard Drawing for P&ID Abbreviations"

2. REFERENCES

Throughout this specification the following dated and undated standards and codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this specification.

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 the dated references that occur after the cited date shall be mutually agreed upon by NIOEC and the vendor /contractor.

ANSI	(AMERICAN NATIONAL STANDARDS INSTITUTE)	
	FCI 70-2	"Control Valve seat Leakage"
API	(AMERICAN PETROLEUM INSTITUTE)	
	MC 96.1	"Special Limits Of Error For Thermocouples"
	MPMS Chapter 5.2	"Measurement of Liquid Hydrocarbons by Displacement Meters"
	MPMS-Chapter 5.3	"Measurement of Liquid Hydrocarbons by Turbine Meters"
	MPMS-Chapter 5.6	"Measurement of Liquid Hydrocarbons by Coriolis Meters"
	MPMS-Chapter 5.8	"Measurement of Liquid Hydrocarbons by Ultrasonic Flow Meters Using Transit Time Technology"
	RP-500	"Recommended Practices for Classification of Locations for Electrical Installations at Petroleum Facilities"
	RP-551	"Process Measurement Instrumentation"
	RP-553	"Refinery Control Valves"
	RP-555	"Process Analysers"
NIOEC SP	(NIOEC SPECIFICATIONS)	
	<u>NIOEC-SP-00-10</u>	"Specification for Units".
	<u>NIOEC-SP-00-55</u>	"Specification for Piping & Instrumentation Diagrams (P & IDs)",
	<u>NIOEC-SP-00-75</u>	"Specification for Pressure and Vacuum Relief Devices",

	NIOEC-SP-50-08	"Specification for Winterizing & Heat Conservation"
	NIOEC-SP-50-54	"Specification for Pig Lurching & Receiving Trap",
	NIOEC-SP-90-52	"Specification for Packing and Packages".
	NIOEC-SP-90-02	"Specification for Welding Shop and/or Field Fabricated Piping"
ASME	(AMERICAN SOCIETY OF MECHANICAL ENGINEERS)	
	B1.20.1	"Pipe Threads , General Purpose"
	B 16.5	"Pipe Flanges and Flange Fittings"
	B 16.34	"Valves Flanged, Threads and Welding End"
	B16.36	"Orifice Flanges"
IEC	(INTERNATIONAL ELECTRO-TECHNICAL COMMISSION)	
	60529	"Classification Of Degree Of Protection Provided By Enclosures"
ISA	(INSTRUMENTATION, SYSTEM, AUTOMATION SOCIETY OF AMERICA)	
	S 75.01	"Flow Equations For Control Valve Sizing"
	S 75.02	"Control Valve Capacity Test Procedure"
	S 75.05	"Control Valve Terminology"
	S 75.11	"Inherent Flow Characteristics And Rangeability Of Control Valves"
	S 75.17	"Control Valve Aerodynamic Noise Prediction"
	S 75.19	"Hydrostatic Testing Of Control Valves"
		"Comprehensive Survey and Guide to Flow meters Selection"
ISO	(INTERNATIONAL STANDARD ORGANISATION)	
	5167-1	"Measurement Of Fluid Flow By Means Of Pressure Differential Devices, Orifice Plates, Nozzles And Venturi Tubes Inserted In Circular Cross Section Conduits Running Full"
	TR 15377	"Measurement Of Fluid Flow By Means Of Pressure Differential Devices, Orifice Plates, Nozzles And Venturi Tubes Inserted In Circular Cross Section Conduits Running Full"
NAMUR	(NORMEN ARBEITSGEMEINSCHAFT FÜR MEß UND REGELTECHNIK IN DER CHEMISCHEN INDUSTRIE)	
	NE-43	"Recommendation For Breakdown Information Of Digital Transmitter"
NEC	(NATIONAL ELECTRICAL CODE)	
NEMA	(NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION)	
NFPA	(NATIONAL FIRE PROTECTION ASSOCIATION)	
TÜV	(TECHNISCHER UBERWACHUNGS VERIEN)	

NACE	(NATIONAL ASSOCIATION OF CORROSION ENGINEERS)	
	MR-01-03	"Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments."
	MR-01-75	"Sulfide Stress Cracking Resistant Metallic Materials for Oil Field Equipment"

3. UNITS

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

4. ABBREVIATIONS

Throughout this document the following abbreviations and acronyms are used:

ESD: Emergency Shutdown System.
PCS: Process Control System.
PES: Programmable Electronic System.
PLC: Programmable Logic Controller.
SGS: Safeguarding System.
SIL: Safety Integrity Level.

