DOC NUMBER: **569-DB07-AIC-530-004**	CLIENT NUMBER: **PRD-AIC-TSP-025**
CLIENT: **TAKEDA/BAXALTA**	
PROJECT **BURITI EPCMV PROJECT**	

INSTRUMENTATION DESIGN CRITERIA

1	01DEC2021	ISSUED FOR CONSTRUCTION CONSIDERING COMMENTS	MAV	MAF	RSP
0	15OCT2021	ISSUE FOR CONSTRUCTION	MAV	MAF	RSP
A	30APR2021	90% DD ISSUE	MAV	MAF	RSP
REV	**DATE**	**DESCRIPTION**	**EXEC**	**CHECK**	**APPROV.**

INDEX

1. REVISION HISTORY

Rev.	Reason for change
A	90% DD ISSUE
0	• General review in index numbering because of the new table 1 (revision history) • Changed the document name • Updated item 3.4.4 • Updated item 4 • Changed item 5 from COMPLEMENTARY to REFERENCE • Updated item 9.3.4 • Updated item 12
1	• Updated item 2.1 • Update item 3.4.3 • Added item 6.7 • Updated item 7.2 • Deleted item 16 and 17

2. OBJECTIVE

2.1. This document aims to establish the general criteria to be followed in the preparation of the documents of the AIC discipline (Automation - Instrumentation - Control) of the detailed design for the Project Buriti - Takeda / Baxalta, to be built in Goiana, PE, Brazil.

3. SCOPE

3.1 This design criteria covers the requirements for the application, installation, specification, testing and documentation of the instruments, control panels, equipment, and materials to be used on the facilities of buildings B07A- Drug Product, B07B-Drug Substance, B07C-Boilers and B07F-Generator Building.

3.2 The quantities and functions of the instruments and equipment, included in the project, must be as indicated in the engineering process diagram (P&ID) and in any other reference document of the detailed project.

3.3 System Performance Requirements

3.3.1 Provide components per the following specifications.

3.4 Quality Assurance

3.4.1 Performance: All work, when completed, shall be in an operable, undamaged state at the acceptance by the Engineer. All equipment shall be guaranteed to be free of defects in workmanship and materials.

3.4.2 Certifications: Where required by local regulations, all engineered wiring systems and their components shall be UL listed or recognized and labeled as such or shall be certified by an approved electrical inspection facility.

3.4.3 Approvals: All engineered wiring systems shall meet the local requirements. The acceptance criterion for this requirement is approval for use by Takeda/Baxalta. The Request for Quotation will indicate any deviations from this approval requirement.

3.4.4 Documentation: Evidence of compliance with the regulatory inspections shall be submitted within 15 days after receipt of the equipment at the job site.

4. CODES AND TECHNICAL STANDARDS

4.1 The detailed project must be prepared in accordance with the technical standards and regulations indicated below:

4.2 ABNT - Brazilian Association of Technical Standards

NBR 5410	LOW VOLTAGE ELECTRICAL INSTALLATIONS
NBR 5597	CARBON STEEL ELECTRODUCT AND ACCESSORIES, WITH PROTECTIVE COATING AND THREAD NPT - REQUIREMENTS
NBR 7289	CONTROL CABLES WITH EXTRUDED PE OR PVC INSULATION FOR VOLTAGES UP TO 1 KV - PERFORMANCE REQUIREMENTS
NBR 10300	INSTRUMENTATION CABLES WITH EXTRUDED PE OR PVC INSULATION FOR VOLTAGES UP TO 300 V - PERFORMANCE REQUIREMENTS
NBR 10861	CABLE GLANDS
NBR 13225	FLUID FLOW MEASUREMENT IN FORCED CONDUITS, USING HOLE PLATES AND NOZZLES IN SPECIAL CONFIGURATIONS
NBR 13774	COMPENSATION OR EXTENSION CABLES AND WIRES FOR THERMOCOUPLE - TOLERANCES AND IDENTIFICATION
NBR 13881	BIMETALLIC THERMOMETERS - MANUFACTURING AND USE RECOMMENDATIONS - TERMINOLOGY, SAFETY AND CALIBRATION
NBR 14153	SAFETY OF MACHINES - PARTS OF COMMAND SYSTEMS RELATED TO SECURITY - GENERAL PRINCIPLES FOR DESIGN
NBR 16198	FLUID FLOW MEASUREMENT IN CLOSED CONDUITS - METHODS USING TRANSIT TIME ULTRASONIC FLOW METER - GENERAL GUIDELINES FOR SELECTION, INSTALLATION AND USE
NBR 16804	FLUID FLOW MEASUREMENT IN CLOSED CONDUITS - ORIENTATION FOR THE SELECTION, INSTALLATION AND USE OF CORIOLIS METERS

NBR 17240	FIRE DETECTION AND ALARM SYSTEMS - DESIGN, INSTALLATION, COMMISSIONING AND MAINTENANCE OF FIRE ALARM AND DETECTION SYSTEMS - REQUIREMENTS
NBR IEC 60079-0	EXPLOSIVE ATMOSPHERES - PART 0: EQUIPMENT - GENERAL REQUIREMENTS
NBR IEC 60079-1	EXPLOSIVE ATMOSPHERES - PART 1: EQUIPMENT PROTECTION BY EXPLOSION PROOF "D"
NBR IEC 60079-14	EXPLOSIVE ATMOSPHERES - PART 14: DESIGN, SELECTION AND ASSEMBLY OF ELECTRICAL INSTALLATIONS
NBR IEC 60079-2	EXPLOSIVE ATMOSPHERES - PART 2: EQUIPMENT PROTECTION BY PRESSURIZED CASING
NBR IEC 60529	DEGREES OF PROTECTION FOR ELECTRICAL EQUIPMENT HOUSINGS (IP CODE)
NBR IEC 61537	CABLE FORWARDING - ELECTRONIC CABLE SYSTEMS AND CABLE BED SYSTEMS
NBRISO9104	FLUID FLOW MEASUREMENT IN CLOSED CONDUITS - METHODS FOR PERFORMANCE ASSESSMENT OF ELECTROMAGNETIC FLOW METERS FOR LIQUIDS
NBR ISO 9951	GAS FLOW MEASUREMENT IN CLOSED CONDUITS - TURBINE TYPE METERS
NBR NM 280	INSULATED CABLE CONDUCTORS (IEC 60228, MOD)
NBR ISO 4287	GEOMETRIC SPECIFICATIONS OF THE PRODUCT (GPS) - RUGOSITY: PROFILE METHOD - TERMS, DEFINITIONS AND RUGOSITY PARAMETERS. ABNT, 20023
NBR 13225	FLUID FLOW MEASUREMENT IN FORCED CONDUITS, USING HOLE PLATES AND NOZZLES IN SPECIAL CONFIGURATIONS (WITH DRAIN HOLES, IN PIPES WITH LOWER DIAMETERS OF 50 MM, AS INPUT AND OUTPUT DEVICES AND OTHER CONFIGURATIONS)
NBR ISO 3966	FLOW MEASUREMENT IN CLOSED CONDUITS - SPEED METHOD USING STATIC PITOT TUBES
NBR ISO 14801	GAS MEASUREMENT AND FLOW IN CLOSED CONDUITS - TURBINE TYPE METERS - CLASSIFICATION AND COMPLEMENTARY TESTS

4.3 ISA - International Society of Automation

ANSI / ISA-5.1	INSTRUMENTATION SYMBOLS AND IDENTIFICATION
ANSI / ISA-50.00.01	COMPATIBILITY OF ANALOG SIGNALS FOR ELECTRONIC INDUSTRIAL PROCESS INSTRUMENTS
ANSI / ISA-51.1	PROCESS INSTRUMENTATION TERMINOLOGY
ANSI / ISA-75.01.01	INDUSTRIAL-PROCESS CONTROL VALVES - PART 2-1: FLOW CAPACITY - SIZING EQUATIONS FOR FLUID FLOW UNDER INSTALLED CONDITIONS
ANSI / ISA-75.05.01	CONTROL VALVE TERMINOLOGY
ANSI / ISA-75.11.01	INHERENT FLOW CHARACTERISTIC AND RANGEABILITY OF CONTROL VALVES
ANSI / ISA-75.13.01	METHOD OF EVALUATING THE PERFORMANCE OF POSITIONERS WITH ANALOG INPUT SIGNALS AND PNEUMATIC OUTPUT
ANSI / ISA-75.19.01	HYDROSTATIC TESTING OF CONTROL VALVES
ANSI / ISA-75.25.01	TEST PROCEDURE FOR CONTROL VALVE RESPONSE MEASUREMENT FROM STEP INPUTS
ANSI / ISA-TR75.25.02	CONTROL VALVE RESPONSE MEASUREMENT FROM STEP INPUTS
ASME / ANSI Y 32.10	GRAPHIC SYMBOLS FOR FLUID POWER DIAGRAMS
ISA-7.0.01	QUALITY STANDARD FOR INSTRUMENT AIR
ISA-75.17	CONTROL VALVE AERODYNAMIC NOISE PREDICTION
ISA-RP12.4	PRESSURIZED ENCLOSURES
ISA-RP2.1	MANOMETER TABLES
ISA-RP31.1	SPECIFICATION, INSTALLATION, AND CALIBRATION OF TURBINE FLOWMETERS
ISA-RP75.23	CONSIDERATIONS FOR EVALUATING CONTROL VALVE CAVITATION

ISA-TR20.00.01	SPECIFICATION FORMS FOR PROCESS MEASUREMENT AND CONTROL INSTRUMENT'S PART 1: GENERAL CONSIDERATIONS

4.4 ASTM - American Society for Testing and Materials

ASTM A269	STANDARD SPECIFICATION FOR SEAMLESS AND WELDED AUSTENITIC STAINLESS STEEL TUBING FOR GENERAL SERVICE
ASTM E230 / E230M	STANDARD SPECIFICATION AND TEMPERATURE-ELECTROMOTIVE FORCE (EMF) TABLES FOR STANDARDIZED THERMOCOUPLES
ASTM E608	STANDARD SPECIFICATION FOR MINERAL-INSULATED, METAL-SHEATHED BASE METAL THERMOCOUPLES
ASTM D1941 - 91	STANDARD TEST METHOD FOR OPEN CHANNEL FLOW MEASUREMENT OF WATER WITH THE PARSHALL FLUME

4.5 ANSI - American National Standards Institute

ASME B16.36	ORIFICE FLANGES
ANSI / FCI 70-2	CONTROL VALVE SEAT LEAKAGE
ASME B1.20.1	PIPE THREADS, GENERAL PURPOSE (INCH)
ASME B16.10	FACE-TO-FACE AND END-TO-END DIMENSIONS OF VALVES
ASME PTC 25	PRESSURE RELIEF DEVICES
ASME B16.5	PIPE FLANGES AND FLANGED FITTINGS NPS 1/2 THROUGH NPS 24 METRIC / INCH STANDARD
ASME B40.100	PRESSURE GAUGES AND GAUGE ATTACHMENTS
ASME SEC. VIII	BOILER AND PRESSURE VESSEL CODE (BPVC)

4.6 INMETRO - National Institute of Metrology, Standardization and Industrial Quality

Ordinance Nº. 114: 1997	GENERAL LEGAL METROLOGY CRITERIA FOR MEASURING INSTRUMENTS

Ordinance 179: 2010	REVIEW OF REQUIREMENTS FOR ASSESSMENT OF COMPLIANCE OF ELECTRICAL AND ELECTRONIC EQUIPMENT FOR EXPLOSIVE ATMOSPHERE
VIM 2012 IN	TERNATIONAL METROLOGY VOCABULARY

4.7 ASME - American Society of Mechanical Engineers

ASME PTC 19.3 TW	THERMOWELLS PERFORMANCE TEST CODES
ASME BPE	BIOPROCESSING EQUIPMENT

4.8 IEC - International Electrotechnical Commission

IEC 60534-8-4	INDUSTRIAL-PROCESS CONTROL VALVES - PART 8-4: NOISE CONSIDERATIONS - PREDICTION OF NOISE GENERATED BY HYDRODYNAMIC FLOW
IEC 60770-1	TRANSMITTERS FOR USE IN INDUSTRIAL-PROCESS CONTROL SYSTEMS - PART 1: METHODS FOR PERFORMANCE EVALUATION
IEC 61000-4-2	ELECTROMAGNETIC COMPATIBILITY (EMC) - PART 4.2 - TESTING AND MEASUREMENT TECHNIQUES - ELETROSTATIC DISCHARGE IMMUNITY TEST
IEC 61000-4-3	ELECTROMAGNETIC COMPATIBILITY (EMC) - PART 4: TESTING AND MEASUREMENT TECHNIQUES - SECTION 3: RADIATED, RADIO-FREQUENCY, ELECTROMAGNETIC FIELD IMMUNITY TEST

4.9 ISO - International Organization for Standardization

ISO 5167	MEASUREMENT OF FLUID FLOW BY MEANS OF PRESSURE DIFFERENTIAL DEVICES INSERTED IN CIRCULAR CROSS SECTION CONDUITS FULL
ISO 9104	MEASUREMENT OF FLUID FLOW IN CLOSED CONDUITS - METHODS OF EVALUATING THE PERFORMANCE OF ELECTROMAGNETIC FLOW-METERS FOR LIQUIDS
ISO 1302	GEOMETRICAL PRODUCT SPECIFICATIONS (GPS) - INDICATION OF SURFACE TEXTURE IN TECHNICAL PRODUCT DOCUMENTATION

4.10 ISPE - International Society for Pharmaceutical Engineering

Volume 3	Pharmaceutical Engineering Guides for New and Renovated Facilities - Sterile Manufacturing Facilities
Volume 4	Pharmaceutical Engineering Guides for New and Renovated Facilities - Water and Steam Systems

4.11 MTE - Ministry of Labor and Employment

NR 10	Security in Installations and Services in Electricity

4.12 API - American Petroleum Institute

API MPMS 5.3	METERING: MEASUREMENT OF LIQUID HYDROCARBONS BY TURBINE METERS

4.13 BS - BRITISH STANDARD

BS 1042-1	MEASUREMENT OF FLUID FLOW IN CLOSED CONDUITS. PRESSURE DIFFERENTIAL DEVICES. SPECIFICATION FOR SQUARE-EDGED ORIFICE PLATES AND NOZZLES (WITH DRAIN HOLES, IN PIPES BELOW 50 MM DIAMETER, AS INLET AND OUTLET DEVICES) AND OTHER ORIFICE PLATES

4.14 Standards, Regulations and Guidelines

ANVISA	National Health Surveillance Agency
EU	Europe Commission
FDA	Food and Drug Administration
GAMP	Good Automated Manufacturing Practice
WHO	World Health Organization
EHEDG	European Hygienic Engineering & Design Group
USP U.S.	Pharmacopeial

4.14.1 The detailed project must be in accordance with the standards and publications, in their latest editions or revisions.

