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1 GENERAL

1.1 GENERAL REQUIREMENTS

- 1 This section covers the general requirements for design, supply, installation and commissioning of all instrumentation, control and automation (ICA) systems complete in every detail as specified in the other Parts of Section 10.
- 2 The complete ICA system, shall be furnished by a single ICA Subcontractor to ensure system uniformity, subsystem compatibility and co-ordination of all system interfaces. Deviations shall be as specified in the Project Specification or approved by the Engineer.
- 3 If the technology or material or specification are not mentioned in this section, modifications are permitted and shall be subjected to approval as mentioned in the introduction of QCS (00-02)
- 4 The purpose of QCS is to provide as a general technical guide for acceptable construction work practices in the State of Qatar, considering this; any addition for technology, material, specification, standard that are not mentioned in this section or their modification, shall be subject to approval as stated in the introduction of QCS (00-02)
- 5 For voltages and frequencies, regulations and requirements of Kahramaa and relevant authorities should be taken into account.

1.1.2 Scope

- 1 Provide all tools, equipment, materials, and supplies and perform all labour required to complete the supply and installation, including all instrumentation signal and power conduit, and wiring not specifically shown on the electrical drawings, validation, start-up and commissioning of a complete and operable ICA system as indicated in the Project Specification and Drawings.
- 2 Provide all the necessary equipment components and interconnections and the services of the manufacturers, engineering representatives for the engineering, implementation, commissioning, operation, and instruction, to ensure that the Owner receives a completely integrated and operational ICA system as herein specified.
- 3 Related Sections and Parts

This Section

- Part 2, General Telemetry/SCADA
- Part 3, Primary Elements
- Part 4, Panel Mounted and Miscellaneous Field Instruments
- Part 5, Panel and Control Room Hardware

- Section 8, Drainage Works
- Section 9, Mechanical and Electrical Equipment
- Section 21, Electrical Works

1.1.3 References Standards

- 1 The standards referred to for Manufacturers quality procedures and documentation are:
 - ASTM A123, A386Galvanizing
 - ASTM A36, A500, A501, A570, A618, Structural steel shapes
 - BS 970.....Wrought steel for mechanical and allied engineering purposes
 - BS 5308Instrumentation Cable

- BS 6739Code of Practice for Instrumentation in process control systems:
Installation, Design and Practice
- EN 10084Case hardening steels. Technical delivery conditions
- EN 60654Operating conditions for industrial process measurement and control
- EN 62381Automation systems in the process industry. Factory acceptance
test (FAT), site acceptance test (SAT) and site integration test (SIT)
- ISO 5725Accuracy (trueness and precision) of measurement methods and
results
- BS ISO 9000-2Quality procedures
- ISO 10303-1Industrial automation systems and integration — Product data
representation and exchange

1.1.4 System Responsibility

- 1 Contractor's attention is directed to the fact that the ICA system as specified in these ICA Parts of Section 10 is an integrated system, and therefore shall be provided by a single competent, qualified instrumentation Subcontractor (hereinafter referred to in these ICA Sections as the ICA subcontractor) who shall have total responsibility for the ICA work of this Section. Entire system installation including calibration, validation, commissioning, operational testing, and training shall be performed by qualified personnel, possessing all the necessary equipment and who have had experience performing similar installations. The system shall be integrated using the most modern and proven design and shall, as far as practical, be of one manufacturer. Overall system performance shall be guaranteed by the ICA Subcontractor.
- 2 The Contractor shall appoint a qualified ICA Subcontractor who shall perform the work under this ICA Section, the Contractor shall be fully responsible at all times for the conduct and performance of the appointed ICA Subcontractor. Although many references made herein are to work requirements and responsibilities of the ICA Subcontractor such references shall only mean that responsibility shall pass through the ICA Subcontractor but in the final analysis shall rest with the Contractor.
- 3 The ICA Subcontractor shall be responsible for the correct installation of all hardware and systems specified in this ICA Section. Certain primary elements, final control elements, etc., although provided as part of this Section, shall be installed in the process lines under other Sections of these Specifications; however, this installation shall be under the direct supervision of the ICA Subcontractor.
- 4 The ICA Subcontractor shall be responsible to see that all components of the instrumentation system, including primary measuring, indicating, transmitting, receiving, recording, totalising, controlling, and alarming devices and all appurtenances, are completely compatible and shall function as outlined and he shall furnish and install such additional equipment, accessories, etc. as are necessary to meet
- 5 An agreement between the contractor and the OEM shall be provided covers the entire period of the contract bearing the responsibility and review / approve the design document.

