



GS 122-3

FORCED DRAUGHT BURNERS FOR FIRED PROCESS HEATERS

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APPLICABILITY Regional Applicability: International											
SCOPE AND PURPOSE This Specification covers BP's general requirements for forced draught burners which are suitable for use in refining and petrochemical fired heaters and chemical reactors. Its purpose is to lay down requirements for performance and flame stability and to outline the tests required in order to establish that the burner can meet these requirements.											
AMENDMENTS <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 15%;">Amd</th> <th style="width: 15%;">Date</th> <th style="width: 20%;">Page(s)</th> <th style="width: 50%;">Description</th> </tr> </thead> <tbody> <tr> <td colspan="4" style="height: 150px;"> </td> </tr> </tbody> </table>				Amd	Date	Page(s)	Description				
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CONTENTS

Section	Page
FOREWORD	ii
1. SCOPE.....	1
2. APPLICATION OF THIS SPECIFICATION	1
3. QUALITY ASSURANCE	1
4. DESIGN.....	2
4.1 General	2
4.2 Mechanical Requirements.....	3
4.3 Noise	8
4.4 Materials for Thermal and Acoustic Insulation.....	8
5. TESTING	9
5.1 General	9
5.2 Test Conditions.....	10
5.3 Test Requirements and Measurements.....	11
6. INFORMATION REQUIRED	13
6.1 Information Required with Offer	13
* 6.2 Information Required After an Order Has Been Placed	15
7. SPARES.....	16
APPENDIX A.....	17
DEFINITIONS AND ABBREVIATIONS.....	17
APPENDIX B.....	18
LIST OF REFERENCED DOCUMENTS	18



FOREWORD

Introduction to BP Group Recommended Practices and Specifications for Engineering

The Introductory volume contains a series of documents that provide an introduction to the BP Group Recommended Practices and Specifications for Engineering (RPSEs). In particular, the 'General Foreword' sets out the philosophy of the RPSEs. Other documents in the Introductory volume provide general guidance on using the RPSEs and background information to Engineering Standards in BP. There are also recommendations for specific definitions and requirements.

Value of this Guidance for Specification

The supply of 'fit for purpose' Forced Draught Burners for Fired Process Heaters that meet the requirements for performance and flame stability, are constructed from suitable material, and are designed to allow ease of installation, operation and maintenance.

Application

This Guidance for Specification is intended to guide the purchaser in the use or creation of a fit-for-purpose specification for enquiry or purchasing activity.

Text in *italics* is Commentary. Commentary provides background information which supports the requirements of the Specification, and may discuss alternative options. It also gives guidance on the implementation of any 'Specification' or 'Approval' actions; specific actions are indicated by an asterisk (*) preceding a paragraph number.

This document 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 document to ensure compliance for the specific application.

Specification Ready for Application

A Specification (BP Spec 122-3) is available which may be suitable for enquiry or purchasing without modification. It is derived from this BP Group Guidance for Specification by retaining the technical body unaltered but omitting all commentary, omitting the data page and inserting a modified Foreword.

Principal Changes from Previous Edition

This BP Group Guidance for Specification has transpired from the general updating and conversion to the new 'Way Forward' style of BP Engineering Standard 107.



Feedback and Further Information

Users are invited to feed back any comments and to detail experiences in the application of BP RPSE's, to assist in the process of their continuous improvement.

For feedback and further information, please contact Standards Group, BP International or the Custodian. See Quarterly Status List for contacts.



1. SCOPE

- * 1.1 This Specification covers the general requirements of BP for forced draught burners suitable for firing liquid fuel and gas both singly and in combination, and where necessary will be used with a supplementary specification to adapt it for a specific application. The burners covered are suitable for use in refinery and petrochemical heaters and chemical reactors, where the air for combustion is supplied by forced draught fans.

This Specification lays down requirements for manufacture, performance and flame stability. It outlines the tests required in order to establish the burner can meet these requirements.

Note: The term chemical reactor cover's specialist heaters such as reformer heaters.

- 1.2 This Specification does not cover burner instrumentation or burner piping, other than flexible hoses (see 4.2.13) and materials of construction (see 4.2.14). Instrumentation and piping will be separately specified by BP if required.

