



REPORT INTERTEK TESTING SERVICES

INDUSTRIAL PARK

CORTLAND, NEW YORK 13045

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DATE: April 24, 1997

REPORT NO. 6927-001

RENDERED TO:

Dartmouth College
6216 Clement West
Hanover, NH 03755-3848

STANDARD AND TEST USED: Six types of thin, examination style gloves were evaluated for permeation resistance in accordance with ASTM F739-96, using dimethyl mercury as the challenge chemical. Each test was conducted for a maximum of one hour.

AUTHORIZATION: The tests were authorized by Michael Blayney, Purchase Order No. 250352.

DATE SAMPLE RECEIVED: Samples were received on March 3, 1997.

DATE OF TEST: The tests and subsequent evaluations were conducted between April 15 - April 23, 1997.

SPECIMEN DESCRIPTION: The tests were performed on specimens identified by the client as:

- (1) Fisher Scientific's Fisherbrand Latex, Catalog no. 11-394-4B, Lot no. 5550022;
- (2) Smith & Nephew Perry's Perry X-AM Style 312 Latex Exam with Beaded Cuff, Catalog no. 60801, Lot 1121708;
- (3) Ansell Edmont Industrial's Medical Exam Tek, Catalog no. 7208, Lot no. 512009705;
- (4) Continental Lab Products' MicroRoughins, Catalog no. 1315, Lot no. 99579;
- (5) Dak Technical Inc's Vinyl (clear), Size Large 96-334; and
- (6) Best Mfg.'s N-Dex (8 mil) Nitrile, Style no. 8005M.

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INTRODUCTION:

This report describes the results of the permeation resistance tests performed on specimens previously described, submitted by Dartmouth College. The specimens were prepared and test evaluations were conducted at Intertek Testing Services.

All test procedures were consistent with ASTM F739-96, except that the requested sample interval was shortened such that the minimum detectable permeation rate for the earliest time intervals exceeded the required $0.1 \mu\text{g}/\text{cm}^2\cdot\text{min}$. Upon agreement with the client, the sample intervals and resulting minimum detectable permeation rates were as follows:

<u>Sample interval</u>	<u>Minimum detectable permeation rate</u>
15 sec	$0.55 \mu\text{g}/\text{cm}^2\cdot\text{min}$
30 sec	$0.55 \mu\text{g}/\text{cm}^2\cdot\text{min}$
60 sec	$0.28 \mu\text{g}/\text{cm}^2\cdot\text{min}$
3 min.	$0.07 \mu\text{g}/\text{cm}^2\cdot\text{min}$
15 min.	$<0.07 \mu\text{g}/\text{cm}^2\cdot\text{min}$

This is significant because breakthrough detection times are generally defined as the time at which the permeation rate exceeds $0.1 \mu\text{g}/\text{cm}^2\cdot\text{min}$. For the purpose of the tests conducted in this study, in general the breakthrough was so immediate and substantial that the difference between the minimum detectable rate of $0.1 \mu\text{g}/\text{cm}^2\cdot\text{min}$ vs. $0.55 \mu\text{g}/\text{cm}^2\cdot\text{min}$ is of little consequence. When comparing the gloves evaluated in this study, however, it is important to keep the minimum detectable permeation rates in mind. An apparent breakthrough time of 0.5 min. must be viewed with the understanding that the permeating chemical is roughly six times higher than the allowable minimum detectable rate given in ASTM F739-96, and that permeation rates could have easily exceeded $0.1 \mu\text{g}/\text{cm}^2\cdot\text{min}$ in the previous time intervals.

Both the analytical requirements of the challenge chemical and the desired sample intervals required that the tests be conducted in an "open-loop" configuration, with manual sampling for detection of the permeant. The collection medium, ethyl ether, was chosen because:

- (1) the solubility of dimethyl mercury in ethyl ether was very good;
- (2) the volatility of ethyl ether minimizes residual contact of the unexposed surface of the test specimen(s) so that collection solvent interferences in the test are minimized; and

- (3) using ethyl ether simplified the chromatography needed for detection of the permeant.

A volume of 1.0 mL of the collection medium was introduced into the collection chamber at each specified interval, swirled over the unexposed surface of the test specimen(s) for approximately 15 seconds, and then collected into sample vials for subsequent analysis. All analyses were complete with 48 hours of collection. Samples pending analysis were held at 4°C to minimize evaporation of the ethyl ether.