1.1.5 Pre-submittal Meeting

- 1 The Contractor shall arrange a meeting between the ICA Subcontractor and the Engineer within sixty (60) days after award of the Contract for a detailed discussion and verification of the ICA Subcontractor's system engineering methods and equipment and to generally provide a framework for communication and co-ordination. This meeting shall be attended by ICA Subcontractor, Contractor and the Engineer.

1.1.6 Submittals

- 1 Submittals and approvals schedule shall generally be as specified under Section 9, Part 1, Clause 1.1.4. All items proposed for this section shall be listed. Items shall be identified by tag number, description, function, manufacturer, model number, descriptive literature and statement as to whether items is "as specified or equivalent". Logic diagrams and flow charts illustrating the process control philosophy, shall be provided.
- 2 Shop Drawings. Before proceeding with any manufacturing, submit shop drawings for approval in complete bound sets indexed by specification number. Describe the items being submitted. Manufacturer's specification or data sheets shall be clearly marked to delineate the options or styles to be furnished. Submit only complete systems, not pieces of equipment from various systems.
 - (a) show dimensions, physical configurations, loop diagrams and cable termination schedules
 - (b) submit fabrication drawings, nameplate legends, and control panel internal wiring and piping schematic drawings clearly showing all equipment and tag numbers on all panels
 - (c) submit panel graphic drawings where applicable. Include material specifications lists where applicable. Include a draft of the theory of operation for all relay or PLC logic circuits and analogue control loops
 - (d) Process and Instrumentation Diagrams. Prepare and submit instrumentation loop diagrams for all work included in the ICA Sections in accordance with BS 1646.
 - (e) The preliminary Function design specification and the control philosophy.
 - (f) The I/O list as per the P&ID and the required interfaced signals.
 - (g) PLC shall be replaced by PLC/DCS
- 3 Within 90 days from the start of the Contract, submit an "Equipment Specification Data" form for each item of equipment which shall summarise the specification features as called for in these Specifications and include such other necessary data as would provide a complete and adequate specification for reordering an exact duplicate of the original item from the manufacturer at some future date. The assigned tag numbers and manufacturer's part numbers shall be included but will not be considered as a substitute for any of the required statement of specifications. More than one tag numbered item may be included on a sheet.
- 4 Operation and Maintenance Manuals and Instructions. Furnish instruction manuals and part lists for instrumentation equipment provided under the ICA sections. Obtain distribution method instructions from the Engineer.
 - (a) schedule. Deliver two (2) copies of manuals 60 days before commencing the Site Acceptance Tests. After installation is complete, update the manuals to reflect any changes which occurred during installation and deliver the remaining three copies of manuals to the Engineer immediately after the Site Acceptance Test. The manuals shall be in English.
 - (b) manuals shall be contract specific, and be fully indexed and sectioned, for allocation and distribution to the specialist staff involved on the particular plant and equipment
 - (c) where several sub-contractors and manufacturers have supplied equipment the Contractor shall, if required by the Engineer provide a complete integrated manual which clearly demonstrates the inter-relation of the equipment
 - (d) manuals shall be provided in durable hard cover backed A4 sized loose-leaf four ring binders. Lever arch binders are not acceptable. The full project title shall appear on the cover and spine