2. APPLICATION OF THIS SPECIFICATION

- * 2.1 The purchaser will specify in an accompanying specification, all requirements necessary to enable the manufacturer to make an offer. These may include any of the 'Specification' actions indicated by an asterisk (*) in the text, but will in all cases include the physical and chemical properties of all the fuels to be burnt, the rates of heat liberation required under all anticipated operating conditions, the condition of available atomising medium, and the nature and extent of testing (see also 2.2).
- 2.2 Note that to meet the requirements of this Specification, a witnessed test shall have been carried out on a burner of the same type, unless otherwise agreed by BP. See also Section 5 of this Specification.

3. QUALITY ASSURANCE

- * Quality system requirements will be specified by the purchaser.

Verification of the vendor's quality system is normally part of the pre-qualification procedure, and is therefore not specified in the core text of this specification. If this is not the case, clauses should be inserted to require the vendor to operate and be prepared to demonstrate the quality system to the purchaser. The quality system should ensure that the technical and QA requirements specified in the enquiry and purchase documents are applied to all materials, equipment and services provided by sub-contractors and to any free issue materials.

Further suggestions may be found in the BP Group RPSEs Introductory Volume



4. DESIGN

4.1 General

- * 4.1.1 Liquid fuel atomisers shall be of the twin fluid type.

Steam is normally used for atomisation, however fuel gas or compressed air may be specified by BP.

- * 4.1.2 All liquid fuel guns and gas guns shall discharge within $\pm 1.5\%$ of the required flow at design heat liberation operating pressure, and shall be flow tested under conditions discussed and agreed with BP. The test conditions shall be subject to final approval by BP who may wish to witness the tests. A record of the tests must be issued with the fuel guns (see section 5.3.2).

In order to operate a multi - burner system at low excess air it is necessary to have equal flow to each fuel gun and have an even air distribution. Flow testing fuel tips and correcting as necessary will ensure they are within the required tolerance. To maintain the required flow tolerance, periodic testing of the fuel tips can be carried out. Badly worn tips should be replaced and those with slight wear can be grouped with others that are similar and used only together. Slightly worn fuel oil tips that produce poor visual atomisation of the fuel oil and emissions of particulates above the statutory limit should be discarded.

- * 4.1.3 BP will specify any limits, statutory or local, on stack emission of particulates, NO_x, SO_x, CO and hydrocarbons.

Emission legislation is constantly under review and differs from country to country. It can also vary within the same country e.g. USA. The emission levels measured during the burner test should be capable of meeting, at least, those already in place. However, BP may specify lower levels so that new burners may meet any future legislation.

- * 4.1.4 When specified by the purchaser, the burner shall be equipped to burn, in addition to the main fuels, a waste gas of which the quantity, composition and condition will also be specified by the purchaser.

Small quantities of waste gases from refinery processes can more easily be disposed of if they are introduced into an existing furnace, eliminating the need for more expensive dedicated equipment. The waste gases should be limited, on a standard burner, to 25% of the total burner liberation. For up to 10% of the total burner liberation one waste gas gun may be positioned within the burner throat. Above 10% two or three gas guns should be used to ensure even distribution of waste gases in the burner throat. It is essential that the waste gases are not fired at a low furnace temperature. Details of this temperature will be dictated by the composition of the waste gases.

- 4.1.5 The burner shall have an out-of-ratio turndown of at least 4:1 as determined by the procedure of 5.3.9.



- * 4.1.6 The purchaser shall submit proposals for the following features to the manufacturer, and shall obtain the manufacturer's agreement that these allow satisfactory functioning of the burner:-

- (a) The positioning of the burner or burners on the fired process heater, and their dimensional relationship to all other main components.
- (b) The manufacturer shall check the design of the combustion air ducting to ensure an equal air mass flow within a tolerance of $\pm 2\frac{1}{2}\%$ of the air flow to each burner, evenly distributed at the entry to each burner windbox.

The designer of the combustion air system should submit the drawings of the total system, plus supporting calculations or test reports to the burner manufacturer for checking. This is to ensure that equal air mass flow within a tolerance of $\pm 2\frac{1}{2}\%$ is available at each burner entry (wind box). In addition, the designer of the windbox shall ensure that the velocity distribution measured within the burner throat shall not exceed $\pm 10\%$.

In the event that serious doubt exists regarding air flow distribution, then the commissioning of a dynamic or mathematical model should be discussed between the windbox designer, end user and burner supplier

4.2 Mechanical Requirements

- 4.2.1 On burners that are to be fitted to an upshot fired process heater, the burner controls, valves, safety interlocking devices, liquid fuel guns and other items that have to be manually operated should be located at a convenient height from grade.

