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Guidance on Industry Standard for ISO 13705 Fired Heaters (API 560)

GIS 22-101

**BP GROUP
ENGINEERING TECHNICAL PRACTICES**

Foreword

This is the first issue of Engineering Technical Practice (ETP) BP GIS 22-101. It is based on ISO 13705 and documents of three merged companies, BP, Amoco, and Arco listed below.

In addition, reference is made to other standards and reports that provide guidance in use of heritage documents or similar documents.

Normative references are mandatory to extent that they are referenced and not superseded by this guide.

British Petroleum

GS 122-1	Fired Heaters to API 560.
GS 122-2	Natural Draught Burners for Fired Process Heaters.
GS 122-3	Forced Draught Burners for Fired Process Heaters.

Amoco

A FE-FH 560-G	Fabricated Equipment Fired Heaters Guide.
A FE-FH 560-E	Fabricated Equipment Fired Heaters API 560 Engineering Specification.

ARCO

ES 30	Fired Process Heaters.
ES 110	Refractory Linings.



Table of Contents

	Page
Foreword	2
Introduction	6
1 Scope (1.1)	6
1.1 Data sheets	7
1.2 Scope exclusions	7
2 Normative references (1.6/1.7/1.3)	7
2.1 Local codes	8
2.2 Compliance	8
2.3 Precedence	8
3 Terms and definitions (1.4)	9
4 General	9
4.5 Alternative designs	9
4.6 Material safety data sheets (MSDS)	9
5 Proposals (1.8)	10
5.1 Purchaser's responsibilities	10
5.2 Vendor's responsibilities (1.2 Alternative designs)	10
5.3 Documentation (1.9)	12
5.3.1 Drawings for purchaser's review	12
6 Design considerations (2)	12
6.1 Process design (2.1)	13
6.2 Combustion design (2.2)	15
6.3 Mechanical design (2.3 Mechanical)	15
7 Tubes (3)	16
7.1 General (3.1)	16
7.3 Materials (3.3)	16
8 Headers (4)	17
8.1 General (4.1)	17
8.2 Plug headers (4.2)	17
8.3 Return bends (4.3)	17
8.4 Materials (4.4)	17
9 Piping, terminals and manifolds (5)	18
9.1 General (5.1)	18
9.2.1 Allowable movement and loads	18
9.3 Materials (5.3)	18
10 Tube supports (6)	18
10.1 General (6.1)	18
10.3 Materials (6.3)	19



11	Refractories and insulation (7)	19
11.1	General (7.1)	19
11.2	Brick and tile construction (7.2)	20
11.3	Castable construction (7.3)	20
11.4	Ceramic fibre construction (7.4)	21
11.5	Multicomponent lining construction (7.5)	23
11.6	Materials (7.6)	23
12	Structures and appurtenances (8)	23
12.1	General (8.1)	23
13	Stacks, ducts and breeching (9)	24
13.1	General (9.1)	24
13.2	Design considerations (9.2)	24
14	Burners and auxiliary equipment (10)	25
14.1	Burners (10.1)	25
14.2	Sootblowers (10.2)	28
14.4	Dampers and damper controls (10.3)	29
15	Instrument and auxiliary connections (12)	30
15.3	Auxiliary connections (12.3)	30
15.4	Tube skin thermocouples (12.4)	30
16	Shop fabrication and field erection (13)	31
16.1	General (13.1)	31
16.2	Structural steel fabrication (13.2)	32
16.3	Coil fabrication (13.3)	32
16.5	Refractories and insulation (13.5)	32
16.6	Field erection (13.7)	32
17	Inspection, examination and testing (14)	32
17.1	General (14.1)	32
17.2	Weld examination (14.2)	33
17.3	Castings examination (14.3)	33
17.4	Examination of other components (14.4)	34
17.5	Testing (14.5)	34
	Annex A (Appendix A) (Informative) Equipment data sheets	36
	Annex B (Appendix B) (Informative) Purchaser's checklist	37
	Annex C (Appendix C) (Informative) Proposed shop assembly conditions	38
	Annex E (Normative) Centrifugal fans for fired heater systems	39
E.2.	Design	39
E.2.1.	General	39
E.2.5.	Rotating elements	39
E.3.2.	Drivers	39
	Annex G (Appendix F, F.A., F.B., F.C., F.D., F.E., F.F.) (Informative) Measurement of thermal efficiency of fired process heaters	41
	Bibliography	42



