

INTERNATIONAL STANDARD

ISO
14555

Fourth edition
2017-05

Welding — Arc stud welding of metallic materials

Soudage — Soudage à l'arc des goujons sur les matériaux métalliques

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[ISO 14555:2017](#)

<https://standards.iteh.ai/catalog/standards/iso/d37587e9-6e10-40e1-ac84-8dc0f93784a5/iso-14555-2017>



Reference number
ISO 14555:2017(E)

© ISO 2017

iTeh Standards

(<https://standards.iteh.ai>)

Document Preview

[ISO 14555:2017](#)

<https://standards.iteh.ai/catalog/standards/iso/d37587e9-6e10-40e1-ac84-8dc0f93784a5/iso-14555-2017>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2017, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

Foreword	vi
Introduction	vii
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Symbols and abbreviated terms	3
4.1 Symbols	3
4.2 Abbreviated terms	4
5 Technical review	4
6 Welding personnel	5
6.1 Stud-welding operators	5
6.2 Welding coordination	5
7 Equipment	6
7.1 Production equipment	6
7.2 Description of the equipment	6
7.3 Maintenance	6
8 Production planning	7
9 Welding procedure specification (WPS)	7
9.1 General	7
9.2 Information related to the manufacturer	7
9.2.1 Identification of the manufacturer	7
9.2.2 Identification of the WPS	7
9.2.3 Reference to the welding procedure qualification record (WPQR) or other relevant documents	7
9.3 Information related to the parent material	7
9.3.1 Parent material type	7
9.3.2 Dimensions	7
9.4 Welding process	8
9.5 Joint	8
9.5.1 Joint design	8
9.5.2 Welding position	8
9.5.3 Preparation of parent material surface	8
9.5.4 Jigs and fixtures	8
9.5.5 Support	8
9.6 Studs	8
9.6.1 Designation	8
9.6.2 Handling	8
9.7 Auxiliaries	8
9.7.1 Ceramic ferrules (if any)	8
9.7.2 Protective gas (if any)	8
9.8 Power source	9
9.9 Movable fixtures	9
9.9.1 Welding gun/lift mechanism	9
9.9.2 Shielding gas system (if used)	9
9.9.3 Stud feeding system (if any)	9
9.10 Welding variables	9
9.10.1 Drawn-arc stud welding with ceramic ferrule or shielding gas and short-cycle drawn-arc stud welding	9
9.10.2 Capacitor discharge drawn-arc stud welding or capacitor discharge stud welding with tip ignition	9
9.11 Thermal conditions	9

9.12	Post-weld heat-treatment	10
9.13	Non-thermal treatment after welding	10
10	Welding procedure qualification	10
10.1	Principles	10
10.2	Welding procedure tests	10
10.2.1	Application	10
10.2.2	Proof of conformity of parent materials and stud materials	10
10.2.3	Shape and dimensions of test pieces	11
10.2.4	Welding	11
10.2.5	Scope of examination and testing	11
10.2.6	Acceptance criteria	11
10.2.7	Re-testing	12
10.2.8	Range of qualification	12
10.3	Pre-production tests	14
10.3.1	Pre-production test for workshop applications	14
10.3.2	Pre-production test for stud welding on site (for through-deck stud welding)	14
10.4	Previous experience	15
10.5	Welding procedure qualification record (WPQR)	15
11	Examination and testing	15
11.1	General	15
11.2	Visual examination	15
11.3	Bend testing	16
11.4	Tensile testing	19
11.5	Torque test	22
11.6	Macro examination	22
11.7	Radiographic examination	22
11.8	Ring test	23
12	Acceptance criteria	23
12.1	General	23
12.2	Acceptance criteria for visual examination	23
12.3	Acceptance criteria for bend testing	23
12.4	Acceptance criteria for tensile testing	24
12.5	Acceptance criteria for torque testing	24
12.6	Acceptance criteria for macro examination	24
12.7	Acceptance criteria for radiographic examination	24
12.8	Acceptance criteria for ring tests	24
12.9	Acceptance criteria for additional tests	24
13	Workmanship	24
14	Process control	25
14.1	General	25
14.2	Production test	25
14.2.1	General	25
14.2.2	Production test for drawn-arc stud welding with ceramic ferrule or shielding gas and short-cycle drawn-arc stud welding	26
14.2.3	Production test for capacitor discharge stud welding with tip ignition and capacitor discharge drawn-arc stud welding	26
14.3	Simplified production test	26
14.4	Re-testing for production test or simplified production test	26
14.5	Production surveillance	27
14.5.1	Visual examination	27
14.5.2	Checking the welding parameters	27
14.5.3	Other examinations and tests	27
14.5.4	Production surveillance for drawn-arc stud welding with ceramic ferrule with qualification according to 10.3.2	27
14.6	Production surveillance record	27
14.7	Non-conformance and corrective actions	27

