

Australian Standard™

**Methods for impact tests on metals**

**Part 5: Assessment of fracture surface  
appearance of steel**

This Australian Standard was prepared by Committee MT-006, Mechanical Testing of Metals. It was approved on behalf of the Council of Standards Australia on 15 August 2003 and published on 19 September 2003.

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The following are represented on Committee MT-006:

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CSIRO Telecommunications and Industry Physics  
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**RECONFIRMATION**

**OF**

**AS 1544.5—2003**

**Methods for impact tests on metals**

**Part 5: Assessment of fracture surface appearance of steel**

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**RECONFIRMATION NOTICE**

Technical Committee MT-009 has reviewed the content of this publication and in accordance with Standards Australia procedures for reconfirmation, it has been determined that the publication is still valid and does not require change.

Certain documents referenced in the publication may have been amended since the original date of publication. Users are advised to ensure that they are using the latest versions of such documents as appropriate, unless advised otherwise in this Reconfirmation Notice.

Approved for reconfirmation in accordance with Standards Australia procedures for reconfirmation on 20 March 2017.

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## NOTES

Australian Standard™

**Methods for impact tests on metals**

**Part 5: Assessment of fracture surface appearance of steel**

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## PREFACE

This Standard was prepared by the Standards Australia Committee MT-006, Mechanical Testing of Metals to supersede AS 1544.5—1981, *Methods for impact tests on metals, Part 5: Assessment of fracture surface appearance of steel*.

The objective of this Standard is to specify a method for the assessment of the fracture appearance of notched bar test pieces for carbon and low alloy steels.

This Standard is Method 5 of a series of Standards on the methods for impact testing of metals. The series comprises the following methods:

## AS

1544	Methods for impact tests on metals
1544.1	Part 1: Izod
1544.2	Part 2: Charpy V-notch
1544.3	Part 3: Charpy U-notch and keyhole notch
1544.4	Part 4: Calibration of the testing machine
1544.5	Part 5: Assessment of fracture surface appearance of steel

In preparing this revision, cognizance was taken of the International Standard ISO/CD 148-1, *Metallic materials—Charpy pendulum impact test, Part 1: Test method*.

The term ‘informative’ has been used in this Standard to define the application of the appendix to which it applies. An ‘informative’ appendix is only for information and guidance.

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STANDARDS AUSTRALIA

Australian Standard

Methods for impact tests on metals

Part 5: Assessment of fracture surface appearance of steel

## 1 SCOPE

This Standard sets out methods for the assessment of the fracture surface appearance of notched bar test pieces of carbon, carbon-manganese and low alloy steels, with particular reference to test pieces of the forms as specified in AS 1544, Parts 1 and 2.

## 2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

### AS

- 1544 Methods for impact tests on metals
- 1544.1 Part 1: Izod
- 1544.2 Part 2: Charpy V-notch

### ISO/CD

- 148 Metallic materials—Charpy pendulum impact test
- 148-1 Part 1: Test method

## 3 DEFINITIONS

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

### 3.1 Assessment of fracture surface appearance

The determination of the areas of crystalline or fibrous fracture, expressed as a percentage of the original cross-sectional area below the notch.

### 3.2 Crystallinity (crystalline fracture)

That portion of the fracture surface showing bright facets and characterized by a lack of visible plastic deformation.

### 3.3 Fibrosity (fibrous fracture)

That portion of the fracture surface showing a dull grey silky appearance in which considerable deformation has occurred.

### 3.4 Percentage crystallinity

## 4 METHODS FOR DETERMINATION OF PERCENTAGE CRYSTALLINITY AND FIBROSITY

### 4.1 Methods and accuracy

#### 4.1.1 General

The fracture surface of the Charpy and Izod test pieces is often rated by the percentage of shear fracture that has occurred. The greater the percentage of shear fracture, the greater the notch toughness of the material. Because the rating is extremely subjective, it is recommended that it be not used in specification.

NOTE: The term 'fibrous-fracture appearance' is often used as a synonym for shear-fracture appearance. The terms, 'cleavage-fracture appearance' and 'crystallinity' are often used to express the opposite of shear fracture. That is, zero percent shear fracture is 100 percent cleavage fracture.

