

DEP SPECIFICATION

CHEMICAL INJECTION SYSTEMS FOR UPSTREAM PRODUCTION FACILITIES

DEP 31.01.10.10-Gen.

February 2011

(DEP Circular 09/12 has been incorporated)

ECCN EAR99

DESIGN AND ENGINEERING PRACTICE

DEM1



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the design of chemical injection systems for new or refurbished upstream production facilities. However, for existing facilities this DEP should be used to ensure that necessary safety critical elements are in place.

It is based on the requirements for offshore and onshore production facilities.

This DEP covers the design of all types of chemical injection systems. DEP 30.10.02.14-Gen. provides requirements corrosion control of carbon steel and focuses in detail on chemicals used for corrosion control. The DEPs have been written so that general chemical injection system requirements are included in this DEP and additional requirements specific to chemicals used for corrosion control are included in DEP 30.10.02.14-Gen. to avoid any overlaps and gaps.

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual DEM 1 – Application of Technical Standards.

This is a revision of the DEP of the same number dated January 2010; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

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This DEP is intended for use in facilities related to exploration and production facilities. 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 capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Very toxic (substances) substances that are very hazardous for the environment or human health, as specified in DEP 01.00.01.30-Gen. (which also identifies "toxic" substances by reference to chemical substances databases).

1.4 ABBREVIATIONS

CRA	Corrosion resistant alloys
IBC	Intermediate bulk container
IRCD	Injection rate control device
MSDS	Materials safety data sheet
NNM	Not normally manned
PEFS	Process Engineering Flow Scheme

NOTE: Also known as P&ID (process and instrumentation diagram)

1.5 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 (5).

1.6 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated January 2010.

Content of the previous version that was background information, explanation and guidance and therefore not required to be communicated to the Contractor, has been moved into a companion document called a "DEP Informative" accessible from the Shell Standards web page.

1.7 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://swwww.shell.com/standards> and on the main page of the DEPs DVD-ROM.

1.8 DUAL UNITS

**Amended per
Circular 09/12**

Dual units have been incorporated throughout this DEP.

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. CHEMICAL INJECTION SYSTEM GOALS, DESCRIPTION AND DESIGN

2.1 SYSTEM GOALS

Functional requirements for subsea chemical injection units shall be in accordance with API Spec 17F.

The design and operation of the chemical injection facilities are an inherent part of the process management system and underpin both Well & Reservoir Management (WRM) and process safety. The chemical injection hardware shall be provided as described in this DEP and appropriate operational procedures shall be developed in order to ensure that the chemical injection goals are met. The selected chemicals and injection dose rates, procedures, operator training and monitoring and inspection data should be analysed and the results fed back to optimise the chemical injection process.

The cost effectiveness of backup systems and automation should be considered during the design in order to improve injection system availability and uptime.

High uptime of the injection system is critically dependent on the people element, particularly during operation. A high level of availability will not be achieved unless there is adequate training and management, e.g. the setting and surveillance of key performance indicators. If there is potentially a conflict between a focus on production or cost control and a focus on achieving the required availability, the effectiveness of the chemical injection system could suffer. Poorly designed systems that require large amounts of operator intervention will likely create a conflict and shall be avoided. Well designed systems will minimise downtime, enhance production and minimise operating costs.

The selection of chemical injection system hardware to achieve a specified availability shall consider a number of factors:

- Remoteness / harshness of location and supply chain.
- Manning levels and frequency of operator intervention.
- Cost / benefit analysis of high availability against production uptime.
- Risk of loss of integrity if availability is not met e.g. corrosion inhibition.
- Power supply suitability

2.2 SYSTEM DESCRIPTION

2.2.1 Storage, bunkering, mixing, metering, dosing and calibration

Chemical flow should be measured before being manifolded to the injection pumps. In addition, each injection stream of the chemical injection skid shall be individually measured. Calibration facilities shall be provided.

Bunkering arrangements for transfer of chemicals to local storage facilities at the point of use shall be suitably designed so as to avoid the inadvertent mixing of chemicals that should be segregated either during the bunkering or by interconnecting drains systems backing up.

Arrangements shall be made to prevent potential exothermic reactions and/or evolution of toxic by-products. Facilities shall take into account the impact of local environmental conditions including high and low temperatures, wind conditions etc.

In all cases, the implications for manual handling shall be considered. Individual OU policies and local regulations in respect of manual handling shall be applied.

2.2.2 Facilities

At manned installations, the chemical bulk storage, mixing, measuring, pumping and calibration facilities shall be located insofar as is practical in one or a very few integrated chemical injection packages. At offshore facilities, this package should be a two-level structure with the storage tanks located adjacent to the pumps. The roof of the package (or

an upper deck) should be used, if possible, as an IBC laydown/unloading area; see Figure 1. For additional layout requirements on offshore facilities, see (3.8).

If an injection duty requires large volumes ($> 10 \text{ m}^3$ [353 ft^3]) of storage and the possibilities of interchanging chemicals and facilities are limited, then a dedicated (subsidiary) chemical injection package should be provided with the ability to be worked in tandem or separately.

For NNM facilities or platforms, the required tanks and pumps should be minimised to ALARP to achieve required availability. Thus for chemical injection on NNM facilities or platforms, the use of pipelines (or umbilicals) from manned installations should be considered. Similarly, chemicals requiring dilution should be supplied to NNM facilities or platforms in diluted form, with any required mixing being done onshore.

If multiple chemical tanks are present on a facility and are filled from an IBC, truck or supply boat, filling hoses shall be clearly marked, colour coded or positively differentiated by other means to avoid mixing of chemicals and contamination.

2.3 SYSTEM DESIGN

2.3.1 General

Table 1 provides a guide to various design items according to different levels of availability, represented by the factor 'f'. In case of wet sour gas fluid system, DEP 31.40.00.19-Gen. shall be used.

The chemical injection system SHALL [PS] have applicable injection quills and nozzles as required for service.

The design should encompass all the operating conditions that are anticipated with sufficient injection points provided for future requirements. Details of equipment sizes and injection rates should be provided in the form of a process flow scheme (PFS) and a process engineering flow scheme (PEFS). The equipment should include piping, instruments, valve actuators, level shutdown devices and other accessories to make a complete and functional system. Sample connections, vents, low point drains and minor material items required to make the system functional are part of the assembly.

Table 1 **Criteria for chemical injection system design to meet a specified system availability (modification of table from Report EP2000-5721)**

Item	Availability, f		
	Good (f = 0.95)	Excellent (f = 0.99)	Critical (f > 0.99)
Chemical SHALL [PS] be demonstrated as suitable for the application [Note 1]	Required	Required	Required
Chemical performance SHALL [PS] be validated on site for corrosion and scale inhibitors or other applications that impact process safety and can be effectively assessed.	Required within 3 months of commissioning or first usage	Required within 1 month of commissioning or first usage	Required within 1 month of commissioning or first usage
Chemical injection pumps [Note 2]	Standard	High reliability	High reliability
Installed back up pumps	Spare pump in maintenance stock.	Required	Required
Back up pump spares in country	Should be assessed. Depends on lead time for spares or pump replacement	Required	Required
Operational status of pump shall be checked and recorded [Note 3]	Daily, manual check with records kept	Automated alarm (shall be checked, at least annually). Pump uptime to be tracked, preferably in DCS / PI	Automated alarm (shall be checked, at least bi-annually) Pump uptime to be tracked in DCS / PI
Pump planned maintenance	Annual	Semi-annual	May be required more often
Chemical tank levels	Daily manual check	Automated alarm or documented daily manual check	Automated alarm
Report on chemical used (or report on compliance with key performance indicators) to responsible engineer	Monthly (or as per agreed frequency) agreed and recorded	Weekly (or as per agreed frequency) agreed and recorded	Daily (or as per agreed frequency) agreed and recorded
Flow rate to individual injection points SHALL [PS] be measured and recorded by:	Flow meters local or linked (preferably) to DCS with readout in a control room	Flow meters linked to DCS or local readout in at least a daily manned control room. Storage of data in PI historian.	Flow meters linked to DCS with readout in at least a 24/7 manned control room Storage of data in PI historian
Chemical availability shall be calculated & reported as an individual KPI [Note 4]	Monthly	Weekly	Daily
Manual check on pump injection rate and calibration check on flow meters/switch	Required quarterly	Required monthly	Required weekly
Low or no flow alarm (out of specification, differential pressure across a critical component, or inline flow meters)	Not required	Required	Required

