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- Australian Atomic Energy Commission
- Australian Institute for Non-destructive Testing
- Australian Pipeline Industry Association
- Australian Welding Institute
- Bureau of Steel Manufacturers of Australia
- Commonwealth Aircraft Corporation Limited
- Confederation of Australian Industry
- Department of Defence
- Department of Industrial Relations, N.S.W.
- Electricity Supply Association of Australia
- Institute of Australian Foundrymen
- Metal Trades Industry Association of Australia
- Ministry of Employment and Training Victoria
- National Association of Australian State Road Authorities
- National Association of Testing Authorities, Australia
- Pipeline Authority
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PREFACE

This standard was prepared by the Association’s Committee on Non-destructive Testing of Metals and Materials, at the request of industry. It provides a method for the measurement of thickness by non-destructive testing, and is one of a series of standards on thickness measurements; others in the series are as follows:

Part 1  Determination of the Wall Thickness of Pipe by the Use of Radiography
Part 2  Determination of the Remaining Wall Thickness of Corroded Pipe by the Use of Radiography

During preparation of the standard, consideration was given to the following documents issued by the Japanese Society for Non-destructive Inspection:

NDIS 2105 — Evaluation of Performance Characteristics of Portable Pulse-echo Ultrasonic Thickness Meter
NDIS 2408 — Thickness Measuring Method using Portable Pulse-echo Ultrasonic Thickness Meters.

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1 SCOPE. This standard sets out five methods for the determination of thickness of material based on the use of ultrasonic pulse-echo principles where scanning and reflecting surfaces are substantially parallel. The methods are as follows:
(a) Single spot — single measurement (SS).
(b) Single spot — double measurement (SD).
(c) Multiple spot measurements (MS).
(d) Close grid survey method (CG).
(e) Open grid method (OG).

NOTES:
1. Supplementary information required to augment the standard is set out in Appendix A.
2. Factors affecting the results and order of accuracy achieved are given in Appendix F.

2 APPLICATION. Methods described in this standard are suitable for the determination of thickness of materials where surface temperature is within the range of -10°C to 60°C and where the velocity of sound through the material is either known or can be determined.

The methods may be used where surface temperature is lower than -10°C, or higher than 60°C, but in such cases special precautions are required.

The methods may also be used where Base Line Survey or Key Point Survey concepts are applied as follows:

2.1 Base Line Survey. Base Line Survey entails the measurement of components at nominated locations on new items or alternatively at the time of commissioning of new plant. Results can then be kept on record for comparison against subsequent measurements taken after service use. In addition, initial survey results can be compared to nominated design or drawing thicknesses for construction checking purposes.

2.2 Key Point Survey. Key Point Survey entails routine repeat testing at specific nominated positions on operating components. The locations of key test points are usually determined from anticipated performance characteristics of the component or alternatively from the performance history of the component. Duration between surveys is similarly determined. The Key Point Survey concept allows component performance to be monitored in terms of section loss at the test location, thus allowing maintenance and repair scheduling to be carried out on an ordered basis.

In the application of this standard, the order of accuracy shall be the accuracy of the test equipment. Additional factors affecting ultimate accuracy of the test depend upon conditions peculiar to individual applications, such as the state of the reflecting and contact surfaces. Flat, smooth surfaces are ideal for accurate measurements whereas irregular surfaces can cause variable ultrasonic response (see Appendix C).

Small pits or pinholes may not be detected because of insufficient reflecting surface.

NOTE: Guidance on the determination of thickness at elevated temperatures is given in Appendix B.

3 REFERENCED DOCUMENTS. The following standards are referred to in this standard:
AS 1929 Non-destructive Testing — Glossary of Terms
AS 2083 Calibration Blocks and Their Methods of Use in Ultrasonic Testing.

4 DEFINITIONS. For the purpose of this standard, the terms and definitions given in AS 1929 and the following apply:

4.1 Nominal thickness (Tn) — specified material thickness at the time of manufacture.

NOTE: Nominal thickness is usually specified in product standards and shown on drawings.

