

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

MANUAL

CHEMICAL INJECTION FACILITIES

PTS 31.01.10.10

JULY 2010



© 2010 PETROLIAM NASIONAL BERHAD (PETRONAS)

All rights reserved. No part of this document may be reproduced, stored in a retrieval system or transmitted in any form or by any means (electronic, mechanical, photocopying, recording or otherwise) without the permission of the copyright owner.

PTS Circular 2010 - 1



PTS No:	PTS 31.01.10.10
PTS Title:	Chemical Injection Facilities

<Applicable for PTS Updates/Review>

This revision of PTS 31.01.10.10 – **Chemical Injection Facilities (July 2010, Revision 1)** has been updated to incorporate PETRONAS Lessons Learnt, Best Practice and new information issued by relevant industry code and standards. All updates in the document are highlighted in *italic* font.

The previous version of this PTS 31.01.10.10 (April 2003) will be removed from PTS binder / e-repository from herein onwards.

The custodian of this PTS is:
Name: Roslan Hamid
Tel. No: 603-27836443

Please direct any questions regarding this PTS to the above-named.

Document Approval

	Name	Designation	Date	Signature
Prepared/ Reviewed	Roslan Hamid / Zulkifli Abdul Rahman	Staff Engineer, Process Design / Principal Engineer, Analytical Technology	16/7/10 16/7/10	<i>[Signature]</i> <i>[Signature]</i>
Approved	Zainab Bt Kayat	Custodian, Process Engineering, GTS	18/8/10	<i>[Signature]</i>
Verified	Shahrul Izan Bakti B A Aziz	Senior Manager, Process Engineering, GTS	18/8/10	<i>[Signature]</i>
Verified	Pau Kiew Huai	General Manager, Engineering, GTS	18.8.10	<i>[Signature]</i>
Endorsed	Sazali B Hamzah	Senior General Manager, GTS	23/08/10	<i>[Signature]</i>

Revision History

Rev No.	Reviewed by	Approved by	Date
1	Roslan Hamid	Zainab Bt Kayat	July 2010

PREFACE

PETRONAS Technical Standards (PTS) publications reflect the views, at the time of publication, of PETRONAS OPU/Divisions.

They are based on the experience acquired during the involvement with the design, construction, operation and maintenance of processing units and facilities. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good technical practice to be applied by PETRONAS' OPU in oil and gas production facilities, refineries, gas processing plants, chemical plants, marketing facilities or any other such facility, and thereby to achieve maximum technical and economic benefit from standardisation.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where PTS may not cover every requirement or diversity of condition at each locality. The system of PTS is expected to be sufficiently flexible to allow individual operating units to adapt the information set forth in PTS to their own environment and requirements.

When Contractors or Manufacturers/Suppliers use PTS they shall be solely responsible for the quality of work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, it is expected of them to follow those design and engineering practices which will achieve the same level of integrity as reflected in the PTS. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the owner.

The right to use PTS rests with three categories of users:

- 1) PETRONAS and its affiliates.
- 2) Other parties who are authorised to use PTS subject to appropriate contractual arrangements.
- 3) Contractors/subcontractors and Manufacturers/Suppliers under a contract with users referred to under 1) and 2) which requires that tenders for projects, materials supplied or - generally - work performed on behalf of the said users comply with the relevant standards.

Subject to any particular terms and conditions as may be set forth in specific agreements with users, PETRONAS disclaims any liability of whatsoever nature for any damage (including injury or death) suffered by any company or person whomsoever as a result of or in connection with the use, application or implementation of any PTS, combination of PTS or any part thereof. The benefit of this disclaimer shall inure in all respects to PETRONAS and/or any company affiliated to PETRONAS that may issue PTS or require the use of PTS.

Without prejudice to any specific terms in respect of confidentiality under relevant contractual arrangements, PTS shall not, without the prior written consent of PETRONAS, be disclosed by users to any company or person whomsoever and the PTS shall be used exclusively for the purpose they have been provided to the user. They shall be returned after use, including any copies which shall only be made by users with the express prior written consent of PETRONAS.

