



**INSTRUMENTATION –
GENERAL REQUIREMENTS
FOR NEW AND MODERNISED PRODUCTION PLANTS – TECHNICAL ANNEXES
TO CONTRACTS**

Włocławek, September 2021




	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

TABLE OF CONTENTS


1.	INTRODUCTION	6
2.	GENERAL TECHNICAL REQUIREMENTS	7
2.1.	Scope	7
2.2.	Standards and regulations	7
2.3.	Certifying organisations	15
2.3.1.	Instrumentation subject to certification as pressure equipment	15
2.3.2.	Instrumentation subject to certification as equipment for use in explosion hazard areas	15
3.	FIELD EQUIPMENT AND CONTROL SYSTEMS	17
3.1.	Technical requirements for field equipment and control systems	17
3.1.1.	Preface	17
3.1.2.	General structure	17
3.1.3.	General design requirements	17
3.1.4.	Standard instrumentation signals	20
3.1.5.	Delivery of technical documentation	21
3.1.6.	Surge protection	21
3.1.7.	Electrical shock protection	21
3.2.	Field instrumentation	21
3.2.1.	Field installation of instrumentation	21
3.2.2.	Access to field instrumentation	23
3.2.3.	Flow measurement	23
3.2.3.1.	Orifice plates	23
3.2.3.2.	Vortex flowmeters	24
3.2.3.3.	Mass flowmeters	24
3.2.3.4.	Solid and Powder Flow Measurement	25
3.2.3.5.	Rotameters	25
3.2.3.6.	Local flow indicators	25
3.2.3.7.	Other flowmeters	25
3.2.4.	Level measurement	26
3.2.4.1.	Level transmitter	26
3.2.4.2.	Vibration level switch	26
3.2.4.3.	Level gauges	26
3.2.4.4.	Other level measuring instruments	27
3.2.5.	Pressure measurement	27
3.2.5.1.	Pressure gauges	27
3.2.5.2.	Pressure and differential pressure transmitters	28
3.2.5.3.	Pressure switches	28
3.2.6.	Temperature measurement	29
3.2.6.1.	Local temperature measurement	29
3.2.6.2.	Thermocouples and resistance temperature detectors (RTD)	29
3.2.6.3.	Thermowells	29
3.2.6.4.	Temperature transmitters	30
3.2.7.	Analysers	30
3.2.7.1.	Analyser types	30
3.2.7.2.	General principles for analyser measuring systems	31
3.2.8.	Gas detectors	34
3.2.8.1.	Types of gas detectors	34
3.2.8.2.	General principles for gas detectors	34
3.2.9.	Analysers house (analysers shelter)	35
3.2.10.	Control valves	37
3.2.11.	ON-OFF valves	39
3.2.12.	Solenoid valves	40
3.2.13.	Current to pneumatic converters I/P (if any)	40
3.2.14.	Local gauge boards	40
3.2.15.	Local control panels and accessories	41
3.2.16.	Instrumentation cables	42
3.2.17.	Junction boxes	43
3.2.18.	Cable trays	44
3.2.19.	Instrument heat tracing	44
3.2.20.	Protection boxes	45


	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

3.2.21.	Air coolers.....	45
3.2.22.	Weighing system	45
3.2.23.	Instrument air buffer tank.....	46
3.3.	Plant balance.....	46
3.3.1.	Balance measuring devices	47
4.	PROCESS HEATERS	48
4.1.	Description of the Burner Management System	48
4.1.1.	Process heater control.....	49
4.1.1.1.	Field instrumentation.....	49
4.1.1.2.	Control panels	50
4.1.1.3.	Interlock and shutdown system based on a certified ESD/BMS controller with accessories	50
4.1.1.4.	Maintenance Override Switches (MOS) and Process Override Switches (POS).....	51
4.1.1.5.	Control and interlock and shutdown logic	51
4.1.1.6.	Logic for safe start-up of process heater	52
4.1.2.	Diagnostics.....	53
4.1.3.	Events recorder and functional tests.....	53
4.2.	Continuous gas monitoring system (if any).....	53
5.	CONTROL ROOM, TECHNICAL INSTRUMENTATION ROOM AND ENGINEERING ROOM.....	54
5.1.	Installation requirements.....	54
5.2.	Basic instrumentation equipment in the control room and technical rooms	56
6.	MONITORING AND CONTROL SYSTEMS (DCS)	57
6.1.	Acquisition and processing of input/output signals	58
6.1.1.	Input/output modules	58
6.1.2.	Protocols and communication standards	58
6.1.3.	Signal processing	59
6.2.	Adjustment and control.....	59
6.3.	Time synchronization.....	60
6.4.	Technological process visualization	60
6.4.1.	Visualization screens.....	60
6.4.2.	Requirements for screen layout	61
6.4.3.	Requirements for graphic symbols	61
6.4.4.	Requirements for control functions	62
6.4.5.	Requirements for operator station software	62
6.4.6.	Requirements for graphics editor.....	62
6.5.	Diagnostics and alarms	62
6.6.	Data historization and archiving.....	63
6.7.	Reporting.....	63
6.8.	Redundancy and uninterrupted operation.....	64
6.9.	Scalability	64
6.10.	Spare capacity.....	65
6.11.	Performance	65
6.12.	Backups.....	66
6.13.	Licensing	66
6.14.	Warranty	67
6.15.	Credentials	67
7.	PLCs (EXCLUDING ESD SYSTEM)	68
7.1.	Requirements for hardware components.....	68
7.2.	Requirements for software components	69
7.3.	Time synchronization.....	70
7.4.	Redundancy and uninterrupted operation.....	70
7.5.	Warranty	70
8.	SAFETY SYSTEMS – ESD	71
8.1.	SIL classification and implementation of interlock functions	72
8.2.	Requirements for design and execution of safety systems.....	73
8.3.	Execution design	75
8.4.	Software	75
8.5.	Delivery and installation.....	76
8.6.	Warranty	77
9.	ASSOCIATED SYSTEMS	79
9.1.	Operator console – Top Box panel	79
9.2.	Asset Management System (AMS).....	79

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

9.3.	Anti-surge system	80
9.4.	Requirements for the APC system Contractor regarding interoperability with the DCS.....	81
10.	COMMUNICATION WITH EXTERNAL SYSTEMS.....	83
10.1.	Communication with machine monitoring system (MMS)	83
11.	INTEROPERABILITY WITH SUPPORTING SYSTEMS.....	84
11.1.	Antivirus systems.....	84
11.2.	Patch management.....	85
11.3.	Backup management.....	85
12.	ACCESS CONTROL TO AUTOMATION SYSTEMS AND OPERATING SYSTEMS.....	87
12.1.	Session management.....	87
12.2.	Password management.....	87
12.3.	Users and user groups	88
13.	PHYSICAL AND ENVIRONMENTAL SECURITY	89
13.1.	Protection against unauthorized access	89
13.2.	Protection against fire hazard	89
13.3.	Electrical power supply	89
13.4.	Maintaining appropriate temperature and humidity.....	90
13.5.	Vibration	90
13.6.	Aggressive environment	91
14.	EQUIPMENT ACCEPTANCE GUIDELINES	94
14.1.	Guidelines for Factory Acceptance Tests (FAT)	94
14.2.	Guidelines for Site Acceptance Tests (SAT).....	95
15.	ANNEXES	97

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------


1. INTRODUCTION

This document defines basic technical requirements in the area of instrumentation and it shall be considered as mandatory design and/or construction criteria for the Project Management, Supervision Department, Investment Department, Procurement Department in ANWIL S.A., etc. (referred to as the Buyer) as well as for Design Offices, Contractors, and other external companies being a party to the contract (referred to as the Contractor) during construction of new plants and process units, modernisation activities, and reconstruction works on the premises of ANWIL S.A.

Based on this document, the Contractor shall establish with the Buyer the detailed assumptions (used design solutions, scope of design, construction works, etc.) which ought to be confirmed with a memo signed by both parties. The Contractor is responsible for making such arrangements.

If a Contractor proposes a solution that deviates from the Technical Requirements described herein, the Contractor should then provide a written description of the proposed solution that identifies the areas in which it deviates from Technical Requirements. Furthermore, the Contractor will be required to identify the potential risk of proposed deviation and provide planned solutions for minimizing or completely eliminating the risks.

Any deviations from Technical Requirements included in this document must be approved by the Buyer at the bidding stage.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

2. GENERAL TECHNICAL REQUIREMENTS

2.1. Scope

Technical requirements for instrumentation are as follows:

- technical standards – technical solutions accepted by the Instrumentation Department at ANWIL S.A.,
- principles of cooperation between participants of the investment process and Maintenance Services.

Any instrumentation-related aspects to the subject of the contract which are not included in this document shall be governed by Polish regulations and standards or internal regulations of ANWIL S.A.

Any deviations from technical requirements included in this document shall be agreed with and accepted by ANWIL S.A. in writing.

This document contains general requirements for designing of the field instrumentation equipment, DCS and ESD and other monitoring systems.

Document is applicable for the preparation of requests for proposals, contracts, agreements for investment and modernisation projects in terms of technical requirements for the instrumentation.


2.2. Standards and regulations

Design and execution of equipment, systems and control systems shall meet the requirements of Polish laws, Directives of European Union, standards and regulations as well as this document, in the following order of priority:


- Acts of the Republic of Poland – acts and regulations of the Council of Ministers,
- Directives of the European Union,
- PN (PN EN) – Polish Standards (harmonised with the European Union standards),
- CEN/CENELEC – European Committee for Standardisation/European Committee for Electrotechnical Standardisation,
- IEC – International Electrotechnical Commission.

The most recent edition of the standards or regulations shall be applied.


Document name	Document title
ASME B.1.20.1	Pipe Threads, General Purpose (inch).
ASME B.16.5	Pipe Flanges and Flanged Fittings
ASME B.16.10	Face-to-Face and End-to-End Dimension of Valves.
ASME B.16.11	Forged Fittings, Socket – Welding and Threaded.
ASME B.16.25	Butt welding ends.
ASME B.16.34	Valves – Flanged, Threaded and Welding End.
ASME B.16.36	Orifice Flanges.
ASME B.46.1	Surface Texture.
API-1164	Pipeline SCADA security.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------


Document name	Document title
API-1165	Recommended practice for pipeline SCADA displays.
API-RP 551	Process Measurement – Second Edition.
API-RP 554	Process Instrument and Control.
API-RP 555	Process Analysers – Third Edition.
API-STD-670	Machinery Protection System – Fifth Edition.
Journal of Laws No 81, item 351 Journal of Laws 2018, item 620	The act of 24 August 1991 - Law on Fire Protection Proclamation of the Marshal of the Polish Sejm of 6 March 2018 on the publication of the consolidated text of the Law on Fire Protection.
Journal of Laws 1994 No 89, item 414 Journal of Laws 2018, item 1202	The act of 7 July 1994 - Construction Law. Proclamation of the Marshal of the Polish Sejm of 7 June 2018 on a consolidated text of the act - Construction Law.
Journal of Laws No 122, item 1321 Journal of Laws 2018, item 1351	The act of 21 December 2000 on Technical Supervision. Proclamation of the Marshal of the Polish Sejm of 29 June 2018 on a consolidated text of the act - Technical Supervision.
Journal of Laws No 63, item 636 Journal of Laws 2018, item 376	The act of 11 May 2001. Law of measures. Proclamation of the Marshal of the Polish Sejm of 30 January 2018 on the publication of the consolidated text of the Law of measures.
Journal of Laws No 243, item 2063 Journal of Laws 2014 No 0, item 1853	Regulation of the Minister of Economy of 21 November 2005 on technical conditions to be met by bases and stations of liquid fuels, pipelines for the long distance transport of crude oil and petroleum products and their location. Proclamation of the Minister of Economy of 14 August 2014 on the publication of the consolidated text Regulation of the Minister of Economy on technical conditions to be met by bases and stations of liquid fuels, pipelines for the long distance transport of crude oil and petroleum products and their location.
Journal of Laws 2007 No 143, item 1002	Regulation of the Ministry of Interior Affairs and Administration of 20 June 2007 regarding the list of products which ensure public safety or health care and life protection and concerning the rules of issuing the certificate of admittance for these products.
Journal of Laws 2017, item 885	Regulation of the Minister of Development and Finance of 13 April 2017 on types of measuring instruments subject to legal metrological control and scope of this control.
Journal of Laws 2017, item 969	Regulation of the Minister of Development and Finance of 13 April 2017 on legal metrological control of measuring instruments.
Journal of Laws 2008 No 21, item 125 Journal of Laws 2014, item 1098	Regulation of the Minister of Economy of 22 January 2008 on the requirements to be met by measuring tanks and the detailed scope of tests and checks to be carried out during the legal metrological control of such measuring instruments. Proclamation of the Minister of Economy of 21 May 2014 on the publication of the consolidated text Regulation of the Minister of Economy on the requirements to be met by measuring tanks and the detailed scope of tests and checks to be carried out during the legal metrological control of such measuring instruments.
Journal of Laws 2010 No 109, item 719	Regulation of the Minister of Interior and Administration of 7 June 2010 on the fire protection of buildings as well as other structures and areas.
Journal of Laws 2010 No 138, item 931	Regulation of the Minister of Economy of 8 July 2010 on minimum requirements for safety and health protection connected with possible occurrence of potentially explosive atmosphere at work place.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------


Document name	Document title
Journal of Laws 2016, item 817	Regulation of the Minister of Development of 6 June 2016 on the requirements for equipment and protective systems intended for use in potentially explosive atmospheres.
PN-EN ISO 5167-1:2005	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full - Part 1: General principles and definitions.
PN-ISO 5725-1: 2002	Accuracy (trueness and precision) of measurement method - Part 1: General principles and definitions.
PN-ISO 6790:1996	Equipment for fire protection and fire fighting - Graphical symbols for fire protection plans - Specification.
PN-EN ISO/IEC 27001:2017-06	Information technology - Security techniques - Information security management systems - Requirements.
PN-EN ISO/IEC 27002:2017-06	Information technology - Security techniques - Code of practice for information security controls.
PN-EN 54-1:2011	Fire detection and fire alarm systems - Part 1: Introduction.
PN-EN 54-2:2002/A1:2007	Fire detection and fire alarm systems - Part 2: Control and indicating equipment.
PN-EN 54-3:2014-12	Fire detection and fire alarm systems - Part 3: Fire alarm devices. Sounders.
PN-EN 54-4:2001/A2:2007	Fire detection and fire alarm systems - Part 4: Power supply.
PN-EN 54-5+A1:2018-11	Fire detection and fire alarm systems - Part 5: Heat detectors - point heat detectors.
PN-EN 54-7:2018-11	Fire detection and fire alarm systems - Part 7: Smoke detectors - Point detectors using scattered light, transmitted light or ionisation.
PN-EN 54-10:2005	Fire detection and fire alarm systems - Part 10: Flame detectors — Point detectors.
PN-EN 54-11:2004/A1:2006	Fire detection and fire alarm systems - Part 11: Manual call points.
PN-EN 54-12:2015-05	Fire detection and fire alarm systems - Part 12: Smoke detectors - Line detectors using an optical beam.
PN-EN 54-13:2017-05	Fire detection and fire alarm systems - Part 13: Compatibility and connectability assessment of system components.
PKN-CEN/TS 54-14:2006	Fire detection and fire alarm systems - Part 14: Guidelines for planning, design, installation, commissioning, use and maintenance.
PN-EN 54-16:2011	Fire detection and fire alarm systems - Part 16: Voice alarm control and indicating equipment.
PN-EN 54-17:2007	Fire detection and fire alarm systems - Part 17: Short-circuit isolators.
PN-EN 54-18:2007	Fire detection and fire alarm systems - Part 18: Input/output devices.
PN-EN 54-20:2010	Fire detection and fire alarm systems - Part 20: Aspirating smoke detectors.
PN-EN 54-21:2009	Fire detection and fire alarm systems - Part 21: Alarm Transmission And Fault Warning Routing Equipment.
PN-EN 54-22:2015-07	Fire Detection And Fire Alarm Systems - Part 22: Resettable Line-Type Heat Detectors.
PN-EN 54-23:2010	Fire detection and fire alarm systems - Part 23: Fire alarm devices - Visual alarm devices.
PN-EN 54-24:2008	Fire detection and fire alarm systems - Part 24: Components of voice alarm systems - Loudspeakers.
PN-EN 54-25:2011	Fire detection and fire alarm systems - Part 25: Components using radio links.
PN-EN 54-26:2015-05	Fire detection and fire alarm systems - Part 26: Carbon Monoxide Detectors - Point Detectors.
PN-EN 54-27:2015-04	Fire detection and fire alarm systems - Part 27: Duct Smoke Detectors

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------


Document name	Document title
PN-EN 54-28:2016-06	Fire detection and fire alarm system - Part 28: Non-resettable line-type heat detectors.
PN-EN 54-29:2015-05	Fire detection and fire alarm systems - Part 29: Multi-sensor fire detectors - Point detectors using a combination of smoke and heat sensors.
PN-EN 54-30:2015-05	Fire detection and fire alarm systems - Part 30: Multi-sensor fire detectors - Point detectors using a combination of carbon monoxide and heat sensors.
PN-EN 54-31+A1:2016-06	Fire detection and fire alarm system - Part 31: Multi-sensor fire detectors - Point detectors using a combination of smoke, carbon monoxide and optionally heat sensors.
PN-EN 1092-1:2018-08	Flanges and their joints - Circular flanges for pipes, valves, fittings and accessories, PN designated - Part 1: Steel flanges.
PN-EN 125+A1:2016-02	Flame supervision devices for gas-burning appliances. Thermoelectric flame supervision devices.
PN-EN 161+A3:2013-06	Automatic shut-off valves for gas burners and gas appliances.
PN-EN 298:2012	Automatic burner control systems for burners and appliances burning gaseous or liquid fuels.
PN-EN ISO 23553-1:2014-07	Safety and control devices for oil burners and oil-burning appliances - Particular requirements - Part 1: Automatic and semi-automatic valves.
PN-EN 676+A2:2008	Forced draught burners for gaseous fuels.
PN-EN 746-1+A1:2012	Industrial thermoprocessing equipment. Part 1 - Common safety requirements for industrial thermoprocessing equipment.
PN-EN 746-2:2010	Industrial thermoprocessing equipment. Part 2 - Safety requirements for combustion and fuel handling systems.
PN-EN 746-3+A1:2012	Industrial thermoprocessing equipment. Part 3- Safety requirements for the generation and use of atmosphere gases.
PN-EN 1349: 2010	Industrial process control valves.
PN-EN ISO 1461:2011	Hot-dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods.
PN-EN 12464-1:2012	Light and lighting - Lighting of work places - Part 1: Indoor work places
PN-EN 14181:2015-02	Stationary source emissions - Quality assurance of automated measuring systems.
PN-EN 14956:2006	Air quality – Evaluation of the suitability of a measurement by comparison with a required measurement uncertainty
PN-EN 15267:2009-1	Certification of automated measuring systems - Part 1: General principles.
PN-EN 45501:2015-05	Metrological aspects of non-automatic weighing instruments.
PN-EN 50271:2018-08	Electrical apparatus for the detection and measurement of combustible gases, toxic gases or oxygen - Requirements and tests for apparatus using software and/or digital technologies.
PN-EN 55024:2011	Information technology equipment - Immunity characteristics - Limits and methods of measurements.
PN-EN IEC 60079-0:2018-09	Explosive atmospheres - Part 0: Equipment - General requirements.
PN-EN 60079-1:2014-12	Explosive atmospheres - Part 1: Equipment protection by flameproof enclosures "d".
PN-EN 60079-2:2015-02	Explosive atmospheres - Part 2: Equipment protection by pressurized enclosures "p".
PN-EN 60079-5:2015-08	Explosive atmospheres - Part 5: Equipment protection by powder filling "q".
PN-EN 60079-6:2016-02	Explosive atmospheres - Part 6: Equipment protection by liquid immersion "o".