List of Tables

Table 1 - RCF temperature limits	21
Table 2 - Soluble Ceramic Fibre temperature limits.....	22
Table 3 - Casing coating requirements based on sulfur content of fuel	23

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Introduction

- a. Guidance for design, fabrication, erection, and testing of fired process heaters is based on ISO 13705:2001.
- b. Guidance statements of this GIS are modifications to ISO 13705.
- c. Modifications to ISO 13705 are identified as Add, Modify to Read, or Delete.
- d. Paragraph numbers in this specification correspond to ISO 13705.
- e. Paragraphs of ISO 13705 that are not revised remain applicable.
- f. *Commentary* additions to Paragraphs in this GIS are provided to further identify BP practices with fired process heaters.
- g. Due to a similarity between ISO 13705:2001 and API Std 560, API Std 560 may be used as a base for process design and purchase of process fired heater. However, all Add, Modify to Read, Delete, or *Commentary* from this GIS still apply.
- h. Paragraph numbers in parenthesis provides reference to API Std 560 sections.

By necessity, ISO 13705:2001 and API Std 560 provide more flexibility than required by BP. These two documents do not include specific BP experience. This GIS adds requirements that BP has found necessary for safe and cost effective operation.

From experience of the industry as a whole, the ISO and API standards are a distillation of general experience. Individual companies have different cultures and operating procedures (again learned from experience). BP requirements in this GIS fit with the BP operating and design philosophy.

This GIS may refer to certain local, national, or international regulations, but the responsibility to ensure compliance with legislation and any other statutory requirements lies with the user. The user should adapt or supplement this GIS to ensure compliance for the specific application.

1 Scope (1.1)

Add

This GIS provides guidance on industry standard for the design, materials, fabrication, inspection, testing, documentation, and preparation for shipment of fired process heaters based on ISO 13705:2001.

Engineers should be acquainted with BP and Industry requirements for fired heater services and ensure appropriate requirements are applied to the specific fired heater application. BP Process Hazard Analyses and siting studies are important sources for both input and review of the engineering of fired heaters. BP experts in applicable areas of heater design should be consulted on new heater designs that have not been previously reviewed.



Add**1.1 Data sheets**

Completion of fired heater data sheets should follow ISO and API documents and exceptions noted in this GIS.

ISO and API documents provide equipment data sheets in Annex A (Appendix A). Equipment data sheets are not included in this GIS. Equipment data sheets and instructions for use are included in DS 22-100.

1.2 Scope exclusions

This standard does not cover steam boilers, except as steam generating and superheating becomes incidental to the process and practical from the standpoint of economic fuel use.

Indirect type oilfield heaters or emulsion treaters are not covered by this GIS and should be designed to API Spec 12K and API Spec 12L.

2 Normative references (1.6/1.7/1.3)Add**BP**

DS 22-100	Data Sheet for Fired Heaters.
GIS 12-201	Guidance on Industry Standard for Low Voltage Induction Motors (IEC).
GIS 12-202	Guidance on Industry Standard for Low Voltage Motors (IEEE 841).
GIS 12-203	Guidance on Industry Standard for High Voltage Induction Motors (IEC).
GIS 12-204	Guidance on Industry Standard for Medium Voltage Motors (API 541).
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 72-004	Guidance on Industry Standard for Refractory Inspection.
GIS-72-102	Guidance on industry Standard for Vee Anchoring Systems.
GIS 72-103	Guidance on Industry Standard for Hex-mesh Anchoring Details.
GIS 72-104	Guidance on Industry Standard for Independent Anchor Systems – Corner Tabs, U-Tabs and Ring Tabs.
GIS 72-105	Guidance on Industry Standard for Refractory Construction Details.
GIS 72-106	Guidance on Industry Standard for Independent Anchor Systems – Hex Cells, S-Bars and Curl Anchors.
GIS 72-108	Guidance on Industry Standard for Miscellaneous Refractory Construction Details.

