



GS 134-8

**REQUIREMENTS FOR THE
PROTECTION
OF DIESEL ENGINES OPERATING IN
ZONE 2 HAZARDOUS AREAS**

March 1998

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SCOPE AND PURPOSE This Guidance for Specification gives guidance on the specification of BP general design requirements for the protection of permanently installed diesel engines and diesel engines driving mobile equipment when their use in Zone 2 Hazardous Areas (as defined in BS 5345 Part 1) is unavoidable It is not applicable to road tanker vehicles and also specifically excludes spark ignition engines. It's purpose is to reflect the general requirements of BP, using the recommendations given in the OCMA Publication No. MEC-1 1977 as a basis.			
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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

This document represents the accumulated knowledge of BP for the specification of requirements for the protection of diesel engines operating in Zone 2 hazardous areas, using the recommendations given in the [OCMA Publication No. MEC-1 1977](#) as a basis.

Application

This Guidance for Specification is intended to guide the purchaser in developing a 'fit for purpose' specification for enquiry or purchase.

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. Resolution of the 'Approval' action is the responsibility of the purchaser's professional engineer.

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.

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.



Principal Changes from Previous Edition

This document is an update of BP Standard 200 (April 1980 - Reprinted Dec 1981). No technical changes have been made, the update comprises only re-formatting into the Guidance for Specification (GS) style with the incorporation of commentary where applicable (shown in italicised text). Users should be aware that this document retains the prescriptive requirements of BP Standard 200.



1. SCOPE

- 1.1 The use of diesel engines in Zone 2 Hazardous Areas, as defined in [BS 5345](#) Part 1, is to be avoided as far as possible. This Specification specifies BP general design requirements for the protection of permanently installed diesel engines and diesel engines driving mobile equipment when their use in these Zone 2 Hazardous Areas is unavoidable.
- 1.2 These requirements have been drawn up primarily for naturally aspirated, water cooled, diesel fuelled, compression ignition engines. They shall also apply to turbo-charged, super-charged, air-cooled or dual-fuelled compression ignition engines, unless otherwise specified by BP, although it should be noted that such engines have relatively higher exhaust and surface temperatures and compliance with this Specification will be more onerous. Spark ignition engines are specifically excluded.
- 1.3 These requirements are not applicable to road tanker vehicles, the design, construction and operation of which must comply with appropriate National or International standards and statutory requirements.

2. GENERAL

- 2.1 This Specification meets the general requirements of BP, using the recommendations given in the [OCMA Publication No. MEC-1 1977](#) as a basis.
- The application of BP Group GS 134-8 to the wide range of diesel engines likely to be employed within BP needs careful assessment before specifying protection requirements.*
- 2.2 Where reference is made to 'approved equipment' or to test by a responsible authority, this refers to acceptance or test by any authority empowered to make statutory regulations, or establishment whose tests are recognised by BP to be sufficiently well conducted to establish reliability of the equipment under the conditions specified.
- 2.3 The main equipment supplier, as appointed by BP or their contractor, shall be responsible for the design and provide evidence of the satisfactory functioning of all the equipment fitted to the diesel engine. In particular the main equipment supplier shall be responsible for



ensuring that all protection equipment is correctly sized and installed and carries the correct certification as required herein.

The main equipment supplier normally refers to the manufacturer of the driven equipment, e.g. fork lift truck, crane, pump or compressor. It is these manufacturers' responsibility to ensure the protection requirements of this Specification are correctly applied to the diesel engine. Part or all of the work involved may be carried out by the main equipment supplier, a specialist protection equipment company or by the engine manufacturer.

- 2.4 The main equipment supplier shall make provision for testing all equipment.
- 2.5 Special attention shall be given to the accessibility and ease of maintenance of the complete installed equipment.

3. UNPROTECTED DIESEL ENGINE HAZARDS THAT MAY EXIST IN THE PRESENCE OF FLAMMABLE GASES

3.1 PRIMARY Ignition Hazards

The following ignition hazards can exist when an engine is started or running normally:-

- (a) Engine surface and exhaust gas temperatures
- (b) Discharge of sparks from exhaust system.
- (c) Overspeeding of engine.
- (d) Discharge of sparks from electrical equipment.
- (e) Flashback through induction system.
- (f) Static electricity discharge.
- (g) Flame transmission through decompression ports.

