GLOVEBOX EXPERIENCE AT BATTELLE-NORTHWEST*

Presented By

E. O. McFall

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Introduction

Battelle-Northwest (BNW) is one of four major contractors engaged in radiation work at Hanford. Some research activities performed by BNW require gloveboxes to contain and control radioactive and other noxious materials. Since the BNW programs do not include either formal evaluation of the effectiveness of glovebox gloves or research efforts to develop new glovebox techniques and equipment, the information reported here was obtained from experience with currently available equipment.

Summary

In 1973 a total of 329 pairs of gloves (with variations in thickness, length, composition and shape) were purchased for use at BNW. Glove environments include alpha, beta, gamma and neutron radiation, various chemicals and solvents, sharp and rough objects, and heat from furnaces and hot plates.

Glove failure results from variables such as age, use frequency, storage, type of work and environment. Although Hypalon gloves offer better resistance to chemicals, solvents, heat, radiation and abrasions than neoprene gloves, they are not easily obtained. Leather and asbestos gloves are worn over glovebox gloves for protection when work involves sharp objects and heat. About 75% of all glove failures occur from wear or rupture in the hand portion of the glove. Improvement in glove durability and flexibility is needed.

The standard Hanford glove port (8") is used with a simple change-out technique which provides good contamination control.

Type of Gloves in Use

The gloves in use at BNW are made of either Hypalon or neoprene, either 15 or 30 mils thick (usually 15 mils) and of varying lengths from 30 to 35" (90% are 32"). About 60% of all gloves used are Hypalon and of these 50% are 30 mils thick. Hypalon gloves are more often used in gloveboxes where heat, liquids and plutonium oxides are handled. Neoprene gloves are used in gloveboxes where permeation is less critical. The types and quantities used in 1973 are as follows:

<table>
<thead>
<tr>
<th>Kind</th>
<th>Thickness</th>
<th>Amount Purchased</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypalon</td>
<td>15 mil</td>
<td>94 pairs</td>
</tr>
<tr>
<td>Hypalon</td>
<td>30 mil</td>
<td>6 pairs</td>
</tr>
<tr>
<td>Hypalon (lead loaded)</td>
<td>30 mil</td>
<td>39 pairs</td>
</tr>
<tr>
<td>Hypalon (durasol)</td>
<td>30 mil</td>
<td>48 pairs</td>
</tr>
<tr>
<td>Neoprene</td>
<td>15 mil</td>
<td>79 pairs</td>
</tr>
<tr>
<td>Neoprene (ambidextrous)</td>
<td>15 mil</td>
<td>29 pairs</td>
</tr>
<tr>
<td>Neoprene</td>
<td>30 mil</td>
<td>29 pairs</td>
</tr>
<tr>
<td>Neoprene (ambidextrous)</td>
<td>30 mil</td>
<td>5 pairs</td>
</tr>
</tbody>
</table>
Failure Experience and Glove Life

Gloves are routinely inspected and surveyed for signs of damage, deterioration and radioactive contamination. Each glove is also inspected prior to and after usage and is frequently monitored for contamination during use. Defective and contaminated gloves are changed when their condition warrants or is questioned. Failure of gloves is variable and dependent upon:

- Use frequency
- Type of work
- Radionuclides - Kind, form, amount
- Liquids
- Heat
- Dry rot - weather check

The life of a glove is primarily determined by the frequency of use. Some gloves are used every day while others are used only occasionally. The failure of seldom-used gloves is related to the method of storage. Deterioration occurs rapidly, especially in the folds, when the glove is tied off outside the glove port. The environment and the type of work definitely affect glove life. Stretching the glove and subjecting it to heat, sharp objects, liquids and metallic tools influence glove failure. About 75% of all glove failures occur in the hand portion. Most failures are pinholes, tears, or cuts from working with or around sharp objects. Leather gloves are worn over glovebox gloves in an effort to reduce glove failures. Asbestos gloves are frequently used for protection against heat.

The kind, amount and form of radioactive material also determines glove life. Hypalon gloves, including lead-loaded and durasol, are most effective when working with plutonium oxide and other types of radionuclides including polonium 210 and promethium 147. Permeation is the most predominant problem for BNW's 210Po operations. Hypalon is used exclusively for these operations and other work where permeation is a problem.

Glove life is affected by dry rot which is prevalent in neoprene gloves and infrequently-used gloves. Dry rot deterioration occurs at the fold seams during extended storage.

