DEP SPECIFICATION

SPECIFICATION FOR SAMPLING AND TESTING OF REFRACTORY BRICKS AND SHAPES

DEP 44.24.90.33-Gen.

February 2012

DESIGN AND ENGINEERING PRACTICE

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1. INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements and gives recommendations for conformance procedures, sampling testing and acceptance criteria for shaped refractory bricks and shapes based on compliance physical property data and manufacturing quality control.

This DEP covers various classifications of shaped refractory with the general chemical classification of alumina–silica. This DEP does not cover chemical-resistant bricks and tiles.

Requirements and recommendations for refractory unshaped materials are found in DEP 64.24.32.30-Gen., which should be read in conjunction with this DEP if shaped and unshaped refractory are required.

The contents of this DEP were in an appendix of DEP 44.24.90.31-Gen., dated March 2001.

1.2 ASSOCIATED DEPS

This DEP may be used in conjunction with one or more of the following DEPs for refractory bricks and shapes:

DEP 44.24.90.31-Gen.	Refractory bricks and shapes
DEP 44.24.90.32-Gen.	Classification of refractory bricks and shapes
DEP 44.24.90.34-Gen.	Classification specification and testing of ancillary materials for refractory brick construction
DEP 44.24.90.35-Gen.	Specification and quality control for precast or specialty cast refractory baffle wall tile (shapes)
DEP 64.24.32.31-Gen.	Construction details for refractory brick construction

1.3 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

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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.

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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 overall responsibly for the quality control of the products and services including those of any sub-contractors or Suppliers related to the installation.

The **Manufacturer/Supplier** is the party that manufactures or supplies materials, equipment and services to perform the duties specified by the Refractory Contractor. The Manufacturer may undertake all or part of the duties of the Refractory Contractor.

NOTE: For the purposes of this DEP, the Manufacturer/Supplier is the party that manufactures the refractory products and/or ancillaries for supply to the Refractory Contractor, Principal or another Supplier, and has primary responsibility for material design properties, manufacturing quality control at the manufacturing site and specific procedures such as but not limited to those for product mixing, installation and start-up.

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
Lot	A **lot** is defined as the number of bricks for the specific product manufactured within a given period of time with a unique ID/date code identifier.
Lot Sample Average	The **lot sample average** is the average of multiple individual physical property test results from a lot of bricks
Sample	A **sample** is a finished brick normally ready for packaging.

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 sent to the Administrator at standards@shell.com, using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of "DEPs on the Web", available through the Global Technical Standards web portal http://sww.shell.com/standards and on the main page of the DEPs DVD-ROM.

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.

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2. COMPLIANCE, SAMPLING AND TESTING DOCUMENTATION

2.1 COMPLIANCE PROCEDURE

Prior to shipment of bricks, the brick Manufacturer/Supplier shall guarantee, test and report results for specified physical properties and provide for inspection testing and documentation verifying all bricks meet physical property and manufacturing workmanship requirements for shipment in accordance with the "compliance" procedure outlined in this DEP.

Where no practical opportunity exists for the following "compliance" procedure for material acceptance, Manufacturer/Supplier's data from normal, in-house, quality procedures may be used for brick qualification where each of the following criterion have been met:

a) The Manufacturer/Supplier manufacturing and test facility has successfully been audited by the Principal or designate.

b) The Manufacturer/Supplier quality documentation on product physical properties and manufacturing defects is suitable to evaluate a minimum of one (1) year's performance of specified brand equalling a minimum of 4 times the anticipated quantity of project specific shape requirements.

c) The specific physical property or characteristics (cracks or flaws) tested falls within a 95 % compliance level from normal statistical evaluation of 2-sigma limit.

d) The specific brand and shape definition has been used in similar applications with documented results or has been pre-approved by the Principal.

2.2 SAMPLING AND TESTING DOCUMENTATION

Sampling and testing documentation shall include:

- Supplier **product property data sheet (TDS)** (with bid documentation)

  Normal as published technical data sheet.

- Manufacturer/Supplier Product Compliance Data Sheet (Appendix A) (with bid documentation)

  This data sheet shall provide guaranteed values for as-specified physical properties and compares guaranteed results to normally published data.

  The data sheet shall include the Manufacturer/Supplier's regular technical data as illustrated on published regular Technical Data Sheets (TDS) and the Manufacturer/Supplier's guarantee for selected physical properties and manufactured defects. The compliance data sheet shall also include appropriate identification and traceability information.

- **Manufacturer/Supplier Material Test Report** (MTR) (Appendix B) (after receipt of order)

  The MTR shall document test results against compliance specification for each physical property tested and results from physical inspection for manufacturing defects.