Since ethyl ether is known to be relatively aggressive against many materials in terms of permeation resistance, control test cells were introduced into the test plan. These controls consisted of specimens which were handled identically to the actual test cells, with the exception that they were not subjected to repeated exposure to the collection media. Instead, a single, cumulative sample was taken at the end of the test period and analyzed to verify that breakthrough had indeed occurred and was not the result of some synergistic effects of the collection solvent on the test specimens or the challenge chemical. In all six cases, the data from the control specimens verified that the apparent breakthrough detected for each cell was consistent with the control specimens.

Additionally, each test conducted included a "blank" test cell, which consisted of the test specimen handled identically to the actual test cells, with the exception that they did not receive exposure to the challenge chemical dimethyl mercury. The blanks were important to verify that:

- 1) the test cells were clean (i.e., not contaminated from previous runs or with some other chemical which could interfere with detection of the challenge chemical);
- 2) no component of the test specimens resulted in interference with the challenge chemical; and
- 3) proper handling technique was observed.

Any other deviations from the established testing protocols outlined in ASTM F739-96 are noted on the accompanying test reports for each chemical/material combination. Visual observations are also included. In some cases, the permeation rates were so high that practical information would no longer be obtained, and the test was terminated. These were noted as "catastrophic breakthrough" (i.e., visible liquid on the unexposed surface or severe degradation of the test specimens) on the accompanying test reports.

ASTM F739-96 PERMEATION TEST RESULTS

MATERIAL NAME: Fisher Scientific's Fisherbrand Latex, Catalog no. 11-394-4B, Lot no. 5550022

TEST TEMP.: 25°C

TEST DURATION: 1 hour

CONCENTRATION: 98%

CAS NO.: 593-74-8

SAMPLE REC'D: 3/17/97

PRIOR CONDITIONING: None

CHALLENGE CHEMICAL: Dimethyl mercury

CHEMICAL SOURCE: Alfa Aesar

TEST DATE: 4/16/97

TEST RESULTS	CELL 1	CELL 2	CELL 3	AVG	STD DEV
ACTUAL BREAKTHROUGH TIME (min.)	0.25	0.25	0.25	0.25	0
NORMALIZED BREAKTHROUGH TIME (min.) (Using BT criteria of 0.1 $\mu\text{g}/\text{cm}^2\cdot\text{min}$)	0.25	0.25	0.25	0.25	0
PERMEATION RATE: $\mu\text{g}/\text{cm}^2\cdot\text{min}$ <input type="checkbox"/> Steady state rate <input type="checkbox"/> Maximum rate	8762	4474	5336	6191	1852
UNIT AREA WEIGHT (g/cm^2)	252.9	179.2	157.8	196.6	40.7
SAMPLE THICKNESS (mils)	6	6	6	6	0

MODIFICATIONS OF METHOD	1" cells; intermittent splash collection	TYPE OF CONTACT	Continuous
ANALYTICAL TECHNIQUE	GC-FID	COLLECTION MEDIUM	Ethyl ether (1.0 mL)
SAMPLING FREQUENCY	15 sec., 30 sec., 1.0 min., 3.0 min., 15.0 min.	MIN. DETECTION LIMIT	1 ppm
CHEMICAL STATE	Liquid	MIN. DETECTABLE RATE	0.07 $\mu\text{g}/\text{cm}^2\cdot\text{min}$. (see chart below)

Notes: Minimum detectable permeation rates varied depending on sample collection time as follows:

Sample interval

Minimum detectable permeation rate

15 sec

0.55 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

30 sec

0.55 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

60 sec

0.28 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

3 min.

0.07 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

15 min.

