

Australian/New Zealand Standard™

## Diesel engine systems for underground coal mines

### Part 3: Maintenance



### **AS/NZS 3584.3:2012**

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee ME-018, Mining Equipment. It was approved on behalf of the Council of Standards Australia on 17 January 2012 and on behalf of the Council of Standards New Zealand on 20 October 2011.

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The following are represented on Committee ME-018:

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Construction and Mining Equipment Industry Group  
Department of Industry and Investment NSW  
Department of Labour New Zealand  
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*This Standard was issued in draft form for comment as DR AS/NZS 3584.3.*

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# Australian/New Zealand Standard™

## Diesel engine systems for underground coal mines

### Part 3: Maintenance

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## PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee ME-018, Mining Equipment, to supersede AS/NZS 3584.3:2005.

This Standard is part of a series on diesel engine systems for underground coal mines, as follows:

### AS/NZS

3584 Diesel engine systems for underground coal mines

3584.1 Part 1: Fire protected—Heavy duty

3584.2 Part 2: Explosion protected

3584.3 Part 3: Maintenance (this Standard)

The objective of this Standard is to control risks to the health and safety of people from the use of diesel engine systems in underground coal mines by providing requirements and guidance for maintaining the safety and integrity of diesel engine systems.

The objective of this revision is to respond to numerous incidents in underground coal mines where maintenance has been a contributing factor, by providing further guidance for additional requirements and maintenance processes.

Major changes to this revision are as follows:

- (a) Additional requirements for establishing maintenance management systems.
- (b) Additional requirements for maintenance procedures.
- (c) New section covering marking and traceability.
- (d) New option for overhaul, Code D examination or repairs to be done in recognized service facilities (see Appendix A).
- (e) New guidance for competence and training (see Appendix B).
- (f) Additional recommendations for coded maintenance (see Appendix E).

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

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## STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

**Australian/New Zealand Standard****Diesel engine systems for underground coal mines****Part 3: Maintenance**

## SECTION 1 SCOPE AND GENERAL

**1.1 SCOPE**

This Standard specifies requirements and recommendations for examining, servicing, maintaining, repairing, overhauling, modifying and testing diesel engine systems including those that comply with AS/NZS 3584.1 and AS/NZS 3584.2, for use in underground coal mines to ensure diesel engine systems remain safe to use (i.e. in an explosion-protected or fire-protected condition) over their life cycle.

NOTE: Appendices in this Standard cover the following:

- (a) Recognized service facilities (see Appendix A).
- (b) Training and competencies (see Appendix B).
- (c) Requirements for hydrostatic testing (see Appendix C).
- (d) Undiluted exhaust emission testing (see Appendix D).
- (e) Examples of coded maintenance (see Appendix E).

**1.2 APPLICATION**

This Standard is intended for use by all service facilities and personnel engaged in examining, servicing, maintaining, repairing, overhauling, modifying and testing diesel engine systems, including the following:

- (a) Manufacturers undertaking examining, servicing, maintaining, repairing, overhauling, modifying and testing of diesel engine systems originally manufactured by themselves or others.
- (b) Service organizations undertaking examining, servicing, maintaining, overhauling, modifying and testing diesel engine systems manufactured by others.
- (c) The users of diesel engine systems undertaking examining, servicing, maintaining, overhauling, modifying and testing.
- (d) Agents and importers of diesel engine systems undertaking examining, servicing, maintaining, overhauling, modifying and testing.

**1.3 NORMATIVE REFERENCES**

The following are the normative documents referenced in this Standard:

NOTE: Documents referenced for informative purposes are listed in the bibliography.

|      |                                                                                                   |
|------|---------------------------------------------------------------------------------------------------|
| AS   |                                                                                                   |
| 1014 | Gauging of metric screw threads                                                                   |
| 1554 | Structural steel welding (all parts)                                                              |
| 3501 | Parallel screw threads of Whitworth form (BSW and BSF) and associated gauges and gauging practice |

## AS

3635 Unified (ISO inch) screw threads, associated gauges, and gauging practice

## AS/NZS

2290 Electrical equipment for coal mines—Introduction and maintenance

2290.1 Part 1: For hazardous areas

3584 Diesel engine systems for underground coal mines

3584.1 Part 1: Fire protected—Heavy duty

3584.2 Part 2: Explosion protected

3800 Electrical equipment for explosive atmospheres—Repair and overhaul

4871 Electrical equipment for coal mines, for use underground

4871.6 Part 6: Diesel powered machinery and ancillary equipment

ISO 17020 General criteria for the operation of various types of bodies performing inspection

## ISO

9001 Quality management systems—Requirements

## IEC

60079 Explosive atmospheres

60079-14 Part 14: Electrical installations design, selection and erection (IEC 60079.14, Ed. 4.0 (2007) MOD)

60079-17 Part 17: Electrical installations inspection and maintenance (IEC 60079.17, Ed. 4.0 (2007) MOD)

60079-19 Part 19: Equipment repair, overhaul and reclamation

## ISO/IEC

Guide 65 General requirements for bodies operating product certification systems

## MP

87 Australian/New Zealand Certification Scheme for explosion-protected electrical equipment (ANZEx Scheme)

87.2 Part 2: Recognized Service Facilities Program—Basic rules and procedures

## 1.4 DEFINITIONS

### 1.4.1 General

For the purpose of this Standard, the definitions below apply.

### 1.4.2 Assessment body

- 1 An organization accredited by JAS-ANZ as a conformity assessment body for the overhaul, repair or modification of diesel engine systems.
- 2 A government-recognized assessment body, established by a memorandum of understanding (MOU), gazetted notice or published specification within the jurisdiction of the issuing regulator.

### 1.4.3 Certification documents

The documents required by the statutory or certifying authority in order to independently audit the results of tests and inspections, so as to ensure compliance with relevant Standards and legislation, resulting in the issue of documentation that indicates compliance.

NOTE: Certification documents may include approval, design registration and compliance/certificate of conformity documents, and may also include conditions.

#### 1.4.4 Competent person

A person who can demonstrate a combination of knowledge, skills and competencies to effectively, efficiently and safely carry out the activities described in this Standard.

#### 1.4.5 Design registration number

An identification number used by regulators to identify a type of design for a diesel engine system.

NOTE: Paragraph E6.2, Appendix E, provides guidance for information to be provided to the regulator for mine design registration.

#### 1.4.6 Diesel engine system

A diesel engine and its—

- (a) inlet systems;
- (b) exhaust systems;
- (c) cooling systems;
- (d) starting systems;
- (e) engine safety shutdown and protection systems;
- (f) electrical or electronic devices, including engine management systems, sensors, injectors, alternators, batteries and wiring, and other ancillary equipment attached to or driven by the engine—
  - (i) including systems that start the engine and are associated with the engine operation or engine control; but
  - (ii) excluding equipment driven from the output side of the engine flywheel.

