

MANUAL

**GRP PIPELINES AND PIPING SYSTEMS
(AMENDMENTS/SUPPLEMENTS TO ISO 14692)**

DEP 31.40.10.19-Gen.

August 2005

DESIGN AND ENGINEERING PRACTICE



This document is restricted. Neither the whole nor any part of this document may be disclosed to any third party without the prior written consent of Shell Global Solutions International B.V. and Shell International Exploration and Production B.V., The Netherlands. The copyright of this document is vested in these companies. All rights reserved. Neither the whole nor any part of this document may be reproduced, stored in any retrieval system or transmitted in any form or by any means (electronic, mechanical, reprographic, recording or otherwise) without the prior written consent of the copyright owners.

PREFACE

DEPs (Design and Engineering Practice) publications reflect the views, at the time of publication, of:

Shell Global Solutions International B.V. (Shell GSI)

and

Shell International Exploration and Production B.V. (SIEP)

and

Shell International Chemicals B.V. (SIC)

and

other Service Companies.

They are based on the experience acquired during their involvement with the design, construction, operation and maintenance of processing units and facilities, and they are supplemented with the experience of Group Operating companies. Where appropriate they are based on, or reference is made to, international, regional, national and industry standards.

The objective is to set the recommended standard for good design and engineering practice applied by Group companies operating an oil refinery, gas handling installation, chemical plant, oil and gas production facility, or any other such facility, and thereby to achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to users 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 companies 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 the quality of work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will expect them to follow those design and engineering practices which will achieve 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 or its technical advisor.

The right to use DEPs is granted by Shell GSI, SIEP or SIC, in most cases under Service Agreements primarily with companies of the Royal Dutch/Shell Group and other companies receiving technical advice and services from Shell GSI, SIEP, SIC or another Group Service Company. Consequently, three categories of users of DEPs can be distinguished:

- 1) Operating companies having a Service Agreement with Shell GSI, SIEP, SIC or other Service Company. The use of DEPs by these operating companies is subject in all respects to the terms and conditions of the relevant Service Agreement.
- 2) Other parties who are authorized 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, SIEP and SIC disclaim 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, SIEP or other Service Company. The benefit of this disclaimer shall inure in all respects to Shell GSI, SIEP, SIC and/or any company affiliated to these companies that may issue DEPs 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 and SIEP, 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, SIEP or SIC. The copyright of DEPs vests in Shell GSI and SIEP. Users shall arrange for DEPs to be held in safe custody and Shell GSI, SIEP or SIC 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

PART I	INTRODUCTION	4
1.1	SCOPE.....	4
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	4
1.3	DEFINITIONS	4
1.4	CROSS REFERENCES.....	4
1.5	CHANGES FROM THE PREVIOUS EDITION	5
1.6	COMMENTS ON THIS DEP	5
PART II	ENDORSEMENTS, AMENDMENTS AND SUPPLEMENTS TO ISO 14692	6
PART III	REFERENCES	7

APPENDICES

APPENDIX 1	HYDROSTATIC TESTING - PRESSURE CHANGE CALCULATION	8
------------	---	---

PART I INTRODUCTION

1.1 SCOPE

This revised DEP specifies requirements and gives recommendations for the use of glass-reinforced plastic (GRP) pipelines and piping systems, both offshore and onshore.

This DEP is based on International Standard ISO 14692. Part II of this DEP gives amendments and supplements to ISO 14692. Clauses of ISO 14692 that are not amended by this DEP shall remain applicable as written.

This DEP is a revision of a previous edition with the same number, dated November 2003. A summary of changes from the previous edition is given in (1.5).

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI and SIEP, the distribution of this DEP is confined to companies forming part of or managed by the Royal Dutch/Shell Group and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them.

This DEP is intended for use in exploration and production 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 may be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are more stringent and which combination of requirements will be acceptable as regards 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 with the object of obtaining agreement to follow this DEP as closely as possible.

1.3 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** 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.

1.4 CROSS REFERENCES

Where cross-references are made, the number of the section or sub-section referred to is shown in brackets. All publications referred to in this DEP are listed in (Part III).

1.5 CHANGES FROM THE PREVIOUS EDITION

The previous edition of this DEP was dated November 2003; a summary of the main changes since the last edition is given below.

Section	Change
General	ISO 14692 is used as the basis. For below ground (buried) GRP pipelines and piping systems, amendments are based on AWWA M45.
Part II	ISO 14692-3: • Added requirements to Clause 8.2 (analyses requirements for buried pipelines and piping systems). ISO 14692-4: • Added requirements to Clause 5.5.4 (installation requirements for buried pipelines and piping systems).

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the DEP Administrator at standards@shell.com. Shell staff may also post comments on this DEP on the Surface Global Network (SGN) under the Standards/DEP 31.40.10.19-Gen. folder. The DEP Administrator and DEP Author monitor these folders on a regular basis.