4.2 Indicated thickness (Ti) — thickness indicated by the ultrasonic test before the application of correction factors.

4.3 Reported thickness (Tr) — indicated thickness corrected for material and temperature variations between the material under test and the calibration block.

4.4 Testing authority — test laboratory or establishments which provide non-destructive testing services.

4.5 Delay block spacer — a block of material used between the test surface and the probe to prevent overheating of the probe and for measuring thin sections.

5 EQUIPMENT.

5.1 General. Ultrasonic instruments for thickness determinations shall use one of the following systems:
(a) A-scan presentation.
(b) Digital display.
(c) Meter display.

5.2 A-scan presentation.

5.2.1 General. Equipment shall be capable of displaying an ultrasonic echo with sufficient definition to permit measurements within ±1 percent over the test range.
5.2.2 **Horizontal linearity.** Horizontal linearity shall be assessed in accordance with AS 2083 for the test range to be used. Any deviation of horizontal linearity greater than 1 percent shall be observed and recorded.

5.2.3 **Frequency.** Equipment should be capable of testing within the frequency range 0.5 MHz to 10 MHz.

5.2.4 **Probes.** Either single or twin crystal probes may be used. They should have a nominal frequency for use in the range 0.5 MHz to 10 MHz. Probes shall be inductively matched with the detector to optimize ultrasonic response.

**NOTE:** Factors affecting probe selection are given in Appendix C.

5.3 **Digital and analog (meter) displays.**

5.3.1 **Readability of meter displays.** The resolution of the reading of the instrument shall be better than 1 percent over the full scale.

5.3.2 **Accuracy of systems.** The accuracy of systems shall be ±0.2 mm or ±1 percent of the indicated reading, whichever is the greater.

5.3.3 **Probes.** Probes used should be those recommended by the manufacturer of the equipment. Probes other than those recommended by the manufacturer may be used, provided that they are proved to be compatible with the test equipment.

5.4 **Couplant.** A couplant with good wetting characteristics at the temperature of test and compatible with the material under test shall be used (see Appendix B).

6 **CALIBRATION.**

6.1 **General.** A step-wedge block(s) covering the thickness range shall be used to calibrate the test range. Blocks should be constructed using material with similar nominal acoustic velocity to the material under test. When using instruments which have variable compression wave velocity control, the control shall be adjusted to align acoustic velocity to within ±1 percent of the acoustic velocity in the material under test.

**NOTES:**
1. Nominal velocities for some common materials are given in Appendix D.
2. Appropriate calibration blocks are covered by AS 2083.

Where calibration blocks of the material under test are not available and compression wave velocity is not known, it is necessary to prepare appropriate correction charts (see Appendix E).

As acoustic velocities can vary with changes in temperature, calibration procedures should be carried out with the calibration block or step-wedge at the same temperature as the material under test.

6.2 **Calibration — A-scan presentation.** Use a step-wedge block and calibrate the equipment for the test range to be used. To calibrate the unit, adjust the zero delay and range controls in such a way that at the baseline of the trace the leading edge of the vertical deflection of the trace, corresponding to the thickness selected, is coincident with the appropriate graticule position. These positions shall correspond to the step thicknesses of the step-wedge selected.

Care must be taken during calibration and each subsequent measurement to ensure that when observing the leading edge of an echo, the echo amplitude must be the same for each thickness reading. Gain control shall be used to adjust the echo being observed to 80 percent graticule height. Suppression, if required, is to be switched on before calibration and should not be altered during the test. Should adjustment of suppression be necessary, calibration should be verified.

6.3 **Calibration — digital and analog (meter) display.** Calibration shall be carried out in accordance with the manufacturer’s recommendations. The accuracy requirement of Clause 5.3 shall be verified by the use of step-wedge blocks as specified in Clause 6.1.

