AD-A186 402

2

Report No. CG-D-16-87

DEVELOPMENT OF A U. S. COAST GUARD CHEMICAL RESPONSE SUIT

Lieutenant Jeffrey O. Stull

July 1987

Final Report

Prepared for:

U.S. Department of Transportation
United States Coast Guard

Office of Research and Development
Washington, D.C. 20593

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
CG-D-16-87		

4. Title and Subtitle
DEVELOPMENT OF A U.S. COAST GUARD CHEMICAL RESPONSE SUIT

5. Report Date
JULY 1987

6. Performing Organization Code

7. Author(s)
J. O. STULL

8. Performing Organization Report No.

9. Performing Organization Name and Address
U. S. COAST GUARD (G-ECV)
2100 2nd STREET, S.W.
WASHINGTON, D.C. 20593-0001

10. Work Unit No. (TRAIS)
4155.4.1.1

11. Contract or Grant No.

12. Sponsoring Agency Name and Address
SAME AS ABOVE

13. Type of Report and Period Covered
FINAL REPORT
SEPTEMBER 1986 TO
JULY 1987

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report describes the U. S. Coast Guard's development of a Chemical Response Suit designed to provide encapsulating protection for Coast Guard personnel against hazardous chemicals. This work follows earlier Coast Guard efforts described in CG-D-24-86, "Early Development of a Hazardous Chemical Protective Ensemble," to select protective materials, design a suit, and test the performance of the finished product.

The development was divided into several phases including: (1) further testing of originally selected garment materials, (2) investigation of alternative materials, (3) selection and evaluation of suit materials/components, and (4) design and testing of the overall suit. The result of the development was the selection of a propretary Teflon/Nomex laminate (Challenge™) which exhibited much greater chemical resistance than earlier materials. This material was tested against over 112 chemicals. Selected Secondary materials include a 10 mil FEP film visor, TFE film gloves, and a neoprene/brass zipper. These components and primary garments seams were each tested against batteries of chemicals to determine their chemical resistance relative to the garment material. An encapsulating suit design was adopted which provides uniform protection to the wearer. The suit's overall evaluation included pressure testing, the measurement of suit intrusion coefficients, an unmanned simulated exposure to hydrogen fluoride vapor, and field heat stress testing. (Keywords:)

17. Key Words
Chemical Protective Suit
Teflon/Nomex Laminate
Material Chemical Resistance Testing
Permeation Resistance Testing
Intrusion Coefficients

18. Distribution Statement
This document is available to the U. S. Public through the National Technical Information Service, Springfield, VA 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	703	

Form DOT F 1700.7 (8-72)

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

The contents of this report do not necessarily reflect the official view or policy of the Coast Guard; and they do not constitute a standard, specification, or regulation.

This report, or portions thereof may not be used for advertising or sales promotion purposes. Citation of trade names and manufacturers does not constitute endorsement or approval of such products.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (continued)

CHAPTER 1

INTRODUCTION AND BACKGROUND

The U. S. Coast Guard is mandated by the Clean Water Act of 1977 (as amended in 1978) and the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) to respond to any chemical discharge into the waters of the United States. The Coast Guard also has the responsibility for inspecting and certifying marine chemical-carrying vessels. Finally, the Coast Guard provides assistance to the U. S. Environmental Protection Agency in the supervision of hazardous waste site cleanup and disposal. These missions require appropriate protection for Coast Guard personnel against a multitude of hazardous chemicals, especially those transported in bulk which are likely to be encountered in marine spills and during marine inspections. To aid spill response and monitoring, the Coast Guard developed its own Chemical Hazard Response Information System (CHRIS)[1], which now defines the properties, hazards, and response techniques for over 1100 chemicals.

As the Coast Guard's role in chemical spill response grew, it found that for many CHRIS chemicals, commercial chemical protective clothing either did not provide adequate protection, or had little chemical data available to judge its performance. As a consequence, a formal research and development project was established in 1978 to develop new chemical protective clothing and equipment that would satisfy Coast Guard requirements. Part of this project was directed toward developing a totally-encapsulating chemical protective suit. The goals of the effort were to:

(1) select a material or group of materials for incoporation into a "uniform" suit design, which would provide broad protection against as many CHRIS chemicals as possible, and eliminate the need for a large inventory of different chemical protective suits;

(2) design a suit which would accomodate different types of ancilliary protective equipment (breathing apparatuses, cooling devices, communications systems, and portable air monitors); and

(3) overcome a lack of performance standards for commercial suits by completely documentating suit capabilities and limitations through thorough laboratory and field testing.

Early Work

When the Coast Guard began its research effort, the majority of chemical protective suits available were constructed of butyl rubber with a polycarbonate visor. From these, the Coast Guard selected a suit manufactured by the U. S. Army for chemical warfare applications. This suit was modified for Coast Guard use and became known as the Hazardous Chemical Protective Clothing Outfit (HCPCO). An early Coast Guard study, "Material Development Study for a Hazardous Chemical Protective Clothing Outfit (CG-D-58-80),"[2] identified 400 CHRIS chemicals which required using a totally encapsulating protective garment and self-contained breathing apparatus for adequate protection. From this same study, measurements of material-chemical permeation indicated that butyl rubber and polycarbonate were compatible with only 38% and 60% of these chemicals, respectively (for a three hour period).[2]

Recognizing the limitations of the HCPCO, the Coast Guard undertook the development of its own totally-encapsulating chemical protective ensemble to include the selection of compatible materials and the development of a suit design meeting its specific needs. This effort and the results described below are documented in the Coast Guard Final Report, "Early Development of a Hazardous Chemical Protective Ensemble (CG-D-24-86)".[3] Several existing and state-of-the-art materials were screened by chemical resistance and physical property testing. This screening yielded two materials to supplement butyl rubber as garment materials in separate suits—Viton[R]/ chlorobutyl laminate and chlorinated polyethylene (CPE). In addition, a Teflon[R] fluorinated-ethylene propylene (FEP)/Surlyn[R] laminate was chosen to replace polycarbonate as the visor material for all three suit materials.

Each of the selected materials were subjected to extensive chemical resistance testing, including one-sided immersion testing against 160 representative CHRIS chemicals and permeation testing against 59 of those chemicals. The immersion testing results indicated few chemical effects on the Teflon[R] visor material, with Viton[R]/chlorobutyl laminate moderately affected, and chlorinated polyethylene greatly affected. No chemicals permeated the FEP Visor material within three hours, but the Viton[R]/chlorobutyl laminate and CPE exhibited breakthrough to 15 and 30 chemicals, respectively.

Prototype suits were constructed from each of the three materials and tested for integrity, function, and fit. All suit prototypes displayed a high level of integrity in both unmanned and manned tests where suits were placed in a closed chamber and exposed to a dioctyl sebacate (DOS) aerosol. Nonetheless there was some uncertainty in the efficiency of the test protocol to accurately measure suit inward leakage rates since most chemical exposures involve chemical gases and vapors as opposed to aerosols. Function testing was conducted to simulate different physical tasks representative of hazardous chemical response activities. During these tests, various physiological parameters were measured under a number of environmental conditions to determine levels of heat stress and the effectiveness of a newly designed, water-recirculating cooling system. The results of these tests indicated that the suit enabled the wearer to perform most functions, however, the effectiveness of the cooling system was judged questionable even though most test subjects indicated a "feeling of improved comfort" when wearing it. Fit tests identified improvements in the suit design in terms of dimensions, seaming, and placement of components.

Following the development contract, Coast Guard Engineering engaged in preparing specifications for each of the three suit materials (Viton[R]/ chlorobutyl laminate, butyl rubber, and chlorinated polyethylene) and the suit cooling system (described in reference 3). Despite the relative poor performance of CPE, it was retained in the Coast Guard's chemical protective suit "system" because of its resistance to inorganic acids and bases, and other chemicals with high spill frequencies. Concurrent with developing suit specifications, a new materials testing effort was launched to provide additional data on the selected materials.

CHAPTER 2

EXPANDED TESTING OF THE ORIGINAL MATERIALS

The Coast Guard R&D Center began to test the three garment and visor materials to further determine their resistance to other chemicals and mixtures under various conditions. Since the chemicals selected for testing in the development contract were only those chemicals incompatible with butyl rubber, one aim of this additional chemical testing was to determine whether Viton® /Chlorobutyl laminate and chlorinated polyethylene could provide the same protection as butyl rubber, i.e., using a two material suit system as opposed to a three material suit system. Other objectives included measuring chemical resistance against additional chemicals, and investigating the effects of temperature, chemical contact time, and mixtures.

In the previous Coast Guard development contract, material chemical resistance was assessed by two different methods—degradation resistance (immersion testing) and permeation resistance. Since that contract, the American Society for Testing and Materials (ASTM) established standard methods for measuring each material-chemical interaction. ASTM defines degradation as "the deterioration in a material of one or more physical properties upon surface contact by a chemical". Degradation resistance is measured by exposing a material sample to a chemical and noting changes in its physical properties. In previous testing, the Coast Guard measured weight gain (loss) and tensile elongation as well as noting changes in physical appearance. Permeation, on the other hand, is the flow of a chemical through a material on a molecular level (Figure 1 illustrates the steps in the permeation process). Permeation resistance is similarly measured by exposing the external surface of a material sample to a chemical, but involves measuring the time for the chemical to be detected on the other side (interior) of the material. This "breakthrough" time is characteristic of the material/chemical combination. Of the two methods, the Coast Guard decided to exclusively measure permeation resistance for determining material-chemical compatibility. Permeation testing is the preferred technique for evaluating protective clothing materials since permeation can occur without visible evidence of degradation. A number of such cases were reported in the previous testing.

Test Plan

A comprehensive test plan was developed to systematically evaluate material/chemical compatability and the conditions affecting permeation. Designing the test plan involved selection of priority chemicals, materials to be tested, testing methods, and ranges of each parameter[4].

Chemical Selection. The list of 1100+ CHRIS chemicals was reviewed using criteria based on encapsulation requirements, toxicity, and spill frequency (history). Encapsulation requirements were taken from an earlier survey of CHRIS chemicals conducted for the Coast Guard by MSA Research Corporation[2]. Chemical toxicity was judged on the basis of carcinogenicity, skin absorption hazards, and various toxicity hazard ratings (such as those by the National Fire Protection Association), and divided into three groups (high, moderate,

MATERIAL-CHEMICAL PERMEATION

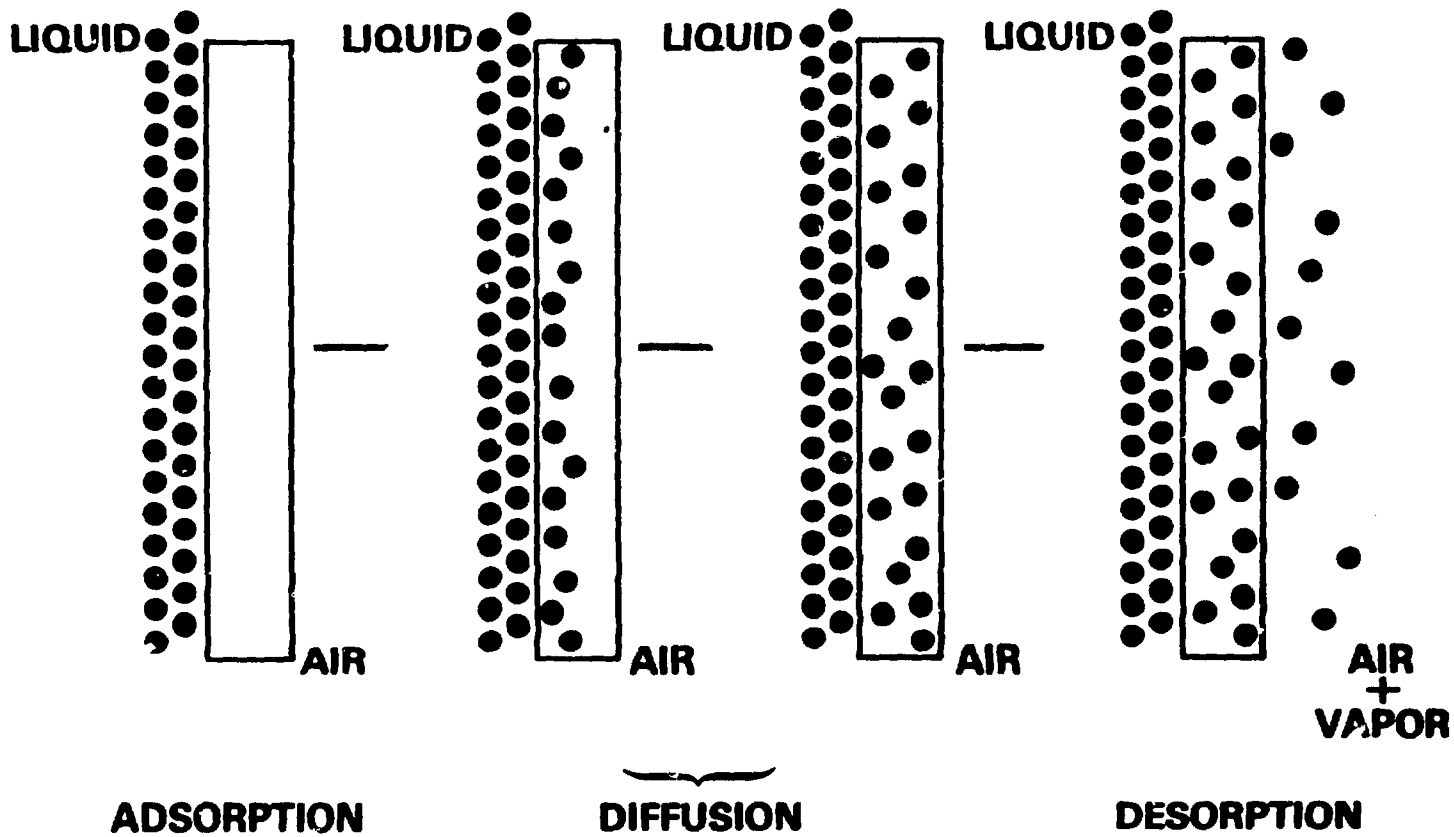


Figure 1

and low). Priority chemicals are those with both a spill history and a need for encapsulating protection, and of either high or moderate toxicity. Also included in the priority list are all chemicals of high toxicity whether or not these chemical need encapsulation or have a spill history. This overall priority list includes 116 chemicals which are listed in Table 1. The specific selection criteria are documented in the Coast Guard Report, "Selection of Priority Chemicals for Permation Testing and Hazardous Chemical Spill Detection and Analysis[7]. Appendix A shows the groupings of these chemicals by priority classes. Additionally, preliminary parameter studies employed an evolving battery of test chemicals. Table 2 lists the fifteen standard chemicals which have been adopted by the ASTM for material chemical testing.[8] These chemicals represent a range of chemical classes and properties.

Test Materials. The Coast Guard tested the selected materials—Viton[R]/Chlorobutyl laminate, butyl rubber, and chlorinated polyethylene (CPE). These materials are described in Table 3. The majority of experiments in this study involved the Viton laminate and CPE since butyl rubber had been thoroughly evaluated in the earlier investigation by MSA Corporation.[2] ChemTech Rubber in New Haven, Connecticut, custom manufactured the Viton[R]/Chlorobutyl laminate using specifications developed by ILC Dover, Inc. The Viton[R] coating is used on the external surface whereas somewhat thicker chlorobutyl is used on the inside of the suit. Chlorinated polyethylene material samples were provided by ILC Dover. ILC Dover's CPE is a proprietary blend fabricated for both increased integrity and heat sealing characteristics. Unlike the other materials, the CPE considered by the Coast Guard has no fabric substrate and consists of two plys bonded together. The previous study[3] demonstrated poorer chemical resistance for the supported CPE materials. Butyl rubber used in the testing conformed to MIL-C-12189 and was fabricated by Plymouth Rubber in Canton, Massachussetts.

Test Methods. ASTM Standard Method F739 or modified versions of this test method were used in all permeation testing.[9] A diagram of the test cell apparatus is given in Figure 2. Typical data from a representative test are illustrated in Figure 3. Both permation breakthrough time and steady state permeation rate were generally measured, although, breakthrough time is primarily used to assess material performance. The test method does not specify the duration of the test, the collection medium, or the chemical detection method. A three hour test period was chosen for testing material/chemical permeation since three hours is considered the maximum suit life during a chemical exposure (though suits are generally worn for one hour or less). All tests were run for at least three hours with breakthrough times reported in minutes. When no chemical breakthrough was detected, tests were usually terminated at the end of three hours. A detection method and corresponding collection medium were selected for each priority chemical taking into account the analytical technique's sensistivity for detecting that chemical. Two collection media were used—air and water. Detection methods specified include gas chromatography (with either flame ionization, electron capture, or flame photometric detectors), colorimetric techniques, ion chromatography (anion or cation columns), use of specific ion electrodes, polarography, and infrared spectroscopy. Table 1 provides the recommended detection methods/collection media for the list of priority chemicals.

Ranges of Test Parameters. The parameters contact time, chemical state,

TABLE 1

LIST OF PRIORITY LIQUID CHEMICALS

CHEMICAL	CHRIS CODE	ENCAPSULATION NEED? (a)	NO. SPILLS	HAZARD INDEX	NFPA INDEX	RECOMMENDED DETECTORS
Acetaldehyde	AAD	Yes	4	3	2	FID
Acetic Acid	AAC	Yes	13	3	2	FID
Acetic Anhydride	ACA	Yes	2	3	2	IR
Acetone	ACI	Yes	11	3	1	FID
Acetone Cyanohydrin	ACY	Yes	0	2S	4	FID
Acetonitrile	ATN	Yes	2	3	2	FID
Acetophenone	ACP	No	0	1	1	FID
Acetyl Chloride	ACE	Yes	1	-	3	IR
Acrolien	ARL	Yes	1	-	3	FID
Acrylic Acid	ACR	Yes	10	3	3	FID
Acrylonitrile	ACN	Yes	12	1S	4	FID
Adipontrile	ADN	Yes	4	4	2	FID
Allyl Alcohol	ALA	Yes	2	2S	3	FID
Allyl Chloride	ALC	Yes	0	2	3	HD, FID
Aniline	ANL	Yes	2	2	3	FID
Benzene	BNZ	Yes	91	1	2	FID
Benzyl Chloride	BCL	Yes	1	2	3	FID
Bromine	BRX	Yes	0	-	4	PLRG, CLMT
n-Butyl Acetate	BCN	No	1	3	1	FID
n-Butyl Acrylate	BTC	No	1	3	2	FID
n-Butylamine	BAM	Yes	1	2S	2	FID
n-Butyl Alcohol	BAN	No	2	3S	1	FID
Butyraldehyde	BTR	Yes	2	5	2	FID
Carbon Disulfide	CBB	Yes	0	2S	2	ECD
Carbon Tetrachloride	CBT	No	6	1S	3	HD, ECD
Chlordane (25%)	CDN	Yes	3	-	-	ECD
Chlorbenzene	CRB	No	1	3	2	HD, ECD
Chloroform	CRF	Yes	3	1	2	HD, ECD
Chlorpicrin	CPL	Yes	0	-	4	HD, ECD
Chlorosulfonic Acid	CSA	Yes	1	2	3	IC(A)
Creosote	CCT	Yes	0	5	2	FID
m-Cresol	CRL	No	33	3S	3	FID, CLMT
Crotonaldehyde	CTA	Yes	0	2	3	FID
Cumene Hydroperoxide	CMH	Yes	0	-	1	FID
Cyclohexane	CHX	Yes	17	3	1	FID
1,2-Dibromoethane	EDB	Yes	0	1S	3	HD, ECD
1,2-Dichloroethane	EDC	Yes	0	3	2	HD, ECD
2,2-Dichloroethyl Ether	DEE	Yes	0	2S	-	HD, ECD
Dichloromethane	DCM	No	4	3	2	HD, ECD
1,2-Dichloropropane	DPP	Yes	2	3	2	FID, ECD
1,3-Dichloropropene	DPR	No	0	2S	2	HD, ECD
Diethylamine	DEN	No	0	3	2	FID
Diethanolamine	DEA	No	2	3	-	FID
Dimethylsulfate	DSF	Yes	0	-	4	FPD
Diisopropylamine	DIA	No	0	2S	3	FID
Dimethylformamide	DMF	No	0	3S	1	FID

TABLE 1 (Continued)

LIST OF PRIORITY LIQUID CHEMICALS

CHEMICAL	CHRIS CODE	ENCAPSULATION NEED? (a)	NO. SPILLS	HAZARD INDEX	NFPA INDEX	RECOMMENDED DETECTORS
1,4-Dioxane	DOX	No	0	2S	2	FID
Di-n-Propylamine	DNA	Yes	0	5	3	FID
Epichlorohydrin	EPC	Yes	1	2S	3	HD, ECD
Ethion 4	ETO	Yes	1	-	-	FPD
Ethyl Acetate	ETA	No	1	3	1	FID
Ethyl Acrylate	EAC	Yes	11	3	2	FID
Ethyl Alcohol	EAL	No	9	3	0	FID
Ethylamine (70%)	EAM	Yes	3	2	3	FID
Ethyl Benzene	ETB	No	3	3	2	FID
Ethylene Cyanohydrin	ETC	Yes	1	5	2	FID
Ethylenediamine	EDA	No	5	3	3	HD, ECD
Ethylene Glycol	EGL	No	23	3	1	FID
Ethyl Ether	EET	No	1	3	2	FID
Formaldehyde (37%)	FMS	Yes	17	1	2	CLT
Furfural	FFA	No	1	3	2	FID
Gasoline	GAT	No	0	3	1	FID
Glutaraldehyde(sol'n)	GTA	Yes	0	2	-	FID
Hexane	HXA	No	4	3	1	FID
Hydrazine	HDZ	Yes	0	-	3	PLRG, CLMT
Hydrofluoric Acid	HFA	Yes	6	3	4	IC(A), CLMT
Hydrogen Peroxide (30%)	HPO	Yes	2	-	2	CLMT
Isopropyl Alcohol	IPA	No	0	3	1	FID
Isopropylamine	IPP	Yes	0	2	3	FID
Malathion (50%)	MLT	Yes	2	-	-	FPD
Methyl Acrylate	MAM	Yes	1	3	2	FID
Methyl Alcohol	MAL	No	11	3	1	FID
Methyl Ethyl Ketone	MEK	No	6	3	1	FID
Methyl Isobutyl Ketone	MIK	Yes	5	3	2	FID
Methyl Methacrylate	MMM	No	3	3	2	FID
Methyl Parathion	MPT	Yes	1	-	4	FPD
Motor Fuel Additives (Lead Alkyls)	MFA	Yes	0	-	-	ECD
Naled	NLD	Yes	1	-	-	ECD
Napthalene	MLT	No	10	3	2	FID
Nitric Acid	NAC	Yes	8	2	3	IC(A), CLMT
Nitrobenzene	NTB	Yes	1	2S	3	ECD
2-Nitropropane	NPP	Yes	0	1	1	FID ,FPD
Oleum	OLM	Yes	0	3	3	IC(A), CLMT
Parathion	PTO	Yes	1	-	4	FPD
Petroleum Ether	NSS	No	0	3	2	FID
Phenol	PHN	No	26	2S	3	FID, CLMT
Phosphoric Acid	PAC	No	22	3	2	IC(A), CLMT
Phosphorous Oxychloride	PPO	Yes	1	-	-	IC(A), CLMT

TABLE 1 (Continued)

LIST OF PRIORITY LIQUID CHEMICALS

CHEMICAL	CHRIS CODE	ENCAPSULATION NEED?	NO. SPILLS	HAZARD INDEX	NFPA INDEX	RECOMMENDED DETECTORS
Phosphorous Trichloride	PPT	Yes	0	-	3	ECD
Polychlorinated Biphenyls	PCB	Yes	92	-	-	ECD
Propionic Acid	PNA	No	1	3	2	FID
n-Propyl Alcohol	PAL	No	1	3	2	FID
n-Propylamine	PRA	Yes	0	4	3	FID
Propylene Oxide	POX	No	1	2	2	FID
Silicon Tetrachloride	STC	Yes	0	3	-	ECD
Sodium Hydrosulfide	SHR	Yes	2	5	-	IC(A/Cat), CLMT
Sodium Hydroxide	CSS	Yes	0	3	3	IC(Cat)
Styrene	STR	No	59	2	2	FID
Sulfur Monochloride	SFM	Yes	1	-	2	IC(A), CLMT
Sulfuric Acid (95%)	SFA	Yes	128	3	3	IC(A), CLMT
1,1,2,2-Tetrachloroethane	TEC	Yes	0	2	3	HD, ECD
Tetrachloroethylene	TTL	No	0	3	2	HD, ECD
Tetraethyl lead	TEL	Yes	1	-	3	ECD
Tetraethyl pyrophosphate	TEP	Yes	1	-	-	FPD
Tetrahydrofuran	THF	Yes	4	3	2	HD, ECD
Tetramethyl lead	TML	Yes	0	-	3	ECD
1,1,1-Trichloroethane	TCL	Yes	5	3S	2	HD, ECD
Trichloroethylene	TCE	Yes	5	2	2	HD, ECD
Toluene	TOL	No	81	3S	2	FID
o-Toluidine	TLI	No	0	1	3	FID
Toluene-2,4-Diisocyanate	TDI	Yes	0	2	3	FID
Turpentine	TPT	No	5	3	1	FID
Vinyl Acetate	VAM	Yes	8	2	2	FID
Vinylidene Chloride	VCI	Yes	8	2	1	HD, ECD
Xylenes	XLM	No	92	3	2	FID
Xylenol	XYL	Yes	1	5	3	FID

(a) Need for encapsulating protection determined in reference (2).
(b) Number of spills reported in Coast Guard Pollution Incident Response System (1973-1983).
(c) Hazard Index is based on Chemical Toxicity Ratings reported in reference (5). 1 is most toxic (carcinogen); 6 is least toxic; S - skin absorption hazard.
(d) NFPA Health Hazard Rating (from reference 6)

TABLE 1 (Continued)

LIST OF PRIORITY LIQUID CHEMICALS

(e) Explanation of Detector Code and Collection Media

METHOD OF DETECTION	COLLECTION MEDIUM
Gas Chromatographic Techniques	
FID = Flame Ionization Detector	air
ECD = Electron Capture Detector	air
Hall = Hall Detector	air
FPD = Flame Photometric Detector	air
Colorimetric Techniques	
CLMT = Colorimetric standard method or commerical test kit based on specific chemical method	water
Ion Chromatography	
IC(A) = Anion column	water
IC(C) = Cation column	water
Other Techniques	
SI = Specific ion electrodes	water
PLRG = Polarography	water
IR = Infrared spectrographic analysis	air

TABLE 2

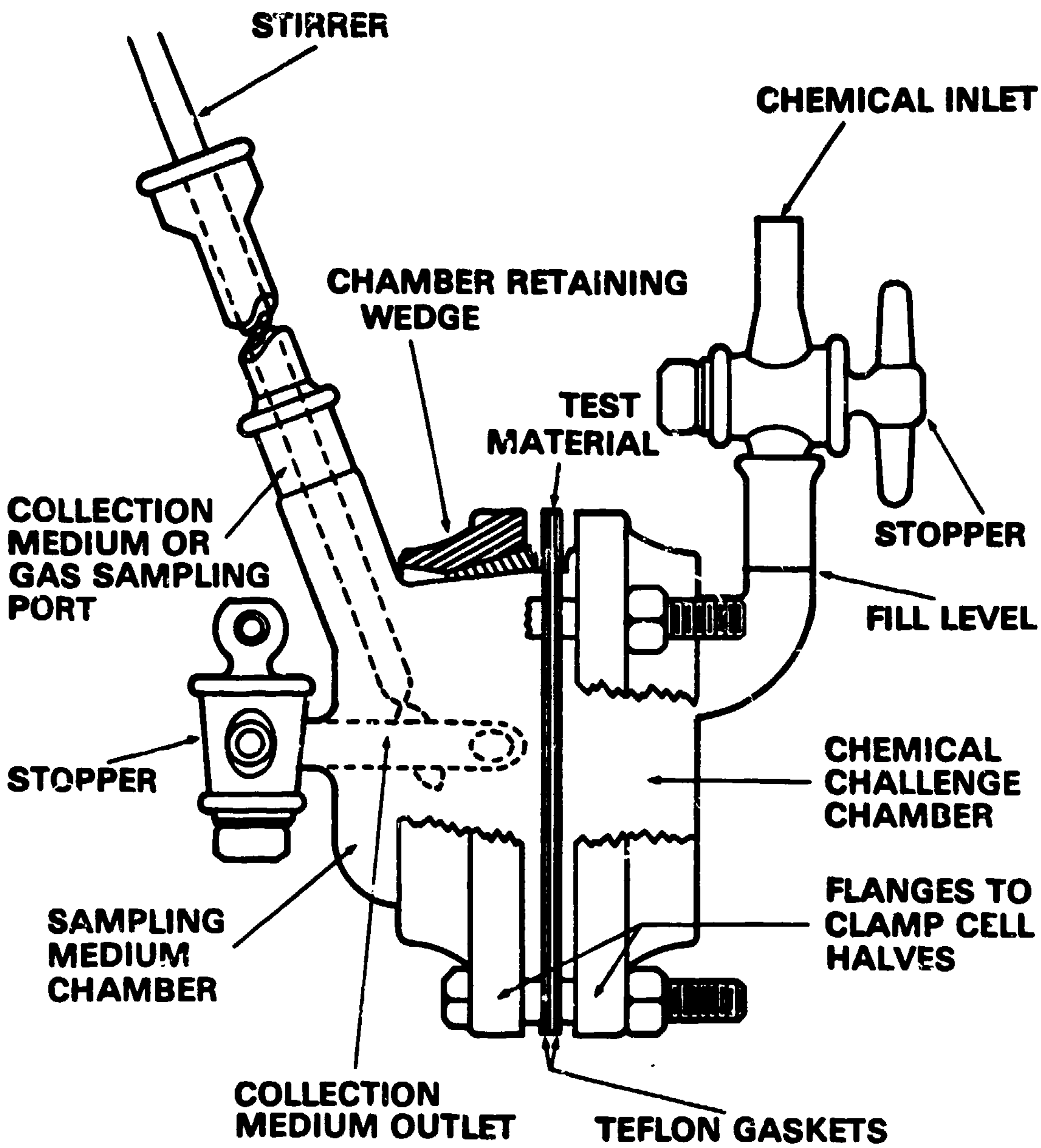
LIST OF ASTM F1001 RECOMMENDED CHEMICALS

Chemical	Chemical Class
Acetone	Ketone
Acetonitrile	Nitrile
Carbon Disulfide	Sulfur Containing Compound
Dichloromethane	Chlorinated Parrafin
Diethyl Amine	Amine
Dimethylformamide	Amide
Ethyl Acetate	Ester
Hexane	Aliphatic Hydrocarbon
Methanol	Alcohol
Nitrobenzene	Nitrogen Containing Compound
Sodium Hydroxide	Inorganic Base
Sulfuric Acid	Inorganic Acid
Tetrachloroethylene	Chlorinated Olefin
Tetrahydrofuran	Oxygen Heterocyclic Compound
Toluene	Aromatic Hydrocarbon

TABLE 3

ORIGINAL SELECTED CHEMICAL PROTECTIVE SUIT MATERIALS

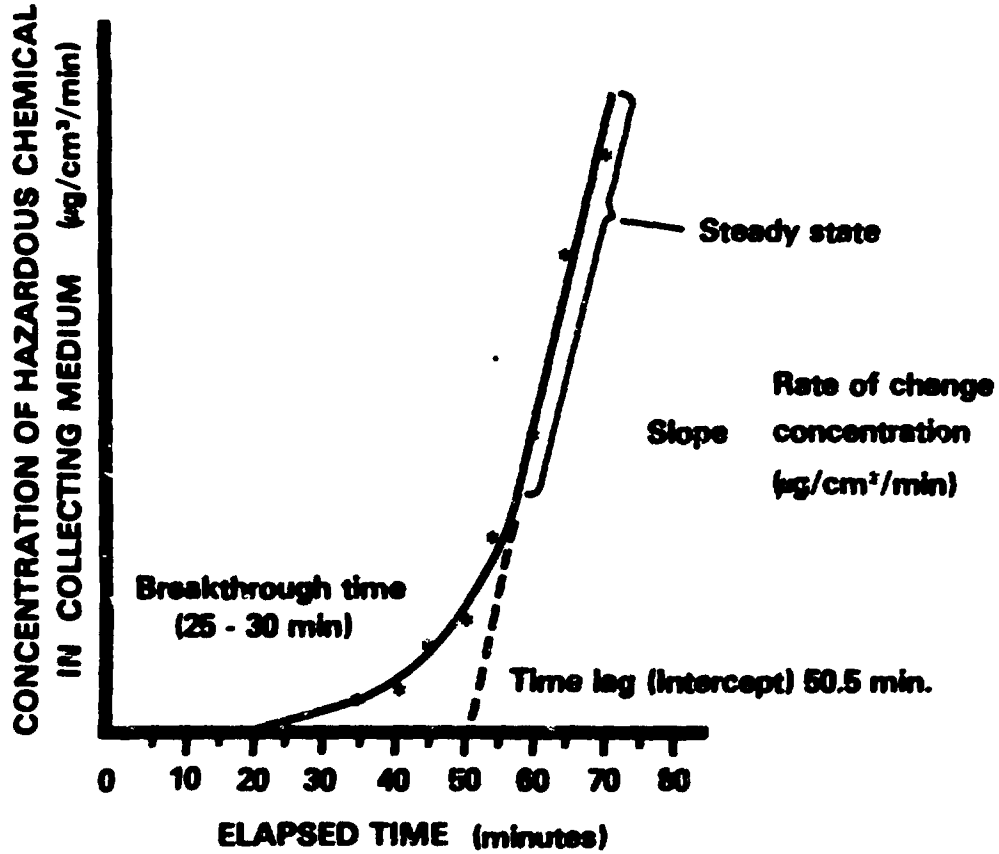
Material (Source)	Color	Thickness (mil)	Weight (oz/yd^2)
Viton[R]/Chlorobutyl Laminate (ChemTech Rubber, New Haven, CT)		13.8	14
Outer Coating: Viton[R]	Orange-Red	4.7	5-6
Substrate: Polyester			3
Inner Coating: Chlorobutyl	Dark Grey	9.1	5-6
Butyl Rubber (Plymouth Rubber, Canton, MA)		14.0	13
Outer Coating: Butyl	Grey	7.5	5-6
Substrate: Nylon			3
Inner Coating: same as outer coating			
Chlorinated Polyethylene (ILC Dover, Frederica, DE)	White	27	19
No substrate, two ply, heat bonded film			



PERMEATION TEST CELL

Figure 2

PERMEATION BREAKTHROUGH CURVE



Typical Permeation Test Output (Closed Loop System)

Figure 3

temperature, and chemicals in mixtures were investigated in preliminary studies to observe general trends for selected material/chemical combinations. Procedures in ASTM F739 involve constant contact with the material sample for the duration of experiment. However, this type of material/chemical contact is not always representative of typical field exposures. The Coast Guard R&D Center modified the standard method to allow for intermittant contact of a chemical with the sample material surface over the three hour period[10]. Chemical contact was designed to simulate the effect of a 'splash', i.e., the momentary contact of a liquid chemical with the material. Three different intermittant contact periods were chosen: one splash every fifteen minutes (12 splashes per three hour period), one splash every half hour (6 splashes during the test period), and one splash at the beginning of the three hour test period. Liquids and gases were the only chemical states investigated. The current ASTM Standard Method does not lend itself for permeation testing of solid chemicals. Permeation testing of chemicals as gases involved saturated vapors at the temperature of the test cell. The range of temperature considered in studying its effect was 0 to 50 degrees Celsius, representing the temperatures that may be encountered in the field. Only simple binary mixtures were considered in this part of the study. Permeation breakthrough was measured for each component of the mixture.

General Permeation Testing

Table 4 lists the breakthrough times for some priority chemicals and those in the recommended ASTM list. All these tests were conducted under ambient conditions of temperature with constant material/chemical contact. The results show that a large proportion of these chemicals broke through both the Viton®/Chlorobutyl laminate and chlorinated polyethylene. Only a few results are provided for butyl rubber. The Viton®/Chlorobutyl laminate was originally chosen because the two materials strongly complement each other for a higher overall resistance to more chemicals[3]. The chlorobutyl is resistant to polar ketones and esters, but it is attacked by non-polar aliphatic and aromatic hydrocarbons. Conversely, the Viton® is resistant to non-polar solvents, and is attacked by polar solvents. However, the data reported here show that while effective against hydrocarbons, the laminate is permeated by several polar compounds, among these are acetaldehyde, acetone, and ethyl acetate. The decision to use chlorinated polyethylene was primarily based on its resistance to inorganic acids and bases, together with its relatively low cost. Nonetheless, it is generally ineffective as a barrier against many of the organic compounds listed in Table 4.

Contact Time and Chemical State Experiments

'Splash' and chemical state testing was conducted by the Coast Guard R&D Center on both Viton®/chlorobutyl laminate and chlorinated polyethylene using several challenge chemicals.[10] Table 5 provides a comparison of liquid, liquid splashes (at the three frequencies, 12X, 6X, and 1x), and saturated vapor (at both 0 and 25°C) permeation testing. Two general trends were observed for this data. In some cases, permeation breakthrough time increased with diminishing molecular contact (constant liquid contact 12X splash 6X splash 1x splash 25°C vapor 0°C vapor). On the other hand, some material/chemical combinations demonstrated relatively constant

TABLE 4

PERMEATION BREAKTHROUGH TIMES OF COAST GUARD CANDIDATE SUIT MATERIALS FOR SELECTED CHEMICALS

Chemical	Breakthrough times (minutes)[a]		
	Viton/CB[b]	Butyl Rubber[b]	CPE[b]
Acetaldehyde	30-40	—	10-30
Acetic Acid	No BT[c]	No BT	No BT
Acetone	52-77	No BT	20-25
Acetonitrile	90-105	No BT	80-85
Benzene	—	—	71-75
Carbon Tetrachloride	—	—	No BT
Chloroform	No BT	11-15	30-35
Cyclohexane	—	—	No BT
Dichloromethane	25-36	0-1	15-25
Dimethyl Sulfoxide	No BT	—	No BT
Ethyl Acetate	20-40	—	58-70
Ethyl Acrylate	14-32	34-45	65-70
Freon TF (113)	No BT	35-40	No BT
Hexane	No BT	13-16	No BT
Lindane in Chloroform	No BT	0-10	—
Lindane in Xylenes	No BT	80-90	—
Methanol	No BT	No BT	No BT
Methyl Ethyl Ketone	25-40	—	28-35
Styrene	No BT	0-1	60-70
Tetrahydrofuran	9-11	7-14	27-39
Toluene	No BT	0-6	69-75

(a) Breakthrough times measured using ASTM F739-81 Standard Method with a Gas Chromatograph/Flame Ionization Detector (approximate sensitivity - 1 ppb).

(b) The materials tested were as follows:
1. Viton/CB - Viton/chlorobutyl laminate; 5 oz/yd^2 viton (outer or exposed surface), polyester, and 5 oz/yd^2 chlorobutyl rubber (inner surface); 14 mil total thickness.
2. Butyl rubber - nylon butyl cloth as per Military Specification Mil-C-12189 (13 mil thickness)
3. CPE - Chlorinated Polyethylene, 30 mil thickness, unsupported

(c) "No BT" denotes no breakthrough within three hour period.

TABLE 5

PERMEATION BREAKTHROUGH TIMES OF SEVERAL MATERIAL/CHEMICAL COMBINATIONS FOR VARYING EXPOSURE CONDITIONS

Material/Chemical Combination	Breakthrough Time (mins.)					
	Liquid	Liquid Splash(a)			Vapor	
		12X	6X	1X	25°C	0°C
Viton[R]/Chlorobutyl Laminate:						
Acetone	43-58	43-58	73-78	94-100	63-74	3 hrs.
Dichloromethane	25-36	30-35	30-35	30-35	35-55	3 hrs.
Methyl Ethyl Ketone	25-40	35-40	35-40	50-55	80-85	3 hrs.
Tetrahydrofuran	9-11	11-17	11-17	11-17	35-45	3 hrs.
Chlorinated Polylethylene:						
Acetone	32-35	50-53	68-72	75-85	130-140	3 hrs.
Chloroform	30-37	46-50	81-86	120-125	132-138	(b)
Dichloromethane	15-24	20-26	25-30	26-32	32-40	3 hrs.
Methyl Ethyl Ketone	28-35	40-45	45-50	46-49	141-148	3 hrs.
Tetrahydrofuran	27-39	39-45	51-58	62-72	105-111	3 hrs.

(a) Liquid splash testing: 12X - one splash every 15 minutes; 6X - one splash every 30 minutes; 1X - one splash at beginning of test.

(b) Test not performed.

breakthrough time with varying contact (excluding vapor data). Figure 4 illustrates both phenomena graphically: the two cases on the left hand side of Figure 4 show increasing breakthrough times with decreasing contact while the right hand side gives two examples of nearly constant breakthrough time with changing chemical contact. It is interesting to note, that in some of the 12X and 6X splash testing, permeation breakthrough occurs before a majority of the individual splashes. For example, tetrahydrofuran breaks through Viton^R/chlorobutyl laminate after the second splash in the 12X test and after the first splash in the 6X test.

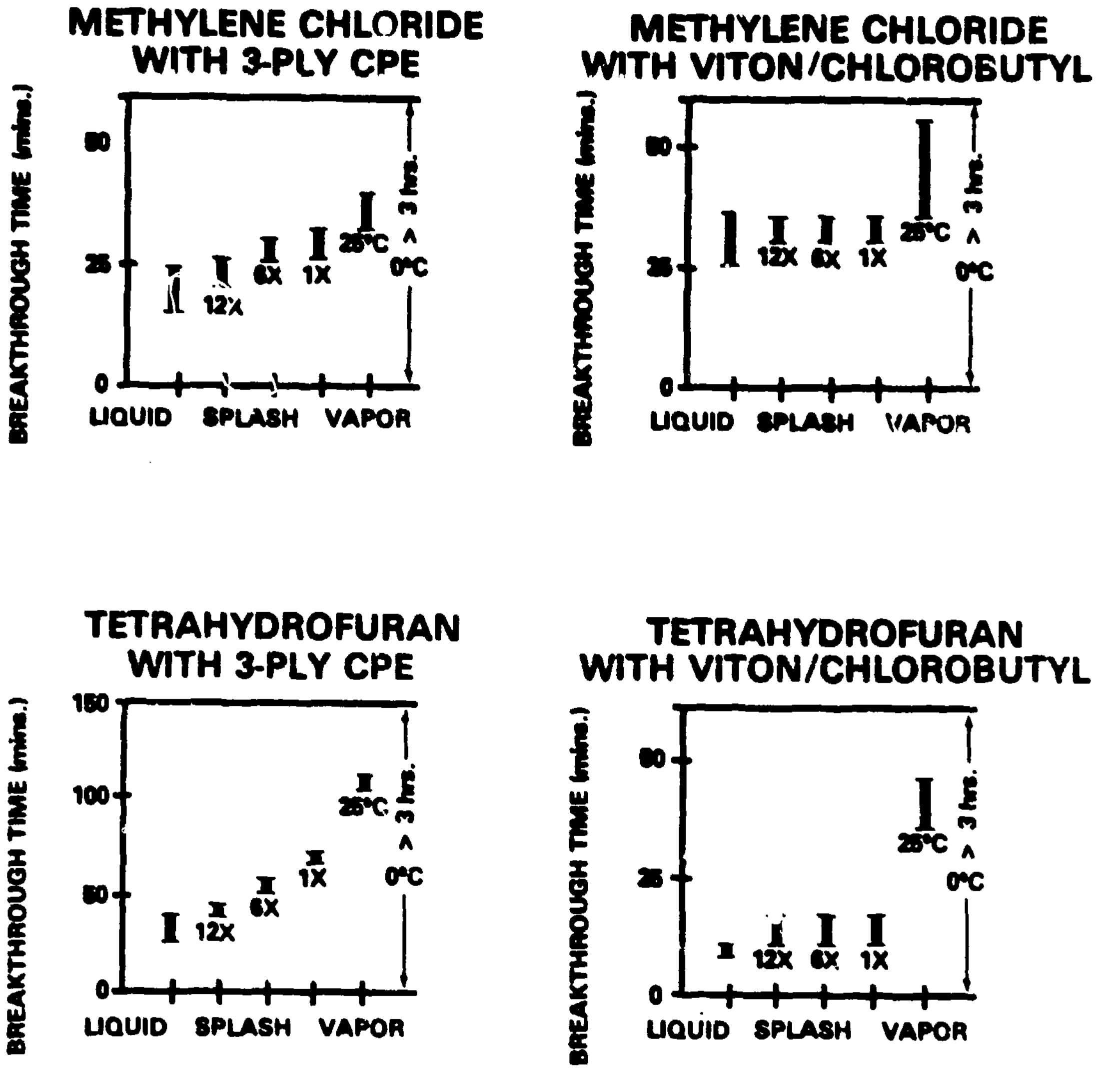
The expected behavior for reducing chemical contact with the material, is an increase in the permeation breakthrough time. If changing liquid contact has little effect on the breakthrough time, then the permeation of the material must be due to the initial 'wetting' of the material. It follows that this initial splash provides extended contact of the chemical with the material. It is therefore reasonable to postulate that the ability of the chemical to 'wet' the material is a factor in this phenomenon. An investigation of this factor is needed to establish if this behavior is predictable on the basis of chemical properties with respect to a particular material. Liquid versus vapor permeation generally followed the expected results for all material/chemical combinations tested.

Temperature Effect Experiments

The ASTM Standard Method F739 states that permeation tests should be run at temperatures 21 $\pm$ 5°C. Early in the work of this materials testing program, differences in permeation testing were being observed for tests run of different days. An examination of the ambient conditions for those days, showed small differences in temperature which affected permeation measurements (see Table 6). Table 7 shows results for measuring the effect of the temperature on the breakthrough time for two chemicals (dichloromethane and methyl ethyl ketone) against Viton^R/chlorobutyl laminate. These breakthrough times were measured using a thermostated permeation test cell. As expected, permeation breakthrough time increases with decreasing temperature because molecular energy also decreases. The same trend is evident for vapors as well. Significant differences in breakthrough times are noted between the saturated vapors at 25°C and 0°C as reported in Table 5. No breakthrough occurred within three hours for any material/chemical combination tested at 0°C.

Mixture Experiments

The permeation behavior of three simple mixtures against VITON^R/Chlorobutyl laminate was investigated. These included dichloromethane/hexane, dichloromethane/toluene, and acetone/hexane. Table 8 shows the results for both dichloromethane mixtures. In both cases, the second solvent (hexane or toluene) does not break through the laminate as a pure chemical whereas dichloromethane has a breakthrough time of 25 to 36 minutes. However, for a 50/50 (by volume) mixture of either dichloromethane and hexane or dichloromethane and toluene, both mixture components permeated the material samples. The breakthrough times were monitored by gas chromatography, therefore it was possible to distinguish individual breakthrough times for



Graphical Representation of Permeation Breakthrough
Times Under Varying Exposure Conditions

Figure 4

TABLE 6

THE EFFECT OF AMBIENT TEMPERATURE ON PERMEATION BREAKTHROUGH TIME

Test Material	Temp (°C)	Acetone BT_a (min)
Viton[R]/Chlorobutyl Laminate	20	95-98
	26.5	43-53
28 mil Chlorinated Polyethylene	22	32-35
	24.5	27-31

(a) BT - Breakthrough Time

TABLE 7

THERMOSTATED TEMPERATURE EFFECT ON DICHLOROMETHANE AND METHYL ETHYL KETONE PERMEATION BREAKTHROUGH TIMES FOR VITON/CHLOROBUTYL LAMINATE

Temperature (°C)	Breakthrough Times (min)[a] Dichloromethane	Methyl Ethyl Ketone
5	8-10	180-199
15	6-8	80-85
25	4-4.5	35-45
35	3.5-4	20-25
45	--	14-20

(a) Breakthrough times measured using ASTM F739-85; Dichloromethane breakthrough measured with GC with ECD; MEK measured by GC with FID.

TABLE 8

PERMEATION BREAKTHROUGH TIMES FOR TWO BINARY MIXTURES AGAINST VITON/CHLOROBUTYL LAMINATE

Percentage CH_2Cl_2	No. Runs	Breakthough Time (min) CH_2Cl_2	Hexane
In Hexane:			
100	1	25-36	---
50	2	42-47	57-62
0 (100% Hexane)	4	---	no BT
In Toluene:			Toluene
100	1	25-36	---
50	1	45-55	58-66
0 (100% Toluene)	1	---	no BT

each component. Again, for both mixtures, dichloromethane broke through first at a time somewhat longer than its normal breakthrough time for the laminate, with the second solvent permeating about 10 minutes later than the dichloromethane. It is suspected that the dichloromethane which readily permeates the Viton^R/Chlorobutyl laminate, carries the second solvent through. This is a similar conclusion reached in previous investigations by Forsberg and Faniadis[11] and Mickelson, Roder, Berardenelli, and Cottingham[12]. The longer breakthrough time for the dichloromethane can be rationalized on the basis of dilution within the mixture.

The third mixture demonstrated rather unusual behavior. Table 9 shows breakthrough times for a number of different mixtures of acetone and hexane. Acetone has a normal breakthrough time of 53 to 61 minutes whereas hexane does not permeate the laminate within three hours. Yet any combination of hexane and acetone results in a significantly shorter breakthrough time. In fact, breakthrough time occurs within ten minutes of initial mixture contact with the laminate in many cases. Furthermore, both acetone and hexane break through the laminate simultaneously as detected by gas chromatography. Most of these experiments were repeated several times to verify this behavior. This synergistic effect of the two chemicals cannot be explained in terms of the individual effects on the material by the two chemicals. In an attempt to rationalize this behavior, it was postulated that acetone permeated the Viton^R layer carrying with it the hexane. Then the hexane permeated through the chlorobutyl rubber layer, taking the acetone with it to be detected at the same time. This theory is consistent with the known chemical resistance of both laminate coatings discussed earlier in the paper. However, sophisticated experiments are needed in order to verify this explanation of the permeation behavior.

Intermanufacturer Material Variability

Included in Table 10 are material compatability recommendations for Viton^R/chlorobutyl laminate and chlorinated polyethylene that appear in the "Guidelines for the Selection of Chemical Protective Clothing"[13]. These recommendations are based on degradation and permeation data from vendors or laboratory test facilities; a material is recommended against a particular chemical if it shows no permeation or degradation within one hour. In comparing the recommendations against the data in Table 5, some cases exist where a material is recommended when the measured breakthrough time is less than one hour (Viton^R/Chlorobutyl - carbon disulfide, dichloromethane; Chlorinated polyethylene - acetaldehyde, acetone). While there are some discrepancies, it is important to realize that material permeation resistance differs between formulations of the same generic material. Previous studies showed significant differences in breakthrough times to the same chemicals of different neoprene and nitrile rubber formulations[14,15].

Of concern to the Coast Guard was its ability to specify materials with the same chemical resistance as measured on test samples. To make this determination, additional Viton^R/Chlorobutyl laminate samples were fabricated by a different manufacturer (Fairprene) having nearly the same specifications as the original laminate. The only difference was the pigmentation of both coatings and the substrate (cotton polyester or nylon). Permeation testing was conducted with the various laminates for a number of

TABLE 9

PERMEATION BREAKTHROUGH TIMES FOR ACETONE/HEXANE MIXTURES AGAINST VITON/CHLOROBUTYL LAMINATE

Percentage Acetone	No. Runs	Breakthrough[a] Time (min)
100	7	53-61
95	1	0-5
86	1	6-11
50	5	2-6
35	2	0-6
15	1	6-11
5	1	0-5
1	1	0-5
0 (100% Hexane)	4	nc BT (3 hrs.)

(a) Breakthrough times reported for both acetone and hexane

TABLE 10

COMPARISON OF PERMEATION TEST DATA AGAINST MATERIAL SELECTION RECOMMENDATIONS

Chemical	Viton^R/Chlorobutyl Laminate Breakthrough Time (min.)	Viton^R/Chlorobutyl Laminate GSCPC Recomm.[a]	Chlorinated Polyethylene Breakthrough Time (min.)	Chlorinated Polyethylene GSCPC Recomm.[a]
Acetaldehyde	30-40	N	10-30	R
Acetic Acid	No BT(b)	R	No BT	X
Acetone	52-77	N	20-25	R
Acetonitrile	90-105	N	80-85	X
Carbon Disulfide	11-15	R	8-10	N
Chloroform	No BT	R	30-35	N
Dichloromethane	25-36	R	15-25	N
Diethyl Amine	27-30	N		X
Diethyl Ether	1-10	N		R
Dimethyl Formamide	No BT	N		X
Dimethyl Sulfoxide	No BT	X	No BT	X
Ethyl Acetate	20-40	N	58-70	N
Ethyl Acrylate	14-32	N	65-70	N
Hexane	No BT	R	No BT	R
Methanol	No BT	R	No BT	R
Methyl Ethyl Ketone	25-40	N	28-35	N
Nitrobenzene	170-180	R	62	R
Sodium Hydroxide	No BT	R	No BT	R
Styrene	No BT	N	60-70	N
Sulfuric Acid	No BT	R	No BT	R
Tetrahydrofuran	9-11	N	27-39	N
Toluene	No BT	R	69-75	N

(a) Material/chemical compatability recommendation from "Guidelines for the Selection of Chemical Protective Clothing (Schwope, Costas, Jackson, and Weitzman, 1985), pp. 37-71. Ratings are generalized as follows:

R - recommended
N - not recommended
X - no data for recommendation

(b) "No BT" denotes no detection of breakthrough within three hour period.

***NOTE: These reported breakthrough times are for illustrative purposes only and should not be used for selecting protective clothing in hazardous chemical response.

chemicals. Table 11 reports the breakthrough times for the different Viton^R/Chlorobutyl laminates. Most results are similar, but large differences were noted for acetone, acetonitrile, carbon disulfide, and dichloromethane among the tested laminates. Even when the specifications are exactly the same (laminates B and C), significant differences still observed. However, the most evident finding from this testing is the extent of material degradation visually observed on the exposed material samples of the newly prepared Viton^R/chlorobutyl laminates. The Viton^R layer of these material samples buckled, wrinkled, or softened with delamination of the overall material. None of these changes were seen during the testing of the original material. Table 12 summarizes the these visual observations.

An investigation of this phenomena revealed that several different types of Viton^R are used in coating fabrics, and that each of these may be cured a number of ways using various additives. For example, Laminate A employed Viton^R B while the Fairprene laminates were coated with Viton^R A. Viton^R A is a copolymer of vinylidene fluoride and hexafluoropropylene, whereas Viton^R B is a terpolymer also involving tetrafluoroethylene. Each type of Viton can be cured a number of different methods with various acid acceptor systems, fillers, and processing aids. Each of these additives can affect the chemical resistance of the finished product.[16]

Summary of Findings

The Coast Guard R&D Center's research found a number of material failures which caused concern for using these materials, even though, the three materials collectively represented the most effective combination to provide broad chemical resistance.[3] Although some findings merely reiterated or reinforced previous observations, taken collectively these findings provided important considerations for evaluating the viability of the three suit system and the formulation of specific suit material-chemical recommendations. In the past, such recommendations have been made on the basis of material performance based on permeation or degradation resistance testing within a specified time period. While this practice may result in a recommendation that has a large 'safety factor', the limited results of this study show that certain effects should also be considered. Among these are:

1. The chemical resistance of a material should be directly assessed. A material's chemical resistance cannot be assumed on the results of 'similar' (generic) materials. This implies that the material specifications cannot guarantee a material with a specific chemical resitance as other similar materials.

2. Liquid chemical permeation may or may not be affected by contact time (length of exposure). An indication should be provided for determining which material/chemical combinations are affected by contact time and those that are not. In general, one cannot assume that chemical splashes present a lesser hazard than continuous contact with a chemical over the duration of exposure. Therefore, the criterion of no breakthrough for one hour seems reasonable given the the large safety factor.

TABLE 11

PERMEATION BREAKTHROUGH TIMES FOR
FOUR VITON/CHLOROBUYTL LAMINATES

Chemical	A	B	C	D
Acetic Acid	No BT	---	No BT	---
Acetone	43-53	176-186 (3)	75-121 (4)	40-45
Acetonitrile	90-105	No BT (2)	---	No BT (2)
Carbon Disulfide	11-15*	---	118-125 (2)*	---
Dichloromethane	25-36 (3)	17-29 (3)	15-23 (5)	27-30 (2)
Dimethylformamide	No BT	---	No BT (2)	---
Ethyl Acetate	20-40	---	19-27 (4)	---
Hexane	No BT	---	No BT	---
Methanol	No BT	---	No BT	---
Nitrobenzene	170-180*	---	No BT (2)	---
Tetrahydrofuran	4-11 (2)	15-27 (4)	11-27	9-14 (2)
Toluene	No BT	---	178-330 (3)	
Diethyl Ether	1-10	---	13 (2)	---

* Gas Chromatography with ECD
(#) = Number of Test Replicates

MATERIAL A - ILC Dover, Viton B on Polyester (orginal material)
MATERIAL B - Fairprene, Viton A on Polyester (first sample received)
MATERIAL C - Fairprene, Viton A on Polyester (first sample received)
MATERIAL D - Fairprene, Viton A on Nylon

TABLE 12

QUALITATIVE EFFECTS OF EXPOSURE FOR VITON/CHLOROBUTYL LAMINATES TO SOLVENTS

Observations made during standard permeation tests of Fairprene* laminates with either cotton/polyester or nylon sCrim.

SOLVENT	COTTON/POLYESTER	NYLON
Acetic Acid	Liquid penetrated Viton layer -trapped at CB interface	———
Acetone	Viton softened, buckled and bubbled. Thinned.	Some Viton flecks broken away
Acetonitrile	Viton material buckled, bubbled, softened and thinned	———
Dichloromethane	No change to Viton; CB layer softened and became sticky	No change
Dimethylformamide	Viton layer buckled, bubbled and delaminated from CB layer	———
2-Ethoxyenthanol	Liquid penetrated Viton and was trapped between layers	———
Ethyl Acetate	Liquid penetrated Viton and was trapped between layers	———
Hexane	No change	———
Tetrahydrofuran	Viton badly wrinkled, CB sticky and soft	Viton flecks broken away
Toluene	Some buckiling of Viton - minimal	———

*NOTE: None of these changes were observed with the ILC Dover Viton/Chlorobutyl samples.

3. Increasing temperature decreases (shortens) breakthrough time for both liquids and vapors. Some chemicals which do not break through at ambient temperatures, may permeate suit materials at elevated temperatures. Conversely, in cold environments, permeation is less likely.

4. Mixture behavior cannot always be prediced on the basis of individual mixture component chemicals. Moreover, mixture permeation can result in drawing other chemicals through materials that normally don't permeate those materials. It may be possible that synergistic mixture permeation may be the result of complex material laminates.

Since these findings are primarily based on the preliminary experiments for two materials, it is impossible to generalize the results to different material-chemical combinations. Nevertheless, they raised serious concerns for using the three material system. As a result, the Coast Guard decided to reexamine alternative materials before it decided to begin construction of the suits based on the two or three recommended materials.

CHAPTER 3

INVESTIGATION OF ALTERNATIVE MATERIALS

In 1984, the Coast Guard initiated a review of protective clothing materials to determine if new materials with greater chemical resistance could be identified. Ideally, the Coast Guard was seeking a single material which would provide at least the same chemical protection as the combination of Viton[R]/chlorobutyl laminate, butyl rubber, and chlorinated polyethylene. A single material offers the advantages of reducing production costs, and suit selection problems for mixtures and unknown chemicals. Moreover, increased barrier properties can result in a material where most contamination takes place on the surface making the garment easier to decontaminate and possibly reuse (Garment reuse, however, is predicated on effective field methods to measure levels of suit contamination before and after decontamination).

The Coast Guard solicited information from material suppliers to evaluate alternative materials. Evaluation criteria for comparing alternative materials[17] were divided into three areas:

(1) Chemical resistance,
(2) Physical properties, and
(3) Fabrication feasibility.

Chemical resistance performance was evaluated using the ASTM standard method for measuring permeation resistance (F739) against a representative battery of test chemicals given in Table 2. A three hour period was specified to assess the compatability of test chemicals. Permeation breakthrough times were used to judge material performance. Physical property behavior was screened based on test methods and minimum performance levels established by Coast Guard Engineering (Table 13). The performance levels were derived from physical property testing on existing chemical protective clothing materials which had demonstrated adequate material integrity and durability in actual field usage. Lastly, the material supplier had to demonstrate their ability to fabricate strong, liquid-proof seams with the garment, visor, and closure tape materials. Testing in this area included measuring seam penetration resistance (ASTM F903-85[18]) for selected chemicals (water, Methyl Ethyl Ketone, Hydrochloric Acid, Toluene, and Hexane) and seam tensile strength.

The Coast Guard evaluated each of the submitted material data packages using the above criteria. Due to proprietary nature of the proposals, only the selected material is described in this report. Chemical Fabrics Corporation introduced three different Challenge[TM] materals. Each of these materials were proprietary, aramid-reinforced fluoroelastoplastic composites (more commonly known as Teflon[R] laminated Nomex[R]). All three materials had the same type of Teflon[R] coating but involved a different Nomex[R] fabric substrate. Challenge[TM] LU has a non-woven subtrate, whereas both Challenge[TM] EW and XHS employed woven substrates of different weights (4.5 and 6.0 ounces/yard^2, respectively). The principal performance differences were found in the physical properties of these materials; only Challenge[TM] EW and XHS met the Coast Guard requirements for material tensile, tearing, and bursting strengths (Table 14). Challenge[TM] EW was selected over

TABLE 13

U. S. COAST GUARD SPECIFICATIONS
FOR ALTERNATIVE PROTECTIVE CLOTHING MATERIALS

A. Chemical Resistance: Measure and report permeation breakthrough time of the material using ASTM F739-85, "Standard Test Method for Resistancxe of Protective Clothing Materials to Permeation by Liquids and Gases" for the ASTM F1001-86 Chemicals listed in Table 2; Continue each test for three hours or until steady-state permeation is achieved.

B. Physical Properties: The material shall meet the following physical property requirements:

Property	Test Method	CG Requirement(type)
Weight (oz/yd^2)	ASTM D751-79	25 (max)
Thickness (mil)	ASTM D751-79	20 (max)
Tensile Strength (lbs/in.)	ASTM D751-79	80 Warp (min) 80 Fill (min)
Tear Strength (lbs)	ASTM D751-79	9 Warp (min) 10 Fill (min)
Busting Strength (psi)	ASTM D751-79	200 (min)
Abrasion Strength	FED STD 191A-5302	No loose fibers
Low Temp. Bending at -20°F	ASTM D2136-66	Pass
Flammibility	ASTM D568-68	Self-extinguishing

C. Fabrication Potential: Demonstrate ability to fabricate seams of garment material to garment material, garment to visor (5-10 mil Teflon[R] FEP), garment to closure tape (neoprene). Measure garment material seam strength using ASTM D751-79, "Standard Test Methods for Rubber Coated Fabrics" (CG Requirement-50lbs.) and seam integrity using ASTM F903-85, "Standard Test Method for Resistance of Protectiva Clothing Materials to Penetration of Liquids (CG Requirement - Pass @ 2 psi for water, hexane, toluene, methyl ethyl hetone, and hydrochloric acid)

TABLE 14

PHYSICAL PROPERTY CHARACTERIZATION OF CHALLENGE™ MATERIALS

PROPERTY	TEST METHOD	CHALLENGE LU	CHALLENGE EW	CHALLENGE XHS	REQUIREMENT
Weight (oz/yd)	ASTM D751-79	10.2	11.1	16.9	25 (max.)
Thickness (mil)	ASTM D751-79	15.2	14.1	18.4	20 (max.)
Tensile Strength (lbs./in.)	ASTM D751-79	46.0 (W) 29.8 (F)	113.7 (W) 95.8 (F)	218.5 (W) 184.5 (F)	80 (W) 80 (F)
Tear Strength (lb.)	ASTM D751-79	12.4 (W) 6.4 (F)	21.0 (W) 19.6 (F)	18.0 (W) 17.3 (F)	9 (W) 10 (F)
Bursting Strength (psi)	ASTM D751-79	172.5	273.0	443.3	200
Abrasion Resistance	FED. STD. 191A-5302	No loose fibers	No loose fibers	No loose fibers	No loose fibers
Low Temperature Bend (-25°F)	ASTM D2136-66	Pass	Pass	Pass	Pass
Flammability	ASTM D568-68	Non-Burning	Non-Burning	Non-Burning	
Relative Cost Index		1.0	2.5	4.0	—

Challenge™ XHS since its unit material cost was lower by a factor of 2 and still met Coast Guard physical property requirements. Challenge™ LU and EW eventually became known as Challenge™ 5000 and 5100, respectively.

Challenge™ 5100 exhibits a high level of chemical resistance and possessed equal or better physical properties relative to the Coast Guard's originally selected materials. Tables 15 and 16 show a comparison of this material's physical properties and permeation results with prior selected materials. Seam performance data provided by Chemical Fabrics Corporation showed garment material seams to have a tensile breaking strength of 95.5 lbs. (using ASTM D751-79) and as passing the ASTM Penetration Test. On the basis of this data, the Coast Guard elected to forego production of suits based on Viton®/chlorobutyl laminate, butyl rubber, and chlorinated polyethylene, and instead redirected its suit development effort for fabricating suits using the new Challange™ 5100 material.

The Coast Guard also adopted a Teflon® FEP visor which facilitated suit fabrication while eliminating lamination difficulties inherent to the FEP/Surlyn composite. Additionally, different Teflon® glove material were chosen and evaluated for use in the Coast Guard Chemical Response Suit. The Coast Guard opted for Teflon components in the suit design where possible to provide a suit with improved uniformity in chemical resistance throughout the garment. The only two major non-Teflon components are the suit closure (a neoprene-brass pressure sealing zipper) and exhaust valves (nylon and silicone rubber).

TABLE 15

PHYSICAL PROPERTY REQUIREMENTS AND DATA FOR CANDIDATE GARMENT MATERIALS

			Materials[a]			
Property (Units)	Test Method	Coast Guard Requirement	Chlorinated Polyethylene	Butyl Rubber	Viton®/ Chlorobutyl	Challenge™ 5100
Weight (oz/yd^2)	ASTM D751	25 (max.)	19.3	13.6	15.3	11.4
Thickness (mil)	ASTM D751	20 (max.)	20	14.2	19.0	18.1
Tensile Strength (lb/in) w - warp; f - fill	FED. STD. 191A,5102	80 w (min.) 80 f (min.)	87 (w) 99 (f)	135 (w) 86 (f)	254 (w) 256 (f)	114 (w) 96 (f)
Tear Strength (lb/in)	FED. STD. 191A,5134	9 w (min.) 10 w (min.)	13 (w) 17 (f)	9.5 (w) 15.5 (f)	9.7 (w) 11.0 (f)	9.6 (w) 10.0 (f)
Hydrostatic Resistance (psi)	FED. STD. 191A,5512	200 (min.)	200	325	385	315
Abrasion (gms lost) H-18 Wheel, 600 cycles	FED. STD. 191A,5306	0.30 (max.)	.39	.31	(b)	.05
Stiffness - Warp (cm)	FED. STD. 191A,5200	5.0 (max.)	No data	No data	No data	4.5
Flammability	ASTM D568[c]					
Ignition Time (sec.)		see note c	2.4	0.8	0.8	Does not ignite
Burn Time (sec)			87	22	47	n/a
Burn Distance (cm)			6.7	8.0	7.5	n/a
Low Temperature Bending Moment (N-m)	FED. STD. 191A,5202	0.025 (max.) @ 0°F (60° def.)	0.037	0.008	No data	0.019

[a]All materials have fabric supports; data for first three materials from ref. (3).

[b]Exposed fibers of the base material appeared after 600 cycles

[c]A modified form of ASTM D568 is used to measure flammability; Exposure conditions of FED STD 191A, Method 5903 are used with measurement of ignition time, burn time, and distance burn. The Coast Guard is in the process of establishing a quantitative requirements for these parameters. The current requirement specifies that material is self-extinguishing.

TABLE 16

COMPARISON OF PERMEATION RESULTS FOR CHLORINATED POLYETHYLENE, VITON/CHLOROBUTYL LAMINATE, AND CHALLENGE 5100

Chemical	Breakthrough Time (minutes)[a] Chlorinated Polyethylene	Viton®/Clorobutyl Laminate	Challenge™ 5100
Acetic Acid	No BT[b]	No BT	No BT
Acetone*	20-25	43-53	No BT
Acetonitrile*	80-85	90-105	No BT
Benzene	71-75	No BT	No BT
Carbon Disulfide*	8-10	11-15	13-23
Dichloromethane*	15-25	25-36	35-45
Diethyl Amine*		27-33	No BT
Diethyl Ether		1-10	No BT
1,2-Dichloroethane	15-25	No BT	No BT
Dimethyl Formamide*		No BT	No BT
Dimethyl Sulfoxide	No BT	No BT	No BT
Ethyl Acetate*	60-70	20-40	No BT
Ethyl Acrylate	14-32	34-45	No BT
Freon TF	No BT	No BT	No BT
Hexane*	No BT	No BT	No BT
Methanol*	No BT	No BT	No BT
Methyl Ethyl Ketone	28-35	25-40	No BT
Nitric Acid (conc.)	No BT	No BT	No BT
Nitrobenzene*	60-70	170-180	No BT
Sodium Hydroxide (50%)*	No BT	No BT	No BT
Styrene	60-70	No BT	No BT
Sulfuric Acid (conc.)*	No BT	No BT	No BT
Tetrachloroethane	60-70	No BT	No BT
Tetrachloroethylene*			No BT
Tetrahydrofuran*	27-39	9-11	No BT
Trichloroethylene	10-15	25-30	108-143
Toluene*	69-75	No BT	No BT

(a) Breakthrough times determined using ASTM F739-81. Blanks indicate the absence of data; breakthrough times are presented as ranges due to the imprecision in determining actual breakthrough time; breakthrough time is heavily dependent of the analytical sensitivity of the detector used.
(b) No BT denotes no breakthrough detected for a three hour period.
* ASTM F1001 Chemicals.

CHAPTER 4

SELECTION AND TESTING OF SUIT COMPONENTS

With the selection of Challenge™ 5100, the Coast Guard was able to achieve a "one-suit system" for encapsulating chemical response. Choosing other materials with similar chemical resistance was paramount to providing uniform chemical resistance for the entire garment. To this end, the Coast Guard adopted a Teflon® FEP visor which facilitated suit fabrication while eliminating lamination difficulties inherent to the FEP/Surlyn composite tested earlier.[3] Additionally, different Teflon® glove materials were chosen and evaluated for use in the Coast Guard Chemical Response Suit. Unfortunately, some critical parts of the suit were not available in Teflon® type materials. These include both the suit closure (a neoprene-brass pressure sealing zipper) and exhaust valves (nylon and silicone rubber). However, Coast Guard Engineering was able to design suit features which protect these components from chemical exposure. Suit design and overall suit testing are discussed in the Chapter 5.

Testing Strategy

The selection of the Challenge™ 5100 and Teflon® materials was based on limited data against a small number of representative chemicals. In order to support the development of a Challenge™ suit, and its use in the field, the Coast Guard initiated an extensive testing program that would document the performance of the overall suit, its materials and components.[19] This testing program encompasses an examination of all primary suit materials (garment, visor, and glove), critical suit seams, and suit components (closure and exhaust valves). The final goals of this test program are:

(1) to integrate test data for assessing overall suit performance, and

(2) to establish suit use recommendations against priority chemicals.

Material performance was further characterized in terms of chemical resistance to a larger set of chemicals under various conditions, and in terms of additional physical property or functional testing. In general, each material and component should be tested in the same fashion and against the same chemicals. Practically, this is difficult due to the enormous size of the test matrix. Therefore, the Coast Guard adopted the philosophy of first testing the garment material against a large set of priority chemicals and then testing other primary materials and seams against a smaller subset of the priority chemicals. In this manner, material performance can be compared and judgements can be made on how to extend the testing of suit materials to more chemicals. Table 17 provides this matrix of suit materials/ components, types of testing, and chemical batteries covered in this report. Eventually predictive models will be necessary to overcome large testing demands and the problems of making suit use recommendations for mixture exposure.

TABLE 17

SUIT MATERIAL/COMPONENT TEST MATRIX

Material/Component	Type of Test	Test Chemical/ or Properties
Garment Material	Permeation[a]	115 Priority Liquids 25 Priority Gases* Variable effects on Selected Chemicals (temp., contact time, pressure, mixtures)**
	Strength	Tensile, Tear, Bursting
	Resistance	Abrasion*, Cut*, Puncture*
	Other Phys. Prop.	Stiffness, Flammability Low Temp. Performance
Creased Garment Mat'l	Permeation	ASTM F1001 Chemicals
Visor Material	Permeation	ASTM F1001 Chemicals plus chemicals permeating garment material
	Strength	Tear, Stiffness, Bursting*
	Resistance	Abrasion/Clarity
	Other Phys. Prop.	Light Transmission, Flammability* Low Temp. Performance*
Creased Visor Mat'l	Permeation	ASTM F1001 Chemicals
Inner Glove Material	Permeation	ASTM F1001 Chemicals
	Strength	Tear, Bursting*
	Resistance	Abrasion
	Other Phys. Prop.	Stiffness, Flammability Low Temp. Performance
Outer Glove Material	Degradation[b]	ASTM F1001 Chemicals
Critical Suit Seams	Penetration[c]	Water, MEK, HCl, Hexane, Toluene
	Permeation	ASTM F1001 Chemicals
	Strength	Tensile, Dead Load
Suit Closure (Zipper)	Penetration	Water, MEK, HCl, Hexane, Toluene
	Degradation	ASTM F1001 Chemicals*
	Strength	Tensile, Bursting*

* Test will performed in future study
** Tests will conducted in study beginning August 1987
(a) Permeation Resistance measured using ASTM F739 over three hour period
(b) Degradation Resistance measured using draft ASTM F23.30.03 method
(c) Penetration Resistance measured using ASTM F903

Garment Material Evaluation

General Chemical Resistance Testing. The garment material comprises more than 75% of the total exposed surface area for the Coast Guard Chemical Response Suit. The Coast Guard Research and Development Center and its contractor, Texas Research Institute (Contract No. DTCG39-86-A-80331), tested the Challenge™ composite against 111 priority liquid CHRIS chemicals using ASTM F739 for measuring permeation resistance (6 priority chemicals were not tested due to their availability or destructiveness on the test apparatus; data for Methyl Isocyanate was provided by NIOSH[18]). The chemicals tested were the same chemicals described in Chapter 2 with their selection based on encapsulation requirement, spill frequency, and toxicity. The contractor established a unique method involving a continuous photoionization detector to measure material permeation parameters and minimum detection limits for each of the chemicals. Initially, each test against a respective chemical was run using three permeation cells operated in parallel, such that the output from each permeation cell went to the detector simultaneously. If any permeation breakthrough was detected, the tests were repeated with three individual test cells run singly. This arrangement was devised to minimize the time in conducting permeation tests with the expectation that few chemicals would permeate Challenge™ 5100. Their apparatus and methods are described in Appendix B.

In general, most tests were conducted for a minimum of three hours. However, several tests were extended beyond the three hour test period when permeation of the material was expected for a particular chemical. This testing identified ten chemicals that permeate the garment material within a three hour period; of these, three chemicals exhibit breakthrough in one hour (see Table 18). Data for all chemicals tested are listed in Table 19. This data include the breakthrough time and steady state permeation rate, if any, along with the specific minimum detection limit (MDL), detector used, and source of the test data. Complete test data and output is provided in Appendix C. The material is also being tested against priority chemical gases listed in Table 20, and eventually will be evaluated against the other CHRIS chemicals requiring encapsulation or having high toxicity.

Investigation of Chemical Resistance Variables. Chemical resistance testing of the garment material also involves investigation of parameters expected to affect material performance. These parameters include contact time, internal suit pressure, temperature, and chemical mixture exposure. This testing takes advantage of earlier work performed by the Coast Guard R&D Center on Viton/chlorobutyl laminate and chlorinated polyethylene reported in Chapter 2.[10,20] Dichloromethane permeation of Challenge™ 5100 at various temperatures is shown in Figure 5 and demonstrates the expected relationship between breakthrough time and temperature—a decrease in breakthrough time at elevated temperatures. Although a theoretical, predictive model for the permeation behavior of Challenge products has not been developed, an apparent inverse, linear relationship between temperature and log(breakthrough) for the limited data is observed. Additional permeation testing at elevated temperatures is planned, particularly for those chemicals which may permeate at high temperatures but not at room temperatures. Splash testing with dichloromethane using the same methods developed by the R&D Center yielded essentially the same breakthrough time as obtained when liquid remains in constant contact with the surface of Challenge™ 5100. This anamolous

TABLE 18

CHEMICALS WHICH PERMEATE CHALLENGE™ 5100[a]

A. Chemicals which permeate within one hour

Chemical Name	CHRIS Code	Breakthrough Time (min)	Permeation Rate (ug/cm²hr)
Carbon Disulfide	CBB	18	3.65
Acrolein	ARL	38	2.82
Methyl Isocyanate	—	28	ND[b]
Acrylonitrile	ACN	45	5.12
Dichloromethane	DCM	47	1.37

B. Chemicals which permeate between one and three hours

Chemical Name	CHRIS Code	Breakthrough Time (min)	Permeation Rate (ug/cm²hr)
Vinyl Acetate	VAM	74	3.30
Allyl Chloride	ALC	102	0.67
Tetrachloroethylene	TTE	108	ND
Propylene Oxide	POX	137	1.43
Trichloroethylene	TCL	143	2.04

(a) Information summarized from Table 19
(b) Not determined

Table 19

Permeation Testing Results for Challenge 5100 (Teflon-Coated Nomex)

All Tests Conducted at 23° —25°C

Chemical	CHRIS Code[1]	BT[2]	Perm Rate[3]	Det Met'd[4]	MDL (ppm)[5]	Source[6]
Acetaldehyde	AAD	>3 hr		PID	ND	TRI
Acetic Acid	AAC	>4 hr		FID	35.46	R&DC
Acetic Anhydride	ACA	>3 hr		PID	0.57	TRI
Acetone	ACI	>3.5 hr		FID	1.16	R&DC
Acetone Cyanohydrin	ACY	N/A		PID	2.74	TRI
Acetonitrile	ATN	>4.5 hr		FID	ND	R&DC
Acetophenone	ACP	>92 hr		FID	ND	R&DC
Acetyl Chloride	ACE	>3.1 hr		PID	35.46	TRI
Acrolein	**ARL**	**38 min**	**2.82**	**PID**	**0.06**	**TRI**
Acrylic Acid	ACR	>3 hr		PID	0.86	TRI
Acrylonitrile	**ACN**	**45 min**	**to 5.12**	**PID**	**0.46**	**TRI**
Adiponitrile	ADN	>3.1 hr		PID	0.3	TRI
Allyl Alcohol	ALA	>14 hr		PID	1.13	TRI
Allyl Chloride	**ALC**	**102 min**	**0.67**	**PID**	**0.16**	**TRI**
Aniline	ANL	>3.3 hr		PID	0.46	TRI
Benzene	BNZ	>3.2 hr		PID	0.05	TRI
Benzyl Chloride	BCL	>3.2 hr		PID	0.11	TRI
Bromine	BRX	>3.3 hr		PID	0.53	TRI
n-Butyl Acetate	BCN	>3 hr		PID	0.25	TRI
n-Butyl Acrylate	BTC	>3 hr		PID	0.22	TRI
n-Butylamine	BAM	>3 hr		PID	0.32	TRI
n-Butyl Alcohol	BAN	>15.6 hr		PID	0.32	TRI
Butyraldehyde	BTR	>7.5 hr		PID	0.29	TRI
Carbon Disulfide	**CBB**	**17.7 mm**	**3.65**	**PID**	**0.05**	**TRI**
Carbon Tetrachloride	CBT	>3.0 hr		PID	0.29	TRI
Chlordane (85%)	CDN	>3.4 hr		PID	0.26	TRI
Chlorobenzene	CRB	>3 hr		PID	0.20	TRI
Chloroform	CRF	>3.6 hr		PID	0.19	TRI
Chloropicrin	CPL	>3.1 hr		PID	1.80	TRI
Chlorosulfonic Acid	CSA	>3.0 hr		Ion Chr	0.50	TRI
Creosote	CCT	>18.1 hr		PID	0.32	TRI
m-Cresol	CRL	>4 hr		PID	0.03	TRI
Crotonaldehyde	CTA	>3.1 hr		PID	0.62	TRI
Cumene Hydroperoxide	CMH	>3.5 hr		PID	1.20	TRI
Cyclohexane	CHX	>3.4 hr		PID	0.25	TRI
1,2-Dibromoethane	EDB	>3.4 hr		PID	0.10	TRI
1,2-Dichloroethane	EDC	>5.7 hr		PID	0.09	TRI
1,2-Dichloroethyl Ether	DEE	>3 hr		PID	ND	TRI
Dichloromethane	**DCM**	**46.8 min**	**1.37**	**PID**	**0.27**	**TRI**
		37 min		ECD	0.03	R&DC
1,2-Dichloropropane	DPP	>3.1 hr		PID	0.31	TRI
1,3-Dichloropropene	DPR	>3 hr		PID	0.17	TRI
Diethanolamine	DEA	>3 hr		PID	ND	TRI
Diethylamine	DEN	>4.5 hr		FID	ND	R&DC

Notes:
1. The CHRIS Code comes from the Coast Guard CHRIS list.
2. BT — Breakthrough Time (>XHr = time test run; nMin = BT in min for those compounds that did break through.)
3. The permeation rate units are micrograms/square centimeter/hour.
4. DET MET'D — Detector used for determination of BT.
5. MDL — Minimum Detection Limit of the detector.
6. SRC — Source of Data: TRI - Texas Research Institute; R&DC - Coast Guard results.

Table 19
Permeation Testing Results for Challenge 5100 (continued)

Chemical	CHRIS[1] Code	BT[2]	Perm[3] Rate	Det[4] Met'd	MDL[5] (ppm)	Source[6]
Dimethyl Sulfate	DSF	N/A		PID	1.52	TRI
Diisopropylamine	DIA	>11.2 hr		PID	0.39	TRI
Dimethylformamide	DMF	>3.2 hr		FID	ND	R&DC
1,4-Dioxane	DOX	>3 hr		PID	0.38	TRI
Di-n-Propylamine	DNA	>3.4 hr		PID	0.22	TRI
Epichlorohydrin	EPC	>3 hr		PID	0.75	TRI
Ethion 4	ETO	>4.8 hr		PID	0.03	TRI
Ethyl Acetate	ETA	>4.3 hr		FID	0.49	R&DC
Ethyl Acrylate	EAC	>17 hr		PID	1.72	TRI
Ethyl Alcohol	EAL	>3 hr		PID	2.86	TRI
Ethylamine (70%)	EAM	>3 hr		PID	0.74	TRI
Ethyl Benzene	ETB	>3 hr		PID	0.14	TRI
Ethylenediamine	EDA	>3.2 hr		PID	2.78	TRI
Ethlyene Glycol	EGL	>16.8 hr		PID	2.63	TRI
Ethyl Ether	EET	>3 hr		PID	0.13	TRI
Formaldehyde (37%)	FMS	>3 hr		PID	ND	TRI
Furfural	FFA	>1 hr		PID	0.08	TRI
Gasoline	GAT	>14.9 hr		PID	1.65	TRI
Glutaraldehyde (sol'n)	GTA	N/A		PID	0.43	TRI
Hexane	HXA	>5 hr		PID	0.25	TRI
Hydrazine Hydrate	HDZ	N/A		PID	0.90	TRI
Isopropyl Alcohol	IPA	>3 hr		PID	1.16	TRI
Isopropylamine	IPP	>3 hr		PID	1.57	TRI
Malathion (50%)	MLT	>3.1 hr		PID	1.03	TRI
Methyl Acrylate	MAM	>3 hr		PID	0.12	TRI
Methyl Alcohol	MAL	>14.2 hr		PID	4.07	TRI
Methyl Ethyl Ketone	MEK	>3 hr		PID	0.65	TRI
Methyl Isobutyl Ketone	MIK	>3 hr		PID	3.98	TRI
Methyl Methacrylate	MMM	>3.1 hr		PID	0.19	TRI
Methyl Parathion	MPT	N/A		PID	0.15	TRI
Naled	NLD	>3.4 hr		PID	N/A	TRI
Naphthalene	MLT	>13.2 hr		PID	ND	TRI
Nitric Acid	NAC	N/A		Ion Chr	0.20	TRI
Nitrobenzene	NTB	>3 hr		PID	0.08	TRI
2-Nitropropane	NPP	>3 hr		PID	0.59	TRI
Oleum	OLM	>3.0 hr		Ion Chr	0.20	TRI
Parathion	PTO	>3.0 hr		PID	0.09	TRI
Petroleum Ether		>3.4 hr		PID	4.55	TRI
Phenol	PHN	>3 hr		PID	0.03	TRI
Phosphoric Acid	PAC	N/A		Ion Chr	0.50	TRI
Phosphorous Oxychloride	PPO	>3 hr		Ion Chr	0.50	TRI
Phosphorous Trichloride	PPT	>3 hr		Ion Chr	0.50	TRI
Propionic Acid	PNA	>3 hr		PID	0.31	TRI
n-Propyl Alcohol	PAL	>3 hr		PID	0.76	TRI
n-Propylamine	PRA	>10.2hr		PID	0.74	TRI
Propylene Oxide	POX	137 min	1.43	PID	0.88	TRI
Silicon Tetrachloride	STC	>3.0 hr		Ion Chr	0.50	TRI
Sodium Hydrosulfide	SHR	N/A		AA	0.50	TRI

Notes:
1. The CHRIS Code comes from the Coast Guard CHRIS list.
2. BT — Breakthrough Time (>XHr = time test run; nMin = BT in min for those compounds that did break through.)
3. The permeation rate units are micrograms/square centimeter/hour.
4. DET MET'D — Detector used for determination of BT.
5. MDL — Minimum Detection Limit of the detector.
6. SRC — Source of Data: TRI - Texas Research Institute; R&DC - Coast Guard results.

Table 19

Permeation Testing Results for Challenge 5100 (continued)

Chemical	CHRIS Code[1]	BT[2]	Perm Rate[3]	Det Met'd[4]	MDL[5] (ppm)	Source[6]
Sodium Hydroxide (50% aqueous)	CSS	>71 hr		SE	ND	R&DC
Sodium Hydroxide (50% aqueous)	CSS	>3.0 hr		Ion Chr	0.50	TRI
Styrene	STR	>4 hr		PID	0.05	TRI
Sulfur Monochloride	SFM	N/A		Ion Chr	0.50	TRI
Sulfuric Acid (conc.)	SFA	>72 hr		Sulfate	ND	TRI
1,1,2,2,-Tetrachloro-ethane	TEO	>15.2 hr		PID	0.23	TRI
Tetrachloroethylene	TTE	108 min		ECD	ND	R&DC
Tetrahydrofuran	THF	>5.5 hr		FID	ND	R&DC
1,1,1-Trichloroethane	TCE	>3 hr		PID	0.60	TRI
Trichloroethylene	TCL	143 min	2.04	PID	0.07	TRI
Toluene	TOL	>3 hr		PID	0.06	TRI
		>18.5 hr		FID	0.69	TRI
o-Toluidine	TLI	>3.3 hr		PID	0.43	R&DC
Toluene 2,4-Diisocyanate	TDI	>3.3 hr		PID	0.69	TRI
Turpentine	TPT	>3.6 hr		PID	0.03	TRI
Vinyl Acetate	VAM	74 min	3.30	PID	0.21	TRI
Vinylidene Chloride	VCI	>3.0 hr		PID	0.49	TRI
Xylenes	XLM	>3 hr		PID	0.13	TRI
Xylenol	XYL	>3.3 hr		PID	ND	TRI

Notes:
1. The CHRIS Code comes from the Coast Guard CHRIS list.
2. BT — Breakthrough Time (>XHr = time test run; nMin = BT in min for those compounds that did break through.)
3. The permeation rate units [illegible] programs/square centimeter/hour.
4. DET METD — [illegible] determination of BT.
5. MDL — [illegible] Detection Limit of the detector.
6. SRC — Source of Data: TRI - Texas Research Institute; R&DC - Coast Guard results.

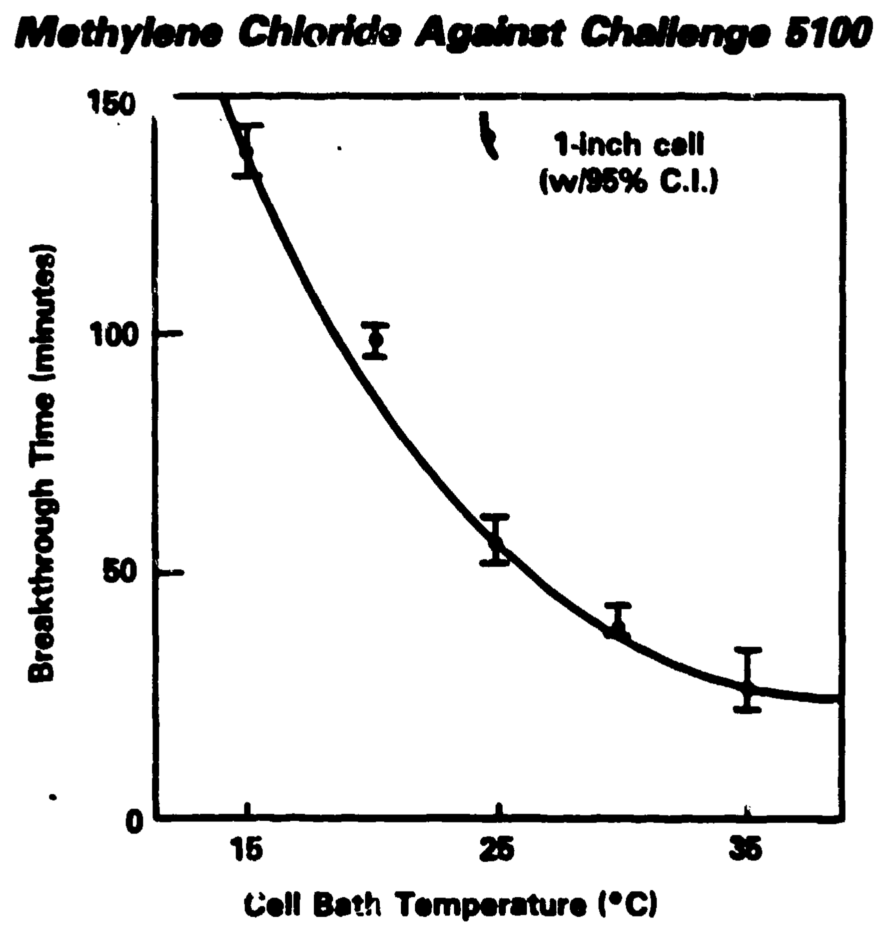
This page left intentionally blank

TABLE 20

LIST OF PRIORITY GASEOUS CHEMICALS

CHEMICAL NAME	CHRIS CODE	ENCAPSULATION NEED?	PIRS # SPILLS	HAZARD INDEX	NFPA INDEX	PRIORITY[e] CLASS
Ammonia	AMA	Yes	85	2	3	IA
Bromine Pentafluoride	BPF	Yes	0	—	4	IIA
1,3-Butadiene	BDI	No	0	1	2	IIA
Butane	BUT	No	0	3	1	IVC
Chlorine	CLX	Yes	35	2	3	IA
Chlorine Trifluoride	CTF	Yes	0	—	—	IIC
Cyanogen	CYG	Yes	0	—	4	IIA
Dimethylamine	DMA	No	0	2	3	IIA
Ethylene Oxide	EOX	Yes	0	1	2	IIA
Fluorine	FXX	Yes	0	—	4	IIA
Hydrogen Bromide	HBR	Yes	0	—	3	IIC
Hydrogen Chloride	HDC	Yes	0	2	3	IIA
Hydrogen Sulfide	HDS	Yes	0	6	3	IIB
Methyl Amine	MTA	Yes	0	—	3	IIB
Methyl Bromide	MTB	Yes	0	2S	3	IIA
Methyl Chloride	MTC	No	15	2	2	IA
Nitric Oxide	NTX	Yes	0	6	—	IIC
Nitrosyl Chloride	NTC	Yes	0	—	—	IIC
Phosgene	PHG	Yes	0	—	4	IIA
Sulfur Dioxide	SFD	Yes	0	2	2	IIA
Trimethylamine	TMA	Yes	0	—	2	IIC
Vinyl Chloride	VCM	Yes	0	1	2	IIA

(a) Need for encapsulating protection determined in reference (2).
(b) Number of spills reported in Coast Guard Pollution Incident Response System (1973-1983).
(c) Hazard Index is based on Chemical Toxicity Ratings reported in reference (5). 1 is most toxic (carcinogen); 6 is least toxic; S - skin absorption hazard.
(d) NFPA Health Hazard Rating (from reference 6)
(e) See Appendix A for chemical classification information



Temperature Effect on Permeation Breakthrough Time
of Challenge(TM) 5100 by Dichloromethane

Figure 5

result is not fully understood and may be a manifestation of the test procedure. Mixture testing will also be conducted to determine if synergistic permeation occurs as observed for acetone/hexane against Viton[R]/chlorobutyl laminate.

Physical Property Testing. An original concern that the Teflon laminate may 'microfracture' with use[21] was investigated by a battery of physical property and chemical resistance testing. As a practice, most permeation testing is conducted with pristine material samples. Chemical Fabrics Corporation devised a standard means for creasing samples as a preconditioning technique to determine if the chemical resistance of the material changes with physical abuse (described in Appendix D). This test has been applied against the thirteen organic chemicals in the ASTM F1001 list of standard chemicals. Results for this testing are given in Table 21 comparing both 'uncreased' and 'creased' material chemical resistance. These tests show only small changes in the permeation breakthrough times for both carbon disulfide and dichloromethane which permeate Challenge[TM] 5100, and no 'new' chemicals which break through the material as the result of creasing. Test data and output are included in Appendix E. Other physical property tests are being performed in separate studies to determine how well Challenge[TM] 5100 retains its characteristics following temperature changes and exposure to flame and abrasive surfaces.

Visor Material Optimization and Evaluation.

Problems with the Original Teflon Laminate. Originally, the Coast Guard selected a Teflon[R] laminate (1 mil FEP/ 20 mil Surlyn) for a visor material in its chemical protective suits.[3] This material possessed excellent chemical resistance but was difficult to laminate and did not stay together well after use. The Coast Guard therefore decided to examine alternative visor materials and select a material without sacrificing the chemical resistance of the Teflon[R] laminate. A requirement of using a single film (non-laminate) was tentatively set to avoid lamination problems encountered in the earlier material. Any delamination of a visor was considered unacceptable since the area between film could allow entrapment of moisture which would then cause significant loss of visor clarity through condensation and fogging.

Primary Visor Material Performance Variables. Critical performance requirements for visor materials in the Chemical Response Suit included:

(1) high visible light transmittance and visual clarity,
(2) chemical permeation resistance, and
(3) physical integrity and damage tolerance.

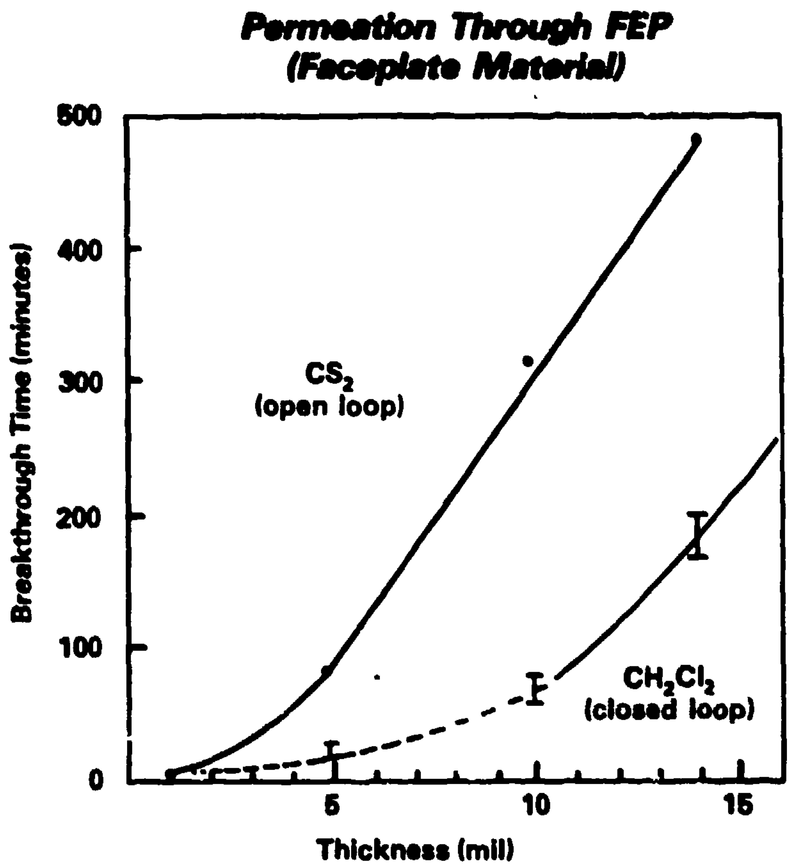
For screening purposes, light transmittance from wavelengths of 390 to 876 nm was measured with a visible light spectrophotometer using ASTM E424, "Test Methods for Solar Energy Transmittance and Reflectance of Sheet Materials." Chemical permeation resistance was performed with selected aggressive chemicals (carbon disulfide and dichloromethane) from the ASTM F1001 battery (Figure 6). Physical integrity and damage tolerance were evaluated in terms of tear strength (FED STD 191A-5136 - trapezoid method) and stiffness (ASTM D1388 - cantilever method). Stiffness was considered the more critical of the two physical properties since it is related to the ease of film creasing which

TABLE 21

COMPARISON OF PERMEATION BREAKTHROUGH TIMES
FOR INCREASED AND CREASED CHALLENGE 5100 SAMPLES[a]

	Uncreased Challenge 5100			Creased Challenge 5100		
Chemical Name	Breakthrough Time (min)	Perm. Rate (ug/cm^{2}hr)	MDL (ppm)	Breakthrough Time (min)	Perm. Rate (ug/cm^{2}hr)	MDL (ppm)
Acetone	No BT[6]	NA	1.16	No BT	NA	0.09
Acetonitrile	No BT	NA	0.60	No BT	NA	0.60
Carbon Disulfide	18–22	2.6–3.7	0.07	11–15	10.0–13.3	0.06
Dichloromethane	47–55	1.0–1.4	0.19	53–58	3.1–3.8	0.75
Diethylamine	No BT	NA	0.15	No BT	NA	0.15
Dimethylformamide	No BT	NA	0.40	No BT	NA	0.40
Ethyl Acetate	No BT	NA	0.49	No BT	NA	0.20
Hexane	No BT	NA	0.25	No BT	NA	0.11
Methanol	No BT	NA	4.07	No BT	NA	0.10
Nitrobenzene	No BT	NA	0.08	No BT	NA	0.06
Tetrachloroethylene	108	ND[c]	ND	No BT	NA	0.07
Tetrahydrofuran	No BT	NA	0.09	No BT	NA	0.09
Toluene	No BT	NA	0.06	No BT	NA	0.02

(a) All test conducted using Gas Chromatograph with photoionization detector
(b) No breakthrough detected in three hours
(c) Not determined



The Effect of Thickness on Visor Material Permeation Breakthrough Time for Carbon Disulfide and Dichloromethane

Figure 5

dramatically reduces visual clarity.

Optimization of Visor Thickness. Of the commercially available Teflon[R] films, fluorinated ethylene-propylene (FEP) possesses the highest visible light transmittance per unit thickness and was thus selected as the visor material. The above screening tests were employed to determine the optimum visor film thickness. Data on commercially available 5, 10, 14, and 20-mil FEP film are presented in Table 22. The data reveal that as film thickness increases, the chemical permeation and physical properties improve at the expense of light transmittance (Figure 7). Ten-mil FEP was selected since it provides adequate clarity and resistance to creasing while offering permeation resistance and tear strength consistent with the garment material (Table 15). Additional physical properties of the FEP visor material are offered in Table 23.

Chemical Resistance Testing. Permeation resistance of the 10 mil FEP Visor material was measured against the chemicals in the ASTM F1001 battery as well as other specific chemicals which have permeated Challenge™ 5100. As explained previously, the strategy of this testing was to determine the chemical resistance of the visor material relative to the garment material (Challenge™ 5100). If the chemical resistance was the same or better than the garment material, the Coast Guard could assume that the visor provides as least equivalent protection as the garment and forego the extensive testing done on the garment material. If the latter was not the case, then further testing would be required to determine where differences in chemical resistance occured by essentially testing the same chemicals. Fortunately, in each case the chemical resistance of the visor is better than the garment material as seen in Table 24. Table 25 shows the effects of creasing on the material's chemical resistance for the ASTM F1001 chemicals. Only a slight reduction in permeation resistance was noted with no 'new' chemicals permeating the creased visor material. Complete permeation data and output for visor material testing are presented in Appendix F.

Glove Material Selection and Evaluation.

Original Material Selection. The first Coast Guard Chemical Response Suits were designed with Teflon (TFE) inner gloves and outer gloves of either butyl rubber or Viton. The inner glove consisted of two simple hand silhouettes with a peripheral heat-sealed seam. The outer elastomer glove provided the shape to the composite glove, which dramatically improved dexterity, though the overall glove form was relatively less comfortable than typical elastomeric gloves. A testing scheme similar to that used for the visor material was employed to evaluate the selected inner glove material (4 mil Teflon-TFE film). This included testing the chemical permeation resistance of the glove material against the 13 organic chemicals in the ASTM battery to determine performance relative to the garment material. Many of the same physical property tests used to evaluate the garment and visor materials were also performed on the TFE film (Table 23).

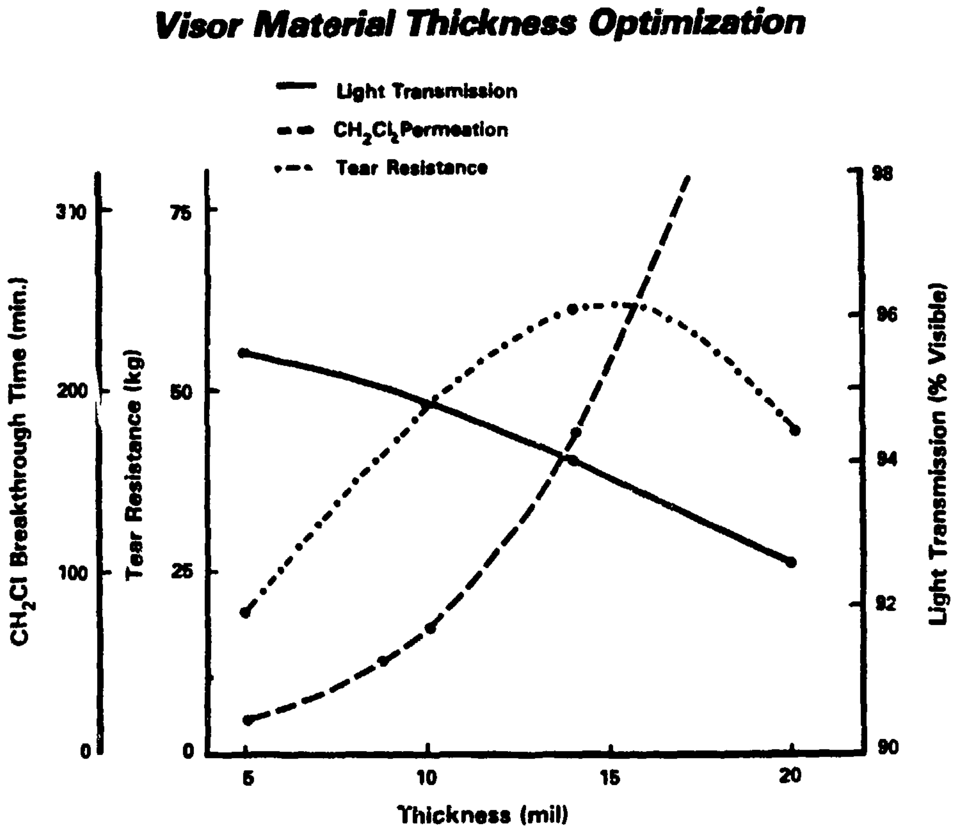
Material Testing Results. Physical integrity in terms of tear strength, abrasion resistance, and stiffness were generally poorer than the visor garment material. Lower physical properties of the glove material were believed to be acceptable due to the compromise between offering user

TABLE 22

PHYSICAL PROPERTIES OF FEP FILM VISOR CANDIDATES

Property (Units)	Test Method	5 Mil	10 Mil	14 Mil	20 Mil
Tear Strength[a] Trapezoid Method (lbs)	FED. STD. 191A-5136	8.9	21.5	28.2	20.2
Flexural Rigidity[a] Cantilever Method (mg-cm x 10^{-3})	ASTM D1388	0.149	1.07	2.85	7.62
Light Transmittance[b] (% Visible)	ASTM E424	95.5	94.8	94.0	92.6
Permeation Breakthrough Time (minutes)	ASTM F739	see Figure 6			

(a) Average of machine-direction and transverse-direction values
(b) Average light transmittance from 390 to 876 nm; Perkin Elmer Lambda 4 Spectrophotometer



Visor Material Thickness Optimization
Light Transmission
CH2Cl2 Permeation
Tear Resistance
CH2Cl Breakthrough Time (min.)
Tear Resistance (kg)
Light Transmission (% Visible)
Thickness (mil)
300
200
100
0
75
50
25
0
98
96
94
92
90
5
10
15
20

Figure 7

TABLE 23

PHYSICAL PROPERTIES OF VISOR AND GLOVE MATERIALS

Property (Units)	Test Method	Visor	Glove
Composition		Fluorinated Ethylene-Propylene	Polytetrafluoro-ethylene
Thickness (mil)	ASTM D374	10	4
Tear Strength (lbs)[a] Trapezoid	FED. STD. 191A,5136	21.5	1.9
Abrasion Resistance[b] Taber (gms lost)	ASTM D3389	0.02	0.05
Flexural Rigidity Cantilever (mg-cm)	ASTM D1388	1.07×10^4	8.65×10^2
Low Temperature Bending (°C)	ASTM D2136	Pass at -40°C	Pass at -40°C
Flame Resistance Vertical	FED. STD. 191A,5903		
Char Length (in)		1.4	1.5
After-Flame (sec)		0	0
After-Glow (sec)		0	0

(a) Average of machine-direction and transverse-direction valves
(b) H-18 wheel, 600 cycles, 250 gram weight

TABLE 24

COMPARISON OF PERMEATION BREAKTHROUGH TIMES FOR
GARMENT AND VISOR MATERIALS AGAINST SELECTED CHEMICALS

Chemical Name	CHRIS Code	Garment Material: Breakthrough Time (min)	Garment Material: Perm. Rate (ug/cm^2hr)	MDL[a] (ppm)	Visor Material: Breakthrough Time (min)	Visor Material: Perm. Rate (ug/cm^2hr)	MD' (ppm)
Acetone	ACI	No BT[b]	NA	1.16	No BT	NA	0.07
Acetonitrile	ATN	No BT	NA	0.60	No BT	NA	0.50
Acrolien	ARL	38-44	1.6-2.4	0.09	No BT	NA	0.60
Acrylonitrile	ACN	54-76	0.9-5.1	0.24	Not Tested		
Allyl Chloride	ALC	102-166	0.6-0.7	0.17	No BT	NA	0.50
Carbon Disulfide	CB3	18-22	2.6-3.7	0.07	90-98	7.3-13.6	0.12
Dichloromethane	DCM	47-55	1.0-1.4	0.19	Not Tested		
Diethylamine	DEN	No BT	NA	0.15	No BT	NA	1.21
Dimethylformamide	DMF	No BT	NA	0.40	No BT	NA	1.16
Ethyl Acetate	ETA	No BT	NA	0.49	No BT	NA	0.27
Hexane	HXA	No BT	NA	0.25	No BT	NA	0.31
Methanol	MAL	No BT	NA	4.07	No BT	NA	1.42
Nitrobenzene	NTB	No BT	NA	0.08	No BT	NA	0.04
Propylene Oxide	POX	137-170	1.1-1.4	0.80	Not Tested		
Tetrachloroethylene	TTE	108	ND[c]	ND	No BT	NA	0.38
Tetrahydrofuran	THF	No BT	NA	0.09	No BT	NA	1.44
Trichloroethylene	TCL	143-156	1.6-2.0	0.09	No BT	NA	0.21
Toluene	TOL	No BT	NA	0.06	No BT	NA	0.40
Vinyl Acetate	VAM	74-137	3.3-3.7	0.21	No BT	NA	0.50

(a) Minimum detection limit of permeation system for particular chemical
(b) No permeation breakthrough detected in 3 hours
(c) Not determined

TABLE 25

COMPARISON OF PERMEATION RESISTANCE
FOR UNCREASED AND CREASED VISOR MATERIAL[a] SAMPLES

Chemical Name	Uncreased TFE Film: Breakthrough Time (min)	Uncreased TFE Film: Perm. Rate (ug/cm^2hr)	Uncreased TFE Film: MDL[b] (ppm)	Creased TFE Film: Breakthrough Time (min)	Creased TFE Film: Perm. Rate (ug/cm^2hr)	Creased TFE Film: MDL (ppm)
Acetone	No BT[c]	NA	0.07	No BT	NA	0.21
Acetonitrile	No BT	NA	0.50	No BT	NA	0.50
Carbon Disulfide	90-98	7.3-13.6	0.12	25-34	8.4-12.8	0.10
Dichloromethane	Not Tested			30-60	2.5-5.2	0.09
Diethylamine				No BT	Na	1.21
Dimethylformamide				No BT	NA	1.16
Ethyl Acetate	No BT	NA	Q.27	No BT	NA	0.14
Hexane	No BT	NA	0.31	No BT	NA	0.21
Methanol				No BT	NA	1.42
Nitrobenzene	No BT	NA	0.04	No BT	NA	0.04
Tetrachloroethylene				No BT	NA	0.38
Tetrahydrofuran				No BT	NA	1.44
Toluene				No BT	NA	0.40

(a) All tests conducted using gas chromatograph with photoionization detector
(b) Minimum detection limit of permeation system for particular chemical
(c) No breakthrough detected in three hours

dexterity and structural integrity. The chemical resistance of the TFE film was clearly unacceptable, with nearly every chemical tested breaking through the material (Table 26). The quick chemical breakthrough times and high steady state permeation rates are possible evidence of material "microfracturing". These results alone demonstrate that the TFE film was unsuitable as Chemical Response Suit glove material. Complete chemical resistance data is provided in Appendix G.

Interim Glove Material Selections. The Coast Guard was faced with the dilemma of providing gloves for the suit which had comparable chemical resistance as the rest of the garment. The gloves are considered a critical area of protection since chemical exposure to the users at the hands is one of the most likely chemical response hazards. A glove development program with Challenge™ materials has begun in August 1987, but in the interim, the Coast Guard decided to employ existing glove material recommendations in the "Guidelines for the Selection of Chemical Protective Clothing"[13] to suggest gloves which would provide adequate chemical resistance for each specific chemical. The results were disappointing. Table 27 gives both the suit and outerglove recommendations. Six different types of gloves are required to cover the range of priority chemicals already tested (Table 28), but for 29 chemicals, no glove recommendations can be made (see Table 29). The reason for these findings are two-fold:

(1) Many glove materials have not been quantitatively evaluated (via chemical permeation testing with ASTM F739) against enough chemicals; and

(2) The chemical resistance of Challenge™ 5100 far exceeds that of conventional glove materials.

The consequence of this finding is that the gloves are the weak 'link' in the suit design. While options such as 'double' gloving or awaiting more testing on existing gloves may obviate the problem in the future, there is no data that exist to recommend suit use against certain chemicals, even though the rest of the garment provides adequate protection.

Suit Seam Design and Testing.

Seam Design. Critical seams of the Coast Guard Chemical Response Suit include:

(1) Garment Material - Garment Material
(2) Garment Material - Visor Material
(3) Garment Material - Inner Glove Material
(4) Garment Material - Suit Closure Tape Material
(5) Glove Material - Glove Material

The individual seam constructions are described in Table 30 and illustrated in Figure 8. Original seam constructions for the garment material to garment material seam involved the combination of sewing in a "T' fashion and heat sealing tape over the sewing holes (Figure 8a). Some seam failures were observed in field testing and Chemical Fabrics Corporation proposed totally heat-sealed seams (Figure 8b). The latter seam demonstrated higher integrity

TABLE 26

PERMEATION RESISTANCE OF INNER GLOVE MATERIAL AGAINST ASTM F1001 CHEMICALS[a]

Chemical Name	CHRIS Code	Breakthrough Time (min)	Permeation Rate (ug/cm^{2}hr)	MDL (ppm)
Acetone	ACI	2.5	128.9-146.7	0.75-0.89
Acetonitrile	ATN	5.0	57.0-66.0	0.60
Dichloromethane	DCM	2.5	487.1-508.0	2.57-2.60
Diethylamine	DEN	2.5	1072	4.60-4.75
Dimethylformamide	DMF	2.5	38.7-49.2	0.28-0.30
Ethyl Acetate	ETA	2.5	258.2-282.9	0.87-0.90
Hexane	HXA	2.5	1810-1898	9.12-9.68
Methanol	MAL	2.5	15.5-21.8	0.64-0.65
Nitrobenzene	NTB	2.5	56.0-57.8	0.13-0.14
Tetrachloroethylene	PER	2.5	1049-1189	2.78-2.92
Tetrahydrofuran	THF	2.5	1655-1905	8.04-9.57
Toluene	TOL	2.5	(b)	0.39-0.47

(a) All tests conducted using a gas chromatograph with photoionization detector in triplicate,-values given represent range of measurments for all three tests
(b) Permeation rate exceeded system's capability to measure it

TABLE 27

CHEMICAL RESPONSE SUIT/OUTER GLOVE RECOMMENDATIONS

CHEMICAL	CHRIS CODE	RECOMMENDED	BASIS	RECOMM. OUTER GLOVE MAT'LS.[b]
Acetaldehyde	AAD	Yes	A	Butyl, Silvershield
Acetic Acid	AAC	Yes	A	Neoprene, Nitrile, NNR, Viton
Acetic Anhydride	ACA	Yes	A	Butyl
Acetone	ACI	Yes	A	Butyl, Silvershield
Acetone Cyanohydrin	ACY	Yes	A	None Recommended
Acetonitrile	ATN	Yes	A	Butyl, PVA, Silvershield, Viton
Acetophenone	ACP	Yes	A	None Recommended
Acetyl Chloride	ACE	Yes	A	Butyl
Acrolien	ARL	No	C	--------
Acrylic Acid	ACR	Yes	A	Butyl, Viton
Acrylonitrile	ACN	No	C	--------
Adipontrile	ADN	Yes	A	Not listed in Guidelines
Allyl Alcohol	ALA	Yes	A	Butyl, Neoprene, PVC
Allyl Chloride	ALC	Yes	B	None Recommended
Aniline	ANL	Yes	A	Butyl, NNR, PVA, Silvershield
Benzene	BNZ	Yes	A	Viton, Silvershield
Benzyl Chloride	BCL	Yes	A	Viton
Bromine	BRX	Yes	A	Neoprene
n-Butyl Acetate	BCN	Yes	A	Butyl, PVA, Silvershield
n-Butyl Acrylate	BTC	Yes	A	None Recommended
n-Butylamine	BAM	Yes	A	None Recommended
n-Butyl Alcohol	BAN	Yes	A	Neoprene, Nitrile, Polyethylene
Butyraldehyde	BTR	Yes	A	Butyl
Carbon Disulfide	CBB	No	C	--------
Carbon Tetrachloride	CBT	Yes	A	PVA, Silvershield, Viton
Chlordane (25%)	CDN	Yes	A	Not listed in Guidelines
Chlorbenzene	CRB	Yes	A	Viton
Chloroform	CRF	Yes	A	PVA, Viton
Chlorpicrin	CPL	Yes	A	Not listed in Guidelines
Chlorosulfonic Acid	CSA	Yes	A	Polyethylene
Creosote	CCT	Yes	A	Neoprene, Viton
m-Cresol	CRL	Yes	A	Neoprene, Nitrile, NNR Polyethylene
Crotonaldehyde	CTA	Yes	A	Butyl
Cumene Hydroperoxide	CMH	Yes	A	Not listed in Guidelines
Cyclohexane	CHX	Yes	A	Nitrile, Silvershield, Viton
1,2-Dibromoethane	EDB	Yes	A	PVA
1,2-Dichlotoethane	EDC	Yes	A	Silvershield, Viton
2,2-Dichloroethyl Ether	DEE	Yes	A	None Recommended
Dichloromethane	DCM	No	C	----------
1,2-Dichloropropane	DPP	Yes	A	PVA, Viton
1,3-Dichloropropene	DPR	Yes	A	PVC, Viton
Diethylamine	DEN	Yes	A	Silvershield
Diethanolamine	DEA	Yes	A	Butyl, Neoprene, Viton
Dimethylsulfate	DSF	Yes	A	Not listed in Guidelines
Disopropylamine	DIA	Yes	A	Nitrile, Viton
Dimethylformamide	DMF	Yes	A	Butyl, Silvershield

TABLE 27 (Continued)

CHEMICAL RESPONSE SUIT/OUTER GLOVE RECOMMENDATIONS

CHEMICAL	CHRIS CODE	RECOMMENDED	BASIS	RECOMM. OUTER GLOVE MAT'LS.[b]
1,4-Dioxane	DOX	Yes	A	Butyl, Silvershield
Di-n-Propylamine	DNA	Yes	A	Viton
Epichlorohydrin	EPC	Yes	A	Butyl
Dimethylsulfate	DSF	Yes	A	Not listed in Guidelines
Disopropylamine	DIA	Yes	A	Nitrile, Viton
Dimethylformamide	DMF	Yes	A	Butyl, Silvershield
1,4-Dioxane	DOX	Yes	A	Butyl, Silvershield
Di-n-Propylamine	DNA	Yes	A	Viton
Epichlorohydrin	EPC	Yes	A	Butyl
Ethion 4	ETO	Yes	A	Not listed in Guidelines
Ethyl Acetate	ETA	Yes	A	Butyl, Silvershield
Ethyl Acrylate	EAC	Yes	A	PVA
Ethyl Alcohol	EAL	Yes	A	Nitrile, NNR, Polyethylene, PVA
Ethylamine (70%)	EAM	Yes	A	Butyl, Nitrile
Ethyl Benzene	ETB	Yes	A	Viton
Ethylene Cyanohydrin	ETC	Yes	A	Butyl, Neoprene, PVA, Viton
Ethylenedlamine	EDA	Yes	A	Butyl, Neoprene
Ethylene Glycol	EGL	Yes	A	Neoprene, Nitrile, NNR, PVA
Ethyl Ether	EET	Yes	A	PVA, Silvershield
Formaldehyde (37%)	FMS	Yes	A	Butyl, Polyethylene Silvershield, Viton
Furfural	FFA	Yes	A	Butyl, PVA, Silvershield, Viton
Gasoline	GAT	Yes	A	Neoprene, Nitrile, PVA
Glutaraldehyde(sol'n)	GTA	Yes	A	Butyl, Neoprene, PVC, Viton
Hexane	HXA	Yes	A	PVA, Viton, Silvershield
Hydrazine Hydrate	HDZ	Yes	A	Butyl, Neoprene, Nitrile, PVC
Hydrogen Peroxide (30%)	HPO	Yes	A	Nitrile, NNR, Polyethylene, PVA, Viton
Isopropyl Alcohol	IPA	Yes	A	Butyl, Neoprene, Nitrile
Isopropylamine	IPP	Yes	A	Butyl
Malathion (50%)	MLT	Yes	A	Not listed in Guidelines
Methyl Acrylate	MAM	Yes	A	Butyl, PVA
Methyl Alcohol	MAL	Yes	A	Butyl
Methyl Ethyl Ketone	MEK	Yes	A	Butyl
Methyl Isobutyl Ketone	MIK	Yes	A	PVA
Methyl Isocyanate	---	No	C	-------
Methyl Methacrylate	MMM	Yes	A	PVA
Methyl Parathion	MPT	Yes	A	Not listed in Guidelines
Naled	NLD	Yes	A	Not listed in Guidelines
Mapthalene	MLT	Yes	A	Not listed in Guidelines
Nitric Acid	NAC	Yes	A	Neoprene, NNR, Polyethylene, Silvershield, Viton
Nitrobenzene	NTB	Yes	A	PVA, Silvershield, Viton
2-Nitropropane	NPP	Yes	A	Butyl, PVA
Oleum	OLM	Yes	A	Not listed in Guidelines
Parathion	PTO	Yes	A	Not listed in Guidelines

TABLE 27 (Continued)

CHEMICAL RESPONSE SUIT/OUTER GLOVE RECOMMENDATIONS

CHEMICAL	CHRIS CODE	RECOMMENDED	BASIS	RECOMM. OUTER GLOVE MAT'LS.[b]
Petroleum Ether	——	Yes	A	Neoprene, Nitrile, PVA
Phenol	PHN	Yes	A	NNR, Polyethylene
Phosphoric Acid	PAC	Yes	A	Neoprene, Nitrile, Polyethylene, PVC
Phosphorous Oxychloride	PPO	Yes	A	None Recommended
Phosphorous Trichloride	PPT	Yes	A	None Recommended
Polychlorinated Biphenyls	PCB	Yes	A	Neoprene, Silvershield, Viton
Propionic Acid	PNA	Yes	A	None Recommended
n-Propyl Alcohol	PAL	Yes	A	Neoprene, Nitrile
n-Propylamine	PRA	Yes	A	Butyl, Neoprene
Propylene Oxide	POX	Yes	B	Butyl
Silicon Tetrachloride	STC	Yes	A	Not listed in Guidelines
Sodium Hydrosulfide	SHR	Yes	A	Not listed in Guidelines
Sodium Hydroxide	CSS	Yes	A	Butyl, Neoprene, Nitrile, NNR, Polyethylene, PVC, Silvershield, Viton
Styrene	STR	Yes	A	PVA
Sulfur Monochloride	SFM	Yes	A	None Recommended
Sulfuric Acid (95%)	SFA	Yes	A	NNR, Polyethylene, Silvershield, Viton
1,1,2,2-Tetrachloroethane	TEO	Yes	A	PVA, Viton
Tetrachloroethylene	TTE	Yes	B	Silvershield, Viton
Tetrahydrofuran	TCE	Yes	A	None Recommended
1,1,1-Trichloroethane	TCL	Yes	A	PVA, Silvershield, Viton
Trichloroethylene	TCE	Yes	B	Silvershield, Viton
Toluene	TOL	Yes	A	Silvershield, Viton
o-Toluidine	TLI	Yes	A	None Recommended
Toluene-2,4-Disocyanate	TDI	Yes	A	Butyl, Nitrile, Polyethylene, PVA, Silvershield, Viton
Turpentine	TPT	Yes	A	PVA
Vinyl Acetate	VAM	Yes	B	None Recommended
Vinylidene Chloride	VCI	Yes	A	PVA
Xylenes	XLM	Yes	A	Viton
Xylenol	XYL	Yes	A	Not listed in Guidelines

[a]Basis of Recommendation:
- A - No breakthrough in three hours - RECOMMENDED
- B - No breakthrough in one hour, but breakthrough time occurs before three hours - RECOMMENDED
- C - Breakthrough occur within one hour - NOT RECOMMENDED

TABLE 27 (Continued)

CHEMICAL RESPONSE SUIT/OUTER GLOVE RECOMMENDATIONS

[b]Outerglove Recommendations based on quantitative recommendations provided in the 3rd Edition of "Guidelines for the Selection of Chemical Protective Clothing" (reference 13). Material abbreviations: PVA - Polyvinyl Alcohol, PVC - Polyvinyl Chloride, NNR - Neoprene and Natural Rubber.
***CAUTION: End users should check with vendor for specific recommendations on selected glove.

