

AS 3788:2024



STANDARDS
Australia



Pressure equipment — In-service inspection



AS 3788:2024

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- Australian Institute for the Certification of Inspection Personnel
- Australian Institute of Petroleum
- Better Regulation Division (Fair Trading, SafeWork NSW, TestSafe)
- Bureau of Steel Manufacturers of Australia
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- Gas Energy Australia
- Materials Australia
- National Association of Testing Authorities Australia
- Office of Industrial Relations (QLD)
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Pressure equipment — In-service inspection

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Preface

This Standard was prepared by the Australian members of the joint Standards Australia/Standards New Zealand Committee ME-001, Pressure Equipment, to supersede AS/NZS 3788:2006.

After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this document as an Australian Standard rather than an Australian/New Zealand.

The objective of this document is to provide guidance on pressure equipment integrity management and assessment practices, consistent with current work health and safety laws.

The major changes in this edition are as follows:

- (a) Revision of the text throughout to correct errors and anomalies.
- (b) Clarification and revision of inspection management requirements.
- (c) Revision of inspection requirements including risk-based inspection.
- (d) Clarification of requirements for repairs, modifications, alterations and re-rating.
- (e) Consolidation of appendices.
- (f) Revision of roles and responsibilities, with some deleted and others retained.
- (g) Update of the format to the current Standards Australia styling.
- (h) Update of referenced documents and alignment.

The inclusion of roles and responsibilities in this document was approved by the Standards Australia Production Management Group (PMG) on 21 June 2022.

The terms “normative” and “informative” are used in Standards to define the application of the appendices 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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Australian Standard®

Pressure equipment — In-service inspection

Section 1 Scope and general

1.1 Scope

This document specifies the minimum requirements for in-service inspection and fitness for service of pressure and associated equipment. This includes repairs, modifications, alterations and re-rating of new and used equipment, manufactured anywhere, to any recognized Standard, for all stages of pressure equipment life from commissioning until disposal.

In particular, this document —

- (a) specifies requirements for determining the inspection interval(s), scope and extent of in-service inspection for the pressure equipment owner, inspection bodies, inspectors and others, to help in assuring safe and economic operation;
- (b) is concerned with inspection and assessment of the integrity of equipment in the pressure-envelope and supporting structures;
- (c) provides requirements for carrying out repairs, modifications, alterations, and re-rating of pressure equipment; and
- (d) in combination with AS 3873, AS 3892, and AS 3920, provides a process for assessing conformance to design, manufacture and/or manufacturing (and fitness for service) standards for the whole-of-pressure equipment life, assisting the parties concerned to comply with workplace health and safety, environmental and other relevant regulatory requirements associated with the operation of pressure equipment.

This document applies to, but is not limited to, pressure equipment covered by AS/NZS 1200 with hazard levels A to E as set out in AS 4343 or other national Standards. Typically, it includes the following:

- (i) Boilers and associated pressure parts, controls and pipe work covered by AS 1228, AS 2593, the BS EN 12952 series, BS EN 12953-1, and ASME BPVC-I.
- (ii) Pressure vessels and associated pressure parts, controls and pipe work covered by AS 1210, the EN 13445 series, ASME BPVC-VIII, AS 2971 (serially produced pressure vessels) and EN 286-1.
- (iii) Pressure piping covered by AS 4041, ASME B31.1 and ASME B31.3.
- (iv) Pressurized storage tanks built to API 620.
- (v) Fired heaters.
- (vi) Heritage boilers and pressure vessels.
- (vii) Metallic and non-metallic pressure equipment.
- (viii) Electrical switchgear and associated auxiliaries where pressure-retaining parts are primarily determined by stress comparable with AS 1210.

This document does not cover the following:

- (A) Gas cylinders (refer to the AS 2030 series).
- (B) “Rotating equipment” (pumps, compressors, turbines) and other pressure machines. The principles may be applied to the static pressure-envelope but not the rotating elements and shaft seals.

- (C) Pneumatic and hydraulic actuators and similar equipment, other than fluid pressure accumulators.
- (D) Hoses.
- (E) Pressure pipelines in accordance with the AS/NZS 2885 series or equivalent.
- (F) Atmospheric storage tanks.

1.2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

NOTE Documents referenced for informative purposes are listed in the Bibliography.

AS 1210, *Pressure vessels*

AS 1228, *Pressure equipment — Boilers*

AS 1271, *Safety valves, other valves, liquid level gauges, and other fittings for boilers and unfired pressure vessels*

AS 1358, *Bursting discs and bursting disc devices — Application, selection, and installation*

AS 1796, *Pressure equipment — Qualification of welders, welding supervisors and welding inspectors*

AS 2337.1, *Gas cylinder test stations, Part 1: General requirements, inspections and tests — Gas cylinders*

AS 2706, *Numerical values*

AS 2809 (all parts), *Road tank vehicles for dangerous goods*

AS 2832.2, *Cathodic protection of metals, Part 2: Compact buried structures*

AS 3892, *Pressure equipment — Installation*

AS 3920, *Pressure equipment — Conformity assessment*

AS 3992, *Pressure equipment — Welding and brazing qualification*

AS 4037, *Pressure equipment — Examination and testing*

AS 4343, *Pressure equipment — Hazard levels*

AS 4458, *Pressure equipment — Manufacture*

AS 4942, *Pressure equipment — Glossary of terms*

AS ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

AS ISO 16809, *Non-destructive testing — Ultrasonic thickness measurement*

BS ISO 4126-2, *Safety devices for protection against excessive pressure – Part 2: Bursting disc safety devices*

1.3 Terms and definitions

For the purposes of this document, the terms and definitions in AS 4942 and the following apply.

1.3.1 commissioning

performing the necessary adjustments, tests and inspections to ensure pressure equipment is in working order in accordance with the requirements specified in the design

1.3.2

commissioning inspection

inspection completed post-installation and/or before use to ensure pressure equipment is operational as per design, in safe working order, and all associated safety devices are fitted

Note 1 to entry: See [Table 2.1](#) for inspection stages during the life of equipment.

1.3.3

competent person

person who has acquired, through education, training, qualification or experience or a combination of these, the knowledge and skill enabling that person to perform the task required

Note 1 to entry: The term “competent person” is used in this document to address a variety of technical requirements.

Note 2 to entry: For some tasks, the person may need to be assessed as competent to perform the task.

1.3.4

damage

material injury or degradation to pressure equipment resulting from the action of a damage mechanism

1.3.5

damage mechanism

means by which material is damaged

EXAMPLE Corrosion, erosion, and stress-corrosion cracking.

Note 1 to entry: If two or more damage mechanisms act synergistically, the term applies to the combined damage mechanism.

1.3.6

defect

one or more flaws whose aggregate size, shape, orientation, location or properties do not meet specified acceptance criteria

Note 1 to entry: The presence of a defect in pressure equipment does not necessarily imply that the equipment is unfit for service (see [Clause 5.2](#)).

1.3.7

deterioration

progression of damage

1.3.8

equipment

1.3.8.1

associated equipment

equipment, not pressure equipment, necessary for the safe and proper functioning of pressure equipment

Note 1 to entry: It may include foundations, structures, supports, attachments, ducts, fans, hoppers, open drains and vents, stacks, instruments, controls and electrical equipment.

1.3.8.2

auxiliary equipment

pressure equipment supplied as an integral package to support operation of machinery

EXAMPLE Coolers, filters, snubber-pots provided as part of a machinery package.

1.3.8.3

pressure equipment

pressure equipment as specified in [Clause 1.1](#)

**1.3.9
failure**

event, resulting from damage, that renders the damaged equipment incapable of operation, or where the damage then exceeds acceptable limits

**1.3.10
flaw**

imperfection or discontinuity detectable by a non-destructive examination

Note 1 to entry: A flaw does not necessarily give cause for rejection.

**1.3.11
indication**

response or evidence from a non-destructive examination

**1.3.12
imperfection**

departure of a quality characteristic from its intended condition

**1.3.13
in-service**

period during the life of pressure equipment from the beginning of commissioning until disposal

**1.3.14
inspection**

activities verifying one or more characteristics of a product design, material, manufacture, product, service or reports and determination of their conformity with specific requirements or, on the basis of professional judgement, with general requirements

Note 1 to entry: Examples of activities include viewing, measuring, examining, testing, gauging, calculating, checking etc, and may require multiple competent persons.

**1.3.15
inspection body**

person or people responsible to the owner for systems and procedures covering in-service inspection, assessment and acceptability of serviceability of pressure equipment including hazard identification and control of risk

Note 1 to entry: See [Clause 3.3](#).

Note 2 to entry: An inspection body may also be a body corporate, firm or person external to that of the owner, or an owner's inspection department, able to provide the inspection services of pressure equipment.

**1.3.16
may**

indicates the existence of an option

**1.3.17
maintain**

to keep pressure equipment in a safe and satisfactory condition, including cleaning, adjustment, replacement, repair and servicing

Note 1 to entry: Refer to the definition in AS 4942.

**1.3.18
owner**

person with management or control of pressure equipment at a workplace who has primary duty of care under work health and safety legislation for the entity that owns and/or operates the pressure equipment

Note 1 to entry: Control is taken to encompass the operational life cycle (i.e. commissioning, operation, inspection and testing, repair and alteration, maintenance, re-rating, preservation, decommissioning and abandonment).

Note 2 to entry: In some jurisdictions, the owner may be referred to as the “person conducting a business or undertaking (PCBU) activities involving management or control of pressure equipment”.

1.3.19

relocation

change in the location of normally fixed-pressure equipment but excludes disposal

Note 1 to entry: It is regarded as an alteration and shall undergo a commissioning inspection. Regulators may need to be notified especially if the pressure equipment is relocated to a new address.

1.3.20

shall

indicates that a statement is mandatory

1.3.21

should

indicates a recommendation

1.3.22

surveillance

activities which observe the general condition of equipment, including monitoring, planned or unplanned condition audits

1.3.23

use

commission, operate, maintain, inspect, clean or decommission pressure equipment

1.4 New designs and innovations

This document does not prevent the use of materials, methods of assembly, procedures and the like that do not conform to the specific requirements of this document, or are not mentioned in it, provided the minimum dimensional and performance requirements specified herein are met.

1.5 Safety

A risk assessment shall be performed to identify hazards and the required control measures before the commencement of inspection of pressure equipment, see [Clauses 3.4](#) and [C.1.2](#).

Methods for managing the hazards shall be in place, including the removal of identified hazards where possible or substitution of the hazard or engineering or administrative controls to minimize the hazard and using suitable personal protective equipment.

NOTE See [Clause 3.4](#) for additional requirements for safety before, during and after inspection.

1.6 Special conditions and variations

It is not possible to write requirements to cover all cases of in-service inspection of pressure equipment. In special cases there may be a need to depart from the requirements in this document.

Where departure from this document is necessary, the departure shall —

- (a) be justified and documented by a competent person;
- (b) give a level of safety and performance no less than that resulting from conformance to this document; and
- (c) be by agreement between the parties concerned.

Where departure from this document is related to the use of an equivalent Standard, the departure (including any applicable limitations) and the basis for its selection shall also be documented.

NOTE AS 1200 provides guidance on the use of equivalent standards.

1.7 Rounding of numerical values

Rounding of numerical values shall be in accordance with AS 2706 and to the same significant number as in the applicable Standard.

