

DEP SPECIFICATION

INSTRUMENT SIGNAL LINES

DEP 32.37.20.10-Gen.

September 2011

DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the design and engineering of instrument signal lines and cabling. It covers design, material selection and installation methods. Cabling for transmitting digital and video signals is also covered in this DEP.

In the context of this DEP, instrument signal lines include:

- a) Electric signal lines (paths), including thermo-electric voltage lines from thermocouples; lines from transmitters to their receiving instruments, auxiliaries, logic systems, controllers etc. and the lines from these to the relevant actuating elements such as solenoid valves, converters, transducers or control valves.
- b) Pneumatic signal lines (paths) from pneumatic transmitters to their receiving instruments, auxiliaries, controllers and the lines from these to the relevant final control elements.

Signal lines for similar applications such as fire and gas detection and protection systems, plant communication systems, CCTV systems, plant information systems, maintenance management systems and plant security systems are also within the scope of this DEP.

This is a revision of the DEP of the same number dated May 2004; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil refineries, chemical plants, gas plants and exploration and production facilities as well as distribution storage depots and installations. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process should be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Term	Definition
Bonding	The act of connecting together exposed conductive parts and extraneous conductive parts of apparatus, systems or installations that are at essentially the same potential (IEC TR 61000-5-2).
Cable ladder	Above-ground, ladder-type cable tray without cover.
Cavity floor	Computer floor or false floor.
Instrument earth	Dedicated earth for instrument systems.
Safety earth	Plant safety earth.
Sealing fitting	Conduit fitting which, when filled with a suitable sealing compound, prevents transportation of flammable substances through the conduit.
Tray	Above-ground, open cable support system, such as U-shaped flat-bottomed or ladder type.
Trench	Underground cable routing system provided with a mechanical protection on top of the cables.
Trunking	Above-ground, U-shaped cable support system with cover. It is flat-bottomed and has a top cover secured by cover clips/fasteners.

1.3.3 Abbreviations

AL/HDPE/PA	Aluminium / high density polyethylene / polyamide (nylon), that combines overall metal screening with inner sheathing. The aluminium acts as metal screen and moisture barrier. HDPE and PA act as chemical barriers, while PA provides also protection against termite attacks. AL/HDPE/PA is a low cost and lightweight alternative for lead sheathing.
AWG	American Wire Gauge
CCR	Central Control Room
CCTV	Closed Circuit Television
DCS	Distributed Control System
EM	Electro magnetic
EMC	Electro magnetic compatibility
EMI	Electro magnetic interference
FAR	Field Auxiliary Room
HDPE	High density polyethylene, used as outer sheathing. HDPE as outer sheathing has a good chemical resistance and water tightness, but is flammable (acts as torch) and stiff. Furthermore, HDPE is only UV-resistant, if it is of black colour and contains carbon black.
IPF	Instrumented protective function
IPS	Instrumented protective system
MDF	Main distribution frame
MESC	Material and Equipment Standards and Code
MS	Metal screen (with drain wire)

PE	Polyethylene, used as conductor insulation or inner sheathing.
PVC	Polyvinyl chloride used as outer sheathing. PVC as outer sheathing is UV-resistant, flame retardant and commercially attractive.
ROV	Remotely-operated valve
SWA	Steel wire armouring
SWB	Steel wire braiding

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced by this DEP are listed in (8).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated May 2004. The following are the main, non-editorial changes.

Old section	New section	Change
All		"SHALL [PS]" assessed and where did not meet criteria changed to "shall".
All		"should" requirement assessed and wherever applicable, changed to "shall"
Several		Several parts of sections that provided informative or practice content were moved from this DEP to DEP Informative
Several		Requirements applicable to North American applications added
2.1		Requirement for product acceptance specified
2.4		Updated the requirement to follow Manufacturer's instruction for cable selection and installation
2.6		Reference to DEP 80.47.10.12-Gen. and DEP 80.47.10.31-Gen. removed. Reference to DEP 31.36.10.30-Gen. and DEP 32.45.10.10-Gen. moved to section 2.5
3.5		Reference to DEP 33.64.10.10-Gen. specified for trunking/tray and relevant fixing material. For facilities in North American Applications, included the relevant DEP requirements.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the Administrator at standards@shell.com, using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of "DEPs on the Web", available through the Global Technical Standards web portal <http://www.shell.com/standards> and on the main page of the DEPs DVD-ROM.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

2. ELECTRIC CABLING

2.1 GENERAL

Single cables are used for signal transmission from field instruments to field mounted junction boxes. Multicore cabling will subsequently transmit the signals from the junction box to a main distribution frame (MDF) in the central control room (CCR) or field auxiliary room (FAR).

Multicore cabling shall be routed underground, wherever possible and consistent with the design of other plant facilities. However, above-ground cabling is acceptable, subject to the Principal's approval, provided a definite cost advantage can be demonstrated, or where it is the standard local practice.