#### 4.1.2 Methods

As crystalline and fibrous areas of a fracture surface of the broken test piece can be distinguished visually by their appearance when viewed from several angles under a point source of light or under parallel light, the percentage of each type of fracture surface present may be determined by—

- (a) direct visual estimation;
- (b) direct measurement without magnification; or
- (c) measurement with magnification.

NOTE: Methods (a) and (b) may not be suitable where there are several areas of crystallinity, as may occur in weld metal.

#### 4.1.3 Accuracy

An accuracy of  $\pm 10$  percent crystallinity or fibrosity can be achieved with methods (a) and (b) and  $\pm 5$  percent with method (c).

### 4.2 Procedure for direct visual estimation.

The procedure shall be as follows:

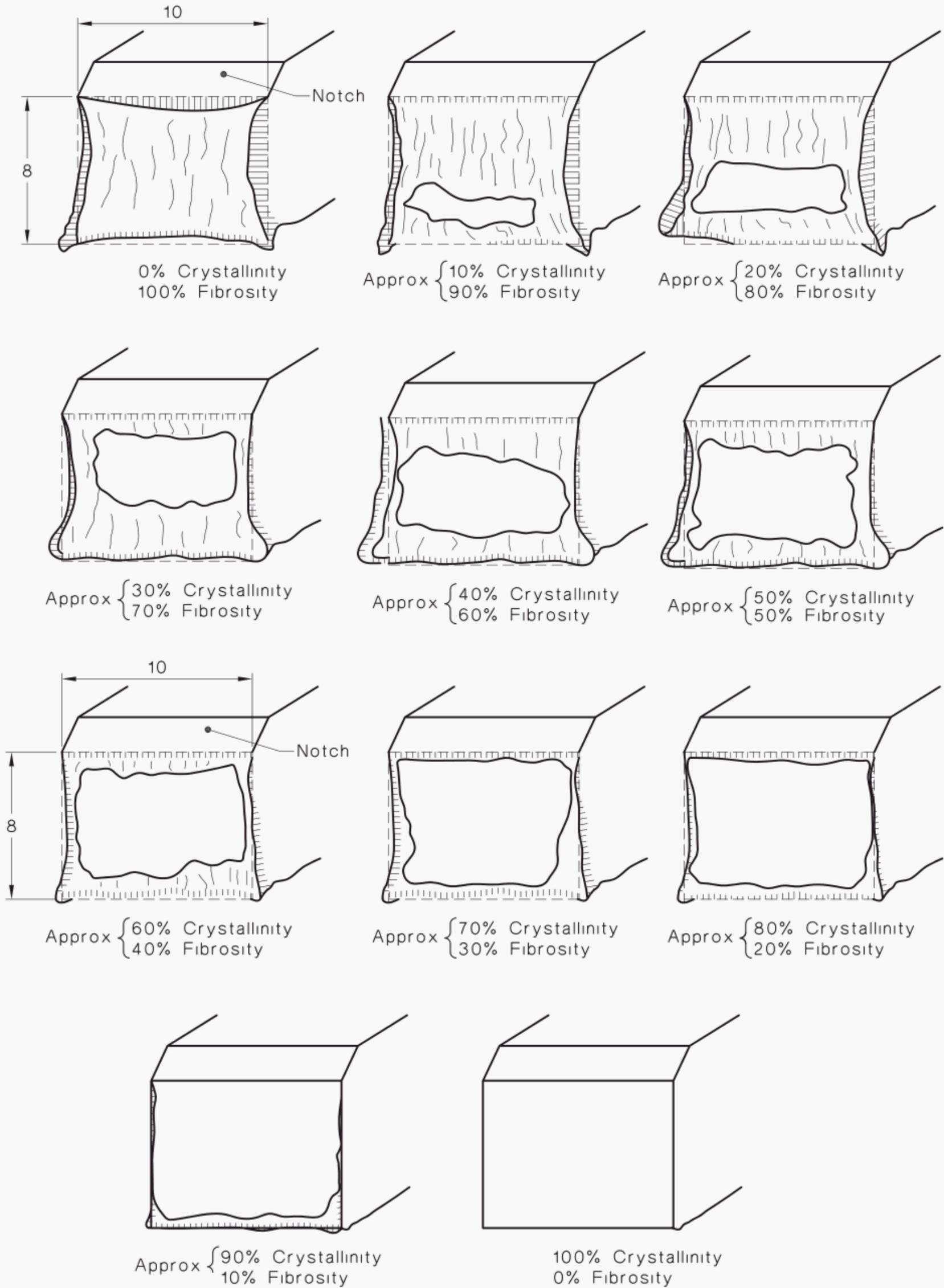
- (a) Examine the fracture surface under a point source of light or under parallel light.