5. DESIGN BASIS

5.1 General

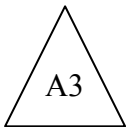
- Design of the instrumentation shall be such that adequate control and safety aspects of the plant during all phases of operation are guaranteed.
- The instrumentation shall be designed for fail safe operation of the plant, as determined by NIOEC.
- All safety and relief valves, control valves and flow meters shall be adequately sized in order to enable the instruments to cope with both normal operation conditions and the conditions existing during start-up, shut-down or permissible over capacity operation. The required over capacity shall be stated on the individual data sheet.
- Furnaces and boilers shall be provided with approved flame management systems, when specified by NIOEC.
- Instrumentation for major package units shall be of the same type and manufacture as for the main process unit, except when this is not practical; in such case written approval of NIOEC shall be required.
- The instrumentation for minor packages such as sampling systems, air dryers, etc. should be of manufacturer's standard design and type.

5.2 Instrument Accessibility

Instrument process connections shall be designed to be located for maximum convenience for operating and servicing of the instruments. Accessibility of the instruments shall be in accordance with the requirements of [NIOEC-SP-70-02](#).

5.3 Instrument Air Supply

- a) All tubing for field-mounted pneumatic equipment shall be plastic coated copper tube with wall thickness of at least 0.065 inch. Fittings shall be brass. The instrument air loop header shall be galvanized carbon steel pipe up to 1.5 inch and plain carbon steel for 2 inches and above.
- b) All field mounted pneumatic instruments shall be provided with individual valves for shutting off the air supply and each instrument shall have an individual air filter/regulator and gage.
- c) The main instrument air supply shall be furnished independent of the plant air supply without interruption from other general air user requirements.
- d) Instrument air quality shall be in accordance with the ISA-7.0.01-1996 "Quality Standard for Instrument Air". Dew point shall be at least 10°C below the Minimum Ambient Temperature. Instrument air shall be dry and oil and dust free.



5.4 Electrical Power Supply

The plant PCS, SGS, F&G System and Packaged units instrumentation shall be fed with at least one electrical power feeder from the UPS. The UPS, which shall be dual redundant, shall be sufficiently sized to provide 230 VAC, 50 Hz power to all connected systems for at least 30 minutes.

All field instruments shall be supplied by the internal power supplies of the PCS, SGS, and F&G Systems.

For details reference shall be made to [NIOEC-SP-70-13](#).

5.5 Instrument Protection

Instruments shall be protected to ensure proper and dependable operation under all operational and climatic conditions.

Instruments in the following conditions require special provisions:

- i) Instruments handling fluids which solidify (or have high viscosity) at 20°C. Such fluids shall not be allowed to enter the instrument, because shop repair would be impractical.
- ii) Instruments handling fluids which solidify at the lowest ambient temperature (including water at sub-zero temperatures). Such fluids shall not be allowed to enter the instruments or pressure piping to prevent malfunctioning and/or damage.

Where the above provisions are not practical, heating of impulse lines, instrument valves and instrument wetted parts shall be adopted and due care shall be taken such that the instrument is not overheated.

- iii) Instruments in gas measurement services, where hydrate formation may occur at low temperatures, and instruments handling fluids containing solids (including coke particles). Diaphragm seals shall be utilized to protect the instruments.

In addition, for the fluids containing solids the process connection shall be made large enough to prevent plugging.

Diaphragm seals shall be shown on the P&IDs.

For detailed requirements of instrument protection, including heat tracing reference shall be made to [NIOEC-SP-70-2](#) and [NIOEC-SP-70-17](#).

5.6 Environmental Protection

All field equipment shall be suitable for the ambient temperature as specified in the project documents and the material and construction shall be resistant to saliferous dust, insect attacks, and moisture and fungus growth.

Outdoor equipment (instruments, panels and enclosures) shall be watertight to IEC 60529, IP 65 as a minimum. Large size outdoor local panels, for which IP 65 may not be applicable, shall be pressurized.

5.7 Hazardous Area Classification

- a) All electrical instrumentation, panels, junction boxes and enclosures, which will be installed in hazardous areas, shall generally be of intrinsically safe type suitable for the hazardous area classification. For equipment that intrinsically safe type is not available or the working supply voltage precludes the use of intrinsically safe circuits, explosion proof or pressurised type may be specified.
- b) Hazardous area classification shall be as per API- 500.

5.8 Data Sheets

Unless otherwise specified, ISA instrument data sheets will be used for all instrumentation.

5.9 Instruments Symbols and Legends

Reference shall be made to the following documents:

- NIOEC-SD-00-0100-1 to 4 "Standard Drawing for P&ID Symbols and Legends",
- NIOEC-SD-00-0101-1/1 "Standard Drawing for P&ID Abbreviations".