7 **PREPARATION OF TEST SURFACE.** All test surfaces shall comply with the following requirements:

(a) The profile of test surfaces shall permit uniform probe contact throughout the measurement.

(b) Any surface condition which interferes with the test such as loose paint and scale shall be removed.

(c) Roughness of the test surface should not exceed 6.3 μm Ra.

Where the surface is pitted and mechanical improvement is not possible, the surface condition shall be recorded and included in the test report together with a statement on the effect of such a surface on the order of test accuracy.

**NOTE:** Care must be taken during the preparation of the test surface to ensure that the removal of any base material is kept to a minimum.

8 **SINGLE SPOT — SINGLE MEASUREMENT METHOD (SS).**

8.1 **Application.** Suitable for use where reflecting surfaces are substantially smooth and parallel.

**NOTE:** Factors affecting results and order of accuracy are given in Appendix F.

8.2 **Procedure.**

(a) Use either a single or twin probe and make a single spot measurement on the test surface.

(b) Record the result. Apply correction factors.

9 **SINGLE SPOT — DOUBLE MEASUREMENT METHOD (SD).**

9.1 **Application.** Suitable for use where the reflecting surface is curved or irregular, e.g. on surfaces with a minor degree of corrosion or erosion.

**NOTE:** Factors affecting results and order of accuracy are given in Appendix F.

9.2 **Procedure.**

(a) Use a twin probe and make a single spot measurement on the test surface.

(b) Rotate the probe 90 degrees on the same spot and make a second measurement.

(c) Record the lower reading. Apply correction factors.

10 **MULTIPLE SPOT MEASUREMENT METHOD (MS).**

10.1 **Application.** Suitable for use where the reflecting surface is severely eroded or corroded, or where the
presence of subsurface discontinuities is suspected (see Appendix G).

NOTE: Factors affecting results and order of accuracy are given in Appendix F.

10.2 Procedure.

(a) Use either a single or a twin probe and make at least four measurements (SS or SD) within a circle of approximately 25 mm in diameter on the test surface.

(b) Record the lowest reading. Apply correction factors.

11 CLOSE GRID SURVEY METHOD (CG).

11.1 Application. Suitable for use where a detailed contour of the reflecting surface is required.

NOTE: Factors affecting results and order of accuracy are given in Appendix F.

11.2 Procedure.

(a) Use the SS or SD method to completely survey a nominated area by making a number of measurements at a maximum of 10-millimetre spacings over the test surface (see Appendix G).

(b) Record the readings. Apply correction factors.

(c) Plot reported thickness vs location on a graph.

12 OPEN GRID MEASUREMENT METHOD (OG).

12.1 Application. Suitable for use where a thickness survey is required over a large area.

NOTE: Factors affecting results and order of accuracy are given in Appendix F.

12.2 Procedure.

(a) Make a number of measurements on a specified grid on the test area (see Appendix G) using any of the methods SS, SD or MS.

NOTE: Recommended grid spacings are 75 mm and 150 mm, however this does not preclude the use of other grid sizes by agreement.

Where any thinning of material is noted, further examination should be carried out by means of a close grid survey.

(b) Record the readings. Apply correction factors.

(c) Plot thickness vs location.

13 RECORD OF RESULTS. A record of results shall be made and shall be capable of providing the following information:

(a) Name of testing authority.

(b) Date of test.

(c) Identification of component, job reference and exact position of measurements from a known datum.

(d) Type of material (see Appendix A).

(e) Condition of scanning surface.

(f) Method of test, including method of applying corrections.

(g) Type of instrument, probes and calibration procedures used.

(h) Order of accuracy (see Appendix F).

(i) Couplant used.

(k) Temperature of test surface and calibration block, if below -10°C or above 60°C.

(l) Indicated thickness, reported thickness and any plots made.

(m) Any abnormal conditions encountered by the operator.

(n) Name of test operator.