Item	Availability, f		
	Good (f = 0.95)	Excellent (f = 0.99)	Critical (f > 0.99)
Liquid samples shall be taken for analysis of critical residual inhibitor levels and water chemistry as defined by responsible engineer	Monthly but may be required more often	Monthly but may be required more often	At least monthly, but may be required more often"
Monitoring system response SHALL [PS] be implemented, e.g. ER corrosion probes, bandwidth on dump valves position or separator gas flow for foam detection, BS&W on sales oil, OIW, Oxygen analysers [Note 5]	At least annual chemical performance measurement	Online sensors: response time less than 7 days	Online fast response monitoring systems: response time ≤ 12 hours
Comprehensive review of untreated events [Note 6]	Recommended	Required	Required
Persistency taken into account	Required	Required	Required
Allowed days chemical system downtime per year (allowed number of days per single event)	18 (3)*	4 (1)*	0 to 4 (0.5)*
Shut in if treatment system goes down for greater than the allowed period of time	Possibly	Probably	Required
Identify operations technician with responsibility for the chemical injection system	Required	Required	Required
Engineering involvement	Monthly review	Weekly review, unless daily concern	Daily review
Key Performance Indicators set for operations technicians, chemical supplier and engineers [Note 7]	Required	Required with quarterly reporting	Required with monthly reporting
Minimum storage capacity of chemical to be applied	7 days	14 days	28 days
* Unless persistency has been established and allows longer duration of events. In all cases the time between events shall be at least 7 days, in order to ensure that corrosion inhibitor films can be re-established. For corrosion inhibitors the value may need to be determined from corrosion rate data or modelling of the specific system. For other chemicals downtime may not be acceptable. NOTES: 1. Corrosion Inhibitors should be selected in accordance with OG 02 20555 Selection and Testing of Corrosion Inhibitors with reference to Appendix 3 2. Standard pumps may be air driven pneumatic. High reliability pumps are generally electric drive. The electric driven pumps can also be connected to the emergency power depending on the criticality of these pumps. 3. Sufficient automation shall be provided according to the integrity criticality of the system and the way in which the system is operated. Systems shall be designed to minimise the need for manual intervention. 4. Chemical availability = time pumping correct dose / total (required) time. 5. The availability of monitoring equipment / devices (such as corrosion probes) should have its own KPI that is routinely monitored. 6. For offshore systems a failure assessment of the complete system, both subsea and topside aspects, shall be undertaken to confirm the adequacy of the design. 7. A system audit is desirable for good availability systems, required bi-annually for excellent systems and required annually for critical systems.			

Equipment shall be procured from Suppliers who are approved by the Principal and shall have a proven track record in similar service.

2.3.2 Design for chemical selection, duty and properties

Chemical injection facilities should be reliable, accurate and flexible.

- This could, for instance, necessitate the installation of 2 pumps to better accommodate the accuracies required over wide turn-down ratios.

Therefore, for any given chemical injection duty:

- a) the pump sizing and storage volume shall be suitable for each chemical which, during the conceptual design, is judged likely to be used in that duty. If adequate turn-up/down by a single installed pump is not practical for the full expected lifecycle, the designer should use, if possible, pumps that may be re-sized by minor field modifications to achieve a lifecycle design and shall install pumps that are serviceable at start-up flow rates.
- b) if the chemical duty or volume required changes, this should be checked against the operating window for the chemical system and if necessary the suitability of the pump sizing should be re-assessed; In the design phase the operating window of the pump (chemical types, minimum and maximum flow rate etc.) shall be documented.
- c) the full range of possible operational conditions and not just the maximum flowrates, e.g., initial low production ramp-up to maximum design rate, likely minimum and maximum chemical dosage rates for these flows shall be included in the design;
- d) material selection SHALL [PS] be compatible with the chemical(s) envisaged and also consider connections downstream of the injection module, e.g. umbilicals, injection valves, wellhead, downhole injection capillary etc.
- e) the required chemical availability shall be adequately documented by conducting a formal availability assessment and cover the whole system from tanks to chemical delivery points e.g. subsea, downhole.
- f) the HSE properties of chemicals SHALL [PS] be provided as a requirement for safety in design. The Principal's chemicals specialists (Production Chemist) shall select the chemicals used. This selection SHALL [PS] give due consideration to minimising fire hazard, occupational hazards and hazards to the environment. Relevant chemicals, design and location hazards should be subject to HSE reviews as may be required.

These requirements shall be detailed in the Chemical Requirements Report.

Based on the requirements, a Chemical Injection Summary Sheet (Figure 2) shall be prepared which defines the range of conditions to be covered by each dosing system. This Summary Sheet shall form part of the Basis for Design of the chemical injection system. Revisions to this list shall be discussed and agreed between all the above-mentioned parties.

The criticality of the chemical injection system should reflect the criticality of the application and the designer SHALL [PS] consider if the injection scheme is part of safety critical equipment (e.g. pumps etc.).

The Environment Manual shall apply. Only chemicals which have been assessed and deemed to be suitable in relation to technical, health, safety, environmental requirements and for which there is a Material Safety Data Sheet SHALL [PS] be used; see (2.4.7).

2.3.3 Import of chemicals

The chemical Vendor shall be responsible for ensuring that transportation tanks are clean before loading any chemical. A cleanliness specification shall be defined and verified on a regular basis.

IBCs shall be placed either on top of the chemical injection package or on a roof area, as directly above as possible. The lifting equipment and the IBCs shall be designed to withstand the loads, including dynamic loads, with appropriate certification available. Transfer to storage through gravity flow shall be done manually. Wherever possible, a single IBC laydown area should be provided to serve all chemical injection packages on the installation.

For offshore platforms located in a relatively calm sea environment, chemicals may be pumped from an IBC on the deck of the supply boat up to the permanent tanks on the platform if appropriate. This approach shall require a proper risk-assessment.

Ships' tanks should preferably not be used to transport any chemicals since the cleanliness of these tanks cannot be guaranteed and the risk of contamination is high. If transport is

required in ship's tanks, these shall be dedicated and the shipping company shall be responsible for ensuring their cleanliness prior to product loading.

In hot climates, the potential chemical losses due to evaporation during transportation shall be considered when selecting the types of chemicals to be used.

2.3.4 Storage facilities

Chemical storage capacity shall ensure an adequate number of days of operation to safeguard against prolonged adverse weather conditions that may prevent further supplies from being delivered or known challenges with customs clearances, or the possibility of unreliable access. The design shall take into consideration the time required at the supply base to order, receive, inspect and transfer the chemicals, along with any safety implications resulting from storage of chemicals. Effective storage volumes shall normally consider (1) routine delivery intervals plus contingency time for adverse conditions, (2) IBC delivery size plus added minimum tank runtime volume, (3) available deck/pan area for safe IBC storage and (4) operator surveillance and work demands.

For NNM facilities/satellite platforms where the chemicals are supplied in IBCs, the storage tanks shall be sized to ensure availability in the event of adverse conditions and optimise the frequency of manned re-filling operations. The chemicals' shelf life shall not be exceeded. Ideally the chemicals should be supplied via an umbilical if practical.

Offshore chemical storage areas shall be fitted with secondary containment facilities to prevent direct discharge into the sea in the event of a spillage (see also 3.6).

For land facilities the storage tanks shall have bund walls with sufficient capacity to hold all chemicals stored at the site. Bunded areas or 'secondary containment' shall be sufficient to hold at least 120% of the total volume of the chemical storage in that area. They shall also be regularly inspected for integrity and kept fit-for-purpose.

All storage tanks shall have a sloping bottom with the (outlet) at the lowest point.

Tank level should be displayed on DCS in addition to locally wherever possible.

