

**WBD DOO, Belgrade  
Serbia**

**NIS AD, Novi Sad,  
Serbia**

**Document Title:**                    **INSTRUMENTATION REQUIREMENTS FOR  
API PUMPS**

**Unit Code:**

**Document No:**                    **U211-IC-SP-0006**

**WBD Contract No:**                **U211**

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|------------------------------------|---------------------|-------------|
| <b>Document Title:</b>             | <b>Document No.</b> | <b>Rev:</b> |
| Instrumentation Req. for API Pumps | U211-IC-SP-0006     | 00          |

## Table of Contents

| Contents   | Page |
|--|------|
| 1.0 INTRODUCTION.....                                    | 3    |
| 2.0 REFERENCES.....                                      | 3    |
| 3.0 DEFINITIONS.....                                     | 3    |
| 4.0 AREA CLASSIFICATION.....                             | 4    |
| 5.0 CODES AND STANDARDS .....                            | 4    |
| 5.1 CE MARKING.....                                      | 5    |
| 5.2 SERBIAN AUTHORITY REQUIREMENTS.....                  | 6    |
| 6.0 SUPPLIER'S SCOPE OF SUPPLY.....                      | 6    |
| 6.1 KICK OFF MEETING.....                                | 7    |
| 6.2 SAFETY REVIEWS .....                                 | 7    |
| 7.0 SUPPLIER'S SCOPE EXCLUSIONS.....                     | 7    |
| 8.0 DESIGN REQUIREMENTS.....                             | 7    |
| 8.1 INSTRUMENT IDENTIFICATION .....                      | 7    |
| 8.2 UNITS OF MEASUREMENT .....                           | 8    |
| 8.3 FIELD INSTRUMENTATION.....                           | 8    |
| 8.3.1 General Requirements.....                          | 8    |
| 8.3.2 Flow Instruments.....                              | 9    |
| 8.3.3 Level Instruments.....                             | 9    |
| 8.3.4 Pressure Instruments .....                         | 10   |
| 8.3.5 Temperature Instruments .....                      | 10   |
| 8.3.6 Relief Valves .....                                | 11   |
| 8.3.7 Protection Boxes.....                              | 12   |
| 8.3.8 Instrument Tubing.....                             | 12   |
| 8.3.9 Instrument Wiring (where applicable).....          | 13   |
| 8.4 CONDITION MONITORING SYSTEM (WHERE APPLICABLE) ..... | 15   |
| 8.4.1 Machine Probes and Sensors .....                   | 15   |
| 8.4.2 Monitoring Racks .....                             | 16   |
| 8.4.3 Control Room Cabinet .....                         | 16   |
| 8.4.4 ModBus Communication.....                          | 18   |
| 8.4.5 System 1 Communication .....                       | 18   |
| 9.0 DOCUMENTATION .....                                  | 18   |
| 10.0 TESTING .....                                       | 18   |
| 11.0 SITE INSTALLATION .....                             | 18   |

|                                    |                     |             |
|------------------------------------|---------------------|-------------|
| <b>Document Title:</b>             | <b>Document No.</b> | <b>Rev:</b> |
| Instrumentation Req. for API Pumps | U211-IC-SP-0006     | 00          |

## 1.0 INTRODUCTION

This specification defines the minimal technical requirements for the supply, design, configuration, implementation, and testing of instrumentation as part of the following packaged equipment (PE):

- API Pumps as listed within mechanical part of requisition

This specification shall be used to assure that instrumentation provided by PE Supplier conforms to the instrument design philosophy of the project, and to specify interfaces between PE and plant control systems. Features not covered by this specification or requisition requirements shall be Supplier's standard suitable for the intended application and shall be approved by Buyer.

## 2.0 REFERENCES

The following documents are referenced herein and form part of the technical requirements. Additional documents, when applicable, will be listed in the requisition. Current editions of the referenced documents including all mandatory addenda in effect at the time of the order shall apply unless otherwise indicated.

## 3.0 DEFINITIONS

| Term                   | Definition   |
|------------------------|--|
| Client                 | NIS a.d., Novi Sad, Serbia   |
| Buyer                  | NIS a.d., Novi Sad, Serbia   |
| Engineering Contractor | WBD d.o.o., Belgrade, Serbia   |
| Supplier               | Party to which the packed equipment purchase order was issued and is responsible for the supply of materials, equipment, and services  |
| Goods                  | Means any and ancillary design and engineering services, warranty related services, technical assistance, all items, articles, materials, apparatus, equipment, spare parts, labour or other supplies including but not limited to manuals, operating instructions, reports and all other documents to be supplied or performed by Supplier, as specified, listed, mentioned, scheduled or implied in the Order or any revision thereof. |
| Order                  | Means the written Purchase Order between Supplier and Buyer which refers to and incorporates these terms and conditions together with any appendices or attachments thereto for supply of the Goods.   |
| Shall                  | Wherever the word "shall" has been used, its meaning is to be understood as mandatory.   |
| Should                 | Wherever the word "should" has been used, its meaning is to be understood as strongly recommended or advised.  |
| May                    | Wherever the wording "may be" has been used, its meaning is to be understood as a freedom of choice.   |

|   |                        |             |
|---|------------------------|-------------|
| <b>Document Title:</b>                    | <b>Document No.</b>    | <b>Rev:</b> |
| <b>Instrumentation Req. for API Pumps</b> | <b>U211-IC-SP-0006</b> | <b>00</b>   |

## 4.0 AREA CLASSIFICATION

The units shall be installed within the hazardous area due to explosive gas atmosphere.