NOTES:

- 1 An ordinary light bulb is preferable to strip lighting, and a small brilliant bulb in a reflector provides the best practical contrast. Direct natural light is also satisfactory.
- 2 In some metals, such as fine-grained alloy steels, the facets in the crystalline fracture face are very small with the result that the area appears dull and only of slightly lighter grey colour than the fibrous area.

In these circumstances, the area of crystallinity can best be distinguished by its dense granular texture compared with the spongy or silky texture of the fibrous area.

- (b) Estimate the percentage crystallinity and percentage fibrosity by one of the following means:
  - (i) Compare the surface with fracture appearance charts as shown in Figure 1.
  - (ii) Use prepared macrographs and Figure 2.
  - (iii) Compare with a reference set of control pieces for which the percentage crystallinity and percentage fibrosity have previously been accurately determined.
- (c) Record the result.



DIMENSIONS IN MILLIMETRES

FIGURE 1 FRACTURE APPEARANCE ASSESSMENT CHARTS FOR 10 mm x 10 mm TEST PIECES

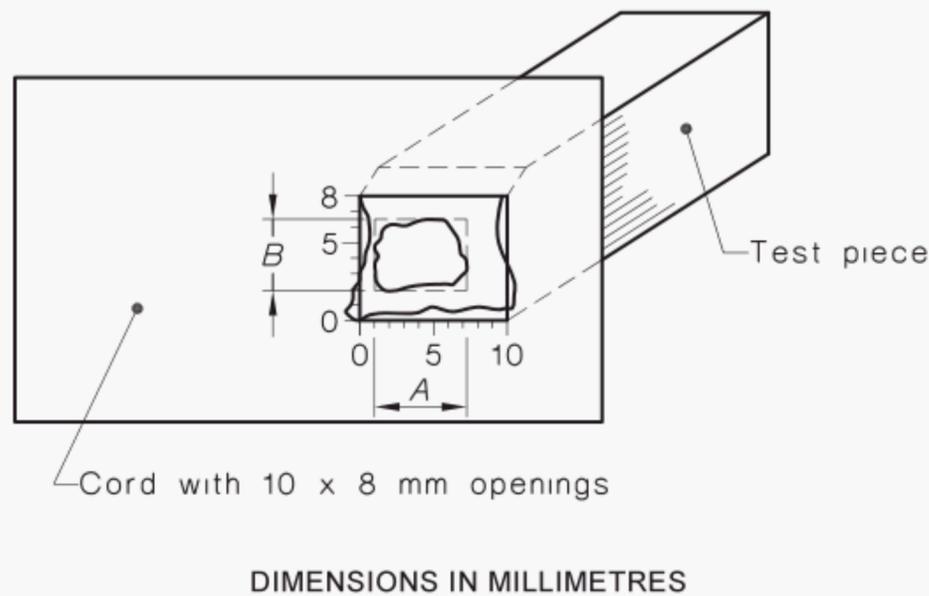


FIGURE 2 DIRECT MEASUREMENT OF CRYSTALLINE AREA

#### 4.3 Procedure for direct measurement without magnification

The procedure shall be as follows:

- (a) View the fracture surface without magnification and measure the apparent mean dimension  $A$  and  $B$  (see Figure 2) of the crystalline area by means of a scale graduated in millimetres, or a card having an opening graduated in millimetres.
- (b) Calculate the percentage crystallinity or percentage fibrosity by use of the equations contained in Clause 5, or read the result directly from a table appropriate to the test piece dimensions.

Tables 1 to 7 have been prepared for Izod and Charpy V-notch test pieces.

NOTE: Table 7 has been included for 10 mm × 6.7 mm test pieces because of increasing use of this size.