4.14.2 In the eventual conflict of requirements specified by the standards, the most restrictive ones must be adopted.

5. ABBREVIATIONS

AC	Alternating Current
BMS	Building Management System
CC	Continuous Current
CIP	Cleaning in Closed Circuit (Cleaning In Place)
CV	Flow coefficient of control valves
EMS	Environmental Management System
ETL	Electrical Testing Laboratories
FLG	Flanged
HVAC	Heating, Ventilation and Air Conditioning (Heating, Ventilation and Air Conditioning)
I / O	Inputs and Outputs
LED	Light Emitting Diode
LSZH	Low Smoke, Zero Halogen (Low Smoke, Zero Halogen)
PCS	Process Control System
PAJ	Adjustment Pressure
PCTFE	Polichlorotrifluoroethylene
PFA	PerFluoroAlkoxy
POP	Operating Pressure
PVC	Polyvinyl Chloride
PSV	Safety and Relief Valve (Pressure Safety and Relief Valve)
PLC	Programmable Logic Controller
Ra	Arithmetic or average roughness
RO	Orifice of Restriction
SPDT	Single Pole, Double Throw
TC	Tri Clamp
TOC	Total Organic Carbon
UL	Underwriters Laboratories
VAV	Variable Air Volume System
WFI	Water for Injection

6. REFERENCE DOCUMENTS

6.1 AUTOMATION SYMBOLS AND LEGENDS

7A-I-0-0-01	DRUG PRODUCT - STANDARD ABREVIATIONS, SYMBOLS AND LEGENDS
7B-I-0-0-01	DRUG SUBSTANCE - STANDARD ABREVIATIONS, SYMBOLS AND LEGENDS
7C-I-0-0-01	BOILER - STANDARD ABREVIATIONS, SYMBOLS AND LEGENDS

6.2 TYPICAL DETAIL OF INSTALLATION

07-I-0-8-03	BMS - INSTRUMENT TYPICAL INSTALLATION
07-I-0-8-02	EMS - INSTRUMENT TYPICAL INSTALLATION
07-I-0-8-01	PCS - INSTRUMENT TYPICAL INSTALLATION

6.3 PROCESS SYMBOLS AND LEGENDS

7A-Z-0-0-01	BLDG-7A-PROCESS-INDEX SHEET
7B-Z-0-0-01	BLDG-7B-PROCESS-INDEX SHEET

6.4 HVAC SYMBOLS AND LEGENDS

07-M-0-0-01	MECHANICAL INDEX SHEET

6.5 SPECIFICATION OF PIPING MATERIALS

PRD-PIP-TSP-501	PIPE CLASS AND SPECIFICATIONS

6.6 ELECTRICAL - DESIGN CRITERIA

PRD-ELE-CRT-513 ELECTRICAL - DESIGN CRITERIA

6.7 NETWORK ARCHITECTURE DRAWINGS

7A-I-0-1-01	PCS_NETWORK_ARCHITECTURE
7B-I-0-1-01	PCS_NETWORK_ARCHITECTURE
7A-I-0-7-03	EMS_NETWORK_ARCHITECTURE
7B-I-0-7-03	EMS_NETWORK_ARCHITECTURE
7A-I-0-7-04	BMS_NETWORK_ARCHITECTURE
7B-I-0-7-04	BMS_NETWORK_ARCHITECTURE

7. PROJECT DESIGN

7.1 The detailed instrumentation design must be developed according to the definitions of the Automation design criteria, using the predecessor documents of the detailed design as a reference and will comply with current Good Manufacturing Practice (cGMP) standards. Any diverging definitions of the Automation design criteria must be previously approved by Takeda / Baxalta.

7.2 The instrumentation project must contemplate, at least, the elaboration of the following documents for the BMS, EMS and PCS systems,not limited to these only:

- Instruments Index
- Cable Schedule
- I / O List
- Typical Details (Process Interconnection; Pneumatic Interconnection; Electrical Interconnection)
- Instrumentation plans
- Data sheets
- Technical specifications.

8. DEFINITIONS

8.1 Calibration

8.1.1 Operation that establishes, under specified conditions, in a first stage, a relationship between the measurement values and uncertainties provided by standards and the corresponding indications with the associated uncertainties; in a second step, it uses this information to establish a relationship with a view to obtaining a measurement result from an indication.

8.2 Cavitation (in Control Valves)

8.2.1 Name given to the phenomenon that occurs when, during the process of pressure reduction in the fluid line in the liquid phase, from P1 to P2, the following situation occurs: P <Pv and P2> Pv.

8.2.2 For a control valve operating with liquid fluid, we have:

• P1: absolute pressure upstream of the valve.

• P2: absolute pressure downstream of the valve, after pressure recovery.

• Pv: fluid vapor pressure at operating temperature.

• P: pressure after leaving the seat and inside the valve.

***Note:** ΔP is the permanent head loss due to the valve, where ΔP = P1 - P2.

8.3 Compensation

8.3.1 For process instrumentation, this term is applied to the provision of special construction, inclusion of device, supplementary circuit or even the use of special materials, in order to reduce sources of error due to variations in the specified operating conditions.

8.4 Normal Operating Conditions

8.4.1 Set of "ranges" corresponding to the operating conditions that a specific instrument or equipment is designed to operate. The influences of such "ranges" on the performance characteristics of that instrument or equipment, must be defined individually and known.

8.5 Terms of Reference

8.5.1 Prescribed operating condition for evaluating the performance of a measuring instrument or measuring system or for comparing measurement results.

8.5.2 Overprinted Back Pressure

8.5.3 Pressure at the exit of a PSV, just before the opening of the PSV.

8.6 Backpressure Developed

8.6.1 Pressure increases at the outlet of a PSV immediately after opening, that is, the pressure increases at the discharge caused by the flow of the fluid relieved by the valve itself.

8.6.2 This value, added to the superimposed back pressure, defines the total back pressure in a PSV.

8.7 Primary Element

8.7.1 Component of a system whose function is to convert part of the energy associated with a measured variable, into a form suitable for measurement.

8.8 Measurement Accuracy

8.8.1 Degree of agreement between indications or measured values, obtained by repeated measurements, on the same or similar objects, under specified conditions.

8.9 Measurement Accuracy

8.9.1 Degree of agreement between a measured value and a true value of a measurand.

8.10 Measurement Error

8.10.1 Difference between the measured value of a quantity and a reference value.

8.11 Hysteresis

8.11.1 Maximum difference that can be observed in the values indicated by the instrument, for the same value of any measurement range, when the variable runs through the entire scale, both in increasing and decreasing directions.

8.12 Measurement uncertainty

8.12.1 Non-negative parameter that characterizes the dispersion of the values attributed to a measurand, based on the information used.

8.13 Resolution

8.13.1 Less variation in the measured quantity that causes a noticeable variation in the corresponding indication.

8.14 Gauge Instrument

8.14.1 Measuring instrument in which the output signal is displayed in visual form.

8.15 Lower Range Limit (LRL)

8.15.1 Smallest lower value of the "range" that can be obtained through adjustment, in each instrument or equipment.

8.16 Upper Range Limit (URL)

8.16.1 Higher superior value of the "range" that can be obtained, through adjustment, in a certain instrument or equipment.

8.17 Lower Range Value (LRV)

8.17.1 Lowest range value that the instrument has been adjusted.

8.18 Higher Range Value (URV)

8.18.1 Highest value of the range that the instrument has been adjusted.

8.19 Linearity

8.19.1 Degree of proximity between a curve and a straight line. Usually quantified as the maximum deviation between the curve and a straight line, positioned so as to minimize such deviation.

8.20 Design Pressure

8.20.1 Pressure value used in the design of a vessel or other process equipment, with the purpose of determining the minimum allowable thickness or physical characteristics of the internal parts, for a given temperature.

8.21 Static Pressure

8.21.1 The pressure applied at steady state to a device, in the case of a differential pressure device, the process pressure applied uniformly to both connections.

8.22 Measurement Interval (Range)

8.22.1 Set of values of quantities of the same nature that can be measured by a given measuring instrument or measuring system with specified instrumental measurement uncertainty, under determined conditions.

8.22.2 Examples:

Measurement. Range: (0 to 15) kgf / cm^2;

Measurement. Range: (-20 to 100) ° C;

Measurement. Range: (0 to 100) m^3 / h.

8.22.3 In some places, the English term is "measuring range" or "measurement range". In Brazil, the term adopted for "range" is "range".

8.23 Repeatability

8.23.1 Degree of proximity between the values obtained through successive measurements, at the exit of a certain instrument or equipment for the same value applied at the entrance, with the other operational conditions kept constant. Such measurements are made over the entire “range” of the instrument or equipment, in the same direction, so as not to include the effects of hysteresis.

8.24 Signal

8.24.1 Quantity that is functionally related to the measurement object.

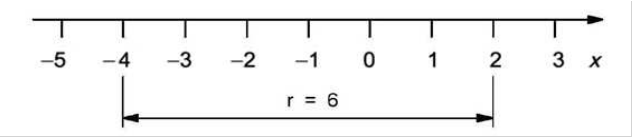
8.25 Supervision and Control System

8.25.1 System that receives measurement signals and sends command signals to act on the process, in order to maintain a set of process variables at predetermined values.

8.26 Span amplitude (Span)

8.26.1 The amplitude of the interval [a; b] is the difference b - a and is represented by r [a; B].

8.26.2 Example: r [-4; 2] = 2 - (-4) = 6



***Note:** In English, the term “span” is sometimes used for this concept.

8.27 Room temperature

8.27.1 Temperature of the medium that surrounds the instrument or equipment, considering them installed and dissipating heat.

8.28 Control valve

8.28.1 Final control element, through which the process fluid flows, and which receives a command signal from the supervision and control system, to adjust the passage area, to modify the value of a certain process fluid variable to reach predetermined values.

8.29 Vaporization (in Control Valves)

8.29.1 Vaporization occurs when during the pressure reduction process, from P1 to P2, the following situation occurs: P <Pv and P2 <Pv in fluid lines in the liquid state.

8.29.2 For a control valve operating with liquid fluid, we have:

- P1: absolute pressure upstream of the valve;
- P2: absolute pressure downstream of the valve, after pressure recovery;
- Pv: fluid vapor pressure at operating temperature;
- P: pressure after leaving the seat and inside the valve.

*** Note:** ΔP = (P1 - P2) is the permanent head loss due to the valve.

8.30 Maximum Allowable Error

8.30.1 (Maximum allowable error; maximum tolerated error; error limit).

8.30.2 Extreme measurement error value, with respect to a known reference value, accepted by specifications or regulations for a given measurement, measuring instrument, or measuring system.

8.31 Communication Protocol HART (Highway Addressable Remote Transducer)

8.31.1 The HART (“Remote Addressable Communication Network Transducer”) is a bidirectional digital communication protocol, modulated in FSK (Frequency Shift Key) and is superimposed on the 4 to 20 mA analog signal in smart instruments for parameterizing and monitoring information . HART allows the use of masters: an engineering console and a second master in the field, for example, a laptop or handheld programmer.

8.31.2 The physical medium for digital communication is the current loop wire pair itself.

8.31.3 Main communication room of a building is called Automation Room. Central point of a star network topology where patch panels, hub and router are located.

8.32 Clean Utilities

8.32.1 Pure utilities. Ex.: Pure Water, Water for Injectables, Pure Steam, Filtered Nitrogen, etc.

8.33 Black Utilities

8.33.1 Common utilities. Ex.: Drinking Water, Steam, Nitrogen, etc.

9. PROJECT CONSIDERATIONS

9.1 Instrument Identification

9.1.1 For the identification of instruments and functions see documents Process Diagrams in their latest revisions.

9.2 Units of Measure Adopted

9.2.1 The units of the International System of Units (SI) should be used, except for the cases enshrined in practice, with preference being given to the following:

VARIABLE	UNITS
Flow rate	
Liquid	m^3/h
Steam	kg/h
Gas	Nm^3/h
Level	
Conventional Type	% faixa ou mm
Type Ruler	m ou mm
Pressure	
Absolute	bar(a)
Below Atmospheric	mmHg(a)
Close to Atmospheric	mmH_2O(a)
Manometric	bar(g)
Room Pressure	Pa
Temperature	°C
Especific Mass	kg/m^3
Viscosity	cP
Conductivity	µS/cm

9.3 Criteria for power supply

9.3.1 The EMS/BMS/PCS automation instruments and equipment involved in the operation of the process must be powered by specific supply boards, and capable of maintaining continuity of operation in case of problems in the primary supply through redundant power sources and / or an uninterrupted system. of power considering the criticality of each equipment.

9.3.2 It is necessary that the AC/DC converter that supplies the instrumentation is independent from the other electrical converters used in the field. For this, 24 Vdc power supplies must be considered within the PLC and / or remote I / O panels for instrument power supply.

9.3.3 The supply voltages and / or their levels of variation in the specification of the instrumentation, automation equipment and other powered systems must be respected.

9.3.4 Standardized nominal voltages are:

• In DC: 24 V for two (2) or four (4) wire field instruments, control signals and preferably for final elements (solenoid valve).

• In AC: 220 V, 2 phase power with 3 conductors (phase-phase-ground), 60 Hz for special field instruments (4-wire instruments), analyzers and pilot lights.

• In AC: 220 V, 2 phase power with 3 conductors (phase-phase-ground), 60 Hz for automation equipment in general.

• In AC: 380 V, 3 phase power with 4 conductors (phase-phase-phase-ground), 60 Hz for motor-operated valves.

9.3.5 The grounding of the housing of the instruments and automation equipment will be in the general grounding grid of the factory.

9.3.6 The grounding of the shielding of the instrumentation cables will be in the automation panels, which will be connected to the general earth grid of the factory.

9.3.7 All instruments and panels must have adequate grounding for their full operation, according to the recommendations of NBR 5410.

9.3.8 For more information on electrical power and grounding, check document PRD-ELE-CRT-513 ELECTRICAL - DESIGN CRITERIA of the Electrical discipline.

9.4 Basic criteria for pneumatic feeding

9.4.1 API RP 552 recommendations should be used for the execution of the instrument air distribution project.

9.4.2 It is recommended that the air distribution of instruments be done through a closed ring.

9.4.3 Each instrument or actuator that requires supply air must be designed with the manual blocking valve and filter / regulator assembly with inlet and outlet pressure gauge.

9.4.4 The installation location of the tubes and supports must be defined in order to facilitate the diversion for feeding equipment, access to maintenance and expansion to new areas of the plant.

9.4.5 The derivations of the main instrument air tubing should preferably be made at the top of this tubing.

9.4.6 In the supervision and control system, pressure indication and low pressure alarm of the instrument air generation and distribution system must be provided.

9.4.7 Pressure taps for monitoring instrument air pressure must be made at the entrance of each consumer building.

9.4.8 Flow measurement on the main feeder at the output of the instrument air generation system is recommended.

9.4.9 The available pressure of the instrumentation air will be between 6.2 to 6.9 bar (g).

9.4.10 Pneumatic actuators must be dimensioned to ensure activation with minimum instrument air pressure supplied at the battery limit 6 bar (g).

9.4.11 Instrument air shall be classification 1.2.1 according to ISO 8573-1: 2010.

10. SELECTION CRITERIA AND SPECIFICATION OF INSTRUMENTS AND VALVES

10.1 General

10.1.1 The transmitters and positioners of control valves in 4 to 20 mA for application in processes and utilities, must be provided with HART protocol.

10.1.2 Transmitters and positioners for application in a 4 to 20 mA HVAC system do not require a HART protocol.

10.1.3 Transmitters with a 4 to 20 mA output signal must have a minimum load resistance of 500 Ω.

10.1.4 All electronic instruments must be provided with asset management via software, with a zero adjustment function, span adjustment and other remote configurations via digital data communication. Electronic instruments without management software will be accepted only when an instrument with this function does not exist in the market.

10.1.5 Software and cables for the asset management feature must be provided with the instruments.

10.1.6 All transmitters must be able to set the value of the output signal, programmable in 0% or 100% of the range, in case of failure of the sensor element.