Hazardous area classification: Zone 2 IIA T3 / Zone 2 IIB T3

For instrumentation standardization purpose the explosion protection shall be provided according to the following requirements:

- Field instruments in intrinsically safe loops: Ex ia IIB T4-T6
- Pushbuttons, switches, signal lights: Ex de IIB T4-T6
- Junction boxes: Ex e IIB T6
- Solenoid valves: Ex d IIB T4-T6

## 5.0 CODES AND STANDARDS

All equipment covered by this requisition shall conform to the latest edition, unless indicated otherwise, for the following Codes and Standards:

|                       |   |
|-----------------------|---|
| API Std 520           | Size, Selection and Installation of Pressure-relieving Devices in Refineries  |
| API Std 521           | Pressure-relieving and Depressuring Systems   |
| API Std 526           | Flanged Steel Pressure-relief Valves  |
| API Std 527           | Seat Tightness of Pressure Relief Valves  |
| API 550               | Manual on Installation of Refinery Instrumentation and Control Systems  |
| API 551               | Process Measurement Instrumentation   |
| API Std 670           | Machinery Protection Systems  |
| ASME B16.5            | Pipe Flanges and Flanged Fittings   |
| ASME B31.3            | Process Piping  |
| ASME B46.1            | Surface Texture (Surface Roughness, Waviness and Lay)   |
| ASME B1.20.1          | Pipe Threads, General Purpose (Inch)  |
| ASME PTC 19.3 TW-2010 | Thermowells   |
| EN 10204              | Metallic Products - Types of Inspection Documents   |
| DIN EN 13190          | Dial Thermometers   |
| IEC 60079             | Electrical Apparatus for Explosive Gas Atmospheres  |
| IEC 60085             | Electrical Insulation – Thermal Evaluation and Designation  |
| IEC 60423             | Conduits for Electrical Purposes - Outside Diameters of Conduits for Electrical Installations and Threads for Conduits and Fittings |
| IEC 60529             | Degrees of Protection Provided by Enclosures (IP Code)  |
| IEC 60571             | Industrial Platinum Resistance Thermometers and Platinum Temperature Sensors  |
| IEC 60584             | Thermocouples   |
| IEC 61000             | Electromagnetic Compatibility for Industrial Process Measurement and Control  |
| IEC 61508             | Functional Safety of Electrical / Electronic / Programmable Electronic Safety Related Systems                                       |
| IEC 61511             | Safety Instrumented Systems for the Process Industry Sector   |

| Document Title:                    | Document No.    | Rev: |
|------------------------------------|-----------------|------|
| Instrumentation Req. for API Pumps | U211-IC-SP-0006 | 00   |

|                           |  |
|---------------------------|--|
| IEC 61518                 | Mating Dimensions between Differential Pressure (Type) Measuring Instruments and Flanged-On Shut-Off Devices Up to 413 bar (41.3 MPa)                        |
| NACE MR 0103              | Standard Material Requirements – Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments                                 |
| NACE MR 0175-2002 edition | Standard Material Requirements – Materials for Sulfide Stress Cracking and Stress Corrosion Cracking resistance in Sour Oilfield Environments                |
| Directive 2014/34/EU      | Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres (ATEX) – mandatory from 20-Apr-2016                                   |
| Directive 2014/68/EU      | Pressure Equipment Directive – mandatory from 20-Jul-2016  |
| Directive 2014/35/EU      | Low Voltage Electrical Equipment Directive - mandatory from 20-Apr-2016  |
| Directive 2014/30/EU      | Electromagnetic Compatibility Directive - mandatory from 20-Apr-2016   |
| Directive 2006/42/EC      | Machinery Directive  |
| EN 13463-1                | Non-Electrical Equipment for Use in Potentially Explosive Atmospheres - Part 1: Basic Method and Requirements  |
| EN 1127-1                 | Explosive Atmospheres – Explosion Prevention and Protection - Part 1: Basic Concepts and Methodology   |
| IEC 60947-5-6             | Low Voltage Switchgear and Controlgear – Control Circuit Devices and Switching Elements, DC Interface for Proximity Sensors and Switching Amplifiers (NAMUR) |

When local regulations prevail over this technical description and the codes and standards referred herein, the Supplier shall inform the Client/Buyer in writing of any such deviation.

## 5.1 CE MARKING

All equipment, materials and components shall be EU certified, shall bear CE marking and shall be compliant to applicable EU directives, such as, but not limited to:

- ATEX Directive
- Pressure Equipment Directive (PED)
- Machinery Directive
- Low Voltage Electrical Equipment Directive
- Electromagnetic Compatibility Directive

Supplier shall provide EU Declaration of Conformity, which shall state full compliance to the applicable EU Directives and standards.

|   |                        |             |
|---|------------------------|-------------|
| <b>Document Title:</b>                    | <b>Document No.</b>    | <b>Rev:</b> |
| <b>Instrumentation Req. for API Pumps</b> | <b>U211-IC-SP-0006</b> | <b>00</b>   |

## 5.2 SERBIAN AUTHORITY REQUIREMENTS

All equipment shall be in compliance with Serbian legislation and law requirements. Equipment Supplier shall deliver all documentation requested by Serbian law to be able to put equipment in operation in Serbia.