TABLE 28

SUMMARY OF OUTERGLOVE MATERIAL RECOMMENDATIONS

No. Materials Recommended	No. Chemicals
3 or more materials	26
2	27
1	25
No materials recommended	13
Not in selection guidelines	16
No recommendations possible	5
TOTAL	112

TABLE 29

AVAILABLE GLOVE MATERIALS

Material	No. Recommendations[a]	
Butyl Rubber	28	
Neoprene	19	
Neoprene/Natural Rubber	10	(b)
Nitrile	17	(b)
Polyethylene	12	
Polyvinyl Alcohol	26	
Polyvinyl Chloride	6	(b)
Silvershield™	27	
Viton®	29	

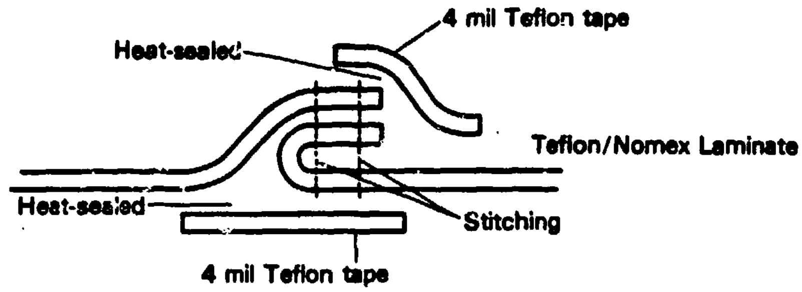
(a) Recommendations based on quantitative measures indicating adequate protection greater than 1 hour.

(b) Not needed in CRS outerglove system due to other gloves providing adequate protection

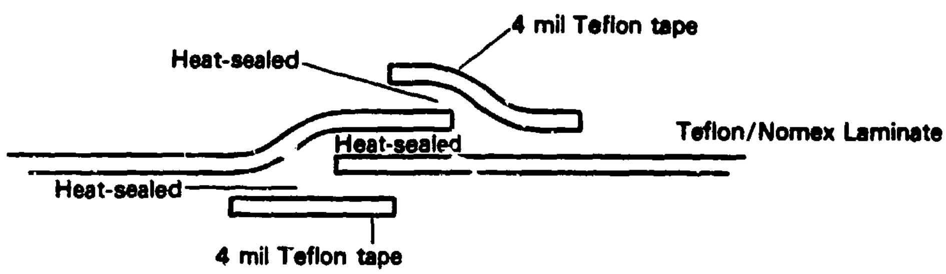
TABLE 30

DESCRIPTION OF SUIT SEAM CONSTRUCTIONS

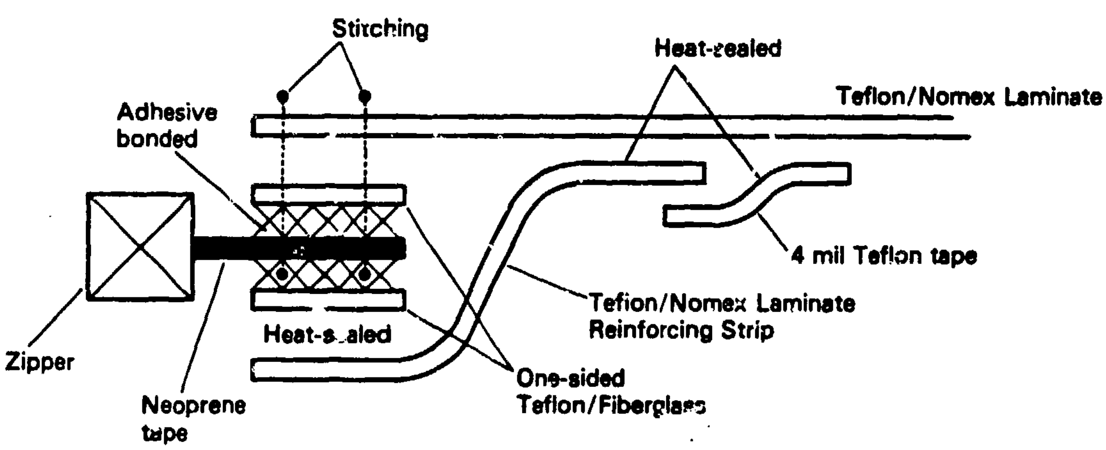
Garment Material Seam: (original construction)	sewn, then heat sealed with 5-6 mil Teflon tape over seam assembly on both sides (Figure 8a)
Garment Material Seam: (new construction)	new suit seams 1/2 inch heat sealed lap seams with tape over seam assembly on both sides (Figure 8b)
Garment-Visor Mat'l Seam:	heat sealed with 5-6 mil Teflon tape over seam assembly on both sides
Garment-Closure Seam:	fiberglass heat sealed to garment material; zipper neoprene tape sewn and bonded to fiberglass with toluene based adhesive (Figure 8c)
Garment-Inner Glove Seam: (Original construction)	fiberglass heat sealed to garment material at sleeve end; fiberglass bonded to plastic glove ring and inner glove
Garment-Inner Glove Seam: (new construction)	Attached with butyl elastic band and stainless steel hose clamp
Glove Material Seam:	1/4 inch heat sealed lap seam



(a) Original Garment Material Seam



(b) New Garment Material Seam



(c) Garment Material-Closure Tape Seam Assembly

Seam Constructions

Figure 8

and fewer seam failures were noted in field tests where significant physical abuse of the suits occurred. Table 31 presents data for three different garment seams, of which the 1/2 lap seam was chosen due to its physical strength and ease of implementation into the suit design. Garment material interfaces with non-Teflon materials presented a problem in heat sealing. The attachment of the suit visor could be done directly by heat sealing but required some adjustments in the heat sealing procedure. The neoprene closure (zipper) tape could not be heat sealed and required using a fiberglass interface between the Teflon and the neoprene tape; the fiberglass was heat sealed to the Teflon laminate and the neoprene tape was both stitched and bonded to the fiberglass section (Figure 9c).

Seam Physical Integrity Testing. Each of the seam constructions have been subjected to two types of seam strength tests: tensile and dead load stresses (Table 32). The ultimate tensile strength of each seam type generally reflects the tensile strength of the weakest base material, as opposed to the actual strength of the heat-sealed joint. In other words, the heat sealed seams are designed to be as strong or stronger than the base materials (with the possible exception of the glove-glove seam which exhibited both film and seam type failures). Dead load or creep testing was conducted to simulate the long term but low stress conditions resulting from the positive pressure in a totally encapsulating suit. Representative seam stresses were calculated for two locations within the suit (torso and glove) based on a internal positive pressure of 5.7 mm Hg and on measured suit dimensions. Dead load testing was conducted at loads for the glove and torso repsectively. No failures occurred in any of the seam configurations in 48 hours under the above loading conditions.

Seam Chemical Resistance Testing. Penetration testing (ASTM F903) of the first three seams was conducted by Anderson Associations for the Coast Guard R&D Center against a five chemical battery (water, hexane, toluene, methyl ethyl ketone, and hydrochloric acid). No penetration was noted for any seam-chemical combination. Appendix H is a copy of the contractor's report. Attempts were made to measure seam permeation testing with the standard ASTM method but anomolous results have been observed. The non-homogeneous surface of the seam may have caused leakage in the test cell; this may explain the relatively short breakthrough times compared to what is expected for seam performance. Placement of a solid sheet material between the seamed material and the collection chamber gave no breakthrough. Use of successively more compressible gaskets also gave longer breakthrough times as confirmed by both the Coast Guard R&D Center and Texas Research Institute (Table 33; other data in Appendix I). The use of a 1/4" expanded PTFE (polytetrafluoroethylene) was the only gasket arrangement which provided the expected results. At the time this report was prepared (July 1987), additional seam permeation test was in progress against the ASTM F1001 chemicals and other chemicals which permeated the garment material (Table 18).

Selection and Testing of Other Suit Components.

Suit Closure Selection. The Coast Guard could not identify suit closures constructed of Teflon[R] (or other highly chemically resistance materials) which also provided an airtight seal. Past Coast Guard suit designs employed pressure sealing zippers, two-track closures (like Ziplock[R]), or the

TABLE 31

OPTIMIZATION OF GARMENT SEAM TYPES[a]

Seam Type	Direction of Separation	Fabric Stress at Failure (lb/in)	Mode of Failure
"T" Sewn/Heat-sealed	Warp	51.5	Stitching[b]
	Fill	49.9	Stitching
1/2" Heat-sealed Lap	Warp	95.0	Adhesion[c]
	Fill	75.0	Adhesion
3/4" Heat-sealed Lap	Warp	110.0	Adhesion
	Fill	88.0	Adhesion

(a) Optimization determined by seam tensile strength testing. Tests were performed using a a modified form of ASTM D751-79; Samples sizes were 1" x 12", with seam down long sample axis; a 0.2 in/min rate of separation was used.

(b) Stitching failures involve seam separation at stitched areas

(c) Adhesion failure involve either delamination of coating from the fabric or the breakdown of the bonding in the lap seam

TABLE 32

SUIT SEAM PHYSICAL PROPERTIES

Seam Type	Ultimate Tensile Strength (lbs/in)	Dead Load[a] (lbs/in)	Test[b] Duration (hr)
Challenge-Challenge (heat-sealed seam)	132	15	48+
Challenge-Visor	25.3	15	48+
Challenge-Closure[c]	129.5	15	48+
Challenge-Glove	12.3	2.3	48+
Glove-Glove	8.2	2.3	48+

(a) Dead loads were conducted at approximately 15 times the static seam stress resulting from normal suit positive pressure (3.0 in Water). Maximum interior dimensions of 10.2 in radius in the suit torso and 2.9 in. radius in the glove yield stresses of 0.55 and 0.15 lbs/in respectively.

(b) n+ indicates no failure in the time stated.

(c) Closure is a neoprene-brass pressure sealing zipper.

TABLE 33

PERMEATION TESTING R.SULTS FOR VARIOUS GARMENT MATERIAL SEAM TESTS AGAINST ETHYL ACETATE

Run	Gasket Type (Number)	Breakthrough Time(min)
A	Neoprene (2)	6
B	Neoprene (1) Teflon (2)	7.5
C	Neoprene (2) Teflon (2)	96
D	1/4" Expanded PTFE Cord	3 Hrs

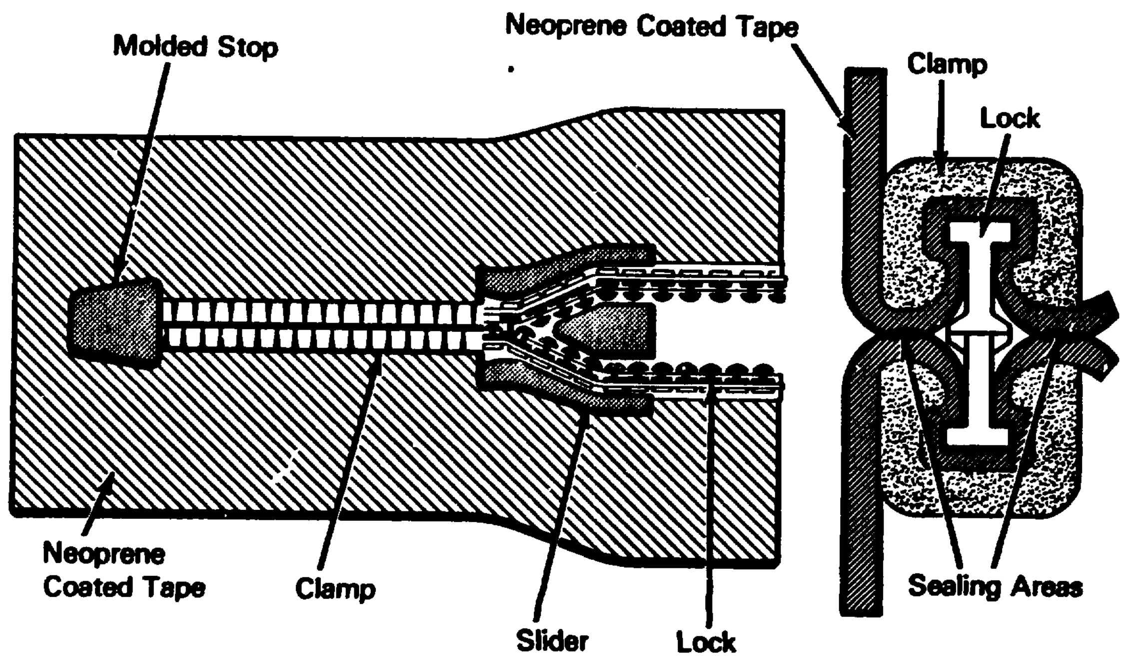
combination of the two.[3] Two-track closures can only be fabricated from plastics with the appropriate physical characteristics (i.e., polyethylene and CPE). Pressure sealing zippers operate with the zipper chain (clamp and lock) compressing the two sides of the coated tape together to form an air-tight seal (Figure 9). These zippers are typically used in diving dry suit applications and are fabricated from neoprene (tape) and brass alloys (clamp, lock, and slider). While other metal components are available (e.g. stainless steel), neoprene is the only coated tape used in the manufacture of these closures. Therefore, both types of closures consist of materials with relatively lower chemical resistance compared to the garment material. The Coast Guard picked a Talon OEB[R] pressure sealing zipper over two-track closures due to its better field performance and air-tight qualities. In order to protect the closure from chemical exposure, the zipper was placed in the rear of the suit and enclosed in a protective cofferdam described in Chapter 5.

Suit Exhaust Valve Selection. Totally-encapsulating chemical protective suits use low-pressure one-way vent valves to allow the escape of exhaust air from the wearer's self-contained breathing apparatus, and to maintain a small positive pressure (1 to 3 inches water column pressure) inside the suit. This latter feature minimizes diffusion or penetration of chemical vapors through poor seams, material punctures, or improperly closed zippers. Satisfactory operation of these valves is critical to the functional and protective qualities of the suit. In earlier suit designs, the Coast Guard used four Halkey Roberts (#780-RPA.1) valves. Though these valves offered adequate performance, they were no longer available for production of the Coast Guard Chemical Response Suit. The Coast Guard identified an alternative valve, the Stratotech P/N 739-2.5 with a 'cracking pressure' of 2.5 inches water column pressure (illustrated in Figure 10). Like other valves, the sealing components are fabricated materials with relatively low chemical resistance. In this case, a silicone rubber valve O-ring seals against the valve body (aluminum). The Coast Guard principal concerns for these valves are:

(1) providing adequate venting of the suit (to prevent overpressurization which limits user mobility and stresses suit seams),
(2) resisting chemical degradation of the valve sealing surface, and
(3) resisting 'backflow' while the valve is operating.

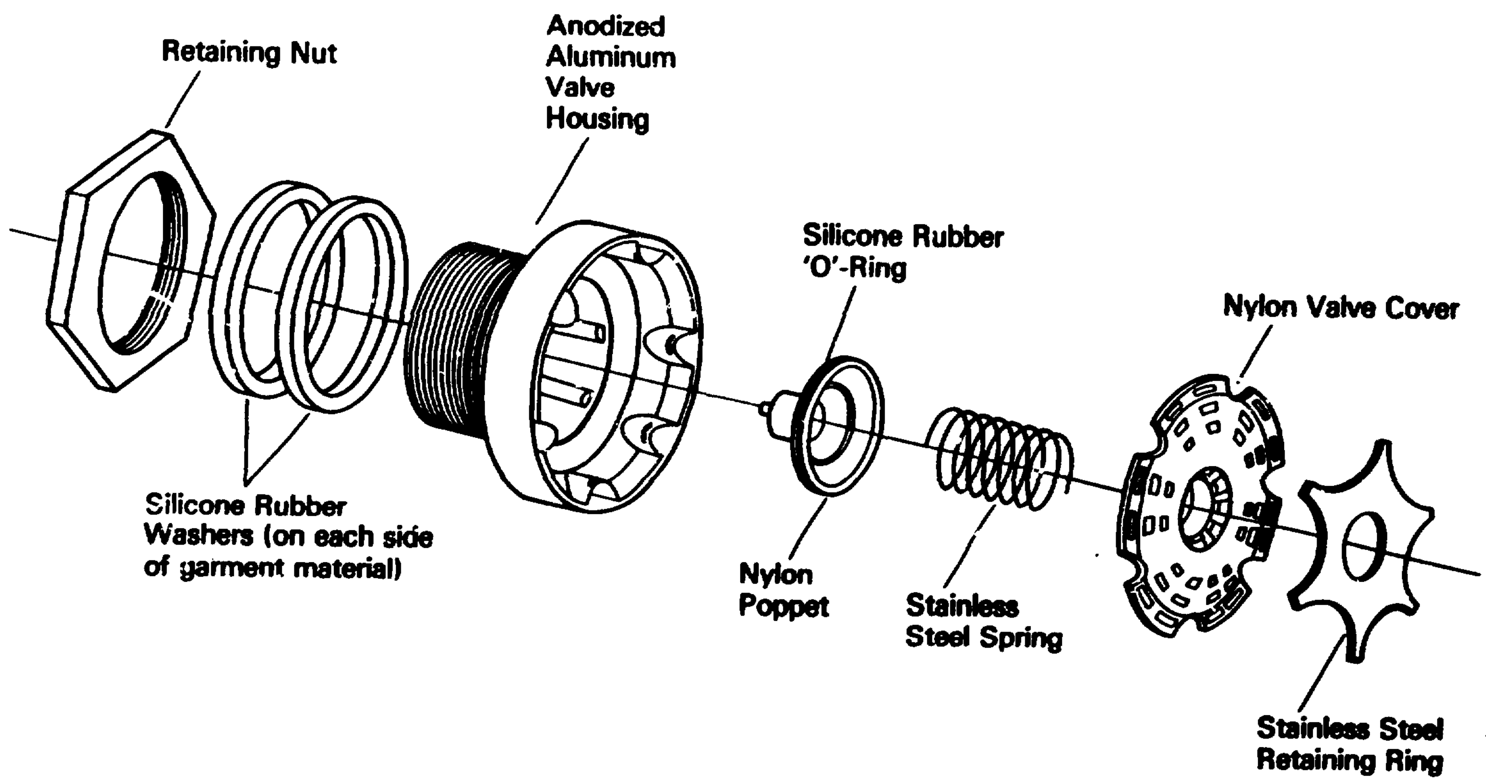
Valve flow rates at different levels of wearer work were measured in manned laboratory tests described in Chapter 5. Attempts at measuring the two other phenomena are discussed below. The valves are partially protected by an inverted pocket to prevent direct liquid chemical impingement.

Closure and Exhaust Valve Testing. Measurement of closure and exhaust valve performance with respect to chemical exposure is difficult to assess since they are not sheet-like materials and standard methods do not exist to measure their chemical resistance. Penetration testing of the suit zipper has been performed using a modified test cell against the five chemical penetration battery with no evidence of penetration as reported in Appendix H. Sample suit zippers have also been subjected to zipper crosswise strength testing to determine tensile properties relative to the garment material. All suit zippers far exceed the Coast Guard requirement of 50 lbs/in. crosswise strength (90 lbs/in.). The Coast Guard intends to measure other closure physical properties such as bursting strength for evaluating suit closure



Suit Closure Design (Courtesy, Talon, Inc.)

Figure 9



Suit Exhaust Valve Design

Figure 10

performance once methods are developed. An initial assessment of suit exhaust valve performance was conducted by Lawrence Livermore National Laboratory in a separate Coast Guard sponsored investigation. The study attempted to measure valve resistance to backflow and tried to clearly establish valve performance characteristics. The results reported in Appendix J are unconclusive. While leak rates for a number of valves including the Stratotech valve were quantitatively defined, the significance of these rates must be still determined. An additional study was begun in June 1987 to answer the following questions:

(1) What is the effect of valve configuation on valve leak rate?;
(2) Is the leak rate of the valve proportional to outside chemical concentration?; and
(3) How do exhaust valve covers (or protective pockets) influence valve leak rate?

Once this study is completed, additional work will be undertaken to examine changes in valve performance following chemical vapor exposure.

Integration of Test Data.

The results from material chemical resistance and physical property testing must be related to overall suit performance in order to provide meaningful results to end-users. Physical property data are used to determine if materials and components possess sufficient integrity and resistance to physical/environmental abuse relative to evolving standards. Generally, each material should have similar physical property requirements, but these may differ based on the material's function. Such requirements should be set to reflect actual use conditions. While standards have been used in the past based on Chemical Warfare clothing material requirements, the Coast Guard is conducting new studies to better define which properties should be measured and what are reasonable requirements for those properties.

Using chemical resistance data to assess suit performance is a much more complex problem. Because dermal exposure limits don't exist, any permeation of hazardous chemicals through a protective garment is considered unacceptable. The problem arises in comparing material swatch testing against overall suit exposure to chemicals. In general, most permeation resistance testing represents "worst case" exposure, where the liquid or gaseous chemical is in constant contact with the material over the length of the test period. This is not the usual case for field exposures during spill response and monitoring. Yet, many researchers recognize that certain variables (i.e., temperature, chemical mixtures) can accelerate a chemical's effect on materials.[19] This combined with the inability to test any material-chemical combination under all conditions makes the establishment of suit recommendations difficult.

The Coast Guard has adopted a one-hour criterion for permeation breakthrough time for initially recommending suit use against a particular chemical. One hour should provide a reasonable safety factor for all anticipated exposures. However, this rule is being applied to all primary materials and components, i.e., the recommendation is based on the performance of all primary materials (garment, visor, and glove). These recommendations appear back in Table 27. Mixture testing was initiated August 1987 to determine if synergistic permeation is observed. If this is not the case, then performance of the garment can be judged on the basis of individual mixture component permeation results. Otherwise, predictive models and field test kits will be required to determine the safety of suit use on a case-by-case basis. Predictive models may also be applied, once developed, to different conditions of exposure such as temperature and chemical concentration.

CHAPTER 5

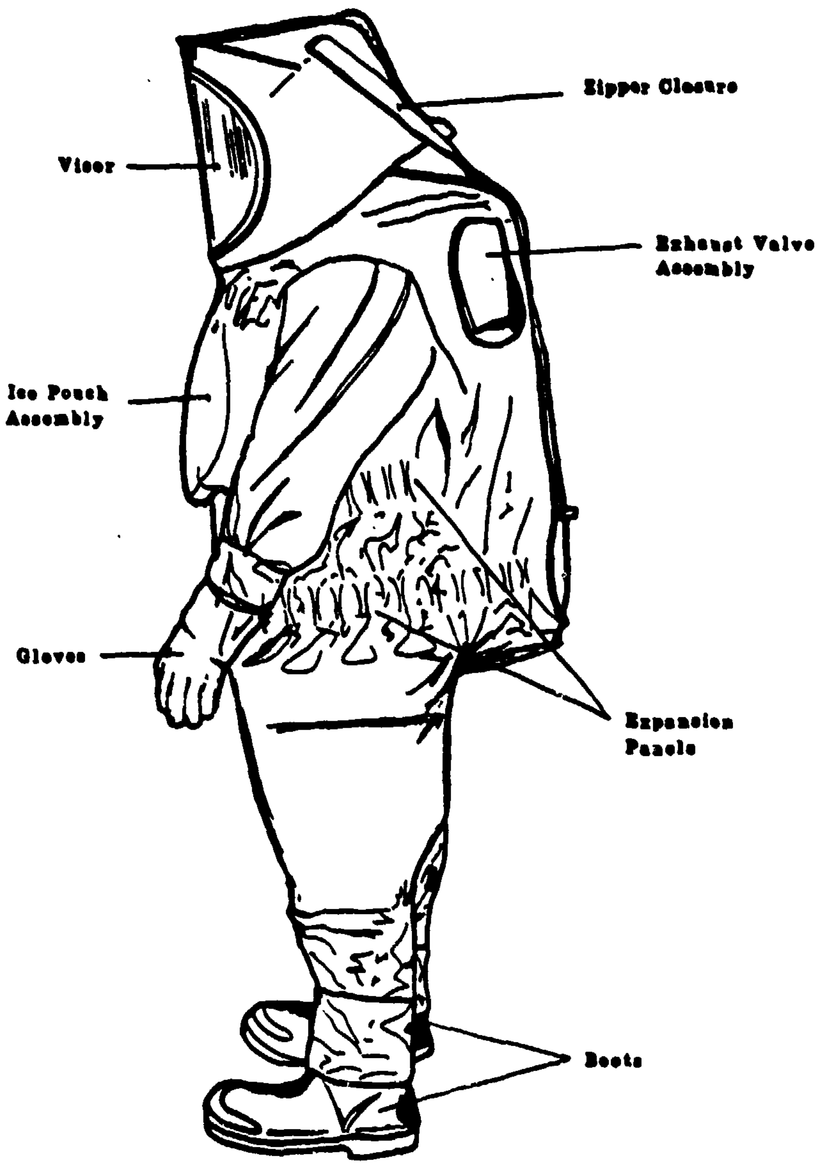
SUIT DESIGN AND OVERALL SUIT TESTING

The Coast Guard was able to capitalize on earlier development efforts for both designing the Chemical Response Suit and testing its overall performance. The original design of the Viton[R]/chlorobutyl chemical response suit served as the basis for specfications to construct new suits made of Challenge[TM] 5100. Likewise, shortcomings of the protection factor and physiological testing conducted on early suit prototypes (described in reference 3), were identified and used to improve test methods to assess overall suit performance. Suit design and testing has been an evolving and iterative process. Through development to deployment, a number of successive suit designs were considered with each new improvement identified through testing. Overall testing has been critical to understand the capabilities and limitations of the Chemical Response Suit. Material and component testing by itself cannot identify all problems, particularly in terms of configuration, fit, comfort, function, and the overall protection offered the ensemble (the suit in combination with the respiratory apparatus and other auxiliary equipment).

Suit Design.

Basic Configuration. The configuration of the Chemical Response Suit was based on the original design for suit prototypes constructed from Viton[R]/chlorobutyl laminate. However, a number of changes have been made to either accomodate the Challenge[TM] material or improve the comfort and suit fit to the user. Some patterning changes took place for the use of heat-sealed seams versus the combined heat-sealed and sewn seams used in earlier suit constructions. Other changes included modification of the hood and torso areas for better integration with the breathing apparatus and to provide greater visibility out of the visor, especially for shorter people. As before, sizing of the suit was based on a single size using data for the 95 percentile person (male) obtained from the U. S. Army. In general, the suit as designed fits people from heights of 5'8" to 6'4". Smaller subjects have more difficulty with sleeve and trouser leg length. Figure 11 shows the original suit design, whereas the most recent design is illustrated in Figure 12. The entire suit less the cooling pouch and heat exchanger weighs approximately 9 pounds.

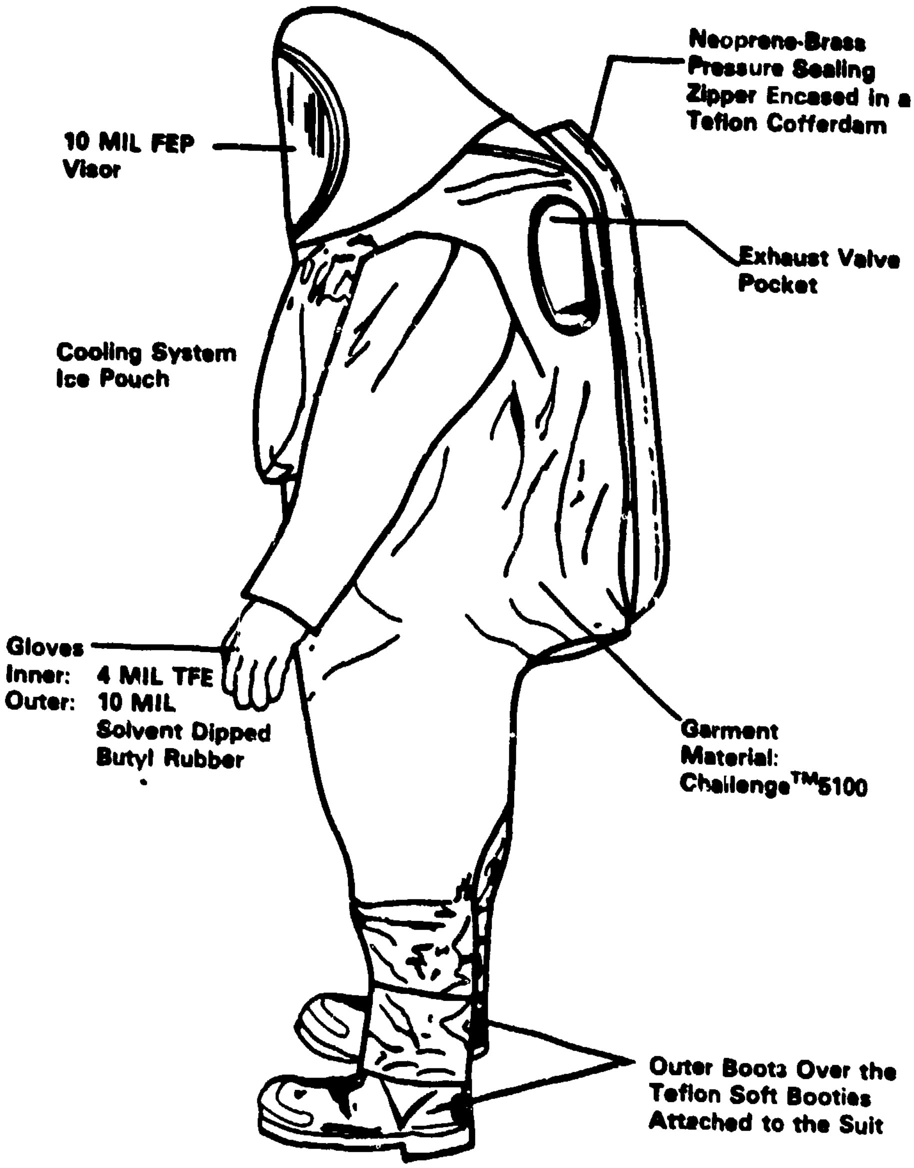
Suit Cofferdam The suit closure, a pressure-sealing zipper is considered one of the weak areas on the suit because of the relatively poor chemical resistance of the materials (neoprene, brass) used in its construction. A cofferdam was designed as part of the Chemical Response Suit to prevent permeation and penetration of chemical vapors or liquid splashes. The cofferdam consists of two long rectangular pieces of Challenge[TM] 5100 heat sealed to the garment wall along both sides of the closure. These two pieces of material flaps extend approximately six inches from the wall of the garment material, and can be heat-sealed using a portable, modified Doboy heat sealer (Metric Model HS-C). The heat-sealer is used to temporarily seal the outer edges of the material flaps resulting in a vapor tight seal that provides



TOTAL ENCAPSULATING SUIT DESIGN

(Original)

Figure 11



Current Chemical Response Suit Design

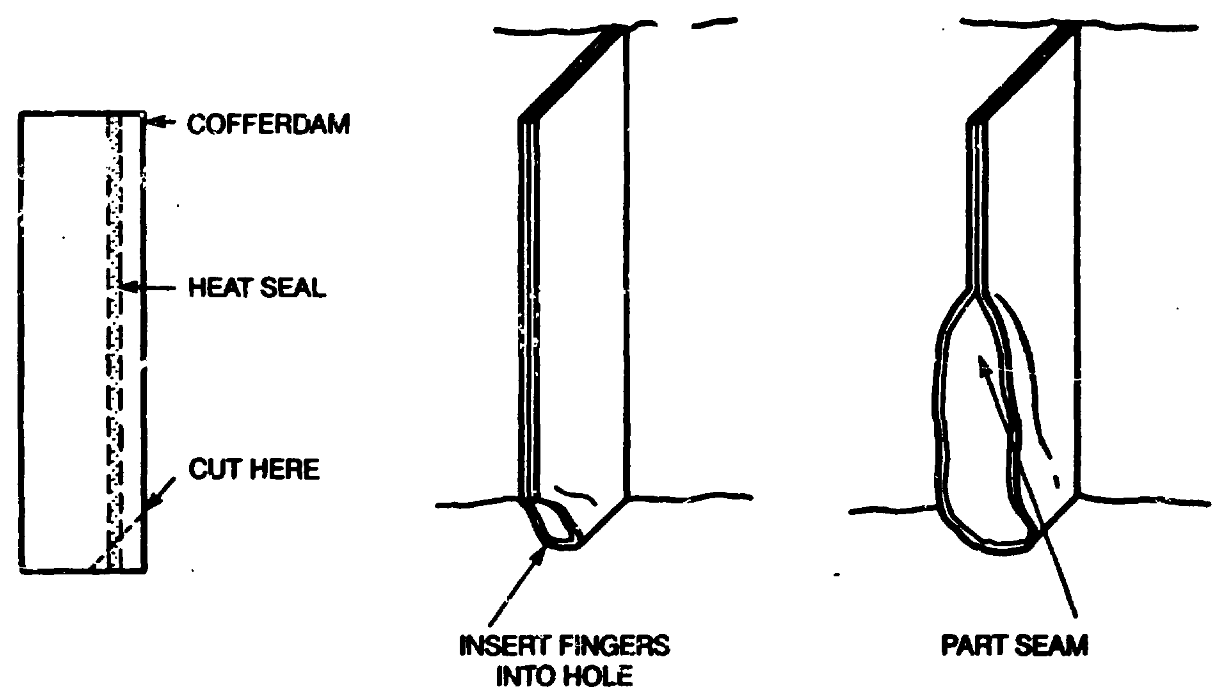
Figure 12

equivalent chemical resistance as the garment material and complete protection to the suit wearer. Doffing of the suit is accomplished by cutting a small portion of the cofferdam away and then separating the heat-seal by simply pulling the flaps apart (see Figure 13). The outer edge of the flaps are long enough such that the heat-sealed portion of the flaps may be cut away 3 to 6 times for reusing the suit (***CAUTION: Reuse of the Chemical Response Suit is only permitted under certain circumstances at the discretion of the On-scene commander for the chemical incident).

<u>Integration with Auxiliary Equipment</u> Consistent with previous Coast Guard chemical protective suit prototypes, the Chemical Response Suit was designed for flexibility in accomodating different types of auxiliary equipment, principally breathing apparatuses. The rear of the suit is expanded (see Figure 12) to allow the wearer to use a NIOSH approved, self-contained breathing apparatus (SCBA) with a 60 minute-rated bottle. The Coast Guard uses 60 minute SCBA's as standard equipment for hazardous chemical response. These types of SCBA's are somewhat larger than the conventional SCBA's and allowances must be made in the suit design for their use. Other features of the Chemical Response Suit impact this choice of respiratory protective equipment. For example, the attachment of the gloves to the glove rings lets a user remove his hands from the garment sleeve and adjust his or her breathing apparatus, if needed. Also, one reason for locating the closure in the rear of the suit was to allow easier exchange of SCBA air bottles for extended missions.

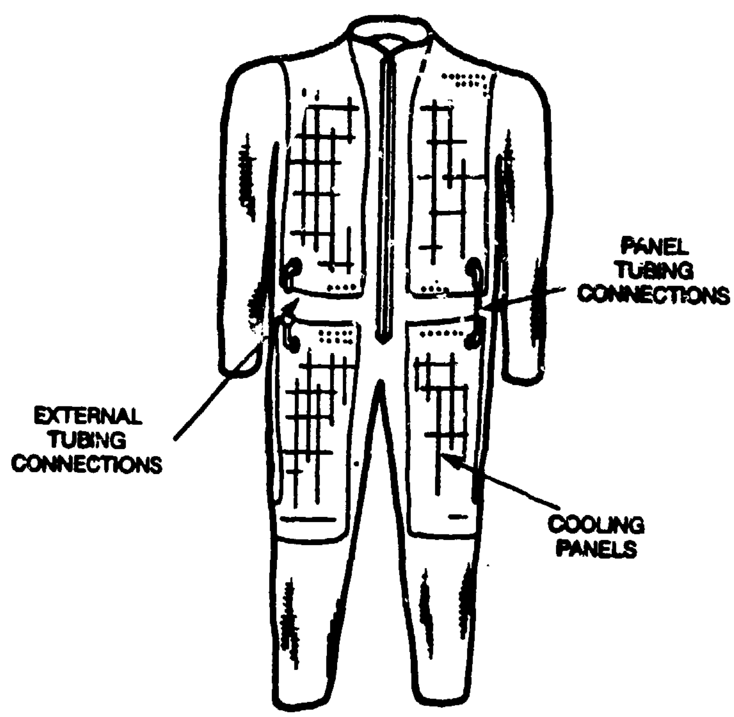
The cooling garment developed for earlier suit prototypes (described in reference 3) was adopted for use with early versions of the Chemical Response Suit. The cooling system consists of a separate full body garment which has 'cooling' panels on the front and back of the upper torso and thighs. Cold water is circulated through these panels, absorbs body heat and is returned to a heat exchanger built onto the front of the Chemical Response Suit. An ice water slurry is used to cool the water which returns to the cooling garment via small battery driven centrifugal pump. This system is illustrated in Figures 14, 15, and 16. When deployed, the additional weight of the system including water and ice is approximately 12 pounds, more than doubling the weight of the suit. The effectiveness of the cooling system in preventing heat stress has not been fully determined. Some suit wearers have expressed that they feel 'cool' when wearing the system. However, the additional weight of the system, plus the reduction in mobility from the incorporation of this equipment, add to the physiological strain on the suit wearer. As a consequence, more recently ordered Chemical Response Suits have been fabricated without the cooling pouch and heat exchanger. A study was initiated in June 1987 to fully investigate the Coast Guard cooling system's effectiveness relative to other cooling devices worn with the Chemical Response Suit. The results of these tests will compared for test subjects wearing the suit without any cooling system. This investigation is being conducted in conjuction with the National Institute for Occupational Safety and Health (NIOSH).

Other clothing or equipment that can be worn with the Chemical Response Suit include Nomex jumpsuits, Tyvek^R disposable suits, communications systems, and heart rate monitors. Tyvek^R disposable suits are worn underneath the Chemical Response Suit to reduce the likelihood of wearer contamination during gross suit decontamination (to allow doffing of the suit



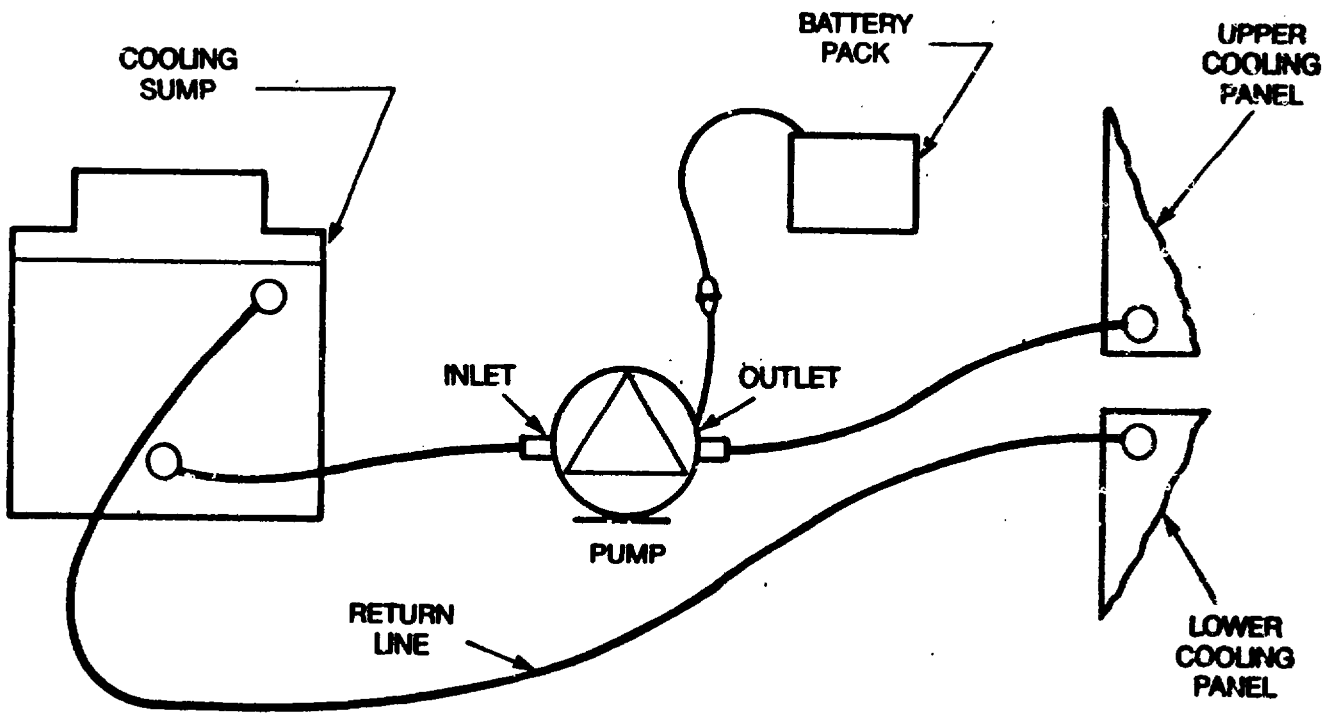
Opening a Suit Cofferdam

Figure 13



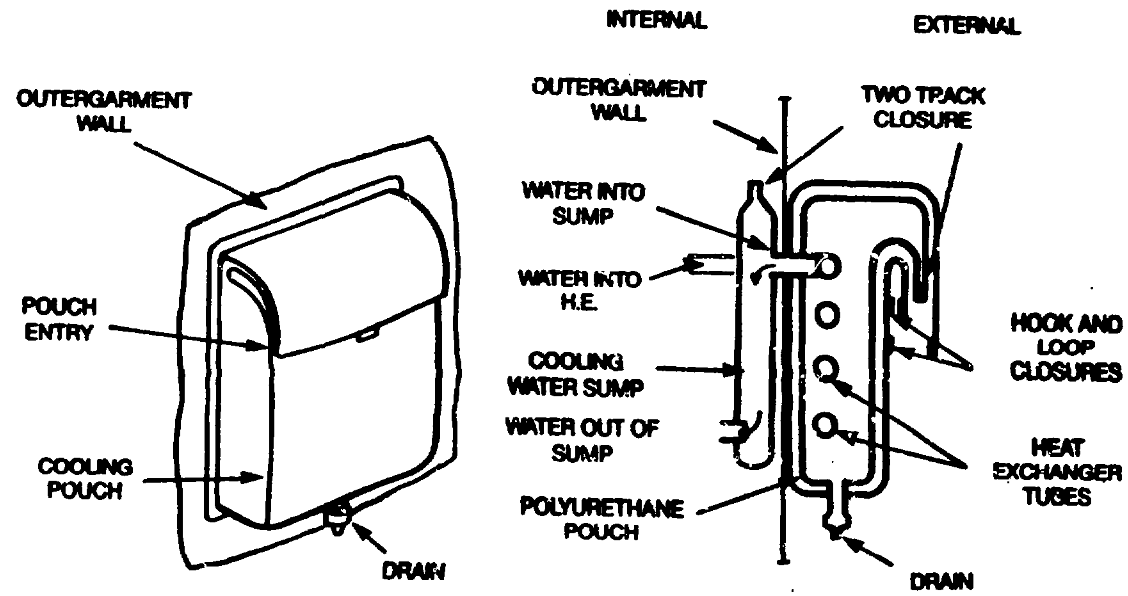
Full Body Cooling Garment

Figure 14



COOLING SYSTEM WIRE AND HOSE ROUTING

Figure 15



COOLING POUCH AND HEAT EXCHANGER DESIGN

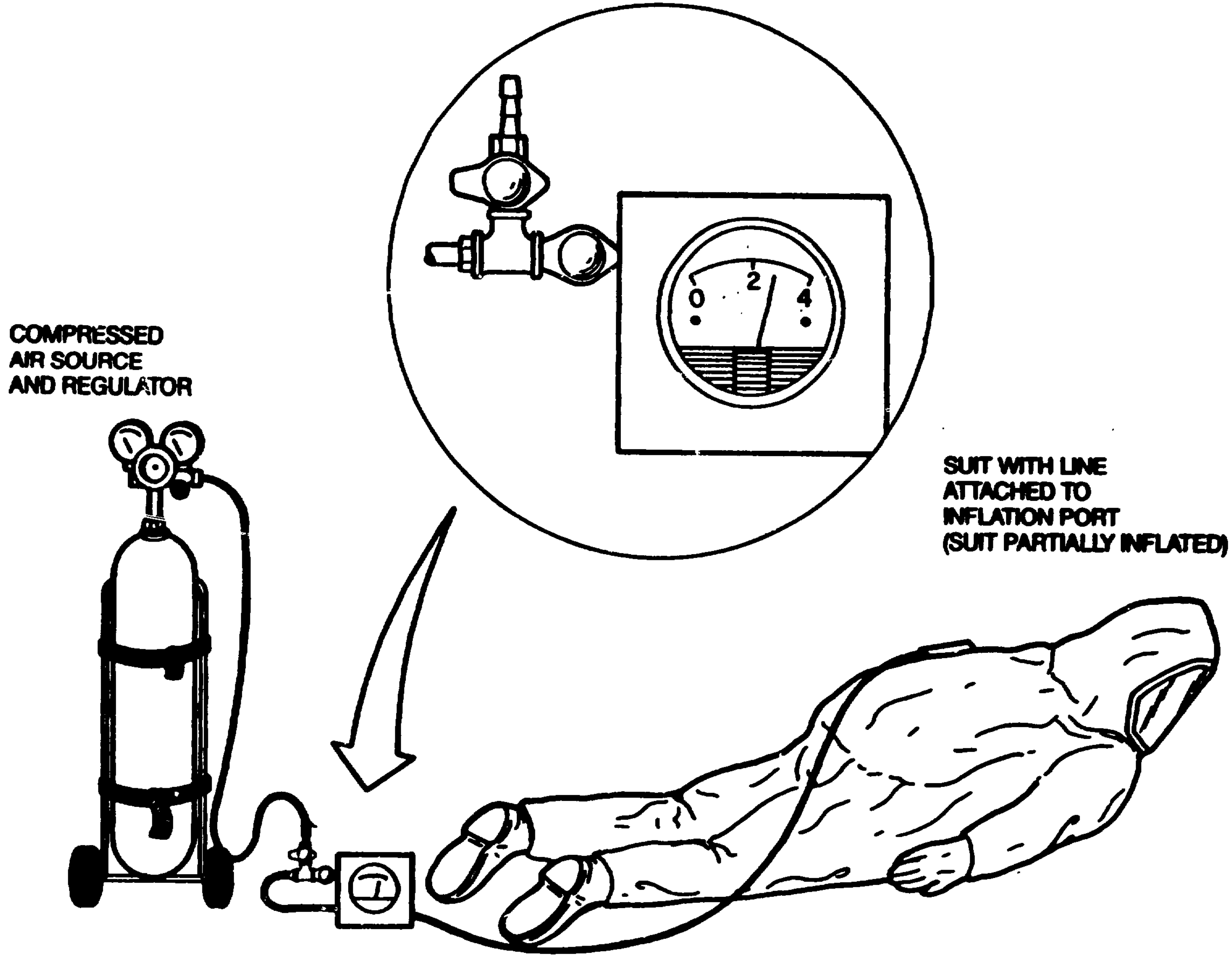
Figure 16

by the wearer). Nomex jumpsuits can be worn underneath the suit to minimize the hazards of flashover or contact with fire. Equipment items including communications systems or heart rate monitors vary widely, but in general their selection is dependent on how well they integrate with both the Chemical Response Suit and the SCBA. Remic Corporation developed a communications system which is usable with all types oil chemical protective clothing.[22] Their development investigated several considerations for the design and selection of communication devices in hazardous chemical response.

Overall Suit Testing.

Pressure Testing. The most widely used methods for assessing chemical protective suit integrity involve the practice of inflating the suit to determine leakage. Pressure testing was used to measure the integrity of all Coast Guard Chemical Response Suit Tests following fabrication by both the manufacturer and the recepient Strike Team. This method tests the suit and visor materials, suit seams, and suit closure for gas-tightness. In the test, the suit is inflated to a specified pressure and either the pressure drop is measured over time, or a soap solution is applied to the outside of the suit for observing the appearance of bubbles (to detect leaks). The suit exhaust valves must be closed (or plugged) to perform the test, and a pressure gauge is attached with a special fixture that replaces one of the suit exhaust valves. ASTM F1052 specifies a maximum inflation pressure (3 inches water gauge), a test pressure (2 inches water gauge), and an allowable pressure drop (20%) over a three minute period.[23] It also requires using the soap solution to locate leaks if the suit does not meet the pass/fail criteria. The Coast Guard used this method but specified higher maximum inflation and test pressures (4" and 3" water gauge, respectively). The method is illustrated in Figure 17 and was found very sensitive to small leaks in the garment.

Quantitative Leak Testing Qualitative leak testing was used to measure the integrity of the entire Chemical Response Suit to both a gaseous and aerosal challenge agent in a manner simulating actual use. This testing involved the exposure of a test subject wearing the suit and a self-contained breathing apparatus in a closed chamber, while measuring the challenge agent concentrations both inside and outside the suit. The ratio of the external and internal challenge agent concentrations is known as the "intrusion coefficent". Large coefficients indicate high suit integrity. During the exposure, the test subject also engaged in a series of exercises to test the suit under dynamic conditions. Lawrence Livermore National Laboratory tested several Coast Guard suit prototypes using both Freon and polyethylene glycol (PEG) aerosol as challenge agents. The analytical equipment for measuring Freon (an infrared spectrometer for high concentrations and a flame ionization gas chromatograph for low concentrations) could measure a larger range of concentration than the light scattering photometer used to measure PEG concentrations. As a consequence, it was possible to measure larger intrusion coefficients for Freon. On the other hand, Freon concentration could only be measured dicretely whereas the PEG aerosol was continuously monitored. For the combined tests, instrusion coefficients ranging from 9,000 to 100,000 were measured. Variations in these determinations appeared to be the result of specific test subject exercises and the location of the sampling probe. For example, when the sample probe was located inside the suit near the exhaust



Pressure Testing of Chemical Response Suit

Figure 17

valve, lower protection factors were observed indicating some diffusion of the chemical agent through the valves. Lawrence Livermore National Laboratory also measured internal suit pressure during these tests to assess the range of positive pressure experienced in the suit during operation. These latter results were used to identify overpressurization problems with the selected exhaust valves which were later corrected. Additional information and the results of this testing are provided in the attached Lawrence Livermore Report (Appendix K).

Simulated Chemical Exposure. An ultimate test of the Coast Guard's Chemical Response Suit was performed by Lawrence Livermore National Laboratory in a hostile chemical environment. Two prototype suits were field tested at the Department of Energy's Nevada Test Site in controlled releases of hydrogen fluoride. These suits were placed on specially designed mannequins in two separate tests and subjected to hydrogen fluoride vapor concentrations up to 12,000 ppm for a 6 minute period. The mannequins contained a pulsed breathing air supply to simulate normal operation of the suit's exhaust valves and four different hydrogen fluoride detection systems. The analytical results of the two tests indicated no penetration of hydrogen fluoride into the suit. There was also no evidence of visible damage to the contaminated suits. A Lawrence Livermore National Laboratory Report on this testing is provided as Appendix L.

Manned Functionality Testing. The Coast Guard conducted several informal manned tests of the Chemical Response Suit to assess ensemble comfort, fit, and function. Manned suit testing is often performed to determine the range of activities that a user can do while wearing the chemical protective suit and a breathing apparatus. These tests included different types of exercises or tasks which simulated the use of the Chemical Response Suit. Results from these tests were generally subjective regarding the design and fit of the garment. A number of improvements were identified for changing various features of the Chemical Response Suit. In one series of tests, the wearer's physiological condition (core temperature, skin temperature, heart rate, and blood pressure) were measured during testing to serve as a means for quantifying the physical stress on the wearer when compared to the same tests of the subject not wearing the suit. This study was also aimed at identifying parameters that could be easily measured in the field for evaluating worker condition to prevent heat stress. The most promising heat stress indicator found was the recovery heart rate, i.e, the measurement of heart rate following a period of rest. The results of these tests are reported in Coast Guard Final Report, "The Measurement of Heat Strain for Workers in Encapsulating, Impermeable Protective Clothing."[24]

Suit Operations

Use of Encapsulating Garments The Chemical Response Suit is the U. S. Coast Guard's Level A suit for hazardous chemical operations where no contact with a chemical or group of chemicals is permitted. These suits are therefore used when the chemical involved in a response includes high respiratory and skin absorption hazards. The criteria for selecting the Chemical Response Suit for level A protection are described in the Coast Guard's "Policy Guidance for Response to Hazardous Chemical Releases[26] and reference 27. The Coast Guard considers the Chemical Response Suit a 'one-use' suit, i.e., the suit is disposed of if it receives any significant chemical exposure. Significant exposure is defined by the on-scene commander for a particular chemical incident. Yet in general, if the suit is worn into an environment where measureable chemical vapors are present, or if the suit is splashed by liquid chemicals, or if an exposure cannot be determined the suit will not be reused. The basis for this policy rests in the fact that no non-destructive methods exist for determining the level of contamination a suit receives nor the effectiveness of any decontamination procedure. Other invesigators have demonstrated that chemical protective suit materials are contaminated below the surface which may render many conventional decontamination methods useless.[28]

General Suit Use The Coast Guard Office of Engineering and Development has prepared a suit operations manual listing procedures for donning, doffing and maintaining the suit. This manual is specific for the use of the Chemical Response Suit and dictates step-by-step procedures and backgound information pertinent to using the suit.

CHAPTER 6

CONCLUSIONS AND FUTURE PLANS

This report has described an extensive suit material/component testing program to support the Coast Guard's use of Challenge™ in their Chemical Response Suit. The program represents a comprehensive approach for selecting materials and evaluating their performance for chemical spill response and clean-up. Moreover, this type evaluation allows end-users to understand suit capabilities and limitations. The Coast Guard believes that the new material, Challenge™ 5100, will provide protection for more chemicals than any one suit or combination of suits it now uses. Few chemical protective suits offer the same level of documentation. It appears, however, that all primary suit materials and components should be tested to identify weaknesses that might otherwise go undetected. This situation was observed with the failure of the Teflon glove materials. Garment material performance alone does not provide a sufficient basis for making suit use recommendations. Recommendations for using the suits must be based on the performance of the weakest material or component.

Despite the extensive material testing conducted thus far, a number of other tests are required for establishing complete confidence in using the Chemical Response Suit. At the time this report was being prepared, several types of testing were underway; these included:

(1) Permeation Testing of Challenge™ 5100 against priority chemical gases;

(2) Additional permeation tests on Chemical Response Suit seams;

(3) Permeation testing of Challenge™ 5200 (a Teflon/fiberglass material) against ASTM F1001 Chemicals plus those chemicals which break through Challenge™ 5100. Preliminary results from Chemical Fabrics Corporation indicate that Challenge™ 5200 may have increased physical integrity and chemical resistance;

(4) Permeation testing of promising outerglove materials such as Siebe-North's Silvershield™ against representative chemicals; and

(5) Exhaust valve testing against various chemical atmospheres

In August 1987, the Coast Guard plans to initiate a new contract for material permeation testing against a large number of chemicals to expand the list of suit use recommendations. As before, the majority of these chemicals will be selected on the basis of their spill history and toxicity using more recent chemical data. Some of the chemicals will be chosen for modelling purposes, i.e., to help determine why some chemicals permeate the material while other similiar chemicals do not (e.g. allyl chloride versus allyl alcohol). The latter testing will be used to study the chemical interactions with Challenge™ 5100 to determine which chemical parameters may be used to predict material performance.

The overall design process for the Chemical Response Suit has been iterative. Successive changes in suit design have increased the comfort, fit, and function of the suit. However, some areas require improvement, as recommended by field units using the suit. Among these are:

(1) Expanding the boot splash cuff to allow wearers to move easily in outer boots; More recent versions of the Chemical Response Suit have been made with elasticized cuffs which may solve this particular problem.

(2) Eliminating the cooling system and replacement with a lighter, more functional cooling device; The current cooling system is heavy, reduces mobility, and is difficult to don. A new study has been initiated to evaluate the effectiveness of the current cooling system relative to other commerical cooling devices. The recommendations from this investigation will be used in considering modifications to the Chemical Response Suit.

(3) Developing Teflon/Nomex gloves; The Coast Guard will attempt to develop gloves made out of similiar materials as those used in the garment. The gloves remain a principal area of weakness in the Chemical Response Suit. Successful development of such gloves would eliminate glove selection problems and provide uniform chemical resistance to the wearer.

(4) Investigating alternatives to the cofferdam; Though the cofferdam provides equivalent protection to the user at the closure area, it can be difficult to heat-seal in a field setting. The alternative of a double zipper may be examined and tested to determine if this protective feature permeation or penetration of the suit closure.

(5) Examining other suit exhaust values; The current Stratotech values have a relatively high cracking pressure (2.5 inches water gauge). Tests at Lawrence Livermore National Laboratory have shown that pressures fluctuate within Chemical Response Suit from 0.1 to 8.0 inches water gauge. The suit manufacturer, Chemical Fabrics Corporation, has identified an alternative valve which has both a lower cracking pressure and high flow volume. Further testing of this valve is being conducted by Lawrence Livermore National Laboratory.

(6) Considering suit sizing; The "one size fits all" concept makes suit fit difficult for the range of Coast Guard personnel who must wear the Chemical Response Suit. The Coast Guard will investigate the possibility of a two or three size suit system in its future procurement of Chemical Response Suits.

The U. S. Coast Guard is actively participating in the development of consensus standards for chemical protective clothing in both the American Society for Testing and Materials (ASTM) and the National Fire Protection Association (NFPA). The latter organization is developing performance standards which will apply to the manufacturing of chemical protective suits. The Coast Guard hopes to transfer much of the testing technology it has developed into these standards. If this process is successful, the Coast

Guard will benefit by being able to use NFPA standards as the basis for its protective suit procurement specifications. The existence of such standards by themselves will also encourage improvements among manufacturers for better materials and end-products. This type of industry effort will therefore reduce the Coast Guard's need to undertake expensive development programs such as the one described in this final report.

REFERENCES

(1) "Chemical Hazard Response Information System (CHRIS)," Coast Guard Commandant's Instruction M16465.12A, Government Printing Office, Washington, D. C., November 1984 (Stock No. 050-012-00215-1).

(2) Friel, J. V., M. J. McGoff, and S. J. Rodgers, "Material Development Study for a Hazardous Chemical Protective Clothing Outfit," Technical Report CG-D-58-80, MSA Research Corp., Evans City, Pennsylvannia, August 1980 (NTIS # AD A095 993).

(3) Stull, J. O., "Early Development of a Hazardous Chemical Protective Ensemble," Technical Report CG-D-24-86, U. S. Coast Guard, Washington, D. C., October 1986 (NTIS # AD A174 885).

(4) Bentz, A. and V. Mann, "Critical Variables Regarding Permeability of Materials for Totally-Encapsulating Suits, Paper presented at 1st Scandanavian Symposium on Protective Clothing Against Chemicals, Copenhagen, Denmark, November 1984.

(5) Prevost, R. J. and P. K. Bowles, "A Marine Hazardous Substances Data System," Final Report CG-D-9-86, U. S. Coast Guard, Washington, D. C., December 1985 (NTIS # AD A167 289)

(6) "Fire Protective Guide on Hazardous Materials," 7th Edition, National Fire Protection Association, Boston, MA, 1978.

(7) Hendrick, M. S. and C. B. Billing, "Selection of Priority Chemicals for Permeation Testing and Hazardous Chemical Spill Detection and Analysis," Technical Report CG-D-22-86, U. S. Coast Guard R&D Center, Groton, Connecticut, July 1986 (NTIS # AD A172 370).

(8) ASTM F1001 (1986), Standard Guide for the Selection of Test Chemicals to Evaluate Protective Clothing Materials, Annual Book of ASTM Standards, Part 15.07.

(9) ASTM F739 (1985), Standard Test Method for Resistance of Protective Clothing Materials to Permeation by Liquids, Annual Book of ASTM Standards, Part 15.07.

(10) Man, V. et al, "Permeation of Protective Clothing Materials: 1. Comparison of Liquid, Liquid Splashes, and Vapors on Breakthrough Times," Paper presented at 1985 Pittsburg Conference on Analytical Chemistry and Applied Spectroscopy, Atlantic City, 1986.

(11) Forsberg, K. and S. Faniadis, "The Permeation by Multi-Component Liquids of Protective Gloves and Glove Reuse," Paper presented at the Scandinavian Symposium on Protective Clothing Against Chemicals, Copenhagen, Denmark, 1984.

(12) Michelson, R. L., M. M. Roder, S. P. Berardenelli, and L. D. Cottingham, "Permeation of Chemical Protective Clothing by Three Binary Solvent Mixtures," American Industrial Hygenists' Association Journel, April 1986, pp. 236-242.

REFERENCES (continued)

(13) Schwope, A. D., P. P. Costas, J. O. Jackson, J. O. Stull, and D. J. Weitzman, Guidelines for the Selection of Chemical Protective Clothing, 3rd Edition, American Conference of Government Industrial Hygienists, Inc., Cincinnati, Ohio, 1987 (NTIS #'s AD A179 516 and AD A179 164).

(14) Spence, Mark W., "Chemical Permeation through Protective Clothing Material: An Evaluation of Several Critical Variables," Paper presented at the American Industrial Hygienists' Conference, Portland, Oregon, 1984.

(15) Michelson, R. L. and R. C. Hall, "Breakthrough Time Comparison of Nitrile and Neoprene Glove Materials From Different Glove Manufacturers," Paper Presented at 1986 American Industrial Hygenists' Association Conference, Houston, Texas, May 1986.

(16) DuPont Technical Bulletin on Viton[R] Coating, 1985.

(17) Stull, J. O., "Criteria for Selection of Candidate Chemical Protective Clothing Materials," J. Industrial Fabrics, Vol. 4, No. 2, 1985, pp. 13-22.

(18) ASTM F903 (1985), Standard Test Method for Resistance of Protective Clothing Materials to Penetration by Liquids, Annual Book of ASTM Standards, Part 15.07.

(19) Berardenelli, S. P., and E. Moyer, "Methyl Isocyanate Liquid and Vapor Permeation Through Selected Respirator Diaphragms and Chemical Protective Clothings," American Industrial Hygenists' Association Journel, April 1987, pp. 324-350.

(20) Stull, J. O. et al, "A Comprehensive Materials Evaluation Program to Support the Development and Selection of Chemical Protective Clothing," Proceedings of the 1986 Hazardous Material Spills Conference, St. Louis, April 1986.

(21) Weeks, R. W. Jr. and M. J. McLeod, "Permeation of Protective Garment Material by Liquid Halogenated Ethanes and a Polychlorinated Biphenyl," Technical Report DHHS 81-110, NIOSH, U. S. Government Printing Office, Washington, D. C., January 1981.

(22) Blood, B. D. and R. E. Radke, "Development of a Communications System Compatible with Chemical Protective Clothing and Equipment," Technical Report CG-D-18-86, Remic Corporation, Elkhart, Indiana, June 1986 (NTIS # AD A170 683).

(23) ASTM F1052 (1987), Standard Practice for Pressure Testing of Totally-Encapsulating Chemical Protective Suits, Annual Book of ASTM Standards, Part 15.07.

REFERENCES (continued)

(24) Eley, W. D., "An Evaluation of Heat Strain Monitoring Methods for Workers in Encapsulating, Impermeable Protective Clothing,: Technical Report CG-D-12-87, University of North Carolina, Chapel Hill, North Carolina, May 1987 (NTIS # AD A180 555).

(25) Veghte, J. H., "Physiologic Field Evaluation of Hazardous Materials Protective Ensembles," Paper submitted to 2nd International Symposium on the Performance of Protective Clothing, Tampa, Florida, January 1987.

(26) U. S. Coast Guard Commandant's Instruction M16465.30, "Policy Guidance for Response to Hazardous Chemical Releases," U. S. Department of Transportation, Washington, D. C.

(27) Gaines, R. B., "The Role of the U. S. Coast Guard Strike Teams in Hazardous Chemical Response," Paper submitted to 2nd International Symposium on the Performance of Protective Clothing, Tampa, Florida, January 1987.

(28) S. Z. Mansdorf, "Risk Assessment of Chemical Exposure Hazards in the Use of Chemical Protective Clothing — An Overview," Performance of Protective Clothing, ASTM STP 900, R. L. Barker and G. C. Coletta, Ed., American Society for Testing and Materials, Philadelphia, 1986, pp. 207-213.

APPENDIX A

SELECTION OF PRIORITY CHEMICALS

(Condensed from Reference 7)

CLASSIFICATION OF CHEMICALS

Encapsulation Requirement:

+ Exposure to chemical requires encapsulating protection based on recommendations in "Material Development Study for a Hazardous Chemical Protective Clothing Outfit," Technical Report CG-D-58-80 (reference 2).

- Exposure to chemical does not require encapsulating protection, or no determination on the need for encapsulation has been made.

Spill History:

+ Chemical was involved in a spill as reported to the Pollution Information as reported in the U. S. Coast Guard Pollution Incident Reporting System, 1979-1983 (See Table A-1).

- No spill history exists for the chemical during 1979-1983 in the Pollution Incident Reporting System.

Hazard Level:

A Chemical has been assigned either a carcinogen class "1" or highly toxic "2", or is toxic through skin absorption as reported in "A Marine Hazardous Substances Data System," Final Report CG-D-9-86 (reference 5); or the National Fire Protection Association has assigned the chemical a "4", its highest health hazard rating (reference 6).

B Chemical has a hazard assessment index of "3" as reported in reference 5, or a NFPA rating of "3".

C Other chemicals not included in either classes A or B.

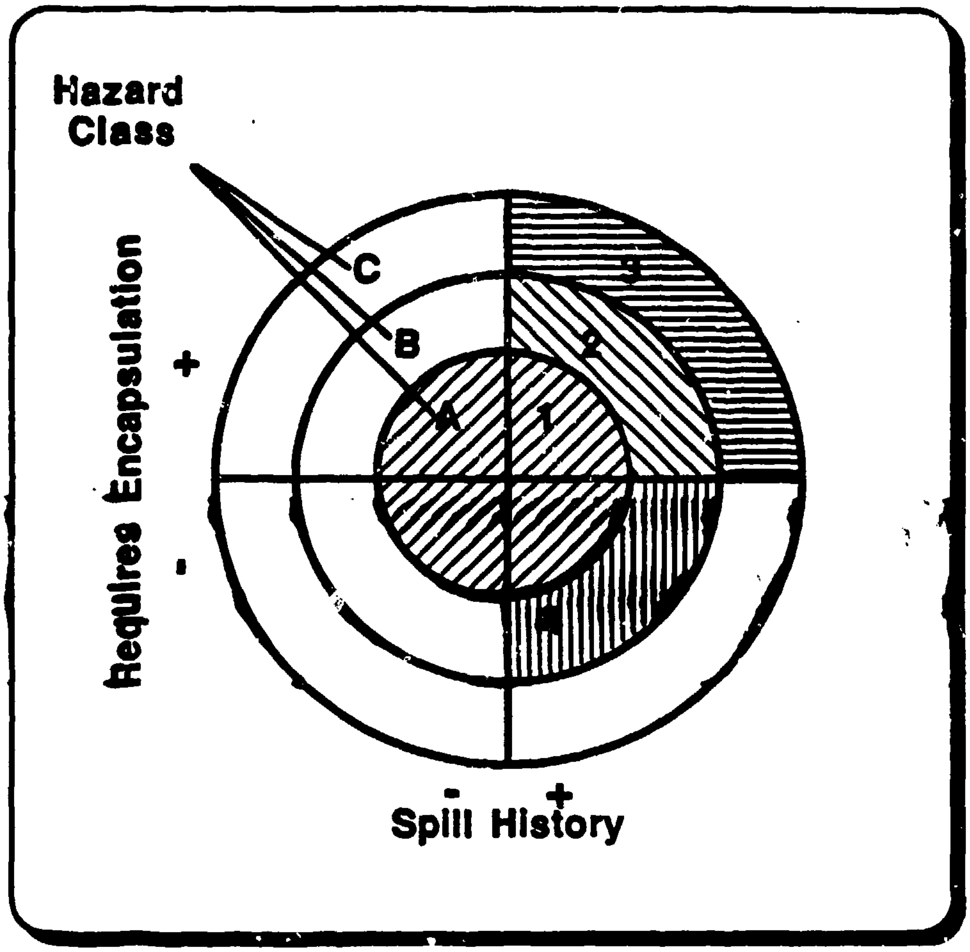


FIGURE 1. - SELECTION CRITERIA USED FOR PRIORITY HAZARDOUS CHEMICALS PERMEATION TESTING

CHEMICAL PRIORITY CATEGORIES
SELECTED FOR TESTING

Category I-IVA - All chemicals at Hazard Level A. Only 12 of these chemicals had not been designated as requiring encapsulation. A decision was made to include them in the testing group to avoid relying on a single source of personnel protection safety information (reference 2). This group included 51 chemicals.

Category IB - Hazard Level B chemicals with both an encapsulating suit requirement and a spill history. There were 24 chemicals in this group.

Category IC - Fourteen chemicals which had both a spill history and a need for encapsulating protection, but were not either of Hazard Level A or B.

Category IIIB - Chemicals in Hazard Level B with a spill history but did not require ensapsulating protection. This group included 27 chemicals.

TABLE A-1

KEY TO DETECTOR CODES AND COLLECTION MEDIA FOR PERMEATING TESTING

Method of Detection	Collection Medium
Gas Chromatographic Techniques	
F = Flame Ionization Detector	air
E = Electron Capture Detector	air
H = Hall Detector	air
FP = Flame Photometric Detector	air
Colorimetric Techniques	
C = Colorimetric standard method or commerical test kit based on method	water
Ion Chromatography	
A = Anion Column	water
Cat = Cation Column	water
Other Techniques	
SI = Specific ion electrodes	water
P = Polarography	water
IR = Infrared spectrographic analysis	air

TABLE A-2

Group I-IVA Liquid Chemicals
Arranged by Number of PIRS Spills ('73-'83)

PS = PIRS spills
S = Need for encapsulated suit (Y=Yes)

CHRIS	CHEMICAL NAME	DETECTOR CODE	PS	S
BNZ	benzene	F	91	Y
TOL	toluene	F	81	
ST	styrene	F	59	
CRS	cresol	F/C	33	
PHN	phenol	F/C	26	
FMS	formaldehyde	C	17	Y
MTC	methyl chloride	H/E	15	
ACN	acrylonitrile	F	12	Y
NAC	nitric acid	A/C	8	Y
VAM	vinyl acetate	F	8	Y
~~VCI~~	~~vinylidene chloride~~	~~H/E~~	~~8~~	Y
~~CBT~~	~~carbon tetrachloride~~	~~H/E~~	~~6~~	
HFA	hydrofluoric acid	A/C	6	Y
~~TCL~~	~~trichloroethylene~~	~~H/E~~	~~5~~	Y
~~ADN~~	~~adiponitrile~~	~~F~~	~~4~~	Y
CRF	chloroform	H/E	3	Y
EAM	ethylamine	F	3	Y
ANL	aniline	F	2	Y
BAN	n-butyl alcohol	F	2	
BCL	benzyl chloride	F	1	Y
BVA	t-butyl amine	F	1	Y
CSA	chlorosulfonic acid	A	1	Y
EPC	epichlorohydrin	H/E	1	Y
HCN	hydrogen cyanide	SI/C	1	Y
MPT	methyl parathion mp=65F	FP	1	Y
NTB	nitrobenzene	E	1	Y
PTO	parathion	FP	1	Y
POX	propylene oxide	F	1	
TEC	1,1,2,2-tetrachloroethane	H/E	0	Y
DPC	1,3-dichloropropene	H/E	0	
DOX	1,4-dioxane	F	0	
NPP	2-nitropropane	F/FP	0	Y
ALC	allyl chloride	H/E	0	Y
BRX	bromine	C/P	0	Y
CBB	carbon disulfide(bisulfide)	E	0	Y
CPL	chloropicrin	H/E	0	Y
CTA	crotonaldehyde	F	0	Y

TABLE A-2 (continued)

CHRIS	CHEMICAL NAME	DETECTOR CODE	PS	S
DEE	dichloroethylether	H/E	0	Y
DIA	diisopropylamine	F	0	
DSF	dimethyl sulfate	FP	0	Y
EDB	ethylene dibromide	H/E	0	Y
EDC	ethylene dichloride	H/E	0	Y
GTA	glutaraldehyde	F	0	Y
HFX	hydrogen fluoride	C/A	0	Y
IPP	isopropylamine	F	0	Y
MFA	motor fuel anti-knock compounds (lead alkyls)	E	0	Y
TLI	o-toluidine	F	0	
STC	silicon tetrachloride	E	0	Y
TDI	toluene diisocyanate	F	0	Y
ACY	acetone cyanohydrin	F	0	Y
BAM	n-butylamine	F	0	Y

There are a total of 51 chemicals.

There are a total of 398 spills.

TABLE A-3

Group IB Encapsulated Suit Liquid Chemicals with a Spill History Arranged by Number of PIRS Spills ('73-'83)

PS = PIRS spills
H = Hazard Index
N = NFPA classification

CHRIS	CHEMICAL NAME	DETECTOR CODE	PS	H	N
SFA	sulfuric acid	A/C	128	3	3
AAC	acetic acid	F	13	3	2
ACT	acetone	F	11	3	1
EAC	ethyl acrylate	F	11	3	2
ACR	acrylic acid	F	10	3	3
MIK	methyl isobutyl ketone	F	5	3	2
AAD	acetaldehyde	F	4	3	2
TCE	trichloroethane	H/E	4	3	2
ACE	acetic anhydride	IR	2	3	2
ATN	acetonitrile	F	2	3	2
ALA	allyl alcohol	F	2	3	3
DPP	dichloropropane	F/E	2	3	2
ACC	acetyl chloride	IR	1		3
ARL	acrolein	F	1		3
MAM	methyl acrylate	F	1	3	2
TEL	tetraethyl lead	E	1		3
XYL	xylenol	F	1	5	3
DNA	di-n-propylamine	F	0	5	3
HDZ	hydrazine	P/C	0		3
PRA	n-propyl amine	F	0	4	3
OLM	oleum	A/C	0	3	3
PPT	phosphorus trichloride	E	0		3
CSS	sodium hydroxide solution	Cat	0	3	3
TML	tetramethyl lead	E	0		3

There were a total of 199 spills.

There are a total of 24 chemicals in this group.

TABLE A-4

Group IC Encapsulated Suit Liquid Chemicals with a Spill History
Arranged by Number of PIRS Spills ('73-'83)

PS = PIRS spills
H = Hazard index
N = NFPA index

CHRIS	CHEMICAL NAME	DETECTOR CODE	PS	H	N
PCB	polychlorinated biphenyl compounds	E	92		
CDN	chlordane	E	3		
HPO	hydrogen peroxide 60%	C	2		2
MLT	malathion	FP	2		
BTR	n-butyraldehyde	F	2	5	2
SHR	sodium hydrosulfide solution	C/A/Cat	2	5	
ETO	ethion	FP	1		
ETC	ethylene cyanohydrin	F	1	5	2
NLD	naled	E	1		
PPO	phosphorus oxychloride	C/A	1		
SFM	sulfur monochloride	C/A	1		2
TEP	tetraethyl pyrophosphate	FP	1		
CCT	creosote	F	0	5	2
CMH	cumene hydroperoxide	F	0		1

There were a total of 109 spills.

There are a total of 14 chemicals in this group.

TABLE A-5

Group IIIB Non-encapsulated Suit Liquid Chemicals with a Spill History
Arranged by PIRS Spills ('73-'83)

PS = PIRS spills
H = Hazard assessment index
N = NFPA classification

CHRIS	CHEMICAL NAME	DETECTOR CODE	PS	H	N
XLM	xylene (meta-xylene as model)	F	92	3	2
EGL	ethylene glycol	F	23	3	1
PAC	phosphoric acid	C/A	22	3	2
CHX	cyclohexane	F	17	3	1
MAL	methyl alcohol	F	11	3	1
NTM	naphthalene	F	10	3	2
EAL	ethyl alcohol	F	9	3	0
MEK	methyl ethyl ketone	F	6	3	1
EDA	ethylenediamine	H/E	5	3	3
TPT	turpentine	F	5	3	1
DCM	methylene chloride	H/E	4	3	2
HXA	n-hexane	F	4	3	1
ETB	ethyl benzene	F	3	3	2
MMM	methyl methacrylate	F	3	3	2
DEA	diethanolamine	F	2	3	
CRB	chlorobenzene	H/E	1	3	2
ETA	ethyl acetate	F	1	3	1
EET	ethyl ether	F	1	3	2
FFA	furfural	F	1	3	2
BCN	n-butyl acetate	F	1	3	1
BTC	n-butyl acrylate	F	1	3	2
PAL	n-propyl alcohol	F	1	3	2
PNA	propionic acid	F	1	3	2
GAT	gasoline	F	0	3	1
IPA	isopropyl alcolol	F	0	3	1
NSS	naphtha	F	0	3	2
TTE	tetrachloroethylene	H/E	0	3	2

There were a total of 224 spills.

There are a total of 27 chemicals in this group.

TABLE A-5

PRIORITY LIST HAZARDOUS CHEMICALS

In order of Spill Frequency

CHRIS	CHEMICAL NAME	PIRS SPILLS
SFA	sulfuric acid	128
SHD	caustic soda (sodium hydroxide)	95
PCB	polychlorinated biphenyl compounds	92
XLM	xylene	92
BNZ	benzene	91
AMA	ammonia	85
TOL	toluene	81
HCL	hydrochloric acid	63
STY	styrene	59
CLX	chlorine	35
CRL	cresol	33
PHN	phenol	26
EGL	ethylene glycol	23
PAC	phosphoric acid	22
FMS	formaldehyde	17
CHX	cyclohexane	17
MTC	methyl chloride	15
AAC	acetic acid	13
TTE	tetrachloroethylene	12
ACN	acrylonitrile	12
ACT	acetone	11
EAC	ethyl acrylate	11
MAL	methyl alcohol	11
ACR	acrylic acid	10
NTM	napthalene	10
EAL	ethyl alcohol	9
NAC	nitric acid	8
VAM	vinyl acetate	8
VCI	vinylidene chloride	8
ALM	aluminum sulfite	7
CBT	carbon tetrachloride	6
HFA	hydrofluoric acid	6
MEK	methyl ethyl ketone	6
TCL	trichloroethylene	5
EDA	ethylenediamine	5
MIK	methyl isobutyl ketone	5
TPT	turpentine	5
AAD	acetaldehyde	4
DCM	methylene chloride	4
HXA	n-hexane	4

TABLE A6(continued)

CHRIS CHEMICAL NAME	PIRS SPILLS
TCE trichloroethane	4
CRF chloroform	3
EAM ethylamine	3
PPW phosphorus	3
ETB ethyl benzene	3
MMM methyl methacrylate	3
ANL aniline	2
ACA acetic anhydride	2
ATN acetonitrile	2
ALA allyl alcohol	2
DEA diethanolamine	2
MLA maleic anhydride	2
BAN n-butyl alcohol	2
BCL benzyl chloride	1
BTY butyl amine	1
CSA chlorosulfonic acid	1
DMA dimethylamine	1
EPC epichlorohydrin	1
NTB nitrobenzene	1
POX propylene oxide	1

APPENDIX B

TEST METHODOLOGY FOR PERMEATION TESTING AND DETERMINATION OF MINIMUM DETECTION LIMIT

(Contractor Report by Texas Research Institute)

86176:LNB
8 April 1986

MONTHLY STATUS REPORT

CHEMICAL TESTING OF PROTECTIVE
CLOTHING MATERIAL

Contract No. DTCG39-86-A-80331
Task Order 0001

Submitted to:

Contracting Officer
U. S. Coast Guard Academy
New London, CT 06320-4195

Submitted by:

Texas Research Institute, Inc.
9063 Bee Caves Road
Austin, TX 78733-6201
512-263-2101
512-263-3151

B-1

1.0 INTRODUCTION

The majority of the time in the reporting period was devoted to setting-up for testing. This included modifications of the test apparatus to accommodate three permeation cells, and addition of valves and plumbing to permit the introduction of the permeant at a known concentration for the purpose of establishing minimum detectable limits. The apparatus and test results are described below.

2.0 PERMEATION TEST APPARATUS

A photograph of the apparatus is attached as Figure 1, and a schematic of the valving and plumbing is shown in Figure 2. This configuration is different from the original design presented to Lt. Stull, the Project Officer, and Dr. Alan Betz, the COTR. The apparatus will simultaneously monitor the collection gas (N_2) from three cells. Rather than switching from cell to cell, the system is currently monitored by routing the collection gas from the cells into a common line and then diverting a portion of this to the photoionization detector (PID). This type of composite testing was established to permit a more rapid testing. No breakthrough will be observed with the majority of the chemicals during the 3-hour maximum exposure period. Therefore, testing these chemicals with individual cells for 3 hours each would result in 9 hours of negative data. If breakthrough is observed, the cells will be re-run individually and average breakthrough times and permeation rates will be calculated.

The testing is conducted in the following manner. Instrument-grade nitrogen is introduced into the system through three flow meters, each controlling the flow to the collection side of the permeation cells (refer to the yellow lines in Figure 2). Flow rates are set at 90 ml/min., which is equivalent to two volume changes per min. in the collection side. Preliminary experiments have shown that with toluene as a permeant and plasticized polyolefin as the barrier, flow rates did not affect breakthrough times except below 30 ml/min. It was reasoned that flow rates above 90 ml/min. would only decrease the sensitivity of the system. More importantly, an increase in flow rate would result in a substantial increase in pressure. This pressure against the sample would more than likely alter the permeation rate. All of the tubing and fittings throughout the system are narrowbore glass, Teflon, and stainless steel and are not conducive to high (> 100 ml/min.) flow rates without rises in pressure. It might by argued that this flow rate is insufficient to result in vaporization of rapidly permeating and poorly volatile chemicals. If this case were to happen, TRI feels that results from every test system could be questioned. Breakthrough times are not expected to vary appreciably. However, permea-tion rates would reflect both diffusion plus the volatilization rate of the chemical. Thus, the flow rate and resulting volatilization rate in one system would give different results from another system even though the recommended minimal flow rates, as specified by the ASTM Standard, were met.

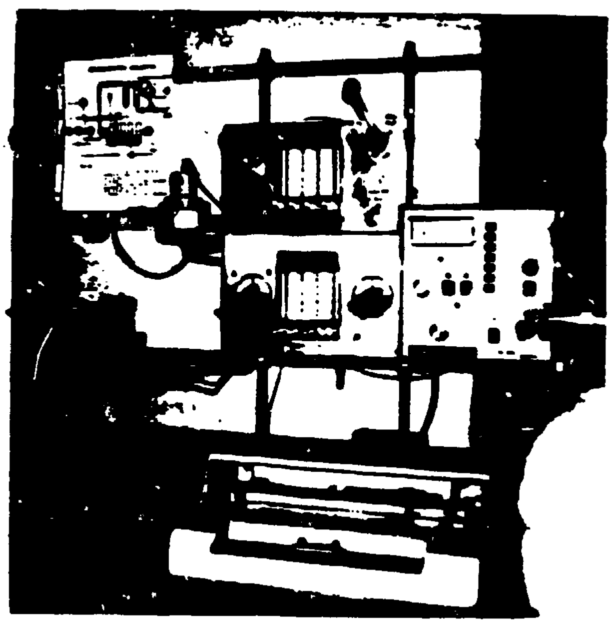
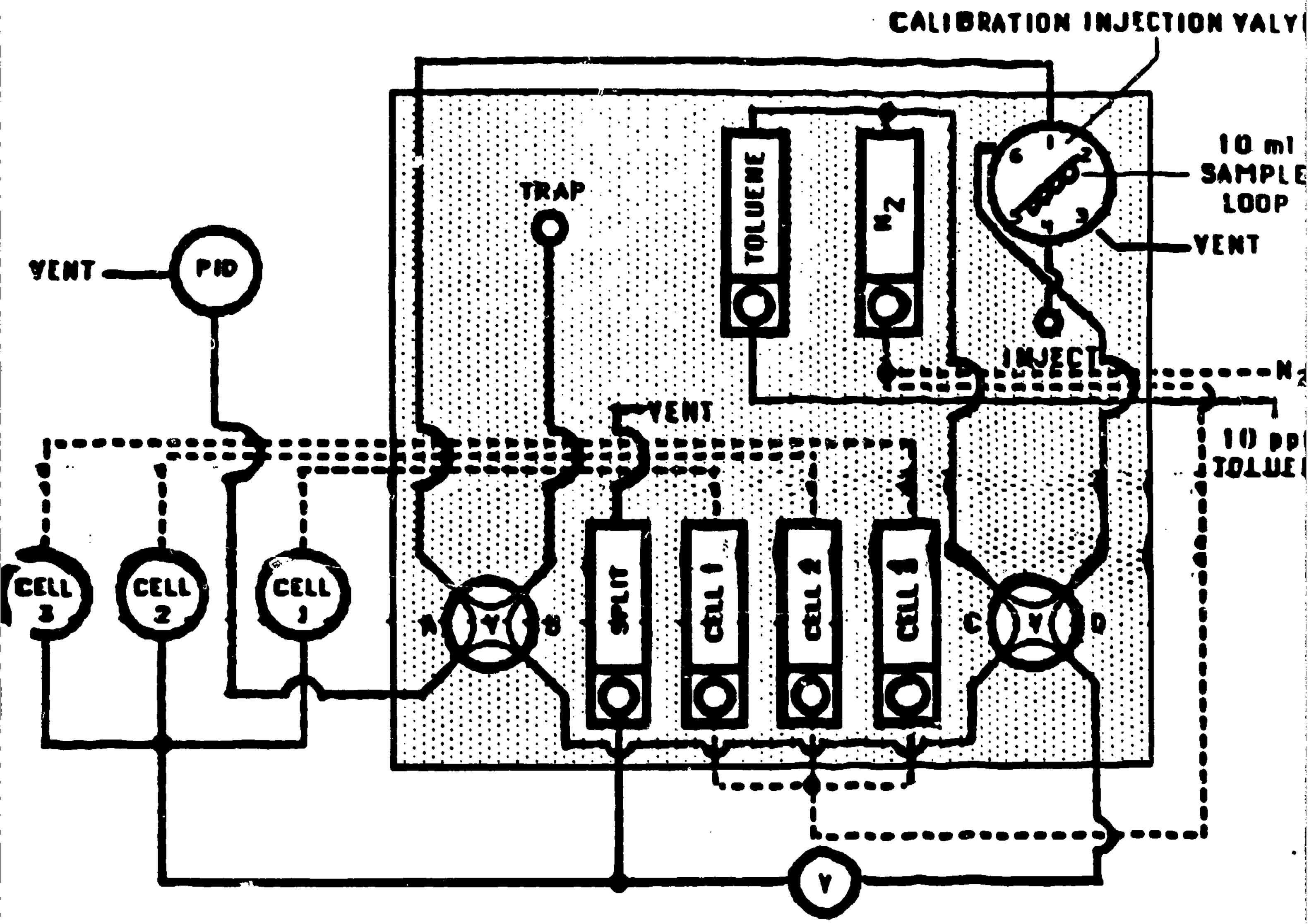


Figure 1 - Photograph of PID System

Figure 2

PERMEATION TEST APPARATUS



POSITION	PROCESS
A C	CELLS TO DETECTOR VIA INJECTION VALVE. N_2/TOLUENE TO TRAP.
A D	CELLS TO TRAP. N_2/TOLUENE TO DETECTOR VIA INJECTION VALVE.
B C	CELLS TO TRAP VIA INJECTION VALVE. N_2/TOLUENE TO DETECTOR.
B D	CELLS TO DETECTOR. N_2/TOLUENE TO TRAP VIA INJECTION VALVE.

The carrier gas exiting the cells is split, so that 60 ml/min. is routed to the PID and the remainder is vented (refer to blue lines in Figure 2). The portion going to the detector flows first through a Swagelok needle valve to control the split and then that to a two-position valve with positions marked "C" and "D". From this valve the gas can either flow directly to a second valve with positions "A" and "B" or arrive at that valve via a calibration injection valve. The gas can then be routed to the PID or to the port for trapping with adsorbents.

A typical test might proceed as follows. A cell is prepared and attached to the system without the challenge chemical. The glassware and Teflon gaskets are baked in a vacuum oven at 100°C to prevent out-gasing of contaminants. The flow rate and electrometer/detector settings are established to record a steady baseline. The timing of the test begins upon addition of the challenge chemical. The recorder indicates the breakthrough time and the lag period before steady-state permeation is reached. When steady-state permeation is indicated, the valve is switched to position "B" thus diverting the gases to the adsorbent trap (e.g., charcoal, Tenax, chromosorb, silica gel). Several adsorbent tubes are used to collect discrete sample volumes. These tubes are desorbed and analyzed by gas chromatographic techniques specified by the NIOSH Manuals. If no breakthrough occurs during the 3 hour maximum test period, two methods for checking the sensitivity and minimum detectable limits for the system are employed.

The first method involves the establishment of a known concentration of toluene in the system. Figure 2 depicts the process of calibration with toluene. A 10.2 ppm toluene in nitrogen mixed gas (Scott Specialty) is routed through a flow meter (marked toluene) and joins downstream to a nitrogen line. The two flow meters (toluene and nitrogen) allow the mixing of a standard gas containing from zero to 10.2 ppm toluene. The mixed gas is then routed through the system to the PID. Figure 3 shows a typical detector response in millivolts as a function of toluene concentration from one to five parts per million. The scatter in data points is not due to the detector response, but rather to the inability to accurately produce a toluene standard using the flow meters. However, for these purposes the accuracy of the toluene standards is acceptable. The sensitivity of the system exceeds the limits of the flow meters to mix a very low (< 1 ppm) toluene standard. The noise in the system is ± 0.4 mv. A signal that is twice the noise would be easily recognized. Based on this assumption, a signal of 0.8 mv above baseline would be the minimum detectable limit. For toluene, the 0.8 mv response would correspond to 0.04 ppm toluene at a 60 ml/min. flow rate through the detector.

Other chemicals with a substantially different response will have different minimum detectable limits with the PID system. Therefore, if no breakthrough occurs, MDLs will be checked in an empirical manner by a second method. This involves a 6-port injection valve and calibration sample loop that is illustrated in Figure 2. A static gas sample is prepared with glass, gas

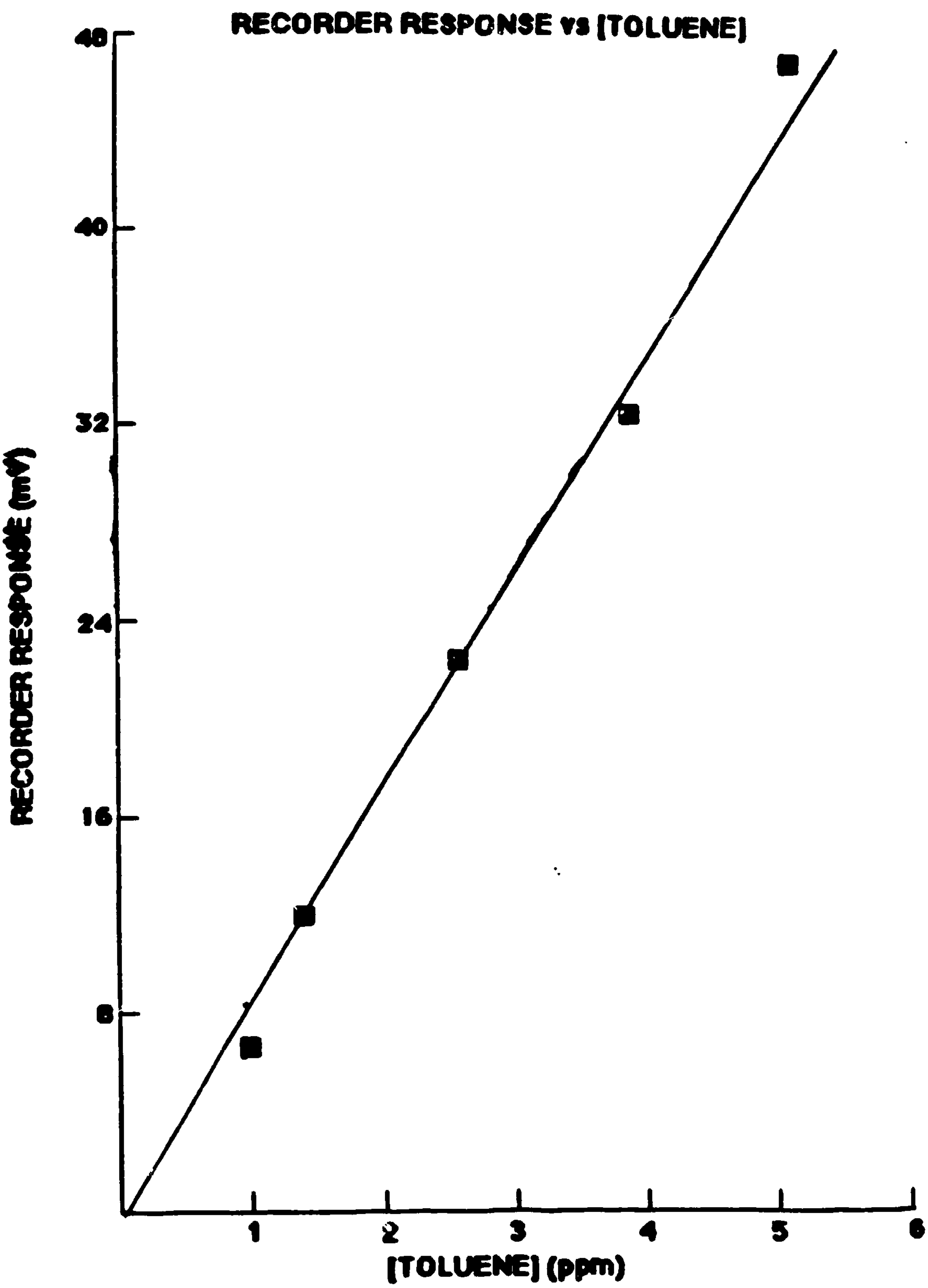


Figure 3 - Sensitivity and Linearity of PID to Toluene.

collection bottles equipped with septa. Typically, the standard is prepared by volatilization of a known amount of the chemical followed by appropriate dilution. The prepared standard ($\leq$ 1 ppm) is then loaded in the injection sample loop (10 ml) and injected in the system at 60 ml/min. The detector will respond for approximately seven seconds to this chemical. Assuming linearity in the detector response, an MDL will be calculated at a signal that is twice the noise. This value will always be overstat ', simply because the standard chemical that is injected will be less than the calculated concentration due to unavoidable sorption of the chemical to glass and metal surfaces.

2.1 Problem Areas

The permeation testing of the Challenge 5100 material has been slow to get started,. There are several reasons for this. One is the re-fixturing to accommodate three cells and to provide for a method of establishing MDLs for each chemical. The following is a list of gliches and set-backs that have been corrected:

(1) Off-gassing of hydrocarbons from O-rings and adsorption of permeants by O-rings. Corrected by going to all stainless steel and glass construction with short segments of Teflon tubing.

(2) Leaks in cells because of back-pressure from low dead volume tubing and improper tightening of flanges. Corrected by re-plumbing the system to eliminate back pressure. Verification of leak-proof assembly was achieved by testing of cells with a device containing a magnahelic gauge. Small leaks can be quickly detected during assembly of the cells.

(3) Sensitivity of the system to vibrations and temperature changes. Corrected, as best as possible, by placement in a stable environment.

(4) Problems with off-gasing of previously used Teflon gaskets and glassware. Corrected by incubation of the gaskets in a vacuum oven at 100 C.

(5) System shut-down due to damaged UV light source. Corrected by replacement of the light source. The light source was of a new design, thus necessitating a restart of permeation testing because of different sensitivity.

(6) Adsorption of chemicals on the walls of the stainless steel tubing. It is apparent that some adsorption of chemicals will unavoidably occur on the walls of the tubing. This has been observed with system checks using toluene. TRI is still in the process of grappling with this problem which is common to all sensitive permeation test apparatuses. The only area that is affected is the minimum detectable limits because the path of the

MDL standards is not exactly the same as the permeants. If no solutions can be found, MDL values will be expressed as "less than or equal" values. that is, if 0.1 ppm of a standard gave a detector signal of twice the noise, then the MDL would be reported as ≤ 0.1 ppm. The less than figure would signify that the concentration at the detector was probably less than 0.1 ppm because of adsorption, but if there were 0.1 ppm at the detector, the detector response would have been at least twice the noise.

3.0 RESULTS

Complete tests of the material with toluene, styrene and cresol have been completed. These are attached in the requisite formatting and with Xerox copies of actual recorder tracings. Phenol has been tested with no breakthrough. However, these results are pending the establishment of MDLs.

4.0 PROJECTED SCHEDULE

The apparatus is currently working well except for the previously stated problem with establishing MDLs. Rather than delay testing, TRI will continue to do the testing and establish MDLs at a later date, when other ideas have tested. TRI will continue to use the toluene standard to verify reproducibility and sensitivity of the system.

The projected schedule is 10 chemicals per week. This schedule was started April 3 and barring unforeseen problems, the 117 chemicals will easily be completed before the end of the fiscal year.

It is suggested that the COTR visit TRI for discussions on MDLs, future work with mixtures, and analytical methods that do not use gas chromatography. it is also suggested that test sheets of well-characterized neoprene be provided to TRI for testing with one or more chemicals. This testing will ensure that test results with the PID system are comparable to those reported by other investigators.

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION DATA
(One Material-One Chemical Series)

I. DESCRIPTION OF PRODUCT EVALUATED

A: TYPE: Teflon laminated NOMEX
B: MATERIAL GENERIC NAME: Challenge 5100
C: CONDITION BEFORE TEST: Unused, no visible imperfections -
D: SUPPLIER: Chemical Fabric Corp.

E: CATALOG NUMBER: N/A
F: LOT OR MANUFACTURER DATE: N/A
G: NOMINAL THICKNESS: 15-20mil
H: DESCRIPTION:

II. TEST METHOD (ASTM F739-81 or EQUIVALENT)

A. DATE TESTED: April 2, 1986
B. TESTING LABORATORY: Texas Research Institute
9063 Bee Caves Road, Austin, TX 78733
C. ANALYTICAL METHOD: Continuous photoionization detection
D. TEMPERATURE: 22-25°
E. COLLECTION MEDIA: N_2
SYSTEM: N_2
F. OTHER TEST CONDITIONS:
G. DEVIATIONS FROM ASTM F739-81 METHOD: Flow rate to cells was 90cc/min
H. COMMENTS:

III. CHALLENGE CHEMICAL

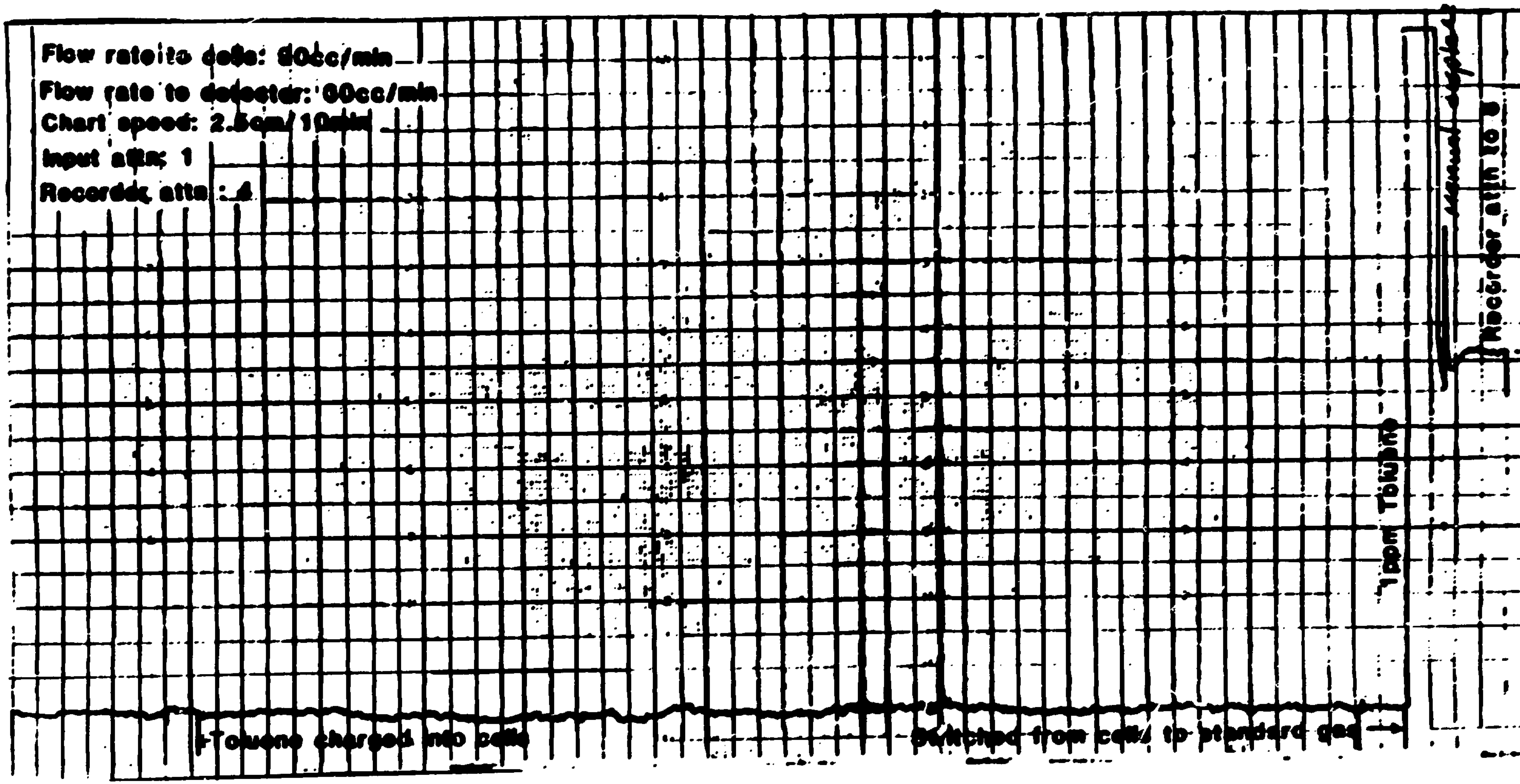
A. CHEM NAME(s)	Toluene	Toluene	Toluene
B. CAS NUMBER(s)	292	292	292
C. CONC. (IF MIX)	N/A	N/A	N/A
D. CHEMICAL SOURCE	J.T. Baker Reagent grade	J.T. Baker Reagent grade	J.T. Baker Reagent grade

IV. TEST RESULTS

A. NUMBER OF SAMPLES TESTED: Three
B. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
MIN DETECTABLE LIMIT: 0.04 ppm
C. STEADY STATE PERMEABILITY RATE: N/A
ANALYTICAL SENSITIVITY: 0.3 Coulombs/gram (benzene)
D. SAMPLE THICKNESS: 17-19 mil
E. OTHER OBSERVATIONS:

V. SOURCE OF DATA
Samples were run by Karen Verschoor on April 2, 1986

Chemical Resistance Testing of USCG Material with Toluene



86176:DJM
15 January 1986

FINAL TASK REPORT

SYRINGE PUMP METHOD FOR DETERMINING MINIMUM DETECTION LIMIT

Chemical Resistance Testing
of Protective Clothing Material

Contract No. DTCG39-86-A-80331
Task Order 003

Submitted To:

Contracting Officer
U.S. Coast Guard Academy
New London, CT 06320-4195

Submitted By:

Texas Research Institute, Inc.
9063 Bee Caves Road
Austin, TX 78733-6201
512/263-2101

B-11

TABLE OF CONTENTS

LIST OF FIGURES

1.0 INTRODUCTION

The determination of minimum detection limits is necessary to obtain meaningful permeation results for the USCG project. A syringe pump method has been used with satisfactory results with TRI's permeation test system. This final report outlines the further development of this methodology. Completion of this third task order also includes an application manual and fabrication of the system.

2.0 EQUIPMENT

The apparatus used to perform the permeation testing consisted of ASTM standard two inch or one inch glass permeation cells with PTFE gaskets and a photoionization detector. Stainless steel tubing and short pieces of flexible PTFE tubing allowed a flow of nitrogen to continually sweep through the collection side of the cell to the detector. The photoionization detector was an HNU model PI-52-02 outfitted with either an 11.7 or 10.2eV lamp. The response from the detector was recorded on a Houston Instruments strip chart recorder.

A Sage Instruments syringe pump Model 341 was used with an SGE, gas tight, removable-needle, 5 μl glass syringe to pump the chemical of interest. The syringe was outfitted with needles cut from small diameter vitreous silica tubing. The syringe was modified to better fit the needs of the system.

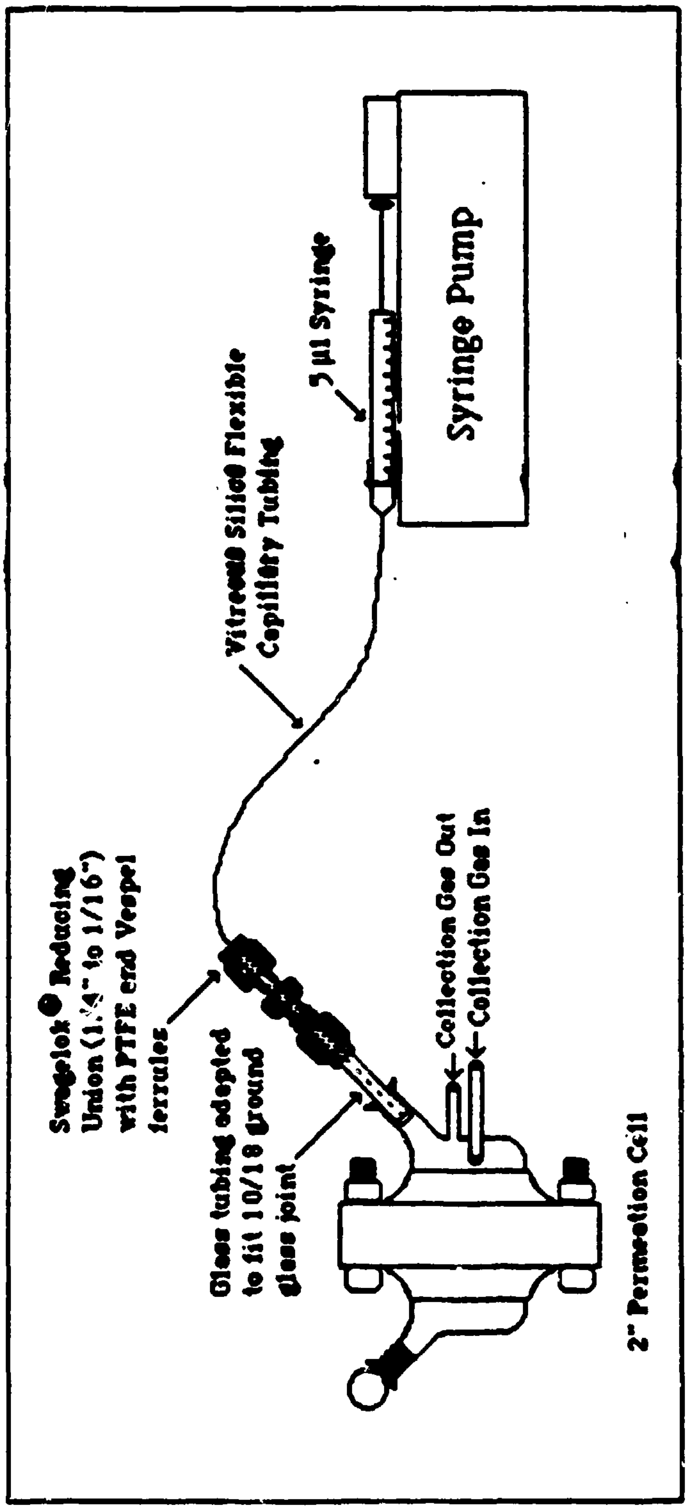
3.0 METHODS

The permeation test apparatus was operated by methods consistent with ASTM method D-739. Standard 2 inch permeation cells were used in which aluminum foil was sandwiched between the challenge side and the collection side of the cell to create an impermeable barrier for MDL determination. Nitrogen flowed at 100 cc/min into the collection side of the cell, across the sample surface and out to the photoionization detector in an open loop system. The collection side of the cell was continually monitored for the presence of the challenge chemical.

Minimum detection limits were determined by pumping the chemical of interest into the collection side of a standard permeation cell at a very slow rate using a syringe pump. The chemical was filtered prior to filling the syringe using a 0.2 micron disposable filter assembly. The tip of the needle was placed into a specifically fabricated glass joint fitted to the permeation cell (see Figure 1).

A constant low level concentration of the chemical of interest was delivered to the detector via the same pathway a permeant would travel. The pump rate could be adjusted from a minimum of 0.116 µl/hr to many higher settings. The concentration of the chemical of interest being delivered to the detector was calculated using the following equation:

FIGURE 1


Syringe Pump
5 µl Syringe
Flexible
Capillary Tubing
Swagelok® Reducing
Union (1/4" to 1/16")
with PTFE and Vespel
ferrules
Glass tubing adapted
to fit 10/18 ground
glass joint
Collection Gas Out
Collection Gas In
2" Permeation Cell

$$ppm = \frac{d \times MV \times PR}{MW \times F}$$

where d is the density, MV is the molar volume (24,450 (µl/mmole)), PR is the syringe pump rate (µl/hr), MW is the molecular weight (mg/mmole), and F is the nitrogen flow rate (l/hr).

The millivolt response generated from the determined concentration was used to calculate the minimum detectable limit. The minimum detectable limit was subjectively defined as the concentration corresponding to the response that was twice the noise level. The noise level was determined as the long term fluctuation from the average baseline.

4.0 APPLICATIONS

Initially the response generated by the slow introduction of the chemical into the permeation cell was not a smooth recorder tracing. The tip of the needle was placed directly in the stream of nitrogen entering the collection side of the permeation cell. This resulted in a wildly pulsating response that centered around the expected value. This was possibly caused by microdroplet formation at the tip of the needle. An increased response was produced when the droplets were dispersed by the force of the nitrogen stream and evaporated. This was followed by a period of lower response while the microdroplet was reforming.

To alleviate this problem, the needle was then placed into the adapter at the glass joint of the permeation cell. This removed the tip of the needle from the turbulent nitrogen stream and forced the chemical to diffuse down the glass adapter before entering the outlet stream. This diffusion process helped to average out minor concentration variations. It was found that the placement of the needle closer to the nitrogen stream caused a more varied response. Placement of the needle tip in the center of the length of the ground glass stopper provided the optimum response.

Three sizes of capillary tubing (0.025, 0.050, and 0.075 mm inside diameter) were used as needles in the system. It was expected that a smaller diameter tubing would decrease the size of the microdroplet formed and help decrease the amplitude of the pulsing response. The tubing had no apparent effect on the response.

A disk of glass fiber filter was cut to fit the inside diameter of the ground glass adapter and placed at the tip of the needle. It was expected that the filter would act as a microporous diffuser and reduce the pulsing effect of the microdroplet formation. In actuality the filter was found to act as an absorbent, retaining the chemical of interest and holding it for a period of time that decreased the efficiency of the MDL determination. It was also difficult to keep the filter in place at the tip of the needle.

Temperature had a strong effect on the response generated. Minor increases in temperature such as those produced by touching the needle created a spiked response. The signal would then fall below the expected value before resuming the initial response. This effect could be explained by thermal expansion of the liquid within the barrel of the syringe and the needle itself. Efforts were made to insulate the needle, although this had little effect on improving the pulsing of the response.

The cells and syringe pump were placed in an incubator in an effort to thermostat the system. This effectively smoothed the signal. Some pulsing was observed that could be attributed to the turning on and off of the heating element to produce slight fluctuations in temperature. The liquid in the needle and the barrel of the syringe emulated a very sensitive thermometer. The expansion and contraction due to temperature changes altered the rate of delivery. Because of this "thermometer effect" it was critical that the temperature be precisely and smoothly maintained.

The concentration delivered to the detector is strongly dependent on the flow rate of nitrogen to the detector and the flow rate of the chemical of interest into the cell. Any leaks in the system or variances in the flow rate had a substantial effect on the response.

The syringe itself was evaluated and modified to better fit the needs of the system. A metal stop was added near the end of the barrel to keep the barrel from slipping in the pump's syringe holder. The syringe guide tip was glued to the base of the syringe to eliminate one source of leaks. It was found that the PTFE tip on the plunger must fit tightly in the barrel of the syringe to insure that the correct amount of chemical is delivered into the permeation cell. It was believed that at slow pump rates a portion of the liquid escapes around the tip of the plunger resulting in a lesser amount of chemical being delivered to the cell.

Detector response for toluene was investigated as a function of standard 1" and 2" permeation cells. There was no discernible difference in the response values.

5.0 VALIDATION

Known concentrations of standard toluene gas were introduced into the system and compared with the detector response from toluene introduced via the syringe pump (Figure 2). As expected, the responses generated from the standard toluene gas were linear with respect to concentration (square symbols in Figure 2). Neat toluene delivered into the system by the syringe pump is shown with the triangular symbols in Figure 2. The lowest concentration, 4.45 ppm, was calculated from the slowest pump rate (0.116 µl/hr) at a flow rate of 100 ml/min. Lower levels of toluene (circular symbols) were achieved by diluting the toluene in acetonitrile, which is not seen by

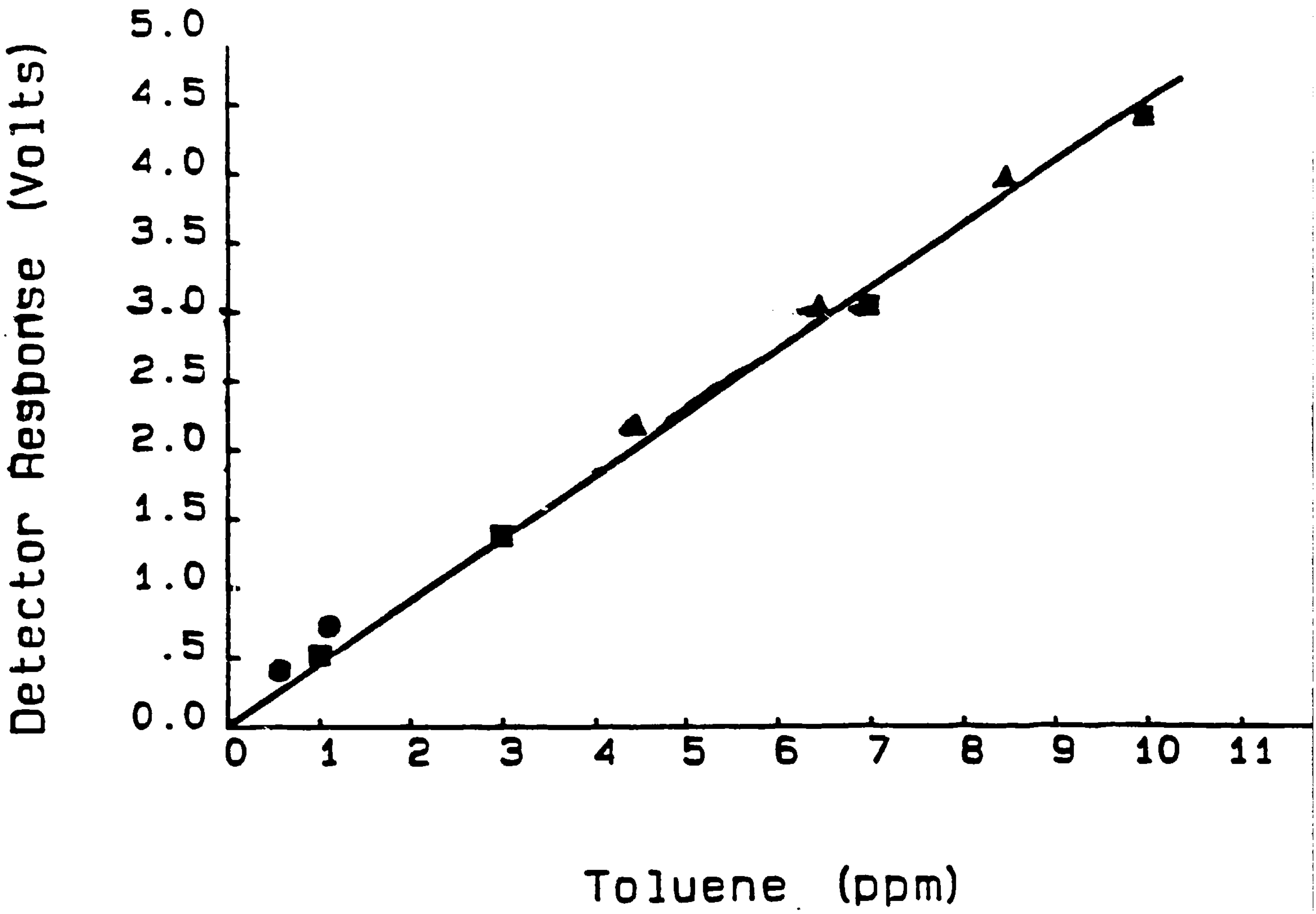


Figure 2. Comparison of the Responses of Toluene Introduced via the Syringe Pump with Known Concentrations of Toluene Gas.

Standard toluene gas concentrations (■); Calculated toluene levels from neat Toluene introduced with the syringe pump (▲); Calculated toluene levels from toluene diluted in acetonitrile and introduced with the syringe pump (●).

the photoionization detector. Figure 2 illustrates that the calculated concentrations of toluene delivered by the syringe pump are the same as known levels of standard toluene gas and that the syringe pump method can reproducibly introduce toluene vapors into the permeation test system in a linear fashion.

The dilution of toluene in acetonitrile is an example of an effective method to achieve low concentrations for MDL determinations. The chemical of interest is diluted in a volatile solvent that is not detected by the method of analysis. For example, for systems using electron capture detectors, 2,2,4-trimethylpentane or other appropriate alkanes would be useful as a dilution solvent. In addition to dilution, solvents provide an effective method for introducing less volatile and viscous compounds into the system for MDL determination. The highly volatile solvents would act in vaporizing the chemicals that would tend to remain at the tip of the needle in the neat, liquid state.

Five other chemicals (acetone, benzene, hexane, tetrachloroethylene, and styrene) with varying volatilities were also tested in the syringe pump system for linearity of response. The results of these tests are outlined in Figures 3-7. The linearity of the responses indicates that the syringe pump method is applicable to MDL determinations for other organics.

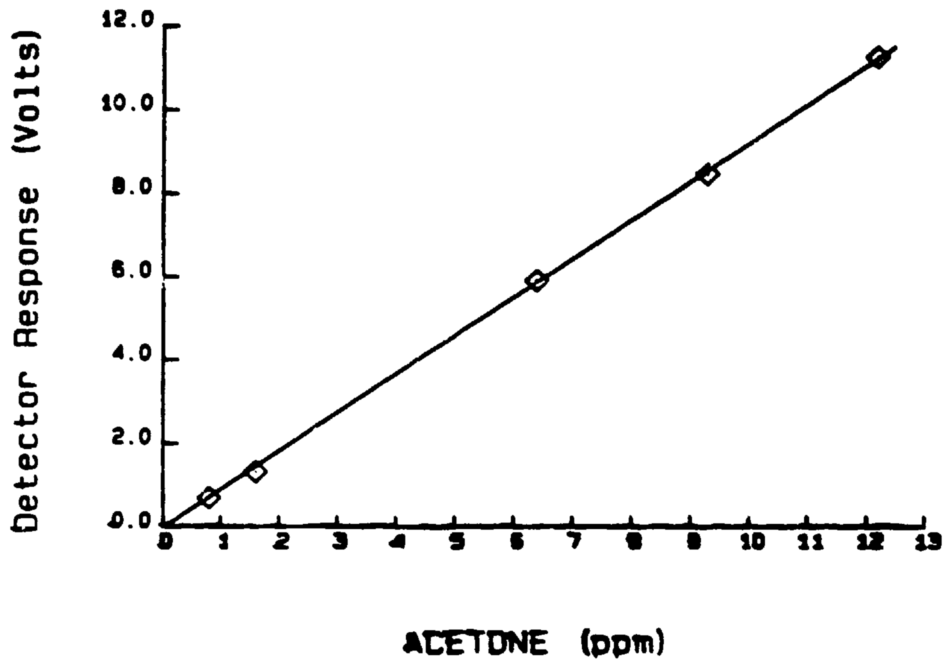


Figure 3 - Linearity of response with respect to concentration of Acetone delivered by the syringe pump system.