The copyright of PTS vests in PETRONAS. Users shall arrange for PTS to be held in safe custody and PETRONAS may at any time require information satisfactory to PETRONAS in order to ascertain how users implement this requirement.

TABLE OF CONTENTS

1.	INTRODUCTION	5
1.1	SCOPE.....	5
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	5
1.3	DEFINITIONS	5
1.4	ABBREVIATIONS	6
1.5	CROSS-REFERENCES	6
1.6	SUMMARY OF CHANGES SINCE PREVIOUS EDITION	6
2.	CHEMICAL INJECTION SYSTEM GOALS, DESCRIPTION AND DESIGN.....	10
2.1	SYSTEM GOALS.....	10
2.2	SYSTEM DESCRIPTION.....	11
2.3	SYSTEM DESIGN	12
2.4	SAFETY	20
2.5	WINTERISATION REQUIREMENTS	22
2.6	SUMMERISATION REQUIREMENTS	22
2.7	DESERT CONDITIONS.....	22
2.8	DESIGN AND FABRICATION	22
2.9	<i>SUBSEA APPLICATION OF PROCESS CHEMICALS.....</i>	<i>22</i>
3.	EQUIPMENT DESIGN DETAILS	23
3.1	BULK TRANSFER TO STORAGE.....	23
3.2	STORAGE TANKS	23
3.3	INJECTION PUMPS	25
3.4	INJECTION POINTS.....	27
3.5	PIPING DESIGN	28
3.6	DRAINAGE	29
3.7	INSTRUMENTATION AND CONTROL	29
3.8	LAYOUT ON OFFSHORE PLATFORMS	31
3.9	PAINTING	32
3.10	<i>VENDOR SELECTION</i>	<i>32</i>
4.	REFERENCES	33
5.	BIBLIOGRAPHY	35
6.	FIGURES	36

APPENDICES

APPENDIX 1	TYPICAL CHEMICAL INJECTION SERVICES.....	47
APPENDIX 2	INJECTION RATE CONTROL DEVICE SYSTEM (IRCD).....	48

1. INTRODUCTION

1.1 SCOPE

This PTS specifies requirements and gives recommendations for the design of chemical injection systems for new or refurbished exploration and production facilities. It is based on the requirements for offshore and onshore production facilities.

This PTS *provides guidance* in the conceptual and detailed design of new projects, and is intended for both the Principal's design team and the engineering design Contractor.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by PETRONAS, the distribution of this PTS is confined to companies forming part of PETRONAS or managed by a Group company.

This PTS is intended for use in exploration and production facilities. When deviates from PTSs, a Management of Change (MOC) process shall 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 may be more stringent than in this PTS, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regard 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 PTS 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 PTS 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 or maintenance of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier/Vendor** 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 its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

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

1.4 ABBREVIATIONS

<i>CRA</i>	<i>Corrosion-Resistant Alloys</i>
<i>IBC</i>	<i>Intermediate Bulk Container</i>
<i>IRCD</i>	<i>Injection Rate Control Device</i>
<i>MSDS</i>	<i>Materials Safety Data Sheet</i>
<i>NNM</i>	<i>Not Normally Manned</i>
<i>VPRV</i>	<i>Vacuum Pressure Relief Valve</i>
<i>OPU</i>	<i>Operating PETRONAS Unit</i>
<i>ER</i>	<i>Electrical Resistance</i>
<i>IR</i>	<i>Infra Red</i>
<i>NRB</i>	<i>Nitrate Reducing Bacteria</i>
<i>SRB</i>	<i>Sulphate Reducing Bacteria</i>

1.5 CROSS-REFERENCES

Where cross-references to other parts of this PTS are made, the referenced section number is shown in brackets. Other documents referenced in this PTS are listed in (4).