#### 1.4.7 Diesel engine system documentation

The documentation, including drawings provided by the manufacturer to the purchaser, providing all of the information required by AS/NZS 3584.1 and AS/NZS 3584.2 and the manufacturer's maintenance information as set out in Clause 2.2.

#### 1.4.8 Emergency stop system

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

#### 1.4.9 Engine safety shutdown system

A protection system that automatically causes an engine to stop when an unsafe condition occurs.

#### 1.4.10 Ex

A general term applying to explosion-protected equipment, components, systems and apparatus.

#### 1.4.11 Examination

Activities relating to the inspection and testing of a diesel engine system, which determine the safety of the system.

#### 1.4.12 Exhaust emissions

Gaseous and particulate pollutants emitted from the exhaust of a diesel engine system.

NOTES:

- 1 Gaseous emissions includes carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), nitric oxide (NO), nitrogen dioxide (NO<sub>2</sub>), and NMHCs (non-methane hydrocarbons).
- 2 Particulate emission includes elemental carbon (EC), organic carbon (OC), and other trace materials including metals, sulfates, minerals and nitrates.

#### 1.4.13 Fire protection

Design features, when taken together, that prevent the diesel engine system from igniting flammable material or substances.

NOTES:

- 1 Such features are not intended to prevent the ignition of flammable or explosive gas.
- 2 AS/NZS 3584.1 specifies requirements for fire-protected diesel engine systems.

#### 1.4.14 Gap (diametral clearance)

- 1 Distance between the corresponding surfaces of a flameproof joint when the equipment has been assembled.
- 2 For cylindrical surfaces, the difference between the diameters (diametral clearance) of the bore and the cylindrical component.

#### 1.4.15 Hazardous area

An area where, during the normal course of events, there is a possibility that there may be an accumulation of flammable or explosive gas, which might create a hazard for the operation, servicing or maintenance of a diesel engine system.

NOTE: Legislation for underground coal mines may define certain parts of the mine as hazardous areas or places, such as explosion risk zones.

#### 1.4.16 High idle speed

Maximum governed rotational frequency of an engine, with minimal output power from the engine and the ancillary equipment.

#### 1.4.17 Item registration number

An identification number used by regulators to confirm that a diesel engine system has been safety-checked in accordance with the applicable Standard and is safe for use.

NOTE: Paragraph E6.2, Appendix E, provides guidance for information to be provided to the regulator for mine item registration.

#### 1.4.18 Low idle speed

Minimum governed rotational frequency of an engine, with minimal output power from the engine and the ancillary equipment.

#### 1.4.19 Maintenance

Combination of any actions carried out to retain a diesel engine system in, or restore it to, a condition in which it is able to meet the requirements of the relevant specification and perform its required functions.

#### 1.4.20 Modification

Work that may be undertaken to vary, change or modify any part, component or assembly that forms a part of a diesel engine system and which affects material, fit, form or function and which may affect the safe operation of the system.

#### 1.4.21 Owner

A company or person that owns or otherwise has control of the diesel engine system.

#### 1.4.22 Overhaul

Work that returns a diesel engine system to a serviceable and safe condition, requiring a considerable degree of dismantling and re-assembly or the replacement of major engine components or parts.

#### 1.4.23 Rated power

The maximum continuous output power at rated speed of an engine, as determined by the testing authority.

#### 1.4.24 Rated speed

The rotational frequency of the engine while producing rated power.

#### 1.4.25 Recognition identifier

A unique combination of letters and numbers that clearly identify the assessment body and the recognized service facility.

NOTE: It is important to identify both the assessment body and the recognized service facility so that it is clear who did the actual work on the Ex equipment and who recognized the service facility, so that both can be included in a consultative feedback loop.

#### 1.4.26 Recognized service facility

An organization that is recognized by an assessment body as having the premises, tools, equipment, instruments, management systems, quality systems, work processes and competencies to examine, service, maintain, overhaul, modify and test diesel engine systems, which is situated at its stated location or stated locations and issues reports of such work in conformance with this Standard and undertakes all obligations in that connection.

NOTES:

- 1 The organization may have restrictions on the type of equipment or components that will be covered by their scope.
- 2 The organization may have the capacity to undertake work at remote locations (e.g. on mine sites or in mines), provided management, quality, documentation and competency systems are designed and audited to demonstrate that capacity.

#### 1.4.27 Repair

Restoration of the diesel engine system back to an operational condition, which does not include routine maintenance, replacement or modification.

#### 1.4.28 Responsible person

A person(s) who can demonstrate competence to effectively carry out and supervise overhaul, Code D examination or repair activities of a diesel engine systems and who is (are) responsible for the overall processes involved in those activities, including the verification and endorsement of reports generated by a service facility.

NOTES:

- 1 The service facility may be a recognized service facility (see Clause 3.2.7.1).
- 2 This definition is consistent with IEC 60079-19.

#### 1.4.29 Safety critical system/component

A system or component whose failure or malfunction may increase the risk of injury or damage to health.

#### 1.4.30 Service

Work that maintains equipment in a serviceable condition (e.g. checking and filling lubricants, fuel and water).

#### 1.4.31 Statutory authority

The government department that administers Acts and regulations pertaining to coal mines in which a diesel engine system operates.

## SECTION 2 MAINTENANCE MANAGEMENT SYSTEM

### 2.1 GENERAL

A maintenance management system shall be established and maintained by the owner of the diesel engine system. This maintenance management system shall identify all lifecycle maintenance activities that are required for the diesel engine system to remain in—

- (a) a safe condition to use (that is, in an explosion-protected or fire-protected condition over its life cycle);
- (b) compliance with the certification documents and diesel engine system documentation;
- (c) compliance with AS/NZS 3584.1 and AS/NZS 3584.2 and this Standard, as applicable; and
- (d) a condition that minimizes harmful exhaust emissions being emitted into the environment.

The maintenance management system shall be developed by a competent person(s) (see Clause 1.4.4) using a risk management process.

NOTE: See AS/NZS ISO 31000.

Consideration shall be given to—

- (i) the information provided by the manufacturer (see Clause 2.2);
- (ii) site-specific conditions;
- (iii) the intended application; and
- (iv) duty cycle of the diesel engine system.

NOTE: Depending on the proposed duty cycle and intended operating environment, the maintenance management system may need to be more stringent than that specified by the manufacturer.

The maintenance management system shall be documented and auditable.