14 TEST REPORT.

14.1 General. The test report shall contain the following information:

(a) Name of the testing authority.

(b) Report number and date.

(c) Identification of material and location of test areas, including the test datum point.

(d) Type of material.

(e) Instrument and probe type.

(f) Order of accuracy.

(g) Couplant.

(h) Test method used.

(j) Date of test.

(k) Temperature of test surface, if below -10°C or above 60°C.

(l) Reported thickness(es) and contour map, if applicable.

(m) Any abnormal conditions encountered by the operator (see Clause 14.2).

(n) The number of this Australian standard, i.e. AS 2452.3.

(o) Name of test operator.

14.2 Abnormal conditions. Features in the material being tested which may interfere with test results such as laminations or failure to obtain a back echo shall be investigated with A-scan presentation, recorded and reported.
APPENDIX A

SUPPLEMENTARY INFORMATION

A1 GENERAL. The following list details minimum relevant information which must be supplied to test personnel before commencement of the test:

(a) Identification or job reference number and/or order number.
(b) Product standard, application standard reference number, if appropriate.
   NOTE: For the purpose of this standard, ‘product standard’ is synonymous with ‘job specification’, and ‘application standard’ with ‘construction standard’.
(c) Plan and description of material to be tested, including nominal thickness and location of areas to be thickness tested.
(d) Method of measurement.
(e) Type of material.
(f) Expected material temperature, if lower than -10°C or higher than 60°C.
(g) Any departures from the test methods or conditions described in this standard.

A2 TESTING AUTHORITIES. The effectiveness of ultrasonic thickness testing depends on the technical competence of personnel performing the tests and on their ability to interpret indications. However, the responsibility for assessing the significance of thickness measurements does not lie with the Testing Authority.

The National Association of Testing Authorities, Australia (NATA) operates the Australian laboratory accreditation system. Facilities for the tests in this standard are afforded by laboratories registered by NATA.

In its assessment of non-destructive testing laboratories, NATA recognizes qualifications granted by the Australian Institute for Non-destructive Testing as evidence of a person’s general knowledge on non-destructive testing techniques, e.g. radiographic testing, ultrasonic testing.
GUIDANCE ON THE DETERMINATION OF THICKNESS AT ELEVATED TEMPERATURES

The pulse-echo ultrasonic methods described in this standard for the determination of thickness are generally valid for material temperatures up to 60°C. Above this temperature the methods require special considerations. These considerations fall into three groups:

(a) Change in velocity of the acoustic transmission. Changes in velocity occur both in the material being measured and in the probe or probe spacer if the temperature in these is allowed to rise. The velocity of the transmission in the material can be predicted if the material type and the temperature is known and hence the apparent thickness measured can be corrected with the aid of charts, to give true thickness.

(b) Protection of the probe crystal. Changes in velocity due to the heating of the probe cannot be predicted accurately. Therefore it is essential for the probe not to be allowed to become overheated. This is achieved by either the use of spacers or by restricting contact time.

(c) Couplant. High temperature grease is considered satisfactory for use up to 200°C but beyond this temperature, brazing flux has been found to be more suitable.

NOTE: Five parts of stainless steel brazing flux powder mixed with 1 part of water has been found to be satisfactory for temperatures up to 500°C.
APPENDIX  C

FACTORS AFFECTING PROBE SELECTION

C1  GENERAL. The choice of probe(s) for the measurement of thickness depends to a great degree on resolution and accuracy required, thickness and type of material under test and on conditions of the test surface(s).

The following information gives guidance on different types of probes used for thickness measurements.

C2  FREQUENCY. Choice of probe frequency is influenced by the following factors:

(a) Nature of the material through which the beam will pass. Attenuation of the ultrasonic beam largely depends on the structure of the material being tested. In a coarse-grained metal the higher frequencies are absorbed so that it may be necessary to use a lower frequency to obtain adequate penetration by the ultrasonic beam.