Serbian authority regulations that have to be adhered:

1. For electrical equipment placed in hazardous area:
  - a. "PRAVILNIK O OPREMI I ZAŠTITNIM SISTEMIMA NAMENJENIM ZA UPOTREBU U POTENCIALNO EKSPLOZIVNIM ATMOSFERAMA" (Sl. glasnik RS, br. 1/2013) - Serbian rulebook on equipment and protective systems intended for use in potentially explosive atmospheres
2. For electrical equipment placed outside of hazardous area:
  - a. "PRAVILNIK O ELEKTRIČNOJ OPREMI NAMENJENOJ ZA UPOTREBU U OKVIRU ODREĐENIH GRANICA NAPONA" (Sl. Glasnik RS, br. 25/2016) - Serbian rulebook on electrical equipment designed for use within certain voltage limits
  - b. "PRAVILNIK O ELEKTROMAGNETSKOJ KOMPATIBILNOSTI" (Sl. Glasnik RS, br. 25/2016) - Serbian rulebook on electromagnetic compatibility
3. For pressure equipment:
  - a. "PRAVILNIK O TEHNIČKIM ZAHTEVIMA ZA PROJEKTOVANJE, IZRADU I OCENJIVANJE USAGLAŠENOSTI OPREME POD PRITISKOM" (Sl. Glasnik RS, br. 87/2011) - Serbian rulebook on technical requirements for the design, manufacture and conformity assessment of pressure equipment
  - b. "PRAVILNIK O PREGLEDIMA OPREME POD PRITISKOM TOKOM VEKA UPOTREBE" (Sl. Glasnik RS, Br. 87/2011, 75/2013) - Serbian rulebook for inspections of pressurized equipment during the operating life
4. For machinery:
 

"PRAVILNIK O BEZBEDNOSTI MAŠINA" (Sl. Glasnik RS, br. 58/2016) - Serbian rulebook on machinery safety

All equipment nameplates shall bear Serbian mark of conformity "3A".

## 6.0 SUPPLIER'S SCOPE OF SUPPLY

The Supplier's scope of supply shall be the design and engineering, delivery of material, software configuration and supply of documentation of the instrumentation including control room equipment as described below:

- Pump seal plan instrumentation
- Where requested by mechanical part of requisition, pump vibration and temperature probes including all necessary cable trays, protection tubes, other cable supporting systems and all bolting material for cabling inside machine skid and machine condition monitoring system (control room cabinet)
- Specification for the design of electrical winterizing of the unit instrumentation.
- Documentation in accordance with chapter 9.0 "Documentation".

**Not every part of this document applies to each PE. It is the Supplier's responsibility to evaluate and comply with applicable sections as specifically required by mechanical requisition.**

The Supplier's scope of supply is not limited to the instrument and controls as mentioned above and it is the Supplier's responsibility to provide the necessary instrumentation to guarantee the PE trouble free operation and start-up as demanded by mechanical specification.

Where applicable, the Supplier shall provide Cause & Effect Diagrams related to machine condition monitoring system.

Supplier shall inform the Buyer of any irregularities found in this specification.

|   |                        |             |
|---|------------------------|-------------|
| <b>Document Title:</b>                    | <b>Document No.</b>    | <b>Rev:</b> |
| <b>Instrumentation Req. for API Pumps</b> | <b>U211-IC-SP-0006</b> | <b>00</b>   |

## 6.1 KICK OFF MEETING

If necessary, an instrumentation and control system specific kick-off meeting should be scheduled shortly after purchase order award. Alternately, a portion of the overall kick-off meeting can be designated to address instrumentation and control system topics. The kick-off meeting should designate all known deadlines and freeze dates for the project, and establish final list of deliverables.

## 6.2 SAFETY REVIEWS

When required, Supplier shall participate in Buyer's safety review meetings and Safety Integrity Level (SIL) classification meetings to determine the level of safety provided, assign target SILs, and develop resolutions for adding layers of protection, decreasing spurious trips, or increasing safety availability if required.

Supplier shall supply the failure rate data of instruments used in safeguarding logic for review and acceptance by Buyer, and for use in SIL verification report.

## 7.0 SUPPLIER'S SCOPE EXCLUSIONS

The Supplier shall be responsible for the delivery of the all necessary components as described above with the following exceptions, to be handed over by Buyer / Client:

- Interconnection cabling between the PE junction boxes and plant control room.
- Power supply feeders and utilities at specified points.
- MCC feeders for main or auxiliary electrical drives including control circuits.
- Plant DCS / ESD system including application software configuration.

## 8.0 DESIGN REQUIREMENTS

### 8.1 INSTRUMENT IDENTIFICATION

All instruments and instrument related equipment shall be numbered in accordance with project requirements. Buyer will assign all instrument and instrument related tag numbers. Supplier shall submit documents for Buyer to add project specific instrument tag numbers, junction box numbers, cabinet numbers, and other instrument and control system related tag numbers. Supplier shall include Buyer tag numbers on all documentation and control system programming. If Supplier needs to include their typical tagging for internal purposes, those tags can be included on the documents, however, Buyer's tags shall always be shown. Details will be finalized at the kick-off meeting following the placement of the order.

|   |                        |             |
|---|------------------------|-------------|
| <b>Document Title:</b>                    | <b>Document No.</b>    | <b>Rev:</b> |
| <b>Instrumentation Req. for API Pumps</b> | <b>U211-IC-SP-0006</b> | <b>00</b>   |

