



Diesel Engine Systems for Use in Underground Coal Mines

Additional Requirements – December 2006

Summary

This document seeks to provide additional requirements to;

- AS 3584.1:2005 *Diesel engine systems for underground coal mines Part 1: Fire protected – Heavy duty*, and
- AS 3584.2:2003 *Diesel engine systems for underground coal mines Part 2: Explosion protected*.

These additional requirements are due to industry safety issues that have arisen from incidents associated with:

1. A diesel engine system continuing to run in a methane environment as a result of abnormal combustion following normal shutdown, refer SA05-08 '*Danger of methane explosion from diesel engine systems*'.
2. Overheating engines and people attempting to access engine cooling systems.
3. Excessive exhaust backpressure causing the inability of the engine to shut down on low exhaust conditioner water.
4. Header tank water flow restrictions between the header tank and the exhaust conditioner.

NOTES:

1. All additional requirements in this document were agreed upon by an AS 3584 subcommittee meeting in November 2006.
2. It is anticipated AS 3584.1:2005 and AS 3584.2:2003 will be republished in 2007 and will incorporate the additional requirements specified herein.

The following requirements are to be considered to be incorporated into AS3584.1:2005 and AS 3584.2:2003 from the date of publication of this DPI amendment.

Standards References

The following standards are referenced in this document:

AS 3584.1:2005	<i>Diesel engine systems for underground coal mines - Fire protected - Heavy duty</i>
AS 3584.2:2003	<i>Diesel engine systems for underground coal mines - Explosion protected</i>
AS 4024.1301:2006	<i>Safety of Machinery - Risks assessment - Principles of risk assessment</i>
AS 4024.1501:2006	<i>Safety of Machinery - Design of safety related parts of control systems - General principles</i>
AS 4024.1502:2006	<i>Safety of Machinery - Design of safety related parts of control systems - Validation</i>
AS 5062:2006	<i>Fire protection for mobile and transportable equipment</i>
AS 62061:2006	<i>Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems</i>

Amend. [1] Clause 1.4, ‘DEFINITIONS’

Insert the following new definitions into clause 1.4 of AS 3584.1:2005 and AS 3584.2:2003 as applicable:

‘Strangler valve’

A valve inserted into the intake air stream capable of completely shutting off the supply of intake air to the diesel engine system.

‘Emergency safety shutdown system’

A system fitted to stop the diesel engine in the event of the failure of the other systems to stop the engine.

‘Abnormal combustion’

Unintended or uncontrolled combustion in the engine.

- 1 Abnormal combustion may be caused by induced flammable gas, liquid or vaporised hydrocarbons.
- 2 Abnormal combustion may cause intake flashbacks, high exhaust temperature or high surface temperatures or catastrophic engine failure, engine overspeed and uncontrollable engine running.
- 3 Abnormal combustion may not be apparent to an operator except for a marginal change of power and/or emissions.

Amend. [2] Clause 2.1, ‘DESIGNATED SAFE AREA BARRIER’

Insert the following additional requirement into clause 2.1 of AS 3584.1:2005:

A risk assessment shall be carried out to demonstrate the integrity of the control system.

The risk assessment shall meet the requirements of AS 4024.1301. The control system shall be assessed and validated against the relevant category or safety integrity level in accordance with AS 4024.1501, AS 4024.1502, AS 62061 or other similar standards.

Note: The risk assessment should be in a form which systematically analyses the failure of individual components of the control system. Upon failure of a sensing device, consideration should be given to the rising of an operator alarm or warning, where practicable.

Amend. [3] New clause 2.2b, ‘FIRE SUPPRESSION’

Insert the following new clause into AS 3584.1:2005 after clause 2.2:

2.2b FIRE SUPPRESSION

Where a fire suppression system is fitted it should be installed and tested in accordance with AS 5062.

Amend. [4] Clause 2.13, ‘COOLING SYSTEMS’

Delete the existing clause and insert the following into clause 2.13 of AS 3584.1:2005 and AS 3584.2:2003 as applicable:

Cooling systems shall comply with the following requirements:

- a) The systems shall—
 - (i) be designed to allow the engine to operate satisfactorily in an atmosphere with a minimum ambient temperature of 40°C;
 - (ii) not entrap air within the system; and
 - (iii) safely vent excess pressure to atmosphere.

- b) Each radiator filler and radiator cap shall be so arranged or interlocked so that coolant pressure behind the fill point cap or radiator cap is safely released prior to the cap being able to be removed.
- c) Pressurised coolant systems shall be fitted with a means of checking the level of coolant in the system without the need to remove pressure from the system.
- d) Cooling fans and rotating parts shall be guarded in accordance with AS 4024.1601.