The above parts shall normally be arranged at a height of not more than 2060 mm (6 ft. 9 in) from grade. To ensure the safe exit of personnel in the event of an emergency the minimum height or any part of the burner as defined in Appendix A shall be 1900 mm (6 ft. 3 in) from grade.

- * 4.2.2 The burner shall be of suitable construction and materials for reliable outdoor operation in a refinery environment under the ambient conditions specified by BP.

The burner should be constructed in carbon steel with high temperature stainless steel being used as necessary. Section 4.2.13 details the use of other materials. Moving parts, such as combustion air dampers, must be capable of being lubricated to prevent seizure due to corrosion or chemical attack. Painting of metal surfaces shall be in accordance with BP Group [GS 106-2](#).

- 4.2.3 The burner as defined in Appendix A, but excluding any refractory parts located in, or attached to, the fired process heater floor or wall, shall be suitable for being removed and replaced while any other burners remain in operation.



This is a burner design requirement only. Should it be decided to remove a burner, while the heater is operational, safe procedures must be followed. The heater load should be steady and the furnace draught increased. The burner must not be removed if the furnace pressure is positive.

- 4.2.4 The burner shall be so designed that the liquid fuel gun and the gas guns can be readily removed for cleaning without dismantling other parts of the burner as defined in Appendix A. The liquid fuel gun shall be secured by a clamping device integral with the main burner body. The clamping device shall be operated by means of a decoupling tool which shall be supplied with the burner.

For dual-fuel burners, the burner shall be suitable for firing on one fuel with the liquid fuel gun or gas guns for the other fuel removed.

The openings for oil guns shall be automatically closed by a mechanical device to prevent the escape of combustion air when the oil gun is removed.

For dual-fuel burners using preheated combustion air, the openings for gas guns shall be automatically closed by a mechanical device to prevent the escape of hot combustion air when the gas guns are removed.

The purchaser and the manufacturer shall ensure there is sufficient un-obstructed clearance to allow the removal of the fuel guns, the pilot and pilot igniter. These should be accessible from grade.

- 4.2.5 To prevent the ingress of dirt into the connections for fuel and atomising medium for the liquid fuel gun, a closure plate shall be provided to cover these connections when the liquid fuel gun is removed. This closure plate shall be permanently attached to the burner, e.g. by a short length of chain.

The closure plate should allow venting of any pressure build up in the lines due to leaking isolating valves.

- 4.2.6 When any liquid fuels are specified to be burnt, a safety interlocking mechanism shall be provided to ensure:-

- (a) That the liquid fuel gun cannot be withdrawn until the supply of liquid fuel and atomising medium have been turned off.
- (b) That the liquid fuel and atomising medium cannot be turned on with the liquid fuel gun withdrawn.
- (c) That the liquid fuel cannot be turned on before the atomising medium, and that the atomising medium cannot be turned off before the liquid fuel.



- (d) When low flash point fuels are burnt BP may require the interlock to have an integral purge valve, which will ensure the oil gun is purged before its withdrawal is permitted.

This interlock mechanism shall be of such design and materials that the interlock cannot be manually overridden, nor allow incorrect connection of liquid fuel and atomising medium to the liquid fuel gun.

* 4.2.7 The following connections for pressure and temperature measurement shall be provided:-

- (a) A plugged connection shall be provided on each burner windbox for measurement of combustion air static pressure.
- (b) Plugged connections shall be provided on each burner gas manifold for measurement of fuel gas temperature and pressure.
- (c) In each batch of burners for a specific fired process heater, one oil gun shall be provided with plugged connections for measurement of temperature and pressure of atomising medium and fuel oil.

The details of all such connections shall be subject to approval by BP.

Measurement of the temperature and pressures of the fuel gas will enable the heat distribution within the heater, when gas firing, to be optimised. A single oil gun fitted with the connections above can be inserted into any burner, on the same process heater, and used to evaluate any maldistributions in the fuel oil and atomising medium temperature and pressure which may occur.

4.2.8 The burner shall be provided with fixings to enable flame failure scanner tubes to be fitted. For burners required to operate with both the flame failure and a continuous pilot, two positions are required, one for monitoring the pilot only and the other for the main flame only. For burners operating with intermittent pilots, the scanner positioning can be capable of seeing the pilot and the main flame. Unless otherwise agreed with BP, continuous pilots shall be fitted.

