

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

INSTRUMENT SIGNAL LINES

PTS 32.37.20.10
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This revision of PTS **32.37.20.10 - Instrument Signal Lines** has been updated incorporating PETRONAS Lessons Learnt, Best Practice and new information issued by relevant industry code and standards. All updates in the document are highlighted in *italic* font.

The previous version of this PTS will be removed from PTS binder/ e-repository from herein onwards.

Document Approval

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Revision History

Date	Version	Description of Updates	Author

Summary of Changes

Section	Description of Changes
Standards	"MESG" standards remove and replaced with other International Standards and/or PTS standard whichever deemed relevant
2.1	Additional clause added as follows: <i>"The selection of instrument signal cables shall be governed by the specific electrical application and by the areas through which the cable is to run.</i> <i>The physical construction of the cable shall be dependent upon the electrical application, the intended service and the type of signals.</i> <i>The locality in which the cable is installed determines whether armouring is necessary and what resistance to environmental elements is required.</i> <i>Locality can also dictate the fire performance of materials used for insulation and sheathing since the acceptability of smoke and toxic gas emission during fire depends on ventilation and accessibility of areas concerned and on the normal manning levels in these areas.</i> <i>However, it is important to note that in all locations, resistance to fire propagation by cable material is of paramount importance. Hence, the minimum requirement for all cables for normal service shall be of reduced flame propagation type conforming to IEC-332 part 3 cat. A.</i> <i>Cables for vital services (where service must be maintained during or after exposure to fire condition) shall be of fire-resistant type conforming to IEC-331."</i>
2.2 - Fundamental Requirements	New clauses and written as follows: <i>"All cables used shall be minimum flame retardant. Fire resistant cables shall be used whenever required.</i> <i>All cable insulation, filler and sheathing material must add a minimum of fuel to any fire.</i> <i>Mud resistant cables shall be used where cables are routed into or through areas exposed to mud/oil.</i> <i>Material used in cables for manned or confined areas e.g. accommodation should produce minimum levels of smoke and acid gas under fire conditions.</i> <i>Installation of cables in hazardous areas must conform to BS 5345 and BS 5501.</i> <i>All field cables shall be armoured. Braided armour is preferred to single wire armour where there is an option since it is lighter, more flexible and easier to install. However for trench and underground cables, single wire armour shall be used. (Note: Braided and single wire armoured cables require different types of cable glands)</i> <i>The capacitance, inductance and L/R ratio must not exceed certain values for intrinsically safe circuits depending on the hazardous area classification and equipment parameters. Reference should be made to the equipment hazardous area certification.</i> <i>Cables for switched signals (e.g. alarm and indication) should be twisted multi-core type whereas cable for analogue signals should be twisted multi-pair with overall screen and drain wire.</i>

Section	Description of Changes
	<i>Multicore cables with collective screen shall be standard, individual screens shall be used only when required.</i> <i>Cable without armour may be used in indoor installation</i> 2.2.1 Cable Specifications - Normal Service <i>Selection of electrical signal cables for control and monitoring shall take account of service, environment and circuit conditions.</i> <i>Mineral Insulated (MI) cables shall only be used on those applications where cables are permanently exposed to intense heat e.g. flare tip thermocouples (Exception to PTS 33.64.10.10 Electrical Engineering Guidelines).</i> <i>In all locations, resistance to fire propagation by cable material is of paramount importance. Hence the minimum requirement for all cables for normal service shall be of reduced flame propagation-type conforming to IEC-332 part 3 cat. A.</i> 2.2.2 Cable Specifications - Emergency Service <i>On all applications where an instrument connection or signal must be maintained for a limited period during or after exposure to a condition, the design shall specify fire-resistant cables (other than MI cables) which conform to IEC 331."</i>
2.3	Additional clause as follows: <i>"The following systems shall have separate multicore cables:</i> - <i>General instrumentation.</i> - <i>Fire and Gas.</i> - <i>ESD.</i> - <i>Telecommunication.</i> - <i>DCS.</i> - <i>Foundation Fieldbus.</i> - <i>General Electrical (control)</i> - <i>Powered Outputs"</i>
Table 1, 2, 3, 4, 5, 6, 7	New table - Incorporate and revised from 20.078.
3.1	Added new clause as follows <i>"Multi-core cables between junction boxes and control rooms shall be laid without splices.</i> <i>Cables entering junction boxes, consoles, cross panels or the like, shall be fastened by means of a cable gland, suitably sized and classified for the area of operation.</i> <i>The design shall incorporate right of way and cable channeling for instrument and electrical signal cables. Instrument signal cables, shall be separated at a distance of at least 0.3 m from electric power cables when laid underground in cable trenches, or be on separate channels with metal separation when laid above ground.</i>