#### 4.4 Procedure for measurement with magnification

The procedure shall be as follows:

- (a) Use a measuring microscope, optical projector or projection microscope at low power magnification to view the fracture surface and determine the areas of crystallinity by one of the following means:
  - (i) The use of a planimeter on a tracing or projected image.
  - (ii) Counting squares on a grid on a tracing, projection screen or graticule eyepiece.
  - (iii) The linear measurement of dimensions  $A$  and  $B$  (see Figure 2).
- (b) Calculate the percentage crystallinity or percentage fibrosity by use of the equations contained in Clause 5 or read the result directly from a table appropriate to the test piece dimensions (see Tables 1 to 7).
- (c) Where there are several areas of crystallinity, as may occur in weld metal, use the aggregate area to calculate the percentage area.

### 5 CALCULATION OF RESULTS

Calculate the results by use of the following equations, as appropriate:

$$(a) \quad \text{Percentage crystallinity} = \frac{A_c}{A_o} \times 100$$

$$(b) \quad \text{Percentage fibrosity} = \frac{A_f}{A_o} \times 100$$

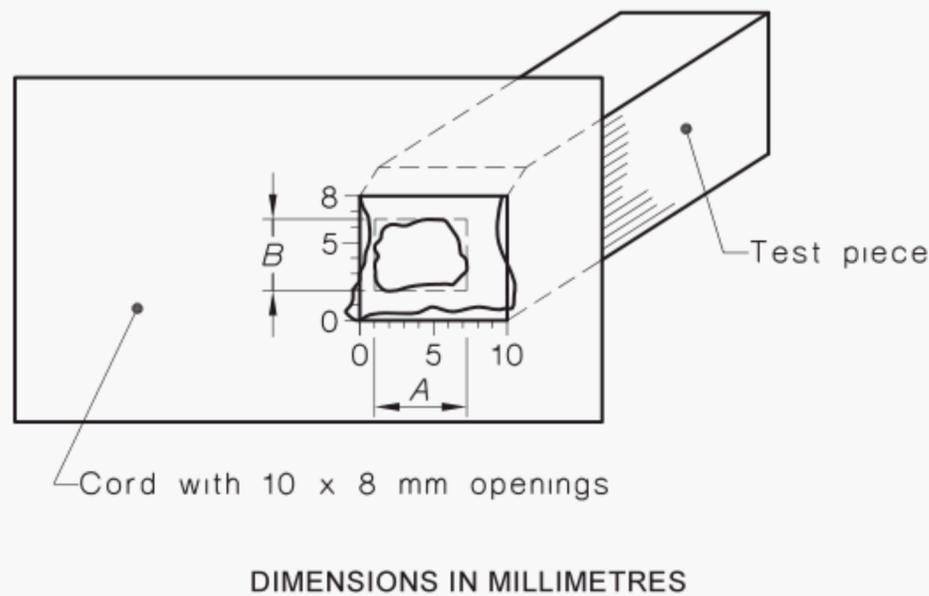


FIGURE 2 DIRECT MEASUREMENT OF CRYSTALLINE AREA

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- Calculate the percentage crystallinity or percentage fibrosity by use of the equations contained in Clause 5, or read the result directly from a table appropriate to the test piece dimensions.

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**TABLE 1**  
**PERCENTAGE FIBROSITY FOR MEASUREMENTS MADE ON IZOD OR**  
**CHARPY V-NOTCH 10 mm × 10 mm TEST PIECES**