3.2 SECONDARY Ignition Hazards

The following ignition hazards will only be expected to occur as a result of engine malfunction or equipment failure:-

- (a) Discharge of sparks from mechanical causes.
- (b) Overheating due to cooling water or lubricating oil failure.



- (c) Excessive engine vibration.
- (d) Explosion in intake or exhaust systems.
- (e) Explosion in crackcase.
- (f) Reverse running of engine.

4. APPLICATION OF PROTECTIVE MEASURES

- 4.1 Diesel engines that are to be permanently installed in Zone 2 Hazardous Areas shall be protected against both primary and secondary ignition hazards listed in Sections 3.1 and 3.2 by applying the protective measures detailed in Section 5 and Section 6.
- 4.2 All mobile or portable diesel engined units that are required to operate unattended in Zone 2 Hazardous Areas shall be protected against both primary and secondary ignition hazards listed in Sections 3.1 and 3.2 by applying the protective measures detailed in Section 5 and Section 6.
- * 4.3 Diesel engines mounted in vehicles, or mobile equipment with an operator in attendance, that are required to operate in Zone 2 Hazardous Areas, shall as a minimum be protected against the primary ignition hazards listed in Section 3.1 by applying the protective measures detailed in Section 5. Protection against some or all of the secondary ignition hazards listed in Section 3.2 shall be provided, when specified by BP, by applying the protective measures detailed in Section 6.

5. PRIMARY IGNITION HAZARDS - DESIGN REQUIREMENTS

5.1 Excessive Temperature of Exhaust Gases and Excessive Surface Temperatures of Engine and Exhaust System

- 5.1.1 The temperature of the exhaust discharge gases and the exposed surface temperature of any part of a diesel engine operating in a Hazardous Area, including exhaust piping and manifold, shall in no circumstances exceed 250°C (480°F) when providing the maximum power requirements imposed by the driven equipment.

The 250°C maximum surface and gas temperature required by this Specification was established following studies of the auto-ignition temperature of flammable materials. This work showed that the effect of heat transfer near a hot surface will increase the auto-ignition temperature by at least 100°C above the temperature determined by BS 4056. If the more conservative figure of 50°C is used for the temperature difference, a maximum surface temperature of 250°C may be



considered acceptable for the majority of refinery and petroleum chemical flammable materials, i.e. those whose auto-ignition temperature determined in the BS test are above 200°C.

In certain mobile plant cases, the engine power requirements when operating in hazardous areas may be significantly lower than when operating outside the hazardous areas. These cases are generally limited to truck mounted units where the equipment is driven from the main engine and has power requirements significantly less than the unit's maximum engine power output e.g. platform hoists, mobile cranes. In these instances, it may be possible to minimise the engine cooling modifications to those necessary to meet the maximum allowable surface and exhaust temperatures when the unit is operated at these reduced engine outputs. From investigation it may be found possible to operate the engine at these reduced outputs without an exhaust gas heat exchanger, particularly for short periods. In all such cases it is essential to provide visual indication of the exhaust gas temperatures with an audible alarm should the maximum allowable temperature be exceeded.

* 5.1.2 When it is specified by BP that diesel engines are to be operated in areas where the products being handled have an auto-ignition temperature below 200°C (392°F), the engine temperatures that occur under maximum rated output shall not exceed these auto-ignition temperatures. Auto-ignition temperatures are to be determined by the test apparatus and method described in [BS 4056](#). Examples of components that have auto-ignition temperatures below 200°C are given in Appendix C.

5.1.3 Water jacketed exhaust systems are the preferred method of meeting the above surface temperature requirements. An exhaust gas temperature indicator and high temperature shutdown shall be provided on all engines. This shutdown device shall isolate the fuel supply. Engine radiators or, where applicable, heat exchangers shall be suitably sized to accept the additional heat load. Lagging is not permitted as a means of reducing surface temperatures.