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	<i>Routing of cables shall take account of any risk of damage or deterioration due to high temperature lines, corrosive fluids, hydrocarbons or radiation (including UV radiation from direct sunlight).</i> <i>In any process-connected instrument where rupture of the sensing element may subject the instrument case to process pressure and where the cable used has interstices which would permit the migration of gas or liquid to a control room, a "Barrier Type" gland with sealing compound shall be specified.</i> <i>All cables for intrinsically-safe circuits must consist of groups of conductors twisted for each independent circuit with screen and drain wires over the cable as a whole. The capacitance, inductance and L/R ratio must not exceed values for intrinsically-safe circuits, depending on the hazardous area classification and equipment parameters. Reference should be made to the equipment hazardous area certification."</i>
3.2	Added new clause as follows: <i>"The preferred method of cable protection is single-wire armouring for onshore and braided for offshore, in accordance with the relevant. Conduit will not normally be approved, except for use inside buildings in non-hazardous areas. All conduits shall be rigid steel, heavy wall, minimum 20 mm diameter, electro - galvanised, and shall be supported with appropriate straps, saddles or hangers. See BS 31, BS 4568 and BS 4607 for conduit requirements. Unarmoured single-pair thermocouple cable shall be protected by U-channel conduits or 1/2" galvanised pipe.</i> <i>Where cables require support or protection from mechanical damage, they shall be run on purpose-made proprietary ladder-rack, U-channel or cable tray, ladder-rack being specified for widths of 300 mm or greater.</i> <i>All components and accessories used with such proprietary systems should be of 316L SS materials.</i> <i>The appropriate proprietary fittings shall be specified for branch connections from tray or channel to individual field instruments.</i> <i>Cable support systems shall not be attached to process lines.</i> <i>Design of the cable support system shall specify minimum clearance from any lines or equipment where close proximity due to heat, chemicals or vibration may adversely affect the cables.</i> <i>Supports for cable trays or cable ladders shall be suitable painted as per PTS 30.48.00.31 and firmly fastened or welded.</i> <i>For underground or trench cables where there is extensive oil contamination in the soil or sand, only then lead sheathed cables shall be used.</i> <i>Horizontal cable trays shall be situated above air supply lines. Vertical cable trays shall be situated behind or by the side of air supply lines unless space is limited by major equipment layout or piping arrangements.</i> <i>Cable trays shall be mounted in such a way as to allow access for maintenance or removal of equipment without undue disturbance to the installation.</i>

Section	Description of Changes
	<i>Cable trays and conduits shall be designed to be supported by steel structures or have their own supports at every 2 meters lengths. Pipes for other services e.g. gas, steam, water etc. shall not be used to support cable trays.</i> <i>When a cable tray is designed for branching out, a flanged section shall be provided on the cable tray leading to at each instrument. The tray shall be extended to the furthest instruments.</i> <i>For cables lying in the cable channel, tray or underground trench, a marking strip (with tag no.) of nylon-covered stainless steel or lead shall be fitted around the cable at every 5 meters length, at both the starting and terminating points of the cable and at where the cable is fed into the control room or auxiliary room. All marking strips for cables in cable channels shall be fastened by stainless steel cable ties.</i> <i>Cables entering junction boxes, consoles, cross panels or the like shall be designed to be fastened by means of a cable clamp,</i> <i>Instrument signal cables shall be designed to be situated at least 300 mm from electric power cables shall be entirely clear of hot process lines.</i> <i>Separate trays shall be used for I.S. and non I.S. cables as far as possible as per BS 5345. Whenever this is a constraint, a barrier shall be provided for cable segregation.</i> <i>Cable trays, conduits and cable ladders shall be galvanized iron or stainless steel.</i>
3.3	Added clause as follows: <i>"The Cable Network shall be separated into:</i> <i>System 1: High voltage systems (above 1000V).</i> <i>System 2: Low voltage power supply and control cables for electrical systems (1000V and below)</i> <i>System 3: Instrumentation and Telecommunication systems.</i> <i>Where the cable support systems are installed horizontally one above the other, the cable network shall be arranged from top to bottom, system 1, system 2 and system 3.</i> <i>Cable ladders installed horizontally shall have sufficient space to facilitate cable pulling and cleating/strapping.</i> <i>Instrument and telecommunication cables shall be separated from low voltage power cables and high voltage cables by minimum 300 mm.</i> <i>Instrumentation and telecommunication cables may be routed on system 2 cable support systems when the defined distance between the individual systems can be kept.</i> <i>When separation of the cable systems specified above is not possible or practical, a metal segregation barrier shall be installed to avoid induced disturbances on the instrument/telecommunication cables.</i> <i>However, crossing at right angles is acceptable without further segregation.</i>