millimetres

Dimension <i>B</i>	Dimension <i>A</i>																		
	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10
1	99	98	98	97	96	96	95	94	94	93	92	92	91	91	90	89	89	88	88
1.5	98	97	96	95	94	93	92	92	91	90	89	88	87	86	85	84	83	82	81
2	98	96	95	94	92	91	90	89	88	86	85	84	82	81	80	79	78	76	75
2.5	97	95	94	92	91	89	88	86	84	83	81	80	78	77	75	73	72	70	69
3	96	94	92	91	89	87	85	83	81	79	78	76	74	72	70	68	66	64	62
3.5	96	93	91	89	87	85	82	80	78	76	74	72	69	67	65	63	61	58	56
4	95	92	90	88	85	82	80	78	75	72	70	68	65	62	60	58	55	52	50
4.5	94	92	89	86	83	80	78	75	72	69	66	63	61	58	55	52	49	47	44
5	94	91	88	84	81	78	75	72	69	66	62	59	56	53	50	47	44	41	38
5.5	93	90	86	83	79	76	72	69	66	62	59	55	52	48	45	42	38	35	31
6	92	89	85	81	78	74	70	66	62	59	55	51	48	44	40	36	32	29	25
6.5	92	88	84	80	76	72	68	63	59	55	51	47	43	39	35	31	27	23	19
7	91	87	82	78	74	69	65	61	56	52	48	43	39	34	30	26	21	17	12
7.5	91	86	81	77	72	67	62	58	53	48	44	39	34	30	25	20	16	11	6
8	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	5	0

**TABLE 2**  
**PERCENTAGE FIBROSITY FOR MEASUREMENTS MADE ON IZOD OR**  
**CHARPY V-NOTCH 10 mm × 7.5 mm SUBSIDIARY TEST PIECES**

millimetres

Dimension <i>B</i>	Dimension <i>A</i>													
	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5
1	98	98	97	96	95	94	93	92	92	91	90	89	88	88
1.5	98	96	95	94	92	91	90	89	88	86	85	84	82	81
2	97	95	93	92	90	88	87	85	83	82	80	78	77	75
2.5	96	94	92	90	88	85	83	81	79	77	75	73	71	69
3	95	92	90	88	85	82	80	78	75	72	70	68	65	62
3.5	94	91	88	85	82	80	77	74	71	68	65	62	59	56
4	93	90	87	83	80	77	73	70	67	63	60	57	53	50
4.5	92	89	85	81	78	74	70	66	62	59	55	51	48	44
5	92	88	83	79	75	71	67	62	58	54	50	46	42	38
5.5	91	86	82	77	72	68	63	59	54	50	45	40	36	31
6	90	85	80	75	70	65	60	55	50	45	40	35	30	25
6.5	89	84	78	73	68	62	57	51	46	40	35	30	24	19
7	88	82	77	71	65	59	53	48	42	36	30	24	18	12
7.5	88	81	75	69	62	56	50	44	38	31	25	19	12	6
8	87	80	73	67	60	53	47	40	33	27	20	13	7	0

**TABLE 2**  
**PERCENTAGE FIBROSITY FOR MEASUREMENTS MADE ON IZOD OR**  
**CHARPY V-NOTCH 10 mm × 7.5 mm SUBSIDIARY TEST PIECES**

millimetres

Dimension <i>B</i>	Dimension <i>A</i>													
	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5
1	98	98	97	96	95	94	93	92	92	91	90	89	88	88
1.5	98	96	95	94	92	91	90	89	88	86	85	84	82	81
2	97	95	93	92	90	88	87	85	83	82	80	78	77	75
2.5	96	94	92	90	88	85	83	81	79	77	75	73	71	69
3	95	92	90	88	85	82	80	78	75	72	70	68	65	62
3.5	94	91	88	85	82	80	77	74	71	68	65	62	59	56
4	93	90	87	83	80	77	73	70	67	63	60	57	53	50
4.5	92	89	85	81	78	74	70	66	62	59	55	51	48	44
5	92	88	83	79	75	71	67	62	58	54	50	46	42	38
5.5	91	86	82	77	72	68	63	59	54	50	45	40	36	31
6	90	85	80	75	70	65	60	55	50	45	40	35	30	25
6.5	89	84	78	73	68	62	57	51	46	40	35	30	24	19
7	88	82	77	71	65	59	53	48	42	36	30	24	18	12
7.5	88	81	75	69	62	56	50	44	38	31	25	19	12	6
8	87	80	73	67	60	53	47	40	33	27	20	13	7	0