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------


Document name	Document title
PN-EN 60079-7:2016-02	Explosive atmospheres - Part 7: Equipment protection by increased safety "e".
PN-EN 60079-10-1:2016-02	Explosive atmospheres - Part 10-1: Classification of areas - Explosive gas atmospheres.
PN-EN 60079-10-2:2015-06	Explosive atmospheres - Part 10-2: Classification of areas - Explosive dust atmospheres.
PN-EN 60079-11:2012	Explosive atmospheres - Part 11: Equipment protection by intrinsic safety "i".
PN-EN 60079-13:2017-11	Explosive atmospheres - Part 13: Equipment protection by pressurized room "p" and artificially ventilated room "v"
PN-EN 60079-14:2014-06	Explosive atmospheres - Part 14: Electrical installations design, selection and erection.
PN-EN 60079-17:2014-05	Explosive atmospheres - Part 17: Electrical installations inspection and maintenance.
PN-EN 60079-18:2015-06	Explosive atmospheres - Part 18: Equipment protection by encapsulation "m".
PN-EN 60079-19:2011/A1:2015-09	Explosive atmospheres - Part 19: Equipment repair, overhaul.
PN-EN 60079-20-1:2010	Explosive atmospheres - Part 20-1: Material characteristics for gas and vapour classification - Test methods and data
PN-EN 60079-25:2011	Explosive atmospheres - Part 25: Intrinsically safe electrical systems.
PN-EN 60079-26:2015-04	Explosive atmospheres - Part 26: Equipment with equipment protection level (EPL) Ga.
PN-EN ISO 80079-36:2016-07	Explosive atmospheres - Part 36: Non-electrical equipment for explosive atmospheres - Basic method and requirements
PN-EN 60529:2003/A2:2014-07	Degrees of protection provided by enclosures.
PN-EN 60584-1:2014-04	Thermocouples - Part 1: EMF specifications and tolerances.
PN-EN 60584-3:2008	Thermocouples - Part 3: Extension and compensating cables - tolerances and identification system.
PN-EN 60751:2009	Industrial platinum resistance thermometers and platinum temperature sensors.
PN-EN 61069-7:2017-02	Industrial-process measurement, control and automation - Evaluation of system properties for the purpose of system assessment - Part 7: Assessment of system safety
PN-EN 61131-3:2013-10	Programmable controllers - Part 3: Programming languages.
PN-EN 61340-5-1:2017-01	Electrostatics - Part 5-1: Protection of electronic devices from electrostatic phenomena - General requirements.
PN-EN 61340-5-2:2014-1	Electrostatics - Part 5-2: Protection of electronic devices from electrostatic phenomena - User guide.
PN-EN 61340-5-3:2015-11	Electrostatics - Part 5-3: Protection of electronic devices from electrostatic phenomena - Properties and requirements classification for packaging intended for electrostatic discharge sensitive devices.
PN-EN 61508-1:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 1: General requirements.
PN-EN 61508-2:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems.
PN-EN 61508-3:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 3: Software requirements.
PN-EN 61508-4:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 4: Definitions and abbreviations.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

Document name	Document title
PN-EN 61508-5:2010	Functional safety of electrical/electronic/programmable electronic safety related systems - Part 5: Examples of methods for the determination of safety integrity levels.
PN-EN 61508-6:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 6: Guidelines on the application of IEC 61508-2 and IEC 61508-3.
PN-EN 61508-7:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 7: Overview of techniques and measures.
PN-EN 61511-1:2017-07	Functional safety - Safety instrumented systems for the process industry sector, Part. 1: Frameworks, definitions, system, hardware and software requirement.
PN-EN 61511-2:2017-07	Functional safety. Safety instrumented systems for the process industry sector. Guidelines for the application of IEC 61511-1.
PN-EN 61511-3:2017-07	Functional safety - Safety instrumented systems for the process industry sector, Part 3: Guidance for the determination of the required safety integrity levels.
PN-EN 60228:2007	Conductors of insulated cables.
PN-EN 60332-1-2:2010	Tests on electric and optical fibre cables under fire conditions – Part 1 – 2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame.
PN-HD 60364-4-41:2017-09	Low voltage electrical installation - Part 4-41: Protection for safety - Protection against electric shock.
PN-EN 60534-1:2005	Industrial-process control valves - Part 1: Control valve terminology and general considerations.
PN-EN 60534-2-1:2011	Industrial-process control valves - Part 2-1: Flow capacity – Sizing equations for fluid flow under installed conditions.
PN-EN 60534-2-3:2016-08	Industrial-process control valves - Part 2-3: Flow capacity – Test procedures.
PN-EN 60534-2-4:2009	Industrial-process control valves - Part 2-4: Flow capacity – Inherent flow characteristics and rangeability.
PN-EN 60534-2-5:2004	Industrial-process control valves - Part 2-5: Flow capacity - Sizing equations for fluid flow through multistage control valves with interstage recovery.
PN-EN 60534-3-1:2004	Industrial-process control valves - Part 3-1: Dimensions - Face-to-face dimensions for flanged, two-way, globe-type, straight pattern and centre-to-face dimensions for flanged, two-way, globe-type, angle pattern control valves.
PN-EN 60534-3-2:2002	Industrial-process control valves - Part 3-2: Dimensions End-to-end dimensions for rotary control valves except butterfly valves.
PN-EN 60534-3-3:2001	Industrial-process control valves - Part 3-3: Dimensions End-to-end dimensions for butt weld, two-way, globe-type, straight pattern control valves.
PN-EN 60534-4:2006	Industrial-process control valves - Part 4: Inspection and routine testing.
PN-EN 60534-5:2004	Industrial-process control valves - Part 5: Marking.
PN-EN 60534-6-1:2001	Industrial-process control valves - Part 6-1: Mounting details for attachment of positioners to control valves - Positioner mounting on linear actuators.
PN-EN 60534-6-2:2002	Industrial-process control valves - Part 6-2: Mounting details for attachment of positioners to control valves - Positioner mounting on rotary actuators.
PN-EN 60534-7:2011	Industrial-process control valves - Part 7: Control valve data sheet
PN-EN 60534-8-2:2012	Industrial-process control valves - Part 8-2: Noise considerations - Laboratory measurement of noise generated by hydrodynamic flow through control valve.
PN-EN 60534-8-3:2011	Industrial-process control valves - Part 8-3: Noise considerations - Control valve aerodynamic noise prediction method
PN-EN 60534-8-4:2016-05	Industrial-process control valves - Part 8-4: Noise considerations - Prediction of noise generated by hydrodynamic flow


	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

Document name	Document title
PN-EN 60534-9:2008	Industrial-process control valves - Part 9: Test procedure for response measurement from step inputs
PN-EN IEC 60332-3-10:2018-12	Tests on electric and optical fibre cables under fire conditions - Part 3-10: Test for vertical flame spread of vertically-mounted bunched wires or cables - Apparatus
PN-EN 62676-4:2015-06	Video Surveillance Systems For Use In Security Applications - Part 4: Application Guidelines.
PN-EN 60947-5-6:2002	Low voltage switchgear and controlgear - Part 5-6: Control circuit devices and switching elements, DC interface for proximity sensors and switching amplifiers (NAMUR).
PN-EN 62368-1:2015-03	Audio/video, information and communication technology equipment - Part 1: Safety requirements
PN-EN 61000-4-2:2011	Electromagnetic compability (EMC) - Part 4-2: Testing and measurement techniques Section 2: Electrostatic discharge immunity test. Basic EMC Publication.
PN-EN 61000-4-3:2007	Electromagnetic compability (EMC) - Part 4-3: Testing and measurement techniques Section 3: Radiated, radio - frequency, electromagnetic field immunity test.
PN-EN 61285:2015-06	Industrial process control - Safety of analyser houses.
VDI 2440	Emission control – Mineral oil refineries.
PTC 19,3 TW-2010	Thermowell Calculations
TA Luft	Technical instructions on air quality control (Technische Anleitung zur Reinhaltung der Luft).
ANSI/NACE MR0175/ISO 15156	Petroleum and natural gas industries Material for use in H ₂ S – containing Environments in oil and gas Production.
IEC 60092-352:2005	Electrical installations in ships - Part 352: Choice and installation of electrical cables.
WUDD-UC WO-A/01	Pressure equipment, General requirements. Accessories. Overpressure devices.
WUDD-UC WO-A/02	Pressure equipment, General requirements. Accessories. Protecting instrumentation.
WUDD-UC WO-A/03	Pressure equipment, General requirements. Accessories. Instrumentation equipment.
WUDD-UC WO-A/04	Pressure equipment, General requirements. Accessories. Valves.
Directive 2014/34/EU (ATEX 114)	Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres.
Directive 99/92/EC (ATEX 137)	Directive 1999/92/EC of the European Parliament and of the Council of 16 December 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres.
Directive 2014/32/EU	Directive 2014/32/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of measuring instruments
Directive 2014/68/EU	Directive 2014/68/EU of the European Parliament and of the Council of 15 May 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment
Directive 2014/35/EU	Directive 2014/35/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

Document name	Document title
Directive 2014/30/EU	Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility
EEMUA Publication 191 Third Edition	Alarm Systems - A Guide to Design, Management and Procurement
ASME/FCI-70.2 -2006	Control Valve Seat Leakage
ANSI/ISA-5.06.01-2007	Functional requirements documentation for control software applications
ANSI/ISA-5.1-2009	Instrumentation symbols and identification
ANSI/ISA-18.2-2009	Management of Alarm System for the Process Industry
ANSI/ISA - S71.04	Environmental conditions for process measurement control system
ANSI/ISA-TR99.00.01 - 2007	Security technologies for industrial automation and control systems.
ISA-18.1-1979 (R2004)	Annunciator Sequences and Specifications
ISA-TR5.1.01 - ISA - TR77.40.01 - 2012	Functional diagram usage.
ISA-5.2 - 1976 (R1992)	Binary logic diagrams for process operations.
ISA-5.3 - 1983	Graphic symbols for distributed control/shared display instrumentation, logic and computer systems.
ISA-5.4 - 1991	Instrument loop diagrams.
ISA-5.5 - 1985	Graphic symbols for process displays.
ISA MC96.1	Temperature measurement thermocouples.
ISO 724	ISO General – Purpose Metric Screw Threads – Basic Dimensions.
NIST SP 800-82 June 2011	Guide to industrial control systems (ICS) security.

If the Contractor wishes to apply another standard or regulation which is not included in the table above, the same shall be agreed with and accepted by the Buyer.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

2.3. Certifying organisations

Instrumentation equipment can be certified as:

- pressure equipment,
- equipment intended for use in explosion hazard areas,
- equipment intended for use in safety system (SIL certification).

2.3.1. Instrumentation subject to certification as pressure equipment

Devices directly installed on pipelines and equipment qualified as pressure equipment belong to the instrumentation which is subject to certification. It applies to the control and isolation valves, direct-acting controllers, thermowells for thermoelements and flowmeters.

Isolation valves installed on instrumentation nozzles belong to the mechanical scope.

Directive 2014/68/EU of the European Parliament and of the Council of 15 May 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment shall apply to the pressure equipment; this Directive supersedes Directive 2004/22/WE.


Material Certificate 3.1 in accordance with EN 10204 is required for all devices in contact with medium.

2.3.2. Instrumentation subject to certification as equipment for use in explosion hazard areas

Instrumentation to be located in the explosion hazard areas of the plant is subject to certification.

It applies to the following equipment:


- pressure and pressure differential transmitters,
- level transmitters,
- flowmeters,
- R/I transmitters for temperature measurement,
- temperature detectors,
- analysers,
- analyser house/shelter,
- gas detectors,
- junction boxes with accessories,
- remote controlled valve actuators and positioners,
- solenoid valves,
- cable glands and plugs,
- switches,
- smart positioners,

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- limit switches,
- instrumentation in electric motors ventilation systems,
- associated equipment (galvanic separators, I/O cards),
- and other field equipment.

Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres shall apply to the manufacturing and operation of the equipment intended for use in explosion hazard areas.

All organizations on the list published in the Official Journal of the European Union are authorized to certify such equipment.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

3. FIELD EQUIPMENT AND CONTROL SYSTEMS

3.1. Technical requirements for field equipment and control systems

3.1.1. Preface

This document defines technical requirements for instrumentation and control systems for production units.

Each time prior to commencement of the engineering, the Contractor shall agree with the Buyer (ANWIL S.A.) all technical requirements, related standards, standard drawings and/or formats which the Contractor plans to use and include in the documentation.

3.1.2. General structure

Instrumentation and control/safety systems for new/modernised units shall comply with mandatory standards and laws and regulations in chemical industry and should be state-of-the-art.

Instrumentation, control/safety systems and monitoring systems shall be located in separate technical rooms and shall be separated from electrical equipment.

The control room and the control cabinet rooms should be located in a single building, if possible.

The basic structure of field instrumentation consists of the following:

- DCS distributed control system,
- ESD (BMS/SIS) emergency shutdown system realized with certified PLCs,
- GDS gas detection system,
- FDS fire detection system,
- CCTV closed circuit television,
- MMS machine monitoring system,
- anti-surge system,
- AMS (Asset Management System) field instrumentation diagnostic system,
- dedicated package-supplied PLCs,
- field instrumentation.


3.1.3. General design requirements

Field instrumentation and control and safety systems shall be designed and made in accordance with standards and regulations listed in section 2.2, basic design and the Buyer's requirements specified herein.

Adopted control structures must be designed and built in a such manner as to reach operational reliability, ensure ease of servicing, low maintenance costs and maximum technical safety at low capital expenses.

Design, and structure of instrumentation and measurement systems and equipment have to meet the following requirements, inter alia:

- continuous operation between turnarounds,
- usually accepted turnaround duration of the plant,

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- the plant/process operation parameters,
- optimum number of operation and maintenance staff.

The following items shall be excluded from the instrumentation engineering (technical design) and included in the mechanical design:

- by-pass valves mounted next to control valves and flowmeters,
- nozzles for field instrumentation,
- bypasses and sampling points on the equipment and pipelines.

All materials used for measuring instruments and accessories shall be adequate for process services, ambient conditions and plant environment.

Field instrumentation designed for ANWIL S.A. production plants shall be adapted to operate at ambient temperatures from minimum -29°C up to +40°C.

Battery limit between instrumentation and mechanical shall run on all first shut-off valves finished with blind flanges. It applies to all process and utilities pipelines, vessels, columns and other equipment on which flow, level, pressure is measured and medium is analysed, etc., and as well as to instrument air collecting pipes ended with isolation valves.

The nozzle for temperature measurement shall be ended with a blind flange, without an isolation valve.

All shut-off and drain valves should be included in the mechanical design. In-line sensors and in-line measurement equipment should be also included in the mechanical design. Moreover, thermowells and skin thermocouples (measuring the pipeline wall temperature) shall be included in the mechanical design. Supervision of temperature sensors installation shall be included in the instrumentation scope.

All power-supply devices, both AC and DC, including cables up to the power distribution/marshalling/interposing cabinets shall be included in the electrical design.

Process variable switches for process pumps (e.g. for the sealing system) shall be included in the instrumentation design. This shall also apply to other accessories (e.g. measurement of motor winding and bearing temperature). An exception is made for the MV (6-30kV) motor winding temperature measurement.


Protection of the DCS/ESD/PLC against medium voltage from the motor windings shall be at least a two-stage protection:

- primary protection - realized by the motor manufacturer,
- additional protection - realized in the structure of measuring circuits.

Maximum standardization and unification of both, field instrumentation and control cabinet equipment shall be applied during design works.

A free and safe access to each instrument shall be provided during start-up and normal operation of the plant.

Instrumentation for potentially explosive areas shall be designed and selected in accordance with European Union directive ATEX 114 (2014/34/EU) and harmonised standards with directive as well as current classification of explosion hazardous areas.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

The following explosion-proof execution of field instrumentation is preferred:

- **Ex i** for control and monitoring systems,
- **Ex d** for ESD systems.

To obtain high level of safety in explosion hazard areas, instrumentation of category **II 3 GD Ex n** (intended for zone 2 or 22) made according to the standard:

PN-EN 60079-15	Explosive atmospheres - Part 15: Equipment protection by type of protection „n”.
----------------	----------------------------------------------------------------------------------

or its equivalent, shall not be used.

Although there are Zone 2 and 22 explosion hazard areas, the electrical instrumentation shall be specified for Zone 1 and 21 and this requirement must be treated as minimum.

All Ex equipment supplied with earth terminal shall be reliably earthed. The term “reliably earthed” shall mean an earthing test report which confirms its correctness.

Documentation for explosion-proof equipment, including certificates of EC type examination and EC declaration of conformity for explosion-proof execution, should meet the requirements of 2014/34/EU directive (ATEX 114) and Regulation of the Minister of Development of 6 June 2016 item 817.

Ex specification for explosion-proof devices shall be made according to following guidelines:

- The Contractor shall prepare the Ex specification. It should be made at the design stage as one of the components of the technical design, and then corrected during the implementation of the project.
- The Ex specification passed for opining shall be complemented by changes effected during the implementation of the project and shall take into account the current status of field instruments.

The Ex specification for explosion proof devices shall be based on "As-is List of Electrical Equipment Ex" (Annex No. 1) and "List of Certificates of Electrical Equipment Ex" (Annex No. 2).


Instrumentation classified as pressure devices shall conform to the PED Directive N° 2014/68/EU of European Union and the Act of 21 December 2000 (Journal of Laws N° 122).

Calculation of instrument air consumption on the plant shall be performed using the safety coefficient 2.

Individual pressure reducers with pressure gauges shall be provided for measuring devices consuming instrument air.

Due to safety reasons, interlock initiators (position switches, level switches) shall be equipped with devices for the line failure detection (LFD) directly connected to the PLC.

Trip signals for the flow, pressure and temperature interlock parameters shall be obtained from analogue signals (from independent flow, pressure, temperature transmitters) connected to the ESD system.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

The ESD systems, including PLCs, shall conform to PN-EN 61508, PN-EN 61511 standards. SIL classification of interlock systems and safety loops shall be done taking into account the following consequence classes: Health and Safety, Economics (assets and production value), and Environment.

Field instrumentation shall comply with requirements of the basic design.

Interlock systems should be designed on the basis of SIL analysis, taking into account the required safety level and required intervals of systems checks/inspections.

All measurement and instrumentation systems shall be powered from UPS 230V AC or redundant power system 24V DC.

Control of skid units, wherever possible, should be realized in DCS or ESD. In case it is necessary to use dedicated PLCs, this shall be agreed with and accepted by the Buyer.

Electrical heating of instrumentation (design and supply) is included in the electrical scope.

Instrumentation shall be protected against adverse influence of weather and ambient conditions.

For all instrumentation equipment and components including equipment installed in gas explosion hazard areas - mechanical protection provided by enclosures shall be minimum IP54 - preferred is as high as possible mechanical protection against ingress of solids and water. For instrumentation equipment and components installed in dust explosion hazard areas - mechanical protection provided by enclosures shall be minimum IP65. All lines and drain nozzles shall be protected with a blind flange or a metal plug.

Measurement units - by default SI units shall be used.

3.1.4. Standard instrumentation signals

Standard pneumatic signal: 0.2 to 1bar.

Standard signal for electronic transmitters/control inputs: 4-20 mA in 2-wire 24V DC line. This does not apply to thermocouples, resistive temperature detection (RTDs) and any other specific measurements.

The instrumentation equipment shall enable communication consistent with the HART protocol (required minimum 7 HART version).


24V DC binary signals.

Signals from limit switches: NAMUR.

Solenoid valves signals - generally 24V DC; in particular cases, e.g. very long distances, 230V AC against consent of maintenance services.

Serial communication according to the requirements of control and safety systems.

In justified cases, after an agreement with the Buyer, the use of wireless devices (Wireless HART technology) is accepted.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

3.1.5. Delivery of technical documentation

Electronic version of technical documentation (*.pdf files with signatures of approvers) must be placed in ARCHEO.

Final "as-built" technical documentation should be delivered by the Contractor in following forms:

- paper - 3 copies,
- pdf electronic version (*.pdf searchable source and *.pdf scans with signatures) – 2 copies,
- electronic version (source version with full access to files, format: *.doc, *.xls, *.vsd, *.dwg, *.dgn, itp.) – 2 copies.

Technical documentation shall have all components indicated in Annex No. 3 ("Contents and Structure of Technical Documentation").

The documentation standard (e.g. typical loop diagrams) shall be agreed with the Buyer's.

For newly designed and modernised plants the documentation shall be made in an integrated design environment agreed with the Buyer (it's necessary to provide all source files and database files with full access for editing).

3.1.6. Surge protection

In justified cases, the following surge protection shall be used:

- field surge limiters,
- stripe surge limiters,
- lightning arresters.

The elements of surge protection shall be selected according to surge hazard level and based on equipment used.

3.1.7. Electrical shock protection

The detailed requirements for electrical shock protection are given in "Electrical - General Requirements for New and Modernised Production Plant - Technical Annexes to Contracts."


3.2. Field instrumentation

It is required to use smart-type measurement transmitters and positioners. The "List of Manufacturers and Vendors Approved by ANWIL S.A." (Annex No. 6) provides a basic framework for selecting the instrumentation.

The scope of supply and type of equipment shall be approved by competent Buyer's technical departments.

3.2.1. Field installation of instrumentation

Instruments shall be in metal enclosures, in standard manufacturer's execution or in accordance with the vendor's standard. Field instrumentation shall have weather resistant

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

seals. The enclosure door ought to be equipped with a peephole enabling observation of being measured variable, settings, etc.

Instrumentation shall be made of appropriate materials for use in chemical plants.

Field-installed instruments shall have protection degree of at least IP-54, according to recommendations of PN-EN 60529. Enclosures for the field instruments shall be of a high strength construction. Cabling shall be protected from possible damage. Contacts of relay devices shall be hermetically encapsulated to assure proper operation in the chemical plant environment.

All items have to be installed in locations free of excessive vibration and exposure to extreme temperatures which could cause a damage. Moreover, the items shall not be installed below drains nor directly above vents.

When manual control is required, the transmitter shall be equipped with an additional indication near to the control valve so that it could be seen from operator's position by the valve hand wheel. Each additional indication must be marked with the label with the tag number. The instrument's reading area shall specify a multiplier and engineering units.

Clamps, holders, installation supports shall be fixed to the permanent components of the structure. If this is not possible, it is acceptable to fix to the base by means of expansion plugs, or to the process piping by means of special elements. Supports must not be welded to columns, vessels or process piping.

Fixing to the hot piping shall be avoided. If it is impossible, then fixing point shall be moved away from the piping by providing a suitable structure. Where piping temperature exceeds 150 °C, the insulation pads of appropriate insulating material shall be inserted between the piping and the fixing clamp.


Wherever possible, fixing of the support construction to concrete walls and pillars shall be avoided. In specific cases, fixing by means of expansion plugs is acceptable, while avoiding any damage of the concrete base.

The pneumatic supply header for measurement and instrumentation purposes shall be made of pipes connected by thread connections. Pipes' material shall be suitable to ambient conditions occurring in a given plant. Air distributors of (for 5 or 10 users) should be placed on piperack, in easily accessible locations. A shut-off valve shall be installed between the header and the air distributor. Air distributors shall be equipped with drain valves.

Connections between shut-off valves on air distributors and instruments should be made of stainless steel tubing laid in cable trays. Air distributors and shut-off valves shall have permanent nameplates. The following recommendations shall be observed during the installation works:

- shut-off valves shall be equipped with lever with a lock option,
- avoid the connecting of tubes,
- avoid reducing the tubes cross-section,
- all thread connections have to be sealed with a Teflon tape.

Field instrumentation installed in explosion hazard areas shall be connected to the earthing system. This shall apply to the transmitters, junction boxes, analysers, local control panels. Parameters of the earthing system have to meet the requirements of the instrumentation manufacturers.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

The measuring instruments and impulse lines - where necessary - shall be trace heated by means of electric heating tapes. The modernised existing plants can continue with steam heating if the User agrees (in mechanical scope). The heating method shall be agreed and adapted to the possibility of installing in the facility at technical design stage. Heated elements shall be thermally insulated.

Electric power supply for heating purposes will be provided from distribution boards located in the LV electrical substation. Electric heating loops shall have a 2-pole breaker switch. Installation of the electrical trace heating system shall be performed in such a manner as to enable the disassembly of the appliances without damaging the heating components. The electrical trace heating should be in the electrical scope. Interlock initiators and field interlock actuators shall be clearly and permanently marked (red nameplate with white description).