1.6 SUMMARY OF CHANGES SINCE PREVIOUS EDITION

The previous edition of this PTS was dated April 2003. Other than editorial changes, a summary of the main changes since the last edition is given below:

Section	Change
1.1	The phrase 'will assist' in paragraph 2 is changed to 'provides guidance'.
1.2	The phrase 'When PTSs are applied' in paragraph 2 is changed to 'When deviates from PTSs'. The word 'should' in paragraph 2 is changed to 'shall'.
1.3.2	Statement added for specific definition of 'very toxic (substances)'
1.4	Abbreviations added are CRA, OPU, ER, IR, NRB and SRB.
2.1	Statements/Phrases added or changes are present in all paragraphs except for paragraph 4.
2.2.1	Statements added or changes can be found in all paragraphs.
2.2.2	Phrases/Words added appear in paragraphs 1, 3 and 4. Statement added is in paragraph 5.
2.3.1	Statements added are in paragraphs 1 and 2. Statements/Phrases added and some words changed in Table 1. One row is deleted from Table 1.
2.3.2	Statement is added in paragraph 1. The word 'must' in paragraph 2 is changed to 'shall'. Other statements added can be found in paragraphs 5, 6, 7, 8, 10, 11 and 12. The word 'above' in paragraph 13 is changed to 'above-mentioned'. Some notes are added at the end of the section.
2.3.3	Full paragraphs 1, 3, 4 and 5 are the new statements added. Statement is also added to paragraph 2.
2.3.4	A few statements added to paragraphs 1 and 2. Full paragraphs 3, 4, 5, 6 and 7 are the new statements added.
2.3.5	Statements added are in paragraphs 2 and 3. Full paragraphs 6, 7 and 8 are the new statements added.
2.3.6	The word 'should' in paragraph 1 is changed to 'may'. A statement is added to paragraph 2. Full paragraphs 3, 4, 5 and 6 are the new statements added.
2.3.7	Statements are added as paragraph 2.
2.3.8	A statement is added as paragraph 2.
2.3.9	For paragraph 1, new points are added as 3 rd and 5 th points. The word 'wellhead' in points number 4 and 6 in paragraph 1 is changed to 'Xmas Tree'. A statement is added to point number 6 in paragraph 1. The word '(seldom used)' in point number 7 in paragraph 1 is changed to 'rarely'. Full paragraphs 3, 4, 5 and 7 are the new statements added. The words 'wellheads' in paragraph 6 are changed to 'Xmas Trees'. A statement is added in paragraph 8.
2.3.10	A statement is added in paragraph 1. A note is added at the end of the section.
2.3.11	Statements are added in paragraphs 1 and 3. Full paragraph 2 is the new statements added.
2.4.1	'EP 95-0319' is changed to 'PTS 60.1502'.
2.4.3	'EP 95-0350 and EP 95-0351' is changed to 'PTS 60.2302 and PTS 60.2303' and a statement is added to the paragraph.
2.4.5	A statement is added to paragraph 1.
2.4.6	The word 'Eyewash' is added to the subsection heading.
2.4.7	Statement change can be found in paragraph 1. A statement is added to paragraph 2.
2.4.8	A statement is added to the end of paragraph.
2.4.9	This is the new subsection added to the PTS.
2.5	A few words/phrases are changed in the section.
2.6	Statements are added to the paragraph.
2.9	This is the new section added to the PTS.
3.1	Statements are added to paragraphs 1 and 4. Full paragraph 2, 5, 6 and 7 are the new statements added.