## 8.2 UNITS OF MEASUREMENT

Unless otherwise approved by Buyer, the following units of measure shall be used for instrumentation:

| Description            | Unit of Measure               |
|------------------------|-------------------------------|
| Flow: Gas / Vapor      | Nm <sup>3</sup> /h, kg/h, t/h |
| Flow: Liquid           | m <sup>3</sup> /h, l/h        |
| Level - Relative       | %                             |
| Level - Absolute       | m, mm                         |
| Pressure: Gauge        | barg, mbarg                   |
| Pressure: Absolute     | bara                          |
| Temperature            | °C                            |
| Length                 | m, mm                         |
| Pipe / Tubing Diameter | inch                          |
| Density                | kg/m <sup>3</sup>             |
| Velocity               | m/s                           |
| Viscosity              | cP                            |
| Axial displacement     | mm                            |
| Speed                  | rpm                           |
| Vibration (absolute)   | mm/s (RMS)                    |
| Vibration (relative)   | µm                            |

## 8.3 FIELD INSTRUMENTATION

### 8.3.1 General Requirements

The instruments make / types shall be in accordance with Vendor list attached to the requisition. The commodities, not mentioned in Vendor list shall be in accordance with Supplier's standard. All of instruments and instrument accessories shall be subject of Buyer's approval.

The all of PE mounted instruments shall be designed to meet -20°C..+40°C (+50°C during summer period due to solar radiation) ambient temperature limits. Mechanical design temperature limit is -28°C.

Flanged connections shall be in accordance with ASME B16.5.

Face finish of the RF flanges shall be smooth 125-250 µinch (3.2-6.3 Ra) in accordance with ASME B46.1.

Screwed connections shall be in accordance with ASME B1.20.1.

All analog instruments shall provide the standard 4-20 mA signal output with superimposed HART protocol communication.

The analog instruments shall be intrinsic safe execution Ex ia in accordance with IEC 60079.

Instruments shall be suitable for outdoor installation, hazardous area. The instruments shall comply the directive 2014/34/EU (ATEX).

The minimum ingress protection shall be IP65 (IEC 60529).

The cable entries shall be of metric thread (IEC 60423). Termination shall be by means of screwed terminal blocks.

|   |                        |             |
|---|------------------------|-------------|
| <b>Document Title:</b>                    | <b>Document No.</b>    | <b>Rev:</b> |
| <b>Instrumentation Req. for API Pumps</b> | <b>U211-IC-SP-0006</b> | <b>00</b>   |

Material trace ability reports / pressure test reports shall be provided for all of the inline instruments (e.g. valves, flow meters, thermowells) in accordance with EN 10204 3.1.

Separate instruments with separate process connections shall be used for process control/indication and safety related functions.

The instruments intended to the emergency shutdown service shall be in compliance with IEC 61508 SIL 2 safety integrity level requirements.

Each instrument shall be equipped with SS manufacturer's identification plate showing Instrument Tag number and information in accordance with ATEX directive 2014/34/EU.

In addition to manufacturer's plate, each instrument shall be provided with stainless-steel tag plate showing the instrument tag number, securely attached to the instrument by means of a stainless-steel wire.

The instruments / instrument scales shall be calibrated (Calibration certificates shall be provided by Supplier) with the engineering units as specified in subsection 8.2.

Level transmitters shall include an integral digital meter, to display the process measurement in engineering units, remaining transmitter types may be blind unless otherwise required by application.

Transmitters shall be used in place of switches wherever practicable.

Where applicable, instrumentation shall comply with NACE MR0103 requirements.

### 8.3.2 Flow Instruments

#### *Local Flow Meters*

Local flow meters shall be of stainless steel cone tube. Connection orientation bottom-top shall be used. The glass flow tubes shall be avoided.

Wetted parts material shall be at least AISI 316(L) if not stated otherwise.

Flow meter housing shall be extended mounted to be out of the insulation when flow meter is to be installed in insulated pipe.

Where requested, transmitters shall be loop powered 24V DC, analogue 4-20mA output signal.

### 8.3.3 Level Instruments

#### *Liquid Level Switches*

Level switches utilized for alarms shall be Supplier's standard (Float or Displacer type).

Switch function shall be snap acting, Single-pole Double Throw (SPDT), 24 V / 1 A, hermetically sealed and potential-free contacts.

Field contacts shall preferably be gold plated.

#### *Level Gauges*

Level gauges shall be Supplier's standard and shall be preferably of weld pad type.

|   |                        |             |
|---|------------------------|-------------|
| <b>Document Title:</b>                    | <b>Document No.</b>    | <b>Rev:</b> |
| <b>Instrumentation Req. for API Pumps</b> | <b>U211-IC-SP-0006</b> | <b>00</b>   |

### 8.3.4 Pressure Instruments

*Pressure Transmitters:*

The transmitter body shall be made of stainless steel.

Wetted parts material shall be at least AISI 316(L) if not required otherwise by application.

Where required, pressure transmitters shall be installed in protection boxes in accordance with subsection 8.3.7.

The pressure transmitter process connection shall be 1/2" NPTF. The differential pressure transmitters shall be of flanged connection in accordance with IEC 61518.

The pressure / differential pressure transmitters shall be equipped with 2-way / 5-way manifolds within the Supplier's scope.

Pressure and Differential pressure transmitters shall have accuracy class 0.15% or better.

The instrument tubing shall be in accordance with subsection 8.3.8.

The pressure switches shall be avoided.

*Pressure Gauges:*

Pressure gauges shall be of bourdon tube, all stainless steel design with blow-out disc and zero adjustment facility, in accordance with EN 837-1. For Gauge window safety glass shall be used.

Nominal dial size shall be 100 mm. Scale shall be white with black scale markings and black pointer.