The mounting for the flame monitoring equipment shall allow the line of view to be readily adjusted during commissioning.

Unless otherwise approved by BP before manufacture commences, the view of the flame through a scanner tube shall not be obstructed by burner components, and it shall be possible to pass a rod, of diameter 2 mm (0.080 in) less than the scanner tube, through the scanner tube and into the combustion area.

When flame monitoring systems are required by BP, the system used shall be capable of differentiating between the flame viewed and adjacent flames for all fuels that are to be burnt. Any provisions made



for the installation of flame monitoring equipment shall take the above into account.

For up-fired process heaters it is acceptable to view the main flame from the side of the furnace as debris in the burner sight tubes may obscure the view of the flames. The position selected should ensure that adjacent flames cannot be seen.

When it is considered beneficial or the burner design or size makes it difficult to view the main flame without seeing the pilot, it is acceptable to view the main flame from a position on the furnace. This position, should be suitable for seeing the flame over the full turndown range and not pick up adjacent flames.

- 4.2.9 Burner parts and refractories which are located near the combustion zone shall be designed for at least 25,000 hours operation at design conditions, without significant deterioration. Other burner components shall be designed for at least 100,000 hours operation. Unless otherwise specified by BP, the average firebox temperature shall be taken as 1095°C (2000°F).

This does not include fuel gun seals, atomiser tips and ignition/ionisation rods.

The manufacturer shall advise on the expected life for the oil atomisers with the fuels to be fired and maintaining the guaranteed emission levels.

- 4.2.10 The manufacturer shall ensure that the burner refractory quarl (muffle block, tile) is suitable for a maximum temperature of 200°C above the maximum anticipated operating temperature. The quarl shall be pre-fired to full ceramic bond before dispatch.

The burner refractory quarl shall be dimensionally checked against the drawings supplied with the burner to ensure no creep or shrinkage has occurred during the bonding process.

- * 4.2.11 The burner shall be provided with a fixed gas pilot operating on the specified gas supply and at a design operating pressure of 0.35 bar(g) (5 psig). See 5.3.6 for performance requirements of the gas pilot.

Each gas pilot shall have its own igniter port independent of any viewing ports. The igniter ports shall be freely accessible and suitable for portable igniters. The igniter manufacturer will be either specified by, or subject to approval by BP.

A pilot with an integral igniter tube should incorporate an isolation valve to avoid the possibility of gas flowing back through the igniter entry when the igniter is withdrawn.

The igniter port shall incorporate a guide tube which shall ensure that, on insertion, the igniter is held in the correct position to ignite the gas pilot. A securing device on the guide tube shall hold the igniter in position, and a collar on the igniter shall ensure that it is inserted for the correct distance.



The reason for the securing device is to allow the operator to operate the ignition switch from a safe location, (i.e. not under the heater).

BP have found the high energy igniter to be the preferred system.

- 4.2.12 It should be possible to view the pilot flame and the tip of the liquid fuel gun through a viewing port in the base of the burner. The viewing ports should be 40 mm (1.5 in) diameter and covered with viewing glass.

The viewing glasses fitted should be readily removable for cleaning. Clear glass is required for gas only burners and either clear or coloured (blue) for oil fired burners. The sight glass mounting should be such as to allow the glass to expand and contract as it is subjected to changes in temperature. If the design of the burner is such that the liquid fuel tip cannot be seen from sight ports or louvers in the burner then it should be possible to view the tip from a viewing port in the side of the process heater.

- * 4.2.13 If required for burner adjustment, the connections for liquid fuel and atomising medium may be of flexible metallic construction flanged at both ends. This flexible pipework shall be of the fire-proof continuously formed stainless steel bellows type, protected by metal braiding and approved by BP.

- 4.2.14 Due to the possibility of failure in the event of fire, brittle materials e.g. cast iron, spheroidal graphite cast iron, malleable iron, and low melting point materials including copper, aluminium and their alloys, and plastics, shall not be used for any burner pressure parts or associated supports. This restriction also applies to zinc and cadmium plating of pressure parts and associated supports, bolts, nuts, springs etc.

The use of copper washers to ensure atomiser tip sealing is acceptable.