American Institute of Steel Construction (AISC)

AISC Specification for Design, Fabrication, and Erection of Structural Steel for Buildings.

American Petroleum Institute (API)

API Std 530	Calculations of Heater Tube Thickness in Petroleum Refineries.
API Std 535	Burners for Fired Heaters in General Refinery Services.
API Std 534	Heat Recovery Steam Generators.



API Std 556	Heaters Instrumentation and Controls.
API Std 560	Fired Heaters for General Refinery Services.
API RP 531	Measurement of Noise from Fired Process Heaters.
API RP 537	Inspection of Fired Boilers and Heaters.
ASME Sec IX	Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
ASME B16.9	Factory-Made Wrought Butt welding Fittings.
ASME B16.11	Forged Fittings, Socket-Welding and Threaded.
ASTM A 407	Standard Specification for Steel Wire, Cold-Drawn, for Coiled-Type Springs.
ASTM E 165	Standard Test Method for Liquid Penetrant Examination.
ASTM E 186	Standard Reference Radiographs for Heavy-Walled (2 to 4 ½ in) [51 to 114 mm]) Steel Castings.
ASTM E 446	Standard Reference Radiographs for Steel Castings up to 2 in. (51 mm) in Thickness.

American Society of Civil Engineers

ASCE 7	Minimum Design Loads for Buildings and Other Structures
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British Standards Institute (BS)

BS 6651	Code of practise for protection of structures against lightning.
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International Conference of Building Officials (ICBO)

ICBO Uniform Building Code.

National Fire Prevention Association (NFPA)

NFPA 8501	Single Burner System.
NFPA 8502	Multiple Burner Systems.

2.1 Local codes

- a. National, state, or local applicable code or regulation shall be considered part of this standard.
- b. Responsibility for becoming familiar with such standard, specification, code, or regulation and compliance with such standard rests with BP and Vendor.

2.2 Compliance

BP and Vendor shall mutually determine measures that must be taken to comply with federal, state, or local codes, regulations, ordinances, or rules that may be applicable to equipment.

As an example, Material Safety Data Sheet is required for all chemicals received at BP Company facilities within the United States (refer to Section 4.6 for more details)

2.3 Precedence

- a. Order of application of the specification shall be:
 1. Statutory or local regulations.
 2. Equipment requisition and data sheets.
 3. BP specifications.



4. ISO 13705.
- b. In absence of specified order of precedence, Vendor shall obtain written approval from BP before proceeding with work.

3 Terms and definitions (1.4)

Add

3.82

coil pressure drop

Difference between coil inlet pressure and coil outlet pressure between terminals, excluding effect of static head.

3.83

guillotine or isolation blind

Single blade device used to isolate equipment or heaters.

3.84

header or return bend

Common term for 180 degree cast or wrought fitting that connects two or more tubes.

3.85

volumetric heat release

Heat released divided by net volume of radiant section, excluding coils and refractory dividing walls, expressed in kW/m³ (BTU/h/ft³).

4 General

Add

4.5 Alternative designs

- a. Alternative designs may be offered in addition to base design if permitted by inquiry.
- b. Variances with this standard or BP specification shall be clearly indicated in proposal.

4.6 Material safety data sheets (MSDS)

- a. Equipment or materials that contain or are coated with any regulated substances, such as the following, shall be prominently tagged at openings to indicate nature of contents and precautions for shipping, storage, and handling:
 1. Insulating oils.
 2. Corrosion inhibitors.
 3. Antifreeze solutions.
 4. Desiccants.
 5. Chemical substances.
 6. Hydrocarbon substances.
- b. Regulated substances shall have MSDSs.



- c. MSDSs shall fully comply with regulations for MSDS preparation specified by entity that has jurisdiction and shall include a statement that the substance is considered hazardous by regulation.
- d. If any substance is exempt from regulation, a statement to that effect shall be included.
- e. Before shipment, MSDSs shall be forwarded to receiving facility.
- f. At shipment, MSDSs in protective envelopes shall be affixed to the outside of the shipment.

