

## SAMPLE EXAMINATION QUESTIONS AND ANSWERS

1. It is suggested applicants attempt questions before looking at answers.
- General Note: 2. In the exams any essential extract from AS/NZS 3788 or other documents will be supplied, unless applicants are notified to bring AS 3788 etc.
3. Underlined words below are important in understanding questions.
4. Answers to each question are generally in order of importance.

<b>PAPER A - PRELIMINARY AND GENERAL PRACTICE</b>	<b>Total Marks = 100</b>
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1. Identify the most appropriate answer using letter and number:
- a) When it is necessary to alter operating conditions outside the limits of the original design of a large pressure vessel, the owner should ensure that the calculations justify the proposed alteration have been verified by:
- i) an in-service inspector
  - ii) the manufacturer
  - iii) a design verifier
  - iv) the person responsible for the operation of the equipment (1 mark)
- b) Resistance to brittle fracture in weldable ferritic steels is more conveniently assessed by:
- i) Charpy impact test
  - ii) nick break test
  - iii) percentage elongation and reduction of area.
  - iv) bend test (1 mark)
- c) In horizontal pressure piping not near supports and bends where the main loading is from internal pressure, the maximum general stresses are:
- i) located near the top of the pipe
  - ii) directed around the pipe
  - iii) directed across the circumferential welds
  - iv) located at the bottom of the pipe (1 mark)
2. a) List four technical objectives of pressure equipment inspection. (2 marks)
3. a) What do you understand by the terms
- i) "Minimum allowable thickness after forming" (MAF) of a dished end
  - ii) "Corrosion allowance" (CA)? (2 marks)
4. List any eight commissioning and initial inspections required of the owner/inspector to ensure that a 10MW water tube boiler is safe to operate. (5 marks)
5. An organisation with three small air receivers requires your advice on how to satisfy the safety requirements of the National Standard for Plant or your local Regulations. What general advice would you provide? (5 marks)

**PAPER B -**  
**INSPECTION PRACTICE FOR SPECIFIC EQUIPMENT. Total Marks = 100**

1. As an independent inspector write a brief report to the equipment owner describing what you did and the outcome of your inspection for any one item of equipment in question 3.

*[Note: This could list any five common types of equipment covered in AS/NZS 3788 Appendices. E-K, P-T and W. (10 marks)*

2. Pitting corrosion up to 1mm deep is detected locally in the shell of a small 1MPa boiler after 10 years of excellent service with negligible metal loss up to the previous inspection 1 year ago. What action(s) would you take as an inspector to assist your client? (5 marks)

**PAPER E -**  
**PRACTICAL EXERCISE. Total Marks = 100**

EXERCISE NO. 1

The two specimens in this exercise represent two critical areas of carbon steel pressure equipment which are suspect because of probable erosion/corrosion. Using your ultrasonic thickness gauge, measure the approximate minimum thickness of the material in the marked area of each specimen and its position and also the area of thinning.

- a) Record as working notes in your answer book, the minimum thickness and position on each specimen. (Maximum 15 minutes) (6 marks)

*THEN MOVE TO YOUR DESK TO ANSWER THE REMAINING PARTS OF THIS EXERCISE*

- b) List the main parts of the procedure you adopted in this test. (3 marks)
- c) Write brief recommendations to your employer. (3 marks)
- d) What different actions would you have taken if the material was aluminium 5083 plate. (3 marks)

**Total 15 marks**

EXERCISE NO.2

As an independent inspector you are requested by the plant operator to urgently carry out a periodic inspection for the first time to show that the vessel (in the examination room) is "safe" for continued service so that the owner can comply with the National Standard for Plant.

Vessel details are:

- manufactured in 1975, installed in 1977 (see nameplate)
- located outside the building in a highly industrialised area (or seaboard or inland)
- reported to normally contain non-harmful gas supplied by the compressor at 1.0MPa and 90°C
- assume the volume is 100L and any defects are assessed by AS/NZS3788 Appendix W.
- no manufacturer's data report or previous inspection documents are available.