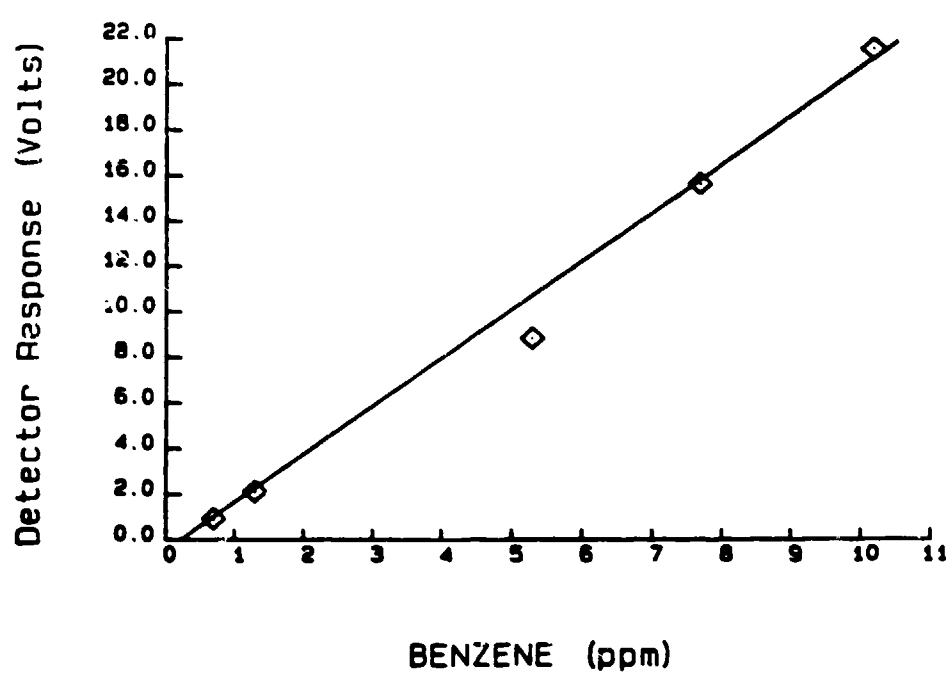


Figure 4 - Linearity of response with respect to concentration of Benzene delivered by the syringe pump system.

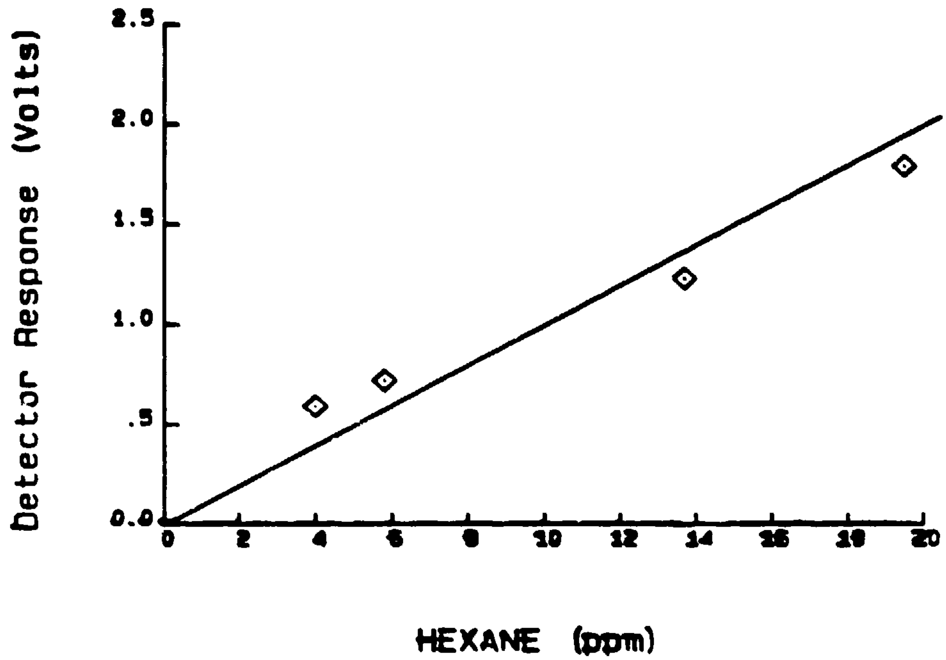


Figure 5 - Linearity of response with respect to concentration of Hexane delivered by the syringe pump system.

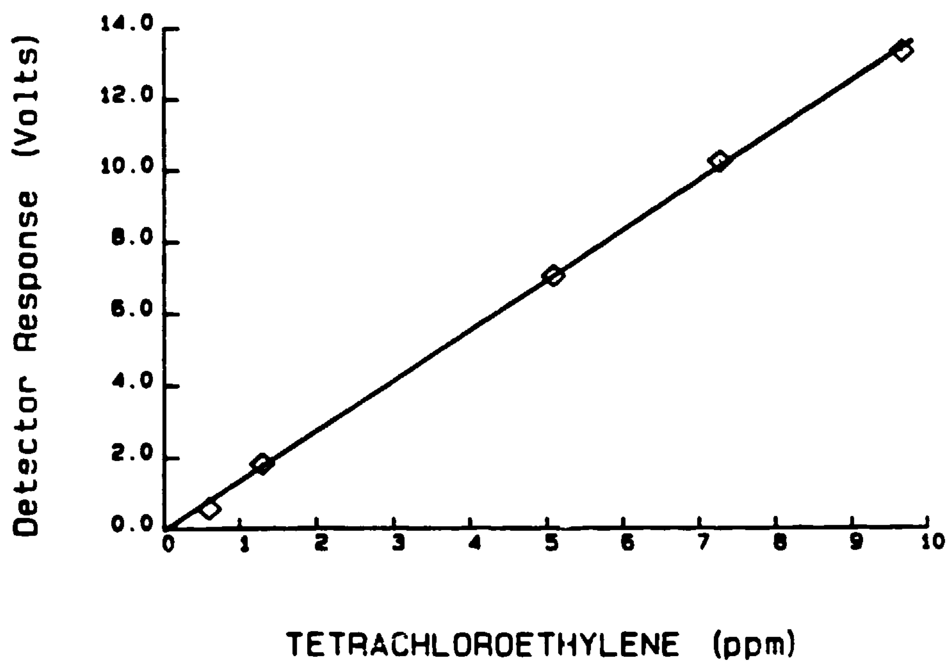


Figure 6 - Linearity of response with respect to concentration of Tetrachloroethylene delivered by the syringe pump system.

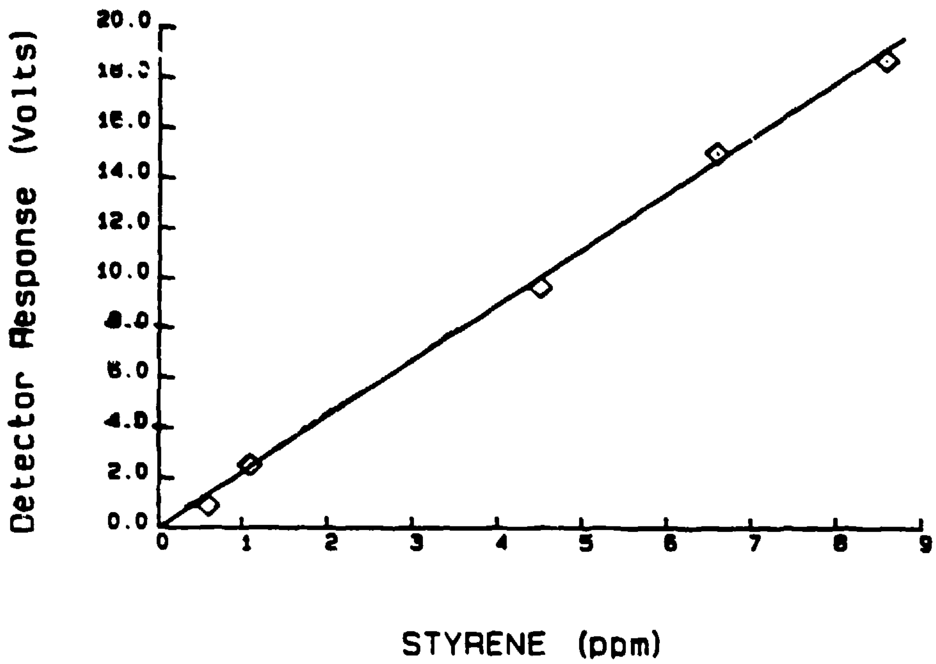


Figure 7 - Linearity of response with respect to concentration of Styrene delivered by the syringe pump system.

6.0 CONCLUSION

Reported breakthrough times in permeation testing are strongly dependent upon the sensitivity of the analytical method used. The standard method, ASTM D-739 gives guidelines for performing permeation testing but does not specify the analytical methods or the complete test apparatus. A universal technique for comparing and correlating results from different systems is needed. The syringe pump method is an effective technique which delivers known concentrations through the same pathway that the permeant would travel. It allows detection limits and permeation testing to be performed at different times and correlated by the relationship of a standard gas (toluene), thus compensating for differences in sensitivity. Differences in the size of tubing, size of permeation cell, and position of the needle tip have little effect on the efficiency of the system. Modification of the syringe, attention to flow rates, and maintenance of a constant temperature are important items to consider when optimizing the syringe pump method for determining MDLs.

86176:DJM
15 January 1987

APPLICATIONS MANUAL

SYRINGE PUMP METHOD FOR DETERMINING MINIMUM DETECTION LIMIT

Chemical Resistance Testing
of Protective Clothing Material

Contract No. DTCG39-86-A-80331
Task Order 003

Submitted To:

Contracting Officer
U.S. Coast Guard Academy
New London, CT 06320-4195

Submitted By:

Texas Research Institute, Inc.
9063 Bee Caves Road
Austin, TX 78733-6201
512/263-2101

B-27

TABLE OF CONTENTS

1.0 INTRODUCTION

An innovative method for determining minimum detection limits in permeation testing has been developed. A syringe pump is used to deliver the chemical of interest into a standard ASTM permeation cell at a very slow rate. A constant low level concentration of the chemical of interest is sent to the detector via the same pathway the permeant would travel. The purpose of this manual is to instruct the reader in the application of this system.

2.0 INSTRUMENTATION

Sage Instruments Model 341 syringe pump

SGE gas tight, removable needle, 5ul glass syringe

SGE vitreous silica tubing, 0.075mm

Glass adapter and fittings

Standard ASTM permeation cell, 1 or 2 inch

3.0 CALIBRATION

Calibration of the syringe pump is necessary to determine the rate of delivery of the chemical of interest.

A. Plug in the syringe pump and note that the power light is on when the toggle switch is set to either pump rate (ml/min or ml/hr).

B. Place the drive carriage (black box) on the gears at the far right position, making sure the box is parallel to the edge of the pump.

C. Mark the position of the drive carriage (a piece of masking tape works well for this).

D. Set the rate selector switch to 1. Turn he mode switch to the "on ml/hr" position.

E. Make note of the time. Allow the pump to operate at least 24 hours.

F. Turn off the pump and again note the time. Measure the distance the drive carriage has traveled in centimeters.

G. Calculate the delivery rate using the following equation:

$$\frac{\text{Distance traveled in cm}}{\text{Time in hours}} \times \frac{5\mu l}{2.55cm}$$

Where 2.55cm corresponds to the length of 5µl of liquid in the SGE syringe.

For example, if the drive carriage traveled 3.5cm in 60 hours the calculation would be:

$$\frac{3.5\,cm}{60\ hrs} \times \frac{5\,\mu l}{2.55\,cm} = 0.114\ \mu l/hr$$

This is the amount of chemical delivered per hour at a pump rate setting of 1ml/hr with the SGE 5µl syringe.

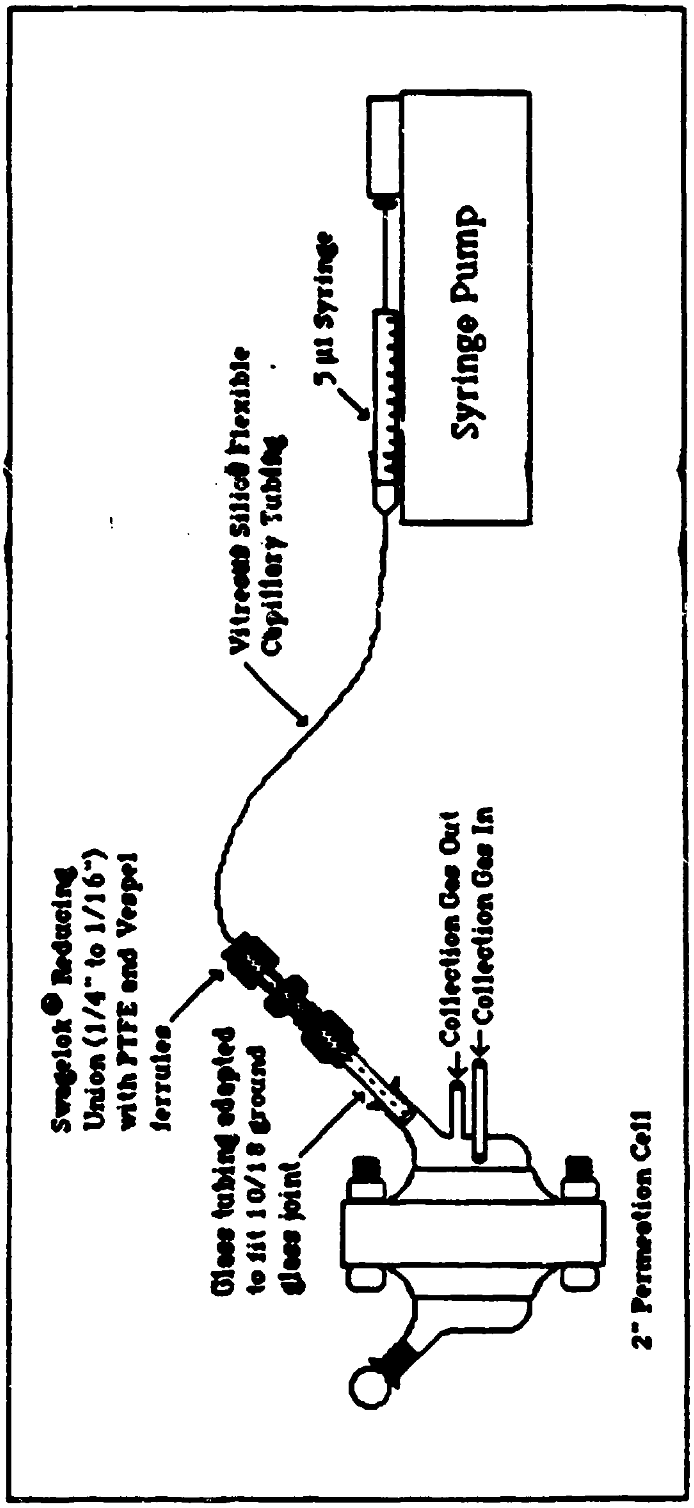
4.0 METHOD

A. Standard 1 or 2 inch permeation cells may be used with this method.

1. To use a standard 2 inch permeation cell, sandwich aluminum foil between the challenge and the collection side of the cell. (This creates an impermeable barrier, keeping the chemical of interest on the collection side of the cell.) Position the cell so that the collection side of the cell is facing the syringe pump (See Figure 1). Place the ground glass stopper in place in the cell.

2. To use a standard 1 inch permeation cell, seal the challenge and the collection sides of the cell together. Position the cell so that the challenge side is facing the syringe pump. Place the ground glass stopper in place in the cell.

FIGURE 1


Syringe Pump
5 µl Syringe
Vitreosil® Silica Flexible Capillary Tubing
Swagelok® Reducing Union (1/4" to 1/16") with PTFE and Vespel ferrules
Glass tubing adapted to fit 10/18 ground glass joint
Collection Gas Out
Collection Gas In
2" Permeation Cell

B. Set the detection system for standard conditions as per normal operating procedure. Set the appropriate nitrogen flow through the permeation cell and to the detection system. Adjust the baseline to zero. Allow the system to stabilize while proceeding with steps C-J.

C. Cut a piece of vitreous silica tubing to a length convenient to reach from the syringe to the inside of the permeation cell. Remove the end cap from the syringe and thread the tubing through the cap and through the teflon spacer so that the tubing extends approximately one inch past the end of the syringe side of the cap. (Note if the tubing will not fit through the teflon spacer, the hole in the spacer can be enlarged with the reaming tool provided with the syringe.)

D. The syringe can be filled with the chemical of interest by one of two methods:

1. The syringe can be back-filled by using another syringe to fill the barrel. A 5-10μl syringe with a small diameter needle slightly longer than the length of the SGE syringe works well for this. Fill the back-fill syringe with the chemical of interest; insert the needle in the SGE syringe and fill the barrel, making sure there are no bubbles in the liquid.

2. The syringe can be filled by directly placing the tip of the syringe (without the tubing or the end cap on) in the chemical of interest and siphoning the chemical into the syringe. A 10 ml size pipette pump works well for this. Attach the pipette pump to the end of the syringe, place the syringe in the chemical of interest and slowly suck the chemical into the syringe. When the chemical is above the plunger line, carefully detach the pipette pump. The pipette pump can also be used to eliminate bubbles in the barrel by pulling a gentle vacuum on the chemical and forcing the bubbles to rise to the surface.

E. Attach the end cap with the vitreous silica tubing to the filled syringe. Make sure that the syringe end of the tubing is "square" and butts up tightly against the metal guide tip. Finger tighten the end cap as tight as possible. Gently tug on the silica tubing to make sure the tubing fits tightly.

F. Carefully place the teflon tipped plunger in the syringe, making sure that no air bubbles are trapped at the tip. The plunger should fit snugly in the barrel, but one should not have to force it. A slight bend to the metal portion of the plunger when pressure is applied is permissible.

G. Apply pressure to the plunger until the chemical comes out of the tubing.

H. Lift the knob of the spring loaded syringe holder high enough to accommodate the syringe barrel. Place the loaded syringe in the syringe holder, resting the metal stop on the back of the holder. Lower the knob to hold the syringe in place.

I. Place the drive carriage on the gears, making sure the carriage is parallel to the edge of the pump. Advance the drive carriage by turning the rate selector switch to 9 ml/min. As the carriage approaches the syringe, check to make sure that the pump actually delivers the chemical from the tip of the needle. As soon as the chemical can be observed coming from the tip of the needle, turn the pump off.

J. Thread the vitreous silica tubing through the fittings in the specially fitted glass adapter. Position the tip of the tubing in the center of the ground glass stopper. Tighten the fitting at the other end of the adapter to hold the tubing in place.

K. Remove the stopper from the equilibrated permeation cell system and replace with the adapter. To insure a tight seal, a small amount of stopcock grease may be placed on the stopper. Hold the stopper in place by sealing with a small piece of parafilm.

L. Set the rate selector to 1 and switch the mode to ml/hr to begin pumping the chemical into the system. A response should be detected within a few minutes, depending on the volatility of the chemical of interest. Allow the response to reach a steady state before concluding the analysis. Remove the adapter and replace with the ground glass stopper to check the baseline at the completion of the run.

5.0 CALCULATIONS

The concentration of the chemical of interest delivered to the detector is determined by the following formula:

$$\text{PPM delivered} = \frac{d \times MV \times PR}{MW \times F}$$

Where d is the density of the chemical of interest

MV is the molar volume (24,450 μl/mmole)

PR is the syringe pump rate (μl/hr)

MW is the molecular weight of the chemical of interest (mg/mmole)

F is the nitrogen flow rate (l/hr)

The minimum detection limit was subjectively defined as the concentration corresponding to the response that was twice the noise level. The noise was determined as the long term fluctuation from the average baseline. The MDL is calculated by the following formula:

$$\text{MDL in ppm} = \frac{\text{ppm delivered} \times 2 \times N}{R}$$

Where N is the noise in millivolts

R is the response of the chemical of interest in millivolts

NOTE: This equation can also be used with detection systems that respond in units other than millivolts. The use of different units will have no effect on the determination as long as the noise and the response are measured in the same units.

For example, the MDL for toluene would be determined as follows:

$$\text{ppm delivered} = \frac{0.8669 \times 24450 \times 0.114}{92.15 \times 6} = 4.37 \text{ ppm}$$

If the millivolt response generated by toluene was 2160, and the noise was 32, the MDL would be determined as follows:

$$\text{MDL in ppm} = \frac{4.37 \times 2 \times 32}{2160} = 0.129 \text{ ppm}$$

6.0 TROUBLESHOOTING

A. No Response, lower than expected response

1. Check all fittings for leaks
2. Check the syringe for clogs and/or bubbles
3. Make sure pump is actually delivering the liquid
4. Check syringe for leaks

   a. Break off the tip of the silica tubing that fits into the guide tip of the syringe and resecure the cap.

   b. Check tip of plunger, resize if necessary. The teflon - tip can be resized by heating it to 350 degrees, causing the teflon to expand. (If the plunger does not fit tight enough, liquid will escape around the tip of the plunger.)

   c. Replace the teflon spacer inside the end cap of the syringe.

B. Excessive noise, Pulsing of response

1. Check all fittings for leaks
2. Check placement of needle in adapter (Generally, the closer the tubing is to the nitrogen flow, the greater the pulsing response).
3. Check syringe for clogs. Clean with cleaning wire.

7.0 NOTES

A. The importance of tightly fitting tubing and ferrules cannot be over emphasized.

B. The syringe should be treated with great care at all times, as it is very easy to apply too much pressure to the plunger and split the barrel. Do not force the plunger. If the plunger requires force to inject the chemical check the barrel and guide tip for clogs and clean with a cleaning wire before proceeding.

C. The syringe should be cleaned with acetone and dried between uses. It should be flushed several times with the chemical of interest when loading.

D. Various sized vitreous silica tubing can be used. Tubing with inside diameters of .025 and .050 mm have also been used with success. The 0.075 mm sized tubing does provide the tightest fit and most durability.

E. Filtering the chemical of interest to remove particulates is not usually necessary when using a good quality reagent.

F. To achieve very low concentrations of the chemical of interest, dilute with a volatile solvent that is not detected by the method of analysis. For example, for systems using electron capture detectors, 2,2,4-trimethylpentane or other appropriate alkanes would be useful as a dilution solvent. This technique is also useful for introducing less volatile and highly viscous compounds into the system. The highly volatile solvents act in vaporizing the chemicals that tend to remain at the tip of the needle in the neat, liquid state.

G. Known concentrations of a standard toluene gas were introduced into the system to provide a means for comparing MDLs run at different times. With this method, it is only necessary to make one MDL estimation. By using the ratio between the responses of the standard gas at the time of the MDL determination and at the time of the actual permeation testing, the response value of the chemical of interest can be adjusted for any differences in the sensitivity of the instrument. This not only provides a means for correlation of results, it acts as a check on the reliability of the system.

APPENDIX C

PERMEATION TEST DATA FOR PRIORITY LIQUID CHEMICALS

(Contractor Report by Texas Research Insitute)

86176:KLV
17 October 1986

MONTHLY STATUS REPORT

CHEMICAL RESISTANCE TESTING
OF PROTECTIVE CLOTHING MATERIAL

Contract No. DTCTG39-86-A-80331
Task 0001

Submitted to:

Contracting Officer
U.S. Coast Guard Academy
New London, CT 06320-4195

Submitted by:

Texas Research Institute, Inc.
9063 Bee Caves Road
Austin, TX 78733-6201
512-263-2101
512-263-3151

C-1

86176:KLV

TABLE OF CONTENTS

1.0 INTRODUCTION

This report outlines the methods and results of the work done on the permeation testing of flat samples of Challenge 5100 for the U.S. Coast Guard. The first task of permeation testing with the 115 CHRIS chemicals was completed October 15, 1986.

2.0 METHODS

The majority of the chemicals were tested using a continuous photoionization detection technique. The standard permeation cells and Teflon gaskets were baked in a vacuum oven at 100C prior to each run to prevent off-gassing of contaminants. Instrument-grade nitrogen was used to sweep the collection side of each cell at a rate of 100 cc/min. A portion of the composite flow from three cells was routed to an HNU photoionization detector model PI-52-02 outfitted with either a 10.2 or 11.7 eV lamp. After a steady baseline was recorded, the challenge chemical was added and the timing of the test began. Three cells were monitored concurrently for three hours or until permeation reached steady state. If breakthrough did occur, one individual cell was rerun.

After each run a response reading was taken for a 1.0 ppm standard toluene mixture. This enabled the monitoring of the sensitivity of the detector daily and allowed repeat runs to be performed under the same conditions by altering the lamp intensity.

Minimum detection limits (MDL's) were determined using a syringe pump. The syringe pump was used to deliver the chemical of interest directly into the permeation cell at a rate of .1257 ul/hour. This slow rate of introduction into the stream of N2 delivered a steady low level concentration of the chemical to the detector. This concentration was calculated as follows:

$$\text{ppm} = \text{ul/ l N2}$$

$$= \frac{\text{density(mg/ml)} \times 24{,}450 \text{ (ul/mmole)} \times .1257 \text{ (ul/hour)}}{\text{molecular weight (mg/mmole)} \times \text{N2 rate (l/hour)}}$$

The response generated by this calculated concentration was then used to determine the MDL. The MDL was defined as the concentration which would give a response of twice the noise level. The noise level was determined as the long term peak to peak deviation from the average baseline.

The syringe pump response was also used to calculate steady state concentrations and permeation rates for those chemicals where breakthrough was observed. Breakthrough was observed for methylene chloride, trichloroethylene, and vinyl acetate before the development of the syringe pump method for determining MDL'S. Permeation rates were determined for methylene chloride and trichloroethylene by trapping on adsorbent charcoal and analyzing by gas chromatography. The NIOSH method for determination of vinyl acetate called for trapping on Chromosorb 107 with thermal desorption. As an alternative, 500 ul samples were taken directly from the carrier gas exit stream and analyzed by GC with a 10:1 split to column. A standard was prepared in carbon disulfide and analyzed using a 1 ul injection.

Xylenol and naphthalene were tested by placing a few crystals in the challenge side of the permeation cell allowing the cell to become saturated with their vapors. MDL's were determined using the analogous cresol for xylenol and benzene for naphthalene.

Included in the 117 chemical CHRIS list were the mixtures gasoline, turpentine, naphtha, and creosote. The pesticides included on the CHRIS list were not tested in their pure state, but as 25-50% solutions in petroleum distillates. MDL's for the mixtures were calculated using the smallest molecular weight of the components in the solution tested. This gave the largest MDL possible for the varying concentrations.

Nine chemicals were tested for breakthrough using ion chromatography as the method for analysis. The challenge side of the permeation cell was filled with the test chemical and the collection side was filled with deionized water. Samples were taken at 15 minute intervals for a total test time of three hours. Prior to sampling, 0.5 ml of deionized water was added to the collection cell. The syringe was flushed with the collection media 3-4 times to allow mixing before a 0.5 ml sample was taken. Standards and samples were analyzed on a Dionex 2000 ion chromatograph equipped with a ASA-4 column. MDL's were determined by diluting the standard to the lowest detectable level. A blank cell was run to determine background levels.

Sodium hydroxide and sodium hydrosulfide solutions were tested for breakthrough using atomic absorption of sodium as the method of analysis. The same sampling method as above was employed to take 1.0 ml samples. Certified atomic absorption standards from sodium chloride and the samples were analyzed on a Microtek Unicam SP-90 atomic absorption spectrophotometer. MDL's were determined by diluting the standard to the lowest detectable level. A blank cell was run to determine background levels.

A 30% solution of hydrogen peroxide was tested for breakthrough using a colorimetric method of analysis. One ml samples were taken as above. To each sample, standard and blank, 0.2 ml of 10mM ferrous ammonium sulfate and 0.1 ml of 2.5M potassium thiocyanate was added. The red colored reaction was observed and the absorbance at 480nm was read on a Gilford 300 microsample spectrophotometer. The MDL was determined by diluting the standard to the lowest detectable level.

Acetonitrile, adiponitrile, and ethylene cyanohydrin were not detected by the photoionization detector. They were tested for breakthrough by trapping the collection gas on adsorbent charcoal for 15 minutes at a flow rate of 200 cc/min over three hours. The last sample was trapped for fifty minutes to assure breakthrough did not occur. The charcoal was desorbed in benzene and analyzed by gas chromatography. The MDL's were determined by diluting the standards to the lowest detectable level.

3.0 RESULTS

The results of the completed test are included in the requisite format along with photocopies of actual recording copies. The following table summarizes the results for those chemicals which were tested with continuous photoionization detection and no breakthrough was observed.

Challenge Chemical	Lamp (eV)	ppm/mV Toluene	ppm/mV Chemical	MDL(ppm)
1,1,2,2-Tetrachloroethane	11.70	.088	.083	.23
1,2-Dibromoethane	11.70	.094	.038	.10
1,2-Dichloroethane	11.70	.061	.057	.09
1,2-Dichloroethylether	11.70	.088	.091	.15
1,2-Dichloropropane	11.70	.085	.097	.31
1,3-Dichloropropene	11.70	.082	.069	.17
1,4-Dioxane	11.70	.094	.117	.38
2-Nitropropane	11.70	.080	.248	.59
Acetaldehyde	11.70	.082	NA	NA
Acetic acid	11.70	.065	7.780	35.46
Acetic Anhydride	11.70	.085	.178	.57
Acetone	11.70	.098	.414	1.16
Acetone Cyanohydrin	10.20	.001	.043	2.74
Acetyl Chloride	10.20	.001	35.460	35.46
Acrylic Acid	11.70	.088	.325	.86
Allyl Alcohol	11.70	.080	.235	1.13
Aniline	11.70	.049	.164	.46
Benzene	11.70	.034	.028	.05
Benzyl Chloride	11.70	.085	.038	.11
Bromine	11.70	.038	.331	.53
Butyl Acetate	11.70	.088	.106	.25
Butyl Acrylate	11.70	.088	.099	.22
Butylamine	11.70	.098	.096	.32
Butyraldehyde	10.20	.001	.002	.29
Carbon Tetrachloride	11.70	.059	.114	.29
Chlordane	10.20	.001	.036	.26
Chlorobenzene	11.70	.085	.085	.20
Chloroform	11.70	.049	.102	.19
Chloropicrin	10.20	.001	.064	1.80
Creosote	10.20	.001	.030	.32
Cresol	11.70	.035	.019	.03
Crotonaldehyde	11.70	.088	.193	.62
Cumene Hydroperoxide	11.70	.082	.502	1.20
Cyclohexane	11.70	.082	.077	.25
Diethanolamine	11.70	.082	NA	NA
Diisopropylamine	11.70	.080	.109	.39
Dimethyl Sulfate	10.20	.001	.038	1.52
Dipropylamine	11.70	.088	.137	.22
Epichlorohydrin	11.70	.088	.234	.75
Ethion 4	10.20	.001	.001	.03
Ethyl Acetate	11.70	.106	.205	.49
Ethyl Acrylate	11.70	.094	.307	1.72
Ethyl Alcohol	11.70	.096	.895	2.86
Ethyl Benzene	11.70	.089	.075	.14
Ethyl Ether	10.20	.001	.001	.13
Ethylamine 70%	11.70	.091	.206	.74
Ethylene Glycol	11.70	.085	.469	2.63
Ethylenediamine	11.70	.080	.870	2.78
Formaldehyde 37%	11.70	.094	NA	NA
Furfural	10.20	.001	.001	.08

Challenge Chemical	Lamp (eV)	ppm/mV Toluene	ppm/mV Chemical	MDL(ppm)
Gasoline	10.20	.001	.007	.16
Glutaraldehyde	10.20	.001	.013	.43
Hexane	11.70	.094	.089	.25
Hydrazine hydrate	10.20	.001	.023	.09
Isopropyl Alcohol	11.70	.080	.241	1.16
Isopropylamine	11.70	.094	.327	1.57
Malathion (50%)	10.20	.001	.129	1.03
Methyl Acrylate	10.20	.001	.151	.48
Methyl Alcohol	11.70	.085	.519	4.07
Methyl Ethyl Ketone	11.70	.091	.311	.65
Methyl Isobutyl Ketone	11.70	.104	1.212	3.98
Methyl Methacrylate	11.70	.080	.117	.19
Methyl Parathion (44.0%)	10.20	.001	.002	.03
n-Butylalcohol	11.70	.098	.147	.32
n-Propyl Alcohol	10.20	.001	.012	.76
n-Propylamine	11.70	.073	.307	.74
Naled	10.20	.001	NA	NA
Naphtha	10.20	.001	.020	4.55
Naphthalene	10.20	.001	.001	.02
Nitrobenzene	11.70	.033	.051	.08
o-Toluidine	11.70	.036	.185	.43
Parathion (45.07%)	10.20	.001	.002	.01
PCBs	10.20	.001	.001	.02
Phenol	11.70	.034	.020	.03
Propionic Acid	10.20	.001	.024	.31
Styrene	11.70	.025	.020	.05
Tetrachloroethylene	11.70	.082	.033	.11
Toluene	11.70	.024	.026	.06
Tolylene 2,4-diisocyanate	11.70	.046	.206	.69
Trichloroethane	11.70	.088	.167	.60
Turpentine	10.20	.001	.0005	.03
Vinylidene Chloride	10.20	.001	.003	.49
Xylene	11.70	.100	.072	.13
Xylenol	10.20	.001	.001	.01

MDL's were not determined for acetaldehyde, formaldehyde, diethanolamine, and naled. Acetaldeyhde has a boiling point of 21C and therefore was too volatile to place in the syringe. The formaldehyde solution was 63% water which had a quenching effect on the detector. Diethanolamine and naled were too viscous to load into the syringe.

Breakthrough was observed for eight chemicals. The following table gives the seven chemicals that broke through, their appropriate breakthrough times, steady state permeation rates, and MDL's.

Chemical	Noise (mV)	MDL (ppm)	BT time (min)	SS rate (ug/hr*cm2)
Acrolein (Composite)	4	.12	44.0	2.37
Acrolein (Run I)	2	.06	38.0	1.61
Acrylonitrile (Run I)	.80	.46	54.0	5.12
Acrylonitrile (Run II)	.80	.18	76.0	.86
Allyl Chloride (Composite)	.80	.16	102.0	.67
Allyl Chloride (Run I)	.80	.16	165.6	.60
Carbon Disulfide (composite)	.80	.10	21.6	2.76
Carbon Disulfide (Run I)	.40	.05	20.5	3.65
Carbon Disulfide (RunII)	.40	.05	17.7	2.59
Methylene Chloride (RunI)	1.60	.27	46.8	1.37
Methylene Chloride (RunII)	.80	.13	50.4	.96
Methylene Chloride (RunIII)	1.00	.17	55.2	1.27
Propylene Oxide (Composite)	1.20	.48	137.0	1.43
Propylene Oxide (Run I)	2.40	1.01	170.0	1.09
Trichloroethylene (Run I)	.96	.07	143.0	2.04
Trichloroethylene (Run II)	1.40	.10	156.0	2.04
Trichloroethylene (Run III)	1.28	.09	146.0	1.63
Vinyl Acetate (Composite)	1.00	.21	74.0	3.30
Vinyl Acetate (Run I)	1.00	.21	137.0	3.73

No breakthrough was observed for the chemicals tested using methods other than continuous photoionization detection. The following table gives the results.

CHEMICAL	METHOD	STANDARD	RET. TIME	MDL
CHLOROSULFONIC ACID	ION CHROMATOGRAPHY	5 ppm SO2OHCl	2.08 min	0.5 ppm
NITRIC ACID	ION CHROMATOGRAPHY	10 ppm nitrate	4.16 min	0.2 ppm
OLEUM	ION CHROMATOGRAPHY	10 ppm sulfate	8.35 min	0.2 ppm
PHOSPHORIC ACID	ION CHROMATOGRAPHY	10 ppm phosphate	6.88 min	0.5 ppm
PHOSPHOROUS OXYCHLORIDE	ION CHROMATOGRAPHY	5 ppm POCl3	2.04 min	0.5 ppm
PHOSPHOROUS TRICHLORIDE	ION CHROMATOGRAPHY	5 ppm PCl3	2.11 min	0.5 ppm
SILICON TETRACHLORIDE	ION CHROMATOGRAPHY	5 ppm SiCl4	2.05 min	0.5 ppm
SULFUR MONOCHLORIDE	ION CHROMATOGRAPHY	5 ppm S2Cl2	2.07 min	0.5 ppm
SULFURIC ACID	ION CHROMATOGRAPHY	10 ppm sulfate	8.59 min	0.2 ppm
SODIUM HYDROXIDE SOLN 50%	ATOMIC ABSORPTION	0.5-4.0 ppm	NA	0.5 ppm
SODIUM HYDROSULFIDE SOLN 10%	ATOMIC ABSORPTION	0.5-4.0 ppm	NA	0.5 ppm
ACETONITRILE	GAS CHROMATOGRAPHY	15.6 ppm	.82 min	0.6 ppm
ADIPONITRILE	GAS CHROMATOGRAPHY	7.2 ppm	1.8 min	0.3 ppm
ETHYLENE CYANOHYDRIN	GAS CHROMATOGRAPHY	11.9 ppm	2.68 min	0.4 ppm
HYDROGEN PEROXIDE 30%	COLORIMETRIC	0.6-6.0 ppm	NA	0.6 ppm

4.0 PLANS

Included in this report are the results from testing 97 different chemicals. Motor fuel antiknock compounds, tetraethyl lead, and tetramethyl lead were not available from the distributor at this time. It may be possible to acquire a small sample of tetramethyl lead within a few weeks and the chemical will be tested at that time. The pesticide, tetraethylpyrophosphate, is no longer manufactured and therefore was not tested. Hydrofluoric acid required fixturing to prevent the etching of glassware. Hydrogen fluoride, hydrogen cyanide, and methyl chloride are gaseous compounds and will be included in a separate task order covering gaseous chemicals.

The chemicals that broke through and show differences in breakthrough times and permeation rates between the composite and individual runs will be repeated. It is also planned to do permeation testing on ten different mixtures as soon as the list of mixtures is received. The testing of the seamed samples and visor samples will continue as scheduled.

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25 °C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Acetaldehyde	N/A	N/A
2. CAS NUMBER(s):	75-05-0	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A
	Reagent Grade	N/A	N/A

4. TEST RESULTS

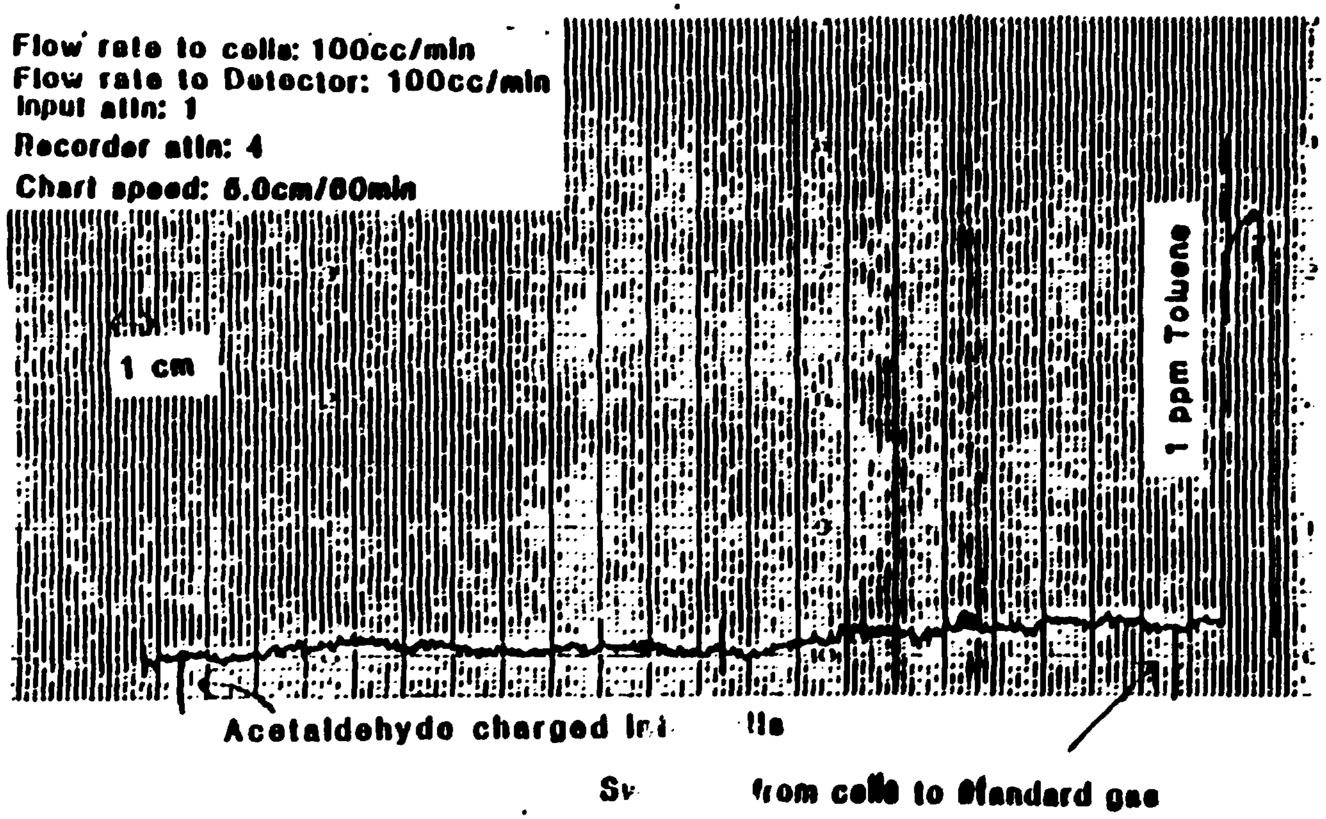
1. DATE TESTED: June 3, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after three hours.
4. MIN DETECTABLE LIMIT N/A
5. STEADY STATE PERMEATION RATE: N/A
6. SAMPLE THICKNESS: 18-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA
Samples were run by Sylvia R. Cooper on June 3, 1986

Chemical Resistance Testing of USCG Material with Acetaldehyde



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Acetic acid	N/A	N/A
2. CAS NUMBER(s):	64-19-7	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

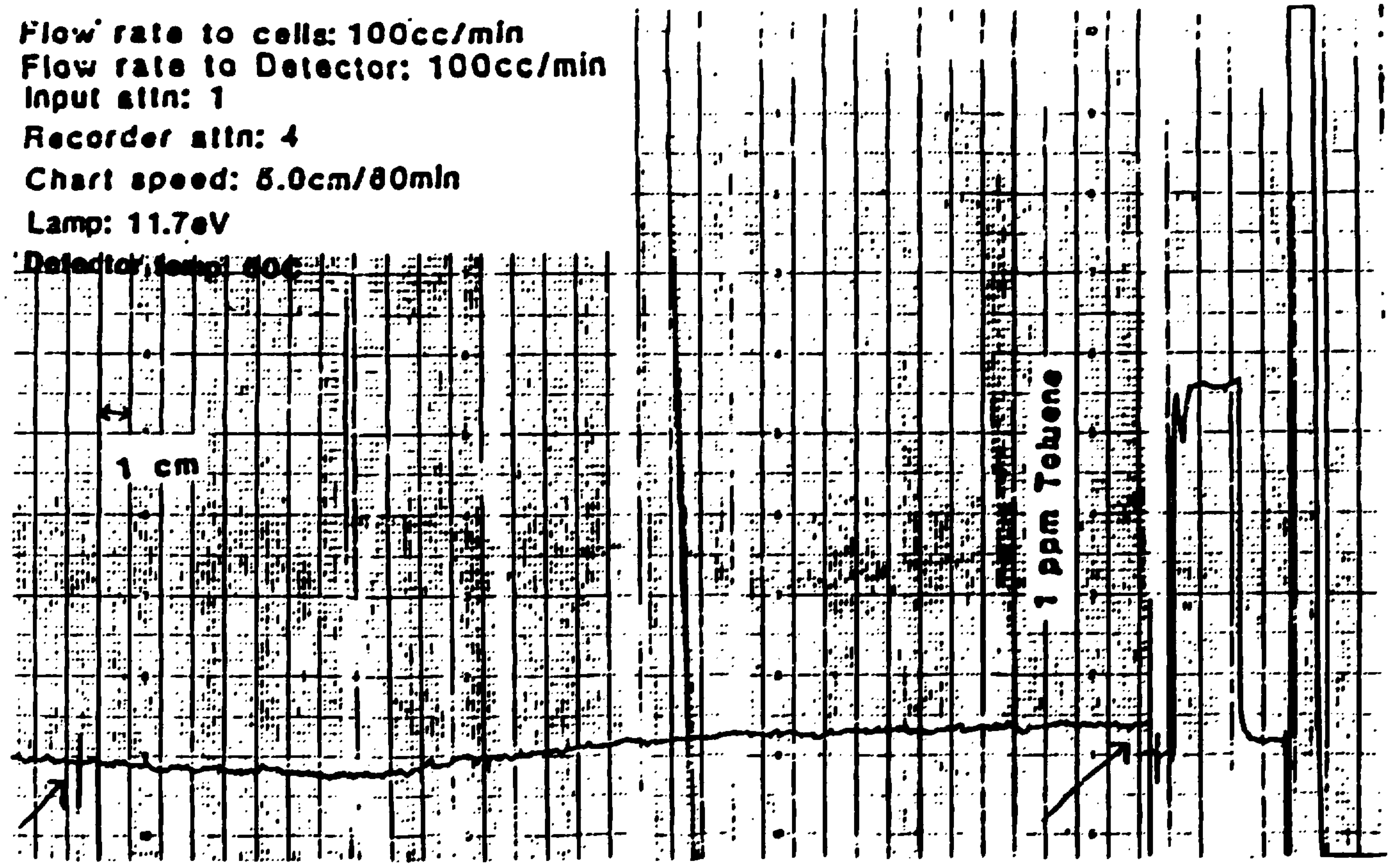
1. DATE TESTED: 9-13-86
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT 35.46 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA
Samples were run by Denise McDonald on September 13, 1986

Chemical Resistance Testing of USCG Materal with Acetic Acid



Acetic acid charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff rolored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s) :	Acetic Anhydride	N/A	N/A
2. CAS NUMBER(s):	108-24-7	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt reagent grade	N/A N/A	N/A N/A

4. TEST RESULTS

1. DATE TESTED: June 28, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT .57 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

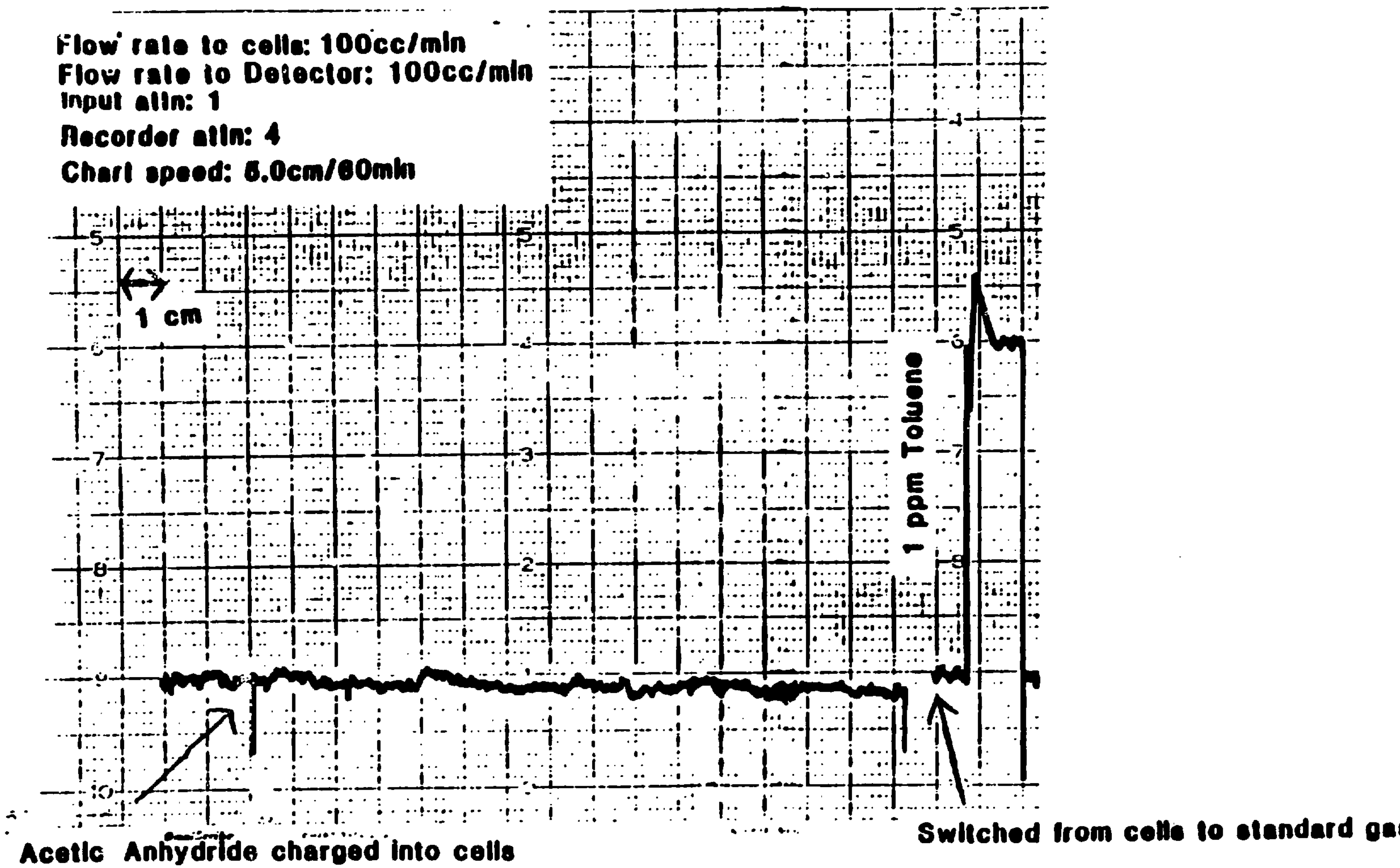
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on June 28, 1986.

Chemical Resistance Testing of USCG Material with Acetic Anhydride



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc /min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s):	Acetone	N/A	N/A
2. CAS NUMBER(s):	67-64-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Centex Technical	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: May 29, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No Breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT 1.16 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-20 mil.
7. SELECTED DATA POINTS N/A

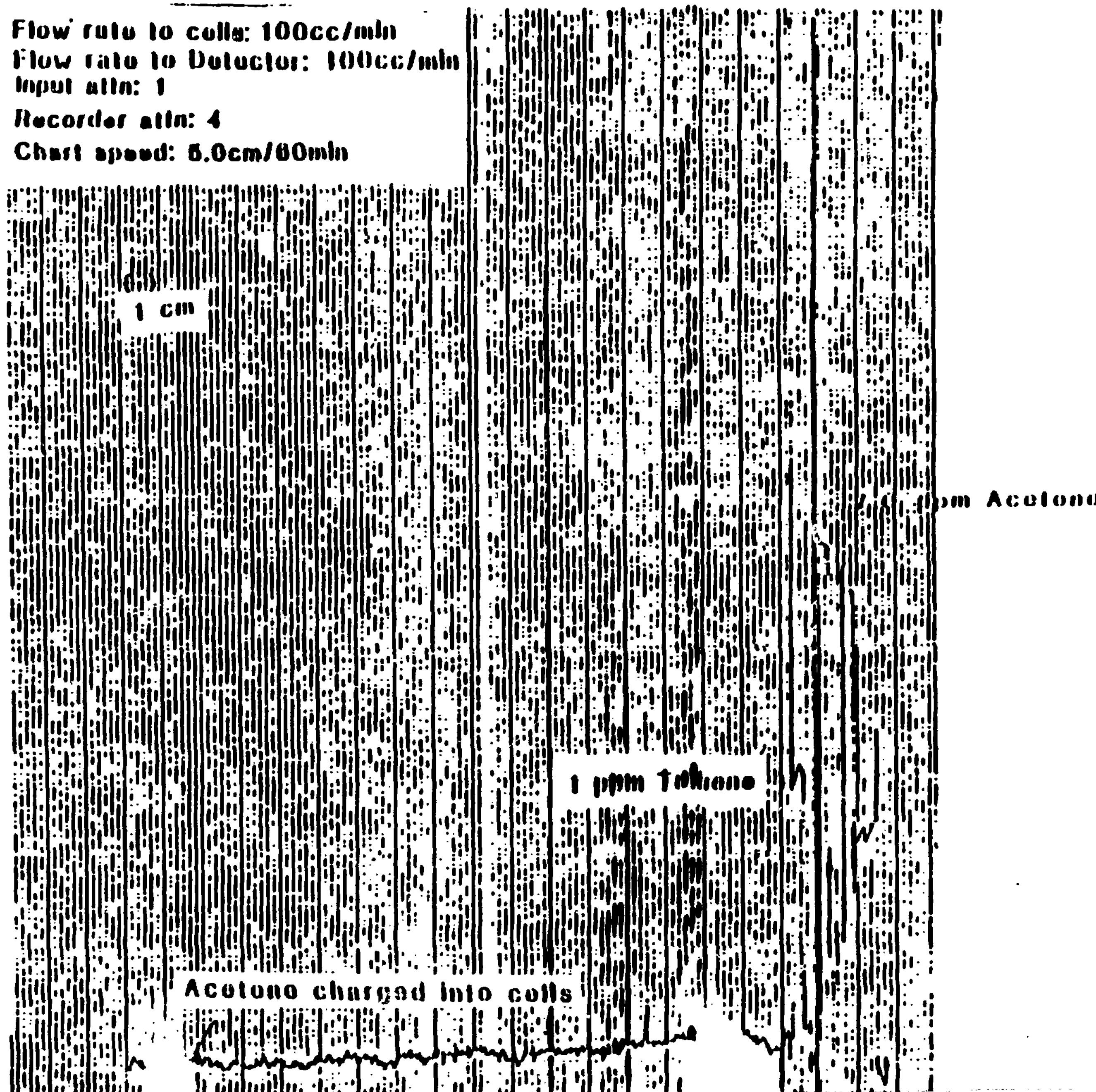
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on May 29, 1986.

Chemical Resistance Testing of USCG Material with Acetone



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.2 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Acetone Cyanohydrin	N/A	N/A
2. CAS NUMBER(s):	75-86-5	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 22, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT 2.74 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

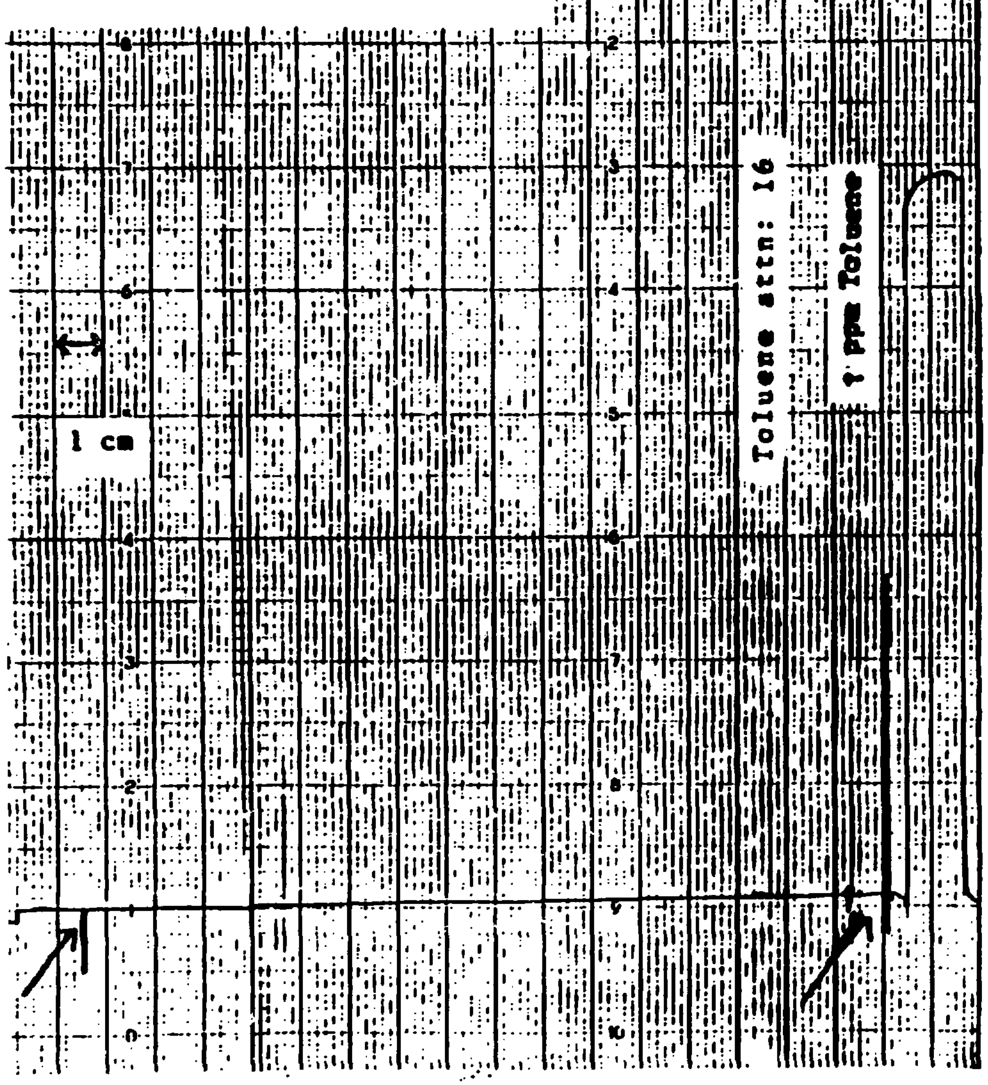
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on September 22, 1986.

Chemical Resistance Testing of USCG Material with Acetone Cyanohydrin

Flow rate to cells: 100cc/min
Flow rate to Detector: 100cc/min
Input attn: 10
Chart speed: 5.0cm/60min
Lamp: 10.2 eV
Recorder attn: 32
Detector temp: 100C



Acetone Cyanohydrin charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Gas Chromatography
3. TEMPERATURE: Ambient
4. COLLECTION MEDIUM: Charcoal
5. COLLECTION SYSTEM: Charcoal
6. OTHER CONDITIONS: One inch cells were used.
7. DEVIATIONS FROM ASTM F739 METHOD:

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s) :	Acetonitrile	N/A	N/A
2. CAS NUMBER(s):	2206-26-0	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher-Pesticide	N/A	N/A
	Grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: October 9, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT 0.6 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mils
7. SELECTED DATA POINTS Cells 1,2 and 3 at end of three hour test.

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	3 hours	<0.6 ppm	<0.6 ppm	<0.6 ppm
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS: 3 hour samples were collected for 50 minutes for a total volume of 10 liters.

5. SOURCE OF DATA

Samples were run by Denise McDonald on October 9, 1986.

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature =100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Acetyl Chloride	N/A	N/A
2. CAS NUMBER(s):	75-36-5	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: August 13, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.1 hours
4. MIN DETECTABLE LIMIT 35.46 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

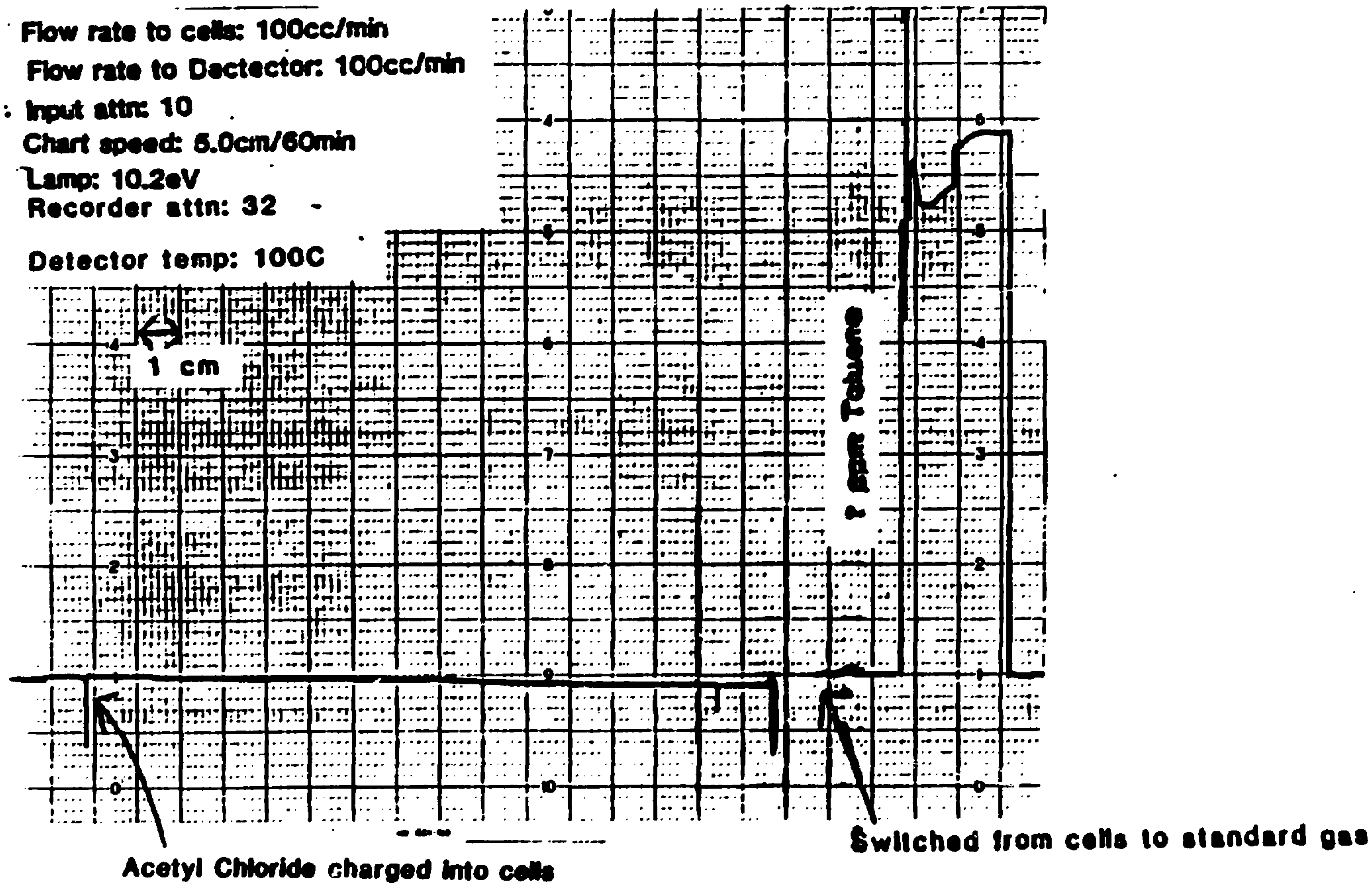
5. SOURCE OF DATA

Samples were run by Sylvia R. Cooper on August 13, 1986.

Chemical Resistance Testing of USCG Material with Acetyl Chloride

Flow rate to cells: 100cc/min
Flow rate to Dectector: 100cc/min
Input attn: 10
Chart speed: 5.0cm/60min
Lamp: 10.2eV
Recorder attn: 32

Detector temp: 100C



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Acrolein (composite)	N/A	N/A
2. CAS NUMBER(s):	107-02-8	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Kodak reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: October 6, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: 44 minutes
4. MIN DETECTABLE LIMIT .12 ppm
5. STEADY STATE PERMEATION RATE 2.37 ug/cm^2*hour
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

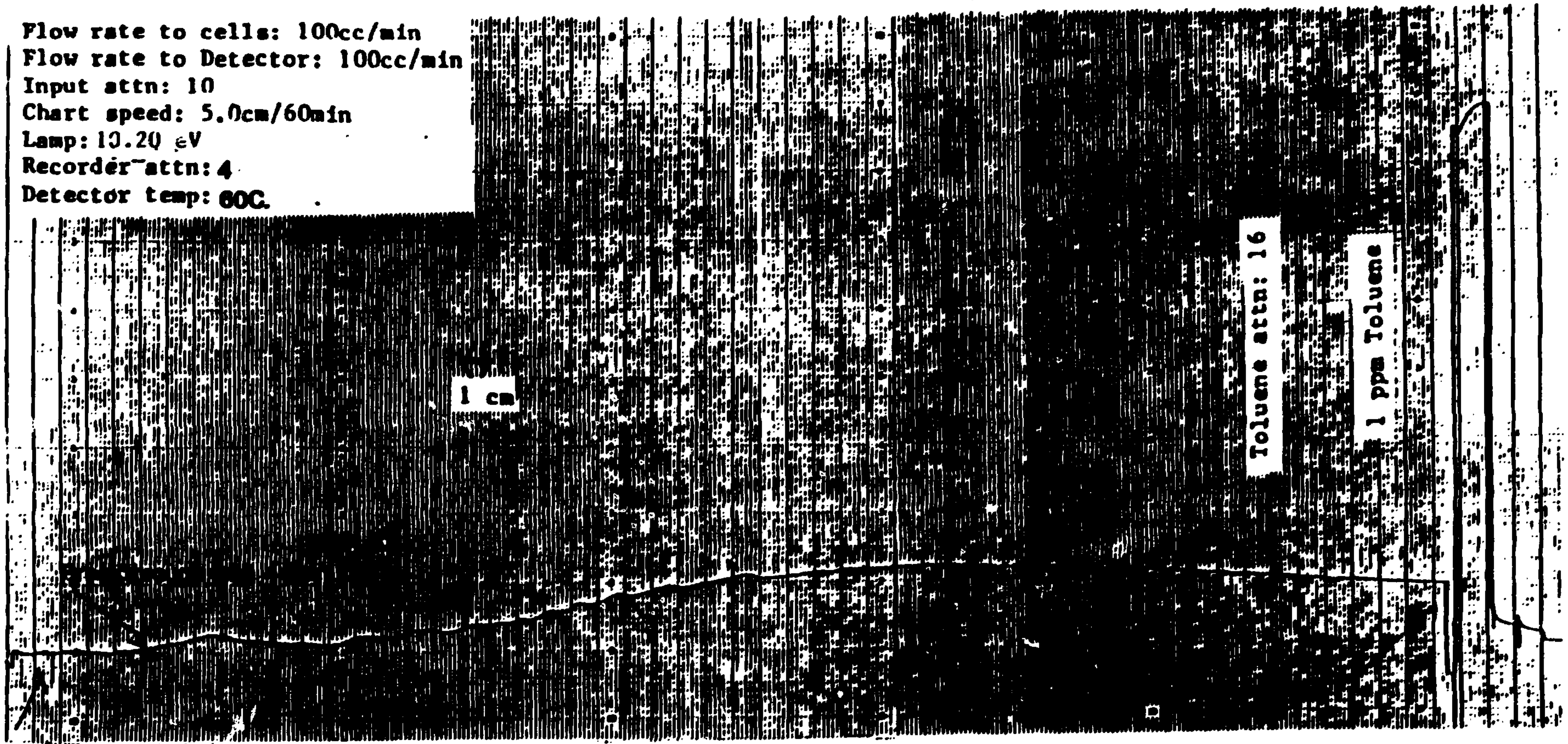
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on October 6, 1986

Chemical Resistance Testing of USCG Material with Acrolein

Flow rate to cells: 100cc/min
Flow rate to Detector: 100cc/min
Input attn: 10
Chart speed: 5.0cm/60min
Lamp: 10.20 eV
Recorder attn: 4
Detector temp: 60C.



Acrolein charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenga 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.?0 eV lamp
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells were 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s):	Acrolein (Run I)	N/A	N/A
2. CAS NUMBER(s):	107-02-8	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Kodak reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: October 8, 1986
2. NUMBER OF SAMPLES TESTED: One
3. BREAKTHROUGH TIME: 38 minutes
4. MIN DETECTABLE LIMIT .06 ppm
5. STEADY STATE PERMEATION RATE 1.61 ug/cm^2 *hour
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

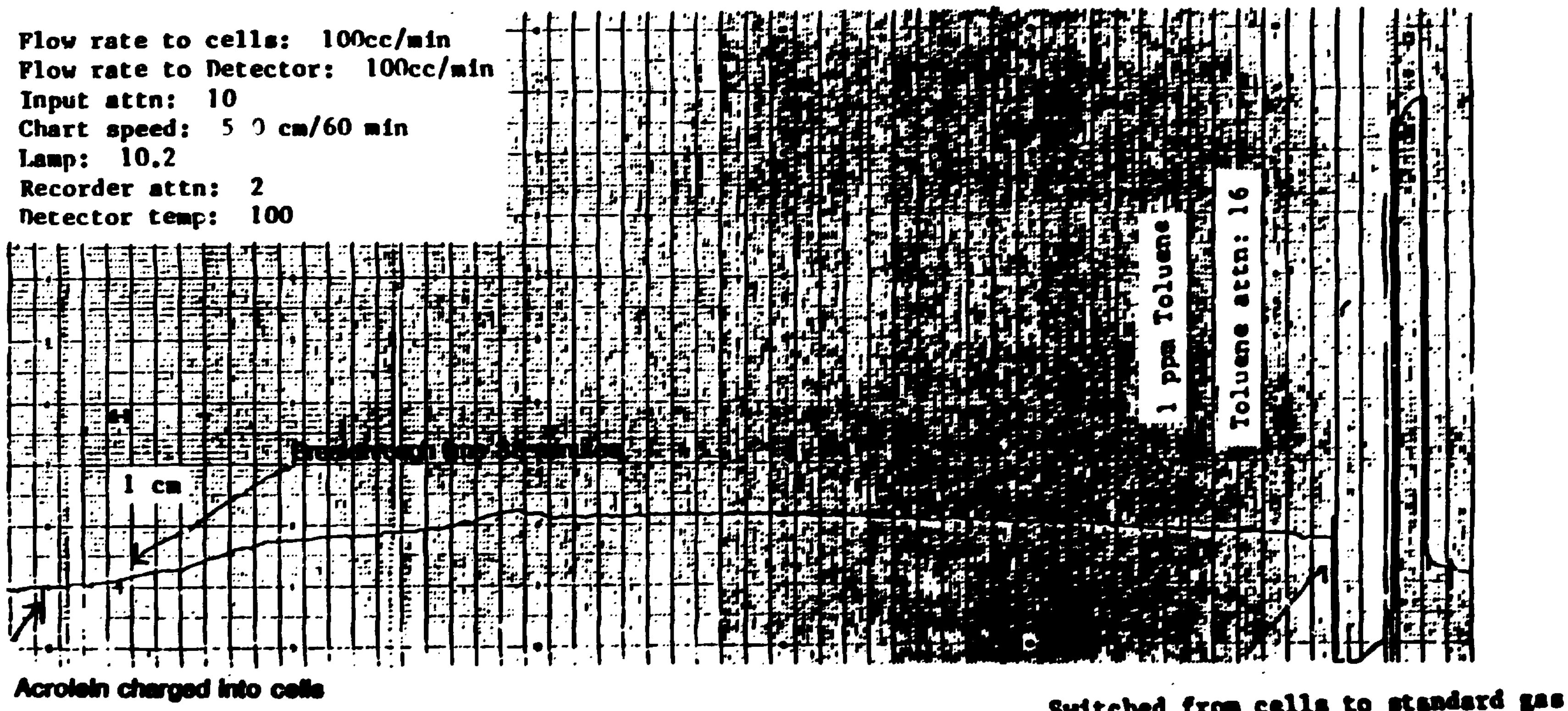
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on October 8, 1986.

Chemical Resistance Testing of USCG Material with Acrolein

Run I



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s) :	Acrolein	N/A	N/A
2. CAS NUMBER(s):	107-02-8	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Kodak	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-22-87
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: 45 minutes
4. MIN DETECTABLE LIMIT .17 ppm
5. STEADY STATE PERMEATION RATE 2.82 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 19-20 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

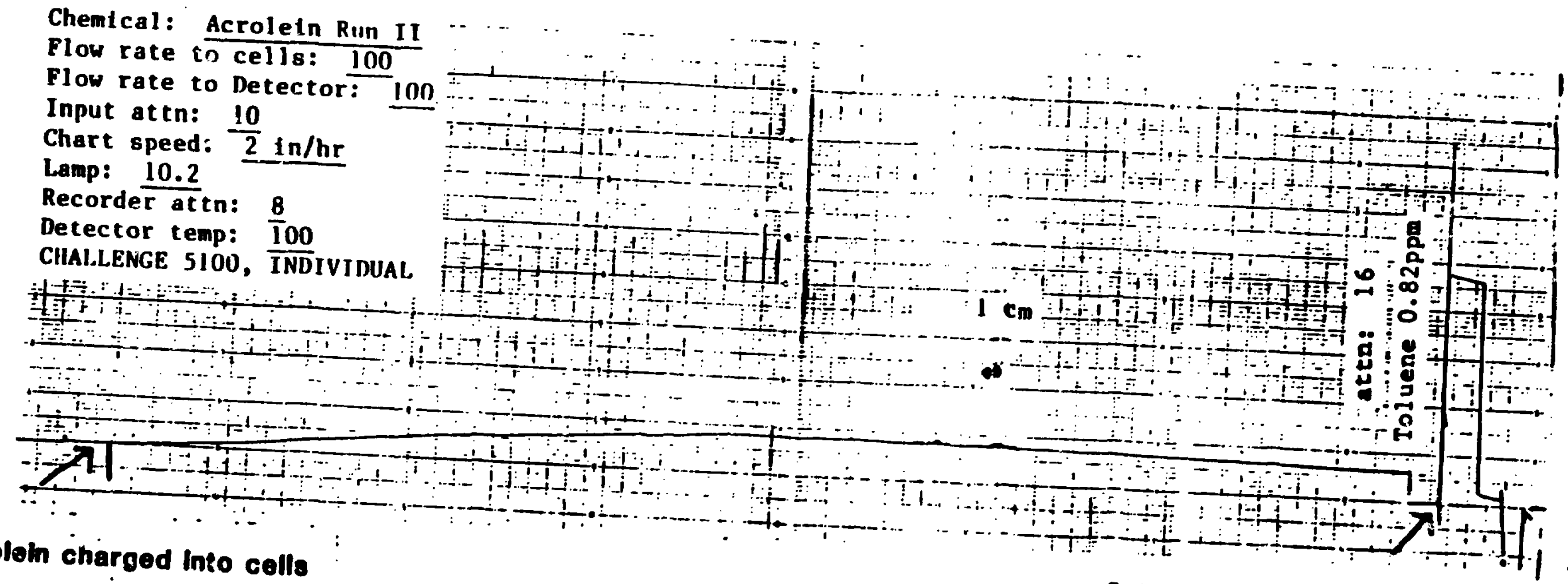
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Denise McDonald on January 22, 1987

Chemical Resistance Testing of Challenge 5100 Material

Acrolein Run II



Acrolein charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./ Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s) :	Acrolein	N/A	N/A
2. CAS NUMBER(s):	107-02-8	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Kodak	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 3-6-87
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT .43 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

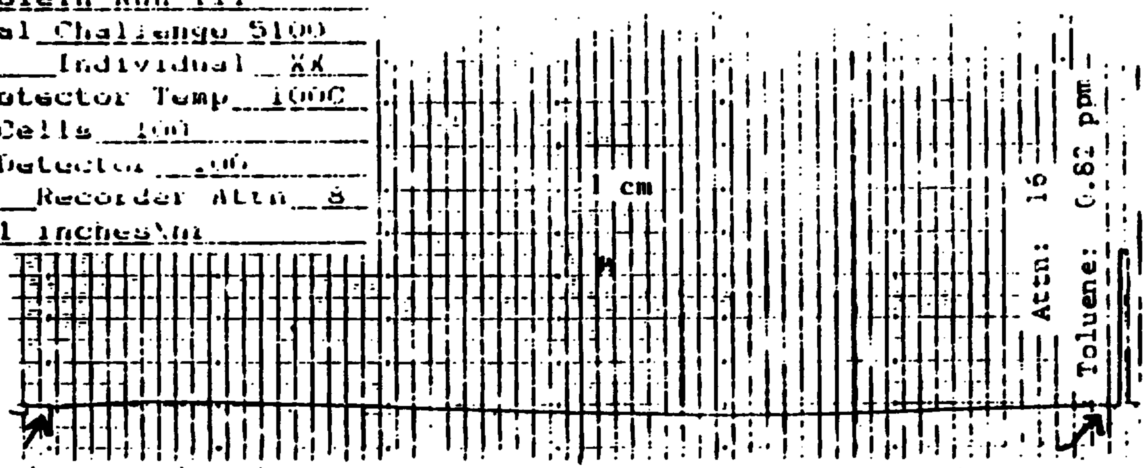
5. SOURCE OF DATA

Sample was run by Denise McDonald on March 6, 1987.

Chemical Resistance Testing of Challenge 5100

Acrolein Run III

Chemical Acrolein Run III
Sample Material Challenge 5100
Composite ______ Individual XX
Lamp 10.2 Detector Temp 100C
Flow Rate to Cells 100
Flow Rate to Detector 100
Input Attn 10 Recorder Attn 8
Chart Speed 1 inches\hr

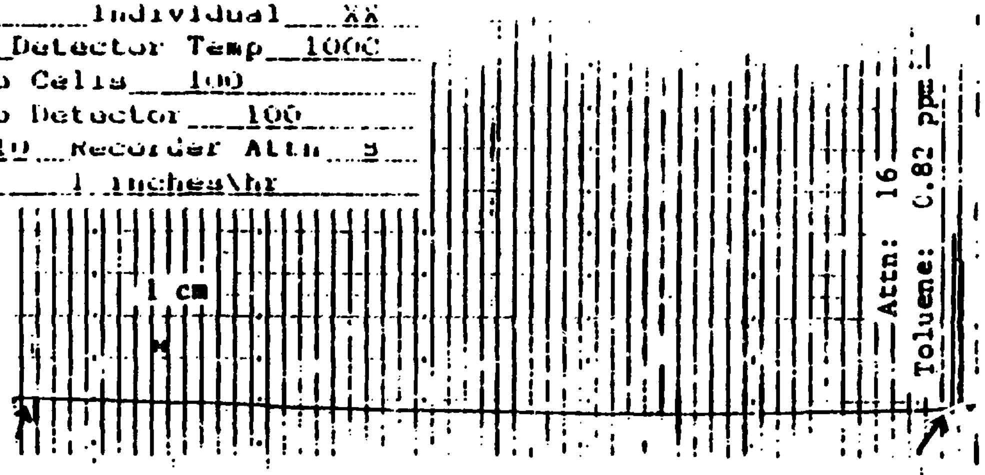


Acrolein charged into cells **Switched from cells to standard gas**

Chemical Resistance Testing of Challenge 5100

Acrolein Run IV

Chemical ___Acrolein Run IV___
Sample Material ___Challenge 5100___
Composite ______ Individual ___XX___
Lamp ___10.2___ Detector Temp ___100C___
Flow Rate to Cells ___100___
Flow Rate to Detector ___100___
Input Attn ___10___ Recorder Attn ___5___
Chart Speed ___1 inches\hr___



Acrolein charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./ Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s):	Acrolein	N/A	N/A
2. CAS NUMBER(s):	107-02-8	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 3-7-87
2. NUMBER OF SAMPLES TESTED: One (Run IV)
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT .46 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	-			
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Denise McDonald on March 7, 1987.

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Acrylic Acid	N/A	N/A
2. CAS NUMBER(s):	79-10-7	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

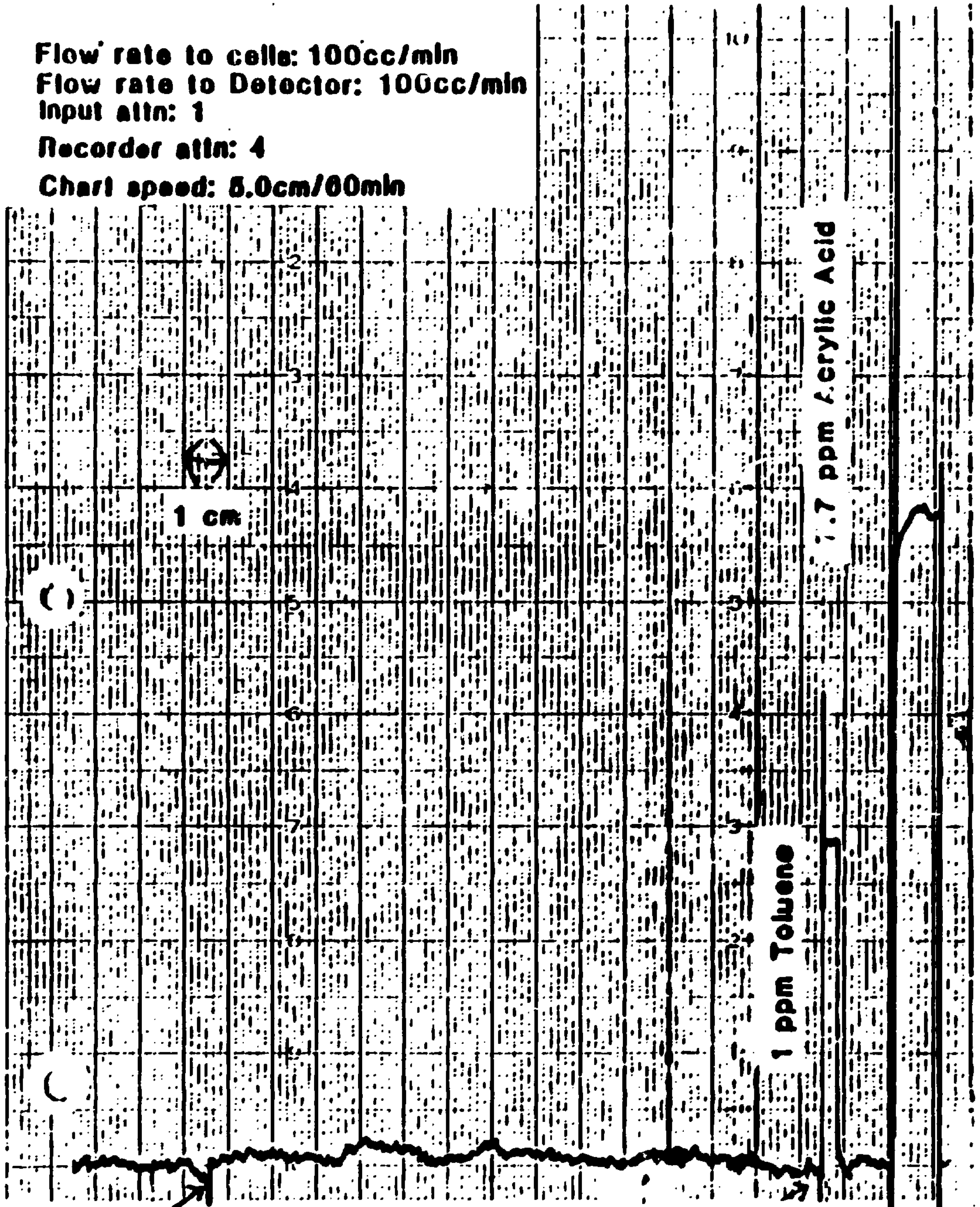
1. DATE TESTED: May 28, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after three hours.
4. MIN DETECTABLE LIMIT 0.86 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-20 mil.
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA
Samples were run by Sylvia Cooper on May 28, 1986.

Chemical Resistance Testing of USCG Material with Acrylic Acid



Acrylic Acid charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s) :	Acrylonitrile (Run I)	N/A	N/A
2. CAS NUMBER(s):	107-13-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A
	reagent grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: May 29, 1986
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 54 min
4. MIN DETECTABLE LIMIT 0.46 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

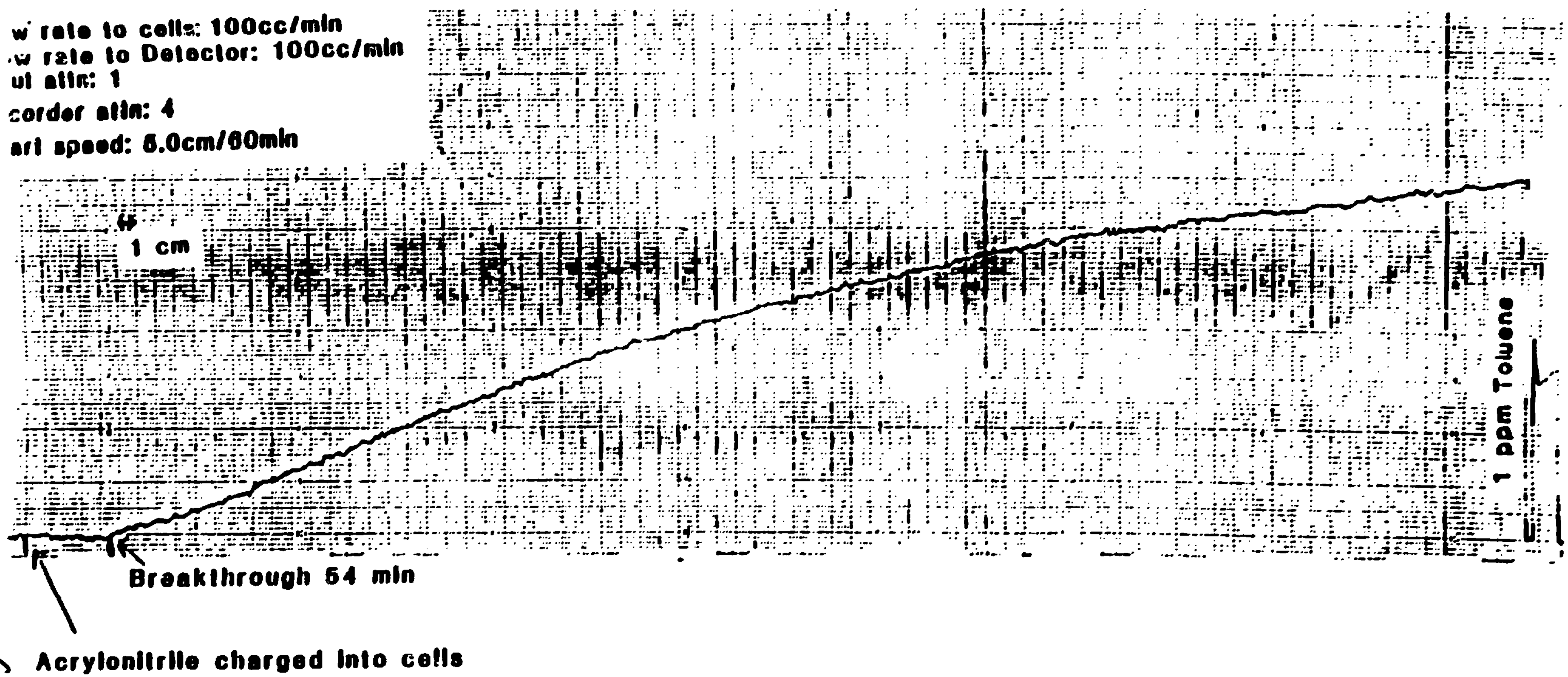
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Sylvia Cooper in May 29, 1986

Permeation of Acrylonitrile through USCG Material

Run I



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s) :	Acrylonitrile(RunII)	N/A	N/A
2. CAS NUMBER(s):	107-13-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 03, 1986
2. NUMBER OF SAMPLES TESTED: One
3. BREAKTHROUGH TIME: 76 minutes
4. MIN DETECTABLE LIMIT .18 ppm
5. STEADY STATE PERMEATION RATE 0.86 ug/cm² x hour.
6. SAMPLE THICKNESS: 18-19
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

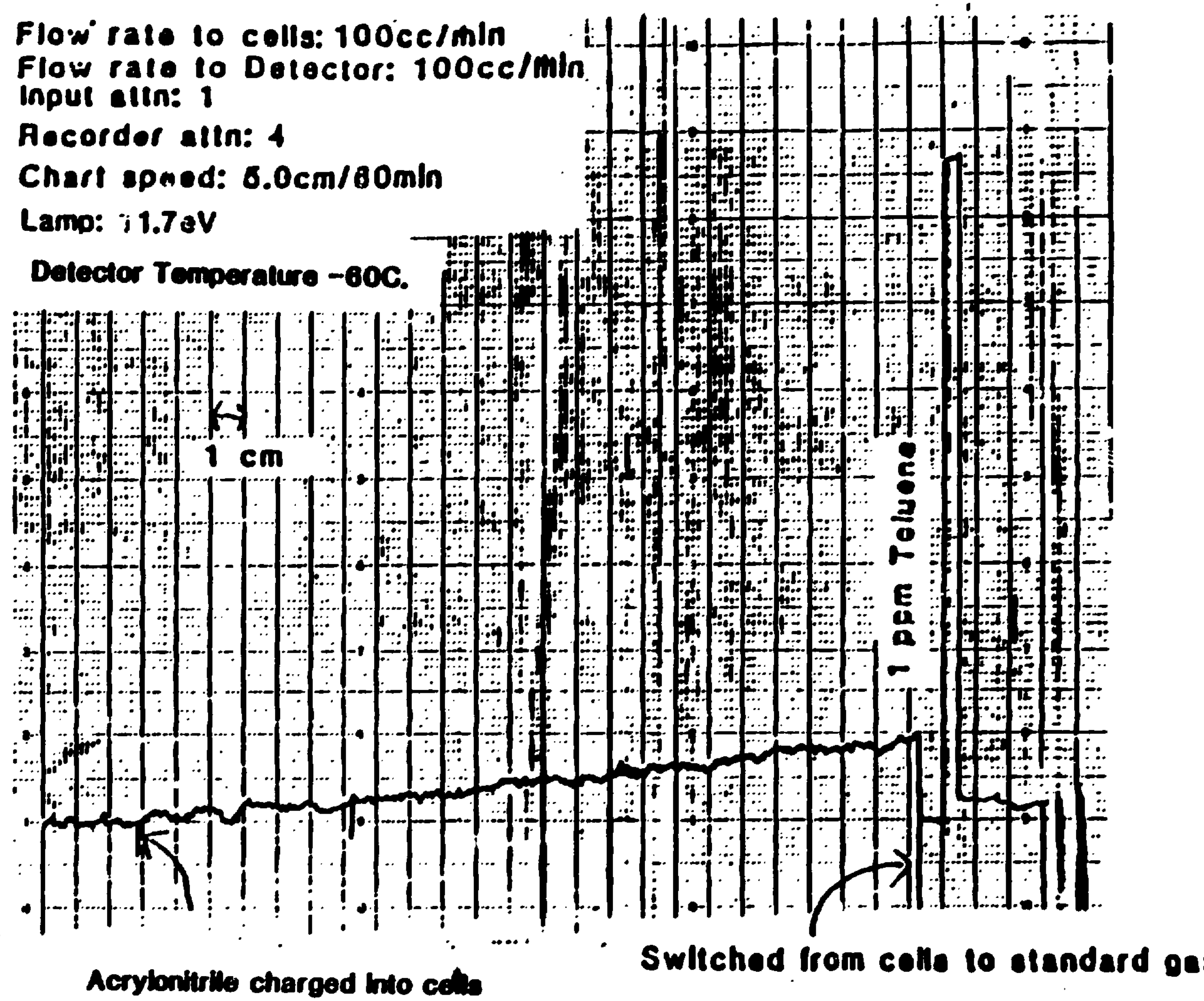
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Karen Verschoor on September 03, 1986.

Chemical Resistance Testing of USCG Material with Acrylonitrile

Run II



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Acrylonitrile	N/A	N/A
2. CAS NUMBER(s):	107-13-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 2-11-87
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 45 minutes
4. MIN DETECTABLE LIMIT .05 ppm
5. STEADY STATE PERMEATION RATE .74 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 19-20 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

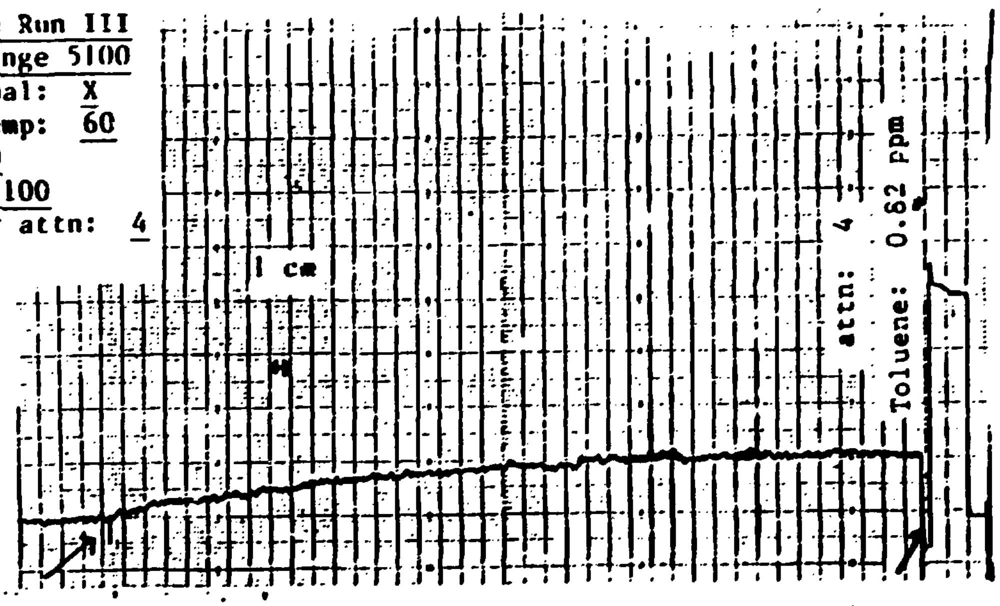
5. SOURCE OF DATA

Sample was run by Denise McDonald on February 11, 1987.

Chemical Resistance Testing of Challenge 5100

Acrylonitrile Run III

Chemical: Acrylonitrile Run III
Sample Material: Challenge 5100
Composite: __ Individual: X
Lamp: 11.7 Detector temp: 60
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1 Recorder attn: 4
Chart speed: 1 in/hr



Acrylonitrile charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Acrylonitrile	N/A	N/A
2. CAS NUMBER(s):	107-13-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 3-9-87
2. NUMBER OF SAMPLES TESTED: One (Run IV)
3. BREAKTHROUGH TIME: 97 minutes
4. MIN DETECTABLE LIMIT .08 ppm
5. STEADY STATE PERMEATION RATE .89 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 19-20 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

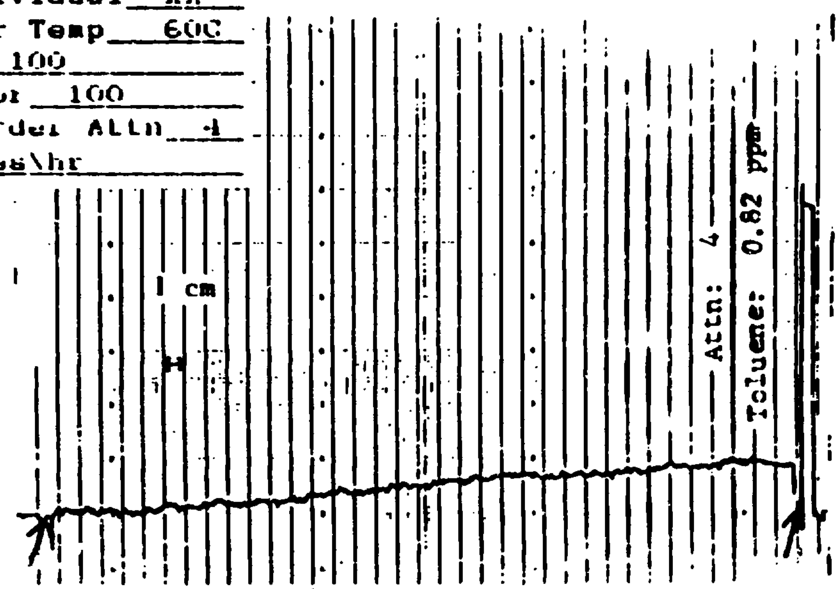
5. SOURCE OF DATA

Sample was run by Denise McDonald on March 9, 1987.

Chemical Resistance Testing of Challenge 5100

Acrylonitrile Run IV

Chemical Acrylonitrile Run IV
Sample Material Challenge 5100
Composite Individual XX
Lamp 11.7 Detector Temp 60C
Flow Rate to Cells 100
Flow Rate to Detector 100
Input Attn 1 Recorder Attn 4
Chart Speed 1 inches\hr



Acrylonitrile charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Gas Chromatography
3. TEMPERATURE: Ambient
4. COLLECTION MEDIUM: Charcoal
5. COLLECTION SYSTEM: Charcoal
6. OTHER CONDITIONS: One inch cells were used.
7. DEVIATIONS FROM ASTM F739 METHOD:

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s) :	Adiponitrile	N/A	N/A
2. CAS NUMBER(s):	111-69-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: October 8, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT 0.3 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mils
7. SELECTED DATA POINTS Cells 1,2 and 3 at end of three hour test.

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	3 hours	<0.3 ppm	<0.3 ppm	<0.3 ppm
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS: 3 hour samples were collected for 50 minutes for a total volume of 10 liters.

5. SOURCE OF DATA
Samples were run by Denise McDonald on October 8, 1986.

This page left intentionally blank

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100cc/min

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s):	Allyl Alcohol	N/A	N/A
2. CAS NUMBER(s):	107-18-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A
	Reagent Grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 4, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No Breakthrough was detected after 14 hours.
4. MIN DETECTABLE LIMIT 1.13 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-20 mil
7. SELECTED DATA POINTS N/A

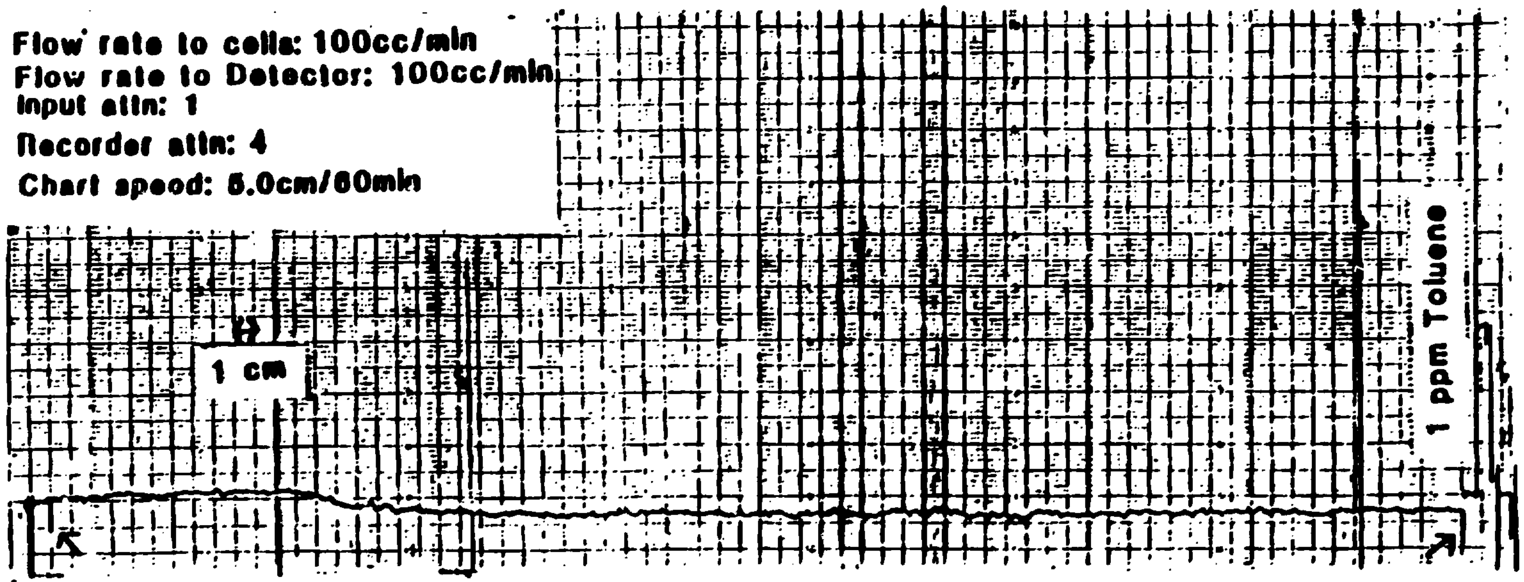
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Karen Verschoor on June 4-5, 1986

Chemical Resistance Testing of USCG Material with Allyl Alcohol



Allyl Alcohol charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Allyl chloride	N/A	N/A
2. CAS NUMBER(s):	107-051	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A
	reagent grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: May 23, 1986
2. NUMBER OF SAMPLES TESTED: Three (composite run)
3. BREAKTHROUGH TIME: 102 min
4. MIN DETECTABLE LIMIT 0.16 ppm
5. STEADY STATE PERMEATION RATE 0.64 ug/hr x cm²
6. SAMPLE THICKNESS: 18-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

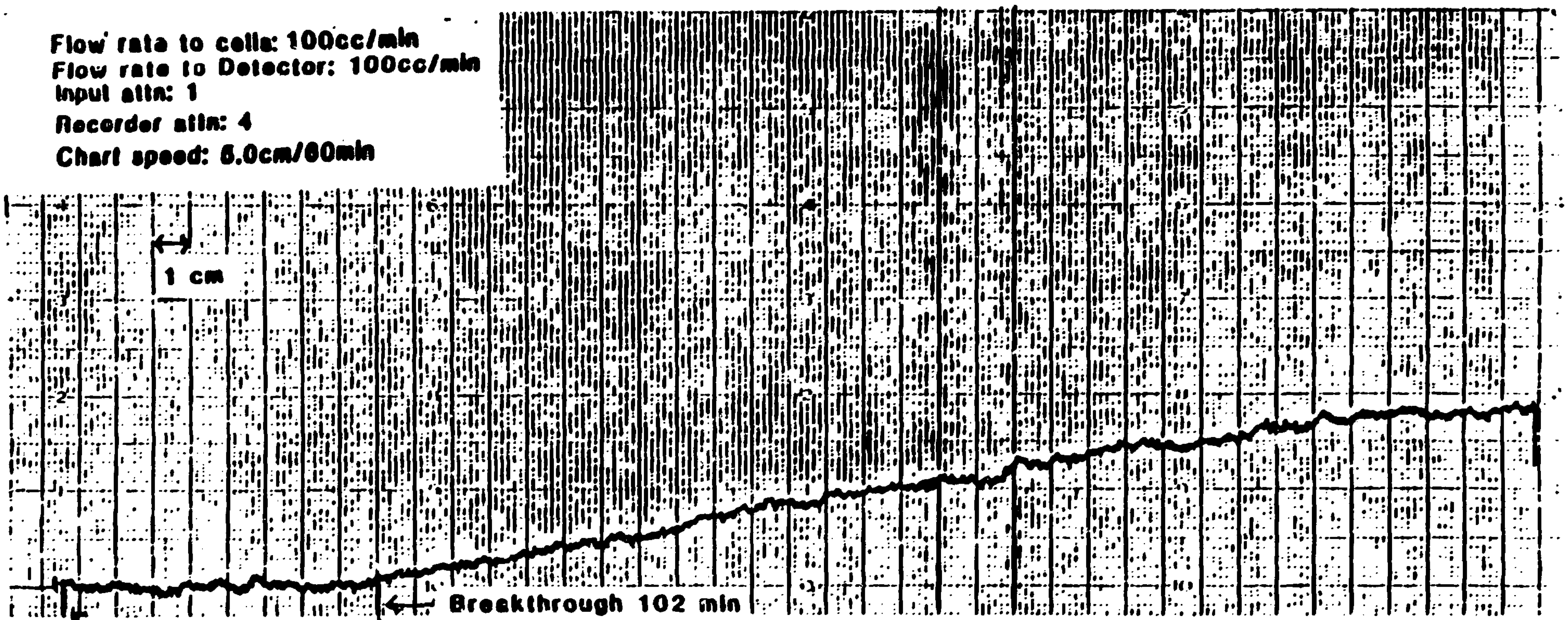
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on May 23, 1986

Permeation of Allyl Chloride through USCG Material

(Composite Run)



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25 °C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cell was used /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100cc/min.

. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Allyl Chloride	N/A	N/A
2. CAS NUMBER(s):	107-051	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 13, 1986
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 165.6 min
4. MIN DETECTABLE LIMIT 0.16 ppm
5. STEADY STATE PERMEATION RATE 0.62 ug/hr x cm^2
6. SAMPLE THICKNESS: 18-21 mil
7. SELECTED DATA POINTS

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

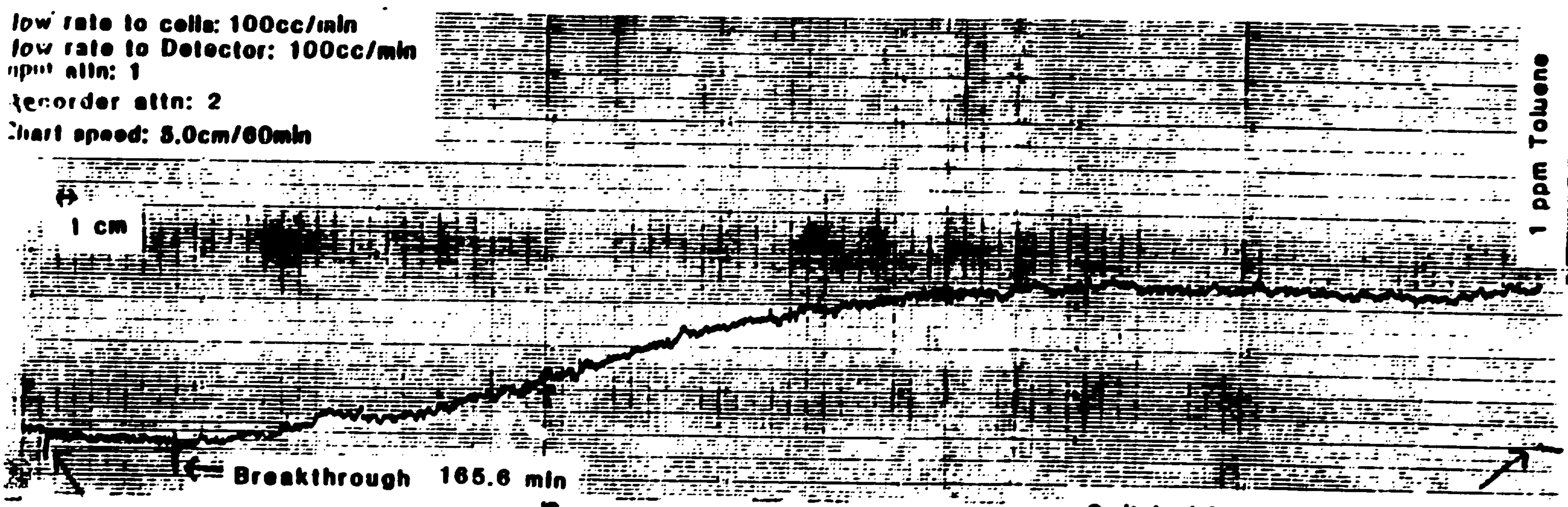
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Sylvia cooper on June 13, 1986.

Permeation of Allyl Chloride through USCG Material

Run I



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

   1: TYPE: Teflon laminated Nomex
   2: PROTECTIVE MATERIAL CODE: 068
   3: CONDITION BEFORE TEST: Unused, no visible imperfections
   4: MANUFACTURER: Chemfab Corp.
   5: PRODUCT IDENTIFICATION: Challenge 5100
   6: LOT OR MANUFACTURER DATE: N/A
   7: NOMINAL THICKNESS: 19-20 mil
   8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

   1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
   2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
   3. TEMPERATURE: 22-25°C
   4. COLLECTION MEDIUM: N_2
   5. COLLECTION SYSTEM: N_2
   6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
   7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Allyl Chloride	N/A	N/A
2. CAS NUMBER(s):	107-05-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

   1. DATE TESTED: 1-27-87
   2. NUMBER OF SAMPLES TESTED: One (Run II)
   3. BREAKTHROUGH TIME: 152 minutes
   4. MIN DETECTABLE LIMIT .03 ppm
   5. STEADY STATE PERMEATION RATE .22 (ug/cm^2*hr)
   6. SAMPLE THICKNESS: 19-20 mil
   7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

   8. OTHER OBSERVATIONS:

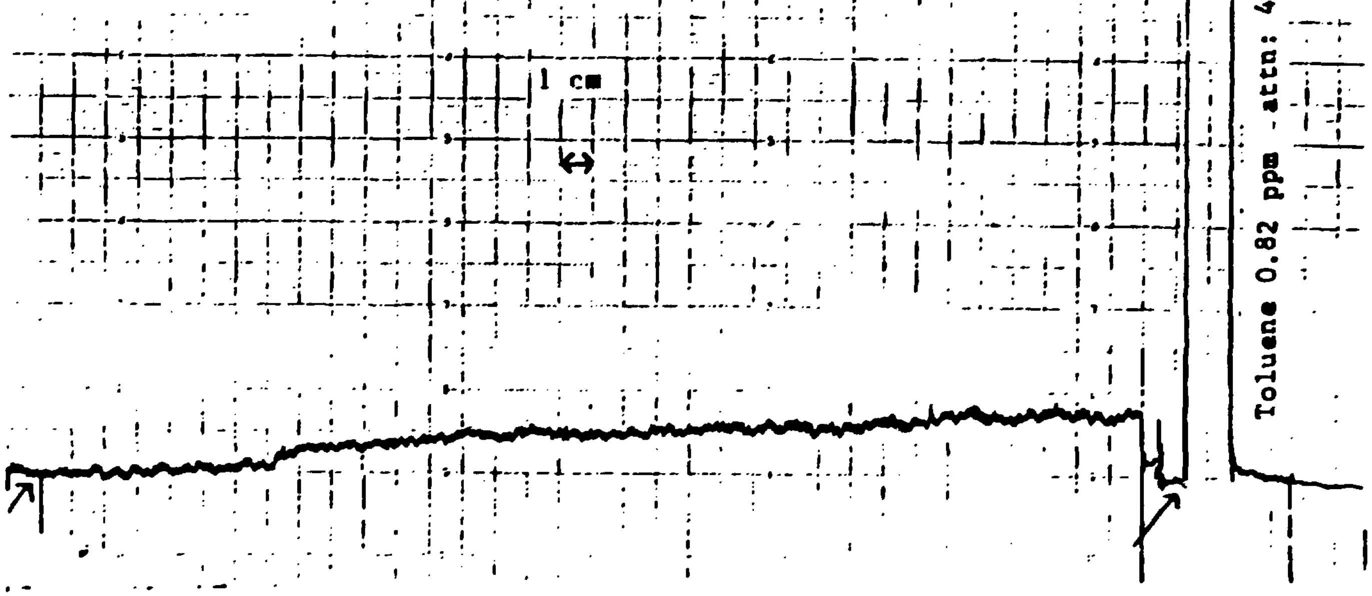
5. SOURCE OF DATA

   Sample was run by Denise McDonald on January 27, 1987.

Chemical Resistance Testing of Challenge 5100 Material

Allyl Chloride Run II

Chemical: Allyl Chloride Run II
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1
Chart speed: 1 in/hr
Lamp: 11.7
Recorder attn: 4
Detector temp: 60
CHALLENGE 5100, INDIVIDUAL



Allyl Chloride charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 19-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lam .
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Allyl Chloride	N/A	N/A
2. CAS NUMBER(s):	107-05-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-28-87
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 203 minutes
4. MIN DETECTABLE LIMIT .03 ppm
5. STEADY STATE PERMEATION RATE .15 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

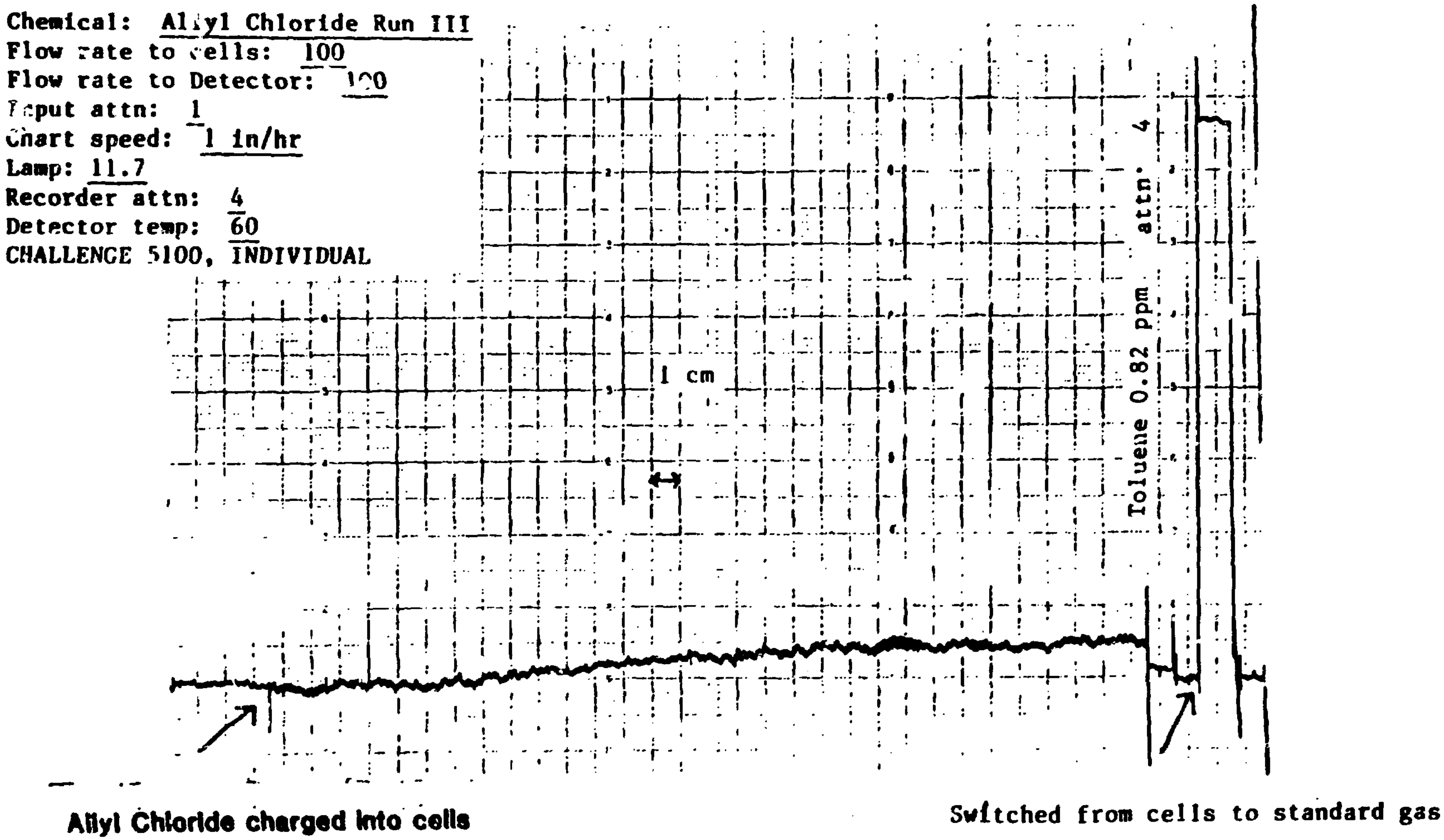
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Denise McDonald on January 28, 1987.

Chemical Resistance Testing of Challenge 5100 Material

Allyl Chloride Run III



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 90 cc/min.

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s) :	Aniline	N/A	N/A
2. CAS NUMBER(s):	62-53-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	J.T. Baker reagent grade	N/A	N/A
		N/A	N/A

4. TEST RESULTS

1. DATE TESTED: April 14, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.25 hours.
4. MIN DETECTABLE LIMIT 0.46 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS N/A

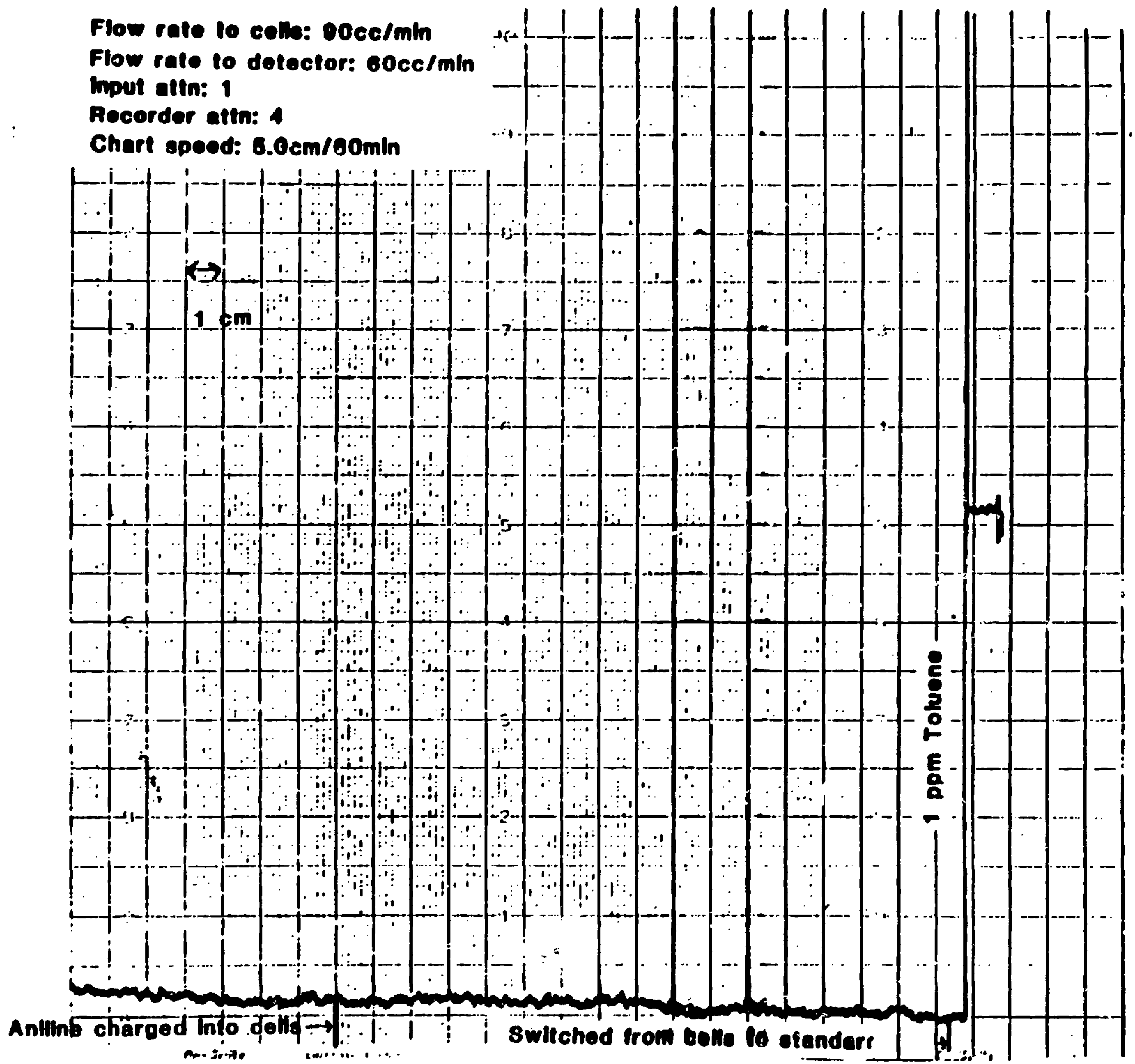
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Karen Verschoor on April 14 , 1986.

Chemical Resistance Testing of USCG Material with Aniline



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25 C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: flow rate to cells was 90cc/min

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Benzene	N/A	N/A
2. CAS NUMBER(s):	71-43-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher reagent grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: April 9, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.2 hours
4. MIN DETECTABLE LIMIT .05 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS N/A

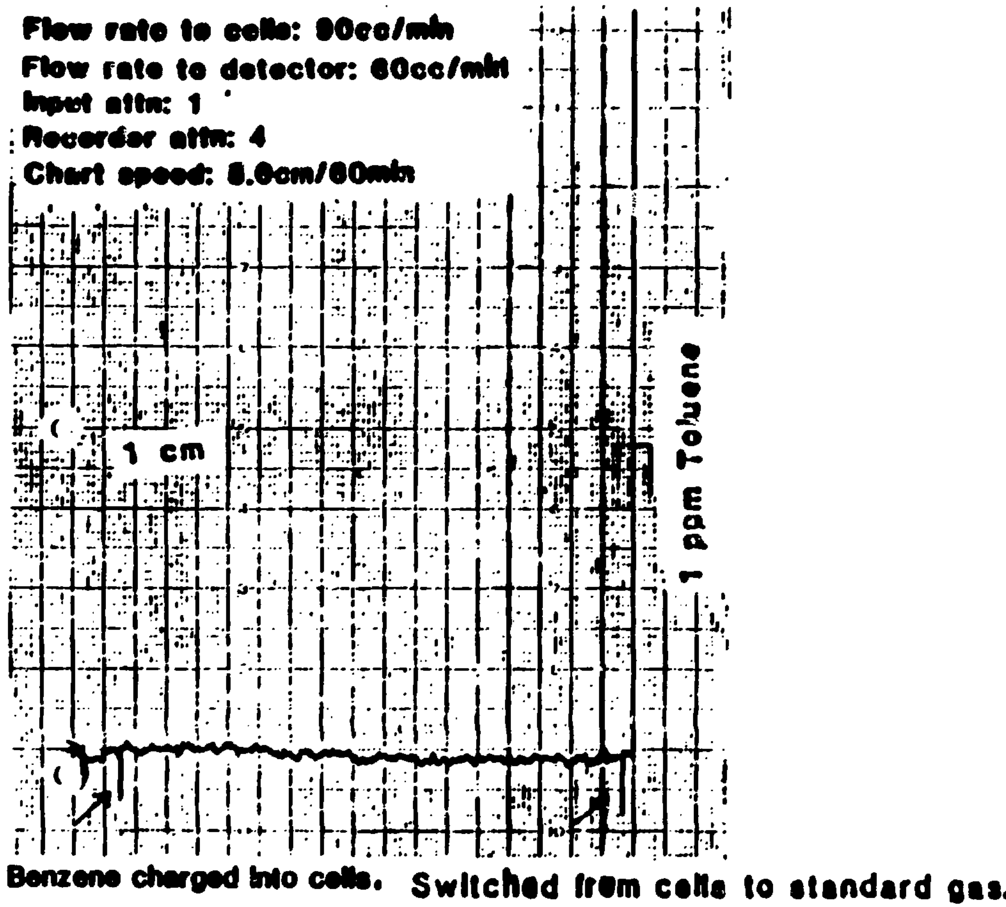
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Karen Verschoor on April 9, 1986

Chemical Resistance Testing of USCG Material with Benzene



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 90cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Benzyl Chloride	N/A	N/A
2. CAS NUMBER(s):	100-44-7	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: April 10, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.2 hours.
4. MIN DETECTABLE LIMIT 0.11 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS N/A

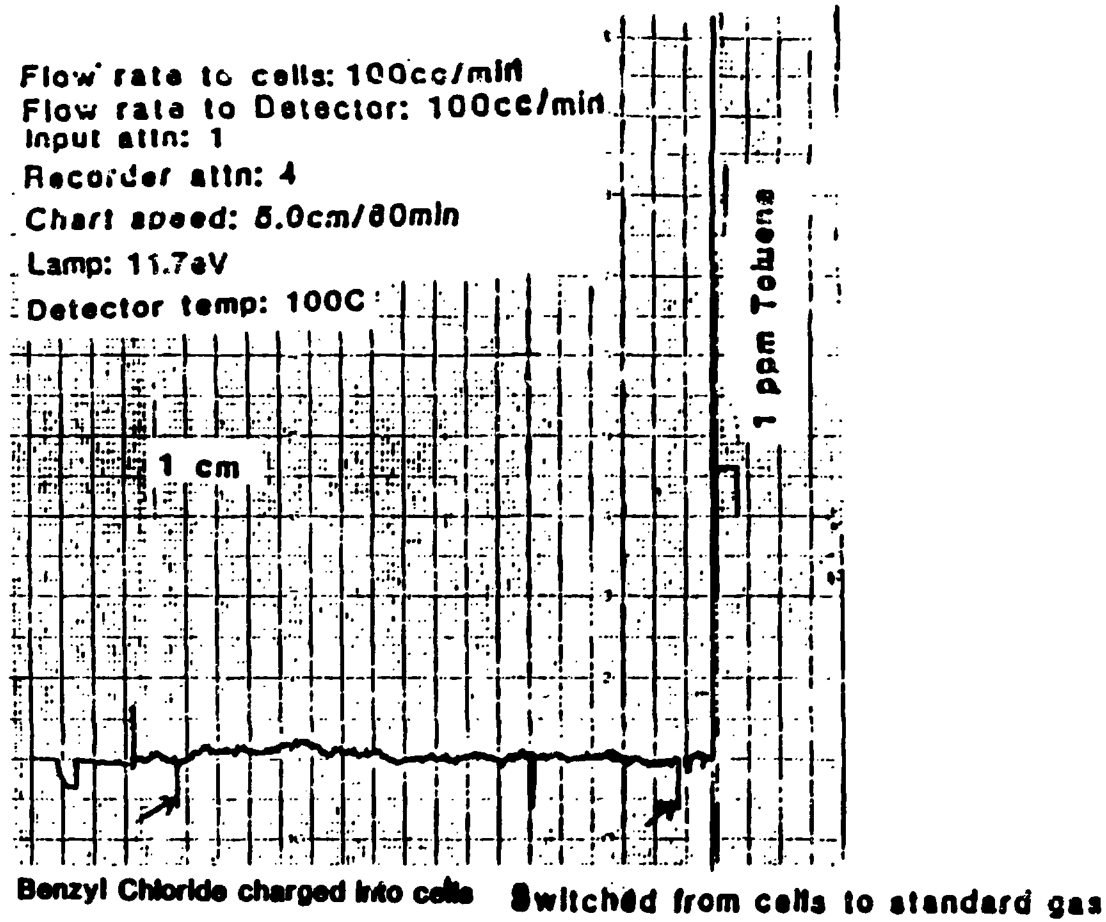
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Karen Verschoor on April 10, 1986.

