

GENERAL SPECIFICATION

INSTRUMENTATION

GS EP INS 107

Design and installation of instrumentation links

09	11/2012	Revised as per marking
08	01/2012	Revised as per marking
07	01/2011	Revised as per marking
06	10/2009	Revised as per marking
00	10/2002	First issue
Rev.	Date	Purpose of the revision

Owning entity: DEV/TEC	Managing entity: DEV/TEC/INS
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General Specification		GS EP INS 107
Design and installation of instrumentation links		
Rev.: 09	Effective date: 11/2012	Page: 2 of 16

Contents

1. Scope	3
2. Reference documents.....	3
3. Links and cabinets descriptions.....	4
3.1 Electrical links	4
3.2 Pneumatic links.....	6
3.3 Hydraulic links.....	7
3.4 Optical fibre links.....	7
4. Segregation of electric and electronic signals	8
5. Instrument earthing.....	8
5.1 Earthing principle	8
5.2 Cabinets earthing.....	9
5.3 Cable earthing.....	10
6. Identification of instrument lines	11
6.1 General.....	11
6.2 Component identification principles.....	11
6.3 Line identification principles	11
6.4 Terminal strips identification principles.....	12
7. Instrument tubing class.....	12
7.1 General.....	12
7.2 Use of piping class.....	12
Appendix 1 Table of "Descriptive" field codes for identification.....	13
Appendix 2 Instrumentation line identification principles.....	14
Appendix 3 Instrument Tubing Classes.....	15

General Specification		GS EP INS 107
Design and installation of instrumentation links		
Rev.: 09	Effective date: 11/2012	Page: 3 of 16

1. Scope

This Specification defines the principles underlying the design and construction of instrument lines.

This specification applies to all onshore and offshore installations.

Submarine links and telecommunication links are not included in this specification.

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the effective date of this document.

Reference	Title
AISI	Data sheet 904L
AISI	Data sheet 316L
IEC 60079-07	Explosive atmospheres - Part 7: equipment protection by increased safety "e"
IEC 60079-14	Explosive atmospheres - Part 14: Electrical installations design, selection and erection
IEC 60331	Parts related to the Tests for electrical cables under fire conditions - Circuit integrity
IEC 60332	Parts related to the Tests on electric cables under fire conditions
IEC 60364	Parts related to the Low-voltage electrical installations and Electrical installations of buildings
IEC 60446	Basic and safety principles for man-machine interface, marking and identification - Identification of conductors by colours or alphanumeric
IEC 60529	Degrees of protection provided by enclosures (IP code)
IEC 61000-5	Sections related to the Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines
ISO 4406-1999	Hydraulic fluid power - Fluids - Method for coding the level of contamination by solid particles

General Specification		GS EP INS 107
Design and installation of instrumentation links		
Rev.: 09	Effective date: 11/2012	Page: 4 of 16

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

Reference	Title
GS EP ELE 161	Electrical cables
GS EP ELE 311	Cable trays/ladders
GS EP INS 101	Instrumentation engineering, supply and construction general requirements
GS EP INS 104	Design of generation and distribution of instrument air or gas
GS EP INS 134	Design and supply of integrated control and safety system
GS EP INS 146	Design of generation and distribution of hydraulic energy
GS EP PVV 112	Piping materials classes
GS EP PVV 171	Steel piping fabrication
GS EP TEL 180	Engineering and installation of telecommunication network pre-cabling

3. Links and cabinets descriptions

3.1 Electrical links

The electrical equipment and installation to be installed in potentially explosive areas shall comply with [IEC 60079](#).

3.1.1 Cables

3.1.1.1 Specifications

All instrument cables shall comply with [GS EP ELE 161](#), with the exception of cable armour which shall be Tinned Copper Wire Braid (TCWB) or Galvanised Steel Wire Braid (GSWB).

Cable used in zone 1 or 2 of explosive areas shall be armoured. Outside the explosive area, the use of armoured cable will depend on the environment.

Individual and multiple pairs cables shall have individual shield for:

- Low level signals
- Frequency signals
- I.S. signals
- System network communication cable.

Individual and multiple pairs cables shall have overall shield for analogue input & output signals.

Cables used for digital outputs do not require any shield.

