

Glovebox Window Seal Test

by

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GLOVEBOX WINDOW SEAL TEST

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A test was carried out to evaluate the effectiveness of the glovebox window seal and design features used in most of the gloveboxes in the Chemical Technology Division (CMT) at Argonne National Laboratory (ANL). The windows used are 0.91- x 0.91- x 0.0095-m thick (36- x 36- x 3/8in thick) laminated safety glass with 0.010-m (4-in.) radiused corners. The windows are installed in the glovebox using a common weatherstrip seal (zipper) in accordance with an established CMT procedure. The window used in the test contained four glove ports equipped with gloves and glove ring covers and was mounted in an opening of a leak-tight pressure-test box. The window opening of the test box had the same dimensions as that used in a glovebox.

The test box contained the necessary helium gas inlet, control valves, and pressure relief devices. The controls provided a readout of the pressure information. A video camera placed adjacent to the test box recorded the test run. The testing was carried out behind a shielded personnel barrier.

The test was done in accordance with a previously reviewed procedure. The completed test indicated that the window seal performed well and was leak tight within the pressure constraints normally encountered in gloveboxes operating with atmosphere controls used in CMT. When the pressure was increased beyond allowable operating or safety control limits, the first leaks began to occur. The test was continued until the leak was considered a total failure at which time the test was terminated. All the events were documented and the results were reviewed to determine if any action was required.

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INTRODUCTION

- Argonne National Laboratory
- Chemical Engineering Division (CMT)
- Windows are used in modular gloveboxes designed for experimental work
 - Laboratory Scale
 - Engineering Scale
- Experimental work includes equipment and process development for:
 - Pyrochemistry
 - Nuclear waste treatment
 - Electrochemistry



HISTORY

- The first ANL-CMT Division modular glovebox was designed and installed in 1959
- Objective:
 - Provide controlled atmosphere environment
 - Maximize viewing accessibility
 - Provide "standardized" work area for laboratory research projects
 - Provide modular utility service access
 - Provide glovebox with two sided access
 - Must include user-friendly considerations



HISTORY (Con't)

- Window viewing area comprises approximately 60% of the glovebox side walls that suffices for monitoring experimental equipment and process operation
- Weatherstrip type "Zipper" seal used for window installation
- Modular end plates provide for:
 - Utility services
 - Ventilation/purification system
 - Filter housings
 - Transfer locks
 - Bagports
- 42 inch glovebox width



GLOVEBOX DESIGN

- Gloveboxes using the modular design concept include:
 - Large controlled atmosphere gloved enclosures 8 feet (2.44m) wide x 12 feet (3.66m) high and 16 feet (4.88m) to 25 feet (7.64m) long
 - Smaller newly designed glovebox 3 1/2 feet (1.06m) wide x 6 1/2 feet (2.0m) high x 10 feet (3.05m) long
 - Capability for either positive or negative pressure operation
 - All use the same window concept



BASIC WINDOW DESIGN

- 36 inch square window opening
- 4 inch radiused corners
- Gloveport through window
- Weatherstrip type "Zipper" seal
- Ease of installation
- Withstands both positive and negative atmospheric pressure variations