Every instrument and actuating element (a valve) should be equipped with the nameplate made of stainless steel which is permanently fixed. This name plate should contain the full list of parameters and the instrument characteristic. Moreover, it shall be placed in a manner that allows reading all information it contains.

3.2.2. Access to field instrumentation

Field instrumentation and elements like orifice plates, temperature sensors etc. as well as instrument shut-off valves that separate instruments from pipelines and equipment shall be easily and safely accessible from platforms. Access from mobile platforms shall be agreed with the Buyer.

To facilitate reading, the field instrumentation shall be installed on supports so the middle point of instrument is at the level of 1.5 m above the platform. The instruments shall be always located in easily accessible places. It is not allowed to locate the instruments in places with difficult access - under the ladders or stairs.

In order to provide easy maintenance, junction boxes for multicore cables shall be located in accessible locations at the elevation around 1.5 m above the platform. Proper distance shall be ensured between these boxes and the structures to which these boxes will be fixed. This distance should be established according to expected thermal or fireproof insulation thickness. All junction boxes shall be described on the outer side of closing covers; the same marking shall be placed on multi-pair cables outgoing from the box.


3.2.3. Flow measurement

3.2.3.1. Orifice plates

A sharp-edge orifice plate, concentric, symmetrical, with flange pressure taps is a typical and most commonly used type of orifice plates.

The orifice plates must meet the following requirements.

- Flanges for installation of the orifice plate assembly - necked, welded, equipped with isolation valves.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- A compact orifice flowmeter shall be used for the process piping smaller than 2". The material supply shall be complete: the flanges with straight pipe runs upstream and downstream the orifice plate, connecting components and gaskets shall be delivered together with the orifice plate.
- A compact orifice flowmeter should have a shut-off and bypass. In case of dirty media it is necessary to use reticular filter (the assembly in mechanical scope).
- Venturi tubes shall be used in cases when a small pressure drop across the measurement component is required or enhanced measurement accuracy is needed. The complete supply shall include gaskets, bolts, nuts and isolation valves.
- If no pressure loss across the measurement component is allowed, then a version of Pitot tubes (e.g. Annubar) which can be replaced under pressure is preferred.
- The flowmeters should be installed in the horizontal run of the piping, if possible. Straight runs of pipes shall be provided on inflow and outflow sides according to the ISO standard. The use of inlet vane guides (IVG) is not allowed.
- Calculations of the orifice plates must be consistent with PN-EN ISO 5167-1-Part 1.
- Orifice plates should have vent or drain holes if the orifice diameter is greater than 25 mm.
- Orifice plates shall be clearly marked with at least the measuring point (tag) name, orifice hole diameter, nominal diameter, material, flow direction.

3.2.3.2. Vortex flowmeters

Vortex flowmeters are preferred in case of pure medium flow (clean gases, liquids and steam) and high span measurements.

They can be used as an alternative measurement method for diameters up to DN 200.


Vortex flowmeters shall be delivered in accordance with relevant obligatory standards and the following requirements.

- Measuring accuracy should be $\pm 1.0\%$ for liquids and $\pm 1.5\%$ for gases or vapours (in reference conditions).
- An integrated signal transmitter is preferred. If a separate transmitter is delivered, it should be equipped with clamps for installation on a 2" pipe.
- Replacement of electronic component in integrated signal transmitter shall be possible without disassembling the complete instrument.
- The flowmeter should be installed on the horizontal run of the piping. Straight pipe runs shall be used on the inflow and outflow sides.
- If possible, Vortex flowmeters should have a 30% reserve of nominal measuring flow range.
- Vortex flowmeters shall be furnished with integrated LCD displays.

3.2.3.3. Mass flowmeters

Mass flowmeters shall be delivered according to relevant obligatory standards and the following requirements.

- Measuring accuracy of the mass flowmeters should be at least $\pm 0.2\%$ of the full measuring range for liquids and $\pm 0.5\%$ of the full measuring range for gases or vapours (in reference conditions).
- Mass flowmeters should directly measure the mass stream flow.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- Isolation valves and by-pass shall be provided for the flowmeter.
- It is required to use Coriolis flowmeters with an integrated measurement procedure verification. Verification shall be performed on-line.
- Mass flowmeters shall be furnished with integrated LCD displays.

3.2.3.4. Solid and Powder Flow Measurement

Flowmeters for solid and powders shall be delivered according to relevant obligatory standards and the following requirements.

- Measuring accuracy of the mass flowmeter should be at least $\pm 1.0\%$ of the full measuring range.
- The flowmeter should be complete and delivered according to Directive 2014/32/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of measuring instruments.

3.2.3.5. Rotameters

Rotameters are dedicated mainly for local measurements and less important remote measurements.

Rotameters shall be delivered in accordance with relevant obligatory standards and the following requirements.

- Rotameters shall be equipped with isolation valves on the inflow and outflow sides.
- Inlet from bottom side, flanged connection in accordance with pipeline class (for analytic purposes, as well as in special cases, NPT connections are acceptable in process instrument).
- The rotameter scale shall be made of safe glass on its whole length, with medium-proof seals on both sides.
- The rotameter shall have a metal housing.
- Measuring accuracy shall be at least 1.6% of full scale.
- The rotameters for purging systems shall feature a constant flow regulation and low flow alarm.


3.2.3.6. Local flow indicators

If there is a need for a local flow indicator, an orifice plate assembly with indication of the pressure difference (pressure difference gauge) shall be used.

If a measured signal is transmitted to the DCS, then the local indicator should be connected in series with the transmitter (in the same current loop).

If any additional calculations are required in the DCS, then the measuring signal should be retransmitted from the system to the indicator.

3.2.3.7. Other flowmeters

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

Depending on the needs or requirements of the basic design (requirements of a given measuring application), the following flowmeters can be used:

- magnetic flowmeters,
- ultrasonic flowmeters,
- turbine flowmeters,
- thermal mass flowmeters.

Each use of instruments listed under 3.2.3.7 requires the Buyer's consent.

3.2.4. Level measurement

3.2.4.1. Level transmitter

In general, the level measuring instruments shall conform with the mandatory standards and the following requirements.


- Radar or displacement level transmitters with measuring chamber shall be used wherever possible for the level range from 350 up to 3000 mm. The measuring chamber shall be equipped with isolation valves (mechanical scope).
- Measuring chamber shall have 2" ANSI connecting flanges, a 3/4" vent valve and a 3/4" drain valve.
- Connecting flanges of the radar or displacement transmitter mounted directly into a vessel interior shall be 4" ANSI size (for a non-corrosive medium and in a non-pressurised vessels).
- It is recommended to use a pressure differential transmitter (Smart type) in case of measuring range above 3000 mm or for viscous, corrosive, contaminated liquids or when the liquid is being mixed or there is vibration.
- For liquids susceptible to separation or solidification or sedimentation in pulse tubes, the transmitters with 3" separators shall be used (other sizes in case of special requirements), it is possible to use electrical pressure differential transmitters.
- Vents and drains shall be directed through a pipe to a safe location or a blowdown system; this shall not apply to the instruments installed on safe media, e.g. low-pressure, non-toxic or non-flammable liquids.

3.2.4.2. Vibration level switch

The vibration level switches shall be chosen in accordance with relevant obligatory standards and the following requirements.

- They shall be installed on the top or side of the vessel.
- They shall have 2" connection nozzles, as a minimum (other sizes in case of special requirements); flange connection; connection class according to vessel class.
- Level switches shall be installed in a manner that allows an easy removal, considering the length of fork; brackets from the internal side of the vessel shall be installed for level switches with the fork longer than 1 metre.
- Avoid installing vibration level switches near the point of filling the tank, strong splashing on the fork or near heat sources.
- In case of viscous substances, level switches shall be installed under angle, fork downwards (installation perpendicular to vessel wall shall be avoided).

3.2.4.3. Level gauges

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

All vessels and columns with continuous level measurement or level switches shall be equipped also with local level indicators. Other vessels shall have the level gauges installed in case the level monitoring is essential for operation of the plant or for safety reasons.

A level gauge shall cover the full measuring range of any other level measuring instruments installed in the same section of the vessel.

Level gauges shall be chosen in accordance with relevant obligatory standards and the following requirements.

- Magnetic level gauges should be used in most applications (especially for toxic liquids, viscous liquids, for high-pressure, high-temperature and dangerous operating conditions).
- Reflex or transparent glass must be used when it is not possible to use level gauges (contaminated, coloured and separated (more than one phase) liquids, when the individual layers can be easily seen).
- Level gauges should be equipped with the quick-acting angle valves of offset type, a $\frac{3}{4}$ " connection on the vessel side made of forged carbon steel.
- Connections for level gauges shall be 2" ANSI flanged type and dedicated solely to level gauges.
- In addition to the cocks, separate shut-off valves between the columns and vessels shall be installed.
- Each level gauge of transparent glass should be equipped with a 230V AC lighting.
- Vents and drains shall be directed through a pipe to a safe location or a blowdown system; this shall not apply to the instruments installed on safe media, e.g. low-pressure, non-toxic or non-flammable liquids.

3.2.4.4. Other level measuring instruments

Depending on the needs or requirements of the basic design, the following instruments for level measurement can be used:

- ultrasonic level transmitters,
- hydrostatic level transmitters,
- floating level switches,
- radar level switches,
- capacity type level switches.


Each use of instruments listed under 3.2.4.4 requires the Buyer's consent.

3.2.5. Pressure measurement

3.2.5.1. Pressure gauges

The pressure gauges shall be chosen in accordance with relevant obligatory standards and the following requirements.

- Indications range: 0 to 1 / 1.6 / 2.5 / 4.0 / 6.0 / 10.0 and tenfold multiples.
- All pressure gauges shall have stainless steel enclosures, preferred diameter 160 mm (measurements of pipelines and equipment), safety glass, M20x1.5 threaded connection and overpressure protection diaphragm.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- Minimum measuring accuracy of the pressure gauges shall be 1.0%, and overload protection shall be 130% of the measuring range.
- If it is necessary to use pulsation dampers and out-of-range protection, these elements shall be made of minimum 316SS; external adjustment of the pulsation dampers should be possible.
- Pressure gauges for measurement of the instrument air pressure shall have approximate diameter of 30 mm and M12x1.5 male thread.
- Pressure measuring points shall be equipped with a shut-off valve and a drain valve (it is possible to use a manifold).
- Pressure gauges with flange separators and capillary tubes shall be used for viscous and high temperature media.
- In applications with high pressure fluctuations or vibration the pressure gauges shall be filled with liquid.

3.2.5.2. Pressure and differential pressure transmitters


Pressure and differential pressure transmitters shall be chosen in accordance with relevant obligatory standards and the following requirements.

- Pressure and differential pressure transmitters shall be of smart type and ought to be installed in protection boxes. In justified cases, following an arrangement with the Buyer, it is possible not to use a protection box.
- Standard measuring signal: 4 to 20 mA, 2-wire, 24V DC.
- Each transmitter shall be delivered with a complete mounting kit.
- Impulse lines should be made of ½" pipes. In justified cases, following an arrangement with the Buyer, it is possible to use a different piping size. Impulse line material - stainless steel (other material depending of the process conditions in accordance with piping mechanical classification).
- Each pressure transmitter shall have an individual two-valve manifold. A five-valve manifold shall be used for differential pressure transmitters.
- Vents and drains shall be directed through a pipe to a safe location or a blowdown system; this shall not apply to the instruments installed on safe media, e.g. low-pressure, non-toxic or non-flammable liquids.
- Transmitters shall be in intrinsically safe Ex i or flameproof Ex d execution. Intrinsically safe execution is preferred for control and monitoring purposes and flameproof execution as an interlock initiator connected to the ESD system.
- Pressure transmitters with 3" separators of minimum 316SS stainless steel, for installation between the flanges, shall be used wherever necessary.
- In applications where type of medium causes clogging of impulse lines (dense medium, solidifying medium etc.) pressure transmitters and differential pressure transmitters with detection of clogged lines (shall be used impulse lines must be short and straight). Flush or purge systems should be used wherever required.

3.2.5.3. Pressure switches

Pressure switches shall be chosen in accordance with relevant obligatory standards and following requirements.

- Pressure switches shall be made of the 316SS steel, in weatherproof execution.
- Pressure switches shall have SPDT or DPDT, 24V DC, 0.5A contacts of microswitch type or NAMUR electronics and they shall be of weatherproof execution. The contact

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

material shall match a given application (e.g. gold-covered contacts shall be used in corrosive atmospheres). A setting knob shall be available inside the enclosure.

- In case of a pressure monitoring system in the ESD systems, it is necessary to use pressure transmitters instead of pressure switches.
- Pressure switches shall have ½" NPT connections, female thread is preferred.

3.2.6. Temperature measurement

3.2.6.1. Local temperature measurement

Local temperature measurement shall be chosen in accordance with relevant obligatory standards and the following requirements.

- Bimetallic thermometers or temperature gauges filled with gas or liquid are acceptable.
- Measuring dial diameter 160mm. A linear scale in degrees Celsius, temperature indication from 20% to 80% of the scale.
- Thermometer connection - M27x2 male thread.
- Thermometers shall be installed in thermowells so they can be easily removed without the need to stop the plant.
- Bimetallic thermometers should be used for temperatures over 0°C.


3.2.6.2. Thermocouples and resistance temperature detectors (RTD)

Thermocouples and resistance temperature detectors (RTD) shall be chosen in accordance with relevant obligatory standards and the following requirements.

- Thermocouples with an unearthed weld shall be used.
- Thermocouples shall be calibrated as per PN-EN 60584.
- The chosen thermocouple type shall depend on the design temperature and media type - "J" and "K" thermoelement types are preferred.
- If a thermocouple is connected to the DCS or ESD system for purpose of control or interlocking, then the transmitter should be preferably installed in the head of measuring sensor.
- For Pt100 RTDs (100 Ohm at 0°C) at least 3-wire connection is required; calibration according to PN-EN 60751.
- Sensor connection - M27x2 male thread.
- Sensors of both types (thermocouples and RTD) shall be installed in thermowells; an exception is made for skin sensors for temperature measurement of the process vessel shells and piping walls (so called skin thermocouples).

3.2.6.3. Thermowells

All temperature sensors shall be installed in thermowells so they can be easily removed without shutting down the plant. An exception is made for skin (coat) temperature sensors for process equipment, piping, bearings, motor windings.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

The thermowells shall have flange connections. The following connections sizes shall be used, unless specified otherwise:

- 1 ½" ANSI flange (piping),
- 2" ANSI flange (vessels and equipment).

Connection between thermoelements and thermowells - M27x2 thread.

Choice of thermowell flange, flange sealing surface type and finishing shall be consistent with the piping or equipment specification.

The thermowells shall be of solid, drilled type, they shall be of conical shape, material at least 316SS or other suitable for process conditions and in accordance with piping specification. All thermowells shall be made of certified material and shall be pressure tested. The flange must be welded to the thermowell on two sides. Welding shall be performed as per ASME IX or Polish regulations.

The thermowell length (length of immersion) shall be such that the thermowell end is located between 1/3 and 2/3 of the pipeline inner diameter.

Calculations according to ANSI/ASME PTC 19,3, including stresses and vibrations, shall be performed for thermowells installed in the gas, or vapour piping or in the piping with high liquid flow velocity.

Thermowells shall not be installed in the piping less than 4". Smaller piping shall be enlarged locally to 4" to install the thermowells. The thermowells shall be installed in the piping elbows.

3.2.6.4. Temperature transmitters

Electronic temperature transmitters shall be chosen in accordance with relevant obligatory standards and the following requirements.


- Standard measuring signal from 4 to 20 mA.
- When a transmitter is connected to the DCS or ESD system, it should be powered from I/O modules in a 2-wire 24 VDC line.
- Measuring accuracy not worse than $\pm 0.2\%$.
- Temperature transmitters shall be SMART type equipped with the HART Protocol.
- Transmitters shall be in intrinsically safe Ex i or flameproof Ex d execution. Intrinsically safe execution is preferred in case of connection to the DCS, and the flameproof execution as an interlock initiator connected to the PLC of the ESD system.
- Transmitters shall be mounted in the head of the temperature sensors or in a separate flameproof box, if there is such need, for example electric motor bearing temperature measurement.

3.2.7. Analysers

3.2.7.1. Analyser types

The following analyser types shall be used:

- liquid sample (classification based on the measured parameter):
 - conductometer,

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------


- pH-meter,
- redox (ORP) analyser,
- dissolved oxygen analyser,
- silica analyser,
- sodium analyser,
- densimeter,
- turbidimeter,
- chlorine analyser,
- TOC analyser,
- other, depending on the process needs,
- gas sample (classification based on the measuring method):
 - chromatograph,
 - photometer:
 - UV photometer,
 - VIS photometer,
 - IR photometer,
 - UV fluorescence,
 - FTIR (Fourier Transform Infrared Spectroscopy),
 - laser analyser,
 - chemiluminescence analyser,
 - flame ionization analyser,
 - thermal conductivity analyser,
 - paramagnetic oxygen analyser,
 - zirconia cell analyser,
 - electrochemical analyser,
 - psychrometer,
 - hygrometer,
 - absorption hygrometer (gravimetric),
 - dew-point hygrometer (cold-spot hygrometer),
 - hygroscopic-based hygrometer,
 - electrical hygrometer (capacitance, resistance with electrolytic sensors, with heated sensors),
 - light scattering,
 - triboelectric,
 - other, depending on the process needs.

3.2.7.2. General principles for analyser measuring systems

Elements of analyser measuring systems shall be designed and made in accordance with relevant obligatory standards, Polish regulations and good engineering practice.

All analyser measuring systems should be adapted to servicing directly on the plant. Therefore, necessary operating conditions and working space for maintenance crew (minimum two people) must be foreseen during the design work.

A design of the analyser measuring system (sampling system, sample transport, sample conditioning system and the analyser) must ensure that the response time of whole analyser measuring system shall not exceed the measurement time is required by the process.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

The industrial analyser measuring systems must be designed and built in a such manner that their impact on the environment as a result of their operation is reduced to a minimum (appropriate system construction, choice of materials, protections, etc.).

The analyser measuring systems have to be designed to allow their inspection, cleaning and calibration during operation. Any maintenance activities listed above shall not require the installation shutdown.

All elements of the process analysers measuring system should be clearly and permanently marked with nameplate. In case of control elements and indicators each nameplates should include, inter alia, the following information: tag number, setting range (min., nor., max.).

The industrial analysers should be powered from a 4...20mA current loop or 24V DC/230V AC circuits of switchgears supplied from the UPS unit (guaranteed voltage).

Auxiliary system such as heaters, fans, air-conditioners, etc. shall be powered from the 230V AC electrical substation (non-guaranteed voltage).

The power supply and signal circuits should have appropriate surge protection systems and an earth-leakage protection (RCDs); additionally, the power supply circuits should have appropriate earth-leakage protection (RCDs) suitable for the receiver type.

Elements of the industrial analyser measuring system installed in explosion hazardous areas shall be connected to earthing.

It is recommended to use separate sampling points for the process analyser system and for manual (laboratory) measurements.

The sampling probes shall be installed is a manner that ensures taking a representative sample.

The sampling system must be designed and built in a such manner as to allow a continuous flow of process medium and should ensure the full and safe discharge of process medium.


When it is necessary to insert the sampling probe into the pipeline, the probe shall be made of material which resistance to the process conditions is not worse than of the pipeline material; typical pipe diameter from 6mm up to 1/2"; for sampling probes diameters in excess of 12mm, the probe shall be terminated with the 1/2"NPT male thread.

The line transporting the sample from the sampling point system to the sample conditioning system should be made of precision tubes, made of material resistant to the process medium (AISI 316, Monel, Hastelloy, etc.). It is recommended that tube end connections be welded or Swagelok two-ferrule tube fitting system be used (a leak-tightness test is required in such case). In case of the emission and immission measurement system and in other justified situations it is possible to use Teflon (PTFE) pipes, after an agreement with the Buyer.

When an application requires a thermal insulation of the line, the pre-insulated pipes with electrical heating shall be used.

Lines filled with liquid must be installed with an approximately 1% slope.

The following elements of the sample conditioning system shall be used:

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- coolers,
- pressure reducers,
- filters,
- flowmeters,
- shut-off valves,
- connecting elements,
- tubes,
- other, depending on the application.

The industrial analyser measuring systems should be adapted to manual calibration; the manual calibration procedure should be delivered before the planned commissioning of the measuring system.

Analysers should be provided with an auto-diagnostic system, enabling a fast and accurate assessment of their technical condition.

After the measurement, the sample should be returned to the process; when it is impossible, the sample shall be sent to the blowdown network (details to be agreed with ANWIL S.A.). The discharged sample should be disposed of safely.

A set of spare parts and consumables for minimum 2 years shall be supplied for a new analyser system.

It is recommended that analyser measuring systems should be installed in analyser shelters. Deviation from this requirement is allowed only when the container foundation is impossible (lack of space) or if the process requirements do not allow the sample transport. In such case, the analysers should be located in protective boxes.

Protection boxes should be made of plastic (for explosion hazard areas a reduced electrical surface resistance is required) or steel with anticorrosion protection.


Basic output signals are 4...20mA (each component must have separate output), galvanic isolated, minimum load 500Ω, and dry contact for alarm (it should be assumed the following logic should be applied: a closed circuit means no alarm); in case of FTIR analysers and chromatographs it is possible to use serial communication with the MODBUS RTU protocol or another (according to ANWIL S.A. standard); when the distance exceeds 600m fibre optic cables are recommended.

When an analyser measures more than one stream and streams are switched sequentially (information about measured stream is transmitted to the DCS), the system should be designed and built in such a manner that the measurements results are precisely presented in the DCS and that the stream analysed at a given moment is highlighted.

In case an analyser requires the use of carrier gases, their delivery is in scope of ANWIL S.A.

In case an analyser requires the use of calibration gases, their delivery for the start-up and first calibration is in scope of the Contractor of the analyser measuring system.

When an analyser needs chemical reagents, the Contractor of the analyser measuring system shall deliver such reagents for the first 6 months of operation; list of necessary chemical

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

reagents as well as specific consumption and instruction of reagents preparation shall be presented at the bidding stage (analysis stage of technical offers).