6. FIELD INSTRUMENTATION

6.1 General

6.1.1 Transmitters

- a) Transmitters shall be smart type, commensurate with the type of the PCS, i.e., 4-20 ma type, Foundation Fieldbus or Profibus compatible type. Integral digital indicators shall be supplied for each transmitter.
- b) All transmitters (pressure, flow, temperature etc.) shall be provided with burnout protection.
- c) Alarm (burnout) and saturation current limits shall be NAMUR-NE-43 compliant as follows:
 - i) If the process variable applied to the transmitters falls outside of the lower or upper range settings, the output signal shall saturate at the following values:
 - ii) Under range; 5% of transmitter lower range
 - iii) Over range: 2.5 % of transmitter upper range
 - iv) The integral indicator shall flash to signify the "out of range" reading.
 - v) In case of transmitter failure, the output shall be driven to less than 10 % of lower range or greater than 5% of upper range (user configurable), with the integral indicator displaying "Alarm" to indicate the failure status.
- d) Selection of transmitters shall be subject to their performance characteristics including the low figure of long term full scale drift, low figure of full scale temperature effect, their insensitivity to vibration, repeatability, hysteresis and overrange protection. The pressure and differential pressure instruments having diaphragm seals shall have high "spring rates" to minimise the error due to seal liquid expansion at elevated ambient temperatures.

6.1.2 Switches

Field mounted transmitters shall be used in alarming, interlock or shutdown services in lieu of field mounted switches as far as possible.

6.1.3 Signal Levels

- a) All field mounted transmitters in connection with the plant PCS shall operate on 24 VDC, 4-20 mA signals if PCS is of conventional DCS type, and shall operate on the appropriate digital signals if the selected PCS is of Foundation Field bus or Profibus type.
- b) All field mounted transmitters in connection with the plant SGS shall operate on 24 VDC, 4-20 mA signals.
- c) Field mounted switches, if any shall operate on 24 VDC, volt free contacts.
- d) Solenoid valves shall be intrinsically safe type operating on 24 VDC.
- e) Local loops, i.e., those not required to be connected to the PCS shall be pneumatic, operating on 0.2-1.0 Barg signal.
- f) Digital communication is prohibited with SGS and wherever three (3) sensors are applied, (used both for midpoint selection in the PCS and 2 out of 3 voting in a logic solver, which is part of a SGS, classified SIL 3 or higher).

6.1.4 Power Supply

- g) The 24 VDC power to all field instruments shall always be supplied by the plant PCS and/or SGS. As such all transmitters shall be of "current sinking" type.

6.1.5 Accuracy of Instruments

The minimum requirement shall be as follows:

- a) Electronic transmitters: $\pm 0.25\%$ of calibrated span
- b) Displacement type electronic Level transmitters: $\pm 0.5\%$ of calibrated span
- c) PT-100 elements: IEC 751 class "A" up to 450 °C
- d) Thermocouples: IEC 584-2 class 1
- e) Pressure gauges: $\pm 1\%$ of span.
- f) Thermometers: $\pm 1\%$ of span.

6.1.6 Instruments Cable Entry

Instrument cable entry size shall be 1/2 " NPTF for single pair cable connection with the appropriate cable gland. For instruments with other than single pair cable connection, appropriate NPTF size with the cable gland shall be specified.

6.1.7 Material

- a) All instrument wetted parts in connection with the process shall generally be AISI 316, unless higher grades are required by the process conditions. Instruments wetted part material in sour services shall comply with NACE standard MR-01-75.
- b) Unless otherwise specified in this document, material of Control valve bodies, ESD valve bodies, Orifice flanges, in-line flow instruments flanges, displacer type level instrument flanges shall conform to the piping flange/valve materials in accordance with the related NIOEC Piping Specification.

6.1.8 Pressure/Temperature Rating of Instruments and Valves

Minimum rating of inline instruments and control/safety valves shall be in accordance with the piping specification. However rating of orifice plates and orifice flanges, body and flanges of control valves, ESD valves and On/Off valves shall be ANSI 300 # minimum.

6.1.9 Impulse Lines

- a) In general, in ANSI flange class 300 and 600 services, all instrument impulse lines downstream of the first process isolating valve, shall be ½ inch OD, 316 Stainless Steel seamless tubing with wall thickness of 0.065 inch minimum, and 316 Stainless Steel, bar stock double-ferrule compression type fittings. Byte type fittings are not permitted.
- b) For ANSI flange class of above 600, or cases where the impulse lines are subject to physical expansion, or the line classes as specified in [NIOEC-SP-70-3](#), impulse lines shall be ½ " OD, seamless pipes.
- c) For service with pressure of greater than 40 Barg, fully butt-welded construction with heavy wall tubing or line pipe shall be provided.
- d) Tubing diameter for analyzer fast loop shall be selected considering the lag time calculation.