5 Proposals (1.8)

5.1 Purchaser's responsibilities

5.1.1

DS 22-100 heater data sheets shall be used to provide BP requirements for heater design, shop fabricated, and field erected fired heaters, sootblowers, air preheaters, fans, and burners.

5.1.2

Verification of Vendor quality system is normally part of the prequalification procedure and is therefore not specified in core text of this specification. If this is not the case, clauses should be inserted to require Vendor to operate and be prepared to demonstrate the quality system to BP. Quality system should ensure that technical and QA requirements specified in the enquiry and purchase documents are applied to all materials, equipment, and services provided by subcontractors and any free issue materials.

5.2 Vendor's responsibilities (1.2 Alternative designs)

Add

5.2.1 Heater design

- a. Vendor shall coordinate design and ensure satisfactory functioning of complete unit (i.e., heater, air preheater, forced/induced draft fans, drivers, transmissions, and other ancillaries).
- b. Detailed design of fired heater system shall be total responsibility of Vendor.
- c. The inquiry document may offer the Vendor an option to offer BP alternative designs in addition to the base design, but any variance with this standard or the BP specification shall be discussed and clearly indicated in the proposal.
- d. Drawings and related documents supplied in BP Specifications shall be used by Vendor as a guideline for requirements and for location of fired heater system components.
- e. Vendor shall perform detail analysis and calculations to establish optimum configurations for system.
- f. If fired heater Vendor supplies equipment that Vendor has not manufactured, Vendor shall ensure that designs of such items are compatible with each other and with Vendor's own equipment in all respects, and these items shall be included in Vendor guarantee. In particular, these items shall be compatible dimensionally, in performance, in control, and in vibration such that fully integrated unit is achieved.
- g. Design information enclosed in attached specification defines minimum requirements for design, materials, fabrication, assembly, testing, and preparation for shipment of proposed process fired heater system.



5.2.2 Equipment guarantee

- a. Vendor shall guarantee that equipment meets all requirements as set forth in this standard, that heater will continuously render satisfactory performance, including noise requirements, at design conditions as outlined in data sheets, and that all parts which prove defective within 1 yr from start of operation because of design, workmanship, or materials will be replaced without charge.
- b. Review of Vendor submitted bid documents, by BP or its representative, will not relieve Vendor from complete compliance with drawings and specifications.
- c. Nothing contained in any specifications or data sheets shall be deemed to relieve Vendor of any warranty expressed or implied.

5.2.3 Furnace stack loss guarantee

- a. Vendor shall state and guarantee furnace stack loss, based on 20% excess air and methane as fuel, unless different fuel is specified for rating purposes on data sheet.
- b. Overall furnace efficiency shall be calculated and guaranteed using guaranteed stack loss in a., plus assumed radiation losses of 1-1/2% in radiant section, 1/2% in convection section, and 1/2% for air preheat system for a total of 2% without air preheat and 2-1/2% with air preheat.
- c. Efficiency calculations shall be based on higher heating value or lower heating value as specified on data sheet.

5.2.4 Exceptions

- a. BP approval of Vendor of design and drawings for construction or release of equipment by authorized inspector shall not relieve Vendor of responsibility for heater and does not alter conditions of guarantee.
- b. At bid submittal stage, all exceptions taken to these specifications, all variances from these specifications, and all substitutions of operating capabilities or equipment called for in these specifications shall be listed in writing and forwarded to BP or its designated representative. Any such exceptions, variances, or substitutions that are not listed at time of bid and which subsequently are identified by BP or its representative in the submittal shall be grounds for immediate disapproval without comment.
- c. Fabrication shall not begin until drawings have been stamped approved for construction by BP or their designated representative.

5.2.5 Emission levels guarantee

Emission levels of heater for sulphur oxides, nitrogen oxides, carbon monoxide, and particulate shall be guaranteed.

5.2.6 Local approvals

Special approvals, if required by national, state, or local code or regulations, shall be obtained without expense to BP.

5.2.7 Safety measures

Adequate safety measures shall be provided and maintained at all times during development and execution of project.

5.2.8 Delivery date

Throughout duration of work, BP or its representative shall be kept informed of changes that may affect equipment delivery.



