

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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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for unshaped refractory materials as used for monolithic refractory linings in furnaces, heaters, boilers, flue gas systems, stacks (if refractory lined) and general applications. For these applications, the lining materials are exposed to neutral or oxidising conditions. This DEP is not intended to be used for processes whereby the refractory lining materials are in contact with process conditions like in FCC, sulphur plants and syngas processes. For FCC and for sulphur plants, separate refractory DEPs exist.

This DEP focusses upon lining design and engineering and upon quality assurance and quality control.

This DEP applies to refractory materials in fired heaters (previously covered by DEP 31.24.00.30-Gen). This DEP largely follows the section(s) on refractory castables in API560/ISO 13705 and includes some amendments as well as several additions.

DEP 64.24.32.12-Gen. addresses specialized application of unshaped materials used in catalytic cracking units, it provides the final basis for all aspects of specification, supply, installation and quality control and supersedes this DEP in areas of conflict.

DEP 44.24.90.34-Gen. covers refractory mortars.

Requirements and recommendations for shaped materials are in DEP 44.24.90.31-Gen., applicable with this DEP if shaped and unshaped refractory are required.

This DEP does not cover man made vitreous fibres, which are addressed in DEP 64.24.32.35-Gen.

This is a revision of the DEP of the same number dated September 2012; see (1.5) regarding the changes.

1.2 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.

1.3 DEFINITIONS

1.3.1 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.

The word **may** indicates a permitted option.

1.3.2 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.
Cold Face	The surface of a refractory section which is not exposed to the source of heat
Dual-layer lining	A refractory lining consisting of two different types of monoliths. Typically this would consist of a low density insulating lining material behind a stronger and more dense lining material.
Hot Face	The surface of a refractory section exposed to the source of heat
Maximum Continuous Use Temperature	The term used by most material Manufacturer/Suppliers 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.
Production Run	The quantity of refractory having the same formulation that is prepared in an uninterrupted manufacturing operation.
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 Subcontractors or Manufacturer/Suppliers related to the installation.

Term	Definition
Sample	The quantity of refractory taken from a single container or installation sequence that is used to make a complete set of test specimens to determine various physical properties and/or chemical composition.
Specimen	Individual cube, bar, plate or other test pieces used for physical property testing.

1.3.3 Abbreviations

Term	Definition
API	American Petroleum Institute
APQ	Applicator's procedure qualification
ASTM	American Society for Testing and Materials
CCS	Cold Crushing Strength
EN	European Standard
FCAW	Flux Core Arc Welding
FCCU	Fluid Catalytic Cracking Unit
GMAW	Gas Metal Arc Welding
GTAW	Gas Tungsten Arc Welding
ISO	International Organization for Standardization
ITP	Inspection Test Plan
LW	Light Weight Material
MW	Medium Weight Material
PWHT	Post Weld Heat Treatment
QC/QA	Quality Control And Quality Assurance
TC	Thermocouple
XLW	Extra Light Weight Material

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (10).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a full revision of the DEP of the same number dated September 2012. This revision combines seven DEPs as follows into one DEP and the changes are too numerous to list individually:

Section/Clause	Change
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 materials

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://swwww.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

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.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

2. THERMAL DESIGN OF MONOLITHIC LINING SYSTEM

The refractory lining system provides thermal resistance to reduce heat losses and to protect the casing from high temperature damage.

1. External insulation shall not be applied to refractory lined equipment.
2. The following information shall be provided to the lining designer to enable a proper thermal design of the lining system(s):
 - a. minimum, normal and normal high process temperatures as well as upset temperatures;
 - b. gas composition including content of high conductivity components like hydrogen;
 - c. ambient conditions including average temperature and average wind velocities over the year.

Ambient conditions can be based upon available meteorological data.

3. Local conditions for the specific equipment shall be taken into account.

Wind data measurements for meteorological purposes are typically taken at elevation (10 m (33 ft) or more) and not at ground level. Wind velocities at ground level and inside a plant might be significantly lower. This effect has to be taken into account for the thermal design.
4. The design calculations shall be based upon the average conditions.
 - a. Calculations for extreme conditions shall be performed for information only.
5. Thermal calculations shall be performed on the basis of a standard calculation method like ASTM C-680 (version 2002 or later) or VDI Waermeatlas (1997 or later), with the following assumptions:
 - a. take a high value ($>1000 \text{ W/m}^2/\text{K}$) for the heat transfer coefficient at the process side;
 - b. base the thermal conductivity data used in the calculations on the hot wire method (DIN EN 993-14 and 993-15, ISO 8894-1 and 8894-2 or ASTM C1113).
 - i. Thermal conductivity data from calorimetric methods (ASTM C201, C202, C417 and C182) should be corrected.
 - ii. Thermal conductivity values for monolithic materials shall be based on an ascending temperature curve.
 - c. Use a value of 0.8 for the surface emissivity ϵ of the vessel, unless the surface condition deviates significantly from normal steel (e.g., coating or severe scaling).
6. The temperature for the outside casing of radiant and convection sections and hot ducting shall exceed 82°C (180°F).
7. The temperature for the outside casing of radiant floors, roofs and arch areas shall not exceed 90°C (195°F).
8. Stack and hot flue gas duct casing temperatures beyond any heat recovery section where personal protection is not required, shall not exceed the lower of the following:
 - a. 121°C (250°F);
 - b. the capability of the external surface coating.
9. The design hot face temperature of the lining system shall be calculated from the maximum hot-face temperature plus 165°C (300°F).
10. The design interface temperature(s) shall be the calculated interface temperature(s) plus 165°C (300°F), based on the maximum flue gas temperature.

11. The refractory material's continuous use temperatures as stated in the refractory data sheets shall be greater than the design hot face or the design interface temperature(s).
12. All the thermal design calculations and all refractory lining material selections shall be subject to review and approval by the Principal.

3. LINING SYSTEMS

1. For all lining systems, the minimum thickness of any monolithic layer shall be 75 mm (3 in), with the exception of the lining for header boxes where a minimum layer thickness of 50 mm (2 in) is allowed.

3.1 SINGLE LAYER DESIGN

Figure 1 **Single layer lining system**

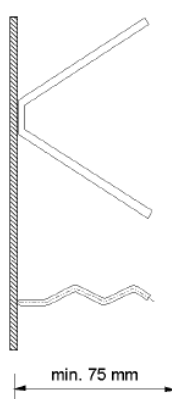


Figure 1 shows a single layer lining design with a type A anchor (see (5)). For thicker linings, type B anchors can be used. Lining installation can be done by gunniting (vertical walls or roofs) or casting.

1. Formwork shall be used for the casting of vertical walls or roofs.

Casting of a floor or a panel in horizontal position normally does not require formwork.

To keep the formwork in position, welding of additional threaded studs (stainless steel) to the wall is required.

After lining installation, these threaded studs do not have to be removed.