General Specification		GS EP INS 107
Design and installation of instrumentation links		
Rev.: 09	Effective date: 11/2012	Page: 5 of 16

Multiple pair cables for on/off input signals shall have individual and overall shields when sharing the same multiple pair cables as analogue input & output signals.

All cables shall be flame retardant as per IEC 60332-3. When required as per GS EP INS 101 they shall be fire resistant as per IEC 60331.

A minimum of 20% spare capacity shall be provided in multicore cables.

All conductors shall be connected to a terminal at both ends.

Spare conductors within non IS cables shall be grounded at both points in compliance with EMC recommendations, whereas within IS cables spares conductors shall be grounded at cabinet side only as per IEC 60079-14.

Long lengths (> 1000 m) may be set up using composite cables and shall be lightning protected.

Cables for digital links - coaxials, twisted pairs or optical fibres - shall be specified by the Vendor of the equipment to be connected.

Selection of conductors section of cables for instruments requiring high consumption (e.g. fire and gas detectors) shall be determined as per voltage drop calculations. Special consideration shall be paid to supply from UPS batteries.

3.1.1.2 Conductor colour-coding

Alternating current:

Blue and **green/yellow** are reserved: **blue** for neutral links and **green/yellow** for earthing links (IEC 60446).

Each phase conductor shall be colour-coded differently.

Direct current:

Green/yellow is reserved for earthing links (IEC 60446).

3.1.2 Junction boxes

It will preferably be of type Ex e (IEC 60079-07) and IP65 (IEC 60529) at the minimum.

The material used will preferably be reinforced polyester with stainless steel screw fastenings.

There shall not be more than one multicable per junction box.

Cable entries shall be through the bottom via glands.

Junction boxes shall be provided with plugs for spare cables.

Bleed valve shall be provided in order to drain the inside condensation.

Junction boxes shall be provided with terminals for all conductors including spare and screens.

All stranded conductors shall be crimped except in case of fast connection type.

3.1.3 Marshalling cabinets

Marshalling cabinets shall be used for cross-connection of I/O's between field image terminal blocks and digital system acquisition boards.

General Specification		GS EP INS 107
Design and installation of instrumentation links		
Rev.: 09	Effective date: 11/2012	Page: 6 of 16

Marshalling cabinets cable entries shall be through the bottom, via the raised floor of the technical room.

For each cable, the first terminal strip in the technical room shall be the image of the terminal strip in the junction box.

The terminal strips shall be arranged vertically.

The terminal blocks shall be spring clamp type, 2 conductors disconnect ("knife" type) with test points or 4 conductors disconnect and shall allow plug-in resistor modules for HART communication or fuse modules for outputs to solenoid valves.

Terminals shall be provided for all conductors.

Screens will be connected to vertical earth rail beside field terminals.

All stranded conductors shall be crimped except in case of fast connection type.

3.1.4 System cabinets

System cabinets design requirements are listed in [GS EP INS 134](#).

3.1.5 Cable trays & ladders

Refer to [GS EP ELE 311](#) for cable trays and ladders requirements.

Cables shall always be run on cable trays.

Dedicated cables trays shall be used for different signal voltages to avoid any interference.

As a general rule, separate cable trays will be used for IS signals. However in congested area, common cable tray & ladder might be used with physical separation between the two groups of cable (IS and Non-IS).

Cables lay out inside cable trays shall allow easy distribution entering the technical rooms.

For the same reason, segregation as per Control and Safety System (i.e. Process Control System, Process Shutdown System, Emergency shutdown system and Fire & Gas System) may also be applied depending on the project size.

Cables shall be arranged in three layers at the maximum.

A minimum of 20% spare capacity shall be provided in cable trays.

Trench cable runs are acceptable for onshore; above segregation requirements will apply.

3.2 Pneumatic links

Also refer to [GS EP INS 104](#).

3.2.1 Installation

Impulse lines shall be made of [AISI 904L](#) stainless steel tubing and of [AISI 316L](#) compression fittings, with the exception of applications on corrosive or toxic duties where other materials are required; these are specified in section 7.

904L tubing hardness shall be limited between 80 and 85 HRB (Hardness Rockwell) for suitable assembly consideration with the associated 316 SS compression fittings.

