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Standard Guide for Design Criteria for Plutonium Gloveboxes¹

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1. Scope

1.1 This guide defines criteria for the design of glovebox systems to be used for the handling of plutonium in any chemical or physical form or isotopic composition or when mixed with other elements or compounds. Not included in the criteria are systems auxiliary to the glovebox systems such as utilities, ventilation, alarm, and waste disposal. Also not addressed are hot cells or open-face hoods. The scope of this guide excludes specific license requirements relating to provisions for criticality prevention, hazards control, safeguards, packaging, and material handling. Observance of this guide does not relieve the user of the obligation to conform to all federal, state, and local regulations for design and construction of glovebox systems.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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

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
- A240/A240M Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
- A269 Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
- A312/A312M Specification for Seamless, Welded, and

- Heavily Cold Worked Austenitic Stainless Steel Pipes
- A376/A376M Specification for Seamless Austenitic Steel Pipe for High-Temperature Central-Station Service
- A480/A480M Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
- A999/A999M Specification for General Requirements for Alloy and Stainless Steel Pipe
- A1016/A1016M Specification for General Requirements for Ferritic Alloy Steel, Austenitic Alloy Steel, and Stainless Steel Tubes
- C859 Terminology Relating to Nuclear Materials
- C1454 Guide for Pyrophoricity/Combustibility Testing in Support of Pyrophoricity Analyses of Metallic Uranium Spent Nuclear Fuel
- F837 Specification for Stainless Steel Socket Head Cap Screws

2.2 Other Standards

- ANSI N13.1 Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities³
- ANSI/ASME NQA-1 Quality Assurance Requirements for Nuclear Facility Applications³
- ANSI/ASME AG-1 Code on Nuclear Air and Gas Treatment³
- NFPA-70 National Electrical Code⁴
- NFPA 72 National Fire Alarm Code⁴
- DOE-HDBK-1081-94 DOE Handbook on Primer of Spontaneous Heating and Pyrophoricity⁵
- 10 CFR 20 Standards for Protection Against Radiation⁶
- 10 CFR 50 Domestic Licensing of Production and Utilization Facilities⁶
- 40 CFR 260–279 Solid Waste Regulations—Resource Conservation and Recovery Act (RCRA)⁶
- 10 CFR 830 Subpart A Quality Assurance Requirements⁶

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

⁴ Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, <http://www.nfpa.org>.

⁵ Available to the public from the U.S. Department of Commerce, Technology Administration, National Technical Information Service, Springfield, VA 22161.

⁶ 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>.

- AGS-G001-2007 [Guideline for Gloveboxes](#)⁷
 AGS-G006-2005 [Standard of Practice for the Design and Fabrication of Nuclear-Application Gloveboxes](#)⁷
 AGS-G005-2003 [Standard of Practice for the Specification of Gloves for Gloveboxes](#)⁷

3. Significance and Use

3.1 The purpose of this guide is to establish criteria for the design of gloveboxes as primary confinement systems to ensure the safety of the workers and the protection of the environment when storing, handling, processing, and disposing of both combustible and non-combustible forms of plutonium. The use of this standard will provide the user with guidance to design a successfully performing glovebox system.

4. Quality Assurance

4.1 A quality assurance program should be established for the design, fabrication, construction, acceptance testing, and operation, including modifications, repairs, replacement and maintenance of structures, systems, and components important to safety. Quality assurance requirements should be specified in the purchase order or contract (see 10 CFR 50 Appendix B, 10 CFR 830 Subpart A, and ANSI/ASME NQA-1).

5. Design Considerations

5.1 Design considerations should include engineered safety features and redundant plant services to achieve confinement reliability. Reliability should be considered in the light of the risk associated with postulated accidents (for example, accidents resulting from pyrophoric behavior of metallic plutonium), the probability of occurrence of the accidents, and the severity of their consequences, as well as in the light of normal processing requirements. See Guide C1454. The design for the glovebox system should consider all of the following subjects:

- 5.1.1 Fire,
- 5.1.2 Explosions,
- 5.1.3 Seismic events,
- 5.1.4 Installation and removal from service,
- 5.1.5 Automated equipment,
- 5.1.6 Glovebox process operations,
- 5.1.7 Criticality,
- 5.1.8 Confinement system leaks,
- 5.1.9 Power failure,
- 5.1.10 Service water failure,
- 5.1.11 Other services failure,
- 5.1.12 Glovebox pressurization,
- 5.1.13 Glovebox evacuation,
- 5.1.14 Health physics, and
- 5.1.15 Need for glovebox isolation or compartmentalization, or both.

6. Glovebox System Design Features

6.1 The glovebox system is defined as a series of physical barriers provided with glove ports and gloves, through which process and maintenance operations may be performed, to-

gether with an operating ventilation system. The glovebox system should minimize the potential for release of radioactive material to the environment under normal and abnormal conditions, protect the operators from contamination under normal operating conditions, and mitigate the consequences of abnormal conditions to the maximum extent practical. Where feasible and practical, the glovebox should incorporate passive safety controls rather than active safety controls. In the event that the glovebox is used to process and handle metallic plutonium, it should provide a dry inert atmosphere such as nitrogen or argon to prevent combustion or pyrophoric behavior of the plutonium. See Guide C1454. Compartmentalization within and between gloveboxes should be considered and installed as necessary to mitigate the potential seriousness of accidents involving fire, explosion, or criticality. The glovebox system design should consider interconnecting tunnels, conveyors, and passageways for transferring materials between adjacent gloveboxes. Provision for containment should be provided.

6.2 Confinement:

6.2.1 The glovebox should be designed to operate at 125 to 250 Pa (0.5 to 1.0 in. H₂O gauge) pressure negative to the room in which it is located. The glovebox and its accessory equipment should be designed to prevent liquid flooding or subjection of the box to excessive vacuum or pressure. Control devices, such as oil filtered U-tubes to relieve pressure, shall be positive-acting or automatic, or both. See USAEC Report TID 24236.⁸

6.2.2 The glovebox, when assembled and blanked off (evacuated to a given negative pressure and sealed off from further evacuation source), should pass a leak-rate not to exceed 0.3 volume % air/h when tested at an initial pressure differential of one kPa (4 in. H₂O gauge) for four hours. Penetrations in the glovebox (such as conduits, ports, ducts, pipes, and windows) shall be constructed to prevent the release of radioactive material under normal operating conditions. See AGS-G001-2007.

6.2.3 The design of gloveboxes should include means to control and minimize the release of radioactive materials to the plant system during normal plant operation and under a postulated design basis accident.

6.3 *Glovebox Construction*—Gloveboxes should be constructed using appropriate materials and workmanship to ensure confinement and to minimize leakage. The glovebox and support structure should be designed for the heaviest anticipated loading in the glovebox. Combustible materials should be held to a minimum. See AGS-G001-2007 and AGS-G006-2005.

6.3.1 *Materials*—Gloveboxes should be constructed of materials that will be compatible with intended use for structural strength, corrosion resistance, resistance to radiation degradation, and radiation shielding. Gloveboxes should be tested to the highest expected abnormal conditions. The containment

⁷ Available from the American Glovebox Society, P.O. Box 9099, Santa Rosa, CA, 95405, <http://www.gloveboxsociety.org>.

⁸ "Glovebox Window Materials: a Glovebox Fire Safety Application," TID-24896, United States Atomic Energy Commission, Factory Mutual Research Corporation, 1969, <http://www.osti.gov/energycitations/servlets/purl/4822006-KYw7jb/>.