3.2.2	Statements are added to paragraphs 6 and 7. Full paragraph 11 is the new statements added.
3.2.3	A statement is added to paragraph 2.
3.2.4	A statement is added to paragraph 1. Full paragraph 3 is the new statements added.
3.2.5.2	A statement is added to the paragraph.
3.3.2	This subsection is broken into 3 sub-subsections (namely 3.3.2.1: General; 3.3.2.2: Pressure relief; and 3.3.2.3: Auxiliaries), while maintaining the same points as previous PTS version, with some rewording and addition of some new statements.
3.3.3	Statements are added to paragraphs 1 and 2. The 3 rd paragraph in old PTS is changed with the new statements in paragraphs 3 and 4 of the new PTS.
3.3.4	Full paragraph 2 is the new statements added.
3.4.1	New phrases are added to paragraph 2. Full paragraph 3 is the new statements added.
3.4.2	Statements are added to paragraphs 1, 5, 7, 9 and 12. Full paragraphs 2, 3, 4, 6, 8, 10 and 11 are the new statements added.
3.5.1	The words 'PTS 31.38.01.12 or' and 'and PTS 31.38.01.11' are added to paragraph 1. Full paragraphs 3 and 4 are the new statements added.
3.5.2	Full paragraphs 7 and 8 are the new statements added.
3.6	New clauses are added to paragraph 4. Full paragraph 2 is the new statement added.
3.7.1	Statements are added to paragraph 2.
3.7.2	Statements are added to paragraph 1. Full paragraphs 4, 5 and 6 are the new statements added.
3.7.3	Full paragraphs 2 and 3 are the new statements added.
3.7.4	The phrase 'Where appropriate' in paragraph 1 is changed to 'For air driven pumps'. Statements are added to paragraph 2. 'OUs' in paragraph 2 is changed to 'OPUs'.
3.7.5	A phrase and a statement are added to the paragraph.
3.7.6	A statement is added to paragraph 2.
3.8	Statements are added to paragraphs 4 and 8. Phrases are added to paragraphs 7 and 8.
3.10	This is the new section added to the PTS.
4	These PTS are removed from the list of PETRONAS STANDARDS reference: - 'PTS 00.00.05.05 – Index to PTS Publications and Standard Specifications' - 'PTS 60.144 – Design' - 'PTS 60.167 – Environmental Assessment' - 'EP 2000-5721 – Corrosion Control Guideline for Inhibited Systems' - 'PTS 60.157 – Safe Handling of Chemicals' The codes for these PTS are changed: - 'FIREPRAN' → From 'PTS 60.164' to 'PTS 60.2302' - 'Fire Control and Recovery' → From 'PTS 60.165' to 'PTS 60.2303' These PTS are added to the list of PETRONAS STANDARDS reference: - 'PTS 01.00.01.30 – Definition of Temperature, Pressure and Toxicity Levels' - 'PTS 30.00.60.10 – Human Factors Engineering in Projects' - 'PTS 31.38.01.12 – Piping Classes – Refining and Chemicals' - 'PTS 80.45.10.10 – Pressure Relief, Emergency Depressuring, Flare and Vent Systems' - 'PTS 80.47.10.12 – Water-based Fire Protection Systems for Offshore Facilities'