Analysers forming a part of the emission monitoring system should meet requirements of certification (procedure QAL1 according to PN-EN:14181:2015) which is conducted according to PN-EN ISO 14956:2006 and PN-EN 15267-1:2009.

If the analyser system contains a computer, then following requirements should be fulfilled:

- use checked and reliable hardware and software configurations,
- deliver the full specification of all computer components as well as list of applied software with necessary licences for the operating system and other installed software as well as the description of operation algorithms and algorithms of performed calculations,
- the Contractor shall make and deliver along with the computer a backup copy in the form enabling booting of the computer without need to reinstall and reconfigure the software,
- an easy and verified data backup procedure must be available after the computer commissioning.

3.2.8. Gas detectors

3.2.8.1. Types of gas detectors

The following types of gas detectors shall be used:

- catalytic sensor,
- thermal conductivity sensor,
- infrared sensor,
- semiconductor sensor,
- electrochemical sensor,
- flame ionisation detector,
- flame temperature analyser (FTA),
- photo ionisation detector,
- paramagnetic oxygen detector.


3.2.8.2. General principles for gas detectors

Elements of the gas detection system must be designed and made in accordance with relevant obligatory standards, Polish laws and good engineering practice.

By their very nature, catalytic sensors and the flame temperature analyser (FTA) directly detect flammable gases by burning and therefore cannot detect non-flammable gases and vapours. The other types of sensors detect the presence of flammable and other gases by the sensor response to other gases properties.

Gas detection system (toxic and flammable gases) shall meet the following requirements.


- The number of detectors should be determined in accordance with relevant obligatory standards and taking into account the characteristics of the plant.
- Detectors and sampling points should be placed in such a manner that gas accumulation is detected before it causes a significant hazard.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- Detectors and sampling points should be located in positions determined in consultation with those who have a knowledge of gas dispersion and production process, and with the engineering personnel.
- Catalytic sensors are a preferred solution for detection of flammable gases.
- Recommended accuracy and repeatability: not worse than 5% of the full range.
- The gas detection system must be designed and built in a such a manner that the delay time of the whole system is less than the maximum delay time allowable for a given application. As a minimum, the following factors should be taken into account:
 - potential release rate of flammable gas,
 - sampling system delay time,
 - detector response time,
 - delay time of data transmission line,
 - delay time of alarm devices and switching circuits,
 - time required for executive device to take action.
- Response time of the toxic gas detector lower than 60s.
- Response time of flammable gas detector lower than 30s.
- Detectors of flameproof execution Ex d are preferred.
- The controller-based gas detector system is recommended (each sensor shall be individually connected to a monitoring card installed in gas detector controller). Communication between the gas sensor and monitoring card can be analogue or digital. Communication between the gas detector controller and the DCS must be hardwired (common binary signals, 4...20mA signals) and serial e.g. MODBUS; as a standard gas detection controllers are located in air-conditioned control rooms; the Buyer's agreement is necessary for connecting the gas detectors to the PLC or directly to the DCS.
- The system must generate the following signals:
 - individual signal: first concentration alarm threshold exceeded,
 - individual signal: second concentration alarm threshold exceeded,
 - common signal of gas detectors' defect,
 - common signal of gas detectors' inhibit,
 - common signal of system failure.
- It must be able to receive the following signals:
 - reset (gas detection controller),
 - lamps test (gas detection controller),
 - acknowledge (gas detection controller).
- During the system start-up the Contractor is required to carry out the system validation and training for local service personnel.
- After the system start-up the Contractor is required to provide calibration reports and check individual main components as well as the arrangement (system) as a whole.

3.2.9. Analysers house (analysers shelter)

The analyser house shall have the minimum dimensions 2.5m length x 2.5m width x 2.7m height, allowing to accommodate analysers, samples conditioning system, auxiliary, equipment required for service and maintenance and ensuring space necessary for two-people maintenance crew working inside shelter with door closed.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

The location of analysers shelter should be selected in such a manner that the delay time of the whole system is less than the maximum allowable delay time for intended application (process requirements).

As a minimum, the following factors should be taken into account:


- sample parameters,
- time required to deliver a fresh sample from the sampling point to the analyser,
- analyser response time,
- delay time of data transmission line,
- delay time of alarm devices and switching circuits,
- time required for executive device to take action.

The analysers shelter foundation on concrete blocks is acceptable (container will not be firmly connected to ground).

Devices that generate more than 50dB shall not be installed in the analysers room.

The analysers shelter shall be equipped with:

- natural or fan forced ventilation, number of air changes according to applicable standards,
- the system shall ensure optimal operating conditions for maintenance crew and installed elements of analyser systems which usually consist of the following:
 - air conditioner suitable to maintain the internal temperature at 20°C, with all devices working and 35°C outside,
 - electrical heater suitable to maintain internal temperature at 18°C, with all devices off and -25°C outside,
- UPS-based power distribution system (analysers),
- “non-guaranteed” electrical power distribution system (auxiliary system) equipped with at least 2 outgoing spare,
- pushbutton for emergency power cut-off to the analysers shelter,
- internal lighting must provide sufficient light to enable service activities inside the container without the need for any additional light sources,
- internal walls must be able to sustain attaching heavy equipment (at least 50kg),
- floor covered with riffled plate of minimum 2mm thickness; floor shall withstand the minimum load of 200kg/m²,
- doors with self-closing devices, doors shall be furnished with patent locks and minimum 3 keys are to be attached to each door. A data plate, made of stainless steel shall be installed on the external side of the door, giving information about tag name of process analysers installed in the shelter,
- rainwater drainage system in vertical posts of the container,
- cable and pipe entrances (minimum 5 spare cable glands of different size must be provided). Cable entry to analysers shelter shall be made with use of dedicated modular cable sealing systems, which ensure individual sealing of each cable, resistance to weather conditions, etc.
- essential equipment and firefighting equipment,
- cylinder racks (if cylinders are needed),
- mechanical construction of the analysers house, used materials and paint coats must provide a guaranteed anticorrosion protection for minimum 10 years,
- in cases when measured sample or carrier gases or/and calibration gases can be dangerous for maintenance crew, it is necessary to install gas detection system (toxic

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

gas detectors and/or flammable gas detectors and/or oxygen detector) inside the analysers shelter with system for signalling danger (local signalling and signalling to the DCS):


- local signalling - consists of the light signals and alarm sounders, installed indoors and outdoors; in justified cases the indoor alarm sounder does not need to be installed. The control system shall be based on dedicated gas detection controller or the PLC controller. It is recommended that a panel with signal lamps be situated near the container entrance (green lamp on - no alarms, dedicated red lamp is flashing - alarm, dedicated red lamp continuously on - alarm deactivated automatically) and push-buttons (reset, lamp test, acknowledge alarm - alarm at the container is deactivated) - detailed alarm mode, operation logic of signalling devices and the panel shall be agreed with the Buyer,
- signalling to the DCS - the status of each signalling device shall be transmitted to the DCS; typically, it is assumed that acknowledging an alarm in the DCS will not reset the visual and sound signalling at the plant,
- when liquid samples are measured, the analysers shelter must be protected from sample spills (leak-tight floor with drain and sloped so sample naturally flows outside),
- in the following cases:
 - analysers shelter is provided is a given location for the first time,
 - modernisation of existing analysers shelter,
 - change of applied carried gases which affect the occurrence of explosion hazard areas,

it is necessary to update the existing documentation or to make a new classification documentation of explosion hazardous areas.

3.2.10. Control valves


Control valves shall comply with relevant obligatory standards and the following requirements.

- For typical applications poppet or ball control valves are preferred; the sealing must not include asbestos.
- Ball valves shall not be used for highly corrosive media and in applications where cavitation is possible.
- Use of flange type valves is required.
- Material for the pressure portion of the valve body shall be chosen in accordance with the piping classes where the valve is installed. The valve manufacturer shall confirm that used materials are both suitable for the intended application and consistent with design data from the data sheet. A material certificate a certificate of execution of pressure tests for flow shutdown shall be provided for each material used to make valve bodies.
- Materials for the internal valve parts shall be individually chosen for each valve depending on medium and required parameters. However, they shall not be worse than 316SS. In case of difficult applications (e.g.: pressure drop on valve 700 kPa and higher, process temperature 315°C and higher, cavitation or evaporation), the surface shall be additionally stellite-coated or hardened in other manner.
- Stuffing box packing must be appropriately selected to the process temperature, the packing must not deteriorate dynamic properties of the valve.
- The valves shall be equipped with diaphragm pneumatic actuators with closing or opening spring, depending on the process requirements in emergency situations. The

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

actuators shall be equipped with a smart electro-pneumatic positioner controlled with 4-20 mA signals.

- The control valve shall assume a safe position in an emergency situation as defined on the P&ID. The valve shall assume the same position in case of pneumatic supply loss or control signal loss.
- The control valve actuator should work at standard pneumatic signal range of 0.2 to 1bar.
- Piston pneumatic actuators shall be used when a long stroke of the valve, high force or high operation speed are required.
- The control valve actuator shall be chosen in such a manner that it is able to overcome at least 125% of the maximum expected load.
- Inductive proximity switches in intrinsically safe execution and of at least IP65 protection degree according to PN-EN 60947 standard shall be used for the open/close signalling in the DCS system.
- Valve size selection shall be conform to PN-EN 60534. The sheet with calculation of the valve size shall be attached to the documentation. Trim and seat arrangement should be selected in such a manner that the (nominal) flow is achieved when the valve is open between 70% and 80%.
- The trim and seat arrangement shall be “linear” if the pressure drop across the valve exceeds 50% of the system dynamic pressure at the designed flow rate. In other cases it shall be “constant percentage.”
- The control valves shall, in general, have tightness class IV in accordance with ASME/FCI-70.2, unless there are any other requirements. All soft-seated valves shall be used for maximum temperature of 180 °C.
- Two additional seal sets shall be supplied for each delivered split-body valve.
- The valves shall be equipped with SMART-type positioners.
- The valve must be delivered complete, i.e. assembled with accessories specified in detailed specification (actuator, positioner, air filter-regulator, solenoid valve, position limit switches, etc.), including pneumatic tubes. Stainless steel pneumatic tubes of minimum diameter of 6 mm shall be used. The cable glands shall have M20x1.5 thread.
- Each valve shall have a permanently fixed stainless steel nameplate. The nameplate shall contain a full set of parameters and the valve characteristics.
- Control valves shall be installed in a manner allowing their easy removal. When the removal requires the use of special machines and equipment, the access road and appropriate workspace should be provided.
- Noise level generated during operation of the valve cannot exceed 85 dB at the distance of 1m downstream of the valve and 1m from the piping wall.
- Each individual air consumer (electro-pneumatic transmitter, positioner) should be equipped with a reducer and filter with a 30mm or 50mm diameter pressure gauge.
- The electro-pneumatic positioners shall be smart type, with possibility of change between direct and reverse mode of operation. The positioners shall be equipped with pressure gauges for supply air and outlet signal pressure measurement.
- The most recent version of diagnostic software with required licence shall be delivered for all valves equipped with smart type positioners. The software shall enable performing the full configuration procedure and advanced diagnostic tests.
- Control valves supply shall be divided into 3 groups taking into consideration positioners diagnostics function, i.e.:

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- with “performance” type diagnostics that enables not only basic and advanced tests, but also online test of the valve. This group shall include the valves classified as process critical - minimum 20% of the supply,
- with “advanced” type diagnostics that enables not only basic tests, but also a test of the step response for the valve and a test to check the valve hysteresis; this group shall include valves classified as process important - minimum 30% of the supply,
- with “standard” type diagnostics that enables: configuration of the positioner, calibration of the valve, selection of the settings for positioner depending on the type of the valve, change of positioner characteristics, movement integrator, alarm record; this group shall include the remaining valves which are not classified as process critical or process important.


The list of the process critical and process important valves shall be previously agreed with the Buyer.

- The positioner shall operate in range between the fully-open and fully-closed positions of the valve plus reserve for the positioner stroke.
- Use of control valves as shut-off valves must not be treated as the only protection in the implementation of the interlock system.

3.2.11. ON-OFF valves

On-off valves with actuators shall conform to relevant obligatory standards and the following requirements.

- For typical services, ball type ON/OFF valves are required (other types are acceptable only if they are necessary) with asbestos-free gaskets and seals. All ON/OFF valves shall be in tightness class VI (tight isolation).
- Material for the pressure portion of the valve body shall be chosen in accordance with the class of the piping on which the valve is installed. The valve manufacturer shall confirm that used materials are both suitable for provided application and consistent with design data in the data sheet.
- Materials for the internal valve parts shall be individually chosen for each valve depending on medium and required parameters. As a standard, the material shall not be worse than 316SS.
- The quarter-rotated ball valves shall have either the pneumatic actuators with return spring or two-sided piston actuators. The two-sided piston actuators shall be used where the pneumatic actuator with return spring cannot be used because of required high force or speed of the closing.
- Closing time of the pneumatic actuator shall conform to the manufacturer’s standards or the requirements defined in safety standards.
- Wherever it is justified, the 2-way acting actuators with a separated air vessel with valve shall be used. The air container volume shall be sufficient for three full operation cycles with the 50% safety factor.
- Actuators shall be equipped with solenoid valves. Use of ESD positioner to implement the on-off function is possible against the Buyer’s approval.
- The valve tubing shall comprise stainless steel tubes with at least 8mm diameter. Where a specific stroke time is needed, the appropriate tube dimension must be chosen.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- Induction proximity switches in intrinsically safe execution and of at least IP65 protection degree according to NAMUR DIN 19234 shall be used for signalling the “open/close” positions in the system.
- In justified cases (e.g. recommendations of SIL analysis), the on-off valves of the ESD system shall be equipped with positioner with partial stroke test (PST).

3.2.12. Solenoid valves

Preferred solenoid valves should have stainless steel body, soft seat with 24V DC energised coil (usually), and 230V AC in case of very long distances. It is required to use coils with power that guarantees a correct operation of the solenoid. The coil shall be powered by a relay output/relay. The line shall be protected by a fuse.

Electromagnetic valve shall have additionally:

- cable glands with the M20x1.5 thread,
- degree of protection shall be at least IP65,
- the valve body shall have an earthing terminal,
- the valve body material shall be steel corresponding to the pipeline classification (applies to valves installed in the process pipelines),
- explosion-proof execution, Ex d is recommended.

3.2.13. Current to pneumatic converters I/P (if any)

Current to pneumatic converters shall comply with the following requirements.


- Current to pneumatic converters shall be dynamically balanced (maximum acceptable non-linearity - 1% of the full range). The coil temperature compensation should be provided if it is necessary to maintain linearity.
- Input impedance shall ensure a proper cooperation with the remaining components of the loop.
- Each current to pneumatic converter shall be equipped with reducer, filter and 50 mm diameter pressure gauge.
- Cable glands with M20x1.5 thread.
- Degree of protection shall be at least IP65.
- If the converters are installed in hazardous areas, they shall be in intrinsically safe or flameproof execution. The intrinsically safe execution is preferred.

3.2.14. Local gauge boards

Local gauge boards are mostly supplementary to the delivery of main process equipment. The local gauge boards are used for installation of pressure indicators and pressure switches which provide accessories for compressors, turbines, etc.

The local gauge boards must be designed and built in a manner allowing an easy access during a day-to-day operation (reading) and for maintenance purposes.


The material of a given local gauge board must match the process conditions. Degree of protection shall be at least IP65.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

3.2.15. Local control panels and accessories

Local control panels and field-installed cabinets shall comply with the following requirements.

- All panels shall be made of steel, finish paint RAL 7035, and they shall have a canopy protecting against weather conditions and lifting lugs.
- The panel elements in terms of materials and workshop shall prevent corrosion. Degree of protection shall be at least IP54.
- Hinged front door shall open easily without causing any damage to the internal cabling and installed equipment.
- For explosion hazard areas, application of the flameproof Ex d and Ex e panels is recommended. The panel enclosure shall have a proper manufacturing certificate and shall be marked in accordance with standards harmonised with ATEX directive; separate Ex certificates shall be provided for instruments installed on the panel (external instruments, indicators, cable glands, etc.).
- The panel enclosure and metal enclosures of instruments mounted on the panel or inside it shall be connected with the earthing grid.
- The panels and other equipment shall be attached to the steel support structure so that the bolts and nuts do not protrude beyond the panel front.
- Both the local control panel as well as its individual parts should be appropriately marked.
- Light-emitting diodes (LED) shall be used as indicators. It is recommended to use the following colours: red (danger or alarm), yellow (warning), green (correct operation).
- The local control panel should have a push button to test the installed indicators (lamp test).
- Alarm and ESD pushbuttons shall be mushroom-shaped in order to facilitate easy and fast pressing. In order to prevent accidental activation, they can be covered with easily removable cover or glass panel to break. Pushbuttons shall feature two stable positions in order to hold the alarm/interlock signal (NC version).
- Intrinsically safe barriers or relays shall be installed on mounting rails in separate columns. Installation shall be with accordance with the CENELEC standards.
- The intrinsically safe signal cables shall be laid in separate cable trays at minimum distance of 300 mm from 24V DC and 220V AC cables.
- All cable cores shall be connected to screw terminals on the terminal strips.
- Earthing of the intrinsically safe loops shall be performed in accordance with recommendations of the standards concerning intrinsically safe loops.
- All cables connected to the screw terminals as well as the accessories on the panel shall be marked with the tag name and with description of terminals at both ends.
- The internal cabling shall be made with leads of the following colours:
 - low voltage signals (24V DC) - light grey or white,
 - intrinsically safe signals - light blue,
 - AC power (phase - black/brown, neutral - dark blue, earth - yellow and green stripes),
 - 24V DC power ("+" - red, "-" - black),
 - thermocouples - according to the thermocouple type,
 - earth PE - yellow and green stripes, FES/ISE - green,
 - cable colours indicated above shall also be used for cabling of PLC cabinets, DCS cabinets, intermediate and marshalling cabinets and for the remaining equipment installed in the control room.


	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- Minimum 20% spare connections on terminal strips shall be provided at the design stage.

3.2.16. Instrumentation cables

Instrumentation cables shall be provided according to PN-EN, IEC regulations and the following requirements.

- The instrumentation cables used shall have the following characteristics:
 - excellent flexibility and mechanical resistance,
 - suitable for outdoor installations in overhead cable ducts or for direct earth burial,
 - excellent resistance to ambient conditions (temperature, humidity, ultraviolet radiation), oil, chemicals,
 - both internal insulation as well as an external cable jacket must be made of flame retardant special polyvinyl chloride (PVC)
 - operating voltage 0.6/1 kV.
- The cable shall be in a single section, connecting cables outside junction boxes is not allowed.
- Leading multiple signals of various rated voltages in single cable is not allowed.
- All cables shall be identified by means of ferrules at both cable ends and at least every 10m (direct earth burial) or 20m (cable ducts) along the cable route as well as near every change of direction, in front of and behind as well as cable duct and connecting elements.
- AC power supply cables shall be 3-core (phase, neutral and earth), minimum 1.5mm² cross section size, solid copper conductor. PVC insulated and overall PVC sheathed. Wire insulation identification colour code shall be as follows: black/brown - phase, dark blue - neutral, yellow and green stripes - earth.
- Solenoid valve cables shall be 2-core 2.5mm² (minimum) solid copper conductor. PVC insulated and overall PVC sheathed, black outer sheath, conductor identification colour code shall be: "+" red, "-" black. Powering of solenoid valves shall be 24V DC. For long distance, 4mm² conductors shall be used to avoid the voltage drop.
- Single-pair 2-core signal cables (analog or binary signals) – flexible, multi-wire conductors, stranded of bare annealed copper wires, conductor cross-section 1.0 mm²; cable core wrapped in a polyester tape; tinned copper wire braid shield; overall grey PVC sheath; conductor identification colour code shall be: "+" white, "-" black.
- Signal multi-pair cables (analogue or binary signals) – flexible, multi-wire conductors, stranded of bare annealed copper wires; conductor cross-section 0.75mm² or 1.0mm²; twisted pairs; pairs laid-up in layers, numbered and shielded (shielded pairs and collective shield). The following numbers of pairs are preferred: 8, 12, 16, 24.
- Thermocouple extension: single-pair cables, conductor cross-section AWG 16 (1.31mm²), material matching the thermocouple type – according to PN-EN 60584-1 standard. Shielding of pair - 100% coverage with aluminium coated polyester band, tinned copper wire. PVC insulated and overall PVC sheathed, wire insulation colour coding - according to PN-EN 60584-3.
- Thermocouple extension multi-pair cables to be same as above but with AWG 20 (0.52mm²) conductors, numbered pairs with an additional insulated copper wire for communication. Overall shielding and tinned copper drain wire.
- RTD minimum single 3-core cables – cross section 1.0mm², insulation colour coding according to PN-EN 60751.


	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- Cables for intrinsically safe circuits shall meet technical requirements regarding the intrinsic aspect – this applies to capacity, inductance and insulation resistance. Instrument cables for intrinsically safe circuits (Ex i) shall have the light blue outer sheath, conductor insulation colour: “+” white, “-” black. The cables for intrinsically safe circuits should be supplied with a list of parameters required for circuit conformity check against the intrinsic safety standard, and with a certificate of intrinsic safety for equipment constituting part of an intrinsically safe circuit (capacity, inductance, inductance/resistance ratio).

3.2.17. Junction boxes

Junction boxes shall conform with relevant obligatory standards and the following requirements.