***Applicants are requested not to remove any sticker on the vessel.***

The vessel in the examination room cannot be moved or operated during the examination. Extracts from AS/NZS3788, AS3920.1 and National Standard for Plant which are relevant are attached to assist in answers.

Conduct the inspection of the exhibited vessel; and record your essential observations as working notes in your answer book. (maximum 15 minutes) (5 marks)

**THEN MOVE TO YOUR DESK TO ANSWER THE REMAINING PARTS OF THIS EXERCISE**

EXERCISES 3 to 9 or 10 may include (Each 5 – 20 marks)

- Test to locate leak in a vessel.
- Identify where on a particular pressure equipment thorough inspection is required and why.
- Assess a weld you have asked to be radiographed, and its radiograph and the NATA test report for acceptability. Partial but not full interpretation of the radiograph is required.
- Determine the acceptability of a dent, corrosion or erosion. (Needle gauge or equivalent will be supplied)
- Inspect a newly installed pressure relief valve.
- Assess the suitability of safety controls mounted on a particular item of pressure equipment
- Review a P&ID for acceptability - for isolation prior to entry into equipment; or, for safety of connection between high pressure equipment and low pressure equipment.
- Assess a weld with an imperfection for various service.
- Comment on probable cause of failure of equipment. (Note: Samples are real failures)
- inspect internally part of a vessel by VT using torch and mirror.
- Measure corrosion depth from corroded side.

<b>PAPER C</b>
<b>SISI CALCULATIONS</b> <span style="float: right;"><b>TOTAL MARKS = 60</b></span>

1. A short horizontal cylindrical pressure vessel suffers from heavy external corrosion damage in the form of local wastage over an area of 2000 mm<sup>2</sup>. What would your recommendations on the need to de-rate the design pressure of the vessel at the same design temperature, for each of the following conditions:
  - A. The remaining wall thickness at the thinnest point is equal to the design thickness.
  - B. The minimum mean thickness  $t_m$  over the wasted area is 19.5mm.
  - C. The minimum mean thickness  $t_m$  over the wasted area is 10mm?.

The following data is given:

Nominal thickness of the affected carbon steel plate is 25mm.

Vessel mean diameter is 1500mm

The wasted area is 50mm x 40mm ( $L_a \times L_h$ ), is not near any weld, opening or support, and its dimensions cannot be changed.

Design pressure is 2 MPa; and the design strength of the plate material is 100MPa at the design temperature.

Measures have been taken to ensure future corrosion is nil.

Data from AS/NZS 3788 is supplied (applicants will be advised if the exam is an open book and requires this Standard) (20 marks)

<b>PAPER D</b> <span style="float: right;"><b>TOTAL MARK 60</b></span>
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1. a) Explain what you understand by “risk management”, “risk assessment” and “quality assurance” and identify the main differences between them. (10 marks)