Satisfying the 250°C maximum exhaust gas and manifold temperatures may involve extensive engine cooling modifications. Engines available with water jacketed exhaust manifolds as standard will be more suitable than engines that require water jackets to be specially manufactured. However, water cooled manifolds alone will not normally provide sufficient cooling to limit temperatures to 250°C and an additional heat exchanger will be required. The design of these heat exchangers will need to recognise the thermal loads required to reduce the exhaust gas temperature to below 250°C when the engine is operated at the maximum power requirements of the driven equipment. The cooling water for these exchangers may be supplied either from the engine's cooling system or from a separate cooling circuit. The choice of system will depend largely on whether the engine's cooling system capacity can be increased (larger radiators, fans, pumps) without affecting the engine cooling performance or involving major modification to the equipment. Separate cooling circuits may be engine driven and of similar design to the engine cooling system or bled from the driven machine in the case of water pumps.



The exhaust gases to be cooled should be passed through the inside of heat exchanger tubes as this allows for easier cleaning and provides for water cooled exterior surfaces of the heat exchanger.

Where exhaust gas heat exchangers are separately mounted to the engine, the water jacketed flexible connections must be designed to accommodate all relative movements between the engine and exchanger that occur under all operating conditions, including engine shutdown.

Reducing surface temperatures by lagging methods are not acceptable due to vulnerability to mechanical damage and difficulty in applying to the intricate shapes found in exhaust manifolds. Such lagging systems are also prone to the formation of pockets or voids which may collect flammable materials and generate a source of ignition.

* 5.1.4 Any particular requirement for an exhaust system flame trap will be specified by BP.

The intended function of a flame trap fitted to the exhaust systems of diesel engines is to extinguish flames before they are discharged from the open end of the exhaust system, i.e. to atmosphere. Although there is no evidence to suggest that flames are discharged from the exhaust system of normally running engines, flames may be present when the engine ingests flammable gas or when abnormal combustion conditions exist. The case for fitting exhaust system flame traps is therefore based on the possibility of flames being discharged when the engine ingests flammable gases.

Whilst the effectiveness of flame traps can be demonstrated under standard laboratory conditions, no work has been reported on the effectiveness of these flame traps when fitted to the exhaust systems of diesel engines, either when running normally or under ingested flammable gas conditions. The influence of the exhaust gas coolers required by BP Group GS 134-8 on possible flame transmission in exhaust systems will also modify the conditions of flame trap effectiveness. Although flame traps are capable of extinguishing a single flame front, their cooling effectiveness under continuous flame conditions will be seriously affected due to temperature rise of the element matrix. It must be concluded that the ability of flame traps to extinguish flames that might be generated in the exhaust systems of diesel engines following the ingestion of flammable gas cannot be clearly demonstrated.

Apart from a few exceptions, diesel engines operated by BP in hazardous areas have not been equipped with exhaust system flame traps. These exceptions relate to rail locomotives operating in loading areas and some fork lift trucks. No cases have been reported within BP of fire or explosion that could be attributed to flames being emitted from the exhausts of diesel engines.

The main practical drawback to the fitting of exhaust flame traps is that they are very susceptible to carbon blockage, which if not rectified will lead to engine power loss and overheating. A typical plate type flame trap may require cleaning after less than 24 hours operating time. In addition flame traps are expensive, vulnerable to damage and spare traps are necessary because of length of cleaning procedures.

The case for fitting exhaust flame traps to diesel engines is not adequately supported by evidence that flame traps will be effective in this application. Also the



requirement for flame traps on the cooled exhaust system of protected engines has not been demonstrated. For these reasons, it would not normally be necessary to fit flame traps to diesel engine equipment of which BP has a safe record of operating experience. Nevertheless, where special reasons for concern exist, flame traps may be fitted as an additional precaution.

In all cases where exhaust system flame traps are fitted, the cleaning interval must be clearly established and cleaning made mandatory. It may also be beneficial to instrument the exhaust system to indicate when the back pressure reaches the maximum acceptable to the engine manufacturer.