6.1.10 Manifold valves

- a) In addition to the process (or piping) isolation valve at the measurement take-off point, each pressure instrument shall be provided with a dedicated manifold valve to enable maintenance, in-situ calibration, venting and draining. The manifold valves shall be provided as follows:
 - 2-valve for pressure gauges, pressure transmitters and switches.
 - 3-valve (double block and bleed type) for pressure gauges, pressure transmitters and switches in services of ANSI Class 900 and above.
 - 5-valve for DP type transmitters
- b) Process connection of the manifold valves shall be ½ inch NPTF. However but welded NPT connection may also be required as per project requirements.
- c) The manifold valves on Pressure and differential transmitters shall be bracket mounted type with the base bracket mounting holes such that the instruments can be directly connected to the manifold valves by flush mounting, and the assembly can be installed and supported on 2" stanchions by bracket mounted manifolds.
- d) As a minimum, material of the manifold valves shall be AISI 316 stainless steel.

6.1.11 Process Isolation Valve

Process isolating valves shall be sized as follows:

- a) Pressure Gauges, pressure switches, pressure transmitters on process lines: Globe valve, ¾ inch.
- b) Pressure Gauges, pressure switches, pressure transmitters on vessels: Flanged Globe valve, 1 inch.
- c) Orifice Plate isolating valves: Gate valves, ½ ", and Globe valve ½ " for ASME flange class 900 and above.
- d) Side mounted external displacer type level transmitters: Flanged Gate valve, 1-1/2 inches.
- e) Top mounted internal displacer type level transmitters or level switches: 6 inches flanged Gate valve (if specifically required in the project specification),
- f) Side mounted external displacer type level switches: Flanged Gate valve, 1 inch.
- g) Level gauges: Flanged ¾ inch gate valve on standpipes, and 1 inch flanged gate valve on direct vessel connections. For hydrogen service, the valve shall be 1 inch flanged gate valve, both on standpipe and on vessels. Level gauges shall be connected to the isolating valves through automatic gauge valves.
- h) Level instrumentation on 2 inch standpipes: Flanged Gate valve, 2 inches.

The process isolating valves are within the battery limit of the Piping discipline and the Instrument discipline battery limit starts at downstream of the valves.

6.1.12 Instrument Nozzle Rating on Vessels

Minimum flange rating for instrument nozzles on vessels shall be as follows:

- a) Level instrumentation standpipes: ANSI 300 #.
- b) Pressure relief valve: ANSI 300 #.
- c) All nozzle sizes equal or lower than 1-½ inches: ANSI 300 #.

6.1.13 Welding

Any welding work related to the instrumentation shall be in accordance with [NIOEC-SP-90-2](#).

6.1.14 Local Indicators

- a) Pressure switches (if any), back pressure valves pressure reducing valves, pressure balanced type valves and blind type pressure transmitters or controllers (if any) shall be specified with local gauges mounted in proximity.
- b) If a transmitter or any of the above mentioned instruments, serving a control valve, has an integral indicator or a local gauge not readable from the location of the control valve, a supplementary readable indicator or gauge shall be provided.
- c) On all control loops connected to the PCS, and all transmitters connected to the SGS, a local gauge, i.e., pressure, temperature or level gauge, shall be provided and installed adjacent to the control loop transmitter, to verify transmitter reading.

6.1.15 Diaphragm Seals

- a) All pressure elements with diaphragm seal shall have capillary bleeder. The entire system above the diaphragm, including the element shall be evacuated and entirely filled with an inert liquid. The bottom section shall be removable for cleaning.
- b) Where remote diaphragm seals are used, the capillary tube shall be stainless steel 316 with stainless steel 304 armoured as a minimum. Seal liquid shall be selected such that the adverse effect of ambient temperature change be kept to the minimum possible.
- c) Where flush mounted diaphragm seals are used, a flushing ring with two 1/2" NPTF connections shall be provided for flushing valves connection.

6.2 Flow Measurement

6.2.1 General

- a) Field mounted flow transmitters shall be used on all flow control loops, monitoring, ESD and interlock services.