## ANSWERS TO PAPER A

Questions	Answers (Comments for Applicants in Brackets)	AS3788 or other ref.
1.(a)	iii) [Alterations ie changes which affect safety usually require some design. For hazard levels A,B & C design verification and registration is needed with boilers and pressure vessels].	1.4.1, 6.1 & AS3920.1
1.(b)	i) [BF is a serious type of sudden failure in ferritic steels due to low toughness at low temperature in presence of notches. CV test is used for parent material, weld and HAZ].	5.2.5.1(b) T.3.1(b) D15.4, M8
1.(c)	ii) Without bending or restraint, hoopstress is twice axial stress in pipe, pressure vessels, boilers and cylinders; hence greater importance of axial type defects].	1.2 (AS4041)
2.(a)	<ul style="list-style-type: none"> <li>• promote the safety and health</li> <li>• assist in ensuring that pressure equipment is safe and performs reliably until the next planned inspection.</li> <li>• verify that the fabrication (MDR) and commissioning data complies.</li> <li>• assist in ensuring that maintenance, repairs, and alterations are carried out without decreasing integrity.</li> <li>• indicate early warning of repairs, replacements or alterations.</li> <li>• assess remaining safe life.</li> <li>• comply with occupational health and safety legislation.</li> <li>• assess performance of new design, material fabrication etc.</li> <li>• investigate failures, dangerous incidents, reduced performance, or abnormal conditions.</li> </ul>	2.1
3.(a)	<p>i) MAF – is designer or purchaser advice for the minimum acceptable thickness (usually in the knuckle radius where thinning occurs during forming) before going into service and includes CA. Some areas may be over 10% thicker than design minimum thickness and can tolerate more corrosion than the knuckle.</p> <p>ii) CA – the design or purchaser allowance to cater for the loss of thickness due to in-service corrosion (including erosion etc)over equipment life..</p>	AS 3738 and AS1210
4	<p>a) All necessary safety devices are fitted and operate correctly.</p> <p>b) Supervise, witness or verify any site pressure tests.</p> <p>c) Pressure equipment is clearly identified.</p> <p>d) Update records.</p> <p>e) Verify design, manufacture and installation (eg MDR etc) complete.</p> <p>f) Check original thickness</p> <p>g) Check protective coating (insulation etc).</p> <p>h) Check that no extraneous material is left in the pressure equipment.</p> <p>i) Ensure valid certificate of inspection.</p> <p>j) Dimension equipment in the temperature creep range.</p> <p>k) Verify special operational and performance tests successfully completed.</p>	4.2
5.	<ul style="list-style-type: none"> <li>• ensure vessels safety devices and inter connections are safe</li> <li>• indicate hazards (eg. pressure energy – burst, projection jet)..</li> <li>• assess risk (usually very small with small air receiver)</li> <li>• control risk by: <ul style="list-style-type: none"> <li>- having evidence of suitable design and fabrication eg. makers name or MDR.</li> <li>- instructions, inspection and maintenance to suit vessels and staff – by persons judged by owner to be competent.</li> <li>- keeping brief record – eg. see AS3873 Appendix J</li> </ul> </li> </ul>	Competency 1.4 See also Answer 4

## ANSWERS TO PAPER B

Question	Answers	AS3788 Ref. & Comment
1	<p>[Typical complete report and check list from “independent inspector” to <u>owner</u>. This would be reduced for most equipment and in house report to inspectors employer].</p> <p style="text-align: center;"><b>Inspection body Name and Address</b></p> <p>To: Customer/Owner Report No:  Company Name/Address Date:  Attention: J Blow Page 1 of 1  Ref: Your O/N</p> <p>Subject: <b>In-Service Inspection Report for PV-10</b></p> <p><b>Equipment:</b></p> <p><i>Title:</i> Unfired process vessel. Ident: PV-10. Reg/No V654321</p> <p><i>Code:</i> AS 1210-Class 2A. DP:MPa. DT 200°C. Vol 10m<sup>3</sup>. made 1982  <i>Contents:</i> LPG mixture. [Hazard Level B]  <i>Location:</i> XYZ Reclaimers, address. <i>Last Inspection</i> 12/95</p> <p><b>Inspection:</b></p> <ul style="list-style-type: none"> <li>• Top 3 strakes – external insul removed (refer last inspection)</li> <li>• 4 yearly internal and external to AS 3788 (valves/controls by others)</li> <li>• Date, 19/3/98</li> <li>• By :Inspector D. Tracey</li> </ul>	<p>App K – modified.</p> <p>ie who from</p> <p>who to, date</p> <p>refs. Short Title</p> <p>Identify equipment</p> <p>Summary of inspection, what, when, who.</p>
	<p><b>Result</b></p> <ul style="list-style-type: none"> <li>• VT of all visible surfaces – OK except as below:</li> <li>• External – rust &amp; 1mm corrosion on top 2 insulation rings &amp; head.</li> <li>• Top platform needs painting: new gasket for manway.</li> <li>• Internal – shell thickness UT: 15.1 – 15.4mm at spots <ul style="list-style-type: none"> <li>- No change.</li> <li>- UT &amp; MT at Nozzle 10 showed 2mm loss of thickness due to erosion (checked with SISI – OK for next 10 years).</li> <li>- UT thickness of skirt under concrete insulation, no significant thinning</li> </ul> </li> </ul> <p><b>Recommendations</b></p> <ul style="list-style-type: none"> <li>• Urgent – Modify top insulation rings to permit drainage. Prepare and repaint top shell, rings and head. Fix insulation, otherwise MAT may be reached in 5 years.</li> <li>• Return to service at least after painting &amp; good installation.</li> <li>• Next inspection. External 2001 sample under insulation Internal 2003</li> <li>• Plan future action re Nozzle 10 if vessel life &gt; 10 years.</li> </ul> <p><b>References</b></p> <p>UT Thickness Survey UT 21 (date) and SISI Report (attached date)</p>	<p>Simplify by only listing abnormals. Detailed results may be in survey report (see results)</p> <p>List what’s needed now.</p> <p>List next inspections &amp; possible future limits</p>