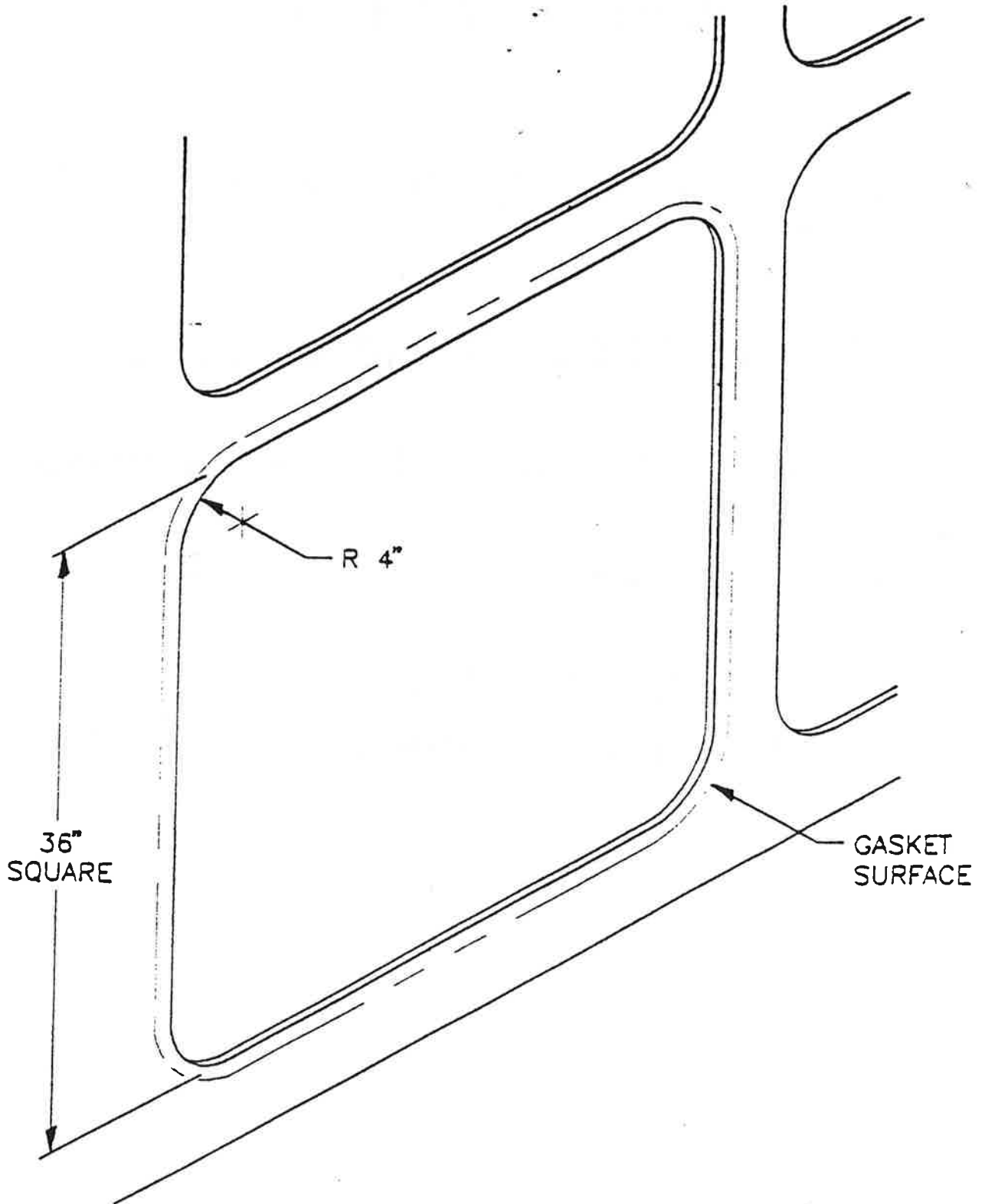


WINDOW OPENING

- Water jet cut glovebox metal panel
- 36 inches square with 4 inch corner radius
- 36 inch x 18 inch with 4 inch corner radius
- 1/2 inch gasket surface around opening both inside and outside
- Gasket surface to be flat within 1/16 inch over 12 inch length



