

DEP SPECIFICATION

SHOP AND FIELD PRESSURE TESTING OF PIPING SYSTEMS

DEP 74.00.10.10-Gen.

February 2014

DESIGN AND ENGINEERING PRACTICE

DEM1



© 2014 Shell Group of companies
All rights reserved. No part of this document may be reproduced, stored in a retrieval system, published or transmitted, in any form or by any means, without the prior written permission of the copyright owner or Shell Global Solutions International BV.

PREFACE

DEP (Design and Engineering Practice) publications reflect the views, at the time of publication, of Shell Global Solutions International B.V. (Shell GSI) and, in some cases, of other Shell Companies.

These views are based on the experience acquired during involvement with the design, construction, operation and maintenance of processing units and facilities. Where deemed appropriate DEPs are based on, or reference international, regional, national and industry standards.

The objective is to set the standard for good design and engineering practice to be applied by Shell companies in oil and gas production, oil refining, gas handling, gasification, chemical processing, or any other such facility, and thereby to help achieve maximum technical and economic benefit from standardization.

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

When Contractors or Manufacturers/Suppliers use DEPs, they shall be solely responsible for such use, including the quality of their work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will typically expect them to follow those design and engineering practices that will achieve at least the same level of integrity as reflected in the DEPs. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the Principal.

The right to obtain and to use DEPs is restricted, and is typically granted by Shell GSI (and in some cases by other Shell Companies) under a Service Agreement or a License Agreement. This right is granted primarily to Shell companies and other companies receiving technical advice and services from Shell GSI or another Shell Company. Consequently, three categories of users of DEPs can be distinguished:

- 1) Operating Units having a Service Agreement with Shell GSI or another Shell Company. The use of DEPs by these Operating Units is subject in all respects to the terms and conditions of the relevant Service Agreement.
- 2) Other parties who are authorised to use DEPs subject to appropriate contractual arrangements (whether as part of a Service Agreement or otherwise).
- 3) Contractors/subcontractors and Manufacturers/Suppliers under a contract with users referred to under 1) or 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, Shell GSI 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 DEP, combination of DEPs or any part thereof, even if it is wholly or partly caused by negligence on the part of Shell GSI or other Shell Company. The benefit of this disclaimer shall inure in all respects to Shell GSI and/or any Shell Company, or companies affiliated to these companies, that may issue DEPs or advise or require the use of DEPs.

Without prejudice to any specific terms in respect of confidentiality under relevant contractual arrangements, DEPs shall not, without the prior written consent of Shell GSI, be disclosed by users to any company or person whomsoever and the DEPs shall be used exclusively for the purpose for which 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 Shell GSI. The copyright of DEPs vests in Shell Group of companies. Users shall arrange for DEPs to be held in safe custody and Shell GSI may at any time require information satisfactory to them in order to ascertain how users implement this requirement.

All administrative queries should be directed to the DEP Administrator in Shell GSI.

TABLE OF CONTENTS

1.	INTRODUCTION	4
1.1	SCOPE.....	4
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	4
1.3	DEFINITIONS	4
1.4	CROSS-REFERENCES	5
1.5	SUMMARY OF MAIN CHANGES	5
1.6	COMMENTS ON THIS DEP	6
1.7	DUAL UNITS.....	6
1.8	NON NORMATIVE TEXT (COMMENTARY).....	6
2.	PRESSURE TESTING.....	7
2.1	GENERAL	7
2.2	STRUCTURAL SUPPORT	7
3.	HYDROSTATIC TESTING	7
3.1	TEST EQUIPMENT	7
3.2	TEST LIQUID QUALITY	7
3.3	PROCEDURES.....	9
4.	PNEUMATIC TESTING APPLICATION CRITERIA	12
5.	PNEUMATIC TESTING SAFETY CONSIDERATIONS.....	12
5.1	SAFETY DISTANCES	12
5.2	PERSONNEL RESTRICTIONS FOR ZONES 1, 2, AND 3	13
5.3	NEARBY OPERATING EQUIPMENT	14
5.4	RISK ASSESSMENTS.....	14
6.	PNEUMATIC PRESSURE TEST PLANNING.....	15
6.1	GENERAL REQUIREMENTS FOR ENGINEERING AND INSPECTION	15
6.2	SPECIAL REQUIREMENTS FOR ENGINEERING AND INSPECTION.....	16
6.3	APPROVALS	16
6.4	TEST LEADER	16
6.5	TEST PLAN.....	16
6.6	SAFETY PLAN.....	16
6.7	PRESSURE TESTING EQUIPMENT	17
6.8	CONTROL OF PERSONNEL	17
6.9	CONTINGENCY PLANNING	17
6.10	PNEUMATIC TEST FLUIDS.....	17
6.11	PRECAUTIONS WITH NITROGEN.....	18
7.	PROCEDURE FOR PNEUMATIC PRESSURE TESTING	18
7.1	PRIOR TO APPLICATION OF TEST PRESSURE.....	18
7.2	TEST PRESSURE	18
7.3	PRESSURIZATION	18
7.4	BOLT TIGHTENING	18
7.5	INSPECTION	19
7.6	DEPRESSURING	19
7.7	AIR FREEING AFTER TEST	19
7.8	DOCUMENTATION	19
8.	REFERENCES	20

