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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 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 or open-face hoods, although the same basic design considerations might apply. 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:*

N13.1 Guides to Sampling Airborne Radioactive Materials in Nuclear Facilities[2]

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

2.2 *NFPA Pamphlets:*

Nos. 71, 72A, 72B, 72C, and 72D[3]

2.3 *U. S. Government Document:*

U. S. Govt. Code of Federal Regulations, Title 10 Part 20 "Standards for Protection Against Radiation" (latest edition)[4]

Nuclear Materials Licensing Code of Federal Regulations, Energy, Part 50 (10CFR50) Licensing of Domestic Production and Utilization Facilities[4]

DOE 6430.1A General Design Criteria for Nuclear Facilities[4]

3. Significance and Use

3.1 The 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.

4. Design Considerations

4.1 Design 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:

4.1.1 Fire,

4.1.2 Explosions,

4.1.3 Criticality,

4.1.4 Power failure,

4.1.5 Uncontrolled water,

4.1.6 Other services failure,

4.1.7 Pressurization or evacuation, or both,

4.1.8 Health physics, and

4.1.9 Need for glovebox isolation or compartmentalization, or both.

5. Glovebox System Design Features

5.1 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 shall minimize the potential for release of radioactive

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

[3] Available from the National Fire Protection Agency (NFPA), 60 Batterymarch St., Boston, MA 02110.

[4] Available from the Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402.

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 *Confinement*:

5.2.1 The glovebox shall be designed to operate a 125 to 174-Pa (0.5 to 0.7-in.) H_2O gage pressure negative to the room in which it is located. The box and its accessory equipment shall 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.[5])

5.2.2 The glovebox, when assembled and blanked off (evacuated to a given negative pressure and sealed off from further evacuation source), shall pass a leak-rate of 0.3 volume % air/h when tested at a pressure differential of 1 kPa (−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 *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.

5.3.1 *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 *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 *Glove Ports*— Glove ports shall be designed to allow replacement of gloves without losing 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, 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.

5.3.4 *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)**.

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

5.5 *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 *Ventilation*:

5.6.1 The ventilation system shall be designed so that its capacity is sufficient to provide and maintain the design negative pressure during normal operation and the design flow through a breach during abnormal conditions.

5.6.2 Where the source of combustible solvents, gases, or vapors can be identified or postulated, explosive conditions shall be precluded and suitable monitoring and alarm systems shall be installed for control. Electrical systems shall be explosion-proof and other potential ignition sources shall be precluded.

5.6.3 There shall be exhaust capacity on demand that will promptly cause an inflow of air of at least 38 linear m/min (125 linear ft/min) through a potential breach of a single glovebox penetration. For the purpose of design, no more than one such failure at a time need be considered.

5.6.4 If desired, a portion of the atmosphere may be recirculated within each glovebox, thus lessening the load on heating, cooling, and moisture control equipment. Other glovebox atmospheres may be employed for special uses, such as recirculating inert gas for handling pyrophoric or unusually reactive materials. For fire protection, the use of bromotrifluoromethane fire extinguishing systems should be considered. Recirculation systems shall be equipped with air-cleaning equipment. Continuous radioactive monitors or samplers may be used to assist in maintaining air quality in such systems.

5.6.5 Filter, scrubbers, demisters, and other air-cleaning devices shall be provided to remove excessive moisture, toxic or noxious gases, and airborne particulates exhausted to the ventilation system to levels that are as low as reasonably achievable; requirements shall be specified by the user. An easily replaced HEPA filter, preceded with a roughing filter to protect it, should be installed at each glovebox atmosphere exit to minimize contamination of duct-work and loading of the final filtration system **(1,2)**. A HEPA filter should be installed on the air inlet to the glovebox to preclude a blow back of

[5] The boldface numbers in parentheses refer to the list of references appended to this standard.