<0.07 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

ASTM F739-96 PERMEATION TEST RESULTS

MATERIAL NAME: Smith & Nephew Perry/Perry X-AM Style 312 Latex Exam w/Beaded Cuff, Cat. no. 60801, Lot no. 1121708

TEST TEMP.: 25°C

PRIOR CONDITIONING: None

TEST DURATION: 1 hour

CHALLENGE CHEMICAL: Dimethyl mercury

CONCENTRATION: 98%

CHEMICAL SOURCE: Alfa Aesar

CAS NO.: 593-74-8

TEST DATE: 4/16/97

SAMPLE REC'D: 3/17/97

TEST RESULTS	CELL 1	CELL 2	CELL 3	AVG	STD DEV
ACTUAL BREAKTHROUGH TIME (min.)	0.25	0.25	0.25	0.25	0
NORMALIZED BREAKTHROUGH TIME (min.) (Using BT criteria of 0.1 $\mu\text{g}/\text{cm}^2\cdot\text{min}$)	0.25	0.25	0.25	0.25	0
PERMEATION RATE: $\mu\text{g}/\text{cm}^2\cdot\text{min}$ <input type="checkbox"/> Steady state rate <input type="checkbox"/> Maximum rate	2132	1372	1452	1652	341
UNIT AREA WEIGHT (g/cm^2)	175.9	176.3	165.7	172.6	4.9
SAMPLE THICKNESS (mils)	7	7	7	7	0

MODIFICATIONS OF METHOD	1" cells; intermittent splash collection	TYPE OF CONTACT	Continuous
ANALYTICAL TECHNIQUE	GC-FID	COLLECTION MEDIUM	Ethyl ether (1.0 mL)
SAMPLING FREQUENCY	15 sec., 30 sec., 1.0 min., 3.0 min., 15.0 min.	MIN. DETECTION LIMIT	1 ppm
CHEMICAL STATE	Liquid	MIN. DETECTABLE RATE	0.07 $\mu\text{g}/\text{cm}^2\cdot\text{min}$. (see chart below)

Notes: Visible material degradation, visible material swelling. Minimum detectable permeation rates varied depending on sample collection time as follows:

Sample interval

Minimum detectable permeation rate

15 sec

0.55 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

30 sec

0.55 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

60 sec

0.28 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

3 min.

0.07 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

15 min.

<0.07 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

ASTM F739-96 PERMEATION TEST RESULTS

MATERIAL NAME: Ansell Edmont Industrial/Medical Exam Tek, Cat. no. 7208, Lot no. 512009705

TEST TEMP.: 25°C

TEST DURATION: 1 hour

CONCENTRATION: 98%

CAS NO.: 593-74-8

SAMPLE REC'D: 3/17/97

PRIOR CONDITIONING: None

CHALLENGE CHEMICAL: Dimethyl mercury

CHEMICAL SOURCE: Alfa Aesar

TEST DATE: 4/16/97

TEST RESULTS	CELL 1	CELL 2	CELL 3	AVG	STD DEV
ACTUAL BREAKTHROUGH TIME (min.)	0.25	0.25	0.25	0.25	0
NORMALIZED BREAKTHROUGH TIME (min.) (Using BT criteria of 0.1 $\mu\text{g}/\text{cm}^2\cdot\text{min}$)	0.25	0.25	0.25	0.25	0
PERMEATION RATE: $\mu\text{g}/\text{cm}^2\cdot\text{min}$ <input type="checkbox"/> Steady state rate <input type="checkbox"/> Maximum rate	9046	4460	2765	5424	2653
UNIT AREA WEIGHT (g/cm^2)	131.0	132.6	124.4	129.3	3.6
SAMPLE THICKNESS (mils)	5	5	5	5	0

MODIFICATIONS OF METHOD	1" cells; intermittent splash collection	TYPE OF CONTACT	Continuous
ANALYTICAL TECHNIQUE	GC-FID	COLLECTION MEDIUM	Ethyl ether (1.0 mL)
SAMPLING FREQUENCY	15 sec., 30 sec., 1.0 min., 3.0 min., 15.0 min.	MIN. DETECTION LIMIT	1 ppm
CHEMICAL STATE	Liquid	MIN. DETECTABLE RATE	0.07 $\mu\text{g}/\text{cm}^2\cdot\text{min}$. (see chart below)

Notes: Visible material degradation, visible material swelling, catastrophic breakthrough @ 1.5 minutes. Minimum detectable permeation rates varied depending on sample collection time as follows:

Sample intervalMinimum detectable permeation rate

15 sec

0.55 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

30 sec

0.55 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

60 sec

0.28 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

3 min.

0.07 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

15 min.