- Junction boxes made of polyester-reinforced glass fibre are recommended.
- Junction boxes shall be weatherproof and shall have proper Ex type execution. Degree of protection shall be at least IP65.
- All junction boxes shall be equipped with screw terminal strips. It is required to keep a minimum 20% reserve on the terminal strips, wired on the multi-pair side of the cable.
- Junction boxes shall have a metal rail isolated from the box body with terminals to connect cable shields.
- Junction boxes shall be equipped with fixing bolts and adapted for an easy installation on a vertical frame or on the wall.
- Single-pair and multi-pair cables shall enter the box from the bottom. Cable entries from the top and side of the box are not acceptable.
- Cable cores shall be directly connected to terminal strips. Cables shall enter to the junction boxes only using cable glands. The cable glands shall be weatherproof. The cable glands used in Ex i, Ex e and Ex d junction boxes shall possess a proper manufacturing certificate and shall be marked in accordance with standards harmonized with the ATEX directive. Unused cable entries in junction boxes shall be plugged. The plugs in explosion-proof junction boxes shall correspond to execution of the related junction box. It is not acceptable to use cable glands, plugs, cable reductions in hazardous areas without appropriate marking.
- All junction boxes shall have white nameplates with black letters for Ex d execution, blue nameplates with white letters for Ex i execution, and red nameplates with white letters for circuits belong to the ESD system. The nameplate must be permanently attached to the junction box and must be weatherproof.
- Separate junction boxes shall be used for the following types of loops:
 - intrinsically safe analogue signals,
 - intrinsically safe digital signals.
 - non-intrinsically safe analogue signals,
 - non-intrinsically safe digital signal,
 - solenoid valves,
 - 230V, 50Hz power supply.
- Dedicated junction boxes shall be used depending on the type of system to which field signals are fed, i.e.:
 - DCS,
 - PLC,
 - ESD,
 - GDS,
 - MMS.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

3.2.18. Cable trays


Cables and impulse lines shall be laid in cable trays. The general requirements for cable trays are listed below.

- Separate cable trays shall be used for the following cable types:
 - 230V AC, 50 Hz power supply cables,
 - low voltage cables in non-intrinsically safe loops (analogue and digital),
 - intrinsically safe cables – analogue and digital, blue cables,
 - digital communication (including fibre optic cables).
- Main cable routes shall run on separated piperacks or supports mounted on piperacks.
- Cable trays cannot possess holes or be perforated, with exception of assembly and drain holes. The cable trays shall be equipped with covers.
- Spacing of cable tray supports shall not exceed 3 metres in a straight run; in case of fittings (elbows, tees, quads, reducers, etc.) supports shall be mounted more densely.
- Galvanized steel cable trays are recommended for non-corrosive atmospheres. Cable trays, supports, connecting components shall be hot dip galvanized on each side after fabrication in accordance with PN-EN ISO 1461. The zinc coat thickness shall be between 50 and 80 microns depending on the thickness of material.
- Stainless steel cable trays shall be used in corrosive atmospheres.
- GRP (Glass-Fibre Reinforced Polyester) cable trays can be used only where the plant conditions require it (after a previous agreement with the Buyer).
- Individual cable routes shall be laid in 50x50mm or telex-type cable trays.
- Sum of cables' cross-sections in a specific tray shall constitute approx. 30% of the tray cross-section area.
- All cable trays shall be properly earthed via metallic connection to the earthing bus.
- Intrinsically safe cable trays additionally shall be painted in blue and/or marked with "Ex i" symbol.

3.2.19. Instrument heat tracing

Specification of instruments and equipment that require heat tracing shall conform to P&ID. Instrument heat tracing shall comply with relevant obligatory regulations and the following requirements.

- Electric heat tracing is required as a freeze-protection system.
- It is recommended that electrical heat tracing be used on the following instruments and equipment:
 - pressure and differential pressure transmitters and their impulse lines,
 - displacement type instruments and gauge glasses, including the connecting pipes,
 - analysers and local control panels.
- Electrical heat tracing shall be made with self-regulating heating cables including all necessary equipment and accessories.
- Monitoring of electric heating operation shall be realized on level of local distribution cabinets. A common tracing remote alarm in case of power failure of each heating group shall be provided in the DCS.
- Heating temperature shall be adequate to the heated process medium.
- The electrical equipment shall meet the requirements of the plant on which will be installed - classification of hazardous area, appropriate degree of protection, etc.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- When electric heat tracing is not possible, steam heating shall be used.
- Instruments installed directly in the process pipelines (in-line), such as control valves, Vortex flowmeters, mass flowmeters and local equipment shall have common heating with these pipelines.
- The insulation of heated instruments shall be made of heat-resistant material. Insulation shall be covered with a galvanized steel sheet (in non-corrosive atmospheres). In corrosive atmospheres the material shall be suitable to ambient conditions occurring on given plant.

3.2.20. Protection boxes

Protection boxes shall conform to the following requirements.

- Instrument protection boxes must be designed and built in a such a manner as to allow the removal of transmitters and manifolds without dismounting the pulse lines.
- Type of used equipment and its location in the box shall enable and easy access to all installed components during maintenance and repair.
- It is recommended to use cuboid-shaped protection boxes composed of two parts, the upper part must open diagonally.
- Mounting on a 2" pipe at the back of the cabinet is preferred.
- If the process so requires, the instrument protection boxes shall be electrically trace heated or in case of a modernisation of the plant where steam heating is used, each time after Buyer's approval, they can still be steam heated (in mechanical scope). The heating method shall be agreed and adapted to the possibility of installing in the plant at technical design stage.
- The protection box shall be installed at the height of 1.5m from the grade "0" or platform level.
- The protection boxes shall be used for the following instrumentation and equipment:
 - differential pressure transmitters in level and flow measurement,
 - pressure transmitters and pressure switches,
 - differential pressure transmitters and differential pressure switches.
- Mechanical construction of the protection boxes, used materials and paint coats must provide a guaranteed anticorrosion protection for minimum 10 years.
- A certificate of anti-static execution is required for all protection boxes located in explosion hazardous areas.


3.2.21. Air coolers

Control of the following air coolers parameters shall be possible from the DCS:

- fan rotation speed,
- fan blade pitch,
- louver angle,
- other being the equipment of air coolers.

3.2.22. Weighing system

The weighing system shall conform with relevant obligatory standards and the following requirements.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- Weighing system and associated transmitters must be designed and built in a such manner as to provide metrological properties (reliable, stable and accurate measurement).
- In case of interference, the weighing system shall prevent significant deviations (difference between error of the system indication and its error of indication under reference conditions) or it shall automatically detect significant deviations and signal them.
- Connection of peripheral devices to weight system shall not influence its metrological properties.
- Each weighing system shall have an analog output (2 wires to DCS), 4...20mA standard measurement signal shall be provided for weighing results.
- The Contractor shall describe in detail the communication between the weighing system and DCS.
- Transmitters must be able to communicate with the DCS system using the HART protocol or be equipped with dedicated software and analysis tools for configuration and testing of measurement functions.

3.2.23. Instrument air buffer tank

The Anwil S.A.network supplies the instrument air up to the Plant Battery Limit at the minimum pressure of 400 kPa and maximum pressure of 700 kPa.

The instrument air buffer tank is required to be installed at every process plant. The purpose of this tank is to ensure instrument air supply which is required for a safe plant shutdown in case of instrument air network failure.


Backup time for the instrument air required for a given plant depends on applied technology and is determined by the Process Department. For preliminary estimation of the instrument air buffer tank, it shall be assumed that the minimum backup time for a plant is 30 minutes and the minimum pressure required for control of the actuators is 350 kPa.

3.3. Plant balance

All incoming raw material stream (feed), outgoing products (yield) and all energy and auxiliary media of the plant are the subject to the balance. The main criterion of the balance accuracy is the difference between the feed and yield, considering the accuracy of measuring instruments used.

Ton, kilogram or megagram are unit of mass used in the balance. Working shift, day, month, year are units of time units used in the balance.

The instruments and measuring systems used for measuring and totalizing of incoming and outgoing streams to/from the plant battery limit should be in accordance with Directive 2014/32/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of measuring instruments and requirements of Polish Central Office of Measures (GUM). The GUM requirements for measuring instruments are included in Journal of Law 2009 No. 104, item 862 or on the website: www.gum.gov.pl

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

3.3.1. Balance measuring devices

The following types of flowmeters shall be used for the process media:


- For the main streams - mass flowmeters – against the Buyer's approval.
- For the remaining smaller streams - volumetric or orifice flowmeters. Density measurement shall be performed in case of media where composition and density vary in a wide range.
- The measuring instruments used shall have the following accuracy:

Medium	Instrument type	Accuracy
Liquid hydrocarbons	Mass flowmeter	±0.1%
Gas hydrocarbons	Mass flowmeter	±0.5%
Liquid chemicals	Mass flowmeter	±0.2%
Polymers	Weighing system	±0.2%

- The measuring instruments for energy media and service streams shall have the following accuracy:

Medium	Instrument type	Accuracy
Steam	Volumetric flowmeters/ orifice measurement	±1.5%
Cooling water	Volumetric flowmeters/ orifice measurement	±1.5%
Other utility/service streams	Volumetric flowmeters/ orifice measurement	±1.5%
Solid weighting	Weight measurement	±1.0%
Chemical media	Dependent on the application	±1.0%
Power	Electricity meter	±1.0%

- The measurements shall be connected to the DCS system.
- The design shall include correcting algorithms for balancing of steam and gases.
- The measuring instruments shall be supplied with documents confirming their accuracy.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

4. PROCESS HEATERS


4.1. Description of the Burner Management System

The Contractor should provide a complete Burner Management System as a control system dedicated to start, stop and supervise the safety and interlock process heater technology which meets the requirements of the UDT/ITD and standards in question. In addition, the BMS must meet the requirements specified in section 8 herein. The design of Burner Management System must comply with the technological requirements and applicable standards, as well as with Anwil S.A. general requirements for instrumentation.

The process heater Contractor's scope shall include delivery of field instruments, delivery of an adequate certified ESD/BMS controller, and calibration and commissioning.

The minimum interlocking requirements for process heater, which shall be taken into account during the design of process heater safety system shall include:

- too low air flow to burners (for process heaters with forced draught),
- too low/too high fuel pressure (fuel gas or oil),
- too low feed flow (process medium) through process heater,
- too high pressure in combustion chamber,
- too high pressure in flue duct,
- too high temperature in combustion chamber,
- no flame on pilot and main burners,

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- too low temperature of fuel oil,
- too high temperature on furnace outlet.

In order to determine all parameters that influence process heater safety, the process heater interconnection with process occurring at the plant it shall be taken into account.

The SIL analysis and SIL validation must be performed during the design process and process heater shall be equipped with required interlock and safety systems (according to PN-EN 61508 and PN-EN 61511). The software necessary to perform the SIL verification shall be indicated at the technical offer stage. The SIL validation must be performed using a tool (software) agreed with and accepted by the Buyer. The SIL validation design shall be submitted in the form of source files which allow full read and write functionality, as well as verification with all the necessary data, libraries, reliability data.

The Burner Management System documentation shall be approved by the Central Laboratory of Technical Inspection (CLDT) before process heater commissioning.

Communication with the PI OSI system must be ensured; the interface to the PI OSI system must transmit the data implementation in the PI system.

4.1.1. Process heater control

According to the API and TUV requirements, the following equipment shall be delivered as a minimum:

- Field instrumentation.
- Local control panels, panels in control room.
- Interlock and shutdown system based on a certified ESD/BMS controller with accessories.
- Maintenance Override Switches (MOS) and Process Override Switches (POS).
- Control and interlock and shutdown logic (cause and effect diagram).
- Logic for safe start-up of process heater.

4.1.1.1. Field instrumentation


Regardless of the absence of explosive hazardous areas, the instrumentation and its components mounted on the process heater and in their area, shall be in the explosion-proof (Ex) execution.

Measuring instruments and actuators shall be independent and directly connected to the BMS system.

Actuators must be designed and built in a such a manner that at the time of their failure, they go a safe position. Solenoid valves and other relay elements must be live during normal operation.

Shut-off valves (valve triads) shall be installed on the gas feed line to the main burners and pilot burners. Newly designed valves must meet the requirements of PN-EN 746-2 and PN-EN 161.

Shut-off valves equipped with positioners realizing the partial stroke test function (PST) must be installed wherever the SIL/IPF analysis indicates. Shut-off valves shall be equipped with double solenoid valves which requires connecting additional signals to the ESD/BMS system.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

The PST allows monitoring the status of shut-off valves critical in terms of safety during normal operation of the furnace.

The main and pilot burners shall be equipped with individual automatic shut-off valves controlled by the ESD and equipped with limit switches confirming open/closed status of the valves (PN-EN 161).

A flame monitoring system with UV/IR photocells (scanners) must be delivered for each process heater. The photocells must enable communication via the RS422/485 with a computer installed software for photocell diagnostics and configuration.

The photocells shall have sensors operating in the ultraviolet and/or infrared and if required by process conditions they should be purged with air in order to ensure cleanliness. When scanner operates at ambient temperatures exceeding the allowable operation temperature, they must be placed in special certified enclosures which are supplied with cooling air to lower permanently the operating temperature.

The Contractor shall ensure a proper selection of burners, fulfilling the condition of selective field of vision of the supervised main burner flame.

The pilot burners shall be equipped with ionization sensors and high-energy ignitors with connection to the ESD/BMS system. Ignition systems where the same electrode acts as the ionization electrode and ignition electrode must not be used.

Air shall be supplied to the combustion chamber of each pilot burner. Aspirated pilot burners must not be used.

In order to stabilize the combustion process, direct action control valves shall be installed on the air supply line to the pilot burners.

Field initiators of interlocks connected to the ESD/BMS system must be in Ex d execution. Exceptions are inductive proximity switches of the valves, which must be in Ex i execution and connected to the Ex i separators equipped with the line fault detection system (LFD).

Digital signals coming from instruments located in hazardous areas should be connected directly to the input modules. Digital signals from electrical equipment should come through intermediate relays. Output signals should pass through terminal strips equipped with fuses or, if necessary, with the intrinsically safe devices with galvanised separation (separators) and without galvanised separation (safety barrier).


4.1.1.2. Control panels

The Burner Management System shall be equipped with field local panels, where the lamps and pushbuttons are installed in order to provide necessary control operations which are the result of control logic. Inputs and outputs from the local panel shall be connected to the ESD/BMS controller.

The operator console – Top Box shall be installed in the control room.

4.1.1.3. Interlock and shutdown system based on a certified ESD/BMS controller with accessories

The BMS shall be an independent controller (in terms of both hardware and software) connected with the DCS by redundant digital communication for information purposes. Where required for mutual transmission of signals for the purpose of implementing appropriate controls the connections shall be hardwired.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

Only double or triple redundant, with single fault tolerance (fail-safe) certified ESD/BMS controller, placed in the cabinet technical room can be used for implementation of the BMS system. The controller must have redundancy at the level of CPU, communication cards, I/O modules, power supplies (power supply units shall be selected with reserve to allow operation of whole system on one power supply unit when the other has failed).

The controller shall be selected according to the "List of Manufacturers and Vendors Approved by ANWIL S.A." (Annex No. 6).

ANWIL S.A. must be the owner of licences for the ESD/BMS controller and software.

Any BMS controller failure should be alarmed at the DCS. Common alarms (cumulative) are acceptable.

All thresholds and interlock conditions must comply with the P&IDs and the cause and effect diagrams.

The Burner Management System (BMS) must be designed and made in accordance with requirements of the following standards: PN-EN 746-1,2,3, referenced standards PN-EN 61508 and PN-EN 61511 and standards pertaining to the equipment intended for use in explosion hazard areas.

The first out alarm of the process heater emergency shutdown must be configured in the BMS system controller and visualized in the DCS. A dedicated engineering station – a separate computer (workstation, monitor, keyboard, mouse) – shall be provided in the control room or the control cabinets room for the BMS.

The basic and utility software (as well as hardware – if necessary) should provide the ability to perform and change the controller configuration.

4.1.1.4. Maintenance Override Switches (MOS) and Process Override Switches (POS)

The particular requirements for Maintenance Override Switches and Process Override Switches are detailed in Section 8.2.


4.1.1.5. Control and interlock and shutdown logic

The control logic, drawings and BMS equipment must meet the requirements of TUV and API 550, Part III "Principles of the process heater operation with semi-automatic control system and possible change in manual control."

A semi-automatic control, also called an operator-supervised control, is the control where all stages of start-up (leakage tests, purging, ignition of pilot and main burners), as well as process heater shut-down are executed sequentially after being initiated by pushbuttons located on local panel (LP), on condition of proper completion of the previous stage, with consideration to start-up conditions and applicable interlocks. In this type of control, a skilled operator is responsible for proper process heater start-up and shutdown. Process heater control logic should provide full automation except the ignition of burners. Automatic ignition of pilot burners is acceptable in justified cases. Logic shall be performed by the BMS controller with visualization and control on the DCS operator consoles.

The BMS logic diagrams shall be realized in negative logic, i.e. all interlock signals shall be activated by logical state "0" understood as the absence of signal (voltage).

The structure of the BMS system logic diagrams is as follows:

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- processing of input signals, taking into consideration the MOS and POS overriding switches,
- interlocks with signalization of readiness to cancel,
- start-up sequence,
- actuation of outputs to valves,
- additional services (first out shutdown logic, checking of valve states discrepancies as compared to the command given, etc.).

4.1.1.6. Logic for safe start-up of process heater

The sequence program for safe process heater start-up and shutdown must contain the following:


- start-up conditions,
- tightness test,
- purging procedures,
- semi-automatic process heater ignition,
- emergency shutdown procedures.

All alarm signals for the purpose of visualization must be sent to the DCS by a redundant communication link.

Additionally, the DCS should prepare graphics collectively illustrating the state of BMS logic and each heater firing step.

General start-up sequence must consist of the following steps:

- check of initial conditions:
 - correct setting of individual valves (flue stack damper open, automatic valves on fuel lines in safe position, i.e. shut-off valves closed, venting valves open, automatic valves (or manual ones in SEMI-AUTOMATIC mode) on burners closed),
 - interlocking signals deactivated,
 - resetting of the safety system logic (by means of a button on the local panel or on operator's station screen in the control room),
- activation of forcing and suction fans (does not apply to natural draught heater),
- leakage test of fuel line to pilot burners,
- leakage test of fuel line to main burners,
Both leakage tests can be executed simultaneously. Control valves on fuel lines shall be fully open during the leakage test (action realized in the DCS).
- process heater purging, air flow adjustment in order to achieve the volumetric exchange according to PN-EN 746 (start of the blowing fan for heaters with natural draught),
- ignition of pilot burners:
 - setting of adequate air flow in order to provide process heater safety in case of ignition failure and gas inflow to chamber (does not apply to natural draught heaters),
 - opening of fuel feed line (closing of automatic venting valve, and after closure is confirmed, opening of cut-off valves),
 - opening of the automatic (or manual in case of the SEMI-AUTOMATIC control) burner valve,
 - igniters start (provide of the energizing pulse),
 - flame presence detection and monitoring.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

All flame detection-related time relationships, as well as number of burner ignition attempts taken into consideration in the BMS system logic, shall meet the requirements of PN-EN 746.

- ignition of main burners:
 - activation of feed flow, flow level must be higher than the interlock set value for a very low flow,
 - fuel gas and/or fuel oil pressure controllers are automatically set to the value above the minimum pressure value for burners,
 - air flow controller is set to the automatic mode, air flow higher than minimum necessary for heater ignition up,
 - opening of fuel line (closing of automatic venting valve, and after closure is confirmed, opening of shut-off valves),
 - opening of the automatic (or manual, in case of the SEMI-AUTOMATIC control) burner valve,
 - flame presence detection and monitoring.

All timing relationship relating to flame detection, as well as number of heaters ignition attempts, shall meet requirement of PN-EN 746.

4.1.2. Diagnostics

The scope of diagnostics of controlled devices and process parameters by the BMS system shall be as wide as possible. As a minimum, this diagnostics must include the following:

- monitoring of exceeding of process parameter thresholds (interlock alarms used in control sequences),
- diagnostics of measuring lines,
- monitoring of consistence between the actual position of shut-off valves and the current system command with separate alarms for open and closed positions,
- control of sequence steps correctness, for example leakage alarm of particular valve in the leakage test, purging failure alarm, exceeding the heaters start-up deadline etc.,
- for interlocking signals, each BMS shall have logic of first cause of emergency shutdown (first-out logic). This logic shall be reset using a separate software button from the DCS operator workstation, optionally this can be done with the interlock reset pushbutton.

4.1.3. Events recorder and functional tests

A sequence of events recorder (SOER) shall be provided – purchase of a separate PC with dedicated software (workstation, monitor, keyboard, mouse).


The Contractor shall perform the commissioning, functional tests of instrumentation loops, field equipment check, and provide the test reports. This scope requires the loop checking (excluding algorithm tests of interlock control logic) and comprehensive functional tests (with algorithm tests).

The FAT and SAT must be performed in accordance with guidelines specified in Section 14.

4.2. Continuous gas monitoring system (if any)

Continuous gas monitoring system shall consist of two components:

- measurement devices (with sampling and conditioning system) that perform physical measurement,
- emission computer that collects and processes data.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

Measurement devices of gas monitoring system must measure the following parameters:

- O₂,
- CO,
- CO₂,
- NO_x,
- dust,
- temperature,
- pressure,
- moisture,
- flow,
- other, depending on the requirements.

The emission computer must realize the following tasks:

- collect analog data and statuses of measurement instruments,
- analyse statuses of measurement instruments,
- convert the measured values to referential values,
- present the measured and processed data,
- data archiving,
- generate reliable reports regarding the concentrations and emissions of pollutants, concentrations and emission standards and billing reports.

5. CONTROL ROOM, TECHNICAL INSTRUMENTATION ROOM AND ENGINEERING ROOM

The section presents the minimum requirements for the control room, the technical instrumentation room, and the engineering room.


5.1. Installation requirements

Connections between the control cabinets located in the technical room and the field-installed junction boxes to individual cables the field-installed equipment are connected shall be made with multicore cables. In justified cases, it is acceptable to use and individual cable directly from the field-installed measuring instrument to the control cabinet.

Entry of cables from the field to the control room must be effected by means of the modular cable transit sealing systems which prevent water, fire, gas, dusts and rodents from entering the buildings and rooms.

Each multicore cable must be connected to the corresponding input terminal strip in appropriate control cabinets. All cable conductors shall be connected to terminals in the terminal block dedicated to a particular cable.

The interconnections between various cabinets located in the technical instrumentation room shall be made by means of multicore and prefabricated cables.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

The control room and the technical instrumentation room shall feature a raised floor system (technical floor) under which cable trays shall be installed to conduct the cables to/between control cabinets, operator consoles, etc.

