



**Technical Reference
for the
Approval
of
Diesel Engine Systems (DES)
for use in
Underground Coal Mines in NSW**

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FOREWORD

The use and operation of Diesel Engine Systems in underground coal mines is considered a high risk activity, which has the potential to create a catastrophic event. DES used in underground coal mines must be designed, manufactured, operated and maintained in a condition to ensure they remain explosion protected throughout their life.

AS 3584.2–2003 provides guidance for the design and testing of explosion protection diesel engine systems. However a risk management approach is required to ensure the DES remains explosion protected throughout its lifecycle. This includes; using fit for purpose equipment, using competent people in the design and maintenance of DES and developing procedures to operate and maintain the DES throughout its life cycle. Appropriate periodic audits, monitoring and review then support this.

The approval of a DES means the DES has been tested and assessed against the latest community standard for explosion protection diesel engine systems at the time of approval. Owners and Manufacturer must monitor and review the DES throughout its lifecycle to ensure that it always remains in a safe condition.

The Department of Mineral Resources sees the ***Safety of people when involved with plant and equipment*** as an integral part of mine safety.

This can be achieved by the safe utilisation of plant and equipment throughout its lifecycle by control of energy sources (e.g. mechanical, electrical, gravitational, potential, chemical energies) resulting in prevention of injury and death from:

1. Hydraulic / pneumatic fluid power systems, e.g. hydraulic injection, explosion of pressure vessels.
2. Catastrophic failure (explosion, uncontrolled release of energy) of plant and equipment, e.g. winders, cranes, explosion protected diesel engine systems, brake failures mobile equipment, tyre explosions, electrical equipment, etc.
3. Ignition of flammable substances (e.g. gas, coal dust, conveyors, bins) caused by malfunctions of plant and equipment.
4. Fires involving mobile equipment
5. Unexpected movement of plant (uncontrolled energy)
6. Unexpected movement or non operation of safety critical controls.
7. Contact with moving / rotation plant and equipment (e.g. nip and shear points).
8. Inappropriate energy dissipation and isolation
9. Exposure to hazardous substances, e.g. exposure to diesel emissions, oils, fuels, lubricants and dust
10. Exposure to excessive noise
11. Inappropriate activities within confined spaces
12. The activity of cutting and welding
13. Construction and maintenance of plant and equipment (e.g. preparation plants, storage bins, drag lines, etc.)

Throughout the life cycle of the mine and the plant and equipment

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SECTION 1 PURPOSE AND SCOPE

1.1 SCOPE

This Technical Reference document provides guidance to Equipment Manufacturers, Equipment Hirers, Equipment Operators, Mine Owners and The Department of Mineral Resources Inspectorate for the process to be followed and information required for the approval of Diesel Engine Systems (DES) for use in Underground Coal Mines in NSW. This document must be read in conjunction with AS 3584.2-2003 and MDG 29.

This document covers-

- a) The approval process to be followed
- b) Requirements for equipment designers and design verifiers.
- c) The assessment of the DES to AS 3584.2-2003.
- d) Information to be provided to the Department of Mineral Resources with the approval application.
- e) Additional Departmental requirements for the approval of DES
- f) Standard Departmental approval conditions.

1.2 APPLICABLE LEGISLATION

1.2.1 Occupational Health and Safety

Clause 11 (1) of the Occupational Health and Safety Act 2000 states:

'11 Duties of designers, manufacturers and suppliers of plant and substances for use at work

- (1) *A person who design, manufacturers or supplies any plant or substance for use by people at work must:*
 - (a) *ensure that the plant or substance is safe and without risk to health when properly used, and*
 - (b) *provide, or arrange for the provision of, adequate information about the plant or substance to the person to whom it is supplied to ensure its safe use.'*

1.2.2 Coal Mines (Underground) Regulation 1999

Clause 13 of the Coal Mines (Underground) Regulation 1999 states:

'13 Diesel engines underground

A mine mechanical engineer must ensure that a diesel engine or a diesel engine system is not used underground at a mine unless it is of an approved type."

1.3 OBJECTIVE

To ensure the safety of people when involved with the use of Diesel Engine Systems underground in coal mines.

1.4 APPLICATION

This Technical Reference applies to all new approvals and variations to existing approvals for Diesel Engine Systems for use Underground Coal Mines in NSW.

It should also be used by Equipment Manufacturers, Equipment Hirers, Equipment Operators, Mine Owners as an audit guide for the auditing of previously approved DES equipment.

1.4.1 Implementation

This Technical Reference will be implemented upon publication of AS 3584.2-2003.

1.5 RISK MANAGEMENT

To ensure the integrity of the explosion protected properties of the DES a life cycles approach must be taken by Equipment Manufacturers, Equipment Owners, Equipment Hirers, Equipment Operators, Mine Owners. This includes:-

- a) Hazard identification
- b) Consultation
- c) Risk assessment
- d) Risk management procedures (e.g. JSA, SWP)
- e) Information to be collated (e.g. manufacturers instructions, MSDS)
- f) Instruction and training, competent people
- g) Supervision
- h) Monitoring
- i) Review
- j) Revision

1.6 ASSESSMENT CRITERIA

Diesel Engine Systems being used in underground Coal Mines in NSW are to be assessed against the following documents:

- a) AS/NZ 3584.2-2003, 'Diesel engine systems for underground coal mines – Part 2: Explosion protected'
- b) MDG 29 - 'Guidelines for the diesel and operator environment testing in underground coal mines'
- c) Section 3 of this document.
- d) Other documents as specified by the Department of Mineral Resources.

1.7 DEFINITIONS

For the purpose of this document the definitions below apply.

1.7.1 Designer

The person who originally designed the DES or its modifications.

1.7.2 Design Verifier

The person that carries out the design verification of the DES against AS 3584.2-2003.

SECTION 2 APPROVAL OF DIESEL ENGINE SYSTEMS

2.1 APPLICATION FOR APPROVAL OF DES

A person may apply to the Department of Mineral Resources for the Approval of a DES as required by Clause 14 of the Coal Mines (Underground) Regulation 1999 pursuant to the provisions of Clause 70 Part 8 of Approval of items of the Coal Mines (General) Regulation 1999.

A person who applies for approval of a DES must ensure that:

- a) A competent person (design verifier) verifies and records in writing that the design and installation of the diesel engine system complies with AS 3584.2-2003, and
- b) The design verifier does not have any involvement in the design being verified, and
- c) The designer and the design verifier are not employed or engaged by the same person unless that person uses a quality system to undertake the design of the DES that:
 - (i) Meets the requirements of AS/NZS/ISO 9001 Quality systems-Model for quality assurance in design, development, production, installation and servicing, and
 - (ii) Has been certified by a body accredited or approved by the Joint Accreditation System of Australia and New Zealand.