Section	Description of Changes
	<i>Non IS, IS instrument cables and Foundation Fieldbus can be routed on the same cable ladders/trays provided segregation/separation is done."</i>
3.4	Added new clause as follows: <i>"All above ground cables shall be routed on cable ladders and trays.</i> <i>Underground cables shall be routed through dedicated cable trenches.</i> <i>Trunking or conduits may be used for special mechanical protection of single field routed cables for shorter distances (approximately 5 m). Where conduits are used, they shall be installed with open ends.</i> <i>A computer based cable routing system reflecting the layout of the main cable support system (i.e. cable ladders with width 300 mm and above) represented by ladder segment references, transit numbers, etc. and necessary describing information related to the individual cable including its route, shall be used in the design.</i> <i>Field cables may utilise the main cable support system provided the route of the individual cable is being registered in the routing system and the filing and loading of the main cable support system is acceptable.</i> <i>The cable ladders shall not be filled so the height of the cable ladder side rail is exceeded.</i> <i>Redundant cable systems shall be routed separately.</i> 3.4.1 Cable Bending Radius <i>The minimum permissible bending radius specified by Supplier shall be adhered to.</i> 3.4.2 Cable Strapping <i>PVC coated stainless steel AISI 316L straps shall be used for vertical runs and for horizontal runs in the vertical plane.</i> <i>For strapping of fibre-optical and coaxial cables, Supplier guidelines shall be adhered to.</i> <i>The distance between cable straps shall not exceed the distance between the horizontal and vertical runs on the cable tray. Therefore each cable shall be strapped on each horizontal and vertical run on the cable tray.</i> 3.4.3 Cable Splicing <i>Cable splicing is not allowed. In the event of damage, temporary cable splicing is allowed (non standard repair) provided the necessary risk assessment has been carried out. Temporary cable splicing shall have a time limit before permanent cable repair takes place.</i> <i>Temporary cable splicing shall be reported to Plant Management and tracking for permanent repair shall be in place."</i>

Section	Description of Changes
3.5	Added new clause as follows: <i>"All junction boxes shall be ingress-protected to IP-65(IEC-529/BS 5490) as a minimum. The dimensions of the boxes should be as close as possible to PETRONAS standard drawing S37.603.</i> <i>Junction boxes for terminating fire-resistant cables (IEC 331) shall be of 316 SS material and also suitably certified for use in the classified area.</i> <i>Separate multi-element cables as well as separate junction boxes, shall be provided for I.S. and non I.S. signals.</i> <i>Signal segregation shall be observed for digital and analogue transmissions with due regard being given to the above mentioned I.S. and non I.S. circuitry segregation.</i> <i>All junction boxes shall be complete with sufficient number of insulated earthing rails to terminate all cable armour (SWA or SWB).</i> <i>All junction boxes shall be sized to terminate all cores of cables and screens with a minimum of 20% spare terminals and cable entries. Spare cable entries shall be plugged with certified plugs.</i> <i>All spare cores shall be terminated at both ends."</i>
3.6	Added clause as follows: 3.6.1 Cable Glands and Multi Cable Transits (MCT) <i>Cables shall be terminated into enclosures using mechanical type compression glands</i> <i>Glands shall be suitable for the reception of all strands of the wire armouring which shall be securely clamped in a permanent manner. Glands shall be provided with clamping rings for cables with wire braids</i> <i>When MCT are used on panels, cables have to be earthed with the braided earth wire under the armour to the earthing bar.</i> <i>MCT shall be installed such that the integrity of the bulkhead or wall is maintained. Contractor shall locate and install MCT. MCT shall be provided with 20% spare entries.</i> <i>When preparing cables prior to fitting glands, the gland manufacturer's instructions shall be followed. In all cases, care shall be taken to ensure that the lay of the armour is maintained after the gland is completely fitted.</i> <i>All spare multicore cable ends which are not terminated, immediately after cutting, shall be sealed effectively to prevent ingress of moisture and shall be protected from damage until termination is complete.</i> <i>Spare and unused glands or MCT frame openings shall be properly blinded (certified plug where applicable) or sealed.</i> 3.6.2 Cable Glands Selection <i>Cable glands/blanking and drain plugs shall be selected as follows:</i> • <i>Metal enclosures (except aluminium) - stainless steel (AISI 316L)</i> • <i>Aluminium enclosures - stainless steel/nickel plated brass</i>