(b) Resolution. Reflecting surfaces separated by small differences in range are more clearly resolved by the use of higher frequencies.

(c) Scanning surface. Rough scanning surfaces will result in greater transfer losses of acoustic energy at higher frequencies. However, where it is not possible or desirable to improve the surface condition, the use of lower frequencies may give better transfer characteristics but with a resulting loss of resolution.

C3  SINGLE PROBES. Single probes may be used on thicker materials, i.e. where thickness is greater than the probe dead-zone.

NOTE: Pitting and some forms of corrosion are not easily detected with single probes.

C4  SINGLE PROBES WITH SPACERS. Single probes with spacers may be used for measurement of thin sections, provided that the multiple-echo from the spacer does not interfere with echoes from the material.

C5  TWIN PROBES. Twin probes may be used on most thicknesses. However, focused probes are necessary to give optimum response from reflectors within the focus range and may be used with advantage where the reflecting surface is pitted or corroded.
### APPENDIX D

**NOMINAL VELOCITY OF SOUND IN SOME COMMON MATERIALS**

<table>
<thead>
<tr>
<th>Material</th>
<th>Density kg/m³</th>
<th>V₁ m/s</th>
<th>Vₛ m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium rolled</td>
<td>2 700</td>
<td>6 300</td>
<td>3 080</td>
</tr>
<tr>
<td>Brass (70/30)</td>
<td>8 600</td>
<td>4 200 to 4 700</td>
<td>2 020 to 2 120</td>
</tr>
<tr>
<td>Copper, annealed</td>
<td>8 930</td>
<td>4 700</td>
<td>2 300</td>
</tr>
<tr>
<td>Copper, rolled</td>
<td>8 930</td>
<td>5 010</td>
<td>2 270</td>
</tr>
<tr>
<td>Gold, hard drawn</td>
<td>19 700</td>
<td>3 240</td>
<td>1 200</td>
</tr>
<tr>
<td>Iron, armco</td>
<td>7 850</td>
<td>5 960</td>
<td>3 240</td>
</tr>
<tr>
<td>Lead, annealed</td>
<td>11 400</td>
<td>2 160</td>
<td>700</td>
</tr>
<tr>
<td>Monel metal</td>
<td>8 900</td>
<td>5 350</td>
<td>2 720</td>
</tr>
<tr>
<td>Nickel</td>
<td>8 900</td>
<td>5 630</td>
<td>2 960</td>
</tr>
<tr>
<td>Platinum</td>
<td>21 400</td>
<td>3 960</td>
<td>1 670</td>
</tr>
<tr>
<td>Silver</td>
<td>10 400</td>
<td>3 600</td>
<td>1 590</td>
</tr>
<tr>
<td>Steel, low carbon</td>
<td>7 850</td>
<td>5 960</td>
<td>3 235</td>
</tr>
<tr>
<td>Steel, stainless (347)</td>
<td>7 900</td>
<td>5 790</td>
<td>3 100</td>
</tr>
<tr>
<td>Steel, 1% C</td>
<td>7 840</td>
<td>5 940</td>
<td>3 220</td>
</tr>
<tr>
<td>Steel, 1% C hardened</td>
<td>7 840</td>
<td>5 854</td>
<td>3 150</td>
</tr>
<tr>
<td>Glass, pyrex</td>
<td>2 320</td>
<td>5 640</td>
<td>3 280</td>
</tr>
<tr>
<td>Glass, light borate brown</td>
<td>2 240</td>
<td>5 100</td>
<td>2 840</td>
</tr>
<tr>
<td>Lucite</td>
<td>1 180</td>
<td>2 680</td>
<td>1 100</td>
</tr>
<tr>
<td>Nylon 6-6</td>
<td>1 110</td>
<td>1 800 to 2 700</td>
<td>1 070</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>900</td>
<td>2 000</td>
<td>540</td>
</tr>
<tr>
<td>Polystyrene</td>
<td>1 060</td>
<td>2 350 to 2 670</td>
<td>1 120</td>
</tr>
<tr>
<td>Rubber, neoprene</td>
<td>1 330</td>
<td>1 600</td>
<td>—</td>
</tr>
</tbody>
</table>