- (e) the manuals shall enable the client to safely operate and maintain all parts of the works
- (f) Original copies of leaflets and instructions provided by the specialist manufacturers shall be provided. Superfluous information shall be clearly deleted and relevant information referred to separately in the text
- (g) all instructions and manuals shall be written in accordance with BS 4884, IEC 278, and in accordance with other recognised guidelines on technical manual writing.
- (h) contents. include, in the manuals, not less than the following information, as applicable, for each instrument, equipment, subsystem and/or control loop:
- (i) general, introduction and overall description, purpose, functions, simplified theory of operations, etc
 - (ii) specifications (including equipment specification data sheet as described above under Shop Drawings)
 - (iii) installation procedures, commissioning and operational procedures and precautions
 - (iv) shut-down procedures
 - (v) suitability based on HAZAN/HAZOP/CHAZOP studies
 - (vi) maintenance, calibration, and trouble shooting instructions
 - (vii) schematics and wiring diagrams or flow charts
 - (viii) detailed circuit operational description including annotated programmable controller ladder diagrams or flow charts
 - (ix) parts list and spare parts recommendations as specified in Section 9.
 - (x) material, test and calibration certificates
 - (xi) copies of final approved equipment specification data forms.
- (i) format. Use drawings and pictorials to illustrate the text to the extent necessary to ensure a clear, concise presentation. If manuals have been written to cover a family of similar instruments or equipment, strike out inapplicable information in a neat fashion or emphasise applicable portion by heavily weighted arrows, circles or boxes; whichever provides the clearest and neatest presentation. Where identical instruments are used in more than one control loop or subsystem, include only one instruction manual, however, an index by tag number for all instruments shall identify its location in that manual
- (j) control loop and/or subsystem operational descriptions shall identify the function of each instrument and its relation to the other instruments in the loop
- 5 binding. Bind each manual in a cover which indicates the system name, manufacturer's name, local address and telephone number, and year of purchase. Punch and bind manuals in standard three ring binders and include system name and ICA Subcontractor's name on binding. Further to the above Clause 1.1.5.4, the Contractor shall ensure that the structure of the operation and maintenance manual meets the conditions specified in Section 1 Clause 7.12.2 or otherwise agreed with the Engineer.
- 6 Record Drawings:
- (a) The Contractor shall submit complete schematics, wiring diagrams and installation drawings to include all installed field and panel conduit and piping/tubing runs and routing, tray systems, supports, mounting details, point to point diagrams with a cable, wire, tube and termination numbers. One copy of applicable schematics and diagrams shall be placed in each control panel in a protective envelope or binder

- (b) the above are to be supplied to the satisfaction of the Engineer. The Contractor shall provide the Owner prints of each on thick paper and one ISO size A1 negative of each. All drawings shall be prepared on a CAD system and printed on ISO standard sized paper A3 unless specifically requested otherwise. One set of drawings shall also be submitted in Windows based AutoCAD System software version and storage media shall be as approved by the Engineer. Each drawing shall be marked with the Owner's, Consultant's, Contractor's and manufacturer's names and references, drawing number, title, scales, date of completion and a full description and date of all amendments, and shall be certified 'as-built'. The project title shall be included in a box at the bottom right hand corner of each drawing.
- 7 ICA Subcontractor's System Validation Report. The ICA Subcontractor, shall submit a report for each control system, panel and associated field instruments certifying that the equipment:
- (a) had been properly installed under his supervision
 - (b) is in accurate calibration
 - (c) was placed in operation in his presence
 - (d) has been checked, inspected, calibrated and adjusted as necessary
 - (e) has been operated under maximum power variation conditions and operated satisfactorily, and
 - (f) fully covered under the terms of the guarantee
- This report shall indicate calculated system tolerances, data verifying that the system meets these tolerances, and any provisional settings made to devices. Data sheets shall be similar to those used for Calibration.
- 8 Factory Acceptance Test (FAT) and Site Acceptance Test (SAT). Submit for approval at least 30 days prior to the test demonstration, a written plan for demonstrating that each system of equipment provided under the ICA Sections meets the specified operational requirements. The plan shall include procedures to be used in final operation testing of entire systems including a description for each system of test methods and materials, testing instruments and recorders, a list of the equipment involved with the functional parameters to be recorded on each item, and shop drawings of required temporary by-passes and like facilities.
- 9 Final Acceptance Report. Submit three copies of certified test results and records.

1.1.7 Quality Standards

- 1 Qualification and Manufacturers. The ICA Subcontractor shall be an approved systems integrator, a panel fabricator, and installer of field instruments. The ICA Subcontractor shall have a minimum of 5 years documented experience in providing ICA equipment on a single system responsibility basis, of which at least 3 years shall be for municipal water and wastewater pumping stations and sewage treatment works. The personnel employed for system engineering, supervision, start-up, operational testing and training shall be regular employees of the ICA Subcontractor. The ICA Subcontractor shall be fully responsible for the technical supervision of the installation to ensure that it is proper in all respects.