Section	Description of Changes
	<i>The certification of the cable glands, blanking and drain plugs shall comply with the certification of the equipment in which the glands/plugs are connected.</i> <i>Ex d gland shall have clamping of braid armour and sealing of inner and outer sheath. Only to be used on Ex d direct entry equipment.</i> <i>Dual certified glands, Ex d and Ex e (flameproof and increased safety) to be used and installed according to Supplier specifications.</i>
3.7	New clause 3.7 CABLE TERMINATIONS <i>All cable conductors shall be terminated by use of compression lugs or ferrules dependent upon the type of termination. The compression ferrule shall be the type where the conductor strands are inserted through the whole ferrule and reach the bottom of the terminal.</i> <i>Support for cleating of cables when entering panels shall be provided.</i> <i>All cables shall enter field junction boxes via suitably sized and certified cable glands Cable entries shall be from bottom and side of the box only.</i> <i>Terminations in field junction boxes shall NOT be of quick disconnect (e.g. knife-edge) type.</i> <i>Terminals shall be industry proven. The number of terminals in a junction box shall be sufficient to terminate all wires of the cables and screens including a minimum of 20% spare terminals. Signal wires shall be terminated with crimped insulated bootlace ferrules and identified by using colour-coded core markers.</i> <i>Terminal blocks shall be non-hygroscopic vibration-proof and shall use captive screws for terminals. Hinged knife-blade switches/terminals may be used in control room or FAR for isolation and testing purposes.</i> <i>Consideration should be given to the use of ceramic high temperature terminals for the terminations of fire-resistant cables.</i> <i>Where the screens shall be left disconnected (applicable for field instruments), it shall be sealed and isolated with an isolating cap which allows for insulation testing without any disconnecting.</i> <i>Only one conductor is allowed in each terminal of a terminal block/row for external connections. This is not related to terminals as an integrated part of internal components (e.g. relays, contactors) of the equipment.</i>
3.11	Added following Para: "3.11.1 MARSHALLING CABINETS <i>Marshalling cabinets in the control room and equipment room (non-hazardous area) for signal distribution should be fitted with quick disconnecting type terminals and ELCO interconnecting boards for interconnection to system cabinets via system cables.</i>

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	<i>However, special care and attention must be given to the requirements of signal separation of I.S. and non-I.S. type of signal in the selection and application of ELCO interconnecting boards. ELCO interconnecting boards shall not be required for applications where system cables are not used.</i> <i>Cable glands are, however, not required for cables or wires usually of small diameter, entering via rubber grommets in the enclosures of equipment installed in the control rooms and cables entering in the bottom of system cabinets or marshalling cabinets via false floors in the control room. In cases like this, it would be appropriate to install arrangements for cable clamping of the bottom of cabinets to avoid possible strain on terminations.</i> <i>The cabinet shall be executed as a complete enclosure and shall be provided with internal iron angle or channel frame work of sufficient strength to support the internal system.</i> <i>The cabinet shall be constructed as follows:</i> 3.11.1.1 Outdoor installation <i>The panels shall be made of 316L stainless steel plate, thickness minimum 3 mm.</i> <i>The carbon steel framing, supports and other construction parts shall be anti-corrosion treated and painted in accordance with Buyer's Painting and Coating Specification</i> <i>The enclosure classification shall be minimum IP-65. Generally, all material shall be selected suitable for the environment conditions as described in section 4 of this specification</i> 3.11.1.2 Indoor installation: <i>The panels shall be made of mild steel plate, thickness minimum 3 mm for the front plate to receive panel mounted instruments. The panels shall be reinforced against buckling.</i> <i>The enclosure classification shall be IP-44 as a minimum.</i> <i>The cabinet(s) shall be provided with front and/or back access door(s) mounted on hinges. The door(s) shall have "T" type door handles without locks.</i> <i>The cabinet(s) shall be furnished with proper mounting assembly suitable for mounting in the specified area/location. A plinth, minimum 100 mm, shall be provided for free-standing type cabinet(s). For wall mounting type, the cabinet(s) shall be provided with the suitable mounting brackets assembly.</i> <i>The cabinet(s) shall also be provided with lifting eyes on the top of the cabinet for lifting purposes.</i> <i>Cable entries, such as MCT's (multi cable transit), Ex'd' cable glands and bulkhead connectors, etc. for interface with other systems, shall also be part of this system cabinet.</i>

Section	Description of Changes
	<i>Buyer will advise the size and numbers of the entries which have interfaces with Buyer's systems.</i> <i>Before shipment all cable entries shall be covered, providing IP-44 degree of protection.</i> 3.11.1.3 Power Supply <i>For electrical services, the cabinet shall be provided with terminals to receive the required power supplies. This power distribution system shall be furnished with a lockable main switch. If required, sub-distribution by means of circuit breakers shall be incorporated.</i> <i>The cabinet shall also be provided with a service lighting fixture and socket outlet connected to 110 VAC power supply. Furthermore a drawing pocket shall be installed. Details of the power consumption of the cabinet shall be provided to enable Buyer to calculate the required size of the power supply cables and fuses.</i> 3.11.1.4 Cooling <i>Cooling shall be adequate for the installed environment. It is Supplier's responsibility to provide heat dissipation calculations showing that the temperature inside the cabinet does not exceed 40°C under the maximum load conditions at maximum ambient temperature. When applicable, Supplier shall supply a forced redundant cooling ventilation fan system to be installed in the system.</i> <i>Any cooling fan installed in the cabinet shall be maintainable and replaceable online. Critical cabinets shall be provided with fan failure alarm.</i> 3.11.1.5 Sparage <i>Wire and cable trunking and/or supporting shall have a minimum of 20% spare capacity on completion, including known future installations</i> 3.11.1.6 Painting and Nameplates <i>The cabinet shall have standard finish and painted 'grey' (RAL 3032).</i> <i>Painting shall be in accordance with Manufacturer's Standard.</i> <i>Stainless steel cabinet for outdoor use shall be painted in compliance with Buyer's Painting and Coating specification</i> <i>Supplier shall furnish one white nameplate, fixed to the cabinet, in black letters, stating the tag number of the cabinet, description, manufacturer, year, power supply, order number, name Supplier.</i> <i>Instrument nameplates shall be made of corrosion resistant weatherproof material with black letters with a minimum height of 5 mm on a white background. Inscription shall be in the English language.</i>

