

PPPL	PRINCETON PLASMA PHYSICS LABORATORY ES&H DIRECTIVES		
	ES&HD 5008 SECTION 9, CHAPTER 14 Vacuum Windows		
Approved	Date: 06/27/00	Revision 2	Page 1 of 3

CHAPTER 14 VACUUM WINDOWS

14.1 INTRODUCTION

Vacuum windows are a potential hazard to personnel as well as to equipment. If a window fails there may be flying debris. If the opening is large enough, an individual may be drawn to, or into, the opening, potentially causing injury.

14.2 SCOPE

This section provides guidelines for the safe use of vacuum windows. Proper design, installation, and safeguards shall be considered when a vacuum window must be used.

14.3 DEFINITIONS (reserved)

14.4 RESPONSIBILITIES

14.4.1 Department Heads, Division Heads, and Supervisors are responsible for approving the need for vacuum windows and to ensure their safe installation/use within their administrative areas.

14.4.2 Cognizant Engineers and Physicists are responsible for:

- A. Implementing this section when designing and considering the necessity of a vacuum window.
- B. Performing calculations to determine stresses and factors of safety. These calculations shall include both mechanical and thermal stresses.
- C. Arranging for and conducting design reviews in accordance with PPPL Procedure 23.016, "Conceptual, Preliminary, & Final Design Reviews"
- D. Ensuring that adequate acceptance tests are performed on the vacuum windows.

14.4.3 Industrial Hygiene (IH) and the Head, Environment, Safety and Health Division (ES&H) are responsible for:

- A. Assisting in the implementation of this section.
- B. Reviewing and approving pressure testing setups prior to testing (see Section 9, Chapter 11 "Pressure Systems" in this manual).

14.4.4 Quality Assurance is responsible for:

- A. Witnessing or performing window inspections and pressure tests, validating that the tests were performed correctly and accurately.
- B. Documenting the results of the inspections and tests, and forwarding these to the Department/Project designated files (typically the PPPL Operations Center) in accordance with GEN-003, "Document Distribution Control."

14.5 REQUIREMENTS

Acceptance of vacuum window designs and installations shall be, at a minimum, in accordance with Procedure PTP-VAC-004.

14.6 PRACTICES/PROCEDURES

14.6.1 Training: Supervisors in charge of devices that have vacuum windows shall train their employees on the potential hazards and safe work practices related to their equipment.

14.6.2 Design

- A. Design reviews of vacuum systems must also include the review of the window design. The review will consider the structural integrity in addition to the physics applications. At these design reviews, safety professionals and vacuum engineers shall evaluate window utilization, structural integrity, and testing.
- B. Design reviews must include a review of design practices with regards to seals, brazed joints, materials and flange and hardware details to assure uniform pressure.
- C. The design philosophy should be that a vacuum vessel will contain windows only when it is necessary, thereby keeping the hazard to a minimum.
- D. The factor of safety on the breaking strength of any window should be at least 6.0. This calculation must include both thermal and mechanical stresses when present.
- E. Prior to installation, the window must be thoroughly inspected. At a minimum, a visual inspection for chips, scratches and imperfections shall take place. A pressure test should be performed with a pressure differential of 1.2 atmospheres. It should be noted that this test level will only “proof test” for atmospheric loads. Consequently, extreme caution and protective barriers should be used during initial operation in applications where the window will also be subject to thermal stresses.

14.6.3 Barriers

- A. Any window that is used for viewing on a regular basis, or is in an area where it could be easily damaged, should be provided with a protective barrier. A polycarbonate sheet (e.g., Lexan) at least 0.5 inch thick is preferred. This is a requirement for any window with a 4 inch or greater aperture (unless paragraph C or D applies) and is recommended for windows less than a 4 inch aperture.
- B. Windows intended for instrumentation should have a protective shroud between the window and personnel to provide additional protection. A protective barrier, as described in A and B, above, should be installed whenever the instrument is removed.
- C. Any window of a 4 inch or greater aperture that cannot have a protective barrier installed, due to spectral transmission requirements for diagnostics, shall have a sign posted stating:

**CAUTION: WINDOW DOES NOT HAVE A PROTECTIVE BARRIER
USE EXTREME CARE WHEN WORKING IN THIS AREA**

Any personnel working in this area while the vacuum vessel is not at atmospheric pressure must wear safety glasses, have the permission of a supervisor, understand the potential hazards and safe practices for vacuum windows, and not work alone (see Section 9, Chapter 13).

- D. Window protection hardware should be installed only when the vacuum vessel is at atmospheric pressure, or windows must be designed such that protection hardware can be mounted under a vacuum with no risk to personnel.

- E. Where a window may be subject to heat radiating from the inside of the chamber to which the window is attached, shutters should be used to reduce temperature and therefore thermal stresses on the window.

14.6.4 Beryllium Windows

- A. Beryllium windows are not subject to pressure differentials in normal operation. Their primary function is to segregate vacuum regions to maintain vacuum purity. They are always located between chambers and never serve as a primary vacuum barrier and are therefore not accessible to personnel except during servicing operations. If they are accessible to personnel during servicing, they must NEVER be subjected to pressure differentials.
- B. Beryllium is a highly toxic material. Handling of this material must be reviewed by the PPPL Industrial Hygienist to ensure adequate precautions. No machining, grinding, sanding, welding, or other mechanical processes may be performed on beryllium at PPPL without special permission of the Industrial Hygienist.
- C. Design reviews of beryllium windows must include provisions to ensure that there are no pressure differentials across the beryllium foil, or alternatively, if the possibility of a pressure differential exists, the window must be designed to handle expected differentials.
- D. Testing of the window should only ensure that the window is leak tight, unless a pressure differential is expected, at which time the window should only be tested to the maximum expected differential.