2.	<p><b>Conditions</b>  Above inspection and results comply with AS 3788. Date of next inspection assumes no significant change in vessel operation.</p> <p>Signed _____ for Inspection body.</p> <ul style="list-style-type: none"> <li>• Sudden pitting suggests major change in operation or conditions.</li> <li>• Need immediate correction as 1mm loss/year is very significant (especially on small thin-walled boilers).</li> <li>• Could be due – <ul style="list-style-type: none"> <li>a) to leaking valves or rain [if external corrosion]. Then paint &amp; fix leaks.</li> <li>b) loss of feed water control [condensate, oxygen] internal corrosion of shell or tubes. Correct changes.</li> <li>c) may be others. Investigate further if needed.</li> </ul> </li> <li>• Record briefly and advise client as above.</li> </ul>	5.3.6 M2.2
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**ANSWER TO PAPER E**

Exercise	Answers	AS3788 Ref.
1	<p>[Only one specimen is reported here] (a)</p> <div style="text-align: center;"> </div> <p>(a) UT Thickness Gauge XYZ Model B4, size Calibrated on job for carbon steel. Acoustic velocity 5xxx</p> <p>Specimen: Sample 4, Flat Plate MS. Surface OK. Couplant: Clear grease. Initial Scanning: 10mm intervals in line 10mm apart. Local scanning at thickness change: sliding and 90° rotation.</p> <p>(b) Local pitting or blind hole at position X  <ul style="list-style-type: none"> <li>• Could be local corrosion – more like a drilled hole during fabrication (may be plugged on other end).</li> <li>• Recommend check for possible cause. Use UT to determine; or remove refractory for VT Monitor].</li> </ul> </p> <p>d) Recalibrate gauge to suit acoustic velocity of aluminum alloy                      [for measure thickness by caliper etc]..</p>	
2.	<ul style="list-style-type: none"> <li>• Give rough sketch of vessel with approx. main dimensions [not given here].</li> <li>• Data Plate details [Copy details]</li> <li>• PRV checked OK. PG OK.</li> <li>• Mild steel approx. 6mm shell and heads.</li> <li>• Stop valve appears OK.</li> <li>• Crack at position X: corrosion at Y: Dent at Z [locate on sketch.]</li> </ul>	PRV = Pressure Relief Valves PG= Pressure Gauge
3-10	Not given here – see AS/NZS 3788	