Outdoor, above-ground and underground cables shall be provided with steel wire braiding (SWB) or steel wire armouring (SWA) even if they are installed in trenches/trunking or on cable trays. For North America, armoured cable is not required when laid in cable tray. Where chemical or moisture attack is possible and HDPE sheathing is not provided, underground cabling shall be additionally provided with a chemical/moisture barrier.

All products shall be technically qualified to the satisfaction of the Principal and shall be sourced from Manufacturers acceptable to the Principal.

Note that references to the MESC system are not applicable in North America.

2.2 SIGNAL SEGREGATION IN MULTICORE CABLES

When electric signals are assigned to multicore cables, the following signal segregation rules shall be followed:

- Intrinsically safe and non-intrinsically safe signals shall be segregated as required by IEC 60079-14 or as per ISA RP 12.06.01 in North America.
- The supply and return conductors of a signal shall be contained in the same cable pair.
- Segregation on the basis of signal level classes shall be applied as shown in Table 1.

Table 1 Classification of instrument power levels

SIGNAL LEVEL CLASS	SIGNAL TYPE	EXAMPLES
1	Analogue low level (mV signals)	Thermocouples
	Analogue medium level	Resistance temperature measurements
2	Analogue high level [e.g. 1-10 V(dc), 4-20 mA]	Electronic instrumentation loops
	Binary low level [below 24 V(dc) and below 0.5 VA]	Actuating logic systems, annunciators
	Digital low level (pulse train)	Turbine meters, proximity sensors
3	Digital high level (pulse train)	Tank gauging system
	Proximity sensors for machine monitoring	Vibration sensors
4	On-off medium level (< 50 V or > 0.5 VA, < 40 VA)	24 V(dc) solenoids (note 2,3)
5	High level signals > 50 VAC and DC power signals higher than class 4	110 V(dc) solenoids (note 2)
	Power supply cables	Power supply cables to instrument cabinets and field instruments
6	Digital (fibre optic)	Communication bus

- NOTES:
1. The classification is based on the use of cables with metal screen for signal level classes 1, 2 and 3.
 2. The classification is based on de-coupled solenoids to limit induction. A solenoid-operated valve shall be equipped with an arc suppression device across the coil if the digital output channel of the associated system does not have this feature built-in. With approval from the Principal, the arc suppression device shall be located at the terminal marshalling terminal strip
 3. For North American application, 24 VDC solenoids may be combined with signal class 2 if the wire size is adequate for the current. Note that Voltage drop calculations shall be performed when sizing wire for DC solenoid valves.

In addition to the above segregation rules for multicore cabling, functional segregation may be desirable for operability and maintainability reasons.

The design shall cater for spare capacity in multicore cabling. When the design is finalised, 10 % to 15 % of the installed cabling capacity shall be available in each signal level class and plant area to accommodate unforeseen future plant modifications.

2.3 SELECTION AND SPECIFICATION OF INSTRUMENT CABLES

2.3.1 Conductors

With the exception of North American application where stranded insulated conductors shall be used, solid insulated conductors shall be used for instrument field cables. The minimum conductor diameter shall be 1.13 mm (16 AWG) for single signal cables and 0.8 mm (18 AWG) for multicore signal cables. The maximum permissible current rating and allowable voltage drop criteria shall be observed in selecting signal cables and larger conductor diameters may be required to reduce the voltage drop. Stranded wires are permitted for internal wiring inside cabinets. Solid/stranded conductors shall not be provided with crimp-on wire pins/lugs.

For thermocouple signals, the conductors shall consist of pairs of dissimilar materials with the correct thermo-electric voltage as a function of temperature, based on IEC 60584-3. For all other signals, the conductor material shall be copper.

For resistance thermometer elements, the conductor resistance shall be compatible with the requirements as specified by the Manufacturer of the resistance thermometer elements and/or the instrument.

Signal wires shall be twisted in pairs. The use of quad cables requires approval by the Principal.

For North American applications, conductors shall meet the requirements of DEP 33.64.20.10-Gen.

2.3.2 Cable Construction

2.3.2.1 Cable construction for signal level classes 1/2/3

Instrument signal cabling for signal level classes 1, 2 and 3 of Table 1 (2.2) shall be specified with a metal screen (shield) and drain wire. Multicore cabling shall be provided with a collective screen (overall shield); individual pair screening (shielding) shall only be applied if specifically needed for the application.

Underground cabling shall be provided with an AL/HDPE/PA inner sheathing as a moisture/chemical barrier. An alternative, subject to Principal's approval, is using lead sheathing.

Cable capacitance and inductance shall be verified to function properly when used on intrinsically safe or non incandive (switched) circuits.

If the ambient temperature is above 90°C (190°F), (e.g., in rotating equipment or in close proximity to furnaces) thermocouple lead wire shall have Teflon or Kapton insulation. Length and gauge of thermocouple lead wire shall be sized so that resistance of wire does not exceed 800 ohms. Splicing of thermocouple extension wires is not acceptable. For vibrating or flexing service, extension wire from the thermocouple to the first junction box shall have stranded conductors. For all other services, wire shall use single solid conductors.