GLOVEBOX WINDOW OPENING

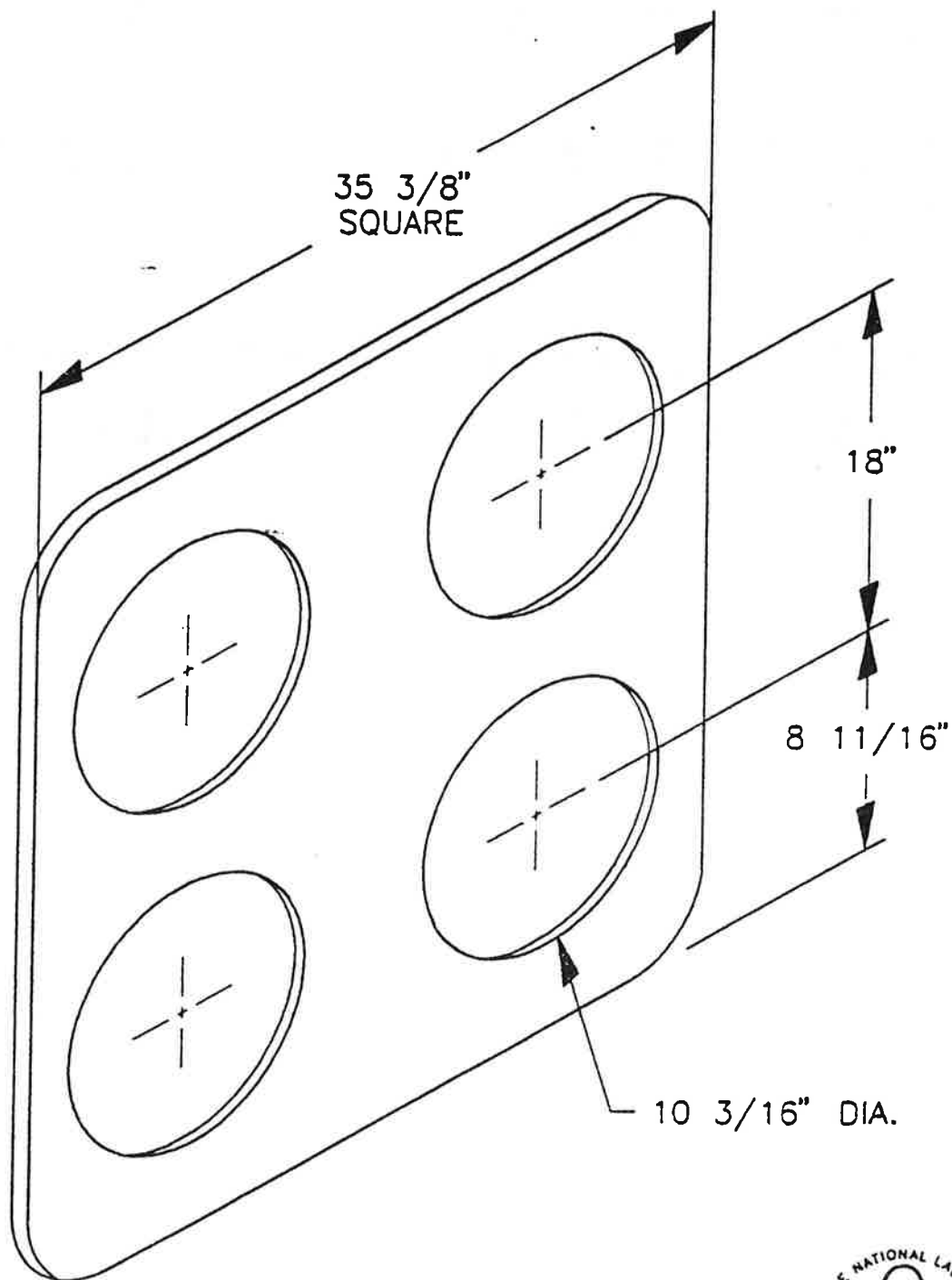


WINDOW DETAIL

- 35 3/8 inches square with radiused corners
- Gloveport holes 18 inches on center
- 3/8 inch thick laminated safety glass
- Water jet cut
- 3/8 inch glass to 1/8 inch glovebox wall using weatherstrip zipper seal