- 4.2.15 Tips for gas and liquid fuel guns, including any internal parts incorporating jets for gas, liquid fuel and atomising medium, shall be designed for assembly using special burner tools. Pressure grip devices, e.g. Stillson wrenches, shall not be used. All special burner tools shall be provided with the burner.

- 4.2.16 The use of taper threads for assembly of all jets/tips for gas and liquid fuel should be avoided. It is preferred that tips are assembled using positive jointing faces which ensure that they are returned to their original position and the jets are aligned correctly.

- 4.2.17 Temperatures of the combustion chamber, fuel and atomising medium shall be taken into account in design, in ensuring that the mechanical and refractory parts of the burner are of the correct grade of material to suit the temperatures under which they will operate.



4.2.18 Where a flame stabilising device such as a swirler or diffuser is used, the material of construction shall be equal or superior to AISI 310 (25 Cr 20 Ni).

4.2.19 Swirler stabilisers 250 mm (10") diameter or smaller shall not have their blades cut away to allow the pilot tip to be positioned. The pilot will either sit behind the swirler or adjacent to it. The manufacturer is responsible for positioning the pilot to ensure correct ignition of the main flame.

BP have experienced problems on small burners where the pilot is positioned through the front face of the swirler. The cut out necessary to do this removes most of the blade area, reducing flame stability and upsetting the flame shape.

4.2.20 An individual combustion air trimming/isolating damper shall be provided in the duct to each burner windbox. The damper shall be fitted with an adjustable stop in the open position so that damper travel can be limited to equalise, if necessary, the air-flow to each burner. This stop shall be suitable for locking in position to prevent unauthorised adjustment. The damper shall be provided with a position indicator.

The design and position of the damper should not affect the air flow distribution within the wind box when in the trimmed position.

4.2.21 All pressure parts, including fuel guns and manifolds, shall be tested to ensure tightness. The test shall be a hydrostatic leak test unless agreed otherwise. Test pressure shall be agreed with BP who may wish to witness these tests.

4.3 Noise

* 4.3.1 The manufacturer shall provide the purchaser with all information necessary to ensure that the noise emission from the fired process heater does not exceed the noise limits specified by BP. BP may wish to witness a test of noise emission from the burners.

As with gaseous and particulate emission legislation noise regulations are also in place at refinery and petrochemical sites. Burners will normally have to be less than 85 dbA at a distance of 1 metre. However, BP will advise of any local legislation which may require further restrictions.

4.4 Materials for Thermal and Acoustic Insulation

4.4.1 Materials for thermal and acoustic insulation shall be in accordance with BP Group [GS 152-1](#).



5. TESTING

5.1 General

5.1.1 This Specification outlines the tests required to establish if a burner can meet BP's requirements and gain approval.

5.1.2 Unless an alternative procedure is agreed with BP, acceptability of the burner performance shall have been demonstrated by witnessed type-testing. The tests necessary in order to meet this Specification can be carried out on any suitable test rig.

BP would normally want to assess the suitability of the rig, the instruments and test procedures.

The test of the burner would normally be carried out on a test rig which is representative of the proposed application in terms of thermal and aerodynamic characteristics.

5.1.3 The full approval test will only be carried out for one size of burner believed to be representative of a particular burner range. The manufacturer will select a burner size and jet it to meet the required conditions.

5.1.4 Should it be necessary to purchase a burner which has not had prior type approval by BP, the manufacturer should be asked to first, ensure their burner meets the mechanical requirements of the Specification and secondly, submit the burner for test as quickly as possible. The test should be completed before burner manufacture is commenced. If this is not possible then the manufacturer remains responsible for any modification necessary to enable the burner to meet the test requirements.

5.1.5 The test programme needed to establish that the burner meets all the requirements of this Specification is fairly lengthy. If it is not possible or unnecessary to meet the requirements of this Specification for a specific contract, then an abbreviated test programme can be agreed. If the burner is seen to have other applications within the BP Group then a full approval test may be carried out at a later date.

5.1.6 In addition to the requirements of 5.1.2, BP may specify a limited testing of one of a batch of burners which have been purchased for a particular application.

Experience has shown that tailoring of the burner to meet specific requirements is not an exact science and that invariably it does not give satisfactory operation at the first attempt. For this reason a test can be carried out at the manufacturer's test plant to a programme agreed with BP. The duration of this programme will probably cover one or two days.