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	<i>Permanent nameplates shall also be provided identifying each instrument, instrument switch, meter, relays, control switch, indication lights, etc. in accordance with IEC regulations.</i> 3.11.1.7 Wiring and Terminations <i>Input/output terminals shall be of proven industrial made and shall be fitted to terminal rails located on a mounting plate in the cabinet. I.S. terminals shall be colored blue.</i> <i>There shall be a physical segregation between the I.S. circuits and the non-I.S. circuits in the cabinet in accordance with the applicable standards.</i> <i>All terminals shall be elevated at least 30 mm from the terminal rails.</i> <i>Terminals for voltage levels >50V AC or 120V AC shall be physically segregated from all other terminals and shall be fitted with a personnel protection cover clearly labeled.</i> <i>Terminals shall be of the non-self loosening type, shall be nickel plated and only accept one wire.</i> <i>Terminals to accommodate wiring by others shall be sized to accept 1.5 mm² wires for signal cables and wires of a minimum 4 mm² for power cables. The terminals shall be of a separation type whereby the input circuit can be separated from the other circuit without shutdown the system.</i> <i>Sockets and terminals for input/output connections shall be arranged and labeled according to the documents and drawings provided by Buyer with Purchase Order. Each shall be identified by a securely fixed label which is clearly visible after site cabling is complete.</i> <i>Cable screens of instrument cables are to be connected to the instrument earth bar which shall be supplied and installed by the cabinet Supplier. All earth connections within Supplier's scope of responsibility shall be made and shall be suitable and in accordance with the system requirements. Note that earth bars for I.S. and non-I.S. earth connections shall be separately installed within the cabinet</i> <i>All powered outputs to solenoid valves, indicating lamps and the like shall be fused on the positive side of the power supply.</i> <i>For AC solenoid, only live conductor shall be fused (neutral shall not be fused).</i>

Section	Description of Changes
	<i>All wires within the panel that are connected to terminal strips used for convenience in internal wiring, or wires terminating on device terminals not otherwise marked, and wires terminating on terminal strips for external connections shall be marked with permanent type wire markers bearing the number of the terminal row and/or the device terminal to which it is connected. Wire markers shall be of the interlockable type.</i> <i>All control wiring within the panel shall be of stranded wire 0.5 mm² with an insulation rating of 500V and a minimum of 2.5 mm² for power busses.</i> <i>Bootlace ferrules shall be used.</i> <i>Systems operating at different voltage levels are to be fully segregated.</i> <i>Wiring to the swing-out rack(s) and door(s) shall be properly secured in wire looms by using spiral lacing or equal.</i> <i>All intrinsically safe equipment and wiring shall be segregated. Overall insulating sheath of intrinsically safe wiring shall be blue. Trunking shall also be segregated and colored blue.</i> <i>Internal wiring shall be by single core, insulated wires, with the following colors:</i> - black colour - AC/DC wiring, power supplies - grey colour - electronic signal, incoming and outgoing contacts - Blue colour - intrinsically safe wiring. <i>Wiring shall be housed in a system of plastic wire ducts. A separate duct is required for the following:</i> - AC wiring, power supply, incoming and outgoing contacts (grey colour) - Electronics signal wiring (grey colour) - Intrinsically safe wiring (blue colour). <i>A 50 mm distance is required between the intrinsically safe wiring and the other wiring types.</i>
4.1	Additional clause added: <i>"All equipment for electric signal transmission, including the enclosures, as well as the armouring, lead sheathing and screening of cables, shall be properly earthed for personnel safety reasons and for obtaining the maximum possible rejection of interference.</i> <i>The instrument 'clean' earth shall be physically separated from the electrical or plant earth. On offshore structures, the instrument 'clean' earth shall be taken to a leg separate from this electrical earth and this earth connection shall be thermic welded. For onshore locations, in addition to the instrument 'clean' earth, a separate 'clean' earth shall be provided for intrinsically-safe system if shunt diode barriers are specified (total loop impedance shall not exceed 1 ohm). The normal instrument earth may be used to ground I.S. systems if onto or transformer-isolation is used.</i>