Chemical Resistance Testing of USCG Material with Benzyl Chloride



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: N/A

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s):	Bromine	N/A	N/A
2. CAS NUMBER(s):	7726-95-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent grade	N/A	N/A
		N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 4, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.26 hours.
4. MIN DETECTABLE LIMIT .53 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Karen Verschoor on September 4, 1986.

Chemical Resistance Testing of USCG Material with Bromine

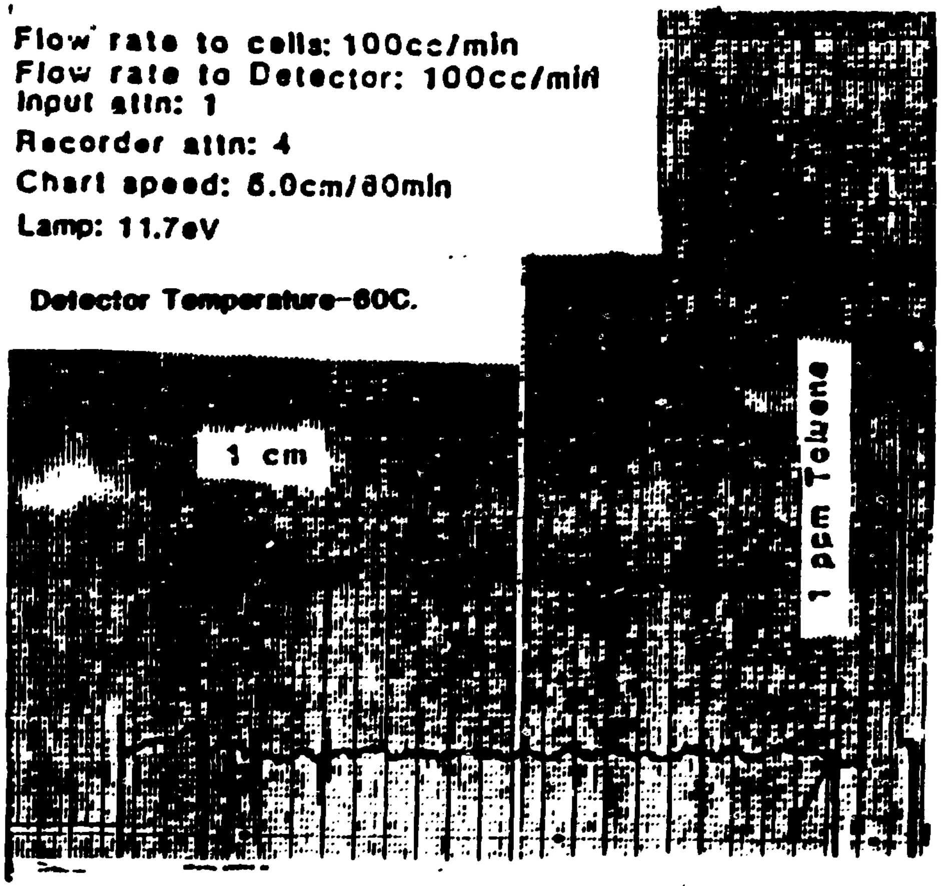
Flow rate to cells: 100cc/min
Flow rate to Detector: 100cc/min
Input attn: 1

Recorder attn: 4

Chart speed: 5.0cm/30min

Lamp: 11.7eV

Detector Temperature–60C.



Bromine charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25 °C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Butyl Acetate	N/A	N/A
2. CAS NUMBER(s):	540-88-5	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	J.T. Baker reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: July 7, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT 0.25 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

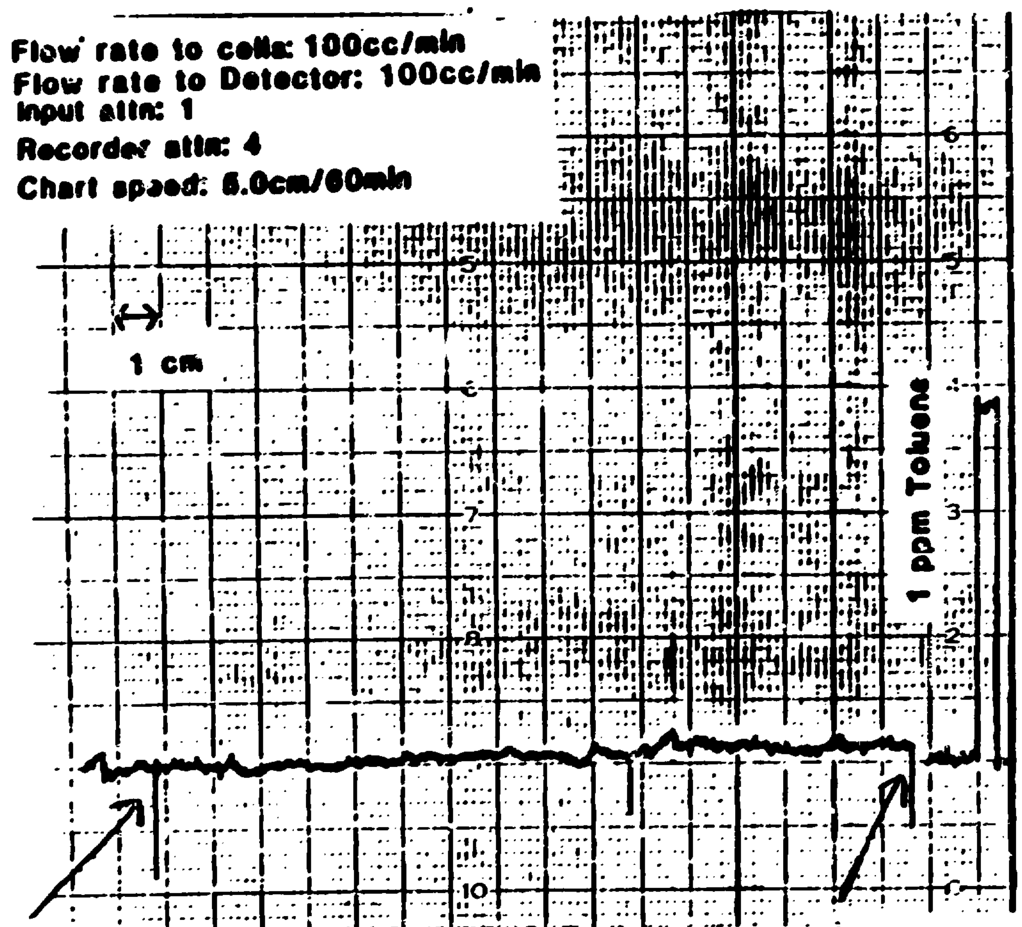
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on July 7, 1986.

Chemical Resistance Testing of USCG Material with Butyl Acetate



Butyl Acetate charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature =60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s):	Butyl Acrylate	N/A	N/A
2. CAS NUMBER(s):	141-32-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: July 21, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT 0.22 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 13-19 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

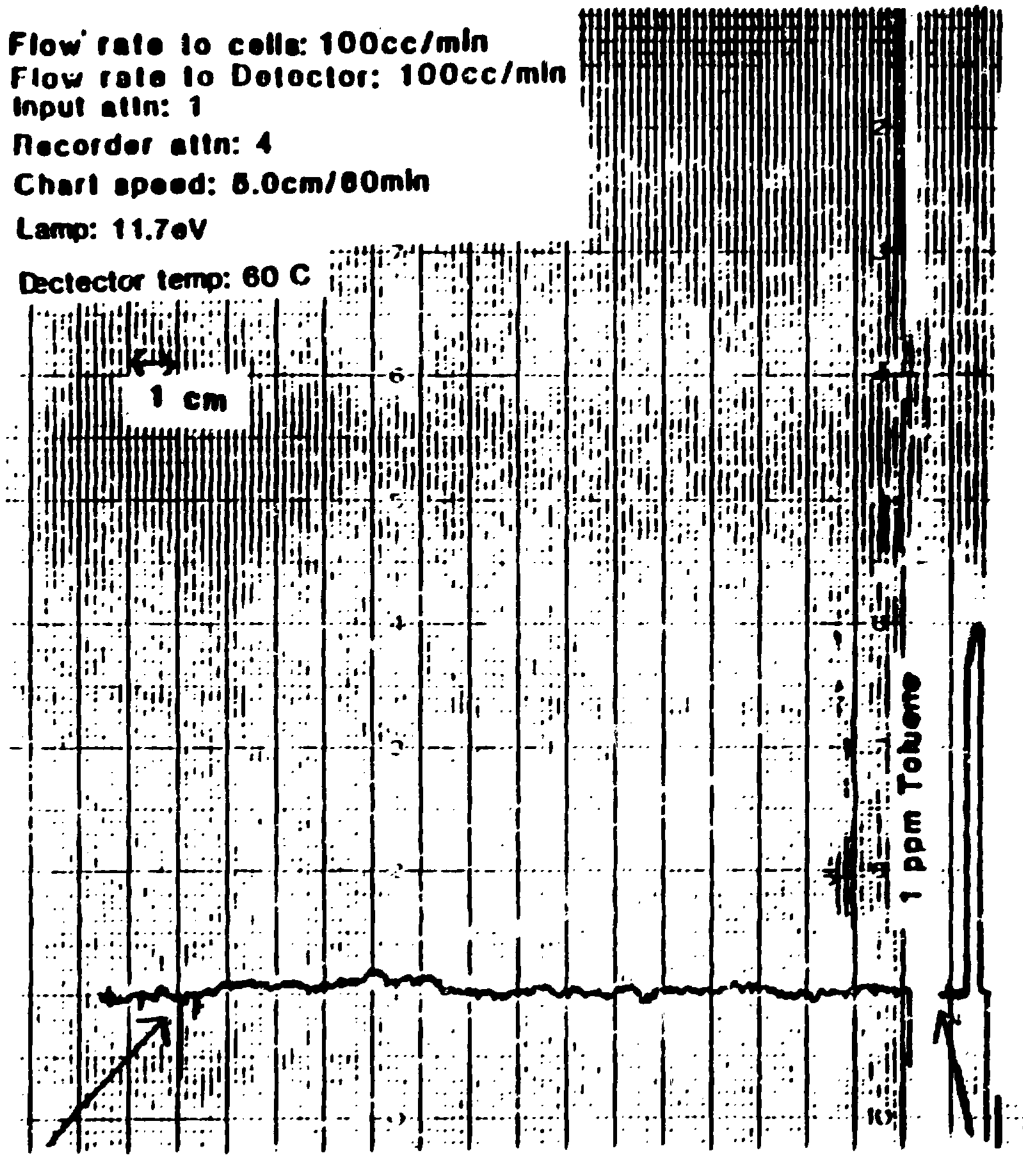
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on July 21, 1986

Chemical Resistance Testing of USCG Material with Butyl Acrylate

Flow rate to cells: 100cc/min
Flow rate to Detector: 100cc/min
Input attn: 1
Recorder attn: 4
Chart speed: 5.0cm/60min
Lamp: 11.7eV
Dectector temp: 60 C



Butyl Acrylate charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used/Detector Temperature =60C
DEVIATIONS FROM ASTM F739 METH D: Flow rate to cells was 100cc/min.

CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s) :	n-Butyl alcohol	N/A	N/A
2. CAS NUMBER(s):	71-36-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Baker reagent grade	N/A	N/A

4. TEST RESULTS

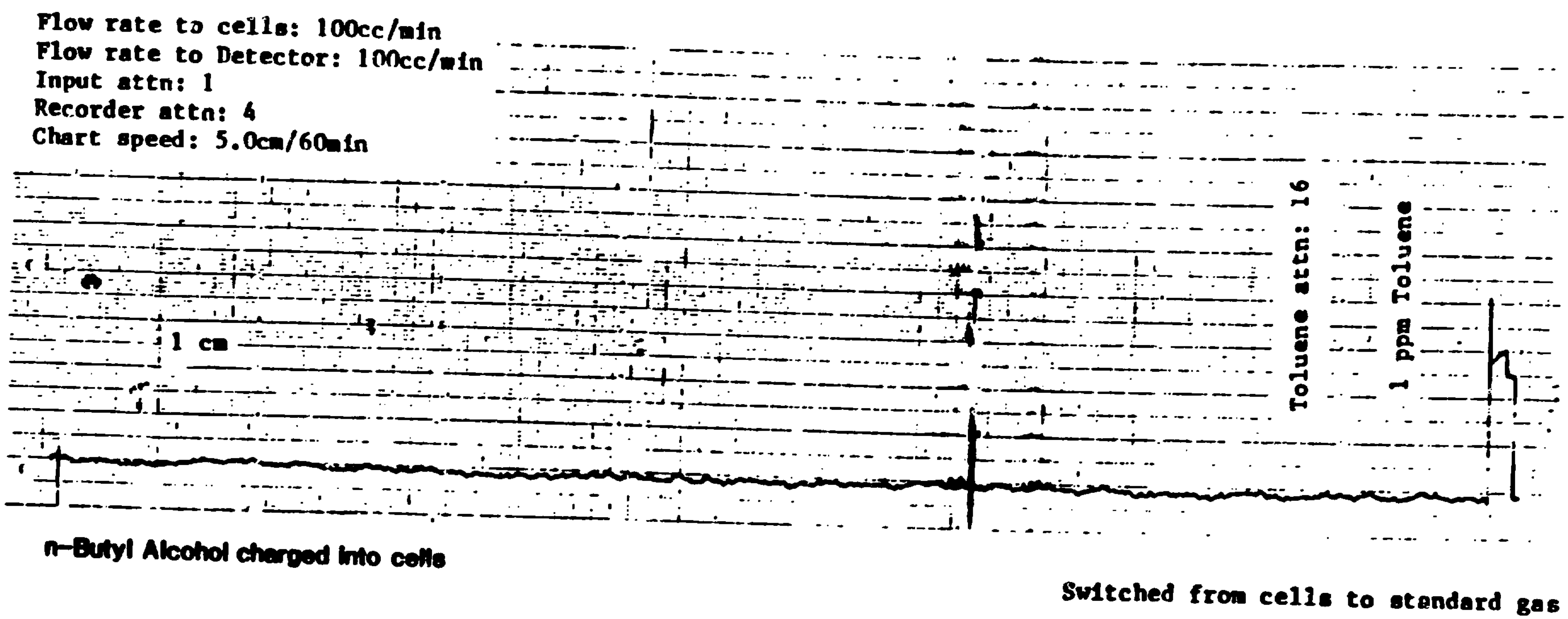
1. DATE TESTED: May 16, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 15.6 hours.
4. MIN DETECTABLE LIMIT .32 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil.
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA
Samples were run by Sylvia Cooper on May 16, 1986.

Chemical Resistance Testing of USCG Material with n-Butyl Alcohol



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used/Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	n-Butylamine	N/A	N/A
2. CAS NUMBER(s):	109-73-9	N/A	N/A
3. CONC. (IF MIX):	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: May 19, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT .32 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil.
7. SELECTED DATA POINTS N/A

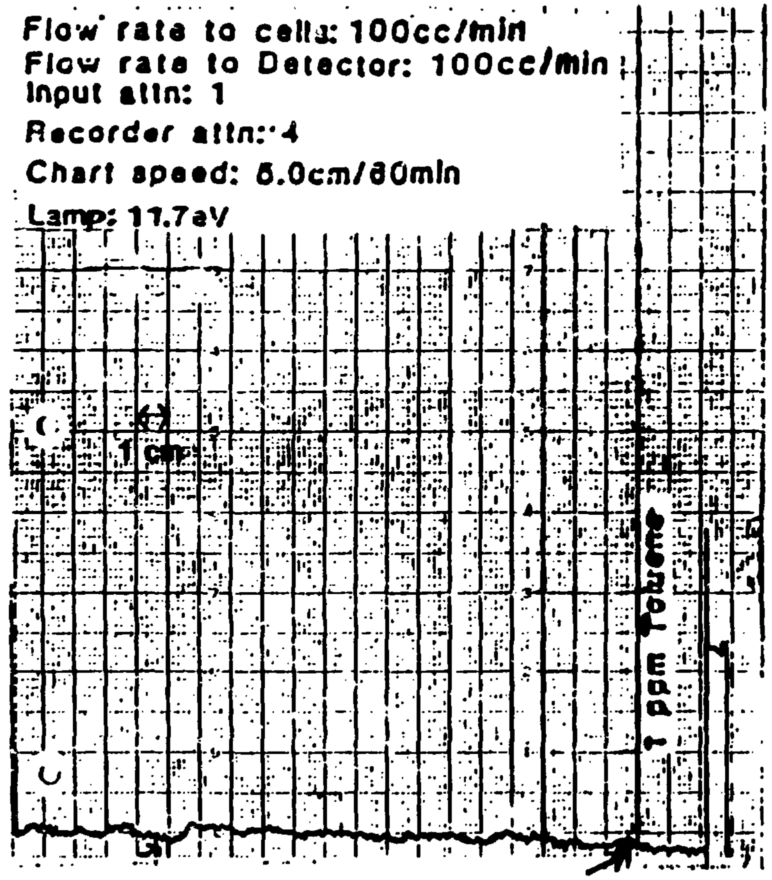
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper May 19, 1986

Chemical Resistance Testing of USCG Material with Butyl Amine



Butyl Amine charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature =100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s):	Butyraldehyde	N/A	N/A
2. CAS NUMBER(s):	123-72-8	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: July 24, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 7.5 hours.
4. MIN DETECTABLE LIMIT .29 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

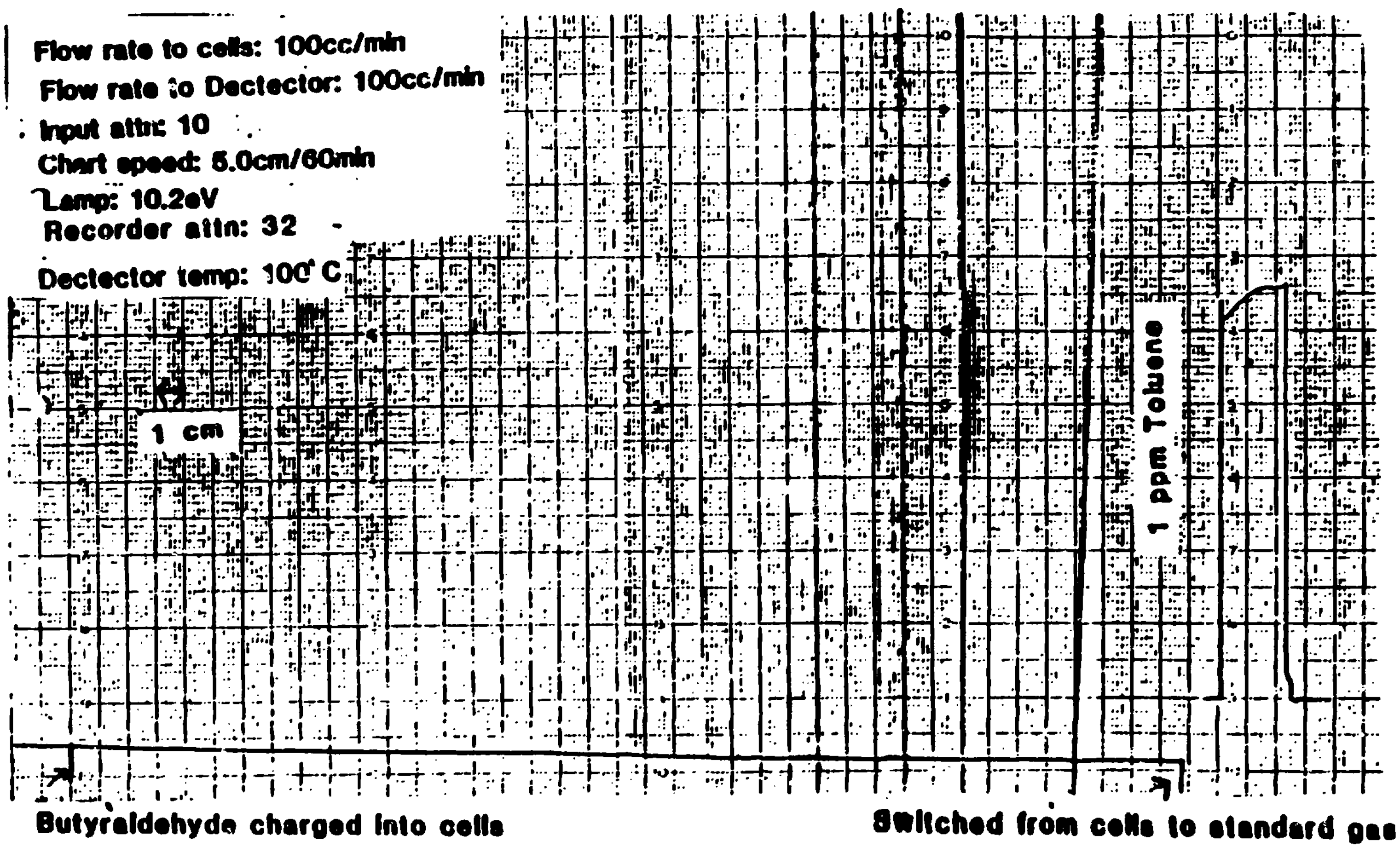
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on July 24, 1986.

Chemical Resistance Testing of USCG Material with Butyraldehyde



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25 °C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature = 60C
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Carbon Disulfide	N/A	N/A
2. CAS NUMBER(s):	75-15-0	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A
	reagent grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 27, 1986
2. NUMBER OF SAMPLES TESTED: Three (composite)
3. BREAKTHROUGH TIME: 21.60 min
4. MIN DETECTABLE LIMIT .10 ppm
5. STEADY STATE PERMEATION RATE 2.76 ug/hr x cm^2
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

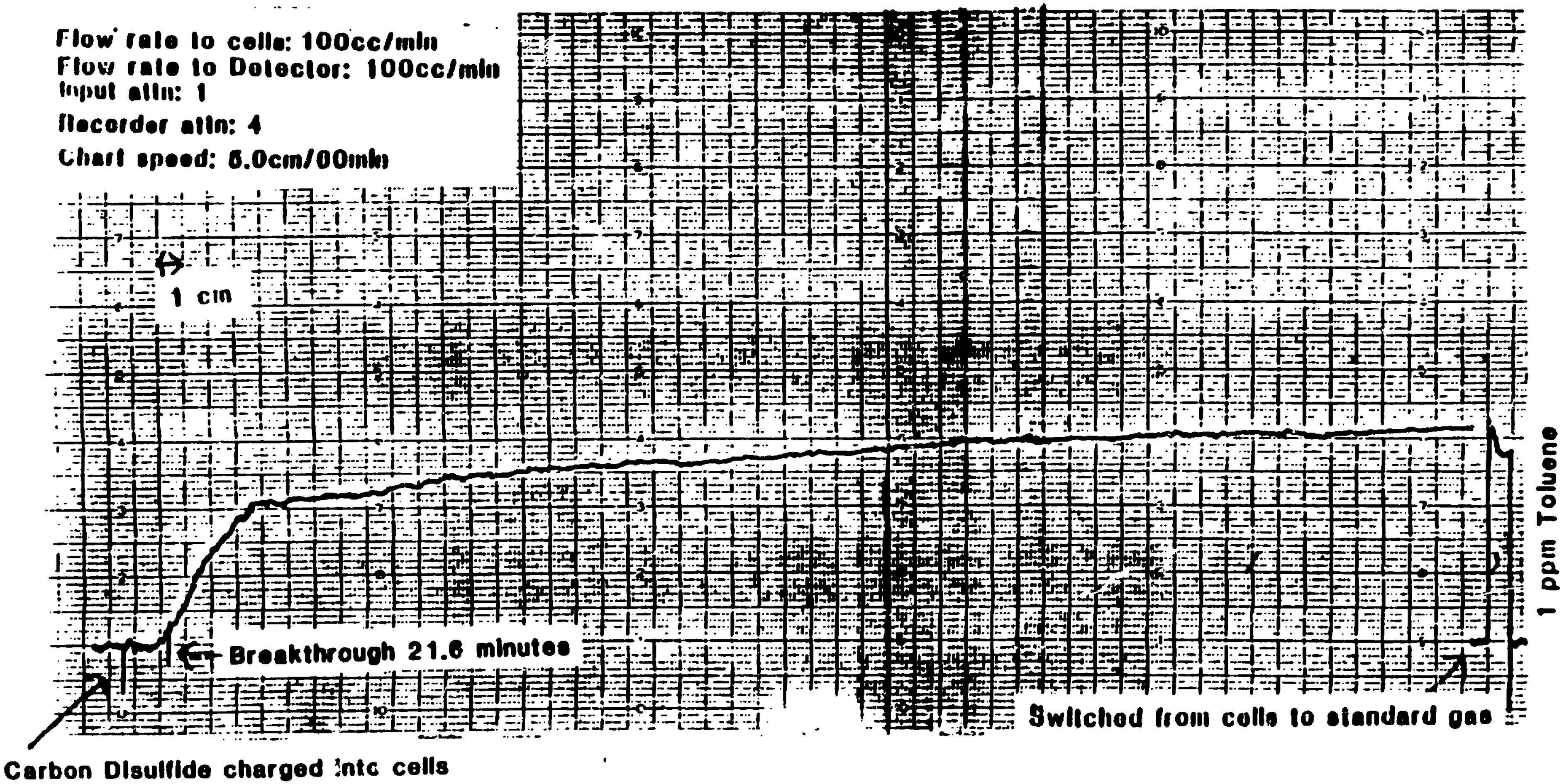
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on June 27, 1986.

Permeation of Carbon Disulfide through USCG Material

Composite



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s) :	Carbon Disulfide	N/A	N/A
2. CAS NUMBER(s):	75-15-0	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A
	reagent grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 27, 1986
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 20.50 min
4. MIN DETECTABLE LIMIT .05 ppm.
5. STEADY STATE PERMEATION RATE 3.65 ug/hr x cm²
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
4.				
5.				
6.				
7.				
8.				
9.				
10.				

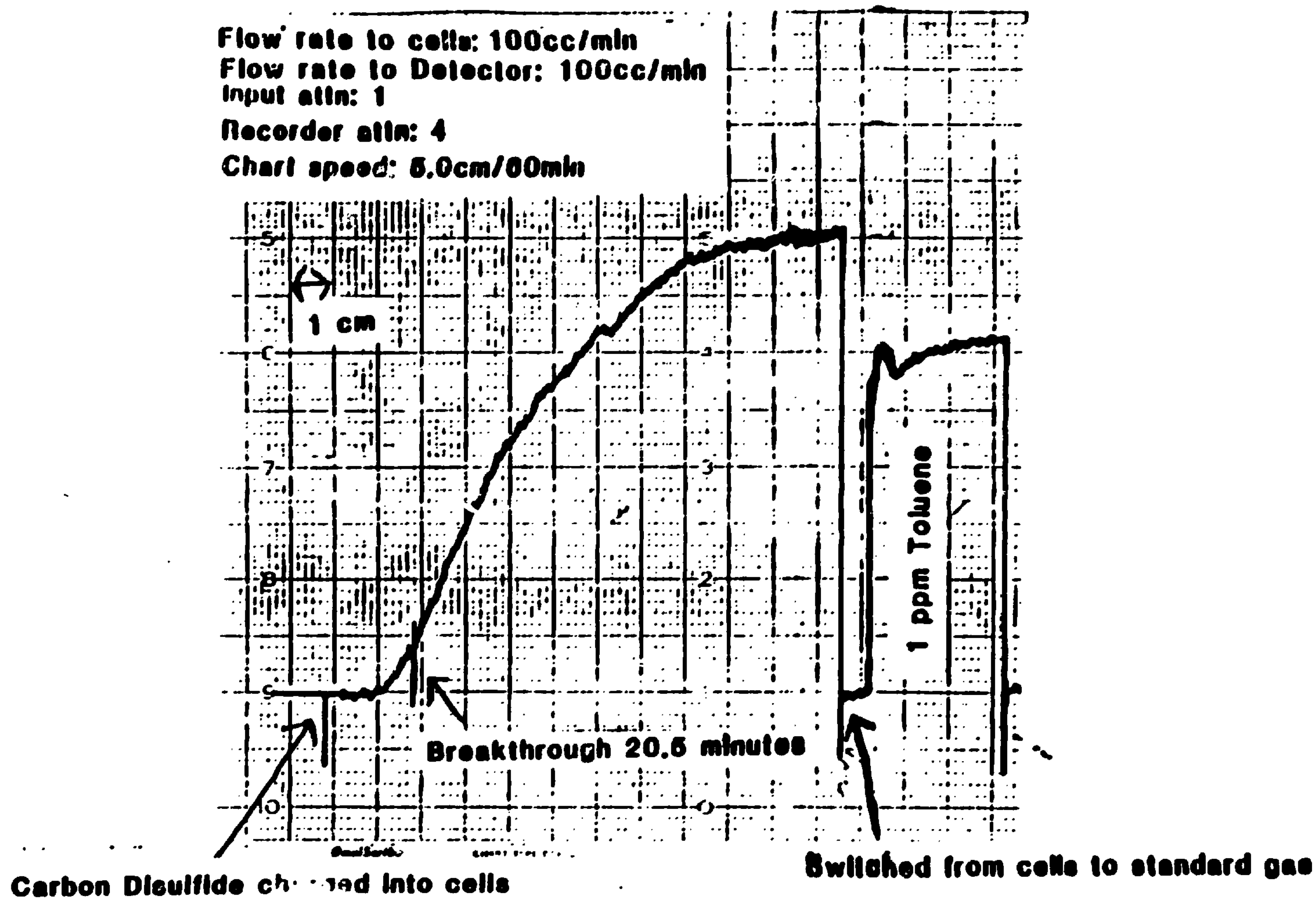
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Sylvia Cooper on June 27, 1986

Permeation of Carbon Disulfide through USCG Material

Run I



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s):	Carbon Disulfide	N/A	N/A
2. CAS NUMBER(s):	75-15-0	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A
	reagent grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 30, 1986
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: 17.70 min
4. MIN DETECTABLE LIMIT .05 ppm
5. STEADY STATE PERMEATION RATE 2.59 ug/hr x cm²
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

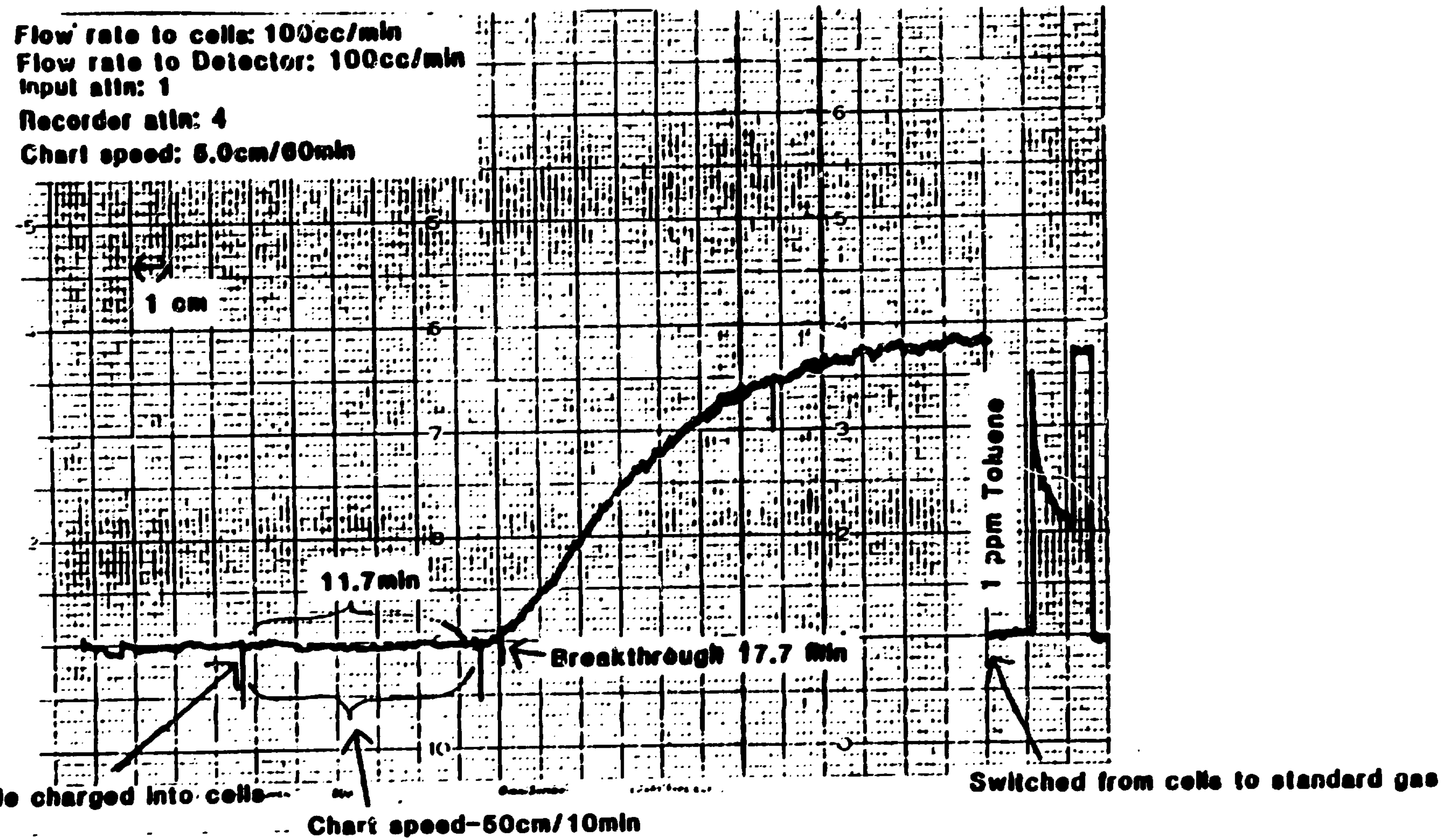
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Sylvia Cooper on June 30, 1986.

Permeation of Carbon Disulfide through USCG Material

Run II



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 069
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 90 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Carbon Tetrachloride	N/A	N/A
2. CAS NUMBER(s):	56-23-5	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A
	reagent grade	N/A	N/A

TEST RESULTS

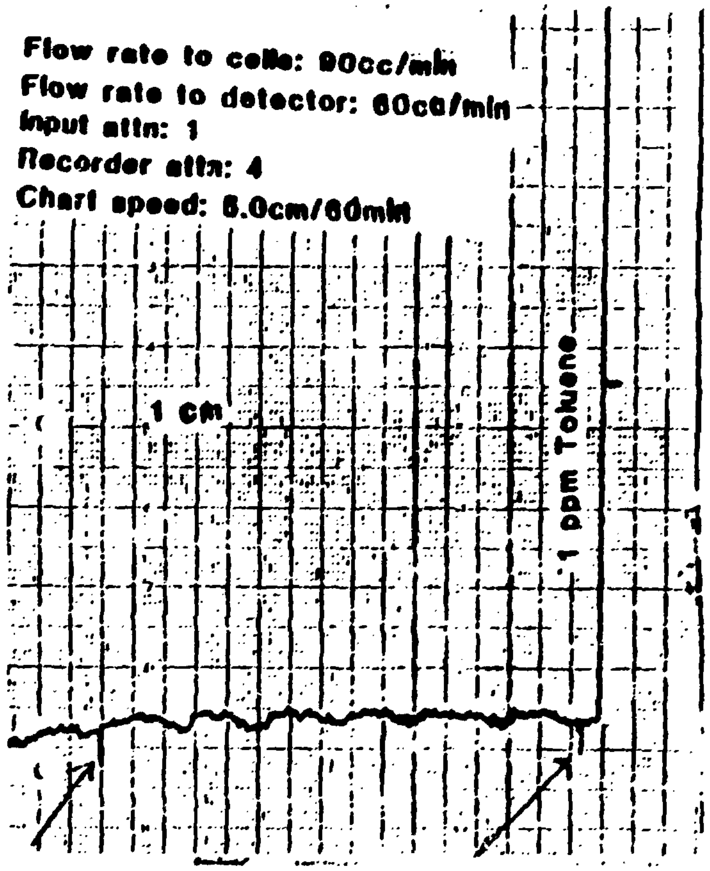
1. DATE TESTED: April 16, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT N/A
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA
Samples were run by Karen Verschoor on April 16, 1986

Chemical Resistance Testing of USCG Material with Carbon Tetrachloride



Carbon Tetrachloride charged into cells. Switched from cells to standard gas.

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s) :	Chlordane (25%)	N/A	N/A
2. CAS NUMBER(s):	N/A	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Voluntary Product	N/A	N/A
	group	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 9, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.44 hours.
4. MIN DETECTABLE LIMIT 0.26 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

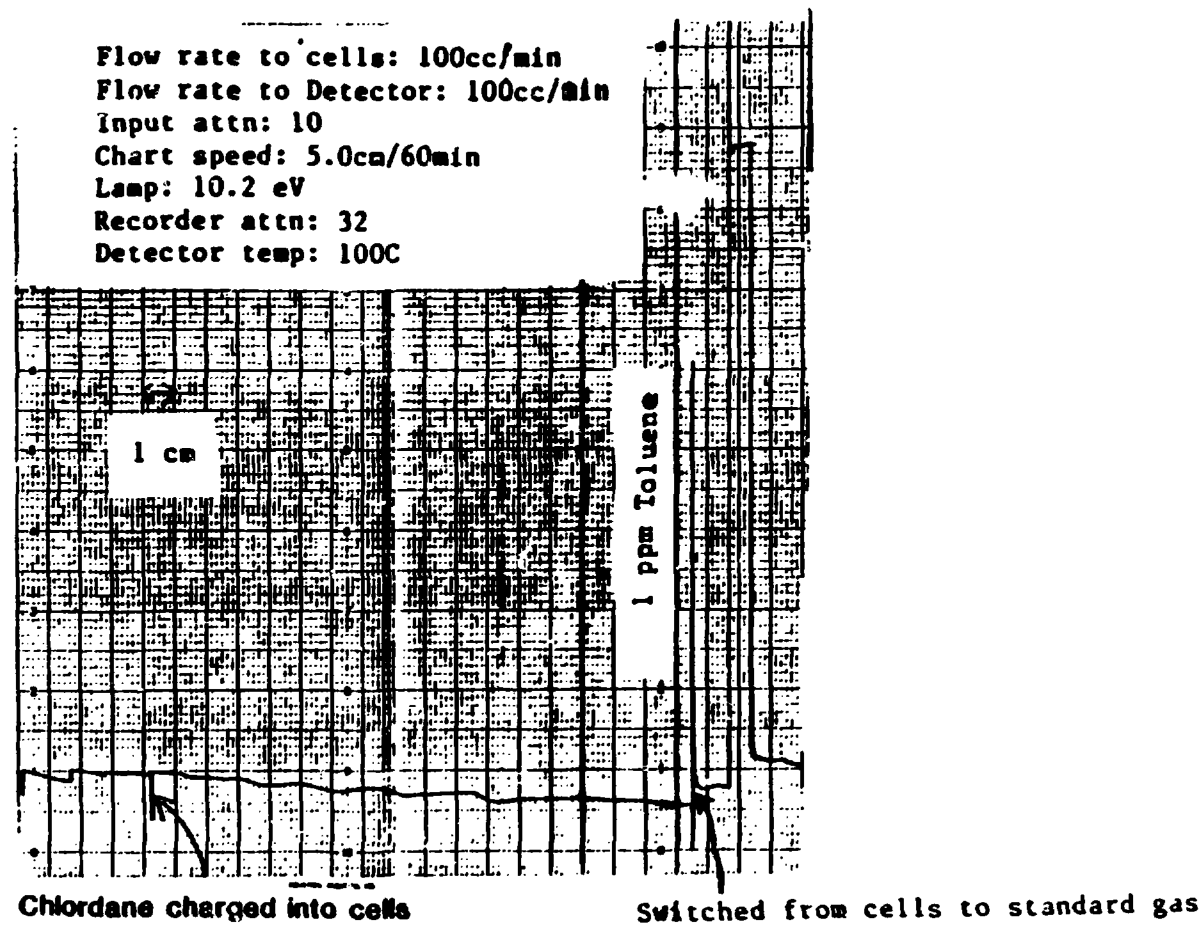
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on September 9, 1986.

Chemical Resistance Testing of USCG Material with Chlordane



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Chlorobenzene	N/A	N/A
2. CAS NUMBER(s):	108-90-7	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: July 16, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT .20 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

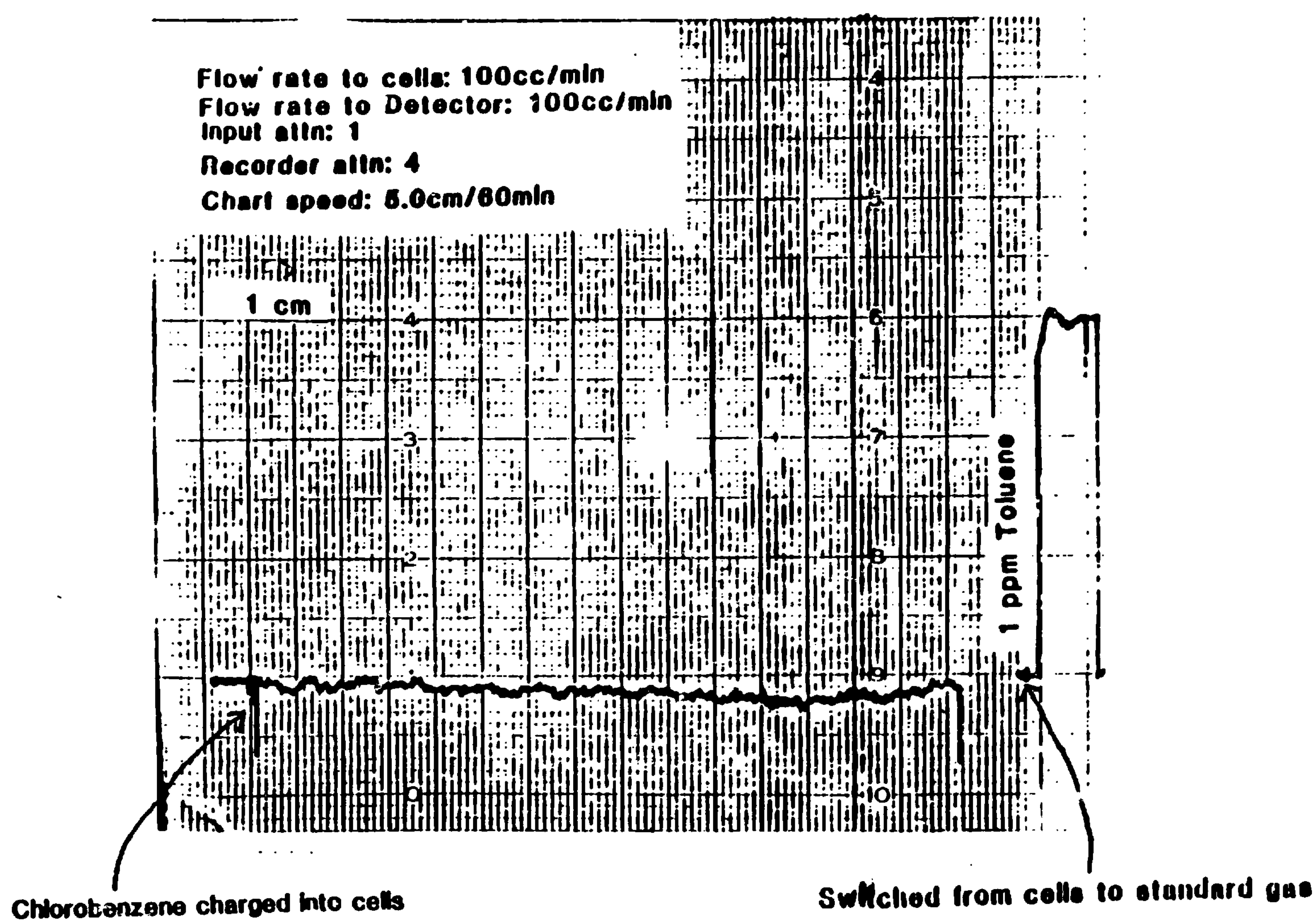
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on July 16, 1986

Chemical Resistance Testing of USCG Material with Chlorobenzene



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material buff colored

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 90 cc/min

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s):	Chloroform	N/A	N/A
2. CAS NUMBER(s):	865-49-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Kodak	N/A	N/A
	reagent grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: April 24, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.6 hours
4. MIN DETECTABLE LIMIT 0.19 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS N/A

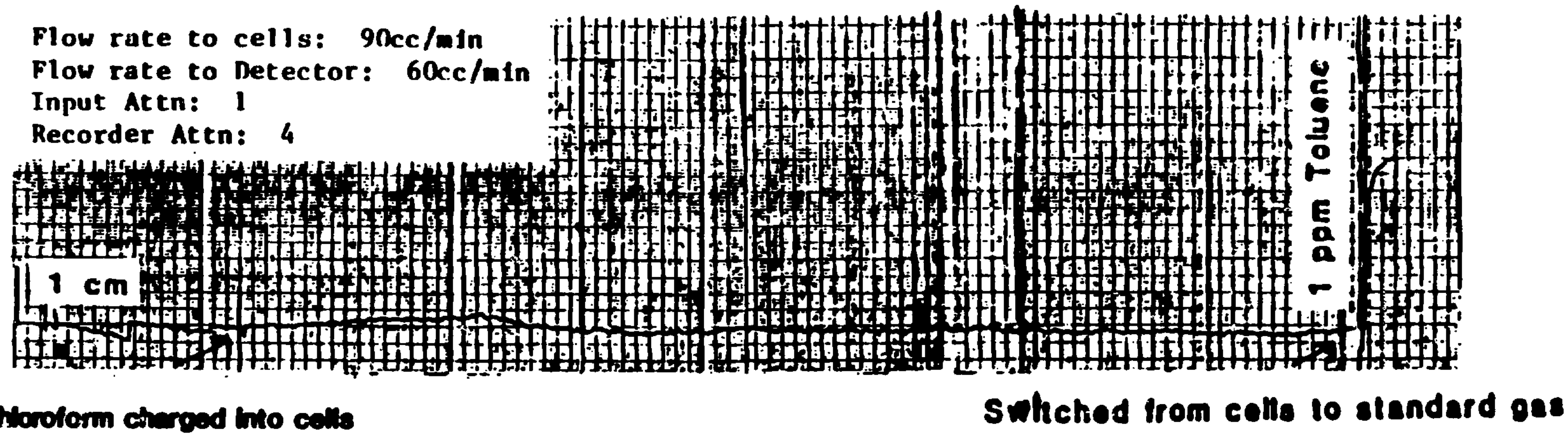
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Karen Verschoor on April 24, 1986

Chemical Resistance Testing of USCG Material with Chloroform



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Chloropicrin	N/A	N/A
2. CAS NUMBER(s):	76-06-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Kodak reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: October 15, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.1 hours.
4. MIN DETECTABLE LIMIT 1.80 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

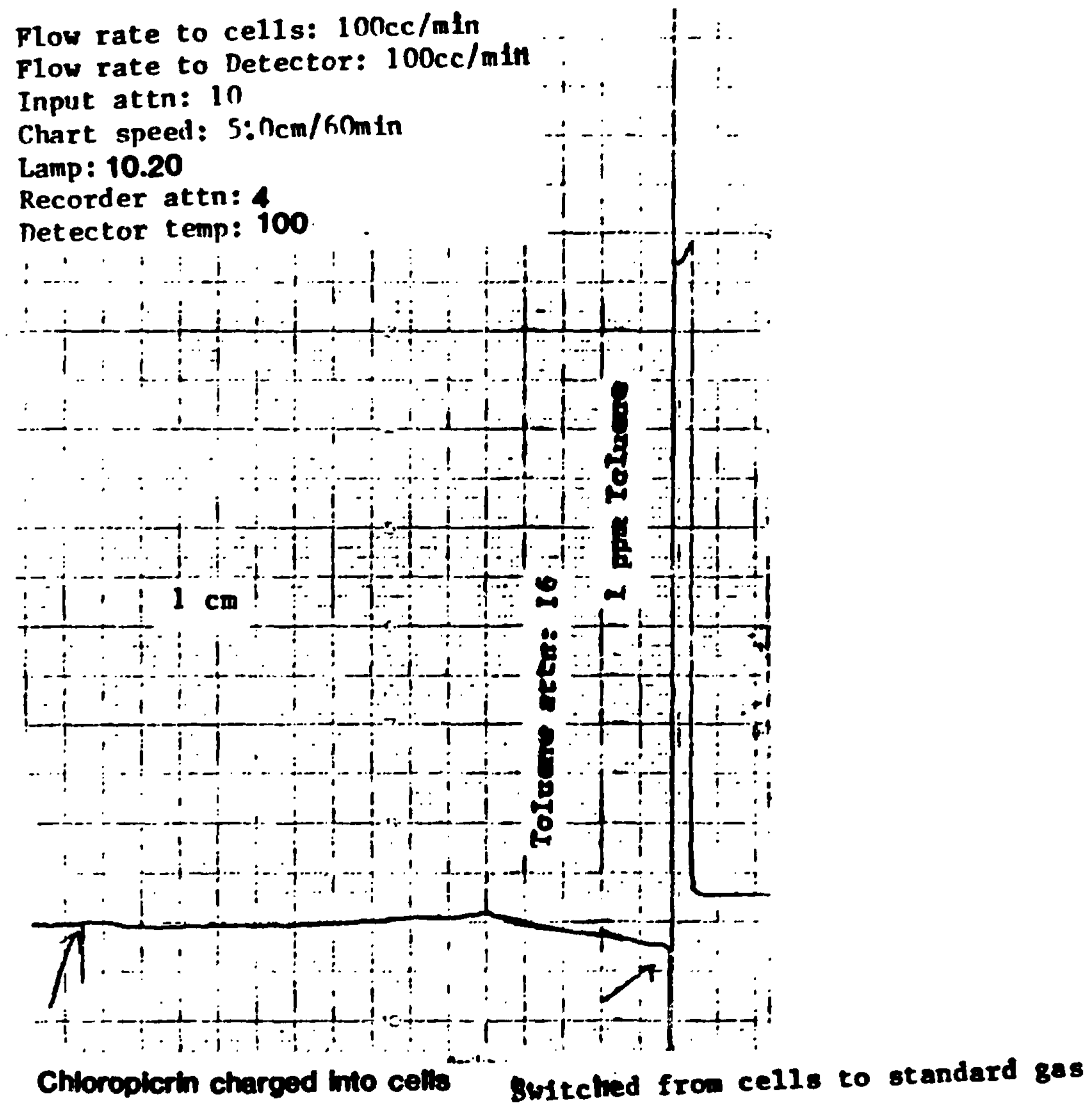
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on October 15, 1986.

Chemical Resistance Testing of USCG Material with Chloropicrin



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Ion Chromatography on Dionex 2000
3. TEMPERATURE: Ambient
4. COLLECTION MEDIUM: Aqueous
5. COLLECTION SYSTEM: Aqueous
6. OTHER CONDITIONS: 2 inch cells were used.
7. DEVIATIONS FROM ASTM F739 METHOD:

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Chlorosulfonic Acid	N/A	N/A
2. CAS NUMBER(s):	7790-94-5	N/A	N/A
3. CONC. (IF MIX)	99%	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: October 10, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT 0.5 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS Cells 1,2, and 3 at end of 3 hour test

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	3 Hours	<0.5 ppm	<0.5 ppm	<0.5 ppm
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS: Retention time for 5 ppm Chlorosulfonic Acid standard was 2.08 minutes.

5. SOURCE OF DATA
Samples were run by Denise McDonald on October 10, 1986.

Calibration-5 ppm Chlorosulfonic Acid STD

CHANNEL A INJECT 21:06:29

PERMEATION 21:06:29 CH= "A" PS= 1.

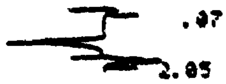
FILE 1. METHOD 5. RUN 42 INDEX 1 CALIB

ANALYST: DJM

NAME	PPM	RT	AREA BC	RF
	0.	1.25	527812 01	
CL 1	5.	2.08	16557985 01	2311597.
TOTALS	5.		17085797	

Chlorosulfonic Acid Cell 1 3 hours

CHANNEL A INJECT 21:30:10



PERMEATION 21:30:10

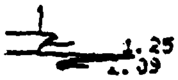
FILE 1. METHOD 5. RUN 48 INDEX

ANALYST: DJM

NAME	PPM	RT	AREA BC
	0.	0.07	110710 0
CL 1	0.5M	2.05	116192
TOTALS	0.		1272

MDL-0.5ppm Chlorosulfonic Acid STD

CHANNEL A INJECT 21:15:00



PERMEATION 21:16:00

FILE 1. METHOD 5. RUN 44 INDEX 1

ANALYST: DJM

NAME	PPM	RT	AREA BC	RF
	0.	1.25	339637 01	
CL 1	0.615	2.09	2041275 01	2211597.
TOTALS	0.615		2421062	

Chlorosulfonic Acid Cell 2 3 Hours

CHANNEL A INJECT 21:33:07

PERMEATION 21:33:07

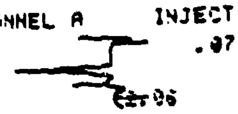
FILE 1. METHOD 5. RUN 49 INDEX

ANALYST: DJM

NAME	PPM	RT	AREA BC
	0.	0.07	114607 01
CL 1	0.5M	2.05	1047643 01
TOTALS	0.		1162250

Reagent Water Blank

CHANNEL A INJECT 21:47:13



PERMEATION 21:47:12

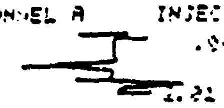
FILE 1. METHOD 5. RUN 52 INDEX 1

ANALYST: DJM

NAME	PPM	RT	AREA BC
	0.	0.07	130505 01
CL 1	0.121	2.06	401554 01
TOTALS	0.		532059

Chlorosulfonic Acid Cell 3 3 Hours

CHANNEL A INJECT 21:42:09



PERMEATION 21:42:09

FILE 1. METHOD 5. RUN 51 INDEX

ANALYST: DJM

NAME	PPM	RT	AREA BC
	0.	0.04	116334 01
CL 1	0.453	2.01	1500933 01
TOTALS	0.		1617317

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 90cc/min

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s):	m-Cresol	N/A	N/A
2. CAS NUMBER(s):	108-39-4	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	J.T. BAKER	N/A	N/A
	reagent grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: April 7, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 4 hours
4. MIN DETECTABLE LIMIT 0.03 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

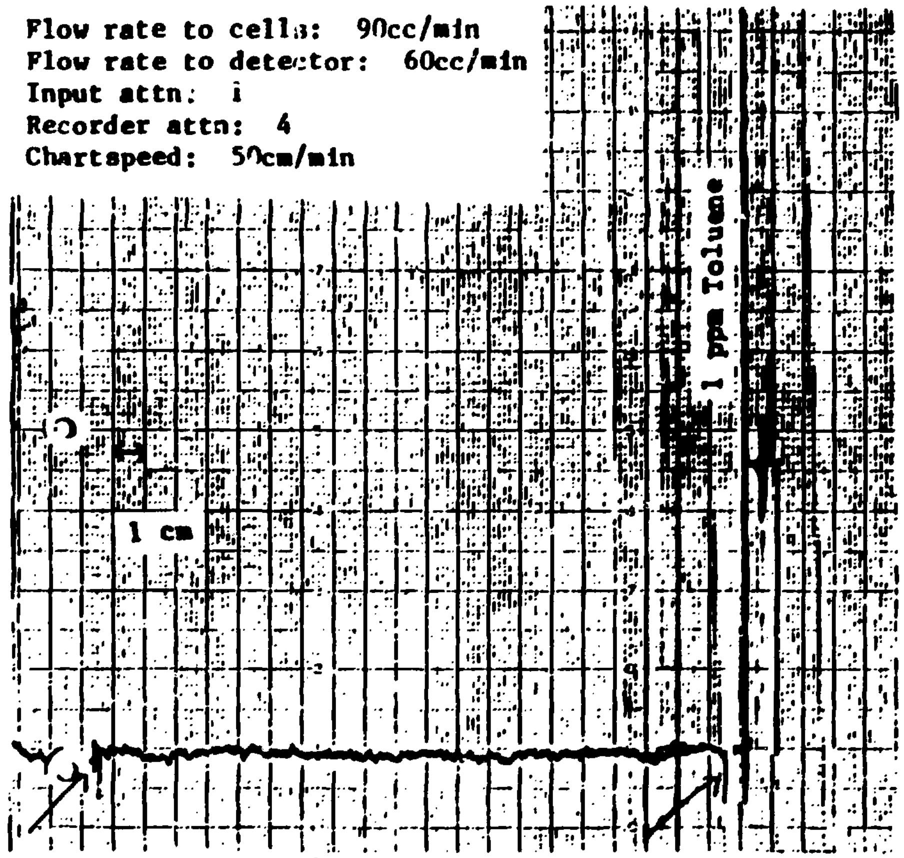
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Karen Verschoor on April 7, 1986

Chemical Resistance Testing of USCG Material with Cresol

Flow rate to cells: 90cc/min
Flow rate to detector: 60cc/min
Input attn: i
Recorder attn: 4
Chartspeed: 50cm/min



Cresol charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: N/A

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s):	Creosote	N/A	N/A
2. CAS NUMBER(s):	N/A	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	T&R Chemicals, Inc.	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: August 18, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 18.1 hours.
4. MIN DETECTABLE LIMIT .32 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

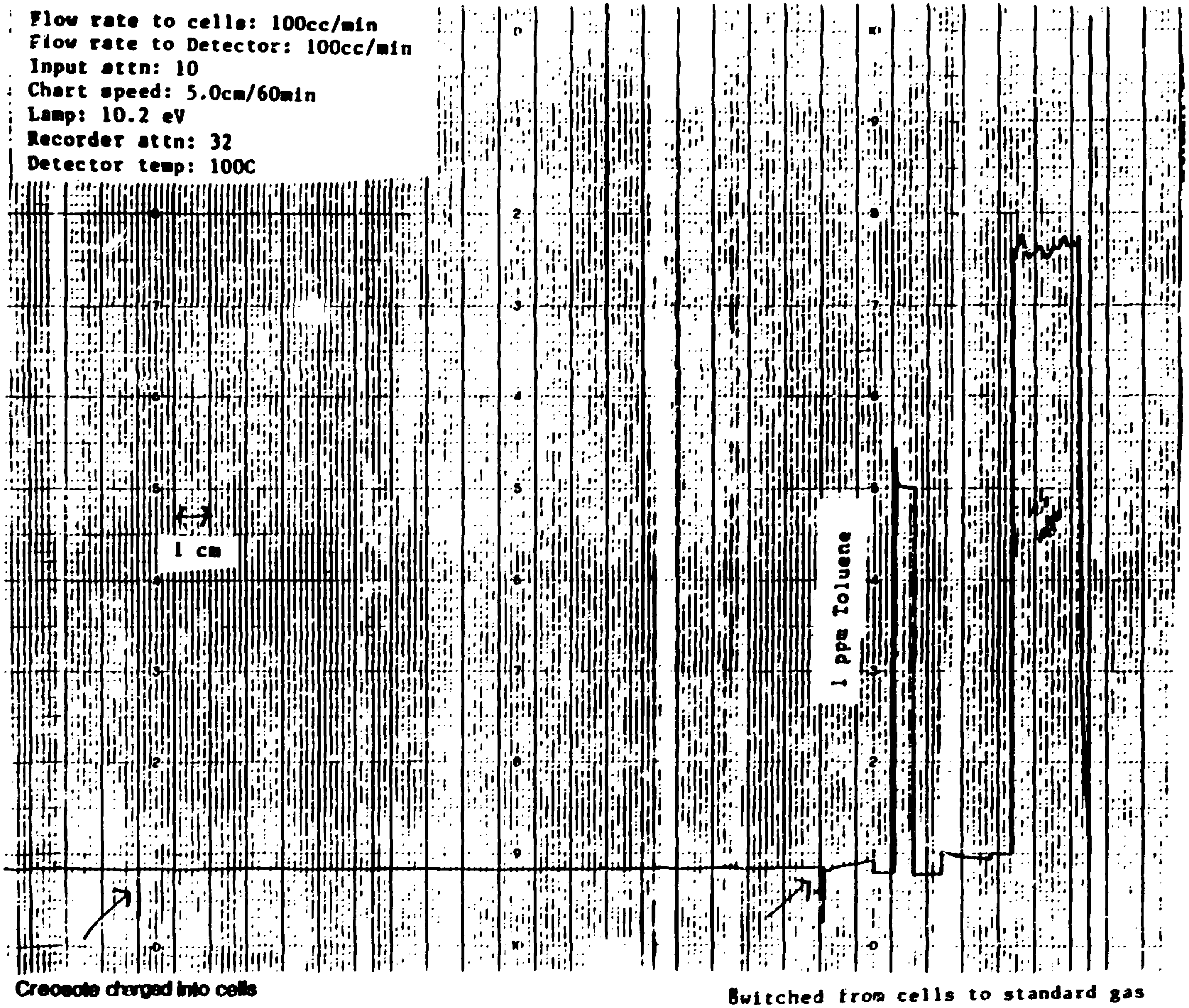
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on August 18, 1986

Chemical Resistance Testing of USCG with Creosote



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Crotonaldehyde	N/A	N/A
2. CAS NUMBER(s):	123-73-9	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: July 15, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.1 hours.
4. MIN DETECTABLE LIMIT 0.62 ppm.
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

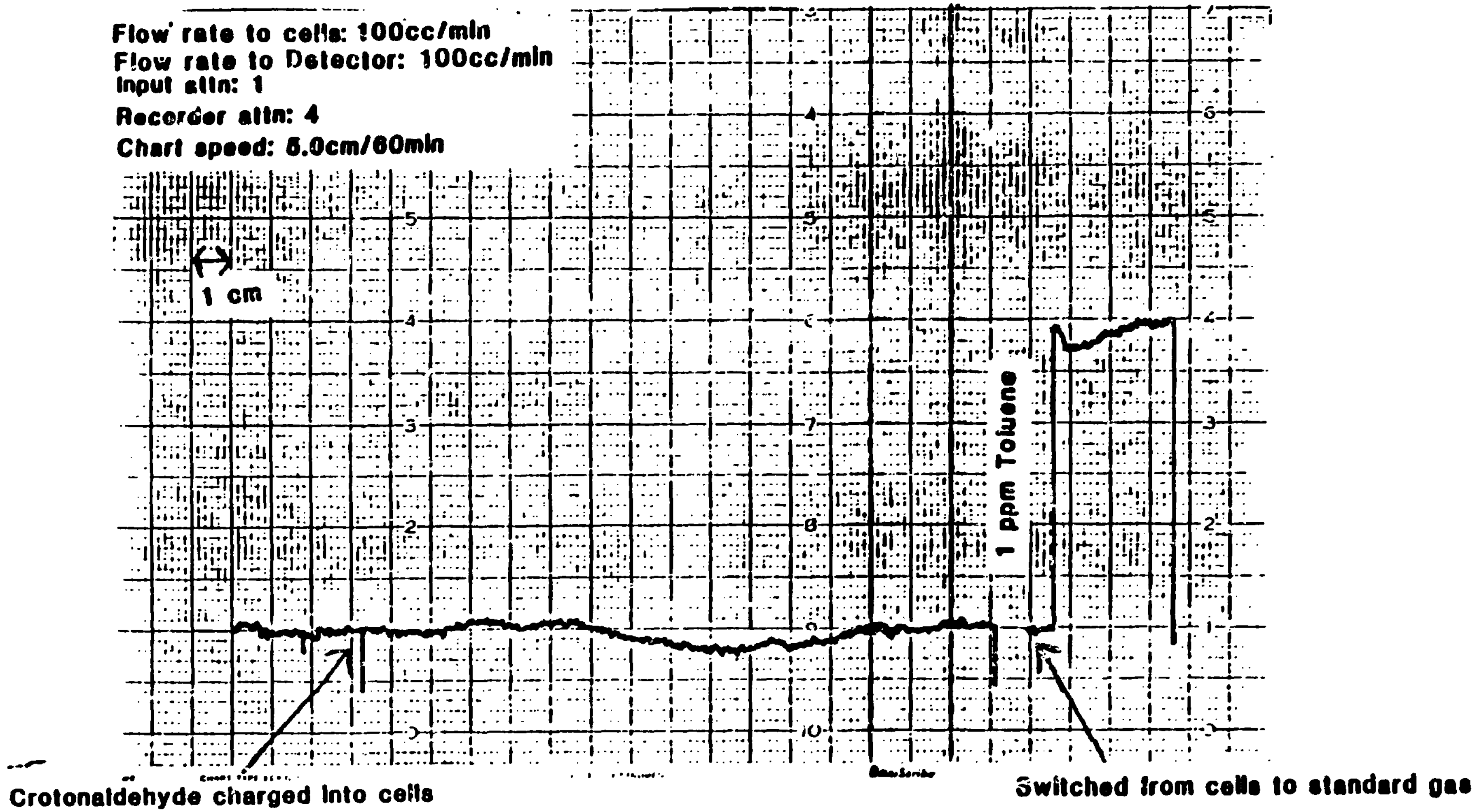
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on July 15, 1986.

Chemical Restance Testing of USCG Material with Crotonaldehyde



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s) :	Cumene Hydroperoxide	N/A	N/A
2. CAS NUMBER(s):	80-15-9	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: July 14, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.5 hours.
4. MIN DETECTABLE LIMIT 1.20 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

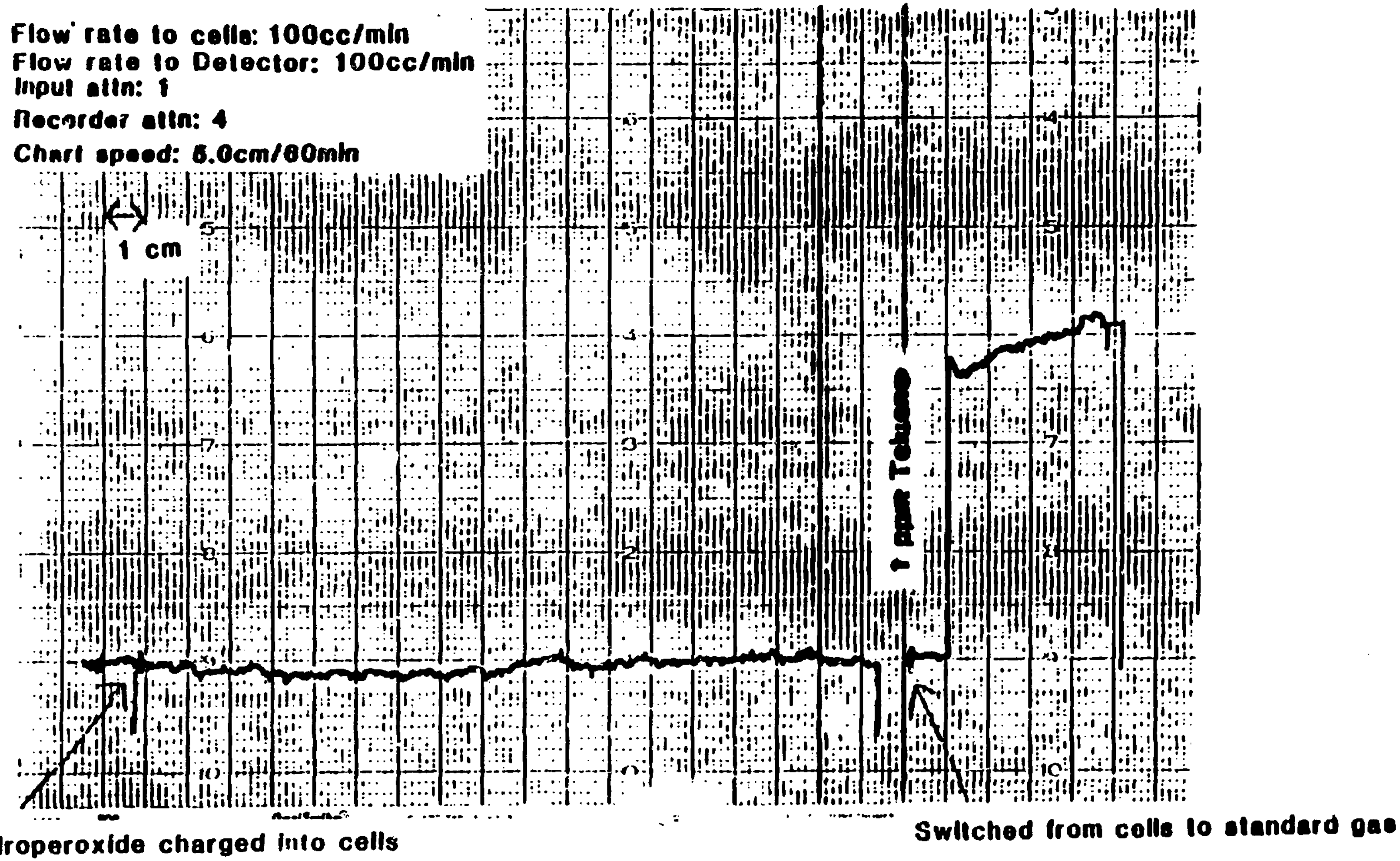
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on July 14, 1986.

Chemical Resistance Testing of USCG Material with Cumene Hydroperoxide



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s):	Cyclohexane		
2. CAS NUMBER(s):	110-82-7		
3. CONC. (IF MIX)	N/A		
4. CHEMICAL SOURCE:	Aldrich reagent grade		

4. TEST RESULTS

1. DATE TESTED: July 3, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.4 hours.
4. MIN DETECTABLE LIMIT .25 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

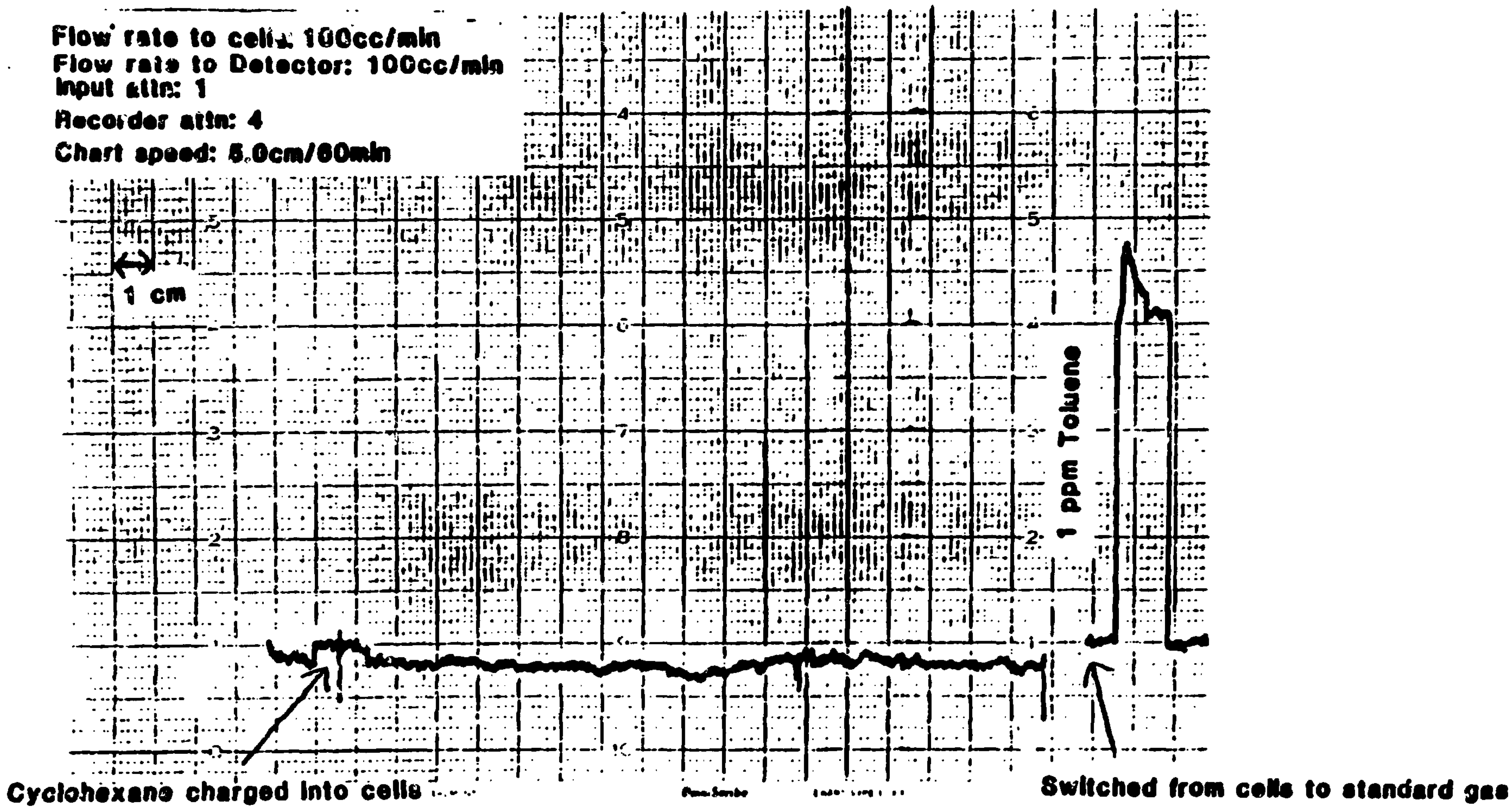
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on July 3, 1986

Chemical Resistance Testing of USCG Material with Cyclohexane



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	1,2 Dibromoethane	N/A	N/A
2. CAS NUMBER(s):	106-93-4	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: May 12, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 5 hours.
4. MIN DETECTABLE LIMIT .10 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS N/A

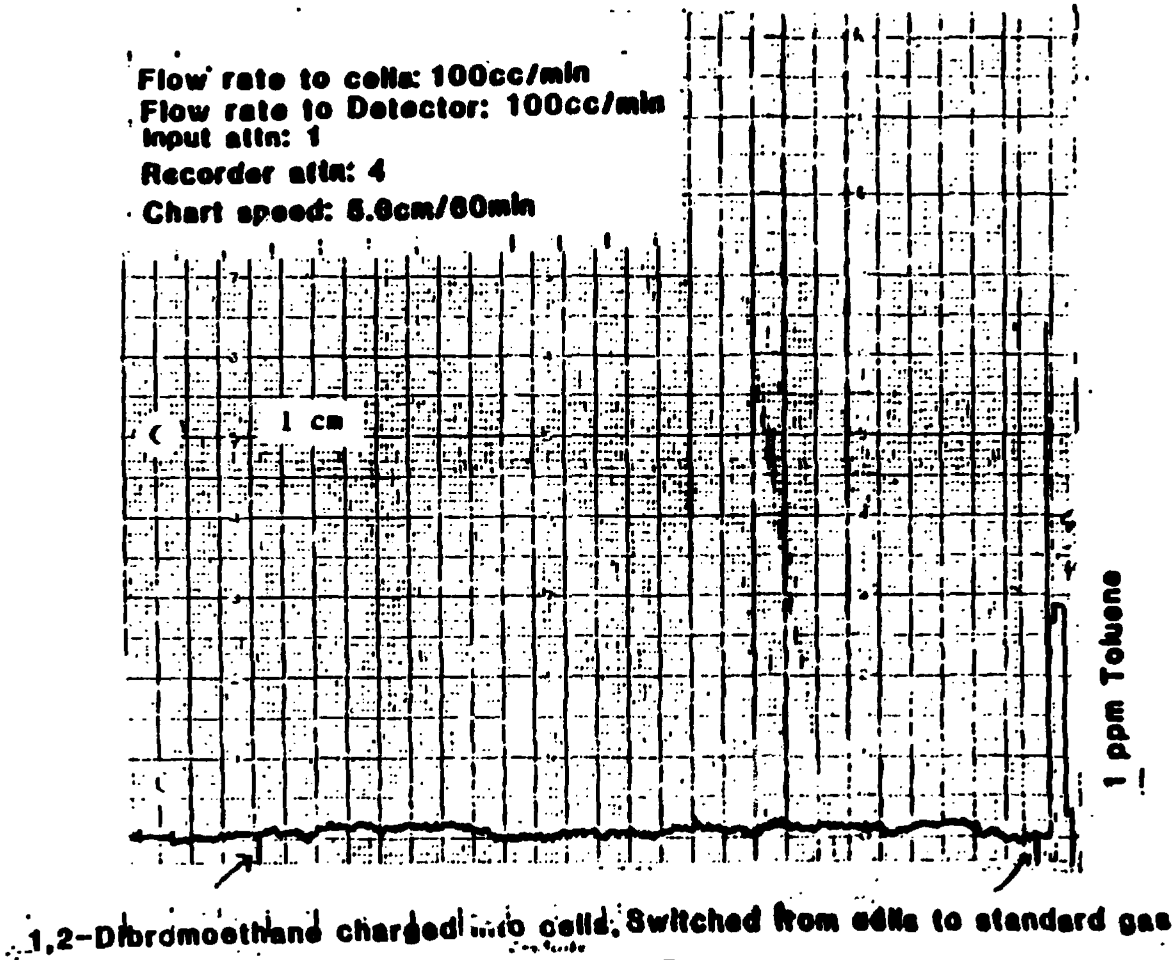
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Karen Verschoor on May 12, 1986.

Chemical Resistance Testing of USCG Material with 1,2-Dibromoethane



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 90cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	1,2-Dichloroethane	N/A	N/A
2. CAS NUMBER(s):	107-06-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

EST RESULTS

1. DATE TESTED: May 1, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 5.7 hours
4. MIN DETECTABLE LIMIT
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS N/A

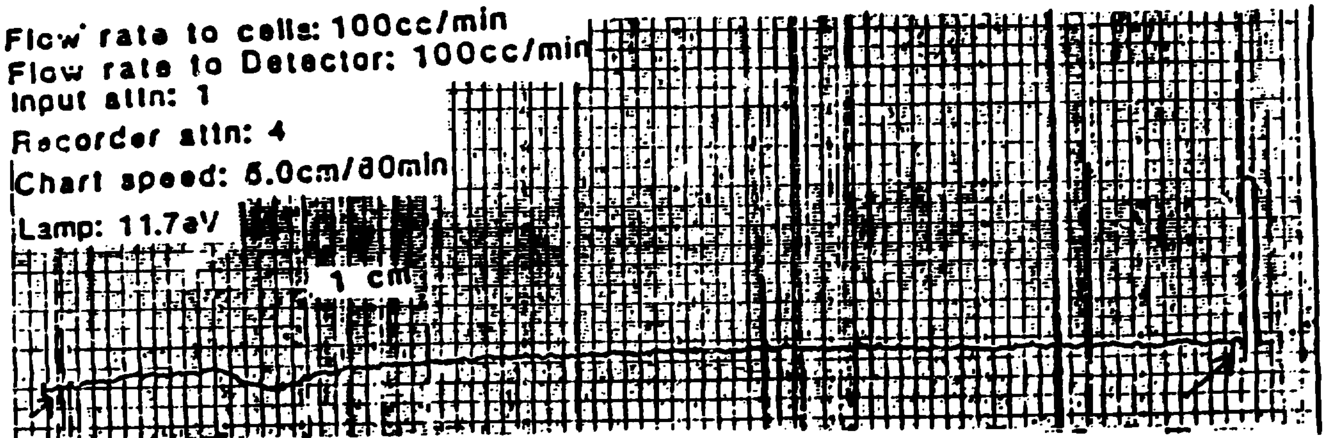
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Karen Verschoor on May 1, 1986.

Chemical Resistance Testing of USCG Material with 1,2-Dichloroethane



1,2-Dichloroethane charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME (s):	1,2-Dichloroethyl	N/A	N/A
	ether	N/A	N/A
2. CAS NUMBER(s):	623-46-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Kodak reagent grade	N/A	N/A

.. TEST RESULTS

1. DATE TESTED: July 16, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT N/A
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

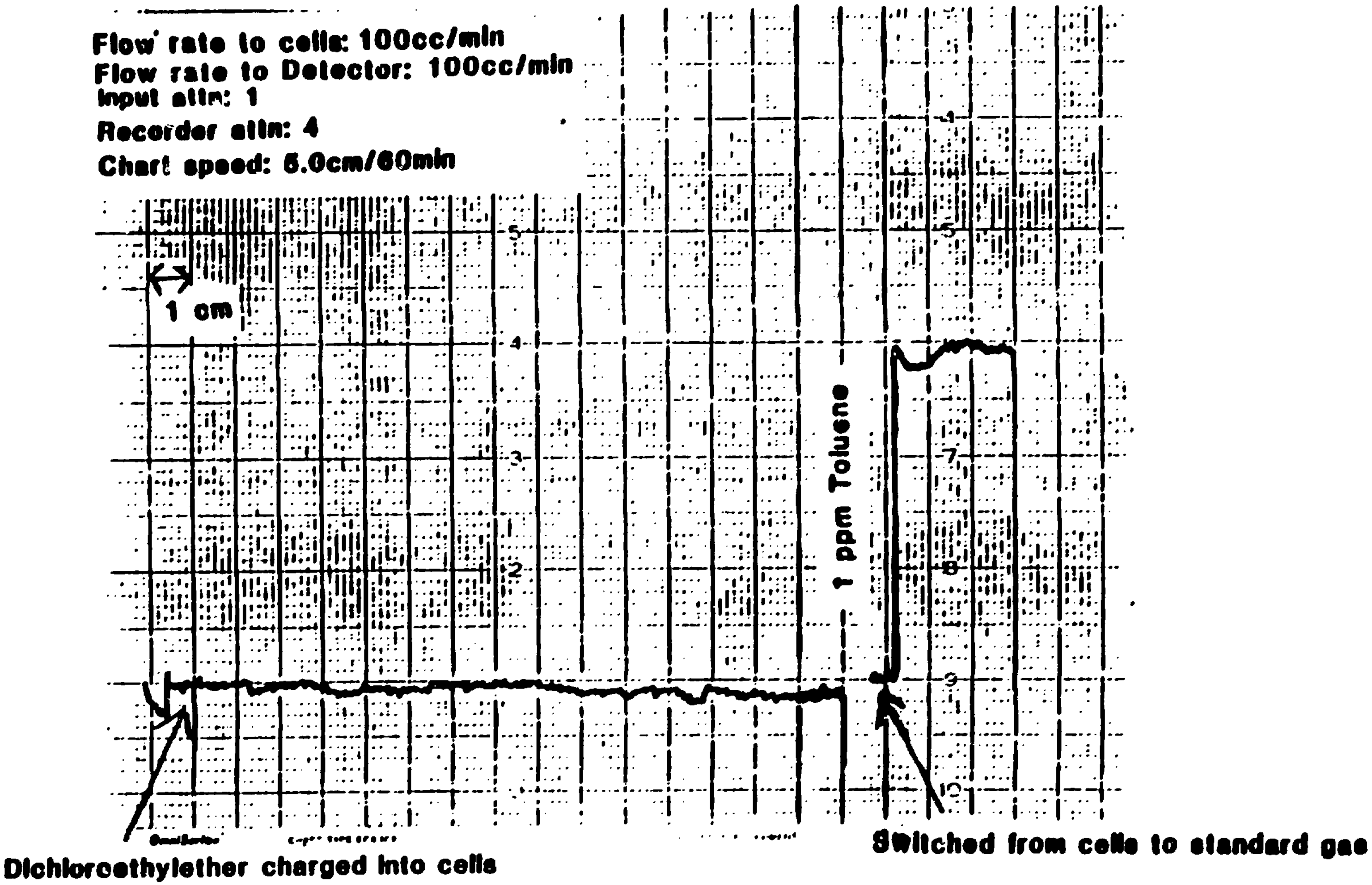
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on July 16, 1986.

Chemical Restance Testing of USCG Matetial with Dichloroethylether



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s) :	1,2-Dichloropropane	N/A	N/A
2. CAS NUMBER(s):	78-87-5	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Kodak reagent grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: July 1, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.1 hours
4. MIN DETECTABLE LIMIT .31 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

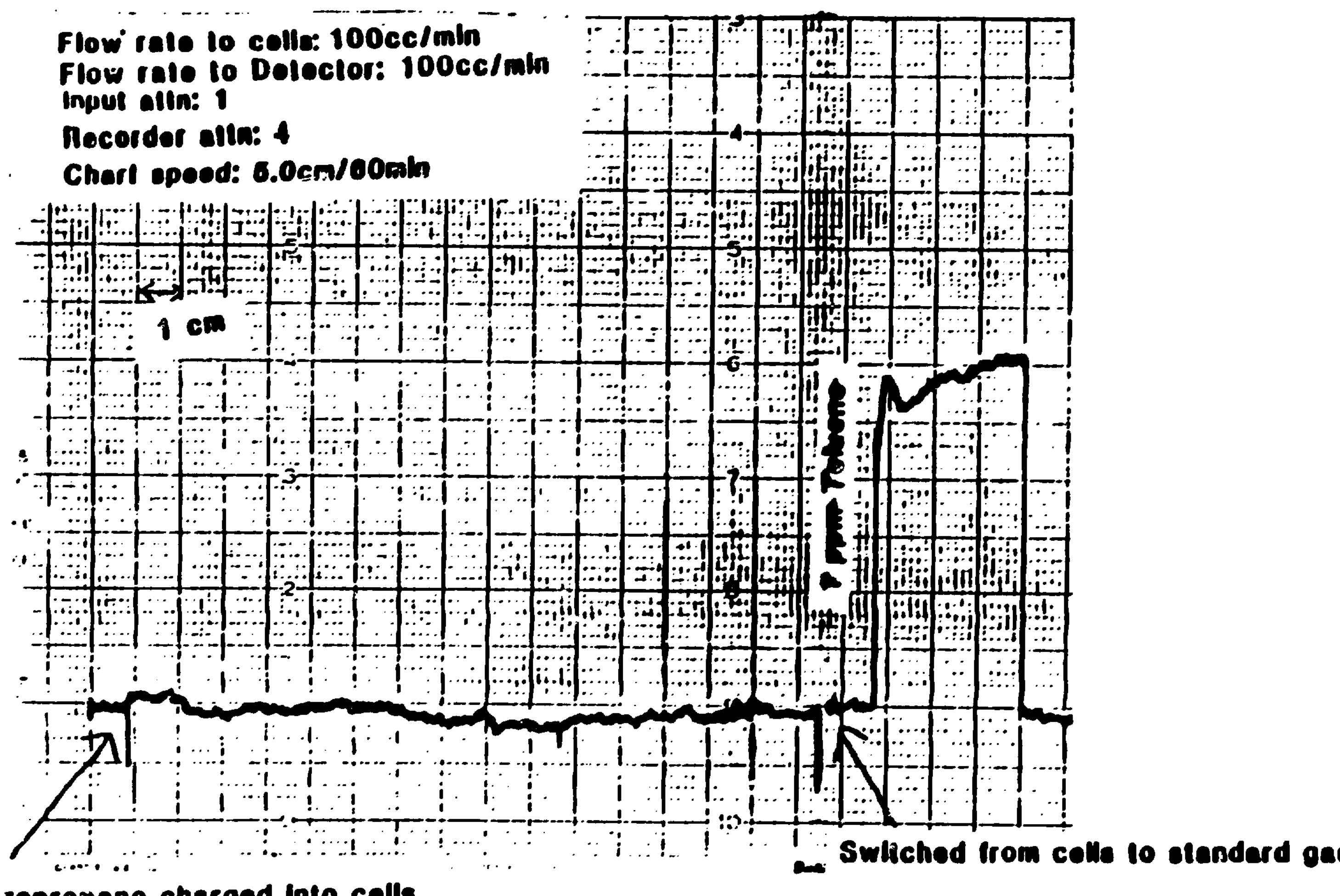
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on July 1, 1986

Permeation Testing of USCG Material with 1,2-Dichloropropane



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

   1: TYPE: Teflon laminated Nomex
   2: PROTECTIVE MATERIAL CODE: 068
   3: CONDITION BEFORE TEST: Unused, no visible imperfections
   4: MANUFACTURER: Chemfab Corp.
   5: PRODUCT IDENTIFICATION: Challenge 5100
   6: LOT OR MANUFACTURER DATE: N/A
   7: NOMINAL THICKNESS: 15-20 mil
   8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

   1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
   2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
   3. TEMPERATURE: 22-25 °C
   4. COLLECTION MEDIUM: N_2
   5. COLLECTION SYSTEM: N_2
   6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
   7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	1,3-Dichloropropene	N/A	N/A
2. CAS NUMBER(s):	542-75-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

   1. DATE TESTED: July 10, 1986
   2. NUMBER OF SAMPLES TESTED: Three
   3. BREAKTHROUGH TIME: N/A
   4. MIN DETECTABLE LIMIT .17 ppm
   5. STEADY STATE PERMEATION RATE N/A
   6. SAMPLE THICKNESS: 18-19 mil
   7. SELECTED DATA POINTS N/A

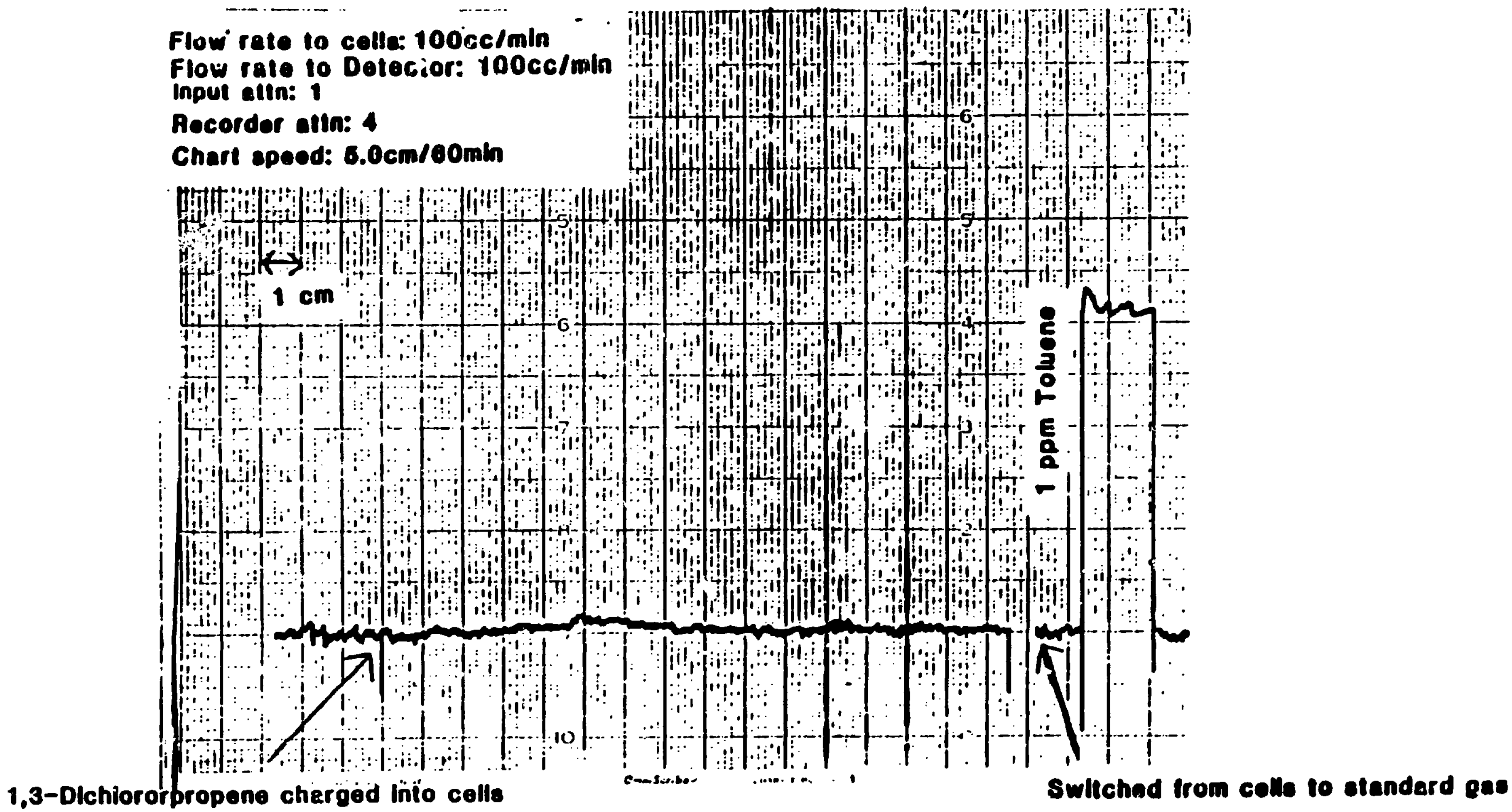
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

   8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

   Samples were run by Sylvia Cooper on July 10, 1986.

Chemical Resistance Testing of USCG Material through with 1,3-Dichloropropene



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s):	Diethanolamine	N/A	N/A
2. CAS NUMBER(s):	111-42-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 25, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT N/A
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

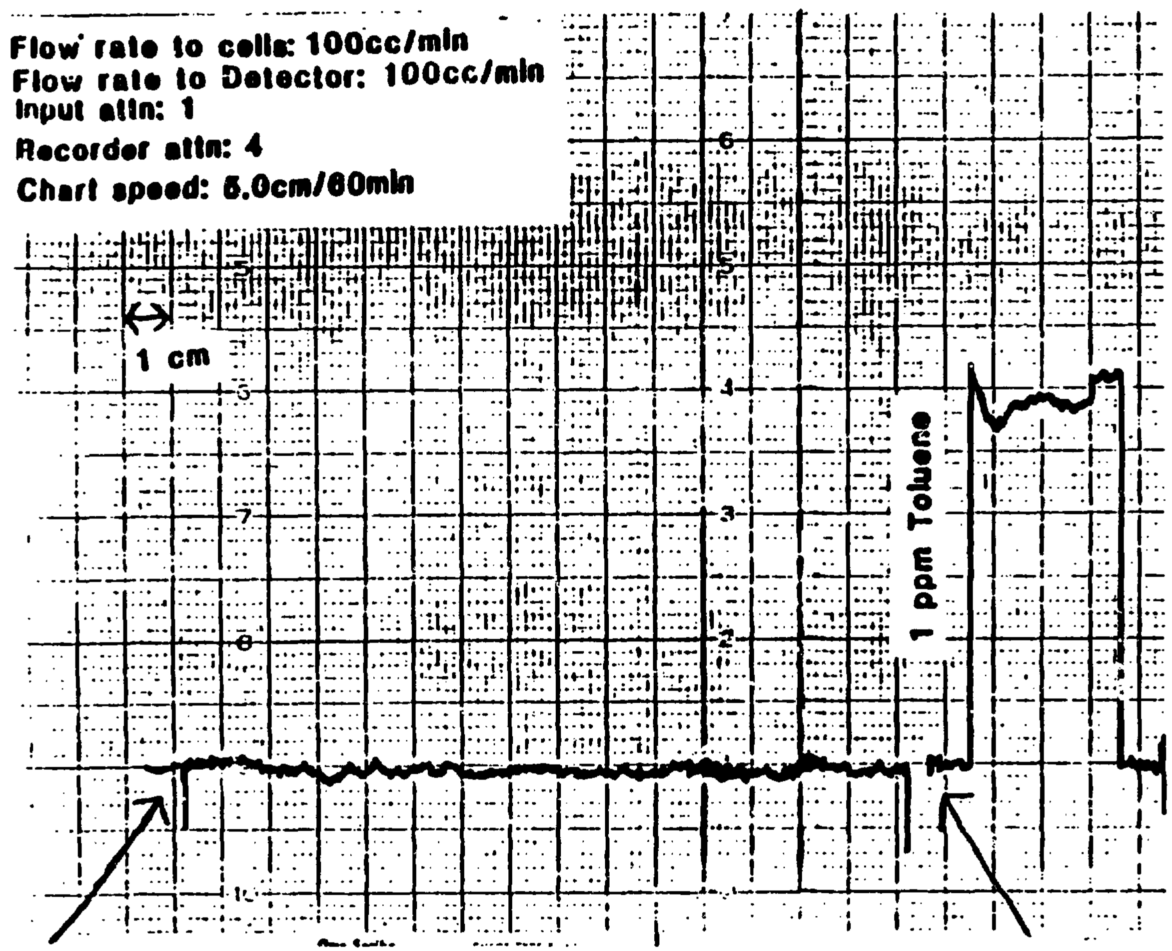
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on June 25, 1986.

Chemical Resistance Testing of USCG Material with Diethanolamine



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s):	Diisopropylamine	N/A	N/A
2. CAS NUMBER(s):	108-18-9	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent grade	N/A N/A	N/a

4. TEST RESULTS

1. DATE TESTED: May 20, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 15 hours
4. MIN DETECTABLE LIMIT .39 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS N/A

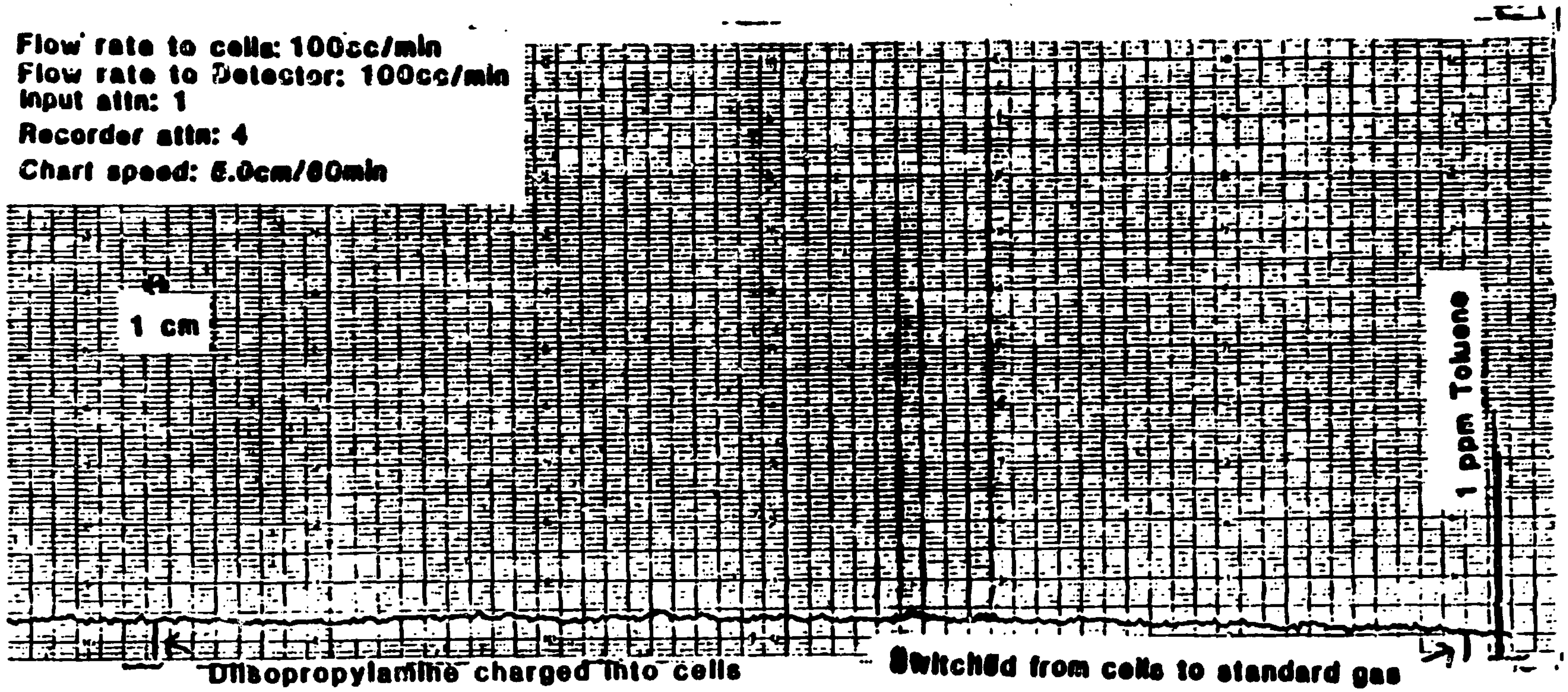
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on May 20, 1986

hemical Resistance Testing of USCG Material with Diisopropylamine



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.2 lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Dimethyl Sulfate	N/A	N/A
2. CAS NUMBER(s):	77-78-01	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Baker	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 21, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT 1.52 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

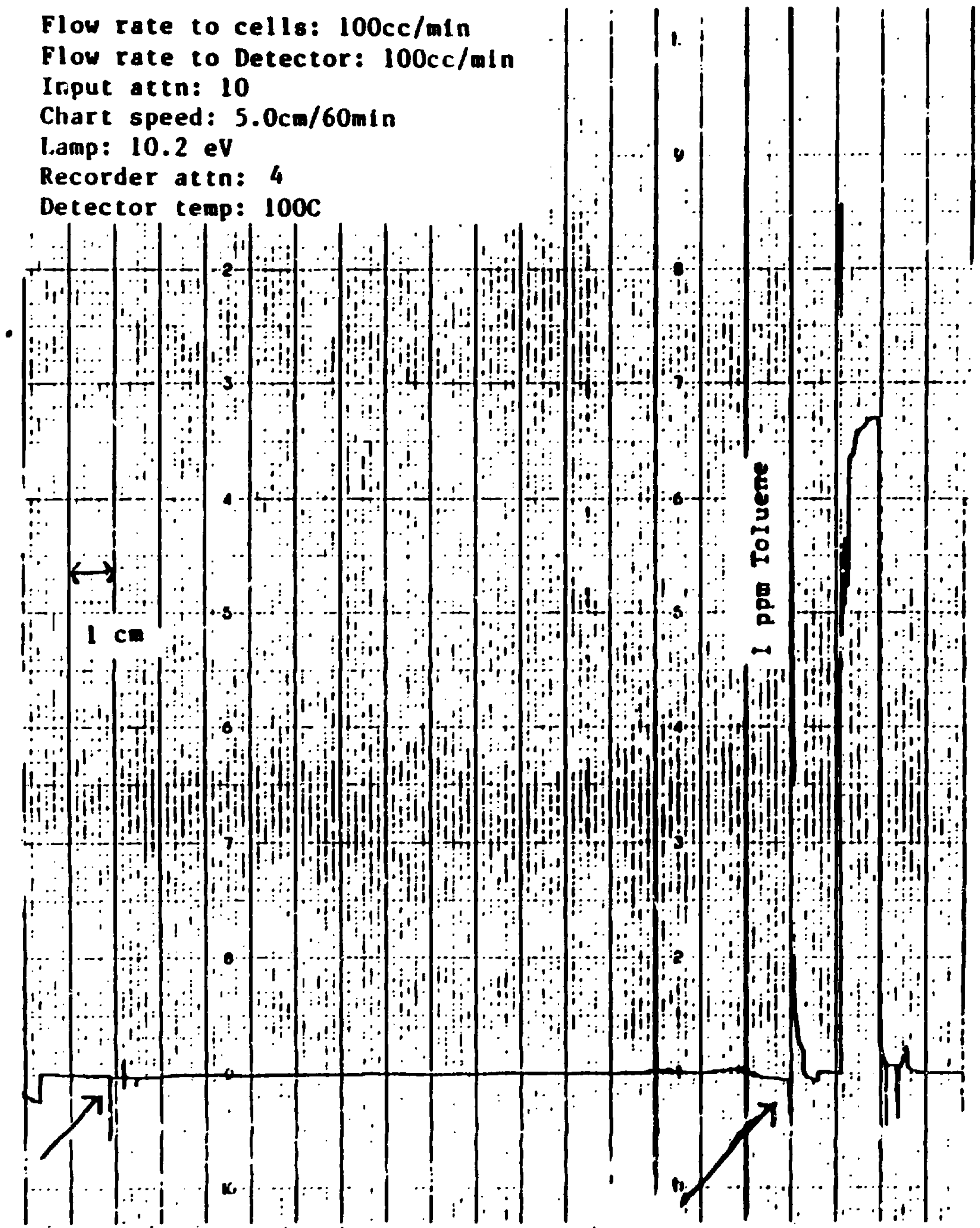
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on September 21, 1986.

Chemical Resistance Testing of USCG Material with Dimethyl Sulfate

Flow rate to cells: 100cc/min
Flow rate to Detector: 100cc/min
Input attn: 10
Chart speed: 5.0cm/60min
Lamp: 10.2 eV
Recorder attn: 4
Detector temp: 100C



Dimethyl Sulfate charged into cells

hed from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s):	1,4-Dioxane	N/A	N/A
2. CAS NUMBER(s):	123-91-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	J.T. Baker reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 26, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT 1.04 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

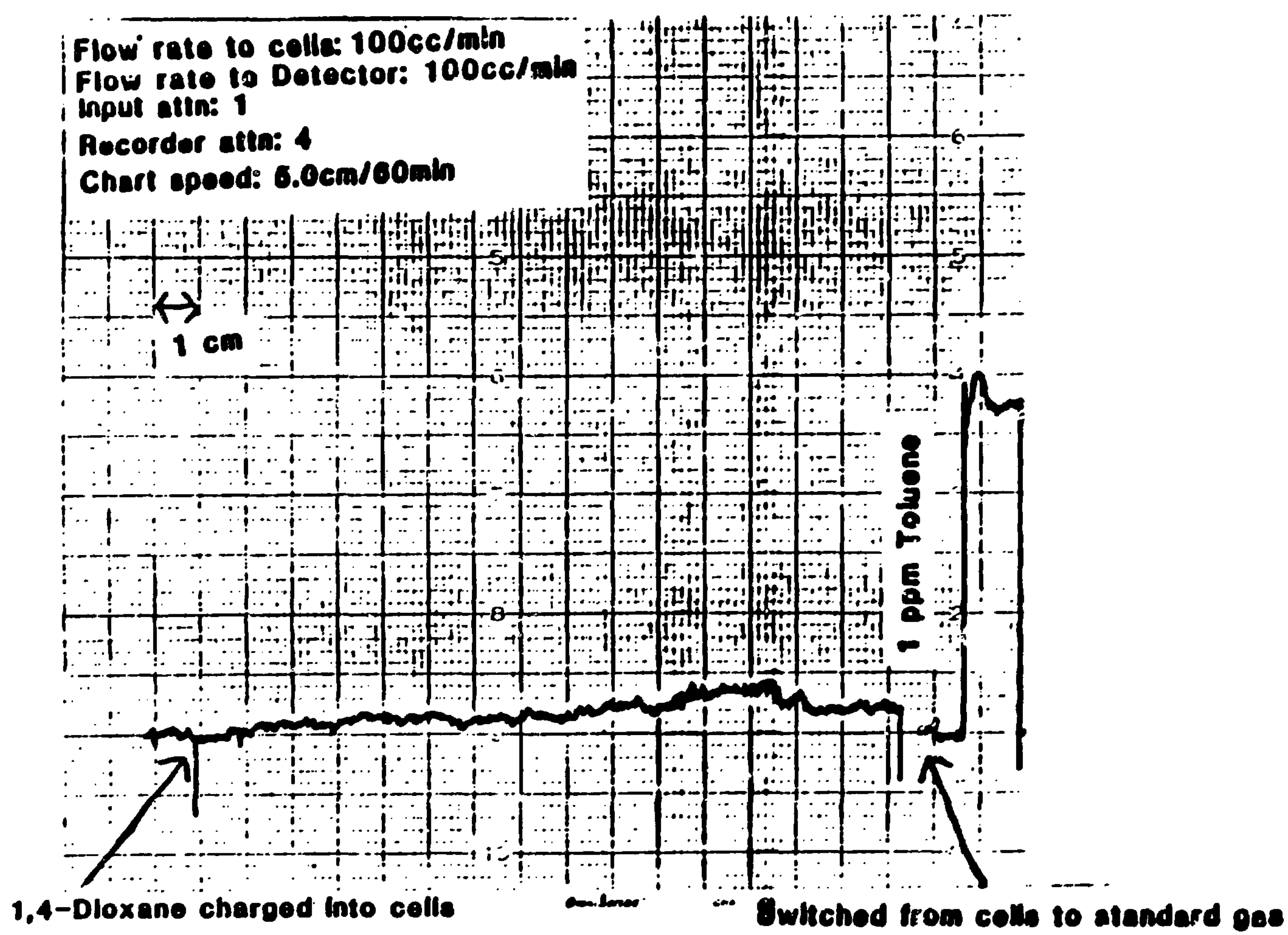
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on June 26, 1986

Chemical Resistance Testing of USCG Material with 1,4-Dioxane



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Dipropylamine	N/A	N/A
2. CAS NUMBER(s):	107-10-8	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: July 18, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.4 hours.
4. MIN DETECTABLE LIMIT .22 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

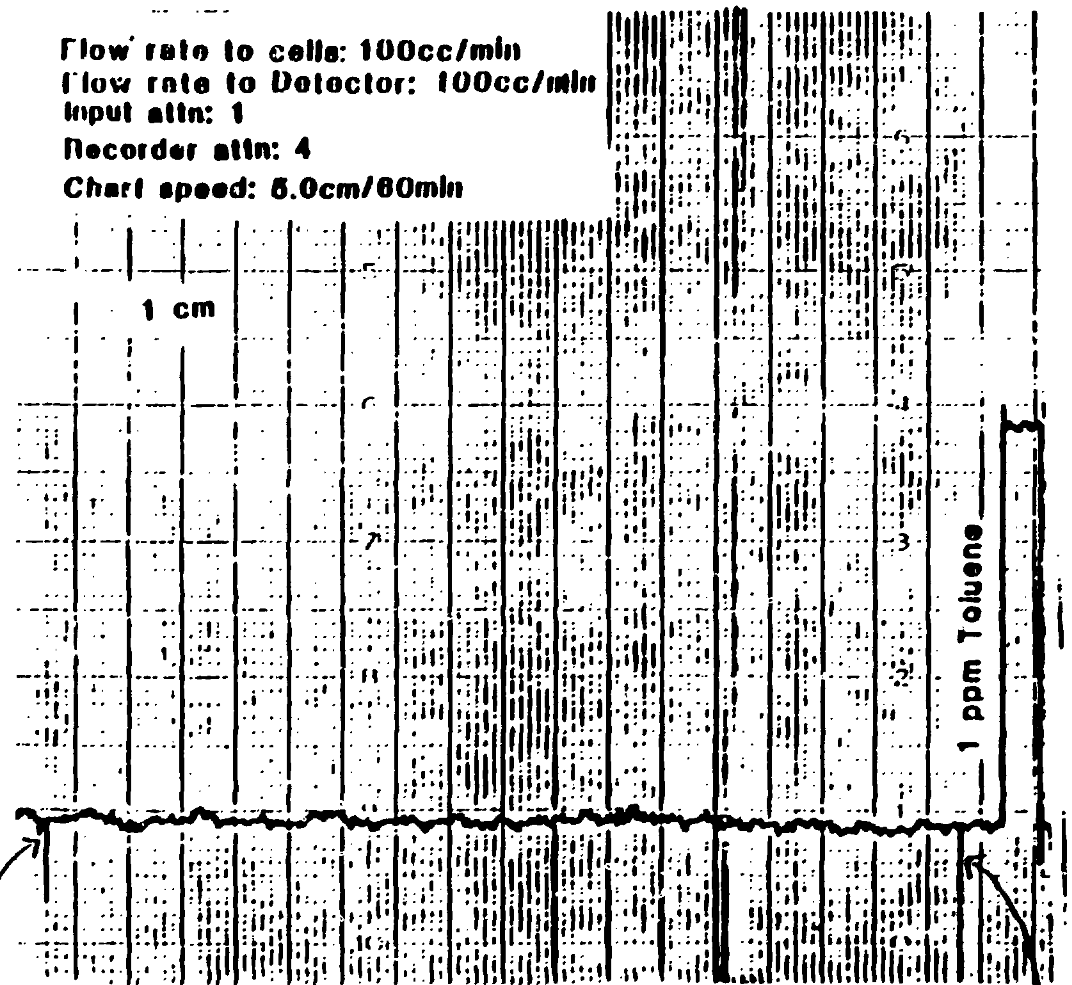
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on July 18, 1986.

Chemical Resistance Testing of USCG Material with Dipropylamine



D-N-Propylamine charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 1[illegible]0cc/m[illegible]

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s) :	Epichlorohydrin	N/A	N/A
2. CAS NUMBER(s):	106-89-8	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A
	Reagent Grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 4, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after three hours.
4. MIN DETECTABLE LIMIT 0.75 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-20 mil
7. SELECTED DATA POINTS N/A

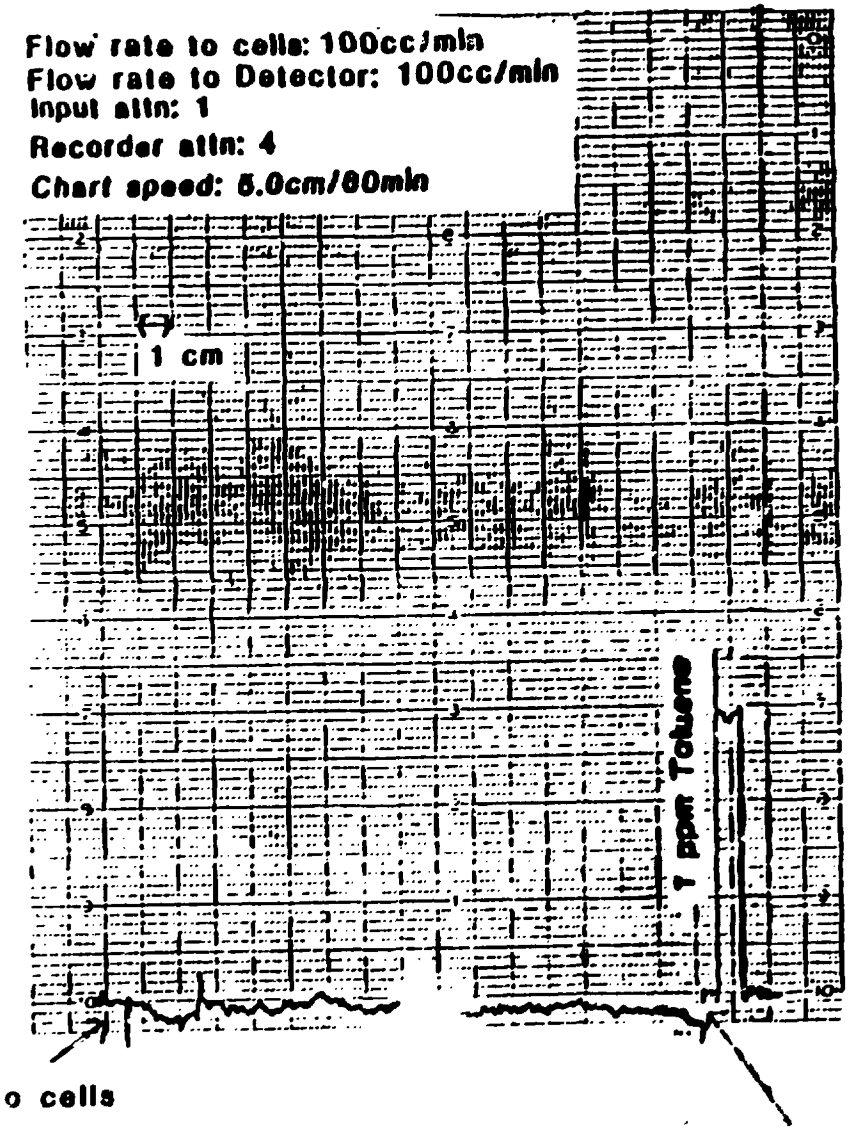
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia R. Cooper on June 4, 1986

Chemical Resistance Testing of USCG Material with Epichlorohydrin



Epichlorohydrin charged into cells

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used./ Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s):	Ethion 4	N/A	N/A
2. CAS NUMBER(s):	N/A	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	FMC Corp.	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: October 12, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 4.84 hours.
4. MIN DETECTABLE LIMIT .03 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

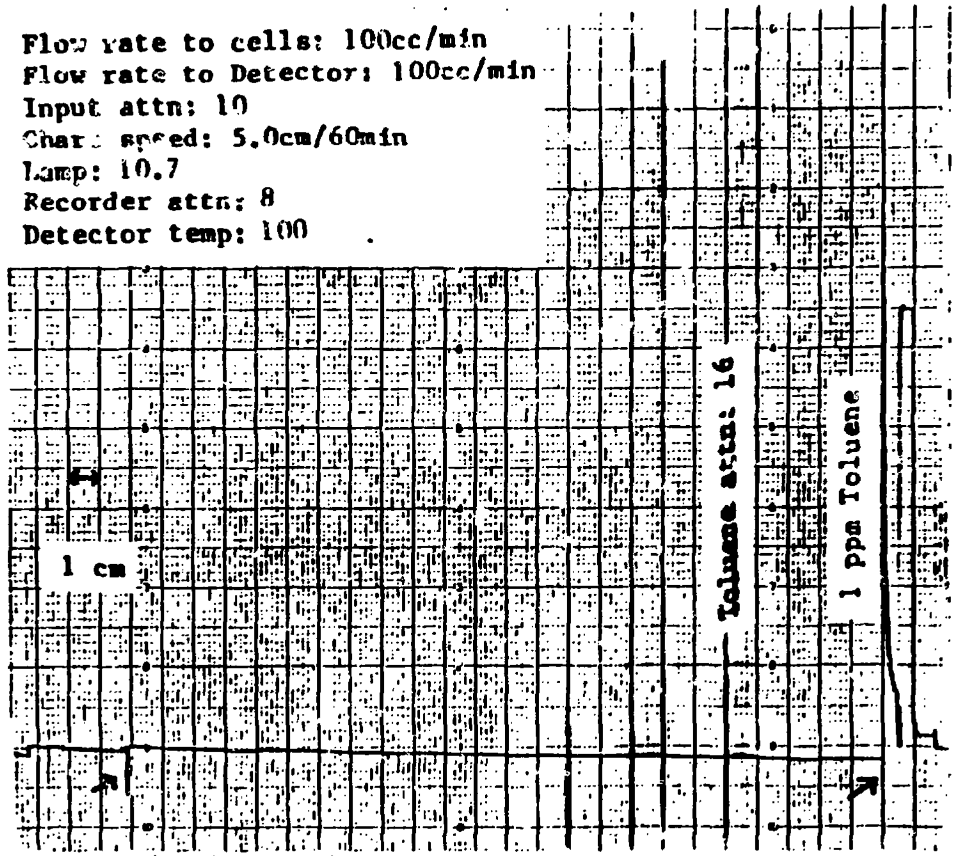
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on October 12, 1986.

Chemical Resistance Testing of USCG Material with Ethion



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25 °C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s) :	Ethyl Acetate	N/A	N/A
2. CAS NUMBER(s):	141-78-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher reagent grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 30, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No Breakthrough was observed after 3.1 hours
4. MIN DETECTABLE LIMIT .49 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

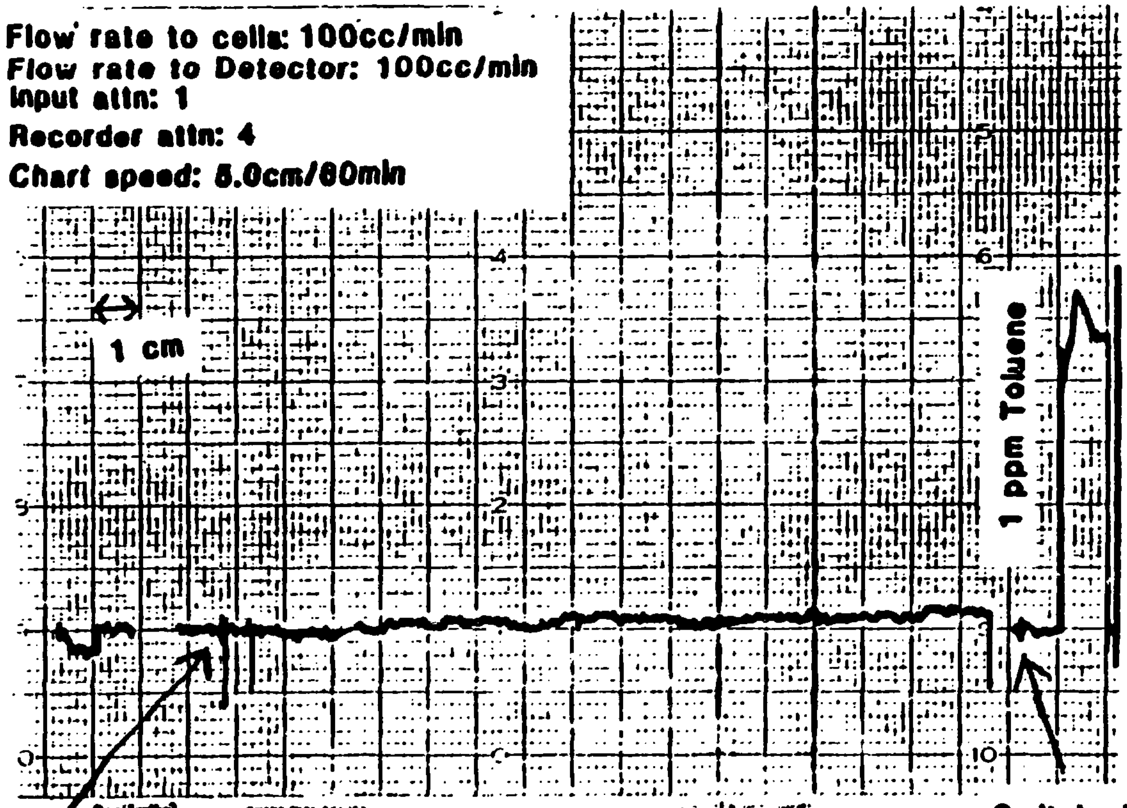
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on June 30, 1986.