The maintenance management system shall include maintenance procedures for maintenance activities. As a minimum, the procedures shall be in accordance with Section 3.

NOTES:

- 1 The maintenance management system for diesel engine systems should be integrated into the owner's health and safety management system (or equivalent).
- 2 The diesel engine maintenance management system should be incorporated into the mine's mechanical engineering management plan.

## 2.2 MAINTENANCE INFORMATION TO BE PROVIDED BY MANUFACTURER TO PURCHASER

For the purpose of AS/NZS 3584.1 and AS/NZS 3584.2, the maintenance documentation provided by the manufacturer to the purchasers shall include, but not be limited to, the following:

- (a) Maintenance instructions that ensure the diesel engine system remains in a safe condition to use over its life cycle.
- (b) Identification of all safety features, warning devices and components that are critical to the safe use of the diesel engine system, including but not limited to the following:
  - (i) Control circuits, including sensing devices, control valves, hoses, etc.
  - (ii) Explosion-protected joints.
  - (iii) Emergency stop systems.
  - (iv) Engine safety shutdown systems and devices.
  - (v) Electrical systems and devices.
  - (vi) Flametraps, spark arrestors and devices fitted to manage exhaust emissions.
  - (vii) Cooling systems.
  - (viii) Structural components critical to the safe operation of the system.
  - (ix) Engine components.
- (c) The systematic inspection, examination or testing that is to be carried out on all safety features, warning devices and safety critical components on the diesel engine system.
- (d) The maintenance information that identifies nominal component life or the required intervals for replacement of all safety critical components, as applicable.
- (e) A coded maintenance program that identifies the recommended frequency and recommended maintenance activities for each specified period, in accordance with Clause 3.2.  
NOTE: Examples of coded maintenance are given in Appendix E.
- (f) Safe work procedures required for maintaining the diesel engine system.
- (g) Guidance as to the diesel engine system specific training recommended to safely maintain the diesel engine system.
- (h) Flatness tolerance, surface finish and service limits (minimum thickness) for machined surfaces.

## 2.3 ELEMENTS OF THE MAINTENANCE MANAGEMENT SYSTEM

The maintenance management system shall include all of the following elements:

- (a) Periodic examination, testing and maintenance of all safety features (safety critical components).  
NOTE: Clause 3.2 and Clause 3.5 set out requirements for the maintenance regime.
- (b) Safe work procedures.
- (c) Competence of maintenance personnel.
- (d) Supervision requirements.
- (e) Facilities required to perform the required tasks.
- (f) Reporting and rectification of defects (see Clause 3.8).
- (g) Monitoring, auditing and reviewing requirements.

## 2.4 SAFETY FILE

Life cycle safety-related aspects of the diesel engine system shall be fully documented. The records shall be maintained in a diesel engine safety file that includes the entire service life of the system.

A safety file for each diesel engine system shall be initiated by the manufacturer and shall be maintained by the owner.

The safety file shall remain with the current owner of the diesel engine system. If ownership changes, the safety file shall be transferred to the new owner.

The safety file shall include (but not be limited to) the following information:

- (a) Information provided by the manufacturer of the engine system as specified in Clause 2.2, AS/NZS 3584.1 and AS/NZ 3584.2.
- (b) Certification documents, diesel engine system documentation, schedules, any special conditions and service manuals.
- (c) Identification of all safety critical systems and their safety category or integrity level.  
NOTE: Requirements for engine shutdown systems are given in AS/NZS 3584.1 and AS/NZS 3584.2.
- (d) Commissioning and test results.
- (e) Competent person's report/decisions, as applicable.
- (f) Coded maintenance records and results, including the following:
  - (i) Code B and Code C records kept for at least 2 years. Where the owner is different to the user, the user shall keep records of Code B and Code C.
  - (ii) Code D examinations kept for the life of the diesel engine system, including 'responsible person' reports.
- (g) Diesel emission tests and results.
- (h) Audit and review reports.
- (i) Details of defects and damage to the engine.
- (j) Modifications to the diesel engine system and documentation associated with the modification (see Clause 3.7).
- (k) Electrical or mechanical certifications, test certificates, registrations, as applicable.
- (l) Calibration or verification certificates (see Clause 3.5.3.4).
- (m) Training records for evidence of competent people.

### NOTES:

- 1 The safety file records should be stored and maintained in such a way that they are readily retrievable and protected against damage, deterioration or loss.
- 2 Guidance for manufacturers, suppliers employers and users of machinery on how to reduce the risks of working with, or near, machinery is given in the AS 4024 Series.
- 3 A diesel engine safety file may not necessarily be one complete document, but may refer to where the information can be obtained.

## SECTION 3 MAINTENANCE PROCEDURES

### 3.1 ESTABLISHMENT OF PROCEDURES

When establishing maintenance procedures, consideration shall be given to the following:

- (a) The operating conditions in the mine.
- (b) The duty cycle of the diesel engine system.
- (c) The manufacturer's recommendations.
- (d) The history of the engine system.
- (e) Any statutory requirements.
- (f) The potential (or likelihood, or risk) of a fire or explosion in the event of a failure of the diesel engine system.
- (g) The condition of the diesel engine system.
- (h) A coded maintenance regime in accordance with Clause 3.2.

### 3.2 CODED MAINTENANCE

#### 3.2.1 Description

Systematic inspection examination or testing processes and procedures, to verify that the engine remains in a safe condition for use, shall be developed and implemented. This shall include, but not be limited to, the following:

- (a) *Routine safety checks* Pre-start inspection.
- (b) *Code A* Daily visual examination and routine tests.
- (c) *Code B* Routine maintenance to maintain ongoing safe operation and function of the engine system.
- (d) *Code C* Routine servicing, maintenance and testing to maintain ongoing reliability and safety.
- (e) *Code D* Establishing the integrity and safety of components and the entire diesel engine system. This may require dismantling parts of the system. Some testing of the system is required.

#### NOTES:

- 1 Examples of typical routine safety checks and Code A to Code D maintenance schedules are given in Appendix E.
- 2 This Standard recognizes that some electrical and electronic devices may be integral to the function, operation and safety of a diesel engine system and that these devices may be explosion protected. All such Ex devices are required to be repaired or overhauled by appropriate electrical service facilities in accordance with relevant electrical Standards and schemes. Such facilities may be required to be licensed, registered or certified by the statutory authority.
- 3 It is intended that the entire diesel engine system be verified at a Code D and activities required to verify the safety and compliance of electrical and electronic devices be undertaken at the same time and in coordination with work to ensure the safety and compliance of the diesel engine system. Reports relating to electrical compliance should be attached to the mechanical systems reports.