Section	Description of Changes
	<i>For EMC plants, single ground is applicable.</i> <i>The cable armouring at each junction box shall be connected to earth via cable gland. Armour shall not be connected to the screen earth at any point in the systems. All screen earthing shall be earthed at the control room end only.</i> <i>All cable screens including spares shall be earthed at one point only (usually in the marshalling cabinet at the control centre except for tip grounded thermocouples) and shall be kept isolated from cable armouring, instrument enclosures, steel structures and any other electric conductors.</i> <i>Instrument equipment installed in control rooms shall be provided with insulated earth busbars, which are interconnected with 6 sq. mm. single core green insulated wire. To form a ring circuit, both ends shall be connected to a suitable earth point below the support frame by using 70 sq. mm. single core green/yellow insulated cables. To facilitate maintenance, two connection bolts shall be provided on the earth point.</i> <i>To ensure high integrity earthing of cabinets and panels, all moving metallic parts including hinged doors, swing frames, slide out racks, etc. shall be permanently bonded or earthed on an individual basis to the main body of the enclosure using flexible earth bonding straps.</i> <i>Ex 'i' or Ex 'd' solenoid valve, switches, etc., which do not have integral junction boxes shall be connected to the signal cable by means of an appropriate connecting box. The thread of the Ex 'd' enclosure cover shall be applied with a thin smear of approved grease before it is installed.</i> <i>To ensure a good earthing via the frame structure (plant or platform earth), instruments having electric connections shall be fixed by means of Mb, 316L SS bolts having a lock washer each under the nut and under the bolt.</i> <i>In field junction boxes, the individual shields of single pairs and those of multi-core cables shall be through connected on insulated terminals. To avoid accidental shorting or grounding of this shield within a terminal box, the shield end and shield drain wire between the end of the cable jacket and the terminal strips shall be insulated. The shield of the ungrounded end of a cable shall be insulated by green/yellow colored PVC sleeve to avoid accidental grounding of any exposed shield or the shield drain wire. The maximum length of an unshielded core at the terminal strips shall be 25 mm.</i> <i>The ring is completed by connecting both ends to a suitable earth point below the support frame by using a 70 mm square single core green/yellow insulated cable.</i> <i>Two M10 316L SS connection bolts shall be provided on this earth point so that each end of the ring, can be connected to an individual bolt, thus allowing maintenance checks that resistance of the ring is less than 1 ohm while the other ring end is still connected and ensures continuous earthing.</i> <i>Where insulated glands are used in metal boxes, the armour shall be through-connected to other cables and connected to plant (or platform) earth in another junction box. Where insulated boxes are used, the armour shall be through connected to a separate earth source.</i> <i>A separate earth bar should be specified for this purpose in all junction boxes."</i>

Section	Description of Changes
6.0	This is new clause: "6. PNEUMATIC TUBING <i>All instrument tubing shall be seamless, soft annealed 316 stainless steel. Recommended tubing hardness shall not exceed ROCKWELL No. Rb 80. .</i> <i>All compression fittings shall be 316 Stainless steel of Swagelok make or equal in order to ensure compatibility with existing facilities and minimise stock holding.</i> <i>It is stressed that metric size tubing and fittings are not compatible with their imperial size counterpart.</i> <i>The Company makes extensive use of hydrocarbon gas as an alternative to instrument air on offshore platforms, particularly unmanned platforms. The design shall ensure that the instrument system is compatible with the expected gas composition.</i> <i>Where the length of pneumatic signal-transmission tubing exceeds 60 m, signal booster relays shall be used. Where the tubing length exceeds 90 m, design consideration shall be given to the use of electronic instrumentation.</i> <i>316 SS tubing is considered to be self-supporting up to a length of 1 m. For longer lengths, the tubing shall be supported over its full length at every 1 m.</i> <i>Air header layout after the primary block valve shall be in accordance with Company practice as shown in the PTS standard drawings.</i> <i>The branch lines shall be connected to the main header with a shut-off valve. All branch line connections shall be made on the top of the line. (Instrument scope commences at the downstream flange of the shut-off valve).</i> <i>Instrument air mains shall be provided with a 316 SS valved branch connection (of one size smaller than the main) at least every 5 m, complete with union coupling, and a 10% spare capacity provision shall be made for future extensions. All future tie-in points shall be valved and plugged.</i> <i>From the main branch lines, all further connections to manifolds and individual air filter/regulators shall be made via 12 mm or ½" O.D. 316L SS tubing. Areas where the carbon steel pipe meets stainless steel piping/fittings, a sacrificial carbon steel nipple shall be installed to cater for galvanic corrosion.</i> <i>The rating of instrument air mains and branch air lines shall be in accordance with Table 4 below unless otherwise specified.</i>