Permeation Testing of USCG Material with Ethyl Acetate



Ethyl Acetate charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25 °C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s)	Ethyl Acrylate	N/A	N/A
2. CAS NUMBER(s)	140-88-5	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: May 27, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 17 hours.
4. MIN DETECTABLE LIMIT 1.72 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-20 mil.
7. SELECTED DATA POINTS N/A

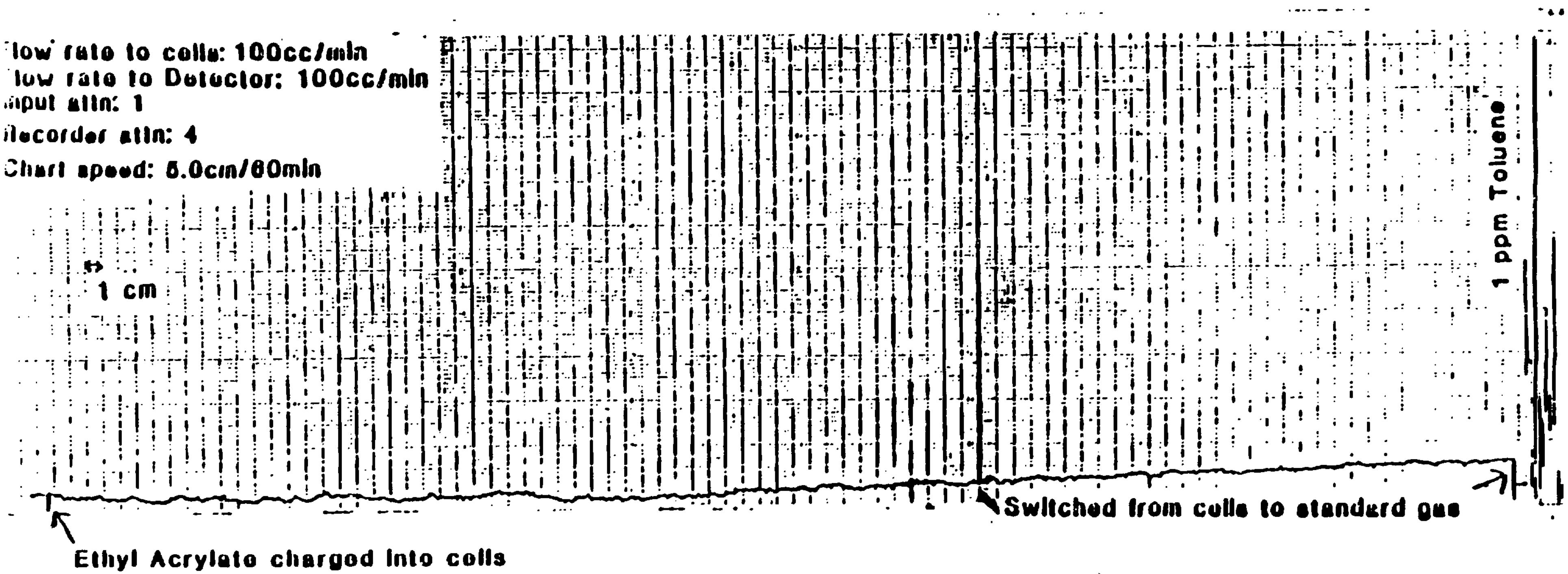
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on May 27, 1986

Chemical Resistance Testing of USCG Material with Ethyl Acrylate



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Ethyl Alcohol	N/A	N/A
2. CAS NUMBER(s):	64-17-5	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 20, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after three hours.
4. MIN DETECTABLE LIMIT 2.86 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

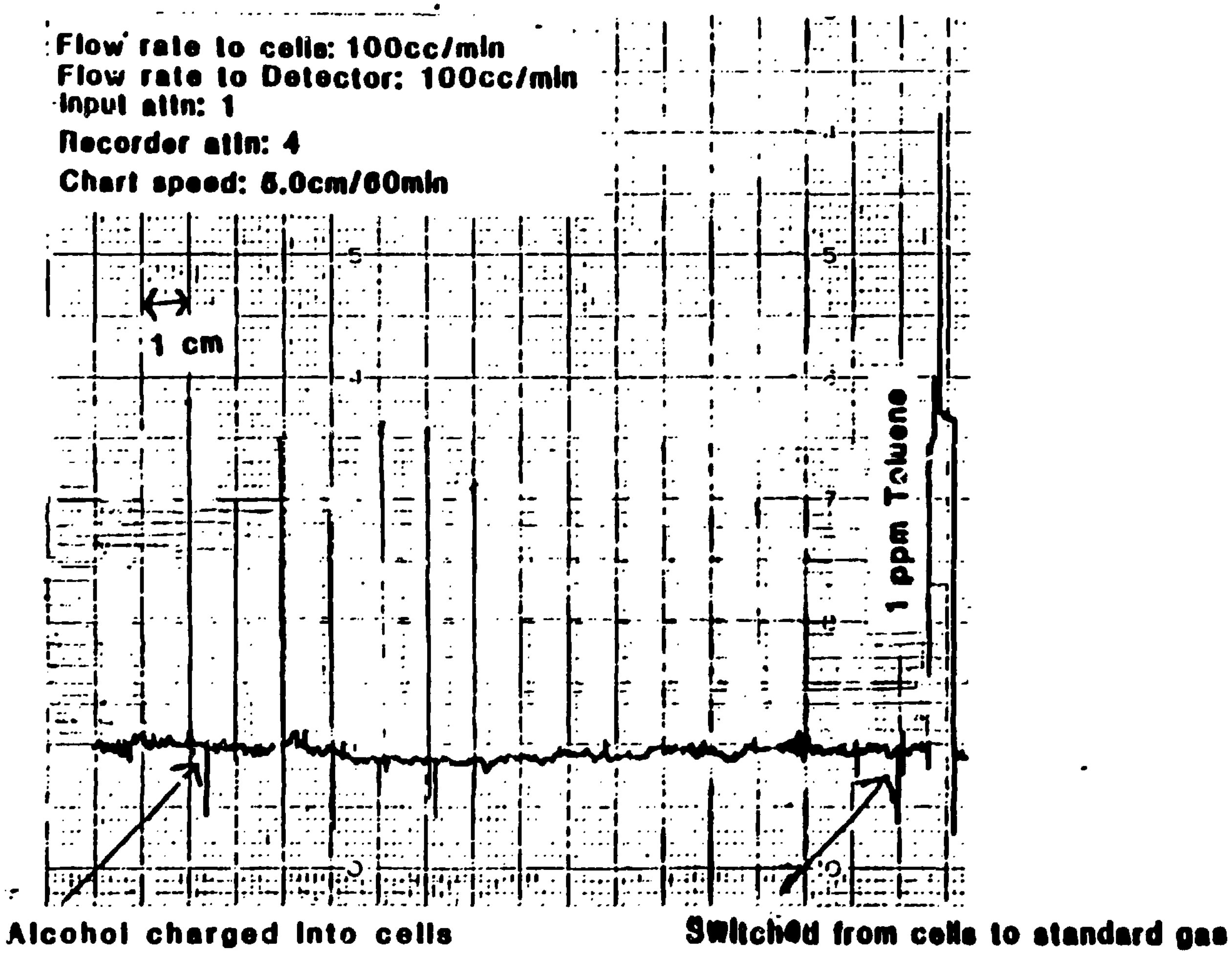
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia R. Cooper on June 20, 1986.

Chemical Resistance Testing of USCG Material with Ethyl Alcohol



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/mil.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Ethylamine	N/A	N/A
2. CAS NUMBER(s):	75-04-7	N/A	N/A
3. CONC. (IF MIX)	70% in water	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: May 15, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT 0.74 ppm.
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS N/A

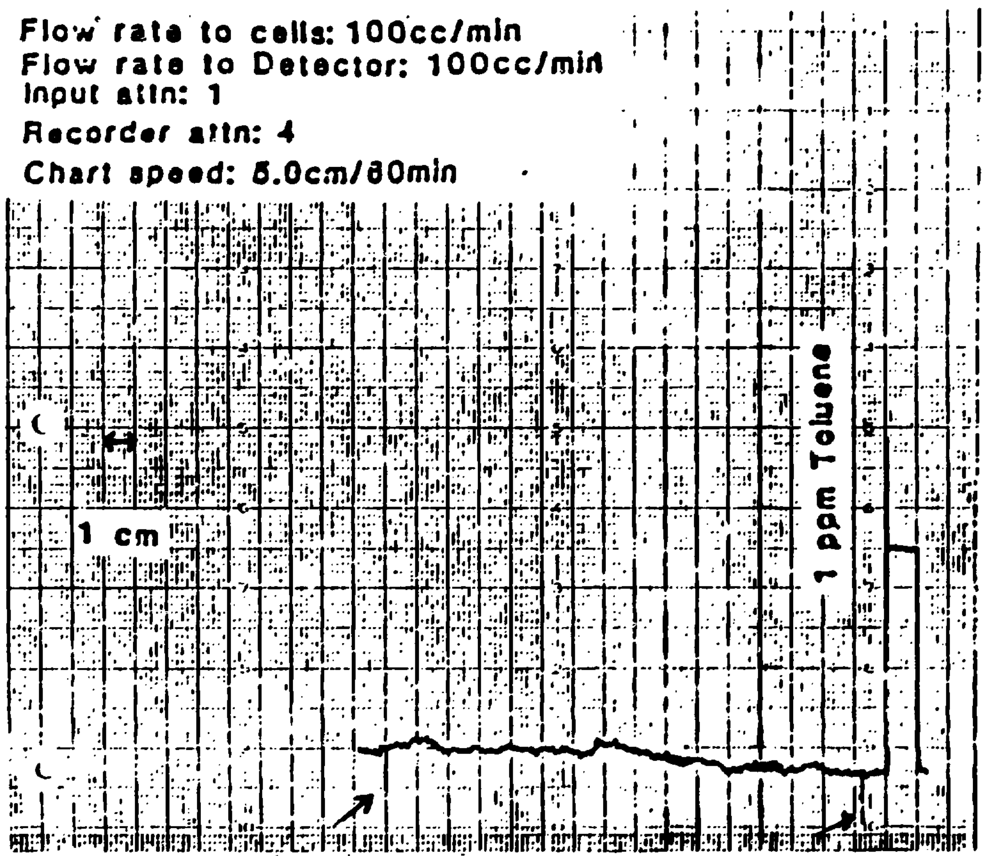
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on May 15, 1986.

Chemical Resistance Testing of USCG Material with Ethylamine



Ethylamine charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

   1: TYPE: Teflon laminated Nomex
   2: PROTECTIVE MATERIAL CODE: 068
   3: CONDITION BEFORE TEST: Unused, no visible imperfections
   4: MANUFACTURER: Chemfab Corp.
   5: PRODUCT IDENTIFICATION: Challenge 5100
   6: LOT OR MANUFACTURER DATE: N/A
   7: NOMINAL THICKNESS: 15-20 mil
   8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

   1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
   2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
   3. TEMPERATURE: 22-25°C
   4. COLLECTION MEDIUM: N_2
   5. COLLECTION SYSTEM: N_2
   6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
   7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Ethyl Benzene	N/A	N/A
2. CAS NUMBER(s):	100-41-4	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

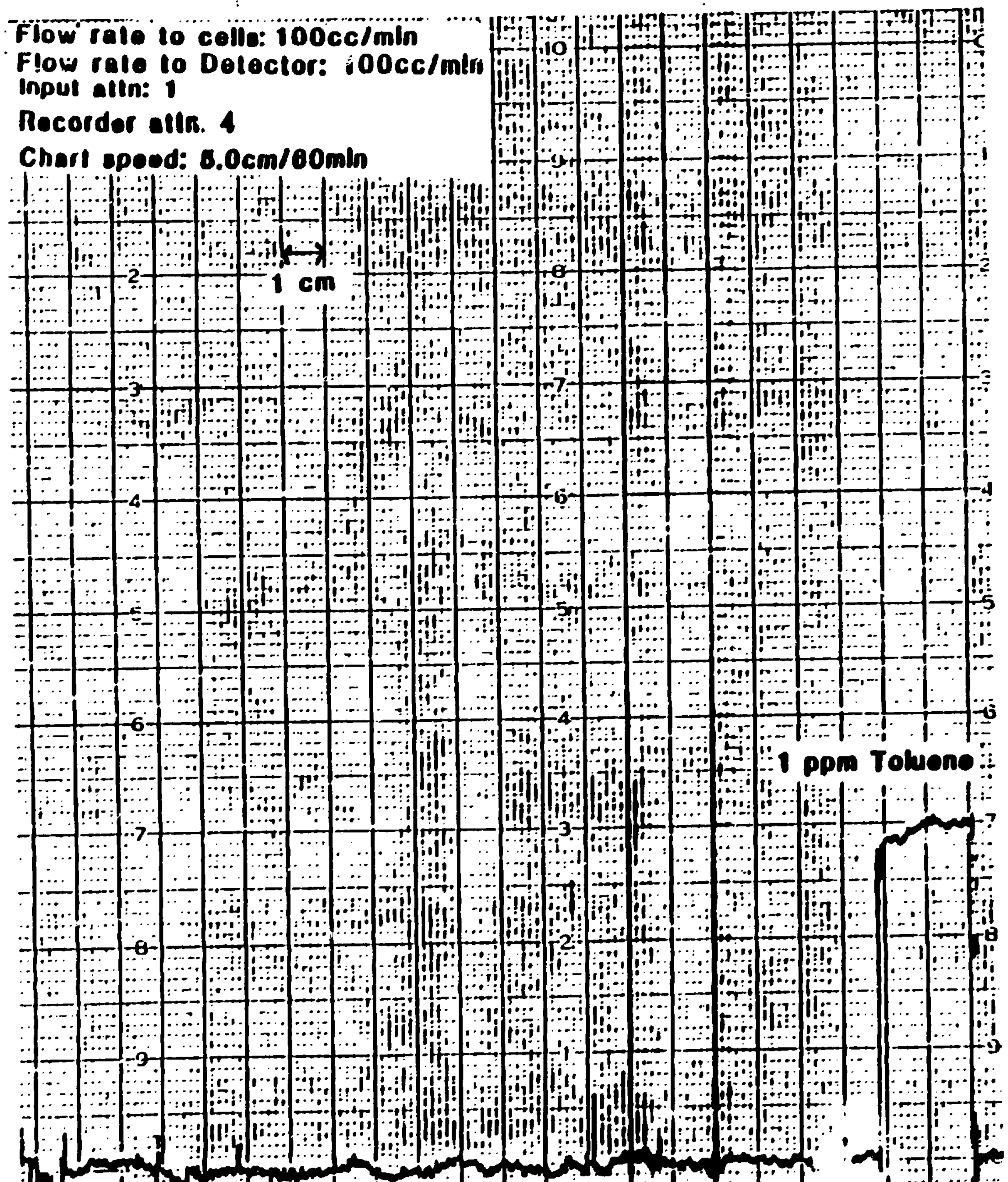
   1. DATE TESTED: June 16, 1986
   2. NUMBER OF SAMPLES TESTED: Three
   3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
   4. MIN DETECTABLE LIMIT .14 ppm
   5. STEADY STATE PERMEATION RATE N/A
   6. SAMPLE THICKNESS: 19 mil
   7. SELECTED DATA POINTS

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

   8. OTHER OBSERVATIONS:

5. SOURCE OF DATA
   Samples were run by Karen Verschoor on June 16, 1986

Chemical Resistance Testing of USCG Material with Ethyl Benzene



Ethyl Benzene charged into cells Switched from cells to Manifold as

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Gas Chromatography
3. TEMPERATURE: Ambient
4. COLLECTION MEDIUM: Charcoal
5. COLLECTION SYSTEM: Charcoal
6. OTHER CONDITIONS: One inch cells were used.
7. DEVIATIONS FROM ASTM F739 METHOD:

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Ethylene Cyanohdrin	N/A	N/A
2. CAS NUMBER(s):	109-78-4	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

.T RESULTS

1. DATE TESTED: October 9,1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT 0.4 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mils
7. SELECTED DATA POINTS Cells 1,2, and 3 at end of three hour test.

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	3 hours	<0.4 ppm	<0.4 ppm	<0.4 ppm
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS: 3 hour samples were collected for 50 minutes for a total volume of 10 liters.

5. SOURCE OF DATA

Samples were run by Denise McDonald on October 9, 1986.

THIS

PAGE

IS

MISSING

IN

ORIGINAL

DOCUMENT

C-137

This page left intentionally blank

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25 °C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Ethylenediamine	N/A	N/A
2. CAS NUMBER(s):	107-15-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 24, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.2 hours.
4. MIN DETECTABLE LIMIT 2.78 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 13-19 mil
7. SELECTED DATA POINTS N/A

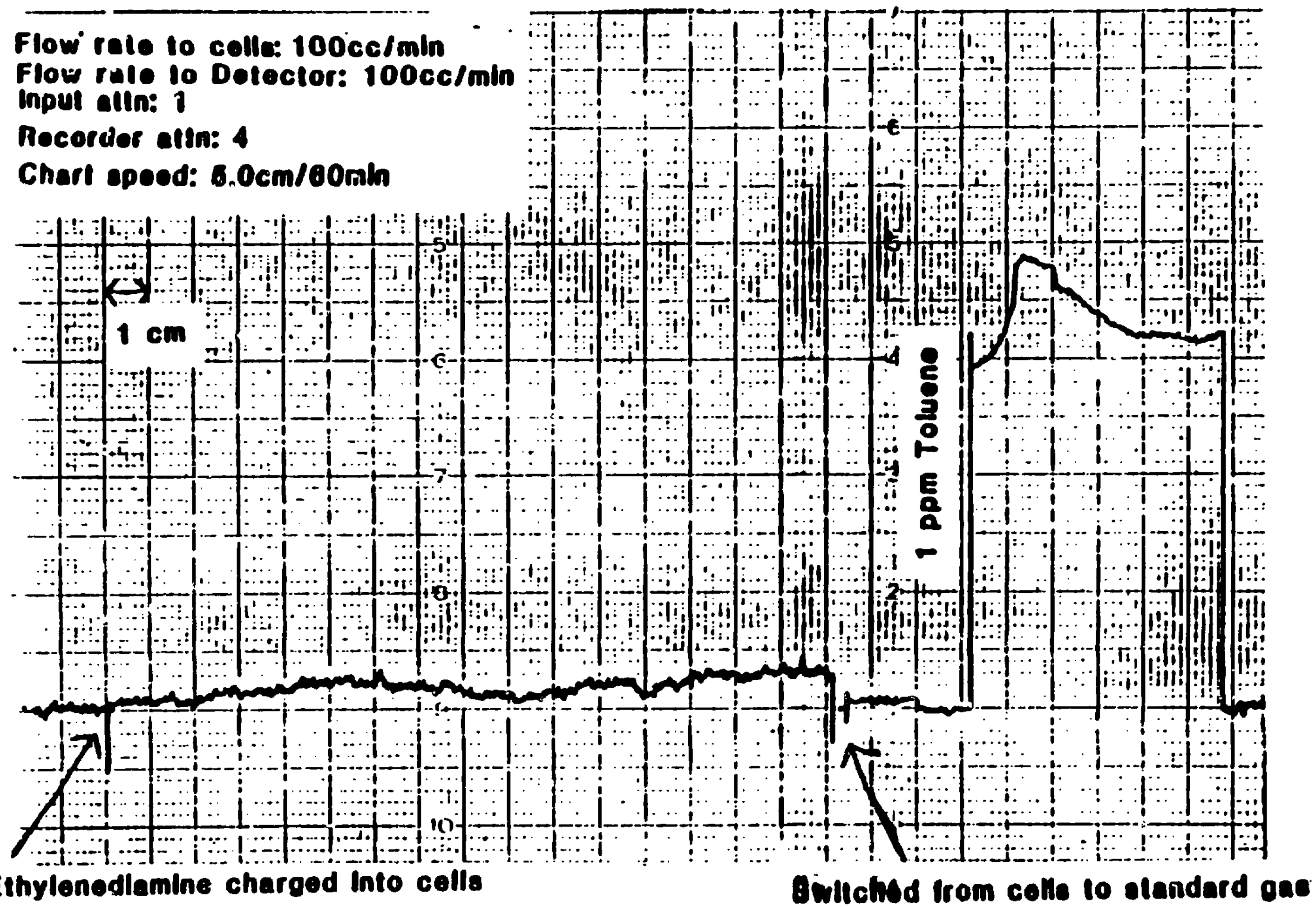
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on June 24, 1986.

Chemical Resistance Testing of USCG Material with Ethylenediamine



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Ethylene Glycol	N/A	N/A
2. CAS NUMBER(s):	107-21-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Baker reagent grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 17-18, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 16.8 hours
4. MIN DETECTABLE LIMIT 2.63 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19 mil
7. SELECTED DATA POINTS

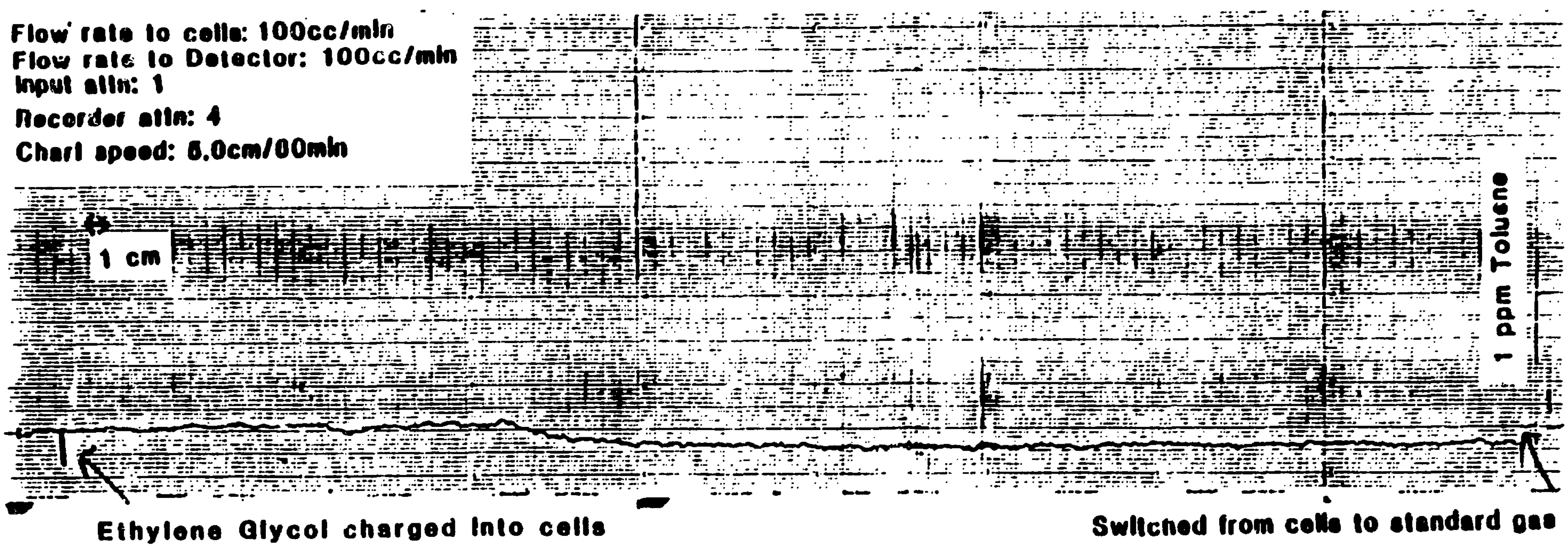
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on June 17-18, 1986.

Chemical Resistance Testing of USCG Material with Ethylene Glycol



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s) :	Ethyl Ether	N/A	N/A
2. CAS NUMBER(s):	60-29-7	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: July 23, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.0 hours.
4. MIN DETECTABLE LIMIT .13 ppm
. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

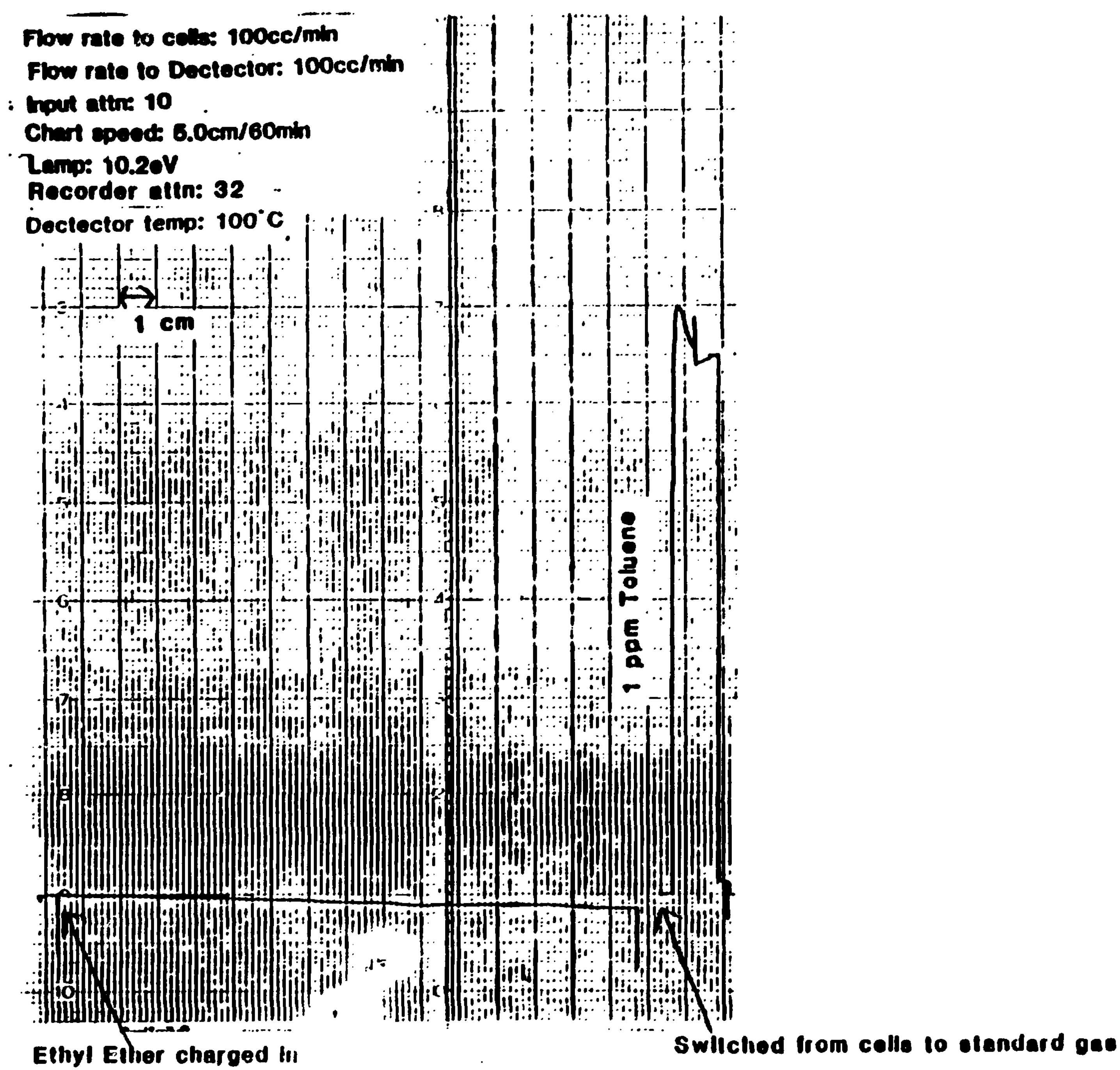
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on July 23, 1986.

Chemical Resistance Testing of USCG Material with Ethyl Ether



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Formaldehyde	N/A	N/A
2. CAS NUMBER(s):	50-00-0	N/A	N/A
3. CONC. (IF MIX)	37% in H_2O	N/A	N/A
	10-15% CH_3OH	N/A	N/A
4. CHEMICAL SOURCE:	Fisher ACS reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: May 13, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT N/A
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS N/A

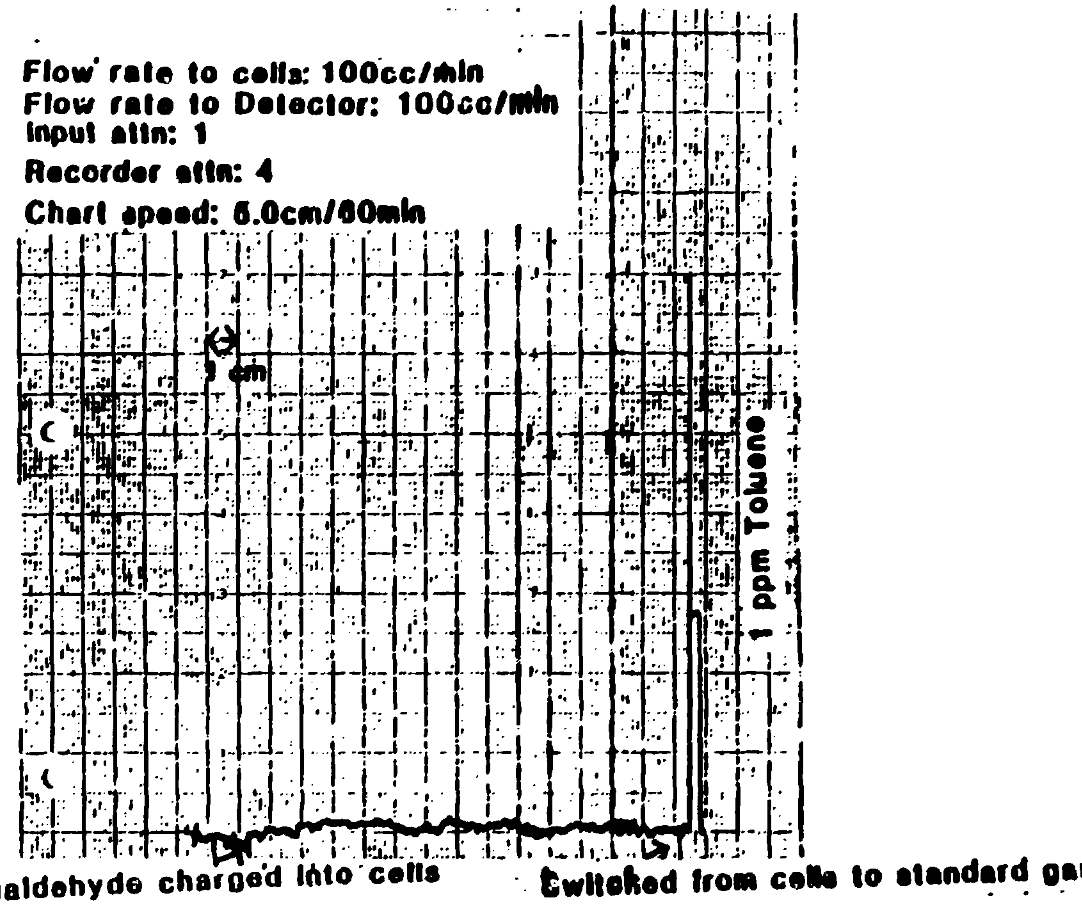
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Karen Verschoor on May 13, 1986

Chemical Resistance Testing of USCG Material with Formaldehyde



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

   1: TYPE: Teflon laminated Nomex
   2: PROTECTIVE MATERIAL CODE: 068
   3: CONDITION BEFORE TEST: Unused, no visible imperfections
   4: MANUFACTURER: Chemfab Corp.
   5: PRODUCT IDENTIFICATION: Challenge 5100
   6: LOT OR MANUFACTURER DATE: N/A
   7: NOMINAL THICKNESS: 15-20 mil
   8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

   1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
   2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
   3. TEMPERATURE: 22-25°C
   4. COLLECTION MEDIUM: N_2
   5. COLLECTION SYSTEM: N_2
   6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature =100C.
   7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Furfural	N/A	N/A
2. CAS NUMBER(s):	98-01-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

   1. DATE TESTED: August 12, 1986
   2. NUMBER OF SAMPLES TESTED: Three
   3. BREAKTHROUGH TIME: No breakthrough was observed after 3.1 hours.
   4. MIN DETECTABLE LIMIT .08 ppm
   5. STEADY STATE PERMEATION RATE N/A
   6. SAMPLE THICKNESS: 18-19 mil
   7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

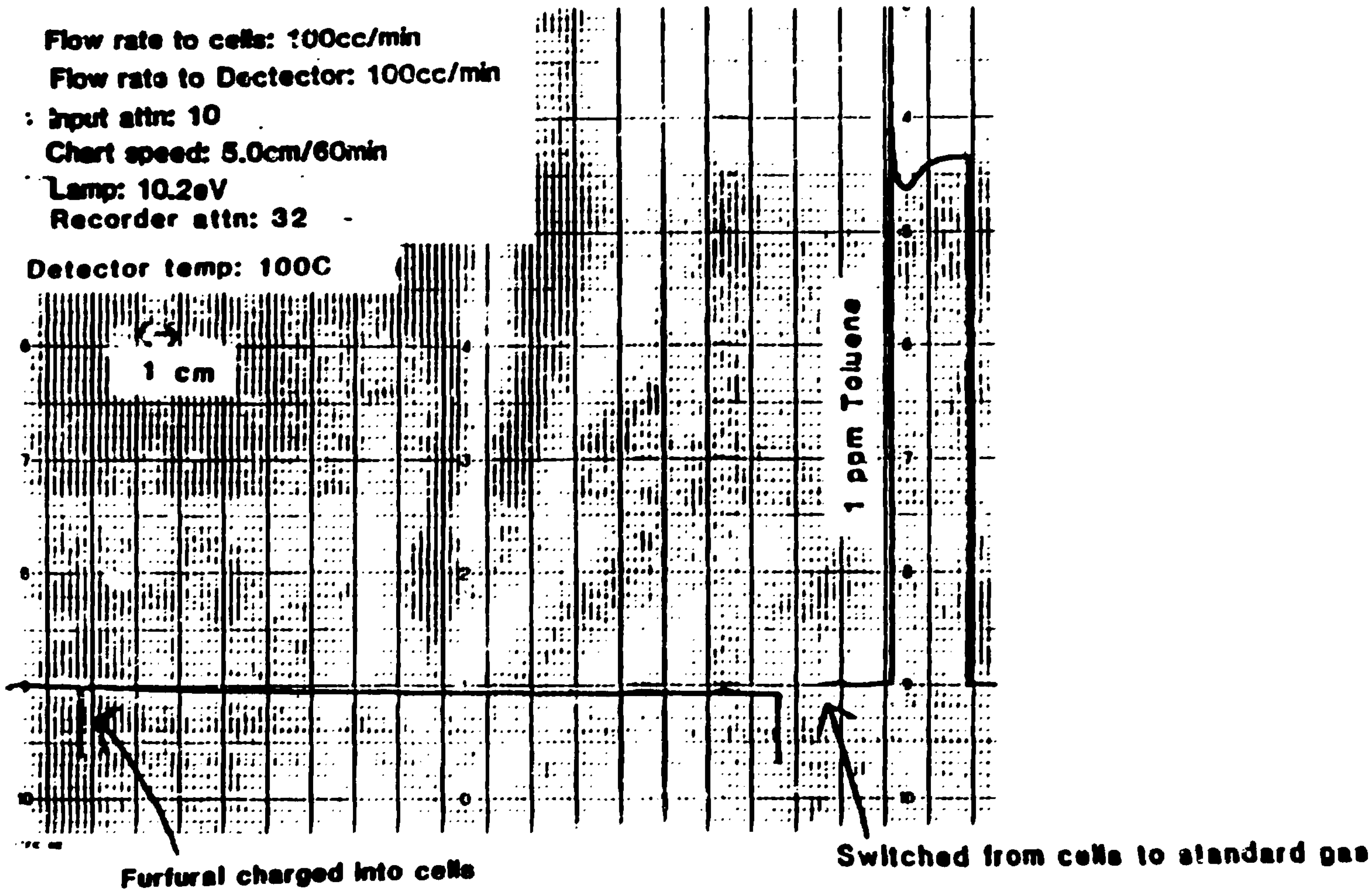
   8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

   Samples were run by Sylvia R. Cooper on August 12, 1986.

C-14

Chemical Resistance Testing of USCG Material with Furfural



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1 TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.2[illegible] eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: N/A

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s) :	Gasoline	N/A	N/A
2. CAS NUMBER(s):	N/A	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Texaco	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 9, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 14.9 hours.
4. MIN DETECTABLE LIMIT 1.65 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

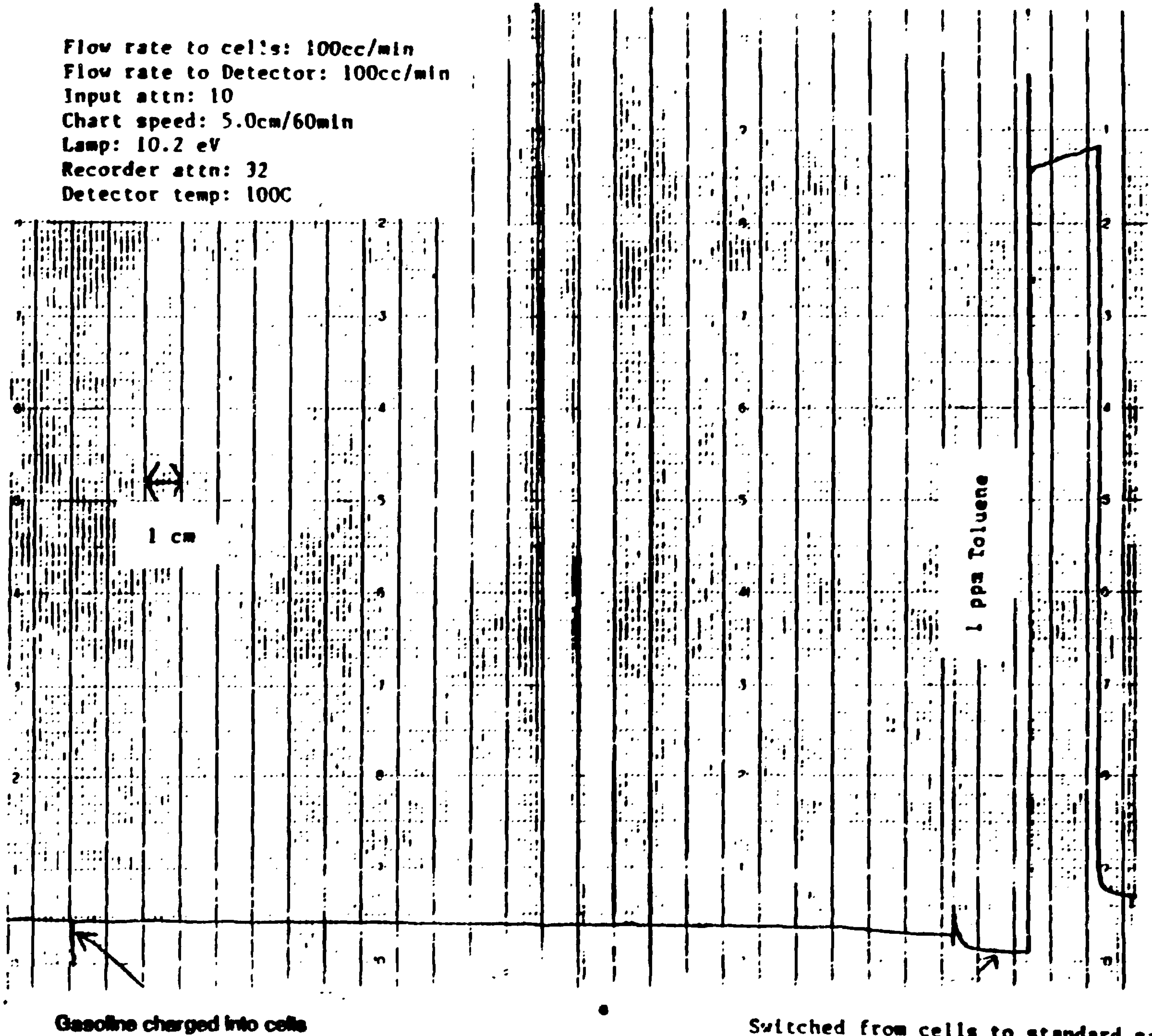
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	-			
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on September 9, 1986.

Chemical Resistance Testing of USCG with Gasoline



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.2 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min.

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s) :	Glutaraldehyde	N/A	N/A
2. CAS NUMBER(s):	111-30-8	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 19, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT .43 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

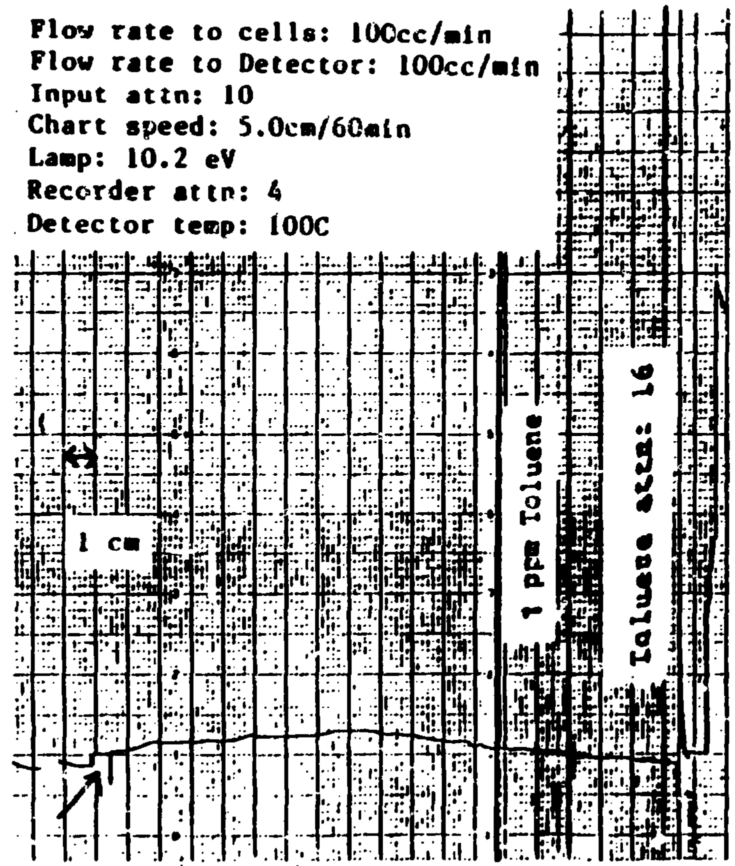
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on September 19, 1986.

Chemical Resistance Testing of USCG Material with Glutaraldehyde



Glutaraldehyde charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s):	Hexane	N/A	N/A
2. CAS NUMBER(s):	110-54-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 16-17, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 11 hours.
4. MIN DETECTABLE LIMIT .25 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19 mil
7. SELECTED DATA POINTS

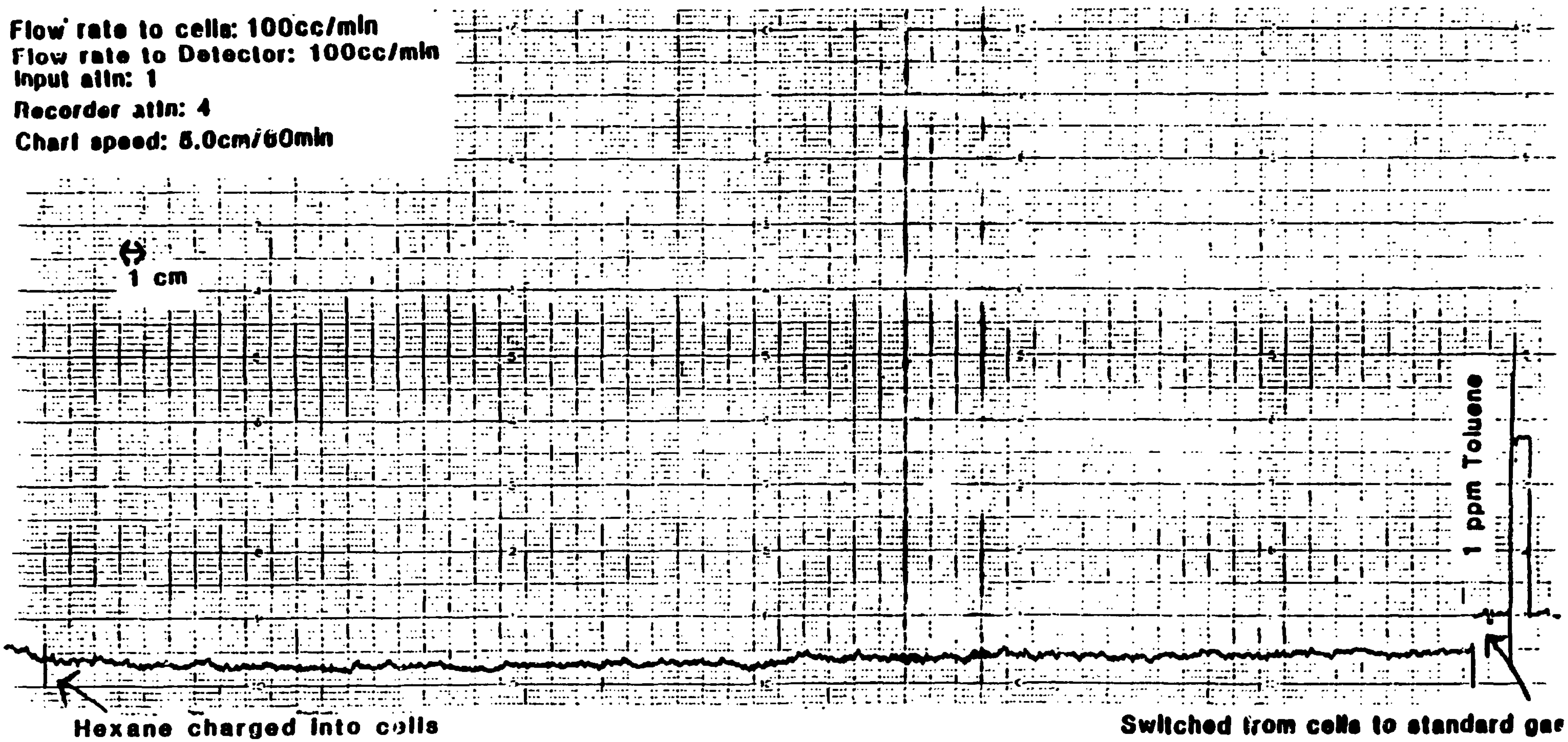
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on June 16-17, 1986.

Chemical Resistance Testing of USCG Material with Hexane



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.2 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Hydrazine Hydrate	N/A	N/A
2. CAS NUMBER(s):	10217-52-4	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 17, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT 0.9 ppm.
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

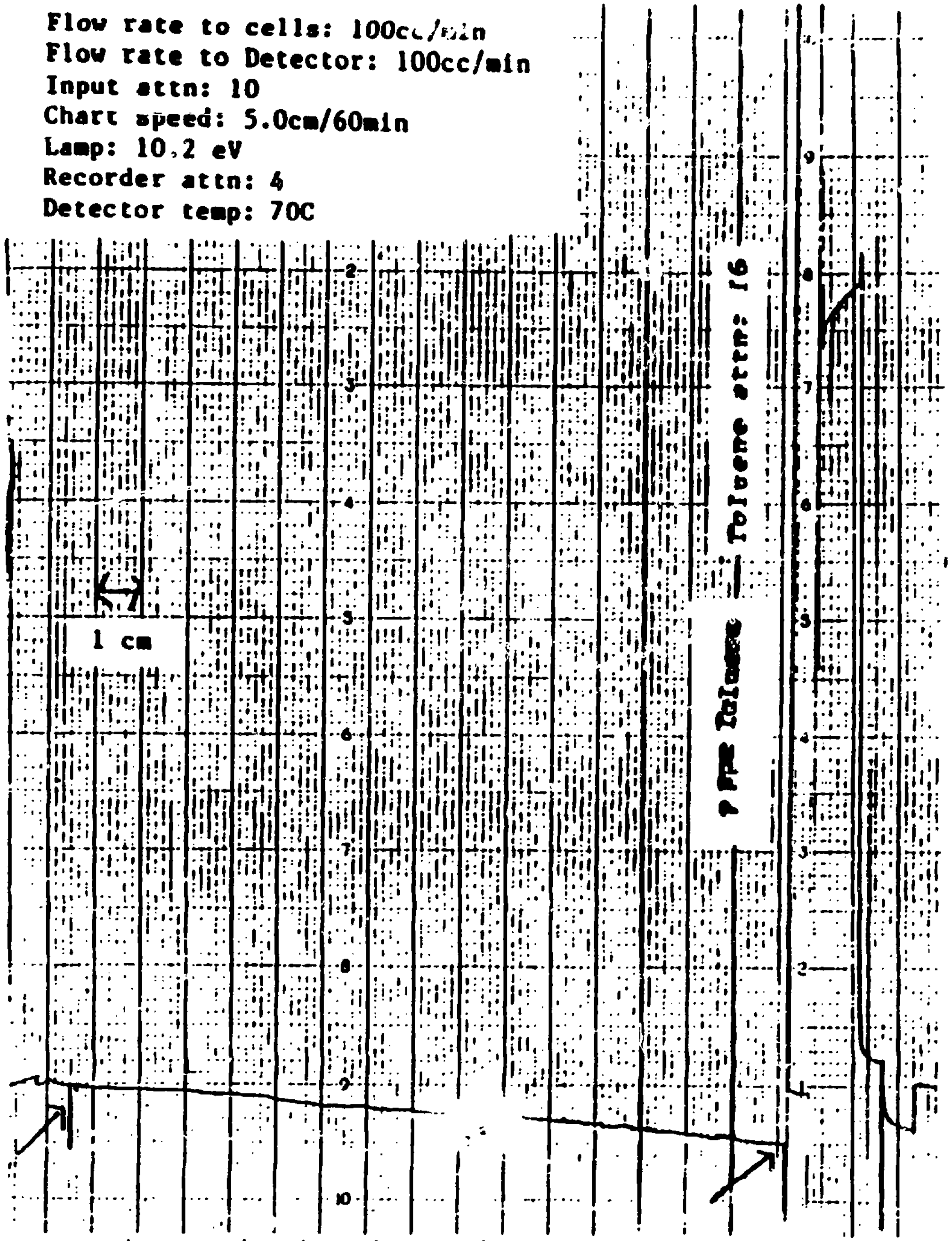
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on September 17, 1986

Chemical Resistance Testing of USCG Material with Hydrazine



Hydrazine charged into cells

Switched fr· · lls to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD-

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Colorimetric; Ferrithiocyanate method
3. TEMPERATURE: Ambient
4. COLLECTION MEDIUM: Aqueous
5. COLLECTION SYSTEM: Aqueous
6. OTHER CONDITIONS: 2 inch cells were used.
7. DEVIATIONS FROM ASTM F739 METHOD:

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Hydrogen Peroxide	N/A	N/A
2. CAS NUMBER(s):	77 22-84-1	N/A	N/A
3. CONC. (IF MIX)	30%	N/A	N/A
4. CHEMICAL SOURCE:	Centex	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: October 10, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT 0.6 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	3 Hours	<0.6 ppm	<0.6 ppm	<0.6 ppm
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS: A reagent blank and 0.6,1.5,3.0 and 6.0 ppm standards were also run.

5. SOURCE OF DATA

Samples were run by Denise McDonald on October 10, 1986.

This page left intentionally blank

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Isopropyl Alcohol	N/A	N/A
2. CAS NUMBER(s):	67-63-0	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A
	Regeant Grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 23,1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT 1.16ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19mil.
7. SELECTED DATA POINTS N/A

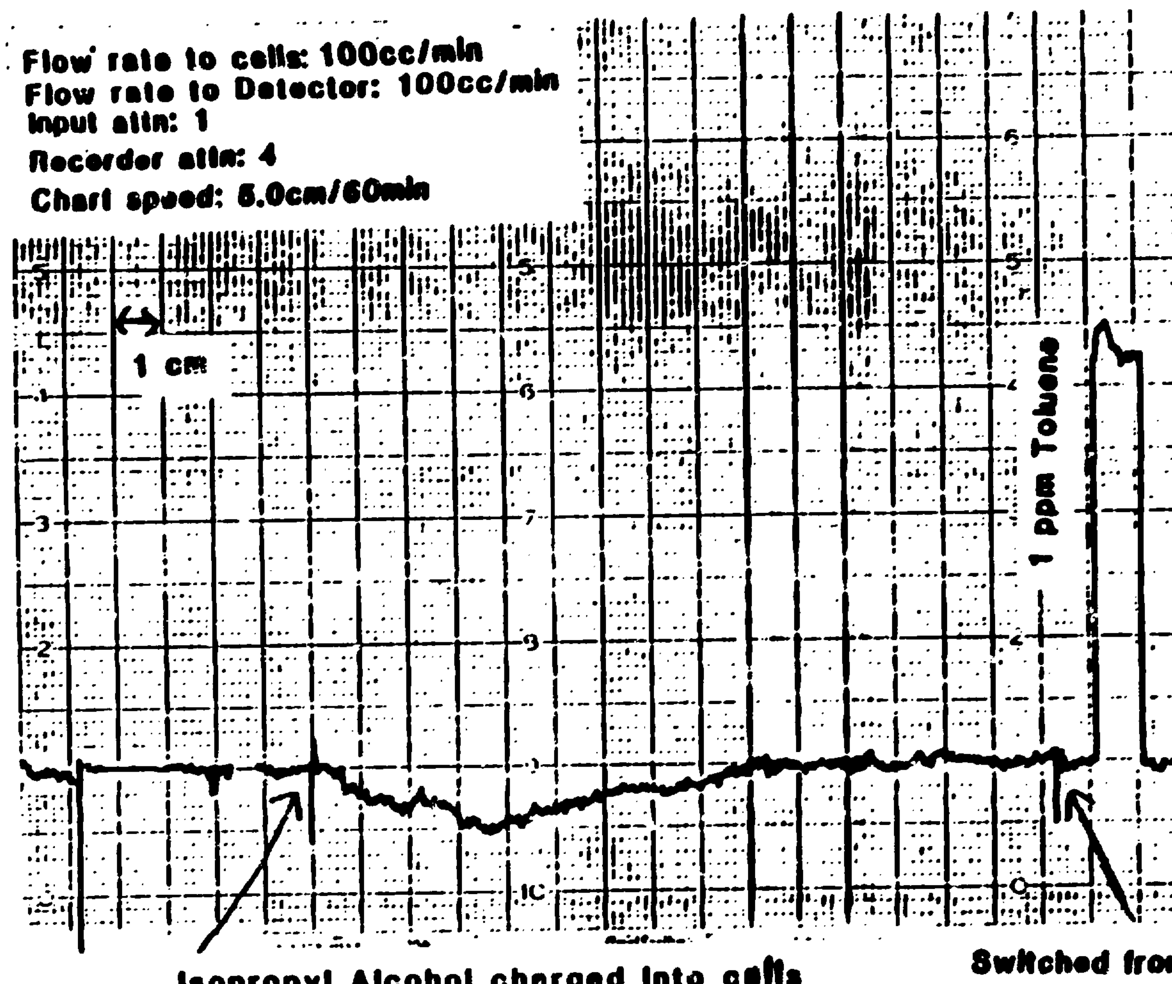
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia R. Cooper on June 23, 1986.

Chemical Resistance Testing of USCG Material with Isopropyl Alcohol



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used/Detector Temperature =60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Isopropylamine	N/A	N/A
2. CAS NUMBER(s):	75-31-0	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

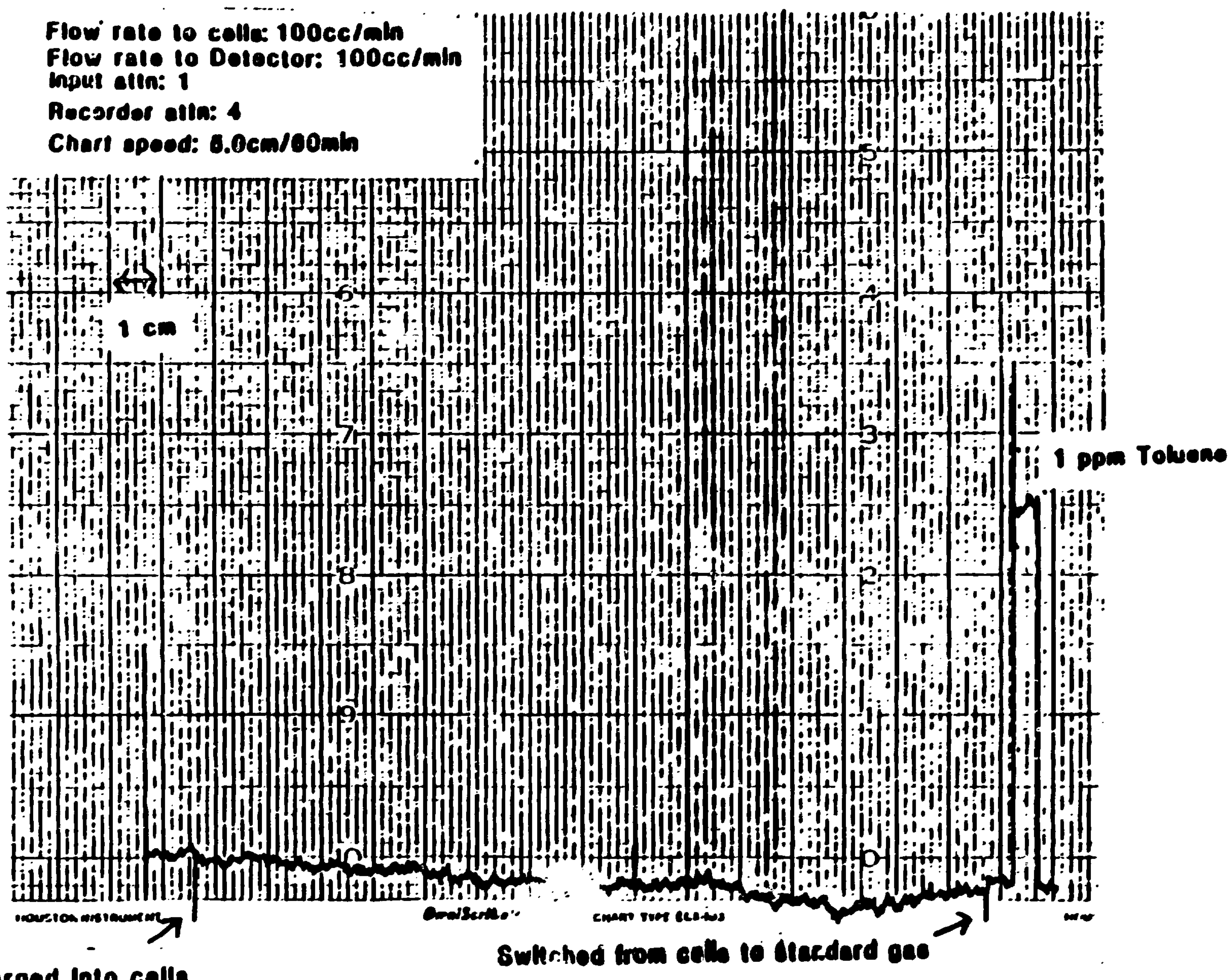
1. DATE TESTED: May 20, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours
4. MIN DETECTABLE LIMIT: 1.57 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA
Samples were run by Sylvia Cooper on May 20, 1986

Chemical Resistance Testing of USCG Material with Isopropylamine



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25 °C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells [illegible]re used./ Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: N/A

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s):	Malathion	N/A	N/A
2. CAS NUMBER(s):	N/A	N/A	N/A
3. CONC. (IF MIX)	50%	N/A	N/A
4. CHEMICAL SOURCE:	Black leaf products	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 5, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after [illegible].10 hours.
4. MIN DETECTABLE LIMIT 1.03 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

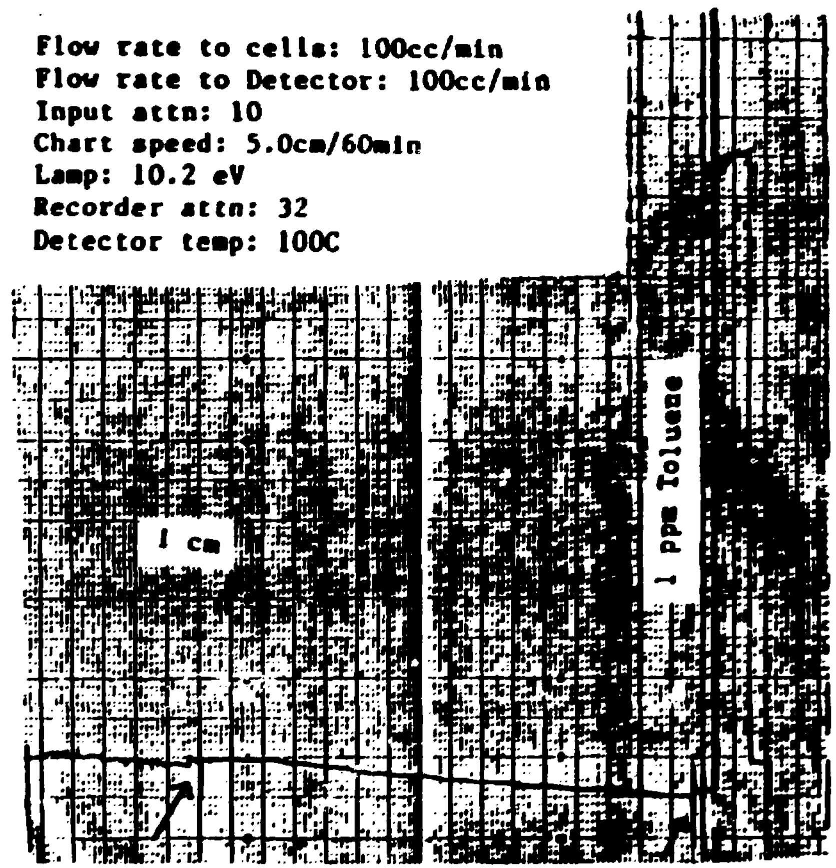
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Karen Verschoor on September 5, 1986.

Chemical Resistance Testing of USCG Material with Malathion

Flow rate to cells: 100cc/min
Flow rate to Detector: 100cc/min
Input attn: 10
Chart speed: 5.0cm/60min
Lamp: 10.2 eV
Recorder attn: 32
Detector temp: 100C



Malathion charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: N/A

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s) :	Methyl Acrylate	N/A	N/A
2. CAS NUMBER(s):	96-33-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: August 14, 1986
2. NUMBER OF SAMPLES TESTED: Three (composite)
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.7 hours.
4. MIN DETECTABLE LIMIT 0.48 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

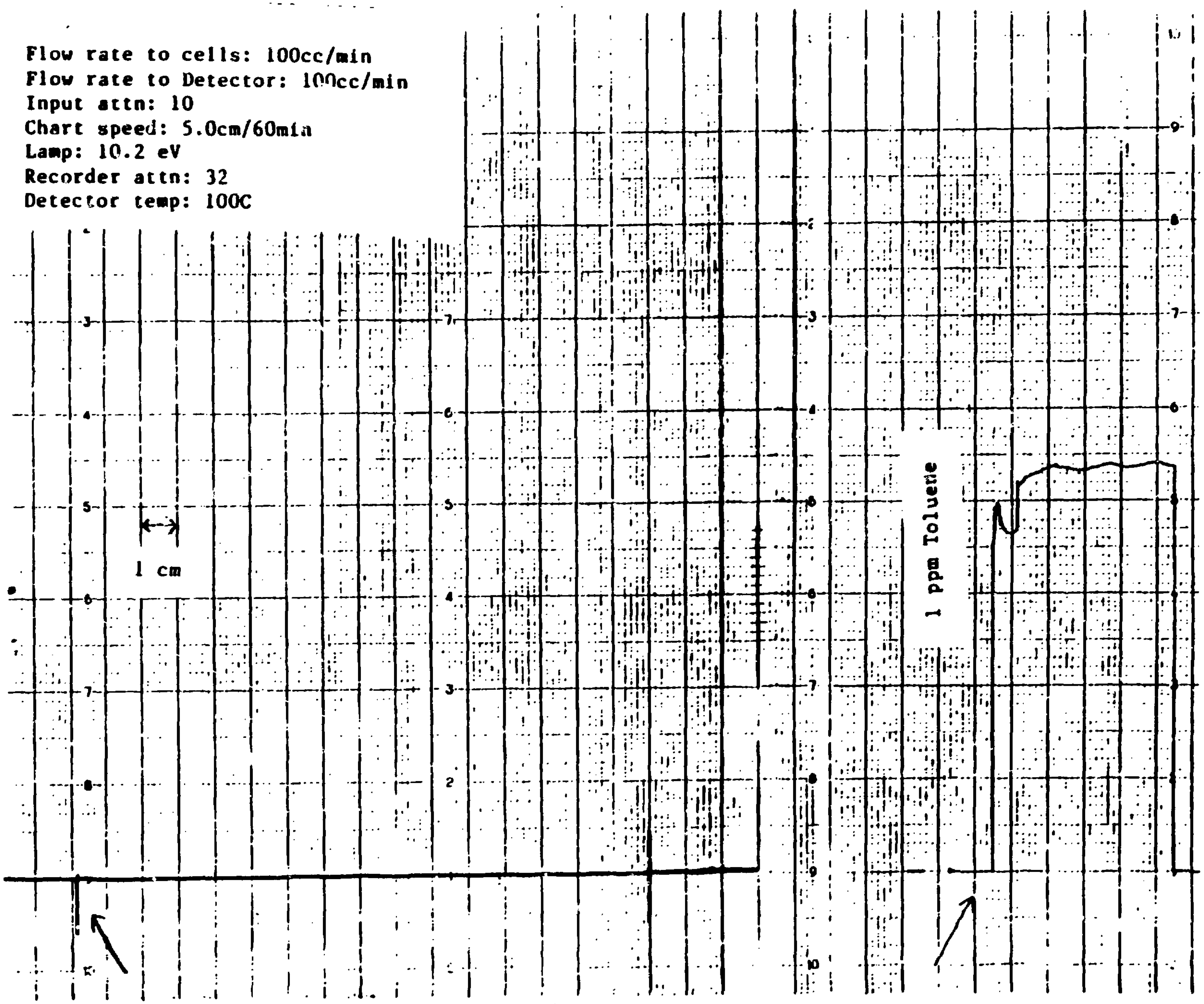
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on August 14, 1986.

Chemical Resistance Testing of USCG with Methyl Acrylate

Flow rate to cells: 100cc/min
Flow rate to Detector: 100cc/min
Input attn: 10
Chart speed: 5.0cm/60min
Lamp: 10.2 eV
Recorder attn: 32
Detector temp: 100C



Methyl Acrylate charg... to cells

Switched from ce... to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: flow rate to the cells was 100cc/min

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Methyl Alcohol	N/A	N/A
2. CAS NUMBER(s):	67-56-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A
	Reagent Grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 19-20, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 14.2 hours.
4. MIN DETECTABLE LIMIT 4.07ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil.
7. SELECTED DATA POINTS N/A

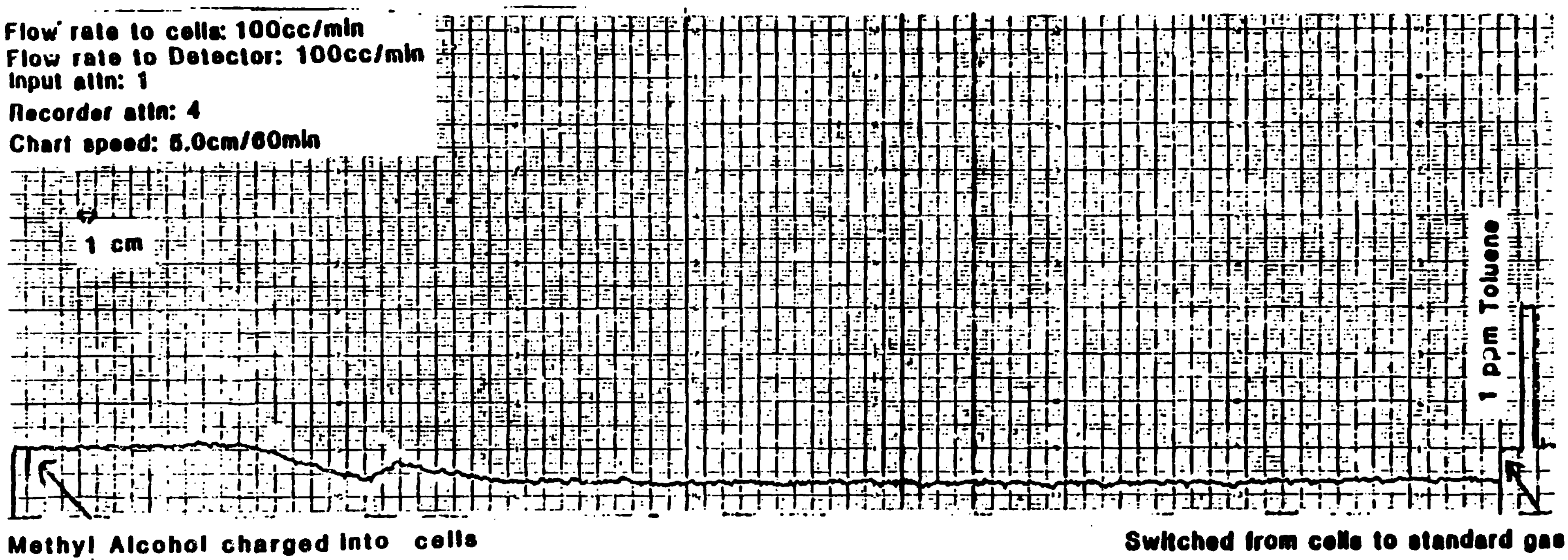
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Karen Verschoor on June 19-20, 1986.

Chemical Resistance Testing of USCG Material with Methyl Alcohol



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cell was used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 90cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s) :	Methylene Chloride	N/A	N/A
2. CAS NUMBER(s):	75-09-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher Pesticide	N/A	N/A
	Grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: April 21-22, 1986
2. NUMBER OF SAMPLES TESTED: One (Run 1)
3. BREAKTHROUGH TIME: 46.8 min
4. MIN DETECTABLE LIMIT 0.27 ppm
5. STEADY STATE PERMEATION RATE 1.37ug/cm^2 hour
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

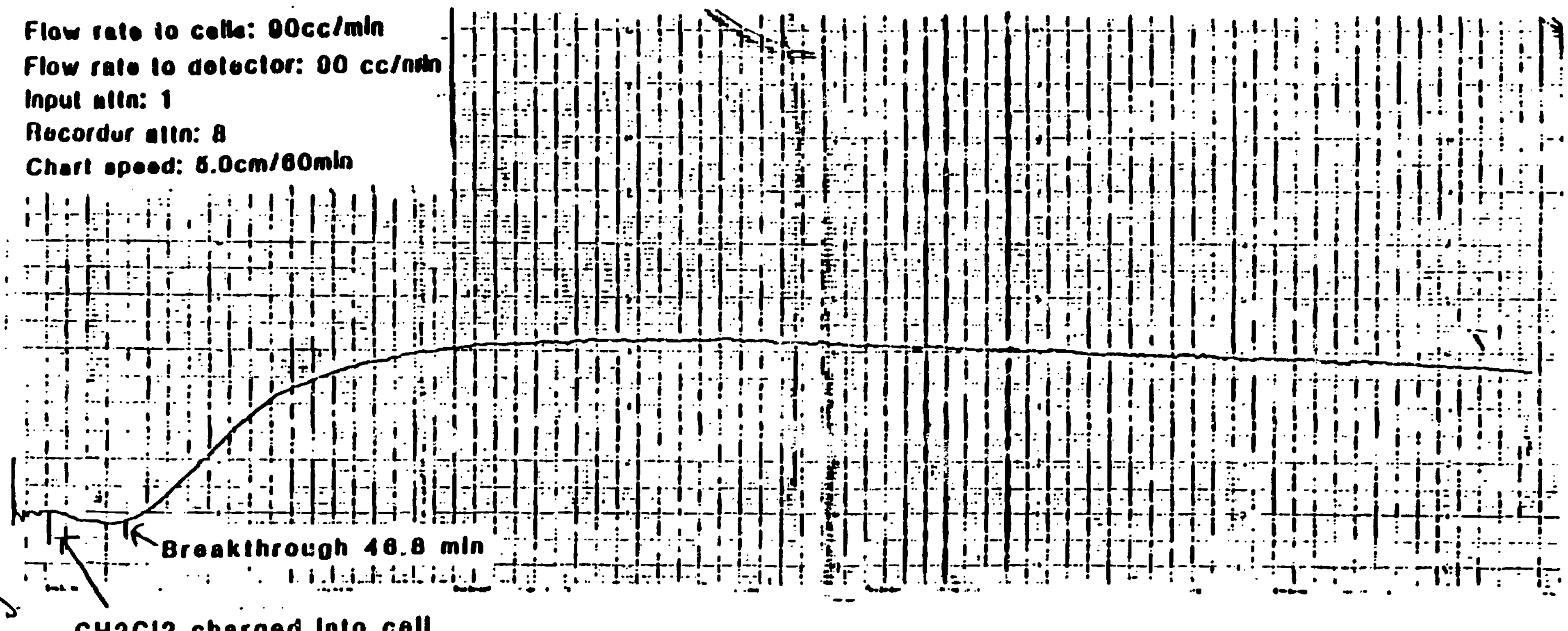
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Karen Verschoor on April 21-22, 1986.

Permeation of Methylene Chloride through USCG Material

Run I



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cell was used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: flow rate to cell was 90cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Methylene Chloride	N/A	N/A
2. CAS NUMBER(s):	75-09-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher Pesticide	N/A	N/A
	Grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: April 22, 1986
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: 50.4 min.
4. MIN DETECTABLE LIMIT 0.13 ppm.
5. STEADY STATE PERMEATION RATE .964 ug/cm² hour
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS

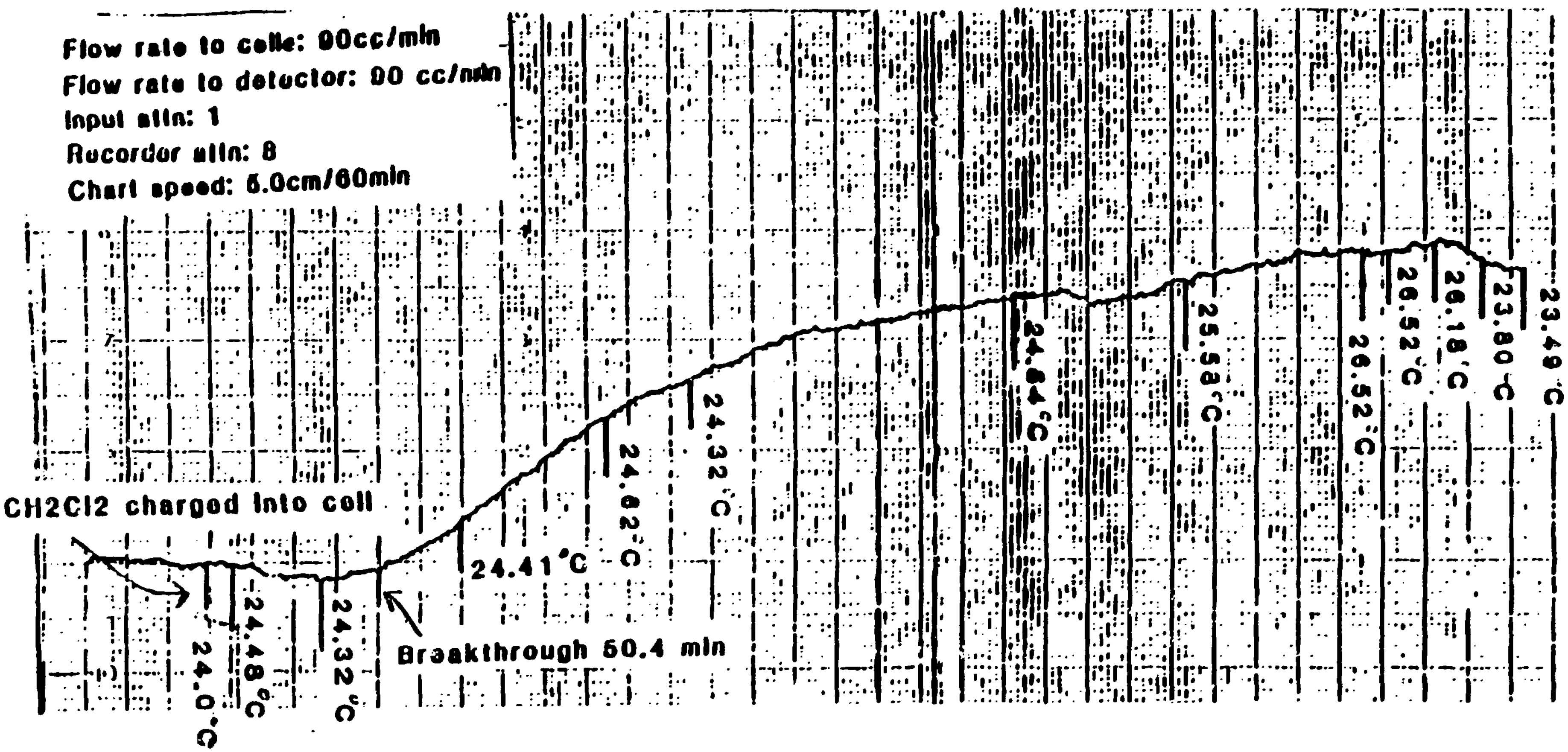
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA
Sample was run by Karen Verschoor on April 22, 1986.

Permeation of Methylene Chloride through USCG Material

Run II



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cell was used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 90cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Methylene Chloride	N/A	N/A
2. CAS NUMBER(s):	75-09-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher Pesticide	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: April 22-23, 1986
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 55.2 min
4. MIN DETECTABLE LIMIT 0.17 ppm.
5. STEADY STATE PERMEATION RATE 1.27 ug/cm² hour
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

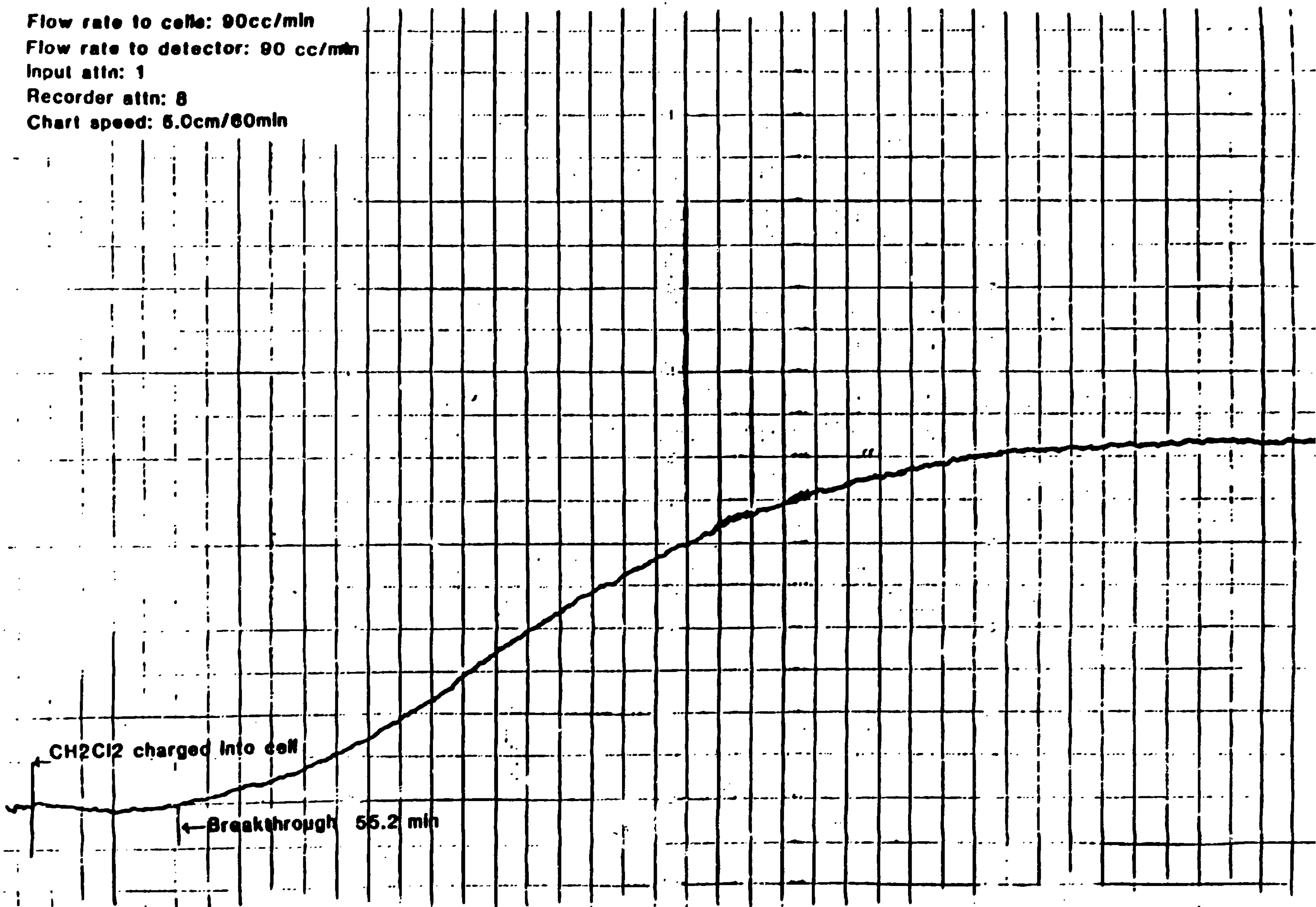
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Karen Verschoor on April 22-23, 1986.

C-170

Permeation Methylene Chloride through USCG Material
Run III



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Methyl Ethyl Ketone	N/A	N/A
2. CAS NUMBER(s):	78-93-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Baker reagent grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 18, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT 0.65ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil.
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

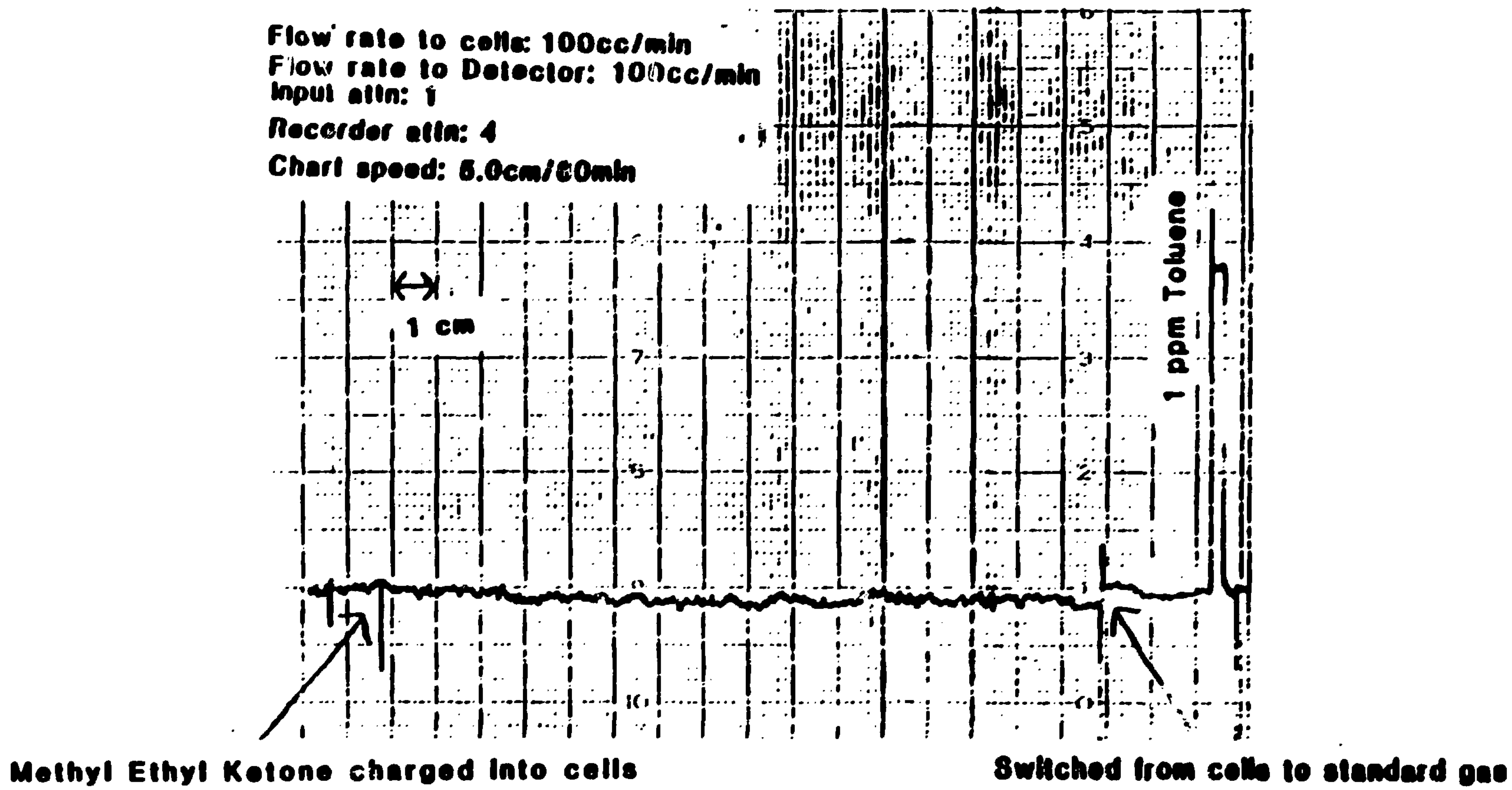
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on June 18, 1986

Chemical Resistance Testing of USCG Material

with Methyl Ethyl Ketone



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s)	Methyl Isobutyl Ketone	N/A	N/A
2. CAS NUMBER(s)	108-10-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE	Aldrich	N/A	N/A
	Reagent Grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 19, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT 3.98ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

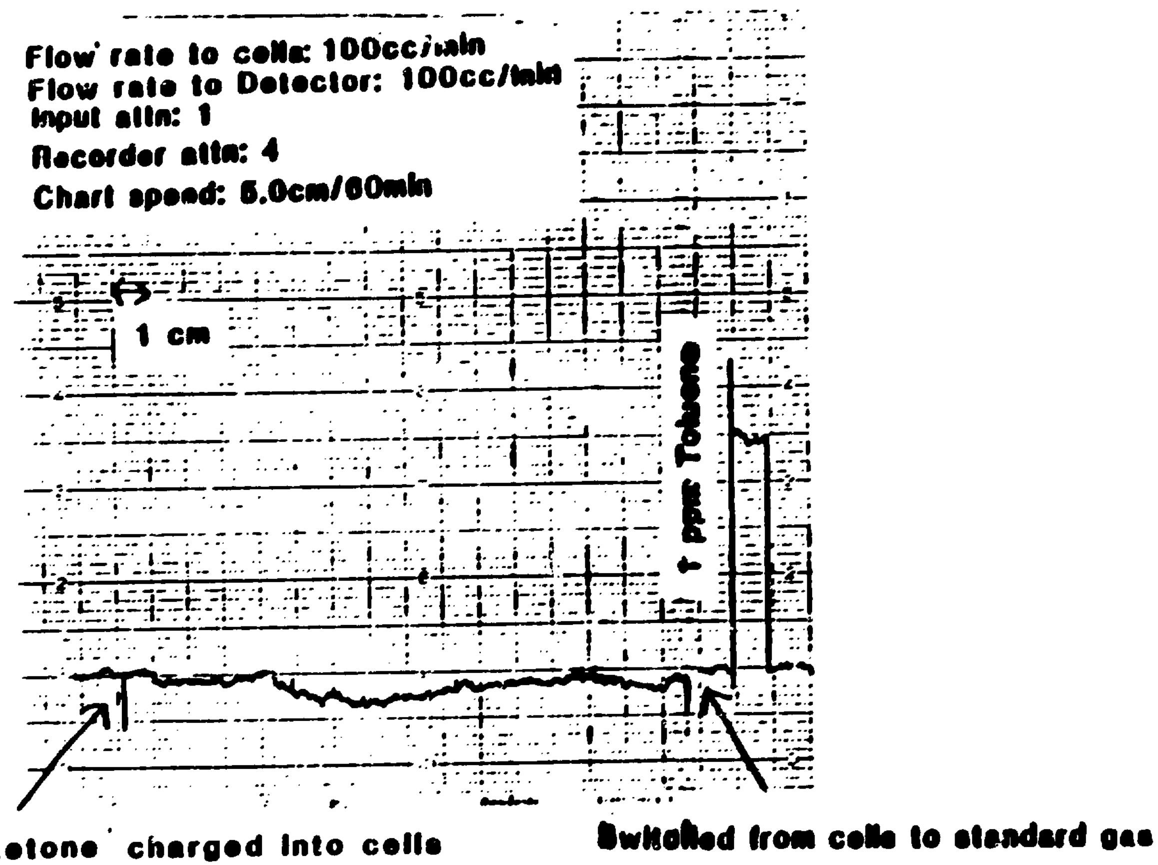
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on June 19, 1986.

Chemical Resistance Testing of USCG Material

with Methyl Isobutyl Ketone



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25 °C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s):	Methyl Methacrylate	N/A	N/A
2. CAS NUMBER(s):	80-62-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent grade	N/A N/A	N/A N/A

4. TEST RESULTS

1. DATE TESTED: June 25, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.1 hours.
4. MIN DETECTABLE LIMIT .19 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

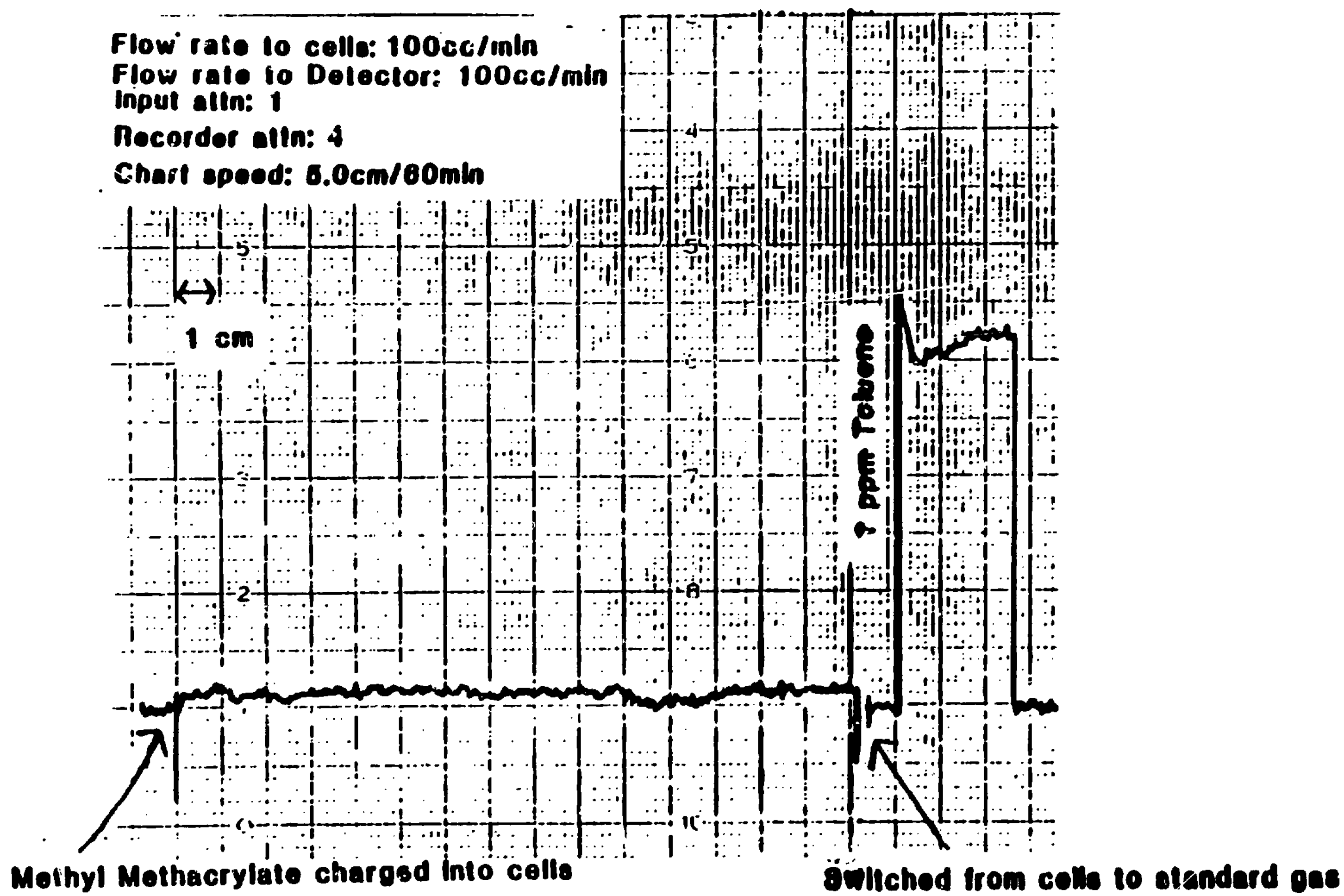
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on June 25, 1986

Chemical Resistance Testing of USCG Material with Methyl Methacrylate



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.2 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s) :	Methyl Parathion	N/A	N/A
2. CAS NUMBER(s):	N/A	N/A	N/A
3. CONC. (IF MIX)	44.0%	N/A	N/A
4. CHEMICAL SOURCE:	Agricultural Supply	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 18, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT .15 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

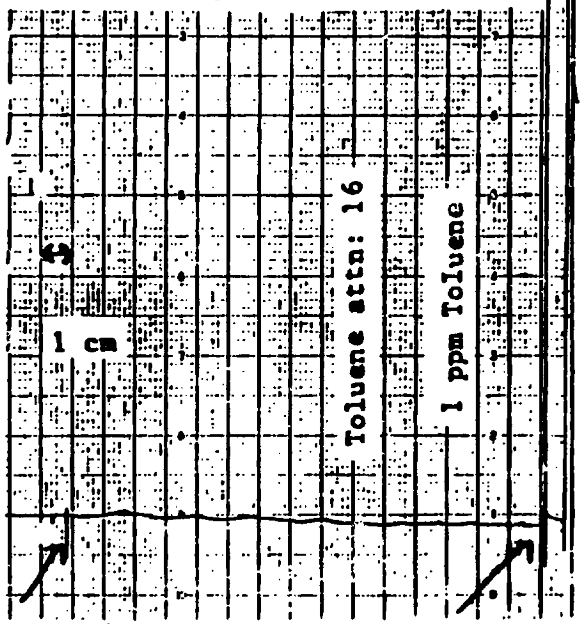
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on September 18, 1986.

Chemical Resistance Testing of USCG Material with Methyl Parathion

Flow rate to cells: 100cc/min
Flow rate to Detector: 100cc/min
Input attn: 10
Chart speed: 5.0cm/60min
Lamp: 10.2
Recorder attn: 4
Detector temp: 100



Methyl Parathion charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Naled	N/A	N/A
2. CAS NUMBER(s):	N/A	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Ortho	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: October 10, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.46 hours.
4. MIN DETECTABLE LIMIT N/A
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

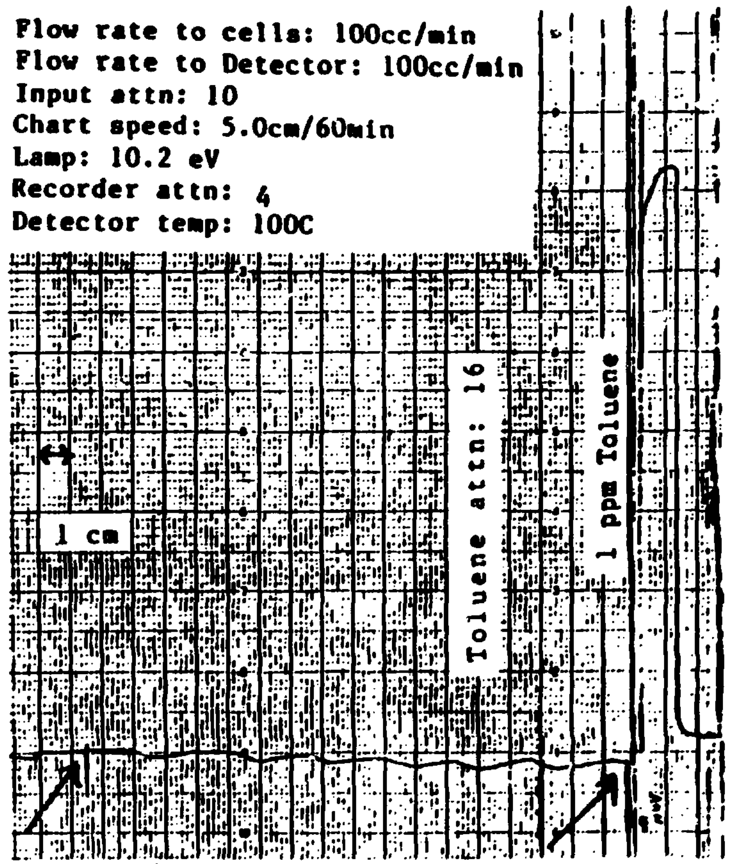
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on October 10, 1986.

Chemical Resistance Testing of USCG Material with Naled



Naled charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used. /Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s) :	Naphtha	N/A	N/A
2. CAS NUMBER(s):	8032-32-4	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent grade	N/A N/A	N/A N/A

4. TEST RESULTS

1. DATE TESTED: September 24, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.46 hours.
4. MIN DETECTABLE LIMIT 4.55 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

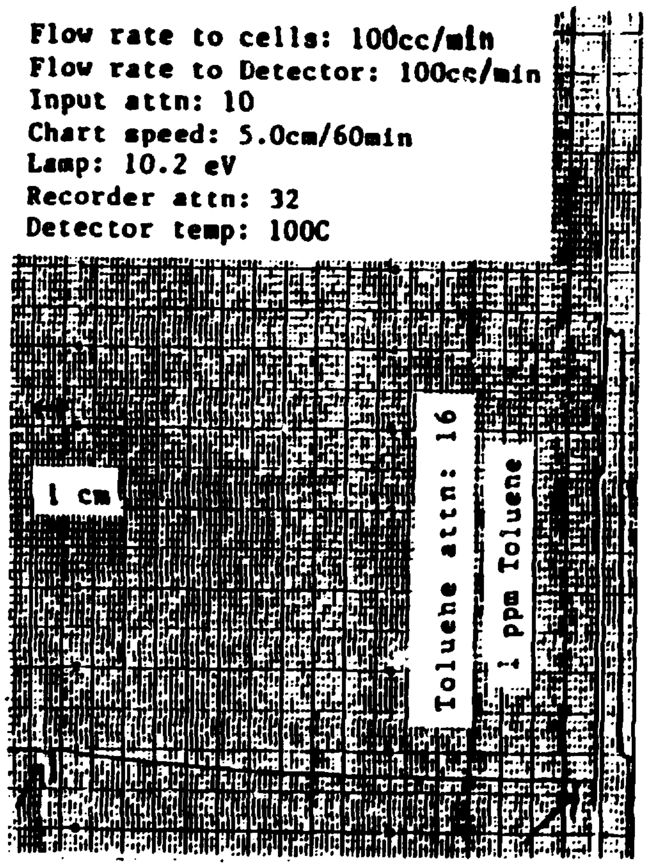
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on September 24, 1986

Chemical Resistance Testing of USCG Material with Naphtha



Naphtha charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s) :	Napthalene	N/A	N/A
2. CAS NUMBER(s):	91-20-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 8, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 13.2 hours.
4. MIN DETECTABLE LIMIT .01 ppm as Benzene
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS. 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

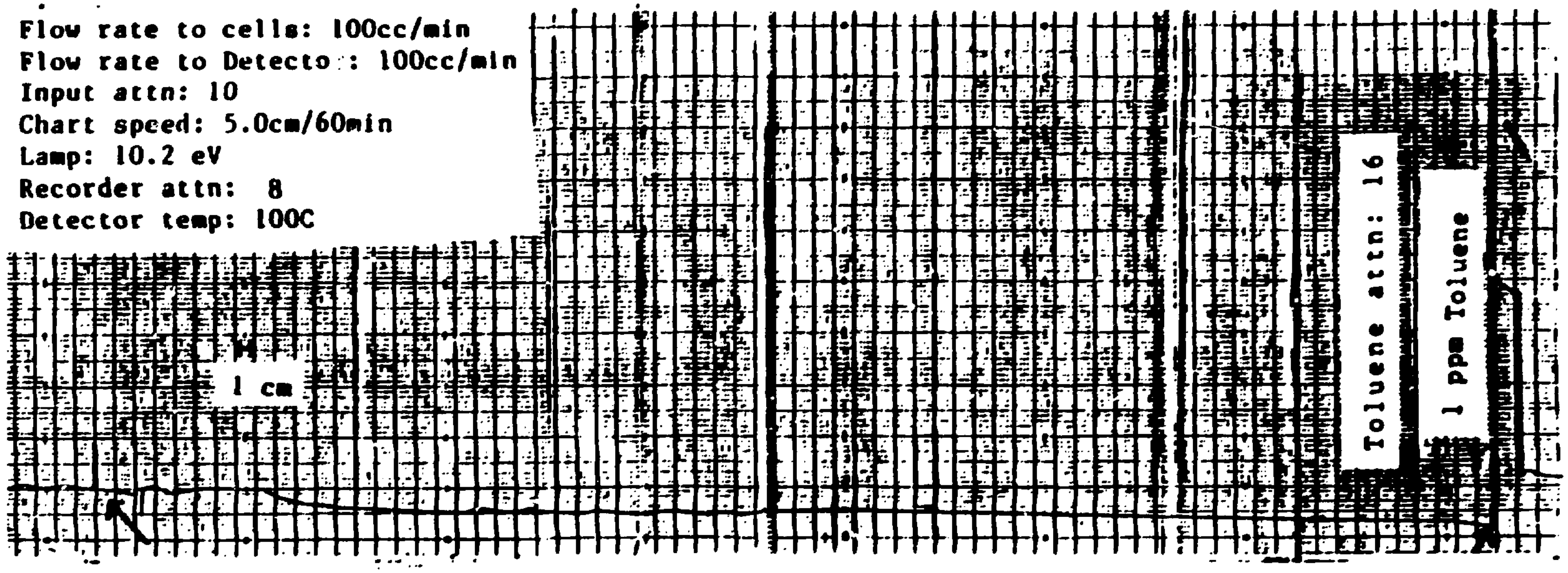
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on September 8, 1986.

Chemical Resistance Testing of USCG Material with Napthalene

Flow rate to cells: 100cc/min
Flow rate to Detecto : 100cc/min
Input attn: 10
Chart speed: 5.0cm/60min
Lamp: 10.2 eV
Recorder attn: 8
Detector temp: 100C



Napthalene charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Ion Chromatography on Dionex 2000.
3. TEMPERATURE: Ambient
4. COLLECTION MEDIUM: Aqueous
5. COLLECTION SYSTEM: Aqueous
6. OTHER CONDITIONS: 2 inch cells were used.
7. DEVIATIONS FROM ASTM F739 METHOD:

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Nitric Acid	N/A	N/A
2. CAS NUMBER(s):	7697-37-2	N/A	N/A
3. CONC. (IF MIX)	70%	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 11, 1986.
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT 0.2 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS cell 1,2, and 3 at end of 3 hour test

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	3 hours	<0.2 ppm	<0.2 ppm	<0.2 ppm
2.				
3.				
4.				
5				
6.				
7.				
8.				
9.				
10.				

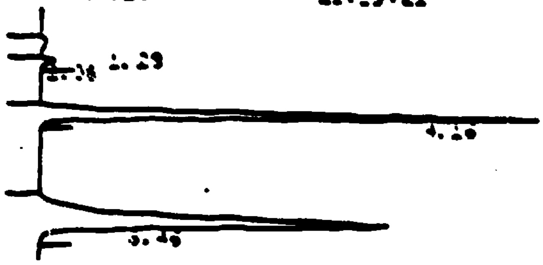
8. OTHER OBSERVATIONS: Retention time for 10ppm Nitrate calibration standard was 4.16 minutes

5. SOURCE OF DATA

Samples were run by Denise McDonald on September 11, 1986.

...libration–10 ppm Nitrate Standard

...NEL A INJECT 22:39:21



...ERMEATION 22:39:21

...ILE 1. METHOD 5. RUN 26 INDEX 1 CALIB

...ALYST: DM

...E	PPM	RT	AREA BC	RF
	0.	1.28	224650 02	
	0.	2.08	335279 03	
...3	10.	4.16	16212891 01	1621288.1
	10.	8.46	21178254 01	2117825.398
...ALS	20.		37961164	

...DL–0.2 Nitrate Standard

CHANNEL A INJECT 00:00:32

PERMEATION 00:00:32

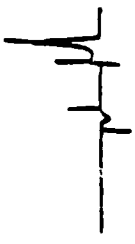
FILE 1. METHOD 5. RUN 28 INDEX 1

ANALYST: DM

NAME	PPM	RT	AREA BC	RF
1	0.	1.26	63764 01	
2	0.	2.13	143816 01	
NO3	0.225	4.36	364745 01	1621288.1
?Y	0.204	8.62	431357 01	2117825.399
TOTALS	0.429		1003683	

Reagent Water Blank

CHANNEL A INJECT 00:10:32



PERMEATION 00:10:32

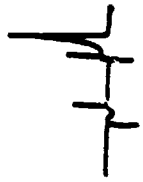
FILE 1. METHOD 5. RUN 29 INDEX 1

ANALYST: DM

NAME	PPM	RT	AREA BC	RF
NO3	0.206	4.32	333891 01	1621288.1
TOTALS	0.206		333891	

Nitric Acid Cell 1 3 hours

CHANNEL A INJECT 00:21:04



PERMEATION 00:21:04

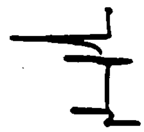
FILE 1. METHOD 5. RUN 30 INDEX

ANALYST: DM

NAME	PPM	RT	AREA BC
NO3	0.123	4.24	191561 0116...
TOTALS	0.123		191561

Nitric Acid Cell 2 3 hou...

CHANNEL A INJECT 00:28:08



PERMEATION 00:28:08

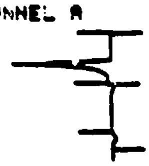
FILE 1. METHOD 5. RUN 31 INDEX 1

ANALYST: DM

NAME	PPM	RT	AREA BC
NO3	0.073	4.26	117647 01162...
TOTALS	0.073		117647

Nitric Acid Cell 3 3 hours

CHANNEL A INJECT 00:34:36



PERMEATION 00:34:36

FILE 1. METHOD 5. RUN 32 INDEX

ANALYST: DM

NAME	PPM	RT	AREA BC
NO3	0.081	4.27	130527 01162...
TOTALS	0.081		130527

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25 °C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 90 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Nitrobenzene	N/A	N/A
2. CAS NUMBER(s):	98-95-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A
	reagent grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: April 9, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS N/A

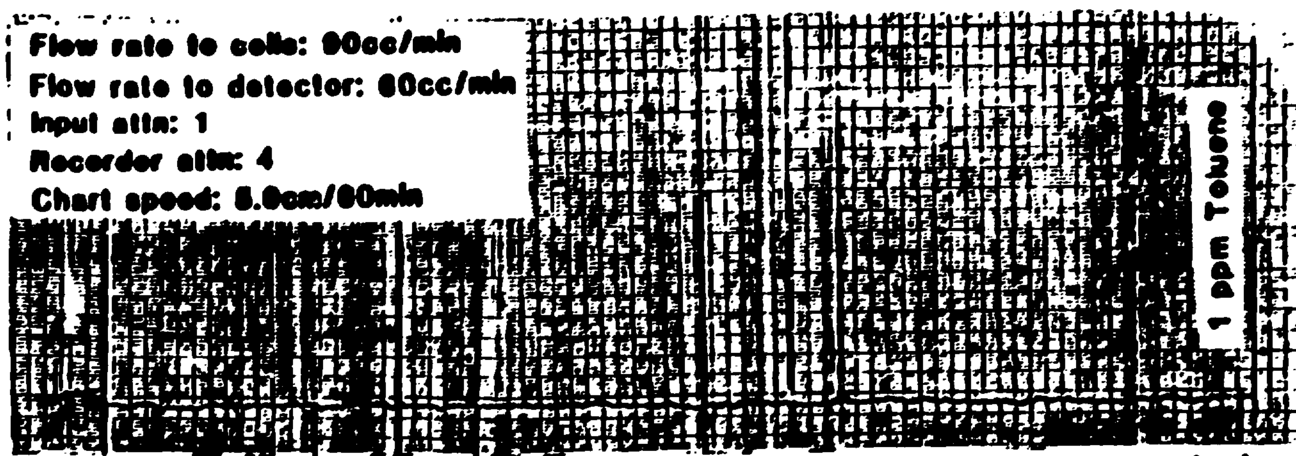
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Karen Verschoor on April 9, 1986.

Chemical Resistance Testing of USCG Material with Nitrobenzene



Nitrobenzene charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	2-Nitropropane	N/A	N/A
2. CAS NUMBER(s):	79-46-9	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Kodak reagent grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: July 8, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT .59 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

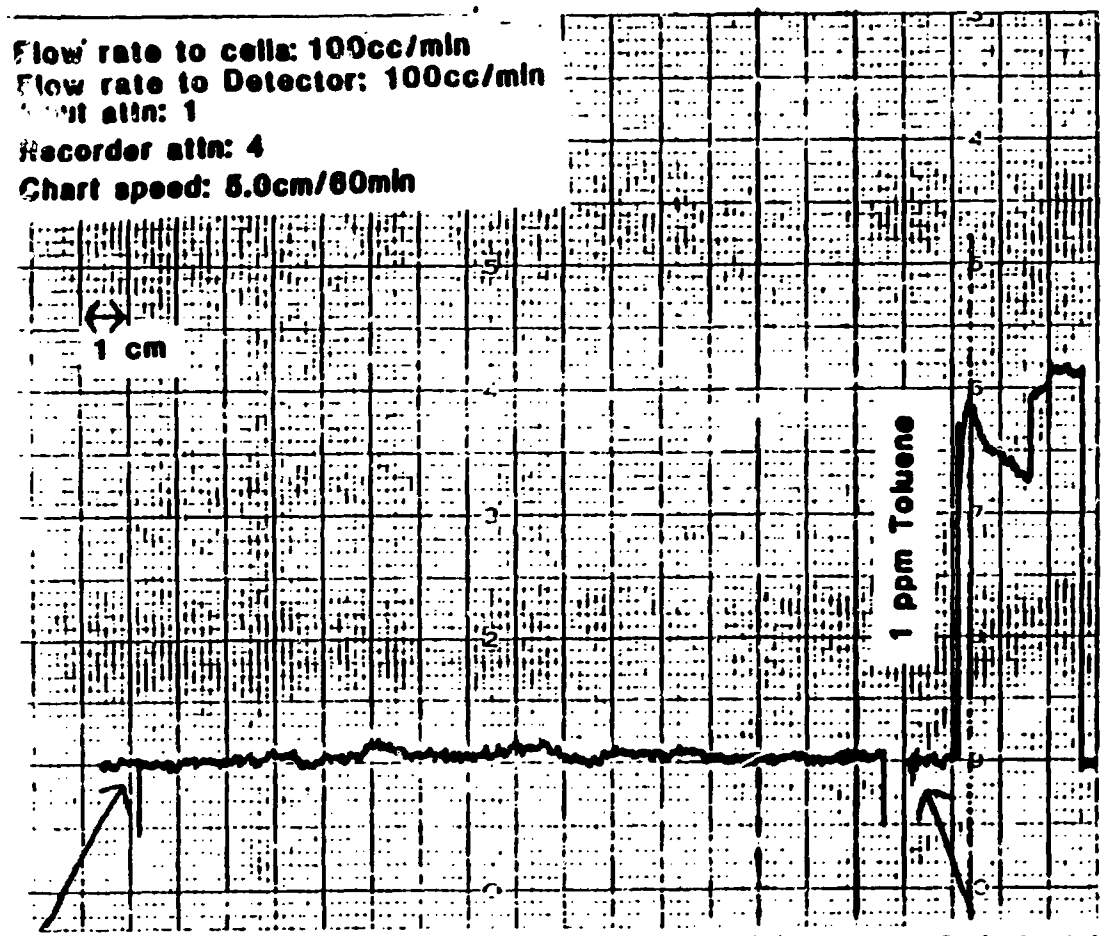
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on July 8, 1986.

Chemical Resistance Testing of USCG Material with 2-Nitropropane



2-Nitropropane charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Ion Chromatography on Dionex 2000.
3. TEMPERATURE: Ambient
4. COLLECTION MEDIUM: Aqueous
5. COLLECTION SYSTEM: Aqueous
6. OTHER CONDITIONS: 2 inch cells were used.
7. DEVIATIONS FROM ASTM F739 METHOD:

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s):	Oleum	N/A	N/A
2. CAS NUMBER(s):	8014-95-7	N/A	N/A
3. CONC. (IF MIX)	20% SO_3	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 22, 1986.
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours
4. MIN DETECTABLE LIMIT 0.2 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS cell 1,2, and 3 at end of 3 hour test

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	3 hours	<0.2 ppm	<0.2 ppm	<0.2ppm
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

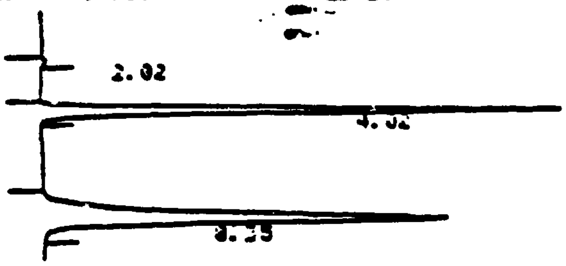
8. OTHER OBSERVATIONS: Retention time for 10ppm sulfate calibration standard was 8.35 minutes.

5. SOURCE OF DATA

Samples were run by Denise McDonald on September 22, 1986.

Calibration–10 ppm Sulfate Standard

EL A INJECT 23:20:47



PERMEATION 23:20:47 CH= "A"

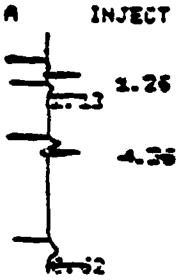
FILE 1. METHOD 5. RUN 5 INDEX 1 CALIB

ANALYST: DM

NAME	PPM	RT	AREA BC	RF
	0.	2.02	110479 01	
	10.	4.02	16022185 01	1602219.5
	10.	8.35	22236163 01	2223616.299
TOTALS	20.		39368927	

MDL–0.2 ppm Sulfate Standard

CHANNEL A INJECT 00:00:32



PERMEATION 00:00:32

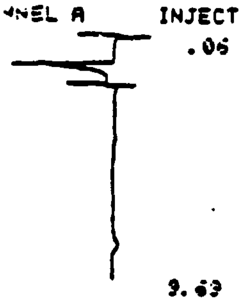
FILE 1. METHOD 5. RUN 28 INDEX 1

ANALYST: DM

NAME	PPM	RT	AREA BC	RF
	0.	1.26	63764 01	
	0.	2.13	143816 01	
SO	0.225	4.36	364746 01	1621208.1
	0.204	8.62	431357 01	2117825.398
TOTALS	0.429		1003683	

Reagent Water Blank

CHANNEL A INJECT 23:48:26



PERMEATION 23:48:26

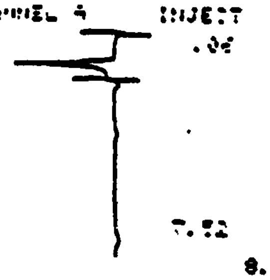
FILE 1. METHOD 5. RUN 7 INDEX 1

ANALYST: DM

NAME	PPM	RT	AREA BC	RF
	0.	0.06	32158 01	
TOTALS	0.		32158	

Oleum Cell 1 3 hours

CHANNEL A INJECT 23:59:52



PERMEATION 23:59:52

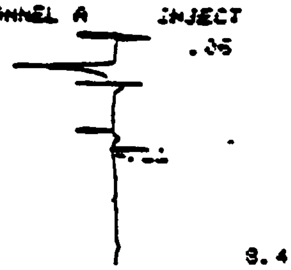
FILE 1. METHOD 5. RUN 8 INDEX 1

ANALYST: DM

NAME	PPM	RT	AREA BC
1	0.	0.06	41162 01
TOTALS	0.		41162

Oleum Cell 2 3 hours

CHANNEL A INJECT 00:09:13



PERMEATION 00:09:13

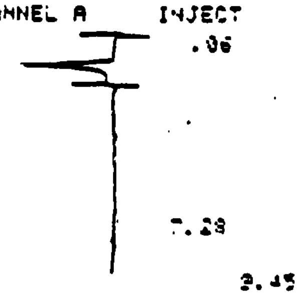
FILE 1. METHOD 5. RUN 9 INDEX 1

ANALYST: DM

NAME	PPM	RT	AREA BC
1	0.	0.06	24589 01
NO	0.111	4.11	177965 01150222
TOTALS	0.111		202554

Oleum Cell 3 3 hours

CHANNEL A INJECT 00:19:40



PERMEATION 00:19:40

FILE 1. METHOD 5. RUN 10 INDEX 1

ANALYST: DM

NAME	PPM	RT	AREA BC
1	0.	0.06	29533 01
TOTALS	0.		29533

C-19

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.2 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: *Flow rate to cells was 100cc/min.*

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s) :	Parathion	N/A	N/A
2. CAS NUMBER(s):	N/A	N/A	N/A
3. CONC. (IF MIX)	45.07%	N/A	N/A
4. CHEMICAL SOURCE:	Agricultural Supply	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 18, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT .09 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

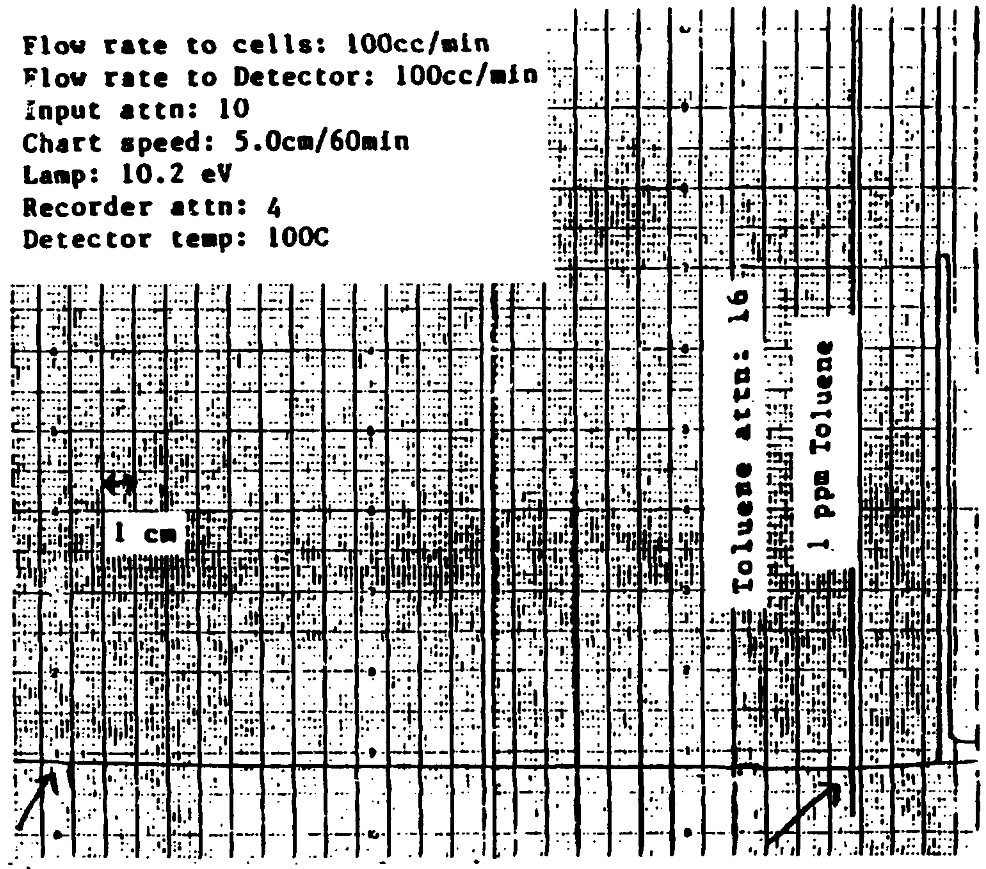
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on September 18, 1986

Chemical Resistance Testing of USCG Material with Parathion

Flow rate to cells: 100cc/min
Flow rate to Detector: 100cc/min
Input attn: 10
Chart speed: 5.0cm/60min
Lamp: 10.2 eV
Recorder attn: 4
Detector temp: 100C



Parathion charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells were 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	PCBs	N/A	N/A
2. CAS NUMBER(s):	N/A	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Laboratory	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 25, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT .02 as Benzene
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

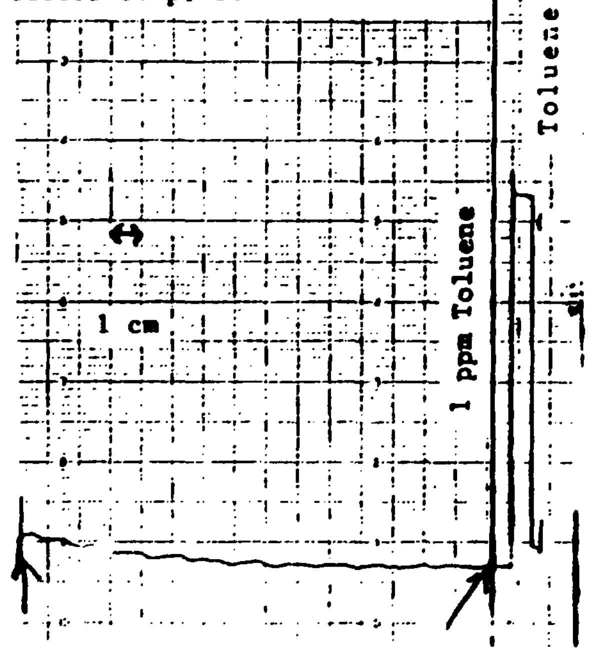
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on September 25, 1986.