### 3.2.2 Frequency

The maintenance management system shall nominate appropriate frequencies for inspections, examinations or tests to be undertaken to keep a diesel engine system in a safe operating condition. Consideration shall be given to the probable or reasonable frequency of any fault occurring.

**NOTES:**

- 1 By reason of the widely varying (operational) conditions and duty cycles under which a diesel engine system may operate, it is not always possible to nominate intervals between examinations. The frequency of activities undertaken may be based on engine operating hours. For engine systems that do not operate for extended periods, or that otherwise only operate intermittently, activity frequencies may be more appropriately determined by time periods.
- 2 Where pre-Code D examinations indicate faults in the system, the frequency may be reduced. Where pre-Code D examinations indicate a compliant system, this may provide justification for extending Code D examinations.
- 3 Table 3.2.2 gives guidance on establishing a program for frequency of examinations.

**TABLE 3.2.2**  
**SUGGESTED FREQUENCY OF EXAMINATIONS**

| Maintenance examination | Suggested frequency<br>(for confirmation or variation by the operator) |
|-------------------------|------------------------------------------------------------------------|
| Code A                  | Daily                                                                  |
| Code B                  | Weekly                                                                 |
| Code C                  | Monthly                                                                |
| Code D                  | Two-yearly                                                             |

### 3.2.3 Routine safety check

NOTE: Guidance on pre-start inspections and checks is given in Paragraph E2, Appendix E.

### 3.2.4 Code A

NOTE: Guidance on Code A examination and test is given in Paragraph E3, Appendix E.

### 3.2.5 Code B

NOTE: Guidance on Code B examination and test is given in Paragraph E4, Appendix E.

### 3.2.6 Code C

NOTE: Guidance on Code C examination and test is given in Paragraph E5, Appendix E.

Code C maintenance examinations shall include, but not be limited to, the following:

- (a) Examination of the diesel engine system in accordance with Code A and Code B,
- (b) All external (accessible) open joints (flamepaths) to be checked to the manufacturer's specification for a maximum gap.
- (c) All external (accessible) fixed connections to be tested for gas tightness in a manner recommended by the manufacturer.
- (d) All engine safety shutdown systems are operating correctly so as to detect an unsafe condition before failure.

NOTE: Exhaust emissions should be tested (see Clause 3.3).

### 3.2.7 Code D

NOTE: Guidance on Code D examination and test is given in Paragraph E6, Appendix E.

#### 3.2.7.1 Service facility

Any overhaul, Code D examination or repair of a diesel engine system shall be undertaken by—

- (a) a service facility having the competent persons (refer Clauses 4.2.1 and 4.2.3), management systems and facilities meeting requirements specified by a competent person; or
- (b) a recognized service facility meeting the requirements of Appendix A.

NOTE: The statutory or certifying authority may require that a Code D maintenance be conducted by a recognized service facility.

#### 3.2.7.2 Examinations

Code D overhauls shall not be carried out unless the relevant certification documents and diesel engine system documentation is held by the facility carrying out the work.

Code D overhauls shall include, but not be limited to, the following:

- (a) Examination of the diesel engine system in accordance with Code A, Code B and Code C.
- (b) The fuel pump to be set to the manufacturer's specification.
- (c) Disassembling of all external connections (fixed connections and open joints) and checking of the flamepath faces for flatness, surface finish, corrosion or damage. Conformance of all surface finishes to the surface finish and flatness tolerances as nominated in the diesel engine system documentation.

Where no tolerances are specified on diesel engine system documentation, the flatness tolerance and surface finishes shall be in accordance with Clause 3.5.4.2 and Clause 3.5.4.3.

- (d) All explosion-protected components to be hydrostatically tested (including gas paths and water jackets), so as to be assured of their integrity, including, but not limited to—
  - (i) inlet manifold;
  - (ii) inlet flametrap assembly;
  - (iii) exhaust manifold;
  - (iv) exhaust adaptor pipe assembly;
  - (v) exhaust conditioner (wet flametrap);
  - (vi) exhaust flametrap (dry); and
  - (vii) exhaust gas treatment devices.

Hydrostatic testing shall be carried out in accordance with Appendix C.

- (e) All gaskets and sealing materials used on fixed connections and open joints to be replaced using parts specified by manufacturer on the diesel engine system documentation.
- (f) On re-assembly, the diesel engine system to be run at sufficient load so as to heat the coolant system to the maximum temperature achievable under full load. The external surfaces on the complete engine to be scanned so as to determine and measure the maximum surface temperature.

NOTE: Manufacturer's recommendations should be sought on suitable means to achieve this condition without causing damage to other drive components.

- (g) Surface temperatures to be within reasonable tolerances of the information provided on the diesel engine system documentation and no greater than 150°C.
- (h) Consideration to be given to published design modifications by the manufacturer.
- (i) The operation of the entire engine shutdown systems, including the following:
  - (i) Operation of the entire automatic safety shutdown system, as set out by AS/NZS 3584.1 and AS/NZS 3584.2 or to the manufacturer's instructions, provided that the system integrity and sensor trip points are confirmed.
  - (ii) Operation of the emergency stop system in accordance with Clause 3.2.7.4, and the time taken from initiation until the engine stops to be recorded.
  - (iii) Operation of the manual fuel shut-off valve, and the time taken from initiation until the engine stops to be recorded.
- (j) Overhaul or replacement of safety critical components in the engine shutdown systems in accordance with Clause 3.2.7.3.
- (k) The calibration or verification of sensors (see Clause 3.5.3).
- (l) Carrying out repairs and replacing safety critical parts in accordance with Clause 3.6.

#### **3.2.7.3 Engine shutdown systems**

All safety critical components that are essential to the operation of the automatic shutdown system or emergency stop system shall be replaced or overhauled at intervals recommended by the manufacturer. Where there is no recommendation from the manufacturer, all such components shall be overhauled or replaced as specified for Code D, unless stated otherwise by a competent person.

#### **3.2.7.4 Emergency stop device**

The emergency stop device shall be tested at high free idle. The time taken from initiation until the engine stops shall be recorded in accordance with the manufacturer's instructions and diesel engine system documentation.

### **3.3 DIESEL EXHAUST EMISSIONS**

Maintenance procedures shall include means to manage diesel engine exhaust emissions including, but be not limited to, the following:

- (a) The establishment of a baseline signature on raw and undiluted exhausts emissions when the diesel engine system is in an 'as new' condition.
- (b) Monitoring of exhaust emission generation over the diesel engine's life cycle, by regularly testing, analysing and monitoring of exhaust emissions (raw and undiluted).
- (c) Good maintenance practices that minimize exhaust emissions being generated.
- (d) Good maintenance of exhaust emission curtailment system.
- (e) Testing of exhaust emissions following a Code D examination.