GLOVEBOX WINDOW



GLASS TYPE

- Glass laminate per ASTM C1172-91
- Two lite laminate of Kind LA, Class 1, q³ quality glass
- Each lite is .19 inch thick with overall composite thickness of .38 inch

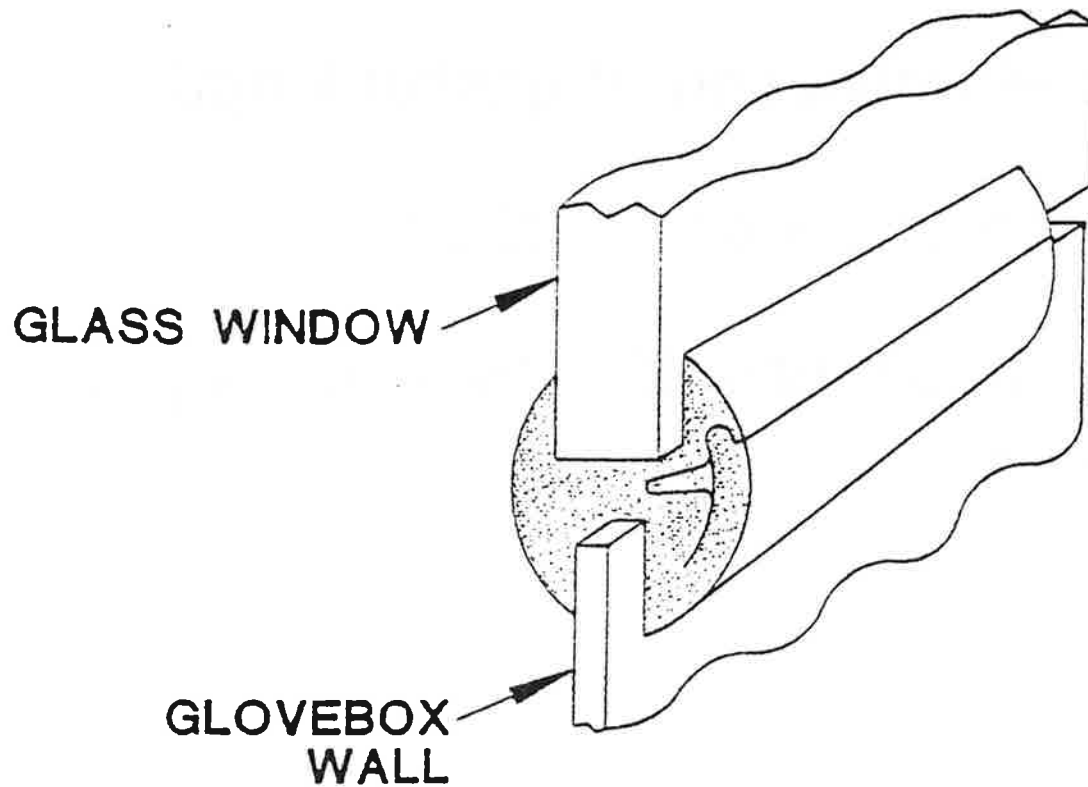
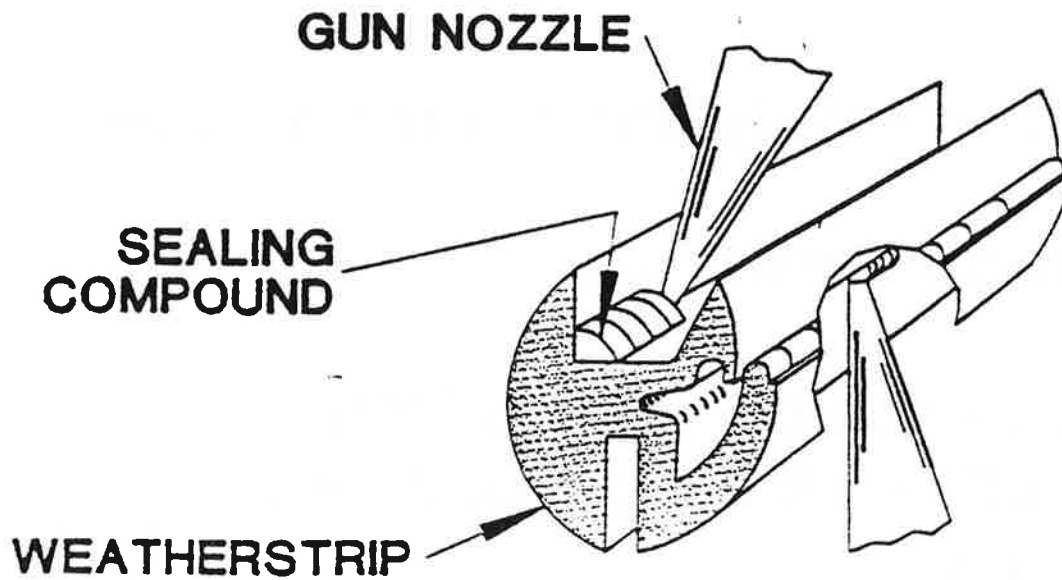


