INTERNATIONAL STANDARD

ISO 15616-4

First edition
2008-12-15

Acceptance tests for CO_2-laser beam machines for high quality welding and cutting —

Part 4: Machines with 2-D moving optics

Essais de réception des machines de soudage et de coupage de qualité par faisceau laser CO_2 —

Partie 4: Utilisation d'optiques mobiles 2D

Reference number
ISO 15616-4:2008(E)

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Published in Switzerland

Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 15616-4 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 10, *Unification of requirements in the field of metal welding*.

This first edition of ISO 15616-4 cancels and replaces ISO/TS 17477:2003, which has been technically revised.

ISO 15616 consists of the following parts, under the general title *Acceptance tests for CO_2-laser beam machines for high quality welding and cutting*:

— *Part 1: General principles, acceptance conditions*

— *Part 2: Measurement of static and dynamic accuracy*

— *Part 3: Calibration of instruments for measurement of gas flow and pressure*

— *Part 4: Machines with 2-D moving optics*

Requests for official interpretations of any aspect of this part of ISO 15616 should be directed to the Secretariat of ISO/TC 44/SC 10 via a national standards body, a complete listing which can be found at www.iso.org.

Acceptance tests for CO_2-laser beam machines for high quality welding and cutting —

Part 4:
Machines with 2-D moving optics

1 Scope

This part of ISO 15616 provides minimum requirements for acceptance testing, using practical test methods, for CO_2-laser beam machines for high quality welding and cutting in two dimensions (2-D), having a fixed workpiece on the platen and moving optics.

This part of ISO 15616 is not applicable to CO_2-laser beam machines which use an articulated robot, nor does it apply to work stations, such as a welding positioner, fixed board cutter, etc.

This part of ISO 15616 does not cover hazard protection devices, such as those for discharging chips and particles generated during welding and cutting.

2 Terms and definitions

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

2.1
deviation from intersection
longest distance between any two points that is made by three or more straight intersects

2.2
mark, verb
trace the trajectory of the machining head when the laser machine is being operated and mark it on paper using a ballpoint pen, an equivalent marking pen installed on the tip of the machining head, a low-power laser beam, or an equivalent instrument agreed between the parties concerned

3 Classification of machine type

Judgement criteria/allowance values are applied to machines classified into two types:

— Class A: the laser beam source is built into the moving machine;

— Class B: the laser beam source is not built into the moving machine.

4 Acceptance test conditions

4.1 Installation

The laser machine under test shall be installed in such a way that the welding and cutting operations will not significantly be disturbed by vibrations and temperature variations.

4.2 Power supply

The power source for the laser machine and its cooling system shall conform with the manufacturer's specifications for the equipment. Output voltage fluctuations shall be within ± 10 % of the nominal voltage.

4.3 Cooling system

If the cooling system is not supplied by the welding and cutting equipment manufacturer, it shall nevertheless conform with the welding and cutting equipment manufacturer's specifications for water flow rate, temperature control range, cooling capacity, etc.

The quality of the cooling water (purity, conductivity, pH, etc.) shall be as specified by the welding and cutting equipment manufacturer.

4.4 Gas supply and gas supply system

The flow rate and quality of the laser gases, assist gases or shield gas (for plasma removal, cutting and welding), and purging gases shall be as specified by the welding and cutting equipment manufacturer.

4.5 Instructions for use

Technical information necessary for operation, maintenance and control of equipment, and at least the minimum information related to the safety of welding and cutting equipment, shall be provided by the equipment supplier.

5 Acceptance test preparation

5.1 Verification of parts

Verify that all specified parts of the equipment are available and properly installed.

5.2 Machine accuracy verification testing

5.2.1 Accuracy test variables

Check the following machine variables for accuracy in accordance with 5.2.3 and 5.2.4:

a) trajectory accuracy;

b) straightness of motion in the X-axis direction;

c) straightness of motion in the Y-axis direction;

d) squareness between the X and Y axes;

e) positioning accuracy of motion in the X-axis direction;

f) positioning accuracy of motion in the Y-axis direction;

g) machining speed accuracy.

NOTE See also Table 1.

5.2.2 Measuring instruments

The measuring instruments used for the accuracy tests shall be calibrated measuring instruments, such as standard scale, tape measure, dial gauge and/or steel wire, or other measuring instruments agreed between the parties concerned.