1.8 Conversion of units

The international SI system of units has been adopted in Australia. Conversion of units shall be to the same significant number as in the applicable Standard.

Section 2 Inspection requirements

2.1 Objectives of inspection

Pressure equipment is inspected to monitor its condition, so that failure can be averted by suitable intervention.

The objectives of the in-service inspection (see asset integrity life cycle in [Clause 2.2](#)) are to —

- (a) promote the safety and health of persons in the workplace and of the public;
- (b) comply with work health and safety legislation;
- (c) determine the immediate condition of the pressure equipment and its acceptability, or not, until the next planned inspection;
- (d) identify actions for future inspection, safety, performance, repair, alteration or improvement of the pressure equipment;
- (e) protect the environment; and
- (f) protect neighbouring property, plant and equipment.

2.2 Asset integrity life cycle

Fitness for service during the overall life cycle of pressure equipment is determined by activities at the following stages:

- (a) Concept.
- (b) Design, including material selection.
- (c) Manufacture.
- (d) Transport and storage.
- (e) Installation.
- (f) Commissioning — including identification and registration.
- (g) Operation — online, including —
 - (i) In-service inspection.
 - (ii) Maintenance.
 - (iii) Special in-service activity, as follows:
 - (A) Repair.
 - (B) Online maintenance or monitoring.
 - (C) Modification or alteration.
 - (D) Re-rating.
 - (E) Investigation of failure or changed performance.
 - (F) Determination of remaining life.
 - (G) Preservation of pressure equipment.
- (h) Disposal.

While this document deals directly only with inspection and assessment at stages (f) and (g) (see items 3 and 4 of [Table 2.1](#)), critical activities and decisions in all other stages may impact on inspection planning and performance and should be considered in the management of in-service inspection.

NOTE [Table 2.1](#) sets out the stages of inspection for the life of equipment from initial design to disposal.

Table 2.1 — Pressure equipment inspection stages from initial design to disposal

Life cycle stage and associated inspection	Reference Standard/clause ^a	Purpose of inspection
1 Design and manufacture (Pre-service) 1.1 Design verification 1.2 Manufacture inspection	AS 3920 AS 3920	Provide assurance that the equipment design conforms to the design standard. Provide assurance that the manufacture is carried out in accordance with the equipment design and the manufacture Standard.
2 Transport, storage and installation (Pre-service) 2.1 Pre-dispatch inspection 2.2 Storage inspection 2.3 Installation inspection	AS 4458 AS 4458 AS 3892	Provide assurance that the equipment is clean before dispatch and protected from physical damage and/or corrosion during transport. Provide assurance that the equipment is received without physical damage and/or corrosion and that such damage is prevented during storage. Provide assurance that the equipment installation is carried out in accordance with the installation Standard.
3 Commissioning (In-service) 3.1 Commissioning inspection	Clause 4.2	Provide assurance that the equipment is in safe working order to the specified requirements before being placed in service. This applies to new equipment, or equipment that has been relocated or re-purposed.
4 Operation (In-service) 4.1 First in-service inspection 4.2 Internal and external inspection 4.3 Operations monitoring and surveillance 4.4 Investigation and failure analysis	Clause 4.4.2 Clause 4.4.3 Clause 4.3.6 Clause 7.2	Provide assurance of design and material suitability and identify pre-service imperfections which may have developed or become more significant during operation. Provide assurance that the equipment remains in safe working order. The inspection is performed at intervals determined by Table 4.1 or through a risk-based inspection methodology in accordance with Section 4.5 . Provide assurance that any abnormalities or excursions outside the established operating limits are identified in a timely manner and that their potential impact on equipment integrity is assessed and addressed. Provide assurance that the root cause(s) of any unexpected damage or failure is/are determined and addressed. This may include further inspection and testing, process fluid sampling and analysis, and/or metallurgical examination of the failure specimen(s).

Table 2.1 (continued)

Life cycle stage and associated inspection	Reference Standard/clause ^a	Purpose of inspection
4.5 Inspection after repair, modification or alteration	Clause 6.6	Provide assurance that equipment repairs, modifications, or alterations are carried out in accordance with the equipment design and manufacture Standard.
4.6 Inspection of pressure equipment not in use	Clause 4.3.7	Provide assurance that the equipment remains structurally sound so as not to pose a risk to personnel or plant, and that equipment integrity is maintained if planned to return to service at a future date.
5 Disposal (Post-service) 5.1 Dismantling, removal and disposal inspection	Clause 6.8.2	Provide assurance that any dismantling, removal or disposal activities are carried out in a safe manner.
^a While Australian Standards are referenced, equivalent international standards may be applied instead where relevant.		

2.3 In-service inspection process

2.3.1 General

The in-service inspection process flow is shown in [Figure 2.1](#), with its main elements listed and summarized in [Clauses 2.3.2](#) to [2.3.7](#). The stages of inspection for the life of equipment from initial design to disposal are summarized in [Table 2.1](#).

2.3.2 Selecting the inspection strategy

A long-term strategy shall be identified for inspection over the equipment design life by adopting —

- (a) a time-based inspection program in accordance with [Clause 4.4](#); or
- (b) a risk-based inspection methodology in accordance with [Clause 4.5](#).

This inspection strategy shall be documented and cover requirements and intervals for all types of inspection, including —

- (i) internal and external inspection;
- (ii) inspection carried out while the equipment is online; and
- (iii) targeted inspections, such as corrosion under insulation, soil-air interfaces, areas with high degradation rate, coating inspection, cathodic protection and the inspection of supports and structures.

2.3.3 Determining the inspection date or interval

Determining the next inspection date or the inspection interval shall be based on the last inspection date and one of the following:

- (a) The requirements of [Table 4.1](#) for inspections undertaken as part of a time-based inspection program where no equipment damage is detected in the inspection.
- (b) The results of a remaining life assessment where a time-based inspection program is in place and equipment damage is detected in the inspection in accordance with [Clause 4.4.3](#).
- (c) The results of a risk-based inspection assessment carried out in accordance with [Clause 4.5](#).

Additionally, inspection shall be carried out following equipment re-purposing, relocation, repairs, modifications, alteration or preservation (see [Clauses 4.3.7](#) and [6.6](#)). Inspection may also be required —

- (i) following equipment failure or changed performance; or
- (ii) following excursions outside operating limits, see [Clauses 4.3.6](#) and [7.2.4](#).

2.3.4 Determining the inspection scope

The inspection scope shall be determined in accordance with [Clause 4.3.3](#), based on the equipment's age and degradation mechanisms expected for the equipment's design and construction under its external and service environments. The scope shall also take into account the inspection and operating history of the equipment.

The inspection scope shall provide assurance of the integrity of the pressure equipment until the next scheduled inspection. It shall, as a minimum, identify —

- (a) the inspection methods, including non-destructive examination where applicable; and
- (b) the extent of the inspection in terms of coverage and test locations.

2.3.5 Preparing the inspection plan

The inspection plan shall establish the equipment to be inspected, the inspection date or interval, the inspection scope, means of access, safety requirements, requirements for cleaning and surface preparation, and other relevant matters.

The inspection plan shall be documented with references to equipment drawings and other relevant equipment documentation.

2.3.6 Conducting the inspection

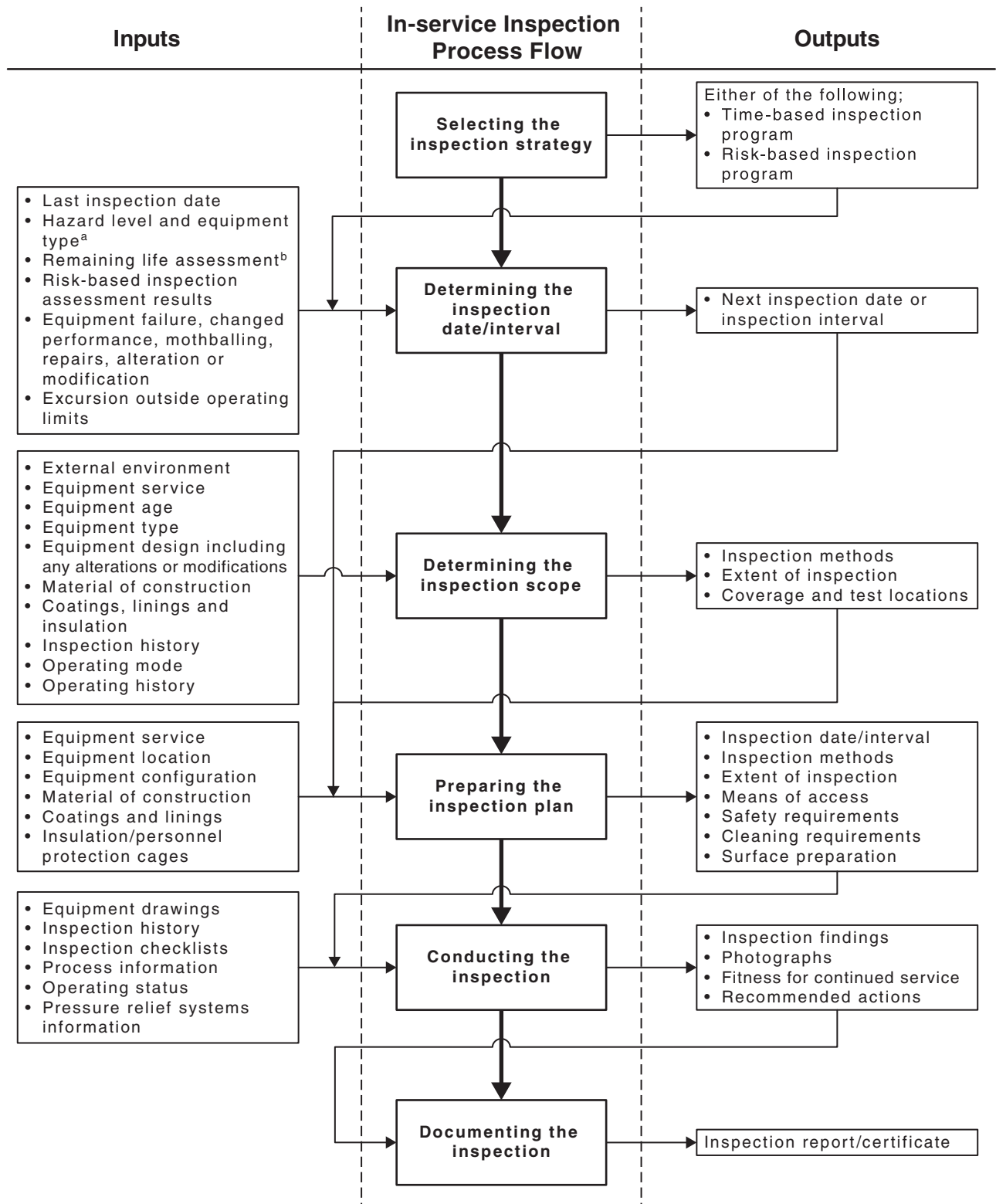
When conducting the inspection, information from previous inspection reports, plant records and other sources shall be used. This includes review of the pressure-relief devices and other protective systems in accordance with [Clauses 4.6](#) and [4.7](#) and other relevant standards.

The competent person performing the inspection shall —

- (a) record and assess the condition of the equipment and collate all necessary evidence in accordance with [Section 4](#); and
- (b) determine the fitness of the equipment for continued service as detailed in [Section 5](#).