	- 'PTS 80.47.10.31 – Active Fire Protection Systems and Equipment for Onshore Facilities' - 'Related PTS on Group HSE Standards & Regulations' - 'PTS 60.1502 – Chemical Management Program' This reference is removed from the list of AMERICAN STANDARDS reference: - 'API RP 521 – Guide for Pressure-relieving and De-pressurising Systems' These references are added to the list of AMERICAN STANDARDS reference: - 'API Spec 17F – Specification for Subsea Production Control Systems' - 'AS 4059 – Aerospace Fluid Power – Cleanliness Classification for Hydraulic Fluids' These references are added to the list of INTERNATIONAL STANDARDS reference: - 'ISO 13628-6:2006 – Petroleum and Natural Gas Industries – Design and Operation of Subsea Production Systems – Part 6: Subsea production control systems' - 'ISO 23251 – Petroleum, Petrochemical and Natural Gas Industries – Pressure-relieving and Depressuring Systems'
6	FIGURE 4 is broken into FIGURE 4A and FIGURE 4B. FIGURE 4A in the new PTS version is just a copy of FIGURE 4 in the old PTS, while FIGURE 4B shows 'EXAMPLES OF MANIFOLD LINE DESIGNS THAT PREVENT MIXING OF CHEMICALS BETWEEN TANKS'
6 – FIGURE 2	Note #12 is added to the figure. General notes a) and b) are added to the figure.
6 – FIGURE 4A	'Further notes' is added to the figure.
6 – FIGURE 5	A note is added at the bottom of the figure.
6 – FIGURE 7	Notes are added at the bottom of the figure.
6 – FIGURE 9	Legends for 'PDG' and 'PDICA' are added at the bottom of the figure.
APPENDIX 1	Statements are added to the 2nd paragraph. The first column in old PTS is removed from the table. Changes to the table:- 1) Chemical removed (from old PTS): - Anti-foam 2) Chemicals added: - Foamer - Glycol Buffer - Demulsifier - NRB Nutrient 3) Chemicals in which statement/phrases are added: - Corrosion inhibitor - H₂S scavenger - Asphaltene dispersant - Drag Reducer 4) Chemicals in which the purposes are rephrased: - Biocide - Glycol
APPENDIX 2 – A.2.1	A statement is added to the 3rd paragraph. The word 'OU' in paragraph 3 is changed to 'OPUs' Full paragraph 4 is the new statement added.

2. CHEMICAL INJECTION SYSTEM GOALS, DESCRIPTION AND DESIGN

2.1 SYSTEM GOALS

Permanently installed chemical injection facilities may be required for oil and gas production, *production enhancement*, *efficient water injection*, *flow assurance*, efficient clean-up and the reduction of corrosion problems; see [Appendix 1](#).

The overall goals of the chemical injection system are:

- to store and deliver chemicals safely in the required quantity and quality (*e.g., loading and unloading of containers, applying fire hazard control*);
- to accommodate changes in dosage rates and chemicals used;
- to satisfy the availability requirements of the facilities being served;
- to allow verification of the injection rate and, for critical applications, to generate an alarm if the injection rate goes outside preset limits.
- *to support minimum intervention philosophy, i.e. minimum maintenance and minimum operator intervention.*

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. The chemical injection hardware should therefore be provided as described in this PTS, and appropriate operational procedures should 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.

In offshore and remote operations, experience with chemical injection systems has varied from highly reliable to very poor: *production downtime, lost process capacity, severe corrosion, and in extreme cases, corrosion failure of pipelines, regulatory non-compliance, and asset failures with personnel harm and environmental damage have all been experienced*. Experience suggests that in actual field situations it is not necessarily the equipment design that is deficient, but operational aspects may not be adequately addressed. The cost effectiveness of back up 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 of the system, *e.g., the setting and surveillance of key performance indicators*. If there is 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:

- For remote operating locations, the more sophisticated equipment required for high availabilities *from a single unit* may be difficult to procure initially and it may *also* be difficult to get spare parts for maintenance. *Hence a very sophisticated system might lead to poor uptime unless the necessary supply chain actions are taken.*
- Operating levels vary by location. In some locations, manual monitoring of pump performance and injection rates is practicable. In other locations, *e.g., NNM platforms*, the number of staff visiting the location has to be strictly limited; *if possible manual monitoring of pump performance shall then be avoided.*
- Higher availability will result in a lower required system corrosion allowance *and will provide increased production uptime*, and an economic assessment of acceptable

options should be carried out to determine the optimal design of chemical injection facilities.

2.2 SYSTEM DESCRIPTION

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

At offshore locations, chemicals are generally transported in *Tote Tanks*. *Intermediate Bulk Containers (IBCs)* may also be used and subsequently transferred to bulk storage tanks / day tanks or as direct replacement for the modular injection unit storage tank if the design permits. Smaller quantities may be transported in small portable tanks, barrels or drums.