APPENDICES

APPENDIX 1	PNEUMATIC TESTING PROCEDURE FORM	21
APPENDIX 2A	SAFETY DISTANCE FOR EACH ZONE (SI UNITS)	23
APPENDIX 2B	SAFETY DISTANCE FOR EACH ZONE (US CUSTOMARY UNITS).....	24

1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for performing shop and field pressure testing of piping systems to establish integrity.

Only under the conditions listed in (2.1) may equipment be included in the field pressure testing of piping.

Shop pressure testing of new equipment is excluded from the scope of this DEP. Reference is made to the relevant equipment/pressure vessel DEPs.

Pressure testing of new pipelines is excluded from the scope of this DEP and is covered in DEP 31.40.40.38-Gen.

This DEP is limited to application for new piping systems, and hence does not address risks associated with repressurisation after deterioration of condition of the pressure boundary, such as temper embrittlement or hydrogen embrittlement. These aspects should be addressed separately.

This DEP incorporates content that was previously in DEP 61.10.08.11-Gen. The relevant pressure testing information has been revised and placed in this DEP. The section on hydrotesting is a compilation of information that was in DEP 61.10.08.11-Gen. and the piping and pressure vessel DEPs. The section on pneumatic pressure testing was substantially revised.

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 February 2012; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

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

This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, 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 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

Term	Definition
Boiler Feedwater	Water having a chloride content of no more than 5 mg/kg (5 ppm).
Condensate	Water having a chloride content of no more than 5 mg/kg (5 ppm).
Demineralized Water	Water having a chloride content of no more than 5 mg/kg (5 ppm).
Potable Water	Water having a chloride content of no more than 250 mg/kg (250 ppm).
Pneumatic Pressure Test	A test carried out using air or inert gas to prove the integrity of a component or system, at a pressure specified by the design code. (In ASME B31.3 para. 345.5 referred to as Pneumatic leak test.)

1.3.3 Abbreviations

Term	Definition
ALARP	As Low As Reasonably Practical
ITP	Inspection and Test Plan
PMI	Positive Materials Identification
RT/UT	Radiographic Testing / Ultrasonic Testing

1.4 CROSS-REFERENCES

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

1.5 SUMMARY OF MAIN CHANGES

This DEP is a full revision of the DEP of the same number dated February 2012. The following are the main, non-editorial changes.

Section/Clause	Change
3.1	The application and specification of test equipment used for hydrostatic testing has been defined more accurately.
3.2.2	The option to use brackish or salt water is only for use by the Principal.
3.3.2	The definition of pressure test temperatures for hydrostatic and pneumatic testing has been updated, to allow testing at lower ambient temperatures.
6.7	The application and specification of test equipment used for pneumatic testing has been defined more accurately.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://www.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (Other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

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

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

2. PRESSURE TESTING

2.1 GENERAL

1. Pressure testing shall comply with local regulations, governing codes or specifications.
2. Equipment that has been pressure tested at the Manufacturer/Supplier's works shall not be re-tested after installation, unless required by local regulations or if there is any reason to suspect the integrity of the equipment, e.g., due to damage during transport.
3. In above circumstances, a retest shall be carried out in accordance with the governing code or specification.
4. For pressure testing of new pipelines, see DEP 31.40.40.38-Gen.

2.2 STRUCTURAL SUPPORT

1. If the equipment is to be pressure-tested in the installed position, it SHALL [PS] be ensured that all parts of the assembly, including the supporting structure, can withstand the loading resulting from the pressure test.
2. Where necessary, temporary supports shall be erected prior to pressure testing.