Vents on storage tanks shall have sufficient capacity to allow air or blanketing gas to escape at the highest chemical filling rate anticipated. The venting system shall be designed in accordance with DEP 80.45.10.10-Gen.

2.3.5 Injection pumps

Pump discharge pressure requirement shall consider downstream pipe configuration and any differential pressure requirements associated with injection quills. The injection quill Manufacturer/Supplier should specify the pressure drop required.

The sparing requirement for the pumps shall be based on the availability required in accordance with Table 1 in (2.3.1). For high availability systems a reliability review should be carried out by a control and automation specialist to verify that the reliability is in line with the target for the chemical system. As a minimum, a common non-installed spare of each pump type should be kept in storage, unless sufficient redundancy is designed into the system to allow continued injection whilst replacement is enacted.

The pumps should have the provision to be locally started and stopped. However, if undiluted chemicals must continue to be injected into a non-flowing system, an alarm shall be installed which will direct the operators to check whether the chemical is flowing even though the rest of the operation has been shut down. If chemicals do not need to be injected into a non-flowing system, the pump SHALL [PS] be shut down automatically if no production is flowing. Alarms should additionally notify operators if production flow is restarted and chemical injection is not.

For NNM offshore platforms, the option of remote starting and stopping by telemetry is not likely to be essential for operational reasons and should be avoided if possible.

Specialised chemical pumping companies or chemical vendors have extensive experience with injection pumps and should be involved in pump selection.

Injection pumps shall be specified in accordance with (3.3). One pump SHALL [PS] not feed more than one injection point, unless IRCDs are used (2.3.6).

Appropriate facilities shall be provided so as to ensure reliable and effective injection rate control. Rate control should be achieved directly by the pumps by such methods as stroke adjustment or speed control. Automated control shall be required for subsea, critical high availability and other chemicals as identified by the Principal.

Sufficient flow meters should be installed which shall be connected to the platform DCS system, thus allowing flow rate data to be readily available both onshore and offshore. Flow meters with totalisers or a robust method for totalising in the DCS shall be provided if critical. A local display should be provided in addition to DCS. Pump alarms and alarm settings shall be agreed with the Project Operations Representative in order to give fast and effective response to the operator.

For most applications and particularly fast-acting systems such as H₂S scavengers, a short-term fluctuation of dose will be undesirable; therefore the requirement for pulsation dampeners or dual head injection pumps, back-pressure valves (subsea systems) etc to attain a constant dose rate shall be considered.

2.3.6 Injection Rate Control Devices (IRCDs)

The use of Injection Rate Control Device (IRCD) systems may be considered for chemicals that need to be injected at many locations or at significantly varying rates.

A constant injection rate should always be maintained irrespective of backpressure fluctuations.

If IRCDs are considered, a complete analysis shall be conducted for the use of an IRCD in lieu of individual injection pumps at the FEED stage of the project. This analysis shall include equipment requirements to achieve the expected range of chemical dosage during the lifecycle of the chemical injection system. If the analysis concludes that equipment changes may be needed during the lifecycle, an appropriate sparing provision should be made. Complete automation of IRCD systems shall be considered to achieve the designed chemical delivery reliability and minimize surveillance and manpower. The cost assessment comparing IRCDs to multiple pumps shall include added instrumentation controls and lifecycle operating / maintenance costs. IRCDs shall not be implemented where the availability of chemical injection is critical.

The lifecycle assessment should critically assess the maintenance intensive nature of IRCD devices and the associated operator requirements.

In any case IRCDs shall be maintained properly. They require regular scheduled interventions, at least every 6 months. Due to the necessity of these regular interventions they are not suitable for a subsea daisy chain, in which the individual isolation of injection points is difficult. IRCDs should have intensive maintenance to ensure their proper functioning. Consequently, subsea applications where IRCDs are located subsea are not recommended unless a high integrity system is designed and maintained, thereby avoiding the potential requirement for frequent subsea interventions.

For an IRCD to function properly, the chemical to be used shall be suitable for such an injection service, i.e. not shear sensitive. The materials compatibility shall be checked using material selection DEP 39.01.10.12-Gen.

2.3.7 Calibration

At least one flow calibration gauge per chemical shall be installed for each individual injection pump. The calibration gauge shall be manifolded to the individual pumps by rigid piping or a high-integrity flexible hose.

As the calibration system is frequently used, it shall be laid out so that it is readily accessible and easily operated. The use of multiple calibration gauges shall be considered for operational convenience and for high availability systems, in accordance with Table 1 in (2.3.1).

2.3.8 Injection points

If injection into a vessel is required, the requirements should be specified as part of the overall vessel design, as this will add an additional nozzle to the vessel.

A downhole backpressure valve capable of ensuring that the liquid line is filled shall be installed if continuous treatment is a functional requirement of the chemical (e.g. scale inhibition, H₂S scavenger).

The injection of more than one chemical at one point shall be avoided. If this is unavoidable it SHALL [PS] be risk assessed first and be covered by an operating procedure.

If more than one chemical is to be injected at a single injection point, their chemical compatibility SHALL [PS] be assessed. This assessment shall include dual chemical exothermic reactivity, solids formation and any impacts on functional performance of the chemicals. Each chemical should arrive at the injection point via separate conduits so that mixing takes place immediately upstream of the injection point. Advice shall be sought from a person with the appropriate technical authority in the Principal's Production Chemistry group.

2.3.9 Treatment monitoring

Manual sampling shall support automatic monitoring. Sampling points shall be provided to sample chemically treated and untreated fluids in order to assess the performance of the chemicals.

2.3.10 System cleanliness/filtration

Chemical injection systems (storage tanks, pumps, piping, meters, control valves and injection points) shall be designed, constructed and commissioned to such a level of cleanliness that the system cannot be blocked under normal operation or due to any foreseeable operator error. In particular, subsea systems with long umbilicals or systems injecting downhole into production tubing, or systems utilising ICRDs or proprietary flow control devices should be given additional attention in order to avoid blockage. Cleanliness requirements for such systems shall be in accordance with API Spec 17F.

Filtration upstream (and downstream of non surface injected products) of all chemical injection pumps shall be considered a priority. Filters installed downstream of pumps shall be designed for full collapse resistance if plugging occurs and shall be installed downstream of pump pressure relief systems.

The appropriate technical authority in the Principal's Production Chemistry Group (see NOTE under 2.3.9) shall specify a level of fluid cleanliness in accordance with ISO 4406, or equivalent (e.g. AS 4059). Long-term system cleanliness in operation SHALL [PS] be ensured by means of filters and suitably selected Corrosion Resistant Alloys for storage tanks and small bore piping. The solids specification of the chemical should be reconciled with the tolerances of the injection facilities (hardware Manufacturer specification).

In addition, the same specification for cleanliness shall be applied when the IBCs are filled.

2.4 HEALTH, SAFETY, ENVIRONMENT AND QUALITY

2.4.1 General

The chemical injection facilities shall comply with the HSSE & SP Control Framework.

2.4.2 Area classification

All instrumentation shall be certified as suitable for installation in the area installed; see DEP 80.00.10.10-Gen. Generally on offshore facilities, instrumentation shall at least be suitable for installation in a Zone 2 classification, gas groups IIA/B, temperature class T3, even if it is actually installed in a non-hazardous area.

At onshore facilities, cost effective designs in which electrical intrinsic safety is deliberately excluded may be acceptable but it should be proved that the area classification and fluid properties (flash point > 55 °C [131°F]) are suitably considered.

2.4.3 Fire protection

As chemical injection facilities may contain low flash point, flammable and/or very toxic substances, these risks shall be used in development of the appropriate protection requirements in line with the project HSSE & SP MS and Activity plan. Fire protection shall be in accordance with DEP 80.47.10.12-Gen. and DEP 80.47.10.31-Gen. as applicable.

2.4.4 Package location

Due to the potential hazards posed by the chemicals, the location of the chemical injection package should, as far as reasonably practicable, be kept clear of safety systems. Escape and evacuation routes shall not be obstructed by any very toxic substances that might result from an incident. See also (2.4.2).