In general, Hypalon gloves are more effective for BNW glovebox operations than neoprene gloves. Hypalon is more resistant to rupture, permeation, radiation damage and dry rot. Excluding ruptures, Hypalon glove life is three to four months and may extend to one year for liquid handling operations. Neoprene gloves are used most frequently for operations in which permeation and tearing are not problems. They are satisfactory for aerosol containment in biology inhalation experiments. For normal use neoprene gloves last about six months.
Chemical and Physical Environment

Chemical Environment

- General Laboratory Chemicals and Solvents
- Concentrated HF, HNO₃, Sulfamic Acids

Gloveboxes for chemical use have air atmospheres. Gloves are exposed to typical laboratory chemicals as well as concentrated acids used in research and development. Hypalon gloves are more often used in chemical environments but must be wiped down after use to avoid blisters and peeling.

Physical Environment

- Sharp Objects - lathes, hand tools
- Heat - hot plates, furnaces

Gloves are used in metallurgical research operations which include heating, casting, machining, blending and grinding. Radioactive and nonradioactive metals are used along with various types of equipment and tools. For this research the gloveboxes have argon, helium and nitrogen atmospheres which are negative compared to the operating areas. The handling of sharp objects and equipment and the frequent stretching of the gloves cause rupture and deterioration. Hypalon gloves are generally used, if available, where rough treatment of gloves is a problem.

In some operations, the gloves may be subjected to extremely high temperatures for short periods. Where heat is a problem, asbestos gloves are worn for protection over the Hypalon gloves.

Radiation Environment

- Alpha, Beta, Gamma and Neutron Radiation
- Radionuclides - Pu, ¹⁴⁷Pm, ²¹⁰Po, ²⁴⁴Cm, ¹⁹⁸Au
- Forms - Liquids, Metals, Powders, Aerosols

Hypalon gloves withstand exposure to all types of radiation better than neoprene gloves. Some gloves are exposed to intense alpha radiation and heat (causing ozone) from ²³⁸Pu, PUO₂. Since rough surfaces on gloves permit the oxide to adhere, the smooth-surfaced, easily cleaned Hypalon gloves are preferred when working with plutonium oxides. Since alpha and beta-gamma aerosols encountered in Biology experiments do not cause glove life problems, neoprene gloves may be used. Permeation problems in ²¹⁰Po operations require use of Hypalon gloves.

Glove Port Design

The standard Hanford glove port (8") is used for all BNW operations. Both plastic and stainless steel types are available. A spring-loaded metal o-ring and/or plastic o-ring is used to attach a glove to the port. Plastic tape is also used to attach the glove to the outer edge
of the port. Change out requires minimal preparation and is relatively simple to complete with contamination control.

The plastic port is made of polycarbonate (General Electric Co. "Lexon") and is installed to the glovebox panel with a plastic cement. Eight set screws (#10) are used in addition to the cement when the port is installed to SE-3 plexiglass panels. The plastic ports are fabricated to BNW specifications by commercial firms and cost $16.00 each.

The stainless steel port is made of 8" stainless steel pipe and is welded in place to the glovebox. The outside portion of the port is similar to the plastic port. Stainless steel ports are included as a part of the glovebox during fabrication of the box.

Glove Improvement Ideas

Glove failure occurs most frequently from stress (rupture, heat, etc.) to the hand portion of the glove. Desirable qualities to be achieved when up-grading gloves are:

- Greater resistance to puncture
- Greater resistance to heat
- Greater resistance to acids and solvents
- Greater resistance to dry rot
- Longer shelf life

Also beneficial would be improved flexibility of gloves to permit easy finger movement.

Disposal of Used Gloves

Used gloves from gloveboxes involving work with plutonium and other transuranic materials are packaged, bagged out of gloveboxes, and stored in metal 55-gallon drums labeled "glovebox waste." When full, the drum is counted for plutonium accountability, and then disposed of as transuranic waste. Beta-gamma contaminated gloves are disposed of by direct waste burial.

Procurement Problems

Battelle-Northwest has been able to procure neoprene gloves easily, but Hypalon gloves have been difficult to obtain. Approximately 100 pairs of Hypalon gloves are now being purchased from Charleston Rubber Company every month to supply all Hanford contractors. Although this number is an improvement, it is not always enough to meet the major contractors' needs. Inquiries on bids to purchase gloves were sent to several manufacturers in January, 1974, yet the only returned bid was from the Charleston Rubber Co.