#### **NOTES:**

- 1 Monitoring of diesel engine emissions provides a good basis for trending the condition of the engine.
- 2 Testing of exhaust emissions should be carried out monthly.
- 3 Further guidance is given in Appendix D of this Standard, MDG 29 and AS/NZS 3584.2.
- 4 The statutory authority may have specific requirements for diesel engine exhaust testing.

### 3.4 PLACES OF WORK

#### 3.4.1 General

Examinations should be carried out at a place that is safe and suitable for the examination to be undertaken. Consideration should be given to—

- (a) the floor (e.g. flat, level, non-slip);
- (b) the illumination, which should be adequate for the task; and
- (c) the ventilation, to ensure adequate dilution of any exhaust fumes.

#### 3.4.2 Service

Service work shall not be undertaken in a hazardous area, hazardous zone or explosion risk zone.

NOTE: This does not prohibit a broken down diesel engine system being repaired for recovery under controlled conditions.

### 3.5 SPECIFIC CHECKING

#### 3.5.1 Regular safety checks

Regular safety checks shall be carried out with sufficient detail so that the engine system will operate in a safe condition. They shall be incorporated in the coded maintenance system.

The proper operation of the engine safety shutdown systems, including the automatic safety shutdown system and its sensing devices (e.g. conditioner safety systems, low engine oil pressure systems, coolant loss systems), manual fuel shut-off valve and emergency stop systems shall be verified in accordance with the manufacturer's instructions.

The operation of the entire automatic safety shutdown system, the emergency stop system and the manual fuel shut-off valve shall be tested not less frequently than specified for Code D.

#### 3.5.2 Electrical

##### 3.5.2.1 *Electrical systems*

Electrical systems shall be subjected to examinations as required by IEC 60079-19, AS/NZS 3800, AS/NZS 2290.1 and AS/NZS 4871.6. These examinations shall be undertaken by workshops meeting the requirements of MP 87.2.

##### 3.5.2.2 *Software*

Where a manufacturer provides revisions to software code, including patches, that improve the integrity and reliability of engine management systems or engine protection systems, they should be incorporated.

Where revisions to software code modify the diesel engine system, including patches that may change the safety, the requirements of Clause 3.7 shall apply.

NOTES:

- 1 A code meeting the requirements and protocols of SAE J1939 should be employed.
- 2 For guidance on the functional safety of programmable systems, see AS 62061.

#### 3.5.3 Calibration or verification of sensors

##### 3.5.3.1 *General*

All sensing devices nominated on the certification documents and diesel engine system documentation shall be regularly tested and, when required, routinely calibrated or verified to ensure correct operation.

The quality processes associated with the calibration of test instruments and the procedure for calibration of sensing devices shall be contained within a quality management system based on the principles of AS/NZS ISO 9001. Documented procedures shall be developed for the calibration of sensors using, when available, manufacturer's recommendations and statutory requirements.

NOTES:

- 1 Guidance on calibration and verification can be found in Handbook HB 86.1.
- 2 It is preferable that the calibration or verification of sensors be conducted through a service facility meeting the requirements of Clause 3.2.7.1 or an accredited NATA laboratory.
- 3 The quality management system need not be certified to AS/NZS ISO 9001.

Copies of calibration or verification certificates shall be supplied to the end user and a record of calibration or verification shall be maintained in the diesel engines safety file.

### **3.5.3.2 Calibration or verification intervals**

The maximum calibration or verification intervals shall be the minimum of—

- (a) the statutory authorities requirements (e.g. methanometers);
- (b) the manufacturer's requirements; or
- (c) at each Code D overhaul.

### **3.5.3.3 New and overhauled sensing devices**

Before use, each new or overhauled sensing device shall be—

- (a) calibrated or verified;
- (b) supplied with a calibration or verification certificate; and
- (c) clearly and indelibly marked with—
  - (i) its part number;
  - (ii) a unique serial number; and
  - (iii) either the calibration or verification due date or the calibration or verification interval after installation.

NOTE: A securely affixed calibration or verification tag may satisfy the marking requirements.

### **3.5.3.4 Calibration or verification certificate**

As a minimum, the calibration or verification certificate shall include the following information:

- (a) A unique traceable calibration/verification report number.
- (b) The sensing device part number.
- (c) The sensing device serial number.
- (d) The name, ABN, address and telephone number of the calibration or verification provider.
- (e) The recognized service facility number, if applicable, and any quality accreditation of the calibration or verification facility.
- (f) The calibration or verification facility's procedure reference number used for the test.
- (g) If available, the name of the customer with order reference numbers.
- (h) The calibration or verification date.
- (i) The maximum shelf or storage life of the sensing device.
- (j) The maximum installation life after the sensing device has been fitted.

- (k) The required and measured result of the calibration or verification test with 'PASS' or 'FAIL' notation.
- (l) Recommendations for use.
- (m) The serial or design registration number for all of the calibrated or verified instruments used to test the sensing device.
- (n) The name and signature of the person conducting the test.
- (o) The name and signature of the person supervising the test facility.

### 3.5.3.5 Calibration or verification tolerances

Unless specified by the manufacturer, the calibration or verification tolerances listed in Table 3.5.3.5 should be applied to determine 'PASS' or 'FAIL'.

**TABLE 3.5.3.5**  
**CALIBRATION TOLERANCES**

| Parameter                            | Permissible deviation       |                        | Notes                                      |
|--------------------------------------|-----------------------------|------------------------|--------------------------------------------|
|                                      | Full scale reading<br>(+/-) | Repeatability<br>(+/-) |                                            |
| Engine speed                         | 2%                          | 1%                     |                                            |
| Torque                               | 2%                          | 1%                     |                                            |
| Fuel consumption                     | 3%                          | 1.5%                   |                                            |
| Air consumption                      | 5%                          | 2%                     |                                            |
| Exhaust gas flow                     | 5%                          | 2%                     |                                            |
| Coolant temperature                  | 2 K                         | 1 K                    |                                            |
| Lube oil temperature                 | 2 K                         | 1 K                    |                                            |
| Exhaust pressure                     | 5%                          | 2%                     |                                            |
| Exhaust temperature                  | 5 K                         | 2 K                    | Not to exceed 150°C                        |
| Inlet manifold pressure              | 5%                          | 2%                     |                                            |
| Inlet manifold vacuum                | 5%                          | 2%                     |                                            |
| Air inlet temperature                | 5 K                         | 2 K                    |                                            |
| Lube oil pressure                    | 2%                          | 1%                     |                                            |
| Surface temperature                  | 2 K                         | 1 K                    | Not to exceed 150°C                        |
| Atmospheric pressure                 | 5%                          | 2%                     |                                            |
| Relative humidity                    | 2%                          | 1%                     |                                            |
| Low water shutdown level<br>(length) | 5 mm                        | 2.5 mm                 |                                            |
| Gases including CH <sub>4</sub>      | 3%                          | 1%                     | Statutory authority may regulate otherwise |
| Particulate matter                   | 10%                         | 5%                     | Statutory authority may regulate otherwise |

### 3.5.4 Mating surfaces

#### 3.5.4.1 General

Where a component is replaced, mating joint surfaces shall be cleaned and measurements of corrosion, surface indentation, tolerances, flatness, concentricity and circularity, as applicable, taken so as to maintain compliance with the certification documents and diesel engine system documentation (see Clause 1.4.7).