2.4.5 Shutdown / Start Up Control Logic

Each chemical injection pump should be tripped on shutdown of the process with which it is associated unless chemical injection is specifically required in a particular shutdown situation (methanol). If the design does not include tripping of chemical injection on a process shutdown, advice shall be sought from the Principal's Production Chemistry group as to the possible detrimental effects of the presence of undiluted chemical(s). Likewise, where more than one chemical is involved in start up activities, the advice of Production Chemistry shall be sought if control logic is required in the start up sequencing. If continuous corrosion inhibitors and batch corrosion inhibitors are being considered, advice shall be sought from the Principal's Corrosion Engineering Department.

All pneumatically driven chemical injection pumps shall be tripped out by an alarm signal to the shutdown valve in the air/gas supply lines. For electric motor-driven pumps, the shutdown signal shall trip the power supply to the pump motor.

2.4.6 Colour coding

All chemical injection piping and hose end connections shall be labelled according to chemical usage. If the usage cannot be readily classified, the labelling shall state the actual chemical.

Quick connectors on flexible hoses should be colour-coded and keyed, i.e. non-interchangeable, for each chemical type. Special connectors should be used to eliminate the possibility of confusion.

All colour coding should have a pattern as well in order to assist colour-blind operators.

2.4.7 Chemical information

The chemical Supplier shall provide all available safety data on MSDSs. Chemical MSDSs should be in accordance with ISO 11014-1. The viscosity profile with temperature and pressure should be provided and checked against the selected injection pump performance curve.

2.4.8 Ergonomics

The layout of a chemical injection system shall be reviewed to assess the demands placed upon personnel operating the equipment, with design in accordance with DEP 30.00.60.10-Gen.

2.4.9 Environment

All fluids and equipment used shall be handled, utilised and disposed of in an environmentally friendly manner in accordance with the HSSE & SP Control Framework and national or international legislation requirements where applicable. Such disposal should take account of the fluids that remain in the equipment and may not have been removed as a result of a blockage.

2.4.10 Quality

Fluid and system designers and manufacturers should work to recognised quality management systems. Such requirements should extend to the manufacturers and

suppliers of precursor fluids / materials and sub-contractors used in the design & fabrication of sub-components.

Audits should be undertaken at the fluid manufacturers and their precursor fluids/materials providers to ensure the above requirements are being complied with insofar as is applicable. Inspection and testing, including retesting where fluid formulations and/or changes to manufacturing processes occur should be considered as a critical part of the quality assurance programme. Such inspection and testing considerations should also apply to fabrication activities, operational maintenance and facilities upgrades.

Management of change procedures shall be followed.

2.5 WINTERISATION REQUIREMENTS

In general, chemicals which crystallise or drop below their pour point in their undiluted state at the specified minimum ambient temperature should not be used, because they are usually transported in unheated IBCs.

If any chemicals become unpumpable or ineffective (either due to falling below their pour point or crystallisation point) at the specified minimum ambient temperature, the tank shall be lagged and either heat-traced or fitted with an immersion heater. The pipework and instrumentation shall be electrically traced and insulated. Heating design shall not exceed a surface contact temperature that may cause thermal degradation of the treatment chemical.

The Principal's Production Chemistry Department should be contacted for specific chemical requirements.

2.6 SUMMERISATION REQUIREMENTS

Special considerations should be made for certain operating environments, e.g. ambient temperatures or black body temperatures in hot climates can reach in excess of 80 °C which may over time, together with strong sunlight, affect non metallic components and chemical stability. The need for additional precautions should be considered for pump electric motors. The Principal's Production Chemistry department shall be contacted to determine any specific chemical requirements. In these circumstances chemical storage tanks shall be provided with appropriate protection from direct sunlight and excessive heat build-up.

2.7 DESERT CONDITIONS

The equipment should be designed to prevent sand from entering vents, etc., during sandstorms. In addition, special protection for pump motors (usually available from the Manufacturer) under such conditions should be considered.

2.8 DESIGN AND FABRICATION

The design and fabrication of the chemical injection facilities may be undertaken in different ways: they should ideally be packages supplied by a Manufacturer/Supplier, but may be designed and fabricated by the Contractor as part of the module on (or in) which they are located, or they may be produced as a combination of both.

2.9 INSTALLATION AND COMMISSIONING

Installation and commissioning SHALL [PS] be considered when designing a chemical injection system as part of the FEED process and take account of the following:-

- Subsea applications: Common delivery fluid of water based ethylene glycol solution shall be selected for each chemical injection fluid conduit (associated with trees, manifold, umbilical, etc.) Conduits shall be clearly identified as to which will be used at start-up or at a later time.
- Erroneous connection of a control fluid conduit to a chemical injection fluid conduit should be prevented. The use of different fitting types shall be considered.
- Flow path shall be checked to ensure erroneous connections are corrected before purging with service fluids.

- Competency of personnel and level of supervision of personnel involved in installing and connecting topsides equipment shall be checked (pumps, reservoir tanks, filters, interconnecting pipe-work, etc.).
- All construction debris (including welding consumables, weld purge dams, general debris) SHALL [PS] be removed from the chemical system before the introduction of service fluids.
- A register of the status of each core in relation to its current liquid content shall be maintained.

2.10 SUBSEA APPLICATION OF PROCESS CHEMICALS

For these special applications, ISO 13628 shall apply.

Relevant guidance for process chemicals shall, as a minimum, be taken from the qualification procedure specified for hydraulic fluids in ISO 13628-6:2006 Annex C and 13628-X:2010 Attributes of production chemicals.

3. EQUIPMENT DESIGN DETAILS

3.1 BULK TRANSFER TO STORAGE

Flexible hoses shall be used to connect IBCs to storage tanks (or inlet piping).

To facilitate safe handling and prevent contamination, dedicated hoses and tank feed lines / connection flanges shall be provided for each chemical, fitted with a suitable IBC connector and a unique male/female snap connector or flange for connection to the storage tank (or inlet piping).

All hoses and flexible connectors shall be clearly marked, colour coded or positively differentiated by other means according to chemical usage, see (2.4.6). Tank inlet feed piping or connection shall be clearly labelled identifying receiving tank and its chemical.

A common hose, fitted with a suitable IBC connection coupling and a hose connector, should not be used for non-hazardous chemicals unless the consequences of contamination are shown to be negligible. An alarm system shall be put in place to prevent overflow of chemical storage tanks.

For linked tanks, the inlet piping shall be provided with a flange in which a restrictive orifice may be fitted, to reduce the IBC drainage rate such that tanks can balance without overflowing.

All chemical unloading and transfer stations shall have highly visible signage.

If IBCs are used as direct feed to chemical injection pumps, the system shall be designed so that no air is drawn into the pump inlet when the IBC is empty and/or being replaced.

3.2 STORAGE TANKS

3.2.1 General

For main chemical injection packages, a single rectangular, compartmentalised style of tank should be considered to minimise space, weight and cost.

3.2.2 Specification

Nozzles not required for any given duty shall be deleted.

Storage volumes shall be determined in accordance with the requirements of (2.3.4).

Tank filling and relief back-flow connections shall be designed to minimise swirl and the build-up of static electricity.

Each tank should be fitted with an overflow sized to discharge the maximum filling rate. The overflow shall be routed via a tundish to provide visual indication of overfill and shall be dipped and fitted with a siphon breaker where appropriate (e.g. on blanketed tanks or to prevent venting through overflow pipework). Overflow piping that is manifolded together shall be designed to prevent the mixing of chemicals between tanks (e.g. Figure 3).

Each tank shall have a single outlet connection that will feed the pump suction header. Tanks initially intended to hold the same chemical shall be manifolded together on the pump suction header.

Tanks shall be mounted above a drip tray. An individual drip tray shall be provided for any tank where accidental contact of its contents with any of the other chemicals would lead to the formation of a new hazardous substance (liquid or vapour) or start an exothermic reaction which might exceed the chemical's flash point. For these cases, a separate skidded unit should be considered. As per 3.1, an alarm system shall be put in place to prevent overflow of chemical storage tanks.