5.3 Documentation (1.9)

5.3.1 Drawings for purchaser's review

Add

- k. Proposal drawings showing heater general arrangement, tube layout, positions and locations of ladders, platforms, peepholes, sootblowers, dampers, isolating plates, expansion joints, ductwork, fans, burners, and air preheaters.
- l. Details of ancillary equipment (e.g., air preheaters, fans, dampers, sootblowers, and burners).
- m. Details of instrumentation or control system supplied or proposed by heater Vendor.

Add

5.3.1.1 Exceptions, variances, and substitutions

- a. At bid submittal stage, all exceptions taken to these specifications, all variances from these specifications, and all substitutions of operating capabilities or equipment called for in these specifications shall be listed in writing and forwarded to BP or its designated representative.
- b. Any such exceptions, variances, or substitutions that are not listed at the time of bid and which subsequently are identified by BP or its representative in submittal shall be grounds for immediate disapproval without comment.
- c. Fabrication shall not begin until drawings have been stamped approved for construction by BP or its designated representative.

5.3.3 Documents for purchaser's review

5.3.3.1 Add

Drawings shall include the following additional details:

- a. Heat treatment requirements.
- b. Nondestructive testing, including hydrostatic test requirements.
- c. Hardness requirements.
- d. Gasket details.
- e. Other details needed for maintenance and repairs.
- f. Painting requirements.
- g. Details of auxiliary equipment and controls.
- h. Weld joint details in cross section, locations, and applicable welding procedures.
- i. Alloy electrode designation, if applicable.
- j. Bolting requirements.

6 Design considerations (2)

Add

Fired heaters and their auxiliary equipment covered by this GIS shall be suitable for all specified operating conditions and shall be designed and constructed to operate for at least 4 years of uninterrupted continuous service periods between shutdowns, unless otherwise approved by BP.



If the heater is expected to run longer between shutdowns, that timeframe should be specified to replace the "4 years".

The 4 years operational requirement shall consider the following:

- a. Design should take into consideration component design and selection of materials of construction to ensure thermal and hydraulic performance is maintained during this period.
- b. If 4 years of continuous operation requirement cannot be met, Vendor should specify:
 1. Why this requirement cannot be met (this could be for process and/or economic reasons).
 2. Which operating periods can be guaranteed.

6.1 Process design (2.1)

Add

General process design requirements include:

- a. If dew point corrosion may be present, Vendor shall submit following data for BP review:
 1. Flue gas acid dew point data for various fuels and/or combination of fuels to be fired.
 2. Minimum metal temperature calculations for metal parts in contact with flue gases operating less than 28°C (50°F) above flue gas acid dew point.
 3. Minimum calculated temperatures for nonmetallic parts in contact with flue gases operating less than 11°C (20°F) above flue gas acid dew point (e.g., air preheater cold end elements, seal packings, duct/stack linings).
 4. If applicable, account shall be taken of metallic and nonmetallic parts in header boxes.
- b. Design exit stack temperature shall be a minimum of 14°C (25°F) over sulphur dew point if furnace is to be fired with fuel oil or sulphur contaminated gas.
- c. Maximum average heat flux and maximum required process film temperature for fired heater shall be obtained from BP. If film temperature is not critical, design tube metal temperature may be provided.
- d. Fired heater design flow rates and heat loads shall be obtained from BP.
- e. Maximum allowable process fluid bulk temperatures, maximum allowable average heat flux on radiant section tubes, and minimum mass velocity of fluid in tubes, if not specified by BP, shall be subject to BP approval.
- f. If both oil and gas are specified, heater shall be capable of firing either fuel separately or in any combination to attain design heat absorption.

6.1.2 Add

- a. In designing fired reboilers, phase condition at heater outlet shall not exceed 80% vapour by weight.
- b. In designing heaters with multiple services in either the radiant or convective sections, Vendor shall provide estimates of extremes in temperatures to be expected for each service and resulting heater limitation for range of potential operating conditions furnished by BP.
 1. Pass splitting within a fired heater shall be avoided where possible.

Pass splitting within a fired heater can result in flow maldistribution and tubes overheating/failing
 2. If pass splitting is used, it should be addressed by proper heater coil arrangement. Vendor shall identify precautions taken to ensure uniform flow splitting.

