

DEP SPECIFICATION

UNSHAPED REFRACTORY MATERIALS FOR MONOLITHIC REFRACTORY LININGS

DEP 44.24.32.30-Gen.

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DESIGN AND ENGINEERING PRACTICE



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TABLE OF CONTENTS

1	INTRODUCTION	5
1.1	SCOPE.....	5
1.2	ASSOCIATED DEPS	5
1.3	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	5
1.4	DEFINITIONS	6
1.5	CROSS-REFERENCES	8
1.6	COMMENTS ON THIS DEP	8
1.7	DUAL UNITS.....	8
2.	CHARACTERIZATION OF UNSHAPED REFRACTORY MATERIALS	9
2.1	GENERAL	9
2.2	PLASTIC REFRACTORY	9
2.3	REFRACTORY MORTAR.....	9
2.4	REFRACTORY COATINGS, CURING COMPOUND, ALKALIS-HYDROLYSIS PROTECTION COATINGS AND ANTI-CORROSION COATINGS	9
2.5	CASTABLE REFRACTORY MATERIALS.....	10
2.6	CASTABLE MATERIALS CHARACTERIZED BY APPLICATION METHOD	11
3.	QUALITY ASSURANCE/QUALITY CONTROL.....	12
3.1	QUALITY CONTROL	12
3.2	CONTINUANCE OF WORK	12
3.3	QUALITY ASSURANCE	12
3.4	TOTAL QUALITY PLAN.....	12
3.5	INSPECTION TEST PLAN (ITP)	14
4.	HEALTH, SAFETY, AND ENVIRONMENTAL CONSIDERATIONS	15
5.	MANUFACTURE, PROCUREMENT, SHIPMENT, AND STORAGE OF REFRACTORY MATERIALS	15
5.1	MANUFACTURE OF MATERIAL	15
5.2	MATERIAL PACKAGING AND MARKING	15
5.3	MATERIAL SHIPMENT	16
6.	CLASSIFICATION OF UNSHAPED REFRACTORY MATERIALS	17
6.1	GENERAL	17
7.	MATERIAL LIMITATIONS AND LINING DESIGN	17
7.1	LINING DESIGN	17
7.2	SULPHUR AND VANADIUM CONSIDERATIONS.....	17
7.3	CO GAS	18
7.4	PRODUCTS CONTAINING PORTLAND CEMENT	18
7.5	OTHER LIMITATIONS.....	18
7.6	ENGINEERED MONOLITHIC CONSTRUCTION	18
8.	INSTALLATION OF REFRACTORY MATERIALS	19
8.1	ANCHORING	19
8.2	GENERAL INSTALLATION	19
8.3	PLASTIC REFRACTORY	21
8.4	CASTING REGULAR CASTABLE REFRACTORY	24
8.5	GUNNING GUN GRADE REGULAR CASTABLES	26
8.6	INSTALLATION OF CASTABLES BY (EXTERNAL) VIBRATION CASTING	27
8.7	INSTALLATION OF LOW CEMENT CASTABLE BY DRY GUNNING	30
8.8	INSTALLATION OF REGULAR OR LOW CEMENT CASTABLE BY PUMPING	30
8.9	INSTALLATION OF REGULAR OR LOW CEMENT CASTABLE BY WET GUNNING "SHOTCRETE"	31
8.10	INSTALLATION OF CHEMICALLY BONDED CASTABLES BY CASTING OF LININGS GREATER THAN 75 MM (3 IN)	31
9.	PRESERVATION, TRANSPORTATION, AND HANDLING OF REFRACTORY LINED EQUIPMENT	32

9.1	TRANSPORTATION AND HANDLING OF LINED EQUIPMENT AND COMPONENTS	32
10.	START-UP	32
10.1	INITIAL FIRING	32
11.	REPAIRS	32
11.1	NEW CONSTRUCTION.....	32
11.2	USED CONSTRUCTION	33
12.	REFERENCES	34

1 INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements and gives recommendations for unshaped refractory materials, and for all types of unshaped materials characterized and classified in DEP 44.24.32.31-Gen. with the general chemical classification of alumina-silica.

This DEP also provides installation guidelines for monolithic lining systems made from unshaped refractory materials.

This DEP excludes man made vitreous fibres. For man-made vitreous fibres for use as expansion joint materials, reference is given to DEP 64.24.32.35-Gen.