The operator consoles and other systems elements with relevant panels, display screens, keyboards, printers, etc. will be installed in the control room.

The control room must feature a self-contained separate room - the engineering room wherein the following shall be located:

- engineering stations, designed for configuration and diagnostics of systems (DCS, PLC, ESD).

Both the control room and the engineering room must be suitably air-conditioned and ventilated. The staff must be able to control the temperature in these rooms.

The control room as well as the engineering room must be designed and built in a manner that ensures a suitable level of ergonomics and safety for the staff.

This particularly applies to:

- furniture (monitors placed under different angles with adjustment of panel position, ergonomic keyboard, table, armchair, etc.),
- noise level (noise level shall not exceed 65dBA),
- lighting (lighting in accordance with PN-EN 12464-1:2014).

The series of cabinets installed in the technical instrumentation room will consist of the following:


- marshalling cabinets,
- DCS system cabinets (I/O cabinets, controller cabinets, operator console and servers cabinets)
- programmable logic controller cabinets – PLC/ESD,
- GDS cabinets/protection boxes,
- power supply distribution cabinets,
- network cabinets,
- auxiliary cabinets.

Appropriate operating temperature and humidity must be ensured in the technical instrumentation room in accordance with the manufacturer's environmental specifications. The room must be equipped with at least two independent air conditioners in such a manner that one of them alone is capable of keeping the required temperature. The air-conditioners shall be supplied from two independent circuits. When the power supply is restored following a power failure, the air-conditioners shall resume operation automatically (without operator involvement). The air-conditioners shall not be installed directly above control cabinets due to the risk of coolant or condensate leaks.

The plumbing lines, gutter systems, etc. must not run in the immediate proximity of the system components. It is not recommended that system components are located below the ground level, if appropriate protections against flooding (rainwater and/or groundwater) have not been taken.

All instrumentation, operator consoles, engineering consoles, cabinets, etc. located in the control room, technical instrumentation room and the engineering room shall be connected to the earthing system.

The required earthing system consists of three independent, separated subsystems:

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- Protective earthing (PE) to which all metal instrumentation cabinet enclosures, cabinets, cable trays, etc. shall be connected.
- Functional earthing system (FES) to which all electric/electronic zero Volt reference signals and cable shields shall be connected. The measuring cables shall be connected to the earthing system on the marshalling cabinet side in place where cable is unsheathed.
- Intrinsically safe circuits earthing system (ISE) to which all intrinsically safe barriers and shield of intrinsically safe cables will be connected. The measuring cables shall be connected to the earthing system on the marshalling cabinet side in the place where cable is unsheathed.

The above-mentioned earthing systems shall be isolated both from each other and from other conductive parts.

Each earthing system must be appropriately marked.

All earthing systems shall be connected to the central point of the earthing network outside control room, the technical instrumentation room and the engineering room.

5.2. Basic instrumentation equipment in the control room and technical rooms

Basic instrumentation equipment in the control room and technical rooms:

- DCS system for control, adjustment and data archiving purposes,
- programmable logic controllers (PLC/ESD) for protections and interlocks,
- dedicated PLC controllers supplied with the packages (SKIDs),
- fire detection system (FDS),
- combustible and toxic gas detection system (GDS),
- anti-surge system,
- machine monitoring system (MMS),
- assets management system (AMS)


The following type of cabinets shall be used to connect the above mentioned systems:

- marshalling cabinets,
- power distribution cabinets,
- interposing relay cabinet (IRC) for connection between the instrumentation and the electrical scope.

The interposing relay cabinet (IRC) applied as a separation for transmission of signals between the instrumentation and the electrical scope must meet the following minimum requirements.

The interposing relay cabinet must meet the requirements described in “Electrical - General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts.”

- Dedicated relays installed in interposing cabinet for interlock loops (between the electrical and instrumentation scope – PLS-ESD controller) with a determined SIL classification shall meet the SIL classification requirements for a given interlock loop.
- Intermediate relays powered from DCS/PLC systems shall have the coil energised with 24V DC. Dry relay contacts adapted to 230V AC shall be used by the electrical scope. The relays shall be resistant to electromagnetic interference and equipped with a LED status signalling.
- Intermediate relays supplied within the electrical scope shall have the coil energised with 230V AC. Dry relay contacts shall be used by the electrical scope. The relays shall be resistant to electromagnetic interference and equipped with a LED status signalling.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- It shall be possible to replace the intermediate relays without disconnecting the circuit.
- Galvanic separation between the instrumentation and electrical scope shall be provided for serial communication and analogue signals.
- Signals inside the cabinet shall be divided into groups by voltage – 24V DC, 230V AC. Separate terminal strips shall be provided for each voltage group.

The system of uninterrupted power supply (UPS) is not the subject of this document.

Signals from each UPS informing about incorrect operation shall be connected to the DCS. Signals shall be transmitted using dry relay contacts located in the interposing relay cabinet or using the Modbus RTU serial communication.

6. MONITORING AND CONTROL SYSTEMS (DCS)


The minimum requirements for proposed DCSs and DCS components to be used at the ANWIL S.A. have been described below. The requirements are related to hardware and software, licensing terms and conditions, and warranty service.

The proposed DCS systems must allow the implementation of the following functions:

- acquisition and processing of input/output signals,
- adjustment and control,
- time synchronization,
- technological process visualization,
- diagnostics and alarms,
- data historization and archiving,
- reporting,
- communication within the system and with external systems.

Additionally, the proposed DCS system shall fulfil the requirements in terms of:

- redundancy,
- uninterrupted operation,
- scalability,

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- spare capacity,
- adequate performance,
- backup copies,
- licensing terms and conditions,
- professional warranty service.

6.1. Acquisition and processing of input/output signals

6.1.1. Input/output modules

As a minimum, the modules used in the proposed DCS systems must support the following standard signal type:

- AI (analog input):
 - 4...20 mA
 - RTD (Pt-100)
 - TC (thermocouples)
- AO (analog output):
 - 4...20 mA
- DI (digital input):
 - potential-free contacts
 - NAMUR-compliant signals
- DO (digital output):
 - 24 VDC,
 - potential-free relay outputs
- PI (pulse input):
 - pulse inputs 0...10 000 Hz

Redundant signals must be connected to the same input/output modules.

Input/output signals shall be allocated to modules in a segregated manner, i.e. grouped by common functionality or by support of a common part of the plant.

For all input/output signals, the DCS system must provide diagnostics based on detection of:

- breaks in the signal loop,
- measurement range overruns,
- short circuits, for signal types where it is possible.


6.1.2. Protocols and communication standards

As a standard, the signal acquisition from field instrumentation and control functionality shall be provided by the DCS input/output modules. In exceptional cases and with the Buyer's approval, communication protocols may be used, such as:

- Foundation Fieldbus
- Profibus
- Device Net

Standard communications protocols shall be used for data interchange (communication) between the DCS and other systems, such as:

- Modbus RTU,

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- Modbus TCP,
- OPC,
- Profibus,
- Profinet.

If communication cannot be supported with above protocols, the Contractor may use a different solution provided that an approval is granted by the Buyer.

Signals exchanged using standard communications protocols may not be used for the purpose of continuous control. It is recommended to use those signals to read only.

The following connection standards shall be used for connectivity between systems,:

- RS232 / RS485 / RS422,
- Ethernet.

Conversion from the electrical signal to optical shall be used if the connection leaves the DCS system room.

In case of data interchange (communication) with other systems, the Contractor will be required to provide a list of the exchanged signals with the following information:

- signal/variable tag,
- signal/variable descriptor,
- type, length,
- address,
- LL/L/H/HH alarm setting,
- measuring range and engineering unit.

6.1.3. Signal processing

Collected analogue and binary signals are processed by the DCS, for example archived in a database or recalculated in order to obtain derivative information.


The DCS must allow at least the following operations to be performed on the processed signals:

- logic (Boolean) operations on discrete signals:
 - AND, OR, NOR, XOR, NOT, NAND, IF ... THEN
- mathematical operations:
 - +, -, *, /, DIV, MOD
- arithmetic and trigonometric functions:
 - SIN, COS, TAN, ABS, LN, MIN, MAX, AVERAGE, SQR, SQRT
- comparison operations:
 - <, <=, >, >=, =, <>
- special functions:
 - filtering, scaling, type conversion, edge delay.

6.2. Adjustment and control

The DCS system must support binary, sequential and analog control.

The DCS system must enable automatic process control and the system's configuration must

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

ensure a bumpless switchover between control modes (i.e. smooth change of control signal values).

As a minimum, the DCS system must enable the process control using the following algorithms:

- on/off controller with hysteresis,
- P, PI and PID controllers,
- cascade controller,
- lead/lag controller,
- step controller,
- ratio controller.

In addition, the following must be supported to accommodate setpoint variability:

- fixed setpoint regulator,
- setpoint tracking regulator.

6.3. Time synchronization

The Contractor shall ensure time synchronization with a reliable time source.

6.4. Technological process visualization


6.4.1. Visualization screens

The visualization application of the DCS system must allow a fast and fluid navigation between screens. The application's framework should be based on three main types of screens:

- A screen showing a diagram of the installation covered by the DCS system, divided into process lines. Items representing specific lines shall be laid out according to process relationships between installations or according to geographic location.
- Screens showing diagrams of the installation's process lines, developed on the basis of piping and instrumentation diagrams (P&IDs). Each diagram shall have display measurement points, including the values being measured, actuator status information, regulatory control loop status information and other information collected from field instrumentation.
- Detailed measurement group and control group screens, used in exceptional cases that require diagnostics or operator response. These screens should contain all information required to perform in a safe and conscious manner the operations for which they are intended. For example, the safety system screen should show: system status information, MOS and POS status information, including permissions to set the overrides, root cause detection information, etc.

Detailed screens include screens that show the status of auxiliary systems, such as:

- electrical power supply system,
- machine monitoring system,
- gas detection system,
- fire detection system,

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- safety systems,

Furthermore, detailed screens include diagnostic screens and screens that represent complex equipment with dedicated control systems, such as:

- current and historical failure screen,
- current and historical event screen,
- measured value trend screen,
- DCS system input/output module status screen,
- communication status screen for communication with associated devices and systems,
- plant material and energy balance screen.

6.4.2. Requirements for screen layout

All screens that show process graphics should have uniform and identical backgrounds. Grey is the recommended colour.

Each screen should have an unambiguous header that describes the process line to which the screen applies and the type of information it shows.

Screens showing the status of process plants shall be based on up-to-date P&IDs.

The operator must be notified of an incoming alarm regardless of the screen being displayed.

Occurring process alarms should be identified by measurement point tag name and description including current measured value.

6.4.3. Requirements for graphic symbols

The appearance of graphic symbols must reflect the shape of the components they represent.

Graphic symbols that represent components of a particular type shall be standardized across the application.


The proposed DSC system must allow creating a library of symbols (measurement points, signalling devices, pumps, valves, etc.). A symbol defined in the library can be used to represent multiple components of the same type. The application developer is obliged to make the broadest possible use of this functionality. The DCS system must be able to change each symbol in the library and to propagate such changes quickly to all places where it is used.

Symbols corresponding to non-monitored components (e.g. manual valves without position indicators) and non-controlled components shall not be displayed on diagrams unless they are important to the understanding of the visualized process.

Symbols for large components, that occupy a significant portion of the screen, should not be colour-filled or animated, and should not disturb in any possible way the access to other important information.

Each symbol must possess a description that enables an unambiguous identification of the component whose status it represents.

Use of colours reserved for alarms should be avoided.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

Flashing items are acceptable only to indicate non-acknowledged alarms (e.g. the use of flashing items is not acceptable for valves in a transition state).

6.4.4. Requirements for control functions

The visualization application should not execute automatic control algorithms for the installation independently (e.g. using scripts). All control algorithms should be executed in the DCS controllers and the operator station should only enable authorized users to deliberately and manually control equipment and actuators, change setpoints, start or stop selected sequences, etc.

6.4.5. Requirements for operator station software

The operator station users with normal privileges may not close or minimize the visualization application.

The operator station users with normal privileges may not launch the system console or any programs other than those assigned to such users.

The visualization application must start automatically when the operator station is started or restarted. During the application start-up, the user may not launch programs other than those assigned to the user's access level.

The operator stations shall be secured against unauthorized access.

6.4.6. Requirements for graphics editor


As a minimum, the graphics visualization editor must fulfil the following requirements:

- a colour palette of at least 256 colours shall be supported,
- it must be possible to create libraries of graphic symbols that can be reused within the application in order to show the status of identical components,
- it must be possible to create animations for components and symbols, such as: colour changes, flashing, size or location changes, visibility changes,
- it must be possible to associate graphic elements and symbols with scripts that perform other DCS system functions (e.g. database operations),
- it must be possible to import graphics created using other programs in standard formats (*.bmp, *.jpg, *.gif),
- it must be possible to distinguish between alarm types and states by differentiating colour schemes.

6.5. Diagnostics and alarms

The DCS system must support alarms and diagnostics for the following events:

- controller's CPU module removal,
- communications module removal,
- input/output module removal,
- controller's CPU module malfunction,
- communications module malfunction,
- input/output module malfunction,

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- input/output module channel malfunction,
- input/output signal value out of range,
- communications errors,
- non-redundant operation (CPU, inputs/outputs, communications),
- power supply failure (system power supply, facility power supply).

6.6. Data historization and archiving

The DCS system must support online historization of all analogue signals (for at least six months) and all alarms, events and operator actions (at least 100,000 items).

The DCS system must provide the ability to display the history of signal changes in the form of trends.

In addition to charts showing momentary values, the DCS system must display maximum, minimum and average values for specific periods of time. When displaying more than one signal at a time, a separate scale must be provided for each signal (or signal type) that represents its full range in engineering units.

In addition to short-term historization, the DCS system must support long-term archiving, including export of historical values to external storage media. Restoring history data from an archive, if required, should be fast and convenient. The Contractor must ensure that restored data can be used by other applications, e.g. reporting tools.

Users of the DCS system must be able to view historical run charts for a specific period of time and search for instances where a particular parameter has reached a specific value (i.e. exceeded a high or low threshold). Charts must be scalable - the user must be able to zoom in on a selected portion of a chart by narrowing down the scale. Also, it must be possible to select any set of signals shown on charts and to print out any chart generated and save it to a file.


6.7. Reporting

The DCS system must provide functionality to:

- create a list of reports,
- define new reports,
- edit previously defined reports,
- delete previously defined reports,
- define methods for automatic report generation (in response to an event or at specific time),
- generate reports at the operator's request,
- archive data from the DCS system and other systems (by using the ability to send a generated report),
- automatic printouts.

When defining a report in the DCS system, it shall be possible to specify the following:

- report name,
- production line name,
- variables to be reported,

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- balance values to be reported,
- period for which the report is being generated,
- details of the person who generates the report.

As a minimum, each report should contain the following information:

- report name,
- production line name,
- report generation date and time,
- signal/variable values (current, historical or calculated, depending on report type),
- period for which the report is being generated.

The DCS system must enable various reports to be generated in a flexible manner, for example:

- a daily/monthly production report for the plant, containing variable values and balance data,
- an end-of-shift report, containing variable values and balance data,
- an alarm report (for alarms which occurred during a particular period of time, showing dates and times of occurrence during a given interval for a selected alarm, etc.),
- an event report (making it possible to search for the times of occurrence of selected events, etc.).

6.8. Redundancy and uninterrupted operation

The DCS system must have redundancy implemented at the level of:

- controllers (CPU),
- internal bus that connects individual components of the DCS system,
- communication with controllers/safety systems (deviation is acceptable provided that approval is granted by the Buyer),
- power supply (power supply units shall be selected with reserve to allow operation of whole system on one power supply unit when the other has failed),
- HMI operator stations by use of several non-redundant computers working with the same application software.

Redundant input/output modules shall be used for circuits which are critical to the technological process (e.g. control system).


The DCS system redundancy must ensure uninterrupted operation. If a redundant components fails, the other component will take over its operation automatically, without operator involvement.

The required level of the DCS system component redundancy depends on the system's criticality, and must be agreed with the Buyer.

It must be possible to perform maintenance operations and replace individual DCS system modules without shutting down the entire system.

6.9. Scalability

The DCS system Contractor must provide the option to expand the licence for the DCS system in range:

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- support for a larger number of signals being processed,
- support for additional operator stations.

The DCS system must support expansion in terms of hardware:

- additional input/output modules,
- additional operator stations,
- additional communication cards for data interchange with other systems,
- additional server for data interchange with other systems.

6.10. Spare capacity

The DCS system must be supplied with the required minimum spare capacity (reserve), that includes minimum 15% of unused inputs/outputs for each type of signal. Spare channels should be wired to output terminals in the cabinet and fully equipped (for example in devices such as Ex separators, etc.).

At least 15% of spare capacity in software licences for the DCS system is required.

At least 20% of available space for expansion in DCS system cabinets is required.

It is required to guarantee the existence of a suitable reserve capacity in the DCS systems power supply units, to support a fully equipped cabinet (after installation of additional modules, relays, etc. in reserve space).

6.11. Performance

During normal operation of the process plant, the average load per CPU cannot exceed 70% of the maximum load.


Maximum refresh times for each type of signal will be defined in more detail at the purchasing stage. Sample times are provided in the table below.

Measured parameter	Refresh time
Velocity, pressure	1 s
Flow	1 s
Level, temperature	1 ÷ 5 s
Special measurements	0.5 s

For signals which, in addition to being visualized, serve as measured parameters for control systems, the primary criterion regarding the required refresh time is to ensure safe operation and the appropriate quality of control for a particular system.

The DCS system must provide fast response times for the following operator actions:

Parameter	Refresh time
Updating values and statuses on operator screens	1 s
Updating information about active alarms and events	1 s

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

Invoking graphics	4 s
Invoking a historical data screen	5 s

6.12. Backups

Before the FAT completion report can be signed and the system can be commissioned for operation, the Contractor shall deliver an up-to-date backup of the DCS systems software (in two copies on separate labelled media).

If the copy of the software is provided by the Contractor before the FAT report is signed, it must be free of any faults and defects detected during the FAT.

The software copies should include all software components of the proposed DCS system that are required for reinstallation, namely:

- operating systems,
- manufacturer's system software and utility software,
- application software,
- communications drivers,
- other software necessary for the DCS system to operate correctly.

The media on which the software is provided must be free from any defects. If the media are found to be defective during the warranty period, they shall be replaced with defect-free media within 14 days of the request.

Upon the delivery of the DCS system, instructions for creating and restoring backups of the system must be provided.

The DCS system must include tools to create and restore backups.

6.13. Licensing


All necessary licences from the systems manufacturer and from third parties must be provided with the DCS system as required to enable:

- correct operation of the DCS system according to the manufacturer's licensing policy,
- full customization of the DCS system, including all functional modules,
- use of software that enables maintenance of the DCS system.

For licences which are limited (by the number of variables, number of seats, etc.), it will be necessary to provide current licensing policies of DCS system component manufacturers and applicable price lists.

The DCS system Contractor will be required to provide a declaration from the system manufacturer that the proposed product will be covered by technical support and that spare parts will be available for a period of at least ten years starting from handover report signature date.

With respect to the software delivered, the Buyer can make changes or upgrades to hardware during the warranty period without incurring additional licence costs for the system.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

6.14. Warranty

The DCS system supplied must have at least a 24-month warranty that covers correct operation in accordance with technical documentation.

The DCS system must support integration with other systems specified by the Buyer.

The Contractor is required to correct all defects and deficiencies detected in the DCS system being implemented, or cover the cost or having such defects and faults repaired, during the warranty period, inter alia: shipping costs, travel expenses of maintenance personnel dispatched to perform repairs at the controller installation location, etc.

During the warranty period, the Contractor is required to receive notices regarding faults and failures of the DCS system.

When the scope of work includes supply of IT hardware (servers, work stations, network elements), the Contractor will provide the necessary specialist staff, spare parts and consumables required to perform maintenance activities and correct any faults/failures of these elements.

The Contractor is required to correct faults/failures in the solution being implemented within the timeframes specified by the Buyer during the purchasing procedure.

The Contractor is required to replace the DCS system's hardware or software in which unrepairable defects are found.


The warranty period for the DCS system will begin on the signing date of the final acceptance report.

If faults/failures of the DCS system occur, the warranty period will be extended by the time required to correct them.

If the DCS system's hardware or software is replaced with new items which are free from defects, the warranty period will begin again on the date of replacement.

6.15. Credentials

Upon the delivery and acceptance of the DCS system, all access passwords must be provided (including administrator passwords, passwords required to perform maintenance operations and any other passwords used in the system).

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

7. PLCs (EXCLUDING ESD SYSTEM)

7.1. Requirements for hardware components

Supplied PLCs shall be of modular design. This solution allows a flexible selection of each controller's hardware configuration, and enables upgrades.

The power supply voltage of PLC elements shall be 230V AC or 24V DC.

The PLCs shall be installed in control cabinets.

PLC input/output terminals module must not be integrated with the modules, so that it is not necessary to disconnect wires if a module needs to be replaced.

Controller CPUs shall be equipped with LEDs that indicate the device's failure status, i.e. RUN/STOP mode, active ALARM.

The modules used in the proposed controllers must support at least the following input/output signal type:

- | | |
|----------------------|--------------------------------------------------------------------------------------------------------------------|
| AI (analog input): | <ul style="list-style-type: none"> • 4...20 mA • RTD (Pt-100) • TC (thermocouple) |
| AO (analog output): | <ul style="list-style-type: none"> • 4...20 mA |
| DI (digital input): | <ul style="list-style-type: none"> • potential-free contacts • NAMUR-compliant signals |
| DO (digital output): | <ul style="list-style-type: none"> • 24 VDC, • potential-free relay output |
| PI (pulse input): | <ul style="list-style-type: none"> • pulse inputs 0...10 000 Hz |


Mixed-signal modules should not be used unless there are valid technical or economic reasons.

Redundant signal sources must not be connected to the same modules.

Signals should be assigned to modules in a segregated manner, i.e. grouped by common functionality or by support for a common part of the plant.

When selecting the configuration, it is necessary to provide at least 15% of unused inputs/outputs for each type of signal. Spare channels should be wired to output terminals in the cabinet and fully equipped (for example in devices such as Ex separators, etc.).