General Specification		GS EP INS 107
Design and installation of instrumentation links		
Rev.: 09	Effective date: 11/2012	Page: 7 of 16

However, where austenitic impulse lines are not installed in marine atmosphere and therefore not vulnerable to chloride stress corrosion cracking and pitting, [AISI 316L](#) stainless steel tubing might be used in association with [AISI 316L](#) stainless steel compression fittings.

Particular attention shall be paid to pipe supports and fixings to avoid areas in which sea water can stagnate.

Downstream of air supply headers, connections shall be via [AISI 316L](#) compression type ring fittings.

The use of PTFE tape shall be prohibited for design temperature above 140°C as per [GS EP PVV 171](#). In that case sealant paste has to be considered.

Moreover the use of PTFE tape is prohibited on pneumatic connections to instruments due to the risk of clogging of pilots orifices.

Plastic pipes shall be used only inside buildings and in automatic control cabinets.

Tube entries into junction boxes and cabinets shall be via the bottom.

3.3 Hydraulic links

Also refer to [GS EP INS 146](#).

Hydraulic links shall be selected from a piping class according to their service pressure.

The installation, support structure and identification system shall be the same as for pneumatic links.

Special attention shall be paid to the cleaning and passivation of the hydraulic lines. Hydraulic lines shall be flushed to reach cleanliness codes 17/15/12 as defined by [ISO 4406-1999](#).

3.4 Optical fibre links

3.4.1 Short lengths

Short length optical fibre network related to the Control System shall be designed and supplied by the Control System Manufacturer.

3.4.2 Long lengths

These links shall be managed by Telecommunications specialists and be designed as per [GS EP TEL 180](#).

Although Control System data can be combined with telecommunication means in the same fibre-optic cable, redundant dedicated fibres shall be kept for process data and safety data.

Particular attention shall be paid to the split of instrument and telecom fibres so that instrument links will not be interrupted or disturbed in case of need for troubleshooting or any other intervention on telecom links.

General Specification		GS EP INS 107
Design and installation of instrumentation links		
Rev.: 09	Effective date: 11/2012	Page: 8 of 16

4. Segregation of electric and electronic signals

Signals within cables shall be segregated following their nature and magnitude:

- Analogue input & output and on/off input signals
- Low level signals
- Frequency signals
- I.S. signals
- Instrument power supplies
- On/off output signals
- System cable (e.g. network cable).

Cables shall be segregated according to the part of the Integrated Control and Safety System they belong to:

- Process Control System
- Process Shutdown System
- Emergency Shut-Down System
- Fire and Gas System.

This segregation principle shall apply for junction boxes and multicore cables.

Dedicated marshalling cabinets shall be used for each system.

However for very simple installation, common marshalling cabinet may be used for PSS, ESD and F&G systems with clear functional segregation within the cabinet.

In addition, depending of the project construction & installation and commissioning philosophy (e.g. topsides split over different modules), segregation might be as per process section.

5. Instrument earthing

5.1 Earthing principle

Design, installation and mitigation guidelines provided by the [IEC 61000-5-2](#), aimed at ensuring electromagnetic compatibility, shall be applied.

Instrument earthing principle is based on potential equalization, achieved by meshing at all locations: instruments, junction boxes and technical rooms.

Cable armour shall be earthed at both ends.

Screens will be earthed at a single point in the marshalling/system cabinets or UCP (Unit control panels for packages).