For specialized application of unshaped materials used in cat cracking units, reference is made 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 made 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 and recommendations for shaped materials are found in DEP 44.24.90.31-Gen. which should be read in conjunction with this DEP if shaped and unshaped refractory are required.

This is a new DEP whereby the content 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 as required 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

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 party that is responsible for the installation of the material utilizing approved procedures produced 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.
Engineered Monolithic Construction	A monolithic lining from unshaped materials with engineered anchors, supports expansion and construction joints from success based installation standards and procedures.
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.
Monolithic Lining	A relative jointless lining from unshaped materials.

Term	Definition
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, coefficient 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.
Production Testing	Physical property tests done on samples prepared during installation of unshaped materials to confirm consistency and quality of workmanship of actual installation. Individual test values are evaluated respective of industry wide generally acceptable deviation from normal compliance data recognising variability in laboratory versus field preparation of samples.
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.
Shelf Life	The allowable time from date of manufacture determined by the Manufacturer that can 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	Non-metallic mixtures of beneficiated aggregates, matrix materials, additives and binders that are stable at high temperatures and pre-blended in a controlled manufacturing process. Unshaped materials are individually 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 conflicts exist, 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
APQ	Applicator's procedure qualification
ASTM	American Society for Testing and Materials

Term	Definition
EU	European Organization for Standardization
FCCU	Fluid catalytic cracking units
FCN	Field change notice
ISO	International Organization for Standardization
ITP	Inspection test plan
LCC	Low cement castable
MSDS	Material safety data sheets
NORM	Naturally occurring radioactive material
PPM	Parts per million
QC/QA	Quality control and quality assurance
RFI	Request for information
WHMIS	Workplace hazards information system
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 (12).

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://swwww.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. CHARACTERIZATION OF UNSHAPED REFRACTORY MATERIALS

2.1 GENERAL

Unshaped refractory materials for monolithic new construction and/or repairs shall be characterized into the following groups:

- a) Plastic
- b) Mortar
- c) Coatings
- d) Castable

Castable refractory materials may be further characterized into the following sub-groups:

- a) Regular, (dense and insulating)
- b) Chemically bonded
- c) Low/ultra low and no cement
- d) Any of the above with additional characterization based on physical properties and method of installation (cast grade, vibration grade, etc.)

Coating materials may be further characterized into the following sub-groups:

- Refractory
- Non-refractory

2.2 PLASTIC REFRACTORY

Plastic refractory should be provided as a soft and workable ready to use material easily compacted without crumbling.

Plastic refractory should be supplied ready to use and manufactured into pre-sliced de-aired slabs less than 64 mm (2.5 in) thick for proper installation by pneumatic sand rammers.

Where climactic conditions make it impractical to supply plastic refractory in pre-moistened condition, dry ingredients of specially-formulated, plastic-refractory raw materials may be supplied for further treatment at installation site with pre-approved mix instructions.

Typically, plastic refractory pre-moistened or from field mixing should have workability index between 45 % and 20 % measured no sooner than 24 hours after manufacture. Refer to ASTM C181.

Pre-mixed phosphate bonded plastic refractories shall have a minimum six-month shelf life determined by a standard "workability" test ASTM C181 or equivalent.

2.3 REFRACTORY MORTAR

Refractory mortar should be provided as a blend of fine aggregate typically less than 0.3 mm (1/64 in) with additives and or bonding agents that, when suitably mixed, has the consistency and texture of heavy skin cream.

For detailed specification of refractory mortars, reference is given to DEP 44.24.90.34-Gen.

2.4 REFRACTORY COATINGS, CURING COMPOUND, ALKALIS-HYDROLYSIS PROTECTION COATINGS AND ANTI-CORROSION COATINGS

2.4.1 Refractory coatings

Refractory coatings should be provided as fine-grained materials, typically manufactured with a blend of fine refractory aggregates from 0.3 mm (1/64 in) to micron size colloids that, when mixed, have the consistency of heavy paint.

Refractory coatings may be supplied with chemical air-set and reactive binders (inorganic) or bonding provided by low temperature sintering bonding clays in "wet" ready-to-use form or dry for field mixing with proper liquid.

2.4.2 Non-refractory coatings

Non-refractory coatings such as bitumen based anti-corrosive coatings and refractory surface sealing coatings (curing compound and anti-hydrolysis mixtures) should be liquids supplied ready-to-use of varying viscosity that can be brushed, sprayed or trowelled and shall only be used as specified for the purposes for which they have been developed.