Notes:

1. Flow transmitters include differential head producers in combination with a dP-transmitter, Coriolis meters, etc., however exclude transmitters with variable area meter.
 2. Instruments for mass balance calculations (when identified as such on the P&IDS) are to be specified with no relaxation on any of the design factors affecting accuracy. These include the physical restraints such as straight lengths, etc., but may also cover requirements for density and temperature corrections and other physical variables, when indicated on the P&ID.
 3. Instruments used for fiscal metering (when identified as such on the P&ID) shall be approved by the local authorities. This will include the primary element, transmission system and instruments required for density corrections (e.g. temperature).
- b) Seal Chambers
- Seal chambers will normally be furnished in the following services:

Where corrosive materials may be present,

Where materials of high viscosity may be present during normal operation or start-ups which may plug the impulse line in normal operation.

- c) Adequate Purge Systems will be provided when orifice or pressure tap plugging may be expected.
- d) Local Recorders shall not be used for accounting purposes in remote off-site locations.
- e) Special Flow Requirements can call from time to time for special measurement devices such as target meters, turbine meters, magnetic meters, weirs, floats, etc. Each situation shall be considered individually by NIOEC and the most suitable type of meter shall be specified.

6.2.2 Instrument Types

The following types of instruments may be selected for the measurement of liquids, vapours and gasses, when their selection can be justified:

6.2.2.1 Differential Pressure Transmitter

a) General

Differential pressure transmitters may be used in combination with any of the following primary elements as required:

- a) Square edge orifice plate with flange tapping, (above 14", radius taps shall be used)
 - Venturi or flow tube Dall (Where low pressure loss is essential) for ISA nozzle with dP-transmitter
 - Conical entrance or quarter circle (quadrant edge) orifice plates (For low pipe Reynolds numbers)
 - Averaging pitot tube (Where no appreciable pressure loss can be tolerated, on clean service only)
 - Segmental or eccentric orifice plates (may be used in horizontal lines where the liquid contains large amounts of solids).

b) Installation and Construction

- Pre-fabricated metering runs shall be used for line sizes below 2". Sizes smaller than 2" shall only be used if it can be shown that swaging up to 2" is not viable. Integral orifices will be considered for very small flows (line sizes 1/2")
- The transmitters shall be able to withstand the application of the maximum service static pressure to the "low" pressure side, with the "high" side at atmospheric pressure, without any adverse effect or requiring recalibration.
- Square root extraction shall be included in the transmitter.

6.2.2.2 Vortex Flow Meters

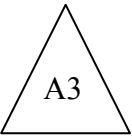
a) General

Vortex meters shall not be employed without the written approval of NIOEC, and in any case vortex flow meters shall not be used in the following applications:

- Wet steam,
- Liquids with high vapour pressures (see note),
- Viscous fluids,
- When the fluid of a control valve mounted upstream or downstream of the vortex flow meter is flashing or cavitating,
- Pulsating flow (e.g. downstream reciprocating compressors),
- When the pipeline in which the vortex flow meter is installed is subject to vibration.
- **Note:**

The vapour pressure at the highest operating temperature shall not exceed the value calculated with the following formula.

$$PV = (P \text{ (upstream)})/1.3 - 0.85 \quad (PV \text{ and } P \text{ in bars})$$

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b) Installation and Construction

If the process fluid is flammable, then wafer type vortex flow meters are not permitted. Vortex meters shall be flanged type, installed in straight lengths of process pipe work in accordance with the Manufacturers instructions. Shorter straight lengths may be accepted when flow is measured for control, safeguarding, indication and alarm loops and the additional inaccuracy does not exceed 0.5% of flow rate.

6.2.2.3 Variable Area Metres

a) General

Variable Area flow meters may be used for small flow rates where local indications, recording and/or controlling is required. They may also be used where rangeability, non-linearity, viscosity or the hazardous nature of fluid makes the differential pressure-type instrument unsuitable.

b) Installation and Construction

Variable Area flow meters shall normally be the armoured type with magnetic pick-up. Variable area meters shall be installed so that repair, maintenance and replacement will not disturb the operation of the plant. If isolation valves be required, they shall be gate type of the same size as the meter connections. The bypass valve, if required, should be a gate type and sized the same as main line size. In general, metal tube VA meters shall be used. Glass type variable area meters may only be used in low pressure/temperature services and if the fluid cannot cause a hazardous situation in case of a broken glass. Meters shall be equipped with inlet and outlet float stops.

6.2.2.4 PD Metres

a) General

Positive Displacement Meters will be used to measure the flows where integrated flowing quantity and high accuracy is required.

The meters shall be suitable the operation of being proved from a proving system.

b) Installation and Construction

The meters shall have an upstream strainer with pressure taps for differential pressure indication and