Tank vents should be manifolded and shall be routed to a vent at a safe location in the open air. When tank overflow is not present, provision shall be made in the manifolded vent piping to prevent the mixing of chemicals between tanks (e.g. Figure 3). The nature and volume of chemical stored, including the effect of gravity of the solvent, should be taken

into consideration in selecting a safe location. Ferric chloride storage shall have an individual vent.

All tanks shall be fitted with a manhole (usually 610 mm [24 in] diameter) to allow internal inspection and a valved utility connection to permit washout and purging.

Both tank and frame shall be individually earthed.

If drip tray contents are drained into a facilities drain system, their compatibility with the contents of the drain fluids and possible construction materials shall be considered, with reference to material selection DEP 39.01.10.11-Gen & DEP 39.01.10.12-Gen.

Sight glasses shall be constructed from materials that will remain transparent during their field life. It should be possible to clean the sight glasses internally.

3.2.3 Design conditions

Most fabricated tanks are rectangular tanks for which there are no specific design codes, but common structural standards shall apply, e.g. API 2000.

Chemical storage tanks shall be designed for a minimum internal pressure of 0.06 bar (ga) (0.87 psig) (at maximum ambient temperature). For tanks without an overflow, the design pressure shall cover the maximum head the tank may experience in the event of overflow, e.g. liquid head pressure in the vent lines.

3.2.4 Materials

Materials for storage tanks of main and subsidiary chemical injection packages shall be selected in accordance with DEP 39.01.10.12-Gen. If a chemical is not covered in DEP 39.01.10.12-Gen., the material shall be selected by a materials and corrosion specialist in consultation with the chemical Supplier and Production Chemist.

In selecting materials both the internal (chemical) and external (atmospheric) environment shall be considered. In offshore, coastal and some desert conditions, the atmospheric environment is high in chlorides and requirement for application of external coating on some CRAs should be evaluated.

Glass-fibre-reinforced epoxy and polyester vessels shall be designed in accordance with DEP 31.22.30.14-Gen.

3.2.5 Miscellaneous

3.2.5.1 Tracing and heating

If any chemical requires heating, either tank tracing or an immersion heater of sufficient capacity shall be provided. Heaters shall be equipped with on/off thermostatic control and shall trip on low level in the tank. Either a paddle mixer, usually top-entry vertical / inclined or a circulation pump, drawing from the base of the tank and flowing into the top, shall be used if a heater is provided or mixing/dilution is required. Consideration should be given to the mixer nozzle size, accessibility required for paddle withdrawal/replacement and to fitting of a filter and sample point for recirculating pump options.

3.2.5.2 Tank blanketing

A tank blanketing system shall be provided if flammable or explosive vapours may accumulate in a tank, the chemical may decompose upon contact with air or dissolved oxygen within chemical products needs to be minimised. Tanks requiring blanketing shall be supplied with inert gas that will not create an explosive condition. Blanketed vessels shall be provided with a vacuum-vent pressure relief valve. Tank blanketing gas shall be supplied to blanketed vessels and tanks shall be vented by means of self-regulating control valves, with a local pressure gauge. Tank vents shall be routed to a safe location and/or be provided with suitable safety equipment, e.g. flame / detonation arrestors. In systems where the presence of oxygen, injected via chemicals, has an impact on the process or materials, tanks shall be blanketed by means of high quality nitrogen ($\geq 99.99\%$ purity).

3.2.5.3 Dilution and mixing

When site chemical mixing is planned, the storage tank should comprise a single tank with three compartments, one each for neat chemical, mixing with diluent and diluted fully mixed service chemical. A centrifugal pump should be used to transfer between the compartments and for re-circulation during mixing. In general, pre-mixing should be carried out onshore wherever practicable.

3.3 INJECTION PUMPS

3.3.1 General

The number of chemical injection pumps shall be determined in accordance with (2.3.5).

3.3.2 Specifications

3.3.2.1 General

Chemical injection pumps shall be positive displacement pumps and shall be in accordance with DEP 31.29.12.30-Gen. The pumps should lie within the Manufacturer's actual field experience of operating temperature, maximum working pressure, material of construction, pump speed and pumped liquid properties. Diaphragm pumps with direct mechanical actuation shall not be used.

Single-head, air driven positive displacement plunger pumps with manual capacity adjustment may be used, but electrically driven single-head pumps are preferred (especially if little or no compressed air is available).

The pump Manufacturer shall specify the lowest capacity that is achievable without sacrificing pump performance. The lowest required chemical injection rate shall not be less than this minimum pump capacity.

Multi-head pumps are common where space is restricted, i.e. offshore. Multi-head pumps should not be used unless the capacity can be adjusted per head to suit the requirements of each individual injection point. Where chemical availability greater than 0.95 is specified a spare interswitchable pump bank shall be incorporated.

Pumps shall be standardised as far as possible, to minimise the number of spares required.

The pump suction line shall be equipped with a block valve, a Y-type strainer with suitably sized mesh screen for specified fluid cleanliness (unless fluid properties prevent it) and an integral drain valve. It shall also have a valved connection with hose connector for flushing the pump with suitable fluid, e.g., potable water, prior to removal. The flushing connection should also be used for connection to the calibration gauge, if required.

The pump suction line should be made as short and direct as possible to ensure that the required acceleration head is minimised. The discharge line pressure rating shall be taken back to (and include) the suction block valve.

3.3.2.2 Pressure relief

A relief valve shall be provided on the discharge of each chemical injection pump where necessary to prevent over-pressurisation of the pump.

- NOTES:
1. Manufacturers may build in a recycle valve which diverts flow back to the suction side when the pressure limit is exceeded. These valves shall not be considered to meet the above requirement for relief valves.
 2. With air-driven pumps, the requirements for a relief valve should be reviewed because the stalling pressure may be less than the system's maximum working pressure.

3.3.2.3 Auxiliaries

An over-run protection or a PD switch that shuts down the pump if supplied product runs dry shall be used to protect the pump and also to prevent any hazards (e.g. a fire).

Each pump discharge line shall also be equipped with a pressure gauge, a valved and blanked connection for the pump flushing outlet stream, a check valve and a block valve.

Each pump shall have a pulsation suppression device in accordance with DEP 31.29.12.30-Gen. The pulsation suppression device should only be shared between pumps that are manifolded on the discharge side although this is not the preferred mode of operation. The piping arrangement shall be symmetric so that a shared pulsation dampener may be used.

The configuration of suction and discharge piping shall allow replacement or maintenance of suction and discharge valves without dismantling the main piping.

The outlet of the pumps shall, if discharged into piping operating below 3 bar gauge (45 psig), be equipped with a backpressure valve.

3.3.3 Installation and maintenance guidelines and operating experience

On offshore platforms, particularly in harsh operating environments, only pumps required in the initial years of platform operation should be installed during module fabrication. However, the uncertainty of requirements should be weighed up against the maintainability of idle equipment and the ease and cost of installing pumps at a later date.

A maintenance philosophy shall be established and adequate spares provided by the project. The formal Availability Assessment (RAM Assessment) should be used to verify whether the maintenance and sparing philosophy is appropriate to deliver the design availability.

3.3.4 Materials

Materials selection for pump wetted parts shall be consistent with the materials selected for the tanks (DEP 39.01.10.12), though it is common to use a higher grade material for pumps than for the piping. In all cases, the compatibility of the chemicals with the selected materials shall be confirmed by the chemical Vendor and, in case of doubt, verified by testing.

Non-metallic materials shall be validated as compatible with the proposed chemical usage(s). As with pump sparing, non-metallics should be chosen so as to achieve compatibility with as many of the potential chemical exposures as is practical.

3.4 INJECTION POINTS

3.4.1 General

The number and location of chemical injection points shall be as documented in the chemical injection Summary Sheet; see Figure 2.

No ID intrusive quill shall be fitted to any line that requires pigging on a regular basis.

Non-return valves shall be installed in subsea injection systems. Backflow into the subsea chemical injection system due to pressure differential or fluid compressibility shall be avoided.

Where an injection point is identified as 'future', the permanently installed facilities shall include sufficient installed isolation (e.g. double block and bleed valving) so that the injection fitting and quill can be installed without necessitating a shutdown in production.

