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Guidance on Practice for Design and Selection of Refractory Lining Systems

GP 72-00

**BP GROUP
ENGINEERING TECHNICAL PRACTICES**

Foreword

This is the first issue of Engineering Technical Practice (ETP) BP GP 72-00. This Guidance on Practice (GP) is based on parts of heritage documents from the merged BP companies as follows:

British Petroleum (Pre-1999)

RP 15-1-1 British Petroleum Internal Insulation and Refractory Linings

Amoco

A NM-REF-00-E Non-metallic Materials – Refractory – Engineering Specification.

ARCO

Engineering STD 110-97 ARCO Engineering Standard Refractory Linings

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Table of Contents

	Page
Foreword	2
Introduction	4
1. Scope	5
2. Normative references.....	5
3. Terms and definitions.....	5
4. Symbols and abbreviations	10
5. Design Criteria	10
5.1. General	11
5.2. Single-Layer Wear-Resistant Lining	12
5.3. Cast Vibrated Linings	12
5.4. Dual-Layer Lining	12
5.5. Brick Linings	12
5.6. Tubesheet Linings w/Ferrules	12
5.7. Lining Thickness	13
5.8. Anchoring	14
5.9. Pressure Drop Across Refractory System	15
5.10. Dew-Point Corrosion	16
5.11. External insulation	16
5.12. Thermal Expansion	16
5.13. Dry-out	16
6. Material Selection	16
6.1. General	16
6.2. Single-Layer Wear-Resistant Lining	17
6.3. One-Shot lining	17
6.4. Cast Linings	17
6.5. Cast Vibrated Linings	17
6.6. Dual-Layer Linings	17
6.7. Stainless Steel Fibres	17
6.8. Vapour Stops	17
6.9. Castable Refractory	18
6.10. Plastic Refractory	18
6.11. Refractory Ceramic Fibre (RCF) Linings	18
6.12. Soluble Ceramic Fibre Linings	18
6.13. Brick Linings	19
6.14. Anchors	19



Introduction

This Guidance on Practice is intended to provide valuable criteria for the design of refractory linings. This practice incorporates empirical data and experiences common to refineries, chemical plants and production facilities.

Manufacturers and installation contractors are also valuable sources of information and data for refractory design. However, this practice should govern refractory lining designs and supplement with manufacturers' and refractory installer contributions.

The key to providing effective refractory designs is to understand the process and how it contributes to refractory performance. All refractory products are designed to favour specific physical properties. For example, insulating castables and insulating firebrick are designed to provide low thermal conductivity. Erosion resistant products are designed to provide the greatest wear resistance to erosive condition and thermal conductivity is not important. Hot wall and cold wall refractory lining designs favour different physical properties and anchoring systems. In each case, it is important to recognize the physical properties that will control performance. Anchoring systems are also very important and must provide for variables within the process and also characteristics of the refractory material.



1. Scope

This GP provides guidance for the selection and design of refractory lining systems. This technical practice is applicable to all types of refractories and refractory linings associated with refineries, chemical plants and production facilities.

2. Normative references

The following normative documents contain requirements that, through reference in this text, constitute requirements of this technical practice. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this technical practice are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

BP

GIS 52-101	Guidance on Industry Standard for Thermal Insulation Procurement (A NM-I-COLD-A and A NM-I-HOT-C)
GIS 72-001	Guidance on Industry Standard for Procurement of Refractory (including Material Performance Requirements).
GIS 72-002	Guidance on Industry Standard for Refractory Installation.
GIS 72-003	Guidance on Industry Standard for Refractory Dry-out.
GIS 72-101	Guidance on Industry Standard for Fluid Catalytic Cracking Unit Refractory Details.
GIS 72-102	Guidance on Industry Standard for Vee Anchoring Systems.
GIS 72-103	Guidance on Industry Standard for Hex-Mesh Anchoring Details.
GIS 72-106	Guidance on Industry Standard for Independent Anchor Systems - Hex Cells, S-Bars and Curl Anchors.
GIS 72-109	Guidance on Industry Standard for Catalytic Reformer Refractory Details - Cold Wall Vessel Design.

American Petroleum Institute (API)

API Publication 941	Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants.
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American Society of Mechanical Engineers (ASME)

ASME BPVC Sec IX	Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.
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3. Terms and definitions

For the purposes of this GP, the following terms and definitions apply:

Alkaline Earth Silicate Wool

A family of fibrous products that possess high temperature exposure limits that features low bio persistence. This family of products was developed to provide a ceramic fibre that is soluble in body fluids of the lung. This fibre material has been thoroughly tested and does not require the hazard label common with Refractory Ceramic Fibres. Thermal Ceramics produces a product called Superwool and Unifrax produces a product called Insulfrax.



Anchor

Metallic or refractory device that retains the refractory or insulation in place.

Castable

Castable is a general term for a mixture of heat-resistant aggregates and heat resistant binder. The binder is typically a hydraulic Calcium Aluminate cement that produce the bonding necessary for physical property development. However, low cement and no cement castables are available that utilizes a non cementitious matrix that is capable of developing the desired physical properties. A castable is mixed with water and rammed, cast, cast vibrated, pumped or gunited. The combination of refractory grain and bonding agent (cement or sintering aids) develops the designed physical or chemical properties after the addition of water.

Casting

The process of placing wet mixed refractory concrete by pouring, pumping, rodding or with internal (submergible) vibrators.

Coking

A coking environment is common to the reactor of all Fluid Catalytic Cracking Units. Hydrocarbons saturate the refractory and form coke at all available sites within the refractory. The coking of refractory changes all physical properties of a refractory as a function of coke content. Some property changes enhance lining performance, while others have a negative influence that must be addressed in design.

Contractor

A company or business that agrees to furnish materials or perform specified services at a specified price and/or rate to BP.

Curing

Process of bond formation in newly installed monolithic refractory. For hydraulic bonded castables, this occurs at room temperature is facilitated by an excess of water being present to react with the cement component. For phosphate bonded (chemically bonded) plastic refractories, heating to 260°C to 370°C (500°F to 700°F) is required to form the bond. For phosphate bonded castables, curing is primary at room temperature, but fully matures when heated to 430°C (800°F).

Dense firebrick

Bricks with densities over 2 000 kg/m³ (125 lb/ft³), normally used as hot face refractory lining systems. Thermal conductivities are typically high and normally require IFB or castables as back-up to meet heat flow (flux) requirements. Dense firebricks are used in applications where ceramic bonding, hot load strength and chemical stability are important.

Dry-out

The initial heating of a newly installed castable lining in which heating rates and hold times are controlled to safely remove retained water (mechanical and chemically bonded water) without explosively spalling and to form a well distributed network of shrinkage cracks in the lining.

Erosion resistant lining

Single layer of erosion-resistant castable/plastic refractory retained in hexmesh or independent anchoring system that has a tested erosion loss of less than 12 cc. Erosion resistant linings are utilized in areas where erosion will compromise vessel walls or pressure boundaries.

Extreme erosion resistant lining

Single layer of erosion resistant castable/plastic refractory retained in hexmesh or independent anchoring system that has a tested erosion loss of less than 7 cc. Extreme erosion resistant linings are