- 5.1.5 Engines shall normally be arranged to allow free movement of ventilating air over all exposed hot surfaces. Avoidance of static vapour pockets, when acoustic protection is added, is essential.

The requirement to maintain free air circulation over exposed hot surfaces and to avoid static vapour pockets is associated with the minimum auto-ignition temperature of flammable material. These ignition temperatures tend to be lower when the air circulation over the hot surfaces is restricted. Under these conditions the difference between the auto-ignition temperature and maximum allowable surface temperature of hot surfaces is reduced. This aspect is particularly important when atmospheres containing flammable materials whose auto-ignition temperatures are below 200°C.

- 5.1.6 Attention is drawn to the high temperatures that are generated by engine driven single stage air compressors.

5.2 Discharge of Sparks or Flames from the Exhaust System

- 5.2.1 A spark arrest shall be fitted to the discharge end of the exhaust system. For land based installations the exhaust outlet to atmosphere is to be as high above ground level as is practicable and so arranged as to prevent the ingress of rain, etc. For offshore installations, downward facing exhaust outlets may be provided if this suits the overall layout.

- 5.2.2 Spark arrestors shall normally be of the dry cyclone type, the baffle type or, where specified, the water bath gas conditioner box type.

Conditioner boxes may be used as an alternative to spark arrestors to quench incandescent sparks. They also provide further means of cooling exhaust gases and some reduction in the poisonous components of the exhaust gas. The main disadvantages of these gas conditioners are that they require frequent (every 3 hours) additions of clean water and water changes every 24 hours or so to prevent acidic build up. They are heavy and bulky and tend to overcool the exhaust gases which leads to the discharge of corrosive water vapours. For mobile plant the water consumption problem can only be solved by fitting large water storage tanks.

In general, gas conditioner boxes find application on diesel rail locomotives which operate in hazardous areas and handle rail tank wagons used for carrying flammable products. Although gas conditioner boxes are not limited to



locomotives, the disadvantages of size, weight and water carrying are less of a problem for a large locomotive than for small items of mobile equipment.

5.2.3 Gas conditioner boxes shall be suitably baffled to prevent water carry-over with the exhaust gas and to ensure thorough mixing of gas and water. Water level indicators and a low level shutdown device shall be provided. The shutdown device shall isolate the engine fuel supply.

5.2.4 Spark arrestors shall be type-tested to the procedure given in Appendix D. The main vendor will be responsible for ensuring that all spark arrestors are correctly sized and installed. Additionally, the main vendor shall be responsible for obtaining test certification from a responsible authority of the effectiveness for the intended service of each spark arrestor provided.

5.2.5 Spark arrestors shall be provided in corrosion resistant materials, and robustly constructed.

5.3 Overspeeding of the Engine due to Induction of Flammable Gas or Vapour

5.3.1 An approved device as described below shall be provided in the air intake system which will automatically stop the engine if it overspeeds above its normal governed speed. The overspeed selected must not exceed the safe limits for the engine or driven equipment. The shutdown device shall preferably be fitted between the inlet flame trap and the intake air filter.

To protect the inlet shutdown valve against damage in the event of an intake flashback, the valve should be positioned between the inlet flame trap and the air filter.

* 5.3.2 The shutdown device shall normally be either a valve to close the air intake or a system which will inject inert gas into the air intake, or a combination of both. Guidance in the use of carbon dioxide is given in Appendix E. Other systems may be proposed, but will be subject to BP approval.

Certain applications may additionally require the overspeed device to isolate the engine's fuel supply.

Injecting inert gas into the intake to prevent an engine overspeeding avoids the high manifold vacuum conditions associated with an inlet manifold shutdown valve, and provides some instantaneous cooling. The use of gas injection systems may also have application for some engines where the high vacuum conditions caused by closing intake valves may cause damage to valve seals and turbocharger shaft seals in the case of turbocharged engines. Engine intake shutdown systems are designed to stop the engine by excluding the supply of combustion air. During the time required for the engine to stop following initiation of the shutdown device, the



engine will be fuelled normally. During this period any combustion air drawn into the engine due to leakage or malfunction of the intake shutdown system may allow the engine to continue running. This can be prevented by cutting off the engine's fuel supply at initiation of the intake shutdown system. This fuel shutdown feature should be provided as a back-up to the shutdown valve on all engines, particularly on unattended engines or engines that can be operated without load.