Pressure gauges for high pressure applications > 70bar shall be provided with solid fronts.

All gauges shall have glycerine oil filled casing.

The accuracy class shall be 1.0

Pressure gauges shall withstand over-range pressure of at least 130% of the scale range without mechanical damage or shift in calibration.

The gauge process connection shall be 1/2" NPT male in accordance with ASME B1.20.1, direct bottom connection.

All gauges shall be equipped with stainless steel gauge cocks.

### 8.3.5 Temperature Instruments

*Thermowells:*

Unless otherwise required, thermowells shall be solid bar stock material, stainless steel 316 as minimum, tapered design, round tip, RF flanged 1 1/2" connection.

All thermowells shall be designed to fit standard 6 mm sensor diameter. The connection for sensor shall be 1/2" NPT female thread.

Each thermowell shall be sized such that adequate immersion of the well into the process fluid is ensured.

Thermowells shall be installed in positions such that the element and head assembly can be easily withdrawn without the need to remove other equipment.

Where thermowell installation could be impractical or impossible, consideration should be given to surface-mounted temperature devices (skin-type temperature devices).

|   |                        |             |
|---|------------------------|-------------|
| <b>Document Title:</b>                    | <b>Document No.</b>    | <b>Rev:</b> |
| <b>Instrumentation Req. for API Pumps</b> | <b>U211-IC-SP-0006</b> | <b>00</b>   |

*Temperature elements:*

Temperature sensors shall be RTD Pt100's class A accuracy, 3 wire connection, increased mechanical resistance in accordance with IEC 60751.

Connection/termination heads should be in accordance with DIN EN 50446:2007-04, head-mounted transmitters are required.

Each connection head shall have a connection chain and shall be equipped with external ground screw.

For services where thermowells are considered to be an obstacle in the process or where intrusion into the line is not acceptable, skin-type thermocouples may be used.

*Temperature transmitters:*

All of temperature loops shall be equipped with electronic transmitters.

The transmitters shall be head mounted.

*Temperature gauges:*

The bimetal type gauges shall be used, casing shall be of stainless steel and shall be of every angle mounting.

Nominal dial size shall be 100 mm. Scale shall be white with black scale markings and black pointer.

The element stem diameter shall be 6 mm, the gauge process connection shall be sliding stem compression fittings.

The accuracy class shall be 1.0

The Temperature Gauges shall withstand an over-range temperature of at least 130% of the scale range.

### 8.3.6 Relief Valves

Liquid expansion relief valves shall be designed in accordance with ASME "Boiler and Pressure Vessel Code", section VIII and shall be minimum 1"x1" size with minimum port size area 38mm<sup>2</sup>, if not required otherwise.

Safety relief valves, except for the thermal relief of liquids, shall be of the full nozzle adjustable blow-down type, designed in accordance with API RP 520 and ASME "Boiler and Pressure Vessel Code", section VIII.

Valve bodies shall be flanged (as a rule, inlet minimum 300 lbs), flanges being an integral part of the body casing. An exception to this requirement shall be made in the case of liquid thermal relief valves.

Sizes shall be identified in accordance with API RP 526 showing inlet size - orifice size - outlet size (e.g. 1D2, etc.).

Materials shall be suitable for the process properties, design pressure and maximum/minimum temperature requirements.

In principle safety relief valves shall be of the conventional direct acting angle pattern, spring loaded, full nozzle entry, high-lift type for relief to the atmosphere or where the back pressure is negligible.

Balanced Safety Relief Valves shall be provided for relief into the closed flare and blow-down system if the superimposed back pressure is variable or where the built-up back pressure exceeds 10% of the required set pressure or the service is of a lethal/toxic (H<sub>2</sub>S) character. The balancing bellows construction shall be preferred.

Balanced type relief valves shall have a vented bonnet. The vent shall be protected against blocking by water and dirt by a protective screen.

|   |                        |             |
|---|------------------------|-------------|
| <b>Document Title:</b>                    | <b>Document No.</b>    | <b>Rev:</b> |
| <b>Instrumentation Req. for API Pumps</b> | <b>U211-IC-SP-0006</b> | <b>00</b>   |

### 8.3.7 Protection Boxes

Where the electrical tracing/winterizing is required due to physical fluid properties taking into account lowest ambient temperature -28°C, the pressure transmitters shall be installed within protection boxes in accordance with following specification.

Instrument protection boxes shall be fabricated from graphite glass fiber reinforced polyester as a complete assembly. Two - part construction shall be used. The lower part for installation of equipment, upper part as swivel lid, locked in open position by mechanical support. The lid shall be locked stainless steel clamps.

Protection box sealing gasket shall be made of elastic material resistant to UV radiation, ozone and chemicals.

The minimum degree of protection for instrument protection housing shall be IP65 according to IEC 60529.

Required design features:

- flame retardant and self-extinguishing
- UV stabilized
- anti-static execution

Instrument protection boxes shall be equipped with stainless steel mounting plate at the back side. Bolts, nuts hinges and other fittings shall be made from stainless steel.

Instrument protection boxes shall be equipped with bracket for 2" stand pipe mounting. Protection box shall be equipped with one external ground screw (shall be internal connected to instrument ground screw).

Complete assembled with instruments and accessories before shipment designed for easy maintenance and removal of transmitter

Boxes shall be fitted with the box heating block and terminal box for two power (incoming / outgoing) and up to two heating tape connections.

Power cable glands shall be M20x1.5, heating tape glands M25x1.5.

