

DEP SPECIFICATION

CHEMICAL INJECTION SYSTEMS FOR UPSTREAM PRODUCTION FACILITIES

DEP 31.01.10.10-Gen.

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(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://swww.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