### 3.5.4.2 Flatness

The following apply to the flatness of joint surfaces.

- (a) All measuring devices shall be calibrated or verified in compliance with the requirements of a quality management system.

NOTE: If straightedges are used, they should be long enough to extend over the full length of the joint surface being checked. The straightedge should be used in such a manner that the worst case deviation may be detected, as shown in Figure 3.5.4.2.

- (b) For open joints and fixed connections, the maximum deviation detected shall never exceed the flatness tolerance specified on the certification documents and diesel engine system documentation (see Clause 1.4.7).

- (c) Where no tolerances are specified, the flatness tolerance shall be in accordance with Table 3.5.4.2.

NOTE: The intent of this practice is to detect imperfections in joints that may result in a gap which, in turn, may result in the joint not being gas-tight when assembled with a gasket or seal, and possibly not conform to the details of the diesel engine system documentation (see Clause 1.4.7).

**TABLE 3.5.4.2**  
**FLATNESS FINISH**

| Size        | Accuracy for Grade H tolerance, mm |
|-------------|------------------------------------|
| < 10        | 0.02                               |
| ≥ 10 <30    | 0.05                               |
| ≥ 30 <100   | 0.1                                |
| ≥ 100 <300  | 0.2                                |
| ≥ 300 <1000 | 0.3                                |
| ≥ 1000      | —                                  |

There are many methods of determining surface flatness deviation. Whatever method is used, it shall be capable of detecting the possibility of excessive gaps that may result in the failure of an open joint or a fixed connection.

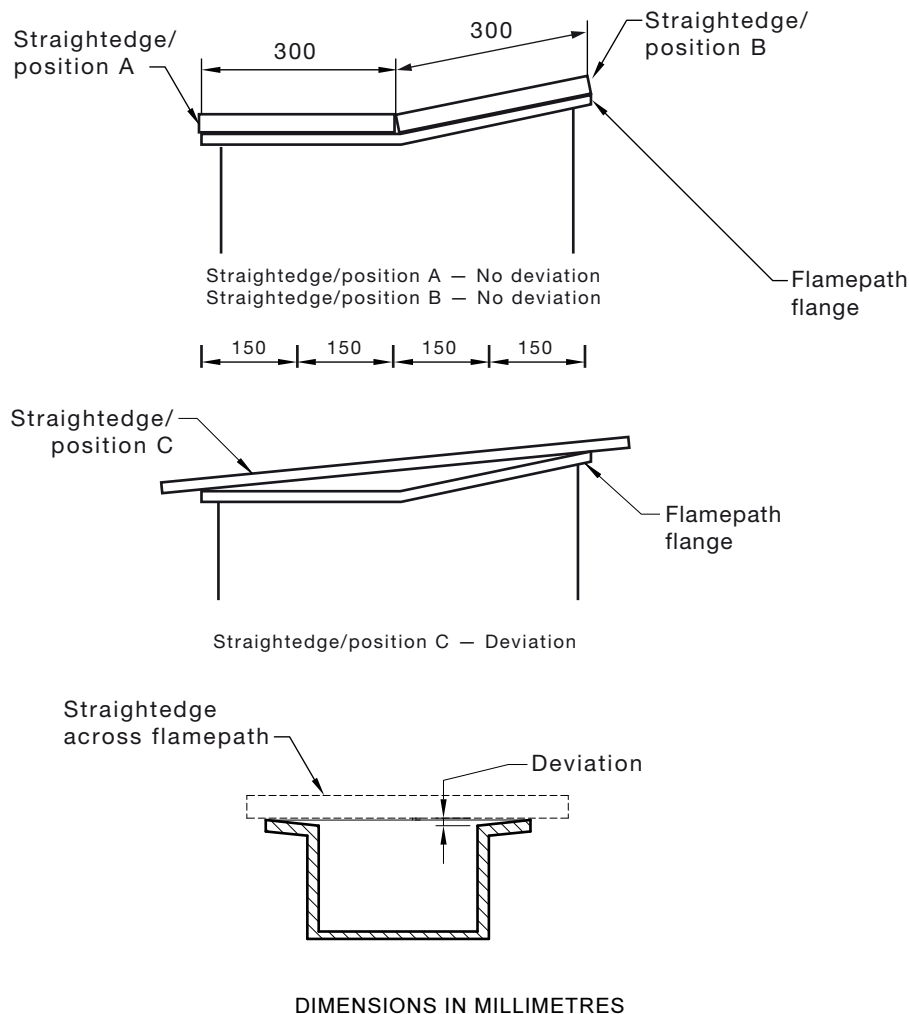


FIGURE 3.5.4.2 TEST FOR THE FLATNESS OF JOINT SURFACES

### 3.5.4.3 Surface finish

Where no tolerances are specified on diesel engine system documentation, the surface finish tolerance shall conform to nominal  $1.6\text{ }\mu\text{m}$  for open joints and, for fixed connections, be selected taking consideration of compressibility of the gasket material but no greater than nominal  $3.2\text{ }\mu\text{m}$ .

### 3.5.4.4 Circular flanges, spigots and holes

The checks to be performed on circular flanges, spigots holes and housings using calibrated micrometers (inside and outside) and dial gauges shall be in accordance with Figure 3.5.4.4(A), Figure 3.5.4.4(B) and Figure 3.5.4.4(C).

NOTE: The intent of this practice is to detect imperfections in joints that may result in—

- (a) for open joints, a flamepath gap exceeding the gap nominated on the diesel engine system documentation (see Clause 1.4.7); and
- (b) for fixed connections, a gap that may result in the joint not being gas-tight when assembled with a gasket or seal and which may not conform to the detail of the diesel engine system documentation (see Clause 1.4.7).