2.3.7 Documenting the inspection

The findings of the inspection shall be documented in an inspection report or a certificate as detailed in [Section 8](#) and [Appendix D](#), with recommendations for future action such as subsequent inspection activities, repairs, modifications, alteration or re-rating.



^a For time-based inspection programs where no equipment damage is identified, as set out in [Table 4.1](#)

^b For time-based inspection programs where equipment damage is identified

Figure 2.1 — In-service inspection process

Section 3 Inspection management and personnel

3.1 General

A management system sufficient to ensure the continuing integrity and safety of items of pressure equipment is required. Such a system shall be documented and detail how objectives are achieved (see [Clause 2.1](#)). Where appropriate, pressure equipment inspection management may form part of the safety management systems as described in AS 3873 and in [Clause 3.4](#).

The system should be representative of the complexity of the plant being managed.

3.2 Owner's responsibilities

The owner is responsible for ensuring that the inspection management system incorporates information on all important safety issues. This should include the following:

- (a) Organization structure and defined roles, responsibilities and authority regarding in-service inspection and operation of pressure equipment.

NOTE Inspection and/or integrity management functions should be independent of plant operation functions.
- (b) Safety and risk management procedures.
- (c) Alterations, maintenance and repair procedures including inspection requirements (see [Section 6](#)).
- (d) Defined limits of design and critical operating parameters (such as temperature, pressure and chemical composition) and methods for recording and reporting of any excursions and, where required, assessment of significance to integrity.
- (e) Procedures for recording and assessing the impact of excursions from design conditions.
- (f) In-service time-based inspection activities (internal and external) or risk-based inspection program including acceptance criteria.
- (g) Where relevant, hazard categorization in accordance with AS 4343 (see [Section 8](#)).
- (h) Requirements for inspection plans and specifications (see [Section 2](#)).
- (i) Identification of the personnel responsible for inspection and assessment.
- (j) The competence requirements of all persons involved in undertaking inspection and assessment of the integrity of pressure equipment (see [Clause 3.6](#)).
- (k) Any specific requirements for inspection bodies (e.g. conformance to AS 3920, AS/NZS ISO/IEC 17020 or equivalent).
- (l) Operational surveillance and audit activities of pressure equipment (see [Section 2](#) and AS 3873).
- (m) Conformance to this document and compliance with any regulatory requirements such as investigation and reporting of dangerous occurrences.
- (n) Training requirements and schedules for periodic assessment of operating, maintenance and inspection staff.
- (o) Preparation of equipment for safe inspection (refer to AS 2865).
- (p) Statement that the equipment is safe to operate after completion of the commissioning inspection.

- (q) Re-rating.
- (r) Approval to return plant to service until next defined inspection.
- (s) Periodic review of inspection management system.

The inspection management system shall be documented in accordance with [Section 8](#).

3.3 Inspection body

The inspection body's responsibilities include the following:

- (a) Implementing and maintaining systems and procedures covering aspects of in-service inspection, assessment, and acceptability of the pressure equipment for service.
- (b) Verifying that inspection activities have been completed and documented in accordance with this document, inclusive of any applicable assessments, repairs, modifications alterations or re-rating activities.
- (c) Issuing applicable statements of conformity (see [Section 8](#)).

Organizations performing inspections shall conform to a suitable inspection management system. The system should include, as appropriate, the following:

- (i) A statement indicating commitment to the conditions of this document.
- (ii) An organizational chart, or similar, showing the reporting line of the inspection and/or integrity management function.
- (iii) The identification and duties of staff involved in in-service inspection.
- (iv) Lines of communication to be followed on inspection and integrity matters including reporting procedures and interface points.
- (v) Required competencies and training needs.
- (vi) Procedures and goals for planning, executing and recording inspection activities.
- (vii) Internal and external auditing procedures and schedules.
- (viii) Periodic review and continuous improvement.
- (ix) Assessment of pressure equipment integrity.
- (x) In-service inspection and testing of safety instrumented systems (SIS) and pressure-relief devices (see [Clauses 4.6](#), [4.7](#) and [4.8](#) and refer to AS 2593).
- (xi) Issuing of reports in accordance with this document.

The inspection management system shall be documented in accordance with [Section 8](#).

NOTE The size and complexity of the inspection management system will depend on the complexity of the plant and should be developed in consultation with the owner.

3.4 Safety during inspection

3.4.1 General

A risk assessment shall be performed to identify hazards and the required control measures before the commencement of inspection of pressure equipment.

The following shall be addressed when relevant —

- (a) Identification of hazards in the workplace by risk assessments or job safety analyses or similar. Hazards may include, but not be limited to —
 - (i) confined space entry hazards, including hazardous atmospheres;

NOTE Refer to refer to AS 2865 and relevant legislation or regulations for the location of the inspection.
 - (ii) working at heights hazards (e.g. risk of fall, slips, trips, and falling objects);
 - (iii) environmental hazards in the workplace (e.g. heat, cold, noise, dust);
 - (iv) hazards including physical hazards during inspection of operating plant (e.g. loss of product containment, radioactive sources, hazardous chemicals or substances, poor lighting, vibration, mechanical hazards and electrical hazards);
 - (v) hazards from other work parties during shutdown for inspection (e.g. welding, painting, grit blasting, grinding) (refer to AS 1674.1, AS 1674.2, Weld Australia's Technical Note 7);
 - (vi) inspection equipment including access equipment; and
 - (vii) hazards presented by equipment that is not permanently fixed in place.

EXAMPLE Transportable vessels, and vessels that have been taken off their foundations.
- (b) Methods of managing the hazards are in place following a hierarchy of controls, including —
 - (i) removal of identified hazards where possible, or substitution of the hazard or engineering controls to minimize the hazard;
 - (ii) owner/operator requirements for access to plant (e.g. permits, isolation, tagging); and
 - (iii) safety equipment and personal protective equipment (PPE).

As part of managing hazards, all safety and work permits needed for the inspection task shall be adhered to.

NOTE Refer to work health and safety (WHS) regulations including codes of practice (COP) available from state and territory health and safety regulators for work health and safety requirements, including any permits.

3.4.2 Preparation for inspection offline

Before internal or external inspection of pressure equipment that has been de-energized and isolated, the pressure equipment shall be prepared for inspection and, where applicable, as follows:

- (a) Emptied of contents, drained and vented.
- (b) Cooled adequately for safe entry.
- (c) Cleaned of materials which could cause harm to persons entering pressure equipment.
- (d) Dried of excessive moisture.
- (e) Vented with fresh air either initially or continually.
- (f) All energy services isolated that pose a risk during inspection (e.g. power, steam, water, gas or product).
- (g) Any slip trip and fall hazard removed or minimized that is inside the space or the immediate area outside.

- (h) Tested by a competent person using suitable calibrated equipment to ensure a safe atmosphere is present throughout the confined space.
- (i) Provided with necessary permits for adequate means for safe entry access and egress, that includes a rescue plan.

When any of Items (a) to (i) apply but cannot be prepared, the following apply:

- (i) An appropriate risk assessment shall be carried out to determine whether safe entry may be achieved with other or additional suitable safety measures such as breathing apparatus. Entry shall then be the subject of agreement between the parties concerned.
- (ii) Pressure equipment situated in dangerous or remote locations should not be inspected until the area has been made safe and inspection personnel are instructed in the safe entry and exit procedures.

NOTE An electrical switchyard is an example of a hazardous or remote location.

- (iii) All safety precautions shall be observed, and any additional precautions shall be followed to protect personnel in the vicinity during functional tests of pressure equipment which could create a hazard (e.g. testing and operating of pressure-relief valves, in-service leak tests, hydrostatic tests).
- (iv) Confirmation shall be sought before inspection that the pressure equipment is safe to inspect. Additional safety procedures may be requested. All access permits and/or requirements shall be met.

3.4.3 Closure

Before the pressure equipment is closed (i.e. “boxed up”) at the conclusion of the inspection, it shall be confirmed that all people have safely vacated the pressure equipment and that internal components are completely assembled and are free from unwanted material or equipment.

3.4.4 Inspection of plant that is operating

Before external inspections on plant that is online or operating, the necessary access permits or permission shall be obtained, and a suitable risk assessment carried out to consider all hazards at the inspection site, including the risk of exposure from contents where loss of containment could occur.

Before commencement of inspection, relevant control measures shall be applied, including suitable means for communication with the plant operator.

3.5 Support organizations

Organizations carrying out support activities such as design, design verification, testing, examining and measuring (e.g. non-destructive examination, mechanical tests and chemical analysis), assessment of fitness for service, maintenance and repair, or heat treatment shall conform to the appropriate specifications and standards.

3.6 Qualification of personnel

3.6.1 General

In-service inspection, welding inspection, and non-destructive examination require specialized skill sets for the respective tasks. The personnel who perform these tasks shall be experienced, competent, trained, instructed and equipped at the level necessary for the particular task as follows:

- (a) In-service inspection, see [Clause 3.6.2](#).

NOTE 1 People performing in-service inspections are typically referred to as inspectors (refer to AS 4942).

- (b) Welding inspection, see [Clause 3.6.3](#).
- (c) Non-destructive examination, see [Clause 3.6.4](#).

NOTE 2 People performing non-destructive examination tasks are usually referred to as technicians.

3.6.2 In-service inspection

Personnel performing commissioning inspection and/or in-service inspection shall —

- (a) have training and experience in the manufacture and inspection of pressure equipment (welded and/or non-welded, see [Clause 3.6.3](#) and [Section 9](#), where applicable) and conform to the requirements set out in [Table 3.1](#); and
- (b) be trained in the key knowledge areas in [Table 3.2](#) and this document.

3.6.3 Welding inspection

Welding inspection personnel shall have training and experience in the manufacture and inspection of welded pressure equipment, refer to AS 3920. Either of the following are acceptable:

- (a) Personnel satisfying AS 1796 Certificate No. 10 for welding supervisors or equivalent or higher (refer to AS/NZS ISO 14731).
- (b) Personnel satisfying AS 1796 Certificate No 11 (or equivalent) for welding inspection.

3.6.4 Non-destructive examination other than visual

Personnel performing and/or responsible for the interpretation, evaluation and reporting of non-destructive examination shall be trained, qualified and experienced to carry out the assessment in accordance with this document and conform to AS ISO 9712 or equivalent for the relevant process.

Table 3.1 — Assessment criteria for in-service inspection

Elements for each area	Criteria
1 Plan and prepare for inspection	(a) Inspection program/requirements are received, analysed, and confirmed/modified. (b) Inspection is prioritized and sequenced/scheduled. (c) Liaison and communication issues with client, authorities and other persons are resolved and access to plant is authorized. (d) Resources including personnel, transport, facilities and inspection and access equipment are identified and scheduled. (e) Briefing of persons participating in tasks, including plant personnel and contractors. (f) Preparation, cooling, cleaning, gas freeing, isolation and safe access of equipment and fitting of tags/warning signs are confirmed.
2 Conduct inspection	(a) Inspection of equipment is in accordance with documented procedures and this document. (b) Required or optimum tests are selected, performed and verified. (c) Assess products and use professional judgement. (d) Inspection is completed in a timely fashion.