- 2 Certification by Single ICA Subcontractor. At the time of quoting to prospective contractors prior to tender opening, each prospective single ICA Subcontractor shall execute and submit a written certification of intent to assume full responsibility for the complete requirements of the ICA Section including deputation of qualified personnel for instructing operating personnel and preparing technical documentation. A certificate of compliance with the ICA specifications shall also be provided.
- 3 Standard of Quality. Furnish equipment of the types and sizes specified which has been demonstrated to operate successfully. Wherever, in the Project Specification and in these specifications, materials or equipment have been specified by using the name of products or manufacturers, the term "or equal and approved" is always understood to follow immediately. Material and equipment, so specified, has been selected as being most suitable and is regarded as a standard and is not intended to eliminate others of equal quality and performance. Workmanship for the installation of instruments, wiring, piping, painting and labelling shall be equal to the best industrial standards for instrumentation and control work.
- 4 All equipment shall be suitable for installation and continuous services in the climatic conditions prevailing in Qatar.
- 5 All electrical equipment and materials, including their installation, shall conform to the standards specified for each equipment, unless specified otherwise in this Section.
- 6 All equipment of a similar type shall be supplied from a single manufacturer to ensure common spares, operation and maintenance procedures.

1.1.8 Manufacturers Experience

- 1 The ICA manufacturers shall demonstrate a successful track record of having complete similar ICA installation works. The ICA Subcontractor shall provide a reference list from the instrumentation manufacturers for having installed and commissioned instruments operating under process and ambient conditions similar to the specified works.

1.1.9 Factory Inspection

- 1 Factory Inspection. The Engineer or his representative may inspect fabricated equipment at the factory. Notify the Engineer at least 30 days prior to shipment, so that factory inspection can be arranged. Factory inspection shall be made only after manufacturer has performed satisfactory checks, adjustments, tests and operations. Tests shall be made using simulated inputs and output loads. Approval of equipment at the factory only allows the manufacturer to ship the equipment to the site, and does not constitute final acceptance by the Engineer.
- 2 The Engineer reserves the right to inspect the ICA equipment at the factory. The Engineer will indicate on return of the approved submittal, each item requiring factory inspection.

1.1.10 Factory Tests and Test Certificates

- 1 Factory test carried out for primary elements shall include pressure and calibration tests. Certificates shall be provided for pressure test, calibration test and conformity to specifications. Material certificates shall be furnished if it is so specified.
- 2 Factory Acceptance Test (FAT) shall be carried out for the control and automation equipment such as control panels. FAT procedure shall be submitted to the Engineer for approval. FAT based on the approved test procedure shall be witnessed by the Engineer or his authorized representative at expense of the Contractor.

- 3 If after examining or testing any equipment the Engineer, or his representative, shall decide that such equipment or any part thereof is defective or, not in accordance with the specification, he may reject the said equipment or part thereof. He shall notify the Contractor in writing within 7 calendar days of the rejection, stating the grounds on which the rejection is based.

1.1.11 Shipment, Storage, and Handling

- 1 Box, crate, or otherwise enclose and protect instruments and equipment during shipment, handling, and storage. Keep all equipment dry and covered from exposure to weather, moisture, corrosive liquids, and gases or any element which could degrade the equipment. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Repair any damage or replace defective equipment, as directed and approved by the Engineer.

1.1.12 Guarantee

- 1 The Contractor shall provide a guarantee during the maintenance period for all the equipment in accordance with the General Conditions of the Contract.
- 2 Equipment warranty shall cover defects in materials or workmanship for two year from date of satisfactory completion of Site performance test and issue of Practical Completion Certificate.
- 3 Individual warranties by component manufacturer in lieu of single source responsibility shall not be acceptable.
- 4 Items which fail during the warranty period, excluding expendable items, shall be replaced without cost to the Owner. Job Conditions
- 5 Drawings are diagrammatic and show the intended arrangement for system operation, piping, and appurtenances. Conform to Drawings as closely as possible and exercise care to secure neat arrangement of piping, valves, conduit, and like items, and to overcome structural interferences. Verify dimensions and conditions at the place of work, and install materials and equipment in the available spaces.

1.1.13 Approved Manufacturers

- 1 The ICA equipment shall be provided by approved, prequalified system manufacturers and suppliers designated in the Project Specification.