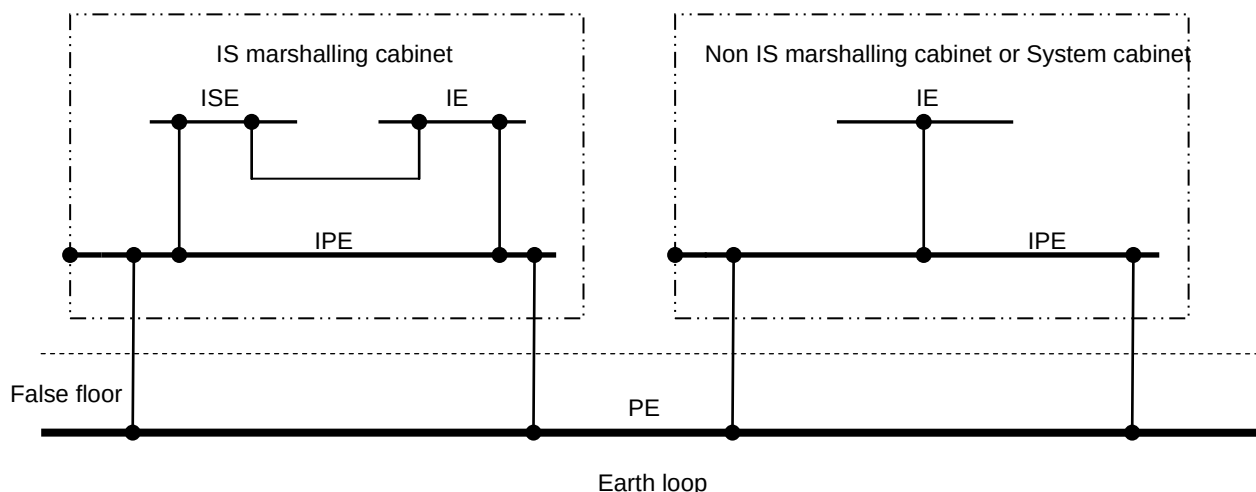
Screen continuity shall be ensured inside the junction boxes.

5.2 Cabinets earthing

For construction facility, three different systems can be identified and installed, especially when considering marshalling and system cabinets:

1. Instrument Protective Earth (IPE): for earthing frames, jackets, plates, cable armouring (for protection of personnel)
2. Instrument Earth (IE): for earthing of:
 - Cable shields and screens for non-intrinsically safe devices
 - Voltage references of electronic systems in case an earthed 0 VDC is required.
3. Intrinsically Safe Earth (ISE): for earthing intrinsically safe devices (shields and/or screens, voltage references, etc.)

Therefore each cabinet will be provided with relevant earth bars, but all of them shall be interconnected inside the cabinet as per the hereafter sketch:



The ISE and IE earth bars shall be isolated from the chassis and shall be mounted together as close as possible. Interconnections between all earth bars shall be ensured as per the above sketch. However, the ISE and IE earth bars shall not be interconnected in case the 0 VDC is connected to earth (i.e. non-floating configuration).

Each earthing connection shall be made directly on the specific earth bar itself; daisy chaining of earthing connections is not permitted. Concerning UCPs consisting of multiple cabinets, having IE/IPE/ISE earth bars in more than one cabinet, then:

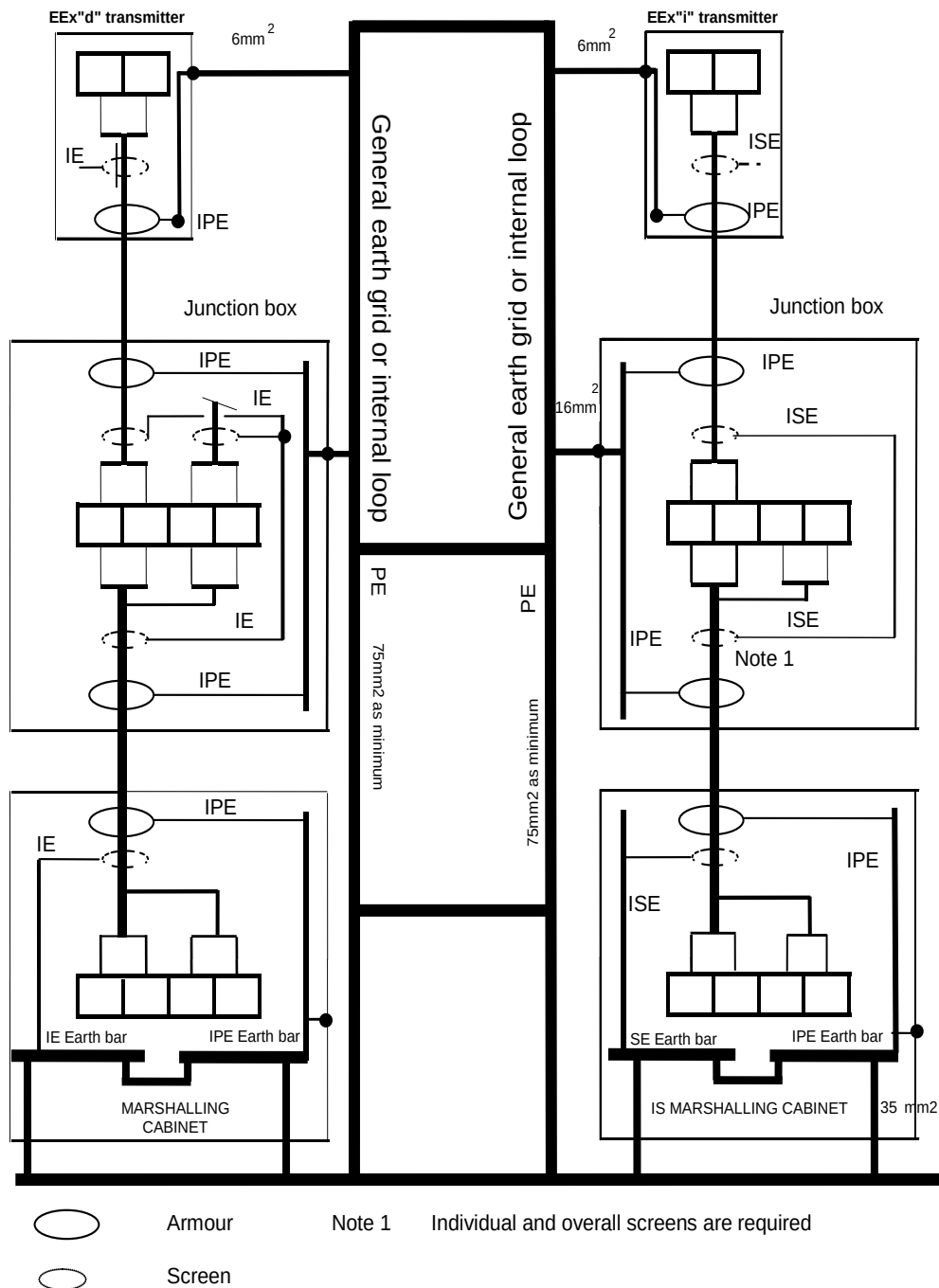
- Each specific earth bar shall be connected to the specific earth bar in the adjacent cabinets using 35 mm² conductors
- Each IPE bar in each cabinet shall be connected to the PE network with 2 conductors.

All connections (e.g. to earth loop or screen to the IE bar) shall be as short as possible with vertical earth bar for instance.

Each cabinet shall be earthed to the PE network by means of 2 conductors, from opposite extremities on the IPE bar, and whose section shall be calculated as per [IEC 60364-5-54](#) and not be less than 35 mm². Resistance between PE bar and IE/IPE/ISE shall not exceed 1 ohm.

5.3 Cable earthing

EARTHING PRINCIPLE



General Specification		GS EP INS 107	
Design and installation of instrumentation links			
Rev.: 09	Effective date: 11/2012		Page: 11 of 16

6. Identification of instrument lines

6.1 General

All components shall be identified by a stainless steel label attached by stainless steel straps.

All lines shall be identified at both ends and at each side of wall penetrations.

Inside the distribution frames, space permitting, for each conductor the identification shall include the identification of the instrument in addition to the terminal number.

Pipe outlets from a manifold to an instrument shall be identified.

Short, positioner/valve actuator type lines shall not be identified.

Inside pneumatic junction boxes, each pipe shall be individually identified by the name of the instrument.

6.2 Component identification principles

Component identification codes shall include three fields:

- First optional field: "Location" on up to four characters
- Second field: "Description" on up to four letters, encoded according to the table in Appendix 1
- Third field: "Serial number" on three digits.

Example:

Identification										
Location				Description				Serial no.		
x	x	x	x	I	B	S	X	1	8	0
x	x	x	x		M	D		0	0	1
x	x	x	x		X	D	O	1	0	1

IBSX180: Intrinsic safety, Junction box, Emergency Shutdown System, Analogue I/O _ Digital input, No. 180.

MD001: Marshalling cabinet, Process Shutdown System, No. 001.

XDO101: Terminal strip, Process Shutdown System, Digital Output, No. 101.

6.3 Line identification principles

These are identified by the letter of the component (C for cable and T for tube...) followed by an identification of the component they are originating from (direction is from field instrument to final control unit).

Examples are given in Appendix 2.