Table 3.1 *(continued)*

Elements for each area	Criteria
3 Report on inspection	(a) Inspection records and reports are made and processed in accordance with documented procedures. (b) Identified abnormal conditions, hazards or risks are reported to the client. (c) Certificates of inspection are signed and transmitted in accordance with the specification requirements.

Table 3.2 — Key knowledge areas of in-service inspection

Knowledge area	Specific elements
1 Basic aspects of inspection	Objectives, elements, stages of inspection and appropriate standards.
2 Requirements of in-service inspection	As set out in Section 3 of this document and SAA/SNZ MP76, including: (a) Hazards associated with pressure equipment. (b) Verification of integrity of equipment. (c) Customer requirements (contract). (d) Regulatory requirements. (e) Communication skills. (f) Skills to deal with contingencies.
3 Safety during inspection	(a) General safety, including site requirements, work site induction and work site requirements, personal protection (PPE) and permits, WHS requirements, confined space entry, safety data sheets (SDS). (b) Safety for specific equipment (see Item 12 in this table).
4 Methods of inspection	(a) Planning (e.g. inspection plans, schedules, audits). (b) Drawings. (c) Non-destructive examinations (ultrasonic, radiographic, magnetic particle, dye penetrant, acoustic emission, thermography), including use and limitations. (d) Visual examination (e.g. AS/NZS ISO 17637) (e) Pressure testing. (f) Destructive testing. See Appendix A .
5 Types of in-service inspection	(a) Commissioning inspection. (b) Operational surveillance. (c) Inspection (internal and external). (d) Opportunistic inspection (e) Investigative inspection
6 Assessment of pressure equipment integrity	As set out in Section 5 (initial review at a basic level).
7 Materials	Basic properties, uses and problems.
8 Manufacture	(a) Forming, cutting, welding and joining, fitting and casting. (b) Heat treatment.

Table 3.2 *(continued)*

Knowledge area	Specific elements
9 Common modes and causes of deterioration and failure	(a) Basic understanding of pressure equipment. (b) Welding, materials and manufacturing imperfections. (c) Corrosion and erosion. (d) Creep. (e) Fatigue. (f) Brittle fracture. (g) Overloading, excess pressure. (h) Temperature. (i) Abnormal loads (e.g. collision, seismic, wind, settlement).
10 Repairs, alterations (modifications), replacement and re-rating	(a) Responsibilities and documentation (b) Typical acceptable methods and procedures (refer to AS 3992)
11 Documentation	Field recording and formal documentation as set out in Section 8 .
12 Inspection and repair of specific pressure equipment to Australian Standards (e.g. this document)	As set out in Section 9 and the appendices of this document — (a) Boilers — Fire-tube, water-tube, electric. (b) Pressure vessels — Fired heaters, heat exchangers, low-temperature vessels, transportable vessels, vacuum vessels, storage vessels, reactors, columns. (c) Pressure piping — High temperature, low temperature. (d) Pressure-relief devices and other safety controls and safeguards
13 Technical experience	Typically will have more than 5 years' experience relating to pressure equipment.

Section 4 Pressure equipment inspection

4.1 General

This section details the requirements for the management and planning of inspection activities, including the timing of inspections.

Inspection plans referred to in [Section 2](#) shall be scoped, executed and documented by a competent person. Where applicable, plans should also take into account manufacturer's recommendations.

4.2 Commissioning inspection

4.2.1 General

Commissioning inspections are required for new pressure equipment as set out in Column 2 of [Table 4.1](#) and also in the following circumstances:

- (a) Following a change of duty or service outside the design parameters which could affect safety.
- (b) Following a relocation of static (i.e. "non-transportable") equipment.
- (c) Before a return to service, including outage for repair (see [Clause 4.3.7](#)).
- (d) For used/re-purposed pressure equipment.

The owner shall ensure that there is no change in condition of the pressure equipment, safety device(s) or safeguard(s) between the completion of the commissioning inspection and use that would result in pressure equipment being unsafe to operate.

For inspection requirements post repairs, modifications or alterations, see [Section 6](#).

4.2.2 Purpose

The purpose of commissioning inspections is to ensure that requirements for maintaining the integrity of the item or plant, including requirements for establishing an inspection program for the life of the equipment, are in place, including the following:

- (a) Equipment is correctly identified and marked (see [Section 8](#)) and located.
- (b) Manufacture conforms to the design.
- (c) The equipment has not been damaged during manufacture, transportation, prior service, storage or relocation, and any damage found is assessed and rectified as required.
- (d) The equipment is ready, equipped (e.g. instrumentation, relief valves, steelwork, surface coatings, insulation, documentation) and safe to be put into operation.

4.2.3 Scope

Commissioning inspections shall include, but not be limited to, the following:

- (a) Confirm all necessary documentation as specified in [Section 8](#) is available.

NOTE Where documentation is incomplete, [Clause 8.5.2](#) gives guidance on how it may be reinstated.
- (b) Verify evidence that the equipment has been manufactured in accordance with the design documentation.
- (c) Establish that all statutory and relevant standard requirements for inspection during design, manufacture and installation are available and that relevant certificates required by regulation are available.

- (d) Verify any operational and performance tests have been successfully completed.
- (e) Confirm that any specified corrosion control or management system is in place, such as anodes, coatings or corrosion probes.
- (f) Check that each item of pressure equipment is uniquely and clearly identified by marking and or stampings, as required by [Section 8](#) and other relevant standards, such as AS 1210.
- (g) Detect, assess, record and remediate where necessary any defect in, or damage to, equipment that may have occurred post manufacture and before installation.
- (h) For used/re-purposed equipment, address the possibility that the equipment might have metallurgical, or other damage that may not be initially apparent, such as temper embrittlement, high-temperature hydrogen attack and creep. This is a critical consideration for used equipment of uncertain origin.
- (i) Confirm correct installation of the following:
 - (i) Pressure connections (e.g. piping, instrumentation, manways).
 - (ii) Supports steelwork and bolting.
 - (iii) Surface coatings and insulation.
- (j) Check all necessary safety devices are fitted and certified.
- (k) Check that no extraneous material remains in pressure equipment.
- (l) Supervise, witness or verify pressure tests.

If the equipment has been preserved internally and the state of preservation has been verified, an internal inspection may not be required.

Where measuring degradation rates will be beneficial for managing future equipment health, it is useful to establish a baseline, such as thickness tests or other inspection data, so that the “as built” condition forms the starting point for inspection monitoring. For pressure equipment designed to operate in the creep temperature range, carrying out “base line” dimensional and metallurgical checks may also be beneficial.

4.3 Inspection during service life

4.3.1 General

Pressure equipment shall be subject to inspection during its service life. These inspections shall assess the condition of the pressure equipment to ensure it is safe to operate until the next inspection. Inspection intervals may be time-based, determined from [Table 4.1](#) (see [Clause 4.4](#)). Alternatively, inspection intervals may be determined using risk-based analysis (see [Clause 4.5](#)). [Figure 4.1](#) provides a guide to options for the inspection process.

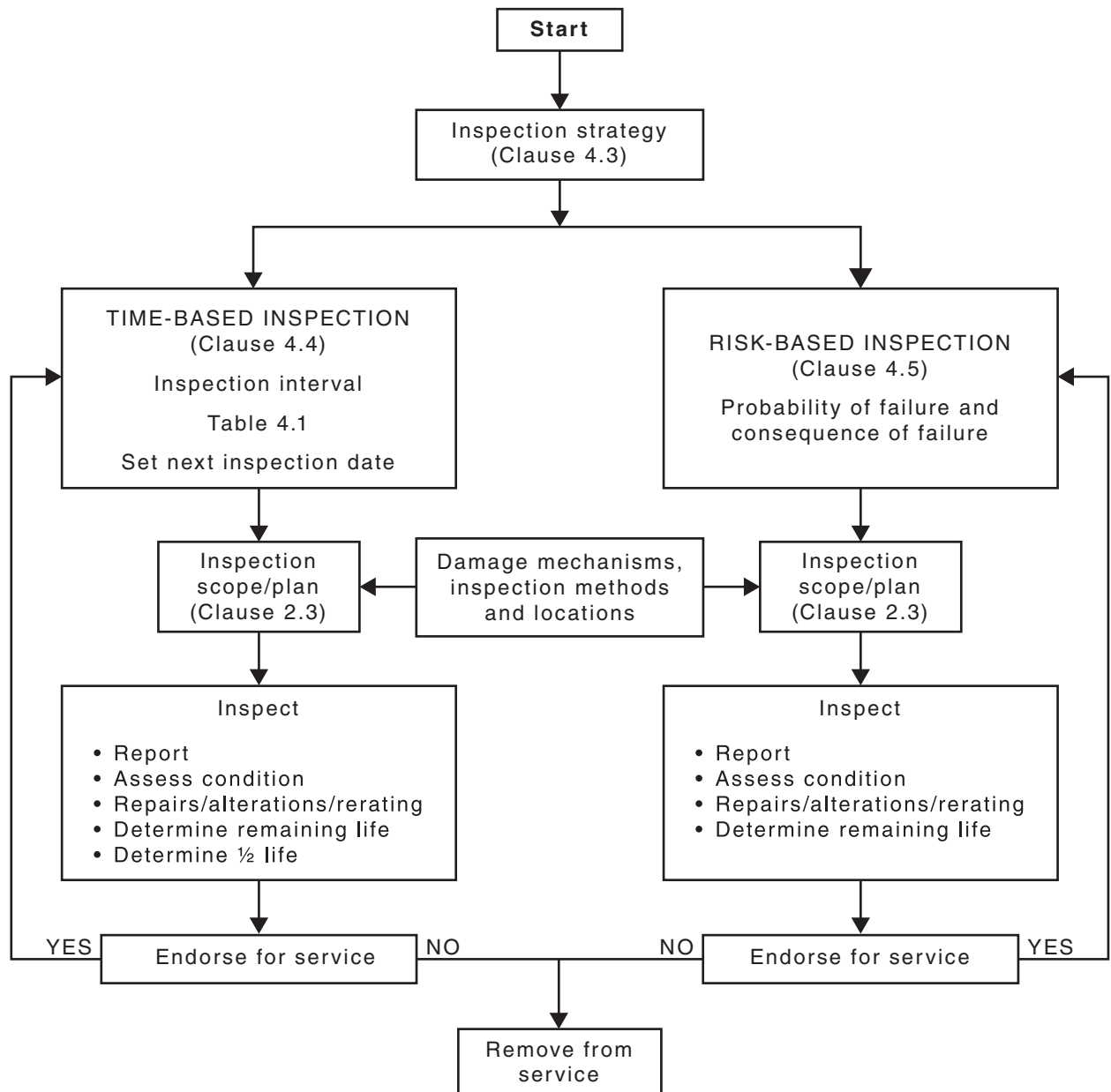


Figure 4.1 — Inspection process options

4.3.2 Inspection planning

Inspection plans and scopes shall be documented and provide guidance to personnel preparing pressure equipment for inspection, including any safety requirements, as well as providing instructions to inspection personnel. [Clause 2.3](#) details the purpose and contents of inspection plans and scopes.

4.3.3 Inspection methods and locations

4.3.3.1 General

Pressure equipment shall be inspected externally and internally at established intervals. Where required, these inspections may include sub-surface and through thickness examination of the material using appropriate non-destructive examination methods.