**TABLE 4**  
**PERCENTAGE FIBROSITY FOR MEASUREMENTS MADE ON IZOD OR**  
**CHARPY V-NOTCH 10 mm × 5 mm SUBSIDIARY TEST PIECES**

millimetres

Dimension <i>B</i>	Dimension <i>A</i>								
	1	1.5	2	2.5	3	3.5	4	4.5	5
1	98	96	95	94	92	91	90	89	88
1.5	96	94	92	91	89	87	85	83	81
2	95	92	90	88	85	82	80	78	75
2.5	94	91	88	84	81	78	75	62	69
3	92	89	85	81	78	74	70	66	62
3.5	91	87	82	78	74	69	65	61	56
4	90	85	80	75	70	65	60	55	50
4.5	89	83	78	72	66	61	55	49	44
5	88	81	75	69	62	56	50	44	38
5.5	86	79	72	66	59	52	45	38	31
6	85	78	70	62	55	48	40	32	25
6.5	84	76	68	59	51	43	35	27	19
7	82	74	65	56	48	39	30	21	12
7.5	81	72	62	53	44	34	25	16	6
8	80	70	60	50	40	30	20	10	0

**TABLE 5**  
**PERCENTAGE FIBROSITY FOR MEAUREMENTS**  
**MADE ON CHARPY V-NOTCH 10 mm × 2.5 mm**  
**TEST PIECES**

millimetres

Dimension <i>B</i>	Dimension <i>A</i>			
	1	1.5	2	2.5
1	95	92	90	87
1.5	92	89	85	81
2	90	85	80	75
2.5	87	81	75	69
3	85	77	70	62
3.5	82	74	65	56
4	80	70	60	50
4.5	77	66	55	44
5	75	62	50	37
5.5	72	59	45	31
6	70	55	40	25
6.5	67	51	35	19
7	65	47	30	12
7.5	62	44	25	6
8	60	40	20	0

APPENDIX A  
ENERGY ABSORBED VS TEMPERATURE AND  
TRANSITION TEMPERATURE

(Informative)

### A1 ENERGY ABSORBED—TEMPERATURE

The energy absorbed—temperature curve (KV-T curve) shows the energy absorbed as a function of the test temperature for a given shape of specification, see Figure A1. In general the curve is obtained by drawing a fitted curve through the individual values. The shape of the curve and the scatter of the test values are dependent on the material, the specimen shape, and the impact velocity. In the case of a curve with a transition zone d, a distinction is made between the upper shelf c, transition zone and the lower shelf e. Further information can be obtained from ISO/CD 148-1