**LEGEND**

V₁ = velocity of plane longitudinal (compression) wave in bulk material
Vₛ = velocity of plane transverse (shear) wave
APPENDIX E

DETERMINATION OF THICKNESS BY THE USE OF CORRECTION FACTORS AND CHARTS

E1 GENERAL. This standard recognizes that one-off thickness determinations may prevent the use of calibration blocks as specified in Clause 6 of this standard. In such cases, thickness may be determined by the use of a correction chart in accordance with Paragraph E2 or by the use of a correction factor determined in accordance with Paragraph E3.

E2 DETERMINATION OF THICKNESS BY MEANS OF A CORRECTION CHART. Where the compression wave velocity of the material under test is not known and two or more thicknesses of sections can be measured mechanically, e.g. by means of a micrometer or vernier, then the reported thickness may be obtained by use of a correction chart.

A correction chart may be constructed as follows:
(a) Calibrate the equipment using a step-wedge of known acoustic velocity and thickness.
(b) Mechanically measure two or more thicknesses of the material under test. Record the measurements.
(c) Position the probe on the material under test at the same spots as used for step (b). Note and record the indicated thicknesses.
(d) Plot the recorded thicknesses obtained by step (c) against the mechanically measured thicknesses obtained by step (b).

NOTE: A typical thickness correction chart for cast 99.9 percent copper showing equipment calibration against plain low carbon steel is given in Fig. E1.
(e) Use the correction chart to determine thickness for indicated readings taken at other locations on the material under test.

Fig. E1. TYPICAL CORRECTION CHART
\textbf{E3 DETERMINATION OF THICKNESS BY THE USE OF A CORRECTION FACTOR.} A correction factor can be applied to the indicated readings to give reported thickness, provided that the velocities of sound in the calibration block and in the material under test are known.

Procedure for determination of velocity in the material under test is as follows:

(a) Measure thickness of the material under test by means of a micrometer or vernier \( (T_m) \).

(b) Calibrate equipment using a step-wedge of known thickness and velocity.

(c) Position probe on the material under test at the same spot as used for step (a). Note and record the indicated thickness \( (T_i) \).

(d) Calculate the compression wave velocity in the material by the use of the following formula:

\[
CL_1 = \frac{T_m \times CL_2}{T_i}
\]

where

\( CL_1 \) = acoustic velocity in material under test
\( CL_2 \) = acoustic velocity in step-wedge
\( T_m \) = measured thickness of material under test
\( T_i \) = indicated thickness of material under test.

(e) Use the ratio \( CL_1/CL_2 \) as the correction factor to be applied to subsequent determinations or to produce a correction chart (see Fig. E1).

\textbf{NOTE:} Alloying elements and conditions of processing may markedly affect the theoretical velocity stated in Appendix D, particularly in respect to copper and aluminium alloys.
APPENDIX F

FACTORS AFFECTING RESULTS AND ORDER OF ACCURACY

F1 GENERAL. Many factors can affect accuracy of the indicated readings especially when using portable pulse-echo ultrasonic thickness measuring instruments. Some of these factors are given in Paragraphs F2 to F6.

F2 DIGITAL AND ANALOG (METER) DISPLAYS — ABNORMAL VALUES.

F2.1 No meter readout. In the case of a complete absence of a meter reading, it is first necessary to check the effectiveness of the couplant. Carry out measurements around the test area; if necessary, change the couplant and use A-scan presentation.

NOTES:
1. Where the test instrument is fitted with a transmission indicator and the indicator shows ‘positive’, then some other cause, e.g. unparallel surfaces, is responsible for the lack of a reading.
2. The surface finish may be such that it is not suitable for the test instrument, in which case it will be necessary to try A-scan procedures.