2.1.1 Approval Process

The process for obtaining a DES approval from the Department of Mineral Resources is as follows:

- a) Design to be carried out in accordance with AS 3584.2-2003.
- b) Design to be tested in accordance with AS 3584.2-2003, MDG 29 and this document.
- c) Design to be verified against 3584.2-2003.
- d) Risk management to be carried out.
- e) Electrical approvals / certifications to be obtain for all electrical equipment. (if required)
- f) Completion of Forms A, B, & C.
- g) Submission of application to the DMR with documentation specified below.

2.1.2 Approval Types

Applications for approval may be in the following forms:

- a) 'Type Approval' – for a new DES or existing DES with major changes.
- b) 'Supplementary Approval' – for changes to existing approved DES.
- c) 'Temporary Approval' – Issued for the purposes of 'Tests' or 'Trials' only

Note: The approval application, documentation and process is the same for all types of approval. However for Supplementary Approvals, only the information relevant to the change from the original type approval needs to be provided. Unless the change may have other adverse affects on the explosion protection characteristics of the DES in which case full testing to AS 3584.2-2003 and MDG 29 may be required.

2.1.3 Changes To Approved DES

A supplementary approval is required whenever the approved DES is altered requiring amendments to the documents submitted for approval.

2.2 DOCUMENTATION

2.2.1 Documents to be provided with Approval application

The application for Approval of DES must be accompanied by all of the following:

- a) Letter of application
- b) Form A - 'Approval Application Form'
- c) Form B - 'Diesel engine system documentation'
- d) Form C - 'AS 3584.2-3000 – Design Verifier Compliance Assessment'
- e) Representational drawings of the DES
- f) Test certificates by testing authority as required by AS 3584.2-2003.
- g) A verification statement by the design verifier
- h) A compliance statement, signed by the designer of the DES,
- i) Risk assessment for any specific non-conformances to AS 3584.2-2003
- j) Risk assessment on the engine safety shutdown circuit
- k) Details of operating instructions
- l) Details of maintenance requirements

Note: Where documentation is not provided or is not complete, then the approval application will be returned to the applicant and the appropriate documentation requested..

2.2.2 Department of Mineral Resources may request further information-

On request from Department of Mineral Resources, the applicant for approval of a DES must provide additional information on the design, testing, operation or maintenance of the DES as specified in the request.

2.2.3 Documentation

All documents supplied with the application must have a document name, documents number, revision and date and be included in Form B. Documents not submitted in this format will be rejected.

2.2.4 Drawings

All drawings submitted for approval application must be included in form B and should be in accordance with AS 1100. They must contain the following information:

- a) Drawing title and unique identification number.
- b) Approval holder's name and ABN number.
- c) Current Revisions of drawing, with tracking of changes made.
- d) Name/initial of draftsman.
- e) Name/initial of designer.

2.3 RISK ASSESSMENT

2.3.1 Specific Non-Conformances to AS 3584.2- 2003

A risk assessment or statement of risk must be provided for each specific non-conformance identified in the verification statement to AS 3584.2003 and as identified in Form C.

An equivalent level of safety must be demonstrated for each non-conformance identified, as required by Clause 1.2 of AS 3584.2-2003.

2.3.2 Engine Safety Shutdown System

A risk assessment must be provided on the engine safety shutdown system. The objective of this risk assessment is to ensure the integrity of the engine safety shutdown system to shut the DES down under all operational and maintenance conditions, including the failure of components.

This risk assessment must be in a form which systematically analysis's the failure of all components of the engine safety shutdown system, e.g. Failure Modes Effect and Critically Analysis (FMECA), Fault Tree Analysis (FTA), Event Tree analysis (ETA), Quantitative Risk Assessment (QRA) etc.

2.3.3 Operational Risk Assessment

Prior to the use of the DES in a coal mine underground, an operational risk assessment is required to be carried out. This risk assessment is not required with the approval documents.

2.4 DESIGN STATEMENTS

2.4.1 Compliance Statement

A 'Compliance Statement' signed by the designer of the DES shall include:

- a) A statement similar to:
'I (name of designer) hereby verify that in relation to the diesel engine system (identification of system for which approval is sought) I have complied with the duties of designers as specified in the Occupational Health and Safety Regulation 2001.'
- b) A statement verifying the design meets the requirements of AS 3584.2-2003 subject to any specific non-conformances and provided an equivalent level of safety is provided.
- c) The minimum ventilation quantity to meet gaseous limits for the diesel engine system
- d) The particulate signature of the DES, $Q_{DP(\min)}$ before and after treatment.
- e) The designer's recommendations in regards to diesel pollutant control and the use of particulate filters.

The designer's compliance statement is to be provided and kept with the documentation for each DES.

2.4.2 Verification Statement

A 'Verification Statement' signed by the design DES verifier of the DES shall include:

- a) A statement similar to:
'I (name of design verifier) declare that the design of the DES, (identification of system for which approval is sought) complies with AS 3584.2-2003, subject to b)'
- b) Identification of any specific non-conformances to AS 3584.2-2003 including a statement the items identified provide an equivalent level of safety.
- c) The name, business address and qualifications of the design verifier of the DES and if applicable the name and business address of any person employing the design verifier.

The verification statement is to be provided and kept with the documentation for each DES.

The design verifier is to check form B and complete form C.

SECTION 3 OTHER ITEMS TO BE CONSIDERED

3.1 EXHAUST POLLUTANTS

Exhaust emission and noise criteria are to comply with MDG 29.

Note: MDG 29 is currently being revised to include all diesel engine pollutants. Its new title will be 'Guideline for the management of diesel engine system pollutants in underground mines'. The requirements below are an interim measure until its publication.

3.1.1 Gaseous Emissions

In addition to the requirements of AS 3584.2-2003 diesel engine systems underground must comply with NSW Government Gazette Notice No. 104 'MONITORING FOR DIESEL EXHAUST EMISSIONS' of September 1999.

- a) The maximum permissible limits for raw undiluted exhaust components, 1500 ppm of CO, 750 ppm NO_x.
- b) The maximum permissible limits for diluted components in mine air, 50 ppm CO , 3 ppm NO₂, 25 ppm NO

3.1.2 Particulate Emissions (smoke)

It must be able to be demonstrated by risk management techniques that diesel particulates are being managed in accordance with current Occupational Health and Safety practices.