10.1.7 Mechanical instruments must have zero and span adjustments on the instrument body.

10.1.8 The minimum precision of the instruments must be selected according to the table below in order to meet the control and / or monitoring ranges of the process.

10.1.9

Tipo de Medição	Precisão Mínima
Level	≤ ± 0,25 % F.E.
Temperature	≤ ± 0,25 % F.E.
Pressure	≤ ± 1,0 % F.E.
Flow rate	≤ ± 0,15 % F.E.
Conductivity	≤ ± 2,0 % F.E.

TOC	≤ ± 5,0 % F.E.

The 4-wire instruments must have a 4 to 20 mA galvanically isolated output signal.

10.1.10 All transmitters must have local indication.

10.1.11 Whenever possible, the electronic part should be integrally assembled in relation to the sensor part.

10.1.12 Pneumatic instrumentation should be restricted to:

- control valve actuators and positioners,
- actuators and solenoid valves of “ON-OFF” valves,
- electropneumatic converters.

10.1.13 The use of pneumatic instrumentation for measurement and control should be limited to cases where previously requested by Takeda / Baxalta.

10.1.14 Damper actuators for HVAC systems must be electrically powered and in VAVs the BACnet network will be used for control and signaling.

10.1.15 The control valves and automatic “ON-OFF” valves of the utility systems for HVAC, eg cold water, hot water, etc., must use electrically motorized actuators.

10.1.16 The control valves and automatic “ON-OFF” valves for the Clean Utilities and Black Utilities systems should preferably be actuated by pneumatic actuators, being allowed the use of motorized actuators in cases where there is a need or absence of compressed air for instruments.

10.1.17 It must always be checked in the process data whether there are any special conditions.

10.1.18 For instruments installed in clean areas, their enclosures must be at least made of AISI 304 stainless steel with surface roughness of 0.8 µm Ra with mechanical polishing and for wet parts in AISI 316L with surface roughness of 0.38 µm Ra with polishing mechanical according to ISO 1302.

10.1.19 The instruments, especially those applied in critical services or that require special care, must meet the requirements established in the specifications of piping material PRD-PIP-TSP-501, in the constructive aspect (materials, manufacturing process, inspection and tests) . Materials in contact with process fluids must be at least 316L stainless steel, including accessories.

10.1.20 All electronic or electrical components that are subject to attacks by fungi and humidity, must be tropicalized, that is, treated with polyurethane coating or equivalent to inhibit this attack.

10.1.21 The enclosures of local instruments and equipment must have a minimum degree of protection IP-65 according to NBR IEC 60529, except when specified otherwise in the project.

10.1.22 In potentially explosive areas (electrically classified) explosion-proof instruments and accessories must be adopted - Ex-d.

10.1.23 All instruments and electrical equipment must have certificates of type of protection compatible with the respective classification of potentially explosive area. In the case of enclosures that need to be certified in terms of the type of protection and in terms of the degree of protection, both proofs must be explained in the same certificate.

*** Note**: These certificates must be issued by INMETRO or by an accredited body, according to Ordinance No. 179 of 2010.

10.1.24 All instruments must have a calibration certificate with traceability, according to ISO 9000.

10.1.25 Instruments installed in clean areas must have special certificates for pharmaceutical facilities such as EHEDG, FDA and USP Class VI.

10.1.26 The electrical connections of the instruments and automatic valves shall be

10.1.27 Ø = 1/2 ”NPT, except where there is a need for other diameters and types of special threads.

10.1.28 The pneumatic connections of instruments and automatic valves shall be Ø = 1/4 ”NPT, except where there is a need for other diameters and types of special threads.

10.1.29 Calibration and parameterization accessories for hardware and / or software (as part of the instrument or valve assemblies themselves) must be included in the supply of instruments and valves (to enable the definition of operational parameters and performance verification).

10.1.30 The switches must meet the following requirements:

- have your contacts hermetically sealed.
- performance differential must meet the minimum required by the application.
- must have an adjustable actuation point.

- the adjustment devices must be internal; when they have external access, they must be provided with a protective cover.

- the current capacity of the switch contacts must be at least 2 A or, 50% greater than that required in normal operation.
-
- the operating voltage of the switches, in DC or AC, must be compatible with the supply of the circuit to which it is connected.

10.1.31 All instruments must be supplied with nameplates in stainless steel AISI 304 permanently attached to the instruments with tag and serial number. When possible, the serial number can be engraved on the instrument's own body.

10.1.32 For installation of instruments and valves, see item 11 of this document.

10.1.33 Instruments without consolidated use in the desired application should not be specified.

10.1.34 When pertinent, the instruments must present a homologation certificate for the application.

10.1.35 All instruments must be standardized throughout the plant in order to facilitate maintenance.

10.1.36 For eventual instruments mounted on panels, specific technical specifications for the set will be prepared.

10.2 Temperature Instrumentation

10.2.1 Selection Criteria

10.2.2 Local indications shall be made with bimetallic thermometers.

10.2.3 For remote indication, the sensors used shall be thermocouples or thermoresistors.

10.2.4 Temperature sensors must be protected by a thermowell. The sensors shall be provided with a thermowell. Except for the cases mentioned in item 8.2.4.

10.2.5 Sealed expansion systems must not be used.

10.2.6 Thermocouples and Thermoresistors (RTDs)

10.2.7 The nomenclature, materials, requirements, usage limits and thermocouple extension / compensation wires must comply with the IEC 60584 standard. All thermocouples must be type K, except when technically indicated.

10.2.8 Thermocouples and thermoresistors must have mineral insulation and AISI 316 stainless steel sheath. Except for the cases mentioned in item 8.2.4 in which the process conditions require other material.

10.2.9 The outer diameter of the sheath must be Ø = 6 mm.

10.2.10 All connections between the thermocouples and the cables for signal transmission must be made at the head of the thermocouples. Example: extension wires, integral to the thermocouples and the extension cables in multiple thermocouples.

10.2.11 Serial or parallel connection of thermocouples is not acceptable for the measurement of temperature difference or average temperature respectively.

10.2.12 Thermocouples must have an insulated (ungrounded) measuring joint. If there is a need for optimization in response time, the use of a grounded measuring joint or sheath diameter of less than 6 mm should be analyzed.

10.2.13 The thermoresistors must be of the type 3 wires, platinum, standard 100 Ω at 0 °C and must comply with the standards established in the standard IEC 60751.

10.2.14 All accessories, including thermowell, head, terminal blocks and others, must be supplied together by the manufacturer of the thermo-element.

10.2.15 The head cover must be threaded and when not installed in a clean area, it must have a stainless steel retaining chain connected to the body.

10.2.16 The connection of the thermo-element to the thermowell must be in accordance with item 11.1.

10.2.17 Bimetallic Thermometers

10.2.17.1 Bimetallic thermometers must have the following general characteristics:

- dial of at least 114 mm in diameter.
- connection of the thermometer to the thermowell must be according
- to item 11.
- AISI 316L stainless steel rod with an external diameter of 6 mm.
- measurement uncertainty: 1% of the “span”.
- zero adjustment on the pointer.

10.2.18 The scales must have a white background with black characters.

10.2.19 The following standardized values are recommended for the ranges, in °C: -50/0/50; 0/100; 0/150; 0/200; 0/300; 0/400; 0/500 and 0/600.

10.2.20 The normal operating temperature should be close to the center of the scale and the maximum must not exceed 75% of the scale.

10.2.21 In applications subject to vibration or measurement at low temperatures, use bimetallic thermometers with compatible liquid filling.

10.2.22 Only in particular cases, the use of thermometers type "every angle" is acceptable.

10.2.23 Thermowells for Temperature Measurement Elements

10.2.24 All temperature sensing elements must be protected with thermowells. Such wells must be supplied together, by the manufacturer of the sensor elements.

10.2.25 In cases where the use of thermometric protection wells is not applicable, the sheath material must be specified in order to guarantee chemical compatibility with the fluids and the conditions of the environment in which it will be installed. Example: Temperature measurements on bearings of machines and equipment such as pumps, generators, electric motors, industrial fans, on surfaces (“skin point”).

10.2.26 Thermowells must be tapered, machined from a AISI 316 stainless steel hex bar unless process conditions require other material.

10.2.27 When the thermowell is flanged or threaded, the material of the thermowell must be stamped in a visible area.

10.2.28 Thermowell in contact with compendial fluids must be straight and machined from an AISI 316L stainless steel bar.

10.2.29 The connections must be in accordance with item 11.1 and PRD-PIP-TSP-501 piping material specification.

10.2.30 Thermostats

10.2.30.1 Thermostats should not be used in this project.

10.2.31 Transmitters

10.2.31.1 Temperature transmitters must have the following characteristics:

- be electronic, smart and programmable, with signal transmission in the same physical environment as the electrical supply.
- be able to operate at 24 Vdc, with a linear output signal at 4 to 20 mA;
- have input for RTD sensor element or thermocouple.
- provide electrical insulation between input and output.
- be able to identify internal and sensor fault, such as: short circuit or open circuit.

10.3 Pressure Instruments

10.3.1 Selection Criteria

10.3.1.1 Sensor elements of the “Bourdon” type are recommended for local pressure measurement instruments.

10.3.1.2 The operating ranges of the instruments must be chosen so that the normal operating pressure of the process is located in the second third of this range, also observing the maximum operating pressure.

10.3.1.3 The scales and resolutions of the local pressure instruments (manometers) must be selected according to the table below:

10.3.1.4

“RANGES” AND STANDARD RESOLUTIONS FOR GAUGE

“Ranges” (kgf/cm²-g)	**Resolutions**
	Pressure Gauges
0 a 0,06	0,01
0 a 1	0,01
0 a 1,6	0,02
0 a 2,5	0,05
0 a 4	0,05
0 a 6	0,1
0 a 10	0,1
0 a 16	0,2
0 a 25	0,5
0 a 40	0,5
0 a 60	1

	Vacuum Gauge
-1 a 0	0,01
	Mano-Vacumeters
-0,6 a +1	0,02
-1 a +0,6	0,02
-1 a +1,5	0,05
-1 a +3	0,05
-1 a +5	0,1
-1 a +10	0,1
-1 a +15	0,2
-1 a +24	0,5

10.3.1.5 The material of the parts in contact with common fluids (non-compendial fluids) must be AISI 316 stainless steel, when in contact with compendial fluids the material of the parts in contact with the fluid must be AISI 316L stainless steel. These materials can be changed when the process fluid requires another material.

10.3.1.6 The connection to the process must be in accordance with the PRD-PIP-TSP-501 piping specification, the connection diameters must be in accordance with item 11.1.

10.3.2 Pressure gauges

10.3.2.1 The color of the gauge dial must be white and the numbers and characters in black.

10.3.2.2 The pressure gauges must meet the following minimum requirements:

- 100 mm diameter dial.
- connection of the instrument with the accessories according to item 11.1.
- balanced pointer with micrometric adjustment.
- filling with glycerin.
- rupture disc at the rear.
- socket material must be the same as the sensor element.

10.3.2.3 The gauge display must be made of safety glass with at least 75% transparency. The cover of the pressure gauge must be of the bayonet type.

10.3.2.4 The need to use pressure gauges with a solid front in applications where there is a danger to the physical integrity of operators must be verified.

10.3.2.5 The measurement uncertainty must be 1% of the final range value. For differential pressure gauge the maximum allowable uncertainty must be 2% of the final value of the range.

10.3.2.6 Pressure gauges with electrical, digital or pointer contacts to indicate the maximum pressure must not be used.

10.3.2.7 The scale used in the differential pressure gauges should directly indicate the measured pressure differential value.

10.3.3 Transmitters

10.3.3.1 Pressure transmitters must have the following characteristics:

- be electronic, smart and programmable, with signal transmission in the same physical environment as the electrical supply.
- can operate at 24 Vdc, with a linear output signal at 4 to 20 mA.
- be able to identify internal failures.
- All differential pressure transmitters must withstand the maximum design pressure of the associated equipment and piping.

10.3.4 Pressure switches

10.3.4.1 Pressure switches should not be used on this project.

10.3.5 Accessories for Pressure Instruments

10.3.5.1 The pressure gauge with pulsation damper must be installed in service where there is a pulsation of the process fluid, such as in the discharge of alternative pumps and in the suction and discharge of alternative compressors.

10.3.5.2 In cases where the maximum process pressure can exceed the overpressure limit of the instrument, overpressure limiters adjusted to 100% of the full scale value must be provided.

10.3.5.3 In lines and equipment with liquid and at high temperatures, which may damage the instrument, additional length must be provided and installed in the impulse lines, for the necessary thermal dissipation. For applications where the process fluid is steam, use a siphon tube or cooling coil.

10.3.5.4 For lines where the process fluid under operating conditions is corrosive, viscous, solidifiable, crystallizing or has a combination of these properties, pressure instruments must:

- pressure gauges: use a sealing diaphragm.
- transmitters: use diaphragm seal and where necessary use capillary tube sealed together with diaphragm seal.

10.3.5.5 For lines containing compendial fluids, pressure instruments must:

- pressure gauges: use a sealing diaphragm.
- transmitters: use diaphragm seal and, where necessary, use capillary tube in conjunction with upstream diaphragm seal.

10.3.5.6 When selecting the sealing diaphragm, the compatibility of the process fluid, the filling fluid, the diaphragm materials, and the limit of the diaphragm itself must be observed. The diaphragm must be supplied attached to the instrument.

10.3.5.7 Differential pressure instruments must have a "manifold" valve of the integral equalization block type, with "vent" / drain, and connection to the Ø = 1/2 "NPT instrument.

10.3.5.8 The material of the instrument manifold valves must be at least made of AISI 316 stainless steel for common fluids and AISI 316L for compendial fluids and made available at the instrument site for the following services:

- 2-way manifold valve for manometric pressure.
- 5-way manifold valve for differential pressure services.

10.4 Flow Instruments

10.4.1 General

10.4.1.1 In the flow measurement several types of instruments can be used, such as: variable area meters, positive displacement, turbine meters, electromagnetic, vortex, ultrasonic, orifice plates with differential pressure flow transmitters and coriolis, as indicated in the flowcharts of engineering.

10.4.1.2 It is recommended that the normal operating flow be between 50% and 80% of the maximum flow.

10.4.1.3 Instruments for purposes of reading comparison for billing must have certificates for fiscal measurement.

10.4.1.4 Basically, the meters defined below will be used:

- **Electromagnetic type meter** - for chilled water flow; Hot water; Industrial Water; Potable water; Grey water; Recovered Water; Cooling water; Blowdown water; Fire Water; Condensate of Steam; CIP and Effluents.
- **Coriolis type meter** - Purified Water; Water for Injectables (WFI); Pure Steam and Pure Steam Condensate.
- **Vortex type meter** - for compressed air flow in general; Steam; Natural gas; GLP; Gases in general; Nitrogen.
- **Turbine type meter** - Diesel oil.