3. HYDROSTATIC TESTING

3.1 TEST EQUIPMENT

1. Only a small-capacity test pump shall be used for pressurization.
2. A pressure relief valve shall be installed on the discharge of the test pump. This pressure relief valve (PRV) shall be set at 110 % of test pressure.
3. A set of 2 pressure gauges shall be installed at the pump discharge and on highest point of the equipment being tested.
 - a. The gauges shall have an accuracy as specified in the applicable code and shall have a scale range from 0 to a maximum of 3 times the test pressure. The test pressure shall fall within one third and two thirds of the scale range.
 - b. The gauge diameter shall be at least 100 mm (4 in) for pressure class 150 and 300, and 160 mm (6 in) for pressure class 600 and above.
 - c. The accuracy shall be at least 1 % of the scale range.
 - d. Test gauges shall be similar, and shall be calibrated/certified and sealed.
 - e. Pressure gauges shall be checked one gauge with the other just prior to use.
 - f. All pressure gauges used in one pressure test shall read within 5 % of each other at all times (it is recognised that a fixed difference may exist when gauges are mounted at different elevations.) Pressure test manifolds shall be composed of welded fittings.
4. Additional guidance for hydrotest equipment may be found in ASME PCC-2.
5. Where bellows are installed in the test circuit, special precautions shall be taken to prevent over-pressurising the equipment. Thrust forces and design test pressure shall be checked prior to testing.

3.2 TEST LIQUID QUALITY

3.2.1 General

1. Wherever reference is made to hydrostatic pressure testing in this DEP, the medium used shall be water.
2. If use of water as the medium is impractical, use of other non-flammable liquids may be considered if agreed by the Principal. In this case a corrosion engineer shall be

involved in the selection of a suitable test fluid, and definition of adequate corrosion measures, if required.

3. The water quality to be used for hydrostatic testing depends on the material(s) from which the equipment to be tested is manufactured (see below). Whatever the source of the hydrotest water, it shall be filtered through a 10 µm (1250 MESH) filter when filling the system.
4. Special precautions shall be taken if weather conditions can cause freezing or heating up of the test water.
5. Leaving systems filled with water shall require the consent of the Principal.
6. Thermal expansion and freezing conditions shall be assessed when leaving systems filled with water.

3.2.2 Carbon steel and low-alloy steel

1. Equipment/piping systems manufactured from carbon steel or low-alloy steel may be hydrostatically tested with potable water. The option to use brackish or salt water is at the discretion of the Principal.

NOTE: If potable water is not used, the test water shall be completely drained and the equipment flushed with potable water immediately after testing and thoroughly dried with hot air or steam. In many cases, it will be impractical or impossible to check if flushing and drying was done adequately. Therefore, the use of potable water may prove the more technically sound and manageable solution.

3.2.3 Austenitic stainless steel

1. The water used for hydrostatic testing shall not contain a concentration of chlorides, either present originally or resulting from evaporation, which may precipitate stress corrosion cracking or pitting. If biological components are left in systems or introduced with the testing water, there is also the possibility of microbiologically induced corrosion (MIC).

NOTE: Clean systems, and the use of boiler feed water or condensate as test water, minimise the risk of microbiologically induced corrosion.

- a. The use of biocide to minimise the risk of MIC shall be considered, if the water will remain in the system for an extended period of time.
 - b. The stainless steel shall be clean prior to final assembly and hydrostatic testing.
 - c. The equipment and/or piping shall be tested with condensate (water), boiler feed water or demineralized water.
 - d. In locations where water of the required quality is not available (initially or permanently), temporary facilities shall be used (e.g., mobile packaged demineralization units) to prepare the test water.
2. Alternatively, austenitic stainless steel may be tested with potable water with a verified chloride content not exceeding 50 mg/kg (50 ppm) **provided** that it is either drained and mechanically dried **immediately** after the testing, or flushed with condensate, boiler feed water or demineralized water **immediately** after the testing.
 3. Austenitic stainless steel piping sections and components such as valves and expansion joints that do not allow full draining or mechanical drying and that do not require field hydrotesting should preferably be isolated from the system, and, if still required, tested separately from the system, using condensate (water), boiler feed water or demineralized water.

NOTE: Equipment such as shell-and-tube heat exchangers, expansion joints, or bellows as part of bellows sealed valves may have crevices which prevent proper draining and mechanical drying.

4. When flushing with condensate, boiler feed water or demineralized water, it is essential that all surfaces previously wetted during the test are flushed. The quantity and velocity of the flushing water depends on the equipment volume and shall be determined in consultation with the Principal.