- 5.3.3 The automatic shutdown device shall normally be actuated either:-
- (a) by differential pressure across the valve, resulting from high induction flow, which provides the closing force to overcome the force exerted by a spring,
 - or
 - (b) by an overspeed sensor, coupled directly to the valve by a mechanical linkage,
 - or
 - (c) by an overspeed sensor, releasing inert gas to actuate the valve.

It should be noted that pressure differential operated valves are not suitable for turbo-charged engines. Automatic shutdown devices actuated by gas detectors may be proposed but are subject to agreement by BP.

- 5.3.4 The overspeed shutdown device shall additionally be capable of being manually actuated. The manual control shall be easily accessible and, in mobile equipment, the control shall be easily accessible from both the cab and outside the vehicle.

5.4 Discharge of Sparks from Electrical Equipment

- 5.4.1 Where possible, electrical equipment shall be avoided and mechanical equipment and components fitted.

- 5.4.2 All electrical equipment associated with the engine shall be certified by a national certifying authority, acceptable in the country in which the equipment will operate. The equipment shall be suitable for operation in a Zone 2 Group IIB T3 hazardous area, unless otherwise specified (see Section 5.1.2). [BS 5345](#) gives guidance on the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres.

- * 5.4.3 Where electrical equipment, such as batteries, cannot be avoided and are not available in a certified form, approval for their use must be obtained from BP.

Acceptable alternatives to electric starting systems are pneumatic, hydraulic, inertia, spring recoil, or hand start.

- 5.4.4 Electrical equipment shall be effectively earthed and bonded to the main engine frame.



5.5 Flashback Through Induction System

5.5.1 Air inlet systems shall be provided with a dry, replaceable type of air inlet filter. The filter shall be sized to suit the particular operating conditions of the plant and allow a reasonable period, to be stated by the supplier, between element change.

5.5.2 Unless specified otherwise, a flame trap shall be fitted, as near to the engine as possible.

Inlet flame traps should always be fitted to engines that take suction from hazardous areas or where the presence of a flammable gas might occur. In cases where the engine inlet takes suction from a non-hazardous area, then inlet flame traps are not essential, e.g. ventilation trunking systems protected by gas detectors.

5.5.3 Flame traps shall preferably be of the crimped, coiled, metal cartridge type. They shall be sized for the specific application, manufactured in corrosion resistant materials and shall be capable of easy dismantling for cleaning and inspection purposes.

Inlet flame traps of the crimped, coiled metal type are more suitable for fitting to the inlet system than the plate type. The plate type are heavy, bulky and are designed for dirty gas application where frequent cleaning is required, e.g. exhaust systems.

5.6 Generation and Discharge of Static from Belt Drives

5.6.1 All driving belts shall be manufactured from anti-static fire resistant material and be in accordance with [BS 2050](#).

5.7 Flame Transmission to Atmosphere by Opening of Decompression Ports

5.7.1 Decompression mechanisms shall not be provided.

6. SECONDARY IGNITION HAZARDS - DESIGN REQUIREMENTS

6.1 Discharge of Sparks from Mechanical Causes

6.1.1 All external auxiliary rotating parts which can cause sparking by contact with other parts, either when running normally or when malfunctioning, are to be so designed and positioned as to avoid such contact. Where possible, external auxiliary components should be manufactured from non-metallic materials. Non-metallic materials shall be fire resistant, anti-static (in compliance with the requirements of [BS 5501](#) - Part 1)



and stable in the presence of organic liquids and vapours. The use of aluminium fan blades is not permitted.

6.2 Overheating due to Failure of the Cooling Water System or Loss of Lubricating Oil Pressure

- 6.2.1 Automatic shutdown devices shall be provided, initiated by excessive engine cooling water temperature and low lubricating oil pressure. The shutdown device shall isolate the engine fuel supply.

Cooling water temperature and lubricating oil pressure indicators shall be provided.