10.4.1.5 Whenever possible, the instrument should be 24 Vdc with two wires.

10.4.2 Differential Pressure Type Meters

10.4.2.1 Orifice plates

- use concentric-type plates, with straight edges, installed between orifices flanges;
- integral orifices can be used for very low flow rates, in pipes with an internal diameter of less than 50 mm and which do not contain suspended solids.
- the material of the plates must be AISI 316 stainless steel, unless the service conditions require another material.
- the orifice plates must have dimensions and manufacturing tolerances according to the standard ABNT NBR 13225, ISO 5167-1 and 5167-2, for straight board plates.
- orifice flanges must have a minimum pressure rating of 300 psi and must meet the recommendations of the ASME B16.36 standard and have two threaded connections of Ø = 1/2 ”NPT on each flange, one of the connections on each flange it must be supplied closed with a square head plug in the same material as the flange;
- the location of the outlets for straight board plates must take place on the orifice flanges.
- sockets located on the pipe taps should not be used.

- for applications where a flow range of up to 9 to 1 is required, 1 single orifice plate and 2 flow transmitters can be used.

10.4.2.2 Other primary elements

- Turbine meters should not be used in fluids with suspended solids. The specification and installation design must follow the manufacturer's recommendations and API MPMS 5.3.

- Applications:

  - legal metrology systems for low viscosity liquids and gases.
  - in-line mixing systems.

- flow nozzles should only be used in applications where the other primary elements cannot be used, such as:

  - fluid flow measurements at high flow speed, where greater measurement capacity is desired with pressure differentials that are not too high.

  - flows where there may be erosion of the primary element by the passing fluid.

- the construction of the nozzles must follow the ISO 5167-3 standard.

- the “Pitot” and “Pitot” multifuro tubes can be used for flow measurement in systems where pressure drop, which is introduced by the use of other primary elements, is not permissible, being also applicable in ducts and lines of great diameter, where other types of gauges are not recommended. According to ABNT NBR ISO 3966 Technical Standard Flow Measurement in Closed Flues - Velocimetric Method Using Static Pitot Tubes.

10.4.2.3 Calculation of orifice plates:

- when calculating straight edge orifice plates, the methodology described in ISO 5167 should be used, as well as the limits of applicability being respected.

- it is recommended that the pressure differential for calculating the plate, as well as the range of the transmitter be equal to 2,500 mmH20.

- when it is not possible to choose this value, it is suggested to adopt one of the following: 125 mmH2O, 250 mmH2O, 500 mmH2O, 1,250 mmH2O, 5,000 mmH2O, 10,000 mmH2O and 20,000 mmH2O.

- for gases and vapors the maximum differential pressure, in the orifice plate, expressed in kgf / cm², must not exceed 4% of the static pressure, expressed in kgf / cm² absolute.

10.4.3 Transmitters

10.4.3.1 Flow transmitters must meet the following requirements:

- be electronic, smart, and programmable, with signal transmission in the same physical environment as the electrical power supply.
- can operate at 24 Vdc, with a linear output signal at 4 to 20 mA.
- extract the square root of the output signal (differential pressure) and calculate the flow rate for application in indication and control loops.
- all flow transmitters must withstand the respective maximum static design pressures.
- be able to identify internal failures.

10.4.4 Restriction Orifices

10.4.4.1 They are recommended when you want to obtain a permanent pressure drop in a stretch of pipe.

10.4.4.2 The design must be done in accordance with ISO 5167. Other methods can be used, such as BS 1042 for tubes smaller than 50 mm.

10.4.4.3 The plates must be manufactured according to the standards - ISA RP 3.2 / DIN 1952 / BS 1042.

10.4.4.4 The most restrictive standard for the application should always prevail.

10.4.5 Positive Displacement Meters

10.4.5.1 They must be used in liquid flow totalization services, free of particles, where small measurement uncertainty is required.

10.4.5.2 They are not recommended for services with liquids of very low viscosity, capable of flowing through the clearances of the instrument.

10.4.5.3 The filter must be installed upstream of the meter.

10.4.6 Turbine Type Meters

10.4.6.1 Turbine meters should have their application limited to custody transfer systems for billing, where less uncertainty is desired than that achieved by positive displacement meters or differential pressure meters.

10.4.6.2 Turbine-type gauges are not recommended for fluids with suspended solids, corrosive or erosive that shorten the life of the turbine.

10.4.6.3 The choice of the turbine type meter must be in accordance with ABNT NBR ISO 9951 standards - Measurement and gas flow in closed conduits - Meters type turbine and ABNT NBR ISO 14801 - Measurement and gas flow in closed conduits - Meters type turbine - Classification and complementary tests.

10.4.7 Electromagnetic Type Meters

10.4.7.1 Electromagnetic meters should have their applications limited to general liquids with a minimum electrical conductivity of 5 µS / cm, that is, for electrically conductive or water-based fluids.

10.4.7.2 Electromagnetic meters are recommended where it is desired to measure the flow of sludge, effluents, sewage, fluids with suspended solids or other fluids that are difficult to measure with other instruments, such as corrosive and abrasive fluids. They are also recommended where the pressure drop in the pipeline is reduced to a minimum and where it has flowed with viscosity, pressure, temperature, or specific weight varying.

10.4.7.3 Grounding rings must be provided in material compatible with the process fluid, being at least AISI 316.

10.4.7.4 Flow transmitters must meet the following requirements:

- be electronic, smart, and programmable, with signal transmission in the same physical environment as the electrical power supply.
- can operate at 24 Vdc, with a linear output signal at 4 to 20 mA.
- be able to identify internal failures.
- PFA lining material for common fluids; for PFA compendial fluids with a roughness less than 0.81 µm Ra.
- AISI 316 electrode material for common fluids; for AISI 316L compendial fluids with a roughness less than 0.38 µm Ra.
- Sensor (tube) and Transmitter must be integrated. An insertion type meter should not be used.

10.4.7.5 The transmitter must be supplied with a pulse-type output to allow total flow.

10.4.8 "Vortex" type meters

10.4.8.1 It is applied in the volumetric measurement of liquids, steam and clean gases where it is necessary to have a low permanent pressure drop from the meter.

10.4.8.2 In the application of these meters, the following aspects must be observed:

- fluids with suspended and viscous solids should be avoided.
- the correct operation of the meter at the minimum operating flow.
- the electronic part must be integrally assembled in relation to the sensor part.
- Reynolds numbers greater than 20000.

10.4.8.3 Flow transmitters must meet the following requirements:

- be electronic, smart and programmable, with signal transmission in the same physical environment as the electrical power supply.
- can operate at 24 Vdc, with a linear output signal at 4 to 20 mA.
- built-in temperature measurement for flow compensation.
- be able to identify internal failures.

10.4.9 Ultrasonic Meters

10.4.9.1 Ultrasonic flow meters are intended for applications with 100 ppm 100 micron size particulates or bubbles in the liquid, for liquids that have suspended or aerated solids.

10.4.9.2 Applies in the measurement of gases and services with solids.

10.4.9.3 Ultrasonic flow meters should be used for applications where a low pressure drop is required.

10.4.9.4 They must be applied according to the AGA report n ° 9.

10.4.9.5 Ultrasonic meters must:

- be of the transit time type and can be of the external assembly type ("clamp-on") or of the insertion type (with reel).

- be used in large diameter pipes where rangeability greater than 10:1 is required, and no associated pressure drop.

- observe the concepts and recommendations present in the NBR 16198 standard.

10.4.9.6 Flow transmitters must meet the following requirements:

- be electronic, smart and programmable, with signal transmission in the same physical environment as the electrical power supply.

- can operate at 24 Vdc, with a linear output signal at 4 to 20 mA.

- be able to identify internal failures.

- Electronic part integrated with the sensor body.

- They must be fixed. A portable external system should not be used.

10.4.10 Coriolis Type Meters

10.4.10.1 They are mass flow meters, indicated where it is necessary to measure the flow of insulating fluids or of very low conductivity, joint measurement of density and high precision. The associated head loss must be considered.

10.4.10.2 The concepts and recommendations in the NBR 16804 standard must be observed.

10.4.10.3 Flow transmitters must meet the following requirements:

- be electronic, smart, and programmable, with signal transmission in the same physical environment as the electrical power supply.

- can operate at 24 Vdc, with a linear output signal at 4 to 20 mA.

- be able to identify internal failures.

10.4.11 Flow Switches

10.4.11.1 Flow switches (flow switches) should only be used in applications whose function is to detect the presence of flow. When it is necessary to detect pre-

determined values, other than zero, a mesh composed of a flow meter instrument should be used.

10.4.12 Parshall gutter open channel flowmeter

10.4.12.1 The Parshall Gutter is a device for measuring flow in open channels of liquids flowing by gravity.

10.4.12.2 Used in water treatment plants to continuously measure the inflows and outflows of liquids containing superfluous solids from the plant.

10.4.12.3 The Parshall Gutter must be manufactured in PRFV (Polyester reinforced with Fiberglass) in one piece, dimensions standardized according to NBR ISO 9826.

10.4.12.4 It must be supplied with an ultrasonic transmitter with output at 4 to 20mA two-wire system, 24 Vdc electrical supply, with temperature compensation, for flow measurement and pulse output for flow accumulation (totalizer), supplied with complete programming for Level Measurement, Flow Measurement in Open Channel, Triangular Spillways and Parshall Gutter.

10.4.12.5 Body and sensor in plastic material resistant to UV rays, minimum degree of protection IP-66.

10.5 Level Instruments

10.5.1 General

10.5.1.1 The level displays must be used for local indication.

10.5.1.2 For transmission and control, the instruments must be electronic type differential pressure or radar. The other types of instruments, such as: buoyancy, RF-admittance, ultrasonic, conductivity, bubbling, servo-operated and others can be used where their application is strictly necessary due to the process conditions.

10.5.1.3 The level displays and transmitters of the process equipment must be specified to measure levels in all situations necessary for the correct operation of the respective equipment.

10.5.1.4 Basically, the meters defined below will be used:

- **Differential Pressure level meter** - For Process Water level; Purified water; Water for Injectables (WFI); CIP; Effluents; Condensed.

- **Ultrasonic level Meter** - For Water level.

- **Radar level Meter** - For Diesel Oil level

10.5.2 Level Displays

10.5.2.1 The level gauges must be of the reflective type, when used in applications with clear, clean, and non-viscous fluids.

10.5.2.2 Transparent level displays must be used in the following applications:

- dark products.
- differently colored liquid interface.
- distillates with a density below 25 ° API and distilled residues, products that attack glass such as water vapor and caustic soda, and which require the application of Mica or PCTFE (Polychlorotrifluoroethylene) protection.
- when it is necessary to use a flushing system for the display (“flushing”).

10.5.2.3 Level displays with expanded chamber should be used in services where there are:

- viscous liquids.
- suspended solids.
- dissolved gases.
- cases where there are rapid variations in level.

10.5.2.4 Tubular level sight glasses, with protective rods with a length of no more than 760 mm, can be used in non-pressurized vessels operating at temperatures below 90 °C, containing non-flammable, non-toxic and non-corrosive products.

10.5.2.5 The reflective and transparent level displays, of flat glass, should only use sections with glass of nominal size 7 and 9, the maximum number of sections being limited to 5.

10.5.2.6 In cases where it is necessary to indicate the level with heights higher than those indicated in the previous paragraph, as many displays as necessary must be used. In this case, the displays must be superimposed at least 50 mm on the visible part, so as not to lose the continuity of indication.

10.5.2.7 The level displays must cover the ranges of the other level measurement instruments for remote indication, control and alarm.

10.5.2.8 The displays must be supplied with 2 angular-type valves to allow cleaning of the display while the equipment is in operation.

10.5.2.9 Visors must be provided with safety balls and drain and relief valves, with a connection compatible with the piping material specification.

10.5.2.10 The material of the display body must be in accordance with the materials used for the fluid and pressure class of the equipment.

10.5.2.11 Illuminators in transparent displays must be avoided, except when indicating the interface between 2 liquids or where strictly necessary, and the enclosure must have a type of protection compatible with the area classification.

10.5.2.12 In services with fluids of high toxicity or whose properties have changed with the presence of light (peroxides), glass displays should not be used, and magnetic level indicators should be used. For compendial fluids, no type of sight glass should be used.

10.5.2.13 For low temperature applications, the level gauges must be provided with an anti-freeze extension.

10.5.3 Transmitters

10.5.3.1 Level transmitters must have the following characteristics:

- be electronic, smart, and programmable, with signal transmission in the same physical environment as the electrical powe supply.
- can operate at 24 Vdc, with a linear output signal at 4 to 20 mA.
- have elevation and suppression adjustments, and the calculation of these values must be carried out by the detailing project.
- be able to identify internal failures.

10.5.3.2 All parts in contact with the process fluid, such as: flanges, displacers, diaphragms, plugs, must be made of at least AISI 316 stainless steel, except when the process conditions require another material.

10.5.3.3 All level transmitters must be suitable to withstand the design pressure of the associated equipment.

10.5.3.4 The use of differential pressure instruments, with remote diaphragm seals, should be restricted to applications where it is difficult to guarantee the integrity of conventional sealing, such as: interface and density measurements. In such cases, the following aspects must be observed:

- capillaries of the same length, whose lengths are less than 5 m.
- external mechanical protection for capillaries.
- filling fluid compatible with the lowest pressure and the highest process temperature.
- in vacuum applications the transmitter must be positioned below the lower socket.

10.5.4 Level Switches

10.5.4.1 Vibrating or capacitive rod type instruments should be used.

10.5.4.2 The switch contacts must be of the SPDT magnetic type, hermetically encapsulated, the current capacity of the switch contacts must be at least 2 A or, 50% greater than that required in normal operation.

10.5.4.3 The level switches must have an adjustable actuation point; adjustment devices must be internal; when they have external access, they must be provided with a protective cover.

10.5.4.4 The material in contact with the process fluid must be at least AISI 316 stainless steel, except when the process conditions require another material.

10.6 Control Valves

10.6.1 Selection

10.6.1.1 For usual services, the following types of valves, listed below, must be used and the respective limits of applicability must be respected:

- diaphragm valves.
- rotary valves (Ball, Butterfly).
- conventional single seated or double seat globe valves.
- 3 way globe valves.

*** Note**: Other types of valves can be used in cases where the mentioned types cannot be applied.

10.6.1.2 Basically, the valves defined below will be used:

- Clean Utility Lines (Liquid and gases up to 150 ° C)

- Diaphragm Valve (Control)

- Clean Utility Lines (Steam)
- Ball Valve (Control)

- General Utility Lines
- Globe Valve (Control)

10.6.1.3 The use of frequency inverters (“variable speed drivers”) to control the rotation of electric motors should be considered as an alternative to the use of control valves, in the processes where the valves are being used to regulate the outflow, equipment driven by an electric motor, with no flow diversions between the equipment and the valve. Examples: discharge of pumps and fan dampers.

10.6.1.4 Balanced cage type valves should be used in high ΔP applications, except for dirty fluids, with suspended solids or very viscous.

10.6.1.5 Globe control valves must be of the type of reversible bodies.

10.6.1.6 For selection between conventional globe valves, single seat or double seat, the following criteria must be observed:

- simple seat: sealing class higher than III; (according to FCI 70-2 standard) lower controllable minimum flow or body less than Ø = 1 1/2 ”;

- double seat: sealing class equal to or less than III and high ΔP values.

10.6.1.7 Double seat shutters must be provided with guides at the top and bottom.

10.6.1.8 Butterfly valves can be applied where high CV flow coefficient is required, replacing globe valves.

10.6.1.9 For butterfly valve applications, where leaks are not allowed, seats with special anti-leakage materials can be used, respecting the pressure and temperature limitations of the materials.

10.6.1.10 The use of self-operated and pilot operated valves for pressure, level and temperature control is permitted as long as the related maximum process variations are small.