14.8 Calibration of the measuring and testing equipment.....	28
Annex A (informative) Processing of stud welding.....	29
Annex B (normative) Quality requirements for stud welding.....	48
Annex C (informative) Manufacturer's welding procedure specification (WPS).....	49
Annex D (informative) Welding procedure qualification record form (WPQR) (for drawn-arc stud welding with ceramic ferrule or shielding gas and short-cycle drawn-arc stud welding).....	50
Annex E (informative) Welding procedure qualification record form (WPQR) (for capacitor discharge stud welding with tip ignition and capacitor discharge drawn-arc stud welding).....	54
Annex F (informative) Test results — Production test (for drawn-arc stud welding with ceramic ferrule or shielding gas and short-cycle drawn-arc stud welding).....	58
Annex G (informative) Test results — Production test (for capacitor discharge stud welding with tip ignition and capacitor discharge drawn-arc stud welding).....	61
Annex H (informative) Example of production surveillance record.....	64
Bibliography.....	65

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[ISO 14555:2017](#)

<https://standards.iteh.ai/catalog/standards/iso/d37587e9-6e10-40e1-ac84-8dc0f93784a5/iso-14555-2017>

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, 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

This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 10, *Quality management in the field of welding*.

This fourth edition cancels and replaces the third edition (ISO 14555:2014), of which it constitutes a minor revision and contains the following changes: [14555:2017](http://www.iso.org/iso/foreword.html)

- undated references to ISO 14732, ISO 13918 and ISO 15607;
- the expression “welding diameter” has been changed to “welded cross-section” in [3.6](#);
- the word “deformability” has been changed to “deformation” in the last sentence of [12.3](#);
- the second and third paragraphs of [12.4](#) have been combined;
- the expression “welding diameter” has been changed to “visible width of the welding zone” in [12.6](#);
- the appearance “Collar off-centre with unacceptable undercut” is now given under “Visual examination or macro cut” in [Table A.5](#);
- the missing symbol “≤” in [Annex D](#) has been introduced for application $\leq 100^{\circ}\text{C}$.

Requests for official interpretations of any aspect of this document should be directed to the Secretariat of ISO/TC 44/SC 10 via your national standards body. A complete listing of these bodies can be found at www.iso.org.

Introduction

The purpose of arc stud welding is to weld predominantly pin-shaped metal parts to metal workpieces. In this document, it is referred to simply as stud welding. Among other things, stud welding is used in bridge building (especially in composite structures), steel structures, shipbuilding, facade-wall fabrication, vehicle manufacture, apparatus engineering, steam-boiler construction, and the manufacture of household appliances.

The quality of a stud weld depends not only on strict compliance with the welding procedure specification but also on the correct function of the actuating mechanism (e.g. welding guns), and on the condition of the components, of the accessories and of the power supply.

This document does not invalidate former specifications, providing the technical requirements are equivalent and satisfied.

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[ISO 14555:2017](#)

<https://standards.iteh.ai/catalog/standards/iso/d37587e9-6e10-40e1-ac84-8dc0f93784a5/iso-14555-2017>

Welding — Arc stud welding of metallic materials

1 Scope

This document covers arc stud welding of metallic materials subject to static and fatigue loading. It specifies requirements that are particular to stud welding, in relation to welding knowledge, quality requirements, welding procedure specification, welding procedure qualification, qualification testing of operators and testing of production welds.

This document is appropriate where it is necessary to demonstrate the capability of a manufacturer to produce welded construction of a specified quality.

NOTE General quality requirements for fusion welding of metallic materials are given in ISO 3834-1, ISO 3834-2, ISO 3834-3, ISO 3834-4 and ISO 3834-5.

This document has been prepared in a comprehensive manner, with a view to it being used as a reference in contracts. The requirements contained within it can be adopted in full, or partially, if certain requirements are not relevant to a particular construction (see [Annex B](#)). For processing of stud welding, see [Annex A](#).