6.3 Excessive Engine Vibration

- 6.3.1 High vibration alarm and shutdown devices shall be provided on all engines that will operate unattended.

6.4 Ignition in Intake or Exhaust Systems

- 6.4.1 Suitable metal-clad or other acceptable jointing material shall be interposed between all exhaust system joint faces to ensure that leakage does not occur. This shall include the inlet system from the engine to the flame trap.

As an alternative to metal clad compressed asbestos jointing, wire mesh reinforced compressed asbestos fibre jointing may be used for exhaust system joints. Jointing based on polymeric or rubber components should not be used for exhaust system joints.

6.5 Explosions in Engine Crankcase: Discharge from Crankcase and Cylinder Head Relief Valves and Breathers

- * 6.5.1 Engines having crankcase volumes of over 0.5m³ (17.7 ft³) shall be provided with crankcase explosion relief devices to the approval of BP. This approval will be based on the design of The British Internal Combustion Engine Research Institute (BICERI), or an approved equivalent. The relief area shall, for preference, be 0.07m² per m³ (3in² per ft³) of crankcase volume and in any case shall not be less than 0.035m² per m³ (1.5in² per ft³).
- 6.5.2 Crankcase relief devices and breathers shall be vented to a safe area or connected to an approved type of flame trap, as described in Section 5.5.3, or connected to the engine inlet manifold downstream of the flame trap.
- 6.5.3 Dipsticks and filler caps shall be screwed or effectively secured by other means.



6.6 Reverse Running of Engine

- 6.6.1 The fuel injection pump and cam shall be so designed that reverse running of the engine is not possible.

7. NAMEPLATES

- 7.1 Engines protected in accordance with this Specification shall be provided with a stainless steel nameplate stating that it is suitable for operation in Zone 2 Hazardous Areas and giving the maximum surface temperature that can occur under the conditions of load, as referred to in Section 5.1.1.

Where engines do not fully comply with Section 6 of this Specification the nameplate shall clearly state that an operator is required to be in attendance when the engine is running.

- 7.2 The emergency manual shutdown lever shall be clearly identified, showing method and direction of operation.

8. OPERATION AND MAINTENANCE INSTRUCTIONS

- 8.1 The main vendor shall provide a manual giving detailed operation and maintenance recommendations covering the engine and all the protection equipment provided.

It must be emphasised that to ensure that protection equipment operates reliably, proper attention must be given to regular maintenance. It is also recommended that before protected diesel engined equipment is operated in hazardous areas, functional checks should be made of the protection equipment. This particularly applies to mobile diesel engined plant.

- 8.2 The manual shall include a clear description of the purpose, testing and operation of all protection equipment fitted to the engine. It shall also include the procedures to be carried out in order to check that the protective equipment will perform satisfactorily in operation. The control set points relating to the protective equipment shall be included in the manual.

9. INSPECTION AND TEST

- 9.1 Equipment covered by this Specification shall be subject to an inspection by BP or their nominated representative.



9.2 The following tests shall be carried out prior to shipment and shall be witnessed by BP representatives.

- (a) Functional test of all equipment fitted to the engine.
- (b) Demonstration that all engine shutdown devices operate reliably at the specified control parameters.
- (c) Demonstration that the maximum surface temperatures are not exceeded when the engine is operated at the load conditions referred to in Section 5.1.1 of this Specification.

10. INFORMATION REQUIRED IN TENDER

- (a) Deviations from this Specification.
- (b) List of protective equipment proposed, including manufacturer, model, size, etc. of all components.
- (c) Full description of the operational and control functions of the engine protective equipment.
- (d) List of all electrical equipment and its suitability for use in Zone 2 Hazardous Areas.
- (e) Maximum exhaust gas and surface temperatures at normal and maximum load conditions.
- (f) Details of instruments and panel mounting.