Coating used to seal moisture into castables (curing compound) shall be a light viscosity solution of resin non-fluxing material mixture of hydrocarbon base that forms a protective membrane when dried in air and decomposes at low temperature. Curing compound shall be non-flammable and non-toxic and shall contain a factory added pigment that allows visual inspection after application.

Anti-corrosive coating can be bituminous based and suitable for a continuous temperature of 200 °C (390 °F). Anti-corrosive coating can have a consistency from paste to thin paint, depending on method of application.

Anti-hydrolysis coatings shall be used as specified by the Principal and shall only be used where the coatings can receive regular maintenance to maintain condition and effectiveness under specific ambient conditions.

2.5 CASTABLE REFRACTORY MATERIALS

2.5.1 General

Castable refractory materials shall be dry blend of aggregate grains with additional, specially-sized, aggregate cement powder or alternative binders and admixtures. Castable shall be factory blended with a documented quality program as further outlined in applicable DEP to develop un-fired strength at ambient temperature within a specified time and suitable for anchored or un-anchored support after proper mixing and installation.

Unless specified otherwise in cooler climates, all castable blends greater than 1200 kg/m³ (75 lb/ft³) should contain factory added special burn out fibres.

2.5.2 Regular castable

Regular castables shall be calcium aluminate or high alumina cement bonded blends that are characterized to contain more than 15 % cement, classified partially by calcium content (oxide form).

2.5.3 Chemically bonded castable

Chemically bonded castable shall be a castable where calcium aluminate or high alumina cement is not the principal cold bond mechanism, and contains one or more alternative bonds such as alumina-phosphate, sodium-silicate gel, and/or ultra-fine reactive alumina.

Chemically bonded castable are acceptable in two general forms:

- The first form is in dry granular powder in which only a carefully controlled amount of water is added to react with inorganic bond as part of dry ingredients.
- The second form is a specialized, two-component mix in which inorganic liquid such as pre-reacted phosphate solution, not water, is added to react with other reactants of the blend.

Chemically bonded castable may be thermo-setting or non-thermo-setting.

2.5.4 Low cement and ultra low cement castables

Low cement castable (LCC) and ultra low cement castable (ULCC) shall be characterized to contain less than 15 % cement, classified partially by calcium content (oxide form).

2.6 CASTABLE MATERIALS CHARACTERIZED BY APPLICATION METHOD

2.6.1 Gunning grade castables

Castable materials specially formulated for application by wet or dry gunning as further characterized below may be specified and are acceptable for “gunned” monolithic lining applications provided:

- physical properties “as gunned” meet the specification requirements,
- all proper quality documentation for “as gunned” and “normally lab tested or as lab cast” physical properties are approved in material physical property compliance process,
- they are installed by gunning in accordance with the Manufacturer’s written and approved job specific procedures.

2.6.1.1 Gun grade regular castable

Gunning grade regular castable should be specially formulated for application by dry pneumatic gun placement. Gun grade regular castable shall not be used for regular casting applications without approval by the Principal and may be used for certain “hand pack” or trowelling applications where procedures are identified and approved by the Principal.

2.6.1.2 Gun grade low cement castable

Gunning grade LCC should be specially formulated for application by dry or wet pneumatic gun placement.

Gunning grade LCC shall not be installed by casting or vibration casting and shall only be gunned in accordance with approved Manufacturer’s procedures.

2.6.1.3 Gun grade chemically bonded castable

Gunning grade chemically bonded castable shall be used in strict compliance with all Manufacturer procedures after approval by the Principal for specific applications.

2.6.2 Vibration cast grade castable

Vibration cast grade castables may be LCC, ULCC or regular materials specially formulated for application by external vibration casting. Vibration cast grade castables should only be installed with the use of external vibration equipment and removable forms.

2.6.3 Free flow grade castable

Free flow grade castable shall self level and de-air without the use of internal or external vibration. Any products advertised as “self levelling” or “free flowing” with the addition of more water only, shall not be used without approval by the Principal.

2.6.4 Cast grade castable

Cast grade castables shall be formulated to be installed by regular casting methods of mixing filling de-airing and vibrating with suitable vibration.

2.6.5 Vibration cast castable

Vibration cast castables shall be formulated to allow for installation by external vibration methods intended to enhance physical properties.