Chemical flow shall be metered before being manifolded to the injection pumps. In addition, each injection stream of the chemical injection skid should be individually metered. Calibration facilities are provided to measure the dosage sent to the individual injection points.

At onshore locations, IBCs are increasingly replacing drums as transport containers because IBCs usually prove more economical, provided the handling capability is present. *IBCs also lower the HSE risk due to the lower need for manual handling.* If required, the chemicals may be diluted and mixed. *Pre-dilution and pre-mixing are preferable where practicable.*

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.

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

2.2.2 Facilities

At manned installations, the chemical bulk storage, mixing, metering, pumping and calibration facilities shall be located *insofar as is practical in one or a very few integrated chemical injection packages* (hereafter referred to as *integrated chemical injection packages*) to ensure flexibility during field life. At offshore facilities, this package should be a two-level structure with the storage tanks located adjacent to the pumps to achieve efficient use of space and good access. 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 [\(3.8\)](#). At onshore facilities, where more space is usually available, the layout may be different to accommodate alternative methods of chemical transfer.

If an injection duty requires large volumes (more than 10 m³) of storage (e.g. methanol injection), and the possibilities of interchanging chemicals and facilities are limited, then a dedicated (subsidiary) chemical injection package should be provided.

Subsea developments use the *injection* facilities of a nearby platform and so *may be* supplied by pipeline (or umbilical) directly into the well stream or subsea process facility.

For NNM facilities or platforms, the required tanks and pumps should be minimised as far as reasonably practicable *to achieve needed 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 preferably 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 or colour coded to avoid mixing up chemicals and contamination.

2.3 SYSTEM DESIGN

2.3.1 General

The optimum system design depends on a number of factors including the desired availability, degree of operator intervention and space available. Table 1 provides a guide to various design items according to different levels of availability, represented by the factor f . *The recommended initial starting point is $f = 0.95$ (95%). This value of f equates to 18 days inhibitor system downtime per year. This is achievable with a basic inhibition system (as illustrated below).*

The minimum recommended f of 95% should be critically assessed in the pre-conceptual design and conceptual design phase. The value of f used in the design can be increased with the use of more automated systems, faster response monitoring, back up systems etc.

For corrosion inhibitor application, as a guide, the frequency of operator involvement is also included in Table 1 to allow the injection system to be designed to facilitate the operator's efforts. A similar approach can be devised for other chemical applications.

Table 1 Criteria for chemical injection system design to meet specified system availability

Item	Description	Availability, f		
		Base (f = 0.95)	Good (f = 0.99)	Excellent (f > 0.99)
a	Chemical demonstrated as suitable for the application	Required	Required	Required
b	Chemical injection pumps	Standard	High reliability	High reliability
c	Installed back up pumps	Not required	Required	Required
d	Back up pump spares on location	Needs to be assessed and depends on lead time for spares or replacement pump	Required	Required
e	Check that pump is operating	Daily, manual check	Automated alarm (the alarm shall be checked regularly, at least annually)	Automated alarm (the alarm shall be checked regularly, at least bi-annually)
f	Pump planned maintenance	Annual	Semi-annual	May be required more often
g	Chemical tank levels	Daily manual check	Automated alarm or documented daily manual check	Automated alarm and daily check via tank dip
h	Report on chemical used (or report on compliance with key performance indicators) to responsible engineer	Monthly (or as per agreed frequency) agreed and recorded by corrosion management meetings	Weekly (or as per agreed frequency) agreed and recorded by corrosion management meetings	Daily (or as per agreed frequency) agreed and recorded by corrosion management meetings
i	Manual check on pump injection rate and calibration check on flow meters/switch	Required quarterly	Required monthly	Required weekly
j	Low or no flow alarm (out of specification, differential pressure across a critical component, or inline flow meters)	Not required	Required	Required
k	Liquid samples for analysis of residual inhibitor levels and water chemistry	Monthly but may be required more often	Monthly but may be required more often	At least monthly, but may be required more often