The NSW Minerals Council recommends a maximum DP exposure limit of 0.2 mg/m³. It should be demonstrated that this exposure limit can be achieved without exceeding the gaseous ventilating air quantity of 0.06m³/s/kW.

One method of achieving this is to install disposable particulate filter assemblies. If fitted then filters elements should be installed during operation of the diesel engine system underground,

3.1.2.1 Diesel Particulate Signature

It is intended to give each diesel engine system a '*diesel particulate signature*' for educational purposes for the end user.

Therefore the minimum ventilation quantity $Q_{DP(min)}$ to meet the NSW Minerals Council Guidelines of 0.2 mg/m³ shall be stated on the designers compliance statement. $Q_{DP(min)}$ shall be calculated with and without the particulate filter, or other system(s) which reduce diesel particulates installed.

The diesel particulate signature is to be based on the ISO duty cycle, refer Table C2 of AS 3584.2-2003.

Note: One method for calculation $Q_{DP(min)}$ may be with the following equation(s) if applicable:

$$\text{Where } Q_{DP(min)} = \frac{DP_{kW}}{3600 DP_{(Exposure\ Limit)}} P_{WA}$$

$Q_{DP(min)}$	= minimum mine ventilation quantity (m ³ /s)
$DP_{(Exposure\ Limit)}$	= 0.2 mg/m ³ (from NSW Minerals Council)
DP_{kW}	= sum of weighted average DP per kW per hour (mg/kW/hr)
P_{WA}	= sum of weighted average power (kW)

Note: One methods for calculating DP_{kW} is by using Appendix K of AS 3584.2-2003 and converting Bosch readings.

Table C2 of AS 3584.2-2003 would be modified as follows:

Speed	Units	Low idle	Rated Torque speed				Rated power speed			
			1	2	3	4	5	6	7	8
Test number			1	2	3	4	5	6	7	8
Torque %		0%	100%	75%	50%	100%	75%	50%	10%	
Torque	Nm	from dynamometer testing								
Speed	rpm	from dynamometer testing								
Power per test number	kW	torque x angular speed								
<i>Exhaust Volumes</i>										
engine nominal exhaust air flow rate	l/s	as measured at testing (include turbo boost)								
engine nominal exhaust air flow rate	m ³ /hr	Using Gas equation Q1= mRT1/P1								
engine nominal flow rate adjusted to 15.6° C and 760 mm HG. Refer K2 AS 3584.2	m ³ /hr	Using Gas equation Q2 = Q1x(P1/T1)x(T2/P2)								
<i>Gravimetric Units</i>										
Bosch smoke units										
Soot Concentration per test number	mg/m ³	From figure K2 of AS 3584.2								
Total DP per hour per test number	mg/hr	Using adjusted exhaust volumes and soot concentration above								
Total DP per kW per test number	mg/kW/hr	Using total DP per test number / Power per test number								
<i>Weighted Results</i>										
Weighting factor		0.15	0.1	0.1	0.1	0.15	0.15	0.15	0.1	
Weighted Bosch smoke results		as per AS 3584.2								
Weighted DP per hour per test number	mg/hr	Using results above X weighting factor								
Weighted DP results for each test number	mg/kW/hr									
Weighted power for each test number	kW									
<i>Sum of Weighted Results</i>										
Bosch smoke index number		As per As 3584.2								
Sum of weighted average DP per hour	mg/hr	Sum of weighted results above								
Sum of weighted average DP per kW per hour (DP _{KW})	mg/kW/hr									
Sum of weighted average power (P _{WA})	kW									
Minimum mine ventilation per kW	m ³ /s/kW	DP _{KW} / (3600x0.2) (To meet minerals council 0.2mg/m3 max)								
Minimum mine ventilation quantity Q_{DP(min)}	m ³ /s	Minimum mine ventilation per kW X P _{WA}								
Note: This calculations should be carried out before and after the particulate reduction device										

3.2 DES TESTING WHERE REMOVABLE PARTICULATE FILTERS ARE INSTALLED

To clarify AS 3584.2-3004, engine systems, which have removable particulate filters installed shall:

1. be explosion tested both with and without the particulate filters installed to simulate the worst possible conditions, refer 8.1 for details , and
2. have the engine protection systems tested to ensure the protection system is functional under normal operating conditions and when the exhaust particulate filter is totally blocked, refer 8.2 for details

3.3 MAINTENANCE OF DES

Maintenance of DES is to include the requirements of MDG 32, ' Guideline for the maintenance of

diesel engine systems in underground coal mines'. Note: This will shortly be replaced by AS 3584.3 when it is published.

Instructions on the maintenance of the DES should be provided to:

- a) Ensure the integrity of the explosion protection characteristics
- b) Minimise diesel gaseous and particulate emissions
- c) For fire control and minimisation

3.3.1 Maintenance People

People involved with the examination, testing and maintenance of explosion protection properties on a DES must carry out competency based training in explosion protected diesel engine systems.

3.4 VENTILATION REQUIREMENTS

Clause 85 (5) of the Coal Mines (Underground) Regulation 1999 states:

'(5) The air volume in each place where a diesel engine system operates must be such that a ventilating current of not less than:

- (a) 0.06 cubic metres per second for each kilowatt of maximum output capacity of the engine, or*
- (b) 3.5 cubic metres per second,*

whichever is the greater, is directed along the airway in which the engine operates'

Note: This ventilation quantity may not be adequate for limiting diesel particulate exposure to maximum recommended level by the NSW Minerals Council.

3.5 COMPLIANCE PLATE

In addition to the requirements of Clause 3.1, AS 3584.2-2003 the compliance plate is to include the minimum ventilation quantity.