WINDOW INSTALLATION

- Glovebox Installation Instruction used
- Instruction prescribes:
 - Worker safety precautions including safety glasses and gloves
 - Determination of gasket length
 - Use of silicone sealant
- Installation time 30 - 45 minutes per window



WEATHERSTRIP SEAL INSTALLATION



WINDOW GASKET INSTALLATION

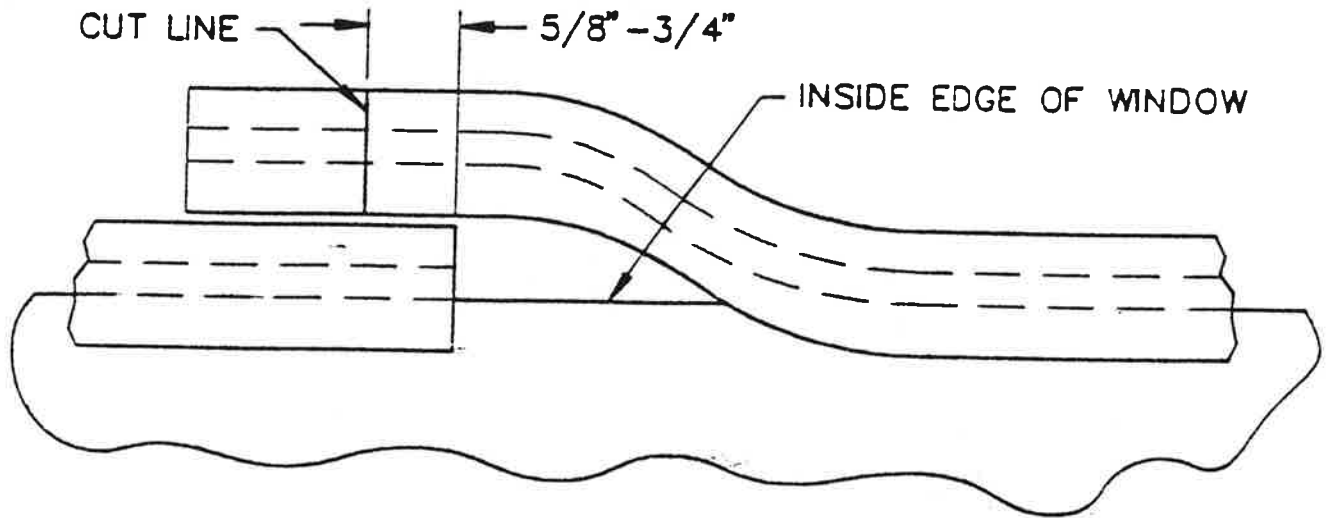


ILLUSTRATION "A"