<0.07 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

ASTM F739-96 PERMEATION TEST RESULTS

MATERIAL NAME: Continental Lab Products' MicroRoughins, Catalog no. 1315, Lot no. 99579

TEST TEMP.: 25°C

PRIOR CONDITIONING: None

TEST DURATION: 1 hour

CHALLENGE CHEMICAL: Dimethyl mercury

CONCENTRATION: 98%

CHEMICAL SOURCE: Alfa Aesar

CAS NO.: 593-74-8

TEST DATE: 4/17/97

SAMPLE REC'D: 3/17/97

TEST RESULTS	CELL 1	CELL 2	CELL 3	AVG	STD DEV
ACTUAL BREAKTHROUGH TIME (min.)	0.25	0.50	0.25	0.33	0.14
NORMALIZED BREAKTHROUGH TIME (min.) (Using BT criteria of 0.1 $\mu\text{g}/\text{cm}^2\cdot\text{min}$)	0.25	0.50	0.25	0.33	0.14
PERMEATION RATE: $\mu\text{g}/\text{cm}^2\cdot\text{min}$ <input type="checkbox"/> Steady state rate <input type="checkbox"/> Maximum rate	1384	2100	2495	1993	563
UNIT AREA WEIGHT (g/cm^2)	176.9	180.6	176.0	177.8	2.4
SAMPLE THICKNESS (mils)	8	8	8	8	0

MODIFICATIONS OF METHOD	1" cells; intermittent splash collection	TYPE OF CONTACT	Continuous
ANALYTICAL TECHNIQUE	GC-FID	COLLECTION MEDIUM	Ethyl ether (1.0 mL)
SAMPLING FREQUENCY	15 sec., 30 sec., 1.0 min., 3.0 min., 15.0 min.	MIN. DETECTION LIMIT	1 ppm
CHEMICAL STATE	Liquid	MIN. DETECTABLE RATE	0.07 $\mu\text{g}/\text{cm}^2\cdot\text{min}$. (see chart below)

Notes: Visible material degradation, visible material swelling, catastrophic breakthrough @ 2.5 minutes. Minimum detectable permeation rates varied depending on sample collection time as follows:

Sample intervalMinimum detectable permeation rate

15 sec

0.55 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

30 sec

0.55 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

60 sec

0.28 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

3 min.

0.07 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

15 min.

<0.07 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

ASTM F739-96 PERMEATION TEST RESULTS

MATERIAL NAME: Dak Technical Inc's Vinyl (clear), Size Large 96-334

TEST TEMP.: 25°C

PRIOR CONDITIONING: None

TEST DURATION: 1 hour

CHALLENGE CHEMICAL: Dimethyl mercury

CONCENTRATION: 98%

CHEMICAL SOURCE: Alfa Aesar

CAS NO.: 593-74-8

TEST DATE: 4/17/97

SAMPLE REC'D: 3/17/97

TEST RESULTS	CELL 1	CELL 2	CELL 3	AVG	STD DEV
ACTUAL BREAKTHROUGH TIME (min.)	0.50	0.50	0.50	0.50	0
NORMALIZED BREAKTHROUGH TIME (min.) (Using BT criteria of 0.1 $\mu\text{g}/\text{cm}^2\cdot\text{min}$)	0.50	0.50	0.50	0.50	0
PERMEATION RATE: $\mu\text{g}/\text{cm}^2\cdot\text{min}$ <input type="checkbox"/> Steady state rate <input type="checkbox"/> Maximum rate	1434	1303	393	1043	463
UNIT AREA WEIGHT (g/cm^2)	180.8	185.7	194.0	186.8	6.7
SAMPLE THICKNESS (mils)	7	6	7	7	1

MODIFICATIONS OF METHOD	1" cells; intermittent splash collection	TYPE OF CONTACT	Continuous
ANALYTICAL TECHNIQUE	GC-FID	COLLECTION MEDIUM	Ethyl ether (1.0 mL)
SAMPLING FREQUENCY	15 sec., 30 sec., 1.0 min., 3.0 min., 15.0 min.	MIN. DETECTION LIMIT	1 ppm
CHEMICAL STATE	Liquid	MIN. DETECTABLE RATE	0.07 $\mu\text{g}/\text{cm}^2\cdot\text{min}$. (see chart below)

Notes: Visible material degradation, visible material swelling. Minimum detectable permeation rates varied depending on sample collection time as follows:

Sample intervalMinimum detectable permeation rate

15 sec

0.55 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

30 sec

0.55 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

60 sec

0.28 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

3 min.