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. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3834-1, *Quality requirements for fusion welding of metallic materials — Part 1: Criteria for the selection of the appropriate level of quality requirements*

ISO 3834-2, *Quality requirements for fusion welding of metallic materials — Part 2: Comprehensive quality requirements*

ISO 3834-3, *Quality requirements for fusion welding of metallic materials — Part 3: Standard quality requirements*

ISO 3834-4, *Quality requirements for fusion welding of metallic materials — Part 4: Elementary quality requirements*

ISO 4063, *Welding and allied processes — Nomenclature of processes and reference numbers*

ISO 6947, *Welding and allied processes — Welding positions*

ISO 9606-1, *Qualification testing of welders — Fusion welding — Part 1: Steels*

ISO 9606-2, *Qualification test of welders — Fusion welding — Part 2: Aluminium and aluminium alloys*

ISO 13918, *Welding — Studs and ceramic ferrules for arc stud welding*

ISO 14175, *Welding consumables — Gases and gas mixtures for fusion welding and allied processes*

ISO 14731, *Welding coordination — Tasks and responsibilities*

ISO 14732, *Welding personnel — Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials*

ISO 15607, *Specification and qualification of welding procedures for metallic materials — General rules*

ISO/TR 15608, *Welding — Guidelines for a metallic materials grouping system*

ISO 15611, *Specification and qualification of welding procedures for metallic materials — Qualification based on previous welding experience*

ISO 15613, *Specification and qualification of welding procedures for metallic materials — Qualification based on pre-production welding test*

ISO 17636 (all parts), *Non-destructive testing of welds — Radiographic testing*

ISO/TR 25901-3, *Welding and allied processes — Vocabulary — Part 3: Welding processes*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 3834-1, ISO 4063, ISO 14731, ISO 14732, ISO 15607 and ISO/TR 25901-3 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <http://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1

stud

fastener to be attached by stud welding

3.2

auxiliaries

ceramic ferrules and shielding gases

3.3

stud-welding operator

operating personnel for stud-welding equipment

Note 1 to entry: In special cases (e.g. mass production at the manufacturer's factory), the welding can be carried out by suitable auxiliary personnel, appropriately trained and supervised.

<https://standards.iteh.ai/catalog/standards/iso/d37587e9-6e10-40e1-ac84-8dc0f93784a5/iso-14555-2017>

3.4

stud diameter

d

stud (3.1) nominal diameter

Note 1 to entry: See ISO 13918.

3.5

welding diameter

d_w

diameter at the weld base

3.6

weld zone

welded area underneath the welded cross-section

3.7

current intensity

root-mean-square (RMS) value of the welding current in the steady state during the burning time of the arc

Note 1 to entry: Current intensity is not applicable to capacitor discharge.

3.8

welding time

time difference between the ignition and the final extinction of the main arc

3.9**lift***L*

distance between the stud tip and the work piece surface with the stud-lifting mechanism in position and activated

Note 1 to entry: For tip ignition, this definition applies to the ignition gap.

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

3.10**plunge**

axial movement of the *stud* ([3.1](#)) towards the surface of the work piece

3.11**protrusion***P*

<unregulated lifting mechanism> distance between the tip of the *stud* ([3.1](#)) and the face of the support device in their initial positions, where the support device faces the work piece

Note 1 to entry: A spring-loaded lifting mechanism is an unregulated lifting mechanism.

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

3.12**arc blow**

magnetic deflection of the arc from the axial direction of the *stud* ([3.1](#))

3.13

<https://standards.iteh.ai>

flux

aluminium additive on the weld end of the *stud* ([3.1](#)), which improves the ignition and de-oxidizes the weld pool

3.14**dual-material stud**

[ISO 14555:2017](#)

<http://www.iteh.ai/standards/iso/iso-14555-10-1-1-81-1-03781> two-material *stud* ([3.1](#)) composed of a material at the weld tip, similar to that of the parent material, and a dissimilar material outside the weld tip, which are joined by a friction weld, thus avoiding a mixed structure in the *weld zone* ([3.6](#)) when stud welding

3.15**structure subjected to fatigue loading**

structure subject to a set of typical load events described by the positions or movements of loads, their variation in intensity and their frequency and sequence of occurrence

3.16**through-deck stud-welding**

application where shear connectors are welded to a steel structure through thin steel sheet with a thickness of less than 3 mm

4 Symbols and abbreviated terms

4.1 Symbols

For the purposes of this document, the following symbols apply.

C	capacitance (expressed in mF)
d	stud diameter (expressed in mm)
d_w	welding diameter (expressed in mm)
h	length of the threaded part of the nut
I	current intensity (expressed in A)
L	lift
P	protrusion
t	thickness of plate
t_w	welding time (expressed in ms or s)
T	torque (expressed in Nm)
U	charging voltage (expressed in V)
E	charging energy (expressed in Ws)
α	bending angle (expressed in °)

4.2 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

CF ceramic ferrule

HAZ heat-affected zone

NP no protection

PA flat welding position

PC horizontal welding position

PE overhead welding position

pWPS preliminary welding procedure specification

SG shielding gas

WPS welding procedure specification

WPQR welding procedure qualification record

iTeh Standards

(<https://standards.itech.ai>)

Document Preview

[ISO 14555:2017](#)

