Designation: C1572 – 10

Standard Guide for Dry Lead Glass and Oil-Filled Lead Glass Radiation Shielding Window Components for Remotely Operated Facilities[1]

This standard is issued under the fixed designation C1572; 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 guidance for the design, fabrication, quality assurance, inspection, testing, packaging, shipping, installation, and maintenance of radiation shielding window components. These window components include wall liner embedments, dry lead glass radiation shielding window assemblies, oil-filled lead glass radiation shielding window assemblies, shielding wall plugs, barrier shields, view ports, and the installation/extraction table/device required for the installation and removal of the window components.

1.2 *Applicability*:

1.2.1 This standard is intended for those persons who are tasked with the planning, design, procurement, fabrication, installation, and operation of the radiation shielding window components that may be used in the operation of hot cells, high level caves, mini-cells, canyon facilities, and very high level radiation areas.

1.2.2 This standard applies to radiation shielding window assemblies used in normal concrete walls, high-density concrete walls, steel walls and lead walls.

1.2.3 The system of units employed in this standard is the metric unit, also known as SI Units, which are commonly used for International Systems, and defined, by ASTM/IEEE SI-10 Standard for Use of International System of Units. Common nomenclature for specifying some terms; specifically shielding, uses a combination of metric units and inch-pound units.

1.2.4 This standard identifies the special information required by the Manufacturer for the design of window components. A1.1 shows a sample list of the radiation source spectra and geometry information, typically required for shielding analysis. A2.1 shows a detailed sample list of specific data typically required to determine the physical size, glass types, and viewing characteristics of the shielding window, or view port. A3 shows general window configuration sketches. Blank copies of A1.2 and A2.2 are found in the respective Annexes for the Owner–Operator's use.

1.2.5 This standard is intended to be generic and to apply to a wide range of configurations and types of lead glass radiation shielding window components used in hot cells. It does not address glovebox, water, X-ray glass, or zinc bromide windows.

1.2.6 Supplementary information on viewing systems in hot cells may be found in Guides C1533 and C1661.

1.3 *Caveats*:

1.3.1 Consideration shall be given when preparing the shielding window designs for the safety related issues discussed in the Hazard Sources and Failure Modes, Section 11; such as dielectric discharge, over-pressurization, radiation exposure, contamination, and overturning of the installation/extraction table/device.

1.3.2 In many cases, the use of the word "shall" has been purposely used in lieu of "should" to stress the importance of the statements that have been made in this standard.

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 and health practices and determine the applicability of regulatory requirements prior to use.*

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, fabrication, quality assurance, inspection, testing, packaging, shipping, installation and maintenance of radiation shielding window components are referenced throughout this standard and include the following:

2.2 *ASTM Standards:*[2]

A27/A27M Specification for Steel Castings, Carbon, for General Application

[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.

A36/A36M Specification for Carbon Structural Steel
A48/A48M Specification for Gray Iron Castings
A240/A240M Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
A747/A747M Specification for Steel Castings, Stainless, Precipitation Hardening
C1533 Guide for General Design Considerations for Hot Cell Equipment
C1661 Guide for Viewing Systems for Remotely Operated Facilities
D1533 Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration
E165 Practice for Liquid Penetrant Examination for General Industry
E170 Terminology Relating to Radiation Measurements and Dosimetry
E2024 Test Methods for Atmospheric Leaks Using a Thermal Conductivity Leak Detector
ASTM/IEEE SI-10 Standard for Use of the International System of Units

2.3 *American Concrete Institute (ACI) Standards:* [3]
ACI C-31 Seismic Requirements

2.4 *American Institute of Steel Construction (AISC) Standard:* [4]
Manual of Steel Construction

2.5 *American National Standards Institute (ANSI) Standards:*[5]
ANSI Y 14 Engineering Drawing and Related Documentation Practices
ANSI/ASME NQA-1 Quality Assurance Requirements for Nuclear Facility Applications
ANSI/AWS A2.4 Standard Symbols for Welding, Brazing and Nondestructive Examination
ANSI/AWS B2.1 Specification for Welding Procedure and Performance Qualification
ANSI/AWS D1.1/D1.1M Structural Welding Code—Steel
ANSI/AWS D1.6/D1.6M Structural Welding Code—Stainless Steel
ANSI/ISO/ASQ 9001 Quality Management Standard Requirements

2.6 *American Society for Nondestructive Testing (ASNT) Standards:* [6]
ASNT-SNT-TC-1A Recommended Practice for Qualification and Certification of Nondestructive Testing

