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BSI Group Headquarters

389 Chiswick High Road London W4 4AL

Tel: +44 (0)20 8996 9000

Fax: +44 (0)20 8996 7400

www.bsigroup.com

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Responsible Committee Secretary: Ms Katherine Imbert (BSI)
Direct tel: 0208 996 6450
E-mail: katherine.imbert@bsigroup.com

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

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- **Annotated drafts are not acceptable and will be rejected.**
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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

ISO/DIS 148-2

Metallic materials — Charpy pendulum impact test —

Part 2: Verification of testing machines

*Matériaux métalliques — Essai de flexion par choc sur éprouvette
Charpy —*

Partie 2: Vérification des machines d'essai (mouton-pendule)

ICS: 77.040.10

ISO/TC 164/SC 4

Secretariat: **ANSI**

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 4, *Fatigue, fracture and toughness testing*.

This fourth edition cancels and replaces the third edition (ISO 148-2:2016), which has been technically revised.

ISO 148 consists of the following parts, under the general title *Metallic materials — Charpy pendulum impact test*:

- *Part 1: Test method*
- *Part 2: Verification of testing machines*
- *Part 3: Preparation and characterization of Charpy V-notch certified reference test pieces for indirect verification of pendulum impact machines*
- *Part 4: Testing of miniature Charpy test pieces (in preparation).*

Introduction

The suitability of a pendulum impact testing machine for acceptance testing of metallic materials has usually been based on a calibration of its scale and verification of compliance with specified dimensions, such as the shape and spacing of the anvils supporting the test piece. The scale calibration is commonly verified by measuring the mass of the pendulum and its elevation at various scale readings. This procedure for evaluation of machines had the distinct advantage of requiring only measurements of quantities that could be traced to national standards. The objective nature of these traceable measurements minimized the necessity for arbitration regarding the suitability of the machines for material acceptance tests.

However, sometimes two machines that had been evaluated by the direct-verification procedures described above, and which met all dimensional requirements, were found to give significantly different impact values when testing test pieces of the same material.

This difference was commercially important when values obtained using one machine met the material specification, while the values obtained using the other machine did not. To avoid such disagreements, some purchasers of materials added the requirement that all pendulum impact testing machines used for acceptance testing of material sold to them are to be indirectly verified by testing certified reference test pieces supplied by them. A machine was considered acceptable only if the values obtained using the machine agreed, within specified limits, with the value furnished with the certified reference test pieces.

This part of ISO 148 describes both the direct verification and the indirect verification procedures.

Metallic materials — Charpy pendulum impact test —

Part 2: Verification of testing machines

1 Scope

This part of ISO 148 covers the verification of pendulum-type impact testing machines, in terms of their constructional elements, their overall performance and the accuracy of the results they produce. It is applicable to machines with 2 mm or 8 mm strikers used for pendulum impact tests performed in accordance with ISO 148-1.

It can be applied to pendulum impact testing machines of various capacities and of different design.

Impact machines used for industrial, general or research laboratory testing of metallic materials in accordance with this part of ISO 148 are referred to as industrial machines. Those with more stringent requirements are referred to as reference machines. Specifications for the verification of reference machines are found in ISO 148-3.

This part of ISO 148 describes two methods of verification.

- a) The direct method, which is static in nature, involves measurement of the critical parts of the machine to ensure that it meets the requirements of this part of ISO 148. Instruments used for the verification and calibration are traceable to national or international standards.
- b) The indirect method, which is dynamic in nature, uses certified reference test pieces to verify points on the measuring scale for absorbed energy. The requirements for the certified reference test pieces are found in ISO 148-3.

A pendulum impact testing machine is not in compliance with this part of ISO 148 until it has been verified by both the direct and indirect methods and meets the requirements of [Clause 6](#) and [Clause 7](#).

This part of ISO 148 describes how to assess the different components of the total energy absorbed in fracturing a test piece. This total absorbed energy consists of

- the energy needed to fracture the test piece itself, and
- the internal energy losses of the pendulum impact testing machine performing the first half-cycle swing from the initial position.

NOTE Internal energy losses are due to the following:

- air resistance, friction of the bearings of the rotation axis and of the indicating pointer of the machine which can be determined by the direct method (see [6.4.5](#));
- shock of the foundation, vibration of the frame and pendulum for which no suitable measuring methods and apparatus have been developed.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 148-3, *Metallic materials — Charpy pendulum impact test — Part 3: Preparation and characterization of Charpy V-notch certified reference test pieces for indirect verification of pendulum impact machines*

3 Terms and definitions

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

3.1 Definitions pertaining to the machine

3.1.1

anvil

portion of the machine that serves to properly position the test piece for impact with respect to the striker and the test piece supports, and supports the test piece under the force of the strike

3.1.2

base

part of the framework of the machine located below the horizontal plane of the supports

3.1.3

centre of percussion

point in a body at which, on striking a blow, the percussive action is the same as if the whole mass of the body were concentrated at the point

Note 1 to entry: When a simple pendulum delivers a blow along a horizontal line passing through the centre of percussion, there is no resulting horizontal reaction at the axis of rotation.