**ANSWER TO PAPER C**

Question	Answers	AS3788 Ref.
1	<p>A. As the remaining thickness is equal to the design thickness, the thinning can be accepted.  <b>No need to re-rate design pressure [except if very significant sudden loss from actual to design thickness and CA is small].</b></p> <p>B</p> <div style="display: flex; align-items: center; margin-left: 40px;"> <div style="border: 1px solid black; width: 150px; height: 50px; margin-right: 20px;"></div> <div style="text-align: center;"> <math>L_a = 50</math>  <math>L_h = 40</math> </div> </div> $t_1 = \frac{pD}{2f} = \frac{2 \times 1500}{2 \times 100} = 15\text{mm}$ $t_2 = \frac{pD}{4f} = \frac{2 \times 1500}{4 \times 100} = 7.5\text{mm}$ $L_s = 0.55 (Dt_1)^{1/2} = 0.55 (1500 \times 15)^{1/2} = 82.5\text{mm}$ <p>Conditions: <math>L_a &lt; 5 L_s</math> }  <math>L_n &lt; 5 L_s</math>, and } Are satisfied.  <math>L_n &lt; 2D/3</math> }</p> $\frac{t_m}{t} = \frac{19.5}{15} > 1, \text{ and } \frac{L}{L_s} = \frac{50}{82.5} = 0.6$ <p>The intersecting point in fig N2 is above the heavy line. Thus thin patch is acceptable.</p> <p>Check with N4 shows vessel acceptable as <math>t_{m12}</math> is say 12mm.</p> <p>C If <math>t_m = 10</math>, then <math>\frac{t_m}{t} = \frac{10}{15} = 0.67</math>  <math>\frac{L}{L_s} = 0.6</math> (no change from previous)</p> <p>From fig N2 this new intersecting point is below the heavy line and thinning patch is unacceptable.</p> <p><math>L/L_s</math> value cannot change. Hence to re-rate the equipment <math>t_m/t</math> has to be modified.</p> <p>Using fig N2 at <math>L/L_s = 0.6</math>, then <math>\frac{t_m}{t}</math> should be 0.78 or above to be over  the heavy line and be acceptable.</p>	<p>N3.3 D = mean diameter</p> <p>N3.4</p> <p>N3.2</p> <p>N3.6 P109</p>

**ANSWER TO PAPER C**

Question	Answers	AS3788 Ref.
	<p><math>t_M</math> is given as 10mm</p> $t = \frac{10}{0.78} = 12.82 \text{ mm}$ $t = \frac{pD}{2f}$ $P = \frac{2ft}{D} = \frac{2 \times 100 \times 12.82}{1500}$ $= 1.709 \text{ MPa}$ <p>Check with N4 shows vessel is acceptable if static.</p> <p>[Note the re-rating pressure may vary if applicant uses <math>t_m &gt; 0.78</math> but</p> <p style="text-align: center;"><math>t</math></p> <p>that will be conservative and acceptable.</p>	

**ANSWER PAPER D**

Question	Answers	AS3788 Ref.
1a	<p>[Note: These terms are used differently by different persons but the intent for AICIP is below.]</p> <p><b>Risk Management (B1)</b> Overall management of risk to “optimise the balance of safety, efficiency and profitability”. It includes hazard identification, risk assessment, control risk and continued monitoring.</p> <p><b>Risk assessment (B2.6)</b> “quantification of total risk (i.e. hazard consequence to life, property, environment &amp; production) and is a combination of previous studies and analyses, which depend on equipment inspection procedures and incident reporting.</p> <p><b>Quality Assurance</b> – the management system documented or not, which provides confidence that the quality of operations should provide products or services fit for purpose and to specification.</p> <p><b>Risk Management</b> is focussed on overall management of risk in a business while <b>quality assurance</b> addresses overall management to provide a <b>quality</b> product (or service). They are related and are essential parts of a “total management system”.</p> <p><b>Risk Assessment</b> is an important <b>part</b> of the overall process of management of risk.</p> <p>All play a role in the overall control of pressure equipment to comply with the National Standard for Plant and most regulations.</p>	<p>1.5 Append. B.1 also AS 3873 &amp; AS/NZS 4360</p> <p>B 2.6</p> <p>AS/NZS-ISO 9000 series &amp; AS 3920.1</p>