Chemical Resistance Testing of USCG Material with PCBs

Flow rate to cells: 100cc/min
Flow rate to Detector: 100cc/min
Input attn: 10
Chart speed: 5.0cm/60min
Lamp: 10.2
Recorder attn: 4
Detector temp: 100



PCBs charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 90 cc/min

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	3
1. CHEM NAME(s) :	Phenol	N/A	N/A
2. CAS NUMBER(s):	108-95-2	N/A	N/A
3. CONC. (IF MIX)	89% (11% H_2O)	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckroot	N/A	N/A
	reagent grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: April 8, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT 0.03 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS N/A

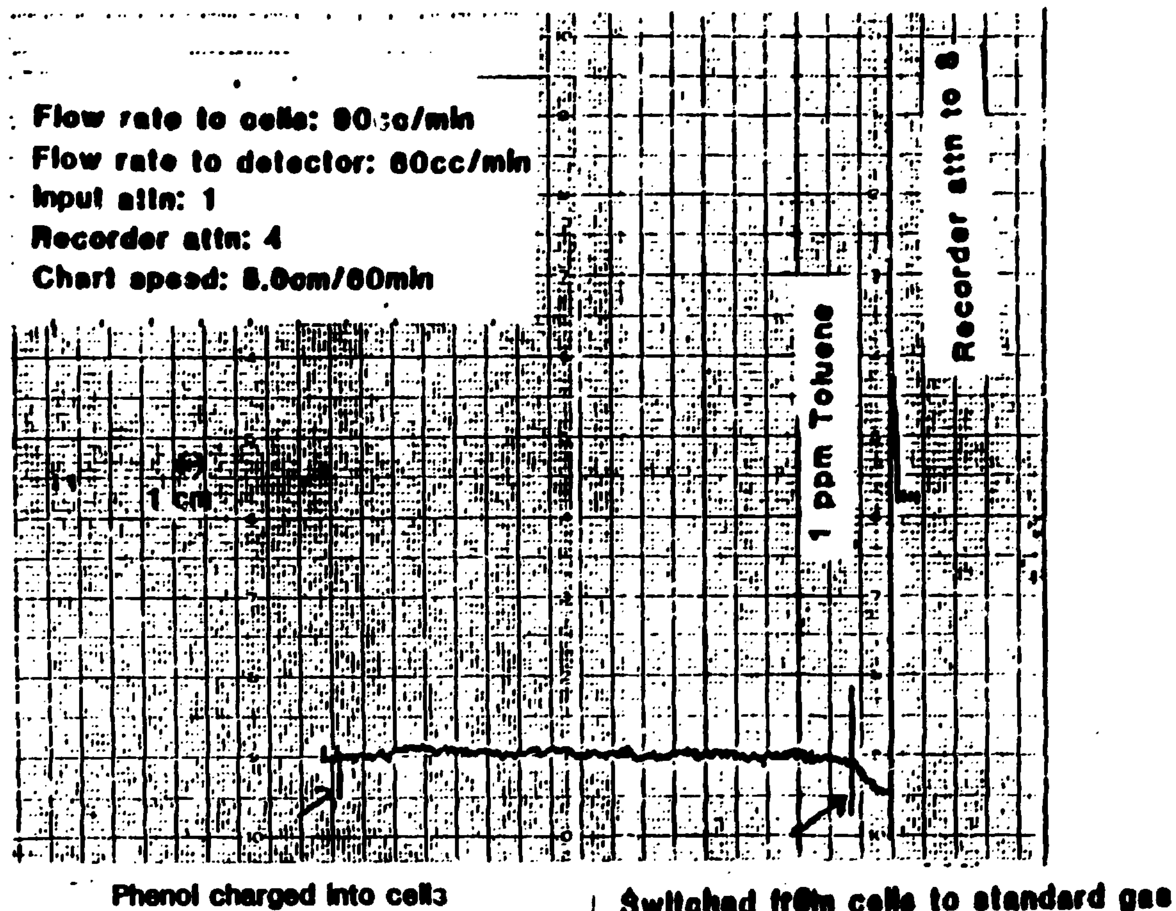
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA
Samples were run by Karen Verschoor on April 8, 1986

d:14

Chemical Resistance Testing of USCG Material with Phenol



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Ion Chromatography on Dionex 2000.
3. TEMPERATURE: Ambient
4. COLLECTION MEDIUM: Aqueous
5. COLLECTION SYSTEM: Aqueous
6. OTHER CONDITIONS: 2 inch cells were used.
7. DEVIATIONS FROM ASTM F739 METHOD:

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Phosphoric Acid	N/A	N/A
2. CAS NUMBER(s):	7664-38-2	N/A	N/A
3. CONC. (IF MIX)	85%	N/A	N/A
4. CHEMICAL SOURCE:	Allied Chemical	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 29, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT 0.5 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil.
7. SELECTED DATA POINTS Cell 1,2, and 3 at end of three hour test

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	3 hours	<0.5 ppm	<0.5 ppm	<0.5 ppm
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

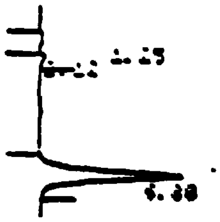
8. OTHER OBSERVATIONS: Retention time for 10ppm phosphate calibration standard was 6.88 minutes.

5. SOURCE OF DATA

Samples were run by Denise McDonald September 29, 1986.

Calibration–10 ppm Phosphate Standard

CHANNEL A   INJECT   01:14:21



PERMEATION   01:14:21

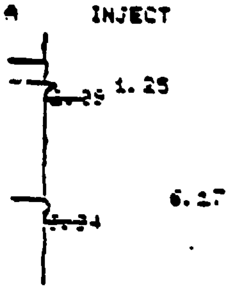
FILE 1.   METHOD 5.   RUN 35   INDEX 1   CALIB

ANALYST: DM

NAME	PPM	RT	AREA BC	RF
1	0.	1.25	172373 02	
2	0.	2.12	153704 02	
3	10.	6.88	7638162 02	763816.3
TOTALS	10.		8031745	

IDL–0.5 ppm Phosphate Standard

CHANNEL A   INJECT   02:27:13



PERMEATION   02:27:13

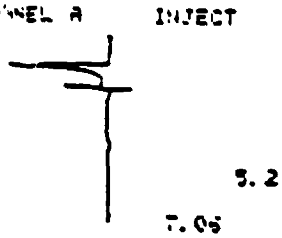
FILE 1.   METHOD 5.   RUN 43   INDEX 1

ANALYST: DM

NAME	PPM	RT	AREA BC	RF
1	0.	1.25	179637 02	
2	0.	2.09	333373 02	
3	0.318	6.94	242967 01	763816.3
TOTALS	0.318		755027	

Reagent Water Blank

CHANNEL A   INJECT   01:22:20



PERMEATION   01:22:20

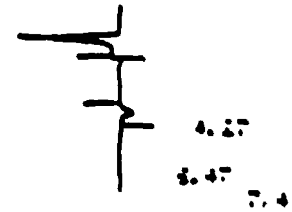
FILE 1.   METHOD 5.   RUN 37   INDEX 1

ANALYST: DM

NAME	PPM	RT	AREA BC
TOTALS	0.		

Phosphoric Acid Cell 1 3 hours

CHANNEL A   INJECT   01:49:29



PERMEATION   01:49:29

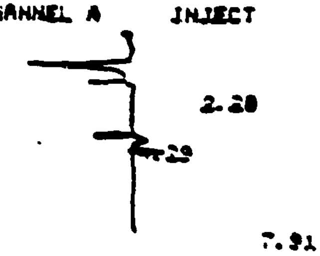
FILE 1.   METHOD 5.   RUN 39   INDEX

ANALYST: DM

NAME	PPM	RT	AREA BC
NYNO3	0.	4.27	403716 01
TOTALS	0.		403716

Phosphoric Acid Cell 2 3 hours

CHANNEL A   INJECT   01:57:13



PERMEATION   01:57:13

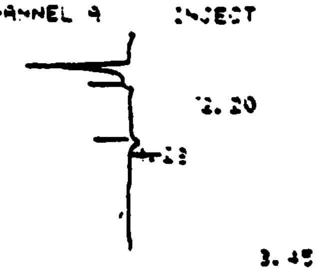
FILE 1.   METHOD 5.   RUN 40   INDEX

ANALYST: DM

NAME	PPM	RT	AREA BC
1	0.	2.2	1025639 01
NYNO3	0.	4.29	509164 02
TOTALS	0.		1534803

Phosphoric Acid Cell 3 3 hours

CHANNEL A   INJECT   02:05:29



PERMEATION   02:05:29

FILE 1.   METHOD 5.   RUN 41   INDEX 1

ANALYST: DM

NAME	PPM	RT	AREA BC
1	0.	2.2	1343161 02
NYNO3	0.	4.29	366651 02
TOTALS	0.		1709812

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Ion Chromatography on Dionex 2000.
3. TEMPERATURE: Ambient
4. COLLECTION MEDIUM: Aqueous
5. COLLECTION SYSTEM: Aqueous
6. OTHER CONDITIONS: 2-inch cells were used.
7. DEVIATIONS FROM ASTM F739 METHOD:

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Phosphorous Oxychloride	N/A	N/A
		N/A	N/A
2. CAS NUMBER(s):	10025-87-3	N/A	N/A
3. CONC. (IF MIX)	99%	N/A	A/A
4. CHEMICAL SOURCE:	Alrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: October 7, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough observed after 3 hours.
4. MIN DETECTABLE LIMIT 0.5 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mils
7. SELECTED DATA POINTS Cells 1,2, and 3 after 15 minutes and at end of 3 hour test.

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	15 minutes	<0.5 ppm (.204)	<0.5 ppm (.516)	<0.5 ppm (.217)
2.	3 hours	<0.5 ppm (.278)	<0.5 ppm (.424)	<0.5 ppm (.177)
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS: Retention time for Phophorous Oxychloride standard was 2.03 minutes. Fifteen minute samples were run to establish chloride background levels within each cell.

5. SOURCE OF DATA

Samples were run by Denise McDonald on October 7, 1986.

..libration–5 ppm Phosphorous Oxychloride

SH

..EL A   INJECT   22:50:3?

..RATION   22:50:39   CH= "A" PS= 1.

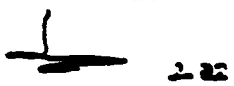
: 1.   METHOD 5.   RUN 55   INDEX 1   CALIB.

..YST: DJM

..E	PPM	RT	AREA BC	RF
	0.	1.44	174393 02	
	5.	2.03	13753096 01	23951919.199
..ALS	5.		13913939	

MDL–0.5 ppm Phosphorous Oxychloride Standard

..ANNEL A   INJECT   22:58:57



..ERMEATION   22:58:57

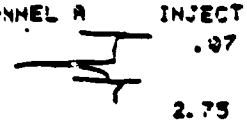
..ILE 1.   METHOD 5.   RUN 57   INDEX 1

..NALYST: DJM

..ME	PPM	RT	AREA BC	RF
..L	0.423	2.02	1690513 01	23951919.199
..TALS	0.429		1690513	

Reagent Water Blank

..HANNEL A   INJECT   23:02:42



..ERMEATION   23:02:42

..ILE 1.   METHOD 5.   RUN 58   INDEX 1

..ALYST: DJM

..ME	PPM	RT	AREA BC	RF
1	0.	0.07	74420 01	
..ALS	0.		74420	

Phosphorous Oxychloride Cell 1 3 hours

CHANNEL A   INJECT   23:06:27

PERMEATION   23:06:27

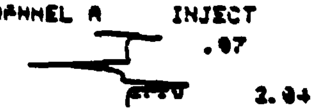
FILE 1.   METHOD 5.   RUN 59   IN..

ANALYST: DJM

NAME	PPM	RT	AREA BC
1	0.	0.06	101735 01
2	0.	1.91	1995938 02
CL	0.270	2.04	1097903 032351..
TOTALS	[illegible].273		[illegible]

Phosphorous Oxychloride Cell 2 3 hours

CHANNEL A   INJECT   23:11:12



PERMEATION   23:11:12

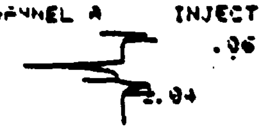
FILE 1.   METHOD 5.   RUN 60   INDEX 1

ANALYST: DJM

NAME	PPM	RT	AREA BC
1	0.	0.07	60650 01
2	0.	1.9	1974102 02
CL	0.424	2.04	1577099 0229513..
TOTALS	0.424		3611851

Phosphorous Oxychloride Cell 3 3 hours

CHANNEL A   INJECT   23:15:15



PERMEATION   23:15:15

FILE 1.   METHOD 5.   RUN 61   INDEX 1

ANALYST: DJM

NAME	PPM	RT	AREA BC
1	0.	0.06	141439 01
CL	0.177	2.04	698230 0139513..
TOTALS	0.177		929379

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Ion Chromatography on Dionex 2000.
3. TEMPERATURE: Ambient
4. COLLECTION MEDIUM: Aqueous
5. COLLECTION SYSTEM: Aqueous
6. OTHER CONDITIONS: 2 inch cells were used.
7. DEVIATIONS FROM ASTM F739 METHOD:

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s) :	Phosphorous Trichloride	N/A	N/A
		N/A	N/A
2. CAS NUMBER(s):	7719-12-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 30, 1986.
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT 0.5 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS Cell 1,2, and 3 at end of three hour test.

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	3 hours	<0.2 ppm	<0.2 ppm	<0.2 ppm
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS: Retention time for 5 ppm Phosphorous Trichloride calibration standard was 2.11 minutes.

5. SOURCE OF DATA

Samples were run by Denise McDonald on September 30, 1986.

libration–5 ppm Phosphorous Trichloride

-NNEL A INJECT 22:28:01

-MEATION 22:28:01 CH= "A" PS= 1.

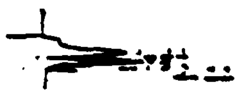
-LE 1. METHOD 5. RUN 36 INDEX 1 CALIB

-ALYST: DJM

-AME	PPM	RT	AREA BC	RF
1	0.	1.41	593300 01	
-	5.	2.11	17208766 01	2441753.199
TOTALS	5.		17802066	

MDL–0.5 ppm Phosphorous Trichloride Standard

CHANNEL A INJECT 22:32:06



PERMEATION 22:32:06

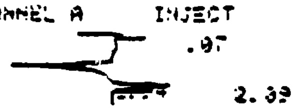
FILE 1. METHOD 5. RUN 37 INDEX 1

ANALYST: DJM

NAME	PPM	RT	AREA BC	RF
1	0.	1.44	490635 02	
2	0.	1.75	3363650 02	
CL	0.521	2.11	2171547 01	2441753.199
TOTALS	0.521		6025332	

Reagent Water Blank

CHANNEL A INJECT 00:08:35



PERMEATION 00:08:35

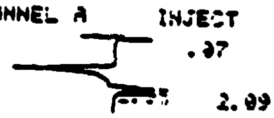
FILE 1. METHOD 5. RUN 45 INDEX 1

ANALYST: DJM

NAME	PPM	RT	AREA BC	RF
1	0.	0.07	64387 01	
2	0.	1.94	1912632 02	
CL	0.433	2.09	1679774 01	2441753.199
TOTALS	0.439		3657393	

Phosphorous Trichloride Cell 1 3 hours

CHANNEL A INJECT 22:50:28



PERMEATION 22:50:28

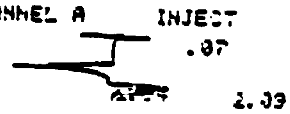
FILE 1. METHOD 5. RUN 41 INDEX 1

ANALYST: DJM

NAME	PPM	RT	AREA BC
1	0.	0.07	36473 01
2	0.	1.95	1879516 02
CL	0.331	2.09	1139492 012441
TOTALS	0.331		3054431

Phosphorous Trichloride Cell 2 3 h

CHANNEL A INJECT 22:54:41



PERMEATION 22:54:41

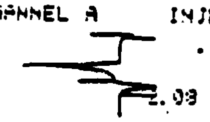
FILE 1. METHOD 5. RUN 42 INDEX 1

ANALYST: DJM

NAME	PPM	RT	AREA BC
1	0.	0.07	37603 01
2	0.	1.94	2015702 02
CL	0.482	2.09	1660253 012441
TOTALS	0.482		3713558

Phosphorous Trichloride Cell 3 3 hours

CHANNEL A INJECT 00:03:15



PERMEATION 00:03:15

FILE 1. METHOD 5. RUN 44 INDEX 1

ANALYST: DJM

NAME	PPM	RT	AREA BC	RF
1	0.	0.07	44443 01	
CL	0.267	2.08	919636 012441753.	
TOTALS	0.267		964129	

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST. Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature =100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Propionic Acid	N/A	N/A
2. CAS NUMBER(s):	79-09-4	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: July 25, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT N/A
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

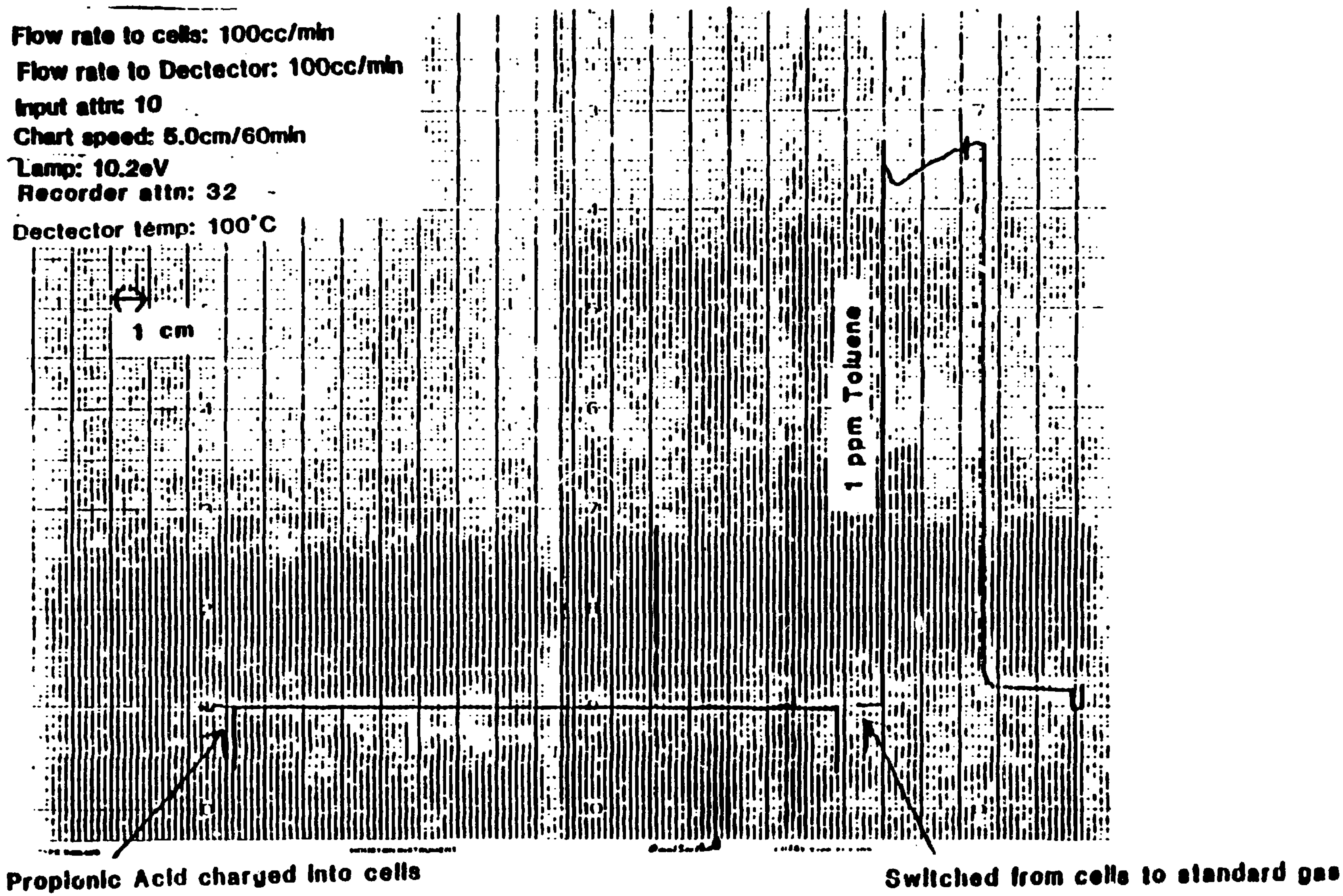
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on July 25, 1986

Chemical Resistance Testing of USCG Material with Propionic Acid



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature =100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	n-Propyl Alcohol	N/A	N/A
2. CAS NUMBER(s):	71-23-8	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: July 28, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT .76 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

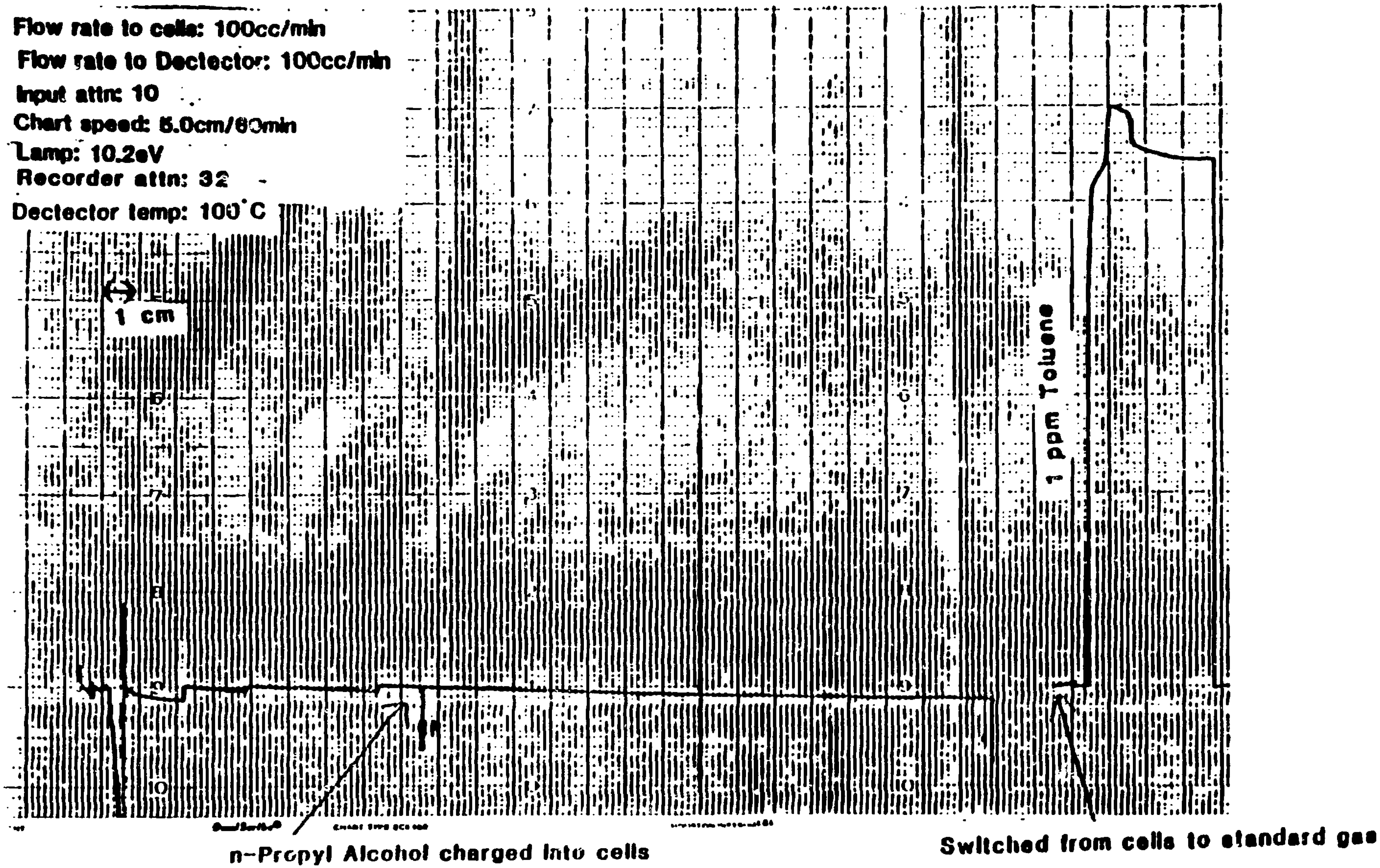
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on July 28, 1986.

Chemical Resistance Testing of USCG Material with n-Propyl Alcohol



C-209

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s):	n-Propylamine	N/A	N/A
2. CAS NUMBER(s):	107-10-8	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: July 14, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 10.2 hours.
4. MIN DETECTABLE LIMIT .74 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

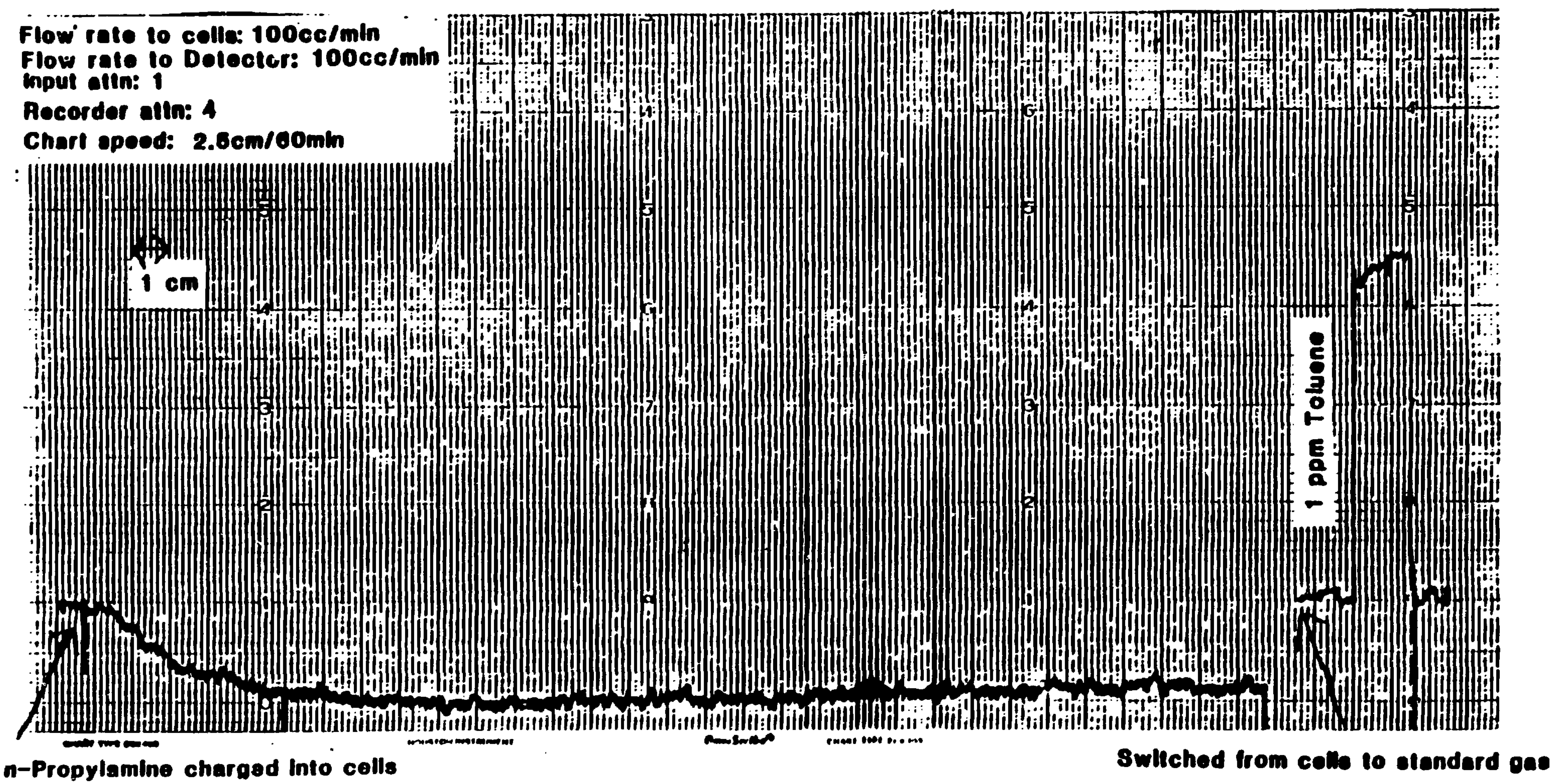
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on July 14, 1986.

Chemical Resistance Testing of USCG Material with n-Propylamine



C-2-11

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challcnge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Propylene Oxide	N/A	N/A
2. CAS NUMBER(s):	16088-62-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A
	reagent grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: May 21, 1986
2. NUMBER OF SAMPLES TESTED: Three (composite run)
3. BREAKTHROUGH TIME: 137 min
4. MIN DETECTABLE LIMIT 0.68 ppm.
5. STEADY STATE PERMEATION RATE 1.43 ug/cm² x hour.
6. SAMPLE THICKNESS: 18-20 mil
7. SELECTED DATA POINTS N/A

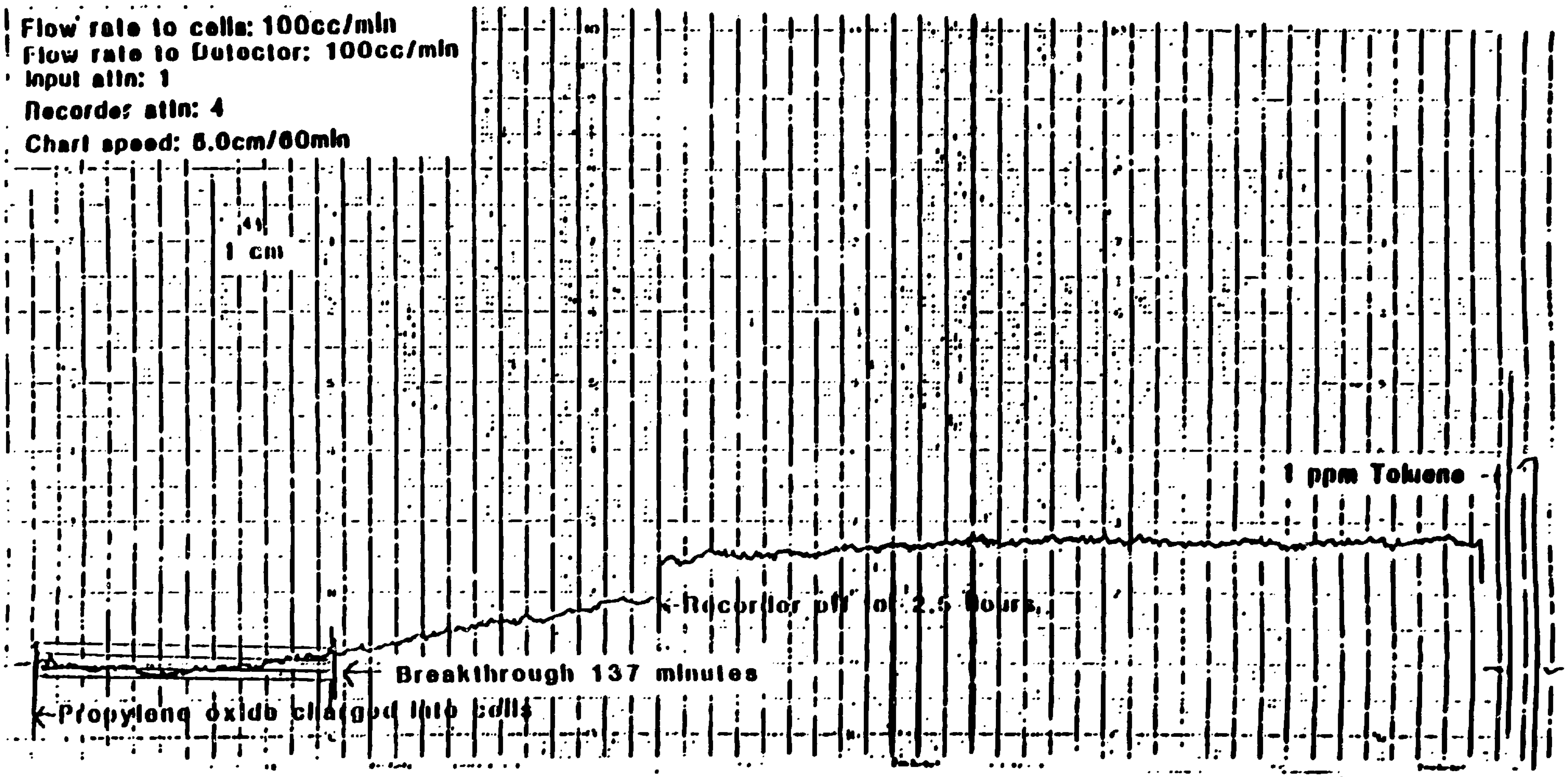
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on May 21, 1986

Permeation of Propylene Oxide through USCG Material
Composite Run



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cell was used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s) :	Propylene Oxide	N/A	N/A
2. CAS NUMBER(s):	75-56-9	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 10, 1986
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 170 min.
4. MIN DETECTABLE LIMIT 1.01 ppm.
5. STEADY STATE PERMEATION RATE 1.09 ug/cm² x hour.
6. SAMPLE THICKNESS: 19 mil.
7. SELECTED DATA POINTS

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

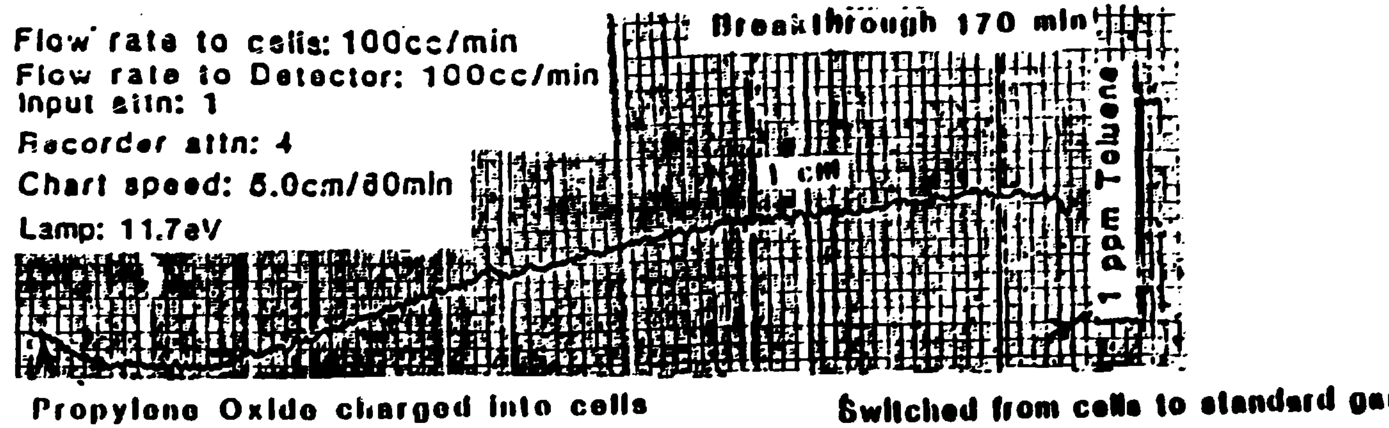
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Sylvia Cooper on June 10, 1986.

Permeation of Propylene Oxide through USCG Material

Run I



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 19-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s) :	Propylene Oxide	N/A	N/A
2. CAS NUMBER(s):	75-56-9	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-30-87
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: 195 minutes
4. MIN DETECTABLE LIMIT .13 ppm
5. STEADY STATE PERMEATION RATE 1.10 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

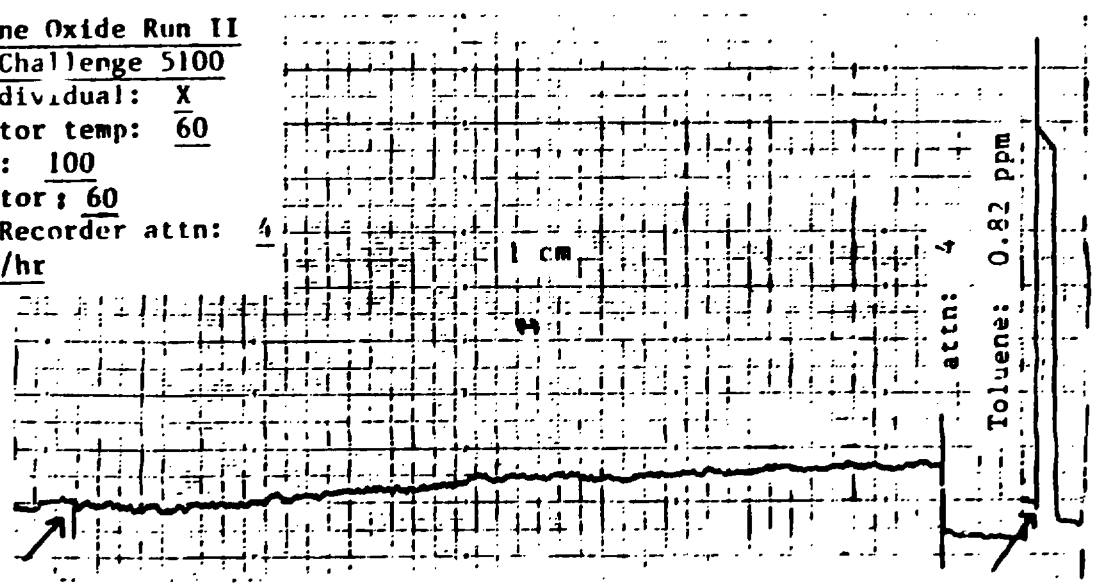
5. SOURCE OF DATA

Sample was run by Denise McDonald on January 30, 1987.

Chemical Resistance Testing of Challenge 5100

Propylene Oxide Run II

Chemical: Propylene Oxide Run II
Sample Material: Challenge 5100
Composite: ___ Individual: X
Lamp: 11.7 Detector temp: 60
Flow rate to cells: 100
Flow rate to Detector: 60
Input attn: 1 Recorder attn: 4
Chart speed: 1 in/hr



Propylene Oxide charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 19-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25 °C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Propylene Oxide	N/A	N/A
2. CAS NUMBER(s):	75-56-9	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 2-09-87
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 169 minutes
4. MIN DETECTABLE LIMIT .13 ppm
5. STEADY STATE PERMEATION RATE .67 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

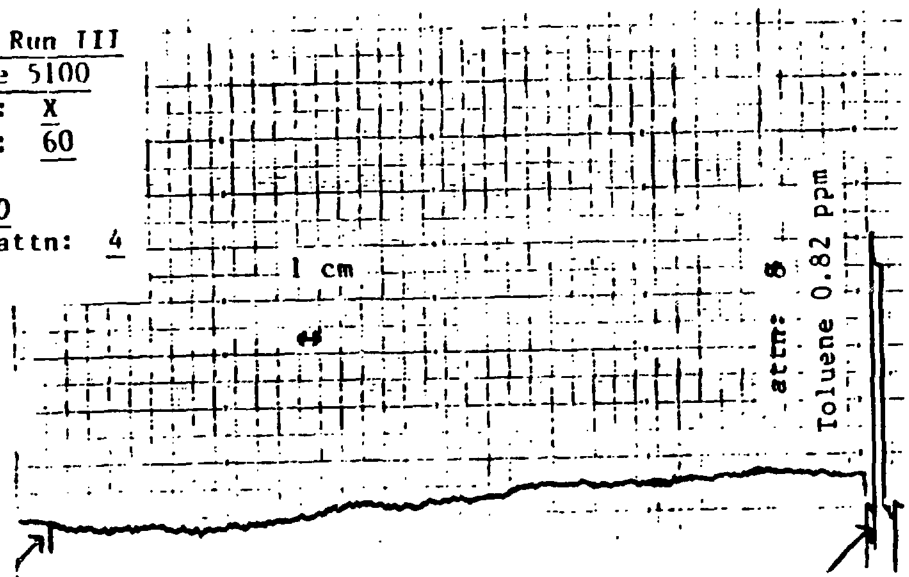
5. SOURCE OF DATA

Sample was run by Denise McDonald on February 9, 1987.

Chemical Resistance Testin of Challenge 5100

Propylene Oxide Run III

Chemical: Propylene Oxide Run III
Sample Material: Challenge 5100
Composite: ___ Individual: X
Lamp: 11.7 Detector temp: 60
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1 Recorder attn: 4
Chart speed: 1 in/hr



Propylene Oxide charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Ion Chromatography on Dionex 2000.
3. TEMPERATURE: Ambient
4. COLLECTION MEDIUM: Aqueous
5. COLLECTION SYSTEM: Aqueous
6. OTHER CONDITIONS: 2 inch cells were used.
7. DEVIATIONS FROM ASTM F739 METHOD:

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Silicon Tetrachloride	N/A	N/A
		N/A	N/A
2. CAS NUMBER(s):	10026-04-07	N/A	N/A
3. CONC. (IF MIX)	99%	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: October 1, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT 0.5 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS Cells 1,2, and 3 at end of three hour test

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	3 hours	<0.2 ppm	<0.2 ppm	<0.2 ppm
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

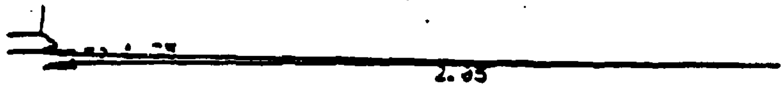
8. OTHER OBSERVATIONS: Retention time for 5 ppm Silicon Tetrachloride calibration standard was 2.05 ppm.

5. SOURCE OF DATA

Samples were run by Denise McDonald on October 1, 1986.

Calibration–5 ppm Silicon Tetrachloride Standard

CHANNEL A INJECT 01:07:34



PERMEATION 01:07:34

FILE 1. METHOD 5. RUN 84 INDEX 1 CALIB

ANALYST: DJM

NAME	PPM	RT	AREA BC	RF
1	0.	1.35	124620 02	
2	0.	1.52	468157 03	
CL	5.	2.05	15223945 01	3045739.
TOTALS	5.		15813742	

MDL–0.5 ppm Silicon Tetrachloride Standard

CHANNEL A INJECT 01:11:34

PERMEATION 01:11:34

FILE 1. METHOD 5. RUN 85 INDEX 1

ANALYST: DJM

NAME	PPM	RT	AREA BC	RF
1	0.	1.53	176307 01	
CL	0.515	2.04	1563952 01	3045739.
TOTALS	0.515		1745859	

Reagent Water Blank

CHANNEL A INJECT 01:16:14

PERMEATION 01:16:14

FILE 1. METHOD 5. RUN 86 INDEX 1

ANALYST: DJM

NAME	PPM	RT	AREA BC	RF
1	0.	0.06	83687 01	
2	0.	1.89	1705529 02	
CL	0.608	2.04	1852435 03	3045739.
TOTALS	0.608		2641621	

Silicon Tetrachloride Cell 1 3 hours

CHANNEL A INJECT 01:20:31

PERMEATION 01:20:31

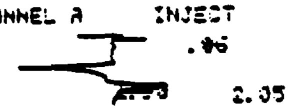
FILE 1. METHOD 5. RUN 87 INDEX 1

ANALYST: DJM

NAME	PPM	RT	AREA BC
1	0.	0.07	82126 01
2	0.	1.91	1728822 02
CL	0.429	2.05	1308063 03 3045??
TOTALS	0.429		3119013

Silicon Tetrachloride Cell 2 3 hrs.

CHANNEL A INJECT 01



PERMEATION 01:25:44

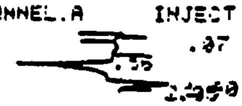
FILE 1. METHOD 5. RUN 89 INDEX 1

ANALYST: DJM

NAME	PPM	RT	AREA BC
1	0.	0.06	55560 01
2	0.	1.9	1486204 02
CL	0.464	2.05	1412021 03 3045??
TOTALS	0.464		2953785

Silicon Tetrachloride Cell 3 3 hours

CHANNEL A INJECT 01:30:15



PERMEATION 01:30:15

FILE 1. METHOD 5. RUN 90 INDEX 1

ANALYST: DJM

NAME	PPM	RT	AREA BC
1	0.	0.07	67661 01
2	0.	0.56	111233 01
3	0.	1.9	1615758 02
CL	0.492	2.05	1499135 03 304573
TOTALS	0.492		3293803

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Atomic Absorption Spectrophotometry
3. TEMPERATURE: Ambient
4. COLLECTION MEDIUM: Aqueous
5. COLLECTION SYSTEM: Aqueous
6. OTHER CONDITIONS: 1 inch cells were used.
7. DEVIATIONS FROM ASTM F739 METHOD:

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s) :	Sodium Hydroxide	N/A	N/A
2. CAS NUMBER(s):	1310-73-2	N/A	N/A
3. CONC. (IF MIX)	50%	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: October 13, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT 0.5 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS Cells 1,2, and 3 at end of three hour test.

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	3 hours	<0.5 ppm	<0.5 ppm	<0.5 ppm
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS: Samples and blanks were analyzed with 0.5, 1.0, and 4.0 ppm sodium standards.

5. SOURCE OF DATA

Samples were run by Denise McDonald on 10-13-86.

This page left intentionally blank

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Atomic Absorption Spectrophotometry
3. TEMPERATURE: Ambient
4. COLLECTION MEDIUM: Aqueous
5. COLLECTION SYSTEM: Aqueous
6. OTHER CONDITIONS: 1 inch cells were used.
7. DEVIATIONS FROM ASTM F739 METHOD:

CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s) :	Sodium Hydrosulfide	N/A	N/A
2. CAS NUMBER(s):	16721-80-5	N/A	N/A
3. CONC. (IF MIX)	10%	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: October 14, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT 0.5 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS Cells 1,2 and 3 at end of three hour test.

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	3 hours	<0.5 ppm	<0.5 ppm	<0.5 ppm
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS: Samples and blanks were analyzed with 0.5, 1.0 and 4.0 ppm Sodium standards.

5. SOURCE OF DATA

Samples were run by Denise McDonald on October 14, 1986.

C-22

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25 °C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 90cc/min

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Styrene	N/A	N/A
2. CAS NUMBER(s):	100-42-5	N/A	N/A
3. CONC. (IF MIX)	99%	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich Co. inhibited	N/A	N/A
	with 10-15ppm 4-TBC	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: April 13, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No break through was observed after 4 hours
4. MIN DETECTABLE LIMIT
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS N/A

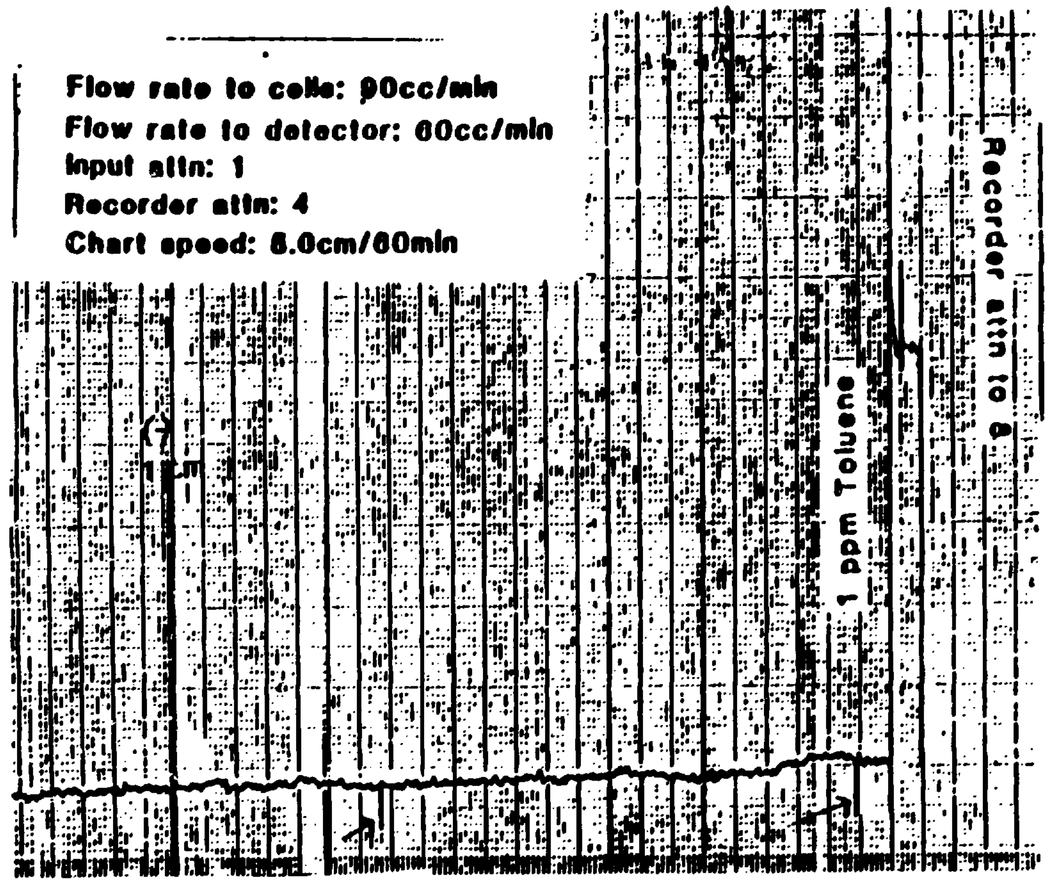
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Karen Verschoor on April 3, 1986

Chemical Resistance Testing of USCG Material with Styrene



Styrene charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Ion Chromatography on Dionex 2000.
3. TEMPERATURE: Ambient
4. COLLECTION MEDIUM: Aqueous
5. COLLECTION SYSTEM: Aqueous
6. OTHER CONDITIONS: 2 inch cells were used.
7. DEVIATIONS FROM ASTM F739 METHOD:

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s):	Sulfuric Acid	N/A	N/A
2. CAS NUMBER(s):	7664-93-9	N/A	N/A
3. CONC. (IF MIX)	95%	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckroot	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 12, 1986.
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough observed after 3 hours.
4. MIN DETECTABLE LIMIT 0.2 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS Cells 1,2, and 3 at end of three hour test

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	3 hours	<0.2 ppm	<0.2 ppm	<0.2 ppm
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

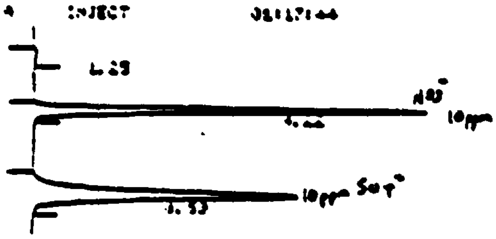
8. OTHER OBSERVATIONS: Retention time for 10 ppm Sulfate calibration standard was 8.59 minutes.

5. SOURCE OF DATA

Samples were run by Denise McDonald on September 12, 1986.

alibration- 10 ppm Sulfate Standard

CHANNEL A INJECT 01:17:44



01:17:44

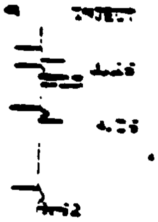
FILE 1. METHOD 5. RUN 9 INDEX 1

ANALYST: BA

NAME	CONC	RT	AREA BC	RF
[illegible]	0.	1.25	39733 01	
[illegible]		4.22	[illegible] 01	
10	0.121	3.59	[illegible]	[illegible]

MDL-0.5 ppm Sulfate Standard

CHANNEL A INJECT 00:30:22



00:30:22

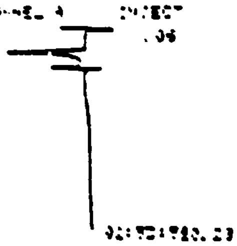
FILE 1. METHOD 5. RUN 29 INDEX 1

ANALYST: [illegible]

NAME	PPM	RT	AREA BC	RF
[illegible]	0.	1.26	42764 01	
[illegible]	0.	[illegible]	142316 01	
[illegible]	0.225	4.26	364746 [illegible]	
10	0.204	3.62	421257 [illegible]	
TOTALS	0.423		1302682	

Reagent Water Blank

CHANNEL A INJECT 02:42:46



02:42:46

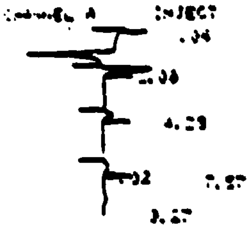
FILE 1. METHOD 5. RUN 15 INDEX 1

ANALYST: BA

NAME	CONC	RT	AREA BC	RF
1	0.	0.06	20223 01	
TOTALS	0.		20223	

Sulfuric Acid Cell 1 3 hours

CHANNEL A INJECT 01:52:04



01:52:04

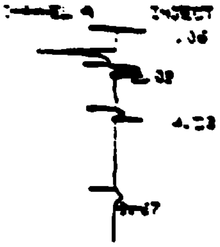
FILE 1. METHOD 5. RUN 12 INDEX 1

ANALYST: BA

NAME	CONC	RT	AREA BC	RF
[illegible]	0.	0.06	[illegible] 01	
[illegible]	0.	2.09	[illegible] 01	
[illegible]	0.	4.23	[illegible] 01	
10	0.235	7.02	[illegible] 01	[illegible]
TOTALS	0.235		1392492	

Sulfuric Acid Cell 2 3 hours

CHANNEL A INJECT [illegible]



02:05:14

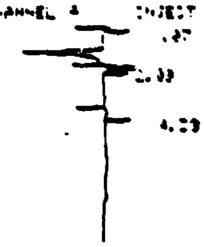
FILE 1. METHOD 5. RUN 14 INDEX 1

ANALYST: BA

NAME	CONC	RT	AREA BC	RF
[illegible]	0.	0.06	[illegible] 01	
[illegible]	0.	2.38	[illegible] 01	
[illegible]	0.	4.23	[illegible] 01	
10	0.133	3.67	[illegible]	[illegible]
TOTALS	0.133		1502210	

Sulfuric Acid Cell 3 3 hours

CHANNEL A INJECT 02:13:12



02:13:12

FILE 1. METHOD 5. RUN 15 INDEX 1

ANALYST: BA

NAME	CONC	RT	AREA BC
1	0.	0.07	[illegible] 01
[illegible]	0.	[illegible]	[illegible] 01
[illegible]	0.	4.23	104093 01
TOTALS	0.		[illegible]

C-22[illegible]

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Ion Chromatography on Dionex 2000.
3. TEMPERATURE: Ambient
4. COLLECTION MEDIUM: Aqueous
5. COLLECTION SYSTEM: Aqueous
6. OTHER CONDITIONS: 2 inch cells were used.
7. DEVIATIONS FROM ASTM F739 METHOD:

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Sulfur Monochloride	N/A	N/A
2. CAS NUMBER(s):	10025-67-9	N/A	N/A
3. CONC. (IF MIX)	97%	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: October 6, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT 0.5 ppm.
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mils
7. SELECTED DATA POINTS Cells 1,2, and 3 at the end of 3 hour test.

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	3 hours	<0.5 ppm	<0.5 ppm	<0.5 ppm
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS: Retention time for 5 ppm Sulfur Monochloride standard was 2.07 minutes.

5. SOURCE OF DATA

Samples were run by Denise McDonald on October 6, 1986.

C-230

Calibration–5 ppm Sulfur Monochloride Standard

CHANNEL A INJECT [illegible]

[illegible]ATION [illegible]

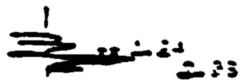
FILE 1. METHOD 5. RUN 27 INDEX 1 CALIB

ANALYST: DJM

NAME	PPM	RT	AREA BC	RF
1	0.	[illegible]	[illegible]	
2	5.	[illegible]	[illegible]	
TOTALS	5.		[illegible]	

MDL–0.5 ppm Sulfur Monochloride Standard

CHANNEL A INJECT [illegible]



PERMEATION [illegible]

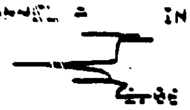
FILE 1. METHOD 5. RUN 29 INDEX 1

ANALYST: DJM

NAME	PPM	RT	AREA BC	RF
1	0.	[illegible]	[illegible] 02	
2	0.	[illegible]	[illegible] 02	
CL	0.5[illegible]	2.05	2021467 [illegible]	
TOTALS	0.5[illegible]		2076[illegible]	

Reagent Water Blank

CHANNEL A INJECT [illegible]



PERMEATION [illegible]

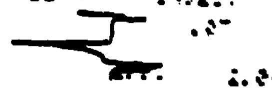
FILE 1. METHOD 5. RUN 30 INDEX 1

ANALYST: DJM

NAME	PPM	RT	AREA BC	RF
1	0.	0.07	[illegible] 01	
CL	0.151	2.05	467173 [illegible]	
TOTALS	0.151		573474	

Sulfur Monochloride Cell 1 3 hours

CHANNEL A INJECT [illegible]



PERMEATION [illegible]

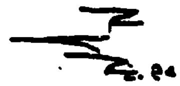
FILE 1. METHOD 5. RUN [illegible] INDEX [illegible]

ANALYST: DJM

NAME	PPM	RT	AREA BC
1	0.	0.07	[illegible]
2	0.	[illegible]	[illegible]
CL	0.496	2.04	[illegible]
TOTALS	0.		[illegible]

Sulfur Monochloride Cell 2 3 hours

CHANNEL A INJECT [illegible]



PERMEATION [illegible]

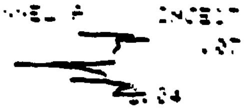
FILE 1. METHOD 5. RUN [illegible]

ANALYST: DJM

NAME	PPM	RT	AREA BC
1	0.	0.07	[illegible]
CL	0.281	2.04	[illegible]
TOTALS	0.		[illegible]

Sulfur Monochloride Cell 3 3 hours

CHANNEL A INJECT [illegible]



PERMEATION [illegible]

FILE 1. METHOD 5. RUN [illegible] INDEX [illegible]

ANALYST: DJM

NAME	PPM	RT	AREA BC
1	0.	0.07	[illegible]
CL	0.191	2.04	[illegible]
TOTALS	0.		[illegible]

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s):	1,1,2,2,-Tetra-	N/A	N/A
	chloroethane	N/A	N/A
2. CAS NUMBER(s):	79-34-5	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: May 19,1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 15.2 hours
4. MIN DETECTABLE LIMIT 0.23 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil.
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

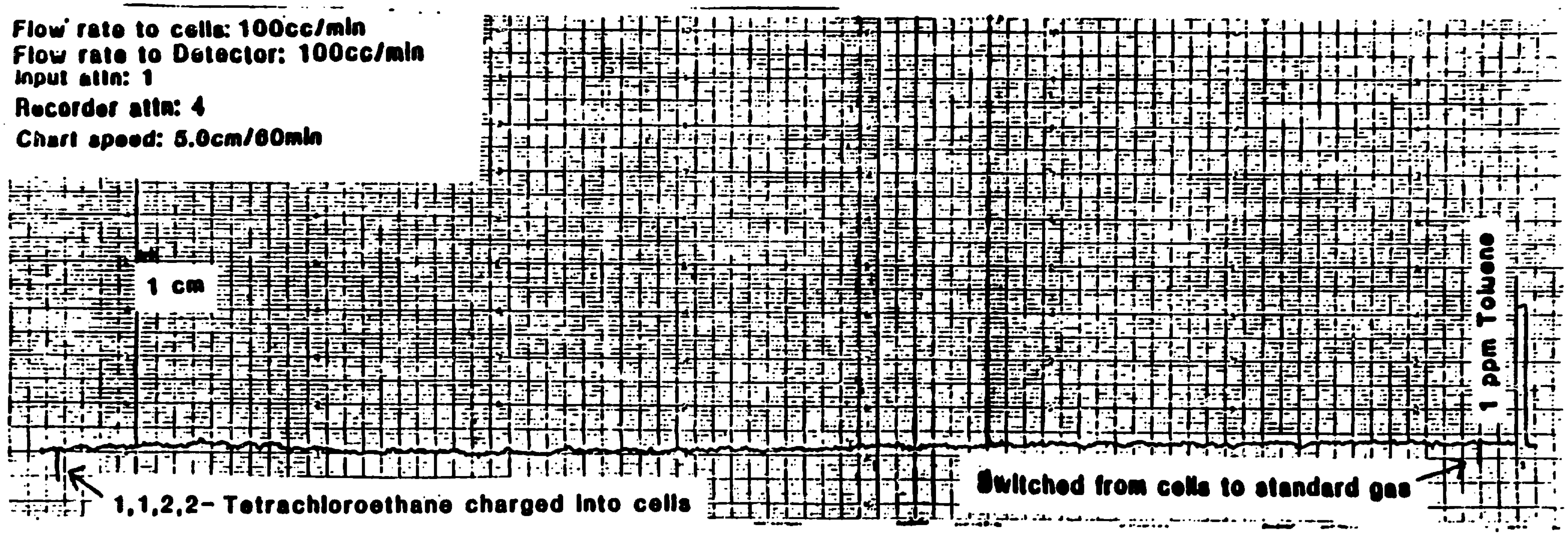
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on May 19, 1986

Chemical Resistance Testing of USCG Material with

1,1,2,2-Tetrachloroethane



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s) :	Tetrachloroethylene	N/A	N/A
2. CAS NUMBER(s):	127-18-4	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: July 15, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 10.4 hours.
4. MIN DETECTABLE LIMIT N/A
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

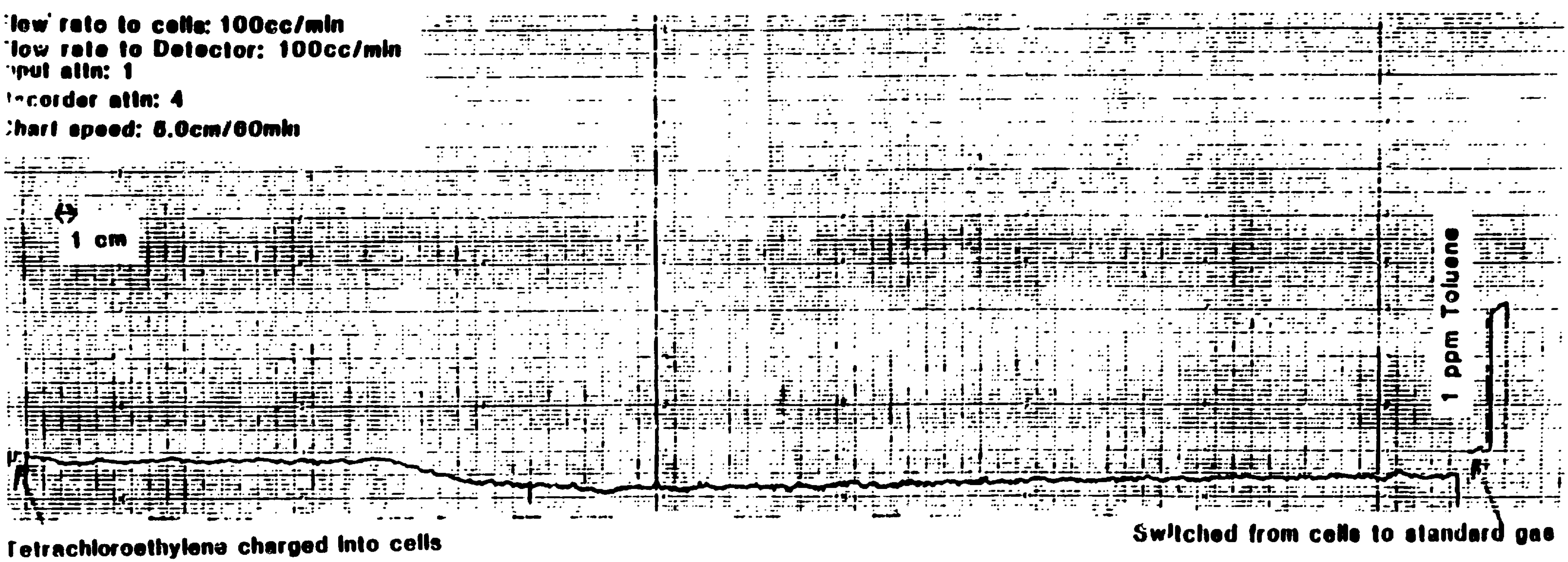
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on July 15, 1986.

Chemical Resistance Testing of USCG Material with Tetrachloroethylene



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: flow rate to cells was 90cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Toluene	N/A	N/A
2. CAS NUMBER(s):	108-88-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	J.T. Baker	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: April 2, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours
4. MIN DETECTABLE LIMIT 0.06 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

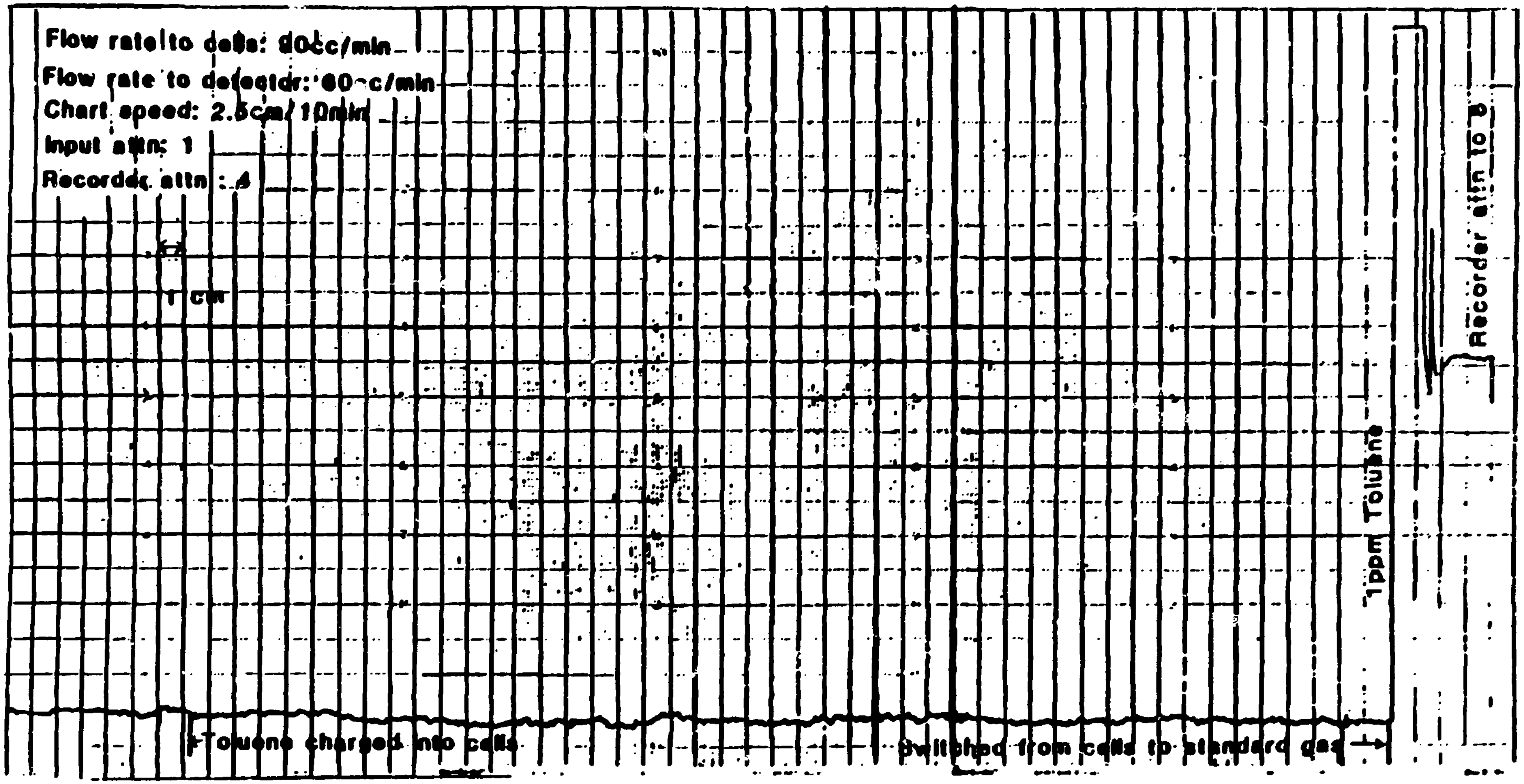
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Karen Verschoor on April 2, 1986

C-236

Chemical Resistance Testing of USCG Material with Toluene



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 90cc/min

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	o-Toluidine	N/A	N/A
2. CAS NUMBER(s):	95-53-4	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	J.T.BAKER practical grade	N/A	N/A

TEST RESULTS

1. DATE TESTED: April 11, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.25 hours
4. MIN DETECTABLE LIMIT 0.43 ppm.
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS N/A

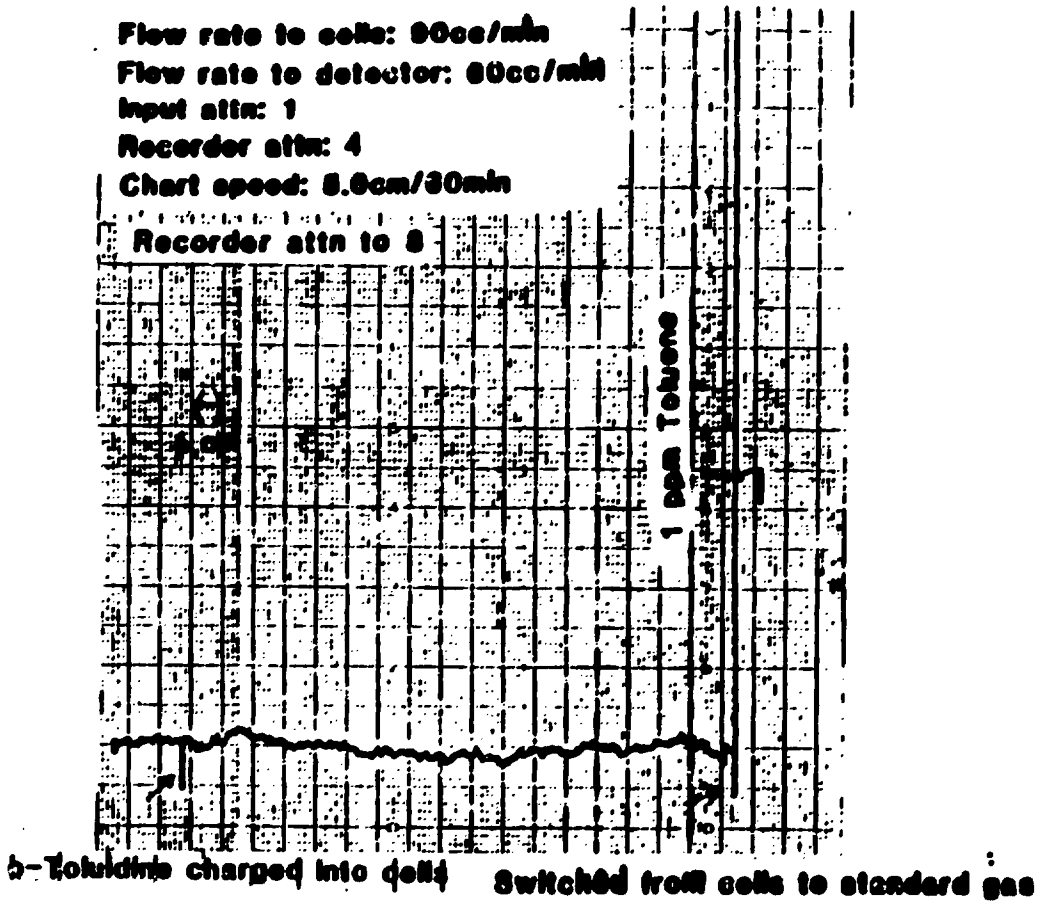
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Karen Verschoor on April 11, 1986

Chemical Resistance Testing of USCG Material with o-Toluidine



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

   1: TYPE: Teflon laminated Nomex
   2: PROTECTIVE MATERIAL CODE: 068
   3: CONDITION BEFORE TEST: Unused, no visible imperfections
   4: MANUFACTURER: Chemfab Corp.
   5: PRODUCT IDENTIFICATION: Challenge 5100
   6: LOT OR MANUFACTURER DATE: N/A
   7: NOMINAL THICKNESS: 15-20 mil
   8: DESCRIPTION: Material was buff colored

2. TEST METHOD

   1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
   2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
   3. TEMPERATURE: 22-25°C
   4. COLLECTION MEDIUM: N_2
   5. COLLECTION SYSTEM: N_2
   6. OTHER CONDITIONS: 2 inch cells were used /Detector Temperature = 60C.
   7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 90cc/min

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s):	Tolylene 2,4-diisocyanate	N/A N/A	N/A N/A
2. CAS NUMBER(s):	584-84-9	N/A	N/A
3. CONC. (IF MIX)	80%	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich Technical grade	N/A N/A	N/A N/A

4. TEST RESULTS

   1. DATE TESTED: April 15, 1986
   2. NUMBER OF SAMPLES TESTED: Three
   3. BREAKTHROUGH TIME: No breakthrough was observed after 3.25 hours
   4. MIN DETECTABLE LIMIT .69 ppm
   5. STEADY STATE PERMEATION RATE N/A
   6. SAMPLE THICKNESS: 17-19 mil
   7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

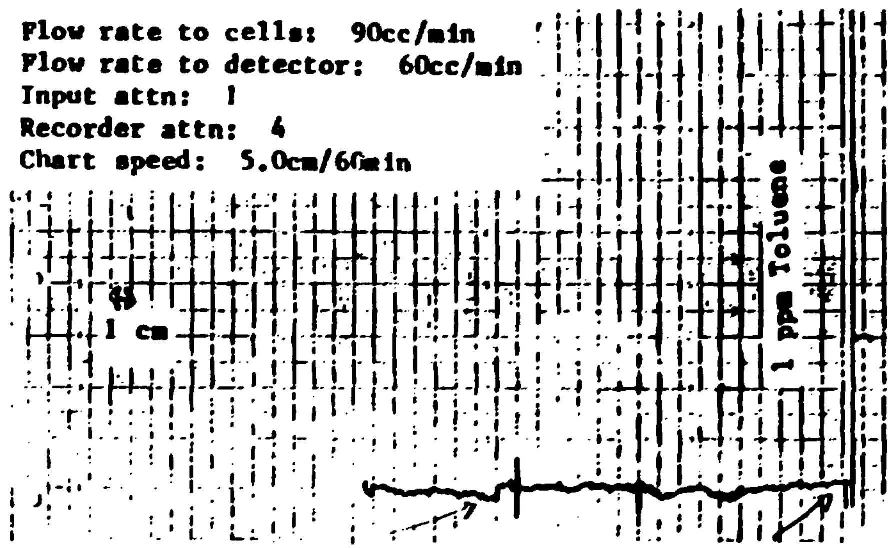
   8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

   Samples were run by Karen Verschoor on April 15, 1986

C-240

Chemical Resistance Testing of USCG Material with Tolylene 2,4-Diisocyanate



Tolylene 2,4-Diisocyanate charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s):	Trichloroethane	N/A	N/A
2. CAS NUMBER(s):	71-55-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 6, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT .60 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-20 mil
7. SELECTED DATA POINTS N/A

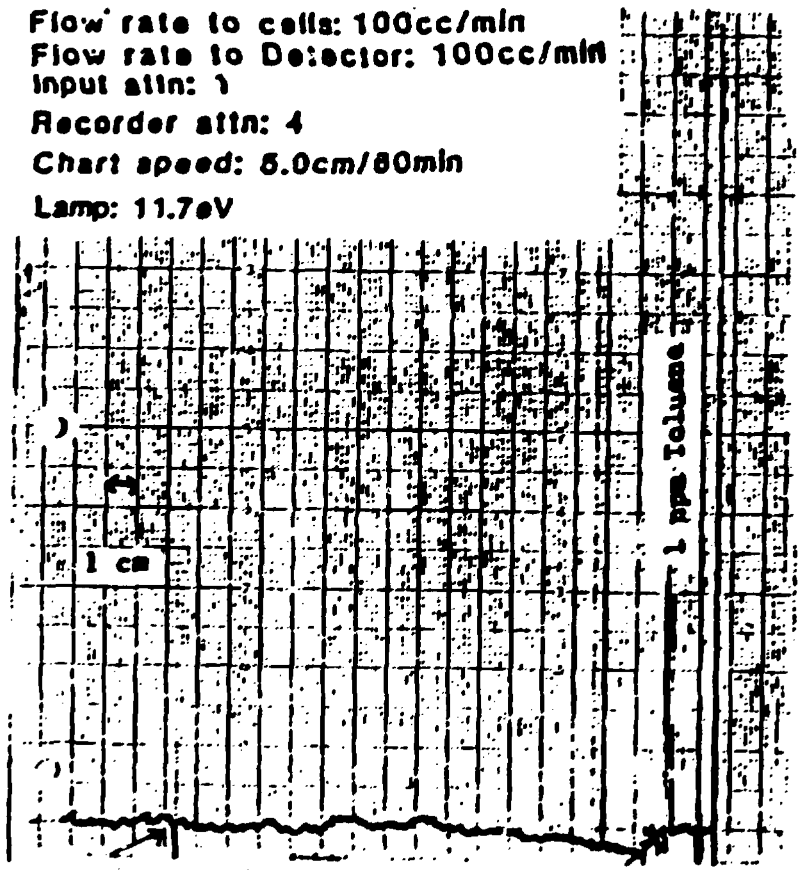
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Karen Verschoor on June 6, 1986.

Chemical Resistance Testing of USCG Material with Trichloroethane



Trichloroethane charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cell was used /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 90cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Trichloroethylene	N/A	N/A
2. CAS NUMBER(s):	79-01-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: April 28-29, 1986
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 143 min.
4. MIN DETECTABLE LIMIT 0.07 ppm
5. STEADY STATE PERMEATION RATE 2.04 ug/cm² hour
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

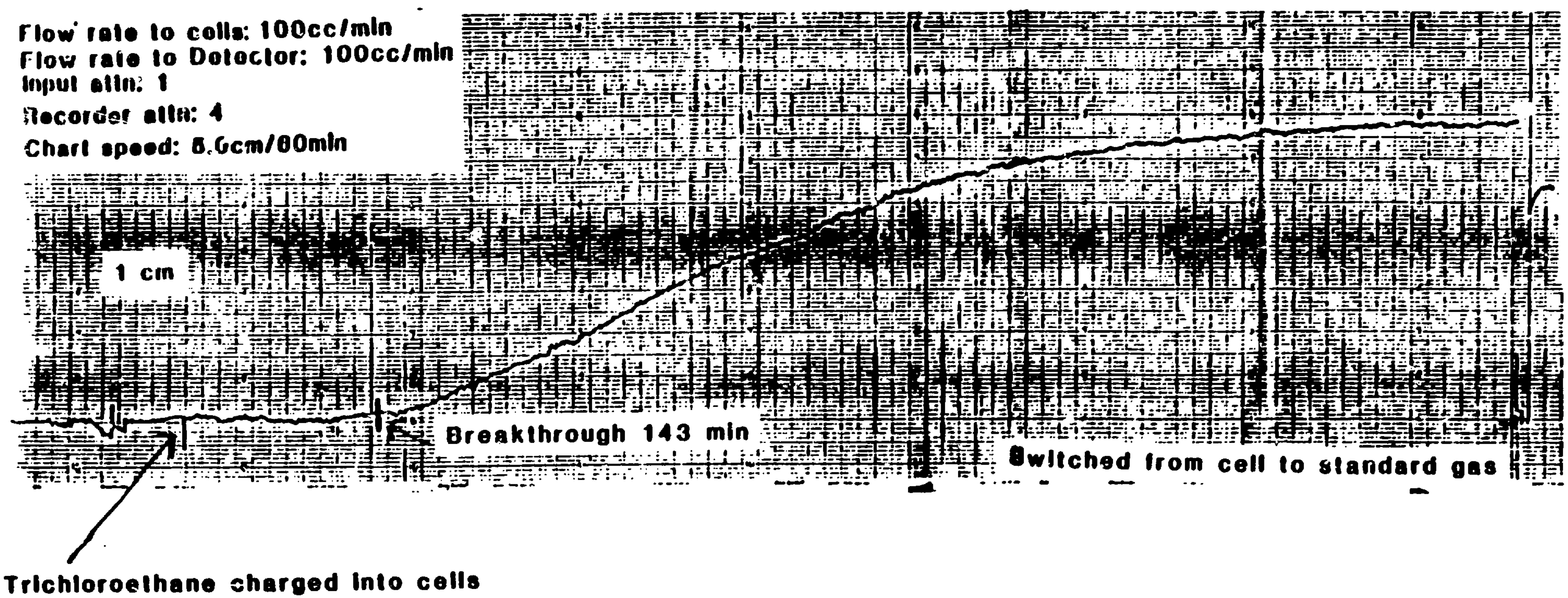
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Karen Verschoor on April 28-29, 1986

Permeation of Trichloroethylene through USCG Material

Run I



C-24

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cell was used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 90cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Trichloroethylene	N/A	N/A
2. CAS NUMBER(s):	79-01-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: April 29, 1986
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: 156 min
4. MIN DETECTABLE LIMIT 0.10 ppm.
5. STEADY STATE PERMEATION RATE 1.63 ug/cm^2 hour
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS

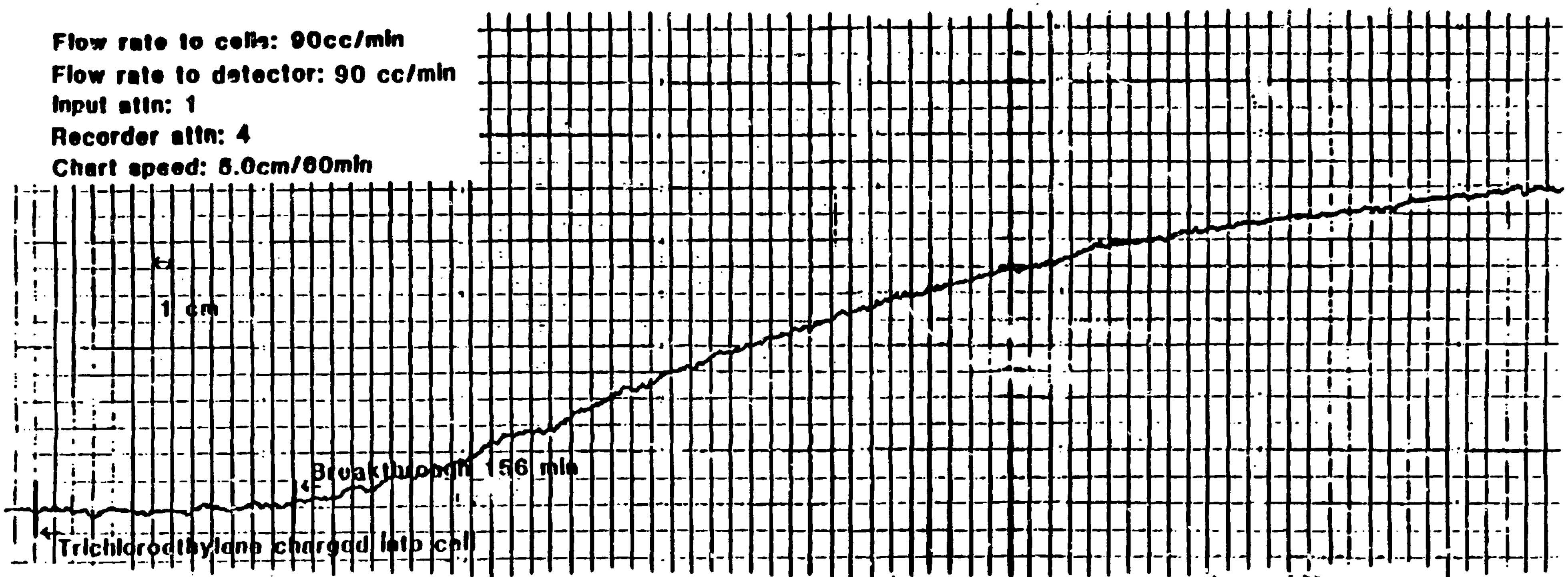
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Karen Verschoor on April 29, 1986

Permeation of Trichloroethylene through USCG Material
Run II



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cell was used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 90cc/min

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Trichloroethylene	N/A	N/A
2. CAS NUMBER(s):	79-01-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: April 30, 1986
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 146 min.
4. MIN DETECTABLE LIMIT 0.09 ppm
5. STEADY STATE PERMEATION RATE 1.91 ug/cm² hour
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS

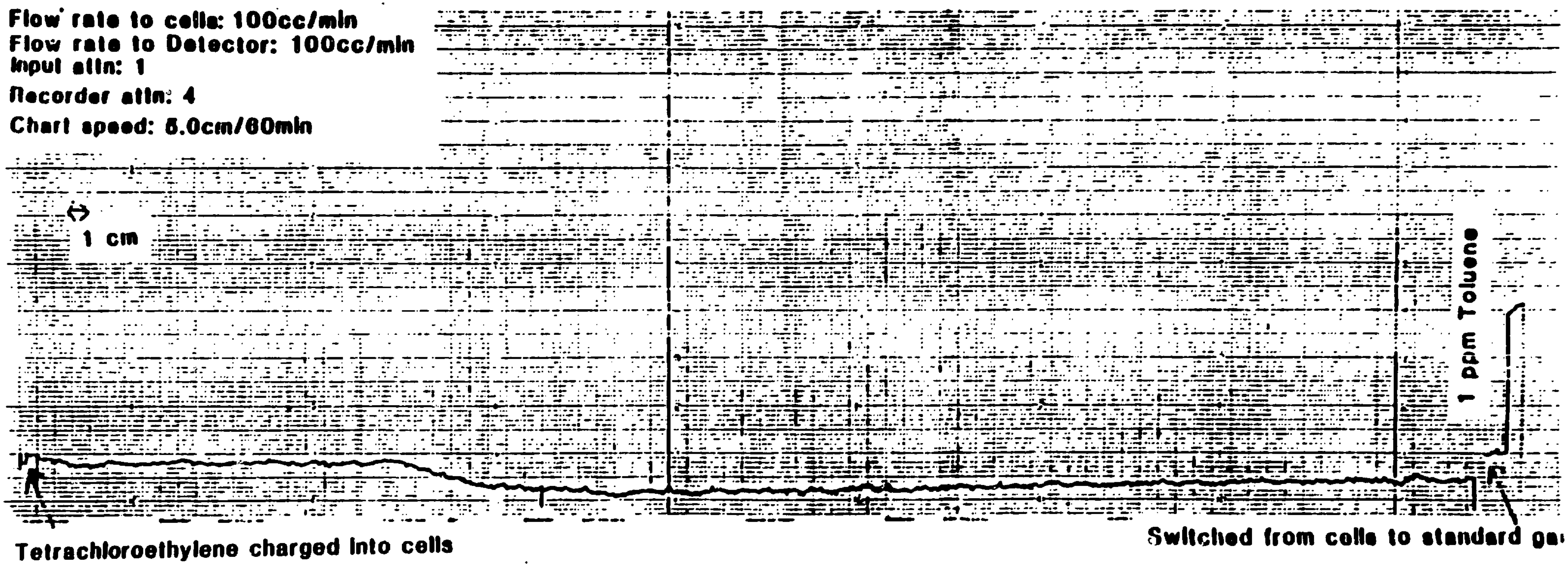
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Karen Verschoor on April 30, 1986.

Chemical Resistance Testing of USCG Material with Tetrachloroethylene



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature =100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Turpentine	N/A	N/A
2. CAS NUMBER(s):	N/A	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Crown reagent grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: July 24, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.6 hours.
4. MIN DETECTABLE LIMIT 0.03 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-19 mil
7. SELECTED DATA POINTS N/A

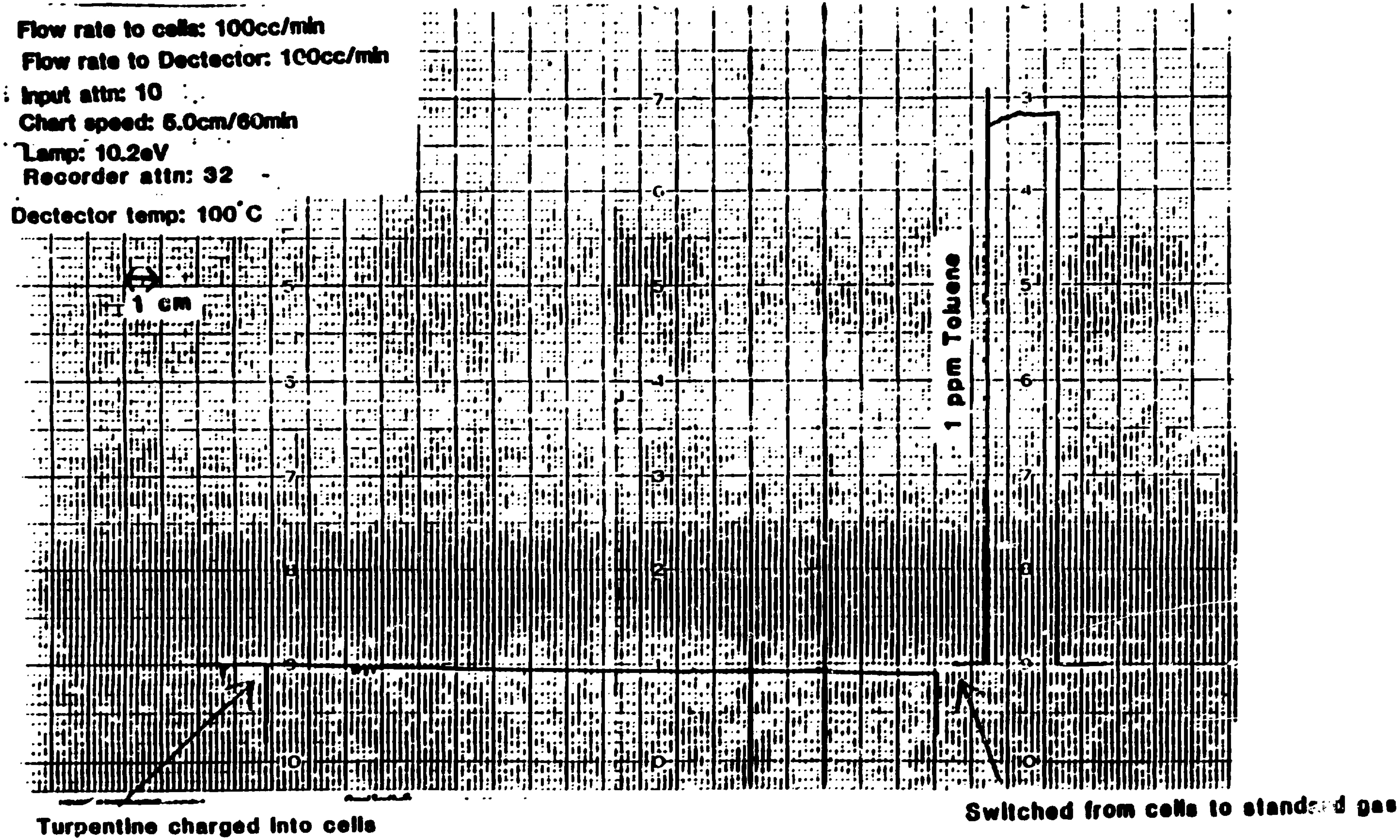
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia Cooper on July 24, 1986.

Chemical Resistance Testing of USCG Material with Turpentine



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s):	Vinyl Acetate	N/A	N/A
2. CAS NUMBER(s):	108-05-4	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich reagent	N/A	N/A
	grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: May 13, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: 74 min.
4. MIN DETECTABLE LIMIT 0.21 ppm.
5. STEADY STATE PERMEATION RATE 3.30ug/cm2/hr
6. SAMPLE THICKNESS: 17-19 mil
7. SELECTED DATA POINTS

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

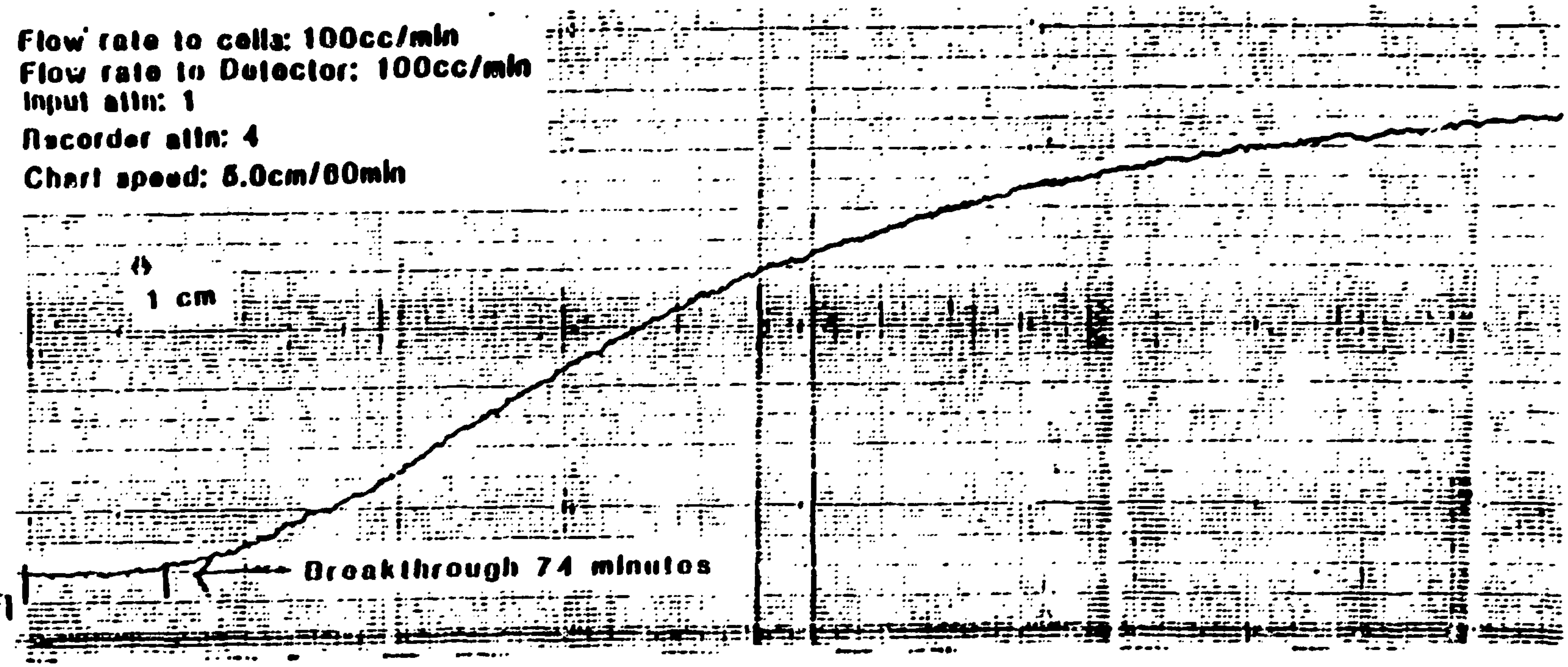
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Karen Verschoor on May 13, 1986.

Permeation of Vinyl Acetate through USCG Material

Composite Run



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was buff colored

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25 C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Vinyl Acetate	N/A	N/A
2. CAS NUMBER(s):	108-05-4	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A
	reagent grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: May 21, 1986
2. NUMBER OF SAMPLES TESTED: one (Run I)
3. BREAKTHROUGH TIME: 137 min.
4. MIN DETECTABLE LIMIT 0.21 ppm.
5. STEADY STATE PERMEATION RATE 3.73 ug/cm^2-hour
6. SAMPLE THICKNESS: 18-20 mil
7. SELECTED DATA POINTS

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	136 min	0.0 ppm		
2.	195.6 min	1.57 ppm		
3.	756 min	3.59 ppm		
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

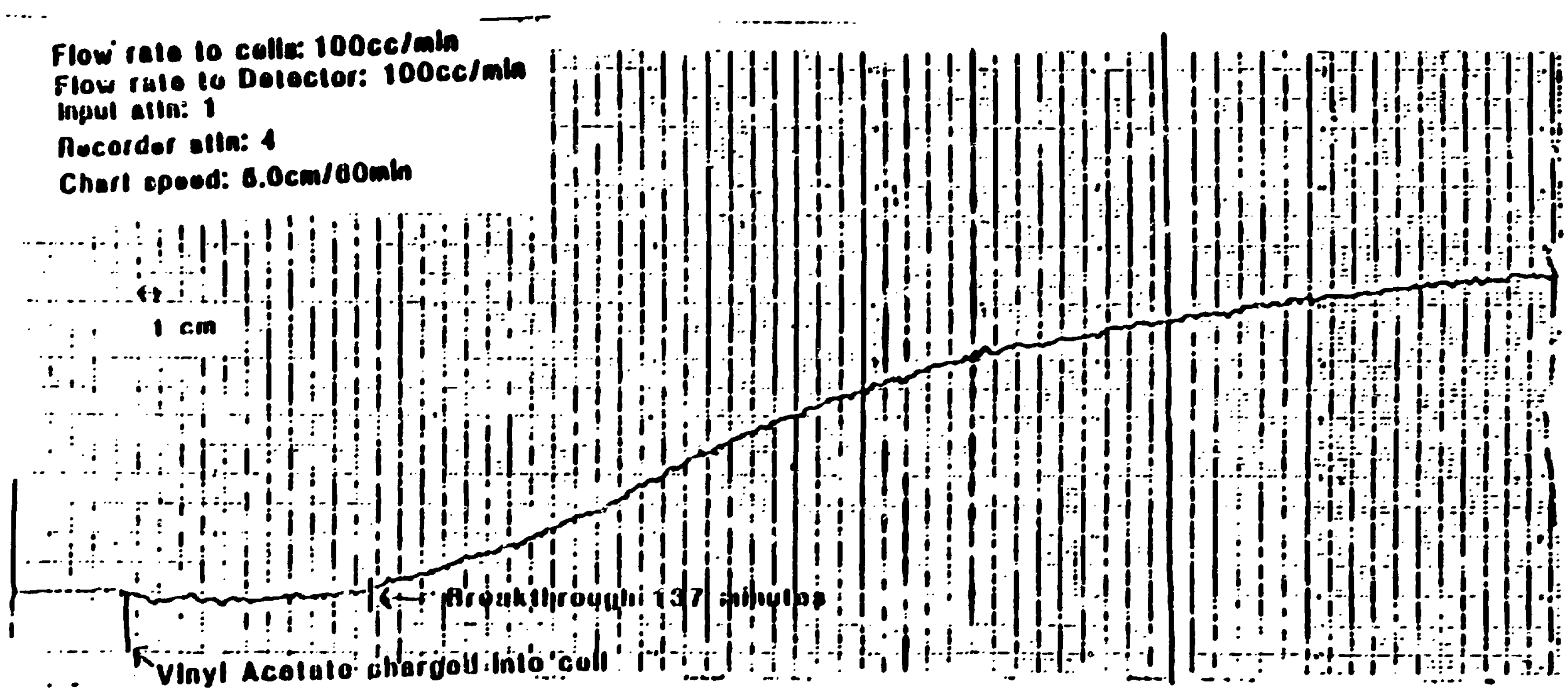
5. SOURCE OF DATA

Sample was run by Karen Verschoor on May 21, 1986

C-254

Permeation of Vinyl Acetate through USCG Material

Run I



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 066
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s):	Vinyl Acetate	N/A	N/A
2. CAS NUMBER(s):	108-05-4	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-9-87
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: 53 minutes
4. MIN DETECTABLE LIMIT 0.01 ppm
5. STEADY STATE PERMEATION RATE 0.46 ug/cm²/hr
6. SAMPLE THICKNESS: 19-20 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

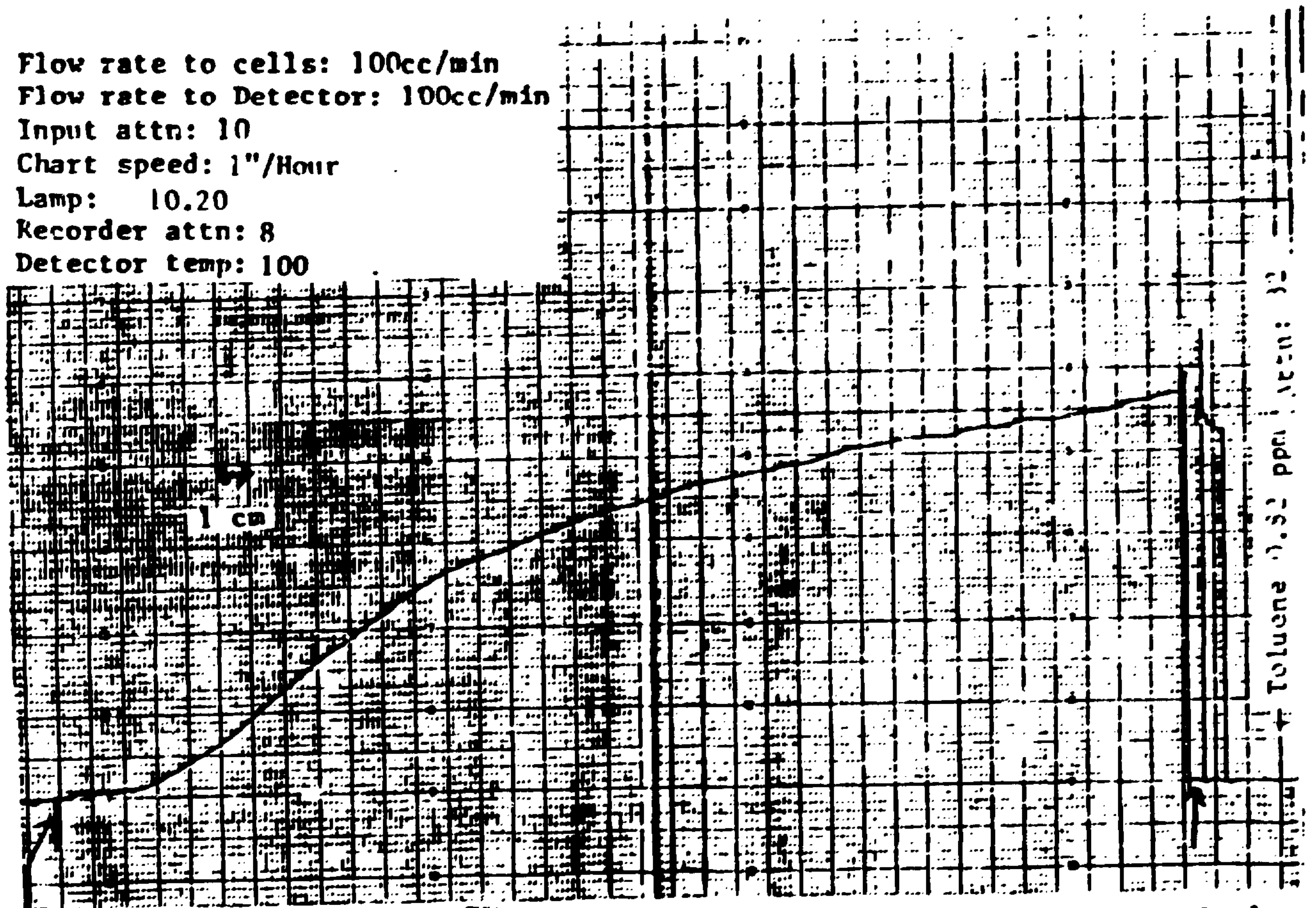
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Denise McDonald on January 9, 1987.

Chemical Resistance Testing of Challenge 5100

Vinyl Acetate Run II



Switched from cells to standard gas

Vinyl Acetate charged into cells

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used/Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Vinyl Acetate	N/A	N/A
2. CAS NUMBER(s):	108-05-4	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 2-24-87
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 68 minutes
4. MIN DETECTABLE LIMIT .02 ppm
5. STEADY STATE PERMEATION RATE 2.78 (ug/cm2*hr)
6. SAMPLE THICKNESS: 19-20 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

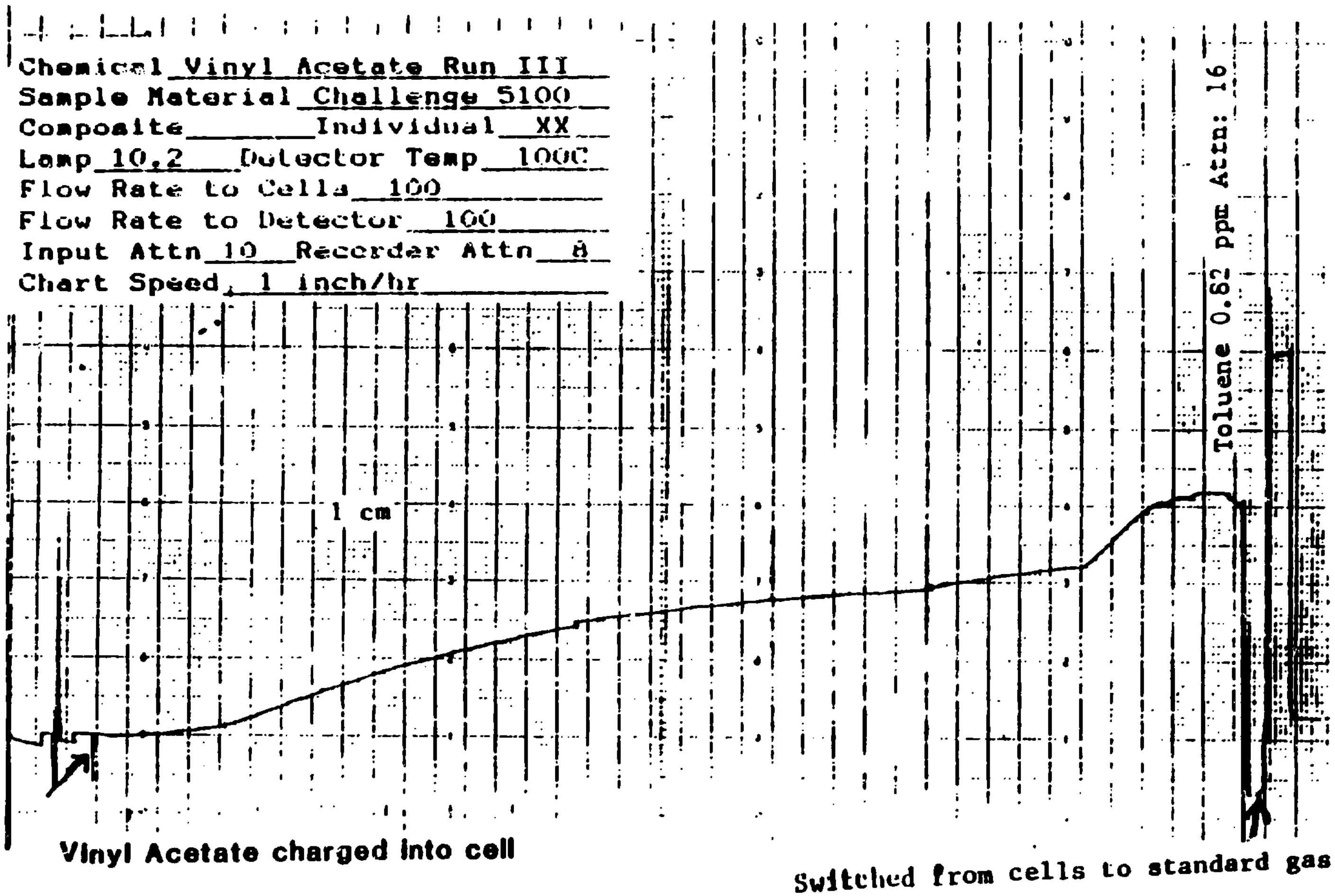
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample run by Denise McDonald on February 24, 1987.

Chemical Resistance Testing of Challenge 5100

Vinyl Acetate Run III



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.2 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: flow rate to cells was 100cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Vinylidene Chloride	N/A	N/A
2. CAS NUMBER(s):	75-35-4	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 23, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT .49 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

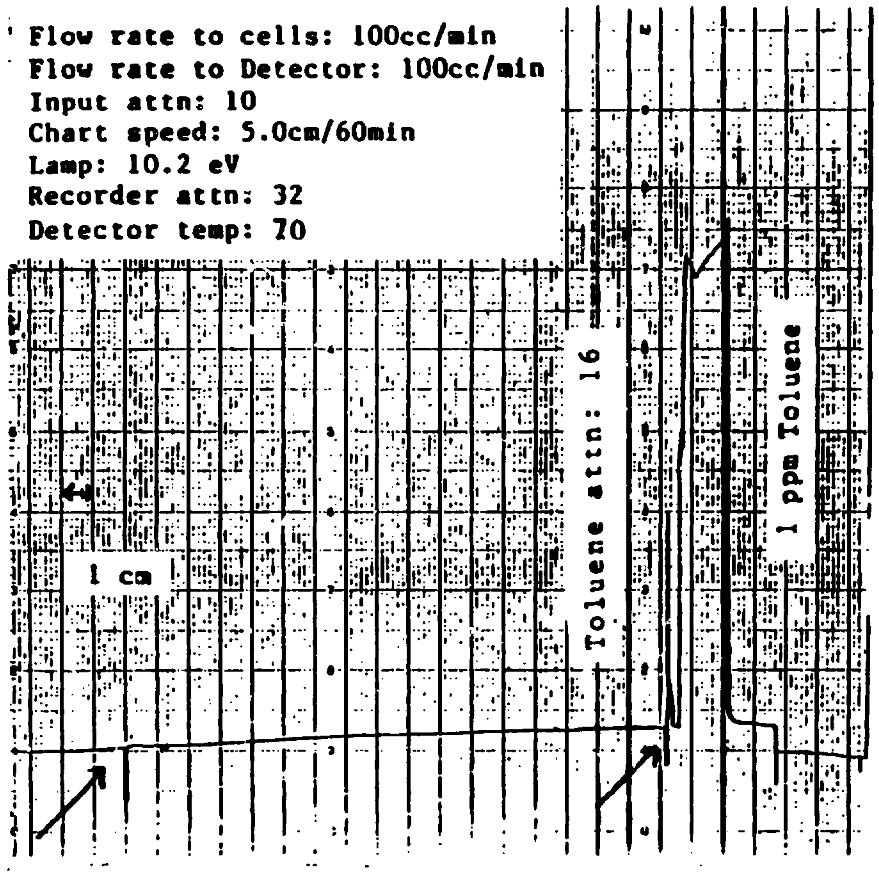
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on September 23, 1986

Chemical Resistance Testing of USCG Material with Vinylidene Chloride



Vinylidene Chloride charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT E[illegible]UATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.7 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 2 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100cc/min

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Xylene	N/A	N/A
2. CAS NUMBER(s):	1330-20-7	N/A	N/A
3. CONC. (IF MIX)	Mixed Isomers	N/A	N/A
4. CHEMICAL SOURCE:	Baker	N/A	N/A
	Reagent Grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: June 2, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after three hours.
4. MIN DETECTABLE LIMIT 0.13 ppm.
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 18-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

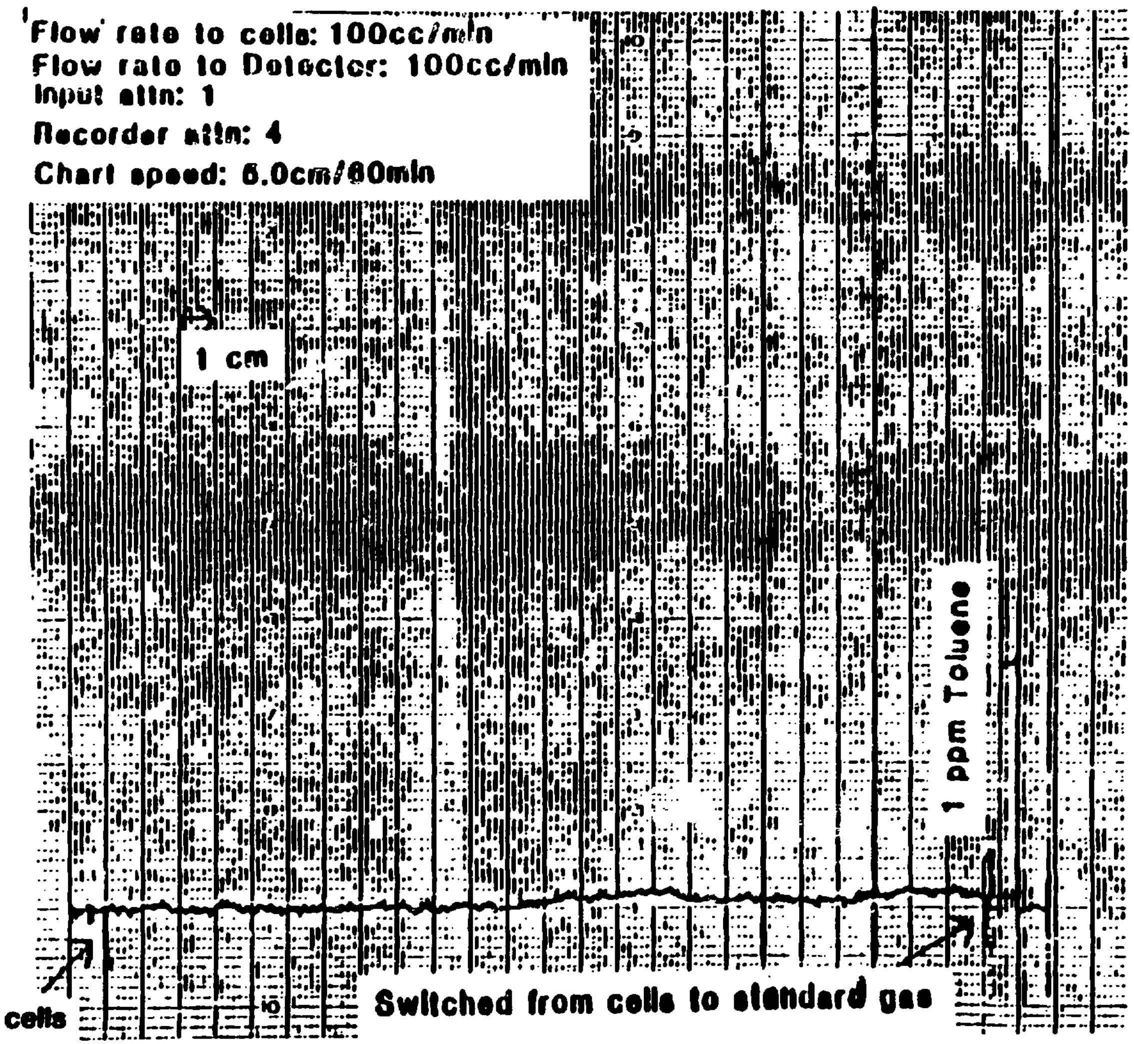
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Sylvia R. Cooper on June 2, 1986

C-262

Chemical Resistance Testing of USCG Material with Xylene



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s) :	Xylenol	N/A	N/A
2. CAS NUMBER(s):	576-26-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: September 9, 1986
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.26 hours.
4. MIN DETECTABLE LIMIT .01 ppm as Cresol.
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

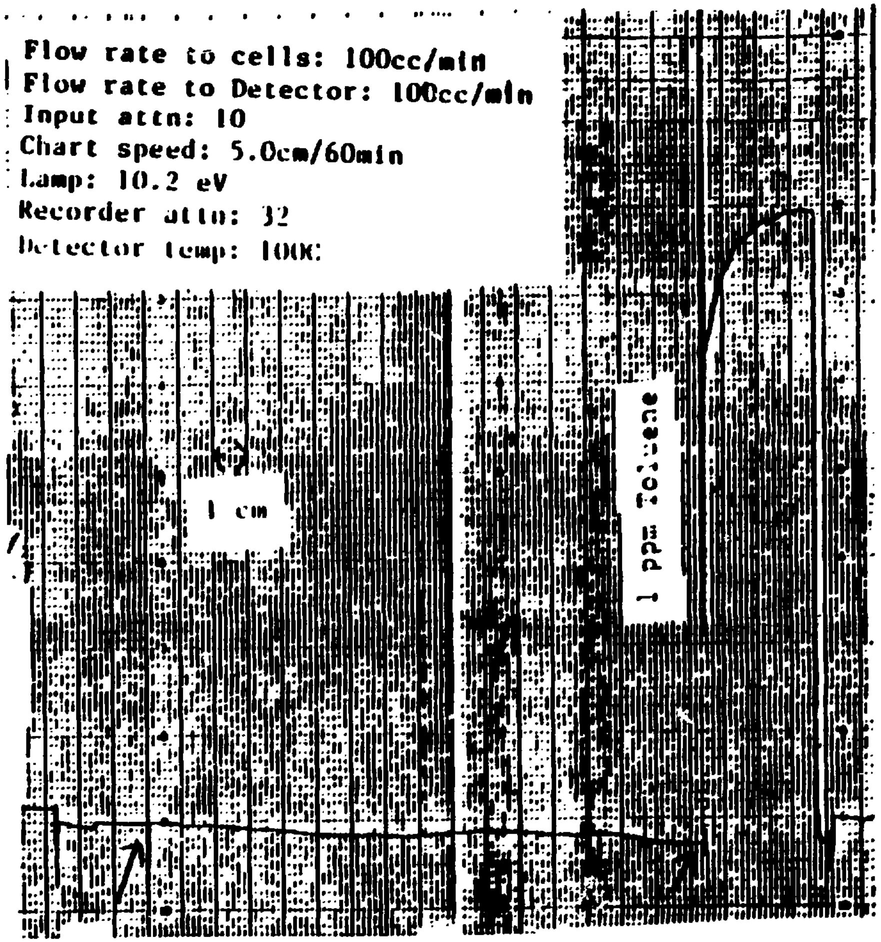
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA
Samples were run by Denise McDonald on September 9, 1986

Chemical Resistance Testing of USCG Material with Xylenol

Flow rate to cells: 100cc/min
Flow rate to Detector: 100cc/min
Input attn: 10
Chart speed: 5.0cm/60min
Lamp: 10.2 eV
Recorder attn: 32
Detector temp: 100C



Xylenol charged into cells

Switched from cells to standard gas

APPENDIX D

METHOD FOR CREASING MATERIAL SAMPLES

(Provided by Chemical Fabrics Corporation)

Rough Draft
CHEMFAB Test Procedure
05 September 1986

Fold Resistance of CHEMFAB Protective Clothing Material

SCOPE:

To evaluate the reduction of chemical permeation resistance of chemical protective clothing material due to hard folding or creasing.

SAMPLE PREPARATION:

Cut a rectangular section of material, 4" x 8", with the long dimension parallel to the warp or machine-direction of the material.

TEST EQUIPMENT:

1.) Steel roller - 1.50" diameter x 2.25 " length, 10 lb. total weight (Fig. 1)

2.) Permeation test apparatus consistent with ASTM 739-81.

PROCEDURE:

1.) Wipe sample with damp cloth to remove any surface dust or abrasive particles which may damage the sample during rolling.

2.) Fold sample perpendicular to long dimension.

3.) Place the folded sample on a hard surface such as a clean lab bench top, metallic or formica table top.

4.) Roll the sample with the ten pound roller so that the direction of the roll is parallel to the sample fold (Fig. 2).

5.) Repeat Step 4 nine (9) times for a total of ten (10) rolls.

Fold Resistance of CHEMFAB Protective Clothing Material

6.) Reverse the fold, taking care to insure that the new fold occurs along the same line as the original fold (Fig. 3).

7.) Repeat Steps 4 and 5.

8.) Cut permeation test sample so that the fold line bisects the exposed area in the test cell.

9.) Perform permeation testing (ASTM 739-81) toward chemical of choice.

RESULTS:

Report breakthrough time and permeation rate of folded samples and pristine control samples. Report all parameters required by ASTM 739-81 including chemical(s) type and concentration.

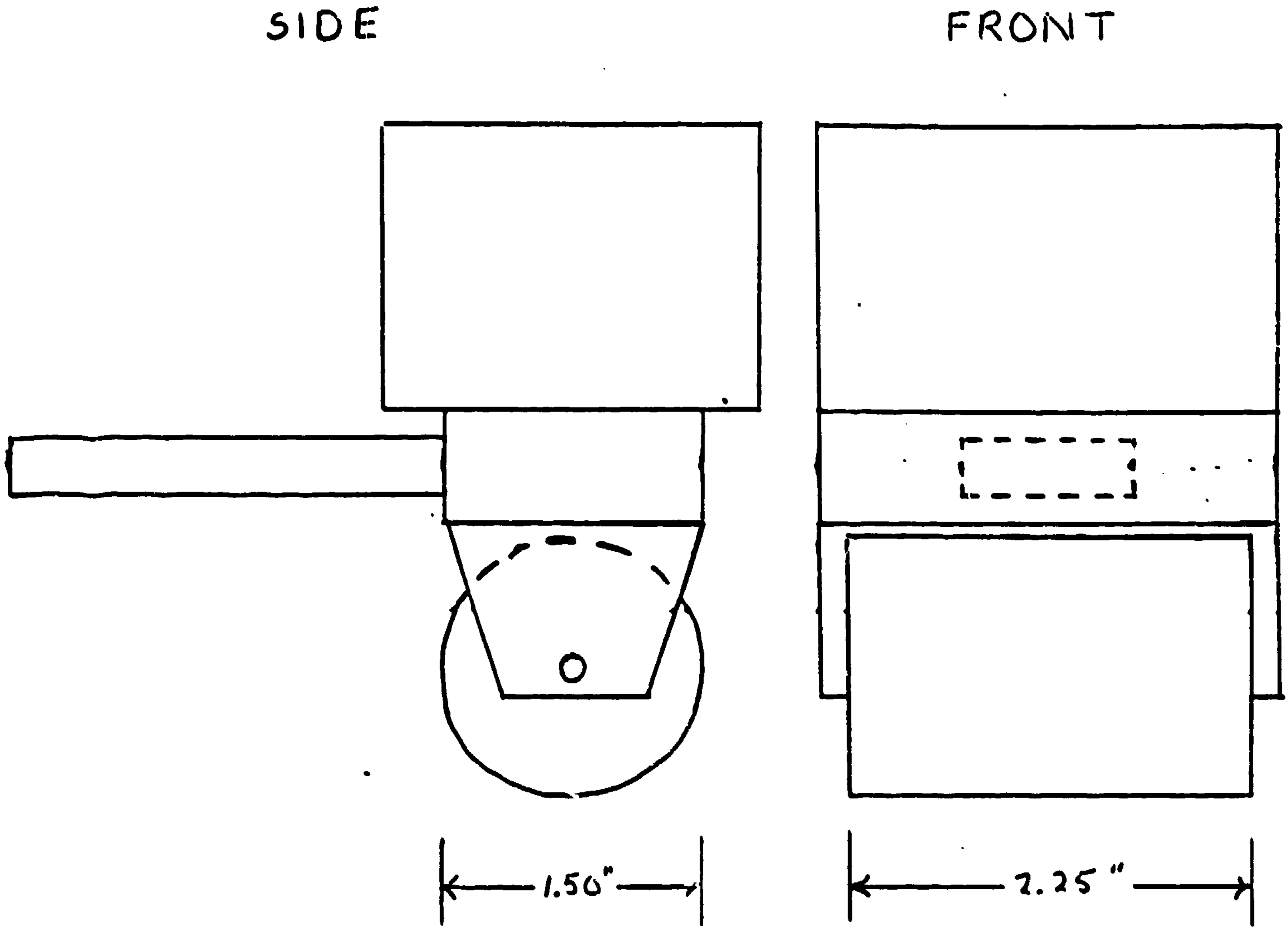


FIG. 1. STEEL ROLLER, TOTAL WEIGHT 10 LB

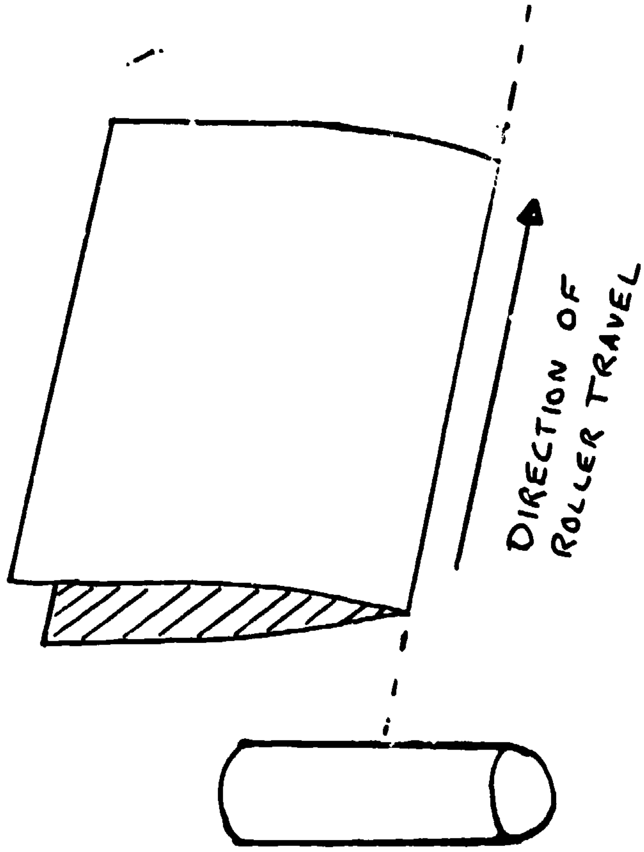


FIG. 2.

