INTERNATIONAL

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Standard Guide for Design Criteria for Plutonium Gloveboxes[1]

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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. ~~This guide does not apply to large scale commercial gloveboxes although many of the criteria contained herein are relevant.~~ Not included in the criteria are systems auxiliary to the glovebox systems such as utilities, ventilation, alarm, and waste disposal. Also not addressed ~~is the massively shielded (concrete)-type enclosure~~ are hot cells or open-face ~~hoods, although the same basic design considerations might apply.~~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 establilsh appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ~~*ANSI Standards:*~~

~~N13.1Guides to Sampling Airborne Radioactive Materials in Nuclear Facilities~~ASTM Standards:[2]

~~ANSI/ASME NQA-1 Quality Assurance Requirements for Nuclear Facilities~~[2]

A 193/A 193M Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications

A 240/A 240M Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

A 269 Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service

A 312/A 312M Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes

A 376/A 376M Specification for Seamless Austenitic Steel Pipe for High-Temperature Central-Station Service

A 480/A 480M Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

A 999/A 999M Specification for General Requirements for Alloy and Stainless Steel Pipe

A 1016/A 1016M Specification for General Requirements for Ferritic Alloy Steel, Austenitic Alloy Steel, and Stainless Steel Tubes

C 859 Terminology Relating to Nuclear Materials

C 1454 Guide for Pyrophoricity/Combustibility Testing in Support of Pyrophoricity Analyses of Metallic Uranium Spent Nuclear Fuel

F 837 Specification for Stainless Steel Socket Head Cap Screws

2.2 ~~*NFPA Pamphlets:*~~ *Other Standards*

ANSI N13.1 Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities[3]

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[1] This guide is under the jurisdiction of ASTM Committee ~~C-26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.02 on Fuel and Fertile Material Specifications.~~

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~~[2] Available from the American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.~~

[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 the National Fire Protection Agency (NFPA), 60 Batterymarch St., Boston, MA 02110.~~

ANSI/ASME NQA-1 Quality Assurance Requirements for Nuclear Facility Applications[3]
Nos. 71,72A, 72B, 72C, and 72D
2.3 *U. S. Government Document:*
U. S. Govt. Code of Federal Regulations, Title 10Part 20 "Standards for Protection Against Radiation" (latest edition)
ANSI/ASME AG-1 Code on Nuclear Air and Gas Treatment[3]
NFPA-70 National Electrical Code [4]
Nuclear Materials Licensing Code of Federal Regulations, Energy, Part 50 (10CFR50) Licensing of Domestic Production and Utilization Facilities[4]
DOE 6430.1AGeneral Design Criteria for Nuclear Facilities[4]
NFPA 72 National Fire Alarm Code[4]
DOE-HDBK-1081-94 DOE Handbook on Primer of Spontaneous Heating and Pyrophoricity[5]
10 CFR 20 Standards for Protection Against Radiation[6]
10 CFR 50 Domestic Licensing of Production and Utilization Facilities[6]
40 CFR 260–279 Solid Waste Regulations—Resource Conservation and Recovery Act (RCRA)[6]
10 CFR 830 Subpart A Quality Assurance Requirements[6]
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

3.1The purpose of this guide is to establish criteria for the design of gloveboxes used as primary confinement systems to ensure the safety of the workers and the protection of the environment when handling plutonium.

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. Design Considerations

4.1Design considerations should include mitigating engineered safety features and redundant plant services to achieve confinement reliability. Reliability shall be considered in the light of the risk associated with postulated accidents, the probability of occurrence of the accidents, and the severity of their consequences, as well as in the light of normal processing requirements. The design for the glovebox system shall consider all of the following subjects:

4.1.1Fire,

4.1.2Explosions,

4.1.3Criticality,

4.1.4Power failure,

4.1.5Uncontrolled water,

4.1.6Other services failure,

4.1.7Pressurization or evacuation, or both,

4.1.8Health physics, and

4.1.9Need for glovebox isolation or compartmentalization, or both. 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

[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 the Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402.
[4] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org.
[5] The boldface numbers in parentheses refer to the list of references appended to this standard.
[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.
[7] Available from the American Glovebox Society, P.O. Box 9099, Santa Rosa, CA, 95405, http://www.gloveboxsociety.org.

consequences, as well as in the light of normal processing requirements. See Guide C 1454. 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

5.1The 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, together with an operating ventilation system. The glovebox system shall 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. Compartmentalization within and between gloveboxes shall 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.

5.2

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, together 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 Guide C 1454. 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*:

5.2.1The glovebox shall be designed to operate a 125 to 174-Pa (0.5 to 0.7-in.) H

6.2.1 The glovebox should be designed to operate at 125 to 250 Pa (0.5 to 1.0 in. H_2O gauge) pressure negative to the room in which it is located. The glovebox and its accessory equipment shallshould 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 Ref (1) for options.)See USAEC Report TID 24236.[8]

5.2.2The6.2.2 The glovebox, when assembled and blanked off (evacuated to a given negative pressure and sealed off from further evacuation source), shallshould pass a leak-rate of not to exceed 0.3 volume % air/h when tested at an initial pressure differential of 1one kPa (−4 in.)(4 in. H_2O gage for 12 h. Penetrations in the box (such as conduits, ports, ducts, pipes, and windows) shall be constructed to prevent the release of radioactive material under normal operating conditions.

