

DEP SPECIFICATION

SPECIFICATION FOR SAMPLING AND TESTING OF UNSHAPED REFRACTORY LINING MATERIALS

DEP 44.24.32.32-Gen.

September 2012

DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements and gives recommendations for sampling, testing, and acceptance criteria of unshaped insulating and dense refractory materials.

In accordance with the total quality plan, testing may be required to:

- a) Specify materials for application,
- b) Qualify materials after manufacture,
- c) Re-qualify materials after shipping and storage (verification testing),
- d) Qualify Applicators and installation procedures,
- e) Verify proper installation and installation procedures (workmanship),
- f) Verify proper curing treatments, drying, firing and/or preservation of installed linings,
- g) Verify used linings.

Section (4.3.2) of this DEP may be used to audit unshaped Material/Suppliers for the selection and use of new Manufacturers or for those having deficiencies meeting all requirements of DEP 44.24.32.31-Gen.

This DEP covers various classifications, types, and forms of unshaped materials with the general chemical classification of alumina-silica, with the exception of man-made, vitreous fibres.

Refractory coatings are included in this DEP. Refractory mortars, normally used in applications of bricks and shapes, are covered in DEP DEP 44.24.90.34-Gen.

For sampling, testing, and acceptance criteria of unshaped insulating and dense refractory 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.

Requirements and recommendations for shaped materials are found in DEP 44.24.90.33-Gen., which should be read in conjunction with this DEP if shaped and unshaped refractory are required.

This is a new DEP with content that is partially based on material previously contained in DEP 64.24.32.30-Gen., December 1997 (now withdrawn).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
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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 **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 word **should** indicates a recommendation.

1.4.2 Specific definitions

Term	Definition
Applicator	The individual responsible to the refractory Contractor that is responsible for the placement or actual installation of the unshaped refractory material utilizing procedures by the refractory Contractor and approved by the Principal.
Batch	A number of raw material components traceably formulated by weight in a proportional and quality controlled recipe collected in a mixer for blending of a single repeatable finished product brand of material for packaging in individual bags or pails.
Batch lot	A blended batch discharged and stored in bulk (outside the blending mixer) prior to packaging.
Brand	An individual material or product name designated by the Manufacturer to identify materials matching physical properties of specific types.

Term	Definition
Bulk Sample	A sample gathered from an un-packaged batch, batch lot or from large containers greater than 90 kg (200 lbs).
Classification Temperature	The classification temperature as typically shown on Manufacturer's technical data sheets as determined by ASTM C401, or ISO 1927, which limits the total as prepared to fired shrinkage to maximum to 1.5 % after drying and firing under laboratory conditions.
Hammer Test	A subjective test of green or fired unshaped material applied in a large sample or installation in which the refractory is impacted with a hammer to gauge soundness and uniformity via audible response.
In-house	A term used in this DEP to describe the material Manufacturers QA/QC procedures for product quality; specifically laboratory sampling, specimen preparation, testing and documentation of test results.
Lab Specimen	A sized bar or cube in accordance with standards committee or approved test procedures created by the laboratory technician under laboratory conditions. Lab specimens may be from unopened containers into specially sized gang or individual molds or from production samples cut to size.
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.
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 but are not limited to thermal conductivity, refractoriness under load, high temperature creep, Young's modulus, hot modulus of rupture, co-efficient of reversible expansion, carbon monoxide 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.
Production Sample	A bulk-sized sample taken from the actual construction site prepared under project site conditions of mixed material of pre-determined size from which the remainder of the mix will be applied as the lining being installed. The Applicator shall prepare production samples in sample box or form inside the vessel to be lined and they shall remain inside the vessel for applicable curing time.
Production Specimen	A sized bar or cube in accordance with standards committee or approved installation test procedures created by the Applicators in specimen sized forms during the actual installation from field mixed materials by mixer operators.

Term	Definition
Refractory Contractor	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.
Run	The entire quantity of the same material produced in an uninterrupted sequence of manufactured batches utilizing the same raw material recipe and utilizing the same blending and packaging procedures.
Sample	An individual unopened container from the series of containers made of designated weight from any individually identified batch.
Shelf Life	Period from manufacture to when normal characteristics and/or physical properties of unshaped materials containing organic or inorganic bond materials can change.
Technical Data Sheet	Publication of "typical" and average information by the Manufacturer to describe characteristics and physical properties of any given material brand or part from testing after or at a range of generally accepted temperatures, in accordance with standards organisation testing or approved in-house quality procedures.
Testing Contractor	The Contractor usually independent of Material/Supplier or refractory Contractor (if different) that is equipped and capable of completing and documenting physical property testing in accordance with applicable testing standards committee procedures.

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, these specific definitions shall be applied.

1.4.3 Abbreviations

Term	Definition
API	American Petroleum Institute
AQL	Acceptance Quantity Limit
EU	European Organization for Standardization
FCCU	Fluidized Cat Cracking Units
ISO	International Organization for Standardization
ITP	Inspection Test Plan
MSDS	Material Safety Data Sheets
MTR	Material Test Report
PPQ	Application Procedure Qualification
QC/QA	Quality Control/Quality Assurance
TDS	Technical Data Sheet

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).