Item	Description	Availability, f		
		Base (f = 0.95)	Good (f = 0.99)	Excellent (f > 0.99)
<i>l</i>	Monitoring system response, e.g., ER corrosion probes, bandwidth on dump valves position or separator gas flow for foam detection, BS&W on sales oil, Online Produced Water IR Measure	At least annual <i>chemical performance</i> measurement	Online sensors: response time less than 7 days	Online fast response monitoring systems: response time less than 24 hours
<i>m</i>	Comprehensive review of <i>untreated</i> events	Required	Required	Required
<i>n</i>	Allowed days chemical system downtime per year (allowed number of days per single event)	18 (3)*	4 (1)*	0 to 4 (0.5)*
<i>o</i>	Shut in if <i>treatment</i> system goes down for greater than the allowed period of time	Possibly	Possibly	Required
<i>p</i>	Identify operations technician with responsibility for the chemical injection system	Required	Required	Required
<i>q</i>	Engineering involvement	Monthly review	Weekly review, unless daily concern	Daily review
<i>r</i>	Key Performance Indicators set for operations technicians, chemical supplier and engineers	Required with quarterly reporting	Required with monthly reporting	Required with bi-weekly reporting
<i>s</i>	Minimum storage capacity of chemical to be applied	10 days	14 days	28 days
<i>t</i>	* 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. Standard pumps may be 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. 2. A system audit is desirable for good availability systems, required bi-annually for excellent systems and required annually for critical systems. 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. 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.			

The following Sections of this PTS describe the variables to be evaluated in the selection of an optimum chemical injection system for an offshore installation.

A typical chemical injection P&ID is shown in [Figure 2](#) for the storage and injection of undiluted chemicals for a system of good availability ($f = 0.95$).

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 *shall be reliable*, accurate and flexible. *Reliability is required to achieve the availability requirements described above.* Accuracy is required to ensure that the treatment is effective and cost-efficient and does not unnecessarily impact the environment. Flexibility is necessary because:

- a wide range of throughputs and/or process fluid properties occur during the life of a production facility, which means that the chemical injection system *shall* have a correspondingly large turn-up or turn-down capability. This could, for instance, necessitate the installation of 2 pumps to better accommodate the accuracies required over wide turn-down ratios.
- many chemical injection systems cannot be designed on the basis of one chemical being used throughout the life of the platform because availability, economics, technology development, HSE policy or operational parameters may dictate changes in chemicals during field life.

Therefore, for any given chemical injection duty:

- 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 shall use, if possible, pumps that may be re-sized by minor field modifications (e.g., change of piston size, change of transmission box) to achieve a lifecycle design.*
- *if the chemical duty or volume required changes, then the suitability of the pump sizing should be re-assessed;*
- *it shall be considered that a pump system might need to function at lower rates, which could mean that it will be necessary to install two identical pumps side by side for a single injection point.*
- 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 considered and the equipment designed accordingly;
- material selection shall be compatible with the chemical(s) envisaged and also consider connections downstream of the injection module, e.g. umbilicals;
- *due to the possibility of a need for other chemicals during the lifecycle, a range of chemicals from different suppliers for a given type of treatment shall be considered;*
- *the required chemical availability shall be adequately documented by conducting a formal availability assessment. This shall cover the whole system from tanks to chemical delivery points subsea. On new projects this is typically a multi-disciplined effort led by Development Division involving as required Control and Automation, Corrosion Engineering, Flow Assurance, Process Engineering, Well Engineering, Subsea Engineering, Pipeline Engineering and Production Chemistry. On existing facilities this work is typically the responsibility for the Production Operation Department.*
- the HSE properties of chemicals shall be considered in the light of any requirements for safety in design. The Principal's discipline engineers and materials/chemicals specialists should select the chemicals used. This selection should give due consideration to minimising fire hazard, occupational hazards and hazards to the environment. *Relevant*