5.2 Test Conditions

- * 5.2.1 The test requirements and measurements of 5.3 shall be determined whilst burning the range, and any combination, of fuels specified by the purchaser for the particular application.

If not already included in the fuels specified for the particular application, BP may specify any of the following additional test fuels:-

- (a) Light distillate oil.
- (b) Residual fuel oil of at least 36 centistokes at 5 °C
- (c) Gas of agreed quality; normally natural gas, propane or butane.
- (d) Mixtures of the gases in (c) with hydrogen.

- * 5.2.2 Methods and equipment used for all measurements, including flue gas analysis, during these tests, shall be subject to approval by BP.

A wide variety of instrumentation is available for the measurement of operating conditions and flue gas analysis. The accuracy of the results are, therefore, dependent on the measurement instruments and systems used. For flue gas analysis of particulates the guidelines in BS 3405:1983 should be followed.

- * 5.2.3 The residual fuel oil used for testing shall contain not less than 5 ppm of vanadium and 5 ppm of sodium. The actual concentrations of vanadium and sodium shall be subject to approval by BP.

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Note: BP may allow lower concentrations by exception.

- * 5.2.4 Unless otherwise approved by BP, the fuel pressure at the liquid fuel gun inlet valve, during testing, shall be 5.5 bar(g) (8 psig) at maximum burner design heat liberation. Testing of different types of atomisers and atomisers designed to operate at different pressures will be considered by BP if manufacturers can show good cause to do so.

- * 5.2.5 Unless otherwise approved by BP, the tests shall be carried out with the burner firing vertically upwards.

- * 5.2.6 The tests shall be carried out using combustion air at ambient temperature and additionally, where specified by BP, air preheated to a nominated temperature.

- * 5.2.7 The test requirements (other than the out-of-ratio turndown flame stability test required by 5.3.9) shall, for all fuels, be met over a minimum burner heat liberation range of 33% to 110%. Alternatively, should a higher turndown and/or lower excess air operation be



required, the range will be either specified by, or subject to approval by, BP. Tests shall be carried out at the following excess air conditions:-

- (a) Range 33% to 60% burner heat liberation.
 - (i) 30% excess air.
 - (ii) 50% excess air.
- (b) Range 60% to 110% burner heat liberation.
 - (i) 5% excess air.
 - (ii) 50% excess air.

A test shall be carried out on each fuel to determine the maximum turndown that can be achieved with satisfactory and stable combustion.

Tests may also be carried out over a range of heavy fuel oil viscosities at the burner of 10 to 50 centistokes. The number of determinations to be made within this range will be either specified by, or subject to approval by, BP.

For burners undergoing type approval 110% burner heat liberation is 10% above the maximum heat liberation of the burner. For burners required for a specific heater application refer to BP [Group GS 122-1](#).

5.3 Test Requirements and Measurements

- * 5.3.1 The flame envelope shall be within the limits specified by the purchaser and finally approved by BP. The envelope limits shall be judged by visual inspection or by combustion analysis or both, as specified by BP.
- * 5.3.2 BP may wish to witness the flow tests required by 4.1.2 and will require copies of the test results.
- 5.3.3 Stack emissions of particulates, NO_x, SO_x, CO and hydrocarbons shall comply with any limitations specified by BP in accordance with 4.1.3.
- * 5.3.4 For a continuous test period of 100 hours under conditions specified by BP, there shall be no drips from the liquid fuel gun, coke formation anywhere in the burner, or deposits of coke or liquid fuel on heater/furnace tubes or refractories.
- * 5.3.5 When steam is used for atomising liquid fuel, and unless otherwise specified by BP, the following requirements shall be met when firing at maximum burner heat liberation:-
 - (a) Where the steam pressure required at the oil gun inlet valve is greater than 3.5 bar(g) (50 psig), the ratio of atomising steam



consumption to oil consumption shall be not more than 0.15 by weight.

- (b) Where the steam pressure required at the oil gun inlet valve is 3.5 bar(g) (50 psig) or less, the allowable steam consumption may be greater, depending on the application and providing it is approved by BP.
- (c) The steam temperature range shall be from dry saturated to a maximum level of superheat specified by the burner manufacturer.

An increase in atomising steam to oil ratio is acceptable on turndown during start-up. If the heater is to be run for long periods at a low load condition, then fitting of low flow atomisers, to conserve steam can be considered.