5 Technical review

When a technical review is required by an application standard, by specification or by use of ISO 3834-2, ISO 3834-3 or ISO 3834-4, the manufacturer shall check, as appropriate, the following aspects:

- the accessibility and welding position of the stud weld;
- the nature of the surface and the collar shape of the welded joint;
- materials and combinations of materials (see [Tables A.3](#) and [A.4](#)); including decking material where the through-deck technique is being proposed;

- d) the ratio of stud diameter to parent material thickness (avoidance of damage on the reverse side of the parent material);
- e) dimensions and details of the weld preparation and of the finished weld, including the nature of the stud and parent-metal surfaces, positional and angular accuracy and the length tolerance of the welded stud;
- f) the use of special techniques to avoid damage to the reverse side of the parent material;
- g) techniques to assure the angular position of the welded stud.

NOTE Consideration is paid to the multi-axial stress state arising from localized heating/cooling. This stress concentration reduces the fatigue strength of a component with welded studs.

6 Welding personnel

6.1 Stud-welding operators

The qualification can be done by a welding procedure test (see [10.2](#)) or a pre-production test (see [10.3](#)) and shall include testing in accordance with the acceptance criteria specified in [Clause 12](#), if relevant.

Stud-welding operators shall have appropriate knowledge to operate the equipment, to adjust it properly, to carry out the welding correctly and, while doing so, to pay attention to good contact and suitable connection between the work piece cables and uniform distribution of ferromagnetic materials (see [Table A.8](#)).

The welding personnel shall be qualified in accordance with ISO 14732.

The qualified operator shall be deemed to be qualified for any stud-welding equipment with the same mode of selecting the parameters which was used in the qualification test. Change in the welding process variant (numbers 783, 784, 785, 786 of ISO 4063) requires a new qualification.

A test of job knowledge is required for all qualification methods. This test shall cover, as a minimum:

- [a\) setting up the welding equipment in accordance with the welding procedure specification;](http://s/setting up the welding equipment in accordance with the welding procedure specification;2017)
- b) basic knowledge of the way in which suitable connection of work piece cables, the polarity of the stud, and arc blowing can influence the weld result (see [Table A.8](#));
- c) basic assessment of the welded joint for imperfections (see [Tables A.5, A.6 and A.7](#));
- d) safe execution of the welding operations, i.e. good contact of the stud in the stud holder, no movement during the welding process, operation checking and correct positioning of the welding gun).

6.2 Welding coordination

Welding coordination shall be performed in accordance with ISO 14731. Refer to [Annex B](#) for quality level according ISO 3834-2, ISO 3834-3 and ISO 3834-4 for the welding coordinator.

Welding coordination personnel for stud welding shall have knowledge of and experience in the relevant stud-welding process, and shall be able to select and set the correct parameters, e.g. lift, protrusion (plunge), current intensity, and welding time.

A welding coordinator is not required for stud welding to structures subjected to unspecified static loading (see [Annex B](#)).

7 Equipment

7.1 Production equipment

Suitable stud-welding equipment shall be used, with power supplies of sufficient capacity to weld the stud properly to the parent material when the equipment is correctly set up. The following equipment shall be available, as required:

- a) power sources, control unit and movable fixtures;
- b) cables with sufficient cross-section, solid connection terminals and sufficient earth connection;
- c) handling equipment for the technical aspects of welding fabrication (jigs, fixtures);
- d) weld data monitoring equipment;
- e) cleaning facilities for contact points and welding points;
- f) measuring and testing equipment;
- g) equipment for pre- and post-treatment;
- h) equipment and welding plant for retouching.

7.2 Description of the equipment

A list of the stud-welding equipment shall be maintained, which shall document performance and stud-welding application field. It shall include:

- a) details of the smallest and largest weldable stud diameter;
- b) the maximum number of studs to be welded per unit of time;
- c) the regulating range of the power supply; [ISO 14555:2017](#)
- d) the mode of operation and performance of mechanized or automatic stud-welding equipment; [ISO 14555-2017](#)
- e) details of the available test equipment.

7.3 Maintenance

The correct functioning of the equipment shall be ensured. During production, a function check of the actuation mechanisms shall be performed at fixed intervals. Cables, terminals, stud and ceramic ferrule holders shall be regularly checked and replaced at the appropriate time. For mass production and comprehensive quality requirements in accordance with ISO 3834-2, a maintenance plan for additional essential systems shall be drawn up. Examples of such systems are:

- a) stud sorting and feeding systems;
- b) stud and ceramic ferrule holders;
- c) mechanical guides and fixtures;
- d) measuring equipment;
- e) cables, hoses, connecting elements;
- f) a monitoring system.