1.1.14 Approved Installation Subcontractors

- 1 Installation Subcontractor shall be approved, prequalified and designated in the Project Specification.

1.1.15 Spare Parts and Tools

- 1 Furnish the following items as specified herein. Provide the Engineer, with an itemised list in a letter of transmittal accompanying each shipment.
- 2 Special Tools and Accessories. Furnish special tools, instruments, and accessories for maintaining instruments and equipment requiring periodic repair and adjustment as specified elsewhere in this Section. Also, furnish special lifting and handling devices for equipment requiring such devices.
- 3 Maintenance Materials and Spare Parts. Deliver in manufacturer's original containers labelled to completely describe contents and equipment for which it is furnished.
- 4 Spare parts shall be sufficient for 2 years of normal service from completion of the maintenance period, and shall include, as a minimum, the following basic items:

- (a) five (5) percent but not less than one (1) minimum of each type of plug-in unit, etched or printed circuit board assembly
- (b) ten (10) percent but not less than one (1) of each type relay and timer used
- (c) ten (10) percent but not less than one (1) of each type switch used
- (d) twenty (20) percent but not less than ten (10) of each type light bulb and fuse used
- (e) 2 years supply of expendable items, diskettes, toner cartridges etc.

1.1.16 Software

- 1 The ICA Subcontractor shall be responsible for obtaining all software user licences for development and runtime systems as necessary. Application software written specifically for the Owner under this contract shall remain the property of the Owner and shall not be disclosed, copied or distributed at any time to a third party without the Owners explicit written consent.

1.2 PRODUCTS

1.2.1 Materials

- 1 The ICA Subcontractor shall provide instruments, equipment and materials suitable for service conditions and meeting the appropriate British Standards. The intent of this Specification is to secure instruments and equipment of a uniform quality and manufacture throughout the plant; i.e., all instruments in the site, i.e., all instruments supplied by the ICA Subcontractor, of the same type shall be by the same manufacturer. This allows the stocking of the minimum number of spare parts.

1.2.2 Structural Steel Fabrications

- 1 The ICA Subcontractor shall design all fabrications for dynamic and vibratory loading. Use structural steel shapes conforming to ASTM A36, A500, A501, A570, A618, or equal and approved, as applicable. Conform welding to AWS D2.0 Code. Galvanize specific items in accordance with ASTM A123 or A386 as applicable; use galvanized bolts and fasteners with galvanized assemblies. Use minimum 6 mm thickness for steel entirely or partially submerged during equipment operation. Submit design calculations showing adequate structural integrity for the intended purpose.

1.2.3 Mountings

- 1 The ICA Subcontractor shall mount and install equipment as indicated in the Project Specification. Where not shown, mount site instruments according to best standard practice on pipe mounts, pedestal mounts, or other similar means in accordance with suppliers recommendation. Where mounted in control panels, mount according to requirements of Part 4 of this Section.
- 2 Equipment specified for Site mounting shall be suitable for direct pipe mounting, pedestal mounting, or surface mounting and non in-line indicators and equipment with calibration adjustments or requiring periodic inspection shall be mounted not lower than 900 mm nor higher than 1500 mm above walkways, platforms, catwalks, etc. so as to provide easy access. All such equipment shall be weather and splash proof, and electrical equipment shall be in IP 66 enclosures. External equipment shall be protected from direct sunlight by a well ventilated cabinet, canopy or other type of sunshade. If mounted in a designated hazardous area, the equipment shall be explosion proof or rated intrinsically safe, whether so specified herein or not.
- 3 The equipment shall be guaranteed suitable for operation under the climatic conditions specified in under Clause 1.2.6 of this Part and shall be designed:-

- (a) such that routine and occasional maintenance throughout its life shall be a practical minimum compatible with the preservation of maximum reliability
- (b) to withstand the electrical, mechanical, thermal and atmospheric stresses to which it may be subjected under operational conditions, without deterioration or failure
- (c) constructed to the highest available standards of manufacture, reliability, accuracy and repeatability
- (d) the degree of protection for equipment enclosures shall be in accordance with EN 60529