Insert the following additional requirements into AS 3584.2:2003:

- e) Fans and fan assemblies shall be constructed so that sparks are not created, in the event of any part of the fan striking a surrounding or neighbouring object.
- f) Cooling fans manufactured from non-metallic materials shall have an electrical resistance of not more than 1 GΩ, as measured in accordance with AS/NZS 60079.0. Any coating employed to meet this requirement shall include an etching process. Evidence shall be provided to demonstrate the durability and wear resistance of the coating. (NOTE paragraph moved)

Amend. [5] Clause 2.14, ‘ENGINE SHUTDOWN SYSTEMS’

Insert the following new requirements into clause 2.14 of AS 3584.1:2005 and AS 3584.2:2003 as applicable:

2.14.1a General

A risk assessment shall be carried out to demonstrate the integrity of the engine safety shut down systems.

The risk assessment shall meet the requirements of AS 4024.1301. The engine shutdown system shall be assessed and validated against the relevant category or safety integrity level in accordance with AS 4024.1501, AS 4024.1502, AS 62061 or other similar standards.

Note: The risk assessment should be in a form which systematically analyses the failure of individual components of the engine shutdown systems. Upon failure of a sensing device, consideration should be given to the rising of an operator alarm or warning, where practicable.

2.14.1b Emergency Stop System

The engine system shall be fitted with an emergency stop system.

The emergency stop system shall be capable of operation in the event that the automatic safety shutdown system fails to cause the engine system to stop for any reason.

The emergency stop control system shall be designed so that a single fault in the controls shall not lead to the loss of the safety function.

The emergency stop system shall be in accordance with AS 4024.1604.

The emergency stop system may be automatically operated.

In addition to any automatic means of operating the emergency stop system, it shall be capable of manual operation in an emergency. The manual control shall be located so that it can be easily reached by the operator (driver) of a vehicle or machine fitted with an explosion-protected diesel engine system. The manual control shall be clearly identified and labelled. Gas systems shall not rely on the operator to continually hold down the emergency stop device to discharge the gas. Consideration shall be given to providing additional gas to shut down the engine on a second occasion in an emergency situation.

The emergency stop system shall be capable of being tested independently of all other engine stopping systems.

Any stored pressure inert gas system fitted to meet the requirements of this clause shall have sufficient gas to stop the engine before the gas is expended.

The operation of the emergency stop system shall be tested. (See amendment 14, clause F6.3.7b.)

Notes:

1. A strangler valve may meet this requirement.
 - a) Care should be taken in the selection of a strangler valve to ensure that it will seal under vacuum conditions. (Many commercial valves may be rated for high pressure but leak under relatively low vacuum conditions). A sudden vacuum applied in the inlet systems of some engine types may cause valve stem seal to become displaced or other failures. The original engine manufacturer should be consulted. For such an engine, a partial sealing strangler valve may need to be combined with other means of ensuring a complete engine stop in an emergency.
 - b) Consideration should be given to the speed of operation of strangler valves. Sudden operation may cause engine damage.
2. An inert gas injection system may meet this requirement.
3. Care should be taken in the selection of any inert gas employed to ensure;
 - a) The gas does not form chemicals under diesel combustion temperatures and pressures that may be poisonous or a carcinogen.
 - b) The temperature of the gas is not so cold that it may cause catastrophic failure of engine components when injected.

Amend. [6] Clause 2.14.2, ENGINE SHUTDOWN SYSTEMS – ‘Manual fuel shut-off valve’

Delete the existing clause and insert the following into clause 2.14.2 of AS 3584.1:2005 and AS 3584.2:2003 as applicable:

The manual fuel shut-off valve shall be clearly identified and labelled including operating instructions. The label shall be as close as practicable to the valve.

In addition, the physical location of the valve shall be clearly indicated by a second label readily visible to the operator (driver) of any vehicle to which an explosion-protected engine system is fitted.

The manual fuel shutoff valve should be connected into the fuel system after all supply (lift) pumps and filters to minimise the time required to shutdown the engine system after operation of the valve.

The operation of the manual fuel shutoff valve shall be tested. (See Paragraph F6.3.7.)

Note: The connection of ‘fuel return’ lines to the fuel tank or filters from the injection pump may require the fitment of check valves to ensure that, when the manual fuel shutoff valve is closed (non-passing), flow cannot reverse in ‘fuel return’ lines causing the engine to continue to run.

Amend. [7] Clause 2.14.4, ENGINE SHUTDOWN SYSTEMS – ‘Engine start and restart’

Insert the following additional requirements into clause 2.14.4 of AS 3584.1:2005 and AS 3584.2:2003 as applicable:

Following any manual operation of the emergency stop system, the system shall be required to be deliberately and manually reset before the engine may be re-started or run.