There are many methods of determining the compliance of circular flanges, spigots holes and housings. Whatever method is used, it shall be capable of detecting the possibility of excessive gaps that may result in the failure of an open joint or a fixed connection.

Diametral measurements shall be taken at a minimum of four diameter points for the internal and outside diameters.

NOTE: An inlet flametrap element and housing may need to be checked as illustrated in Figure 3.5.4.4(A), if the joint is specified as being an open joint on the diesel engine system documentation (see Clause 1.4.7).

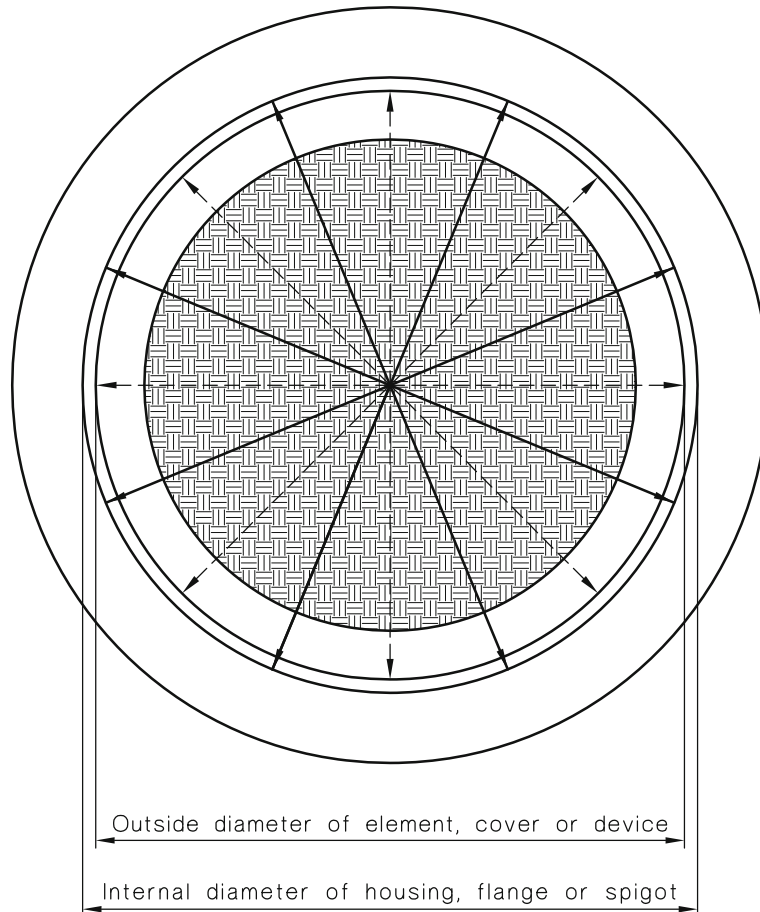


FIGURE 3.5.4.4(A) DIAMETRAL CHECKING

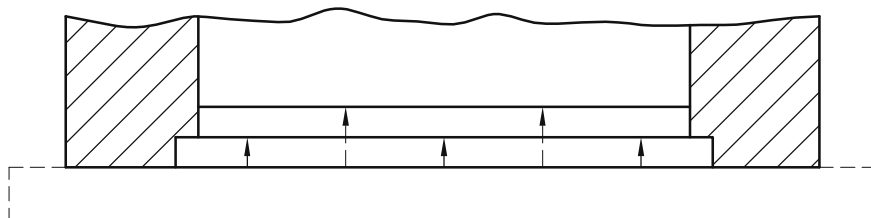


FIGURE 3.5.4.4(B) FLANGE FLATNESS AND SPIGOT DEPTH CHECKING

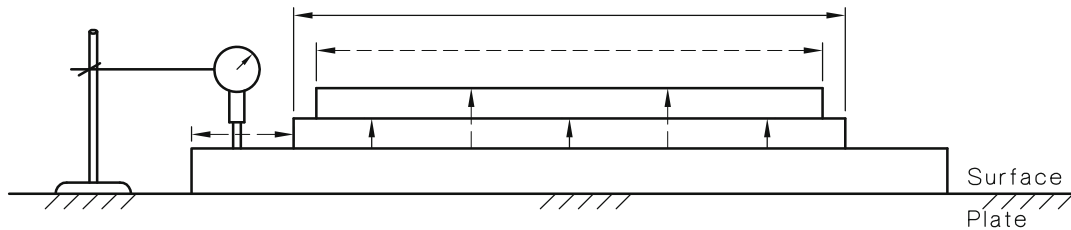


FIGURE 3.5.4.4(C) END COVER FLATNESS, DIAMETRAL AND SPIGOT DEPTH CHECKING

### 3.5.5 Machining

Where machining is required, flat surfaces that form any part of a flamepath or fixed connection gas-tight surface shall be machined to within a maximum deviation, as shown in Figure 3.5.4.4(A).

The remaining flange thickness shall be assessed by a competent person as to whether the component can continue in service.

### 3.5.6 Welding and brazing

Where welding and brazing repairs are carried out to Ex components within the diesel engine system, the minimum requirements shall be as follows:

- (a) Welds shall only be made in accordance with a qualified welding procedure specification in accordance with AS 1554, all Parts, as applicable.

NOTE: Suitable forms for recording the details of welding procedure specifications and procedure qualification records can be found in welding Standards.

- (b) Only welders qualified to use the qualified welding procedure shall make the welds.
- (c) Qualification testing shall be carried out to prove the process and procedure.

NOTE: Welding and brazing repairs should be covered in a welding quality management system. For guidance, see AS/NZS ISO 3834 (all Parts), as applicable.

### 3.5.7 Fasteners

#### 3.5.7.1 General

To ensure the safety of diesel engine systems, broken, missing or damaged fasteners should be replaced with identical fasteners as noted on the diesel engine system documentation (see Clause 1.4.7).

No washers, plain or lock, shall be placed under boltheads, screw heads or nuts unless they form part of the original certification documents.

Where replacement bolts, studs or cap screws are used, they shall be of the same type, diameter, pitch and length and at least the same tensile strength as specified for the original diesel engine system.

NOTE: Where the specification of bolts, studs or cap screws is not noted on the diesel engine system documentation (see Clause 1.4.7)—

- (a) the manufacturer should be consulted to determine the specification of the fasteners required or if the manufacturer is no longer available, then the specification of the fasteners should be determined by a competent person (see Clause 1.4.4); and
- (b) fasteners should be not less than Grade 8.0 for imperial threaded fasteners and not less than Grade 8.8 for metric threaded fasteners.