General Specification		GS EP INS 107
Design and installation of instrumentation links		
Rev.: 09	Effective date: 11/2012	Page: 12 of 16

6.4 Terminal strips identification principles

These are identified using the letter of the component "X" followed by the identification of the cable which is connected to (without the letter "C").

This can be amended when several individual cables are grouped onto the same terminal strip.

Examples are given in Appendix 2.

7. Instrument tubing class

7.1 General

Instrument links shall be made of stainless steel thinwall tubing ([AISI 904L](#) for marine atmosphere and [AISI 316L](#) for non marine atmosphere).

All tubing and fittings exposed to seawater shall be Monel 400 or Hastelloy C.

Particular attention shall be paid to handling and protection of instrument piping during construction activities.

Instrument tubing must be supported in such a way that corrosion points will be avoided. Links longer than 1 metre shall be correctly supported and protected.

Tubes shall preferably be secured to the trays using fastening blocks made of hydrophobic clamp assemblies with rubber insert. In all cases the method of support and fastening shall be submitted to the Company for approval.

Instruments and process piping classes are correlated in Appendix 3. For all other conditions approval shall be obtained.

7.2 Use of piping class

When a process fluid exists in instrument connections such as:

- Level gauge glass
- Level switch
- Level torque tube
- Etc.

then the tubing class shall be strictly in compliance with the process piping class as defined in General Specification [GS EP PVV 112](#).

Design and installation of instrumentation links

Rev.: 09

Effective date: 11/2012

Page: 13 of 16

Appendix 1
Appendix 1 Table of "Descriptive" field codes for identification

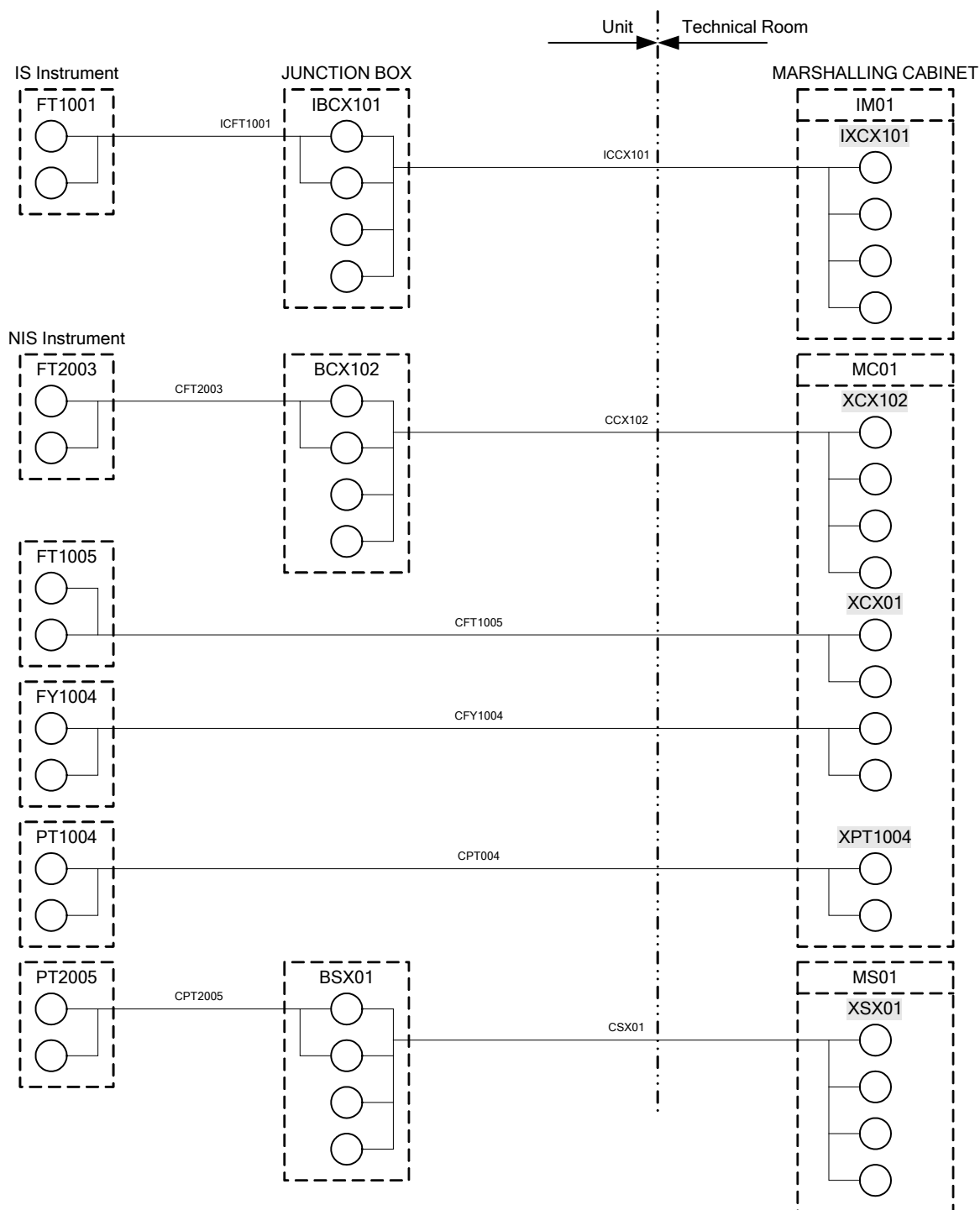
	Prefix	1st rank Element	2nd rank System	3rd rank Type
A				
B		Junction Box		
C		Cable	Process Control System	
D			Process Shutdown System	
E			Electrical Power Supply	
F		Optical Fibre		
H			Hydraulic	
I	Intrinsic Safety			
L				Low-Level Signal
M		Marshalling Cabinet		
N				Network
O				Digital Output
P			Pneumatic	
R			Fire & Gas System	Return
S		System Cabinet	Emergency Shutdown System	Supply
T		Tube	Telecom	
U		Unit Control Panel		
X		Terminal Strip		Analog Input / Output or Digital input