For all injection point locations (pipelines, piping and vessels), separate isometric drawings shall be produced covering orientation of the injection point, all equipment to be installed at the location (indicating if some of this is 'future' if applicable), and space required for access to / servicing the injection point (e.g. space required to install service valve and access tool on the fitting to change out quill).

3.4.2 Specification

Injection into a pipe shall be accomplished by means of injection quills located at the pipe centre-line in a location of turbulent mixing, e.g. upstream of valves, pumps and pressure drops, or (in liquid flow) upstream of bends and generally as far upstream from the location where the chemical is required as possible. The minimum reaction time of the chemical shall be taken into account in addition to any incompatibility with other chemicals and shadow effects. In selecting the location at the end of the injection quill, the line diameter

and produced fluid flow rate shall be considered. When injecting into large diameter (above DN 300 [NPS 12] nominal size) high velocity lines, a D/4 insertion length should be used to reduce the risk of damage to the quill from excessive flow induced vibration. The use of static mixers within pipework to aid mixing/dispersion should also be considered.

Should the neat injected product be modestly corrosive to the pipe (e.g. some scale and corrosion inhibitors), the injection point SHALL [PS] be chosen so that the treatment chemical is appropriately diluted by the product stream before contacting pipe walls.

Injection quills and nozzles shall be used to inject into both gas and liquid lines to ensure uniform dispersion. The nozzle spray characteristics should be a minimum 60° full cone pattern for gas line injection.

Injection quills shall use retrievable access fitting connections. Welding is preferable in sour service to reduce the number of potential leak paths. Screw type quills shall not be used. The design shall also allow for retrieval by providing sufficient head height for operation of the retrieval tool, easy access to the working location and convenient operating ergonomics.

Injection quills should be retrievable without a full shutdown of the associated process and should ideally be changed at least every 6 months wherever practicable.

Each injection point shall be provided with a block valve and a non-return valve. The injection system shall contain a valved and blanked connection for flushing purposes.

Injection points shall be adequately supported, considering the fatigue loading on these branch connections.

For downhole injection, side pocket or fixed injection mandrels shall be specified during the design of the downhole well completion equipment. Mandrels inserted in the side pockets for chemical injection shall be wireline-retrievable. The impact of net pressure at the injection point (well pressure versus liquid head) and its impact on consistent chemical delivery shall be considered in the well downhole injection design, with a provision for downhole backpressure provided as needed.

3.4.3 Design codes and conditions

Care should be taken when selecting quills; the design should allow for all flow conditions including flow-induced vibration.

The injection branch, non-return valve and block valve shall meet the requirements of the injection line pipework and the main line into which the chemical is being injected.

3.5 UMBILICALS

Compatibility of chemicals for delivery via umbilical shall be checked with other chemicals and fluids used in the system.

In specifying functional component performance requirements within subsea production system umbilicals, designers should take into account the following:

- Very small bore fluid cores/tubes and associated end fittings should not be used. As a guide, for chemical injection service, minimum core size should not be less than 9.5 mm (3/8 inch).
- For longer umbilical lengths, consideration should be given to increasing the minimum bore size of the chemical cores/tubes.
- For combined power umbilicals, the temperature build-up should be evaluated to ensure it does not adversely contribute to thermal degradation of chemicals.
- Chemical compatibility and stability for extended low temperature residence time in the umbilical shall be confirmed.

3.6 PIPING DESIGN

3.6.1 Piping codes and standards

All new chemical injection pipework shall be designed in accordance with DEP 31.38.01.12-Gen. Additionally, chemical injection pipework outside packages shall be designed to comply with DEP 31.38.01.11-Gen. Material selection design for internal corrosion control requiring routine internal surveillance and maintenance e.g. coatings, cathodic protection; shall not be chosen.

Materials shall be selected in accordance with DEP 39.01.10.11-Gen. and DEP 39.01.10.12-Gen. If a chemical is not covered in DEP 39.01.10.11-Gen., the material shall be selected by a materials and corrosion specialist in consultation with the chemical Supplier and Production Chemist.

In selecting materials both the internal (chemical) and external (atmospheric) environment shall be considered.

In offshore, coastal and some desert conditions, the atmospheric environment is high in chlorides and the requirement for application of external coating on some CRAs should be evaluated. A number of CRAs are subject to chloride stress cracking and/or chloride pitting in this environment. A more resistant CRA shall then be selected, or alternatively the CRA shall be coated to isolate it from its environment. It is not possible to provide a good paint coating on tubing and piping less than 50 mm (2 in) diameter, which accounts for most of the tubing and piping on the chemical injection system but externally pre-lined compatible tubing may be used per DEP 39.01.10.12-Gen.

Protection from the external environment should be achieved by materials selection, as covered in DEP 39.01.10.11-Gen.

If used, the resistance of GRP to the specific chemicals should be checked. See DEP 31.40.10.19-Gen. for guidelines and recommendations on the use of GRP.

3.6.2 Piping requirements

Distribution pipework should be sized so that pipe diameters are as small as possible to minimise the chemical inventory. Support requirements for small-bore injection piping should be considered.

Small-bore tubing may be used for local offtakes to injection points, or where individual distribution lines from a common manifold tend to be long and tortuous (e.g. wellhead area), but shall be continuously supported and protected from mechanical damage.

The injection pipework shall be protected against over-pressurisation; see (3.3.2.2).

All isolation (block) valves or integral double block and bleed valves shall be configured so that they meet the minimum isolation requirements.

Chemical injection isolation valves should be ball valves or integral double block and bleed valves in accordance with the appropriate piping class.

The chemical injection pipework for future pumps that is installed shall be blanked off and preserved in accordance with DEP 70.10.70.11-Gen.

If umbilicals are designed, the number of spare tubes or cores should be at least equal to the number of critical ones.

Where cold chemical dosing streams are injected into hot process streams, the effects of metal fatigue shall be taken into account in the piping and/or injection nozzle design.

3.7 DRAINAGE

Any drainage, chemical spill or accidental overflow shall be routed in accordance with the facility's Environmental Assessment (see HSSE & SP Control Framework). To mitigate the potential effects of a spill/overflow, a facility to flush the drainage system with large amounts of water should be designed either as part of the chemical injection package or as part of the module design.

When drainage, spill or overflow lines are manifolded together from multiple tanks, the design shall prevent cross-contamination between tanks (e.g. Figure 3).

Due to the aggressive nature of ferric chloride, its drainage system should include a permanent water flush facility to instantly dilute any spill.

3.8 INSTRUMENTATION AND CONTROL

3.8.1 General

All instrumentation shall be in accordance with DEP 32.31.00.32-Gen. All instrumentation and controls shall be assessed in a reliability review, conducted by the control and automation specialist, to verify that their reliability is in line with the target chemical system's availability.

3.8.2 Flow

The chemical usage meters shall have an accuracy of 2% to 5%. Flow meters shall be easily removed from the system and without chemical shutdown for critical chemicals. Flow meter selection shall consider the range of chemical treatment rates as may be encountered in the system life cycle. If a single meter cannot meet this range of rates, the piping run should be designed to accommodate other acceptable flow meters and those other flowmeters shall be available on-site.

Positive displacement meters should not be used for small volumes.

When the chemical injection pumps and relief valve are selected, consideration should be given to the potentially large pressure drops across flow sensors.

Where multiple flowmeters are required), the use of different types of flow meters in parallel, to avoid common mode failure, should be considered.

Flowmeters can be supported by the calculations of flow rates by pump stroke counters, but this should be considered as a low accuracy system used for pump diagnostics, rather than for primary flow measurement.

Provision for flow meter calibration shall be made.

3.8.3 Level

Gauge glasses should, where possible, be of standard length, externally mounted and fitted to each storage tank, although some facilities may prefer wall-type gauge glasses.

Where filling is carried out from a location remote from the chemical tanks (e.g. on some offshore facilities), indicators from the level transmitted shall be visible at the filling location.

Tank level gauges shall be readily visible to operators and provisions shall be made to assure readability for tall tanks.

Each tank shall be fitted with a low level alarm that shall trip the associated injection pumps. All level switches shall be of the externally mounted float-operated type and should be mounted directly on the tank.