PART II ENDORSEMENTS, AMENDMENTS AND SUPPLEMENTS TO ISO 14692

For ease of reference, the clause numbering of ISO 14692 has been used throughout this Part.

ENDORSEMENTS:

The following standards are endorsed for use with no additional requirements:

ISO 14692-1:2002;

ISO 14692-2:2002.

AMENDMENTS:

ISO 14692-3:

ISO 14692-3:2002 is endorsed for use with the following additional requirements.

5.6.2 Criticality and reliability

Add to this clause:

For services proven to be harmless for the environment, the standard joints should be used. Adhesive-bonded and/or laminated joints shall be used for aromatic hydrocarbon service, for very toxic service (as defined in DEP 01.00.01.30-Gen.) and for services in which leakage could cause unacceptable environmental damage (as specified by the Principal).

8.2 Analyses requirements

Add to this clause:

For buried GRP pipelines and piping systems, design calculations shall include external soil loading, according to AWWA M45.

ISO 14692-4:

ISO 14692-4:2002 is endorsed for use with the following additional requirements.

5.5.4 Installation

Add to this clause:

Installation of buried GRP pipelines and piping systems shall be in accordance with AWWA M45.

5.6.2.3 Testing

Add to this clause:

As an additional check to determine whether any pressure variation has been caused by a temperature change or whether a leak is present, the theoretical pressure change resulting from the measured temperature change shall be calculated using the formulae given in Appendix 1 of this DEP.

PART III 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://sww05.europe.shell.com/standards/>.

SHELL STANDARDS

Definition of temperature, pressure and toxicity levels DEP 01.00.01.30-Gen.

AMERICAN STANDARDS

Manual of water supply practices, Fiberglass pipe design AWWA M45

Issued by:
American Water Works Association
6666 West Quincy Avenue
Denver, CO 80235

ISBN 0-89867-889-7

INTERNATIONAL STANDARDS

Petroleum and natural gas industries – Glass-reinforced plastics piping

Part 1: Vocabulary, symbols, applications and materials ISO 14692-1:2002

Part 2: Qualification and manufacture ISO 14692-2:2002

Part 3: System design ISO 14692-3:2002

Part 4: Fabrication, installation and operation ISO 14692-4:2002

Issued by:
International Organization for Standardization
1, Rue de Varembe
CH-1211 Geneva 20 Switzerland

Copies can also be obtained from national standards organizations.

APPENDIX 1 HYDROSTATIC TESTING - PRESSURE CHANGE CALCULATION

To determine the theoretical pressure change resulting from a given temperature change, the following formulae shall be used:

$$P_f - P_i = A_1 (T_f - T_i) + A_2 \log \left[\frac{\frac{d(1-\nu^2)}{tE} + C_1 + a_2 T_f + a_3 T_f^2}{\frac{d(1-\nu^2)}{tE} + C_1 + a_2 T_i + a_3 T_i^2} \right] + A_4 \left[\arctan \left(\frac{a_2 + 2a_3 T_f}{A_3} \right) - \arctan \left(\frac{a_2 + 2a_3 T_i}{A_3} \right) \right] \quad (1)$$

Where:

$$A_1 = \frac{b_3}{a_3}$$

$$A_3 = \sqrt{4a_1 a_3 - a_2^2}$$

$$A_2 = \frac{1}{2a_3} \left(b_2 - \frac{b_3 a_2}{a_3} \right)$$

$$a_1 = \frac{d}{E \cdot t} (1 - \nu^2) + C_1$$

For restrained ends:

$$A_4 = \left(\frac{2(C_2 - 2((1+\nu)\alpha) - 2\frac{a_1 b_3}{a_3} - \frac{a_2 b_2}{a_3} + \frac{a_2^2 b_3}{a_3^2})}{A_3} \right)$$

For unrestrained ends:

$$A_4 = \left(\frac{2(C_2 - 3((1+\nu)\alpha) - 2\frac{a_1 b_3}{a_3} - \frac{a_2 b_2}{a_3} + \frac{a_2^2 b_3}{a_3^2})}{A_3} \right)$$

where:

P _i	Initial Pressure (MPa)	C ₁	498.3 x 10 ⁻⁶ (1/MPa)
P _f	Final Pressure (MPa)	C ₂	-63.32 x 10 ⁻⁶ (1/°C)
T _i	Initial Temperature (°C)	a ₂	-2.93 x 10 ⁻⁶ (1/MPa.°C)
T _f	Final Temperature (°C)	a ₃	0.038 x 10 ⁻⁶ (1/MPa.°C ²)
E	Hoop Modulus (16000 MPa)	b ₂	1.58 x 10⁻⁵ (1/°C²)
ν	Poisson's ratio (0.35)	b ₃	-0.0113 x 10⁻⁵ (1/°C³)
α	Thermal expansion coefficient (30 μm/m°C)	t	Pipe wall thickness (mm)
		d	Pipe wall outer diameter (mm)