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**Acceptance tests for CO<sub>2</sub>-laser beam  
machines for high quality welding and  
cutting —**

Part 1:

**General principles, acceptance conditions**

*Essais de réception des machines de soudage et de coupage de qualité  
par faisceau laser CO<sub>2</sub> —*

*Partie 1: Principes généraux et conditions de réception*

ISO 15616-1:2003

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Reference number  
ISO 15616-1:2003(E)

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Published in Switzerland

## 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 part of ISO 15616 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15616-1 was prepared by the European Committee for Standardization (CEN) in collaboration with Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 10, *Unification of requirements in the field of metal welding*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this document, read "...this European Standard..." to mean "...this International Standard...".

ISO 15616 consists of the following parts, under the general title *Acceptance tests for CO<sub>2</sub>-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*

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## Foreword

This document (EN ISO 15616-1:2003) has been prepared by Technical Committee CEN/TC 121, "Welding", the secretariat of which is held by DS, in collaboration with ISO/TC 44 "Welding and allied processes".

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2003, and conflicting national standards shall be withdrawn at the latest by September 2003.

This European Standard "Acceptance test for CO<sub>2</sub> – laser beam machines for high quality welding and cutting" consists of the following Parts:

- *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.*

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovak Republic, Spain, Sweden, Switzerland and the United Kingdom.

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## 1 Scope

This Part of this European Standard is applicable to CO<sub>2</sub>-laser beam machines for welding and cutting in two operating directions (2D).

The main purpose of this standard is to provide requirements for acceptance testing of CO<sub>2</sub>-laser beam machines prior to or during installation at the user's premises. The acceptance tests are used to document the ability of CO<sub>2</sub>-laser beam machines to produce welded joints and cuts of consistent quality.

This standard is intended to be used for preparation of the technical specification for CO<sub>2</sub>-laser beam machines for high quality welding and cutting in two operating directions (2D). This standard specifies basic requirements. Additional tests and requirements may be specified in the technical specification for the CO<sub>2</sub>-laser beam machine.

NOTE 1 The technical specification for the CO<sub>2</sub>-laser beam machine usually forms a part of the contract and it is agreed by the parties concerned (the manufacturer of the CO<sub>2</sub>-laser beam machine and the customer/user).

NOTE 2 The requirements may be too stringent for non-high quality cutting.

However, the standard may also be used for testing as part of maintenance, as appropriate.

If modifications are made to a CO<sub>2</sub>-laser beam machine (rebuilding, repairs, modifications to the operating conditions etc.) that may have an effect on the acceptance testing, repeat test may be necessary covering the machine parameters affected by such modifications.

If a CO<sub>2</sub>-laser beam machine that has already been accepted is dismantled (e.g. in order to change its location) such tests may involve verification according to the requirements in 6.4 as a minimum.

## 2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 60204-1, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:1997)*.

EN ISO 11145:2001, *Optics and optical instruments — Lasers and laser-related equipment — Vocabulary and symbols (ISO 11145:2001)*.

EN ISO 11146:1999, *Lasers and laser-related equipment — Test methods for laser beam parameters — Beam widths, divergence angle and beam propagation factor (ISO 11146:1999)*.

EN ISO 11554, *Optics and optical instruments — Lasers and laser-related equipment — Test methods for laser beam power, energy and temporal characteristics (ISO 11554:1998)*.

EN ISO 11670, *Lasers and laser related equipment — Test methods for laser beam parameters — Beam positional stability (ISO 11670:1999)*.

EN ISO 15616-2, *Acceptance tests for CO<sub>2</sub>-laser beam machines for high quality welding and cutting — Part 2: Measurement of static and dynamic accuracy (ISO 15616-2:2003)*.

EN ISO 15616-3, *Acceptance tests for CO<sub>2</sub>-laser beam machines for high quality welding and cutting — Part 3: Calibration of instruments for measurement of gas flow and pressure (ISO 15616-3:2003).*

ISO 230-2, *Test code for machine tools — Part 2: Determination of accuracy and repeatability of positioning numerically controlled axes.*

*International Vocabulary of Basic and General Terms in Metrology.*

### 3 Terms, definitions and symbols

For the purposes of this Part of this European Standard, the terms and definitions given in EN ISO 11145:2001, EN ISO 11146:1999 and in the International Vocabulary of Basic and General Terms in Metrology apply.

The symbols listed in Table 1 are used in this standard.

**Table 1 — Explanation of symbols**

Symbol	Unit	Term
	—	effective $f$ -number, see EN ISO 11145
$D$	mm	work piece diameter
$d_{(s)}$	mm	laser beam diameter at the distance $s$ , see EN ISO 11145
$d_{o,u}$	mm	laser beam waist diameter, see EN ISO 11145
$d_{opt}$	mm	laser beam diameter on the focusing optic, see EN ISO 11145
$E_u$	W/cm <sup>2</sup>	average power density, see EN ISO 11145
$f$	mm	focal length, see EN ISO 11146
$f_a$	mm	error in rounding-off
$f_o$	mm	error in overshooting
$K$	—	beam propagation factor, see EN ISO 11145. $M_2$ is an alternative term, frequently used instead of $K$
$m_N$	kg	working load
$n$	min <sup>-1</sup>	rotational speed
$P_L$	W	laser beam power output of the cw laser
$P_P$	W	laser beam power at the point-of-use
$r$	mm	error in reversibility
$t$	mm	error in circularity
$U'_v$	mV	speed signal
$U''_v$	mV	speed signal



Table 1 (continued)