Note 2 to entry: See [Figure 4](#).

3.1.4

centre of strike

point on the striking edge of the pendulum at which, in the free hanging position of the pendulum, the vertical edge of the striker meets the upper horizontal plane of a test piece of half standard thickness (i.e. 5 mm) or equivalent gauge bar resting on the test piece supports

Note 1 to entry: See [Figure 4](#).

3.1.5

industrial machine

pendulum impact testing machine used for industrial, general or most research-laboratory testing of metallic materials

Note 1 to entry: Industrial machines are not used to establish reference absorbed energy values for batches of certified reference test pieces, unless they also meet the requirements of a reference machine (see ISO 148-3).

Note 2 to entry: Industrial machines are verified using the procedures described in this part of ISO 148.

3.1.6

pendulum impact testing machine

testing machine equipped with a swinging hammer (pendulum) that is used to perform impact tests on Charpy test pieces

Note 1 to entry: For the sake of simplicity, the term “machine” is often used in this document to generically indicate a pendulum impact testing machine.

3.1.7

reference machine

pendulum impact testing machine used to determine reference absorbed energy values for batches of *certified test pieces* ([3.3.4](#))

Note 1 to entry: Reference machines are verified using the procedures described in ISO 148-3.

3.1.8**striker**

portion of the pendulum that contacts the test piece

Note 1 to entry: The edge that actually contacts the test piece has a radius of 2 mm (the 2 mm striker) or a radius of 8 mm (the 8 mm striker).

Note 2 to entry: See [Figure 2](#).

3.1.9**supports**

portion of the machine that serves to properly position the test piece for impact with respect to the *centre of percussion* ([3.1.3](#)) of the pendulum, the *striker* ([3.1.7](#)) and the *anvils* ([3.1.1](#))

Note 1 to entry: See [Figure 2](#) and [Figure 3](#).

3.2 Definitions pertaining to energy**3.2.1****total energy**

K_T
total absorbed energy spent to break a test piece with a pendulum impact testing machine, which is not corrected for any losses of energy

Note 1 to entry: It is equal to the difference in the potential energy from the starting position of the pendulum to the end of the first half swing during which the test piece is broken.

3.2.2**initial potential energy****potential energy**

K_p
potential energy of the pendulum hammer prior to its release for the impact test, as determined by direct verification

Note 1 to entry: See [6.4.2](#).

3.2.3**absorbed energy**

K
energy necessary to break a test piece with a pendulum impact testing machine, after correction for friction as described in [6.4.5](#)

Note 1 to entry: The letter V or U is used to indicate the notch geometry, which is KV or KU . The number 2 or 8 is used as a subscript to indicate striker radius, for example KV_2 .

3.2.4**calculated energy**

K_{calc}
energy calculated from values of angle, length and force measured during direct verification

3.2.5**nominal initial potential energy****nominal energy**

K_N
energy assigned by the manufacturer of the pendulum impact testing machine

3.2.6**indicated absorbed energy**

K_S
energy indicated by the display/dial of the testing machine, which may or may not need to be corrected for friction and air resistance to determine the *absorbed energy*, K ([3.2.3](#))

3.2.7**reference absorbed energy**

K_R
reference value of *absorbed energy* (3.2.3) assigned to the *certified reference test pieces* (3.3.4) used to verify the performance of pendulum impact machines

3.3 Definitions pertaining to test pieces**3.3.1****width**

W
distance between the notched face and the opposite face

Note 1 to entry: Prior to 2016, the distance between the notched face and the opposite face was specified as “height”. Changing this dimension to “width” makes ISO 148-2 consistent with the terminology used in other ISO fracture standards.

3.3.2**thickness**

B
dimension perpendicular to the *width* (3.3.1) and parallel to the notch

Note 1 to entry: Prior to 2016, the dimension perpendicular to the width that is parallel to the notch was specified as “width”. Changing this dimension to “thickness” makes ISO 148-2 consistent with the terminology used in other ISO fracture standards.

3.3.3**length**

L
largest dimension perpendicular to the notch

3.3.4**certified reference test piece**

impact test piece used to verify the suitability of a pendulum impact testing machine by comparing the *indicated absorbed energy* (3.2.3) measured by that machine with the *reference absorbed energy* (3.2.7) associated with the test pieces

Note 1 to entry: Certified test pieces are prepared in accordance with ISO 148-3.