4 Provide protection from direct sun light for all ICA equipment installed outdoors.

1.2.4 Instrument Identification

1 All instrumentation and equipment items or systems specified in the Project Specification shall be identified by system and tag numbers. This same number shall appear in the tag number designations on the Drawings and on the schedules of the Project Specification. Nameplates for panels and panel mounted equipment shall be as specified in the Project Specification. Field equipment shall be tagged with assigned instrumentation tag number and function. Tags shall be black lamacoid with engraved white characters of 5 mm minimum height. Tags shall be attached to equipment with a commercial tag holder using a stainless steel band with a worm screw clamping device or by a holder fabricated with standard hose clamps and meeting the same description. In some cases where this would be impractical, use 0.5 mm² stainless steel wires. For field panels or large equipment cases use stainless steel screws, however, such permanent attachment shall not be on an ordinarily replaceable part. In all cases the tag shall be plainly visible to a standing observer. In addition to tags, field mounted control stations, recorders or indicators shall have a nameplate indicating their function and the variable controlled or displayed. Nameplate shall be attached by one of the above methods.

1.2.5 Electronic Equipment

1 If the equipment is electronic in nature, provide solid state equipment to the extent practicable. Select components of construction for their suitability and reliability. Employ adequate component derating to preclude failures because of transients and momentary overloads reasonably expected in normal operation. Provide units for operation without forced cooling, unless such cooling is an integral part of the device. Provide protection on all relevant circuits and equipment against the effects of lightning and other induced voltages.

1.2.6 Equipment Operating Conditions

1 All equipment shall be rated for normal operating performance with varying operating conditions over the following minimum ranges.

2 Power:

- (a) electrical. 240 V a.c. \pm 6 %, 50 Hz \pm 1 Hz except where specifically stated otherwise on the drawings or in the specifications
- (b) air. 1.4 bars.

3 Field Instruments:

- (a) all the ICA equipment supplied shall be suitable for operation in the tropical climate prevalent in Qatar. All ICA equipment shall be designed and constructed to operate satisfactorily and without any deleterious effect for prolonged and continuous periods at the following maximum ambient temperature conditions:

- (i) indoors in normally air-conditioned environment - 50 oC

(ii)	indoors in a ventilated environment	-	55 oC
(iii)	outdoors under direct sunlight	-	85 oC

1.2.7 Power Supplies

- 1 The ICA Subcontractor shall provide electrical instruments, transmitter power supplies and control devices for operation on 240 V a.c., 50 Hz. Transmitter power supplies shall be provided for individual transmitters. Where designated in the Project Specification, process critical instruments shall receive power from a UPS, as specified in Section 21.

1.2.8 Signal Isolators, Converters and Conditioners

- 1 The ICA Subcontractor shall ensure that input-output signals of all instruments and control devices (whether supplied by the ICA Subcontractor or not) are compatible. Unless otherwise specified in the Project Specification, signals between field and panels shall be volt free contacts or 4 to 20 mAdc, unless specifically approved otherwise. Granting such approval does not relieve the ICA Subcontractor from the compatibility requirement above. Provide signal isolators and converters as necessary to obtain the required system performance. Mount the devices behind control panels or in the Site at the point of application.

1.2.9 Auxiliary Contacts by Others

- 1 The ICA Subcontractor shall provide instruments and equipment to interface with auxiliary contacts provided under other Contracts, for alarms, status of equipment, interlocking, and other functions as indicated and as specified in Project Specification.

1.2.10 Air Supply Valves

- 1 The ICA Subcontractor shall provide 316S12 valves for instrument air supply shutoff, regulating, switching, metering, valve manifolds, etc. Provide a separate isolation valve for each instrument or actuator feed line.

1.2.11 Instrument Piping

- 1 The ICA Subcontractor shall provide instrument air header and instrument pneumatic piping, as specified in the Project Specifications and as necessary and/or as specified herein. Connect to main instrument air header at a point not more than 3 m distant from air consuming device(s). Use 10 mm minimum 316S12 tubing. All connections to equipment shall be made with separable or union type fittings and shall include shut-off valves. All hydraulic and/or pneumatic piping shall be tested for leaks prior to placing the system in operation. All instrument pneumatic air fittings, shall be double compression type.

1.2.12 Filter Regulator

- 1 The ICA Subcontractor shall provide a filter-regulator and discharge pressure gauge with a dripwell assembly for each point of use where regulated instrument air is required. Separate regulators shall be used for each control loop.