SECTION 4 APPROVAL CONDITIONS

4.1 CONDITIONS FOR SUPPLY AND USE

4.1.1 General Conditions

1. The user of the Approved System shall conduct a site specific Operational Risk Assessment and implement all barriers to risk identified in the Risk Assessment prior to the introduction of the system into a Coal Mine in New South Wales. This Operational Risk Assessment shall be reviewed when operating conditions vary and at periods not exceeding five (5) years.
2. The Chief Inspector of Coal Mines has the right to vary or revoke this approval at any time.
3. The manufacturer is to certify in writing that the particular system supplied is in accordance with the requirements of this approval insofar as those matters assessed for the approval are concerned.
4. There shall be no variation in the materials, design or construction of the equipment associated with this approval without prior consent of the Chief Inspector. Unauthorised alteration or substitution of approved equipment shall render this approval void.
5. The Owner of this System shall ensure that adequate information is retained at the mine to enable the system to be operated, tested and maintained in the approved condition. This information shall also be made available wherever the system is overhauled or repaired.
6. This approval ceases to be valid if the system is not designed, modified, examined, tested, maintained, overhauled and repaired in accordance with the approval conditions, Occupational Health and Safety Act, 2000 Coal Mines Regulation Act, 1982 and Associated Regulations.
7. The Mine Managers Defect Management System required by Clause 42 Part 2 Division of the Coal Mines (General) Regulation 1999 should include providing details of any defects to the approval holder.
8. The Manager of the mine shall ensure the recommendations of the Approval Holder are complied with as far as they relate to the system, unless an appropriate documented risk assessment process is used to identify alternative means of providing at least equivalent levels of safety and these alternatives are implemented.
9. In accordance with the Occupational Health and Safety Act, 2000 it is a requirement that the Mine Management, Equipment Manufacturers, Equipment Owners, Hire / Lease Organisations, Approval Holders and the Designer of the equipment all take considerable responsibility for the safety related aspects of the system. Compliance with safety related recommendations of the Approval Holder should be viewed as an integral part of the responsibility of all concerned.
10. A safety audit of the Approved System shall be carried out at intervals not exceeding five (5) years. This safety audit shall be documented and shall include:
 - a) an assessment for compliance against these approval conditions, and
 - b) an assessment for compliance against the current community standards, applicable to the Approved System at the time of the audit, and implementation of interim control measures to reduce risk to an acceptable level, and
 - c) an assessment of the safety defects identified since the previous audit and a review of the improvements required to minimise these defects.

4.1.2 Specific Conditions

1. Type Approval No. MDA DES XXXXXX , the Suppliers name or mark and the required minimum ventilation quantity of XX m³/sec shall be inscribed on a durable plate fixed in a prominent position on the equipment. In addition, the approval number shall be stamped on each of the following components:
 - a) Inlet flame trap and manifold assembly.
 - b) Exhaust manifold.
 - c) Exhaust pipe assembly.
 - d) Exhaust gas heat exchanger.
 - e) Exhaust gas catalytic purifier.
 - f) Exhaust particulate filter assembly.
 - g) Exhaust flame trap.
2. An individual DE number shall be allocated for each diesel engine by the Department of Mineral Resources Mine Safety unit. This number shall be stamped on the engine block in an accessible location.
3. MDG32 or any relevant Australian Standard should be considered in the development of the mine's standards of engineering practice for the maintenance of the Diesel Engine System and for the mines 103 scheme.
4. Each installation of this engine type shall be checked to ensure compliance with Australian Standard AS 3584.2-2003. These checks shall include but are not limited to:
 - a) Protection of exposed Aluminium or light metal alloys.
 - b) Operation of the engine shutdown system.
5. The diesel fuel used in this engine system shall comply with that specified under Clause 69 of the Coal Mines Regulation (Underground) 1999 and with any additional criteria nominated by the Engine System Manufacturer.
6. The exhaust gas emissions shall comply with that specified under Clause 14 (2) of the Coal Mines (Underground) Regulation 1999.
7. Routine testing of exhaust gas emissions shall fall within the range specified in AS 3584.2-2003

SECTION 5 FORM A - APPROVAL APPLICATION FORM

Approval Holder	
Name	
ABN	
ACN	
Office Address	
Postal Address	
Phone Number	
Facsimile Number	
Email	
Name of Approval Holders Representative	
Approval Sort	
Type of Approval	
Description of Approval (as requested to appear on approval documentation)	
Equipment Type	
Equipment Model	
DES Designer	
Name	
Job Title	
Employers Name	
Address	
Contact details	
Employer	
Qualifications	
Experience with DES design	
DES Design Verifier	
Name	
Job Title	
Business address	
Employer's name	
Employer's address	
Qualifications	
Experience with DES design	

The signer warrants he is empowered to act on behalf of the approval applicant

Signed (for and behalf of approval holders)

Name & Date

SECTION 6 FORM B – DIESEL ENGINE SYSTEM DOCUMENTATION

Note: This information is required as input to the approval documents. It is to be completed by the designer and verified as being correct by the verifier.

6.1 DRAWINGS TO BE ASSESSED

6.1.1 Approval Drawings

The drawings listed must be supplied with each Diesel Engine System approval package.

DRAWING NO:	ISSUE	DATE	TITLE

6.1.2 Drawings Submitted for Reference:

The drawings are listed for reference only and need not be supplied with each Diesel Engine System approval package.

DRAWING NO:	ISSUE	DATE	TITLE

6.2 DOCUMENTS TO BE ASSESSED

6.2.1 Approval Documents:

The documents listed must be supplied with each Diesel Engine System approval package

DOCUMENT NO:	ISSUE	DATE	TITLE
			Compliance Statement by designer
			Verification Statement by design verifier

6.2.2 Documents Submitted for Reference

The documents are listed for reference only and need not be supplied with each Diesel Engine System approval package.

DOCUMENT NO:	ISSUE	DATE	TITLE

6.3 ENGINE SPECIFICATIONS

Description of Diesel Engine System including its major components:

(E.g.. XXXXX DITA overhead valve, 6 cylinder, 4 cycle, water to air intercooler fitted with XXXX flameproof components and wet exhaust system comprising; exhaust catalytic converter, water based exhaust conditioner, particulate filter assembly and pneumatic / hydraulic shutdown system as follows:)

Details of Approved Diesel Engine System

Combustion System		(e.g. direct injection, exhaust driven turbo charged.)
Piston Displacement	l	
Cylinder bore and stroke	mm	
Firing order		
Compression Ratio		
Testing Dynamometer		
Power Rating / speed	kW / rpm	
Rated Torque / speed	Nm/rpm	
Fuel setting		
Fuel timing		
In service		
Torque stall power / speed	kW / rpm	
High idle	rpm	
Idle speed	rpm	
Minimum ventilation requirements	m ³ /sec	

6.4 TYPICAL TEST RESULTS AT APPROVED POWER RATING

Speed	(rpm)	
Torque	(Nm)	
Power	(kW)	
Turbo Boost	(kPa)	
Inlet Vacuum	mm Hg	
Exhaust Pressure	mm Hg	
Fuel Consumption	kg/hr	
Maximum surface temperature / location	°C	
Conditioner water consumption over 1 hour	l	
Carbon Dioxide CO ₂ (before/after treatment)	%	
Carbon Monoxide CO (before/after treatment)	ppm	
Oxides of Nitrogen NO _x (before/after treatment)	ppm	

Nitrogen Oxide NO (before/after treatment)	ppm	
Nitrogen Dioxide NO ₂ (before/after treatment)	ppm	
Smoke – Single point (before/after treatment)	Bosch	

Signed (Designer)

Date

I have checked the above information against the Testing Authorities test results and confirm it is correct.