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using the DEP Feedback Form by:

- Entering comments directly in the DEP Feedback System on the Technical Standards Portal <http://www.shell.com/standards> (mandatory for users with access to Shell Wide Web);
- Clicking on the DEP Feedback Form button on the DEPs DVD-ROM main page (for users without access to Shell Wide Web);
- Requesting a copy of the DEP Feedback Form from the Administrator at standards@shell.com (for users without access to Shell Wide Web).

For the last two options, the completed DEP Feedback Form can be attached to an email and submitted to the Administrator at standards@shell.com. Only feedback that is entered into the Feedback Form will be considered.

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.

2. TEST STANDARDS AND DOCUMENTATION

2.1 SAMPLE AND TEST DOCUMENTATION

2.1.1 Compliance procedure documentation

The following documentation shall be provided:

- a) Manufacturer product property **technical data sheet** (TDS) (with bid documentation).

Normal as published technical data sheet that includes physical properties normally found on compliance data sheet.

- b) **Product compliance data sheet** - See (Appendix A) and (Appendix B) with bid documentation.

The data sheet shall list the Manufacturer/Supplier regular technical data as illustrated on technical data sheets (TDS) and the refractory Contractor's guarantee for selected design and compliance physical properties, including, if applicable, special requirements from the Principal.

The compliance data sheet shall also include appropriate reference to specimen preparation, test procedures, batch numbers and date code traceability information.

If materials will have steel fibre reinforcement or are special gun mix or pump mix types, compliance data are required for both lab cast (all preparation requirements to be listed and provided if different from (2.2)) and as "design basis" applied such as "as gunned" or "as pumped" with or without the addition of steel fibres.

Therefore, unless otherwise specified, if steel fibre reinforcement is specified for a gun-grade castable to be gunned with steel fibres, up to four sets of data are required to include samples from each "lab cast" and "design data from gunning" each "with" and "without" inclusion of the specified percent addition of metal fibres.

- c) **Manufacturer/Supplier material test report** (MTR) - See (Appendix C), (Appendix D) and (Appendix E) after manufacture and test.

The MTR shall document qualification test results against compliance physical property specification for each physical property tested with appropriate identification and traceability information.

2.1.2 Additional documentation

The following additional documentation shall be provided before or after receipt of order as applicable:

- a) Installation/APQ/Sample Record. See (Appendix F) as requested or required. This record shall map production samples to installation location in the equipment to be lined or Applicator or Application testing.
- b) Material safety data sheets (MSDSs) current and in compliance with other local regional and site-specific HSSE regulations.
- c) List of shelf life and storage requirements for all material brands.
- d) Curing, drying and initial firing procedures for the lining material (maximum heat rates and recommended hold time and temperatures).
- e) Test or sample procedures for different tests or procedures used in the Manufacturer/Supplier's laboratory not listed (2.2) or individual project specification.

2.2 TESTING STANDARDS

Unless otherwise specified, physical properties testing shall be in accordance with American Society for Testing and Materials (ASTM) standard test procedures listed in Table 1 or alternative and comparable international test methods listed in Table 2.

In addition and unless otherwise specified, where API 936 has modified referenced ASTM standard procedures with API modified procedures, the modified procedures as outlined in latest Standard 936, may be utilized.

Where individual project documentation references the alteration of any methods from ASTM, API, ISO or EN standards or the use of alternative testing methods such as Principal-approved, Manufacturer/Supplier's own methods, all conflicts and clarifications shall be resolved at bid stages (4.2.2.1) prior to testing, final approval and shipment of any materials.

Unless otherwise specified, chemical analysis of refractory material shall be by X-Ray florescence. The definitive document for this analysis is ISO 12677.

Table 1 ASTM standards for testing unshaped refractory material

Std. No.	Std Title
A820	Standard Specification for Steel Fibers for Fiber-Reinforced Concrete
C24	Standard Test Method for Pyrometric Cone Equivalent (PCE) of Fireclay and High Alumina Refractory Materials
C 71	Standard Terminology Relating to Refractories
C92	Standard Test Method for Sieve Analysis and Water Content of Refractory Materials
C133	Standard Test Methods for Cold Crushing Strength and Modulus of Rupture of Refractories
C135	Standard Test Method for True Specific Gravity of Refractory Materials by Water Immersion
C179	Standard Test Method for Drying and Firing Linear Change of Refractory Plastic and Ramming Mix Specimens ASTM C1054 (Practice for Pressing and Drying Refractory Plastic and Ramming Mix Specimens) related to ASTM C179, shall not be used. Instead, recommendations by API 936 for sample preparations shall be used. Alternatively, with procedural approval by the Principal, standard "workability" cylinders may be used for the determination of PLC of phosphate bonded plastic shipped with workability 20 % - 45 %.
C181	Standard Test Method for Workability Index of Fireclay and High-Alumina Plastic Refractories
C201	Standard Test Method for Thermal Conductivity of Refractories
C288	Standard Test Method for Disintegration of Refractories in an Atmosphere of Carbon Monoxide
C401	Standard Classification of Alumina and Alumina-Silicate Castable Refractories
C467	Standard Classification of Mullite Refractories
C583	Standard Test Method for Modulus of Rupture of Refractory Materials at Elevated Temperatures
C673	Standard Classification of Fireclay and High-Alumina Plastic Refractories and Ramming Mixes
C680	Standard Practice for Estimating of the Heat Gain or Loss and Surface Temperature of Insulated Flat, Cylindrical and Spherical Systems by use of Computer Programs