At least 20% of available space in the PLC cabinets for possible expansion is required.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

A reserve capacity in the PLC power supply units shall be provided to support a fully equipped cabinet (after installation of additional modules, relays, etc. in reserve space).

The PLC Contractor is required to provide a declaration from the manufacturer that the proposed product will be covered by technical support and that spare parts will be available for at least five years starting from handover report signature date.

7.2. Requirements for software components

The PLC applications must be developed using one of the following programming languages that conform to PN-EN 61131-3:

- FBD – Functional Block Diagrams,
- LD – Ladder Diagram,
- SFC – Sequential Function Chart.

Acceptance of the PLC application will be contingent upon the provision of a complete version of the software, including lists of variables and detailed descriptions and comments in Polish or English. The copy supplied must be up-to-date and consistent with the tested version of the software stored in the controller's memory.

Symbols shall be assigned in the software code to all input/output signals, consistent with measurement point tag names in the documentation.

The program must have a logical structure that allows the code analysis. The Contractor is required to use mechanisms that shorten the program code's length, such as functional blocks. The program shall enable editing and changing the source code.

The Buyer must have access to the contents of all program blocks (with the exception of standard blocks developed by the manufacturer of the controller or utility software). If the controller memory or program blocks are password-protected, the Contractor is required to provide the passwords to the Buyer.


The latest versions of utility software should be used to develop the PLC program.

In case of exchange of data (communication) with other systems, the Contractor is required to deliver the list of exchanged signals including the following information:

- signal/variable tag,
- signal/variable descriptor,
- type, length,
- address,
- LL/L/H/HH alarm setting,
- range and engineering unit.

The PLC Contractor is required to deliver utility software that makes it possible to:

- create new and modify existing programs using languages that conform to PN-EN 61131-3,
- program the controllers using variables (and not only addresses in memory),
- force input/output signal statuses,
- download the programs developed to the controller memory,
- upload programs from the controller memory for backup purposes.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

The software should contain all libraries required to support the PLC controller configuration. Furthermore, a licence shall be supplied along with the software as required for the software to be used legally.

7.3. Time synchronization

The Contractor shall ensure the PLC time synchronization with a reliable time source.

7.4. Redundancy and uninterrupted operation

PLCs must have redundancy implemented at the level of:

- controller CPU,
- communication with controllers and security systems (deviation is acceptable after an approval by the Buyer).

If a PLC is used to support circuits which are process-critical (as specified in the engineering design), redundancy shall be provided at the level of:

- input/output modules,
- power supply units (power supply units shall be selected with reserve to allow operation of whole system on one power supply unit when the other has failed).

The PLC redundancy must ensure uninterrupted operation. If a redundant component fails, the other component will take over its operation automatically, without operator involvement.

The required level of PLC components redundancy depends on the system's criticality, and must be agreed with the Buyer.

It must be possible to perform maintenance operations and replace individual PLC modules without shutting down the entire system.

7.5. Warranty


The supplied PLC controller must have at least a 24-month warranty that covers correct operation in accordance with technical documentation.

The PLC controller must support integration with other systems specified by the Buyer.

The Contractor is required to correct all defects and deficiencies detected in the PLC controller being implemented, or cover the cost or having such defects and faults repaired, during the warranty period, inter alia: shipping costs, travel expenses of maintenance personnel dispatched to perform repairs at the controller installation location, etc.

During the warranty period, the Contractor is required to receive notices regarding faults and failures of the PLC controllers.

When the scope of work includes supply of IT hardware (servers, work stations, network elements), the Contractor will provide the necessary specialist staff, spare parts and consumables required to perform maintenance activities and correct any faults/failures of these elements.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

The Contractor is required to correct faults/failures in the solution being implemented within the timeframes specified by the Buyer during the purchasing procedure.


The Contractor is required to replace PLC's hardware or software in which unrepairable defects are found.

The warranty period for the PLC controller will begin on the signing date of the final acceptance report.

If faults/failures of the PLC controller occur, the warranty period will be extended by the time required to correct them.

If the PLC's hardware or software is replaced with new items which are free from defects, the warranty period will begin again on the date of replacement.

8. SAFETY SYSTEMS – ESD

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------


8.1. SIL classification and implementation of interlock functions

The implementation of interlock functions in safety controllers and the qualitative and quantitative selection of field safety automation equipment will be based on the results of a SIL analysis to be completed beforehand.

The safety systems Contractor will perform the SIL analysis using a methodology based on the PN-EN 61511 requirements. The SIL analysis will be performed in accordance with the following assumptions:

- The risk assessment will cover human safety, environmental safety and economic safety aspects.
- Economic consequences will include property damage and lost production.
- The Safety Integrity Level (SIL) classification will be completed on the basis of the risk matrix presented below.
- Lost production will be estimated on the basis of data provided by the Buyer that describe financial losses due to production downtime.
- The final SIF implementation (including both software and hardware) must comply with the test interval (TI) specified by the Buyer for final elements and initiators while retaining the required SIL classification. Details of the required test intervals will be presented by the Buyer at the basic design stage.

		Frequencies of occurrence (yr)	IPF - SIL (Safety Integrity Levels)				
			a2	2	3	n/a	n/a
Probability	D4	0-0.5	a2	2	3	n/a	n/a
	D3	0.5-4	a2	1	2	3	n/a
	D2	4-20	a1	a2	1	2	3
	D1	>20	-	a1	a2	1	2
Consequence categories	L	Economic (\$)	Slight damage <10k	Minor damage 10-100k	Major damage 0,1-1M	Major damage 1-10M	Extensive damage >10M
	S	People	Slight injury	Minor injury	Major injury	Single fatality	Multiple fatalities
	E	Environment	Slight effect	Minor effect	Localised effect	Major effects	Massive effects
Consequence			1 (N)	2 (L)	3 (M)	4 (H)	5 (E)

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------


The SIL analysis shall be performed in cooperation with the Buyer's representative and final report and proposed technical solutions shall be accepted by the Buyer. Two weeks before commencement of the works, the Contractor shall deliver to the Buyer the HAZOP study, P&ID diagrams, C&E diagrams and instrumentation loops database.

8.2. Requirements for design and execution of safety systems

The ESD System shall be independent from the DCS.

The ESD System shall conform to following requirements:


- The emergency shutdown system (ESD) and the process interlocks (BMS/SIS) shall be based on PLC controller from the "List of Manufacturers and Vendors Approved by ANWIL S.A." (Annex No. 6)
- The ESD controller redundancy shall ensure that if a redundant component fails, the other component shall take over its operation automatically (without operator involvement) and without interruption.
- The process interlock and emergency shutdown system (ESD) must be designed, tested and certified according to PN-EN 61508 and PN-EN 61511.
- The process interlock and emergency shutdown system (ESD/BMS/SIS) must have separate inputs/outputs, other than inputs/outputs of the primary control and monitoring system DCS.
- Input and output hardware segregation for individual interlock and emergency shutdown systems (e.g. compressors, process lines) must be provided.
- Signal lamps and pushbuttons of the ESD system should be located on the operator console (Top Box) in the control room.
- Digital signals from the field equipment located in explosion hazardous areas should be directly connected to the input modules. These modules should be equipped with the line failure detection system (LFD). Digital signals from/to the electrical equipment shall come via interposing relays. Output signals to solenoid valves and lamps should go through the terminal strips equipped with fuses.
- Field initiators of interlocks connected to the ESD system shall be in Ex d execution. An exception is made for inductive proximity switches which should be in Ex i execution and should be connected to Ex i certified separators equipped with the line failure detection system (LFD).
- Solenoid valves connected to the ESD shall be in Ex d execution and powered with 24V DC. Logic digital outputs to the solenoid valves should be transmitted through interface relays, fail safe type, located in a separated part of the cabinet or on the output card of the ESD controller.
- Input signals from the MCC to the ESD shall have the form of potential-free relay contacts. Output signals from the ESD to the MCC shall have the form of potential-free relay contacts. The relays shall be installed in a separated interposing relay cabinet (IRC) in the technical instrumentation room. Such solution prevents transferring a voltage (230V AC, 110V DC) from MCC to I/O cards of the ESD system.
- MOS (Maintenance Override Switch) switches shall be used for testing of the interlock initiating devices without activating of the interlock system during operation of the plant. MOS switches shall be implemented in software and it must be possible to activate them from the ESD visualizations screen - visualization in the DCS is recommended. The required MOS status will be transmitted to the ESD via a redundant

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

software communication connection by means of two independent pulse signals (on/off). It is required to use a lamp placed on the operator console (Top Box) for the logic group of signals. This lamp will inform about the use of any MOS switch in the group. At technical design stage, the Contractor shall present a concept of grouping the signals which will be checked and approved by the Buyer in the agreed period of time.

In addition to software MOS switches, there shall be a key-operated switch for each logic signals group. Key-operated switches shall provide additional safety - if these switches are open, the software MOS switches cannot be operated from the operator visualization screens. These switches shall be located in the control room and shall be accessible only to technical supervision.

- Activation of any MOS switch in any group must generate an alarm message in the DCS which must be recorded in the event history.
- An additional switch, hard-wired to the ESD controller digital input, must be installed on the operator console (Top Box). This switch must enable a manual switchover of all MOS switches to the safe status (i.e. "off"). This is an additional safety measure which can be used in case of failure of the serial communication between the DCS and the ESD. The deactivation switch function can be integrated with the authorizing switch for MOS activation in a dedicated group.
- POS (Process Override Switch) switches shall be used for by-passing of input signals which activate the interlocks. It will enable a start-up of the plant. Activation of a POS causes de-blocking of the signal from the interlock-initiating device (the signal does not activate the interlock and the shutdown) and the operator is informed about the situation by a lamp on the operator console (Top Box). The POSs shall be key-operated switches. The POSs and lamps shall be located on the operator console (Top Box). Use of POS must be recorded as an alarm message in the DCS and recorded in the events history. The concept of using the POSs must be agreed and accepted by the Buyer.
- To enable the status identification of MOS and POS switches by the process operators, the dedicated graphs in the DCS shall be configured to visualize the status of MOS and POS switches.
- The alarm of the first cause of the interlock shutdown (e.g. compressor, process line) must be configured in the ESD and visualized in the DCS for each interlock system.
- Each failure of the ESD controller must cause an alarm in the DCS. Common (cumulative) alarms are acceptable.
- A dedicated engineer station shall be provided for operation of the ESD controller.
- The ESD must be equipped with interfaces for communication with:
 - DCS system - via redundant data transmission bus,
 - printers,
 - engineer station for programming and configuration of the ESD controller,
 - local system/console for the ESD visualization.
- Connection to the DCS data transmission bus must be made using the redundant serial interface with the Modbus RTU protocol.
- The ESD controllers shall be equipped with the hardware and software diagnostic system for the software. This system should control operation correctness of I/O modules, processor and memory. Test results should be printed and/or displayed on the monitor. Status of inputs/outputs, clock and memory must be accessible through a dedicated computer (engineer station) or an off-line terminal.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

8.3. Execution design

The existing risks must be analysed and threats must be identified at the plant design phase. If the planned safety features, other than electronic systems, (e.g. safety valves) are insufficient, the methods shall be devised to reduce the risk to an acceptable level by implementing SIFs in safety controllers.

A Safety Requirement Specification shall be developed for each SIF as described in PN-EN 61511-1.

For the implementation of the required SIFs, equipment which is certified for conformity to PN-EN 61508 and provides the required SIL shall be selected. Following the initial selection of the SIF implementation method, compliance with requirements shall be verified according to the Safety Requirement Specification. As a result of the verification, the configuration of the equipment that delivers SIF functionality may change.

The final execution design of the safety system shall undergo a documented validation process.

Once the design process has been completed, the Contractor is required to have a safety evaluation performed by an Independent Entity with respect to the designed system. Upon the completion of the design, the Contractor is required to provide the following documentation:

- results of the hazard identification and analyses of existing risks,
- required Safety Instrumented Functions (SIFs),
- developed Safety Requirement Specification,
- documents that certify the completion of the verification and validation processes,
- documents that certify the completion of a safety evaluation by an Independent Entity,
- complete documentation for system components (reliability coefficients, frequency and coverage of internal test, SIL level, certificates and their validity conditions),
- list of requirements to be met in order to achieve and maintain the expected safety level.

8.4. Software


The following programming languages that conform to PN-EN 611331-3 are accepted:

- FBD - Functional Block Diagram,
- LD - Ladder Diagram,
- SFC - Sequential Function Chart.

The programs delivered should include lists of variables and detailed descriptions and comments in Polish or English.

The program structure and code must have a logical structure and must be as simple as practicable. The Contractor is required to use mechanisms that shorten the program code's length, such as functional blocks. Security program blocks shall only use functions available in the library intended to support the safety program.

The safety system software must be secured against unauthorized access. Program passwords shall be given to the person designated by Buyer.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

A failure or disruption of communication between the controller and other systems should not interrupt the operation of the safety system. The Buyer must have access to the contents of all program blocks (with the exception of standard blocks developed by the manufacturer of the controller or the developer utility software). If the controller memory or program blocks are password-protected, the Contractor is required to provide the passwords to the Buyer.

The latest versions of utility software should be used to develop the ESD program.

Unless the technical specification provides otherwise, the ESD controllers Contractor is required to deliver utility software that makes it possible to:

- create new and modify existing programs using languages that conform to a proper standard,
- program the controllers using variables (and not only addresses in memory),
- force input/output signal statuses,
- download the programs developed to controller memory,
- upload programs from the controller memory for backup purposes.

The software must contain all libraries required to support the controller configuration. Furthermore, a licence shall be supplied along with the software as required for the software to be used legally.

Delivered primary and utility software (and hardware, if necessary) should guarantee a possibility of controller configuration and its subsequent modification.

The software should consist of the following parts - packages:

- application software,
- utility software,
- additional diagnostic software,
- visualisation software,
- sequence of events recording software (SOER).

8.5. Delivery and installation

The delivered safety system components must comply with the execution design.


Operation manuals shall be provided for all equipment included in the safety system.

The following documents shall be provided for equipment included in the safety system: reliability coefficients, environmental conditions, frequency of required periodic tests, frequency and coverage of internal test, certificates of conformity with PN-EN 61508 and their validity conditions, and the SIL classification of equipment.

When selecting the safety controller's CPUs, it is necessary to take into account their operating conditions so that they do not operate close to their specified limits (temperature, humidity, current).

The safety controllers delivered should support at least the following types of signals:

AI (analog input): • 4...20 mA

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- AO (analog output): • 4...20 mA
- DI (digital input): • potential-free contacts
 • NAMUR-compliant signals
- DO (digital output): • 24 VDC,
 • potential-free relay output

Redundant components should be connected to separate input/output modules.

Each safety controller shall be equipped with line failure detection functionality.

Safety controller interfaces and interfaces used in other components that deliver the SIF functionality shall be secured against an unauthorized access.

Each safety controller must allow on-line software changes to be made without interrupting its operation (and the operation of the entire plant). For controllers with a specific SIL classification, this capability must be confirmed in the controller's certificate.

The safety system to be delivered must have the ability to test the SIF performance (for all components involved in its implementation).

After the completion of the installation process, but before commissioning, a functional safety evaluation of the safety system shall be performed by an Independent Entity.

8.6. Warranty

The supplied ESD controller must have at least a 24-month warranty that covers correct operation in accordance with the documentation.

The ESD controller must support integration with other systems specified by the Buyer.


The Contractor is required to correct all defects and deficiencies detected in the ESD controller being implemented, or cover the cost or having such defects and faults repaired, during the warranty period, inter alia: shipping costs, travel expenses of maintenance personnel dispatched to perform repairs at the controller installation location, etc.

During the warranty period, the Contractor is required to receive notices regarding faults and failures of the ESD controllers.

When the scope of work includes supply of IT hardware (servers, work stations, network elements), the Contractor will provide the necessary specialist staff, spare parts and consumables required to perform maintenance activities and correct any faults/failures of these elements.

The Contractor is required to correct faults/failures in the solution being implemented within the timeframes specified by the Buyer during the purchasing procedure.

The Contractor is required to replace ESD controller's hardware or software in which unrepairable defects are found.


	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

The warranty period ESD controller will begin on the signing date of the final acceptance report.

If faults/failures of the ESD controller occur, the warranty period will be extended by the time required to correct them.

If the ESD controller's hardware or software is replaced with new items which are free from defects, the warranty period will begin again on the date of replacement.

The ESD system Contractor is required to provide a declaration from the manufacturer that the proposed product will be covered by technical support and that spare parts will be available for at least ten years starting from handover report signature time.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

9. ASSOCIATED SYSTEMS

9.1. Operator console – Top Box panel

The alarming system – the operator console must be executed as a standard Top Box located near the operator DCS system consoles (to which the most important alarm signals and interlock pushbuttons of the monitoring and ESD systems will be connected in the "hardware manner").

The Top Box panel must be equipped in inter alia:

- LED type alarm lamps informing about exceeding of very important process parameters or about the events affecting technical safety of the plant (e.g. general alarm from activation of flammable/toxic gas detectors, exceeding of very important process parameters),
- pushbuttons (mushroom type with protection) to shut down the important technological equipment (e.g. process heaters, machines (e.g. compressors, pumps),
- alarm sounder,
- pushbutton to test the lamps and sounder installed on the Top Box panel,
- pushbutton to acknowledge the alarm and switch off the sounder.

Equipment installed on the Top Box panel shall be controlled directly by the ESD safety system.

9.2. Asset Management System (AMS)

The Asset Management System must be based on an open communication standard and provide a single integrated software application. It must be independent of the control system and type of delivered equipment. This system must ensure safe and direct access to the instruments for configuration, documentation, and predictive diagnostics for devices with the following communication protocols:


- FOUNDATION fieldbus,
- HART,
- Wireless HART,
- PROFIBUS DP,
- PROFIBUS PA.

The Asset Management System must be installed on a personal computer (PC) and must provide the following functionalities:

- management of configuration and calibration data for smart devices, including the integration with portable smart calibrators and communicators,
- automatic recording of events for configuration change control and service of current diagnostic communications,
- on-line display and historization of diagnostic messages from instruments,
- data transfer between systems.

The software shall provide a display of device hierarchy on-line and off-line between the physical system and the diagnostic computer.

Diagnostic software for smart positioners integrated in the AMS must provide access to all diagnostic functions of a device.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

The exchange of information between devices and the AMS must not have any impact on the ability to control the process by the control and safety systems. A certificate to confirm lack of impact on the DCS and SIS by the AMS shall be required.

All necessary licences shall be supplied with the system to ensure full functionality of the software in terms of installed field instruments. All licences must be provided with a minimum 30% reserve (licensing of number of devices connected to the system).

The Asset Management System must be able to create automatic backup copies and have the ability to restore the system after a failure.


9.3. Anti-surge system

Anti-surge systems should fulfil the following functional requirements:

- Protect a compressor against surge phenomenon in all operational modes, during start-up, normal operation and shutdown and a minimized impact on the processes carried out on the plant.
- Automatically extend the compressor safe operation range depending on the speed at which the compressor operating conditions are approaching the surge boundary.
- Prevent the compressor surging and the exceeding of set limiting conditions.
- Automatically adapt the system parameters depending on the type of disturbance to suppress the growth of a pre-surge situation and stop the surge if it appears for the reasons not attributable to the system.
- Represent visually in real time the location of the compressor operation point in the plane of its gas-dynamic characteristics and the position of anti-surge controller set line.
- Software connections responsible for individual compressing sections must ensure a full protection of the whole compressor. A disturbance in one section must not be transferred to other sections.

The anti-surge controller should be realized based on a dedicated PLC or a controller of individual loop which meets the following conditions:

- The control loop processing time should ensure safe operating conditions and the required response time defined by machine Contractor.
- The controller must be able to perform proper diagnostic functions which allow locating an equipment failure (processor, cards and I/O circuits, communication interfaces).
- Diagnostic information regarding the controller operation shall be transferred to the DCS in such a manner that this information shall enable visualization and alarming on proper synoptics or system screens. Common (cumulative) alarms are acceptable.
- A controller hardware failure must not generate a dangerous situation for the machine. The emergency mode should force the anti-surge valve to a safe position.
- A failure of a single input circuit should not generate an emergency situation. The emergency mode of operation should support two scenarios: use the last proper process value and continue the control system operation, or force the anti-surge valve to a safe position. The final choice of the emergency situation handling scenario should be specified during the project execution and agreed with the Buyer.
- A dedicated engineering station should be provided for the anti-surge system. This station should provide the following functions:

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- operate the system software,
- record and historize the controller diagnostics,
- record and historize the process data and events,
- develop and modify the application software (optional),
- visualize the application software operation,
- make backup copies,
- restore the controller status from a backup copy.
- The software should consists of the following parts - packages:
 - system and diagnostic software,
 - utility software,
 - utility software,
 - visualization software.
- The system and application software shall be supplied with all licenses required to perform the described tasks.

The anti-surge system actuator – a control valve – shall be selected for a particular application in such a manner as to ensure the optimal control responses of the whole system in terms of a proper flowrate, speed and precise positioning.

The control valve requires a smart positioner with the full diagnostic function.

Additional functions of the anti-surge system:

- exchange the process and diagnostic information with the DCS through a communication link (for example RS-232/485 serial link with Modbus RTU protocol),
- use individual service bridges (MOS) on input signals to the controller (flow, pressure and temperature) in order to perform service operations during the plant operation,
- control signals and commands between the DCS and the anti-surge system shall be realized by hardware connections.

The final anti-surge system configuration must be approved by the Buyer.


9.4. Requirements for the APC system Contractor regarding interoperability with the DCS

The Contractor must perform an analysis of current and planned DCS workloads in the following aspects:

- communications buses (min./avg./peak load),
- controller CPU performance in terms of the ability to implement new algorithms (min./avg./peak load),
- data historization system performance,
- operator station (operator graphics) performance,
- existing licences (in terms of possible extension),
- system software up-to-dateness (in terms of requirements for possible extension).

The summary document must contain information about current workload, margins for safe extension, and planned target workload, which shall be verified when the implementation has been completed.