Signed (Design Verifier)

Date

SECTION 7 FORM C – AS 3584.2 3000 – DESIGN VERIFIER COMPLIANCE ASSESSMENT

The verifier's compliance assessment is to be completed following all issue of all test certificates by the testing authority. It is to be based on the installed diesel engine system.

Clause AS 3584.2-2003	Description	Complies			Comments
		Yes	No	N/A	
SECTION 1	SCOPE AND GENERAL				
1.2	Application				
3 rd paragraph	Alternative technologies or innovations may also provide solutions to the management of these hazards. An alternative technology or innovation may be adopted, provided the alternative meets or exceeds the applicable requirements of this Standard.				
SECTION 2	DESIGN AND CONSTRUCTION				
2.1	ENGINE TYPES				
2.2	CONDITION MONITORING - Sampling points shall be provided to allow for monitoring of				
(a)	engine oil pressure				
(b)	engine speed				
(c)	engine coolant temperature				
(d)	inlet manifold vacuum				
(e)	exhaust back-pressure				
(f)	gas stream emissions, before & after				
2.3	SURFACE TEMPERATURE – Not exceed 150 ⁰ C under any condition of operation				
2.4	MATERIALS				

Clause AS 3584.2-2003	Description	Complies			Comments
		Yes	No	N/A	
2.4.1	Non-metallic materials				
2.4.2	Light metals				
2.4.3	External thermal insulation				
2.5	FLEXIBLE METALLIC PIPES				
2.6	JOINTS				
2.6.1	Designation – Each joint to be designated				
(a)	Fixed connection – Shall be be gas tight				
(b)	not include parts or components between which there is or may be relative movement				
(c)	when tested in accordance with M4.1 & M4.2 withstand hydrostatic test pressure specified in table M1				
(d)	have metallic or fire-resistant gasket interposed between mating surfaces of flanged connections				
(e)	where screwed fixed connections are used, be gas tight, without the use of thread sealing compound...				
2.6.3 (a)	Open joints flamepath length and flame gap of any linear continuous open path.. constraints specified by figures 2.3 & 2.3				
2 nd paragraph	The following components are exempt provided they are capable of passing the flameproof test specified by appendix M: (i) valve stems and guides (ii) intake and exhaust flametraps (iii) water injection nozzles (iv) turbo-charger and supercharger (v) fuel injectors				
(b)	for joints with a spigot the length of the flamepath				

Clause AS 3584.2-2003	Description	Complies			Comments
		Yes	No	N/A	
(c)	threaded joints shall have a min of five full threads ..				
(d)	where the internal parts are pierced by a spindle. the diametrical clearance shall be as specified in figure 2.2				
(e)	the minimum dimensions for flamepath length and flamepath gap for joint surfaces interrupted by bolt or fastener holes shall be as specified in figure 2.3				
2.7	TRANSMISSION BELTS – Shall be FRAS in accordance with AS 2784				
2.8	ENGINE BREATHER				
2.9	STARTING AIDS				
2.10	FUEL SYSTEM				
1 st paragraph	Setting screws and stops on fuel injector pumps shall be sealed after adjustment using a method that indicates unauthorised entry				
2 nd paragraph	Injectors with external means of adjustment shall be sealed after adjustment and clearly marked with a part number				
3 rd paragraph	High pressure fuel lines shall comply with the engine manufacturers specification				
4 th paragraph	Low pressure fuel lines shall be installed so that they are shielded from any heat, which may cause damage				
2.11	AIR INLET SYSTEM				
1 st paragraph	The air inlet system shall be tested in accordance with Appendices L & M				
2 nd paragraph	Air inlet system shall be fitted with an inlet flametrap, an air filter assembly and an inlet vacuum monitor, which shall be set to operate at less than the diesel engine system manufacturers recommended minimum intake vacuum				
3 rd paragraph	Any connections made to the air inlet system between the air inlet flametrap and the engine inlet valves shall be fitted with a mechanical flametrap and tested to L & M				

Clause AS 3584.2-2003	Description	Complies			Comments
		Yes	No	N/A	
4 th paragraph	Unless propagation testing of the flame trap is carried out at the maximum positively controlled operating pressure and temperature ... then enhanced margin of safety gas shall be usedwhen either (a) the flametrap operates at boosted pressure (b) controlled operating temperature > 80 deg C				
2.12	AIR COMPRESSORS				
2.13	COOLING SYSTEMS				
(a)	The system shall (i) be design to allow the engine to operate...with a min ambient temperature of 40 ^o C (ii) not entrap air within the system (iii) safely vent excess pressure to atmosphere				
(b)	Each radiator filler and radiator pressure cap shall be arranged so that pressurised coolant can be safely released				
(c)	Cooling fans and rotating parts shall be guarded ...4024.1				
(d)	Fans and fan assemblies shall be constructed so sparked are not created in the event of any part ... striking a surrounding or neighbouring object.				
(e)	Cooling fans manufactured from ...non-metallic materials shall have an electrical resistance of not more than 1Ω				
2.14	ENGINE SHUTDOWN SYSTEMS				
2.14.1	Automatic safety shutdown				
1 st paragraph	Fitted with a fail-to-safety automatically operated engine (fuel) shutdown system				
2 nd paragraph	Able to be stopped by manual actuation of the automatic shutdown system				
3 rd paragraph	Automatic safety shutdown should include fault indication on shutdown				
4 th paragraph	Shutdown systems shall meet test requirements of appendix F				

Clause AS 3584.2-2003	Description	Complies			Comments
		Yes	No	N/A	
2.14.2	Manual fuel shut-off valve Manually operated fuel shut-off shall be provided, to stop the diesel engine ...				
2.14.3	Sensing devices – to automatically shutdown the system				
(a) (l)	engine cooling system - include (i) coolant temperature sensor(s) on each cooling circuit not exceeding 2 ^o C less than boiling temp of coolant				
(ii)	(ii) coolant pressure, level or flow sensor on each cooling circuit				
(b)	engine oil pressure – set at manufacturer's min				
(c)	spark arrester (2.15.5)				
(d)	positive flametraps (2.15.4.2)				
(e)	water based flametraps (21.15.4.3)				
(f)	exhaust cooling system (2.15.16)				
(g)	exhaust filter (2.15.7)				
2.14.4 1 st paragraph	Engine start and restart following operation .. safety shutdown system .. shall not be able to be restarted until fault is rectified ..				
1 st paragraph	Engine start and restart period of automatic override shall not exceed 30s on low oil pressure and low coolant pressure only.				
2 nd paragraph	No manually operated override system shall be fitted.				
2.15	EXHAUST SYSTEM				
2.15.1 1 st paragraph	General hoses, pipework, fixtures and fastenings ...shall be designed and rated for the temp, pressure, vibration and environment ..				
2 nd paragraph	Exhaust system shall be tested in accordance with L & M				