The connection box terminals shall be designed to accommodate the power cables up to 6 mm<sup>2</sup> cross section.

The unused cable entries or cable entries to be utilized by others shall be plugged by means of explosion certified plugs.

### 8.3.8 Instrument Tubing

Tubing with compression type fittings (twin ferrule type) shall be used.

Instrument process impulse lines shall be ½" O.D. x 0.065" wall thickness, stainless steel 316 annealed seamless. Fittings will be compatible with the tubing size and selected material shall be equal or better than the tubing material specifications.

Tubing runs for instrument impulse lines will be kept as short as possible, consistent with good practise and accessibility.

At the instrument side of the first block valve, tubing will be used for instrument connections. Where applicable, piping take-offs shall be provided with flanges with ½" O.D. tube connector to accommodate instrument connection requirements. Screwed connection at the block valve is allowed for ratings up to and including 600#.

Pressure gauges shall be installed with direct mounted manifold unless otherwise required by application.

All pressure instruments will be provided with a block valve and a drain/vent facility, except for those instruments with diaphragm seals, to provide the capability of depressurizing the impulse line.

Tubing shall be supported and protected from vibration and physical damage by means of tubing clamps.

|   |                        |             |
|---|------------------------|-------------|
| <b>Document Title:</b>                    | <b>Document No.</b>    | <b>Rev:</b> |
| <b>Instrumentation Req. for API Pumps</b> | <b>U211-IC-SP-0006</b> | <b>00</b>   |

### 8.3.9 Instrument Wiring (where applicable)

Wiring practices shall follow IEC 60079.

Field cables shall be installed in cable trays with cover. Cable trays and fixings shall be hot dip galvanized.

All off-tray cables shall be adequately supported by OPEN conduit.

Signal cables shall be segregated from power cables. IS cables should be run on separate trays from other signals, but may be in same tray if segregated by means of a mechanical barrier.

#### *Junction Boxes:*

All junction boxes shall be of stainless steel material.

Junction box explosion protection shall be Ex e in accordance with ATEX Directive 2014/34/EU. The box shall be suitable for wall mounting and shall be fitted with external earth screw M8 and breather.

Bolts, nuts and other fittings shall be made of corrosion-resistant material.

Ingress protection class of junction boxes shall be IP 65 (IEC 60529).

For a different kind of signals separate junction boxes shall be used. The signal segregation shall be as follows:

- 4-20 mA analog signals, ESD system, intrinsic safe.
- Digital input signals, ESD system, intrinsic safe.
- 4-20 mA analog signals, DCS system, intrinsic safe.
- Digital input signals, DCS system, intrinsic safe.
- Vibration monitoring voltage signals, intrinsic safe.
- Temperature monitoring RTD signals, intrinsic safe.

Termination of wiring shall be screwed connection type. Terminal rows shall be arranged horizontally. The box shall be fitted with 10% of the spare terminals. All terminals shall be numbered on both sides. The junction boxes shall be fitted with insulated bar for shield drain wire connections.

If required, the terminal boxes shall be equipped with mounting plate and C rail suitable for the Bently Nevada proximity transducers installation.

All boxes shall be equipped with cable glands, intended for the cables within the Supplier's scope of supply. The cable glands shall be of double compression type, nickel coated brass or stainless steel, and suitable for steel wire armour (SWA) signal cables.

All cable entries shall be located on the box bottom. All unused cable entries shall be plugged by certified plugs.

The cable glands, intended for the Bently Nevada proximity probes and bearing temperature sensors shall be suitable for the flexible conduit system used (e.g. Anaconda).

The cable glands for Buyer's control room multi core cables shall be included within the Supplier's scope. The appropriate cable size (inner and outer sheath diameter, SWA diameter) will be specified in later design stage.

The box size shall be standardized to suit the multi core cables within the Buyer's scope in accordance with the following table:

|   |                        |             |
|---|------------------------|-------------|
| <b>Document Title:</b>                    | <b>Document No.</b>    | <b>Rev:</b> |
| <b>Instrumentation Req. for API Pumps</b> | <b>U211-IC-SP-0006</b> | <b>00</b>   |

| Signal designation                           | Buyer cable size             | Terminals    |
|--|------------------------------|--------------|
| Electronic signals (4-20 mA, digital inputs) | 12 x 2 x 0.5 mm <sup>2</sup> | 30           |
|  | 24 x 2 x 0.5 mm <sup>2</sup> | 60           |
| Vibration voltage signals                    | 6 x 3 x 1.0 mm <sup>2</sup>  | 18 + shields |
|  | 12 x 3 x 1.0 mm <sup>2</sup> | 36 + shields |

*Instrument cables:*

All electronic signal cables within the Supplier's scope of supply shall be in accordance with the following specification:

- Installation: outdoor, laid in cable trays
- Temperature: -20 .. 70 °C.
- Environment: oil refinery, sulfur containing atmosphere
- Area: hazardous, Zone 2 IIB T3
- Type: flame retardant, low smoke, per EN 60332
- Nominal voltage: 500 V
- Conductor: copper, annealed, 7 stranded wires
- Cross section: 0.5 mm<sup>2</sup> multi-core cables, 1.5 mm<sup>2</sup> signal cables
- Insulation: PVC or XLPE
- Cable elements: twisted pairs (triads), 13 twists / m
- № of elements: 24, 12, 2, 1 pairs  
12, 6, 1 triads
- Colour code: black/white wire pairs (black/white/red wire triads), pairs (triads) continuously numbered
- Collective screen: Aluminum / PET tape, tinned copper drain wire 0.5 mm<sup>2</sup>
- Inner jacket: PVC (halogen free)
- Armor / braid: zinc coated steel wires, galvanized braiding
- Outer sheath: PVC (halogen free)