2.7 *Steel Structures Painting Council (SSPC):*[7]
SSPC-SP1 Solvent Cleaning
SSPC-SP6 Commercial Blast Cleaning
SSPC-P1 Paint Application Specification

2.8 *Federal Standards (FS):* [8]
QQ-C-40 Caulking, Lead Wool, and Lead Pig

2.9 *Federal Regulations (FR):* [8]
10 CFR20.1003 Definitions
10 CFR50, Appendix B Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants
10 CFR830.120 Subpart A Nuclear Safety Management, Quality Assurance Requirements

2.10 *International Building Code (IBC):* [8]
IBC Section 2314 Earthquake Regulations

2.11 *Other Standards:*
AESS (R) 44/70000/6 Atomic Energy Standard Specification for Shielding Glass[9]
NCRP Report No. 82 SI Units in Radiation Protection and Measurements[10]
ICRU Report 10b Physical Aspects of Irradiation[11]

3. Terminology

3.1 *Definitions:*

3.1.1 *absorbed dose, D, [L^2T^2], n*—absorbed dose is the mean energy imparted by ionizing radiation to a mass of specified material.

3.1.1.1 *Discussion*—The SI unit for absorbed dose is the gray (Gy), defined as 1J/kg. **NCRP-82**

3.1.2 *activity, A, [T^1], n—in the nuclear industry*, the measure of the rate of spontaneous nuclear transformations of a radioactive material.

3.1.2.1 *Discussion*—The SI unit for activity is the becquerel (Bq), defined as 1 transformation per second.

3.1.2.2 *Discussion*—The original unit for activity was the curie (Ci), defined as 3.7×10^{10} transformations per second. **NCRP-82**

3.1.3 *air dryer cartridge*, *n*—a cloth bag containing moisture-absorbent crystals.

3.1.3.1 *Discussion*—The bag is inserted into the dryer assembly. The crystals are used to absorb moisture from the contained environment.

3.1.4 *alpha radiation*, *n*—the spontaneous emission of an alpha particle, composed of two protons and two neutrons with a positive charge of plus two, during the nuclear transformation process.

3.1.4.1 *Discussion*—An alpha particle is the same as a helium atom with no electrons.

3.1.5 *anti-reflection treatment*, *n*—a process applied to the surface of the glass that reduces reflection and increases the light transmission through the glass.

3.1.5.1 *Discussion*—It is often called a low-reflection treatment.

3.1.6 *as-built drawings*, *n*—a set of drawings that reflect all of the changes that were incorporated into the components during the manufacturing process since the original design.

[3] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.concrete.org.
[4] Available from American Institute of Steel Construction (AISC), One E. Wacker Dr., Suite 700, Chicago, IL 60601-2001, http://www.aisc.org.
[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.
[6] Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, http://www.asnt.org.
[7] Available from Society for Protective Coatings (SSPC), 40 24th St., 6th Floor, Pittsburgh, PA 15222-4656, http://www.sspc.org.
[8] 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.
[9] HMSO, St. Clements House, 2-16 Colegate, Norwich, NR3 1BQ. UK.
[10] Available from National Council of Radiation Protection and Measurements, 7910 Woodmont Avenue, Suite 400, Bethesda, MD 20814-3095.
[11] Available from International Commission on Radiation Units and Measurements, Inc., 7910 Woodmont Avenue, Suite 400, Bethesda, MD 20814-3095.

3.1.7 *barrier shield assembly*, *n*—consists of steel frames, gaskets, and a glass plate; typically cerium-stabilized, assembled together to form a see through barrier.

3.1.7.1 *Discussion*—The assembly is mechanically fastened to the hot side of the wall liner to provide a gas tight containment barrier, which protects the window assembly from any radioactive contamination within the hot cell (alpha particles and other contaminates).

3.1.8 *barrier shield glass*, *n*—a glass plate; typically cerium stabilized that is used as a cover glass to see through and isolate the window assembly from contamination.

3.1.8.1 *Discussion*—It is normally mounted in a barrier shield frame with gaskets to make up a barrier shield assembly.

3.1.9 *becquerel (Bq), [T^{1}]*, *n*—the SI unit of measure for activity, defined as one transformation per second.

3.1.10 *bellows*, *n*—a flexible enclosure generally made of a pliable gasket material, which expands and contracts with the temperature change of the inert gas and other components, maintaining a controlled atmosphere within the window assembly.

3.1.10.1 *Discussion*—When employed, the bellows is generally connected to the top of the expansion tank on an oil-filled window, and directly above the air dryer on the window housing of a dry window. The material of selection must be compatible with the environment, and with the window components.