Clause AS 3584.2-2003	Description	Complies			Comments
		Yes	No	N/A	
2.15.2	Required equipment				
(a)	Flametraps (2.15.4)				
(b)	Spark arrestor (2.15.5)				
(c)	Exhaust cooling system (2.15.6)				
(d)	Monitoring and shutdown devices (2.14) & tested to K				
(e)	Surface temperature control not exceed 150°C est to E				
2.15.3	Optional equipment				
(a)	Catalytic converters – If regenerative type used care shall be taken ... excessive exhaust temperatures do not occur during regeneration				
(b)	Fume diluters and forced air systems				
(c)	Particulate filters				
2.15.4	Exhaust flametraps				
2.15.4.1	General Flametraps shall be tested in accordance with appendix L				
2.15.4.2	Positive flametraps				
1 st paragraph	An enhanced margin of safety gas				
2 nd para (a)	One sensor shall be fitted where the exhaust gas meets the mine atmosphere and installed after all treatment devices, before dilution. (150°C)				
(b)	One sensor shall be fitted before the positive flametraps. Set at temperature which flame propagation testing was carried out or 150°C if enhanced margin of safety gas used.				
(c)	Where the manufacturer can justify a higher temperature for the sensor nominated under (b) the higher setting may be adopted – see Cl 1.2				

Clause AS 3584.2-2003	Description	Complies			Comments
		Yes	No	N/A	
2.15.4.3	Water-based flametraps				
1 st paragraph	Water-based flametraps shall be of materials resistant to corrosion... and suitable for raw exhaust temperature..				
2 nd paragraph	A low water test valve shall be provided, with its take off at or above the minimum shutdown water level. Test to F				
3 rd paragraph	Provision shall be made for the draining water-based flametraps for cleaning. The opening ... shall require the use if a tool				
4 th paragraph	Access shall be provided top the main internal chamber of water based flametraps, to permit inspection and cleaning.				
5 th para (a)	Primary low water sensor – A primary low water sensor that will directly sense the level of water in the flametrap and stop the engine at or above the minimum shutdown level....				
	The sensor shall ensure that the minimum shutdown water level is maintained under all conditions of operation and inclination				
(b)	Secondary low water sensor – shall be fitted and (i) comply with (a) above, or (ii) be located upstream of the water makeup valve ... and comply with F6.3.12(a)(i) & F6.3.2(b)				
6 th paragraph	Manual isolation valves shall not be fitted between any low-water sensing device and the main flametrap				
7 th paragraph	Float (level) sensing devices shall fail to safety. Provisions to test primary and secondary .. independently				
8 th paragraph	At least one exhaust gas temperature sensing device shall be fitted at the point where the exhaust first meets the mine atmosphere, which shall shutdown the engine system before the exhaust gas temperature exceeds 150°C with the engine operating at idle				
9 th paragraph	Where a temperature sensing device is employed to sense water level or flow, it shall operate before an unsafe condition arises				
2.15.5	Spark arrester				

Clause AS 3584.2-2003	Description	Complies			Comments
		Yes	No	N/A	
(a)	The spark arrester shall eliminate the emission of sparks ..				
(b)	Comply with Appendix G, 1019 or requirements for water based type				
(c)	Spark arresters that are reliant on water level or flow for effectiveness shall be fitted with two sensors Sensors may be one of the following (i) Two minimum safe water level sensors (2.15.4.3) (ii) Two sensors measuring water flow (iii) One sensor measuring exhaust gas stream temperature and the other measuring the minimum safe level or flow				
(d)	Where a spark arrester coolant circuit is separated and isolated from the main engine coolant circuit, a loss of coolant shall cause the engine system to automatically stop.				
(e)	A spark arrester shall not be fitted with a bypass device.				
(g)	spark arresters shall not be manufactured from flammable material				
2.15.6	Exhaust cooling system				
1 st paragraph	General – The exhaust gas cooling system may be a separate device or may be combined				
2 nd paragraph	Where a positive flametrap is used, the temperature of the exhaust gas stream ... shall not exceed 150°C.				
3 rd paragraph	Where a water based flametrap is used, the temperature of the exhausts gas stream at both the point of discharge and where is first meets the mine atmosphere shall not exceed 77°C for type testing ... Appendix E				
4 th paragraph	Water supply tanks shall be manufactured from corrosion resistant material. Where contamination from the water tank supply can cause... control valve to fail, the water supply circuit shall include a strainer.				
2.15.6.2	Water Bath Shall be fitted with a minimum of two sensors, which shall cause engine				

Clause AS 3584.2-2003	Description	Complies			Comments
		Yes	No	N/A	
	to stop on loss of water barrier. The sensors shall fail to safety				
2 nd paragraph	Sensors shall measure the minimum effective safe level, or flow of water, or the exhaust gas stream temperature. The sensors shall cause the DES to automatically stop before the exhaust gas stream reaches 150 ^o C.				
2.15.6.3 1 st paragraph	Air dilution An exhaust diluter with a gas temperature of more that 150 ^o C before dilution shall not introduce unfiltered mine air directly into an exhaust gas stream. Unfiltered mine air shall not come in contact with any surface with a temperature greater than 150 ^o C.				
2 nd paragraph	Where a fume dilution system is the primary means of cooling the exhaust gas stream, it shall be fitted with at least two independent sensors that will cause the engine to stop before ...150 ^o C.				
3 rd paragraph	Any device employed for the purpose of dilution or dissipation shall be designed, ...to minimise the disturbance of dust from the floor, rib or roof of the mine				
2.15.6.4	Heat exchanger				
2 nd paragraph	Access should be provided for inspection and cleaning of heat exchangers.				
3 rd paragraph	Where the exhaust water cooling circuit is separated and isolated from the main engine coolant circuit, a loss-of-coolant sensor shall be fitted to the cooling circuit....				
4 th paragraph	Every exhaust cooling heat exchanger shall be fitted with one of more sensors that will measure either the temperature or flow of the coolant. The sensor shall be fitted within the coolant circuit, on the downstream side of and as close as practicable to the heat exchanger. This sensor shall be in addition to any sensor that is fitted to comply with 2.14.3(a)				
5 th paragraph	In the event that the flow falls below the minimum required to maintain the temperature of the exhaust to less than 150 ^o C the sensor shall cause the DES to stop.				