The cable outer sheath colour shall be in accordance with the signal type as summarized within the table below:

| Default Cable Colours    |  |
|--------------------------|--|
| Instrument Cables Non IS | Grey or Black                                      |
| Instrument Cables IS     | Light Blue   |
| Thermocouple Cables      | As per thermocouple type/Code (IS with blue strip) |

The wire colour coding shall be in accordance with table as follows:

|   |                        |             |
|---|------------------------|-------------|
| <b>Document Title:</b>                    | <b>Document No.</b>    | <b>Rev:</b> |
| <b>Instrumentation Req. for API Pumps</b> | <b>U211-IC-SP-0006</b> | <b>00</b>   |

| Configuration        | Polarity   | Wire colour    |
|----------------------|------------|----------------|
| Pair                 | +          | black          |
|                      | -          | white          |
| Thermocouple         | +          | IEC 60584      |
|                      | -          |                |
| Triad                | + / Signal | black          |
|                      | - / Common | white          |
|                      | Power      | red            |
| 230 V AC power cable | L          | brown          |
|                      | N          | blue           |
|                      | PE         | green / yellow |
| 24 V DC power supply | +          | red            |
|                      | -          | dark blue      |

#### 8.4 CONDITION MONITORING SYSTEM (WHERE APPLICABLE)

Where required by mechanical, in order to ensure the machinery protection and to allow the diagnostics of the plant critical machinery, the machine condition monitoring system shall be applied.

##### 8.4.1 Machine Probes and Sensors

Temperature sensors shall be sheathed, magnesium oxide insulated, Pt100 IEC 60751 RTD's, duplex type with increased mechanical resistance.

The temperature elements shall be connected to the machine junction boxes.

Where used, the instrument leads shall be of silicone or PTFE to withstand the increased temperatures. The Supplier shall be fully responsible to design the sufficient lead length to freely accommodate the sensors within the machine junction boxes.

The proximity probes shall be of standard BN3300 XL 8 mm, metric, 9 meter system. The extension cable connector shall be located in easily accessible junction box, directly mounted on the machine. The junction box shall have sufficient space to accommodate proximity probe cable spare coil.

The proximity probes should be preferably adjustable from outside of the machine.

The Supplier shall supply the fully equipped stainless steel proximitors installed on the machine skid. The proximitors shall be C rail mounting style.

Absolute vibration probes should be of Bently Nevada accelerometers. The probes mounted outside the machine casing shall be protected by Bently Nevada mounting kit. The probe extension cable shall be stainless steel armoured.

All electrical equipment installed in machine train shall be intrinsic safe execution, Ex ia certified according to the ATEX Directive 2014/34/EU. Non incendive Ex n type of explosion protection shall not be used.

The Supplier shall be fully responsible for cable routing and sufficient lead supporting inside the machine. The Supplier shall design and deliver all necessary supports and strain anchors required.

The probe leads outside the machine shall be protected by means of flexible conduits. The conduits shall be of stainless steel or galvanized steel core, thermoplastic coated (Anaconda or equivalent).

| Document Title:                    | Document No.    | Rev: |
|------------------------------------|-----------------|------|
| Instrumentation Req. for API Pumps | U211-IC-SP-0006 | 00   |

The Ex d rigid conduit system shall not be used.

#### 8.4.2 Monitoring Racks

The machine condition monitoring system shall be Bently Nevada 3500 (GE Energy). The monitoring rack shall be in accordance with API 670-4 requirements.

The rack shall be equipped 230V 50 Hz redundant power supplies.

All intrinsic safe field inputs shall be equipped with galvanic isolators. Zener barriers shall not be used.

The intrinsic safety converters should be preferably installed on the back planes interconnected with the monitoring rack by Bently Nevada system cables.

Each rack shall be equipped with configurable ModBus interface module BN3500/92 providing the Ethernet / RS serial interface. The Ethernet ModBus TCP protocol is foreseen to be connected to the plant DCS system.

The trip / safeguarding functions shall be realized via the configurable relay contacts BN3500/32, conforming to API 670 requirements, hardwired to the plant ESD system due to the sequence of event recording.

The rack shall have sufficient spare slots allowing the future extension. No additional spare monitor channels are required.

The Supplier shall fully configure/parameterize the monitors (range setting, alarm and trip setting, delays, alarm drive logic adjustment, trip multiply set up, etc.).

The Supplier shall parameterize the output relay cards in order to provide the machinery shutdown contacts in accordance with Supplier's cause and effect diagram.

The following parameters shall be transmitted to the DCS system via the ModBus/TCP link (per each measuring point):

- direct value
- alert set point
- danger set point
- alert status
- danger status
- channel status

The Supplier shall be fully responsible for the communication gateway configuration, including the ModBus register assignment.

#### 8.4.3 Control Room Cabinet

*General:*

The Supplier shall deliver the PE unit control cabinet, to be installed in the unmanned instrument room ~250 m distant from the PE. The control cabinet shall contain the following major items:

- Bently Nevada machine condition monitoring rack.
- Intrinsically safe converters, auxiliary relays, etc.
- redundant 24 V power supplies
- Cabinet auxiliaries

*Cabinet Requirements:*

The cabinet shall be of standard modular size 800 x 800 x 2100, Rittal TS8808 series, RAL7035 light gray colour.