The purpose of external and internal inspections is to detect anomalies, defects, degradation or other conditions (e.g. corrosion, leaks, deformation, cracking) that may have developed during service which could impair or reduce the service life of the pressure equipment or render the equipment unfit for service. External inspections may be carried out either online or offline. Online is preferred to capture potential issues (such as leaks, vibration) that may not be apparent offline.

An external or internal inspection shall consist of a thorough visual inspection of all accessible surfaces of the pressure equipment, including fittings, coatings, insulation, bolting, supports, internal structures, appurtenances and associated structural steelwork, and shall verify identification markings (see [Appendix A](#)).

In some situations, access may need to be provided or confined space entry may be required to facilitate inspections where degradation is credible, or visual inspection may need to be carried out using visual aids such as borescopes or video scopes where no access for entry is possible.

Alternatively, if applicable, internal inspections may be executed by using appropriate non-intrusive or non-destructive techniques/processes as long as such techniques/processes provide results at least equivalent to a thorough visual inspection (see [Clause 4.3.4](#)).

4.3.3.2 Determining the method and location of inspection

Inspections and examinations shall be based on methods capable of detecting and measuring the damage that is present in the equipment and shall be applied at appropriate locations. A competent person shall determine the methods and locations of inspection and also perform the following:

- (a) Identify the damage mechanisms acting in the equipment under consideration, through assessment of —
 - (i) materials and methods of construction;
 - (ii) operating conditions (e.g. pressure, temperature, and flow rate, including excursions);
 - (iii) fluid contents, fluid characteristics, chemistry, composition, contaminants, catalysts, including excursions; and,
 - (iv) the reported history of this and similar equipment.
- (b) From consideration of each damage mechanism, determine the nature and likely locations of related damage, including when the damage mechanisms act alone or (if feasible) together.
- (c) If unanticipated damage is found, investigate and document the situation, and amend inspection plans. The implications for other pressure equipment shall also be assessed and incorporated into inspection plans as appropriate.
- (d) If damage mechanisms are identified that may be non-time dependent, inspect for these and assess them [see [Clause 4.4.3](#)].

4.3.4 Non-intrusive inspection

Non-intrusive inspection (NII) may be used to fully or partially substitute for intrusive inspection. It consists of a comprehensive non-destructive testing program applied to the whole or parts of the equipment, see [Clause 4.3.3.1](#).

NII may also include statistical approaches to infer the condition of the equipment, based on the non-destructive testing results from the areas inspected.

For NII to substitute fully or replace an internal intrusive inspection, all of the following criteria shall be addressed and documented:

- (a) The first in-service inspection has been completed.

- (b) All relevant degradation mechanisms are identified.
- (c) The location of and form of damage expected is determined, and the inspection techniques adjusted as required.
- (d) The damage expected and its extent are capable of being detected by the non-destructive testing techniques being employed.
- (e) If the non-destructive testing inspection covers only a sample of the susceptible areas, it can be shown that the NII inspection results are representative of the complete internal condition of the pressure equipment.

When applying NII, the limitations of the inspection techniques and the inability to visually assess the following shall be taken into account:

- (i) Deposits or scale.
- (ii) Any internal items, including, but not limited to, linings (particularly non-metallic) and internal structures, that may affect the integrity of the external pressure boundary.
- (iii) Damage in unexpected locations (or from unidentified mechanisms) not detectable from the external surface.
- (iv) Potential for foreign objects or manufacturing defects, and their effect on the equipment.
- (v) NII results shall not be grounds for applying the extended inspection intervals in [Table 4.1](#).

NOTE 1 Consideration should be given to the consequence and subsequent risk of not completing an internal intrusive inspection.

NOTE 2 Documents such as HOIS-RP-103 give guidance on NII.

4.3.5 Inspection of equipment in similar service

4.3.5.1 General

If two or more items of pressure equipment of similar design and materials are in similar service, the internal inspection of one may be taken as representative of the group.

This clause specifies when it is acceptable to perform inspection on a group of equipment by a sampling inspection of one or more items within the group.

This clause does not apply to transportable vessels or equipment containing lethal contents.

For this clause to apply, the following conditions shall be met:

- (a) The group of equipment experiences the same damage mechanisms acting in equivalent locations and with similar rates of deterioration (e.g. formation of deposits in low-flow areas).
- (b) Operating conditions, including non-routine operations, are deemed to be equivalent.
- (c) Materials of construction are similar.
- (d) Where, through experience or assessment, it is found that damage does not occur in each piece of equipment at the same rate, or that a sample is not a true representation across the group because of differences in age, individual design details, material or original wall thickness, this shall be taken into account in determining the details of the inspection plan and which equipment is inspected.
- (e) Each identified damage mechanism shall be accounted for in the inspection plan;

- (f) Internal inspection is carried out sequentially on each item in the group at an interval determined by [Table 4.1](#) or by risk-based inspection.
- (g) All assumptions and the process applied shall be documented.

4.3.5.2 Equipment in parallel streams

The operating conditions in parallel streams may be considered equivalent when the following conditions apply:

- (a) The parallel stream shall constitute a distinct section of the process with shared controls, such that process conditions will always be the same in each stream.
- (b) The items of equipment shall have the same process function and always share the feed and product streams.
- (c) The damage mechanisms shall be comparable between the streams.
- (d) Minor differences in feed, preferential flow, take-off or chemical injection and other similar considerations that may affect damage mechanisms or deterioration rates shall be taken into account.

4.3.5.3 Equipment in series

The principles of Clause [4.3.5.1](#) may be applied to equipment in series with the following additional conditions:

- (a) The damage mechanisms do not change through the train, or the worst case for each damage mechanism is determined, and inspection accounts for this (but not neglecting other equipment).
- (b) No detrimental feed, chemical injection or auxiliary process is introduced into the train.
- (c) Process or auxiliary streams leaving the train are accounted for. For example, sequential removal of water or acidic gas may bias corrosion to one end of the stream.

4.3.6 Operations monitoring and surveillance

Any excursions outside established operating limits or abnormalities such as unusual odours, noise, leaks or vibration shall be assessed by a competent person to determine if any remedial actions are required.

Consideration should also be given to these excursions or abnormalities affecting the inspection intervals and/or scopes.

NOTE AS 3873 covers the operation, surveillance and monitoring of pressure equipment.

4.3.7 Pressure equipment not in use

Pressure equipment that is not in use (see [Table 2.1](#), item 4.6) shall be depressurised and isolated from sources of pressure and process fluids.

A preservation plan should be developed to ensure the equipment —

- (a) remains structurally sound;
- (b) does not pose a threat to personnel or plant; and
- (c) if required, allows a safe return to service at a future date.

The requirement for inspections and the effect that the change in conditions will have on inspection intervals shall be taken into account.

Pressure equipment that has not been in use for 6 months shall have a commissioning inspection carried out (see Column 2, [Table 4.1](#)) before returning to use.

NOTE Guidelines for the preservation and inspection of pressure equipment are given in [Appendix C](#).

4.4 Time-based inspection intervals

4.4.1 General

This clause provides a simplified process for setting maximum inspection intervals for pressure equipment through the application of [Table 4.1](#).

Column 1 of [Table 4.1](#) provides a list of pressure equipment. Columns 3, 4, 5, and 6 specify intervals for various inspections.

When referred to in the table, the notes at the end of the table provide additional guidance.

NOTE The alternative method for determining inspection intervals is referred to as risk-based inspection (see [Clause 4.5](#)).

4.4.2 First in-service inspection

Where required by Column 3 of [Table 4.1](#), pressure equipment managed by time-based inspection shall be inspected internally and externally after its first year of service to confirm the equipment integrity for ongoing service and to justify the inspection interval through the following:

- (a) Identifying any unexpected deterioration of the pressure envelope, associated piping and fixtures, or deterioration of supports, cladding and foundations.
- (b) Confirming the suitability of materials and design to resist degradation.
- (c) Identifying manufacturing or construction anomalies which may have developed or become significant during operation.

The nominal lapsed time shall be 12 months, to ensure that any significant damage has had time to develop to a point where it can be detected or to ensure that the deterioration rate is low. The designated inspection date may be adjusted by a maximum of 90 days.

Provided that the conditions of this clause are satisfied, non-intrusive inspection (see [Clause 4.3.3](#)) may be used as a substitute to intrusive vessel entry.

The extent of inspection and the inspection techniques applied for the 12-month inspection shall be determined in accordance with [Section 4.3.3](#).

4.4.3 Internal and external inspections

Columns 4 and 5 of [Table 4.1](#) specify inspection intervals for external and internal inspections, grouped by the hazard level of the equipment as determined by AS 4343 or grouped in other ways such as by pV value, material of construction or content.

Subsequent inspection dates shall be determined from the actual inspection date.

If damage from time-dependant damage mechanisms is identified, where the observed or calculated degradation rate is the controlling factor for pressure equipment life, the maximum interval between inspections shall not exceed the lesser of half the calculated remaining life of the pressure equipment and the period specified in [Table 4.1](#).

If damage from non-time-dependent damage mechanisms is identified, a competent person shall assess the damage and determine any actions required to ensure the pressure equipment remains fit for service.

4.4.4 Extended internal inspection intervals

The extended internal intervals up to the maximum nominated in Column 6 of [Table 4.1](#) can only be applied after completion and documentation of the following:

- (a) The commissioning inspection.
- (b) The first in-service inspection, where required.
- (c) The first nominal internal inspection.

Demonstrating that extended intervals are safe requires a documented process that reviews the equipment and process history and advises of changes to any conditions that may have an impact on equipment integrity. This documented process shall confirm the following as a minimum:

- (i) Degradation mechanisms have been identified and any wastage rate or rate of deterioration is predictable.
- (ii) The equipment is to stay in the same service.
- (iii) Operating conditions will remain unchanged, without adverse excursions, excessive corrosion, fouling, or contamination.
- (iv) No defects are present that could lead to an unpredictable failure.
- (v) Protective systems remain in place and have not returned a failed result in any of the previous two tests/inspections.

If equipment is withdrawn from service for any reason during an extended interval, consideration should be given to completing an internal and external inspection.

4.4.5 Allowable deferral of inspection intervals

To help meet production schedules and to provide flexibility in shutting equipment down, the designated inspection date may be deferred by a maximum of 90 days, provided this is supported by the known condition of the equipment and an assessment that operating conditions have not substantially changed in a manner that would reduce the remaining life. The justification for deferral shall be documented.

4.4.6 Special cases

Exceptions to typical pressure equipment designs may alter material degradation rates or hinder access for inspection activities. In these cases, pressure equipment inspection intervals whether taken from [Table 4.1](#) or derived via risk-based methods, and/or inspection plans, may need to be modified. This section acknowledges known special cases and provides guidance in the following:

- (a) Internally lined vessels — If part or all of the vessel wall has a protective lining, the interval between inspections shall be determined by a competent person from a consideration of consequence and the following:
 - (i) Previous history for the lining material under similar service conditions.
 - (ii) The wastage allowance and degradation rate of the parent metal if the lining fails.
 - (iii) The remaining corrosion allowance and the degradation rate of the parent metal if it is not protected by a lining.

- (iv) The possibility of damage to the parent metal, by species diffusion through the lining.
- (b) Vessels of advanced design — Pressure equipment designed in accordance with AS 1210 or vessels of a similar category designed in accordance with other national standards, may allow higher design stresses for the materials of construction.