F2.2 Readout approximately half or double anticipated thickness.

F2.2.1 Half anticipated thickness. Such readings are indicative of mid-thickness discontinuities in a material. In such circumstances carry out multiple readings around the area to delineate extent of the discontinuity. If necessary, recheck with A-scan presentation.

F2.2.2 Double anticipated thickness. Such readings are indicative of suppression of the first back echo. Recheck with A-scan presentation to determine the cause.

F3 CURVATURE OR LACK OF PARALLELISM OF REFLECTING SURFACES. Such surfaces, when not suspected, can introduce errors. When a probe is moved in a straight line and values change at a steady rate, it is indicative of a changing beam path due to curvature or lack of parallelism of reflecting surfaces.

F4 CORRODED REFLECTING SURFACES. Such surfaces, especially pitted or badly corroded surfaces, cause a variable ultrasonic response with twin crystal probes when the probe is rotated and is caused by changes in beam geometry resulting from changes in reflectance at the pit bottom.

In the case of very small deep pits or pinholes, there may be insufficient reflecting surface to allow proper thickness testing. Where this condition is suspected, use higher resolution probes and A-scan presentation.

F5 MULTIPLE ECHOES. Multiple echoes can be used to advantage when determining the thickness of thin sections, where the first echo occurs in the dead zone, or for situations where it is not possible or it is undesirable to remove surface coatings from the scanning surface.

Under these circumstances an accurate measurement of thickness can be achieved by reading horizontal separation on the screen between two adjacent multiple echoes. A confirmation check may be made by reading the separation between three adjacent echoes and halving the result.

F6 SURFACE COATINGS. Surface coatings may influence test results due to increased beam path, acoustic velocity variation within the coating, and the degree of impedance mismatch between the coating and the parent metal.

F7 REPORTED ORDER OF ACCURACY. For a given reported thickness, the order of accuracy achieved will depend on a number of influencing factors which must be considered before a statement of accuracy can be made.

These factors include the following:
(a) Actual thickness range measured, together with equipment resolution, readability and calibration accuracy at that thickness range.
(b) Surface condition in terms of coating roughness and contour both of the probe contact surface and the reflecting back wall surface.
(c) Acoustic velocity variations within the material under test and also between the calibration block and the material under test.
(d) Reproducibility of probe contact position for Base Line and Key Point Surveys.
Order of accuracy may be reported either as —
(a) a plus or minus percentage of the values for the range of thickness results reported; or
(b) an absolute plus or minus value for the range of thickness results reported.
APPENDIX G

NOTES ON METHODS OF MEASUREMENT

G1 SINGLE SPOT — SINGLE MEASUREMENT (SS). The method can be used on new work or on work where light or uniform corrosion is known to exist (approx. \(\frac{1}{4}\) wavelength or less). In this method no cognizance is taken of the orientation of twin crystal probes.

G2 SINGLE SPOT — DOUBLE MEASUREMENT (SD). The profile of the sound beam from twin crystal probes is wide when viewed normal to the acoustic shield and narrow when viewed parallel to the acoustic shield. Because the orientation of a beam can be altered by the sloping side of a pit, it is recommended that the probe be turned through 90° at the test point. This will enable two measurements to be made; record the lower reading (see Fig. G1).

G3 MULTIPLE SPOT MEASUREMENTS (MS). Where doubt exists as to the nature or origin of a reflector, it is preferable to make numerous measurements over a small area (such as 25 mm dia.); record all readings.

G4 GRID METHODS (CG AND OG). Grid methods are preferred for detailed or general surveys because they allow accurate profiles of corroded, eroded or irregular surfaces to be drawn in the form of a contour map. Contour maps assist in initial decision making processes associated with the integrity of plant. Typical contour maps are shown in Fig. G2.

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Fig. G1. ALIGNMENT OF BEAM ON CORROSION PIT
Fig. G2. TYPICAL GRID SPACINGS