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Standard Guide for Hot Cell Specialized Support Equipment and Tools[1]

This standard is issued under the fixed designation C1725; 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 This guide presents practices and guidelines for the design and implementation of equipment and tools to assist assembly, disassembly, alignment, fastening, maintenance, or general handling of equipment in a hot cell. Operating in a remote hot cell environment significantly increases the difficulty and time required to perform a task compared to completing a similar task directly by hand. Successful specialized support equipment and tools minimize the required effort, reduce risks, and increase operating efficiencies.

1.2 *Applicability:*

1.2.1 This guide may apply to the design of specialized support equipment and tools anywhere it is remotely operated, maintained, and viewed through shielding windows or by other remote viewing systems.

1.2.2 Consideration should be given to the need for specialized support equipment and tools early in the design process.

1.2.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *Caveats:*

1.3.1 This guide is generic in nature and addresses a wide range of remote working configurations. Other acceptable and proven international configurations exist and provide options for engineer and designer consideration. Specific designs are not a substitute for applied engineering skills, proven practices, or experience gained in any specific situation.

1.3.2 This guide does not supersede federal or state regulations, or both, or 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 *ASTM Standards:*[2]

A193/A193M Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications

A354 Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners

A453/A453M Specification for High-Temperature Bolting, with Expansion Coefficients Comparable to Austenitic Stainless Steels

A962/A962M Specification for Common Requirements for Bolting Intended for Use at Any Temperature from Cryogenic to the Creep Range

C859 Terminology Relating to Nuclear Materials

C1217 Guide for Design of Equipment for Processing Nuclear and Radioactive Materials

C1533 Guide for General Design Considerations for Hot Cell Equipment

C1554 Guide for Materials Handling Equipment for Hot Cells

C1615 Guide for Mechanical Drive Systems for Remote Operation in Hot Cell Facilities

C1661 Guide for Viewing Systems for Remotely Operated Facilities

SI10-02 IEEE/ASTM SI 10 American National Standard for Use of the International System of Units (SI): The Modern Metric System

2.2 *Federal Regulations:*[3]

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

[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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[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.

[3] 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.

2.3 *Other Standards:*[4]
ANSI/ASME NQA-1 Quality Assurance Requirements for Nuclear Facility Applications
ANSI/ISO/ASQ 9001 Quality Management Standard Requirements

3. Terminology

3.1 The terminology employed in this guide conforms to industry practice insofar as practicable.

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

3.3 *Definitions of Terms Specific to This Standard:*

3.3.1 *acorn-head (cone-head) fastener*—a bolt or screw with a rounded spherical head tapering into a standard hex head resembling the shape of the bottom portion of an acorn (or cone), the purpose of which is used to guide and align a tool onto the bolt head.

3.3.2 *alignment (guide) pin*—a pin used to align two mating components by mating a pin mounted in one component with a precisely sized and positioned hole in the mating part. Multiple pins are typically required for proper alignment depending on the configuration and orientation of the mating surfaces.

3.3.3 *captive fastener*—a bolt or screw physically retained on a component that remains attached when mating parts are separated. Using captive fasteners eliminates the risk of dropping the fastener and helps to maintain the fastener in a ready to use position. It can also apply to nuts when mating components are too thin for threading.

3.3.4 *grapple*—a removable tool that attached by means of a non-threaded connection to equipment and interfaces with an overhead crane or electro-mechanical manipulator to lift and move the equipment.

3.3.5 *lifting bail*—lifting handle, hook, or cable generally attached over the center of gravity of the equipment to aid remote handling.

3.3.6 *power manipulator*—manipulator controlled by an operator outside of the hot cell with the in-cell slave-arm powered by electric, pneumatic, or hydraulic actuators.

4. Significance and Use

4.1 This guide is relevant to the design of specialized support equipment and tools that are remotely operated, maintained, or viewed through shielding windows, or combinations thereof, or by other remote viewing systems.

4.2 Hot cells contain substances and processes that may be extremely hazardous to personnel or the external environment, or both. Process safety and reliability are improved with successful design, installation, and operation of specialized mechanical and support equipment.

4.3 Use of this guide in the design of specialized mechanical and support equipment can reduce costs, improve productivity, reduce failed hardware replacement time, and provide a standardized design approach.

5. Design Requirements

5.1 The complexity, performance, reliability, and life expectancy of support equipment will be determined by the facility purpose, configuration, and radiation levels. A production facility may require robust designs intended to be extensively used for the life of the facility. In contrast, equipment for a research or analytical facility may be intended only for limited short-term experiments.

5.2 Present and future radiation levels, chemical exposures, and other severe environmental conditions should be well understood for their impact on material performance, life expectancy, and disposal.

5.3 Limitations of the facility handling equipment should be identified and possible constraints imposed on support equipment and tools understood. Applicable inputs include lift capacities, range of motion, force limits, and areas of coverage. A specific example is to use the repeatable minimum incremental movement of the handling equipment to size features for easy alignment with appropriate tool.

5.4 Operator interfaces with handling equipment should also be identified to understand how the operator verifies successful task completion or recognizes when a problem occurs. Refer to Guides C1217, C1533, C1554, C1615, and C1661 for additional descriptions of hot cell equipment design requirements.

6. Quality Assurance, Qualification and Acceptance

6.1 Facility owners and program managers should establish a quality assurance program to assure proper equipment operation and reliability consistent with that required for facility operations as outlined by law or the agency of jurisdiction. Quality assurance programs may be required to comply with 10 CFR830.120, ANSI/ASME NQA-1, or ANSI/ISO/ASQ 9001.

6.2 Quality assurance specifications should be established to ensure all procurement and fabrication meets the design specifications. The level of complexity and risk consequences should be used to determine the level of required certification documentation and the degree of inspection.

6.3 Components should be tested in a simulated operating environment (mockup) before in-cell installation or use to verify remote operability, maintainability, and to reduce the risk of unexpected problems. The level of complexity and risk consequences should be used to determine the degree of simulation required to test designs before remote implementation.

6.4 Equipment to be used in nuclear or other regulatory controlled facilities may be required to meet specific qualification requirements and documentation by the regulatory agency prior to installation or use.

7. Remote Handling Features

7.1 *Manipulator Finger Guides*—Guides for the fingers on the in-cell portion of the manipulators provide positive grips

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