The plans for in-service inspection of such vessels shall include a review of the operating conditions that might affect the vessels' integrity, such as the following:

- (i) Full range pressure cycles (start up, shutdown).
- (ii) Pressure and temperature excursions.
- (iii) Fluctuations in the temperature differences between the extremities of a vessel (e.g. a column if the bottom operates at 30 °C and the top operates at -80 °C).
- (iv) Fluctuations in temperature for vessels that are constructed of materials with different thermal expansion rates (e.g. austenitic stainless steel nozzles in a carbon steel shell).
- (v) Process-induced vibration (e.g. cavitation or vibration in supply pumps and compressors).
- (vi) Any vibrations or displacements caused by other forces (e.g. cyclonic winds, earth tremors, impact, unstayed nozzles).

During the inspection of such vessels, particular attention shall be given to areas that could be subject to fatigue cracking.

When the operating history shows that the fatigue (design) life of the vessel has been reached, the integrity of the vessel shall be re-evaluated before further use.

NOTE See [Clause B.4](#) for additional guidance.

- (c) Pressure equipment placed inside secondary containment structures — Pressure equipment that is prevented from being exposed to external corrosion through the use of a secondary structure and/or inert gas atmosphere, which excludes the presence of water, need not have the secondary structure opened to perform an external inspection of the equipment. However, the condition of the secondary structure (such as a cold box casing) shall be inspected periodically and maintained as necessary. The atmosphere within shall be monitored regularly to confirm a lack of water or species that may promote external corrosion.

If the protective atmosphere is lost for any reason or if other damage mechanisms not dependant on the protective atmosphere be plausible, the pressure equipment inspection intervals and plans shall be amended accordingly.

- (d) Pressure equipment operating outside of established operating parameters — When pressure equipment's operating conditions or regimes are changed from established norms (e.g. changing from base-load to flexible operation of power generation plant), the impact on equipment health of, new damage mechanisms, or the acceleration of known damage mechanisms shall be assessed. Appropriate changes shall be made to inspection intervals, scopes and plans so that equipment health is maintained under the new operating regime.

Table 4.1 — Inspection intervals

1		2	3	4		5	6
Pressure equipment		Commissioning inspection required?	First in-service inspection required?	External inspection	Internal inspection	Extended interval (see Note 1)	
1	Boilers (see Clause 9.2)						
1.1	Electric boilers	Yes	No	2	4		8
1.2	Coil-type forced circulation boilers	Yes	No	2	Note 2(b)		Note 2(b)
1.3	All other boilers	Yes	Yes	1	1		4
2	Steam pressure vessels						
2.1	Jacketed vessels						
	pV ≤ 30 MPa.L	No	No	Note 6	Note 6		Note 6
	pV > 30 MPa.L	Yes	Yes	2	4		8
2.2	Other steam pressure vessels (see Appendix C for deaerators)						
	pV ≤ 30 MPa.L	No	No	Note 6	Note 6		Note 6
	30 < pV ≤ 100 MPa.L	Yes	No	2	4		8
	pV > 100 MPa.L	Yes	Yes	2	4		8
3	Vessels with quick-actuating closures						
3.1	Containing gases (including steam)						
	pV ≤ 15 MPa.L	No	No	Note 6	Note 6		Note 6
	pV > 15 MPa.L	Yes	Yes	2	4		8
3.2	Containing liquids						
	pV ≤ 10 MPa.L	No	No	Note 6	Note 6		Note 6
	pV > 100 MPa.L	Yes	Yes	2	4		8
4	Fired heaters or convection banks	Yes	Yes	2	4		8
5	Water heaters	Yes	No	4	12		12
6	Compressed air containing vessels						
	pV ≤ 100 MPa.L	No	No	Note 6	Note 6		Note 6
	100 ≤ pV ≤ 150 MPa.L	Yes	No	Note 6	Note 6		Note 6
	pV > 150 MPa.L	Yes	No	2	4		12

Table 4.1 (continued)

1	2	3	4	5	6	
Pressure equipment	Commissioning inspection required?	First in-service inspection required?	Inspection interval a, years (see Note 1)			
			External inspection	Internal inspection	Extended interval	
7	Non-transportable storage vessels for hydrocarbon gas and anhydrous ammonia (see Note 3)					
7.1	Gases (non-corrosive condition) including above-ground LPG storage vessels	Yes	No	2	10	12
7.2	Gases (other conditions) including anhydrous ammonia	Yes	Yes	2	2	4
8	Storage tanks to API 620 or equivalent		See Appendix C			
9	Process vessels					
9.1	Hazard Level A	Yes	Yes	2	4	8
9.2	Hazard Level B	Yes	Yes	2	4	12
9.3	Hazard Level C	Yes	Yes	2	4	12
9.4	Hazard Level D	Yes	No	4	Note 6	Note 6
10	Auxiliary vessels - Accumulators					
10.1	pV ≤ 100 MPa.L	No	No	Note 6	Note 6	Note 6
	100 < pV ≤ 200 MPa.L	Yes	No	2	Note 6	Note 6
	pV > 200 MPa.L	Yes	Yes	2	12	12
11	Auxiliary vessels - Other					
11.1	Auxiliary vessels containing corrosive, toxic or flammable contents and except those covered in Note 5.	Yes	Yes	2	4	12
11.2	Auxiliary vessels not containing corrosive, toxic or flammable contents and except those covered in Note 5.	Yes	Note 6	Note 6	Note 6	Note 6
11.3	Particular auxiliary vessels (Note 5)	Yes	Yes	4	Note 5	Note 5
12	Refrigeration and air-conditioning vessels (see Note 7)					
12.1	Group A1 refrigerants					
	pV ≤ 100 MPa.L	No	No	Note 6	Note 6	Note 6
	100 < pV ≤ 200 MPa.L	Yes	No	Note 6	Note 6	Note 6
	pV > 200 MPa.L	Yes	Yes	2	12	12
12.2	Groups A2, A3, B1 and B2 refrigerants	Yes	Yes	2	12	12

Table 4.1 (continued)

1	Pressure equipment	2	3	4		6
				Inspection interval ^a , years	Extended interval	
13	Static low temperature (below -10 °C) vessels (see Clause 4.10)	Commissioning inspection required?	First in-service inspection required?	External inspection	Internal inspection	Inspection interval ^a , years (see Note 1)
				Inspection interval ^a , years	Extended interval	
13.1	Insulated, non-vacuum, non-jacketed, non-toxic contents	Yes	No	4	12	12
13.2	Insulated non-vacuum, non-jacketed, toxic contents	Yes	No	4	12	12
13.3	Vacuum insulated:					
	(a) inner vessel	Yes	No	Clause 4.10	Clause 4.10	Clause 4.10
	(b) outer vessel	Yes	No	4	Clause 4.10	Clause 4.10
13.4	Jacketed non-vacuum vessels:					
	(a) inner vessel	Yes	No	Clause 4.10	Clause 4.10	Clause 4.10
	(b) outer vessel	Yes	No	4	Clause 4.10	Clause 4.10
14	Buried or mounded pressure equipment	Yes	Clause 9.5		Table 4.1 for vessel type	Table 4.1 for vessel type
15	Pressure piping (see Note 8)					
15.1	Hazard Level A	Yes	Yes	2	4	8
15.2	Hazard Level B or C confirmed to be in corrosive, vibrating or elevated temperature service after 1st yearly inspection	Yes	Yes	2	4	8
15.3	Hazard Level D piping and Hazard Level B or C piping confirmed to be in non-corrosive, non-vibrating service and non-creep service after 1st yearly inspection	Yes	Yes	8	Note 6	Note 6
16	Transportable vessels (see Clause 9.3)					
16.1	Service conditions					
16.1.1	Cargo (refer to AS 4343)					
16.1.1.1	Lethal	Yes	Yes	1	2	N/A
16.1.1.2	Very harmful	Yes	Yes	1	5	N/A
16.1.1.3	Harmful	Yes	Yes	1	5	N/A
16.1.1.4	Non-harmful					
	(a) Non-harmful powder discharge vessel (Aluminium construction)	Yes	No	2	2	4

Table 4.1 (continued)

1	2	3	Inspection interval ^a , years (see Note 1)		
			External inspection	Internal inspection	Extended interval
Pressure equipment	(b) Non-harmful powder discharge vessel (Steel construction)	No	3	6	9
	(c) Non-harmful powder discharge vessel (Other material construction)	Yes	1	5	5
16.1.2	Low-temperature (<−10 °C) (see Clause 4.10)				
16.1.2.1	(a) Non-vacuum insulated, non-jacketed (see Clause 9.3.5)	Yes	1	6	6
	(b) Non-vacuum insulated cold stretched	Yes	1	3	3
16.1.2.2	Vacuum insulated (see Clauses 9.3.6 and 4.10.1)				
	(a) Inner vessel	Yes	N/A	N/A	N/A
	(b) Outer vessel	Yes	1	N/A	N/A
16.2	AS 1210 Group G steels [see Clause 9.3.4(c)]	Yes	1	3	6
16.3	Liquefied gas transport drums (chlorine and ammonia)	Clause 9.4			
16.4	Other transportable vessels	Yes	1	5	5
17	Pressure-relief devices	Yes	1	Clause 4.6	Clause 4.6
18	Heritage and historic pressure vessels		Clause 9.6		

^a In this table, P = Design pressure, in megapascals, V = Maximum volume and liquid space, in litres, and N/A = Not applicable.

NOTE 1 Inspection intervals — See [Clause 4.4.5](#) for the maximum allowable deferral period and the associated prerequisites.

NOTE 2 Boilers (see [Clause 9.2](#)):

(a) The inspections given in Columns 3, 4 and 5 should not be confused with the inspections listed in AS 2593. The listed intervals apply regardless of attendance category. Boilers with Hazard Levels D and E, and miniature boilers conforming to AMBSC, do not require inspection to this table.

(b) Coil-type forced circulation boilers are often not constructed in a manner that permits inspection. Such boilers are managed by close attention to water quality and other relevant parameters. For any that can be inspected, the intervals for Item 1.3 (All other boilers) apply.

NOTE 3 Non-transportable storage vessels for hydrocarbon gases and anhydrous ammonia:

(a) Gases may be stored in either the liquefied or gaseous state. These vessels exclude low-temperature vessels normally operating below −10 °C and buried storage pressure equipment.

(b) Conditions may only be considered non-corrosive based on demonstrated experience in identical service.

Table 4.1 (continued)

1	2	3	4			5	6
Pressure equipment	Commissioning inspection required?	First in-service inspection required?	Inspection interval ^a , years (see Note 1)			Extended interval	
			External inspection	Internal inspection			
NOTE 4 Process vessels — These vessels form part of a process train. If the type of vessel used in the process is specifically referred to in another part of this table, the more stringent of the two inspection intervals applies.							
NOTE 5 Auxiliary vessels — Some of these vessels are designed for internal access in intervals in excess of 10 years (e.g. high voltage electricity circuit breakers). If such vessels contain no known deterioration mechanism and there is a significant population of such vessels, the interval between inspections should be determined and agreed by the parties concerned (see Clause C.6.6.3).							
NOTE 6 This equipment is sometimes considered as low hazard and low risk when operated in accordance with good engineering practice and process control, where applicable. Despite this low risk, the pressure equipment and control equipment, where applicable, should be maintained in a fit and safe condition for service, including regular operating surveillance. For repairs or alterations to pressure equipment, see Section 6 .							
NOTE 7 Refrigeration and air-conditioning vessels — For Group A1 refrigerants, internal inspection is not required on the refrigerant side.							
NOTE 8 Pressure piping — See Clause 4.11 and Appendix C .							