3.8.4 Air Pressure and Quality

For air driven pumps, the air supply to the pumps shall pass through a self-regulating controller. The air supply shall be instrument air quality, see DEP 31.37.00.11-Gen.

In some Operating Units, air driven pumps are not allowed as air systems can be contaminated with fuel gas or water. The Principal shall be consulted to confirm whether this is the case.

3.8.5 Relief valves

Pump relief valves shall be designed and installed in accordance with the requirements of equipment design codes and with API RP 520, ISO 23251 (for onshore facilities) and API RP 14C (for offshore facilities). The relief valve outlet should be connected back to the tank or pump inlet to minimise losses should the valve pass. The relief valve inlet should be installed upstream of the first pump discharge block valve.

3.8.6 No flow/pump stroke monitoring

The need to detect no flow or low flow to an individual injection point shall be considered and depending on the required availability of the injection system, provision shall be made for manual supervision or, in higher availability systems, an automatic alarm as indicated in Table 1 in (2.3.1).

Flow measurement shall be carried out at a point in the injection system piping where valve leakage, e.g. through a relief device, will not indicate a false positive flow.

Where the application calls for remote adjustment of the dose rate, this should be achieved through actuated pump stroke adjustment, an electronic variable speed drive system, or remote adjustment of an injection rate control device's setpoint.

3.9 LAYOUT ON OFFSHORE PLATFORMS

The chemicals shall be stored so that if a tank rupture occurs the spill is contained and the possibility of a chemical reaction is minimised.

Frequently operated (control and calibration) equipment shall be readily accessible and easy to operate. Both pumps and drivers should be readily accessible for individual removal or maintenance and all pump isolation valves be reached from the central or external access way. For high reliability systems on NNM platforms the pumps should be provided with quick connect/disconnect fittings.

For subsidiary chemical injection packages, the tank, pumps and auxiliary equipment shall be located together and as close as possible to the injection point.

If the package is located on the weather deck, the lower level shall be suitably louvered or partially clad to provide weather protection to the pumps while ensuring adequate natural ventilation.

If necessary, flare or sun radiation shielding shall be supplied to prevent the IBCs or storage tanks from exceeding their design temperature.

If the IBCs are to be laid down on the package roof or an upper loading station, the following considerations shall apply:

- the roof or loading station area shall be constructed with solid plate skids, with a lipped edge and drain gullies. Ferric chloride and other incompatible chemical IBCs shall have separately drained areas;
- a utility washdown station shall be provided;
- since frequent access is required for tank top load stations, one stairway and one vertical ladder shall be provided;
- guard-rails shall be provided around the top of the package if provision for access is made;
- deck loading design shall consider the weight of the full IBCs.

3.10 PAINTING

Exterior surface preparation and painting shall be in accordance with DEP 30.48.00.31-Gen. Use offshore painting DEP 70.48.11.30-Gen Protective Coatings for Offshore Facilities for systems in offshore environments.

3.11 VENDOR SELECTION

Operations personnel shall have adequate training on how to operate and maintain the system. This shall be delivered by the project in conjunction with the Vendors and co-ordinated by the Project Operations Representative. The selection of equipment Vendors and final purchase specifications shall be subject to the approval of the appropriate technical authority in the Principal's Production Chemistry Group (see NOTE under 2.3.9).

4. CHEMICAL REQUIREMENTS

4.1 GENERAL

When considering a fluid for service in a Chemical injection system, consideration should be given to the following:-

- In undertaking fluid selection, only fluids which have been subject to a formal design verification programme for use in a Chemical Injection System shall be used.
- Where fluid is to be circulated in a closed loop (supply/return arrangement) the chemicals will remain in the system much longer than conventional applications. Such durations and additional events such as interruption to production shall be considered against the fluid shelf life. Additional monitoring procedures to ensure no degradation occurs should be considered.
- For long transmission lengths, the potential for increase in viscosity with time and in conjunction with flow path restrictions shall be evaluated as part of the modelling process. Such output should be considered as part of the fluid selection process.
- Where specific fluids cannot be specified at the design stage, indicative fluid characteristics and make-up should be advised to the system designer to enable design activities to be undertaken in a timely manner and potential process issues to be identified at an early stage.

As part of the design process, flow modelling should be undertaken to demonstrate design flow requirements can be achieved. Such modelling shall determine if sensitivity of a fluid to shear and viscosity variation with pressure and temperature change are applicable.

4.2 SUBSEA CHEMICALS

Subsea chemicals specifications shall follow as a minimum the application data and common parameters displayed in ISO 13628 and may be expanded upon by requirements defined within the scope of the Vendor GFA (Global Framework Agreement).

Selection of chemical type for subsea systems presents additional requirements. Chemicals selected for injection into subsea systems should preferably not be water solvent based due to the risk of blockage by hydrates. If this is unavoidable then these chemicals shall be formulated so that hydrates cannot form under operational conditions, e.g. some of the water is replaced by solvents such as ethylene glycol and products are tested for their potential to form hydrates. Long umbilicals to subsea systems require low viscosity fluids to reduce the pressure drop over the umbilical length at the required flowrate. High levels of filtration and selection of stable chemicals not prone to solids dropout, are also required to prevent blockage and/or restrictions.

5. REFERENCES

In this DEP, reference is made to the following publications:

- NOTES:
1. Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.
 2. The DEPs and most referenced external standards are available to Shell staff on the SWW (Shell Wide Web) at <http://sww.shell.com/standards/>.

SHELL STANDARDS

Definition of temperature, pressure and toxicity levels	DEP 01.00.01.30-Gen.
Human factors engineering in projects	DEP 30.00.60.10-Gen.
Carbon steel corrosion engineering manual (Upstream Facilities)	DEP 30.10.02.14-Gen.
Painting and coating of new equipment	DEP 30.48.00.31-Gen.
Glass-fibre reinforced epoxy, polyester and vinyl ester vessels and tanks	DEP 31.22.30.14-Gen.
Reciprocating positive displacement pumps and metering pumps (amendments/supplements to API 674 and API 675)	DEP 31.29.12.30-Gen.
Instrument air supply	DEP 31.37.00.11-Gen.
Piping – General requirements	DEP 31.38.01.11-Gen.
Piping classes – Refining and Chemicals	DEP 31.38.01.12-Gen.
Corrosion mitigation strategy for wet sour gas carbon steel pipelines	DEP 31.40.00.19-Gen.
Glass-fibre reinforced plastic pipeline and piping systems	DEP 31.40.10.19-Gen.
Instruments for measurement and control	DEP 32.31.00.32-Gen.
Selection of materials for life cycle performance (EP)	DEP 39.01.10.11-Gen.
Selection of materials for life cycle performance (Upstream Facilities)- Equipment	DEP 39.01.10.12-Gen.
Preservation of old and new equipment and piping standing idle	DEP 70.10.70.11-Gen.
Protective coatings for offshore facilities	DEP 70.48.11.30-Gen.
Area classification (amendments/supplements to IP 15)	DEP 80.00.10.10-Gen.
Pressure relief, emergency depressuring, flare and vent systems	DEP 80.45.10.10-Gen.
Water-based fire protection systems for offshore facilities	DEP 80.47.10.12-Gen.
Active fire protection systems and equipment for onshore facilities	DEP 80.47.10.31-Gen.