5.3.6 The gas pilot shall operate continuously with a stable flame at the gas design operating pressure $\pm 40\%$, and over the following range of main burner combustion air flows:-

- (a) Minimum: An air flow that will give a pressure drop across the burner together with its individual air flow damper of 0.62 mbar (0.25 inch H₂O).
- (b) Maximum: The maximum possible air flow as determined by the forced draught fan/burner characteristics with the main burner unlit.

The gas pilot flame shall be readily visible and identifiable under all conditions.

For burners which are tested for a specific application, the maximum air flow shall be determined by the fans and draught available on the application. During type testing for BP approval, the maximum air flow is defined as that which would be delivered from the fans whilst firing at 100% burner design heat liberation and 45% excess air.

* 5.3.7 The heat liberation and combustion air flow at which ignition of the main flame takes place shall be specified by the manufacturer for all fuels that are to be burnt, and shall be subject to approval by BP.

5.3.8 The gas pilot shall ignite the main burner smoothly and safely for all specified fuels at the recommended main burner ignition heat liberation $\pm 25\%$.

5.3.9 The burner shall be tested for out-of-ratio turndown flame stability, on both liquid fuel and gas, to determine the maximum safe turndown of a fuel with the combustion air flow remaining constant. Unless otherwise



approved by BP for a specific application, tests shall be carried out in accordance with the following procedure:-

- (a) The combustion air flow shall be set to give 45% excess air when the burner is at 100% heat liberation.
- (b) The selected fuel flow shall be reduced until the first signs of flame instability occur. The fuel flow shall then be increased until the flame is stable; this fuel flow and the corresponding fuel pressure and excess air shall be recorded.

The tests shall be carried out for each fuel to be fired on the burner with the gas pilot operating, and repeated with the gas pilot 'off'.

When testing flame stability for combination burners when firing with fuel gas only, the tests shall be carried out with atomising medium for the liquid fuel gun both 'on' and 'off'.

The limitations of the burner as determined by the tests shall be included in the burner operating instructions.

This test simulates the conditions which would occur when firing in combination and either of the two fuels, liquid or gas, is lost.

5.3.10 The burner gas firing performance and stability shall not be affected by the oil gun being in position, having the atomising medium on at cooling or atomising rates and when the oil gun is removed.

5.3.11 When firing gas only, the liquid fuel gun shall be capable of remaining in position without suffering any deterioration. Atomising medium, at the flow rate recommended by the manufacturer, may be used for cooling.

When firing liquid fuel only, the gas guns shall remain in position without suffering any deterioration.

The firing performance and stability must not be affected when firing in combination, oil and gas together.

5.3.12 To ensure the flame remains stable, should the air fuel ratio vary significantly from specification, a test shall be carried out for each fuel fired. At full liberation and at turndown, the combustion air shall be reduced until the burner is firing close to or substoichiometric.

The extent to which the air can be reduced shall be determined by the effect on the burner emissions. Should emissions of CO or unburnt hydrocarbons be excessive the test must be limited.



6. INFORMATION REQUIRED

6.1 Information Required with Offer

The following drawings and data shall be provided by the manufacturer when responding to a purchase enquiry from the purchaser:-

6.1.1 Drawings

- (a) Dimensioned general arrangements of the burner showing components including: windbox and quarl; stabiliser/swirler, with position of gas guns, liquid fuel gun and gas pilot; viewing and ignition ports; integral piping; valves; mechanical safety interlocks; mounting for flame monitoring systems when applicable; and showing the space required for extracting the liquid fuel gun, gas guns, pilot and pilot igniter.
- (b) Dimensioned sectioned drawings of the gas guns, liquid fuel gun, gas pilot, and the mechanical safety interlocks with separate detail showing valve sequencing.

6.1.2 Data

- (a) Materials of construction of all components that comprise the burner as defined in Appendix A. Materials shall be related to operating temperatures.
- (b) Performance curves showing burner heat liberation as a function of combustion air register draught loss (RDL) at the design excess air, and air temperatures.
- (c) Performance curves showing burner heat liberation as a function of fuel pressure, atomising medium pressure and atomising medium consumption.
- (d) Heat liberation of the gas pilot at 0.35 bar(g) (5 psig) gas pressure and the range of fuel gases specified by the purchaser.
- (e) Confirmation of the suitability of the properties of gas, liquid fuel and atomising medium as specified by the purchaser.
- (f) Confirmation of the range of viscosities of the liquid fuel specified by the purchaser, and the temperature required at the liquid fuel gun inlet.
- (g) Filtration requirements (mesh size) for the following:-
 - (i) Liquid fuel.