Section	Description of Changes												
	Table 4: Instrument Air Mains and Branch Air Lines <table><tr><th>Nominal Pipe Size (OD)</th><th>Pipe/tubing & fitting Material</th><th>Maximum Number of Users</th></tr><tr><td>DN 15 (½ inch)</td><td>316L SS</td><td>5</td></tr><tr><td>DN 25 (1 inch)</td><td>316L SS</td><td>25</td></tr><tr><td>DN 50 (2 inch)</td><td>316L SS</td><td>100</td></tr></table> Air supply lines shall be sloped towards drain points. A sufficient number of filters, regulators, drain and bleeders shall be provided in the instrument air system. A filter regulator shall be provided for each individual air user and shall be complete with an output gauge. Filter regulators shall be stainless steel to minimise life cycle costs. Instrument air supply lines from the nearest block valve to the air user and the pneumatic signal line shall consist of 12 mm O.D. x 1.0 mm WT or 1/2" OD x 0.035" WT 316 SS tubing and compression fittings. Instrument air receivers/headers capacity primarily depends on a summed tabulation of all the known users, instruments and instrument system, and their respective consumption rates, which can be obtained from the manufacturers. It also depends on the availability of alternative air sources and has to match other back-up requirements such as UPS, batteries etc."	Nominal Pipe Size (OD)	Pipe/tubing & fitting Material	Maximum Number of Users	DN 15 (½ inch)	316L SS	5	DN 25 (1 inch)	316L SS	25	DN 50 (2 inch)	316L SS	100
Nominal Pipe Size (OD)	Pipe/tubing & fitting Material	Maximum Number of Users											
DN 15 (½ inch)	316L SS	5											
DN 25 (1 inch)	316L SS	25											
DN 50 (2 inch)	316L SS	100											
	Tubing shall be joined by compression type fittings only. Tubing shall be selected for the applicable pressure ratings specified and sized adequately for the required capacity and duty. Tubing material shall be 316 SS as per ASTM A269, with the exception of Molybdenum (Mo) content which shall be 2.5% minimum. Mill certificates of tubing shall be required for every batch of tubing ordered or supplied by fabricators and suppliers. For offshore installation, tubing material shall be either Tungum, 254 SMO, Super duplex Stainless Steel and Alloy 625 to avoid crevice and pitting corrosion caused by chloride attack. For reasons of variety control, fast delivery and to minimise life cycle costs, 317 SS tubing (Mo content of between 3% and 4%) shall not be used unless the process conditions and field conditions warrants their use. With the exception of hydraulic lines, all SS 316 instrument tubing shall have the following dimensions:												