0.07 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

15 min.

<0.07 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

ASTM F739-96 PERMEATION TEST RESULTS

MATERIAL NAME: Best Mfg.'s N-Dex (8 mil) Nitrile, Style no. 8005M

TEST TEMP.: 25°C

TEST DURATION: 1 hour

CONCENTRATION: 98%

CAS NO.: 593-74-8

SAMPLE REC'D: 3/17/97

PRIOR CONDITIONING: None

CHALLENGE CHEMICAL: Dimethyl mercury

CHEMICAL SOURCE: Alfa Aesar

TEST DATE: 4/17/97

TEST RESULTS	CELL 1	CELL 2	CELL 3	AVG	STD DEV
ACTUAL BREAKTHROUGH TIME (min.)	0.25	3.0	0.25	1.2	1.3
NORMALIZED BREAKTHROUGH TIME (min.) (Using BT criteria of 0.1 $\mu\text{g}/\text{cm}^2\cdot\text{min}$)	0.25	3.0	0.25	1.2	1.3
PERMEATION RATE: $\mu\text{g}/\text{cm}^2\cdot\text{min}$ <input type="checkbox"/> Steady state rate <input type="checkbox"/> Maximum rate	231	124	258	204	57.9
UNIT AREA WEIGHT (g/cm^2)	199.2	194.6	203.0	198.9	3.4
SAMPLE THICKNESS (mils)	8	7	8	8	1

MODIFICATIONS OF METHOD	1" cells; intermittent splash collection	TYPE OF CONTACT	Continuous
ANALYTICAL TECHNIQUE	GC-FID	COLLECTION MEDIUM	Ethyl ether (1.0 mL)
SAMPLING FREQUENCY	15 sec., 30 sec., 1.0 min., 3.0 min., 15.0 min.	MIN. DETECTION LIMIT	1 ppm
CHEMICAL STATE	Liquid	MIN. DETECTABLE RATE	0.07 $\mu\text{g}/\text{cm}^2\cdot\text{min}$. (see chart below)

Notes: Visible material degradation, visible material swelling. Minimum detectable permeation rates varied depending on sample collection time as follows:

Sample intervalMinimum detectable permeation rate

15 sec

0.55 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

30 sec

0.55 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

60 sec

0.28 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

3 min.

0.07 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

15 min.

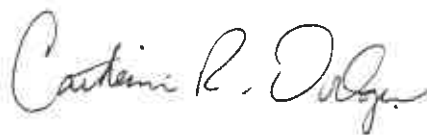
<0.07 $\mu\text{g}/\text{cm}^2\cdot\text{min}$

CONCLUSION: The six types of latex, vinyl, and nitrile examination style gloves (previously described in detail), submitted by Dartmouth College, were evaluated in accordance with ASTM F739-96, between 4/15/97 - 4/23/97. The results are summarized in the following table:

Sample Description	Average Breakthrough Time (minutes)	Average Permeation Rate ($\mu\text{g}/\text{cm}^2 \cdot \text{min}$)
Fisher Scientific's Fisherbrand Latex, Catalog no. 11-394-4B, Lot no. 5550022	0.25	6191
Smith & Nephew Perry's Perry X-AM Style 312 Latex Exam with Beaded Cuff, Catalog no. 60801, Lot 1121708	0.25	1652
Ansell Edmont Industrial's Medical Exam Tek, Catalog no. 7208, Lot no. 512009705	0.25	5424
Continental Lab Products' MicroRoughins, Catalog no. 1315, Lot no. 99579	0.33	1993
Dak Technical Inc's Vinyl (clear), Size Large 96-334	0.50	1043
Best Mfg.'s N-Dex (8 mil) Nitrile, Style no. 8005M	1.2	204

These test results are presented for the client's information and evaluation. No conclusions or interpretations, regarding the test specimens or other specimens of the products, are drawn. ITS makes no statements regarding the appropriateness or comprehensiveness of the test procedures, which were specified by the client. ITS makes no statements regarding the test specimens other than those contained in this report.

Signed by:



Catherine R. Dodgen
Senior Project Engineer
Performance Group

Reviewed and Approved by:



John Sabelli, P.E.
Program Manager
Performance Group