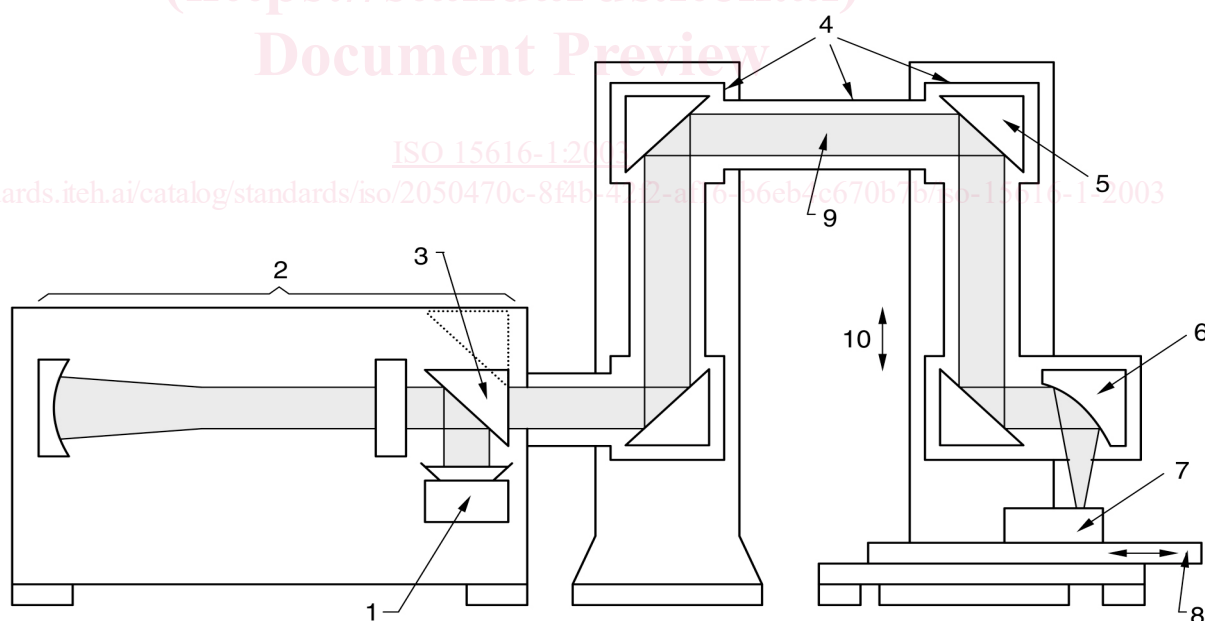
Symbol	Unit	Term
$\Delta U'_v$	mV	deviation of speed signal
$\Delta U'_{v \max}$	mV	maximum deviation of speed signal
$v$	m/min	linear speed
$v_s$	m/min	average velocity in trajectory
$v_{\max}$	m/min	maximum velocity in trajectory
$v_{\min}$	m/min	minimum velocity in trajectory
$v_{\text{prog}}$	m/min	programmed velocity in trajectory

## 4 Acceptance test conditions

### 4.1 Setting up the CO<sub>2</sub>-laser beam machine

The CO<sub>2</sub>-laser beam machine shall be erected and installed in such a way that the processing operation is not disturbed by environmental factors, e.g. vibrations, large temperature variations, contaminated atmosphere. The conditions specified by the laser system manufacturer have to be fulfilled during erection and installation.

A schematic view of a typical CO<sub>2</sub>-laser beam machine is shown in Figure 1.



#### Key

- |   |                     |    |                         |
|---|---------------------|----|-------------------------|
| 1 | absorber            | 6  | focusing head           |
| 2 | laser               | 7  | work piece              |
| 3 | shutter             | 8  | working table           |
| 4 | beam guiding system | 9  | laser beam              |
| 5 | bending optics      | 10 | movement in z direction |

Figure 1 — Schematic view of CO<sub>2</sub>-laser beam machine

## 4.2 Power supply

The power source for the CO<sub>2</sub>-laser beam machine shall be an electrical main system with voltage fluctuations not exceeding  $\pm 10\%$ , see EN 60204-1.

## 4.3 Health, safety and environment

### 4.3.1 Health and safety

This standard does not cover inspection of safety devices and other safety aspects.

NOTE Current health and safety regulations, accident prevention rules, as well as generally accepted technical specifications should be applied and adhered to, respectively.

### 4.3.2 Environment

Exhaust systems removing hazardous gaseous and particulate emission from the laser beam source or the processing operation process shall be designed and installed according to the requirements of the local environmental regulations.

## 4.4 Cooling system

The cooling system shall meet the laser equipment manufacturer's specifications with respect to the operation temperature (compared to atmospheric dew point), temperature stability, control of high and low temperatures, operation pressure, flow rate and quality of the cooling medium. The laser equipment shall be fitted with a safety cut out system in the event of any anomaly occurring in the cooling system.

## 4.5 Gas supply and gas supply system

The purity and properties, e.g. dew point, of the laser gases, the purging gas of the beam guiding system, working gases (plasma control, cutting and shielding gases), other gases (for the aerodynamic window, beam shutter) and the gas supply system shall meet the specifications of the CO<sub>2</sub>-laser beam machine manufacturer and the standards.

## 4.6 Operation instructions

All instructions in the technical specification for the CO<sub>2</sub>-laser beam machine for the operation, safety, service and maintenance of the CO<sub>2</sub>-laser beam machine shall be followed.

## 5 Acceptance test principles

### 5.1 Range of system settings

The range of system settings (minimum and maximum values) shall be specified in the technical specification for the CO<sub>2</sub>-laser beam machine. The parameters shall include (as appropriate):

- laser beam power;
- focal length;
- laser beam path and motion system (processing speed; processing length, motion direction);
- revolutions per minute (rotary fixture);