4.5 Risk-based inspection

4.5.1 General

The purpose of this clause is to specify the minimum requirements of applying risk-based inspection (RBI) as a means to optimize inspection intervals, inspection scope and monitoring plans. This is an alternative to the requirements of [Section 4.4](#) and [Table 4.1](#) with the exception of commissioning inspection requirements detailed in Column 2 of [Table 4.1](#).

Risk is a function of the likelihood of failure and consequence of failure, used to determine the inspection date and/or interval, as indicated in [Equation 4.5.1](#).

$$\text{Risk} = \text{Probability} \times \text{Consequence}$$

4.5.1

4.5.2 Conditions for adopting risk-based inspection methodology

A risk-based inspection methodology may be used for all pressure equipment provided —

- (a) the methodology is documented;
- (b) the methodology is undertaken by competent persons with specific knowledge of the type of plant being assessed, appropriate for the task (e.g. inspection, corrosion engineering, mechanical engineering, process engineering, maintenance, operations);
- (c) consideration is given to design, manufacture, transit, storage, installation and preservation imperfections; and
- (d) a change management process exists which ensures changes in process conditions, operating mode, equipment design or materials of construction are captured, assessed and addressed.

For transportable vessels, the principles of risk-based inspection may be used to supplement the requirements of [Table 4.1](#) and [Clause C.1](#) to assist in establishing inspection methods and locations but shall not be used to extend the inspection intervals beyond those specified in the table.

4.5.3 Conducting the risk-based inspection assessment

4.5.3.1 Determination of probability of failure

The probability of failure (PoF) shall be determined, as a minimum, by considering the impact of each of the following:

- (a) Damage mechanisms present, taking into account the following:
 - (i) Materials of construction.
 - (ii) Fluid contents.
 - (iii) Operational conditions.
 - (iv) Rate of deterioration.
- (b) Form and extent of damage.
- (c) Inspection effectiveness.
- (d) Inspection findings.

4.5.3.2 Determination of consequence of failure

The consequence of failure shall be determined, as a minimum, by considering the impact of failure in the following categories:

- (a) Health.
- (b) Safety.
- (c) Environment.

Any other categories of consequence may be included. Such categories may include financial impact, equipment damage, reputation, regulatory matters, and loss of production.

4.5.4 Inspection planning and optimization

An important part of developing an optimized inspection plan is the ability to determine the most appropriate inspection methods and/or monitoring program that is proportionate to the assessed risk.

The output of the risk-based inspection process is an inspection scope for each equipment item as detailed in [Clause 2.3.4](#) and an inspection interval commensurate with the risk level determined for the equipment.

4.5.5 Risk-based inspection reassessment

The risk-based inspection program shall be maintained to ensure that it accounts for the most recent inspection and monitoring, process, and maintenance information.

Risk-based inspection reassessment shall be carried out either at a set interval, or after every inspection activity, and additionally after the following:

- (a) Changes to inputs/factors in the risk-based inspection assessment.
- (b) Process excursions outside acceptable limits.
- (c) Adverse inspection findings.
- (d) The identification of new degradation mechanisms.
- (e) Repairs, modifications, alterations, or re-rating.

4.5.6 Risk-based inspection date

The inspection shall be carried out within the maximum inspection interval determined by the risk-based inspection methodology.

Inspection intervals determined using a risk-based inspection methodology may revert to the time-based inspection intervals in [Clause 4.4](#) and [Table 4.1](#) provided —

- (a) the risk-based inspection interval is greater than or equivalent to the time-based inspection intervals in Columns 4 and 5 of [Table 4.1](#); and
- (b) the equipment has been internally and externally inspected where required by Column 3 of [Table 4.1](#).

4.6 Pressure-relief devices

4.6.1 General

This clause applies to all pressure-relief devices, such as safety valves, relief valves, safety relief valves, pressure-relief valves, pilot-operated safety relief valves, thermal relief valves and bursting discs.

referenced in AS 1210, AS 1228, AS 1271, AS 2593, AS 2671, AS 4041, the AS/NZS 5149 series and other international standards. Refer to AS 4942 for definitions of various pressure-relief devices.

NOTE 1 Information is also contained in API 527 and API 576.

Inspection and testing (where applicable) provide means of determining the in-service integrity and adequacy of a pressure-relief device for service. Such devices are the primary safety mechanism for safe-guarding a system from over pressure and are fitted to —

- (a) pressure equipment and auxiliary equipment;
- (b) pressure/vacuum relief valves on atmospheric storage tanks; and
- (c) piping systems to prevent overpressure due to expansion of liquids and gases.

A documented system that includes controls and procedures for each pressure-relief device shall be set in place and include (as a minimum) the following information on each pressure-relief device:

- (i) Manufacturer's data (e.g. type, serial number, size, set point).
- (ii) Identification of valve (e.g. unique plant number).
- (iii) Location.
- (iv) Inspection records.
- (v) Maintenance intervals.
- (vi) Record of adjustments and approver.
- (vii) Setting data (including bench set pressure, relieving pressure, back pressure as appropriate).
- (viii) Record of permanent changes to settings and details of authorization.

If operation of the device is determined to be outside the set parameters or outside the manufacturer's specification or operational settings, the cause shall be investigated and one or more of the following actions shall be taken:

- (A) Eliminate the cause(s).
- (B) Decrease the inspection or test interval.
- (C) Install a device of more appropriate specification.

4.6.2 Commissioning

The installation of pressure-relief devices shall conform to relevant pressure equipment standards, such as AS 1210 and AS 3892, and take into account manufacturer recommendations.

Pressure-relief devices should be installed on full bore fittings to avoid restriction of flow.

Pressure-relief devices that are not attached to flare or vent systems shall discharge to, or be piped to a safe, visible area. Any discharge piping shall be arranged to prevent ingress of foreign material, accumulation of water, fouling and blockage by vermin. If caps are used for sealing, these should be press-fitted into position, and should be easily ejected on discharge of the pressure-relief device, so as not to cause injury to personnel or equipment.

NOTE 1 Refer to AS 3892 for discharge piping requirements.

Each pressure-relief device shall be given a unique identification and its location shall be recorded. [Section 8](#) of this document details identification requirements.

New or serviced pressure-relief devices shall be inspected by a competent person before installation or process start up to ensure that the integrity of the device has not changed during transport or storage, and that any gags, plugs and other such items have been removed. It may be appropriate for the device to be retested before installation, to verify its settings.

New pop action relief valves with soft seats, which are fitted to vessels used for the storage or transport of liquefiable gases, do not require pre-installation testing other than that carried out in the manufacturer's works as witnessed by the stamping on each valve. If the valve is not used within 5 years of the manufacturer's test date, the valve may be preconditioned, before retesting in accordance with [Clause C.4](#).

NOTE 2 Soft seated valves suffer from a memory effect and sticking is common. This may result in excessive over pressure lifts.

4.6.3 Online external visual inspection

Online external visual inspection of pressure-relief devices shall be carried out by a competent person. Such inspections shall be carried out at commissioning, after repair, maintenance or any other time the device is re-installed for duty, or at a nominal ongoing interval according to [Table 4.1](#) Column 4 for time-based inspection (limited to 1 year if the device is not in clean service), or interval determined by risk-based inspection. Regular operating surveillance should be carried out in addition to this.

The inspection interval shall be determined with due consideration of issues such as the consequences of failure, the pressure-relief device history, and specific local conditions such as operating environment and the possible effect of nearby construction or maintenance activities.

An online inspection shall examine each device to ensure the following:

- (a) The correct device is installed.
- (b) Identification provides means to establish the correct set pressure for the equipment protected by the device.
- (c) Gags, blinds or closed valves shall not affect the device's functionality.
- (d) There is no unacceptable external mechanical damage.
- (e) The bonnets of non-balanced valves are plugged.
- (f) The bonnets of balanced valves are vented to a safe location, and the vent is clear and not discharging process fluid.
- (g) Vent stacks, discharge piping and receiving vessels are properly supported.
- (h) Upstream and downstream block valves (where applicable) are secure, and interlocks are managed appropriately.

NOTE AS 1210 includes requirements for the use of interlocks with pressure-relief devices for pressure vessels.
- (i) Any lifting lever is operable and positioned properly.
- (j) External corrosion is not excessive.
- (k) There is no evidence of device tampering.
- (l) Blockage in the outlet or discharge piping has not occurred, nor in any drains fitted to the relief valve or its discharge piping (where possible).
- (m) The device is leak-tight.
- (n) Adequacy and condition of weather protection (where applicable).

- (o) Where discharge piping terminates outdoors, or where ingress of water, dust, debris or vermin is possible, control measures are in place to prevent ingress, accumulation, damage, fouling or blockage.
- (p) Rupture disc integrity is sound by monitoring pressure between rupture discs and pressure-relief valves, when installed in series.
- (q) If possible, inspect for evidence of chattering when the valve discharges and notify a responsible person if observed.

Items (c), (f), (h), (i) and (k) shall be included in operational surveillance.

These inspections shall be documented.

If weather protection has failed, the device should be externally examined and assessed for continued service.

If a pressure-relief device is found to be functioning incorrectly (e.g. excessive leakage, chattering, vibration), it shall be repaired and tested in accordance with [Clauses 4.6.5 to 4.6.10](#).

4.6.4 Handling of pressure-relief devices

Pressure-relief devices (e.g. pressure-relief valves) shall be handled with care at all times as rough handling can misalign intricate internal components, alter the set pressure, increase the leak rate, and cause internal and external damage to the valve.

Pressure-relief valves shall be braced and transported in an upright position, unless otherwise specified by the manufacturer. Pressure-relief valves shall be stored in the upright position.

NOTE Valves 40 mm and above DN should be physically restrained in an upright position in a dedicated box or suitable lifting jig that may be manipulated by proprietary lifting equipment (i.e. forklift, overhead crane, pallet lifter).

Easing gear should be secured so as to prevent upsetting during transport and installation.

4.6.5 Scheduled testing and maintenance

4.6.5.1 General

At appropriate intervals each pressure-relief device shall be tested for operation and, if necessary, overhauled.

AS 1271, API 527 and API 576 provide guidance in determining testing procedures. The terms “pass” and “fail” refer to the acceptance criteria provided in these standards.

All pressure gauges used as a part of the test apparatus for tests (see [Appendix C](#)) shall conform to the relevant requirements for gauges in AS 2337.1.

Pressure-relief device maintenance, overhaul, repairs and testing shall be carried out by a competent person.

A maintenance report shall be prepared and provided for each pressure-relief device tested. All pressure-relief devices shall be subject to an as-received test to measure actual relief pressure and leakage rate. Results of this test should be reported in the pressure-relief device maintenance report and be taken into consideration in setting the intervals between subsequent tests.

NOTE 1 Resilient seat type valves normally require replacement of the seat at the established test interval.

NOTE 2 Springs are the “working element” of a spring-operated safety or relief valve, and may be susceptible to conditions such as fatigue, corrosion and relaxation. Springs should be periodically tested and inspected for performance, wear and defects, and that the correct spring is installed.