The minimum protection degree of cabinet and its accessories shall be IP42.

|   |                        |             |
|---|------------------------|-------------|
| <b>Document Title:</b>                    | <b>Document No.</b>    | <b>Rev:</b> |
| <b>Instrumentation Req. for API Pumps</b> | <b>U211-IC-SP-0006</b> | <b>00</b>   |

The cabinet shall be equipped with front and rear lockable doors (width 400 mm) on both front and rear sides if no door mounted LCD panel is foreseen. Cabinet handles shall be of Rittal TS8611.010 series. 2 keys shall be provided per door.

Each door shall be fitted with a 130 degree opening hinges and mechanical door stays. All doors shall have three point latching mechanisms.

Cabinet shall be equipped with fans, fault tolerant to single power supply failure (e.g. 24V powered). The ventilation system should be Rittal SK3325 or equivalent.

Each cabinet side shall be equipped with fluorescent light, including door operated switch and service socket.

Each cabinet part shall be bonded to the safety earth screw.

Cabinet shall be fitted with rail for cable clamping and Rittal standard removable 3-piece sliding gland plate fitted with a foam rubber sealant that will allow penetration of incoming cables, to a rating of IP 55. Cable entry shall be from cabinet bottom.

Cabinet shall be equipped with separated instrument and protective earth strips with sufficient capacity to accommodate the cable shields and steel wire braiding.

Cabinet shall be identified with front and rear of panel screw fixed laminated plastic labels. All labels shall state the full cabinet tag number and have black letters on a white background.

Each cabinet door on the both sides shall be equipped with A4 drawing holder.

*Power Supply Requirements:*

All vital consumers shall be powered from redundant power supplies, each sized for the full load with the sufficient spare. Each power supply shall be removable for maintenance without disturbing the system operation. Each consumer shall be individually fused. The power supply distribution shall be arranged so that no single fuse failure can disturb the system availability.

The power supplies shall be overload and short circuit protected.

The use of melt fuses shall be minimized as far as practicable. The essential system components shall be protected by circuit breakers. Melt fuses shall have blown indication. The Buyer will provide the two UPS AC power feeders for each cabinet with the following parameters:

- Power supply: single phase, TN-S
- Nominal voltage: 230 V  $\pm$  5%
- Frequency: 50 Hz  $\pm$  1%

In addition to, Buyer may provide the unsecured power supply, intended for the service sockets, lightning and other non-vital auxiliaries.

The detailed requirements on AC power feeders shall be specified by Supplier.

The maximum cabinet circuit breaker rating shall be 20A, C characteristics.

The Supplier shall specify the rated / maximum inrush current for the each power supply used with respect to feeder fusing. The power supply start up shall not cause the circuit breaker trip in the whole power supply line.

The incoming power feeder terminals intended for the Buyer's connection shall be designed for wire cross section to 6 mm<sup>2</sup>.

*Wiring Requirements:*

Signal wiring shall be separated from power or high voltage wiring and shall be run in separate cable ducts. Terminals and ducts for the intrinsically safe loops shall be blue coloured and segregated in the cabinet from the other wiring.

The wiring capacities shall be provided as follows:

- multi-core cables - 10% spare capacity terminated on the both ends

| Document Title:                    | Document No.    | Rev: |
|------------------------------------|-----------------|------|
| Instrumentation Req. for API Pumps | U211-IC-SP-0006 | 00   |

- terminals - 15% free space on C-rails
- cable ducting - 30% free space

Terminal block arrangement shall be such that all single cores, including spares, of the multi-core cables can be connected in the sequential order as the pattern and layout of the cores in the cable.

The terminals shall be of screwed type. The input terminals intended for the field signals shall be of disconnect type. The terminals for the intrinsic safe signals shall be blue colour.

Multi-level terminal blocks shall not be used.

All terminals shall be numbered at the both ends.

Each wire connected to the terminal shall be marked to identify the point of connection for both ends (source-destination).

Each cabinet component and individual card locations shall be identified. The nameplates shall be engraved laminated plastics, white/black/white coloured. PVC stick on (DYMO) labels shall not be used.

Power terminals carrying voltages higher than 50 volts shall be protected against accidental contact by having removable cover plates and shall be labelled to indicate high voltage.

#### 8.4.4 ModBus Communication

The single ModBus TCP link to the plant DCS is foreseen.

#### 8.4.5 System 1 Communication

The monitoring rack shall be provided with transient data interface card for future connection with System 1 condition monitoring and diagnostics.

### 9.0 DOCUMENTATION

The Supplier shall provide the printed and electronic documentation in accordance with the requisition attached doc. U211-SDR-0003 "SDR – Instrumentation".

### 10.0 TESTING

Instrumentation as part of the packaged equipment (PE) shall undergo formal FAT and SAT testing according to the Supplier's standard factory and site acceptance test procedures.

### 11.0 SITE INSTALLATION

In general, interconnecting cabling will be installed by Buyer in accordance with Supplier's project documentation.

The Supplier shall be fully responsible for the instrument installation inside the PE skid.

Supplier site activities and services related to instrumentation shall be as follows:

- Unless otherwise agreed, the Supplier's representative shall be present at the condition monitoring system cabinet power up.
- The Supplier's representative shall assist during the initial set up and checking of the communication line to the plant DCS system.
- The Supplier's representative shall verify and confirm the machine probes settings and alarm and trip set point adjustment during the machine commissioning.

The Supplier shall propose the supervisor site assignment schedule and training for process and maintenance staff, with expected man hours expressed.