

DEP SPECIFICATION

CLASSIFICATION OF UNSHAPED REFRACTORY LINING MATERIALS

DEP 44.24.32.31-Gen.

September 2012

DESIGN AND ENGINEERING PRACTICE



© 2012 Shell Group of companies
All rights reserved. No part of this publication 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	ASSOCIATED DEPS	4
1.3	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	4
1.4	DEFINITIONS	5
1.5	CROSS-REFERENCES	6
1.6	COMMENTS ON THIS DEP	7
1.7	DUAL UNITS.....	7
2.	TEST PROCEDURES FOR CLASSIFICATION BY PHYSICAL PROPERTIES.....	8
2.1	APPLICABLE TESTING STANDARDS	8
3.	CLASSIFICATION OF UNSHAPED REFRACTORY MATERIALS	8
3.1	GENERAL CLASSIFICATIONS IN ACCORDANCE WITH STANDARDS ORGANIZATIONS	8
3.2	SPECIFIC CLASSIFICATIONS	8
3.3	SPECIALIZED CLASSIFICATION OF UNSHAPED LINING MATERIALS	8
4.	MATERIAL ADDITIVES	9
4.1	PRODUCTS CONTAINING BURN OUT FIBRES	9
4.2	UNSHAPED PRODUCTS CONTAINING METAL FIBRES	9
4.3	PHYSICAL PROPERTIES FOR SPECIFICATION OF UNSHAPED MATERIAL TYPES	9
5.	MATERIAL TABLES	10
5.1	TABLE NOTES	10
6.	REFERENCES	17

1. INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements and gives recommendations for “Type” classification of characterized unshaped refractory materials with the general chemical classification of alumina–silica, for use in engineered monolithic construction. It specifies minimum requirements for non-refractory protective coatings for steel vessel wall and refractory lining systems and refractory coatings used for fortification of new and old linings.

This DEP does not include man made vitreous fibres or refractory mortars.

For specialized classification of unshaped materials used in cat cracking units, reference is given to DEP 64.24.32.12-Gen., which provides the final basis for all aspects of specification, supply, installation and quality control and supersedes this DEP in areas of conflict.

For refractory mortars reference is given to DEP 44.24.90.34-Gen., which for specification purposes should be read in conjunction with the family of DEPs for refractory bricks and shapes noted therein.

Requirements of the refractory Manufacturer, other refractory application DEPs, and/or individual project specifications that conflict with requirements in the associated DEPs listed in (1.2) shall be clearly resolved in a derogation process approved by the Principal.

The content in this DEP is based partially on material previously contained in DEP 64.24.32.30-Gen., December 1997 (now withdrawn).

1.2 ASSOCIATED DEPS

The following DEPs are intended to be used in conjunction with each other for unshaped refractory:

DEP 44.24.32.30-Gen.	Unshaped refractory materials for monolithic refractory linings
DEP 44.24.32.31-Gen.	Classification of unshaped refractory lining materials
DEP 44.24.32.32-Gen.	Specification for sampling and testing of unshaped refractory lining materials
DEP 44.24.32.33-Gen.	Specification for anchoring systems of unshaped refractory lining materials
DEP 64.24.32.33-Gen.	Guidelines for curing, drying and firing of unshaped refractory lining materials
DEP 64.24.32.34-Gen.	Refractory Contractor selection and applicator qualification for installation of unshaped refractory lining materials
DEP 64.24.32.35-Gen.	Construction design details of unshaped refractory lining materials

For specialized application of unshaped materials used in fluidized cat cracking units (FCCU), reference is given to DEP 64.24.32.12-Gen., which shall provide the final basis for all aspects of specification, supply, installation and quality control and shall supersede this DEP in areas of conflict.

1.3 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.

1.4 DEFINITIONS

1.4.1 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 **refractory Contractor** is the party that carries out all or part of the construction design, engineering, material procurement and installation of refractory materials. The refractory Contractor has the final overall responsibility for the total quality control of the materials and services including those of any Sub-contractors or Suppliers related to the installation.

The **Manufacturer/Supplier** is the party that manufactures the metallic and non-metallic materials and/or ancillaries for supply to the refractory Contractor, Principal or another Contractor. The Manufacturer/Supplier has primary responsibility for material design properties, manufacturing quality control at the manufacturing site and all or part of brand specific applicable procedures such as, but not limited to, those for construction design, mixing, installation, curing, dry and fire and start-up. The Manufacturer/Supplier may take on all or part of the responsibility of the refractory 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 word **should** indicates a recommendation.

1.4.2 Specific definitions

Term	Definition
Engineered Monolithic Construction	A monolithic lining from unshaped materials with engineered anchors supports expansion and construction joints from success based installation standards and procedures
Hot Face	Reference to layer of material exposed directly to the process
Maximum Use Temperature	The term used by most material Manufacturers to "suggest" a limit temperature after which products can be expected to undergo adverse affects on physical properties.
Maximum Continuous Use Temperature	The term used by most material Manufacturers to "suggest" a limit temperature after which products can no longer be expected to work for extended periods without adverse affects on physical properties, also referred as continuous use temperature.

Term	Definition
Monolithic Lining	A relative jointless lining from unshaped materials
Physical Properties- Compliance	Also referred to as compliance data are the guaranteed physical properties of unshaped materials used in compliance procedure of total quality plan for qualifying materials prior to shipment. Compliance properties and/or agreed standardized deviations may also be used for Applicator qualification and production testing. Compliance properties wherever possible should be selected based on normal "in house" testing done by the Manufacturer such as cold crush strength, density and permanent change after drying and firing to specified applicable but lower than normal operating temperatures.
Physical Properties- Design	Also referred to as design data are the guaranteed physical properties of unshaped materials used in compliance procedure for design purposes and are not normally done as part of Manufacturer normal quality control and are not required for product qualification, however are part of the total quality plan for specifying and guaranteeing materials prior to shipment. Design properties often include thermal conductivity, refractoriness under load, creep, young's modulus, co-efficient of reversible expansion, CO disintegration, corrosion testing and chemical analysis. At the request of the Principal design properties may also be used for compliance for qualifying materials prior to shipment under special conditions with specific temperature or atmospheric conditions.
Shelf Life	The allowable time from date of manufacture determined by the Manufacturer that may be allowed before the material is applied or installed without harmful effects on physical properties. Shelf life is critical for all unshaped materials with reactive binder systems included in the original batch blend or as packaged material.
Unshaped Material	Unshaped refractory materials are non-metallic mixtures of treated aggregates, matrix materials, additives and binders that are stable at high temperatures and pre-blended in a controlled manufacturing process. Unshaped materials are packaged as a unit and ready for use, either directly in the supplied condition or by field mixing with a suitable liquid additive.

Other specific definitions and terms relating to unshaped refractory materials may be in accordance with ASTM C71, API 936 and ISO 1927. Where conflict exists for the purpose of this and the family of related DEPs, the above specific definitions shall be applied.

1.4.3 Abbreviations

Term	Definition
API	American Petroleum Institute
ASTM	American Society for Testing and Materials
EU	European Organization for Standardization
ISO	International Organization for Standardization
LCC	Low cement castable
MSDS	Material safety data sheets
ULCC	Ultra low cement castable

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 (6).