Clause AS 3584.2-2003	Description	Complies			Comments
		Yes	No	N/A	
6 th paragraph	Where the heat exchanger is the primary means of cooling the exhaust gas, one or more temperature sensors shall cause the engine to stop before the exhaust gas temperature reaches 150°C..... If two sensors are fitted one may be fitted before the exhaust filter.				
2.15.6.5	Water Injection May be used to achieve the exhaust temperature limits				
(a)	Sensors shall be provided to measure either the flow or pressure in the water supply line, and				
(b)	the temperature of the exhaust gas stream...				
3 rd paragraph	The sensors shall cause the DES to stop automatically, in the event that the flow rate or pressure falls below the minimum required to maintain the temperature of the exhaust gas to less than 150°C				
2.15.7	Particulate filter				
2.15.7.1	General Filter systems ... shall meet the requirements of appendices C and H				
2 nd paragraph	Where a failure of a filtering system could cause an unsafe condition, devices shall be fitted to cause the DES to be automatically stopped, in the event of such failure occurring.				
3 rd paragraph	Where a blocked-filter bypass (waste-gate) valve is fitted, an audible or visual indicator indicating bypass operation shall be fitted.				
4 th paragraph	Where a filtering system is required, the concentration of smoke shall comply with the requirements of Clause 2.15.8.3... The nameplate shall state that the system shall not be operated without a filter fitted and that a blocked-filter bypass shall not be fitted.				
2.15.7.2	Replacement element type filters				
(a)	Be rated for continuous operation without ignition, smoking or the production of noxious gases				
(b)	Be fitted on the output side of the spark arrester, unless manufactured from non-combustible material				

Clause AS 3584.2-2003	Description	Complies			Comments
		Yes	No	N/A	
(c)	Be fitted with a stainless steel nameplate and marked with the manufacturers name or mark, the replacement element part number and the elements safe operating temperature rating				
(d)	Have either an engine shutdown sensor or a visual indication of a blocked filter				
(e) (i)	Have filter elements that – (i) withstand a temperature greater than the maximum exhaust temperature that may be reached while the exhaust gas cooling circuit device is removed or disabled, or				
(ii)	Have at least two independent sensors so that the DES will stop automatically if the exhaust gas stream temperature becomes hotter than either (A) 50°C below the auto ignition temperature of the filter assembly (B) 25°C below the rated maximum continuous operating temperature of the filter assembly				
	At least one of these sensors shall be installed upstream and one downstream of the filter assembly				
(iii)	are permanently marked with the manufacturers name, mark, part number and rated maximum continuous operating temperature rating.				
2.15.7.3	Filter –ignition temperature measurements Tests to measure rated maximum continuous operating temperature of the filter and filter-auto-ignition temperatures shall be conducted on both new and blocked filter – See H.				
2.15.8	Exhaust emissions				
2.15.8.1	Exhaust Undiluted exhaust gas emissions shall be measured in accordance with Appendix D, before and after any treatment and prior to dilution. Emissions after treatment shall not contain more than....				

Clause AS 3584.2-2003	Description	Complies			Comments
		Yes	No	N/A	
(a)	0.01% (100 ppm) by volume of NO ₂				
(b)	0.09% (900 ppm) by volume of NO				
(c)	0.11% (1100 ppm) by volume of CO				
(d)	0.2% (2000 ppm) by volume of CO while 1% CH ₄ is injected into intake				
2.15.8.2	Gravimetric emissions (gaseous) – in accordance with Appendix D				
2.15.8.3	Smoke Prior to dilution, the smoke shall be measured in accordance with Appendix C, both before and after treatment. After exhaust treatment....smoke shall comply with				
	(a) Duty cycle test – Less than that indicated by figure C1				
	(b) Single point tests – within limits of graph line figure C2				
2 nd paragraph	Test results for untreated exhaust shall be recorded for reference purposes				
2.15.8.4	Test point - shall be provided before and after exhaust treatment device, so that emissions and temperatures in the exhaust system may be measured. (a) as close as possible to the exhaust valves (b)exhaust gas first meets the mine atmosphere (c) before final dilution				
2.16	ELECTRICAL SYSTEMS				
2.16.1	General – electrical system or equipment ... shall be explosion protected and conform to the relevant requirements of AS 4871				
2.16.2	Starter motor current protection Starter motors and associated high current circuits shall be protected by a time-limited thermal protection device that isolates the supply to the starter circuit before the temperature rating of the cable is exceeded.				

Clause AS 3584.2-2003	Description	Complies			Comments
		Yes	No	N/A	
2.16.3	Battery isolator switch Where a storage battery, other than Exia, is employed, an isolator switch shall be installed close to the battery. The isolator shall – (a) to (g)				
2 nd paragraph	Any timed override for initial start and power down shall not operate for more than 100 s.				
3 rd paragraph	Any device employed to automatically open the isolator shall fail to safety				
2.16.4	Connections to the frame, including the engine block Two-wire isolated earth wiring shall be used. ..The electrical system shall be isolated/insulated from the frame of the ..DES				
SECTION 3	MARKING				
3.1	COMPLIANCE PLATE A compliance plate giving the following information shall be provided for each DES, permanently fixed to the system ...				
(a) & (b)	engine system protection rating / designation and date of this standard				
(c) & (d)	approval, certification or registration numbers				
(e), (f) & (g)	Name of manufacturer, date of manufacture and serial number				
(h)	the maximum compound, traverse and longitudinal angles of operation				
(i)	maximum concentrations of undiluted exhaust gasses measured during type testing ...				
3.2	ENGINE SPECIFICATION PLATE A engine specification plate giving the following information shall be provided for each DES, permanently fixed to the system ...				
(a) & (b)	Engine protection rating / designation and date of this standard				

Clause AS 3584.2-2003	Description	Complies			Comments
		Yes	No	N/A	
(c) & (d)	approval, certification or registration numbers				
(e) & (f)	Name of manufacturer and date of manufacture				
(g)	injector timing				
(h)	Fuel pump setting for type testing				
(i) & (j)	low idle speed of the engine / high idle speed of the engine				
(k)	rated power and speed				
(l)	rated torque and speed				
3.3	Warning labels				
2 nd paragraph	Warning labels shall not be manufactured from light metals .				
3 rd paragraph	Every guard and every cover that is fitted to comply with the requirements herein shall have a label that warns against its removal				
4 th paragraph	Labels that provide instructions for safe operation shall be permanently attached.				
SECTION 4	TESTING				
4.1	Type testing – The following information about each new type and model of DES shall be determined				
(a)	engine performance ...				
(b)	the three highest surface temperatures ..(2.3)				
(c)	exhaust emission concentrations and weighted(2.15.8)				
(d)	safety shutdown function and fail to safe operation of sensors .. (2.14.3)				
(e)	any automatic override facilities (2.14.4)				
(f)	the temperature of the exhaust gas stream where it first meets ...				
(g)	the ability of the inlet and exhaust flametraps to prevent propagation ...				