The Contractor must develop the Functional Design Specification (FDS) in the range of:

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------


- APC<->DCS communication connections (standards, redundancy),
- data exchange security, authentication and authorization,
- system solution security, i.e. antivirus software, patch management, network separation and segregation, firewalls, user account security, etc.),
- assumptions for APC and DCS application integration (operator interface),
- assumptions for hardware integration and standardization,
- assumptions for control application segregation and integration.

The Contractor must develop necessary technical designs and specifications for use in RFPs for the DCS modifications, the FDS and other requirements of the APC application in terms of:

- hardware,
- software licences,
- hardware and software installation services,
- application software change services.

The Contractor must develop a risk scorecard with respect to the implementation of the APC system in the range of:

- ability to make hardware changes in the DCS during the operation of the plant,
- ability to make software changes during the operation of the plant.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

10. COMMUNICATION WITH EXTERNAL SYSTEMS

10.1. Communication with machine monitoring system (MMS)

A machine monitoring system (MMS) is used to monitor the operating parameters of machinery such as pumps, turbines, generators and compressors whose correct operation is critical to process continuity.

The MMS provides the following functionalities:

- monitor and record machine operating parameters,
- send information to emergency stop controllers and relays,
- send the machine status information to the DCS.

Modbus RTU is the recommended protocol for communication between the DCS and the MMS. Upon a written permission by the Buyer, one of the following standard communications protocols is acceptable to be used:

- ModBus RTU,
- ModBus TCP/IP over Ethernet,
- ProfiBus DP,
- ProfiBus on Ethernet.

The DCSs retrieve data directly from individual MMS modules.

A complete list of input/output signals retrieved from each module to the DCS must be provided. As a minimum, the following information must be available for each signal:


- signal/variable tag,
- signal description,
- type, length,
- address,
- LL/L/H/HH alarm setting,
- range and engineering unit.

Clock synchronization must be ensured between the MMS and the DCS. The way of implementation of such synchronization (list of data registers) shall be agreed with the Buyer in each case.

The following information shall be retrieved from each MMS module into the DCS:

- signal values from measuring sensors in each channel,
- channel status information (whether set HI or LO limits are exceeded),
- signal values from discrete inputs,
- diagnostics for each channel (e.g. circuit break),
- status of communication with the module,
- overall module status signal.

Additionally, alarms should be configured in the DCS to indicate whether the allowed values of the signals measured by the MMS have been exceeded. Alarm thresholds must be consistent with those set in the MMS.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

11. INTEROPERABILITY WITH SUPPORTING SYSTEMS

11.1. Antivirus systems

Antivirus software must be installed on operator/engineer stations and on system servers.

The Contractor must verify whether the system to be delivered is compatible with the antivirus software used as a standard at ANWIL S.A. If the Contractor determines that there are issues which may prevent both systems from working together, the Contractor is required to deliver antivirus software which is compatible with the system to be delivered and which provides the same level of security as the software used at ANWIL S.A. (according to reputable independent evaluations).

The antivirus software implemented in the system should be configured in accordance with the system manufacturer's recommendations.

The antivirus software installed in order to protect the system should use up-to-date virus signatures verified by the system manufacturer.

The Contractor should provide instructions for the correct installation, configuration and update of the antivirus systems it delivers.

During the warranty period, the Contractor is required to notify the Buyer whenever new virus signatures approved by the system manufacturer are released. The information should be provided within 7 days of the release of such signatures according to the antivirus system manufacturer's release schedule.

The software to be delivered must support remote configuration.

The software to be delivered must support both "on demand" scanning and scanning triggered automatically according to the set schedule.


The antivirus software to be delivered must enable performing the full scan or scan of selected files/folders.

The antivirus software to be delivered should support centralized management (i.e. the ability to introduce the same configuration settings automatically on multiple operator stations within a group).

The antivirus systems to be delivered must allow generation of reports on completion of each scan.

Before an external storage medium can be connected to any system component, the full scan of the medium must be performed using the antivirus program.

Along with the delivery of system components, the Contractor must provide the required licences for the antivirus software installed (including the assignment of such licences to the Buyer).

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

The system should operate correctly in an architecture that is isolated from the Internet. This means that signatures cannot be downloaded directly to the central system used for management purposes (which is connected to the protected operator/engineer stations and the system servers).

11.2. Patch management

The patch management shall include inter alia:

- patches for server/operator station operating systems,
- patches for application software,
- patches for utility software,
- patches for communications drivers,
- patches intended for other software necessary for the operation of the systems.

The patch management must comply with the system manufacturer's recommendations.

The system Contractor must provide the patch management manual developed by the system manufacturer.

During the warranty period, the Buyer must be notified whenever new patches for the system are released by the manufacturer.

For the installation and testing of new systems, a version that includes all official patches available on the SAT acceptance date must be used. This applies to all software being part of the system, including:

- server/operator station operating systems,
- application software,
- communications drivers,
- other software necessary for the system to operate,
- utility software.

A secure access to a list of security patches and service packs important to the system must be provided. For Windows software, the list of patches should be available for download in a standard format compatible with the MWSUS (Microsoft Windows Server Update System).


Patches and service packs confirmed by the Contractor shall be delivered directly by the system manufacturer.

11.3. Backup management

The systems to be delivered must provide functionality to make backup copies and restore all system software, including:

- server/operator station operating systems
- application software,
- communications drivers,
- other software necessary for the system to operate,
- utility software.

If additional software is required to make a backup copy, such software must be provided with the system.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------


The system Contractor is required to provide the complete documentation, including:

- instructions for making backups of the system,
- instructions for restoring the system from backups,
- backup policy.

The tools to be delivered and the recommended backup policy must allow creation of backups without disrupting normal operation of the system.

The tools provided for making backups must support three core areas to enable a rapid restoration of the system:

- system protection - the ability to restore the entire system, including user settings, registry, etc. within the shortest possible time,
- data protection - the ability to restore all important data (including databases) collected by the system as at the time of the last backup,
- online backup - the ability to create backups without shutting down the system (which makes it possible to increase the frequency of backups creation).

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

12. ACCESS CONTROL TO AUTOMATION SYSTEMS AND OPERATING SYSTEMS

12.1. Session management

The use of insecure protocols for remote access to the system components is prohibited.

Remote access to system components shall be provided using encrypted protocols (such as ssh or ssl) that ensure cryptographic protection of the data being transferred (especially user authorization data, i.e. logins and passwords).

The protocols used for remote access to the system should apply the strongest encryption method possible commensurate with the technology platform and the required response time.

The screensaver functionality cannot be active on operator stations.

Access to unencrypted protocols (such as telnet, login, ftp) shall be disabled.

The manufacturer should not allow:

- multiple concurrent remote logons using the same account to the same system component,
- use of a single authenticated session to access multiple resources,
- use of auto-complete functionality during logon,
- anonymous logon.

12.2. Password management

User names and passwords are the primary method of access to systems.

Access passwords are required in order to prevent an unauthorized access to the systems.


User access by logon is required to prevent access by unauthorized individuals.

Before the production implementation of each system, all default passwords and passwords that do not comply with the requirements listed below should be removed. The list of all users with their open (overt) passwords must be transferred to the Buyer in writing and in a safe manner.

The password policy should contain the following requirements:

- access password should be changed at least every 180 days,
- minimum length of a password is 8 characters,
- access passwords must contain upper-case and lower-case letters, digits, and at least one of the following characters: @ # \$ % A & * () _ + | ~ - = \ ' { } [] : " ; " < > / ? ,
- access passwords must be encrypted. Access passwords cannot be stored in a readable form.

There are the following exceptions to the these rules:

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- operator accounts are not subject to password management as long as they are used locally without the ability to log on remotely,
- automatic logon is only allowed on an operator console using an operator account,
- automatic logon must not be used for remote logon,
- engineer accounts in the system are exempt from the requirement to change passwords every 180 days (in this case, passwords must consist of at least 12 characters),
- system accounts are not subject to the above rules.

12.3. Users and user groups

The system should support creating users and user groups.

Access rights and access levels should be defined per user group.

Each user should have an individual account assigned. As an exception, a shared operator account may exist in the system.

The Contractor should assign minimum privileges to user accounts.


Due to the unique nature of the systems, there are two types of accounts:

- accounts that allow access to the operating system,
- accounts that allow access to the system's applications.

The following groups of users exist in the system:

- Administrators - these accounts have administrative privileges that allow users to perform all operating system administration tasks. The accounts are only created for IT administrators, if a particular resource is shared by support engineers from the GA Department and IT administrators (e.g. the OPC server).
- Engineers - these accounts have administrative privileges that allow users to perform all system administration (including operating system administration) tasks. This is a dedicated group for GA Department support engineers. They are authorized to make configuration changes in the system, e.g. to create graphics or modify applications.
- Maintenance personnel - these are dedicated accounts for external support personnel, with configured access restrictions.
- Operators - these accounts have operator privileges that enable operational monitoring and management.

User privileges may only be changed by using accounts with administrative privileges.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

13. PHYSICAL AND ENVIRONMENTAL SECURITY

13.1. Protection against unauthorized access

The system components must be protected against an unauthorized access.

Access to newly built/designed and upgraded rooms in which system components are located shall be restricted to authorized individuals by installing an access control system (ACS).

The system components located in technical rooms must be placed in lockable cabinets.

13.2. Protection against fire hazard

With respect to fire protection, the requirements specified in current national regulations and in internal ANWIL S.A. directives shall apply.


Partition walls in the rooms in which system components are located should be made of durable materials that provide an adequate level of resistance to burglary and fire.

The rooms should be equipped with a fire detection system and manual firefighting equipment.

13.3. Electrical power supply

Each power distribution cabinet for the DCS should meet the following requirements:

- Copper busbars should be used to distribute power from the main power distribution cabinet to individual system cabinets/panels (for the phase and the neutral lines). Each outgoing feeder that leads to a cabinet/panel should be protected by a fuse and an insulated circuit breaker. Fuses on each feeder should have tripping indicators.
- Individual terminal strips installed in control cabinets, panels and consoles will be powered using dual cables routed from the main power distribution cabinet. From these terminal strips, power supply lines will be routed to individual circuits/devices through fuses and insulated circuit breakers. Fuses on each feeder should have tripping indicators.
- Two copper busbars (designated "A" and "B") should be installed in the distribution cabinet. Each busbar shall be connected to a different uninterruptible power supply (UPS) source. In case of the large number of non-redundant electrical loads it is acceptable to place the busbar "C" supplied from busbars "A"/"B" through a static switch. In each case the final solution will be determined in consultation with the Buyer.
- Electrical loads equipped with redundant power supply units shall be connected to the power distribution cabinet so that one PSU is connected to section "A" and the other to section "B."
- Electrical loads equipped with non-redundant power supply units shall be connected to section "A" of the power distribution cabinet, or using a fast "A"/"B" switch. In case there is busbar "C" in the power distribution cabinet, electrical loads equipped with non-redundant power supply units shall be connected to busbar "C".

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- Auxiliary contacts of fuses in each terminal strip in the control cabinet should be connected in series, and a common potential-free security trigger signal should be sent to the DCS (one alarm per cabinet).
- Each main busbar ("A" and "B") should have a status indicator light and a relay with a potential-free terminal available for connection to the DCS.

13.4. Maintaining appropriate temperature and humidity

Appropriate operating temperature and humidity must be ensured for monitoring, control and safety system components in accordance with the manufacturer's environmental specifications.

Cabinets that contain automation systems must be equipped with devices that generate forced airflow within the cabinets (cooling fan panels). If cooling fan panels and solid cabinet walls are used, the fans should be activated using a thermostat installed in the cabinet.

Sensors must be placed in the room to monitor vital environmental characteristics. The system should monitor the measured characteristics in order to detect when acceptable levels are exceeded.

13.5. Vibration

When planning the system locations, it is necessary to evaluate environmental conditions (vibration) by:


- analysing the surrounding areas of the potential locations to determine whether vibration sources exist,
- analysing the surrounding areas of the potential locations to determine whether vibration sources may appear in the future (e.g. by reviewing investment plans),
- measuring the existing vibration to determine their characteristics.

When selecting a location, it is necessary to:

- compare the characteristics of the existing vibration at each potential location with the maximum acceptable values specified by manufacturers of system components,
- prefer locations which are not exposed to vibration or locations where the vibration values are lower than the maximum acceptable values specified by manufacturers of system components,
- make the decision to use vibration-proofing measures if a location which is not exposed to vibration cannot be selected (because such location does not exist or cannot be used for reasons associated with the operation of the installation being controlled) or if the use of a particular location is not economically viable (as determined by comparing the estimated cost of vibration-proofing the location with the cost of routing cables and power lines to another location, etc.).

When preparing a location for operation, it is necessary to:

- measure the vibration value at the location and use vibration-proofing measures if the vibration values are higher than the maximum acceptable values specified by manufacturers of system components or if vibration is expected to appear at the location in the future;
- develop an "initial" vibration measurement report;

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- develop a plan for the cabinets layout in the room, including dimensions and total weight (for cabinets with installed equipment);
- choose damping elements, such as damping and anti-vibration mats, to absorb vibration energy (independently or in collaboration with a specialist supplier), provided that the damping elements should be appropriate for the conditions that exist at the production plant;
- install the damping elements according to the manufacturer's recommendations.

During the location commissioning, it is necessary to:

- measure the value of vibration in the cabinets after the installation of all system components in order to determine the effectiveness of the vibration-proofing measures;
- develop the "final" vibration measurement report;
- include the vibration measurement reports (i.e. the "initial" report and the "final" report) and the plan showing cabinets layout and weight in the design documentation.

Deviations

The economic viability of the proposed solution must be analysed before commencing each test and developing any solution to reduce the impact of harmful vibrations. If the solution is not viable, an alternative solution shall be proposed that will eliminate the impact of harmful vibration to an acceptable extent.

If there is a risk that the installed system components will be exposed to vibration which exceeds the maximum acceptable values specified by the equipment manufacturer, appropriate measurements shall be performed in order to determine the vibration level.

If the acceptable vibration level is exceeded, the system components must be appropriately protected against harmful vibration (e.g. by equipping the racks with vibration isolators, or by using damping and anti-vibration mats to absorb vibration energy). The solution to be used should be appropriate for the conditions that exist at the production plant.

Once an appropriate solution is installed to eliminate the adverse impact of vibration on the system components, detailed vibration level measurements shall be performed again.


A detailed report on the vibration level measurements performed before and after the installation of the system components shall be included in the design documentation.

If the vibration values exceed the maximum acceptable values specified by the manufacturer and it is not possible to use damping elements, it will be necessary to consider replacing the existing components with components whose vibration resistance is greater than the vibration level which exists at the location.

13.6. Aggressive environment

When planning locations for the system, it is necessary to evaluate the environmental conditions by:

- Analysing the surrounding areas of the potential locations to determine whether sources of aggressive substance emissions exist.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

- Analysing the surrounding areas of the potential locations to determine whether sources of aggressive substance emissions may appear in the future (e.g. by reviewing investment plans).
- Measuring the existing environmental conditions to determine the classification of the environment according to ANSI/ISA-S71.04, which includes:
 - performing laboratory environmental measurements at the potential locations or installing pollution meters at the potential locations to measure environmental aggressiveness or installing passive samples at the potential locations (to be evaluated after a specific period of time in order to determine environmental aggressiveness).

If measurements cannot be performed or are not economically viable, it shall be assumed that the aggressive environment at the location is class G3 according to ANSI/ISA-S71.04. 2.

When selecting a location, it is necessary to:

- Compare the environmental characteristics at each potential location with the allowable values specified for system components by the manufacturers.
- Prefer locations which have the lowest classification according to ANSI/ISA-S71.04 or locations whose selection is economically justified (taking into account the cost of implementing protective measures against aggressive environment, if required).
- Use protective measures if environmental severity level at a selected location (as expressed using ANSI/ISA-S71.04 classification) exceeds the acceptable values specified by manufacturers of system components.

If the severity of the environment at a given location exceeds the allowable operating limits specified for a component by its manufacturer (or if severity class G3 was assumed at an earlier stage), system components must be protected against the adverse impact of such environment.


In order to protect the entire room in which the system components are located against aggressive environment, air filtering systems shall be used to maintain normal conditions inside the room. To ensure effective filtering, wall penetrations and doorways should be sealed (similarly to a gaseous fire suppression system). The room's air supply system should allow maintaining a slightly higher pressure inside the room than outside. Standard execution equipment shall be used inside the room.

Individual components or groups of components shall be protected by:

- using sealed installation cabinets or enclosures (which ensure heat removal and internal air filtering),
- installing components in (or relocating components to) rooms where no aggressive environment exists,
- using equipment in special execution - resistant to aggressive environment (class G3 according to ANSI/ISA-S71.04 shall be assumed).

Before selecting a method for the protection of system components against environmental impact, the following activities shall be completed:

- economic analysis that covers:

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------


- the cost of relocating components to rooms where no aggressive environment exists, including the cost of arranging space for such components and connecting the components,
- the cost of implementing protective measures,
- the cost of more frequent replacement of worn (standard execution) equipment and loss of warranty,
- the cost of purchasing equipment in special execution - resistant to aggressive environment,
- the cost of equipment downtime and reinstallation (due to more frequent failures of equipment in standard execution).
- risk analysis that covers:
 - the impact of failures of equipment in standard execution on the safety and operational continuity of the managed process/plant.

Once an appropriate solution has been installed to eliminate the impact of aggressive environment on the system components, the Contractor for the solution shall issue a statement that contains a commitment to maintain appropriate environmental characteristics within the isolated room/cabinet (the statement should include warranty terms, and the warranty period for the implemented solution should be at least two years).

The detailed report on the measurements concerning the impact of aggressive environment on the system components shall be a part of the design documentation.

Deviations

Before commencing each test and developing any solution to reduce the impact of harmful environment, the economic viability of the proposed solution must be analysed. The decision can be made not to implement protective measures against aggressive environment for the system components in special cases where analysis indicates that the cost of protecting the components outweighs the cost of faster component wear, risk, etc.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

14. EQUIPMENT ACCEPTANCE GUIDELINES

14.1. Guidelines for Factory Acceptance Tests (FAT)

The purpose of FATs is to validate the system operation and compliance with the technical specification approved by the Buyer before components are shipped to the target location.

FATs should be considered and included in the preliminary schedule provided at the bidding stage. While the test start date may be determined in detail during the contract signing or at the contract performance stage, information regarding the duration and location of the tests should be binding.

FATs will be executed once the Contractor reports its readiness for testing and the test date is approved by the Buyer. The Contractor is required to report its readiness for testing one month before the commencement of the tests at the latest.

A detailed FAT plan shall be provided to the Buyer at least four weeks before the commencement of the tests. The test plan must contain the following:

- detailed test schedule,
- list of tests with testing procedures.


The test plan must cover the broadest possible scope of system operation, namely all structural and functional components which can be tested before installation and commissioning.

In general, the tests should cover:

- system cabinets (compliance with documentation, correct wiring between input terminals in the cabinet and system modules),
- communication between system components,
- workstations functionality,
- system performance and quality parameters specified in the technical specification,
- check of redundancy mechanisms,
- creation a system backup file and system restoration from the file,
- applications tests,
- input/output circuits tests (minimum 30%) - during the tests inputs on I/O cards should be simulated by controllers to check correctness of reading, alarming, printing, lock function, archiving.

The Buyer will review the list of test procedures within two weeks of receipt, and will submit its comments.

The final suite of tests will be agreed by the Buyer and the Contractor.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

The Contractor will provide an environment that will enable FATs to be executed according to the agreed schedule.

The Buyer will have the right to engage third-party experts to participate in tests or to execute tests.

All discovered faults will be documented. It is recommended to correct all faults as soon as they are discovered.

Once a fault has been corrected, the test should be executed again.

Stability and performance parameters should be verified according to the provisions contained in the technical design agreed with and approved by the Buyer.

The completion of the FATs will be acknowledged with a test completion certificate which should contain information regarding checking of minimum 30% system inputs/outputs and about any uncorrected faults with their descriptions.

Upon the completion of system FATs, all access passwords must be provided (including administrator passwords, passwords required to perform maintenance operations and any other passwords used in the system).

14.2. Guidelines for Site Acceptance Tests (SAT)

The purpose of the SATs is to confirm the correct operation of the system once its components have been installed at the target location.

SATs should be considered and included in the preliminary schedule provided at the bidding stage.

SATs will be executed once the Contractor reports its readiness for testing and the test date is approved by the Buyer.

A detailed SAT plan shall be provided to the Buyer at least four weeks before the commencement of the tests. The test plan must contain the following:

- detailed test schedule,
- list of tests with testing procedures,
- SATs may repeat any of the FATs.


The SAT plan should cover at least the following areas:

- communication between system components (functionality, diagnostics),
- communication with external systems (functionality, diagnostics),
- test of 100% input/output circuit.

The Buyer will review the list of test procedures within two weeks of receipt, and will submit its comments.

The final suite of tests will be agreed by the Buyer and the Contractor.

The Buyer has the right to engage third-party experts to participate in tests or to execute tests.

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------


During the execution of the tests, the Contractor will ensure that the required personnel can participate in the tests.

All faults detected will be documented, and will need to be resolved by the Contractor before the completion of the SATs.

Once a fault has been corrected, the test should be executed again.

The completion of the SATs will be acknowledged with a test completion certificate, which should contain information regarding checking of minimum 30% system inputs/outputs and about any uncorrected faults with their descriptions.

Upon the delivery and acceptance of the system, all access passwords must be provided (including administrator passwords, passwords required to perform maintenance operations and any other passwords used in the system).

	Automation & Electrical Department (SG)	Instrumentation – General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts
-----------------------------------------------------------------------------------	------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------

15. ANNEXES

The following annexes are an integral parts of the document “Instrumentation - General Requirements for New and Modernised Production Plants – Technical Annexes to Contracts.”

- Annex No. 1 - As-is List of Electrical Equipment Ex***
- Annex No. 2 - List of Certificates of Electrical Equipment Ex***
- Annex No. 3 - Contents and Structure of Technical Documentation***
- Annex No. 4 - Corporate Guidelines for Coding Tag Names of Real Analogue and Digital variables***
- Annex No. 5 - Instrument Index***
- Annex No. 6 - List of Manufacturers and Vendors Approved by ANWIL S.A.***