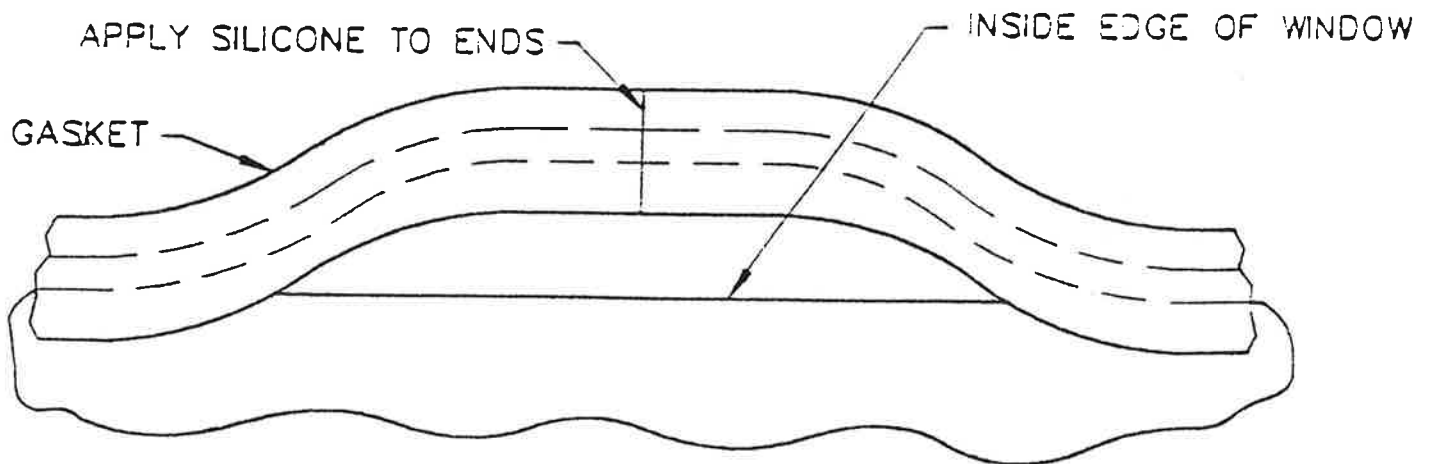
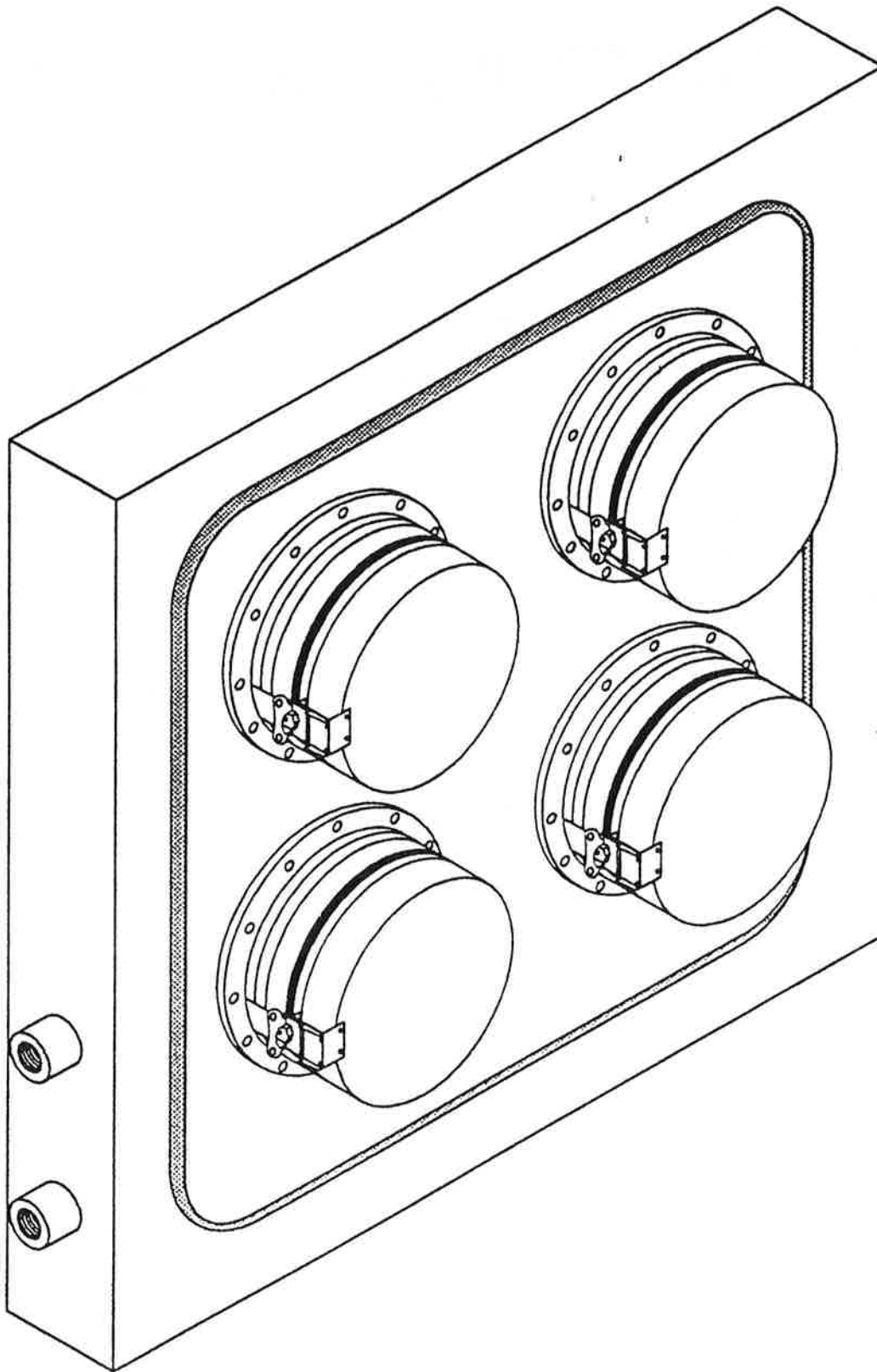