1.2.13 Manifolds

- 1 The ICA Subcontractor shall furnish an integral three-valve manifold for each differential pressure transmitter on a flow application.

1.2.14 Painting and Protective Coatings

- 1 The ICA Subcontractor shall provide factory paint for all instruments and equipment except where in pipelines. Provide paint as required for structural supports, brackets, etc. Painting and protective coatings shall generally comply with the requirements specified in Part 8 of Section 8.

1.2.15 Electrical

- 1 The ICA Subcontractor shall provide all the power supply wiring, instrumentation wiring, interconnecting wiring and equipment grounding as indicated, specified and required.
- 2 Wiring installations shall include cables, conductors, terminals connectors, wire markers, conduits, conduit fittings, supports, hardware and all other required materials not specifically included in the work of other Sections.
- 3 Provide the materials and complete all the required installations for equipment grounding as specified in Section 21 of these Specifications indicated on the Electrical Drawings or necessary to complete the Work.
- 4 Incidental items, not specifically included in the Contract Documents, that can legitimately and reasonably be inferred to belong to the instrumentation work shall be provided by the ICA Subcontractor.
- 5 Field Wiring. Ring out signal wiring prior to termination. Provide wire number tags marked in indelible waterproof form of slip-on type or equal for each termination. Provide preinsulated crimp-on connectors for wire terminations and splices. Use ratchet type crimping tool which does not release until proper crimp pressure has been applied.

1.2.16 Process Connections

- 1 Piping, tubing, and capillary tubing shall be of stainless steel. If this material is unsuitable for ambient or process conditions, piping and tubing shall be of a material approved by the Engineer. Slope lines according to service to promote self draining or venting back to the process. Terminate connection to process lines or vessels in a service rated block valve, that will permit closing off the sense line or removal of the element without requiring shut down of the process. Include drip legs and blow-down valves for terminations of sense lines at the instruments when mounted such that condensation can accumulate. Process vessels, line penetrations, connecting fittings, and block valves shall be furnished and installed under other Sections of these Specifications but coordinated by the ICA Parts. Instrument process taps shall be a minimum 18 mm BSP except flowmeter taps which shall be 12 mm BSP.

1.3 INSTALLATION

1.3.1 Inspection

- 1 Inspect each instrument and piece of equipment for damage, defects, completeness, and correct operation before installing. Inspect previously installed related work and verify that it is ready for installation of instruments and equipment.

1.3.2 Preparation of Installation Areas

- 1 Ensure that installation areas are clean and that concrete or masonry operations are completed prior to installing instruments and equipment. Maintain the areas in a clean condition during installation operations.

1.3.3 Installation and Supervision

- 1 Provide the services of suitably trained and experienced personnel in the installation of the equipment to:
 - (a) complete the installation in accordance with the manufacturers instruction manual
 - (b) inspect, check, adjust as necessary, and prepare the equipment for system validation
 - (c) calibrate the instruments, in accordance with the specifications herein, until all trouble or defects are corrected and the installation and operation are acceptable.

1.3.4 Instrument Calibration

- 1 Calibration points shall be at least 5 points for any mechanical part transducer such as PT.
- 2 The Contractor shall provide the services of trained and experienced instrumentation technicians, tools and equipment to site calibrate each instrument to its specified accuracy in accordance with the manufacturer's specifications and instructions for calibration.
- 3 Each instrument shall be calibrated at 10 percent, 50 percent and 90 percent of span using test instruments to simulate inputs and read outputs that are rated to an accuracy of at least 5 times greater than the specified accuracy of the instrument being calibrated.
- 4 Test instruments shall hold a valid calibration certificate from a NAMAS accredited calibration centre or alternative, subject to the approval of the Engineer
- 5 Provide a list and basic specifications for instruments used. Certify to the Engineer that each instrument has been calibrated to its published specified accuracy. The calibration certificate shall include all applicable data as listed below plus any defects noted, correction action required, and correction made. Data shall be recorded on separate proformas attached to the certificate and shall include not less than the following items:
 - (a) facility identification (name, location, etc.)
 - (b) loop identification (name or function)
 - (c) equipment tag and serial numbers
 - (d) scale ranges and units
 - (e) test mode or type of test
 - (f) input values or settings
 - (g) expected outputs and tolerances
 - (h) actual readings
 - (i) explanations or special notes as applicable
 - (j) tester's certification with name and signature.