10.6.1.11 The ball valves can be used in large flows of liquids with suspended solids, where the ΔP is high, for cutting operations or "ON-OFF" control.

10.6.1.12 Divergent / convergent 3-way globe valves can be used in services where a deviation / flow mixture is required, as long as the controllability limits and the

maximum diameter of 6 ”are observed. As an alternative, you can use 2 valves in “split-range” configuration.

10.6.2 Inherent Flow Characteristic

10.6.2.1 The flow characteristic must be chosen according to the following criteria: either X = (ΔP) / (ΔPs), where: ΔP is the pressure differential in the valve under the normal operating flow condition, ΔPs is the dynamic pressure differential total system in which the valve is inserted, including the ΔP of the valve itself, in the normal flow of operation. Therefore, static pressure values should not be considered, so:

- for X ≥ 0.6 use a linear characteristic.
- for 0.4 <X <0.6 use modified parabolic characteristics.
- for 0.3 ≤ X ≤ 0.4 use characteristic equal percentage.
- care must be taken in cases where X <0.3, as the control capacity of the valve is compromised in this range.

10.6.2.2 The following aspects should also be considered:

- exceptionally, when the pressure drop is not known, an equal percentage characteristic should be used.
- in cascade control, the selection of characteristics of the control valve must consider only the secondary mesh.
- Compressor recycle valves must have linear characteristics.

10.6.2.3 For modified parabolic flow characteristics, “V-port” type shutters should be preferred for reasons of rangeability.

10.6.2.4 The flow characteristic chosen can be obtained both by the valve plug, as well as using an appropriate positioner.

10.6.3 Constructive Features

10.6.3.1 General

10.6.3.1.1 conventional globe valves should be, whenever possible, of the type with upper and lower guides.

10.6.3.1.2 contour shutters must be used.

10.6.3.1.3 type “V” obturator must be restricted in use, and its application in fluids containing solid particles in suspension and high ΔP is not allowed.

10.6.3.1.4 the cage and conventional globe valves, with a diameter greater than or equal to 1 1/2 ”, must be of the flow type tending to open;

10.6.3.1.5 the sealing class of the control valves must follow the FCI 70-2 standard, in cases where total sealing is explicitly required, the sealing class of the control valves must follow the requirements of the API STD 598 standard.

10.6.3.1.6 sealing class VI valves must be of the flow type tending to close, unless the valves:

- the sound fails to open and operate with high ΔP;
- will operate with nominal CV less than 30% of the selected valve CV;
- are rotating eccentric;
- control valves must be provided with AISI 304 stainless steel nameplates, permanently attached to the valve body, with engraving of the respective “TAGs”, CV, model, body material, manufacturer, diameter, type, characteristic, class pressure and serial number.

10.6.3.2 Connections

10.6.3.2.1 the types and materials of valve connections will obey the piping specification in which the valve is installed, except when the piping specification requires valves with threaded or welded connections, in these cases they must be used with flanged ends.

10.6.3.2.2 the smallest permitted control valve body is 3/4 ”.

10.6.3.2.3 under no circumstances should a control valve be used with a body diameter less than half the nominal pipe diameter.

10.6.3.2.4 Valves with diameters of 1 1/4 ”, 2 1/2”, 3 1/2 ”, 4 1/2”, 5 ”and 7” must not be used.

10.6.3.3 Bonnet

10.6.3.3.1 bonnets without extension must be used in the range of 0 °C and 200 °C.

10.6.3.3.2 outside these limits, bonnets with flat or finned extension must be used.

10.6.3.3.3 all valves must have an open position indicator by means of devices connected to the stem or shaft.

10.6.3.4 Materials

10.6.3.4.1 the material for the manufacture of the control valve body must be in accordance with the PRD-PIP-TSP-501 piping material specification.

10.6.3.4.2 the shutters and seats (internal) must be manufactured, at least, in stainless steel AISI 316.

10.6.3.4.3 the guides of the shutters must be made of a material of greater hardness than those of the shutters, such as: stainless steel 420.

10.6.3.4.4 the rods must be manufactured, at least, in stainless steel AISI 316, coated to obtain the hardness required by the application.

10.6.3.4.5 other materials must be used when required by the process conditions.

10.6.3.4.6 hardened trim must be used in the following cases:

- fluid temperature above 300 °C.
- ΔP greater than 7 kgf / cm².
- fluids containing solid particles.
- vaporization.

10.6.3.4.7 the packing material must be PTFE except when technically contraindicated.

10.6.3.4.8 the use of a lubricator is not permitted.

10.6.3.5 Design

10.6.3.5.1 For the design of control valves, the ISA 75.01.01 standard must be used, and the following items must also be checked:

- rangeability (CVMÁX / CVMIN).
- type of flow (subcritical, vaporization, cavitation and biphasic);
- influence of viscosity.
- noise level according to ISA 75.17 and IEC 60534-8-4.
- speed limit at the valve inlet.

- minimum diameter in compressible flows, to avoid sonic speeds.

10.6.3.5.2 As for rangeability, the following criteria must be observed:

- the maximum flow to be controlled must be limited to 90% of the available stroke of the control valve.
- the minimum flow to be controlled must be limited to 10% of the available stroke of the control valve.
- considering the minimum, normal and maximum flow through the valve, the flow coefficient chosen for the valve (valve CV) must be:
    - o (CVMIN / CV) > 0.10;
    - o 0.30 < (CVNORMAL / CV) < 0.70;
    - o (CVMAX / CV) < 0.90.
- if it is not possible to fit these limits, 2 or more control valves must be used, in a “split range” configuration.

10.6.3.5.3 Incipient or total cavitation is undesirable, so it is necessary to eliminate this condition in the project, using one of the following alternatives:

- select control valve such that its pressure recovery factor eliminates the cavitation condition.
- install one or more control valves downstream of the control valve initially considered, in order to reduce the value of ΔP in the valve, in this case, it is necessary to ensure that none of these valves are still in cavitation.
- use a control valve with anti-cavitation internals.

10.6.3.5.4 It is not acceptable to use restriction holes to reduce or eliminate cavitation conditions.

10.6.3.5.5 As for the noise generated by the control valves, the following items must be observed:

10.6.3.5.6 maximum permissible noise level is 82 dbA at 1 m from the valve;

10.6.3.5.7 control valves operating at a noise level above the established maximum limit are undesirable, therefore it is necessary to eliminate this condition, in the project, through one of the following alternatives:

- install one or more control valves downstream of the control valve initially considered, in order to reduce the value of ΔP in the valve, in this case, it is necessary to ensure that none of these valves is still exceeding the maximum permissible noise limit.

- use control valve with low noise trim.

10.6.3.5.8 for gas applications, external anti-noise devices can also be used.

10.6.3.5.9 external noise reduction devices have a noise reduction capacity limitation of 20 dB to 25 dB.

10.6.3.5.10 It is not acceptable to use restriction orifices to reduce or eliminate the condition of excessive noise.

10.6.3.5.11 In general, valves with an inherent characteristic of equal percentage should not have more than 85% of the stroke at normal flow and valves with linear characteristic, 60% of the stroke at normal flow.

10.6.3.5.12 3-way valves must have a linear characteristic and the selected CV must be immediately above the calculated CV, for maximum flow conditions, without a safety factor. Butterfly valves must be dimensioned for a maximum opening angle of 60 °.

10.6.3.6 Pneumatic Actuators

10.6.3.6.1 The actuators of the control valves of the "Clean Utilities" and "Black Utilities" systems (see item 8.1) must be pneumatic with spring return.

10.6.3.6.2 Whenever possible, for diaphragm actuators, the operating range should be 0.2 to 1.0 kgf / cm²-g for normal applications and 0.4 to 2.0 kgf / cm²-g for applications high ΔP.

10.6.3.6.3 For piston-type actuators, the upper range value must be 4.5 kgf / cm²- g.

10.6.3.6.4 The selection of the actuators must be made after choosing the size and type of the control valve, considering the maximum pressure differential to which it must be subjected, when fully closed. This differential must be less than the maximum acceptable differentials for each type of actuator, according to values provided by the manufacturers.

10.6.3.6.5 The performance speeds must be observed as to their suitability for the processes in which they must operate.

10.6.3.6.6 To regulate the actuation speeds, the use of flow regulators for the compressed air of the instrument should be foreseen.

10.6.3.6.7 The action of the valve / actuator assembly must be as required by the project, for the safety of the plant. Examples: fault opens, fault closes or stationary fault.

10.6.3.6.8 The fail-safe mode of a piston-type actuator, without return spring, is only possible with the use of a capacity tank, which must be supplied with the valve for this application. The manufacture of the tank must meet the specifications relevant to the piping or pressure vessels, in accordance with regulatory standard Nº. 13 (NR-13).

10.6.3.7 Motorized Actuators

10.6.3.7.1 The motorized actuators for activating the dampers and control valves of the HVAC systems must be supplied complete, with a command and control unit in the actuator itself.

10.6.3.7.2 The actuators for control valves must have modular control from 0 to 100%.

10.6.3.7.3 Motorized actuators must communicate via hardwired signals.

10.6.3.7.4 The valves / actuators must be supplied with a local position switch /indicator, open, closed and stop position indicators, local control for the open, close, stop and local / remote / off functions.

10.6.3.7.5 The actuator must be sized to a torque corresponding to the maximum pressure of the pressure class of the valve to be actuated.

10.6.3.7.6 The boxes of the electrical devices for command, protection and control, must be supplied with a drilling of Ø = 1” NPT.

10.6.3.7.7 Local commands must be carried out using push-button buttons for the open, close and stop functions.

10.6.3.7.8 Local commands for the local / remote / off functions must be performed using a selector switch. This selector switch must be able to be locked / locked in the off position.

10.6.3.7.9 They must be supplied with set 2 (two) torque wrenches. These tools must be easy to adjust.

10.6.3.7.10 Motorized actuators must be provided with a handwheel for operation in the event of failure.

10.6.3.7.11 The actuators of the motorized control valves and dampers for application in HVAC systems should preferably be without spring return. The rotation range of the motorized actuators must be greater than 90 °. Actuator supply should preferably be at 24 Vdc.

10.6.3.7.12 The selection of the actuators must be made after choosing the type and size of the valve or damper considering the maximum differential pressure to which it will be subjected when fully closed. This pressure differential must be less than the maximum differential pressure accepted by the actuator.

10.6.3.7.13 The speed of action must be observed as to its suitability for the processes in which they must operate.

10.6.3.7.14 The action of the valve / actuator or damper / actuator assembly must be as required by the project, for the safety of the plant. Example: fault opens, fault closes, or fault holds in position.

10.6.3.8 Electropneumatic Positioners

10.6.3.8.1 Except for motorized valves, electropneumatic positioners should always be used, except in the following cases:

5.1. when the response time required in the application is less than the response time obtained with the positioner and actuator assembly.

5.2. in 2-position control (“ON-OFF”).

10.6.3.8.2 The positioners must be of the electro-pneumatic type, except in cases of excessive vibration in the actuator / positioner assembly.

*** Note:** In these cases, it is recommended to use a pneumatic positioner and I / P converter, mounted on a support that is not subject to vibration.

10.6.3.8.3 Electropneumatic and pneumatic positioners must be fitted with pressure gauges to indicate the supply air pressure and the positioner output signal.

10.6.3.8.4 Pneumatic positioners must be contoured (by-pass) to allow the pneumatic control signal to be applied directly to the positioner output.

10.6.3.8.5 Except for the following cases:

- valves in “split-range” configuration.
- positioners that need to operate in reverse action.
- actuators that need to operate in the "range" from 0.4 kgf / cm² to
- 2 kgf / cm².

10.6.3.9 Accessories

10.6.3.9.1 Handwheels should be used to manually activate the control valves in the event of a power failure or emergency intervention.

10.6.3.9.2 Handwheels should not be used on self-operated valves.

10.6.3.9.3 The lock-up valve accessory is used when it is desired that the valve remains in its last control position ("fail locked"), in case of supply air failure.

10.6.3.9.4 All limit switches for the position of the control valves or dampers must not be mechanically operated.

10.6.3.10 Solenoid valves

10.6.3.10.1 the solenoid valves must be of the compact type, without packing and internal in resilient materials.

10.6.3.10.2 must be electrically driven, at 24 Vdc and power not exceeding 2 W.

10.6.3.10.3 the connections of the body of the solenoid valves must be threaded Ø = 1/4" NPT, unless a larger diameter is required to increase the actuation speed of the valve.

10.6.3.10.4 the insulation class of the solenoid valve coils must be suitable for the ambient temperature, with the minimum allowable class being class H.

10.6.3.10.5 the body must be made of AISI 316 stainless steel.

10.6.3.11 Regulator Filter Assembly

10.6.3.11.1 The regulating filter assembly is a mandatory accessory and its material must be suitable for the fluid and local environmental conditions. It must be provided with a coalescing filter.

10.7 "ON-OFF" valves

10.7.1 Selection

10.7.1.1 The types of automatic "ON-OFF" valves will follow the specification of piping materials, except for gate valves that will not be used for automatic "ON-OFF" valves. In this case, the use of ball or butterfly valves will be evaluated.

*** Note:** Other types of automatic valves can be used in cases where the mentioned types cannot be applied.

10.7.1.2 The automatic “ON-OFF” valves must be provided with a solenoid valve and limit switches with local indication of open and closed position and regulating filters.

10.7.1.3 To prevent contamination of the classified (clean) areas, the automatic valves installed in these areas should not be provided with local solenoids. The limit switches for position indication will be installed only where necessary.

10.7.1.4 In these cases, the automatic valves installed in clean areas, the actuation will be through blocks of solenoid valves installed in panels outside the clean area. These solenoid valve blocks will communicate with the PLC via an Ethernet field network.

10.7.1.5 The “ON-OFF” valves must be provided with nameplates in AISI 304 stainless steel, permanently attached to the valve body, with engraving of the respective “TAGs”, model, body material, manufacturer, diameter, type, and class of pressure.

10.7.2 Connections

10.7.2.1 The types and materials of valve connections will obey the piping specification in which the valve is installed, except when the piping specification requires valves with threaded or welded connections, in these cases they must have flanged connections.

10.7.2.2 Valves with diameters of 1 1/4 ”, 2 1/2”, 3 1/2 ”, 4 1/2”, 5 ”and 7” must not be used.

10.7.3 Materials

10.7.3.1 The material for the manufacture of the body of the “ON-OFF” valves must be in accordance with the PRD-PIP-TSP-501 piping material specification.

10.7.3.2 The shutters and seats (internal) must be manufactured, at least, in stainless steel AISI 316.

10.7.3.3 The guides of the shutters must be made of a material of greater ardness than those of the shutters, for example: stainless steel AISI 420.

10.7.3.4 The rods must be manufactured, at least, in stainless steel AISI 316, coated in order to obtain the hardness required by the application.

10.7.3.5 Other materials must be used when required by the process conditions.

10.7.3.6 Hardened trim must be used in the following cases:

- fluid temperature above 300 ° C.
- fluids containing solid particles.

10.7.3.7 The gasket material must be PTFE except when it is technically contraindicated.

10.7.4 Pneumatic Actuators

10.7.4.1 The actuators of the automatic “ON-OFF” valves of the "Clean Utilities" and "Black Utilities" systems (see item 8.1) should preferably be pneumatic with spring return.

10.7.4.2 The action of the valve / actuator assembly must be as required by the project, for the safety of the plant. Examples: failure opens or failure closes.