ILLUSTRATION C





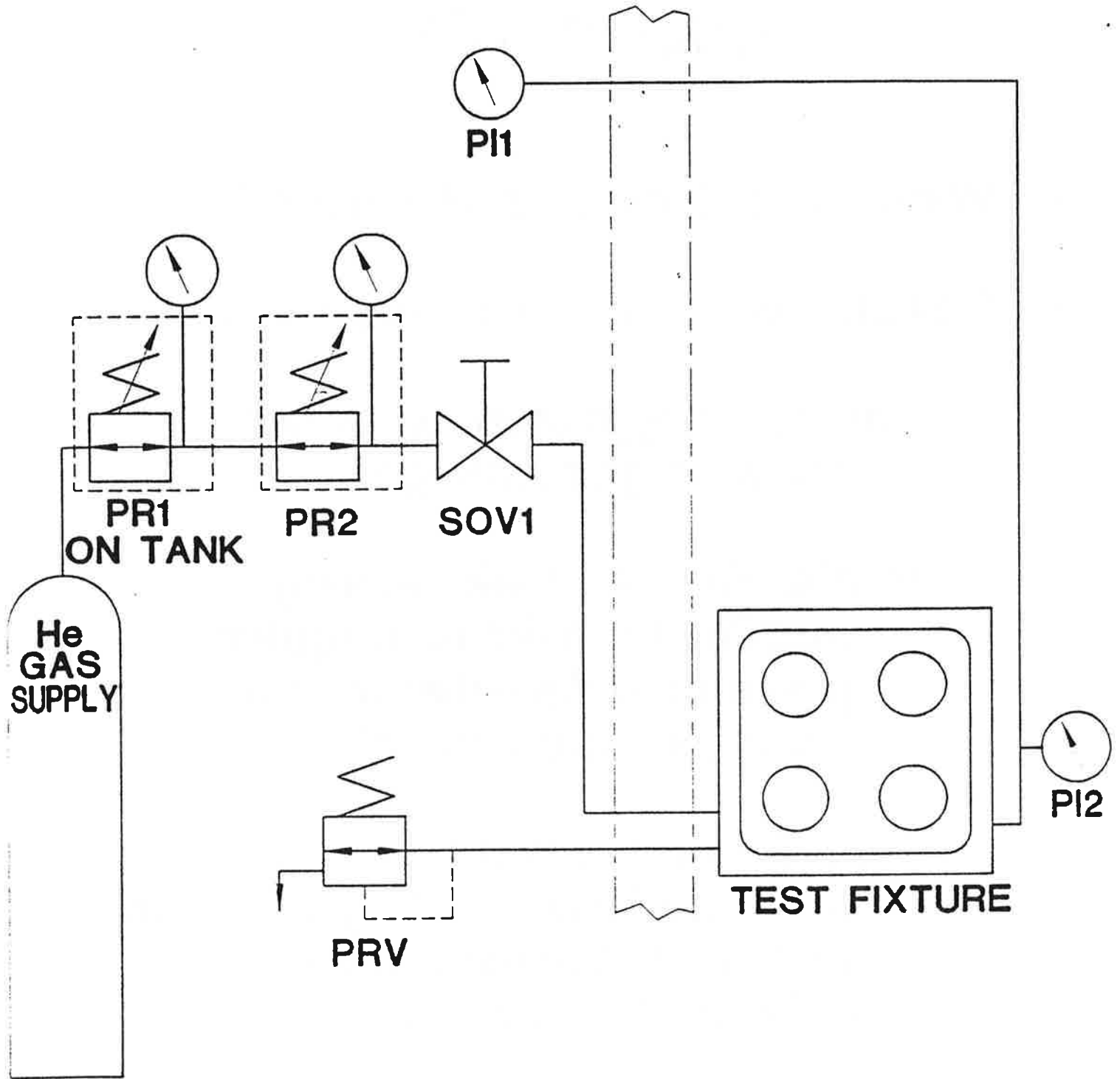
GLOVEBOX WINDOW TEST FIXTURE



WINDOW TEST

- Window seal test plan developed
- Possible window seal failure modes:
 - Failure: any disruption of seal allowing gas leakage
 - Partial Failure: leak causing inability to maintain targeted pressure differential over a specified time interval
 - Total Failure: disruption at the seal interface resulting in a leak that will not allow a pressure differential to be maintained