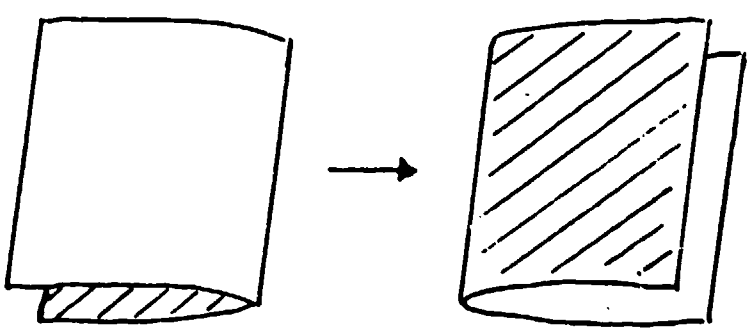


FIG. 3.

APPENDIX E

PERMEATION TEST DATA FOR CREASED GARMENT MATERIAL SAMPLES

(Data Provided by Texas Research Institute Under Contract)

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

   1: TYPE: Teflon laminated Nomex
   2: PROTECTIVE MATERIAL CODE: 068
   3: CONDITION BEFORE TEST: Unused, no visible imperfections
   4: MANUFACTURER: Chemfab Corp.
   5: PRODUCT IDENTIFICATION: Challenge 5100
   6: LOT OR MANUFACTURER DATE: N/A
   7: NOMINAL THICKNESS: 15-20 mil
   8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

   1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
   2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
   3. TEMPERATURE: 22-25°C
   4. COLLECTION MEDIUM: N_2
   5. COLLECTION SYSTEM: N_2
   6. OTHER CONDITIONS: 1 inch cells was used./Detector Temperature = 100 C.
   7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Acetone	N/A	N/A
2. CAS NUMBER(s):	67-64-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

   1. DATE TESTED: 2-23-87
   2. NUMBER OF SAMPLES TESTED: Three
   3. BREAKTHROUGH TIME: N/A
   4. MIN DETECTABLE LIMIT .09 ppm
   5. STEADY STATE PERMEATION RATE N/A
   6. SAMPLE THICKNESS: 19-20 mils
   7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

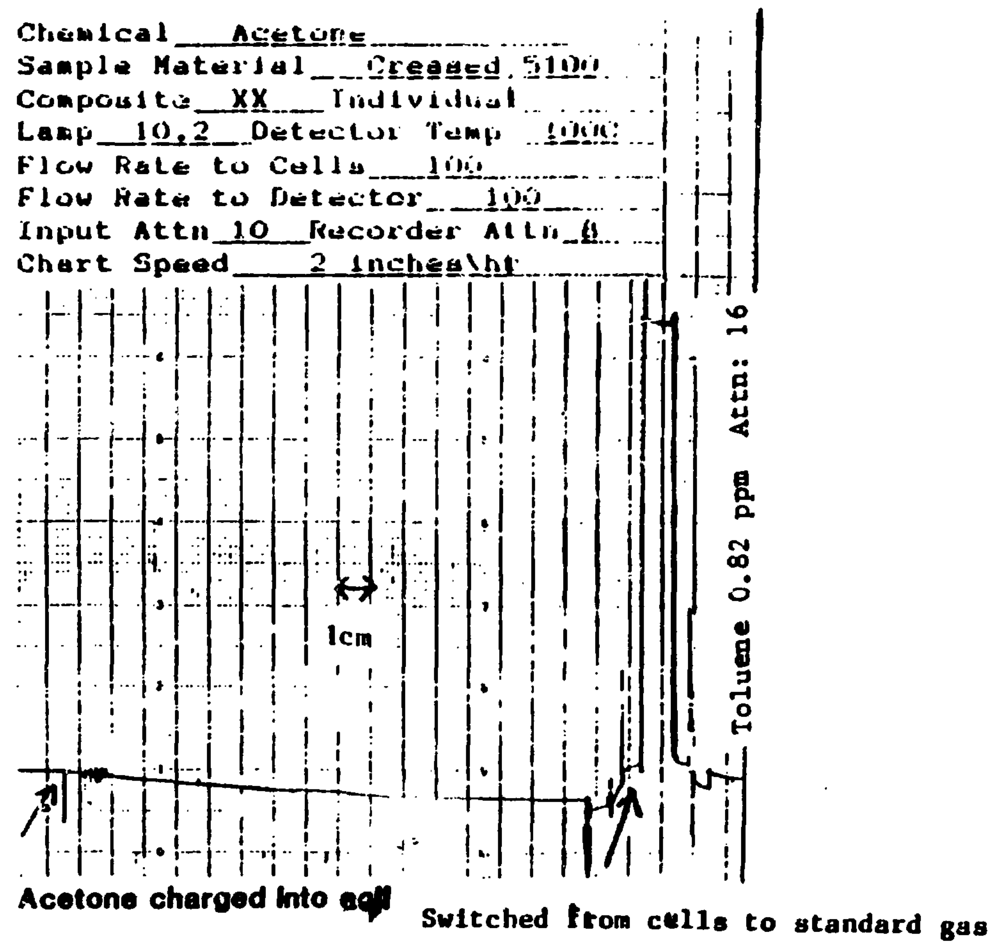
   8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

   Samples were run by Denise McDonald on February 23, 1987.

Chemical Resistance Testing of Creased 5100

Acetone



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Gas Chromatography
3. TEMPERATURE: Ambient
4. COLLECTION MEDIUM: Charcoal
5. COLLECTION SYSTEM: Charcoal
6. OTHER CONDITIONS: 1 inch cells were used.
7. DEVIATIONS FROM ASTM F739 METHOD:

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Acetonitrile	N/A	N/A
2. CAS NUMBER(s):	2206-26-0	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher-Pesticide	N/A	N/A
	Grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 2-06-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT 0.6 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS Cells 1,2, and 3 at end of three hour test

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	3 hours	<0.6 ppm	<0.6 ppm	<0.6 ppm
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA
Samples were run by Denise McDonald on February 6, 1987.

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s) :	Carbon Disulfide	N/A	N/A
2. CAS NUMBER(s):	75-15-0	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 2-19-87
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 15 minutes
4. MIN DETECTABLE LIMIT .07 ppm
5. STEADY STATE PERMEATION RATE 13.33 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

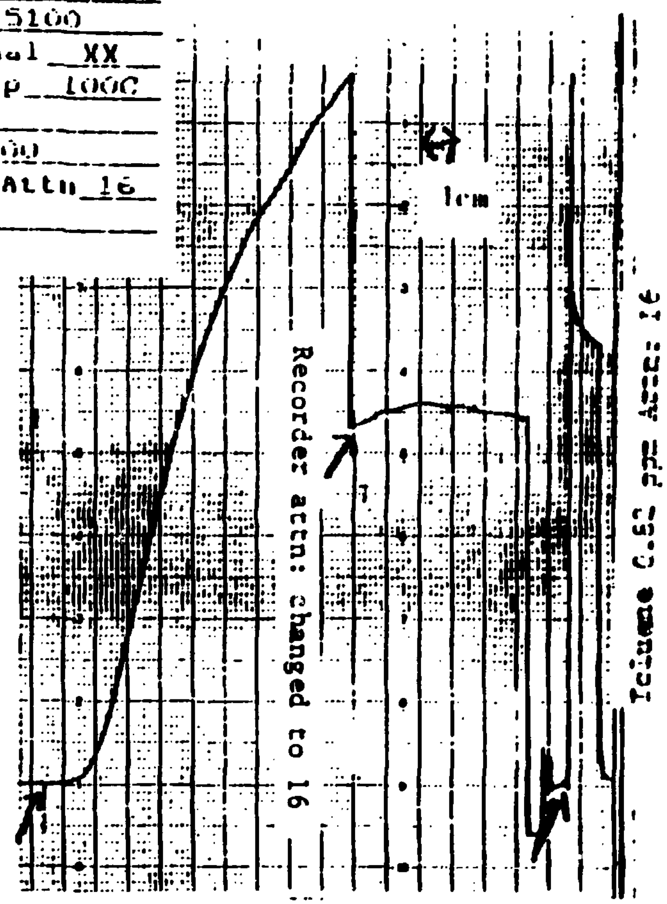
5. SOURCE OF DATA

Sample was run by Denise McDonald on February 19, 1987.

Chemical Resistance Testing of Creased 5100

Carbon Disulfide Run I

Chemical Carbon Disulfide Run I
Sample Material Creased 5100
Composite ______ Individual XX
Lamp 10.2 Detector Temp 100C
Flow Rate to Cells 100
Flow Rate to Detector 100
Input Attn 10 Recorder Attn 16
Chart Speed 4 Inches/h



Carbon Disulfide charged into cells   Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

   1: TYPE: Teflon laminated Nomex
   2: PROTECTIVE MATERIAL CODE: 068
   3: CONDITION BEFORE TEST: Unused, no visible imperfections
   4: MANUFACTURER: Chemfab Corp.
   5: PRODUCT IDENTIFICATION: Challenge 5100
   6: LOT OR MANUFACTURER DATE: N/A
   7: NOMINAL THICKNESS: 15-20 mil
   8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

   1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
   2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
   3. TEMPERATURE: 22-25°C
   4. COLLECTION MEDIUM: N_2
   5. COLLECTION SYSTEM: N_2
   6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 100C.
   7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Carbon Disulfide	N/A	N/A
2. CAS NUMBER(s):	75-15-0	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

   1. DATE TESTED: 2-20-87
   2. NUMBER OF SAMPLES TESTED: One (Run II)
   3. BREAKTHROUGH TIME: 11 minutes
   4. MIN DETECTABLE LIMIT .07
   5. STEADY STATE PERMEATION RATE 12.85(ug/cm^2*hr)
   6. SAMPLE THICKNESS: 19-20 mils
   7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

   8. OTHER OBSERVATIONS:

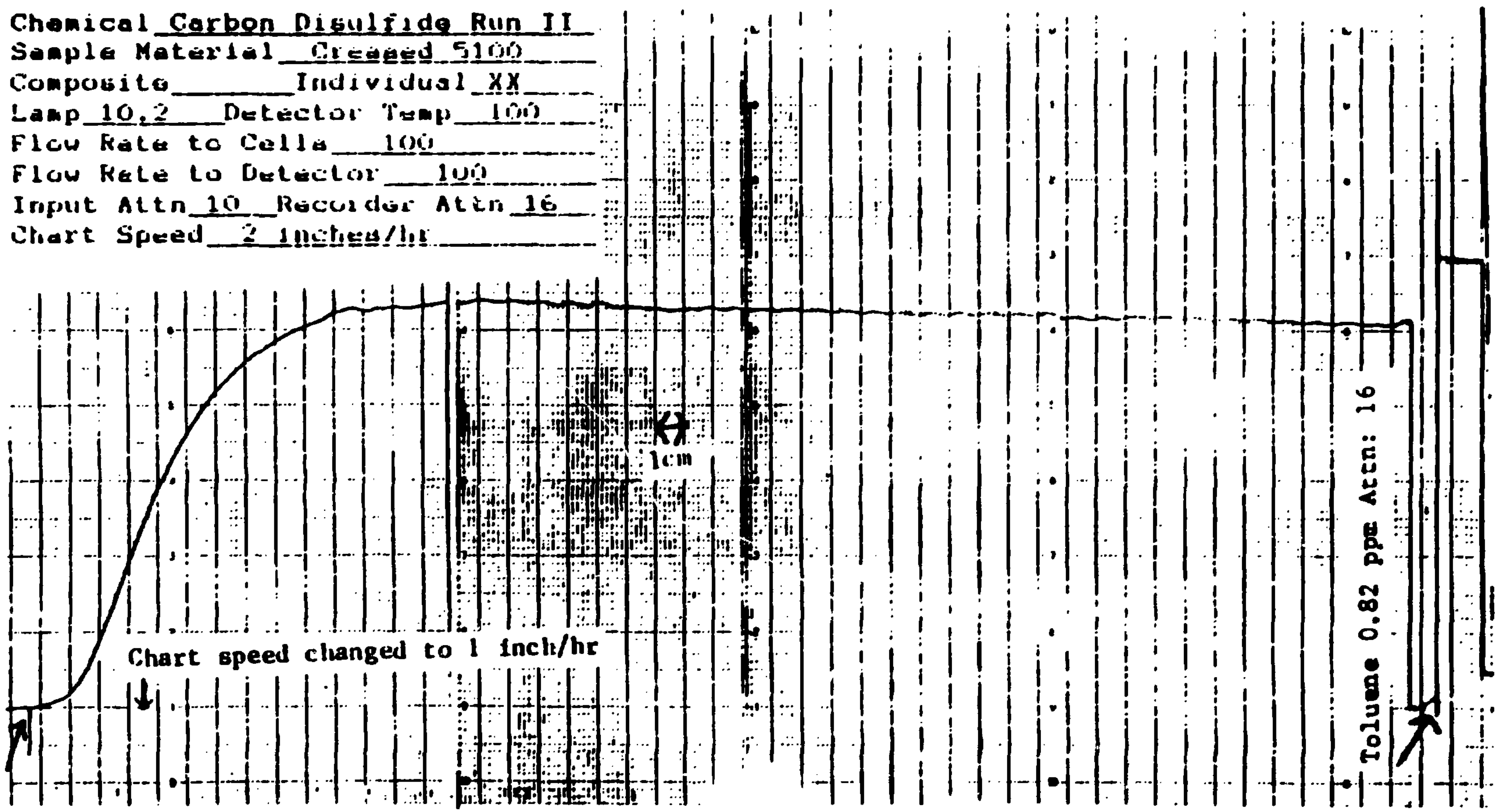
5. SOURCE OF DATA

   Sample was run by Denise McDonald on February 20, 1987.

E-7

Chemical Resistance Testing of Creased 5100

Carbon Disulfide Run II



Carbon Disulfide charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used/Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Carbon Disulfide	N/A	N/A
2. CAS NUMBER(s):	75-15-0	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 2-24-87
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 15 minutes
4. MIN DETECTABLE LIMIT .04 ppm
5. STEADY STATE PERMEATION RATE 10.04 ($\mu g/cm^2$*hr)
6. SAMPLE THICKNESS: 19-20 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

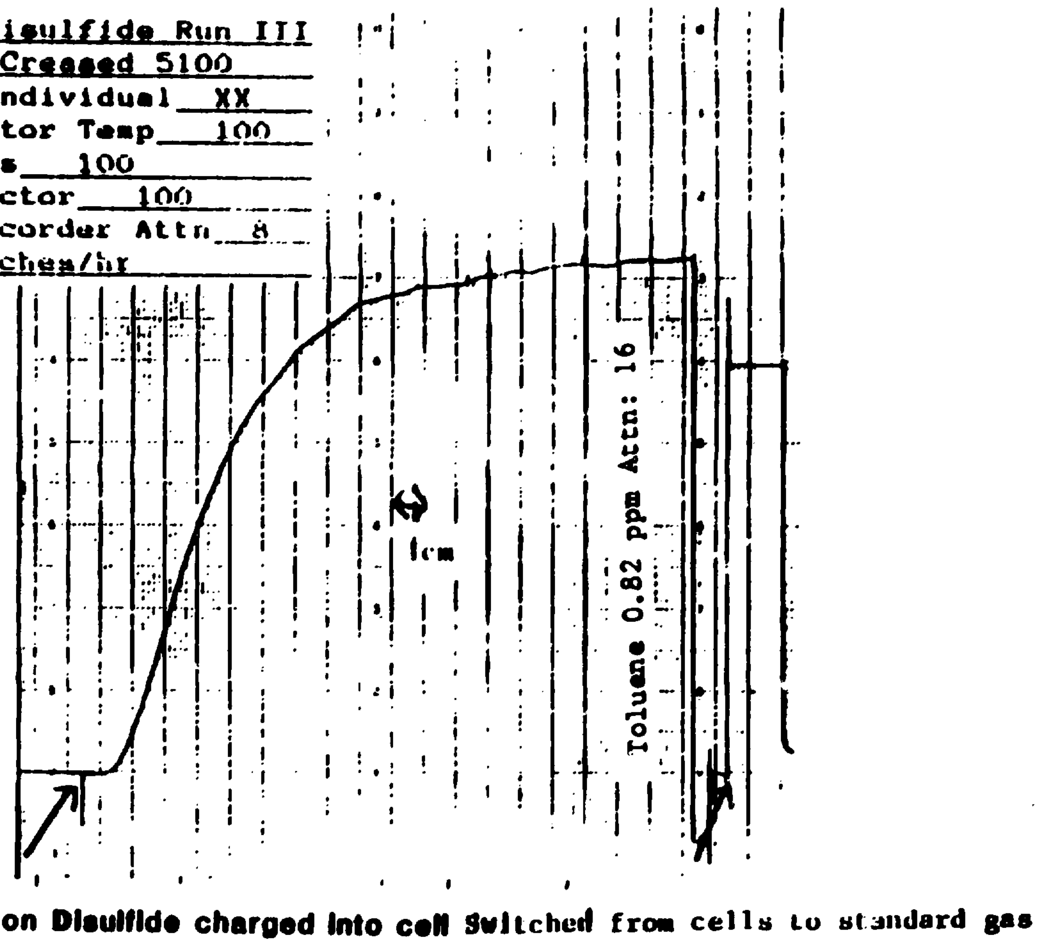
Sample was run by Denise McDonald on February 24, 1987.

E-C

Chemical Resistance Testing of Creased 5100

Carbon Disulfide Run III

Chemical Carbon Disulfide Run III
Sample Material Creased 5100
Composite ______ Individual XX
Lamp 10.2 Detector Temp 100
Flow Rate to Cells 100
Flow Rate to Detector 100
Input Attn 10 Recorder Attn 8
Chart Speed 2 inches/hr



CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Dichloromethane	N/A	N/A
2. CAS NUMBER(s):	75-09-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-13-87
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 53 minutes
4. MIN DETECTABLE LIMIT .71 ppm
5. STEADY STATE PERMEATION RATE 3.79 (ug/cm_2*hr)
6. SAMPLE THICKNESS: 19-20 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

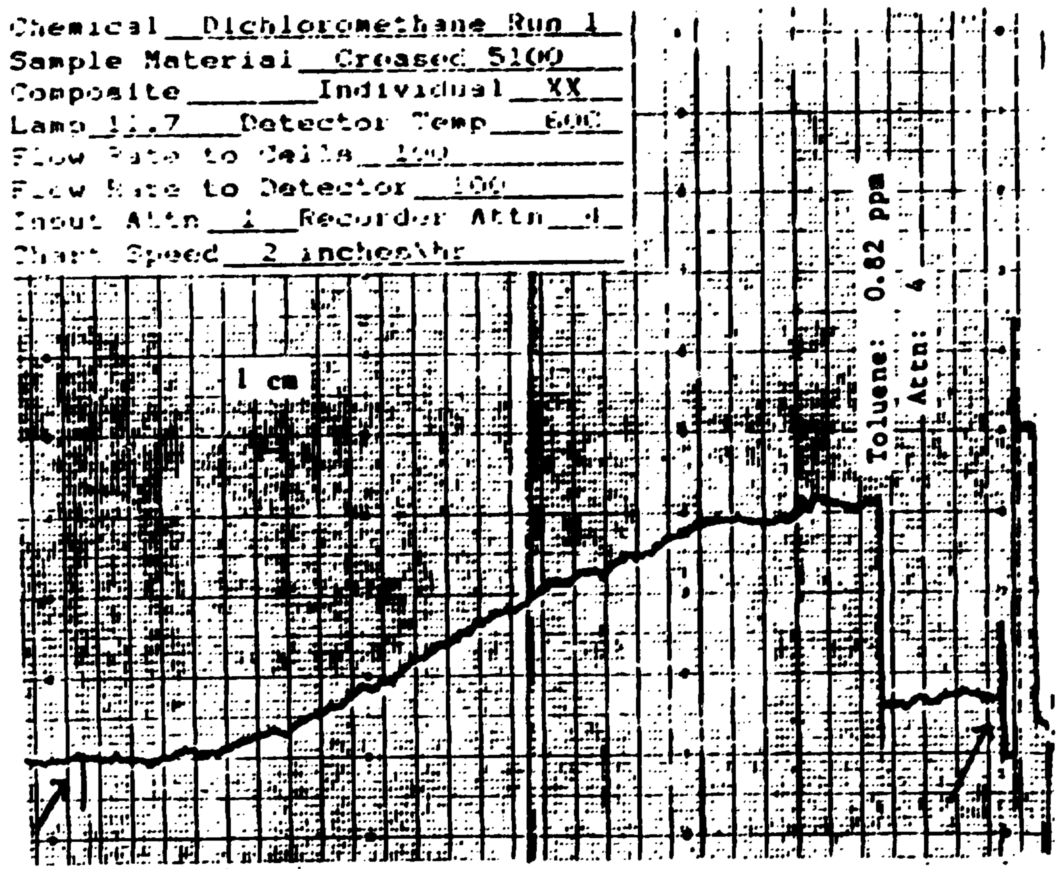
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Denise McDonald on April 13, 1987.

Chemical Resistance Testing of Creased 5100

Dichloromethane Run I



Dichloromethane charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

   1: TYPE: Teflon laminated Nomex
   2: PROTECTIVE MATERIAL CODE: 068
   3: CONDITION BEFORE TEST: Unused, no visible imperfections
   4: MANUFACTURER: Chemfab Corp.
   5: PRODUCT IDENTIFICATION: Challenge 5100
   6: LOT OR MANUFACTURER DATE: N/A
   7: NOMINAL THICKNESS: 15-20 mil
   8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

   1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
   2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
   3. TEMPERATURE: 22-25°C
   4. COLLECTION MEDIUM: N_2
   5. COLLECTION SYSTEM: N_2
   6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
   7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Dichloromethane	N/A	N/A
2. CAS NUMBER(s):	75-09-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

   1. DATE TESTED: 4-13-87
   2. NUMBER OF SAMPLES TESTED: One (Run II)
   3. BREAKTHROUGH TIME: 58 minutes
   4. MIN DETECTABLE LIMIT .79 ppm
   5. STEADY STATE PERMEATION RATE 3.08 (ug/cm_2*hr)
   6. SAMPLE THICKNESS: 19-20 mils
   7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

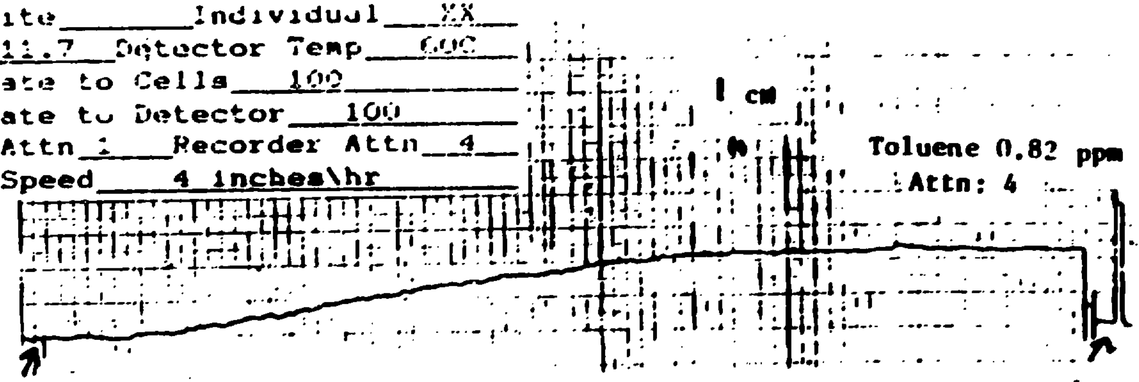
   8. OTHER OBSERVATIONS:

5. SOURCE OF DATA
   Sample was run by Denise McDonald on April 13, 1987.

Chemical Resistance Testing of Creased 5100

Dichloromethane Run II

Chemical ___Dichloromethane Run II___
Sample Material ___Creased 5100___
Composite _______ Individual ___XX___
Lamp ___11.7___ Detector Temp ___60C___
Flow Rate to Cells ___100___
Flow Rate to Detector ___100___
Input Attn ___1___ Recorder Attn ___4___
Chart Speed ___4 inches\hr___



Dichloromethane charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Dichloromethane	N/A	N/A
2. CAS NUMBER(s):	75-09-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-14-87
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 53 minutes
4. MIN DETECTABLE LIMIT .79 ppm
5. STEADY STATE PERMEATION RATE 3.24 (ug/cm$_2$*hr)
6. SAMPLE THICKNESS: 19-20 mils
7. SELECTED DATA POINTS N/A

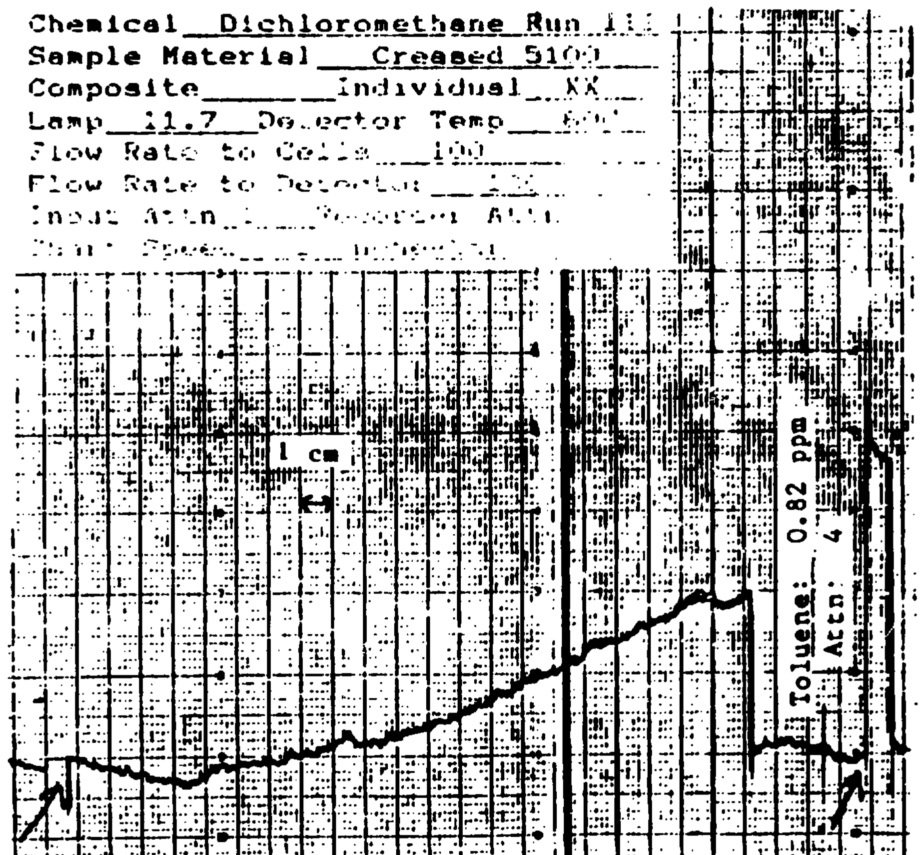
	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA
Sample was run by Denise McDonald on April 14, 1987.

Chemical Resistance Testing of Creased 5100

Dichloromethane Run III



Dichloromethane charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Diethylamine	N/A	N/A
2. CAS NUMBER(s):	109-89-7	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 2-10-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.0 hours
4. MIN DETECTABLE LIMIT .15 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

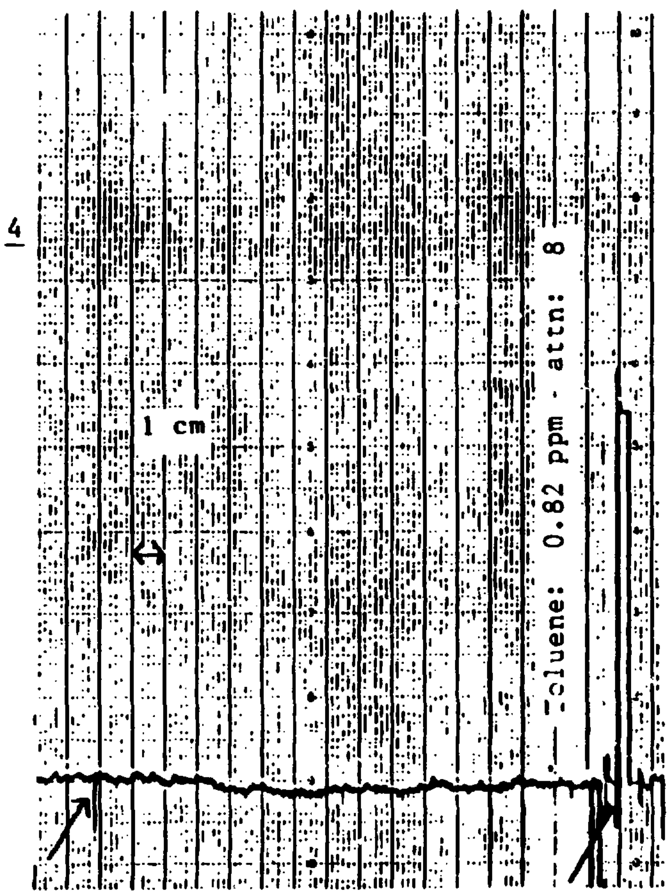
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA
Samples were run by Denise McDonald on February 10, 1987.

Chemical Resistance Testing of Creased 5100

Diethylamine

Chemical: Diethylamine
Sample Material: Creased 5100
Composite: X Individual:
Lamp: 11.7 Detector temp: 60
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1 Recorder attn: 4
Chart speed: 2 in/hr



Diethylamine charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Dimethylformamide	N/A	N/A
2. CAS NUMBER(s):	68-12-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 2-11-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 4.0 hours
4. MIN DETECTABLE LIMIT .40 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

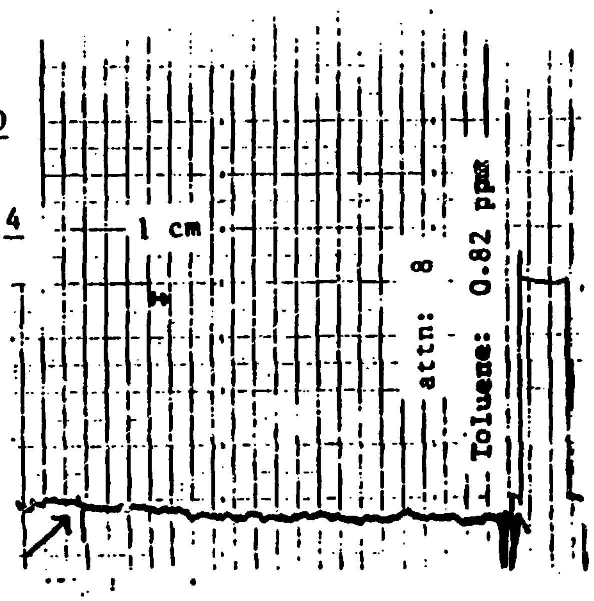
5. SOURCE OF DATA

Samples were run by Denise McDonald on February 11, 1987.

Chemical Resistance Testing of Creased 5100

Dimethylformamide

Chemical: Dimethylformamide
Sample Material: Creased 5100
Composite: X Individual:
Lamp: 11.7 Detector temp: 60
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1 Recorder attn: 4
Chart speed: 2 in/hr



Dimethylformamide charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: No
5. COLLECTION SYSTEM: No
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Ethyl Acetate	N/A	N/A
2. CAS NUMBER(s):	141-78-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	EM Science	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 3-4-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT .20 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

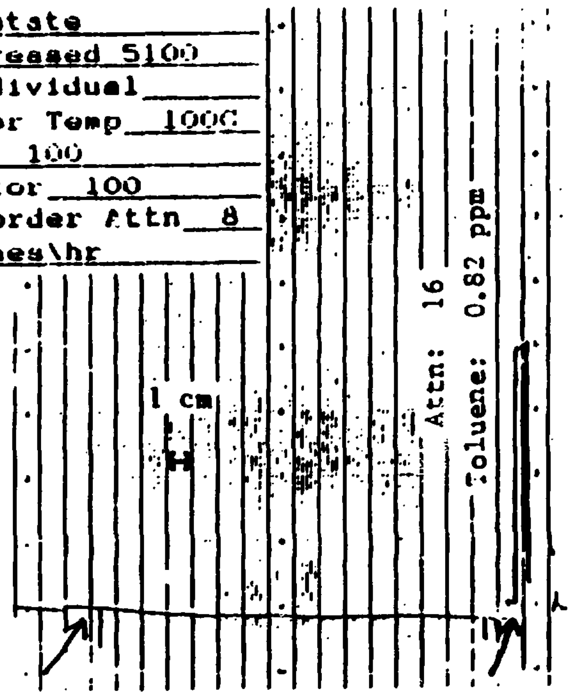
5. SOURCE OF DATA

Samples were run by Denise McDonald on March 4, 1987.

Chemical Resistance Testing of Creased 5100

Ethyl Acetate

Chemical Ethyl Acetate
Sample Material Creased 5100
Composite XX Individual
Lamp 10.2 Detector Temp 100C
Flow Rate to Cells 100
Flow Rate to Detector 100
Input Attn 10 Recorder Attn 8
Chart Speed 2 inches\hr



Ethyl Acetate charged into cells Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s) :	Hexane	N/A	N/A
2. CAS NUMBER(s):	110-54-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 3-3-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT .11 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

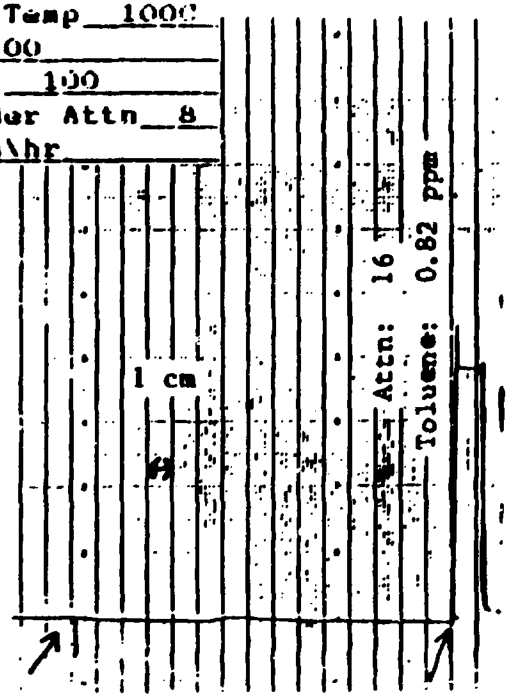
5. SOURCE OF DATA

Samples were run by Denise McDonald on March 3, 1987.

Chemical Resistance Testing of Creased 5100

Hexane

Chemical Hexane
Sample Material Creased 5100
Composite XX Individual
Lamp 10.2 Detector Temp 100C
Flow Rate to Cells 100
Flow Rate to Detector 100
Input Attn 10 Recorder Attn 8
Chart Speed 2 inches\hr



Hexane charged into cells   Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s) :	Methanol	N/A	N/A
2. CAS NUMBER(s):	811-98-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 2-04-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.2 hours.
4. MIN DETECTABLE LIMIT .10 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

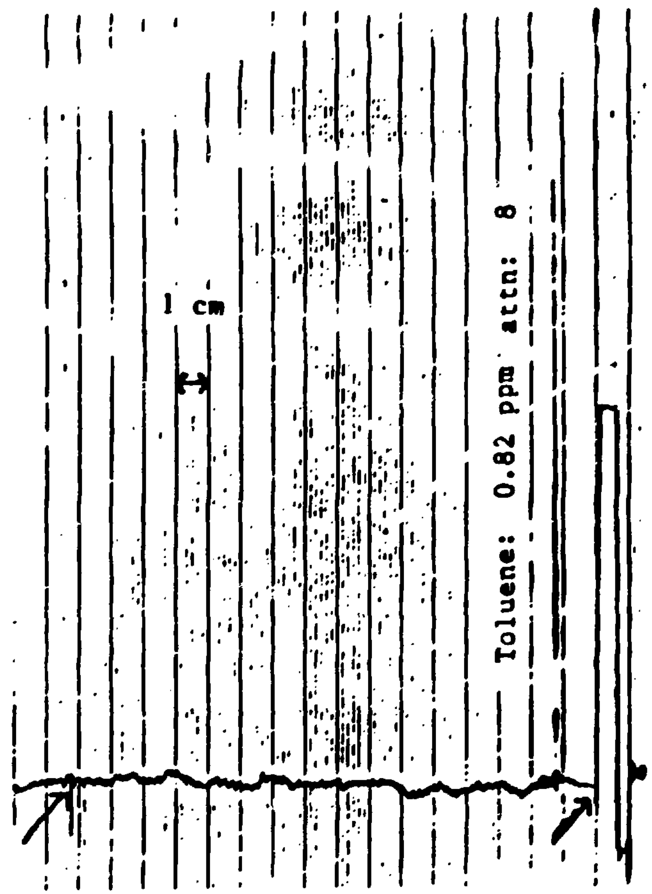
5. SOURCE OF DATA

Samples were run by Denise McDonald on February 4, 1987.

Chemical Resistance Testing of Creased 5100

Methanol

Chemical: Methanol
Sample Material: Creased 5100
Composite: X Individual:
Lamp: 11.7 Detector temp: 60
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1 Recorder attn: 4
Chart speed: 2 in/hr



Methanol charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

   1: TYPE: Teflon laminated Nomex
   2: PROTECTIVE MATERIAL CODE: 068
   3: CONDITION BEFORE TEST: Unused, no visible imperfections
   4: MANUFACTURER: Chemfab Corp.
   5: PRODUCT IDENTIFICATION: Challenge 5100
   6: LOT OR MANUFACTURER DATE: N/A
   7: NOMINAL THICKNESS: 15-20 mil
   8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

   1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
   2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
   3. TEMPERATURE: 22-25°C
   4. COLLECTION MEDIUM: N_2
   5. COLLECTION SYSTEM: N_2
   6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 100C.
   7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Nitrobenzene	N/A	N/A
2. CAS NUMBER(s):	98-95-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

   1. DATE TESTED: 2-26-87
   2. NUMBER OF SAMPLES TESTED: Three
   3. BREAKTHROUGH TIME: N/A
   4. MIN DETECTABLE LIMIT .06
   5. STEADY STATE PERMEATION RATE N/A
   6. SAMPLE THICKNESS: 19-20 mils
   7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

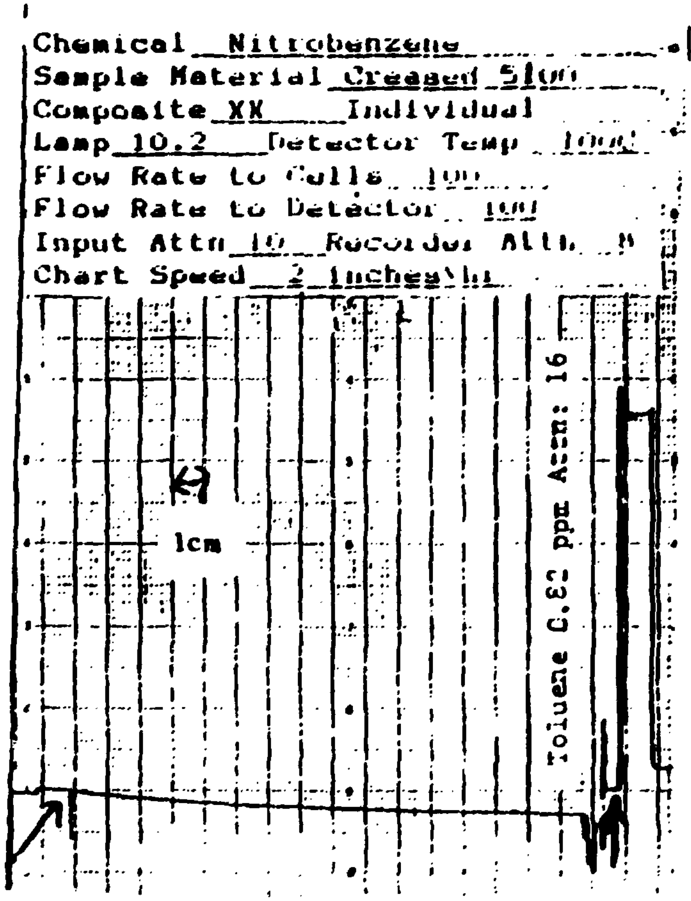
   8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

   Samples were run by Denise McDonald on February 26, 1987.

Chemical Resistance Testing of Creased 5100

Nitrobenzene



Nitrobenzene charged into cell

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Tetrachloroethane	N/A	N/A
2. CAS NUMBER(s):	79-34-5	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 2-05-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.2 hours.
4. MIN DETECTABLE LIMIT .07 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

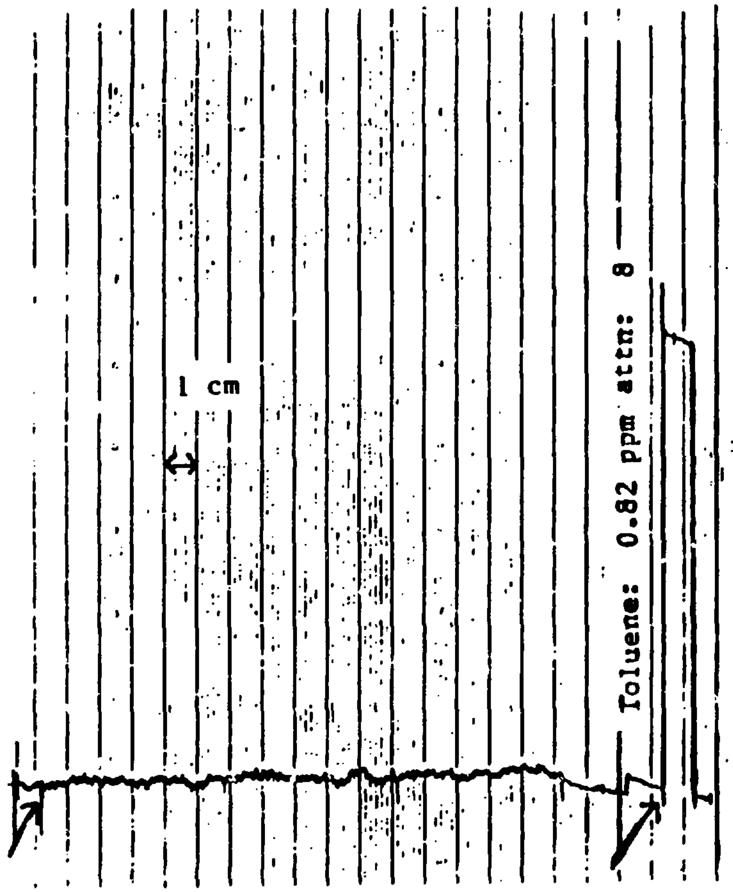
Samples were run by Denise McDonald on February 5, 1987.

E-2

Chemical Resistance Testing of Creased 5100

Tetrachloroethane

Chemical: Tetrachloroethane
Sample Material: Creased 5100
Composite: X Individual: __
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1 Recorder attn: 4
Chart speed: 2 in/hr



Tetrachloroethane charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used. / Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Tetrahydrofuran	N/A	N/A
2. CAS NUMBER(s):	109-99-9	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 2-05-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.9 hours.
4. MIN DETECTABLE LIMIT .09 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

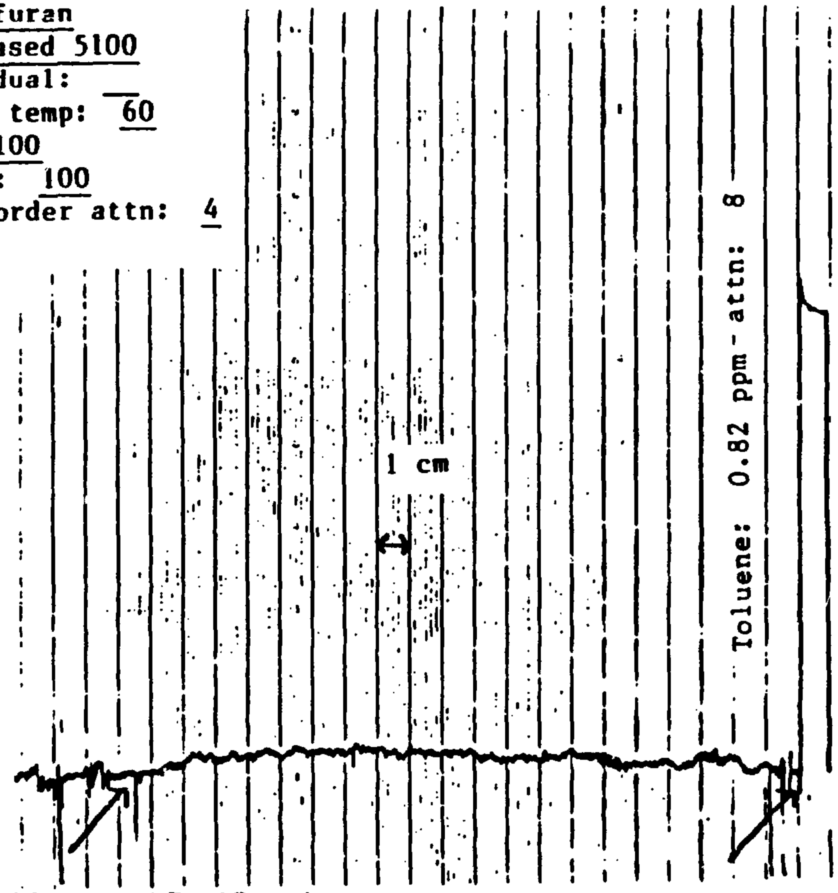
5. SOURCE OF DATA

Samples were run by Denise McDonald on February 5, 1987.

Chemical Resistance Testing of Creased 5100

Tetrahydrofuran

Chemical: Tetrahydorfuran
Sample Material: Creased 5100
Composite: X Individual: __
Lamp: 11.7 Detector temp: 60
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1 Recorder attn: 4
Chart speed: 2 in/hr



Tetrahydrofuran charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Challenge 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 15-20 mil
8: DESCRIPTION: Material was orange colored on one side and buff colored on the other side. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./ Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Toluene	N/A	N/A
2. CAS NUMBER(s):	108-88-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 2-09-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.6 hours
4. MIN DETECTABLE LIMIT .02 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mil
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

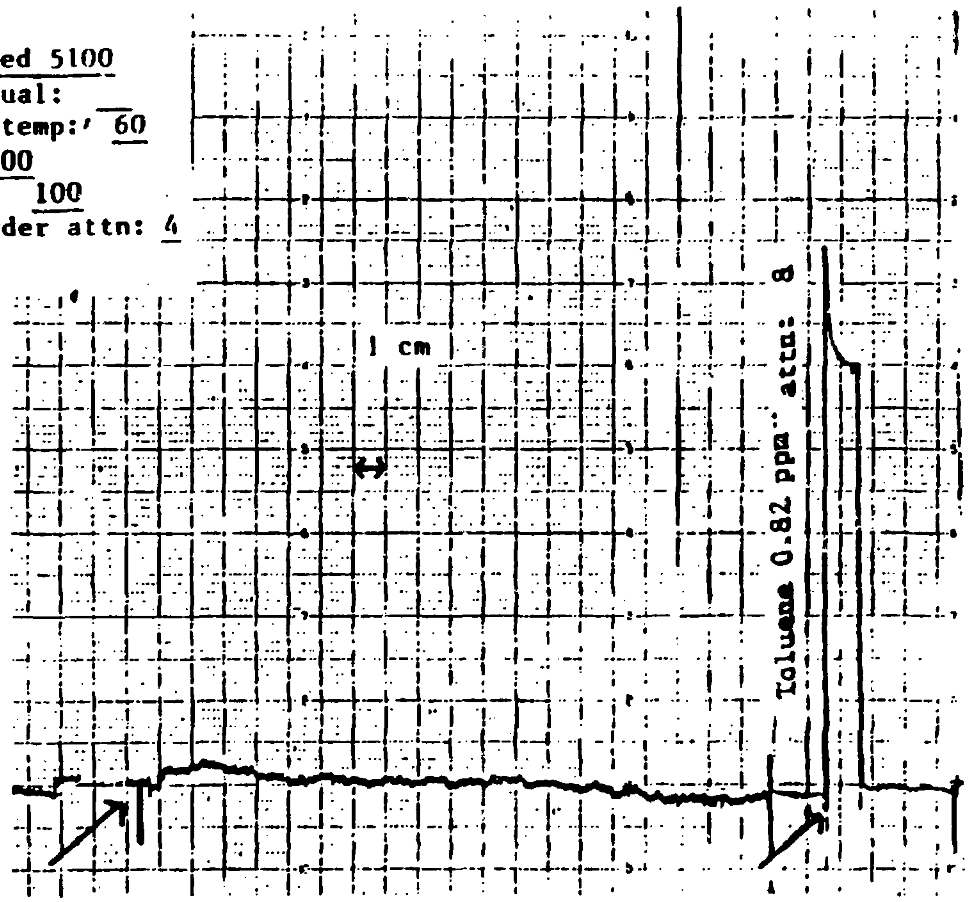
5. SOURCE OF DATA

Samples were run by Denise McDonald on February 9, 1987.

Chemical Resistance Testing of Creased 5100

Toluene

Chemical: Toluene
Sample Material: Creased 5100
Composite: X Individual:
Lamp: 11.7 Detector temp: 60
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1 Recorder attn: 4
Chart speed: 2 in/hr



Toluene charged into cells

Switched from cells to standard gas

APPENDIX F

PERMEATION TEST DATA FOR VISOR MATERIAL SAMPLES

(Data Provided by Texas Research Institute Under Contract)

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mils
8: DESCRIPTION: Material was a white transparent sheet.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV amp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature= 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells were 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Acetone	N/A	N/A
2. CAS NUMBER(s):	67-64-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-6-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.25 hours.
4. MIN DETECTABLE LIMIT .07 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

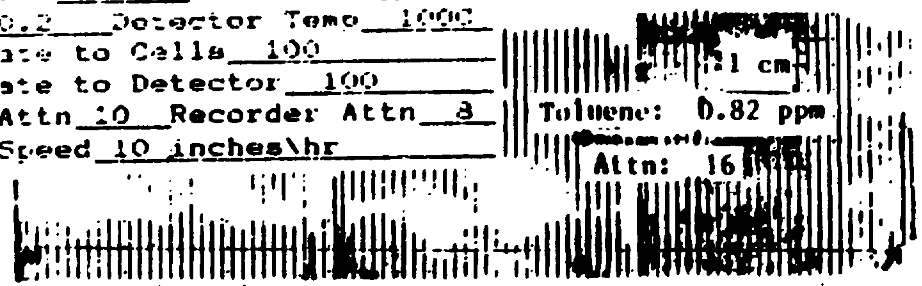
5. SOURCE OF DATA

Samples were run by Denise McDonald on April 6, 1987.

Chemical Resistance Testing of Visor Material

Acetone

Chemical __Acetone__
Sample Material __Visor__
Composite __XX__ Individual ____
Lamp __10.2__ Detector Temp __100C__
Flow Rate to Cells __100__
Flow Rate to Detector __100__
Input Attn __10__ Recorder Attn __8__
Chart Speed __10 inches\hr__



Acetone charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: Nitrogen
5. COLLECTION SYSTEM: Nitrogen
6. OTHER CONDITIONS: 1 inch cells were used. /Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 60 cc/min.
8. PERMEATION TEST SYSTEM: Individual Cell Monitoring

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s) :	Acrolein	N/A	N/A
2. CAS NUMBER(s):	107-02-8	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 6-29-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.0 hours.
4. MIN DETECTABLE LIMIT .60 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Denise McDonald on June 29, 1987.

This page left intentionally blank

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: Nitrogen
5. COLLECTION SYSTEM: Nitrogen
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 60 cc/min.
8. PERMEATION TEST SYSTEM: Individual Cell Monitoring

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s) :	Allyl Chloride	N/A	N/A
2. CAS NUMBER(s):	107-05-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 7-01-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 4 hours.
4. MIN DETECTABLE LIMIT .50 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on July 1, 1987.

This page left intentionally blank

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9C63 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Carbon Disulfide	N/A	N/A
2. CAS NUMBER(s):	75-15-0	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-3-87
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 90 minutes
4. MIN DETECTABLE LIMIT .06 ppm
5. STEADY STATE PERMEATION RATE 10.61 (ug/cm2*hr)
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

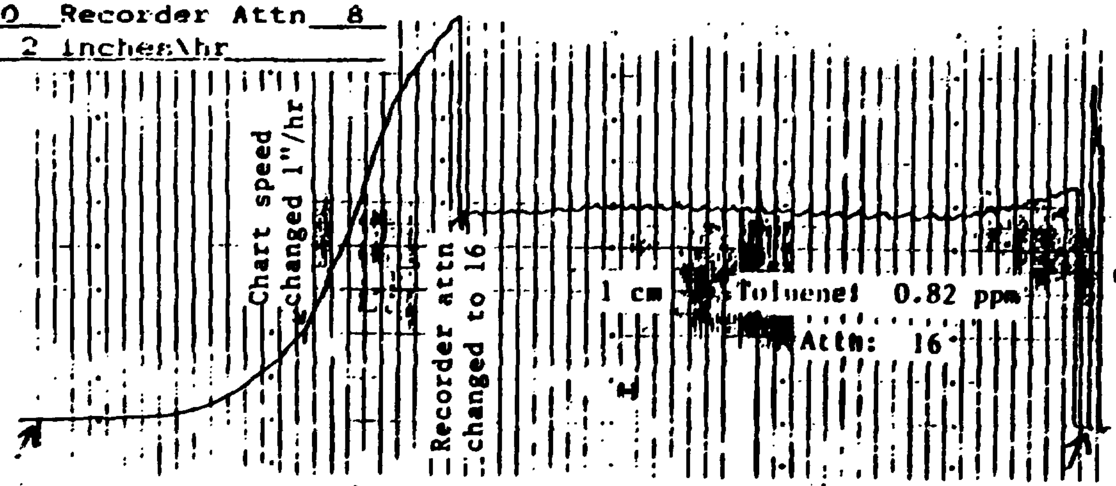
5. SOURCE OF DATA

Sample was run by Denise McDonald on April 3, 1987.

Chemical Resistance Testing of Visor Material

Carbon Disulfide Run I

Chemical Carbon Disulfide Run I
Sample Material Visor
Composite ______ Individual XX
Lamp 10.2 Detector Temp 100C
Flow Rate to Cells 100
Flow Rate to Detector 100
Input Attn 10 Recorder Attn 8
Chart Speed 2 inches\hr



Carbon Disulfide charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Carbon Disulfide	N/A	N/A
2. CAS NUMBER(s):	75-15-0	N/A	N/A
3. CONC (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-4-87
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: 94 minutes
4. MIN DETECTABLE LIMIT .16 ppm
5. STEADY STATE PERMEATION RATE 13.58 (ug/cm_2*hr)
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10				

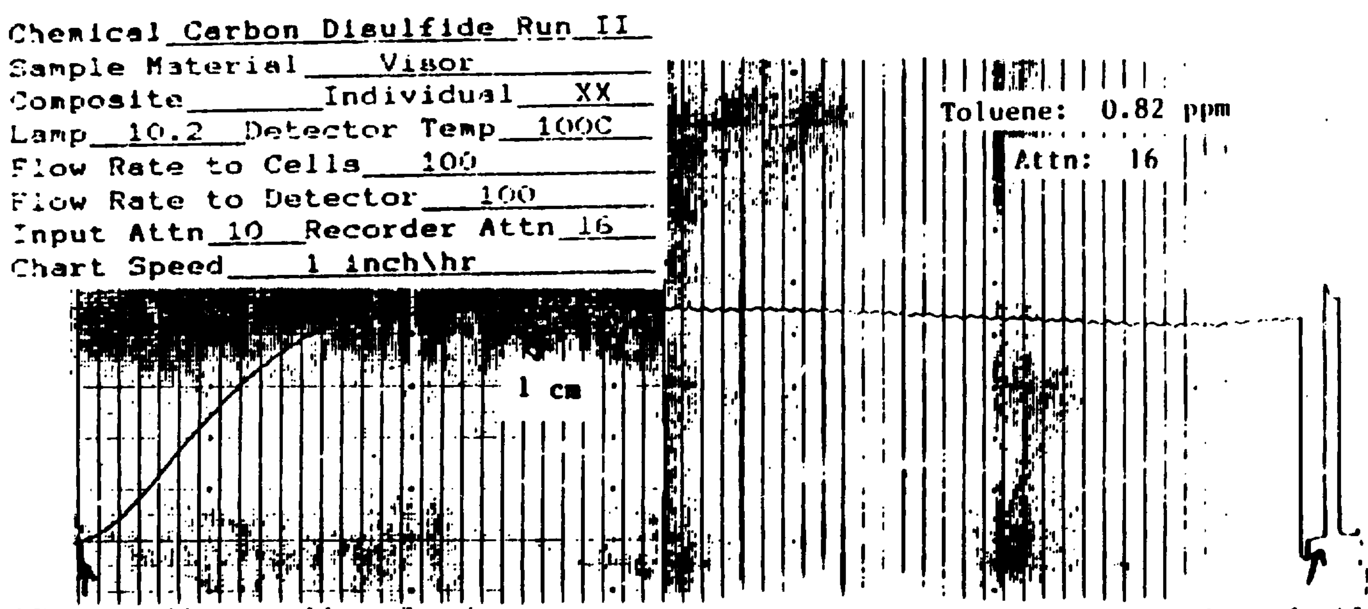
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Denise McDonald on April 4, 1987.

Chemical Resistance Testing of Visor Material

Carbon Disulfide Run II



Carbon Disulfide charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Carbon Disulfide	N/A	N/A
2. CAS NUMBER(s):	75-15-0	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-6-87
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 98 minutes
4. MIN DETECTABLE LIMIT .17 ppm
5. STEADY STATE PERMEATION RATE 7.27 (ug/cm_2*hr)
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

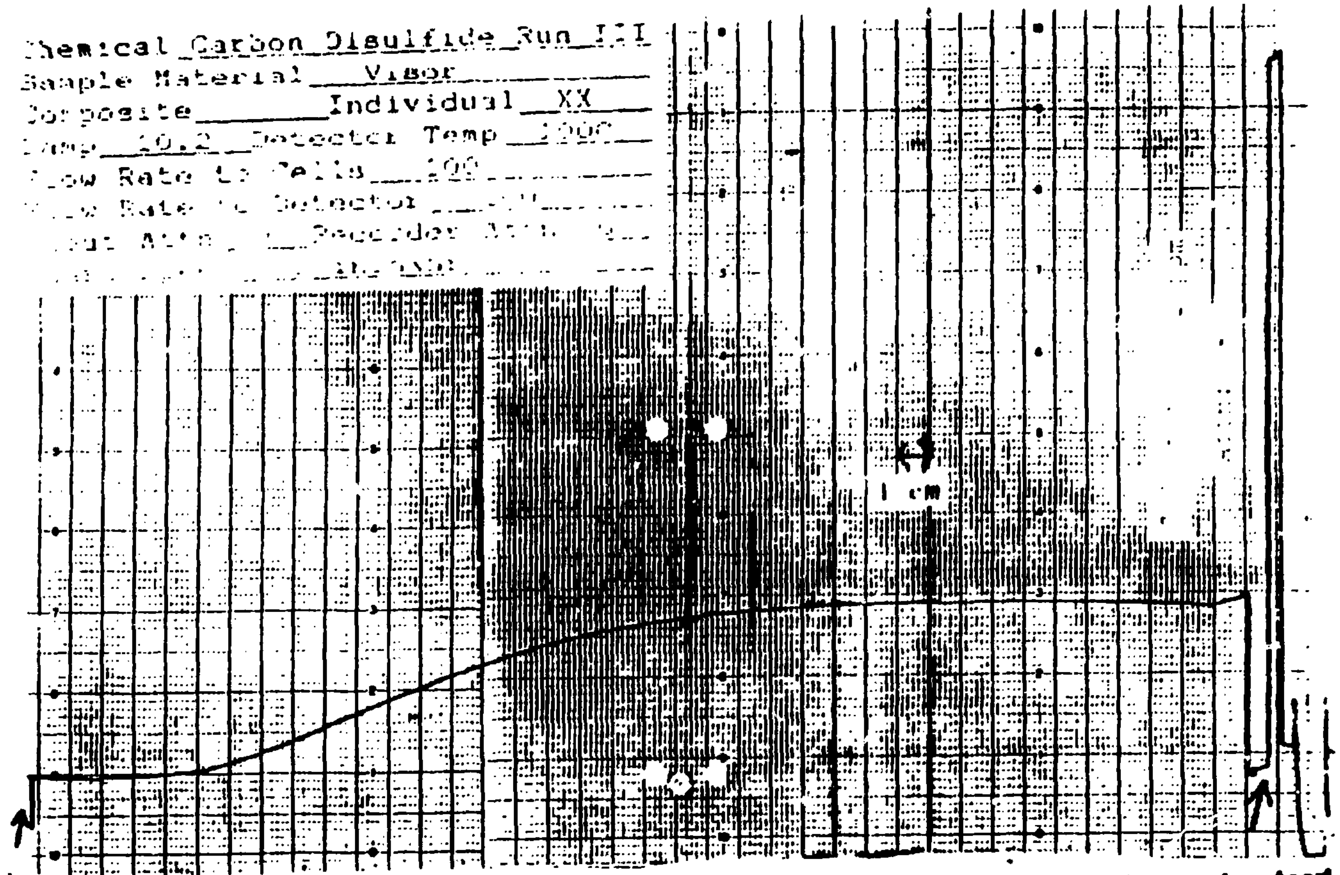
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Denise McDonald on April 6, 1987.

Chemical Resistance Testing of Visor Material

Carbon Disulfide Run III



Carbon Disulfide charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: FLow rate to cells were 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Ethyl Acetate	N/A	N/A
2. CAS NUMBER(s):	141-78-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	EM Science	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-7-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT .27 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

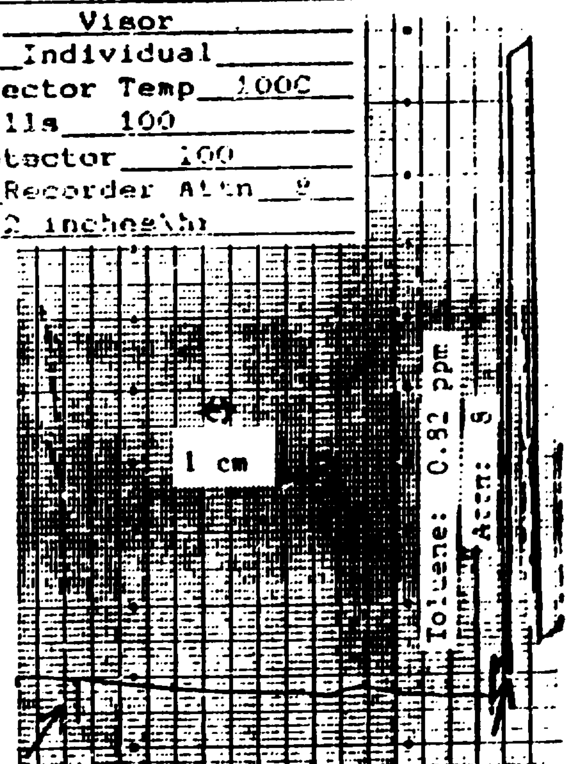
5. SOURCE OF DATA

Samples were run by Denise McDonald on April 7, 1987.

Chemical Resistance Testing of Visor Material

Ethyl Acetate

Chemical Ethyl Acetate
Sample Material Visor
Composite XX Individual
Lamp 10.2 Detector Temp 100C
Flow Rate to Cells 100
Flow Rate to Detector 100
Input Attn 10 Recorder Attn 9
Chart Speed 2 inches/hr



Ethyl Acetate charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells were 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Hexane	N/A	N/A
2. CAS NUMBER(s):	110-54-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-2-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.0 hours.
4. MIN DETECTABLE LIMIT .31 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

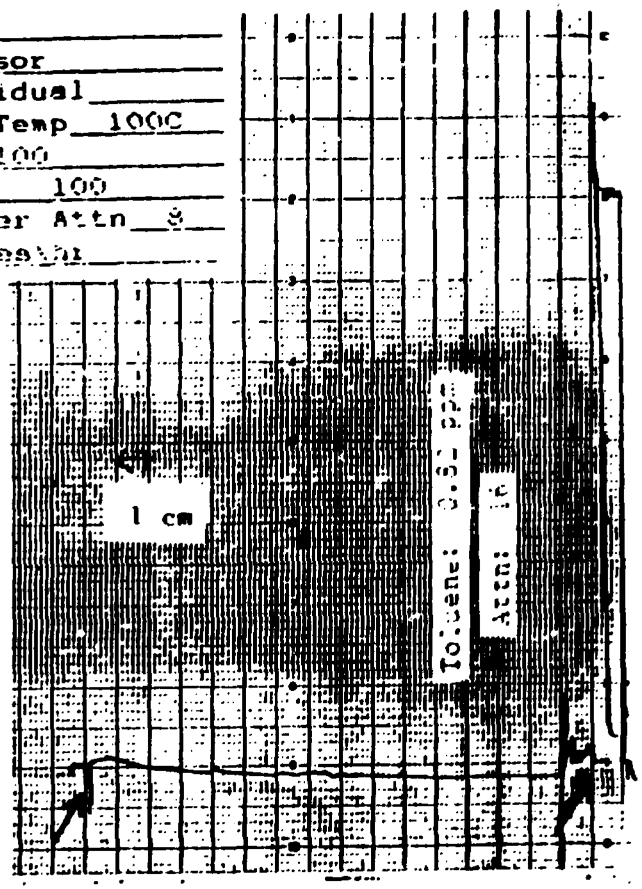
5. SOURCE OF DATA

Samples were run by Denise McDonald on April 2, 1987.

Chemical Resistance Testing of Visor Material

Hexane

Chemical __Hexane__
Sample Material __Visor__
Composite __XX__ Individual __
Lamp __10.2__ Detector Temp __100C__
Flow Rate to Cells __100__
Flow Rate to Detector __100__
Input Attn __10__ Recorder Attn __8__
Chart Speed __2 inches/hr__



Hexane charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mils
8: DESCRIPTION: Material was a white transparent sheet.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s) :	Nitrobenzene	N/A	N/A
2. CAS NUMBER(s):	98-95-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-6-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.8 hours.
4. MIN DETECTABLE LIMIT .04 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

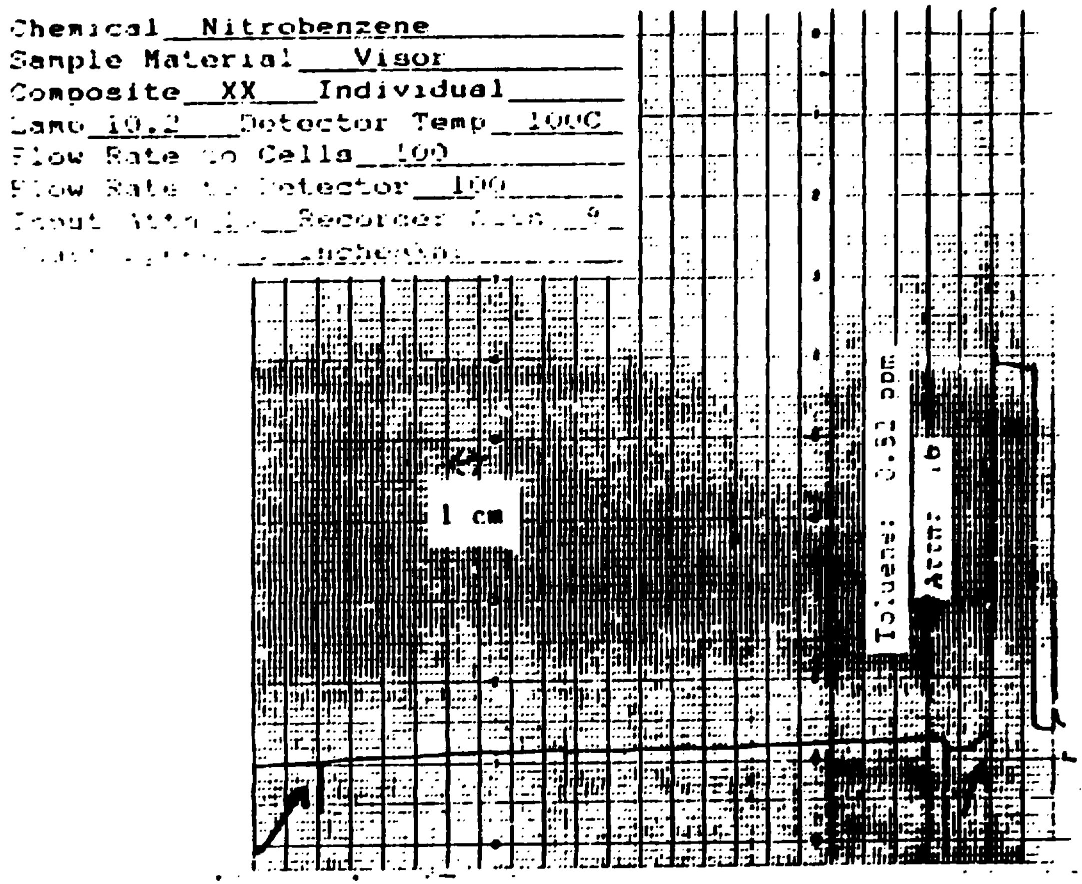
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on April 6, 1987.

Chemical Resistance Testing of Visor Material

Nitrobenzene



Nitrobenzene charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: Nitrogen
5. COLLECTION SYSTEM: Nitrogen
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 60 cc/min.
8. PERMEATION TEST SYSTEM: Individual cell monitoring

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Trichloroethylene	N/A	N/A
2. CAS NUMBER(s):	79-01-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 6-29-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 4.1 hours.
4. MIN DETECTABLE LIMIT .21 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on June 29, 1987.

This page left intentionally blank

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: Nitrogen
5. COLLECTION SYSTEM: Nitrogen
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells was 60 cc/min.
8. PERMEATION TEST SYSTEM: Individual cell monitoring

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Vinyl Acetate	N/A	N/A
2. CAS NUMBER(s):	108-05-4	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 6-30-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 4.5 hours.
4. MIN DETECTABLE LIMIT .50 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Denise McDonald on June 30, 1987.

This page left intentionally blank

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 100 C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells were 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Acetone	N/A	N/A
2. CAS NUMBER(s):	67-64-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-7-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 4 hours.
4. MIN DETECTABLE LIMIT .21 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

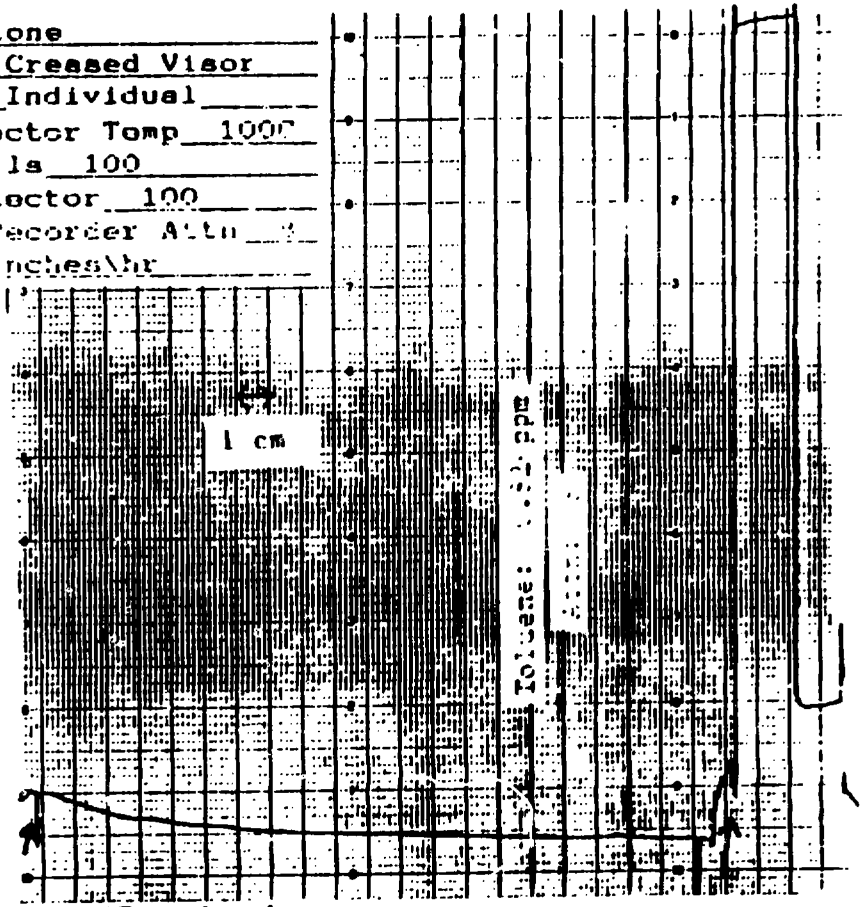
5. SOURCE OF DATA

Samples were run by Denise McDonald on April 7, 1987.

Chemical Resistance Testing of Creased Visor Material

Acetone

Chemical ____Acetone____
Sample Material Creased Visor
Composite __XX__ Individual ______
Lamp 10.2 __ Detector Temp __100C
Flow Rate to Cells __100__
Flow Rate to Detector __100__
Input Attn __10__ Recorder Attn __3__
Chart Speed __2__ inches\hr



Acetone charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Gas Chromatography
3. TEMPERATURE: Ambient
4. COLLECTION MEDIUM: Charcoal
5. COLLECTION SYSTEM: Charcoal
6. OTHER CONDITIONS: 1 inch cells were used.
7. DEVIATIONS FROM ASTM F739 METHOD:

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Acetonitrile	N/A	N/A
2. CAS NUMBER(s):	2206-26-0	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 5-13-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: N/A
4. MIN DETECTABLE LIMIT 0.5 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 19-20 mils
7. SELECTED DATA POINTS Cells 1,2, & 3 at end of three hour test

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.	3 hours	<0.5 ppm	<0.5 ppm	<0.5 ppm
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS: 3 hour samples were collected for 60 minutes for total volume of 11.5 liters.

5. SOURCE OF DATA

Samples were run by Denise McDonald and Kevin Selby on May 13, 1987.

This page left intentionally blank

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Carbon Disulfide	N/A	N/A
2. CAS NUMBER(s):	75-15-0	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-8-87
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 34 minutes
4. MIN DETECTABLE LIMIT .09 ppm
5. STEADY STATE PERMEATION RATE 8.40 (ug/cm_2*hr)
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

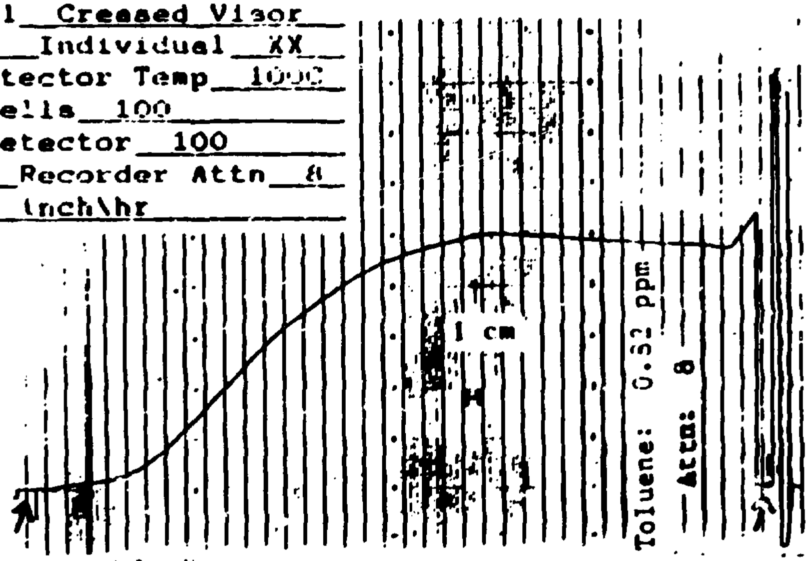
5. SOURCE OF DATA

Sample was run by Denise McDonald on April 8, 1987.

Chemical Resistance Testing of Creased Visor Material

Carbon Disulfide Run I

Chemical __Carbon Disulfide Run I__
Sample Material __Creased Visor__
Composite ______ Individual __XX__
Lamp __10.2__ Detector Temp __100C__
Flow Rate to Cells __100__
Flow Rate to Detector __100__
Input Attn __10__ Recorder Attn __8__
Chart Speed __1 inch\hr__



Carbon Disulfide charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s) :	Carbon Disulfide	N/A	N/A
2. CAS NUMBER(s):	75-15-0	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-9-87
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: 25 minutes
4. MIN DETECTABLE LIMIT .10 ppm
5. STEADY STATE PERMEATION RATE 8.60 (ug/cm_2*hr)
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

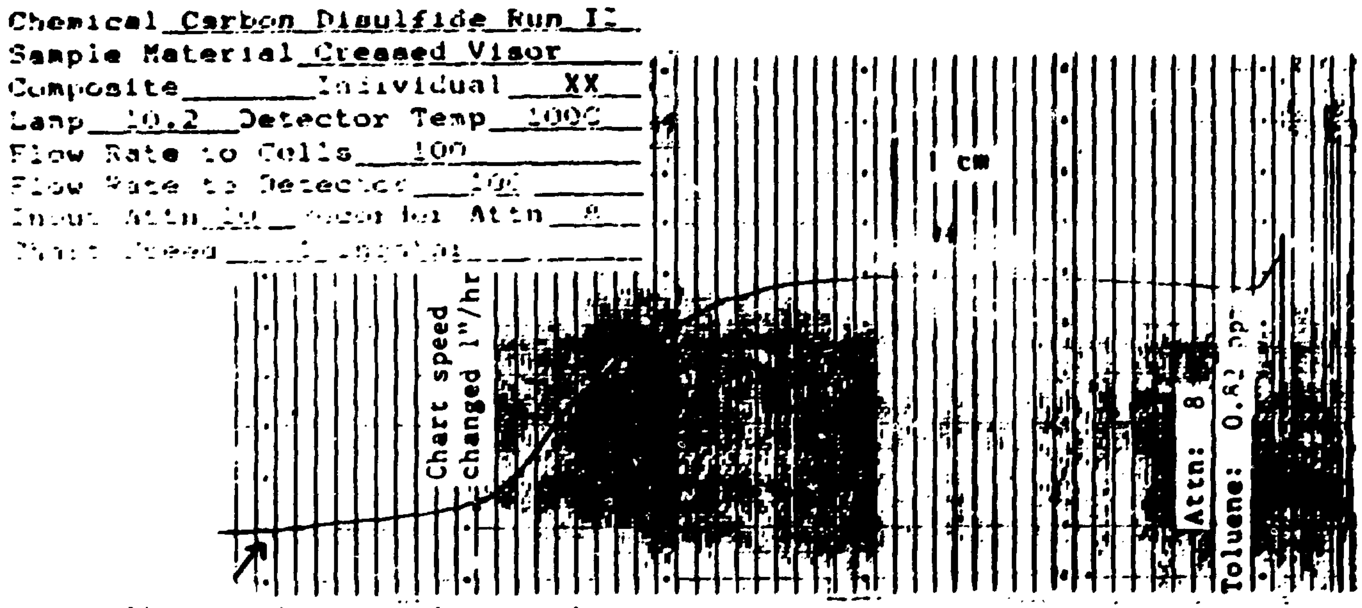
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Denise McDonald on April 9, 1987.

Chemical Resistance Testing of Creased Visor Material

Carbon Disulfide Run II



Carbon Disulfide charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s):	Carbon Disulfide	N/A	N/A
2. CAS NUMBER(s):	75-15-0	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-10-87
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 34 minutes
4. MIN DETECTABLE LIMIT .10 ppm
5. STEADY STATE PERMEATION RATE 12.80(ug/cm^2*hr)
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

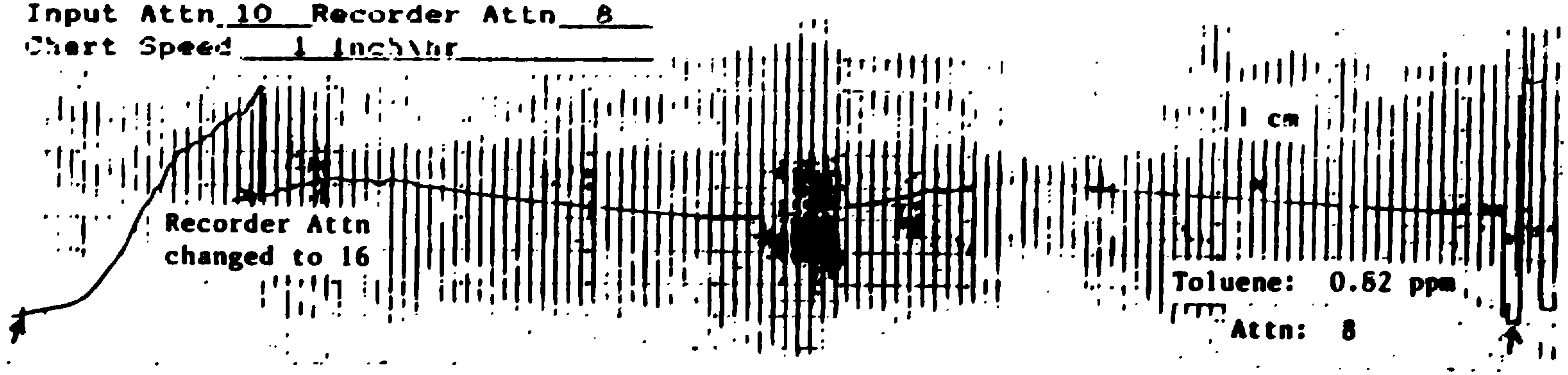
5. SOURCE OF DATA

Sample was run by Denise McDonald on April 10, 1987.

Chemical Resistance Testing of Creased Visor Material

Carbon Disulfide Run III

Chemical Carbon Disulfide Run III
Sample Material Creased Visor
Composite ______ Individual XX
Lamp 10.2 Detector Temp 100C
Flow Rate to Cells 100
Flow Rate to Detector 100
Input Attn 10 Recorder Attn 8
Chart Speed 1 inch\hr



Carbon Disulfide charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s) :	Dichloromethane	N/A	N/A
2. CAS NUMBER(s):	75-09-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-15-87
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 38 minutes
4. MIN DETECTABLE LIMIT .14 ppm
5. STEADY STATE PERMEATION RATE 5.22 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

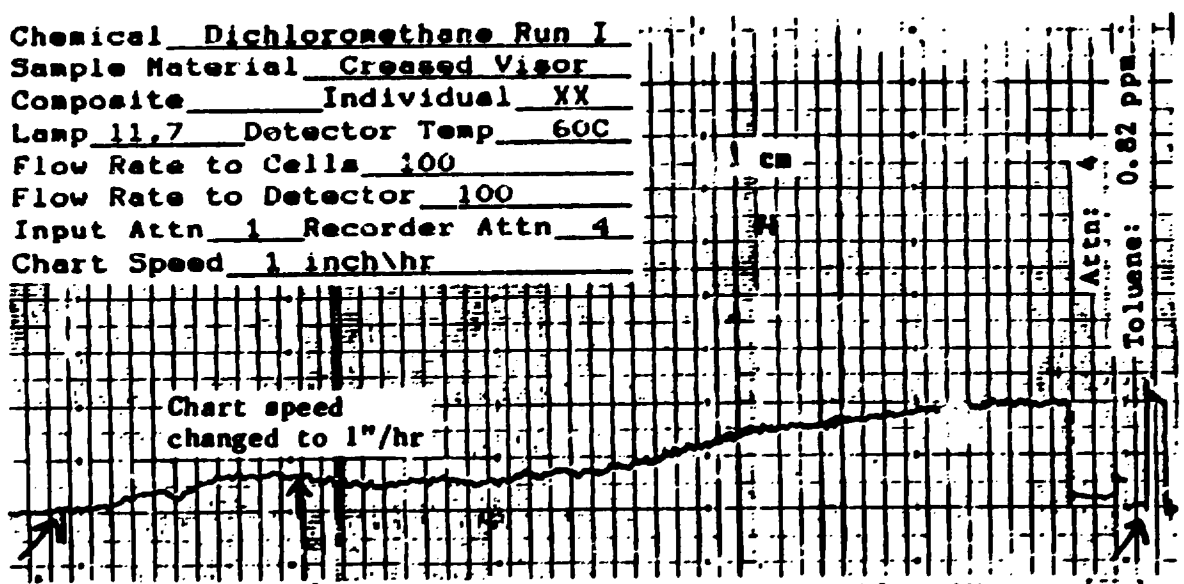
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Denise McDonald on April 15, 1987.

Chemical Resistance Testing of Creased Visor

Dichloromethane Run I



Dichloromethane charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s) :	Dichloromethane	N/A	N/A
2. CAS NUMBER(s):	75-09-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-21-87
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: 60 minutes
4. MIN DETECTABLE LIMIT .06 ppm
5. STEADY STATE PERMEATION RATE 2.45 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

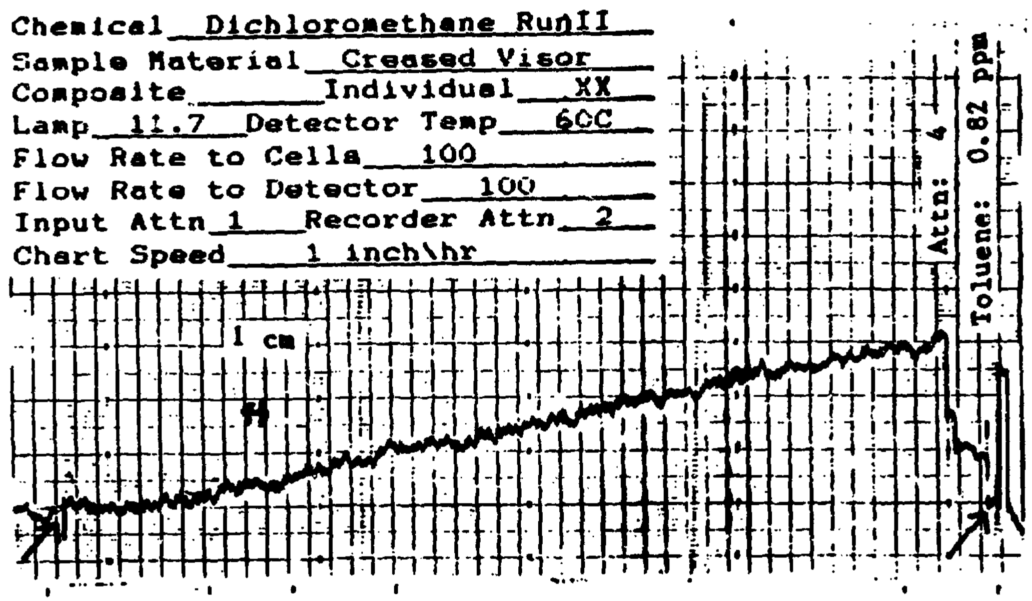
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Denise McDonald on April 21, 1987.

Chemical Resistance Testing of Creased Visor

Dichloromethane Run II



Dichloromethane charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Dichloromethane	N/A	N/A
2. CAS NUMBER(s):	75-09-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-22-87
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 30 minutes
4. MIN DETECTABLE LIMIT .08 ppm
5. STEADY STATE PERMEATION RATE 3.55 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

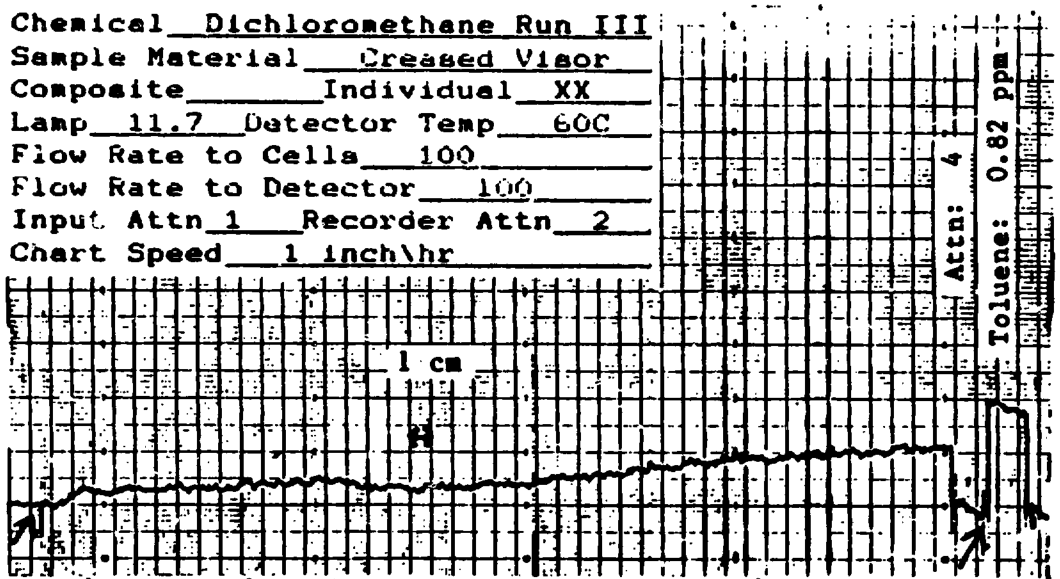
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Sample was run by Denise McDonald on April 22, 1987.

Chemical Resistance Testing of Creased Visor

Dichloromethane Run III



Dichloromethane charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells were 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s):	Diethylamine	N/A	N/A
2. CAS NUMBER(s):	109-89-7	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	EM Science	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-23-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 17.8 hours.
4. MIN DETECTABLE LIMIT 1.21 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

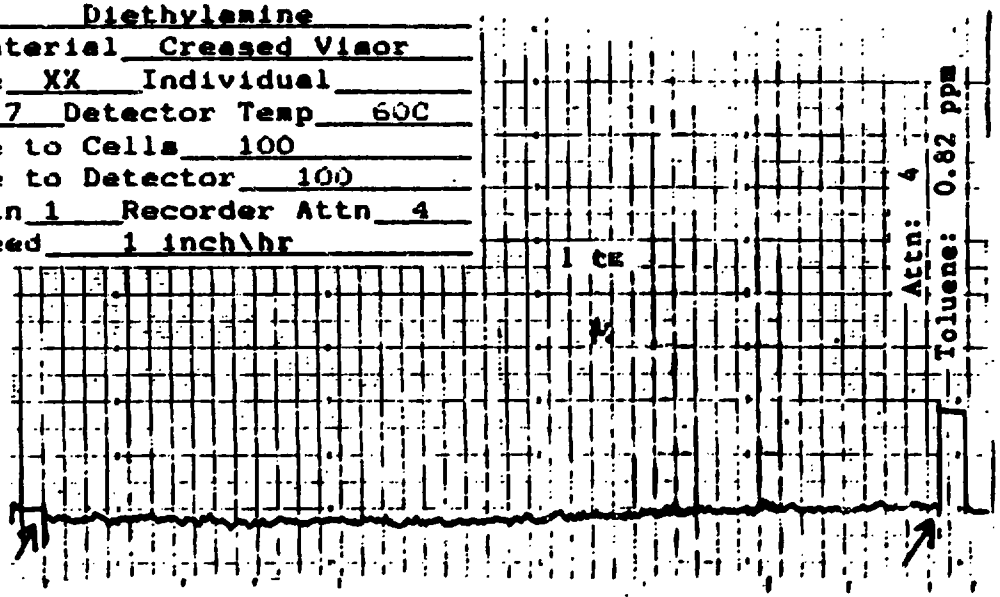
5. SOURCE OF DATA

Samples were run by Denise McDonald on April 23, 1987.

Chemical Resistance Testing of Creased Visor

Diethylamine

Chemical: Diethylamine
Sample Material: Creased Visor
Composite: XX Individual:
Lamp: 11.7 Detector Temp: 60C
Flow Rate to Cells: 100
Flow Rate to Detector: 100
Input Attn: 1 Recorder Attn: 4
Chart Speed: 1 inch\hr



Diethylamine charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells were 100 cc/min.

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s) :	Dimethylformamide	N/A	N/A
2. CAS NUMBER(s):	68-12-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-24-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 20.3 hours.
4. MIN DETECTABLE LIMIT 1.16 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

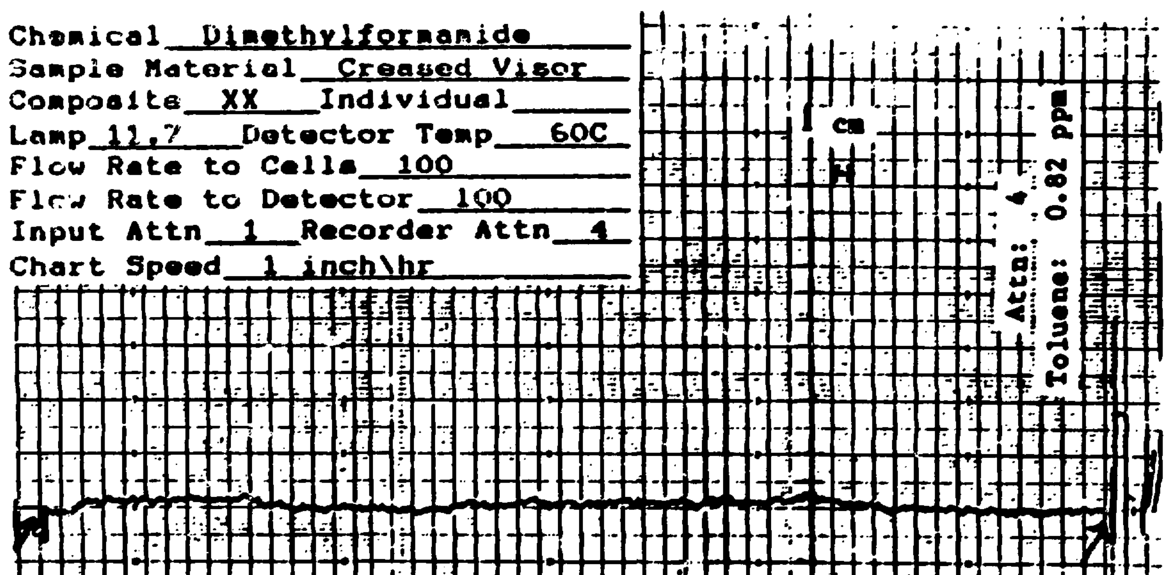
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on April 24, 1987.

Chemical Resistance Testing of Creased Visor

Dimethylformamide



Dimethylformamide charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells were 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s) :	Ethyl Acetate	N/A	N/A
2. CAS NUMBER(s):	141-78-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	EM Science	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-8-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.4 hours.
4. MIN DETECTABLE LIMIT .14 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

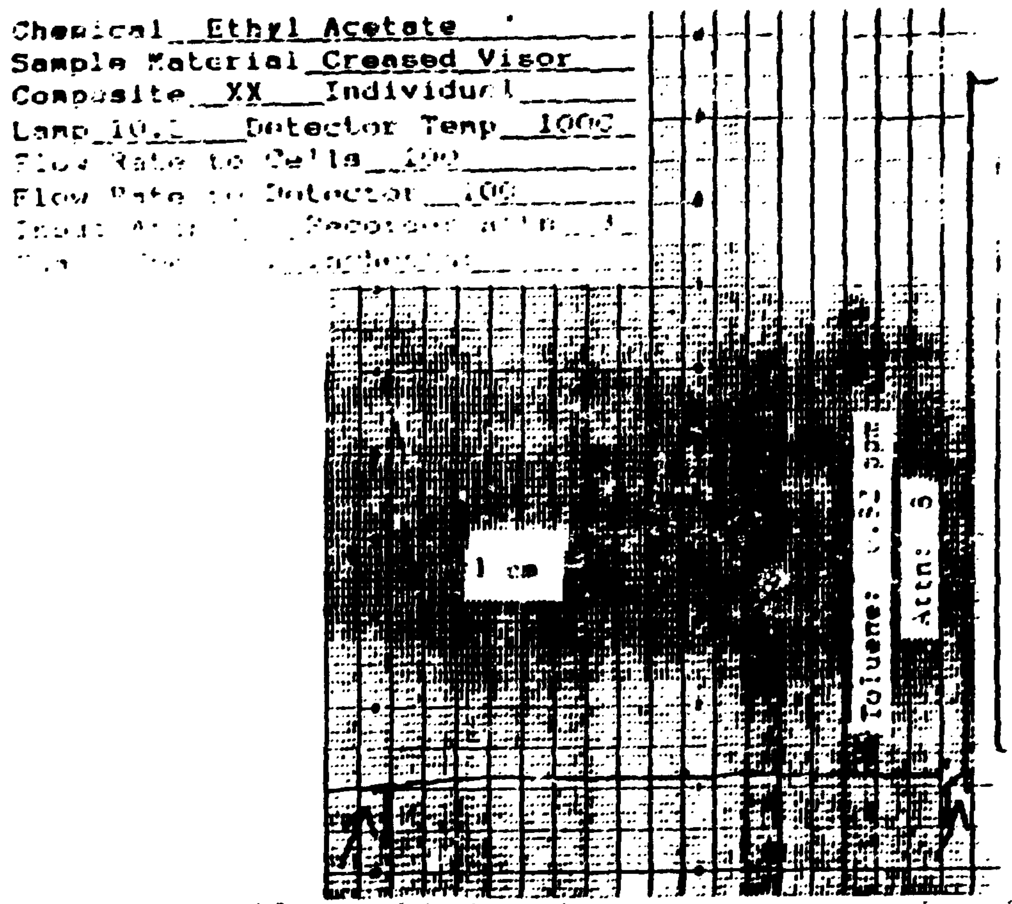
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on April 8, 1987.

Chemical Resistance Testing of Creased Visor Material

Ethyl Acetate



Ethyl Acetate charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells were 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Hexane	N/A	N/A
2. CAS NUMBER(s):	110-54-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	EM Science	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-8-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.1 hours.
4. MIN DETECTABLE LIMIT .21 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

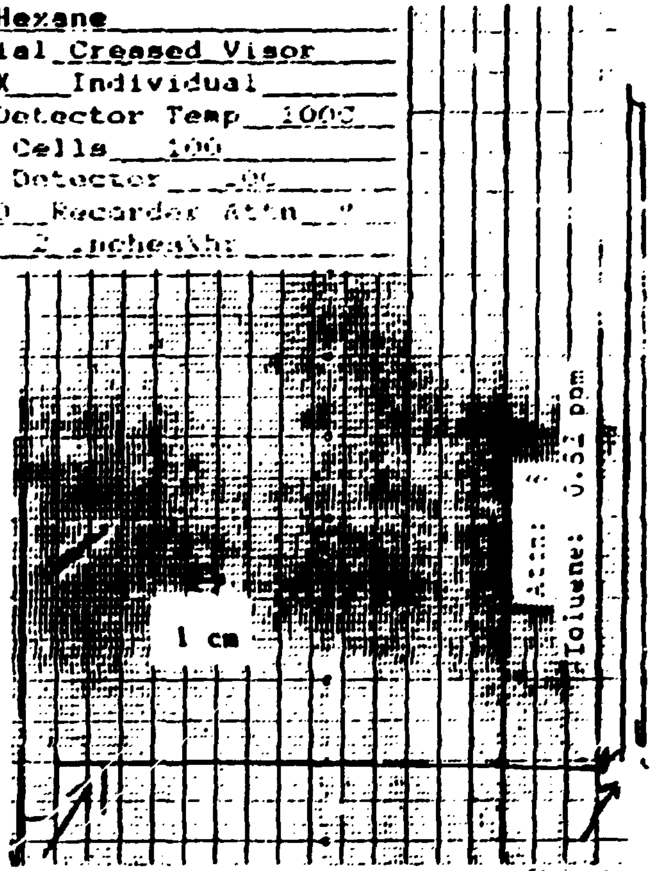
5. SOURCE OF DATA

Samples were run by Denise McDonald on April 8, 1987.

Chemical Resistance Testing of Creased Visor Material

Hexane

Chemical ___Hexane___
Sample Material _Creased Visor_
Composite __XX__ Individual ____
Lamp __10.2__ Detector Temp __100C__
Flow Rate to Cells __100__
Flow Rate to Detector ___30___
Input Attn _10_ Recorder Attn __2__
Chart Speed ___2 inches/hr___



Hexane charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells were 100 cc/min.

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s):	Methanol	N/A	N/A
2. CAS NUMBER(s):	811-98-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-16-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours
4. MIN DETECTABLE LIMIT 1.42 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on April 16, 1987.

Chemical Resistance Testing of Creased Visor

Methanol

Chemical ______ Methanol

Sample Material ___ Creased Visor

Composite __ XX ___ Individual ______

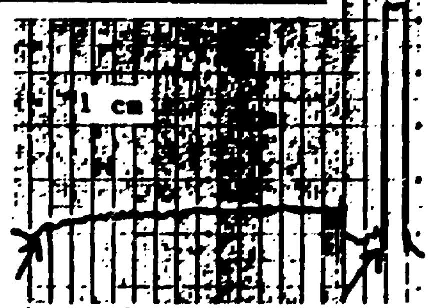
Lamp __ 11.7 __ Detector Temp ___ 60C

Flow Rate to Cells ___ 100

Flow Rate to Detector ___ 100

Input Attn __ 1 ___ Recorder Attn __ 4

Chart Speed ___ 2 inches\hr



Methanol charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells were 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Nitrobenzene	N/A	N/A
2. CAS NUMBER(s):	98-95-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-9-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 4 hours.
4. MIN DETECTABLE LIMIT .04 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

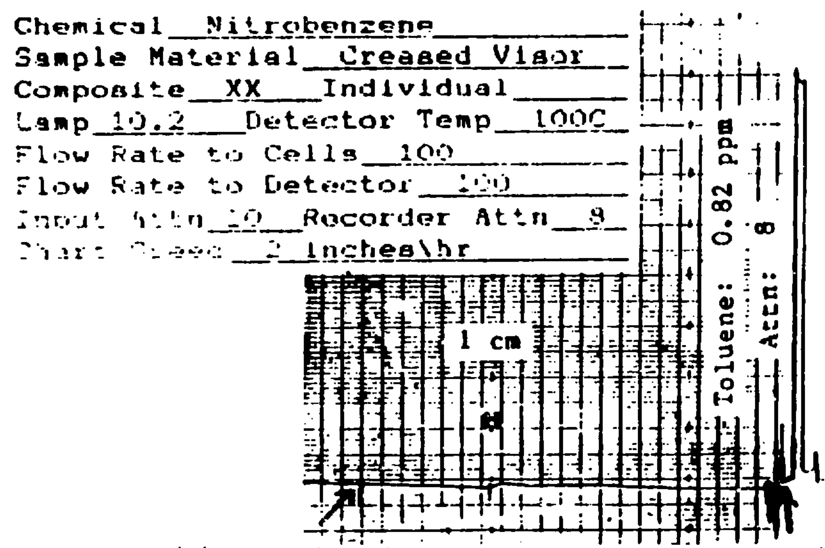
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA

Samples were run by Denise McDonald on April 9, 1987.

Chemical Resistance Testing of Creased Visor Material

Nitrobenzene



Nitrobenzene charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells were 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Tetrachloroethane	N/A	N/A
2. CAS NUMBER(s):	79-34-5	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-24-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3 hours.
4. MIN DETECTABLE LIMIT .38 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

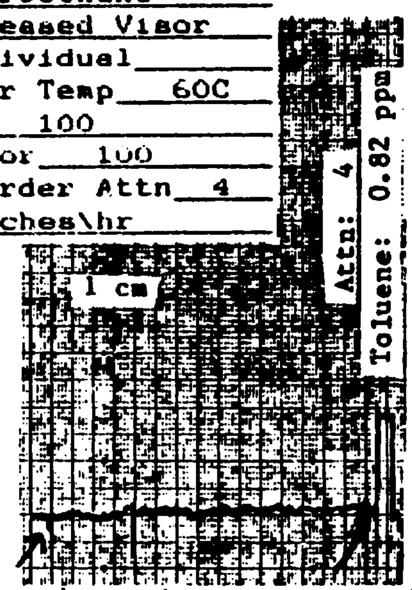
5. SOURCE OF DATA

Samples were run by Denise McDonald on April 24, 1987.

Chemical Resistance Testing of Creased Visor

Tetrachloroethane

Chemical __Tetrachloroethane__
Sample Material __Creased Visor__
Composite __XX__ Individual ____
Lamp __11.7__ Detector Temp __60C__
Flow Rate to Cells __100__
Flow Rate to Detector __100__
Input Attn __1__ Recorder Attn __4__
Chart Speed __2 inches\hr__



Tetrachloroethane charged into cells   Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells were 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s):	Tetrahydrofuran	N/A	N/A
2. CAS NUMBER(s):	109-99-9	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-16-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.2 hours.
4. MIN DETECTABLE LIMIT 1.44 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

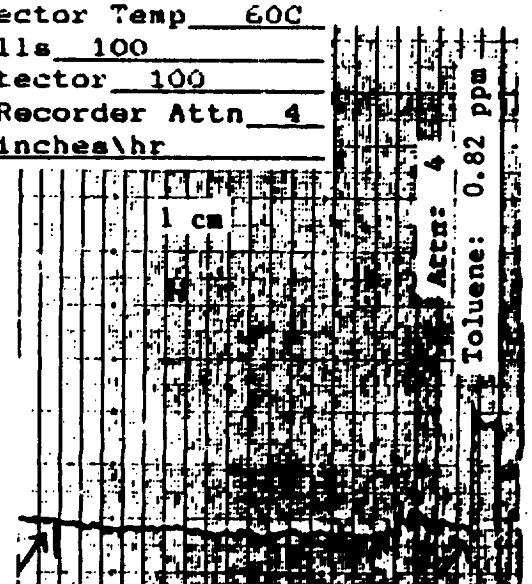
5. SOURCE OF DATA

Samples were run by Denise McDonald on April 16, 1987.

Chemical Resistance Testing of Creased Visor

Tetrahydrofuran

Chemical ___Tetrahydrofuran___
Sample Material ___Creased Visor___
Composite ___XX___ Individual ______
Lamp ___11.7___ Detector Temp ___60C___
Flow Rate to Cells ___100___
Flow Rate to Detector ___100___
Input Attn ___1___ Recorder Attn ___4___
Chart Speed ___2 inches\hr___



Tetrahydrofuran charged into cells   Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 09
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Dupont
5: PRODUCT IDENTIFICATION: Visor
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 11-13 mil
8: DESCRIPTION: Material was a white transparent sheet. Sample was creased using CHEMFAB Fold Resistance Test procedure of 5 September 1986.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cells were used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cells were 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Toluene	N/A	N/A
2. CAS NUMBER(s):	108-88-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 4-24-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: No breakthrough was observed after 3.3 hours.
4. MIN DETECTABLE LIMIT .40 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 12 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

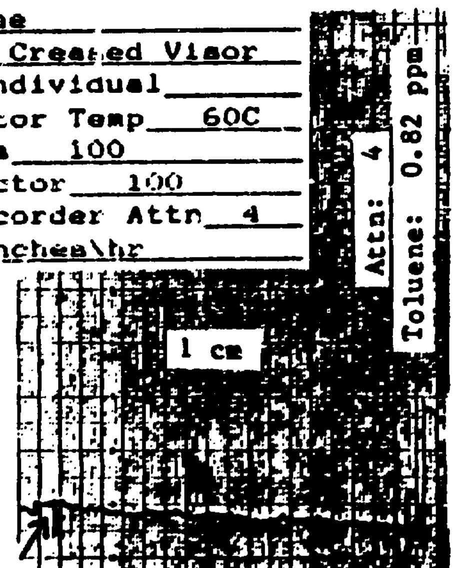
5. SOURCE OF DATA

Samples were run by Denise McDonald on April 24, 1987.

Chemical Resistance Testing of Creased Visor

Toluene

Chemical ___Toluene___
Sample Material ___Creased Visor___
Composite ___XX___ Individual ______
Lamp ___11.7___ Detector Temp ___60C___
Flow Rate to Cells ___100___
Flow Rate to Detector ___100___
Input Attn ___1___ Recorder Attn ___4___
Chart Speed ___2 inches\hr___



Toluene charged into cells   Switched from cells to standard gas

APPENDIX G

PERMEATION TEST DATA FOR INNER GLOVE MATERIAL SAMPLES

(Data Provided by Texas Research Institute Under Contract)

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./ Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Acetone	N/A	N/A
2. CAS NUMBER(s):	67-64-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 12-17-86
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT .75 ppm
5. STEADY STATE PERMEATION RATE 128.87 ug/cm^2*hr
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

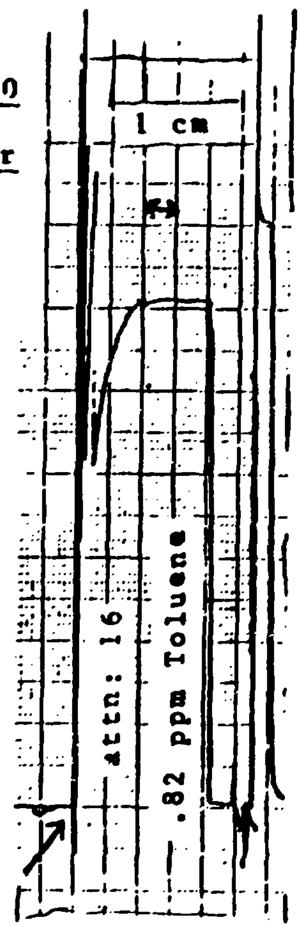
5. SOURCE OF DATA

Sample was run by Denise McDonald on December 17, 1986.

Chemical Resistance Testing of Glove Liner

Acetone Run I

Chemical: Acetone Run I
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 10
Chart speed: 2 inches/hour
Lamp: 10.2
Recorder attn: 512
Detector temp: 100
GLOVE LINER-INDIVIDUAL



Acetone charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Acetone	N/A	N/A
2. CAS NUMBER(s):	67-64-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 12-18-86
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT .85 ppm
5. STEADY STATE PERMEATION RATE 145.66 ug/cm^2*hr
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

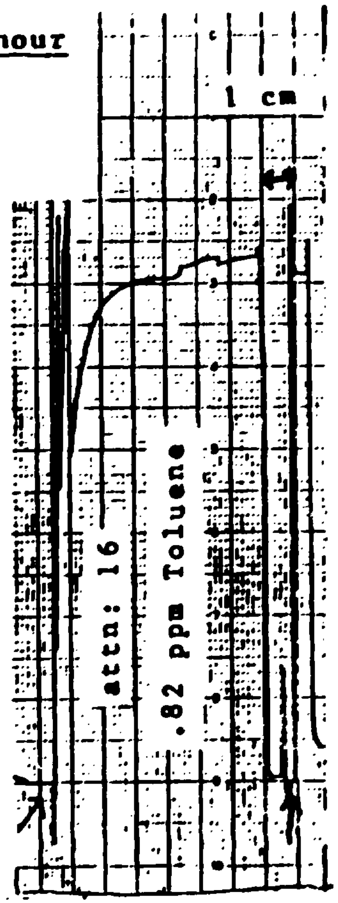
5. SOURCE OF DATA

Sample was run by Denise McDonald on December 18, 1986

Chemical Resistance Testing of Glove Liner

Acetone Run II

Chemical: Acetone Run II
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 10
Chart speed: 2 inches/hour
Lamp: 10.2
Recorder attn: 512
Detector temp: 100
GLOVE LINER-INDIVIDUAL



Acetone charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./ Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Acetone	N/A	N/A
2. CAS NUMBER(s):	67-64-1	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 12-18-86
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT .89 ppm
5. STEADY STATE PERMEATION RATE 145.58 $ug/cm^2/hr$
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

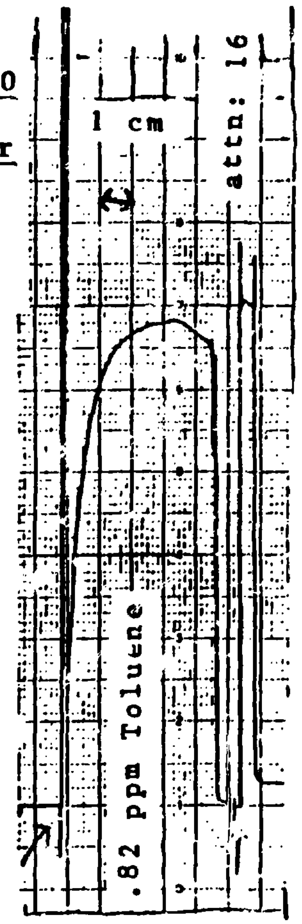
5. SOURCE OF DATA

Sample was run by Denise McDonald on December 18, 1986.

Chemical Resistance Testing of Glove Liner

Acetone Run III

Chemical: Acetone Run III
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 10
Chart speed: 2 inches/hour
Lamp: 10.2
Recorder attn: 512
Detector temp: 100
GLOVE LINER-INDIVIDUAL



Acetone charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Gas Chromatography
3. TEMPERATURE: Ambient
4. COLLECTION MEDIUM: Charcoal
5. COLLECTION SYSTEM: Charcoal
6. OTHER CONDITIONS: 1 inch cells were used.
7. DEVIATIONS FROM ASTM F739 METHOD:

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Acetonitrile	N/A	N/A
2. CAS NUMBER(s):	2206-26-0	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher-Pesticide	N/A	N/A
	Grade	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 2-06-87
2. NUMBER OF SAMPLES TESTED: Three
3. BREAKTHROUGH TIME: 5.0 minutes
4. MIN DETECTABLE LIMIT 0.6 ppm
5. STEADY STATE PERMEATION RATE (Average) 62 (ug/cm*hr)
6. SAMPLE THICKNESS: 19-20 mils
7. SELECTED DATA POINTS 60,80,100, and 120 minutes

	TIME	ug/cm^2*hr Cell 1	ug/cm^2*hr Cell 2	ug/cm^2*hr Cell 3
1.	60 minutes	60	67	73
2.	80 minutes	53	70	64
3.	100 minutes	59	61	52
4.	120 minutes	57	65	60
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS: The first sample was collected 5 minutes after initiation of testing. All subsequent samples were collected at 20 minute intervals.

5. SOURCE OF DATA

Samples were run by Denise McDonald on February 6, 1987.

This page left intentionally blank

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used. /Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Dichloromethane	N/A	N/A
2. CAS NUMBER(s):	75-09-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-28-87
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT 2.57 ppm
5. STEADY STATE PERMEATION RATE 487.10 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

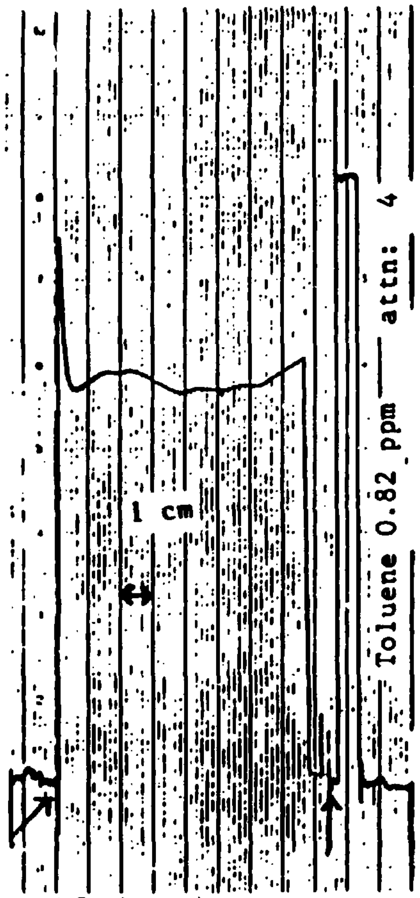
5. SOURCE OF DATA

Sample was run by Denise McDonald on January 28, 1987.

Chemical Resistance Testing of Glove Liner

Dichloromethane Run I

Chemical: Dichloromethane Run I
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1
Chart speed: 2 in/hr
Lamp: 11.7
Recorder attn: 512
Detector temp: 60
GLOVE LINER, INDIVIDUAL



Dichloromethane charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Dichloromethane	N/A	N/A
2. CAS NUMBER(s):	75-09-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-29-87
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT 2.57 ppm
5. STEADY STATE PERMEATION RATE 507.95 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

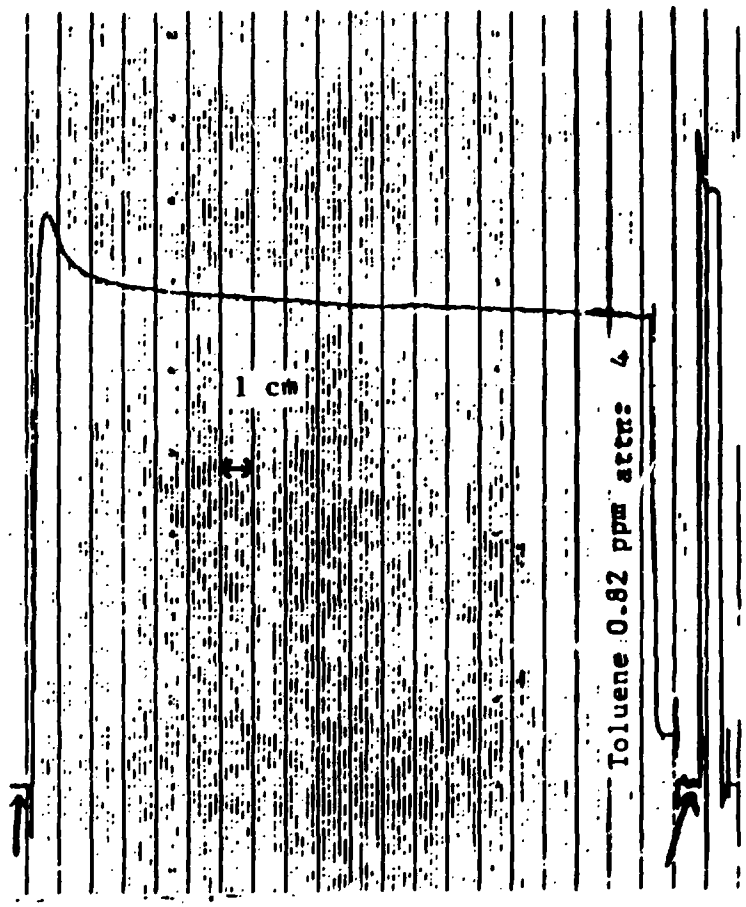
5. SOURCE OF DATA

Sample was run by Denise McDonald on January 29, 1987.