Design and installation of instrumentation links

Rev.: 09

Effective date: 11/2012

Page: 14 of 16

Appendix 2
Appendix 2 Instrumentation line identification principles


Design and installation of instrumentation links

Rev.: 09

Effective date: 11/2012

Page: 15 of 16

Appendix 3

Appendix 3 Instrument Tubing Classes

I01 – INSTRUMENT TUBING SPECIFICATIONS

					PROCESS CONDITIONS:			
ASSEMBLY TYPE: Thinwall tubing and compression fittings					150 #, 300 #, 600 # (and 900 #, 1500 # production water P < 200 barg)			
BASE MATERIAL: Stainless steel					PRESSURE AND TEMPERATURE FOLLOWING ANSI B 16.5			
COMPONENT	SIZE	RATING	CONNECTION	TYPE	PACKING BOX MATERIAL	REFERENCE STANDARDS		NOTES
INSTRUMENT BALL VALVE	1/4" to 3/4"	3000 psig	OD	Ball type; end entry; full bore; forged SS 316L body; SS 316 ball; ball seals: Viton O-rings	Graphite	AISI F 316L	AISI F 316L	1
INSTRUMENT PLUG VALVE	1/4" to 1/2"	3000 psig	OD	Forged SS 316L body, Non-rotating stem.	Graphite	AISI F 316L	AISI F 316L	
INSTRUMENT GAUGE VALVE	1/2"	6000 psig	Inlet 1/2" NPT(M) Outlet 1/2" NPT(F)	Bar stock SS 316L body x 1 male inlet x 3 female outlets	Graphite	AISI F 316L	AISI F 316L	
INSTRUMENT COMPACT MANIFOLD	1/2"	6000 psig	NPT	With bypass, 3 or 5-valve, with or without drains, 1/2" NPT female inlets, fixed flanged or 1/2" NPT female outlets	Graphite	AISI F 316L	AISI F 316L	1
FLANGE	3/4"	According to Piping Class	Threaded 3/4" NPT	Flange to compression fitting connector Flange and gasket type and material according to Process Piping Class		ANSI B16.5	ANSI B16.5	1
FITTING	1/4" to 3/4"			For thinwall tubing, of forged SS, twin ferrule compression-type,		AISI F 316L	AISI F 316L	1
UNION	1/4" to 2"	3000 psig	NPT	3 parts, forged SS		AISI F 316L	AISI F 316L	1
PLUG / CAP	1/4" to 1"	3000 psig	NPT	Forged SS		AISI F 316L	AISI F 316L	1
TUBE	1/4" to 1" 1/2	Sch. 80S to Sch. 160S		Seamless drawn SS		AISI TP 316L	AISI TP 904L	1, 3
THINWALL TUBING	1/4" OD to 1/2" OD	0.049" thick		Seamless drawn SS		AISI TP 316L	AISI TP 904L	2