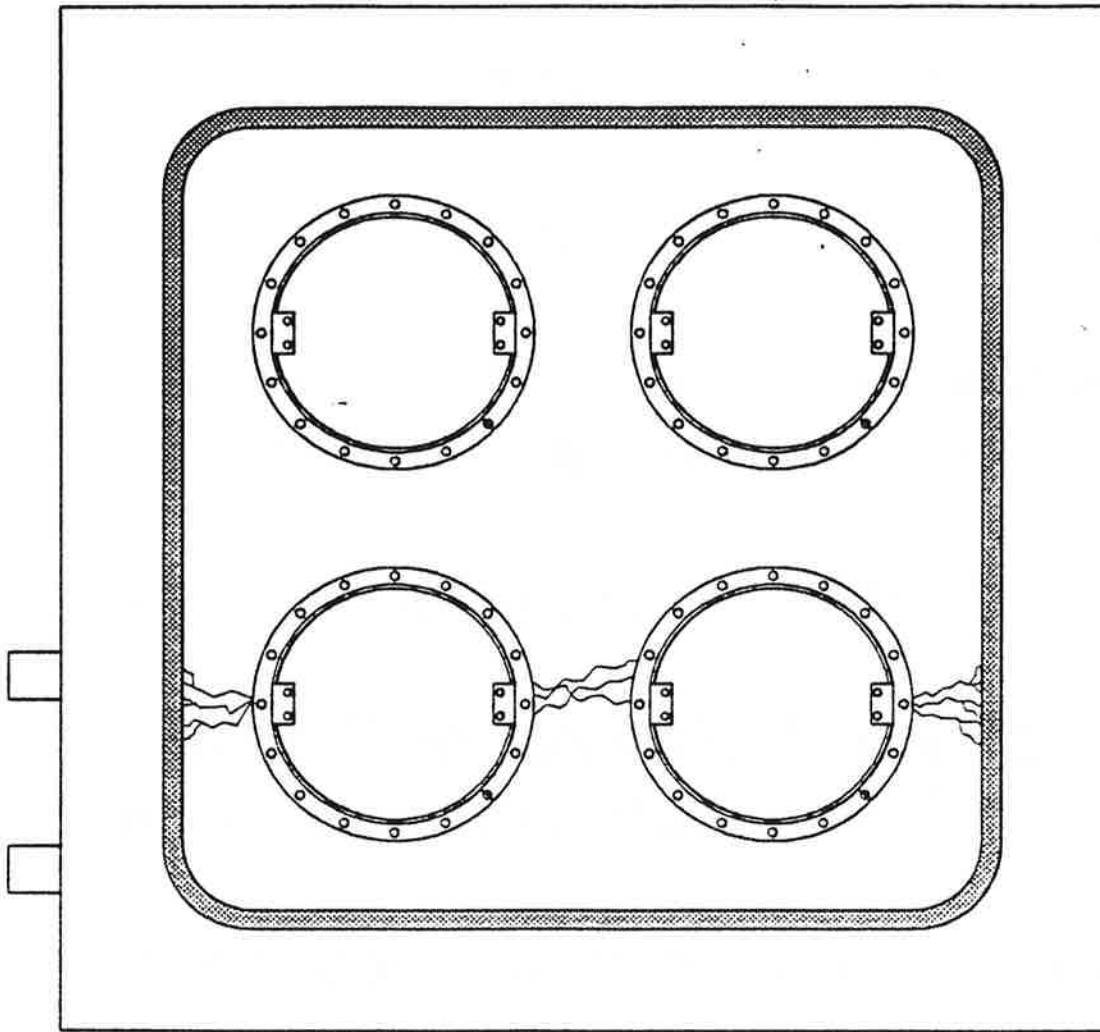


TEST FIXTURE SCHEMATIC

PROCEDURE

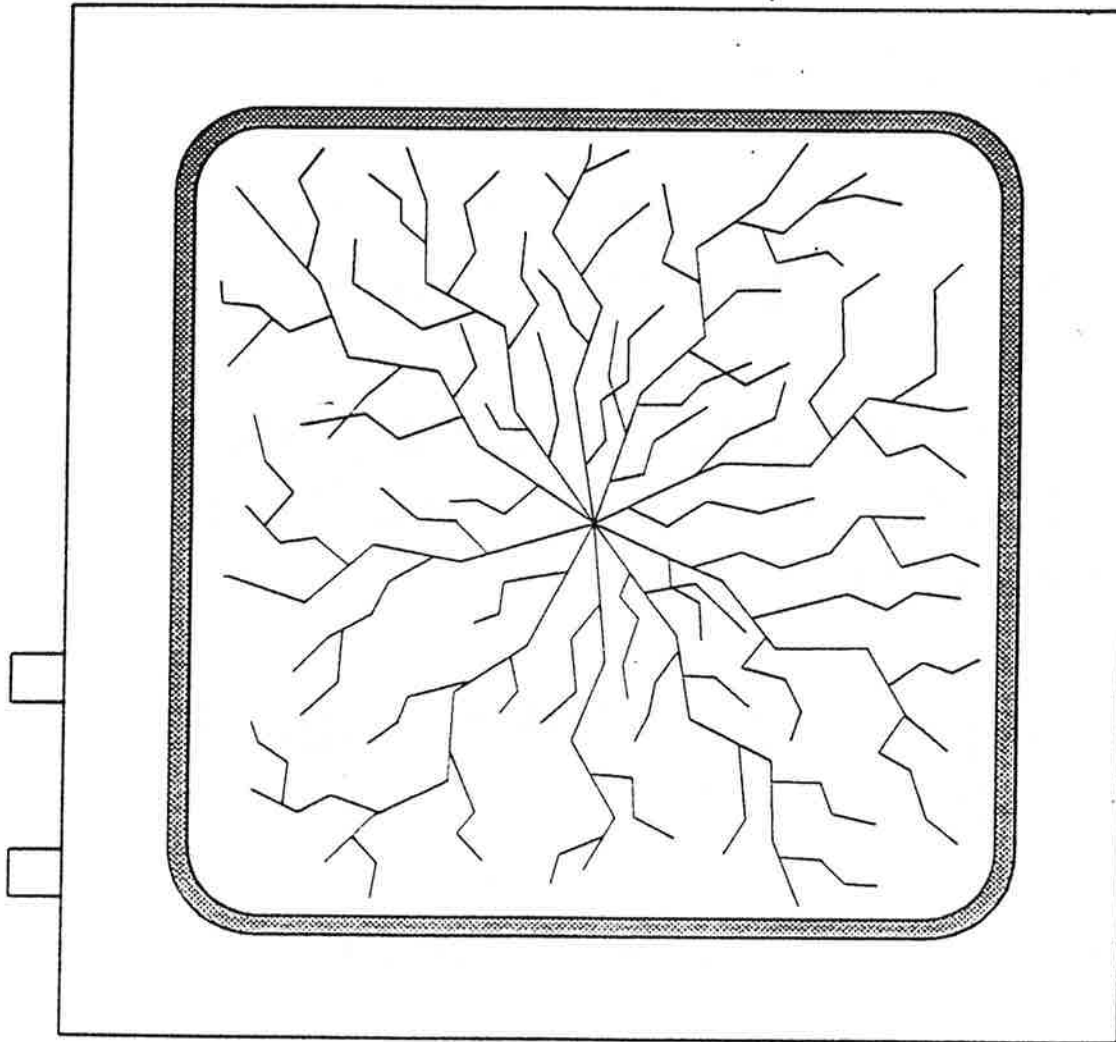
- Stable outdoor barometric pressure
- All systems operational
- Raise test chamber internal pressure to 4 inches of water and record
- After 3 minutes record pressure again
- No evidence of "Failure" or "Partial Failure". Record and continue testing
- If "Total Failure" occurs, record and end testing
- Continued testing was done by raising pressure incrementally at 1 inch of water column and recording





FAILURE OF GLOVEBOX WINDOW WITH GLOVEPORTS





FAILURE OF GLOVEBOX WINDOW WITHOUT GLOVEPORTS



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WINDOW TEST RESULTS

- Window with four gloveports
 - Test terminated due to structural failure of the window glass
 - Cracks developed in the glass extending across the two lower gloveports
 - Test pressure at failure was 17 inches of water
 - No evidence of seal failure



WINDOW TEST RESULTS

- Window without gloveports
 - Test terminated due to structural failure of the window glass
 - Crack developed in the glass radiating out from the center
 - Test pressure at failure was 30 inches of water (> 2 psig)
 - No evidence of seal failure



CONCLUSIONS

- With limited testing
- Window with four gloveports
 - Weatherstrip "Zipper" seal and gloveport seals can withstand pressure differential of 17 inches of water column without any type of seal failure
- Window without gloveports
 - Weatherstrip "zipper" seal can withstand pressure differential of 30 inches of water column without seal failure