Clause AS 3584.2-2003	Description	Complies			Comments
		Yes	No	N/A	
(h)	hydrostatic test pressures for inlet and exhaust				
4.2	MODIFIED COMPONENTS modifications shall not be made that invalidate the approval ...				
4.3	INSTALLED TESTS BY THE DIESEL ENGINE SYSTEM MANUFACTURER				
1 st paragraph	The integrity, performance and safety of each type-tested engine system shall be confirmed by the				
2 nd paragraph	Where a water-based flametrap is fitted, tests shall be conducted by the manufacturer to ensure the engine exhaust system remains explosion testes at all angles of inclination during operation. The minimum angle is 15 ⁰ , longitudinally and transversely and compound angles also need to be considered.				
4.4	ROUTINE COMMISSIONING TESTS BY THE MANUFACTURER				
4.5	USE of LOW EMISSION FUEL ... after such adjustments, the engine shall be tested by either ..				
4.6	MANAGEMENT SYSTEM Manufacturers shall adopt a traceable management system, to				
SECTION 5	DOCUMENTATION				
5.1	DOCUMENTATION TO BE SUPPLIED				
5.2	GENERAL ARRANGEMENT DRAWINGS				
(a)	General arrangement of the DES, giving overall dimensions and mass				
(b)	A block diagram of the DES that represents the major components and sensor locations with their settings				
(c)	Type and location of each safety device, including part numbers ..				
(d)	The location and principal dimensions of the exhaust system, ...				
(e)	The location and principal dimensions of the inlet system, ...				

Clause AS 3584.2-2003	Description	Complies			Comments
		Yes	No	N/A	
(f)	Location of the cooling radiator, fan and part numbers or				
(g)	The location of each ancillary driven by the engine.				
(h)	Details of the coolant path through the engine and exhaust systems				
(i)	Details of the path of the exhaust gases through the exhaust system ..				
(j)	Schematic diagram, illustrating the function of the safety shutdown system				
(k)	A fuel schematic diagram				
(l)	System specifications including				
(m)	Identifying part numbers for the following				
(n)	Gasket engineering specifications				
(o)	Specification of exhaust filter material, including				
(p)	recommended replacement exhaust filter back pressure				
(q)	identification details of any engine management system required for safe operation of the DES				
(r)	fuel pump, injector engine timing and relevant settings				
(s) to (z)					
APPENDIX B	DETERMINING LOAD-SPEED CHARACTERISTICS				
APPENDIX C	DETERMINING CONSTITUENTS OF EXHAUST GAS				
APPENDIX D	DETERMINING GASEOUS EMISSION LEVELS				
APPENDIX E	DETERMINE DURATION, TEMPERATURE AND FLUID USAGE				
APPENDIX F	TEST ENGINE PROTECTION SYSTEMS (without disposable filters)				
APPENDIX F	TEST ENGINE PROTECTION SYSTEMS (with disposable filters and maximum exhaust back pressure)				
APPENDIX G	TESTING SPARK ARRESTER COMPONENTS				

Clause AS 3584.2-2003	Description	Complies			Comments
		Yes	No	N/A	
APPENDIX H	TESTING PARTICULATE FILTER COMPONENTS				
APPENDIX I	SPECIFICATION FOR MEASURING EQUIPMENT				
APPENDIX J	SPECIFICATION FOR DIESEL FUEL				
APPENDIX L	TESTING SUB-ASSEMBLY COMPONENTS (without disposable filters)				
APPENDIX L	TESTING SUB-ASSEMBLY COMPONENTS (with disposable filters)				
APPENDIX M	HYDROSTATIC TESTING OF INTAKE AND EXHAUST SYSTEMS				
APPENDIX N	IMPACT TESTING OF LIGHT ALLOY PARTS				

I have checked designated diesel engine system, as installed in the vehicle, against 3584.2 2003 and hereby recommend approval be granted

Signed (Design Verifier)

Date

SECTION 8 APPENDICES

8.1 EXPLOSION AND PRESSURE TESTING FOR DES WITH REMOVABLE PARTICULATE FILTERS

1. A pressure transducer is to be installed in the top of the exhaust conditioner or as near as practicable to the exhaust outlet on the exhaust conditioner. This pressure (pressure of the exhaust conditioner) will be recorded for all tests.
2. The engine is to be tested as per AS 3584.2-2003 without the particulate filters installed.
3. The flame propagation test (L7.5 (a)-(d)) is to be repeated with the dirty filters installed. After each explosion, the filters are to be inspected for deterioration, evidence of flame and their condition recorded. Any ignition of gas exterior to the water barrier and before the filter is also to be considered a failure.
4. The pressure determination test L7.4 (g) will be repeated as follows (To simulate maximum back pressure):
 - (a) Block the exhaust pipe either at the exhaust conditioner or directly behind the filter housing.
 - (b) Remove the filters if the exhaust pipe is blocked behind the filter housing.
 - (c) Repeat test L7.4(g).
 - (d) If the recorded pressure in the exhaust conditioner is 230 kPa (350 kPa / 1.5 MOS) or less, then no further testing is required.
 - (e) If the recorded pressure in the exhaust conditioner is greater than 230 kPa then either:
 - (i) The exhaust conditioner is to be hydrostatically tested to 1.5 time the recorded pressure (Appendix M) and NOT to 350 kPa as per Table M1, or alternatively
 - (ii) Repeat test L7.4(g) as follows:
 - Unblock the exhaust pipe
 - Install the filters in a plastic bag, individually. Record type and thickness of bag used.
 - Place filters in filter housing and repeat test L7.4(g).
 - The exhaust conditioner is now to be hydrostatically tested to 1.5 time the recorded pressure or 350 kPa which ever is the greater.
5. Install the dirty filters in the housing when the engine is on the dynamometer. Record back pressure for low idle, high idle, rated power and rated torque. (Appendix E).
6. With the engine running and the dirty filters installed, retest the operation of the primary and secondary sensor in the exhaust conditioner and check the minimum shutdown level is maintained. F6.3.12 (a).