10.7.5 Motorized Actuators

10.7.5.1 The actuators of motorized “ON-OFF” valves and dampers for application in HVAC systems should preferably be spring return. The rotation range of the motorized actuators must be greater than 90 °. Actuator supply should preferably be at 24 Vdc.

10.7.5.2 Motorized actuators must be supplied complete with a command and control unit on the actuator itself.

10.7.5.3 Motorized actuators must communicate via hardwired signals.

10.7.5.4 The valves must be supplied with a local position switch / indicator, open, closed and stop position indicators, local control for the open, close, stop and local / remote / off functions.

10.7.5.5 The actuator must be sized for a torque of at least 25% more than the shut-off differential pressure of the valve to be actuated.

10.7.5.6 The boxes of the electrical devices for command, protection and control, must be supplied with a Ø = 1 ”NPT hole.

10.7.5.7 Local commands must be carried out using push-button buttons for the open, close and stop functions.

10.7.5.8 Local commands for the local / remote / off functions must be performed using a selector switch. This selector switch must be able to be locked / locked in the off position.

10.7.5.9 They must be supplied with set 2 (two) torque wrenches. These keys must be easy to adjust.

10.7.5.10 Motorized actuators must be provided with a handwheel for operation in the event of failure.

10.7.5.11 The actuator selection must be made after choosing the type and size of the valve or damper considering the maximum differential pressure to which it will be subjected when fully closed. This pressure differential must be less than the maximum differential pressure accepted by the actuator.

10.7.5.12 The speed of action must be observed as to its suitability for the processes in which they must operate.

10.7.5.13 The action of the valve / actuator or damper / actuator assembly must be as required by the project, for the safety of the plant. Example: fault opens, fault closes, or fault holds in position.

10.7.6 Accessories

10.7.6.1 Solenoid valves

10.7.6.1.1 The solenoid valves must be in accordance with item 8.6.3.9.1.

10.7.6.2 Regulator Filter Assembly

10.7.6.2.1 The regulating filter assembly is a mandatory accessory and it material must be suitable for the fluid and local environmental conditions. It must be provided with a coalescing filter.

10.7.6.3 Limit Sensors

10.7.6.3.1 The limit sensors must be of the inductive type, with local indication of "actuated" or "not actuated".

10.7.6.3.2 The limit sensors of the valves in hazardous (clean) areas will be connected to the interface devices of communication with the PLC through an Ethernet field network. These devices will be located on the solenoid valve block panels.

10.8 Safety and Relief Valves

10.8.1 Selection and Dimensioning

10.8.1.1 The design of relief and safety valves will be in accordance with ASME section I and section VIII in its latest edition.

10.8.1.2 The conventional relief and safety valve must be used in applications with non-toxic, non-viscous or non-corrosive fluids and when the following condition occurs: the value of the superimposed back pressure is constant or variable

less than (PAJ -1.1 POP) and the value of the developed back pressure is variable less than 0.1 PAJ, where:

- PAJ is the PSV adjustment pressure.
- POP is the equipment's normal operating pressure.

10.8.1.3 The balanced relief and safety valve must be used in applications with toxic, viscous, corrosive fluids or when the following condition occurs: the value of the superimposed back pressure is greater than (PAJ - 1.1 POP) or the value of the back pressure developed is greater than 0.1 PAJ, where:

- PAJ is the PSV adjustment pressure.
- POP is the equipment's normal operating pressure.

10.8.1.4 The pressure limits to which the bellows can resist must be respected. Otherwise, operated pilot valves must be used.

10.8.1.5 For material selection, the design values must be the set pressure and the design temperature or, if this is not available, the maximum operating temperature. For example, in the case of sizing for the fire condition, the materials must be chosen considering the values of the setting pressure and the maximum operating temperature, although the orifice is calculated with the inlet temperature in the valve when in the condition of fire.

10.8.1.6 The value of the set pressure of the valve must be equal to the design pressure of the equipment, according to the standard ASME Section VIII Div. 1 UG 125 and UG 134. If necessary, the valve can be adjusted to the maximum allowable working pressure (MAWP - “Maximum Allowable Working Pressure”).

10.8.1.7 For gas applications, only when the process data for gas is not known, the compressibility factor (Z) and the relationship between the specific heats (k = Cp / Cv) must be assumed to be 1 and 1.4 respectively.

10.8.1.8 The reset pressure of the relief and safety valves must always be higher than the operating pressure, thus preventing leakage from occurring in the valve under normal operating conditions.

10.8.2 General Features

10.8.2.1 Safety valves must have their connections as specified in piping materials. When the specification of piping materials allows threaded connections, they can be used in the following cases:

- used for thermal relief;
- with input ≤ 1 ".

10.8.2.2 The safety and relief valves must be of the full nozzle type. Valves of the reduced nozzle type are only allowed in the following cases:

- for thermal relief in pipes;
- in applications with high pressures and high temperatures when the inlet connections are of the welded socket type.

10.8.2.3 The safety and relief valves must be of the calibrated orifice type, with compressed spring, except in cases where technically contraindicated.

10.8.2.4 Conventional safety and relief valves must have castles and screw plugs. Balanced valves must have closed, vented castles and threaded plugs. For use with steam (ASME standard section I) the valve must be open boned with a lever.

10.8.2.5 The materials of the relief and safety valves must be compatible with the process and environmental conditions, and the materials must be equivalent or better than those listed below:

- carbon steel body and bonnet.
- nickel-plated carbon steel spring.
- AISI 316 stainless steel trim.
- AISI 410 stainless steel rod.
- AISI 316 stainless steel guide.
- AISI 316 stainless steel bellows.

10.8.3 Technical Requirements

10.8.3.1 In the certified drawings of the relief and safety valves, the spring pressure range must be included. The valve must allow adjustments of: ± 10% at the specified relief pressure, for pressures ≤ 18 kgf / cm², and ± 5% at the specified relief pressure, for pressures> 18 kgf / cm².

10.8.3.2 The spring adjustment screw must be protected by a hood (threaded or screwed).

10.8.3.3 All safety and relief valves must have capacity certificates as required by ASME Section VIII Div. 1.

10.8.3.4 Relief and safety valves must be provided with nameplates in stainless steel AISI 304, permanently attached to the valve body, with the recording of the respective tags, setting pressure, model, manufacturer, diameter, type and pressure class input and output connections and other main features.

10.8.4 Accessories

10.8.4.1 Blocking for hydrostatic test ("test gag") is only required when it is necessary to keep the relief and safety valve locked, during tests on the equipment at a pressure higher than the set pressure and where it is not possible to remove the valve.

10.9 Pressure and Vacuum Relief Valves

10.9.1 The selection and dimensioning of pressure and vacuum relief valves must follow the API STD 2000 standard.

10.9.2 Normally the pressure and vacuum relief valves must be of the "with counterweight" type. In pressurized tanks, operated pilot type valves can be used.

10.9.3 The sizing criterion should be that of product entry and exit, unless technically contraindicated.

10.10 Rupture Disc

10.10.1 Rupture discs must be used in services with corrosive and / or solidifying fluids, to allow complete isolation of the safety or relief valve, from contact with such fluids.

10.10.2 The rupture discs can also be used without safety valves, for application in processes with compendial fluids, where the accumulation and impregnation of substances is not allowed.

10.10.3 The rupture discs must be of the non-fragmentative type and with a crease, that is, there should be no disc material coming off at the rupture; providing a complete and unobstructed opening, it must also have a disk rupture alarm system.

10.10.4 The limit of error of ± 5% in the burst pressure must be guaranteed by the manufacturer of the rupture discs.

10.10.5 The rupture pressure value of the disc must be equal to the value of the design pressure of the equipment, and the opening pressure of the associated safety valve must be adjusted 5% below this value.

10.10.6 For the design of the safety and relief valve, the effect of loss of capacity due to the use of the rupture disc must be considered.

10.10.7 Pressure gauge and drain valve must be installed between the rupture disc and the safety and relief valve inlet.

10.10.8 The rupture discs must contain rupture sensors for alarm in the supervision and control system.

10.11 Analyzers

10.11.1 The analyzer must be supplied with the necessary accessories to allow a simple calibration on the spot, without having to connect or disconnect tubes.

10.11.2 The use of analyzers whose operation requires periodic replacement of the analysis cell should be avoided.

10.11.3 Conductivity Analyzers

10.11.3.1 Conductivity analyzers must be suitable for direct measurement in pipes, with Tri Clamp connections, and must have a minimum measuring capacity of 0.05 µS / cm.

10.11.3.2 These analyzers must have a temperature sensor type Pt-100 or Pt-1000 integrated in the conductivity measurement cell and use MEMOSENS technology or similar.

10.11.3.3 The need to use a retractable system in each application of these analyzers must be verified, the use of this system will only be in cases that are strictly necessary, and when it is not possible to release the analyzer installation site.

10.11.3.4 In cases where the fluid is fouling, the measuring cell must be self-cleaning.

10.11.3.5 The analyzers must be supplied with a cable to interconnect the analysis cell with the transmitter.

10.11.3.6 The transmitters must be suitable for measuring and transmitting conductivity and temperature and must meet the following requirements:

- be electronic, smart and programmable, with signal transmission in the same physical environment as the electrical power supply.

- can operate at 24 Vdc, with linear output signals at 4 to 20 mA.
- be able to identify internal failures.

10.11.3.7 These transmitters can be multiparameter accepting two or more sensors from the same system.

10.11.3.8 If the sensor requires solutions or other products for calibration, ‘testing and cleaning the analyzer, these must be supplied with the analyzers.

10.11.4 ORP (Oxy-Reduction Potential) Analyzers

10.11.4.1 ORP analyzers must be suitable for direct measurement in pipes, with an appropriate connection for the process (Tri Clamp, Thread, etc.).

10.11.4.2 The need to use a retractable system in each application of these analyzers must be verified, the use of this system will only be in cases that are strictly necessary, and when it is not possible to release the analyzer installation site.

10.11.4.3 In cases where the fluid is fouling, the measuring cell must be self cleaning.

10.11.4.4 The analyzers must be supplied with a cable to interconnect the analysis cell with the transmitter.

10.11.4.5 Transmitters must be suitable for ORP measurement and must meet the following requirements:

- be electronic, smart and programmable, with signal transmission in the same physical environment as the electrical supply;
- can operate at 24 Vdc, with a linear output signal at 4 to 20 mA;
- be able to identify internal failures;

10.11.4.6 These transmitters can be multiparameter accepting two or more sensors from the same system.

10.11.4.7 If the sensor requires solutions or other products for calibration, testing and cleaning the analyzer, these must be supplied with the analyzers.

10.11.4.8 Where it is necessary to install pH and ORP sensors on the same line and current / flow, this measurement can be on the same sensor.

10.11.5 Ozone Analyzers

10.11.5.1 Ozone analyzers must be suitable for direct measurement in pipes, with an appropriate connection for the process (Tri Clamp, Thread, etc.).

10.11.5.2 The need to use a retractable system in each application of these analyzers must be verified, the use of this system will only be in cases that are strictly necessary, and when it is not possible to release the analyzer installation site.

10.11.5.3 In cases where the fluid is fouling, the measuring cell must be self cleaning.

10.11.5.4 The analyzers must be supplied with a cable to interconnect the analysis cell with the transmitter.

10.11.5.5 The transmitters must be suitable for measuring ozone and must meet the following requirements:

- be electronic, smart and programmable, with signal transmission in the same physical environment as the electrical power supply.
- can operate at 24 Vdc, with a linear output signal at 4 to 20 mA.
- Be able to identify internal failures.

10.11.5.6 These transmitters can be multiparameter accepting two or more sensors from the same system.

10.11.5.7 If the sensor requires solutions or other products for calibration, testing and cleaning the analyzer, these must be supplied with the analyzers.

10.11.6 pH analyzers

10.11.6.1 The pH analyzers must be suitable for direct measurement in pipes, with an appropriate connection for the process (Tri Clamp, Thread, etc.).

10.11.6.2 The analyzers must be supplied with a cable to interconnect the analysis cell with the transmitter.

10.11.6.3 The necessity of using a retractable system in each application of these analyzers must be verified, the use of this system will only be in cases that are strictly necessary, and it is not possible to release the analyzer installation site.

10.11.6.4 In cases where the fluid is fouling, the measuring cell must be self-cleaning.

10.11.6.5 The pH sensors must have an integrated temperature sensor type Pt-100 or Pt-1000.

10.11.6.6 The transmitters must be suitable for pH measurement and must meet the following requirements:

- be electronic, smart and programmable, with signal transmission in the same physical environment as the electrical power supply.
- can operate at 24 Vdc, with a linear output signal at 4 to 20 mA.
- be able to identify internal failures.

10.11.6.7 These transmitters can be multiparameter accepting two or more sensors from the same system.

10.11.6.8 If the sensor requires solutions or other products for calibration, testing and cleaning the analyzer, these must be supplied with the analyzers.

10.11.6.9 Where it is necessary to install pH and ORP sensors on the same line and current / flow, this measurement can be on the same sensor.

10.11.7 TOC analyzers

10.11.7.1 The TOC (Total Organic Carbon) analyzers will be installed on wall brackets or on pedestal type brackets. A socket must be provided in the piping to continuously collect the process samples with a blocking valve, this socket must be positioned 30 ° to 60 ° from the bottom of the tube. Where the analyzers are installed, a drainage point must be provided for disposal of the analyzed fluid.

10.11.7.2 The necessity of using a retractable system in each application of these analyzers must be verified, the use of this system will only be in cases that are strictly necessary, and it is not possible to release the analyzer installation site.

10.11.7.3 Electricity at 220 Vac must be provided to supply the sensor and, if necessary, the TOC analyzer pump.

10.11.7.4 The analyzers must be supplied with a cable to interconnect the TOC sensor with the transmitter and other accessories necessary for proper functioning.

10.11.7.5 TOC analyzers must be provided with an automatic system to perform calibration and suitability testing without the need to manually change tubes containing standard solutions.

10.11.7.6 The transmitters must be suitable for measuring and transmitting TOC and conductivity and must meet the following requirements:

- be electronic, smart and programmable, with signal transmission in the same physical environment as the electrical power supply.

- can operate at 24 Vdc, with linear output signals at 4 to 20 mA.
- be able to identify internal failures.

10.11.7.7 These transmitters can be multiparameter accepting two or more sensors from the same system.

10.11.7.8 If the sensor requires solutions or other products for calibration, testing and cleaning the analyzer, these must be supplied with the analyzers.

10.11.8 Moisture Meters

10.11.8.1 Moisture meters must be able to measure 0 to 100% relative humidity.

10.11.8.2 The humidity meters should preferably have a temperature sensor type Pt 100 or Pt-1000 integrated in the same instrument and may also have a pressure sensor.

10.11.8.3 Moisture meters must be suitable for mounting on walls or ducts.

10.11.8.4 Transmitters must meet the following requirements:

- be electronic, smart, and programmable.
- the output signals must be independent for humidity, temperature and pressure, all outputs must be at 4 to 20 mA.
- be able to identify internal failures.
- Electrical supply at 24 Vdc or 220 Vac.

10.11.8.5 These transmitters can be multiparameter accepting two or more sensors from the same system.

11. SOLENOID VALVE PANELS

11.1. The solenoid valve panels for controlling the “ON-OFF” valves installed in clean areas, must consist of solenoid valve blocks, discrete input modules for valve limit switches, modules for Ethernet TCP / IP network communication, 24 Vdc power supplies, air handling units with pressure regulating filters, automatic drains, pressure transmitter and instrument air supply header.

