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Title: **Determining the Radiation Damage Effect on Glovebox Glove Materials**

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DETERMINING THE RADIATION DAMAGE EFFECT ON GLOVEBOX GLOVE MATERIALS

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1 INTRODUCTION

The Nuclear Material Technology (NMT) Division has the largest inventory of glove box gloves at Los Alamos National Laboratory. The minimization of unplanned breaches in the glovebox, e.g., glove failures, is a primary concern in the daily operations in NMT Division facilities, including the Plutonium Facility (PF-4) at TA-55 and Chemical and Metallurgy Research (CMR) Facility [Ref. 1]. Glovebox gloves in these facilities are exposed to elevated temperatures and exceptionally aggressive radiation environments (particulate ^{239}Pu and ^{238}Pu). Predictive models are needed to estimate glovebox glove service lifetimes, i.e. change-out intervals. Towards this aim aging studies have been initiated that correlate changes in mechanical (physical) properties with degradation chemistry. This present work derives glovebox glove change intervals based on previously reported mechanical data of thermally aged hypalon glove samples [Ref. 2].

Specifications for 30 mil tri-layered hypalon/lead glovebox gloves (TLH) and 15 mil hypalon gloves (HYP) have already been established [Ref. 3]. The relevant mechanical properties are shown on Table 1.

Table 1. Mechanical Property Specifications

Property	HYP	TLH
Tensile Strength (psi)	1900	1200
Ultimate Elongation (%)	500	300

Tensile strength is defined as the maximum load applied in breaking a tensile test piece divided by the original cross-sectional area of the test piece (Also termed maximum stress and ultimate tensile stress). Ultimate elongation is the elongation at time of rupture (Also termed maximum strain). The specification for the tensile test and ultimate elongation are the minimum acceptable values. In addition, the ultimate elongation must not vary 20% from the original value. In order to establish a service lifetimes for glovebox gloves in a thermal environment, the mechanical properties of glovebox glove materials were studied.

2 RESULTS

A listing of the mechanical data for the hypalon (HYP) and hypalon tri-layer (TLH) aged samples is shown in Table 2. Tensile strength and ultimate elongation are listed as stress and strain, respectively. Fields highlighted in **bold** fail the minimum acceptable values for the tensile test and/or ultimate elongation specification. One data point (TLH, 60ºC, 56 days) failed the minimum acceptable values for the 20% change in the original value for the ultimate elongation specification. It is also highlighted in **bold**.

Table 2. Tensile Data for samples of Hypalon and Aged Hypalon Materials

Time (Days)	Tensile Data			
	Stress		Strain	
	HYP	TLH	HYP	TLH
60ºC				
0	2150	1800	530%	400%
1	2259	1863	537%	368%
3	2306	1908	527%	370%
5	2316	1880	534%	364%
7	2239	1849	**491%**	350%
14	2248	1923	**498%**	363%
21	2357	1909	**476%**	344%
28	2327	1935	**462%**	337%
56	2276	1893	**424%**	**309%**
80ºC				
0	2150	1800	530%	400%
1	2033	1695	541%	343%
3	1926	1743	**474%**	349%
5	2030	1719	**492%**	338%
7	2071	1666	**470%**	321%
14	2138	1774	**424%**	318%
21	2163	1789	**414%**	320%
28	2076	1723	**386%**	302%
56	2138	1659	**360%**	**260%**
100ºC				
0	2150	1800	530%	400%
1	2028	1676	513%	333%
3	2029	1638	**461%**	313%
5	2006	1570	**442%**	301%
7	2055	1570	**405%**	**279%**
120ºC				
0	2150	1800	530%	400%
1	2272	1608	**483%**	**245%**
3	2360	**1194**	**460%**	**98%**

Based on the specification in Table 1 and the tensile data in Table 2, the recommended change-out intervals for hypalon and hypalon tri-layer glovebox gloves from North Safety Products are listed in Table 3.

Table 3. Recommended Change-out Intervals for North Glovebox Gloves in a Thermal Environment

Temperature	Glove Material	
	Hypalon	Tri-Layered
60ºC	5 days	28 days
80ºC	1 day	28 days
100ºC	1 day	1 day
120ºC	< 1 day	< 1 day

3 DISCUSSION

The lead-loaded glovebox glove made from Hypalon® (hereafter referred to as hypalon) is the workhorse of NMT Division programmatic operations due to its superior properties. Hypalon material is resistant to interactions with alcohols and strong acids and bases. Glovebox gloves materials stored at ambient temperature and used as control samples meet the acceptance criteria. In general, both materials become out of specification because the aging causes the strain to drop below the minimum specification. The tensile properties of the hypalon/lead-neoprene/hypalon tri-layered material degrade more quickly and more extensively compared to the hypalon material, although it is the latter that falls out of specification sooner. Changes to glovebox glove maintenance procedures should be made to reflect this. Additionally, there is the issue of ^{238}Pu heat sources that can reach temperatures between 85 and 450ºC. If the hot surfaces of the heat sources or storage containers are touch, the glovebox gloves should be immediately inspected and replaced if visual discoloration in the area where the hot surfaces touched the glove is noticed. It should be noted that the change-out intervals recommendation derived in this study are formulation-specific; they should not be assumed to apply to other formulation of the same generic material classes. Formulation differences, particularly with regard to the identity and amount of stabilizing additives, can exert a strong influence on the thermal resistance of a given material.

4 CONCLUSIONS

We have derived a general methodology for calculating glovebox glove change-out intervals from tensile data. Under various temperatures stress and strain were measured. The resulting data is compared to product specifications. Once the tensile data is out of specification, the recommended change-out date is reached. The information from this study represent an important baseline in gauging the acceptable standards for polymeric gloves used in a laboratory glovebox environment.

5 REFERENCES

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