11. INFORMATION REQUIRED DURING CONTRACT

- (a) Any alterations to tender information submitted.
- (b) Construction drawings showing layout and installation details of protective equipment.
- (c) Construction drawings of protective equipment.
- (d) Details and construction drawing of any engine modifications to meet this Specification.
- (e) Equipment approval certificates.
- (f) Evidence that the installed protection equipment does not affect or restrict the intended use for that engine.
- (g) Works test reports on installed protective equipment, indicating that the equipment meets the requirements of this Specification.
- (h) Schematic diagram showing control functions of protective equipment.
- (i) List of protective equipment supplied
- (j) Operating and maintenance manuals.
- (k) Spares list proposals.



DEFINITIONS AND ABBREVIATIONS

Definitions

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

Abbreviations

BS British Standard

OCMA Oil Companies Materials Association



LIST OF REFERENCED DOCUMENTS

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

Reference 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.

BS 2050	Electrical Resistance of Conductive and Anti-Static Products made from Flexible Polymeric Material.
BS 4056	Method of Test for Ignition Temperature of Gases and Vapours.
BS 5345	Code of Practice for the Selection, Installation and Maintenance of Electrical Apparatus for use in Potentially Explosive Atmospheres (Other than Mining Applications or Explosive Processing and Manufacture).
BS 5501	Electrical Apparatus for Potentially Explosive Atmospheres - Part 1 General Requirements.
OCMA Publ. MEC-1	Recommendations for the Protection of Diesel Engines Operating in Hazardous Areas.
Health and Safety Executive (M and Q) Testing Memo No. 12	Test and Approval of Diesel and Storage Battery Powered Locomotives and Trackless Vehicles and Diesel Powered Equipment for use Underground in Mines (Draft 1976)



APPENDIX C

EXAMPLES OF COMPONENTS THAT HAVE AUTO-IGNITION TEMPERATURES BELOW 200°C

(Extract from [OCMA Publ. MEC-1](#))

The following compounds have ASTM minimum auto-ignition temperatures below 200°C (392°F) and must be considered as hazardous under all circumstances when confronted with a 250°C (480°F) hot surface.

Compound	Minimum Auto-ignition Temperature	
	°C	°F
diethylene oxide	180	356
diethyl ether	160	320
dibutyl ether	198	388
di-n-propyl ether	189	372
diaryl ether	171	340
dihexyl ether	187	369
methyl ethyl ether	190	374
2-ethylhexonal	197	387
benzaldehyde	192	378
acetaldehyde	140	284
carbon disulfide	102	216
ethyl nitrite	90	194
propyl nitrite	175	347



APPENDIX D

EXHAUST SPARK ARRESTORS - METHODS OF TEST

(Based on [OCMA Publ. MEC-1](#))

The following method of test is based on a test procedure prescribed for diesel engines in explosive areas by the Explosives Storage and Transport Committee of the Ministry of Defence.

The spark arrestor shall be fitted to a test engine, which shall be run until stable engine temperatures are reached. The following charcoal test shall be carried out:-

30 g of sieved powdered charcoal between 0.5 mm (0.02in) and 1 mm (0.039in) in size is to be introduced over a period of approximately 30 s into the air intake manifold of the engine under each of the following conditions and the results observed:

- (a) fast idling;
- (b) acceleration from slow idling to full speed;
- (c) full speed and full load.

If any spark from the exhaust system is observed under dark room conditions, the equipment will be deemed to have failed the test and should be rejected.

A photographic record of the test shall be made.



APPENDIX E

CARBON DIOXIDE INJECTION SYSTEM

(Based on [OCMA Publ. MEC-1](#))

The carbon dioxide injection system shall comprise a gas cylinder with a valve and a fixed orifice designed to discharge at a predetermined flow rate.

The following table gives recommended cylinder sizes and flow rates related to the brake power of the engine.

Engine Power (kW)	CO2 Cylinder size (by weight of contents) (kg)	CO2 Flow rate (g/s)
0-45	1.1	50
46-90	2.2	100
91-180	4.5	200

For engines above 180 kW (240 HP), the cylinder size and flow rate shall be computed to discharge carbon dioxide gas at 50% of the air aspiration volume flow rate of the engine, for not less than 20 seconds.

The cylinder valve may be operated:

(a) manually

or

(b) automatically by a speed sensor or a gas detector