1.3.5 System Validation

- 1 Provide the services of trained and field experienced instrumentation engineer(s) to validate each system to verify that each system is operational and performing its intended function within system tolerance. System tolerance is defined as the root-mean-square sum of the system component published specified accuracies from input to output.
- 2 Validate each system by simulating inputs at the first element in loop (i.e. sensor) of 10 percent, 50 percent and 90 percent of span, or on/off and verifying loop output devices (i.e. recorder, indicator, alarm, etc. except controllers). During system validation, make provisional settings on levels, alarms, etc. Verify controllers by observing that the final control element moves in the proper direction to correct the process variable as compared to the set point. Verify that all logic sequences operate in accordance with the specifications.
- 3 Cause malfunctions to sound alarms or switch to standby to check system operation. Check all systems thoroughly for correct operation. Test equipment shall comply with Clause 1.3.4.
- 4 Immediately correct all defects and malfunctions' disclosed by tests. Use new parts and materials as required and retest.
- 5 System validation report. Provide a report certifying completion of validation of each instrument system.

1.3.6 Commissioning

- 1 Upon completion of instrument calibration and system validation, test all systems under process conditions. The intent of this test is to demonstrate and verify the operational interrelationship of the instrumentation systems. This testing shall include, but not be limited to, all specified operational modes, taking process variables to their limits (simulated or process) to verify all alarms, failure interlocks, and operational interlocks between systems and/or mechanical equipment.

1.3.7 Final Acceptance

- 1 Final acceptance report. Immediately correct defects and malfunctions with approved methods and materials in each case and repeat the testing. Upon completion of final operational testing, submit certified report, with substantiating data sheets, indicating that total ICA System meets all the functional requirements specified herein. The Engineer will countersign this report and it shall constitute final acceptance of the ICA System.
- 2 Final Operational Testing shall be witnessed and approved by the Engineer. Notify the Engineer in writing a minimum of 48 h prior to the proposed date for commencing the test. Upon completion of this test the Contractor shall begin or have begun system start-up. The Owner reserves the right to set the schedule.

1.3.8 Commissioning Assistance

- 1 When specified elsewhere in this section or designed in the Project Specification, provide the services of a factory trained and field experienced instrumentation engineer to assist the Owner's personnel during commissioning of the system. Purpose of this assistance is to support in making final adjustments of settings on the instrument systems.

1.3.9 Instruction and Training of The Owner's Personnel

- 1 After the ICA equipment has been calibrated, installed, tested and placed in satisfactory operation the Contractor shall provide the services of qualified staff approved by the Engineer, or if specified in the Project Specification, of the manufacturer's representatives, to instruct and train the Owner's personnel in the use and maintenance of the ICA equipment. An instruction and training programme shall be conducted for up to six personnel designated by the Owner. The Contractor shall give the Owner at least one month's written notice of the proposed instruction and training programme. Instruction and training covering basic system operation theory, routine maintenance and repair, and "hands on" operation of the ICA equipment shall be included. Each trainee shall be provided with a training manual covering operation and maintenance of the ICA equipment. The duration of the programme shall be based on the complexity of equipment involved, and the Engineer's approval of instruction adequacy obtained before terminating the programme. Instruction and training periods shall be acceptable to the Engineer.

1.3.10 Specialised Training Programme for Owner's Personnel

- 1 Where designated in the Project Specification the Contractor shall provide a specialised training programme and manual for the Owner's key personnel in the equipment, electrical systems and instrumentation systems, to be conducted by the supplier/manufacturer and held at locations outside Qatar. The training programme and manual shall be submitted to the Owner for approval and shall be designed to:
 - (a) provide in depth information and familiarisation of the equipment installed in the Project
 - (b) receive specialised training in the design, proper operation, maintenance and replacement of the equipment and components

- 2 The Contractor shall provide whatever assistance is requested by the Owner to develop meaningful itineraries for the training programme. The Contractor shall provide hotel accommodation, travelling expenses by air, land transport and per diem allowance as per the Ministry of Education guidelines.

END OF PART

ARAB ENGINEERING BUREAU