THIS PAGE INTENTIONALLY LEFT BLANK.
Technical Report
for Industrial Robots and Robot Systems — Safety Requirements —
Collaborative Robots

Secretariat
Robotic Industries Association

Registered December 25, 2016
American National Standards Institute, Inc.
Foreword

The Robotic Industries Association (RIA) has prepared this Technical Report with the objective of enhancing the safety of personnel associated with collaborative robot systems used in an industrial setting, including robots, robot end-effectors, and ancillary equipment. This Technical Report updates and expands upon the information on collaborative robots and collaborative robot systems as previously presented in ANSI/RIA R15.06-2012.

This Technical Report is a national adoption of ISO/TS 15066:2016 which is presented in its entirety. Please note that the values in Annex A are the result of a single study in a subject area that has not been the basis of extensive research, at the time of publication of this document. These values may be modified in future, as the field matures and more studies are conducted.

Changes to the ISO document were limited to page formatting from ISO A4, spelling changes of words from the traditional British/ISO spelling (i.e., centre, behaviour) to common American spelling, and decimal annotation of numbers. Although the original ISO Technical Specification is a normative document and therefore uses the word syntax “should” and “shall” to indicate normative requirements, an ANSI-registered U.S. Technical Report cannot contain normative requirements. Therefore, though this U.S. Technical Report is based on an ISO document, the use of “should” and “shall” in this context indicate the relative importance of specific criteria or features in this Technical Report.

This technical report is supplemental to ANSI/RIA R15.06-2012 and is not itself a standard. The referenced industry standards and technical reports are voluntary. RIA makes no determination with respect to whether any robot, robot system or robot cell, associated safety devices, manufacturer, or user is in compliance with published standards and technical reports. Users of this document should consult applicable federal, state, and local laws and regulations.

Publication of this Technical Report that has been registered with the American National Standards Institute (ANSI) has been approved by the Accredited Standards Developer, Robotic Industries Association. This document is registered as a Technical Report according to the Procedures for the Registration of Technical Reports with ANSI. Comments on the content of this document should be sent to:

Robotic Industries Association
Attn: Subcommittee on Safety
900 Victors Way, Suite 140
Ann Arbor, MI 48108

Members of the R15 Standards Approval Committee and the Committee Secretary participated in the development of this technical report.
Contents

Foreword [U.S. Edition] ..................................................................................................................................... iii
Foreword [ISO/TS 15066] ................................................................................................................................... v
Introduction [ISO/TS 15066] ..............................................................................................................................vi

Robots and robotic devices — Collaborative robots ...................................................................................... 1
1 Scope ...................................................................................................................................................... 1
2 Normative references ............................................................................................................................ 1
3 Terms and definitions ........................................................................................................................... 1
4 Collaborative industrial robot system design .................................................................................... 2
  4.1 General................................................................................................................................................ 2
  4.2 Collaborative application design ......................................................................................................... 3
  4.3 Hazard identification and risk assessment ......................................................................................... 4
5 Requirements for collaborative robot system applications .............................................................. 6
  5.1 General ................................................................................................................................................ 6
  5.2 Safety-related control system performance ....................................................................................... 6
  5.3 Design of the collaborative workspace ............................................................................................... 6
  5.4 Design of the collaborative robot operation ....................................................................................... 7
  5.5 Collaborative operations ....................................................................................................................... 8
6 Verification and validation .................................................................................................................. 20
7 Information for use .............................................................................................................................. 21
  7.1 General ................................................................................................................................................ 21
  7.2 Information specific to collaborative robot operations ....................................................................... 21
  7.3 Description of the collaborative robot system ................................................................................... 21
  7.4 Description of the workplace application ......................................................................................... 21
  7.5 Description of the work task ............................................................................................................... 21
  7.6 Information specific to power and force limiting applications ....................................................... 22

Annex A (informative) Limits for quasi-static and transient contact ......................................................... 23
  A.1 General .............................................................................................................................................. 23
  A.2 Body model ...................................................................................................................................... 23
  A.3 Biomechanical limits ......................................................................................................................... 23

Bibliography ...................................................................................................................................................... 35

Foreword [ISO/TS 15066]

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 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 Technical Committee ISO/TC 299, Robots and robotic devices.

This Technical Specification is relevant only in conjunction with the safety requirements for collaborative industrial robot operation described in ISO 10218-1 and ISO 10218-2.
Introduction [ISO/TS 15066]

The objective of collaborative robots is to combine the repetitive performance of robots with the individual skills and ability of people. People have an excellent capability for solving imprecise exercises; robots exhibit precision, power and endurance.

To achieve safety, robotic applications traditionally exclude operator access to the operations area while the robot is active. Therefore, a variety of operations requiring human intervention often cannot be automated using robot systems.

This Technical Specification provides guidance for collaborative robot operation where a robot system and people share the same workspace. In such operations, the integrity of the safety-related control system is of major importance, particularly when process parameters such as speed and force are being controlled.

A comprehensive risk assessment is required to assess not only the robot system itself, but also the environment in which it is placed, i.e. the workplace. When implementing applications in which people and robot systems collaborate, ergonomic advantages can also result, e.g. improvements of worker posture.

This Technical Specification supplements and supports the industrial robot safety standards ISO 10218-1 and ISO 10218-2 [ANSI/RIA R15.06-2012] and provides additional guidance on the identified operational functions for collaborative robots.

The collaborative operations described in this Technical Specification are dependent upon the use of robots meeting the requirements of ISO 10218-1 and their integration meeting the requirements of ISO 10218-2 [ANSI/RIA R15.06-2012].

NOTE Collaborative operation is a developing field. The values for power and force limiting stated in this Technical Specification are expected to evolve in future editions.
Robots and robotic devices — Collaborative robots

1 Scope

This Technical Specification specifies safety requirements for collaborative industrial robot systems and the work environment, and supplements the requirements and guidance on collaborative industrial robot operation given in ISO 10218-1 and ISO 10218-2 [ANSI/RIA R15.06-2012].

This Technical Specification applies to industrial robot systems as described in ISO 10218-1 and ISO 10218-2 [ANSI/RIA R15.06-2012]. It does not apply to non-industrial robots, although the safety principles presented can be useful to other areas of robotics.

NOTE This Technical Specification does not apply to collaborative applications designed prior to its publication.

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 12100, Safety of machinery — General principles for design — Risk assessment and risk reduction

ISO 13850, Safety of machinery — Emergency stop function — Principles for design

ISO 13855, Safety of machinery — Positioning of safeguards with respect to the approach speeds of parts of the human body

IEC 60204-1, Safety of machinery — Electrical equipment of machines — Part 1: General requirements

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10218-1, ISO 10218-2 and ISO 12100 and the following apply.

3.1 collaborative operation
state in which a purposely designed robot system and an operator work within a collaborative workspace

[SOURCE: ISO 10218-1:2011, 3.4, modified]