AMERICAN STANDARDS

Recommended practice for analysis, design, installation and testing of basic surface safety systems for offshore production platforms

API RP 14C

Specification for subsea production control systems

API Spec 17F

Sizing, selection and installation of pressure-relieving devices in refineries

API RP 520

Issued by:
American Petroleum Institute
Publications and Distribution Section
1220 L Street Northwest
Washington DC 20005
USA

Aerospace fluid power – cleanliness classification for hydraulic fluids

AS 4059

Issued by:
US Society of Automobile Engineers
400 Commonwealth Drive
Warrendale
PA 15096-0001
USA

INTERNATIONAL STANDARDS

Hydraulic fluid power – Fluids – Method for coding the level of contamination by solid particles

ISO 4406

Safety data sheet for chemical products – Part 1: Contents and order of sections

ISO 11014-1

Petroleum and natural gas industries – Design and operation of subsea production systems – Part 6: Subsea production control systems

ISO 13628-6:2006

Petroleum, petrochemical and natural gas industries – Pressure-relieving and depressuring systems

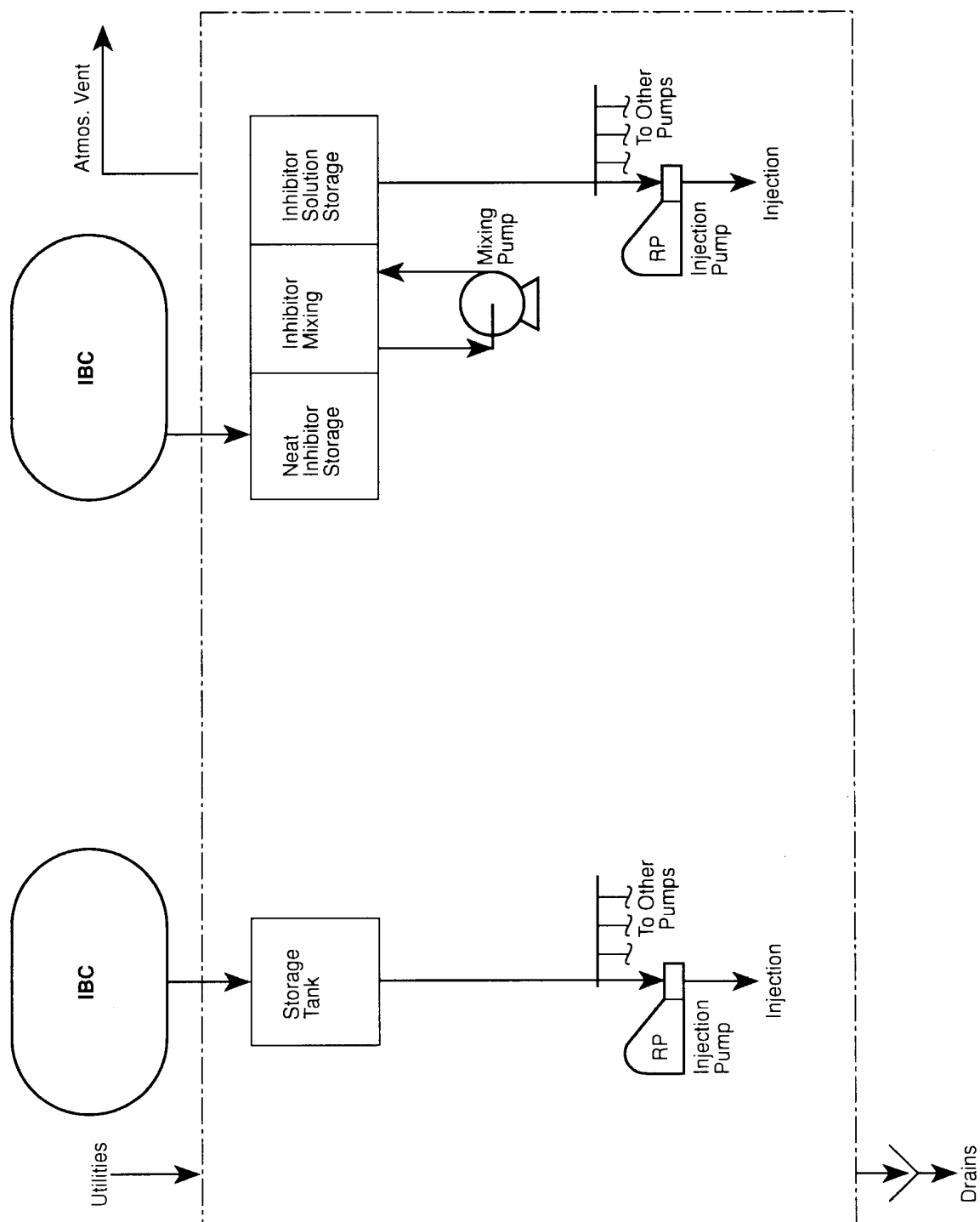
ISO 23251

Issued by:
ISO Central Secretariat
1, ch. de la Voie-Creuse
Case postale 56
CH-1211 Genève 20
Switzerland

Copies can also be obtained from national standards organizations.

6. FIGURES

- FIGURE 1 ASSUMED MAIN BOUNDARIES OF SYSTEM
- FIGURE 2 TYPICAL CHEMICAL INJECTION SYSTEM SUMMARY SHEET
- FIGURE 3 EXAMPLES OF MANIFOLD LINE DESIGNS THAT PREVENT MIXING OF
CHEMICALS BETWEEN TANKS

**FIGURE 1 ASSUMED MAIN BOUNDARIES OF SYSTEM**

Duty	Chemical	Solvent	Dilution		Flow (L/Day)		Flow (Gal/Day)		S.G.	Viscosity (At Min. Application Temp.)	Pour Point	Pour Point	Freezing Point	Freezing Point	Volume For Days Of Storage Of Storage (M³) (Note 3)	Flash Point	Flash Point	Cleanliness (ISO 4406 Classification)	Injection Point	Remarks (Note 2)
			Medium	Conc. (ppm)	Max	Min	Max	Min		(cP)	(° C)	(°F)	(°C)	(°F)		(° C)	(° F)			

- NOTES:
- 1. Summary sheet to be completed for each chemical possible for each duty to enable range of requirements to be determined.
 - 2. Criticality, Blanketing, Incompatibility with other chemicals, etc.
 - 3. Default values for 7/14/28 days of storage depending on remoteness of location.

FIGURE 2 TYPICAL CHEMICAL INJECTION SYSTEM SUMMARY SHEET

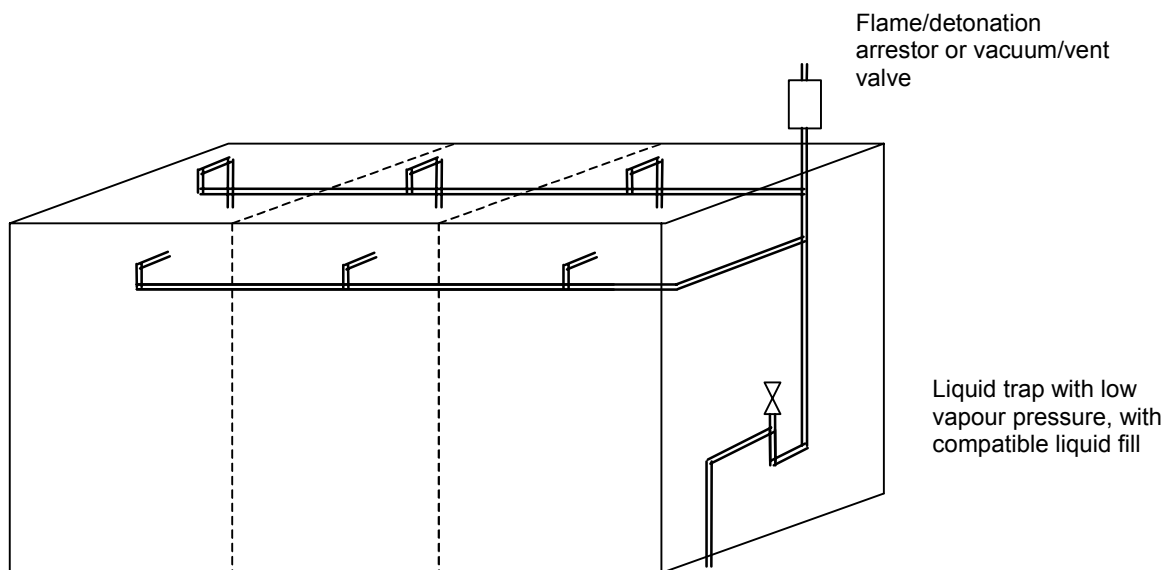


FIGURE 3 **EXAMPLES OF MANIFOLD LINE DESIGNS THAT PREVENT MIXING OF CHEMICALS BETWEEN TANKS**