For non-balanced valves in applications where a back pressure is expected, the cold differential test pressure (CDTP) shall account for this back pressure so that the desired relief pressure can be achieved. For valves in high temperature applications, any allowances for temperature effects in the CDTP shall be in accordance with the valve manufacturer's instructions. The owner shall provide the valve operating conditions to the service and test facility.

In addition to the maintenance on the pressure-relief device, the inlet and outlet piping shall be inspected for fouling before the pressure-relief device is reinstalled.

A "clean" service is characterized by the condition of the service fluid when no signs of particles, contaminants, damage, corrosion or fouling or any other characteristic which could impair its functionality are found internally or externally.

A "non-clean" or "dirty" service is one that cannot be classified as "clean".

If a service fluid is prevented from being in contact with the pressure-relief device, usually by means of a bursting disc installed upstream and in series, then the service may be considered "clean" on the inlet side. Conditions on the discharge side shall also be taken into account. For vacuum service, bursting discs are fitted on the discharge side of a relief device and the equivalent conditions will apply.

4.6.5.2 Test interval

Test intervals for pressure-relief devices shall be determined by one of the following:

- (a) New pressure-relief device installation that is not subjected to a bench test at commissioning shall be tested after one year of service to verify their suitability for the nominated service. If a pressure-relief device is bench tested at commissioning, the first test interval can be extended up to maximum period of 5 years if an assessment is completed. The assessment should consider the following:
 - (i) Demand rate assessment.
 - (ii) Prior experience with the same devices operating in the same fluid service and environments.
 - (iii) Common industry practice (i.e. if experiential data are available).
 - (iv) Documented online external surveillance and inspection results.
 - (v) The results of commissioning tests.
 - (vi) Safety and environmental consequences of leakage or failure.
 - (vii) Any other relevant factors (i.e. a due process for management of change (MoC) is in place).

Following the second in-service bench test and inspection, the next test interval may be extended up to an interval as follows:

- (A) The interval specified in other relevant standards (e.g. AS 2593).
- (B) If the internal inspection interval of the associated pressure equipment is less than or equal to 5 years, up to the inspection interval of the pressure equipment being protected.
- (C) If the internal inspection interval of the associated pressure equipment is greater than 5 years and the service is clean, the test interval of the pressure-relief device may be extended up to a maximum of 8 years.

If a pressure-relief device does not operate in accordance with design function or with set and reseal procedures during testing or inspection, it shall be overhauled and reset. The competent person shall reduce the next test interval to half the current test interval or no

more than 2 years, whichever is less, to ensure that the relief device will function as required on demand.

For devices in dirty service, overhaul should be considered at each test interval.

- (b) Changes to the test interval for a relief device in-service shall be based on an assessment which considers the following factors:
 - (i) Stability of the operating envelope and process parameters.
 - (ii) Demand rate assessment.
 - (iii) Results of at least of the most recent service/as-received test and inspection reports. The reports shall comply with [Clause 4.6.6](#).
 - (iv) The design and materials of the relief device.
 - (v) Any failures or events in service and root cause analyses outcomes.
 - (vi) The contents of the pressure equipment.
 - (vii) Prior experience with similar devices (e.g. similar design, application, service manufacturer).
 - (viii) Common industry practice.
 - (ix) The safety and environmental consequences of leakage or failure.
- (c) Application of a risk-based inspection methodology in accordance with the requirements in [Clause 4.5](#) The risk assessment shall include as a minimum:
 - (i) Demand rate assessment.
 - (ii) Prior experience with the same devices operating in the same fluid service and environments.
 - (iii) Common industry practice (i.e. if experiential data are available).
 - (iv) Documented online external surveillance and inspection results.
 - (v) The results of commissioning tests.
 - (vi) Safety and environmental consequences of leakage or failure.
 - (vii) Any other relevant factors (i.e. a due process for management of change (MoC) is in place).
- (d) Pop action relief valves with soft seats, which are fitted to vessels used for the storage or transport of liquefiable gases in clean service, the test interval shall not exceed the internal inspection interval for the vessel, or the test interval specified by the manufacture of the relief valve, whichever is less.

In all cases, the assessment shall be fully documented and retained in the information file for the relevant pressure equipment.

Based on this risk assessment, the test interval may be optimized (i.e. either increased or reduced). However, the maximum allowable test interval shall be no more than the inspection interval of the vessel it is designed to protect, subject to the following:

- (i) Justification by a competent person and supported by a risk assessment or a risk assessment if a risk-based inspection methodology is applied.
- (ii) Agreement between all parties concerned.

- (iii) Documented in a manner that provides an auditable trail.

In the absence of a risk assessment, the test interval shall not exceed 5 years or the internal interval of the equipment it protects.

NOTE For devices in dirty service, overhaul should be considered at each test interval.

If a pressure-relief device does not operate in accordance with design function or seat and reseal procedures during testing or inspection, it shall be overhauled and reset. The cause shall be investigated and one or more of the following actions shall be taken:

- (A) Eliminate the root cause.
- (B) Decrease the inspection/test interval to half the current test interval or no more than 2 years, whichever is less.
- (C) Install a device of more appropriate specification.

4.6.5.3 *In situ* testing

For pressure-relief devices in clean service where it is required to determine set pressure, and in some cases valve displacement, an alternative *in situ* online test method may be used. *In situ* testing is not a replacement for periodic bench testing but is an interim option when deemed suitable by a competent person.

Whenever *in situ* test methods are used, the associated risks shall be considered and documented before performing the test. Such risks shall include the following:

- (a) Probability and consequence of failure of the valve to reseal.
- (b) Possibility of damage to valve components, particularly the valve seat.
- (c) Consequences of ongoing product leakage from the valve seat post testing.
- (d) Relief of product to atmosphere.
- (e) Noise.

In situ test methods may be used provided —

- (i) the methods shall only be used to extend the pressure-relief device's test date by 6 months beyond its next scheduled test date;
- (ii) the methods shall be used for one test cycle only (i.e. shall not be used for consecutive tests);
- (iii) contingency plans shall be implemented in case the device fails to re-seat;
- (iv) the nozzle diameter shall be accurately known as the test result is obtained by a calculation that depends on this. The nozzle diameter should be confirmed and recorded at the next strip-down inspection; and
- (v) the raw test result and calculation shall be documented.

Any deviation from restrictions (i) and (ii) shall be supported by a documented risk assessment carried out by a competent person.

For pressure-relief devices tested *in situ*, records of the valve performance and a testing tag and tamper proof seal shall be installed upon completion of testing, equivalent to a conventional bench test. The tag shall contain the following minimum information:

- (A) Date test conducted.
- (B) Serial number.

- (C) Calculated lift pressure or cold differential pressure as appropriate.

4.6.5.4 Testing pressure-relief devices on steam generating equipment

The method historically used for *in situ* testing of pressure-relief devices on steam generating equipment (e.g. boilers) is live lifting. Live lifting is where the pressure is raised in the steam generating equipment, to the point where the valve lifts, relieves pressure and then re-seats.

It is not recommended that live lifting be applied to steam generating equipment with either a long service life or service that has seen many duty cycles, without due consideration. An example of when live lifting may be considered appropriate is for new installations of pressure-relief devices where relief capacity, discharge pipe sizing and support have not yet been proven.

Before subjecting pressure-relief devices on steam generating equipment to live lifting, the risks and hazards involved in these tests shall be taken into account and documented by all parties concerned.

As an alternative to live lifting, *in situ* online testing may be utilized (after applying [Clause 4.6.5.2](#)) where it is required to determine set pressure, spring rate or valve displacement of the pressure-relief device.

NOTE The cold differential test pressure (CDTP) method does not always provide accurate results when considering the differences between test temperature and service temperature.

In steam service, pressure-relief devices with easing gear should have the easing gear function tested before strip down, after the as-received bench test, and the results recorded in the maintenance report.

4.6.6 Maintenance and repair procedures

Maintenance and repair procedures shall cover at least the following items:

- (a) Procedures for dismantling, including procedures for overhauling.
- (b) Procedures for testing and resetting if necessary, including specifications for critical dimensions, spindle run-out, leak testing, set pressure and blow down settings.
- (c) Sealing, marking of tag or nameplate, and certification.
- (d) Documentation of findings and assessed condition of components, records of replacements, and any modifications.
- (e) Records of final pop-test set pressure and blow-down ring settings.

The report should include a declaration by the repairer as to the overall serviceability of the valve in its as-received condition e.g. a statement such as “Conditions were/were not seen that, in the opinion of the repairer, would have prevented operation of the device”.

4.6.7 Re-adjustment and testing

After reassembly, each valve shall be readjusted for set pressure, leakage tested and any blow-down settings and undergo a seat leakage test.

Seals shall be installed in a manner to prevent changing the adjustment without breaking the seal. One seal is normally located on the body sealing the position of the adjusting ring locking pins. A second seal is normally located on the valve cap and lever assembly sealing the position of the compression screw used to adjust the valve set pressure.

Relief valves fitted to steam boilers shall be tested *in situ* after reinstallation or overhaul (see [Clause 4.6.5.4](#) for test methods) unless a documented assessment is completed to justify foregoing the *in situ* tests. Any seals which are broken to effect adjustment shall be replaced on completion of the test.

4.6.8 Bursting discs

Bursting discs (also referred to as rupture discs) or other non-reclosing devices may be used as sole relieving devices or in combination with a pressure-relief device. Bursting discs shall be selected in accordance with AS 1358, BS ISO 4126-2 or another relevant standard.

If the burst disc manufacturer specifies a bolting torque procedure and the tightened bolts are loosened during installation, the burst disc should be replaced.

Inspection and any necessary maintenance shall, where practicable, coincide with the inspection of the associated pressure equipment or pressure-relief valve (if the bursting disc is installed in series with the pressure-relief device). Inspection shall include the following:

- (a) Review of bursting disc nameplate information, including stamped burst pressure and coincident temperature, to ensure the device is compatible with the vessel design and/or pressure-relief device.
- (b) Check for any leakage between bursting disc and pressure-relief valve and any deposits or signs of corrosion.
- (c) Check of the markings indicating direction of flow, as some bursting discs when installed incorrectly may burst well above the stamped pressure.

The service life of a bursting disc is a function of the —

- (i) type of bursting disc;
- (ii) creep strength of bursting element; and
- (iii) operating conditions.

Fluctuating loadings, alternating loadings, temperature changes, corrosion and erosion may considerably reduce the life. The bursting disc shall be changed at the interval recommended by the manufacturer. The disc should be changed sooner under adverse operating conditions.

4.6.9 Rupture pin valves (buckling pin non-reclosing pressure-relief device)

Rupture pin pressure-relief valves shall be inspected in accordance with AS 1210 or an equivalent standard. Installation of rupture pin pressure-relief devices shall be in accordance with the manufacturer's recommendations and AS 3892.

Inspection of rupture pin pressure-relief valves should coincide with the inspection of the associated pressure equipment. This inspection should include the following:

- (a) The correct rupture pin is selected and correctly installed.
- (b) Inspection of local piping to check that distortion has not affected the intended performance of the rupture pin.
- (c) A check of the piston seal and seat surfaces.

If manufacturer's recommendations for inspection are available, they shall be taken into account.

4.6.10 Fusible plugs

Fusible plugs shall be inspected at each internal inspection. If deterioration is detected, they shall be replaced.

NOTE Further guidance is provided in AS 1732.