Section	Description of Changes																								
	Table 5: SS316 Instrument Tubing Dimensions <table><tr><th>OD</th><th>Thickness</th><th>Applications</th></tr><tr><td></td><td></td><td></td></tr><tr><td>¼"</td><td>0.035"</td><td>Signal Lines</td></tr><tr><td>3/8"</td><td>0.065"</td><td>Fusible Loops, Impulse Lines, Supply Lines</td></tr><tr><td>½"</td><td>0.035"</td><td>Supply Lines, Drain Lines</td></tr><tr><td>6 mm</td><td>1.0 mm</td><td>Signal Lines</td></tr><tr><td>10 mm</td><td>1.5 mm</td><td>Fusible Loops, Impulse Lines, Supply Lines</td></tr><tr><td>12 mm</td><td>1.0 mm</td><td>Supply Lines, Drain Lines</td></tr></table> 316L Stainless steel compression type fittings shall be selected for the applicable pressure ratings specified and sized for the tubing described above and shall be installed in strict accordance with the manufacturer's recommendations. Fittings shall be manufactured by Swagelok. Only NPT type threads shall be used for screwed connections. The thread cutting shall be in accordance with API Code for threading. The number of joints in piping and tubing shall be kept to a minimum, consistent with good practice. All shall be made with the aid of approved tubing benders, correct for the size of tube being worked, to ensure neat serviceable bends. Pipes and tubes shall be run in vertical and horizontal planes as far as possible and shall be run with the minimum number of changes of direction consistent with the good practice and neat appearance. Horizontal runs shall have the pipes or tubes mounted one above the other. Where pipes or tubes run parallel to each other, joints shall be systematically staggered and neatly off-set. Isolation valves shall be located as close to the source as practical. No piping or tubing shall be installed in such a way that it is subject to vibration or any other mechanical stress. All piping and tubing shall be de-burred properly after cutting (preferably with a de-burring drill on a drilling machine). After de-burring process, all piping and tubing shall be cleaned by blowing through with filtered dry and oil-free compressed air before connection to instrument. The installed, but not connected, pipes and tubes shall have their ends capped to prevent the entry of foreign material. All instrument piping connected to process piping shall be run with a slope of not less than 1 to 12, except where otherwise specified. The slope shall be down from the tapping points for liquids and up from the tapping points for gas service. The Contractor must pay special attention to the correct location of vents and drains to ensure that they are respectively at the highest and lowest point of piping runs. All drains shall be connected to the closed drain systems or plugged by an isolation valve.	OD	Thickness	Applications				¼"	0.035"	Signal Lines	3/8"	0.065"	Fusible Loops, Impulse Lines, Supply Lines	½"	0.035"	Supply Lines, Drain Lines	6 mm	1.0 mm	Signal Lines	10 mm	1.5 mm	Fusible Loops, Impulse Lines, Supply Lines	12 mm	1.0 mm	Supply Lines, Drain Lines
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Section	Description of Changes								
	Handling and storage of Tubing <i>Tubing shall be stored and transported in dedicated plastic boxed/tubes, to prevent tubing corrosion before installation. The transport and storage in dedicated plastic boxed/tubes applies for offshore locations and any onshore location, including construction sites.</i> Multi-core Tubing <i>Where indicated on the hook-up drawings, multi-core tubing shall be used.</i> <i>Multi-core tubing shall be routed, supported and secured in a similar manner to that of the electrical cable.</i> <i>All entries to junction boxes shall be made weatherproof, using suitable cable glands and/or bulkhead fittings.</i> Piping and Tubing Support <i>All piping and tubing shall be adequately supported and/or braced so as to provide maximum protection against mechanical damage and vibration.</i> <i>The distance between supports shall not exceed those in the following table:</i> <i>Table 6: Distance Requirement for Tubing Support</i> <table> <tr> <th><u>Line Size</u></th><th><u>Maximum Distance</u></th></tr> <tr> <td>$\frac{3}{4}$ inch</td><td>1.0 m</td></tr> <tr> <td>1 inch</td><td>1.5 m</td></tr> <tr> <td>1½ - 2 inch</td><td>2.0 m</td></tr> </table> <i>Multi-core tube shall be supported each 0.25 m. Single tube size 1/2 inch or less shall be supported continuously.</i> <i>For continuously supporting five or more single tubes, one 316L SS cable tray shall be used. For continuously supporting four or less single tubes, 316L SS angle bar (50 x 50), or 316L SS Unistrut channel shall be used.</i> <i>The tubing shall be secured to the tray with fastening blocks at (maximum) 0.6 meters intervals. Blocks with stainless steel cover plates, bolts and nuts shall be delivered and supplied by the Contractor.</i> <i>The supports shall be fabricated by the Contractor (or supports to be made of SS 316L), including coating in accordance with the Painting and Coating Specification 525. Coating shall be finished before installation supporting materials. The required small mounting materials and consumable items shall be delivered and supplied by the Contractor.</i> <i>Capillaries of filled systems shall run independently of all other lines and shall be continuously supported using 316L SS angle bar 316L SS Unistrut channel with adequate fastening clamps or tie-wraps at 0.25m intervals. Adequate means of protecting capillaries from damage shall be employed. Special care shall be taken against kinks in the capillaries on bends or changes of direction.</i> <i>Cable trays shall be run with the width of the tray in a horizontal plane. A short section may be run with the width in a vertical plane after Company's approval. In this case, additional support shall be provided to prevent sagging.</i>	<u>Line Size</u>	<u>Maximum Distance</u>	$\frac{3}{4}$ inch	1.0 m	1 inch	1.5 m	1½ - 2 inch	2.0 m
<u>Line Size</u>	<u>Maximum Distance</u>								
$\frac{3}{4}$ inch	1.0 m								
1 inch	1.5 m								
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Section	Description of Changes
	<i>Under certain circumstances and with Company's approval, trunking or conduits may be used instead of cable trays. The required materials shall be delivered and supplied by the Contractor.</i> <i>Unless otherwise specified, the process pipelines and handrails shall not be used to support instrument pressure and air piping and tubing.</i> <i>Process equipment, rotating equipment and electric motors which are liable to vibration shall not be used to support instrument pressure and air piping and tubing.</i> <i>Multi-core transit, insert frames and blocks, supplied by the Contractor, shall be provided after piping or tubing installation, in accordance with the drawings or when required by Company.</i>
7.1	7.1 CABLE IDENTIFICATIONS <i>Quads or pairs shall be identified by black numbers on each individual core of the quads or pairs, no greater than 50 mm apart. If the dimension of a core does not permit this, other means of identifying the cores shall be used.</i> <i>A purpose-made identification method shall be specified for cables in the cable channel, at every 5 meters. In addition, similar identification markings/bands shall be specified for the starting and terminating points of the cable, and on both sides of any wall or bulkhead penetration. The identification markings/bands shall be blue for I.S. cables, green for non I.S. cables and red for F&G cables.</i> <i>Cable identification numbers shall be permanent, character size being 10 mm.</i> <i>Cable numbers shall be as per PTS 32.37.20.31.</i> <i>All cables, whether I.S. or non I.S., shall have black outer sheath regardless of type of cable and conform to BS 5308.</i>