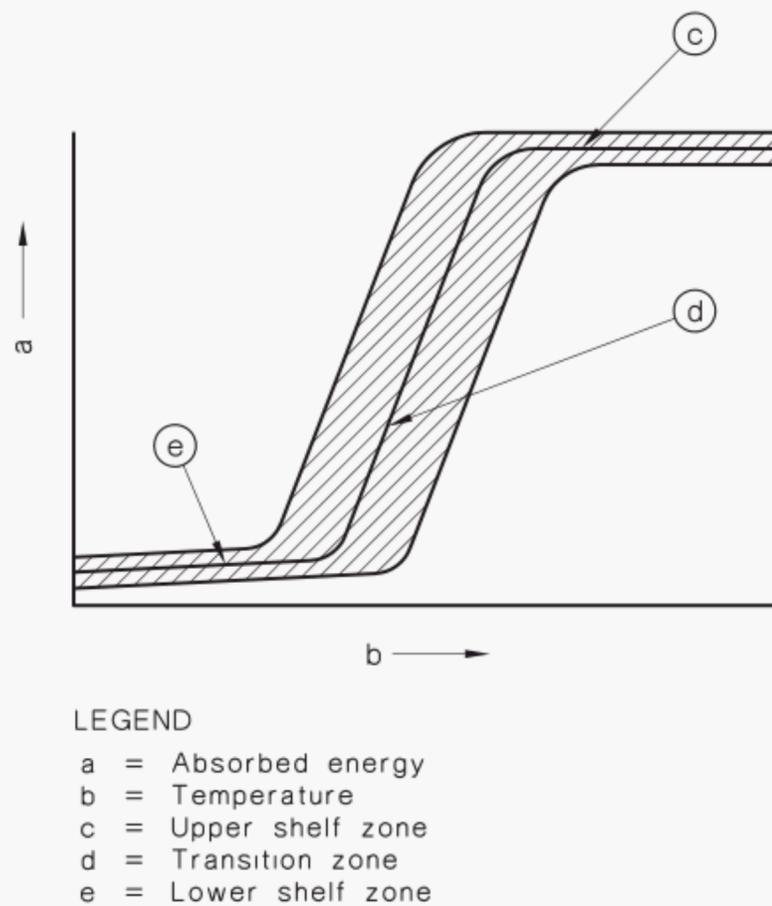


FIGURE A1 ENERGY ABSORBED—TEMPERATURE CURVE  
SHOWN SCHEMATICALLY

### A2 TRANSITION TEMPERATURE

The transition temperature  $T_t$  characterized the position of the steep rise in the energy absorbed-temperature curve. Since the steep rise usually extends over a fairly wide temperature range, there can be no generally applicable definition of the transition temperature. The following criteria have among others been found useful for determining the transition temperature.

The transition temperature  $T_t$  is that temperature at which:

- (a) A particular value of absorbed energy is reached, e.g.  $KV_8 = 27$  J.
- (b) A particular percentage of the absorbed energy of the upper shelf value reached, e.g. 50%.

APPENDIX A  
ENERGY ABSORBED VS TEMPERATURE AND  
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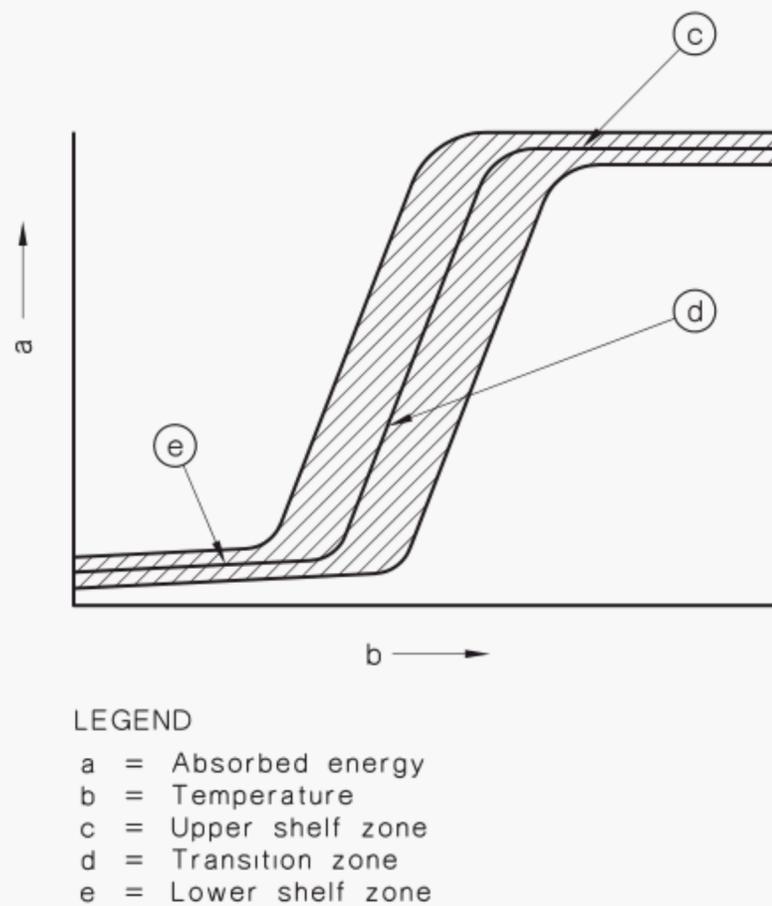


FIGURE A1 ENERGY ABSORBED-TEMPERATURE CURVE  
SHOWN SCHEMATICALLY

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## NOTES

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### **Standards Australia**

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### **Australian Standards**

Australian Standards are prepared by committees of experts from industry, governments, consumers and other relevant sectors. The requirements or recommendations contained in published Standards are a consensus of the views of representative interests and also take account of comments received from other sources. They reflect the latest scientific and industry experience. Australian Standards are kept under continuous review after publication and are updated regularly to take account of changing technology.

### **International Involvement**

Standards Australia is responsible for ensuring that the Australian viewpoint is considered in the formulation of international Standards and that the latest international experience is incorporated in national Standards. This role is vital in assisting local industry to compete in international markets. Standards Australia represents Australia at both ISO (The International Organization for Standardization) and the International Electrotechnical Commission (IEC).

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