5.3*O 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 shall be constructed using high-quality materials and workmanship to ensure confinement and to minimize leakage. Combustible materials should be held to a minimum.

[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/.

5.3.1—*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 shall be constructed of materials that will be compatible with intended use for structural strength, corrosion resistance, resistance to radiation degradation, and radiation shielding. The interior should be smooth and free of crevices and sharp objects to a practical degree in order to minimize hold-up of plutonium, facilitate decontamination, and prevent injury to the worker. Surface coatings may be applied to enhance corrosion resistance or facilitate cleaning, or both. (See Ref **(1,2)** for options.) Box fabrication tolerances shall be specified.

5.3.2—*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 structure should be constructed from a minimum of 3-mm (0.120 in.) thick 304L or 316L series stainless steel per Specifications A 240/A 240M and A 480/A 480M. The interior should be smooth and free of crevices and sharp objects. Internal radii should be compatible with decontamination and radiation monitoring in accordance with AGS standards. Strippable surface coatings may be applied to the interior of the glovebox to facilitate cleaning or decontamination. Surface coatings on the interior of the glovebox may be required for protection when certain acids (hydrochloric, sulphuric, or hydrofluoric) or other corrosive materials are present in the glovebox. Any coatings applied to the interior of the glovebox must be considered as part of the combustible material loads for that glovebox. Glovebox fabrication tolerances should be specified. See USAEC Report TID-24236,[8] USAEC Report TID-16020,[9] and AGS-G001-2007 for options.*

6.3.2 *Windows*—Windows shall be conveniently located for the worker, and shall be constructed of noncombustible or fire-resistant materials that are resistant to mechanical shock and radiation. They shall be securely fastened and gasketed or sealed with material that will resist deterioration by chemical attack and radiation degradation, and permit replacement with minimum risk of laboratory contamination. (See Ref **(3)** for types of material.) Laminated glass and laminated polycarbonate are the preferred materials.

5.3.3—*Windows should be conveniently located for the worker, and should be constructed of noncombustible or fire-resistant materials that are resistant to mechanical shock and radiation. Gloveboxes intended for the processing and handling of metallic plutonium or uranium should avoid using windows made of plastic or other combustible materials. Laminated glass or a combination of laminated glass and polycarbonate is the preferred construction. The windows shall be securely fastened and should be gasketed or sealed with material that will resist deterioration by chemical attack and radiation degradation, and permit replacement with minimum risk of contamination to the facility. See USAEC Report TID-24896[10] and AGS-G001-2007 for types of material.*

6.3.3 *Glove Ports*— Glove ports shallshould be designed to allow replacement of gloves without losing compromising the glovebox atmosphere or contamination control. Ports should be located to facilitate both operating and maintenance work, and take into account the need for two-handed operation, depth of reach, operator comfort from an ergonomic perspective, and positioning with respect to other ports. The glove ports should be installed in a metal front panel to reduce window cracking hazards, and provide shielding and additional strength. A detailed dimensional analysis of the operations would assist in eliminating blind spots or inaccessible areas.

5.3.46.3.4 *Gloves*—Gloves shall be chosen on the basis of resistance to possible corrosive atmospheres in the glovebox; resistance to radiation degradation, tearing, and puncturing; and their capability to provide some radiation shielding to the hands. They shall also be selected on the basis of maintaining maximum dexterity of hand movement **(4)**—Gloves should be chosen on the basis of resistance to possible corrosive atmospheres in the glovebox; resistance to radiation degradation, tearing, and puncturing; and their capability to provide some radiation shielding to the hands. Consideration should be given to high or low temperature sources within the glovebox and their proximity to the gloves. Pinch points and sharp corners should be avoided to the greatest extent possible consistent with ergonomic considerations. Gloves should also be selected on the basis of maintaining maximum dexterity of hand movement. See AGS-G005-2003.

5.4

6.4 *Equipment Insertion-Removal* —Bagout ports, sphincter seals, and air locks shallshould be designed and installed to facilitate the introduction or removal of needed equipment without compromising the glovebox atmosphere or contamination controls.

5.56.5 *Lighting*—1076-lx (100 foot candles) lighting shall be provided on all surfaces for close work, and 538-lx (50-fc) lighting shall be provided for general illumination **(5)**. To the maximum extent, practical lighting fixtures should be mounted on the glovebox exterior to facilitate repair and replacement and to avoid the possibility of broken glass within the glovebox.

5.6—*1076-lx (100 foot candles) lighting should be provided on all surfaces for close work, and 538-lx (50-fc) lighting should be provided for general illumination within the glovebox. The lighting should be adjusted to compensate for glare, reflection, heat, and light intensity prior to going operational. To the maximum extent practical, lighting fixtures should be mounted on the glovebox exterior to facilitate repair and replacement and to avoid the possibility of broken glass within the glovebox. Consideration should*

[9] Garden, Nelson B., et al, AdHoc Committee on Gloveboxes, United States Atomic Energy Commission, Factory Mutual Research Corporation, 1969.

[10] "Glovebox Window Materials," Factory Mutual Research Corp., 1969.