3.1.11 *beta radiation*, *n*—an electron that was generated in the atomic nucleus during decay and has a negative charge of one.

3.1.12 *browning*, *n*—the discoloration and darkening of glass to a brownish color due to excessive radiation exposure.

3.1.13 *bubbler system*, *n*—a device used as a pressure relief, and constructed of an outer open top container or chamber that is filled with a liquid.

3.1.13.1 *Discussion*—It has a separate pressurized tube inserted into the liquid. When over-pressurization occurs in the tube, the gas bubbles out the bottom of the tube and up to the surface through the liquid.

3.1.14 *buffer seal*, *n*—a specially configured seal gasket used on a barrier shield.

3.1.15 *build-up factor*, *n*—for radiation passing through a medium, buildup factor is the ratio of the total value of a specific radiation quantity (direct and scattered) measured as absorbed dose at any point within that medium to the contribution to that quantity from the incident uncollided radiation reaching that point.

3.1.15.1 *Discussion*—The build-up factor increases with increased shielding thickness and is higher for low atomic number materials.

3.1.16 *canyon*, *n—in the nuclear industry*, a long, narrow, remotely operated radiological facility.

3.1.16.1 *Discussion*—A large, heavily-shielded facility where nuclear material is processed or stored.

3.1.17 *cave*, *n—in the nuclear hot cell applications*, typically a small-scale hot cell facility.

3.1.17.1 *Discussion*—This term is sometimes used synonymously with hot cell.

3.1.18 *central viewing area, [L^{2}]*, *n*—the central viewing area of a glass slab or glass plate is that viewing area, circular or elliptical, of which the diameter of axis is 80 % of the maximum usable viewing window dimensions.

3.1.19 *cerium-stabilized glass*, *n*—a glass type that contains a small percentage of cerium oxide to help stabilize the glass from discoloration due to radiation exposure.

3.1.19.1 *Discussion*—It is often called non-browning glass.

3.1.20 *CMTR*, *n*—the abbreviation for a Certified Material Test Report, which is a document that certifies the results of tests and analyses performed on the item provided.

3.1.21 *checks*, *n*—very small fractures, or breakouts, normally around the edge of a glass plate or glass slab.

3.1.22 *chip*, *n*—a fragment broken from an edge or surface.

3.1.23 *clear view, [L^{2}]*, *n*—the physical size (length × width) of the smallest glass slab of all the glass components in a shielding window assembly.

3.1.23.1 *Discussion*—The actual clear view may be reduced by the method of retention of the glass in the window.

3.1.24 *cold side*, *n*—the surface on a radiation shielding window that is farthest from the radioactive source, and usually is not subject to contamination.

3.1.25 *cold side load*, *n*—a cold side load window assembly is an assembly that is inserted into a wall liner or removed from a wall liner from the operator (cold side) of the hot cell.

3.1.26 *cover glass (hot or cold side)*, *n*—a glass plate positioned on the hot or cold side of the window.

3.1.26.1 *Discussion*—The cover glass is often held in place with a trim frame assembly and seal gaskets. This assembly achieves a seal, which isolates the inner glass slabs from the external atmosphere and may also hold or contain the mineral oil within the window assembly.

3.1.27 *curie (Ci), [T^{1}]*, *n*—the original unit of measure for activity, defined as 3.7×10^{10} transformations per second.

3.1.28 *density inch*, *n*—a term used to describe the specific gravity of a shielding material multiplied by the thickness of that material in inches. The units are g/cc × (in.).

3.1.29 *desiccant air dryer*, *n*—a device filled with crystals and is used to remove moisture from a contained environment.

3.1.30 *dielectric discharge*, *n*—an instantaneous flow of electrical current from an irradiated glass component to the ground, causing severe damage to the glass, usually in the form of a dendritic fracture (Lichtenberg Figure) or heavy cleavage.

3.1.31 *dose equivalent, [L^{2} T^{2}]*, *n*—a measure of the biological effects of radiation dose from all types of radiation expressed on a common scale.

3.1.31.1 *Discussion*—The SI unit for dose equivalent is the sievert (Sv), which is equal to 100 rem (specialized unit for human dose equivalent). Radiation dose equivalent is often expressed in terms of microsieverts (μSv) or millirem (mrem).

3.1.32 *dose rate, [L^{2} T^{3}]*, *n*—a quantity of absorbed dose received in a given unit of time.

3.1.33 *dry lead glass window*, *n*—a radiation shielding window that is filled with slabs of lead glass with polished glass surfaces.