5.2.3 Test methods

5.2.3.1 Trajectory accuracy

The laser machine shall be used to draw a diagram, shown in Figure 1, with external dimensions 800 mm × 800 mm. The starting position shall be A and follow the sequence as listed under Figure 1, i.e. A, B, C, D, A, C, H, etc. For laser machines with an effective machining range less than 800 mm × 800 mm, the largest square covering the effective machining range shall be drawn. The pattern shall be drawn at a speed of 1 m/min using the numerical control system of the machine. Deviations from the intersections, meandering of trajectories, and deviations of arc trajectories shall be monitored in accordance with the following procedures. For laser machines with a single-sided drive, the test shall be carried out on the driving side.

The pattern shown in Figure 1 shall be drawn in the specified sequence using the following criteria.

a) One side of the external square shall be drawn parallel to the X-axis.

b) All straight lines shall be drawn continuously.

c) The circle shall be drawn continuously.

d) The circle shall be overwritten once in both the clockwise and counterclockwise directions.

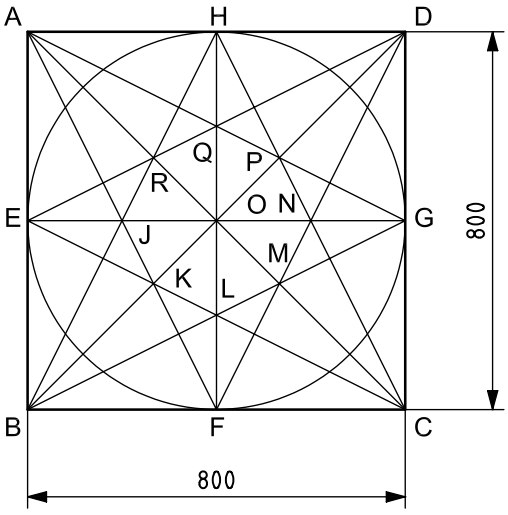
e) Dwell time shall be determined by the parties concerned.

The deviation of any line at an intersection where three or more straight lines come together (A to H) or intersect (J to R) shall be measured.

Meandering of the trajectory shall be checked by measuring the maximum deviation of the actual trajectory from each straight ruled line shown in Figure 1.

Deviation of the arc trajectory shall be checked by measuring the maximum deviation of the circle that has been overwritten in both the clockwise and counterclockwise directions.

Dimension in millimetres



Sequence of trajectory: A → B → C → D → A → C → H → B → D → F → A → G → E → C → G → B → E → D → H → F → E → H → G → F → G → H → E → F

Figure 1 — Diagram for evaluatiion of trajectory accuracy

5.2.3.2 Straightness of motion in X-axis direction

Fit a ballpoint pen onto the machining head and draw a straight line on the paper placed on a flat plate, such as a steel plate, or scribe a straight line using the low power laser beam and moving the laser machine in the X-axis direction.

Stretch a steel wire between both ends of this straight line, and measure the maximum deviation of the straight line from the steel wire, using the measurement scope, at every 1 m in the X-axis direction.

This test should be performed over the whole range of the effective machining length of the laser machine.

5.2.3.3 Straightness of motion in Y-axis direction

Fit a ballpoint pen onto the machining head and draw a straight line on the paper placed on a flat plate, such as a steel plate, or scribe a straight line using the low power laser beam and moving the laser machine in the Y-axis direction.

Stretch a steel wire between both ends of this straight line, and measure the maximum deviation of the straight line from the steel wire, using the measurement scope, at every 1 m in the Y-axis direction.

This test should be performed over the effective machining range of one machining head.

5.2.3.4 Squareness between X-axis and Y-axis

Mark a square parallel to the X-axis and having sides of length 2 m (or, for a laser machine having an effective machining range of less than 2 m × 2 m, the largest square covering the effective machining range). Measure the lengths of the two diagonals with a tape measure, and determine the difference in length between them.

5.2.3.5 Positioning accuracy of motion in the X-axis direction

Make a unidirectional movement of 1 m from an arbitrarily selected point in the X-axis direction using a numerically controlled command. Measure the length of the movement using a standard scale, and determine the difference in length between the programmed value and measured value.

5.2.3.6 Positioning accuracy of motion in the Y-axis direction

Make a unidirectional movement of 1 m from an arbitrarily selected point in the Y-axis direction by a numerically controlled command. Measure the length of the movement using a standard scale, and determine the difference in length between the programmed value and the measured value.

5.2.3.7 Machining speed accuracy

Measure the deviation between the programmed speed and the actual machining speed, in regard to 1/4, 1/2, and 1/1 times the maximum speed in the X-axis and Y-axis directions respectively. Measurement shall be made at the time when the head passes between the two target positions, after the normal constant speed has been attained. For numerically controlled machines, the speed can be checked using the self-diagnosis function.