- Notes
- 1) Refer to § 3.2.1 for screwed assemblies
 - 2) Elbows shall be made by bending, following standards and with adequate bending tools. Compression fittings shall be at least 2" from bends.
 - 3) Bending prohibited; use 90° Female elbows.

Design and installation of instrumentation links

Rev.: 09

Effective date: 11/2012

Page: 16 of 16

Appendix 3
I09 – INSTRUMENT TUBING SPECIFICATIONS

					PROCESS CONDITIONS:			
ASSEMBLY TYPE: 1/2" Sch. 160S pipe with threaded fittings BASE MATERIAL: Stainless steel					900#, 1500# PRESSURE AND TEMPERATURE FOLLOWING ANSI B 16.5			
COMPONENT	SIZE	RATING	CONNECTION	TYPE	PACKING BOX MATERIAL	REFERENCE STANDARDS		NOTES
						Non marine atmosphere	Marine atmosphere	
INSTRUMENT BALL VALVE	1/2"	1500#	SW	Ball type; end entry; full bore; forged SS 316L body; SS 316 ball; ball seals: Viton O-rings	Graphite	AISI F 316L	AISI F 316L	1
INSTRUMENT PLUG VALVE	1/2" to 3/4"	5000 API	NPT	Needle valve; Y shaped SS 316 body, 1/2" male in, 1/2" female out (Kerotest type); steel needle, seat seal F6	Graphite	AISI F 316L	AISI F 316L	1, 2
INSTRUMENT GAUGE VALVE	1/2" to 3/4"	6000 psig	Inlet 1/2" NPT(M) Outlet 1/2" NPT(F)	Bar stock SS 316L body x 1 male inlet x 3 female outlets	Graphite	AISI F 316L	AISI F 316L	1
INSTRUMENT COMPACT MANIFOLD	1/2"	6000 psig	NPT	With bypass, 3 or 5-valve, with or without drains, oval flanges inlets, fixed flanged outlets	Graphite	AISI F 316L	AISI F 316L	3
FLANGE	3/4"	900# to 1500#	Outlet 3/4" OD	Flange to compression fitting connector Flange and gasket type and material according to Process Piping Class		ANSI B16.5	ANSI B16.5	7
FITTING	1/2"	3000 psig or 6000 psig		Forged SS		AISI F 316L	AISI F 316L	1, 6
UNION	1/2"	3000 psig or 6000 psig		2 or 4 bolt forged SS flanges, tapered seat, lapped seals, integral seat		AISI F 316L	AISI F 316L	5
PLUG / CAP	1/4" to 1"	3000 psig or 6000 psig	NPT	Forged SS		AISI F 316L	AISI F 316L	1
TUBE	1/2	Sch. 160S		Seamless drawn SS		AISI TP 316L	AISI TP 904L	1, 4
THINWALL TUBING	1/4" OD to 1/2" OD	0.049" thick mini		Seamless drawn SS thickness > 0.049" according to P and T		AISI TP 316L	AISI TP 904L	8

- Notes
- 1) Refer to § 3.2.1 for screwed assemblies
 - 2) Use these valves to build manifolds above 150 barg.
 - 3) Oval inlet flanges shall be welded onto 1/2" process taps.
 - 4) Bending prohibited; use 90° Female elbows.
 - 5) Use 2 bolt flanged union, 1/2" 3000 psig rated up to 150 barg and 4 bolt flanged unions, 1" 6000 psig rated from 150 to 250 barg (with 1" x 1/2" reducer).
 - 6) Use 3000 psig rated fittings up to 150 barg, 6000 psig rated fittings from 150 to 250 barg.
 - 7) Use 900# rated flanges up to 150 barg, 1500# rated flanges from 150 to 250 barg.
 - 8) Use the I01 instrument piping class for production water (P < 200 barg).