11.2. All terminals with discrete signals must have fuses to individualize the protection and signaling of the operation with LED indication.

11.3. The supply of these panels must be 220 Vac.

11.4. These panels and internal equipment must be protected by circuit breakers.

11.5. The panels must be dimensioned considering an installed reserve of 20% of the installations.

11.6. The electrical and pneumatic connections must meet the requirements of items 11.2 and 11.3 of this document.

11.7. The equipment and accessories of the panels must be mounted on mounting plates.

11.8. The cables destined to interconnect the equipment mounted inside the panel must meet the requirements of item 12 of this document. These cables must be identified according to the panel design documentation.

11.9. These panels must have internal lighting, activated by microswitches located on the panel doors, and service outlets at 220 Vac.

11.10. The panels must be self-supporting with the characteristics described in item 10 of this document.

11.11. The panels must be supplied completely assembled, with all equipment and accessories.

11.12. For these panels, a technical specification must be prepared for purchase, considering all components of the same.

12. PANELS / JUNCTION BOXES

12.1. The panels and junction boxes must be made of carbon steel plate with electrostatic painting. The panels and junction boxes installed in classified (clean) areas must be made of AISI 304 stainless steel with mechanically polished external surfaces. All openings must be provided with an adequate seal.

12.2. All panels and junction boxes must have a minimum degree of protection IP-54, front doors with lock and key, and mounting plate.

12.3. The surfaces of the panels and boxes must be flat and designed in such a way as to avoid the accumulation of substances.

12.4. All panels must meet the requirements of NR-10 and NBR-5410.

12.5. Conductors and Terminals

12.5.1 The internal electrical wiring must be composed of cables with thermoplastic insulation, and the cables of analog and digital signals must be routed separately to the power and control cables.

12.5.2 Conductors must be identified with sleeve wire markers.

12.5.3 Conductors shall meet ABNT - Brazilian Association of Technical Standards requirements for their use. Conductors for 24 VDC wiring may be rated for 300 Volts, all other wiring wil be rated 450/750 Volts. 24 VDC digital wiring shall be 1.5 mm2 minimum size and no less 19 strands (class 5) and 24 VDC analog wiring shall be 1.0 mm2 minimum size. 220 VAC wiring shall be 2,5 mm2 minimum size.

12.5.4 Conductors shall have Type XLPE/HPR-PVC insulation suitable for the purpose and installation.

12.5.5 Conductors and cable shall have a minimum insulation temperature rating 90 degrees Celsius.

12.5.6 Conductors shall have Roof with PVC, PE or LSZH materials (halogen free).

12.5.7 All panel cables must use tubular type terminals for DIN mounted tubular screw and pressure plate devices.

12.5.8 Terminal blocks must be identified and chall be of heavy duty service having a minimum rating of 600 volt AC.

12.5.9 Thermocouple extension wire shall be color coded in accordance with ANSI/ISA MC96.1.

12.5.10 Shielded cable shall be Belden (Poliron) cable or approved equivalent with polyethylene insulation, mylar-foiled shielding, and a drain line.

12.5.11 All field wiring shall land on terminal blocks provided with the panel or enclosure.

12.5.12 All spare I/O shall be wired out to terminal blocks.

12.5.13 Where required as indicated on the I/O List, intrinsically safe isolation barriers will be installed.

12.5.14 Terminal blocks SAK-Series from Weidmueller are recommended.

12.6. Power Supplies and Distribution

12.6.1 Incoming power to the main control panel shall terminate at properly rated breakers providing both overload and short circuit protection as required per NBR 5410.

12.6.2 The Vendor shall supply installed transformers or power supply equipment required by the equipment and its components at the voltage specified in the Request for Quotation. A minimum oversizing for the supply by 100 VA is required.

12.6.3 If the electrical service is not specified in the Request for Quotation, the Vendor shall use the following guidelines.

a) For electrical loads of less than 2 kW with no motors greater than 1/2 HP, the equipment may be designed for either 220 V, 60 Hz, single phase power or 380 V, 60 Hz, 3 phase power.
b) For direct connections to building electrical supply, the system may be designed for 380 V, 60 Hz, 3 phase power.
c) Portable equipment shall typically be serviced by one of the supplies listed above.

12.6.4 The 24 VDC Power Supply shall be Siemens SITOP Series.

12.7. Disconnects and Circuit Breakers

12.7.1 All devices shall be suitable for 600 Volt, 10 amp minimum service.

12.7.2 A single disconnect shall be provided for all power to the engineered wiring system.

12.7.3 Provisions for padlocking the disconnect handle shall be provided to allow Lockout & Tagout Requirements.

12.7.4 Disconnects shall be interlocked with all enclosure doors so that the either the disconnect must be an open circuit for the enclosure door to open, or the opening of the enclosure door trips the disconnect.

12.7.5 A method for defeating the interlock using a dedicated maintenance tool shall be provided.

12.7.6 A properly rated fuse or circuit breaker mounted in the enclosure shall be series connected with each ungrounded leg of the control circuitry.

12.7.7 All fuse holders shall have indicator LEDs to indicate a blown fuse.

12.7.8 All control devices shall be 600 Volt, 10 amp minimum rated.

12.7.9 All power sources leaving the enclosure shall be individually fused. This will include 24 VDC digital outputs, 220 VAC feeds to external equipment, and 380 VAC feeds to motors.

12.7.10 Main switch Eaton 053110 T0-1-8200/EA/SVB is recommended.

12.7.11 Circuit breakers Siemens 5SX1 Series is recommended.

12.7.12 Surge protection device Phoenix Contact TTC-6 Series is recommended.

12.8. Connectors, Receptacles and Plugs

12.8.1 All systems shall be furnished with heavy duty cords and plugs (type SO).

12.8.2 A separate ground shall be included in all rubber cords.

12.8.3 Accessory receptacles shall be specified as follows:

a) 220 Volt, single phase service shall have a 20 amp rated, 2 wire, 3 pole receptacle, NBR 14136 standard, with a spring loaded cover.
b) 380 Volt, 3 phase service shall have a 30 amp rated 3 wire, 4 pole locking receptacle with a spring door. The housing shall be grounded through the shell and extra pole.
c) Equipment incorporating an operator accessible supply circuit for supply to other equipment shall be labeled at each receptacle indicating its available power rating.

12.8.4 220 Volt, single phase service, Receptacle Legrand is recommended.

12.8.5 380V, 3 phase service, Plugs&Receptacles Legrand Series P17 is recommended.

12.9. Switches and Indicating Devices

12.9.1 Switches and push buttons shall be of heavy-duty oil-tight construction.

12.9.2 Push buttons shall be backlit.

12.9.3 Indicating lights shall be of the push-to-test type.

12.9.4 All alarms, buzzers and other external indicators shall be provided as specified in the Request for Quotation. Internal wiring shall be block terminated for external connection by the field wiring contractor.

12.9.5 Pushbuttons, switches, and pilot lights Schneider Electric Harmony XB4 Series is recommended.

12.10. **Nameplates**

12.10.1 Instrument, component, terminal block, bulkhead connector and field connector nameplates shall be phenolic materials, black background with white recessed lettering, and minimum of 3/8" high.

12.10.2 All phenolic labels shall bereversed engraved to provide a smooth, edgeless, and cleanable surface on the nameplate.

12.10.3 Nameplates shall be attached with suitable adhesives, with waterproof silicone adhesive being the preferred method.

13. CRITERIA FOR INSTALLING INSTRUMENTS

13.1. Installation to the Process

13.1.1 The instruments must have their connections standardized according to the table below, except for special cases.

INSTRUMENT	PROCESS CONNECTION			INSTRUMENT CONNECTION
	THREADED	FLAGED	TRI-CLAMP	
PRESSURE				
Pressure gauge	1/2” NPT	1”	2” TC	1/2” NPT
Pressure switch	1/2” NPT	1”	2” TC	1/2” NPT
Pressure Transmitter or D/P with seal	-	2”	2” TC	1/2” NPT
Pressure Transmitter or D/P without seal	1/2” NPT	2”	-	1/2” NPT
TEMPERATURE				
Thermowell	1” NPT	1.1/2”	1.1/2” TC	1/2" NPT
LEVEL				
Transmitter D/P with seal	-	2”	4” TC	1/2” NPT
Transmitter D/P without seal	1/2” NPT	2”	-	1/2” NPT
Level Switch (eletronic)	1/2” NPT	2”	2” TC	2”

Capacitive type transmission	1/2” NPT	1.1/2”	1.1/2” TC	1 1/2”
Radar transmission	-	4”	4” TC	4”
Ultrasonic transmission	1.1/2” NPT	4”	4” TC	4”
Level visor	3/4" NPT	1”	-	1/2” NPT
FLOW RATE				
Transmitter D/P without seal	1/2” NPT	1”	-	1/2” NPT
Flux key	1.1/2” NPT	2”	-	2”

13.1.2 Threaded connections must be NPT in accordance with ANSI / ASME B.1.20.1

13.1.3 Flanged connections must be used according to the application and must comply with the ANSI / ASME B16.5 standard.

13.1.4 Tri-Clamp connections must be used according to the application and must meet the requirements of the ASME BPE standard.

13.1.5 For instruments not standardized in the table above, the types of connections, diameters and pressure classes defined by the Process / Piping / Mechanics / HVAC will be respected.

13.1.6 All instrumentation valves will have connections to the process with flanges or Tri Clamp as needed (types of process fluids indicated in the piping material specification), except butterfly valves that will follow the type of connection indicated in the piping material specification PRD-PIP-TSP-501.

13.1.7 Instruments installed in line, for example: magnetic flow meter; will have connections to the flanged or Tri-Clamp type process as indicated in the piping material specification.

13.1.8 For common fluids, all process sockets in piping and equipment nozzles for the installation of non-intrusive instruments such as pressure transmitter, must be provided with multiple valves with the exception of piping and equipment with compendial fluids in order to reduce the dead leg in the sockets and nozzles, as directed by ASME BPE.

13.1.9 The instruments installed in pipes or equipment with compendial fluids, the installation must be observed in order to reduce the dead leg in the equipment sockets and nozzles, according to the guidelines of the ASME BPE standard. Pressure transmitters, manometers and other instruments that normally use blocking valves in their installation, when installed in processes with compendial fluids, the use of blocking valves and / or drain to reduce the dead leg in the pipes and equipment should be avoided.

13.1.10 The temperature sensors installed in lines with common fluids (non-compendial fluids) must be installed in a pipe segment with a minimum diameter of 3 ". In pipes with diameters less than 3 ", the recommendations contained in the document" Typical Piping Details "must be followed. In lines with compendial fluids, no extensions to the pipes should be used and the outlet neck should be as small as possible.

13.1.11 All connections of pressure instruments in lines of compendial fluids must have diaphragm seal in AISI 316L stainless steel. For the other processes, the type of fluid used for the diaphragm seal must be evaluated.

13.1.12 Pressure instruments installed in common fluid lines (non-compendial fluids) and at high temperatures must be installed with a siphon tube. In the lines with compendial fluids, the use of a siphon tube is not allowed, in this case a diaphragm seal with capillary tube or extension should be used.

13.1.13 The connections for the reference sockets in the process must use 12 mm tubing made of AISI 304 stainless steel.

13.1.14 The tubing connections must be made of AISI 304 stainless steel of the compression type for connection with the tubing and threaded connection for connection with instruments. Process connections must be as permitted in the PRD-PIP-TSP-501 piping material specification, example, RO, ES, FLG or TC.

13.1.15 In installations with compendial fluids, tubing and connectors made of 316L stainless steel should be used.

13.1.16 The distance between the sockets and the transmitters should be as short as possible.

13.1.17 Automatic instruments and valves should preferably be located in an easily accessible area.

13.1.18 Special attention must be paid to the space required for maintenance, removal of instruments and valves and opening of doors or covers.

13.1.19 For typical details of installation to the process, see documents of section 5.2 in its last revision.

13.2. Electrical Installation

13.2.1 All instrumentation cables must be routed through profiled cable trays and conduits until close to the instrument or valve.

13.2.2 The analog signals in the field must be carried by cables / multi-cables directly to the automation panels and / or junction boxes. The shielding of these cables must be individual and total and must be interconnected to the factory's general earth grid.

13.2.3 Discrete signals in the field must be carried by unshielded cables to the automation panels and / or junction boxes.

13.2.4 All connections to the instruments must have cable glands. For applications in common areas the cable glands must be made of polyamide. For application in clean areas, the cable glands must be special for this purpose and made of AISI 316L stainless steel. For potentially explosive areas, the cable glands must be explosion proof with a certificate according to the classified area that is intended. The connection of the cable glands must be with NPT thread, preferably Ø = 1/2 "NPT.

13.2.5 For junction boxes and cable routing within areas that are not electrically classified, common TGVP cable glands (weatherproof, gas, steam, and dust) in polyamide will be used.

13.2.6 The cable glands must be compatible with the diameter of the cables and must have a minimum degree of protection IP-65 according to NBR IEC 60529.

13.2.7 For typical details of electrical installation, see documents of section 5.2 in its latest revision.

13.3. Pneumatic Installation

13.3.1 The air supply for instruments and automatic valves for applications in common areas must be routed through a flexible polyurethane tube in blue color. For potentially explosive areas, the air supply must be through tubing and connections in AISI 304 stainless steel.

13.3.2 The connections for the polyurethane tubes must be quick coupling type, and the body made of AISI 304 stainless steel.

13.3.3 All polyurethane tubes for pneumatic signal must be protected by wire / profile and / or metallic conduits until close to the instrument.

13.3.4 Inside clean areas, only the use of stainless steel tubing is allowed according to item 15.4. Whenever possible shafts should be provided.

13.3.5 Manifolds

13.3.5.1 A supply header of suitable length shall be provided in the control panel. The header shall be sized larger in tube size than the manifold drops.

13.3.5.2 The header shall have a shutoff valve and an appropriately sized pressure regulator and air filter which services the supply to the manifold.

13.3.5.3 Each instrument or control loop branching from the main header shall have its own air supply tube with a shutoff valve at the manifold connection.

13.3.5.4 A minimum of 10% spare manifold connection capacity shall be provided. Spare or unused connections shall be capped.

13.3.5.5 A drain valve shall be placed at the end of the header.

13.3.6 Routing of Tubing

13.3.6.1 All pneumatics routing in the control enclosure shall be approved by the Engineer before installation.

13.3.6.2 All placement of tubing and service manifolds shall be done by competent personnel in accordance with the best procedures for instrument installation.

13.3.6.3 Tubing runs shall not be in a fashion that renders front panel space unusable for future installations and modifications.

13.3.6.4 Tubing runs shall be grouped between instruments in horizontal planes to allow access to both control equipment and tubing fittings.

13.3.6.5 All tubing shall be well supported at regular intervals.

13.3.6.6 Tubing shall be labeled at each termination point in the same manner as wiring. Labels shall reference the design documents.

13.3.6.7 All connection points for field tubing shall be stainless steel Swagelock or Parker bulkhead unions mounted and tagged in accordance with the design documents.

13.3.6.8 A minimum of 10% spare bulkhead union capacity shall be provided.

13.3.7 For typical details of pneumatic installation, see documents of section 5.2 in its last revision.

13.4. Supports

13.4.1 The remote field instruments will be mounted on wall or floor supports, made of painted carbon steel.

13.4.2 The location of the supports will preferably be in beams on the ceiling or columns, with the fixation being on the floor for cases where there is difficulty with another fixation point.