- (ii) Atomising medium.
- (iii) Main fuel gas.
- (iv) Pilot fuel gas.

- * (h) Where required by BP, an estimate of particulates, NO_x, SO_x, CO and hydrocarbons, in products of combustion for the specified range of fuels.
- (j) Overall dimensions of flame for all fuels being fired, both singly and in combination, under the specified conditions.
- (k) Test data as required by Section 5.
- (l) Noise data as required by 4.3.1.

* **6.2 Information Required After an Order Has Been Placed**

The following drawings and data shall be provided by the manufacturer as part of the burner supply and, with the exception of 6.2.2(c) and 6.2.2(d), shall be subject to approval by BP before manufacture is started.

6.2.1 Drawings

- (a) Final dimensioned general arrangements of the burner as required by 6.1.1(a). In particular, the dimensioned positions of the gas pilot retention tip, liquid fuel gun atomiser and gas gun tips relative to the flame stabilisation device(s).
- (b) Final dimensioned and sectioned drawings as required by 6.1.1(b).
- (c) Final dimensioned drawing of the burner quarl (tile) in relation to the heater refractory lining showing, where necessary, recommended expansion joints.
- (d) Final dimensioned drawing of the burner(s) positioned on the fired process heater.

6.2.2 Data

- (a) Materials of construction of all components that comprise the burner as defined in Appendix A. Materials shall be related to operating temperatures.
- (b) Test certificates for all the pressure parts and the fuel gun flow checks.
- (c) Performance curves as required by 6.1.2(b).



- (d) Performance curves as required by 6.1.2(c).

Note that these performance curves showing burner heat liberation as a function of fuel pressure, atomising medium pressure and atomising medium consumption, shall be determined by the flow testing required by 4.1.2.

- (e) Installation, operating and maintenance instructions.

7. SPARES

- * 7.1 Detailed requirements of spares for Plant and Equipment shall be as specified in an accompanying BP specification.
- 7.2 Spares shall be considered in three categories:-
 - (a) Pre-commissioning
 - (b) Commissioning
 - (c) Permanent
- 7.3 The manufacturer shall specify in his proposal all pre-commissioning spares, see 7.2(a).
- * 7.4 The manufacturer shall submit, prior to any order, a list of commissioning spares, see 7.2(b). These shall include consumable spares for twelve months operation and spares for installation at the first overhaul. This list shall be subject to approval by BP before ordering.
- * 7.5 The manufacturer shall submit, prior to commissioning, a complete spares manual, to include all spares recommended as permanent stock. This shall also be subject to approval by BP who will specify the format to be used.



DEFINITIONS AND ABBREVIATIONS

Definitions

Standardised definitions may be found in the BP Group RPSEs Introductory Volume.

burner:	the complete device for mixing the combustion air and fuel and for stabilising the flame. It includes any valves for the fuel(s) and atomising medium that are attached to the burner as specified, gas manifolds, gas guns, liquid fuel gun, air register, air control linkages, refractories including refractory quarl (tile) in the furnace floor or wall, primary block, igniter and gas pilot. It also includes the means of attaching the burner to the fired process heater.
liquid fuel:	normally this will be fuel oil but may be a waste fuel, details of which will be specified by the purchaser.

Abbreviations

AISI	American Iron and Steel Institute
API	American Petroleum Institute
BS	British Standard
ppm	parts per million
QA	Quality Assurance



LIST OF REFERENCED DOCUMENTS

A reference invokes the latest published issue or amendment unless stated otherwise.

Referenced standards may be replaced by equivalent standards that are internationally or otherwise recognised provided that it can be shown to the satisfaction of the purchaser's professional engineer that they meet or exceed the requirements of the referenced standards.

British Standards

BS 3405: 1983 *Measurement of Particulate Emission Including Grit and Dust (simplified method).*

BP Group Documents

BP Group GS 106-2 *Painting of Metal Surfaces*
(replaces BP Std 141)

BP Group GS 122-1 *Fired Heaters to API 560*
(replaces BP Std 162)

BP Group GS 152-1 *Materials for Thermal and Acoustic Insulation.*
(replaces BP Std 172)