5.2.4 Acceptance criteria

The results of the tests carried out in accordance with 5.2 shall be within the acceptance limits given in Table 1.

Table 1 — Acceptance criteria

Letter (see 5.2.1)	Accuracy test variable	Judgement criteria/allowance value	
		Class A	Class B
a)	Trajectory accuracy Measuring items:		
	a 1) deviation of intersection	⩽ 0,5 mm	⩽ 0,2 mm
	a 2) meandering of trajectory	⩽ 0,2 mm	⩽ 0,1 mm
	a 3) deviation of arc trajectory	⩽ 0,5 mm	⩽ 0,3 mm
b)	Straightness of motion in the X-axis direction	⩽ 0,4 mm	⩽ 0,1 mm
c)	Straightness of motion in the Y-axis direction	⩽ 0,4 mm	⩽ 0,1 mm
d)	Squareness between X-axis and Y-axis	Difference in length between diagonals is ⩽ 0,5 mm	Difference in length between diagonals is ⩽ 0,2 mm
e)	Positioning accuracy of motion in the X-axis direction	Difference from programmed value is ⩽ ± 0,2 mm	Difference from programmed value is ⩽ (± 0,1) mm
f)	Positioning accuracy of motion in the Y-axis direction	Difference from programmed value is ⩽ (± 0,2) mm	Difference from programmed value is ⩽ (± 0,1) mm
g)	Machining speed accuracy	Error against programmed speed is ⩽ (± 5) %	Error against programmed speed is ⩽ (± 2) %

6 Test report

Sample test reports are provided in Annex A for Class A laser machines and in Annex B for Class B laser machines.

Include the following items in the test report:

— a reference to this part of ISO 15616 (ISO 15616-4);

— model number of the laser machine;

— manufacturing number of the laser machine;

— date of test;

— place of test;

— name(s) of the person(s) responsible for test;

— test items and measured values;

— description of the equipment used for testing and certification, and/or calibration records of the measuring devices used to certify equipment performance.

Annex A
(informative)

Class A test report on acceptance test of CO_2-laser beam machines

Customer (name, address): .....

Manufacturer (name, address): .....

Model numbers of laser machines: .....

Manufacturing number of machine: .....

Date of test: .....

Place of test: .....

Names of the persons responsible for test: .....

Ref. in 5.2.1	Accuracy test variable	Measuring instruments		Judgement criteria/allowance value	Measured value	Remarks
		Description of the instruments	Calibration records			
a)	Trajectory accuracy a 1) deviation of intersection			⩽ 0,5 mm		
	a 2) meandering of trajectory			⩽ 0,2 mm		
	a 3) deviation of arc trajectory			⩽ 0,5 mm		
b)	Straightness of motion in X-axis direction			⩽ 0,4 mm		
c)	Straightness of motion in Y-axis direction			⩽ 0,4 mm		
d)	Squareness between X-axis and Y-axis			Difference is ⩽ 0,5 mm		
e)	Positioning accuracy of motion in X-axis direction			Difference is ⩽ (± 0,2) mm		
f)	Positioning accuracy of motion in Y-axis direction			Difference is ⩽ (± 0,2) mm		
g)	Machining speed accuracy			Error is ⩽ (± 5) %		

Annex B
(informative)

Class B test report on acceptance test of CO_2-laser beam machines

Customer (name, address): .....

Manufacturer (name, address): .....

Model numbers of laser machines: .....

Manufacturing number of machine: .....

Date of test: .....

Place of test: .....

Names of the persons responsible for test: .....

Ref. in 5.2.1	Accuracy test variable	Measuring instruments		Judgement criteria/allowance value	Measured value	Remarks
		Description of the instruments	Calibration records			
a)	Trajectory accuracy a 1) deviation of intersection			⩽ 0,2 mm		
	a 2) meandering of trajectory			⩽ 0,1 mm		
	a 3) deviation of arc trajectory			⩽ 0,3 mm		
b)	Straightness of motion in X-axis direction			⩽ 0,1 mm		
c)	Straightness of motion in Y-axis direction			⩽ 0,1 mm		
d)	Squareness between X-axis and Y-axis			Difference is ⩽ 0,2 mm		
e)	Positioning accuracy of motion in X-axis direction			Difference is ⩽ (± 0,1) mm		
f)	Positioning accuracy of motion in Y-axis direction			Difference is ⩽ (± 0,1) mm		
g)	Machining speed accuracy			Error is ⩽ (± 2) %		