4 Symbols and abbreviated terms**Table 1 — Symbols/abbreviated terms and their designations and units**

Symbol/ abbreviated term ^a	Unit	Designation
B_V	J	Bias of the pendulum impact machine as determined through indirect verification
b	J	Repeatability
CRM	—	Certified reference material
F	N	Force exerted by the pendulum when measured at a distance l_2
F_g	N	Force exerted by the pendulum due to gravity
g	m/s ²	Acceleration due to gravity
GUM	—	Guide to the expression of uncertainty in measurement ^[1]
h	m	Height of fall of pendulum
h_1	m	Height of rise of pendulum

^a See Figure 4.

Table 1 (continued)

Symbol/ abbreviated term ^a	Unit	Designation
K	J	Absorbed energy (expressed as K_{V2} , K_{V8} , K_{U2} , K_{U8} , to identify specific notch geometries and the radius of the striking edge)
K_T	J	Total absorbed energy
K_S	J	Indicated absorbed energy
K_{calc}	J	Calculated energy
K_{VR}	J	Certified K_V value of the certified reference material used in the indirect verification
$\overline{K_{VV}}$	J	Mean K_V value of the certified reference test pieces tested for indirect verification
K_N	J	Nominal initial potential energy (nominal energy)
K_P	J	Initial potential energy (potential energy)
K_R	J	Reference absorbed energy of a set of Charpy certified reference test pieces
K_1	J	Indicated absorbed energy when the machine is operated in the normal manner without a test piece in position
K_2	J	Indicated absorbed energy when the machine is operated in the normal manner without a test piece in position and without resetting the indication mechanism
K_3	J	Indicated absorbed energy after 11 half swings when the machine is operated in the normal manner without a test piece in position and without resetting the indication mechanism
l	m	Distance to centre of test piece (centre of strike) from the axis of rotation (length of pendulum)
l_1	m	Distance to the centre of percussion from the axis of rotation
l_2	m	Distance to the point of application of the force F from the axis of rotation
M	N·m	Moment equal to the product $F \cdot l_2$
n_V	—	Number of certified reference samples tested for the indirect verification of a pendulum impact testing machine
p	J	Absorbed energy loss caused by pointer friction
p'	J	Absorbed energy loss caused by bearing friction and air resistance
p_β	J	Correction of absorbed energy losses for an angle of rise β
r	J	Resolution of the machine scale
s_V	J	Standard deviation of the K_V values obtained on n_V certified reference test pieces
S	J	Bias in the scale mechanism
t	s	Period of the pendulum
T	s	Total time for 100 swings of the pendulum
T_{max}	s	Maximum value of T
T_{min}	s	Minimum value of T
u	—	Standard uncertainty
$u(\overline{K_{VV}})$	J	Standard uncertainty of $\overline{K_{VV}}$
$u(B_V)$	J	Standard uncertainty contribution from bias
$u(F)$	J	Standard uncertainty of the measured force, F
$u(F_{ftd})$	J	Standard uncertainty of the force transducer
$u(r)$	J	Standard uncertainty contribution from resolution
u_{CRM}	J	Standard uncertainty of the reference value for the certified reference material used for the indirect verification

^a See Figure 4.

Table 1 (continued)

Symbol/ abbreviated term ^a	Unit	Designation
U_{CRM}	J	Expanded uncertainty of the reference value for the certified reference material used for the indirect verification
u_{V}	J	Standard uncertainty of the indirect verification result
α	°	Angle of fall of the pendulum
β	°	Angle of rise of the pendulum
β_1	°	Angle of rise when the machine is operated in the normal manner without a test piece in position
β_2	°	Angle of rise when the machine is operated in the normal manner without a test piece in position and without resetting the indication mechanism
β_3	°	Angle of rise after 11 half swings when the machine is operated in the normal manner without a test piece in position and without resetting the indication mechanism
ν_B	—	Degrees of freedom corresponding to $u(B_V)$
ν_V	—	Degrees of freedom corresponding to u_V
ν_{CRM}	—	Degrees of freedom corresponding to u_{RM}
^a See Figure 4 .		

5 Testing machine

A pendulum impact testing machine consists of the following parts (see [Figure 1](#) to [Figure 3](#)):

- foundation/installation;
- machine framework: the structure supporting the pendulum, excluding the foundation;
- pendulum, including the hammer;
- anvils and supports (see [Figure 2](#) and [Figure 3](#));
- indicating equipment for the absorbed energy (e.g. scale and friction pointer or electronic readout device).

6 Full direct verification

6.1 General

Full direct verification of the machine involves the inspection of the items a) to e) listed in [Clause 5](#).

Uncertainty estimates are required under [Clause 6](#) for direct verification measurements to harmonize the accuracy of the applied verification procedures. Uncertainty estimates required in [Clause 6](#) are not related to product standards or material property databases in any way.

The uncertainty of dial gauges, micrometres, callipers, and other commercial instrumentation used for the direct verification measurements shall be estimated once, by the producer.

Uncertainty of a method to measure a direct verification parameter is assessed as part of the method validation. Once method validation is completed, the uncertainty can be routinely used (provided the same method is followed, the same instrumentation is used, and the operators are trained).