  1. The Manufacturer/Supplier shall provide frequency distribution, in both chart and graph form, for all dimensions for brick and fired shapes tested.
  2. This information shall include all identification information, length, width and thickness, (both hot face and cold face thickness dimensions in the case of arch and wedge configurations), and allowable tolerance for each dimension with mean and standard deviation calculations for each dimension.
  3. Graph shall show frequency against dimension (length, width, thickness $_{hf,}$ thickness $_{cf}$) for the entire allowable specification range and frequency of each measurement within the specification.

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Additional documentation (after receipt of order) shall include:

a) Installation **Sample/Specimen Record** (Appendix C) (as requested);

- This record shall map production samples to installation location in the equipment to be lined.

b) **Material Safety Data Sheets** (MSDSs) updated and in compliance with local regulations;

c) Shelf life and storage precautions for all materials;

d) 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 in this or project specification;

f) As requested, full information about appropriate mortars to be used with the refractory bricks.

2.3 APPLICABLE TESTING STANDARDS

Unless otherwise specified or agreed, physical properties for acceptance of refractory bricks shall be tested in accordance with ASTM standard test procedures listed in Table 1. Table 2 lists an acceptable cross-reference for alternative acceptable test methods. Where individual project specification references the use of alternative methods, all conflicts between results of alternative methods shall be resolved prior to final approval and shipment of bricks and shapes and suitably documented in turnover or purchase documentation.

Reference is given to DEP 44.24.32.31-Gen. and DEP 44.24.32.32-Gen. for classification of special shapes from unshaped materials that inherit the classification based on the physical properties of the host unshaped material.

Table 1 ASTM standards for testing refractory bricks and shapes

Standard	Title
C16	Standard test method for load testing refractory shapes at high temperatures
C20	Standard test methods for apparent porosity, water absorption, apparent specific gravity, and bulk density of burned refractory brick and shapes by boiling water
C27	Standard classification of fireclay and high-alumina refractory brick
C113	Standard test method for reheat change of refractory brick
C133	Standard test methods for cold crushing strength and modulus of rupture of refractories
C134	Standard test methods for size and bulk density of refractory brick and insulating firebrick
C135	Standard test method for true specific gravity of refractory materials by water immersion
C155	Standard classification of insulating firebrick
C182	Standard test method for thermal conductivity of insulating firebrick
C198	Standard test method for cold bonding strength of refractory mortar
C199	Standard test method for pier test for refractory mortars
C201	Standard test method for thermal conductivity of refractories
C202	Standard test method for thermal conductivity of refractory brick

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Standard	Title
C210	Standard test method for reheat change of insulating firebrick
C279	Standard specification for chemical-resistant masonry units
C467	Standard classification of mullite refractories
C583	Standard test method for modulus of rupture of refractory materials at elevated temperatures
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
C832	Standard test method of measuring the thermal expansion and creep of refractories under load
C861	Standard practice for determining metric dimensions of standard series refractory brick and shapes
C909	Standard practise for dimensions of a modular series of refractory brick and shapes
C1113	Standard test method for thermal conductivity of refractories by hot wire (platinum resistance thermometer technique)

Table 2 ASTM and alternative material test standards

Properties	Alternative standard	ASTM standard
Permanent Linear Change	ISO 2477, ISO 2478	ASTM C113, ASTM C210
Porosity	ISO 5017,EN 993-1	ASTM C20, ASTM C830
Thermal Conductivity	ISO 8894-1, ISO 8894-2, EN 993-15,	ASTM C201, ASTM C1113
Density (true & bulk)	EN 993-1, EN 1094-4, ISO 5016, ISO 5017	ASTM C134, ASTM C830, ASTM C914
Cold Crushing Strength	EN 993-5, ISO 8895, ISO 10059-1, ISO 10059-2	ASTM C133
Modulus of Rupture	EN 993-6, EN 993-7, ISO 5014	ASTM C133
Hot Modulus of Rupture	ISO 5013, EN 993-7	ASTM C583
Refractoriness under Load	ISO 1893	ASTM C16
Creep	ISO 3187, EN 993-9	ASTM C832
Abrasion Resistance	ISO 16282	ASTM C704
Chemical Analysis	ISO 12677, ISO 21587-1, ISO 21587-2, ISO 21587-3	Use alternative
Dimensions of Standard Shapes	ISO 5019-1, ISO 12678-1, ISO 5019-2	ASTM C909

NOTE: Testing in North America will be generally performed in accordance with primary standards however, in case of non-availability of a test facility for completion in accordance with primary standards, such as for EU supplied materials, alternative test standards may be used with the approval of the Principal.

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