Amend. [8] Clause 2.15.4.3, ENGINE SHUTDOWN SYSTEMS – Exhaust flametrap – ‘Water based flametraps’

Insert the following additional requirement into clause 2.15.4.3 of AS 3584.2:2003

Where water based flametraps utilise make up water from another vessel during operation, then water shall flow between the makeup tank and the water cooling system under each of the following conditions when tested in accordance with amendment 15, clause F6.3.15:

- a) exhaust restriction;
- b) exhaust back pressure;
- c) any grade of operation.

Amend. [9] Clause 2.15.6.1, ENGINE SHUTDOWN SYSTEMS – Exhaust cooling systems – ‘General’

Insert the following additional requirement into clause 2.15.6.1 of AS 3584.2:2003:

Where water based exhaust cooling systems utilise make up water from another vessel during operation, then water shall flow between the makeup tank and the water cooling system under each of the following conditions when tested in accordance with amendment [15], clause F6.3.15:

- a) exhaust restriction;
- b) exhaust back pressure;
- c) any grade of operation

Amend. [10] Clause 4.1, ‘TYPE TESTING’

Insert the following new requirements at the end of clause 4.1(d) in AS 3584.1:2005 and AS 3584.2:2003:

- The operation of the emergency stop system shall be tested to ensure proper functioning.

Insert the following new requirements at the end of clause 4.1(d) in AS 3584.1:2005:

- Fire suppression initiated engine shutdown.

Amend. [11] Clause 4.3, ‘INSTALLED TESTS BY THE DIESEL ENGINE SYSTEM MANUFACTURER’

Insert the following additional requirement into clause 2.15.6.1 of AS 3584.2:2003:

Where water based flame traps or water based exhaust cooling system utilise make up water from another vessel during operation then the system shall be tested in accordance with amendment 15, clause F6.3.15.

Amend. [12] Clause 5.2, ‘GENERAL ARRANGEMENT DRAWINGS’

Insert the following new requirements into clause 5.2 in AS 3584.1:2005 and AS 3584.2:2003:

- The location and specifications of any devices related to the functioning of the emergency stop system.

Amend. [13] Clause F6.3.6, PROCEDURE – Protection system tests – ‘Particulate filter’

Insert the following additional requirement at the end of clause F6.3.6 of AS 3584.2:2003:

The exhaust conditioner floats shall be tested to ensure they shut down the diesel engine system by progressively restricting the exhaust backpressure to a point where,

- a) the particulate filter bypass operates (if fitted), or
- b) the point just before the device, referred to in Clause 2.15.7.1 paragraph 2 operates, or
- c) the engine loses significant power or stalls.

Amend. [14] New Clause F6.3.7b, PROCEDURE – Protection system tests – ‘Emergency stop system’

Insert the following new clause F6.3.7b into AS 3584.1:2005 and AS 3584.2:2003:

The emergency stop system shall cause the diesel engine system to stop in the event that the automatic system and the manual fuel shutoff valve should fail for any reason. The emergency stop system shall be tested independently of all other systems.

The operation of the emergency stop system shall be tested at:

- a) low idle;
- b) rated power; and
- c) high free idle.

The time taken from initiation until the engine stops shall be recorded for each test.

For any system including a strangler system, tests shall be undertaken to ensure that the emergency stop system shall be manually and deliberately reset after any manual operation before the engine can be re-started or run.

For any stored pressure, inert gas type system;

- (i) Tests shall be undertaken to ensure that the engine can be stopped at rated power before the stored gas is expended. The number of stops achieved at rated power shall be recorded.
- (ii) The temperature of the gas immediately before it enters the inlet manifold shall be measured during testing and the lowest temperature shall be recorded.

Amend. [15] New Clause F6.3.15, PROCEDURE – Protection system tests – ‘Header tank water flow’

Insert the following new clause at the end of F6.3 of AS 3584.2:2003:

‘Header tank water flow’

Where applicable, the procedure to confirm that makeup water flows from a header tank to an exhaust conditioner or exhaust cooling system is as follows:

- a) Set the water level in header tank at minimum.
- b) Incline the machine to worse condition as far as flow from the header tank into the exhaust conditioner or exhaust cooling system is concerned.
- c) Provide a means to observe whether water is flowing from the header tank into the exhaust conditioner or exhaust cooling system.
- d) Run the engine at flight revs.
- e) Restrict engine exhaust to the maximum pressure recommended by the manufacturer.
- f) Observe that water continuous to flow into the conditioner to make up water removed from exhaust flow.

- g) Increase the restriction on the exhaust system to the maximum that may occur in-service or 150% of that recommended by the manufacturer, which ever is the greater.
- h) Observe that water continuous to flow into the conditioner to make up water removed from exhaust flow.