



Designation: C1615/C1615M – 17 (Reapproved 2022)

Standard Guide for Mechanical Drive Systems for Remote Operation in Hot Cell Facilities¹

This standard is issued under the fixed designation C1615/C1615M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 Intent:

1.1.1 The intent of this standard is to provide general guidelines for the design, selection, quality assurance, installation, operation, and maintenance of mechanical drive systems used in remote hot cell environments. The term mechanical drive systems used herein, encompasses all individual components used for imparting motion to equipment systems, subsystems, assemblies, and other components. It also includes complete positioning systems and individual units that provide motive power and any position indicators necessary to monitor the motion.

1.2 Applicability:

1.2.1 This standard is intended to be applicable to equipment used under one or more of the following conditions:

1.2.1.1 The materials handled or processed constitute a significant radiation hazard to man or to the environment.

1.2.1.2 The equipment will generally be used over a long-term life cycle (for example, in excess of two years), but equipment intended for use over a shorter life cycle is not excluded.

1.2.1.3 The equipment can neither be accessed directly for purposes of operation or maintenance, nor can the equipment be viewed directly, for example, without radiation shielding windows, periscopes, or a video monitoring system (Guides C1572 and C1661).

1.2.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 User Caveats:

1.3.1 This standard is not a substitute for applied engineering skills, proven practices and experience. Its purpose is to provide guidance.

¹ This guide is under the jurisdiction of ASTM Committee C26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.14 on Remote Systems.

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1.3.1.1 The guidance set forth in this standard relating to design of equipment is intended only to alert designers and engineers to those features, conditions, and procedures that have been found necessary or highly desirable to the design, selection, operation and maintenance of mechanical drive systems for the subject service conditions.

1.3.1.2 The guidance set forth results from discoveries of conditions, practices, features, or lack of features that were found to be sources of operational or maintenance problems, or causes of failure.

1.3.2 This standard does not supersede federal or state regulations, or both, and codes applicable to equipment under any conditions.

1.3.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *Industry and National Consensus Standards*—Nationally recognized industry and consensus standards which may be applicable in whole or in part to the design, selection, quality insurance, installation, operation, and maintenance of equipment are referenced throughout this standard and include the following:

2.2 ASTM Standards:²

ASTM/IEEE SI-10 [Standard for Use of the International System of Units](#)

[C859 Terminology Relating to Nuclear Materials](#)

[C1533 Guide for General Design Considerations for Hot Cell Equipment](#)

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

C1554 Guide for Materials Handling Equipment for Hot Cells

C1572 Guide for Dry Lead Glass and Oil-Filled Lead Glass Radiation Shielding Window Components for Remotely Operated Facilities

C1661 Guide for Viewing Systems for Remotely Operated Facilities

2.3 Other Standards:

NEMA MG1 Motors and Generators³

AGMA 390.0 American Gear Manufacturers Association, Gear Handbook⁴

ANS Design Guides for Radioactive Material Handling Facilities and Equipment⁵

ASME B17.1 Keys and Keyseats⁶

NLGI American Standard Classification of Lubricating Grease⁷

ASME NOG-1 American Society of Mechanical Engineers Committee on Cranes for Nuclear Facilities – Rules for Construction of Overhead and Gantry Cranes⁶

ANSI/ASME NQA-1 Quality Assurance Requirements for Nuclear Facility Applications⁸

ANSI/ISO/ASQ Q9001 Quality Management Standard Requirements⁸

NCRP Report No. 82 SI Units in Radiation Protection and Measurements⁹

ICRU Report 10b Physical Aspects of Irradiation¹⁰

CERN 70-5 Effects of Radiation on Materials and Components¹¹

2.4 Federal Standards and Regulations:¹²

10CFR 830.120, Subpart A Nuclear Safety Management Quality Assurance Requirements

10CFR 50 Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants

40CFR 260-279 Solid Waste Regulations – Resource Conservation and Recovery Act (RCRA)

3.1.2 For definitions of general terms used to describe nuclear materials, hot cells, and hot cell equipment, refer to Terminology **C859**.

3.2 Definitions:

3.2.1 *encoders, n*—for the purpose of this standard, are measuring devices that detect changes in rotary or linear motion, direction of movement, and relative position by producing electrical signals using sensors and an optical disk.

3.2.2 *inert gas, n*—a type of commercial grade moisture free gas, usually argon or nitrogen that is present in the hot cell.

3.2.3 *linear variable differential transformer (LVDT), n*—a transducer for linear displacement measurement that converts mechanical motion into an electrical signal that can be metered, recorded, or transmitted.

3.2.4 *mechanical drive systems, n*—refers to but is not limited to motors, gears, resolvers, encoders, bearings, couplings, bushings, lubricants, solenoids, shafts, pneumatic cylinders, and lead screws.

3.2.5 *resolvers, n*—for the purpose of this standard, are rotational position measuring devices that are essentially rotary transformers with secondary windings on the rotor and stator at right angles to the other windings.

4. Significance and Use

4.1 Mechanical drive systems operability and long-term integrity are concerns that should be addressed primarily during the design phase; however, problems identified during fabrication and testing should be resolved and the changes in the design documented. Equipment operability and integrity can be compromised during handling and installation sequences. For this reason, the subject equipment should be handled and installed under closely controlled and supervised conditions.

4.2 This standard is intended as a supplement to other standards, and to federal and state regulations, codes, and criteria applicable to the design of equipment intended for this use.

4.3 This standard is intended to be generic and to apply to a wide range of types and configurations of mechanical drive systems.

5. Quality Assurance and Quality Requirements

5.1 The owner-operator should administer a quality assurance program approved by the agency of jurisdiction. QA programs may be required to comply with 10CFR 50, Appendix B, 10CFR 830.120, Subpart A, ASME NQA-1, or ISO Q9001.

5.2 The owner-operator should require appropriate quality assurance of purchased mechanical drive systems and components to assure proper fit up, operation and reliability of the equipment in the hot cell.

6. General Requirements

6.1 For safe and efficient operation, a minimum number of mechanical drive system components should be placed in a hot cell. Unnecessary equipment in a cell adds to the cost of

³ Available from National Electrical Manufacturers Association (NEMA), 1300 N. 17th St., Suite 1752, Rosslyn, VA 22209, <http://www.nema.org>.

⁴ Available from American Gear Manufacturers Association (AGMA), 500 Montgomery St., Suite 350, Alexandria, VA 22314-1581, <http://www.agma.org>.

⁵ Available from ANS, 555 North Kensington Avenue, LaGrange Park, Illinois 60526.

⁶ Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

⁷ Available from NLGI, 4635 Wyondotte Street, Kansas City, MO 64112.

⁸ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁹ Available from National Council of Radiation Protection and Measurements, 7910 Woodmont Avenue, Suite 400, Bethesda, MD 20814-3095.

¹⁰ Available from International Commission on Radiation Units and Measurements, Inc., 7910 Woodmont Avenue, Suite 400, Bethesda, MD 20814-3095.

¹¹ Available from CERN European Organization for Nuclear Research, CH-1211, Geneva 23, Switzerland.

¹² Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, <http://www.access.gpo.gov>.