13.4.3 For instruments installed in a clean area, wall support is not allowed, special support for the area must be provided, made of AISI 304 stainless steel, and with a construction free from the accumulation of impurities.

13.4.4 The use of shafts in clean rooms should be the preferred solution whenever possible.

13.4.5 The supports must be fixed in places free from vibration, heating, passage of people and machines.

13.4.6 The display of instruments mounted on supports must be positioned at a height between 1.40 m and 1.60 m from the floor.

13.4.7 For typical support installation details, see documents of section 5.2 in its latest revision.

14. CABLES

14.1. Instrumentation cables

14.1.1 Instrumentation cables and multicables must be suitable for installing into cable trays and / or conduits, the nominal section of each conductor must be at least 1.0 mm², the conductors must be of electrolytic copper with electrostatic shielding through aluminized polyester, and conductor tinned copper drain. The insulation of the conductors must be in PVC or expanded polyethylene, and the cable cover in flame-retardant PVC in black.

14.1.2 Analog Signals

Section:	1.0 mm² for pairs / suits.
Colors:	White and Black for pairs. White, Black and Red for suits. Black outer cover
Shielding:	Individual and total

14.1.3 Discrete Signals

Section:	1.0 mm² for pairs.
Colors:	White and Black for pairs. Black outer cover
Shield:	Total only

14.1.4 Command signals and interlocks between panels

Section: 1.5 mm²
Colors: Black, with chronological numbering.
Black outer cover

14.1.5 Vdc Digital Signals

Section: 2.5 mm²
Colors: White and Black for pairs.
Black outer cover
Shield: Total only

14.2. Communication Network Cables

14.2.1 Communication network cables and connectors must meet the concepts of industrial networks. The cables must be installed in such a way that they are protected against mechanical impact and electromagnetic interference. For interconnection between equipment and industrial switches or between industrial switches, fiber optic cables should be used whenever the bids exceed 90 m.

14.2.2 Redundant network cables must be installed in different routes.

14.2.3 The ends of the cables must have identification.

14.2.4 Ethernet Network Cable (UTP)

14.2.4.1 Twisted pair cable with 4 pairs, consisting of 24 AWG gauge solid wires and nominal impedance of 100 Ω. The minimum performance specification for this cable must be compatible with EIA / TIA 568C and ISO / IEC 11801. Category 6 (enhanced). The maximum allowed length for UTP cables is 90 m. The black outer cable cover was adopted as standard.

14.2.4.2 The cable must meet the following requirements:

- Have UL and / or ETL Verified and Listed certifications.
- CM flammability class according to UL standards.
- The cable used must have Anatel certification printed on the cover.
- The product must comply with RoHS guidelines.
- Have the manufacturer's name, cable model, and traceability system printed on the outer cover to identify the date of manufacture of the cables.

- Be composed of solid copper conductors; outer layer in non-flame-retardant PVC.

14.2.5 Shielded Ethernet Network Cable (STP)

14.2.5.1 Twisted pair cable with 4 pairs, consisting of 24 AWG gauge solid wires and nominal impedance of 100 Ω. The minimum performance specification for this cable must be compatible with EIA / TIA 568C and ISO / IEC 11801. Category 6 (enhanced). The maximum permitted length for STP cables is 90 m. The black outer cable cover was adopted as standard.

14.2.5.2 The cable must meet the following requirements:

- Have UL and / or ETL Verified and Listed certifications.
- CM flammability class according to UL standards.
- The cable used must have Anatel certification printed on the cover.
- The product must comply with RoHS guidelines.
- Have the manufacturer's name, cable model, and traceability system printed on the outer cover to identify the date of manufacture of the cables.
- Be composed of solid copper conductors; outer layer in non-flame-retardant PVC and resistant to UV rays, with shielding of the cable and twisted pairs in metallic tape and with drain wire.

14.2.6 Fiber optic cable

14.2.6.1 The optical cables will be single-mode and dielectric with a fully dry core, complying with the ITU-T G.652 / D Standard, with a wavelength of 1310/1550 nm (500 MHz / km), a diameter of the modal field of 9.0 µm, shell diameter 125 µm, and maximum attenuation of 0.10 dB / km.

14.2.6.2 The cable must meet the following requirements:

- Have UL and / or ETL certifications;
- Class of flammability LSZH;
- The cable used must have Anatel certification printed on the cover;
- Have the manufacturer's name, cable model, and traceability system printed on the outer cover to identify the date of manufacture of the cables;

- external cover in thermoplastic material, non-flame propagating and resistant to UV rays, with protection against rodents;

- Have a traction element made of dielectric material.

14.2.6.3 6 (six) core Fiber optical cables should be used for single connection equipment, for example: smart relay, frequency inverters, etc.

14.2.6.4 12 (twelve) core Fiber optical cables should be used for multi-connection equipment, for example: optical distributors.

14.3. Connectors for Network Cables

14.3.1 Ethernet network cables (UTP / STP) must have RJ-45 connectors. These connectors must meet the specifications contained in the ANSI / TIA / EIA-568B.2-1 Category 6 standard, have a body in high impact thermoplastic material that does not propagate the flame and meets the UL 94 V-0 (flammability) standard, have contact paths produced in phosphor bronze with nickel and gold layers, for protection against oxidation, double claws to guarantee electrical connection with the cable veins.

14.3.2 The RJ-45 connectors must have a protective cover, with the same dimension as the RJ-45 plug and protection to the locking tongue. This protective cover should help to avoid excessive cable curvature in connection movements, as well as protect the connectors' unlocking pin from being twisted and broken.

14.3.3 Fiber optic cables must be connected to optical strands by fusion. The optical cords must have LC type connectors. All installed fibers and their fusions must be certified through test and approval reports.

14.4. Electrical Cables

14.4.1 Control & Instrumentation cables

Instrumentation cables and multicables must be suitable for launching into cable trays and / or conduits, the nominal section of each conductor must be at least 1.0 mm², the conductors must be of electrolytic copper with electrostatic shielding through aluminized polyester, and conductor tinned copper drain. The insulation of the conductors must be in PVC or expanded polyethylene, and the cable cover in flame-retardant PVC in black.

14.4.2 Feeders

14.4.2.1 2 pole cable (24 Vdc)
Section: minimum 2.5 mm²
Colors: black, white.

14.4.2.2 3 pole cable (220 Vac)
Section: minimum 2.5 mm²
Colors: black, white, and green-white.

14.4.2.3 The electric power cables must be installed in conduits, or cable trays, for exclusive use of power cables.

15. INFRASTRUCTURE

15.1 All components / materials installed in Clean Rooms must be resistant to attack by products that will be used for disinfection / fumigation and sterilization with chemicals. They must also not have external surfaces with pores or recesses that may be points of accumulation of impurities.

15.2 Cable trays

15.2.1. The instrumentation cable trays must be perforated U-type, manufactured with # 14MSG sheet of fire-galvanized carbon steel. Cable trays installed outdoors and upright must be equipped with covers.

15.2.2. Instrumentation cable trays may not be routed below pipes containing liquids, vapors, or solvents, and may be routed below pipelines and other HVAC systems. In the detailed design of the trays, easy access must be provided for installation and maintenance on the cable trays.

15.2.3. The loading of the cable trays must be a maximum of 40% of the total capacity, when calculating the loading of the cable trays, a reserve of 15% of the capacity must be provided for future use.

15.2.4. Instrumentation cable trays must be dedicated and installed in a way that is protected against electromagnetic interference. Analog, discrete, power signals for instruments other than 24 Vdc and pneumatic must be installed in separate cable trays, and the use of a dividing septum is not permitted.

15.2.5. When the cable trays are installed on top of each other, a minimum gap of 300 mm should be left between them.

15.2.6. The cable trays must be connected to the general earth grid of the factory.

15.2.7. All cable trays must be properly installed with metal supports at a maximum distance of 2 m between one support and another.

15.2.8. The installation of cable trays is not permitted inside clean areas.

15.3 Trunking Cable Tray

15.3.1. The instrumentation Trunking Cable Tray must be drilled, made with # 14 MSG sheet of carbon steel, galvanized in fire.

15.3.2. Trunking Cable Tray installed outdoors and upright must be equipped with covers.

15.3.3. Instrumentation Trunking Cable Tray cannot be routed below pipes containing liquids, vapors or solvents, and can be routed below pipelines and other HVAC systems. In the detailed design of the profiles, easy access must be provided for installation and maintenance of the profiles.

15.3.4. The loading of the Trunking Cable Tray must be a maximum of 40% of the total capacity, when calculating the loading, a reserve of 15% of the capacity must be provided for future use.

15.3.5. The instrumentation Trunking Cable Tray must be dedicated, and installed in a way that is protected against electromagnetic interference. The analog, discrete, power signals for instruments other than 24 Vdc and pneumatic must be installed in separate profiles.

15.3.6. When the Trunking Cable Tray are installed on top of each other, a minimum gap of 300 mm must be left between them.

15.3.7. The Trunking Cable Tray must be connected to the general earth grid of the factory.

15.3.8. All Trunking Cable Tray must be properly installed with metal supports at a maximum distance of 2 m between one support and another.

15.3.9. The installation of Trunking Cable Tray in clean areas is not permitted.

15.4 Conduits

15.4.1. The instrumentation conduits for external use, built-in, and in an area subject to damage must be heavy type made of seamed galvanized carbon steel. For installation in wet, humid and / or corrosive areas, PVC conduits must be used.

15.4.2. Conduit boxes and other conduit accessories must be made of aluminum, waterproof, and vapor proof. All threaded connections must be NPT.

15.4.3. The conduits installed above the floor must have a minimum diameter of 3/4 ", and the connections in NPT.

15.4.4. The conduits that interface between areas with different classifications, pressures, and temperatures, should be used a sealing unit with a non-inert fiber-

based synthetic oil compound, free of asbestos to seal and caulk, insoluble in water and unaffected by humidity.

15.4.5. The instrumentation conduits must be installed in such a way that they are protected against electromagnetic interference. Analog, discrete, power signals for instruments other than 24 Vdc and pneumatic must be installed in separate conduits.

15.4.6. In clean areas, the use of exposed conduits should be avoided, but if necessary, AISI 304 sch 40 stainless steel conduits should be used, with mechanically polished external surfaces and installed so that cleaning is easy.

15.4.7. All conduits must be properly installed with metal supports at a maximum distance of 2 m between one support and another.

15.4.8. For typical support installation details, see documents of section 5.2 in its latest revision.

15.5 Junction boxes

15.5.1. The junction boxes inside clean rooms shal be constructed of 14 gauge type 304 stainless steel and neoprene joints. The outlets for the instruments must be sealed and the assembly (box / gasket / cover / cable gland) must have an IP 66 class as a minimum.

15.5.2. The connections and accessories used inside the clean rooms must be made of AISI 304 stainless steel.

15.5.3. The junction boxes should preferably be installed 300 mm or 1200 mm from the finished floor.

15.5.4. Exit boxes or conduit boxes for the necessary electrical voltage installations, installed at the edges of rooms or areas with explosive classification, must include Sealing Units and accessories for this.

16. DOCUMENTATION

16.1. Supply 3 printed sets of the information for customer review and 3 printed sets of certified information prior to fabrication. At the completion of the project, 3 printed sets of “as built” copies of all of the information shall be supplied as well as 1 electronic copy on optical media.

16.2. As a minimum the following information shall be provided for review, as certified for fabrication and for record:

18.2.1. Panel Layout Drawings (front & back)

18.2.2. Wiring diagrams

18.2.3. Parts list

18.2.4. Descriptive literature for all installed components (catalog cut sheets)

18.2.5. PLC ladder logic diagrams

16.3. All wiring diagrams shall conform to ANSI standards and shall include wire terminal numbers.

17. TESTING, CLEANING AND CERTIFICATION

17.1. Accessories shall be factory-leak-tested and cleaned of manufacturing oils and debris per manufacturer's standards.

17.2. Accessories shall be blown out with clean dry compressed air.

17.3. Accessories shall be certified in writing that they were manufactured of specified stainless steel.

18. EXECUTION

18.1 Inspections and Tests

18.1.1 All test procedures shall be submitted to Engineer for approval. The tests required by this specification are as follows:

18.1.2 In-Production Control

18.1.2.1 Vendor shall be responsible for compliance with their standard in-production test procedures that progressively check the assembly and wiring systems.

18.1.3 Tests After Assembly

18.1.3.1 The following tests shall be performed after the complete assembly of each enclosure.

18.1.3.1.1 Device Check

18.1.3.1.1.1 Vendor shall test the contact configuration on all auxiliary relays having convertible contacts and verify conformance with the N/O and N/C positions.

18.1.3.1.1.2 Vendor shall determine the contact configuration on all control and instrument switches, synchronizing switches, selector switches, and pushbuttons, and verify conformance with switch contact diagrams.

18.1.3.1.1.3 Vendor shall verify that each contact operates in each switch position as indicated on the switch contact diagrams, and that all switches with spring return action do return to the intended positions freely and without binding.

18.1.3.1.1.4 Vendor shall check all devices to ensure complete conformance with the equipment list.

18.1.3.1.1.5 Non-conformances shall be corrected.

18.1.3.1.2 Wiring Check

18.1.3.1.2.1 Vendor shall perform a point-to-point check with wiring diagrams, check for correct wire and terminal block markings, and verify that all connections are correct and tight. All wiring terminations shall be connected to the specific device terminals as shown on the approved diagrams. Vendor shall make an electrical continuity test on each conductor and provide documentation.

18.1.3.1.2.2 Non-conformances shall be corrected.

18.1.3.1.3 Functional Tests

18.1.3.1.3.1 A function test shall be performed to ensure that the digital and analog I/O points function correctly in conjunction with the software logic. Where practical, each control function shall be tested from the HMI through to the actuator device. In the case of field components that are not present in the Vendor's factory, provisions should be made to simulate the field component.

18.1.3.1.3.2 Vendor shall be responsible to protect all devices from exposure to overvoltage or other hazards during testing. A test procedure shall be submitted to Engineer prior to testing for approval. The test procedure shall contain the test area hardware available, Vendor personnel and schedule support and any special safety requirements unique to the Vendor's facility.

18.1.3.1.3.3 Vendor shall notify Engineer of any defective equipment supplied to them for mounting by other vendors as soon as individual defects are discovered.

18.1.3.1.3.4 Non-conformances shall be noted and corrected prior to the next day's functional test. Demonstration of the corrected nonconformance will be required.

18.1.3.1.3.5 Engineer will provide a technical sign-off procedure for each control enclosure. This sign-off signifies the functional test is complete with all known non-conformities corrected. The panel is to be immediately prepared for shipment and stored. The actual release for the shipment of the equipment must be obtained in writing from the Engineer prior to shipping.

18.1.4 Inspection

18.1.4.1 The following are mandatory hold points for which prior notification is required:

18.1.4.1.1 Functional testing.

18.1.4.1.2 Release for shipment.

18.2 System Installation Criteria

18.2.1 Instrumentation shall be installed per original equipment manufacturer's recommendation.

18.3 Demostration

18.3.1 Provide services of a factory-authorized service representative of all equipment provided to demonstrate equipment, startup and shutdown procedures, preventive maintenance, and servicing procedures, and troubleshooting procedures. Review operating and maintenance information.

18.3.2 Provide 7 days written notice in advance of demonstration.