Nuts fitted to fasteners shall be the same grade as the bolts or studs to which they are fitted. All nuts, including self-locking nuts, shall be rated for the temperature to which they may be exposed.

### 3.5.7.2 Testing threads

The compliance of the thread of fasteners and the thread in blind holes that are critical to the safety and integrity of a diesel engine system shall be confirmed by test.

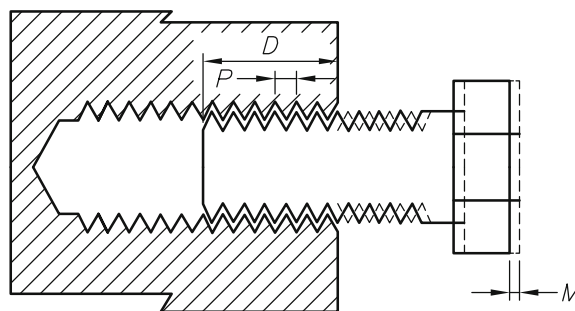
NOTE: For testing, see Appendix E.

The checking of bolt or stud thread condition shall be carried out by a competent person—

- (a) using calibrated GO/NO-GO thread gauges; or
- (b) using thread pitch gauge micrometers, ensuring conformance to thread specifications in accordance with AS 1014, AS 3501 and AS 3635 for the specification of parallel screw thread forms and associated gauges and gauging practice.

The checking of blind threads and mounting threads shall be carried by a competent person—

- (i) using calibrated GO/NO-GO thread gauges; or
- (ii) by assessing the longitudinal movement when a new bolt or stud is inserted in the threaded hole  $1/10$  of the thread pitch being the maximum allowable longitudinal movement when measured by a calibrated dial indicator, as shown in Figure 3.5.7.2.



Legend:  
 $D$  = depth of engagement  
 $P$  = pitch of thread  
 $M$  = movement of bolt thread

NOTE:  $D$  shall be equal to the diameter of bolt in completed threads; if  $M > 0.1 P$ , then hole requires attention.

FIGURE 3.5.7.2 CRITERIA FOR DETERMINING THREAD COMPLIANCE

### 3.5.7.3 Repairing threads

External (male) threads on fasteners shall not be repaired. The fastener shall be replaced.

NOTE: Internal (female) threads should not be repaired. Wherever practicable, the part or component should be replaced with a new part or component.

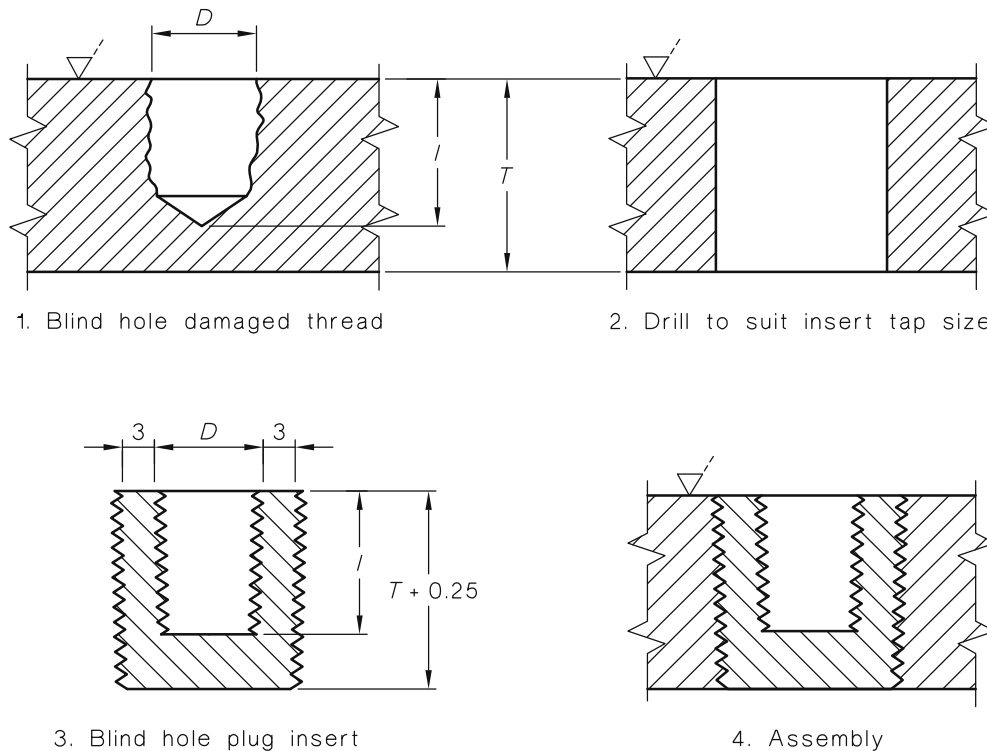
If a repair to an internal (female) thread is required, a competent person shall assess that the part or component is not weakened in the process of repair.

The following apply to repair methods:

- (a) The process described in Figure 3.5.7.3 should be followed where practicable. Inserts should be fixed with a suitable thread locking compound.
- (b) Coil insert type repair systems may be used.
- (c) Other methods providing equivalent levels of safety may be used.

The repair method shall be verified. The repair details shall be included in reports.

NOTE: Guidance and sample forms for reports are given in Appendix E.



DIMENSIONS IN MILLIMETRES

FIGURE 3.5.7.3 STEPS IN THE REPAIR OF THREADED HOLES

### 3.6 REPAIRS AND REPLACEMENT PARTS

#### 3.6.1 General

Repaired or replacement parts/component shall be manufactured, repaired or overhauled in accordance with the requirements of the certification documents and diesel engine system documentation.

NOTE: The suppliers of new or repaired components should consider the packaging and protection requirements for Ex components. When parts are fitted at mine sites, there may be minimal checking for storage or transport damage. For example, suppliers should consider issues such as the protection of joint surfaces to prevent transport impact damage, the application of corrosion inhibitors on joint surfaces, damage to joint surfaces or gaskets due to bending, water damage to electrical components and similar issues.

#### 3.6.2 Repairs

Any repairs to the explosion-protected or fire-protected properties of the diesel engine system as defined by Clause 1.4.6 shall be—

- (a) carried out in a facility meeting the requirements of Clause 3.2.7.1;
- (b) supplied with a component compliance certificate; and
- (c) clearly and indelibly marked with an overhaul label in accordance with Clause 5.2.

Welding and brazing repairs shall conform to Clause 3.5.6.

Thread repairs shall conform to Clause 3.5.7.3.

Machining and fitting repairs shall conform to Clause 3.5.5.

Hydraulic/pneumatic component repairs/overhauls shall be carried out in accordance with the component manufacturer's instructions and good engineering practice.