Chemical Resistance Testing of Glove Liner

Dichloromethane Run II

Chemcial: Dichloromethane Run II
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1
Chart speed: 5 in/hr
Lamp: 11.7
Recorder attn: 512
Detector temp: 60
GLOVE LINER, INDIVIDUAL



Dichloromethane charged into cells Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Dichloromethane	N/A	N/A
2. CAS NUMBER(s):	75-09-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-29-87
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT 2.60 ppm
5. STEADY STATE PERMEATION RATE 498.52 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

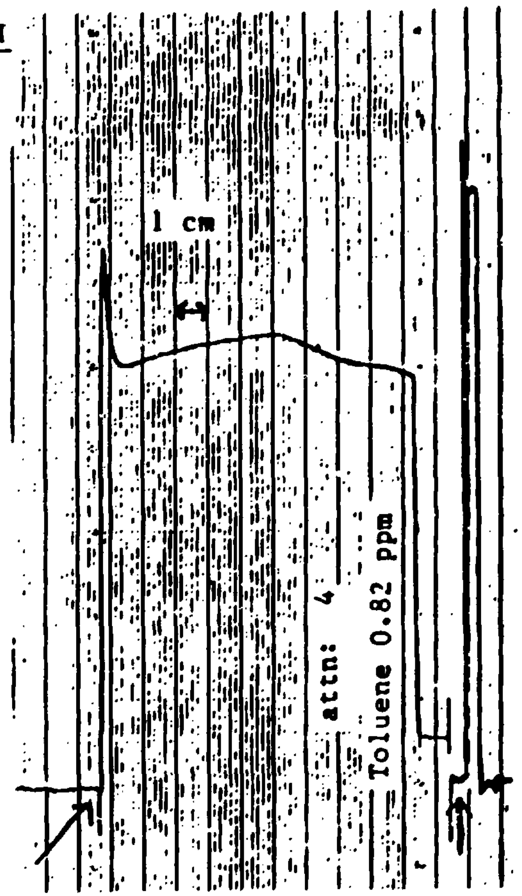
8. OTHER OBSERVATIONS:

5. SOURCE OF DATA
Sample was run by Denise McDonald on January 29, 1987.

Chemical Resistance Testing of Glove Liner

Dichloromethane Run III

Chemical: Dichloromethane Run III
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1
Chart speed: 2 in/hr
Lamp: 11.7
Recorder attn: 512
Detector temp: 60
GLOVE LINER, INDIVIDUAL



Dichloromethane charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

   1: TYPE: Teflon
   2: PROTECTIVE MATERIAL CODE: 044
   3: CONDITION BEFORE TEST: Unused, no visible imperfections
   4: MANUFACTURER: Chemfab Corp.
   5: PRODUCT IDENTIFICATION: Inner glove sheet stock
   6: LOT OR MANUFACTURER DATE: N/A
   7: NOMINAL THICKNESS: 7-9 mils
   8: DESCRIPTION:

2. TEST METHOD

   1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
   2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
   3. TEMPERATURE: 22-25°C
   4. COLLECTION MEDIUM: N_2
   5. COLLECTION SYSTEM: N_2
   6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
   7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Diethylamine	N/A	N/A
2. CAS NUMBER(s):	109-89-7	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	EM Science	N/A	N/A

4. TEST RESULTS

   1. DATE TESTED: 2-2-87
   2. NUMBER OF SAMPLES TESTED: One(Run I)
   3. BREAKTHROUGH TIME: 2.5 minutes
   4. MIN DETECTABLE LIMIT 4.75 ppm
   5. STEADY STATE PERMEATION RATE 1124 (ug/cm^2*hr)
   6. SAMPLE THICKNESS: 7 mils
   7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

   8. OTHER OBSERVATIONS:

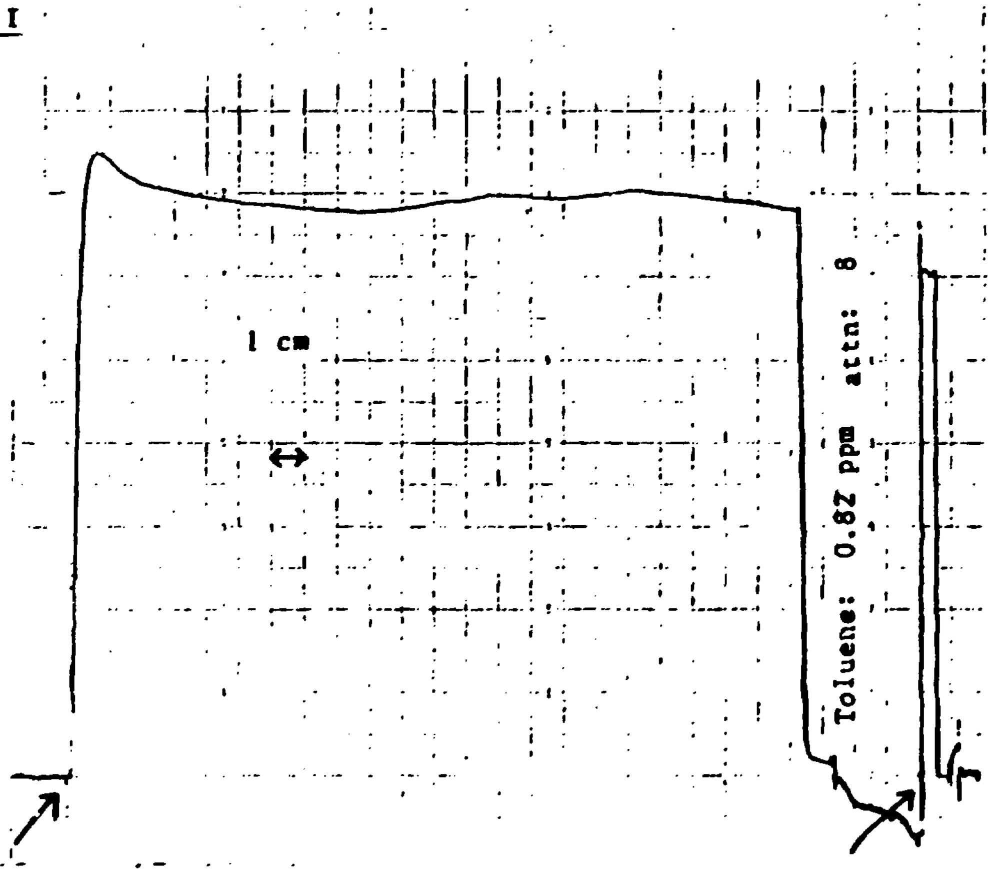
5. SOURCE OF DATA

   Sample was run by Denise McDonald on February 2, 1987.

Chemical Resistance Testing of Glove Liner

Diethylamine Run I

Chemical: Diethylamine Run I
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1
Chart speed: 5 in/hr
Lamp: 11.7
Recorder attn: 512
Detector temp: 60
GLOVE LINER, INDIVIDUAL



Diethylamine charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Diethylamine	N/A	N/A
2. CAS NUMBER(s):	109-89-7	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	EM Science	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 2-3-87
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT 4.72 ppm
5. STEADY STATE PERMEATION RATE 1116 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

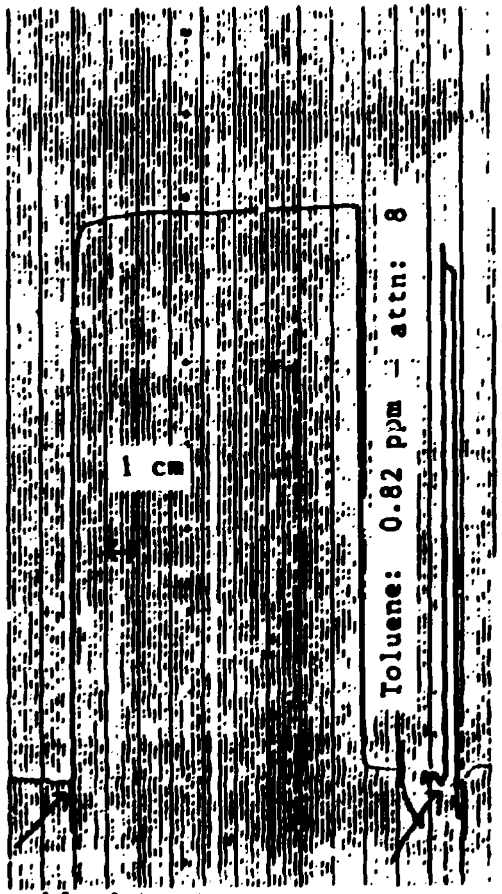
5. SOURCE OF DATA

Sample was run by Denise McDonald on February 3, 1987.

Chemical Resistance Testing of Glove Liner

Diethylamine Run II

Chemical: Diethylamine Run II
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1
Chart speed: 2 in/hr
Lamp: 11.7
Recorder attn: 512
Detector temp: 60
GLOVE LINER, INDIVIDUAL



Diethylamine charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25 °C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Diethylamine	N/A	N/A
2. CAS NUMBER(s):	109-89-7	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	EM Science	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 2-3-87
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT 4.60 ppm
5. STEADY STATE PERMEATION RATE 1072 (ug/cm*hr)
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

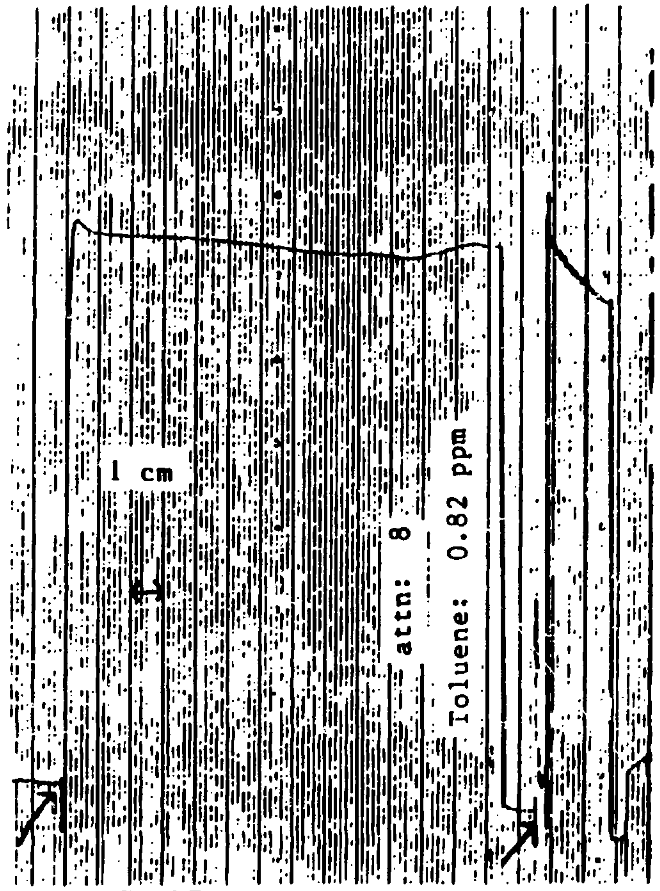
5. SOURCE OF DATA

Sample was run by Denise McDonald on February 3, 1987.

Chemical Resistance Testing of Glove Liner

Diethylamine Run III

Chemical: Diethylamine Run III
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1
Chart speed: 2 in/hr
Lamp: 11.7
Recorder attn: 512
Detector temp: 60
GLOVE LINER, INDIVIDUAL



Diethylamine charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Dimethylformamide	N/A	N/A
2. CAS NUMBER(s):	68-12-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-27-87
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT .28 ppm
5. STEADY STATE PERMEATION RATE 49.19 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

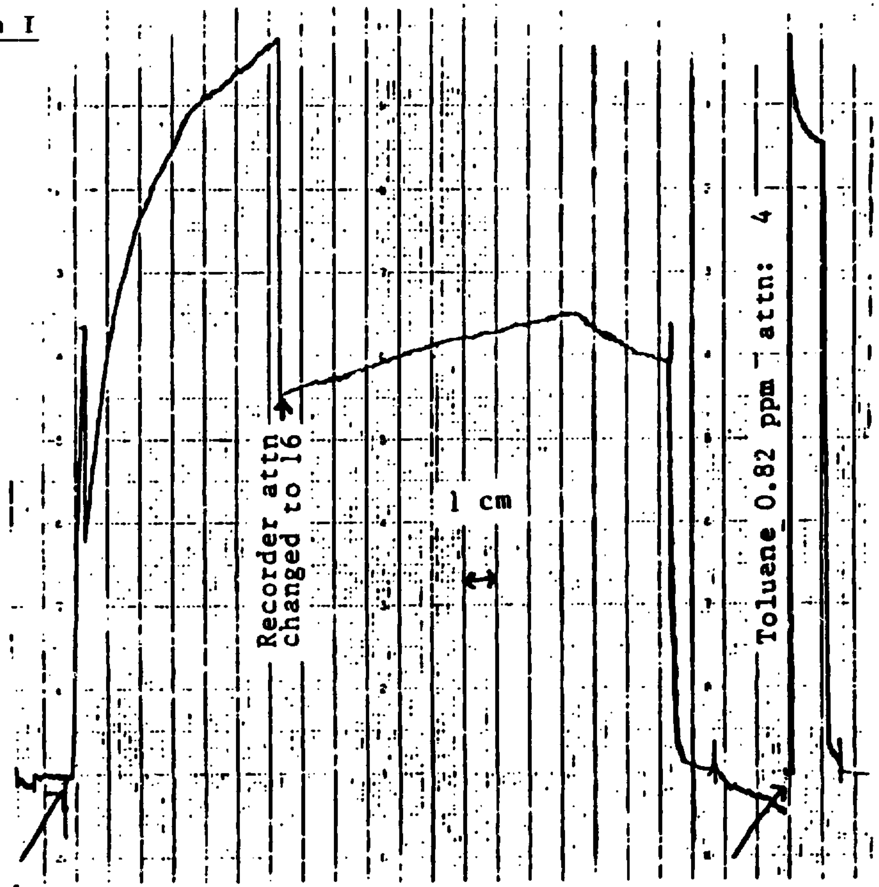
5. SOURCE OF DATA

Sample was run by Denise McDonald on January 27, 1987.

Chemical Resistance Testing of Glove Liner

Dimethylformamide Run I

Chemical: Dimethylformamide Run I
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1
Chart speed: 2 in/hr
Lamp: 11.7
Recorder attn: 16
Detector temp: 60
GLOVE LINER, INDIVIDUAL



Dimethylformamide charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Dimethylformamide	N/A	N/A
2. CAS NUMBER(s):	68-12-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-27-87
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT .30 ppm
5. STEADY STATE PERMEATION RATE 38.73 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

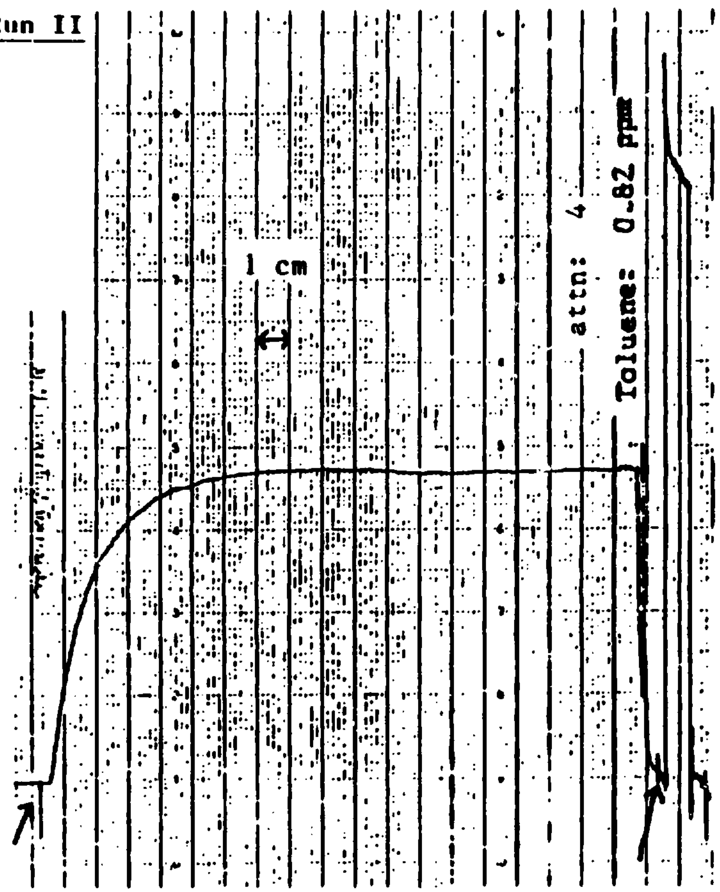
5. SOURCE OF DATA

Sample was run by Denise McDonald on January 27, 1987.

Chemical Resistance Testing of Glove Liner

Dimethylformamide Run II

Chemical: Dimethylformamide Run II
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1
Chart speed: 5 in/hr
Lamp: 11.7
Recorder attn: 16
Detector temp: 60
GLOVE LINER, INDIVIDUAL



Dimethylformamide charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Dimethylformamide	N/A	N/A
2. CAS NUMBER(s):	68-12-2	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-28-87
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT .29 ppm
5. STEADY STATE PERMEATION RATE 40.42 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

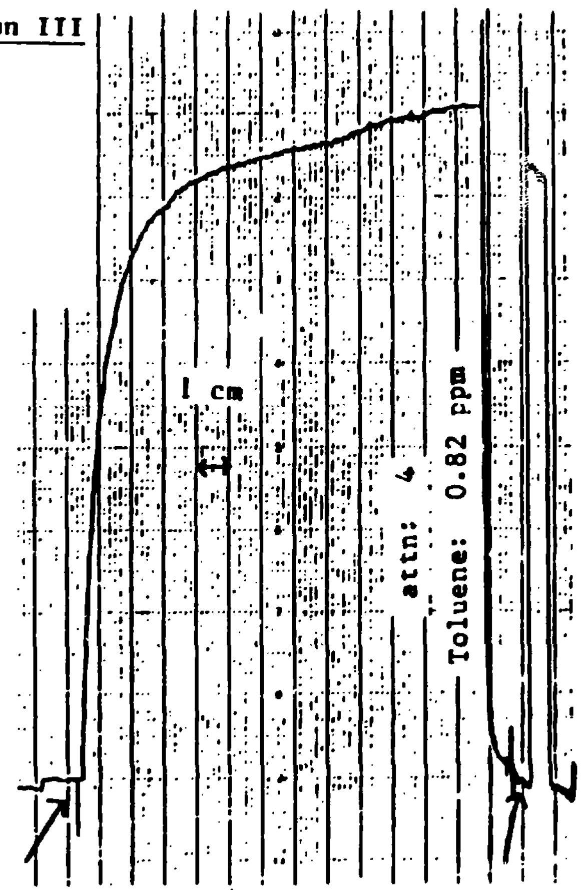
5. SOURCE OF DATA

Sample was run by Denise McDonald on January 28, 1987.

Chemical Resistance Testing of Glove Liner

Dimethylformamide Run III

Chemcial: Dimethylformamide Run III
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1
Chart speed: 2 in/hr
Lamp: 11.7
Recorder attn: 8
Detector temp: 60
GLOVE LINER, INDIVIDUAL



Dimethylformamide charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mil
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s):	Ethyl Acetate	N/A	N/A
2. CAS NUMBER(s):	141-78-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	EM Science	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 12-17-86
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT .87 ppm
5. STEADY STATE PERMEATION RATE 282.68 $ug/cm^2/hr$
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

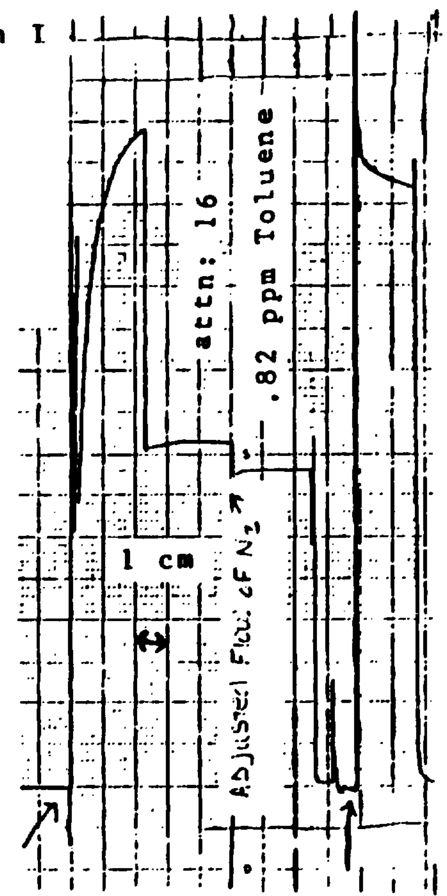
5. SOURCE OF DATA

Sample was run by Denise McDonald on December 17, 1986.

Chemical Resistance Testing of Glove Liner

Ethyl Acetate Run I

Chemical: Ethyl Acetate Run I
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 10
Chart speed: 2 inches/hour
Lamp: 10.2
Recorder attn: 256
Detector temp: 100
GLOVE LINER-INDIVIDUAL



Ethyl Acetate charged into cells   Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used. / Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Ethyl Acetate	N/A	N/A
2. CAS NUMBER(s):	141-78-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	EM Science	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 12-17-86
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT .89 ppm
5. STEADY STATE PERMEATION RATE 269.64 ug/cm^2*hr
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

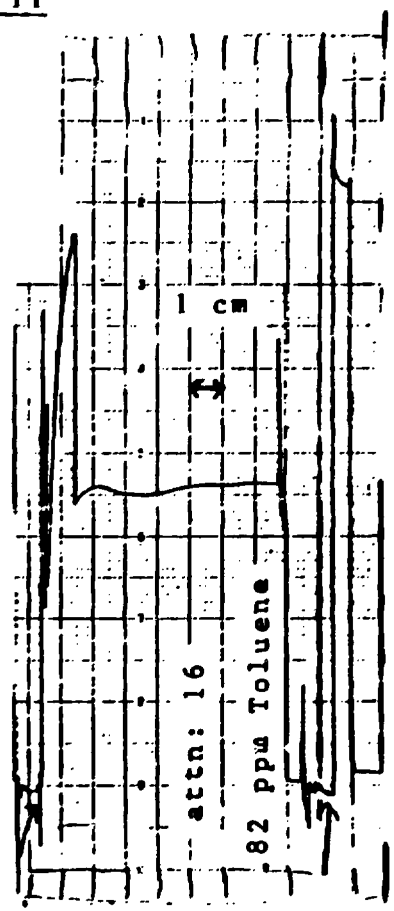
5. SOURCE OF DATA

Sample was run by Denise McDonald on December 17, 1986.

Chemical Resistance Testing of Glove Liner

Ethyl Acetate Run II

Chemical: Ethyl Acetate Run II
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 10
Chart speed: 2 inches/hour
Lamp: 10.2
Recorder attn: 512
Detector temp: 100
GLOVE LINER-INDIVIDUAL



Ethyl Acetate charged into cells   Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mil
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Ethyl Acetate	N/A	N/A
2. CAS NUMBER(s):	141-78-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	EM Science	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 12-17-86
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT .90 ppm
5. STEADY STATE PERMEATION RATE 258.24 ug/cm^2/hr
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

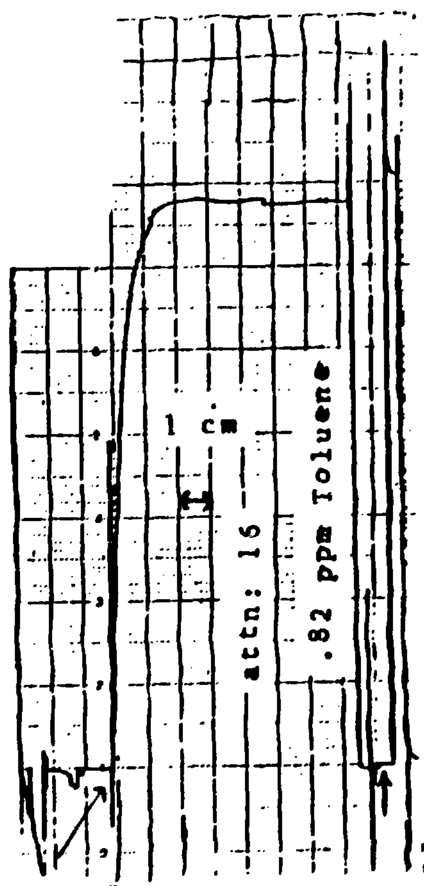
5. SOURCE OF DATA

Sample was run by Denise McDonald on December 17, 1986.

Chemical Resistance Testing of Glove Liner

Ethyl Acetate Run III

Chemical: Ethyl Acetate Run III
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 10
Chart speed: 2 inches/hour
Lamp: 10.2
Recorder attn: 256
Detector temp: 100
GLOVE LINER-INDIVIDUAL



Ethyl Acetate charged into cells Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used. / Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Hexane	N/A	N/A
2. CAS NUMBER(s):	110-54-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 12-22-86
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT 9.12 ppm
5. STEADY STATE PERMEATION RATE 1898 $ug/cm^2/hr$
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

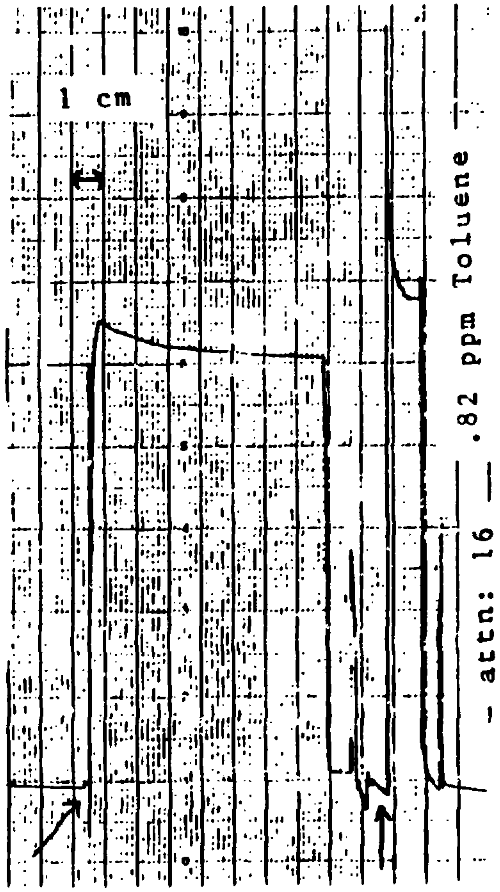
5. SOURCE OF DATA

Sample was run by Denise McDonald on December 22, 1986.

Chemical Resistance Testing of Glove Liner

Hexane Run I

Chemical: Hexane Run I
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 10
Chart speed: 2 inches/hour
Lamp: 10.2
Recorder attn: 1024
Detector temp: 100
GLOVE LINER



Hexane charged into cells   Switched from cells to stan'·rd gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used. / Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Hexane	N/A	N/A
2. CAS NUMBER(s):	110-54-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 12-22-86
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: · 2.5 minutes
4. MIN DETECTABLE LIMIT 9.60 ppm
5. STEADY STATE PERMEATION RATE 1838 ug/cm^2/hr
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

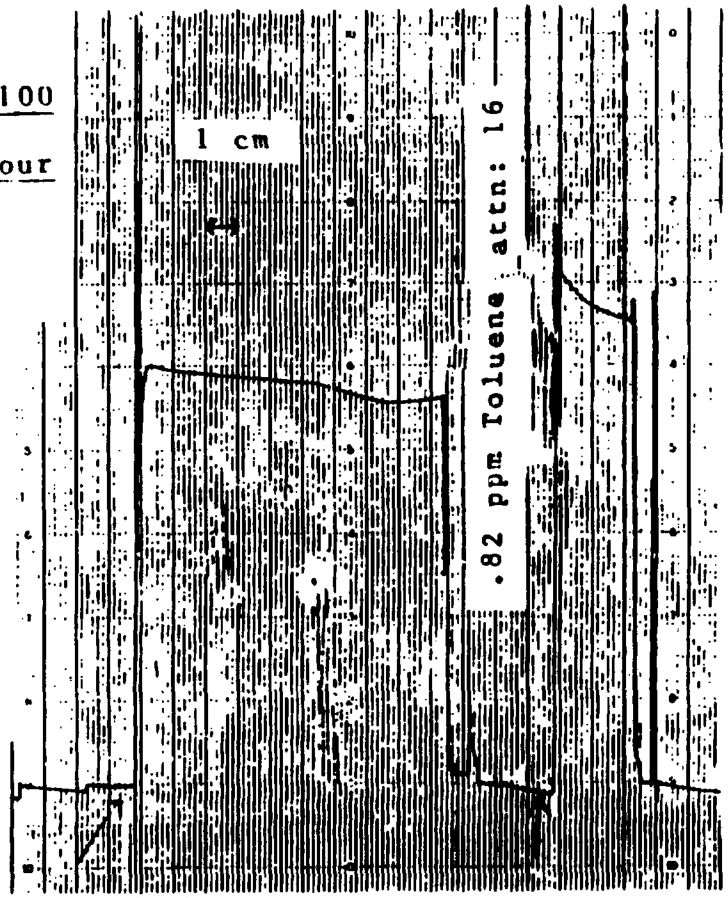
5. SOURCE OF DATA

Sample was run by Denise McDonald on December 22, 1986.

Chemical Resistance Testing of Glove Liner

Hexane Run II

Chemical: Hexane Run II
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 10
Chart speed: 2 inches/hour
Lamp: 10.2
Recorder attn: 1024
Detector temp: 100
GLOVE LINER



Hexane charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used. / Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	COMPONENT 2	COMPONENT 3
1. CHEM NAME(s):	Hexane	N/A	N/A
2. CAS NUMBER(s):	110-54-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 12-22-86
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT 9.68 ppm
5. STEADY STATE PERMEATION RATE 1810 $ug/cm^2/hr$
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

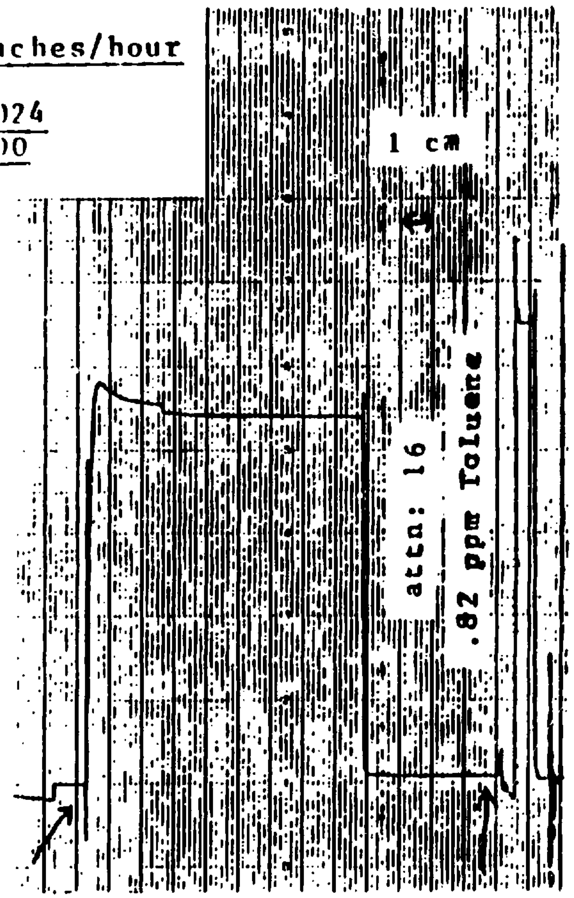
5. SOURCE OF DATA

Sample was run by Denise McDonald on December 22, 1986.

Chemical Resistance Testing of Glove Liner

Hexane Run III

Chemical: Hexane Run III
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 10
Chart speed: 2 inches/hour
Lamp: 10.2
Recorder attn: 1024
Detector temp: 100
GLOVE LINER



Hexane charged into cells Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Methanol	N/A	N/A
2. CAS NUMBER(s):	811-98-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-26-87
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT .65 ppm
5. STEADY STATE PERMEATION RATE 20.21 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 8 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

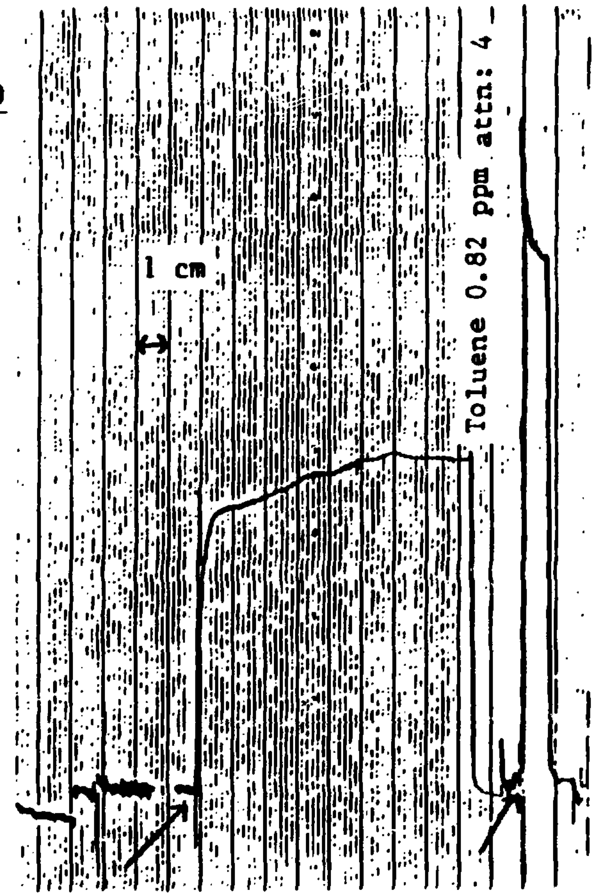
5. SOURCE OF DATA

Sample was run by Denise McDonald on January 26, 1987.

Chemical Resistance Testing of Glove Liner

Methanol Run I

Chemical: Methanol Run I
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1
Chart speed: 2 in/hr
Lamp: 11.7
Recorder attn: 16
Detector temp: 60
GLOVE LINER INDIVIDUAL RUN



Methanol charged into cells Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Methanol	N/A	N/A
2. CAS NUMBER(s):	811-98-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-26-87
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT .64 ppm
5. STEADY STATE PERMEATION RATE 15.54 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

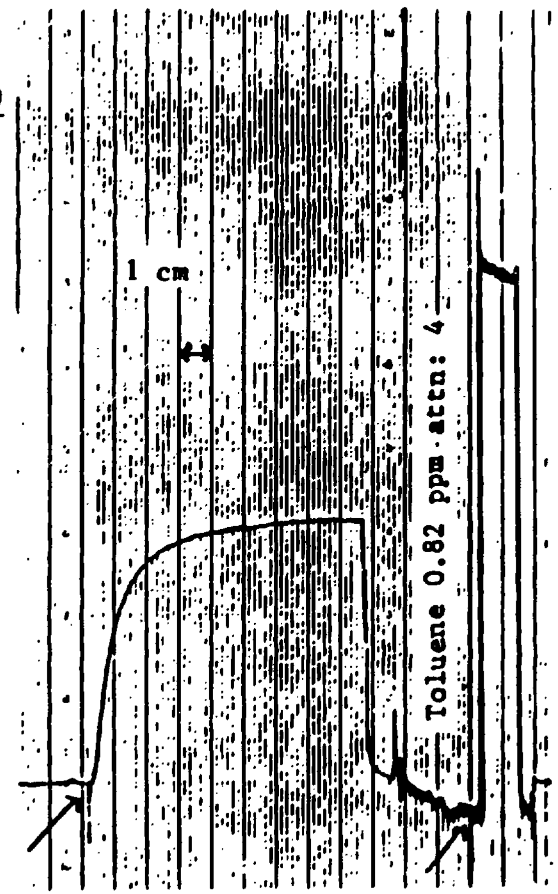
5. SOURCE OF DATA

Sample was run by Denise McDonald on January 26, 1987.

Chemical Resistance Testing of Glove Liner

Methanol Run II

Chemical: Methanol Run II
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1
Chart speed: 2 in/hr
Lamp: 11.7
Recorder attn: 16
Detector temp: 60
GLOVE LINER INDIVIDUAL



Methanol charged into cells   Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Methanol	N/A	N/A
2. CAS NUMBER(s):	811-98-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Fisher	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-26-87
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT .65 ppm
5. STEADY STATE PERMEATION RATE 21.79 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

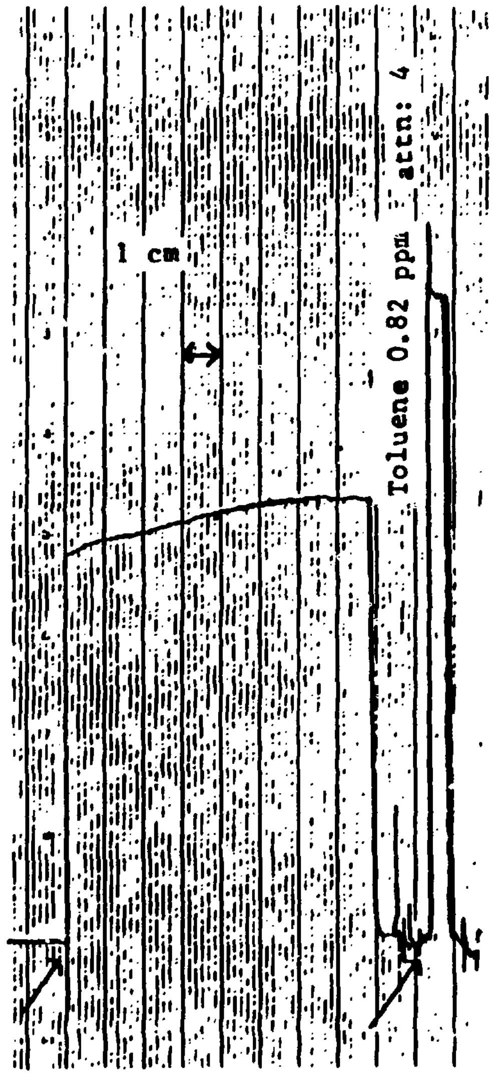
5. SOURCE OF DATA

Sample was run by Denise McDonald on January 26, 1987.

Chemical Resistance Testing of Glove Liner

Methanol Run III

Chemical: Methanol Run III
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1
Chart speed: 2 in/hr
Lamp: 11.7
Recorder attn: 16
Detector temp: 60
GLOVE LINER, INDIVIDUAL



Methanol charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature =100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Nitrobenzene	N/A	N/A
2. CAS NUMBER(s):	98-95-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 12-23-86
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 2.50 minutes
4. MIN DETECTABLE LIMIT .13 ppm
5. STEADY STATE PERMEATION RATE 57.18 ug/cm^2*hr
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

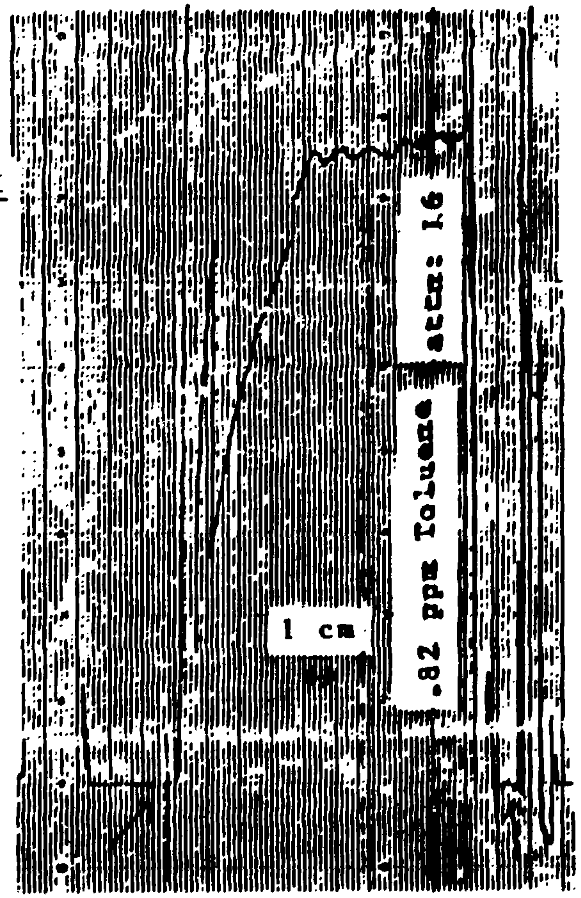
5. SOURCE OF DATA

Sample was run by Denise McDonald on December 23, 1986

Chemical Resistance Testing of Glove Liner

Nitrobenzene Run I

Chemical: Nitro Benzene Run I
Flow rate to Detector: 100
Flow rate to Detector: 100
Input attn: 10
Chart speed: 2 inches/hour
Lamp: 10.2
Recorder attn: 128
Detector temp: 100
GLOVE LINER



Nitrobenzene charged into cells Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detectoe Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Nitrobenzene	N/A	N/A
2. CAS NUMBER(s):	98-95-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 12-23-86
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: 2.50 minutes
4. MIN DETECTABLE LIMIT .14 ppm
5. STEADY STATE PERMEATION RATE 55.97 $ug/cm^2/hr$
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

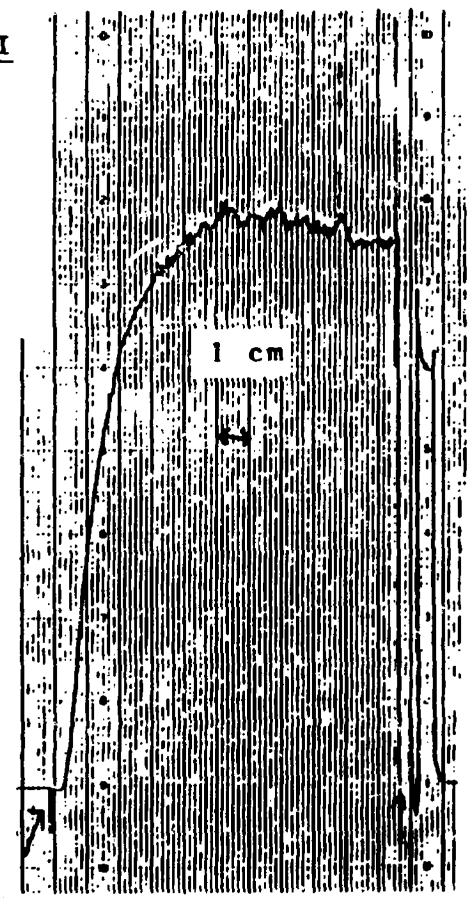
5. SOURCE OF DATA

Sample was run by Denise McDonald on December 23, 1986.

Chemical Resistance Testing of Glove Liner

Nitrobenzene Run II

Chemical: Nitro Benzene Run II
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 10
Chart speed: 2 inches/hour
Lamp: 10.2
Recorder attn: 128
Detector temp: 100
GLOVE LINER



Nitrobenzene charged into cells Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Nitrobenzene	N/A	N/A
2. CAS NUMBER(s):	98-95-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 12-23-86
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 2.50 minutes
4. MIN DETECTABLE LIMIT .14 ppm
5. STEADY STATE PERMEATION RATE 57.79 ug/cm^2*hr
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

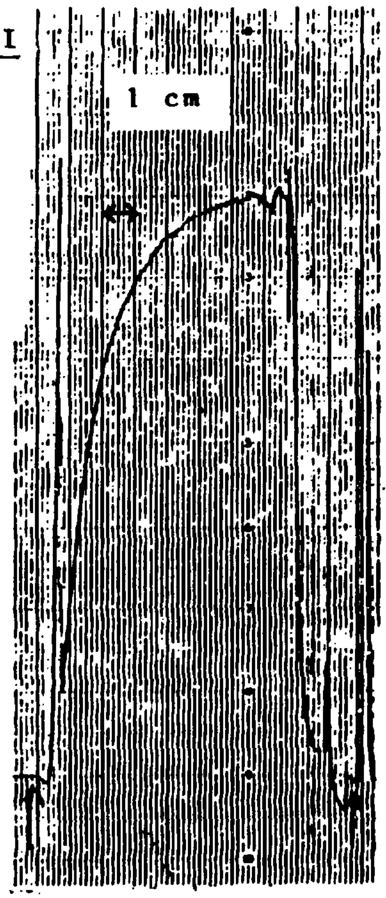
5. SOURCE OF DATA

Sample was run by Denise McDonald on December 23, 1986

Chemical Resistance Testing of Glove Liner

Nitrobenzene Run III

Chemical: Nitro Benzene Run III
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 10
Chart speed: 2 inches/hour
Lamp: 10.2
Recorder attn: 128
Detector temp: 100
GLOVE LINER



Nitrobenzene charged into cells   Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL	1	COMPONENT 2	3
1. CHEM NAME(s) :	Tetrachloroethane	N/A	N/A
2. CAS NUMBER(s):	79-34-5	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-29-87
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT 2.81 ppm
5. STEADY STATE PERMEATION RATE 1189 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

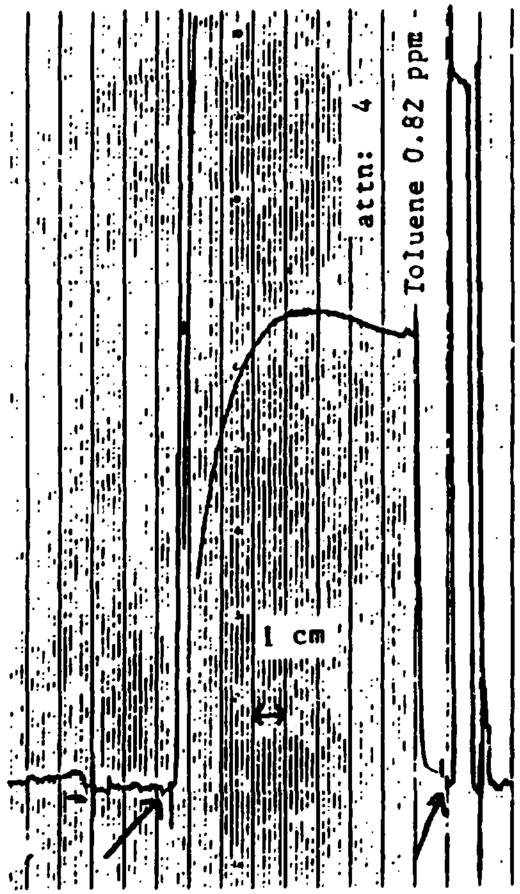
5. SOURCE OF DATA

Sample was run by Denise McDonald on January 29, 1987.

Chemical Resistance Testing of Glove Liner

Tetrachloroethane Run I

Chemical: Tetrachloroethane Run I
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1
Chart speed: 2 in/hr
Lamp: 11.7
Recorder attn: 256
Detector temp: 60
GLOVE LINER, INDIVIDUAL



Tetrachloroethane charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s) :	Tetrachloroethane	N/A	N/A
2. CAS NUMBER(s):	79-34-5	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-30-37
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT 2.78 ppm
5. STEADY STATE PERMEATION RATE 1132 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

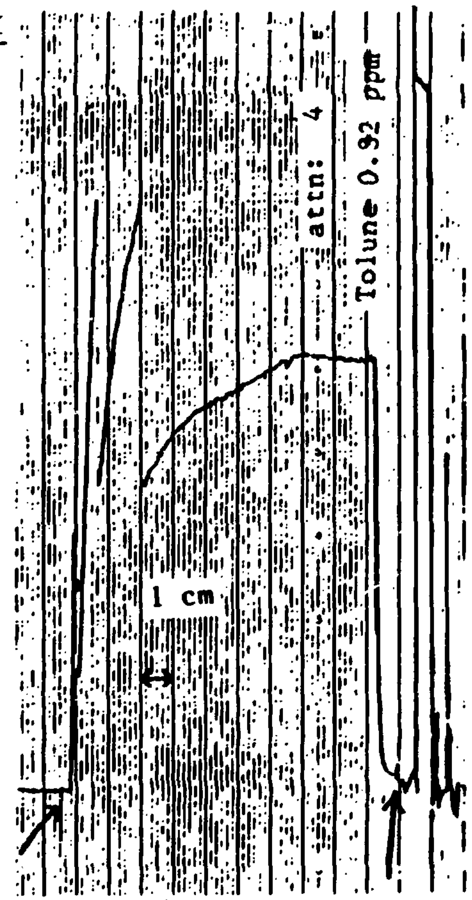
5. SOURCE OF DATA

Sample was run by Denise McDonald on January 30, 1987.

Chemical Resistance Testing of Glove Liner

Tetrachloroethane Run II

Chemical: Tetrachloroethane Run II
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1
Chart speed: 2 in/hr
Lamp: 11.7
Recorder attn: 256
Detector temp: 60
GLOVE LINER, INDIVIDUAL



Tetrachloroethane charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Tetrachloroethane	N/A	N/A
2. CAS NUMBER(s):	79-34-5	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-30-87
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT 2.92 ppm
5. STEADY STATE PERMEATION RATE 1049 (ug/cm*hr)
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

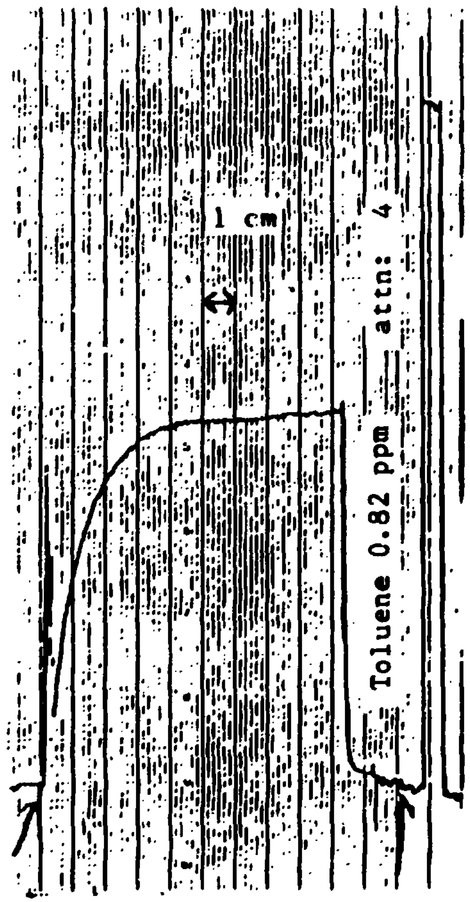
5. SOURCE OF DATA

Sample was run by Denise McDonald on January 30, 1987.

Chemical Resistance Testing of Glove Liner

Tetrachloroethane Run III

Chemical: Tetrachloroethane Run III
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1
Chart speed: 2 in/hr
Lamp: 11.7
Recorder attn: 256
Detector temp: 60
GLOVE LINER, INDIVIDUAL



Tetrachloroethane charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Tetrahydrofuran	N/A	N/A
2. CAS NUMBER(s):	109-99-9	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-30-87
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT 8.04 ppm
5. STEADY STATE PERMEATION RATE 1655 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

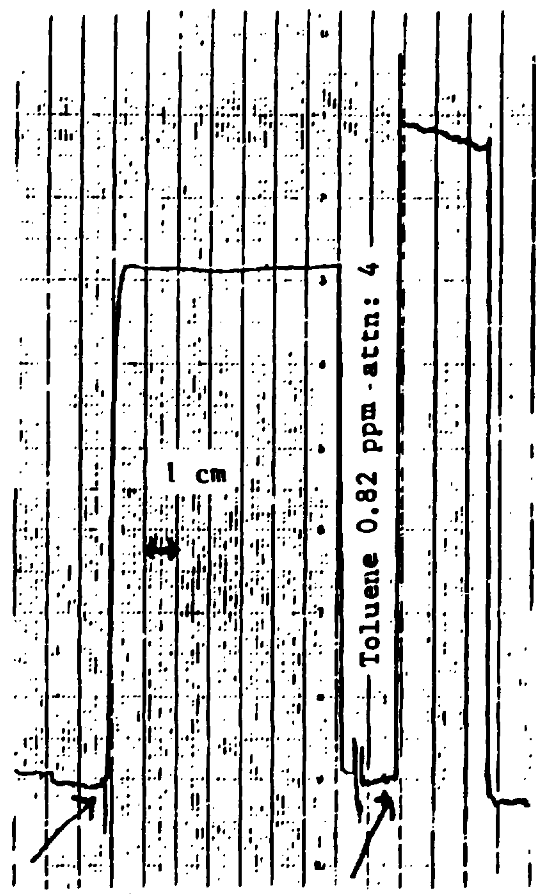
5. SOURCE OF DATA

Sample was run by Denise McDonald on January 30, 1987.

Chemical Resistance Testing of Glove Liner

Tetrahydrofuran Run I

Chemical: Tetrahydrofuran Run I
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1
Chart speed: 2 in/hr
Lamp: 11.7
Recorder attn: 512
Detector temp: 60
GLOVE LINER, INDIVIDUAL



Tetrahydrofuran charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Tetrahydrofuran	N/A	N/A
2. CAS NUMBER(s):	109-99-9	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-30-87
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: 2.5 minutes
4. MIN DETECTABLE LIMIT 9.57 ppm
5. STEADY STATE PERMEATION RATE 1905 (ug/cm^2*hr)
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS:

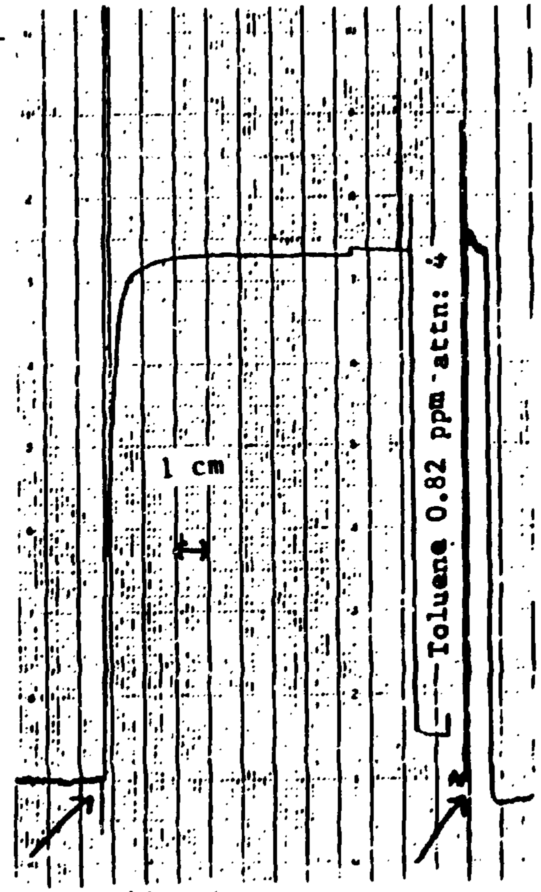
5. SOURCE OF DATA

Sample was run by Denise McDonald on January 30, 1987.

Chemical Resistance Testing of Glove Liner

Tetrahydrofuran Run II

Chemical: Tetrahydrofuran Run II
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1
Chart speed: 2 in/hr
Lamp: 11.7
Recorder attn: 512
Detector temp: 60
GLOVE LINER, INDIVIDUAL



Tetrahydrofuran charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

   1: TYPE: Teflon
   2: PROTECTIVE MATERIAL CODE: 044
   3: CONDITION BEFORE TEST: Unused, no visible imperfections
   4: MANUFACTURER: Chemfab Corp.
   5: PRODUCT IDENTIFICATION: Inner glove sheet stock
   6: LOT OR MANUFACTURER DATE: N/A
   7: NOMINAL THICKNESS: 7-9 mils
   8: DESCRIPTION:

2. TEST METHOD

   1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
   2. ANALYTICAL METHOD: Continuous photoionization detection with a 11.70 eV lamp.
   3. TEMPERATURE: 22-25°C
   4. COLLECTION MEDIUM: N_2
   5. COLLECTION SYSTEM: N_2
   6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 60C.
   7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Tetrahydrofuran	N/A	N/A
2. CAS NUMBER(s):	109-99-9	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Aldrich	N/A	N/A

4. TEST RESULTS

   1. DATE TESTED: 2-02-87
   2. NUMBER OF SAMPLES TESTED: One (Run III)
   3. BREAKTHROUGH TIME: 2.5 minutes
   4. MIN DETECTABLE LIMIT 8.99 ppm
   5. STEADY STATE PERMEATION RATE 1882 (ug/cm^2*hr)
   6. SAMPLE THICKNESS: 7 mils
   7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

   8. OTHER OBSERVATIONS:

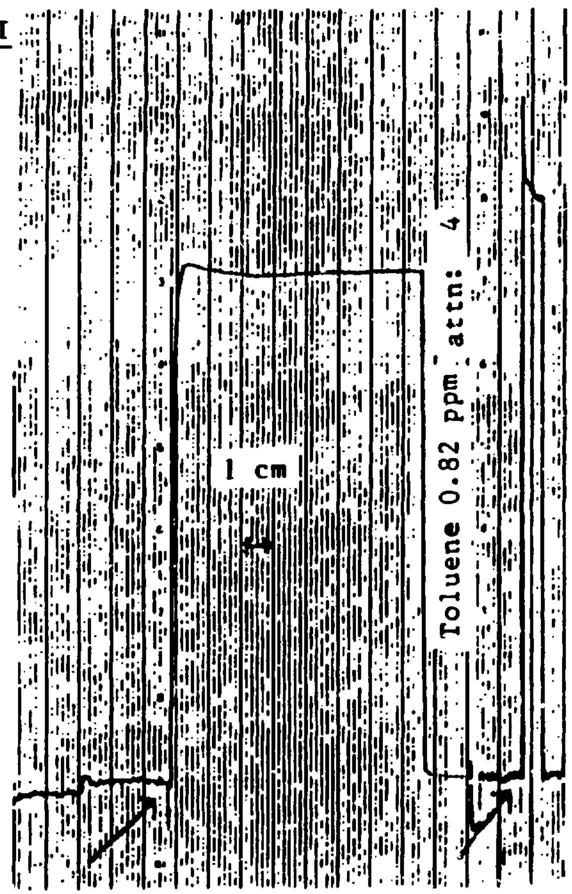
5. SOURCE OF DATA

   Sample was run by Denise McDonald on February 2, 1987.

Chemical Resistance Testing of Glove Liner

Tetrahydrofuran Run III

Chemical: Tetrahydrofuran Run III
Flow rate to cells: 100
Flow rate to Detector: 100
Input attn: 1
Chart speed: 2 in/hr
Lamp: 11.7
Recorder attn: 512
Detector temp: 60
GLOVE LINER, INDIVIDUAL



Tetrahydrofuran charged ito cells Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./ Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Toluene	N/A	N/A
2. CAS NUMBER(s):	108-88-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 12-30-86
2. NUMBER OF SAMPLES TESTED: One (Run I)
3. BREAKTHROUGH TIME: 2.50 minutes
4. MIN DETECTABLE LIMIT .39 ppm
5. STEADY STATE PERMEATION RATE Not measureable
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS: Toluene broke through at a rate exceeding the limits of the detection systems. The steady state permeation rate was greater than 500 $ug/cm^2/hr$.

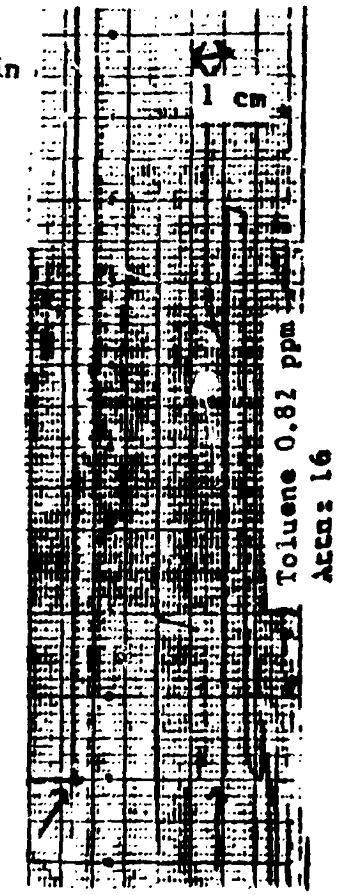
5. SOURCE OF DATA

Sample was run by Denise McDonald on December 30, 1986.

Chemical Resistance Testing of Glove Liner

Toluene Run I

Flow rate to cells: 100cc/min
Flow rate to Detector: 100cc/min
Input attn: 10
Chart speed: 2 inches/hour
Lamp: 10.20
Recorder attn: 1024
Detector temp: 100



Toluene charged into cells   Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./ Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Toluene	N/A	N/A
2. CAS NUMBER(s):	108-88-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-15-87
2. NUMBER OF SAMPLES TESTED: One (Run II)
3. BREAKTHROUGH TIME: 2.50 minutes
4. MIN DETECTABLE LIMIT .44 ppm
5. STEADY STATE PERMEATION RATE Not measureable
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS: Toluene broke through at a rate exceeding the limits of the detection systems. The steady state permeation rate was greater than 500 $ug/cm^2/hr$.

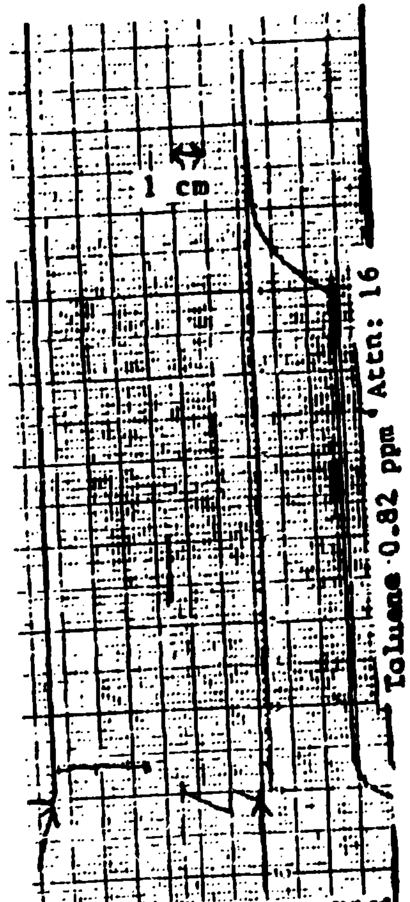
5. SOURCE OF DATA
Sample was run by Denise McDonald on January 15, 1987.

G-

Chemical Resistance Testing of Glove Liner

Toluene Run II

Flow rate to cells: 100cc/min
Flow rate to Detector: 100cc/min
Input attn: 10
Chart speed: 2 inches/hour
Lamp: 10.20
Recorder attn: 1024
Detector temp: 100



Toluene charged into cells   Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon
2: PROTECTIVE MATERIAL CODE: 044
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Inner glove sheet stock
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 7-9 mils
8: DESCRIPTION:

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./ Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Toluene	N/A	N/A
2. CAS NUMBER(s):	108-88-3	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	Mallinckrodt	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 1-15-87
2. NUMBER OF SAMPLES TESTED: One (Run III)
3. BREAKTHROUGH TIME: 2.50 minutes
4. MIN DETECTABLE LIMIT .47 ppm
5. STEADY STATE PERMEATION RATE Not measureable
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS: Toluene broke through at a rate exceeding the limits of the detection systems. The steady state permeation rate was greater than 500 $ug/cm^2/hr$.

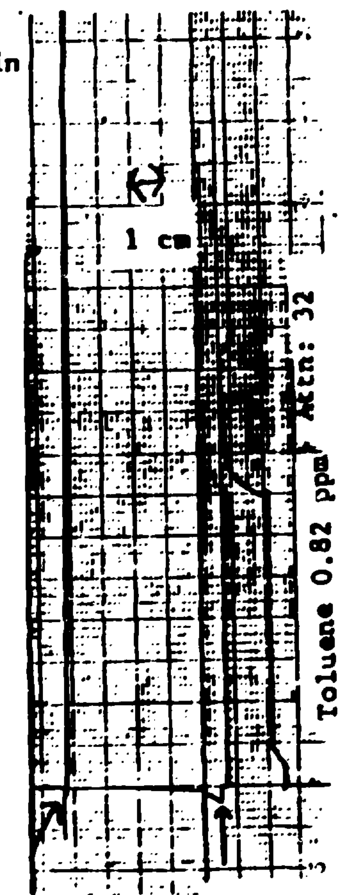
5. SOURCE OF DATA

Sample was run by Denise McDonald on January 15, 1987.

Chemical Resistance Testing of Glove Liner

Toluene Run III

Flow rate to cells: 100cc/min
Flow rate to Detector: 100cc/min
Input attn: 10
Chart speed: 2 inches/hour
Lamp: 10.20
Recorder attn: 1024
Detector temp: 100



Toluene charged into cells   Switched from cells to standard gas

APPENDIX H

PENETRATION TEST DATA FOR SEAM AND CLOSURE SAMPLES

(Contract Report by Anderson Associates)

Penetration and Degradation Tests of Selected Samples

Final Report
August 1986

Anderson Associates

H-1

Penetration and Degradation Tests of Selected Samples

I. Objectives

This was a two-part study. One part was to conduct tests for the resistance of Challenge 5100 seams, neoprene zippers, and Teflon glove material to penetration by five chemicals; the second part was to evalulate butyl rubber gloves for resistance to degradation by fifteen chemicals.

II. Approach

The approach used in the penetration test was the *ASTM Standard Test Method for Resistance of Protective Clothing Materials to Penetration by Liquids (Designation: F903-84)(Appendix i)*; and that for degradation was *Test Method for Evaluating Protective Clothing Materials For Resistance to Degradation by Liquid Chemicals (Designation: NIOSH 200-84-2702 Deg(Revision 4))(Appendix ii)*. Penetration is defined in the method as the flow of a chemical through closures, porous materials, seams and pinholes, or other imperfections in a protective clothing material on a nonmolecular level. Degradation is defined as a deleterious change in one or more physical properties of a protective clothing material due to contact with a chemical.

III. Penetration Tests

Four materials were tested:

1. Challenge 5100/ Challenge 5100 Seam
2. Challenge 5100/ 10 mil FEP Seam
3. 6" Talon zipper on neoprene
4. Teflon innerglove (4 mil)

Each material was studied for penetration by five chemicals: water, hexane, toluene, methyl ethyl ketone, and hydrochloric acid. The method was essentially that described in the Standard except that expandable Teflon tape was used in place of the rubber cell-gasket for samples like seams that varied in thickness. It was also necessary to tighten the nuts that hold the cell together to about 15 lbs with a torque wrench. To minimize the amount of liquid leaking, the cell was filled only to cover the test material when it was in the horizontial position and the air pressure was reduced to 1 psig (in accordance with latest draft version of the method).

Final printing and photographs used in this report were prepared by the U.S. Coast Guard Research and Development Center, Avery Point, Groton, CT 06340-6096

Figure 1(a) shows the standard penetration cell. It was necessary to use a different cell for testing the zippers (Figures 1(b) and 1(c)). The cell was designed by MSTC Walke and constructed at the U. S. Coast Guard Research and Development Center's machine shop. The upper chamber was designed to accomodate the heavy zipper and permit liquid to cover it under pressure (Figure 2). This cell required a great deal of care to seal properly and needs modifications.

Each zipper was tested for leaks with water before any other chemical was tested.

All samples were measures using the same micrometer and thickness was recorded as an averaged value of five readings.

None of the tests required using a dye for visibility.

IV. Degradation Tests

Butyl rubber gloves from North Hand Protection, a division of Siebe North, Inc., were evaluated for resistance to degradation by:

Acetone
Acetonitrile
Carbon Disulfide
Dichloromethane
Dimethyl formamide
Ethyl Acetate
n-Hexane
Methanol
Nitrobenzene
50% Sodium Hydroxide
Concentrated Sulfuric Acid
Tetrachloroethylene
Tetrahydrofuran
Toluene

The method was that described in the Standard Method with no modifications. (The method was awkwardly written and required study to insure it was interpreted as its author intended.) The standard degradation test apparatus is shown in Figure 3. Figure 4 shows the setup used to measure elongation.

V. Recommendations

Zipper Test Cell

The zipper test cell should be revamped. First, the gap between the plexiglass and the frame of the cell is a potential hazard; the plexiglass should be fastened to the frame with more than four screws. Second, the opening in the plate for the zipper seems to be too large; the neoprene does not get good support. This may be one source of leakage. Third, the cell material should be changed. Not only did the acid attack the cell but also components of the cell had rusted from the water. Finally the cell is too heavy and cumbersome to handle safely. A lighter weight material in a more comp design should be used. A new support that would fit more easily in the hood would allow more work to be done in the hood adjacent to the test.

Elongation Test

The elongation test procedure should indicate how much material should be in the clamp. The elongation measurement also seem to depend on the *contour* of the material. Since the butyl rubber samples were cut from gloves the samples varied in contour, e.g. around the thumb hole.

Test samples were very difficult to cut after exposure to a destructive chemical, i.e. one that swells the sample and makes it gummy. Results cannot be precise because of inaccurately cut samples.

Room air currents (from the hood, air conditioner, dehumidifier) also affected measurements.

Weight measurements

The blotting paper drying technique did not always give "dry" samples. A few samples had to be air dried before they where mea' :red.

The Ziploc® bag used as a weighing bottle is a very handy device, but care must be taken that the test chemical does not react with the bag. And it was not always possible to remove all the gases by "burping" the bag and weight was naturally affected.

The description of the calculations for the weight change seemed needlessly complex.

Cleaning the cells

Better methods for cleaning the test cells should be outlined.

Safety

The degradation cell should come with a fitted cover. This would prevent loss o: test chemical and also prevent accidential spilling when the test set-up is in the hood.

VI. Penetration Conclusions

No penetration was observed durin) any of these tests, either during the first 5-minute test at 1 atmosphere pressure or the subsequent 10 minutes at 1 or 2 psig. Thickness measurements varied widely on single seam samples.

VII. Degradation Conclusions

The results of the degradation tests are summarized in Table I. While no chemical totally destroyed the glove material, several chemicals have enough of an effect on the rubber to pose a hazard for using these gloves for protection. These chemical are listed in Table II.

Table I.
Results of the Degradation Tests on Butyl Rubber

Chemical	Thickness (percent change)	Elongation (percent change)	Weight (percent change)	Visible Changes
Acetone	3.40	0.76	3.20	Discolored
Acetonotrile	0.95	2.10	1.80	
Carbon Disulfide	24.00	28.70	19.20	Softened/bubbled
Dichloromethane	9.80	46.50	7.75	Softened/distorted
Diethylamine	17.20	65.70	4.50	
Dimethylformamide	0.05	4.10	8.00	
Ethyl Acetate	0.31	0.84	1.32	
N-Hexane	11.40	57.96	3.80	Cracked
Methanol	0.66	3.30	1.70	
Nitrobenzene	1.60	3.20	1.40	
50% Sodium Hydroxide	0.95	0.86	4.50	
Sulfuric Acid	0.98	0	0.87	
Tetrachloroethylene	80.50	Tore	86.60	Sticky/softened
Tetrahydrofuran	9.20	93.40	10.40	
Toluene	46.00	90.00	33.00	Softened/discolored

Table II.
Hazardous to use with Butyl Rubber

Carbon Disulfide	Tetrachloroethylene
Dichloromethane	Tetrahydrofuran
Diethylamine	Toluene
N-Hexane	

Table III.
Penetration Test Conditions for 6 inch Zippers

	Initial Thickness	RH	Temp °C	Date ('86)
Toluene				
1.	12	78%	22	6/5
2.	11.4	78%	22	6/5
3.	12.8	78%	22	6/5
Hexane				
1.	12.2	77%	22	6/2
2.	13.4	77%	22	6/2
3.	12.7	77%	22	6/2
HCl				
1.	15.2	75%	25	7/2
2.	12.4	75%	25	7/2
3.	10.3	75%	25	7/2
Methyl Ethyl Ketone				
1.	4.2	77%	24	6/5
2.	4.3	77%	24	6/5
3.	4.2	77%	24	6/5
Water				
1.	10.3	69%	23	5/29
2.	10.3	69%	23	5/29
3.	11.3	69%	23	5/29

Table IV.
Penetration Test Conditions for 4 mil Teflon

	Initial Thickness	RH	Temp °C	Date ('86)
Toluene				
1.	3.5	78%	24	6/5
2.	3.7	78%	24	6/5
3.	3.7	78%	24	6/5
Hexane				
1.	12.2	68%	19	6/2
2.	13.4	68%	19	6/2
3.	12.7	68%	19	6/2
HCl				
1.	3.8	75%	25	7/2
2.	3.5	75%	25	7/2
3.	3.4	75%	25	7/2
Methyl Ethyl Ketone				
1.	3.4	77%	24	6/5
2.	3.7	77%	24	6/5
3.	3.7	77%	24	6/5
Water				
1.	4.3	68%	19	6/2
2.	4.3	68%	19	6/2
3.	4.3	68%	19	6/2

H-

Table V.
Penetration Test Conditions for 5100/10 mil FEP

	Initial Thickness	RH	Temp °C	Date ('83)
Toluene				
1.	11	75%	24	6/26
2.	9.6	75%	24	6/26
3.	10.2	75%	24	6/26
Hexane				
1.	9.9	65%	19	6/26
2.	9.7	65%	19	6/26
3.	10.1	65%	19	6/26
HCl				
1.	8.9	75%	25	7/2
2.	8.5	75%	25	7/2
3.	7.0	75%	25	7/2
Methyl Ethyl Ketone				
1.	11.6	65%	23	6/27
2.	10.7	65%	23	6/27
3.	8	65%	23	6/27
Water				
1.	11.8	65%	19	6/26
2.	13.9	65%	19	6/26
3.	11.8	65%	19	6/26

Table VI.
Penetration Test Conditions for 6 inch Zippers

	Initial Thickness	RH	Temp °C	Date ('86)
Toluene				
1.	21.4	77%	25	6/16
2.	22.6	77%	25	6/16
Hexane				
1.	20.4	77%	25	6/16
2.	20.7	60%	26	6/17
HCl				
1.	20.95	75%	25	7/2
2.	21.00	75%	25	7/2
Methyl Ethyl Ketone				
1.	20.00	60%	25	6/17
2.	19.90	60%	25	6/17

H-

Table VII.
Degradation Data for Butyl Rubber Gloves

Hexane	RH 73%	Temp 26C	6/20/86	
Thickness	Before	After	% Diff.	Elong.
1	11.1	10.6	-4.5	46.2
2	10.1	11.0	+8.9	60.8
3	10.1	8.0	-20.7	66.9
			avg 11.4	avg 57.96
Weight	Before	Change	Corrected	% Diff.
1	7.338	0.572	2.20	7.8
2	7.779	0.177	2.33	2.3
3	7.838	0.112	2.36	1.4
				avg 3.8

Dichloromethane	73%	26C	6/20/86	
Thickness	Before	After	% Diff.	Elong.
1	10.7	9.6	-10.1	63
2	10.3	11.3	+9.7	45
3	10.3	9.4	-9.1	31.5
			avg 9.8	avg 46.5
Weight	Before	Change	Corrected	% Diff.
1	7.815	0.212	2.56	9.25
2	8.054	0.140	2.42	5.80
3	7.863	0.192	2.35	8.20
				avg 7.75

Methanol	RH 73%	Temp 26C	6/19/86	
Thickness	Before	After	% Diff.	Elong.
1	10.1	10.0	-0.99	3.1
2	10.1	10.0	-0.99	2.2
3	10.6	10.6	0	4.6
			avg 0.66	avg 3.3
Weight	Before	Change	Corrected	% Diff.
1	7.957	0.05	2.39	2.1
2	8.134	0.05	2.44	2.1
3	7.833	0.02	2.35	0.8
				avg 1.67

H-

Table VII. (continued)
Degradation Data for Butyl Rubber Gloves

Acetone RH73% Temp 25C 6/19/86

Thickness	Before	After	% Diff.	Elong.
1	11.6	11.0	-5.6	0.76
2	10.8	10.8	0	0.77
3	11.1	10.6	-4.5	0.76
			avg 3.4	avg 0.76

Weight	Before	Change	Corrected	% Diff.
1	7.679	0.021	2.30	0.9
2	7.798	0.040	2.34	1.7
3	7.338	0.570	2.20	7.8
				avg 3.2

Toluene RH 72% Temp 27C 6/18/86

Thickness	Before	After	% Diff.	Elong.
1	10.2	6.32	-38.04	115.60
2	10.2	4.9	-51.96	96.20
3	10.3	5.4	-47.76	58.56
			avg 45.92	avg 90.05

Weight	Before	Change	Corrected	% Diff.
1	7.861	0.49	2.36	20.8
2	8.030	0.59	2.41	24.6
3	8.038	1.29	2.41	53.5
				avg 32.96

Ethyl Acetate RH 72% Temp 27C 6/18

Thickness	Before	After	% Diff.	Elong.
1	10.7	10.7	0	.76
2	10.7	10.7	0	1.5
3	10.3	10.8	0	1.7
			avg 0	avg 0.84

Weight	Before	Change	Corrected	% Diff.
1	8.300	0.055	2.49	2.2
2	8.228	0.055	2.47	0.07
3	8.229	0.042	2.47	1.7
				avg 1.32

H-

Table VII. (continued)
Degradation Data for Butyl Rubber Gloves

Acetonitrile RH73% Temp 25C 6 19 86

Thickness	Before	After	% Diff.	Elong.
1	10.8	10.6	-1.9	1.5
2	10.6	10.5	-0.94	1.5
3	10.3	10.3	0	3.4
			avg 0.95	avg 2.1

Weight	Before	Change	Corrected	% Diff.
1	8.212	0.047	2.46	1.9
2	8.511	0.011	2.55	0.43
3	8.133	0.075	2.44	3.1
				avg 1.8

Tetrachloroethylene 72% 27C 6 18 86

Thickness	Before	After	% Diff.	Elong.
1	10.9	2.2	-79.82	tore
2	10.7	2.2	-77.60	tore
3	10.7	1.7	-84.11	tore
			avg 80.51	tore

Weight	Before	Change	Corrected	% Diff.
1	8.320	2.32	2.50	92.8
2	8.046	.655	2.41	27.2
3	8.253	3.47	2.48	140
				avg 86.6

Diethylamine RH62.5% Temp 24C 6 18

Thickness	Before	After	% Diff.	Elong.
1	10.6	9.6	-9.6	67.70
2	10.0	9.6	-3.6	60.77
3	10.7	6.6	-38.25	69.23
			avg 17.22	avg 65.70

Weight	Before	Change	Corrected	% Diff.
1	8.259	0.15	2.48	6.2
2	8.071	0.04	2.42	1.6
3	8.220	0.14	2.47	5.8
				avg 4.5

H·

Table VII. (continued)
Degradation Data for Butyl Rubber Gloves

Nitrobenzene RH62.5% Temp 24C 6/19

Thickness	Before	After	% Diff.	Elong.
1	10.6	10.8	-1.9	4.2
2	11.0	11.0	0	2.6
3	10.5	6.6	-37.1	2.9
			avg 13.0	avg 3.2

Weight	Before	Change	Corrected	% Diff.
1	8.259	0.05	2.47	0.6
2	8.129	0.41	2.44	1.7
3	8.251	0.26	2.42	2.0
				avg 1.4

Dimethylformamide 62% 21C 6/25/86

Thickness	Before	After	% Diff.	Elong.
1 *	10.6	9.9	-6.6	5.0
2	10.4	10.4	0	3.4
3	10.5	10.6	+.95	4.7
			avg 0.05	avg 4.7

Weight	Before	After	Corrected	% Diff.
1	8.212	6.615	2.46	64.9
2	8.122	.8.126	2.43	0.16
3	8.626	8.217	2.59	15.8
				avg 8.0

Carbon Disulfide 62.5% 24C 6/18/86

Thickness	Before	After	% Diff.	Elong.
1	10.2	9.9	-2.9	30
2	10.8	5.2	-52	38
3	10.7	8.9	-17	18
			avg 23.97	avg 28.7

Weight	Before	After	Corrected	% Diff.
1	8.160	8.213	2.448	2.17
2	8.165	8.234	2.450	30.0
3	8.065	7.921	2.420	6.0
				avg 19.2

* Glove label dissolved

H-

Table VII. (continued)
Degradation Data for Butyl Rubber Gloves

Sodium Hydroxide 62% 21C 6 26 86

Thickness	Before	After	% Diff.	Elong.
1	10.3	10.5	+1.9	1.5
2	10.0	10.0	0	0.38
3	10.6	10.5	-0.94	0.69
			avg 0.95	avg 0.86

Weight	Before	After	Corrected	% Diff.
1	8.226	8.232	2.47	0.24
2	8.200	8.320	2.46	4.8
3	8.342	8.126	2.50	8.6
				avg 4.5

Sulfuric Acid 65% 23C 6 25 86

Thickness	Before	After	% Diff.	Elong.
1	10.6	10.6	0	none
2	9.96	9.76	-2.0	none
3	10.7	10.6	-0.93	none
			avg 0.98	

Weight	Before	After	Corrected	% Diff.
1	8.307	8.359	2.49	2.09
2	7.949	7.944	2.39	0.21
3	8.260	8.268	2.48	0.32
				avg 0.87

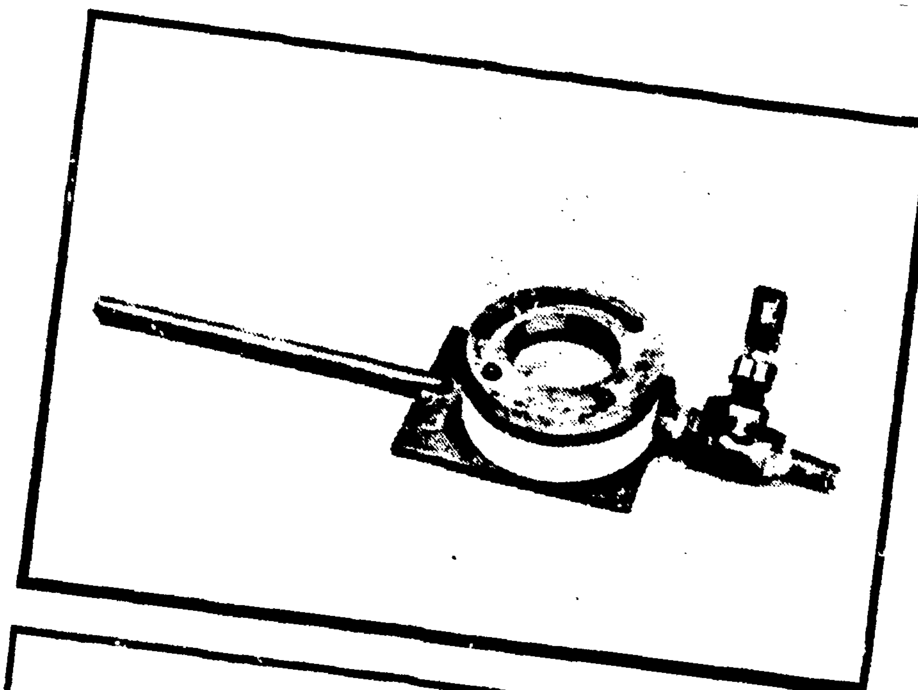
Tetrahydrofuran 62% 21C 6 18 86

Thickness	Before	After	% Diff.	Elong.
1	10.5	10.3	-1.9	142
2	10.3	8.8	-14.6	90.7
3	10.0	8.8	-11.2	47.6
			avg 9.2	avg 93.4

Weight	Before	After	Corrected	% Diff.
1	7.881	8.258	2.36	16
2	8.163	8.457	2.45	4
3	7.994	7.261	2.40	11.1
				avg 10.4

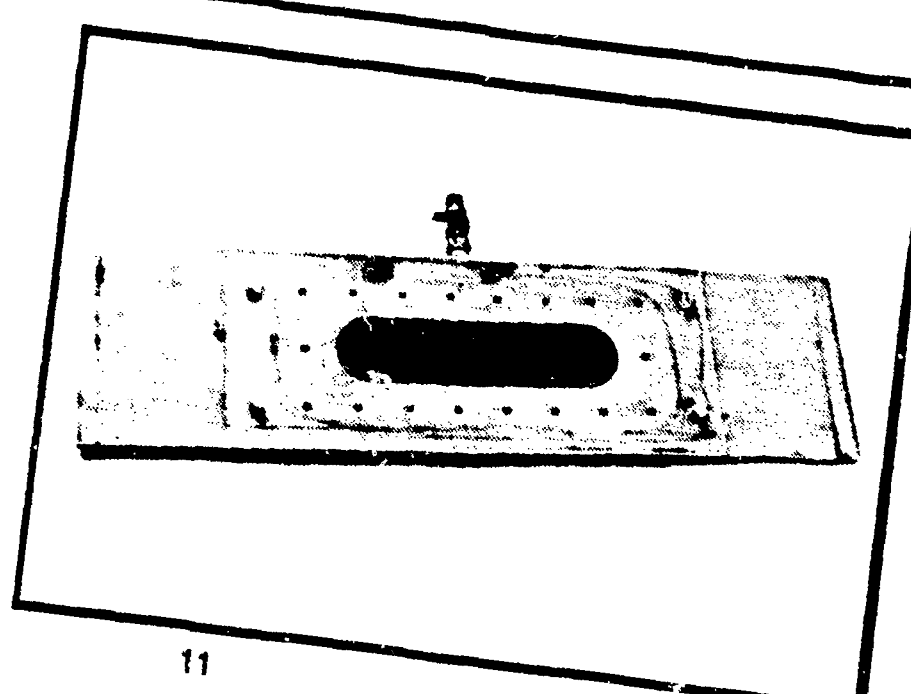
H-

Figure 1.



A. Standard penetration cell

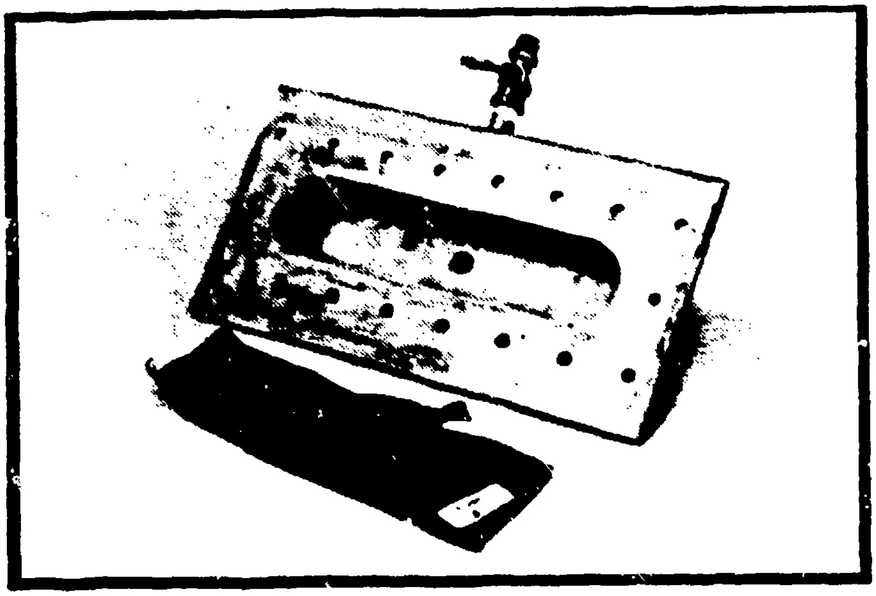
B. Zipper penetration cell (top view)



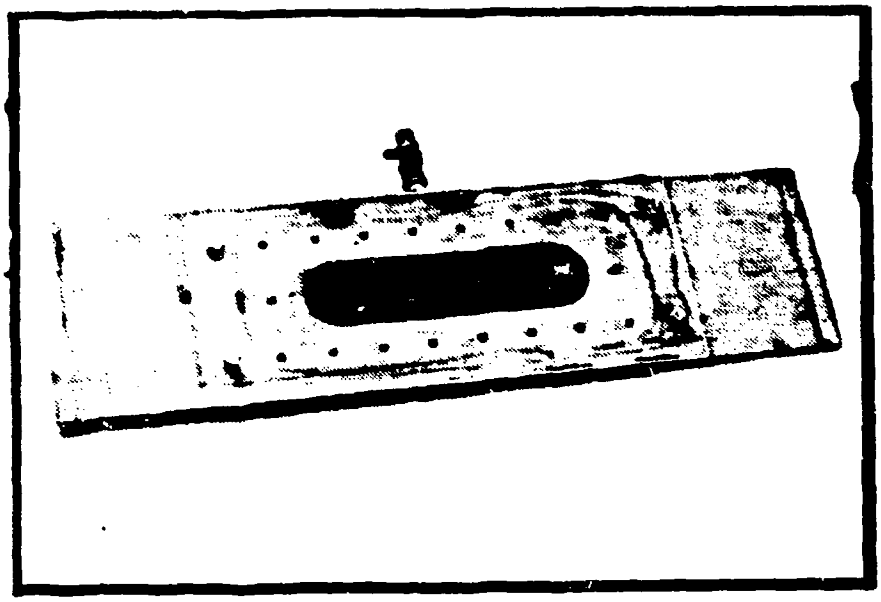
C. Zipper penetration cell (bottom view)

H-1?

Figure 2.



A. Top of permeation test cell for zippers

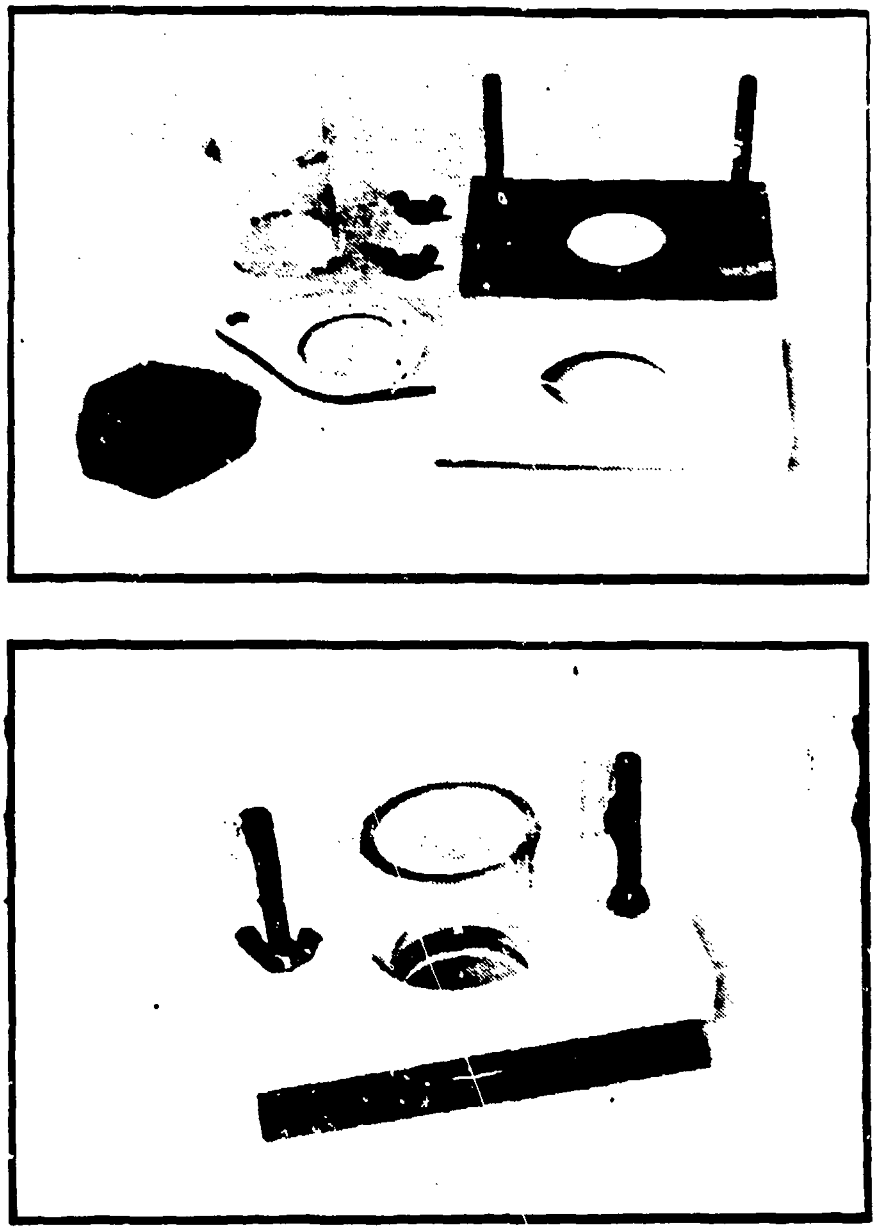


B. With zipper in place

H-

Figure 3.

Standard degradation test apparatus



H-

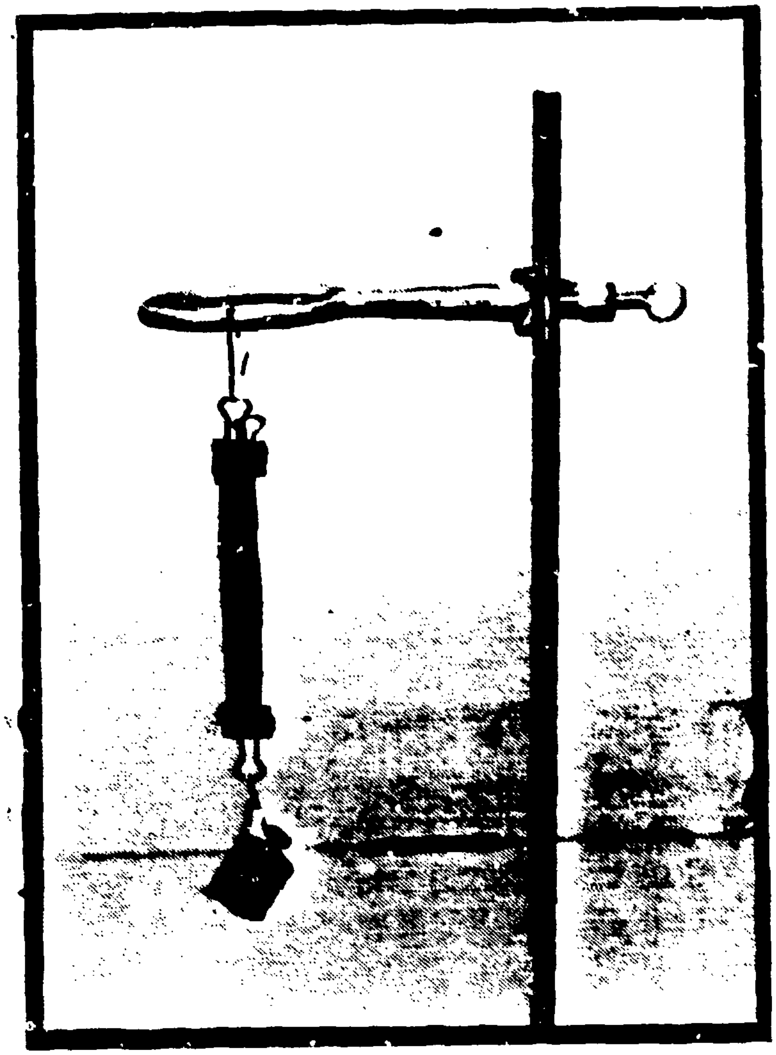


Figure 4.

Elongation test setup

H

APPENDIX I

PERMEATION TEST DATA FOR SEAM SAMPLES

(Data Provided by Texas Research Institute Under Contract)

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Seamed 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 40-50 mil
8: DESCRIPTION: Material was buff colored.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s) :	Ethyl Acetate	N/A	N/A
2. CAS NUMBER(s):	141-78-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	EM Science	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 5-7-87
2. NUMBER OF SAMPLES TESTED: One (Run A)
3. BREAKTHROUGH TIME: 6 minutes
4. MIN DETECTABLE LIMIT N/A
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 48 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS: Sample was sealed in ASTM cell with 2 Neoprene gaskets.

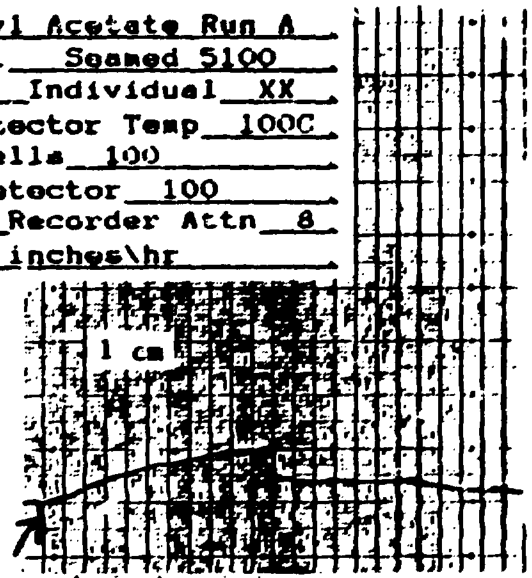
5. SOURCE OF DATA

Sample was run by Denise McDonald on May 7, 1987.

Chemical Resistance Testing of Seamed 5100

Ethyl Acetate Run A

Chemical __Ethyl Acetate Run A__
Sample Material __Seamed 5100__
Composite ____ Individual __XX__
Lamp _10.2_ Detector Temp _100C_
Flow Rate to Cells _100_
Flow Rate to Detector _100_
Input Attn _10_ Recorder Attn _8_
Chart Speed _2 inches\hr_



Ethyl Acetate charged into cells

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Seamed 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 40-50 mil
8: DESCRIPTION: Material was buff colored.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s) :	Ethyl Acetate	N/A	N/A
2. CAS NUMBER(s):	141-78-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	EM Science	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 5-7-87
2. NUMBER OF SAMPLES TESTED: One (Run B)
3. BREAKTHROUGH TIME: 7.5 minutes
4. MIN DETECTABLE LIMIT N/A
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 45 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

8. OTHER OBSERVATIONS: Sample was sealed in ASTM cell with 1 Neoprene gaskets and 2 Teflon gaskets.

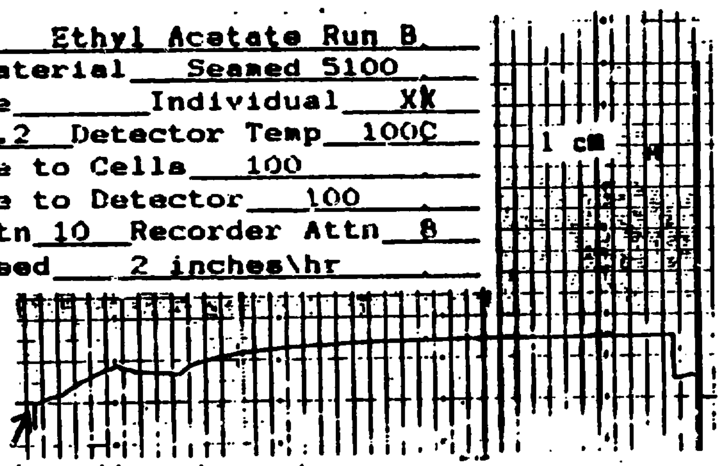
5. SOURCE OF DATA

Sample was run by Denise McDonald on May 7, 1987.

Chemical Resistance Testing of Seamed 5100

Ethyl Acetate Run B

Chemical __Ethyl Acetate Run B__
Sample Material __Seamed 5100__
Composite ____ Individual __XX__
Lamp __10.2__ Detector Temp __100C__
Flow Rate to Cells __100__
Flow Rate to Detector __100__
Input Attn __10__ Recorder Attn __8__
Chart Speed __2 inches\hr__



Ethyl Acetate charged into cells

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Seamed 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 40-50 mil
8: DESCRIPTION: Material was buff colored.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s) :	Ethyl Acetate	N/A	N/A
2. CAS NUMBER(s):	141-78-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	EM Science	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 5-7-87
2. NUMBER OF SAMPLES TESTED: One (Run C)
3. BREAKTHROUGH TIME: 96 minutes
4. MIN DETECTABLE LIMIT N/A
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 46 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

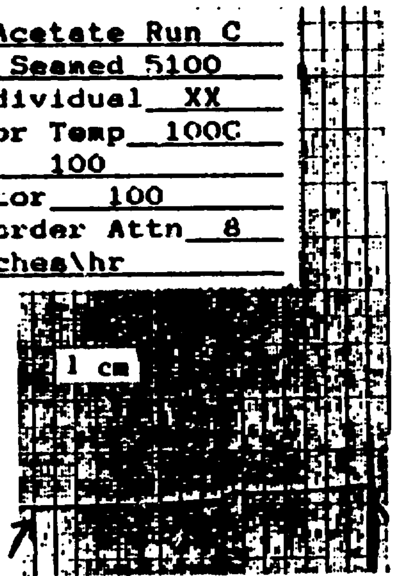
8. OTHER OBSERVATIONS: Sample was sealed in ASTM cell with 2 Neoprene gaskets and 2 Teflon gaskets.

5. SOURCE OF DATA
Sample was run by Denise McDonald on May 7, 1987.

Chemical Resistance Testing of Seamed 5100

Ethyl Acetate Run C

Chemical ___Ethyl Acetate Run C___
Sample Material ___Seamed 5100___
Composite ___Individual XX___
Lamp 10.2 Detector Temp 100C
Flow Rate to Cells 100
Flow Rate to Detector 100
Input Attn 10 Recorder Attn 8
Chart Speed 2 inches\hr



Ethyl Acetate charged into cells

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 066
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Seamed 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 40-50 mil
8: DESCRIPTION: Material was buff colored.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used. / Detector Temperature = 100C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate was 100 cc/min.

3. CHALLENGE CHEMICAL

	1	COMPONENT 2	3
1. CHEM NAME(s):	Ethyl Acetate	N/A	N/A
2. CAS NUMBER(s):	141-78-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	EM Science	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 12-31-86
2. NUMBER OF SAMPLES TESTED: One (Run IV)
3. BREAKTHROUGH TIME: 60 minutes
4. MIN DETECTABLE LIMIT .16 ppm
5. STEADY STATE PERMEATION RATE 1.08 $ug/cm^2/hr$
6. SAMPLE THICKNESS: 7 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

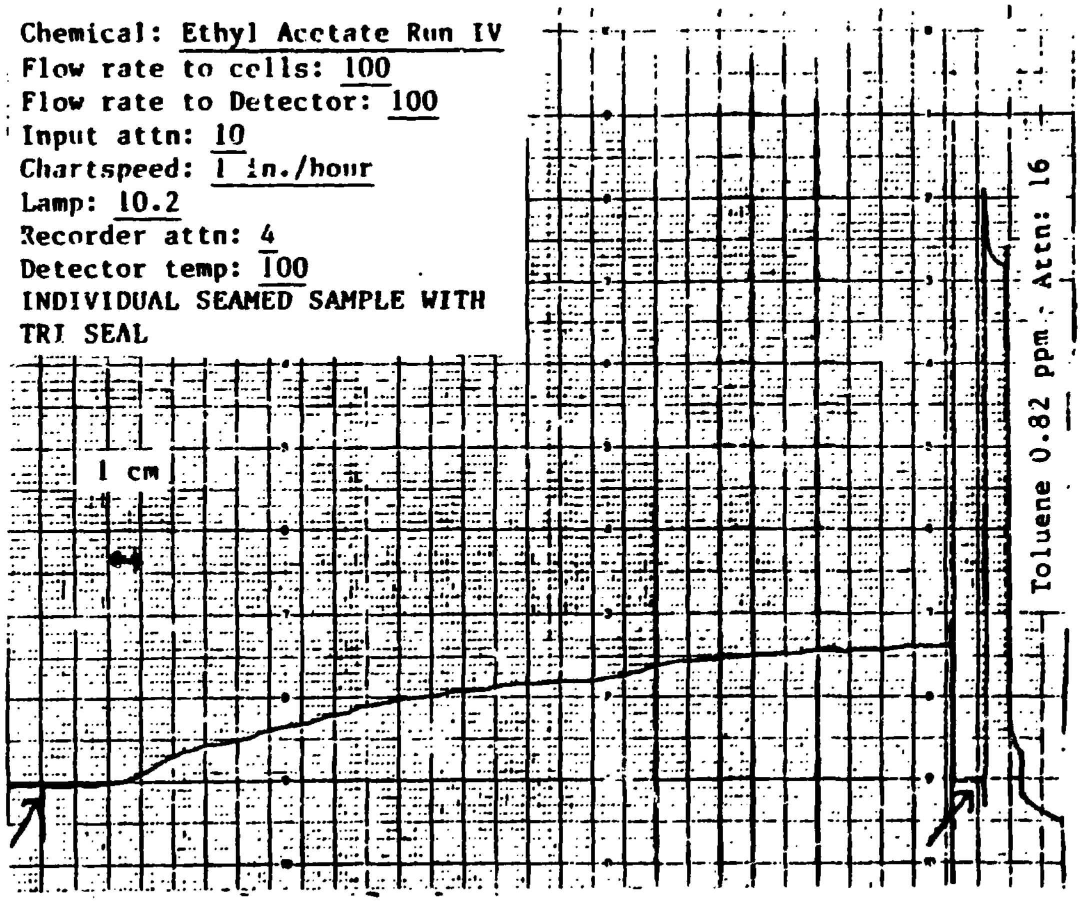
8. OTHER OBSERVATIONS: Sample was sealed with 0.65 in. TRI-SEAL low density polyethylene.

5. SOURCE OF DATA

Sample was run by Denise McDonald on December 31, 1986.

Chemical Resistance Testing of Seamed 5100

Ethyl Acetate Run IV



Ethyl Acetate charged into cells

Switched from cells to standard gas

CHEMICAL PROTECTIVE CLOTHING PRODUCT EVALUATION RECORD

1. DESCRIPTION OF PRODUCT EVALUATED

1: TYPE: Teflon laminated Nomex
2: PROTECTIVE MATERIAL CODE: 068
3: CONDITION BEFORE TEST: Unused, no visible imperfections
4: MANUFACTURER: Chemfab Corp.
5: PRODUCT IDENTIFICATION: Seamed 5100
6: LOT OR MANUFACTURER DATE: N/A
7: NOMINAL THICKNESS: 40-50 mil
8: DESCRIPTION: Material was buff colored.

2. TEST METHOD

1. TESTING LABORATORY: Texas Research Institute, 9063 Bee Caves Road, Austin, TX
2. ANALYTICAL METHOD: Continuous photoionization detection with a 10.20 eV lamp.
3. TEMPERATURE: 22-25°C
4. COLLECTION MEDIUM: N_2
5. COLLECTION SYSTEM: N_2
6. OTHER CONDITIONS: 1 inch cell was used./Detector Temperature = 100 C.
7. DEVIATIONS FROM ASTM F739 METHOD: Flow rate to cell was 100 cc/min.

3. CHALLENGE CHEMICAL

	COMPONENT 1	2	3
1. CHEM NAME(s) :	Ethyl Acetate	N/A	N/A
2. CAS NUMBER(s):	141-78-6	N/A	N/A
3. CONC. (IF MIX)	N/A	N/A	N/A
4. CHEMICAL SOURCE:	EM Science	N/A	N/A

4. TEST RESULTS

1. DATE TESTED: 6-03-87
2. NUMBER OF SAMPLES TESTED: One
3. BREAKTHROUGH TIME: No breakthrough was observed in 4.5 hours.
4. MIN DETECTABLE LIMIT .17 ppm
5. STEADY STATE PERMEATION RATE N/A
6. SAMPLE THICKNESS: 47 mils
7. SELECTED DATA POINTS N/A

	TIME	CONCENTRATION	CONCENTRATION	CONCENTRATION
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

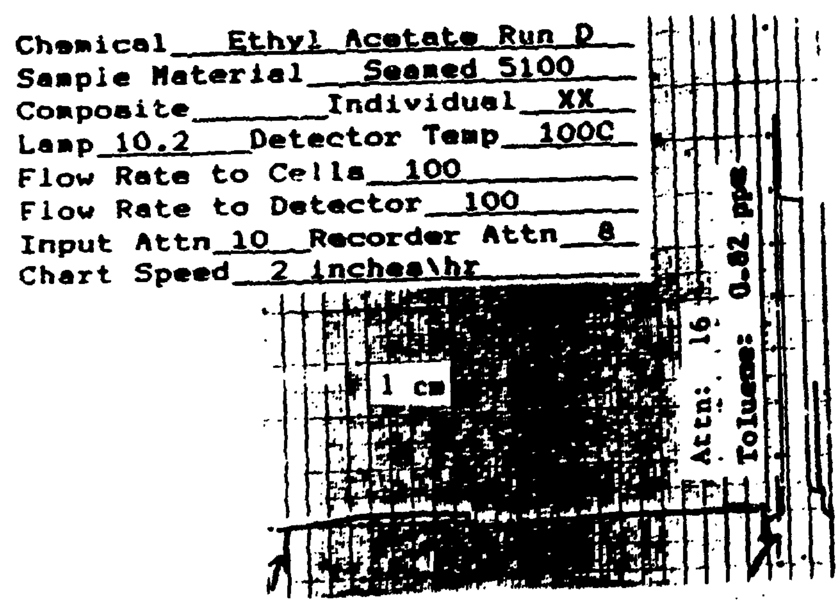
8. OTHER OBSERVATIONS: Sample was sealed on both sides of ASTM cell with 1/4" expanded P.T.F.E. cord.

5. SOURCE OF DATA

Sample was run by Denise McDonald on June 3, 1987.

CHEMICAL RESISTANCE TESTING OF SEAMED 5100

ETHYL ACETATE RUN D



Ethyl Acetate charged into cells

Switched from cells to standard gas

APPENDIX J

INTERIM REPORT OF SUIT EXHAUST VALVE TESTING

(Contractor Report by Lawrence Livermore National Laboratory)

REPORT TO USCG
ON ONE-WAY VENT VALVES

[illegible]

Safety Science Group

Special Projects Division

Hazards Control
Department

Lawrence Livermore National Laboratory

Evaluation of the Performance of One-Way Valves
Used in Chemical Protective Suits*

Introduction

We are reporting preliminary results from a study on low-pressure vent valves that we are conducting for the U.S. Coast Guard. Test results from four valves will be discussed here. The valve currently used in the Coast Guard totally-encapsulating chemical protective (TECP) suit is made by Stratotech Corporation. A second suit valve that was evaluated is made in Sweden by Trelleborg. Then, to provide a comparison for the evaluation, we included two valves that are used in respirators. These valves are made by MSA Corporation, and included a standard flapper valve and a pressure demand valve.

Background

The U.S. Coast Guard has developed a new totally-encapsulating suit for the protection of personnel during chemical spill response. Low-pressure one-way vent valves are used in the suit to allow escape of exhaust air from the occupant's self-contained breathing apparatus, and to maintain a small positive pressure (1 to 3 inches water column pressure) inside the suit. This latter feature minimizes diffusion or penetration of chemical vapors through poor seams, material punctures, or improperly closed zippers. Satisfactory operation of these valves is critical to the functionality and protective qualities of encapsulating suits.

While protection factors have been measured for the overall suit in operation, there has been no attempt to exclusively determine suit exhaust valve protection factors. Furthermore, recent overall suit testing has shown differences in suit protection factors when the internal suit probe is located near the breathing zone as compared to locating the probe internally near the exhaust valve. This information indicates that diffusion of the challenge agents through the suit exhaust valves may be significant.

*This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract No. W-7405-ENG-48.

Experimental Considerations

We prepared an experimental system that would provide for a high degree of control over the valve environment. A small cast aluminum box (roughly 9 inches long by 5 inches wide by 6 inches high) was fitted with several openings to provide for breathing and test air inputs, analytical sampling ports and environmental measurements (pressure, temperature). A diagram of the box is shown in Fig. 1. The box was constructed so that a plastic plate could be inserted between the two halves. At the center of the plate, a recessed orifice was machined that allowed the different valves to be inserted with a leak tight seal. When the box and plate were assembled, the valve was positioned to function as the only conduit between the two resulting compartments. One compartment could then function as the "inside" of a TECP suit, and the other as the "outside."

The complete assembly was tested for leakage with a Stratotech valve installed. A solid cap was threaded onto the inside half of the valve. The outside compartment was filled with methane from a lecture bottle. With the pressure differential between the two chambers at zero, no methane was detected within the second (inside) chamber. We interpreted this data to [illegible] that the test box was leaktight when the insert plate containing a valve was installed. Conversely, with the cap removed, future measurement of methane in the inside chamber would have to indicate the valve as the source of penetration. A diagram of the Stratotech valve in this testing arrangement is shown in Fig. 2.

A schematic of the complete test assembly is given in Fig. 3. The top left of the diagram shows a source of air that allowed precise control of flow, temperature, and relative humidity (Miller-Nelson Research, HCS-301). At the top center is shown a source (lecture bottle) of test gas (methane) which can be added to the air flow through a mass flow controller. The mixture of air and test gas is passed through a calibrated infrared analyzer (Foxboro Corporation, Miran 1A) to measure test gas concentration. When pure methane was used in this work, the air source and infrared analyzer were disconnected and the methane from the lecture bottle passed through the mass flow controller and then directly to the test chamber.

The previously described test box is shown as a diviced box in the lower right of the schematic. Also shown are the probes for differential pressure measurement between the two chambers of the box. In addition, a single pressure transducer could be placed in either part of the box to measure chamber pressure relative to the atmosphere. Finally, the exhaust flow from the lower half of the box was checked for temperature with a thermistor probe (YSI Series 700, Yellow Springs Instrument Company) and a digital thermometer (Cole-Parmer Model 8502-20). A comparison of temperature was continually made between the test box exhaust flow and either the controlled air source or the room air. The concentration of test gas within the inside chamber of the box was measured with a calibrated total hydrocarbon analyzer (Beckman, Model 400, FID principle).

We chose methane as a test gas for several reasons. First, under the conditions of this experiment, this gas is inert to the materials used in the several valves. Second, this hydrocarbon can be detected at very low levels with conventional methods. In addition, the THC can be calibrated to measure methane over a very large linear dynamic range. Finally, the measured diffusion coefficient for methane is on the same order of magnitude as that reported for hydrogen[1,2], and gaseous diffusion of the compound is therefore quite rapid.

Test Results

Our first test was to observe the valves under static conditions, i.e., without use of simulated breathing. A valve was installed in the plastic insert, and the plate was assembled between the box halves. The outside chamber of the test box was filled with pure methane. Leakage rates were determined from the change in the observed concentration of methane in the inside chamber over a specified time period. The calculated volume of the upper chamber is 1616 cm^3 (24.4 cm x 13.0 cm x 5.1 cm). If we take the definition of parts-per-million by volume to be ppmv = [(vol. of analyte) / (vol. of dilutant)] x 10^6, and then make the appropriate substitutions, the leak rates can be determined.

Two valves were tested in this manner, the Stratotech valve, and the MSA positive pressure valve. After an initial measurement at a pressure differential of zero, compressed air was forced to the inside chamber through a precision valve, and the new concentration recorded over time at the higher pressure. The result of our preliminary testing is shown in Fig. 4. Our technique shows an observable leak of the outside gas into the inside chamber. To provide comparison, we make reference to the current Bureau of Mines Standard for Respiratory Protection Devices.[3] The standard used by the Bureau of Mines is the same as that reported in use by the Chemical Warfare Service during WWII.[4] In this standard, the designated respirator exhalation valve leakage is not to exceed 30 ml min^{-1} at a suction of 25 mm of water column height. The implication from this standard is that there is measurable leakage through respirator exhaust valves under normal operating conditions. To provide data comparable to the respirator standard, the suit's one-way vent valves would have to be tested in the same manner.

Our next experiment was to observe the valves during the simulated breathing provided from a breathing machine. We tested four valves at two separate breathing rates, 10 and 20 breaths min^{-1}, respectively. In all cases except one, a constant inside concentration of methane was achieved. Our technique was to observe the background signal of the THC analyzer with the breathing machine on, and then to fill the outside compartment of the box with methane. The internal concentration of methane would rise and then level off at an equilibrium value, which is the data reported in Fig. 5. The exception occurred with the MSA pressure demand valve at the 10 cycle min^{-1} breathing rate. Over the 10-min duration of the test, the internal concentration continued to rise (at a rate of 4.8 μl min^{-1}).

In all the other cases except one, we observed the internal concentration to fluctuate within a few ppmv. The single exception was that the Trelleborg valve exhibited large oscillations around an average internal concentration. It is these (sawtooth appearing) concentration variations that are shown in the bar graph of Fig. 5. Finally, in addition to the small sinusoidal type fluctuations seen in the other valves, and the large variation seen in the Trelleborg valve, there was in every case a very small oscillation superimposed on the general trend. This occurred in exact sequence with the cycles of the breathing machine. We could only attribute this fluctuation to the immediate changes that occurred when the valve opened and closed.

We also made observations of the differential pressure during operation of the breathing machine. This was done for each valve and was recorded as a positive pressure within the inner chamber relative to the pressure within the outside chamber. The data are presented graphically in Fig. 6. This data separated the four valves by pairs. The two valves that were controlled by spring tension (to open only after a certain pressure threshold was attained) allowed larger internal chamber pressures. The two flapper type valves maintained lower pressures. The pressures seen were higher at faster breathing rates, and again the flapper type valves maintained lower pressure than the spring tension valves.

Conclusions

We have developed a method to test TECP vent valves. This method isolates the valve between two chambers and tests for leakage of the valves by measuring concentration of a test gas in the inside chamber of the test box. The use of a removable plate that contains a valve installed in a leaktight manner allows for simple and rapid exchange of valves for testing. Our preliminary data indicates that there is leakage of the test gas under normally closed conditions (zero differential pressure). When the pressure on the inside chamber is increased, this leak rate is observed to decrease. One conclusion that follows from these test results is that the vent valves may be a major leak source for the intact suit. Further research is necessary to allow more general conclusions to be drawn.

References

1. W.A. Wakeham D.H. Slater, J. Phys b: Atom. Molec. Phys., Vol. 6, 1973, pp. 886-896.

2. CRC Handbook of Chem. and Physics, 61st Ed., R.C. Weast, ed., p. F-62.

3. Federal Register, 37 (59), part II, par. 11.162-2 (1972).

4. L. Silverman, R.C. Lee, and G. Lee, "Fundamental Factors in the Design of Protective Respiratory Equipment", Office of Scientific Research and Development, Report No. 1864, 1943, p. 6.

Figure Captions

Figure 1. A schematic of the cast aluminum box that was used in the valve testing experiment.

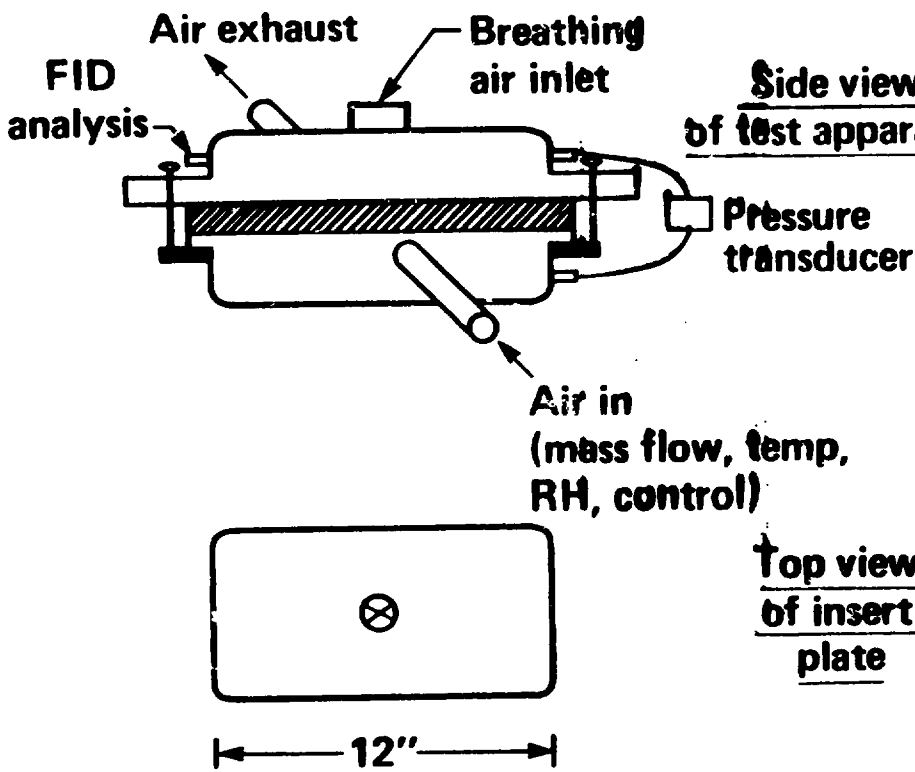
Figure 2. drawing of the Stratotech valve as it appears when installed in the Plexiglas[R] plate.

Figure 3. Schematic of the experimental test system used in the study on one-way vent valve performance.

Figure 4. Graphic representation of the leak rates observed during static leak testing of one-way vent valves.

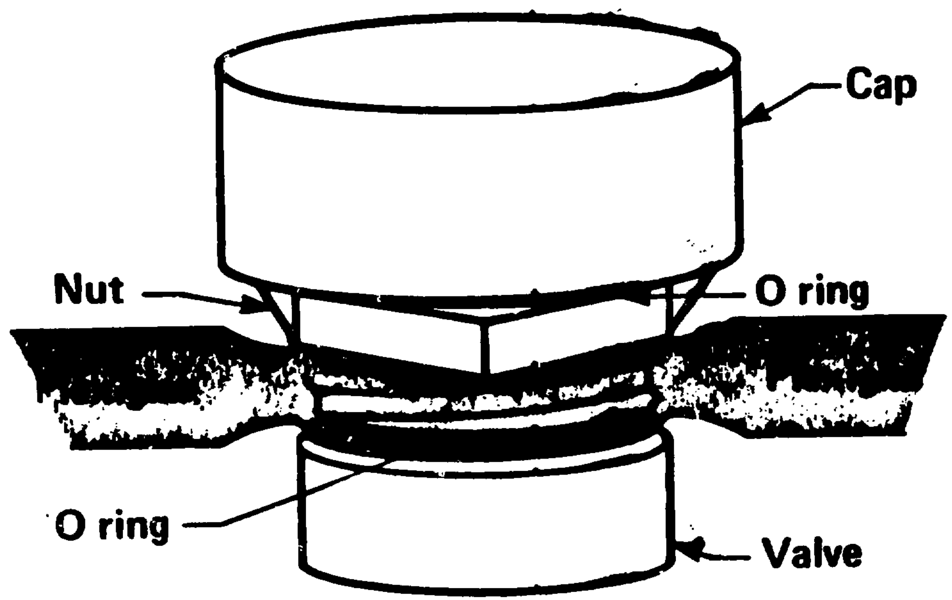
Figure 5. Graphic representation of the concentration of methane observed in the "inside" chamber of the test box during simulated breathing.

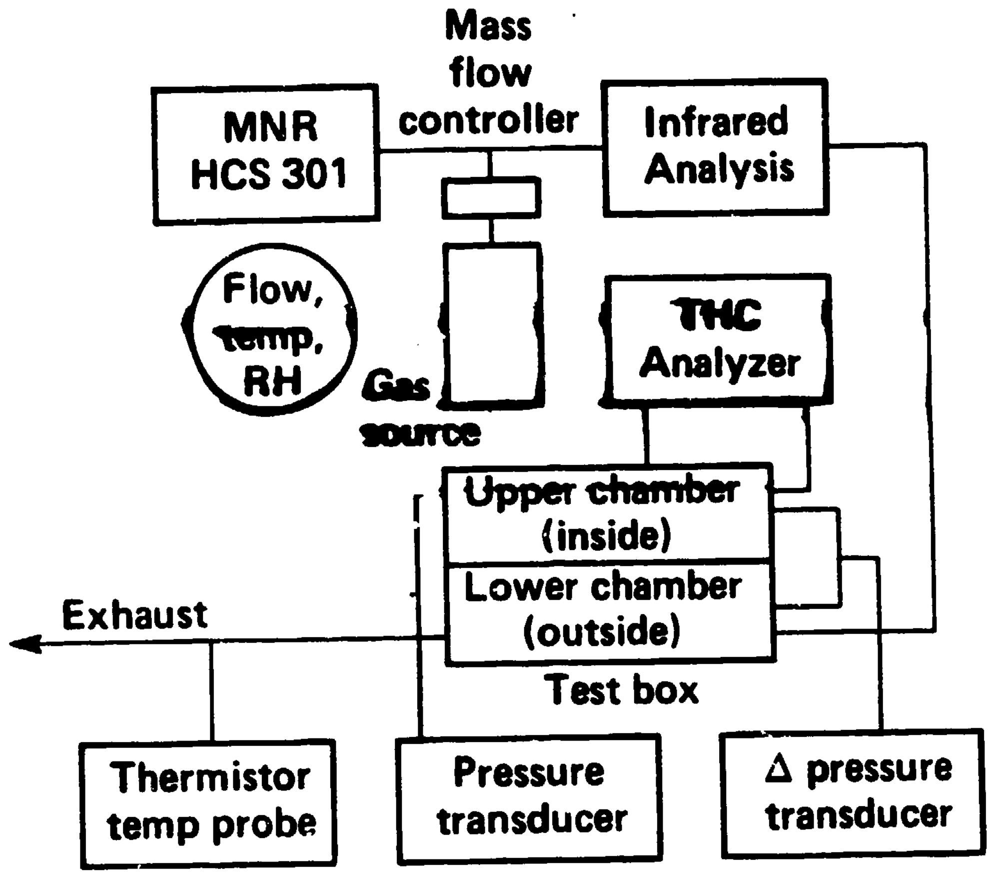
Figure 6. Differential pressure observed with different valves during breathing machine operation.

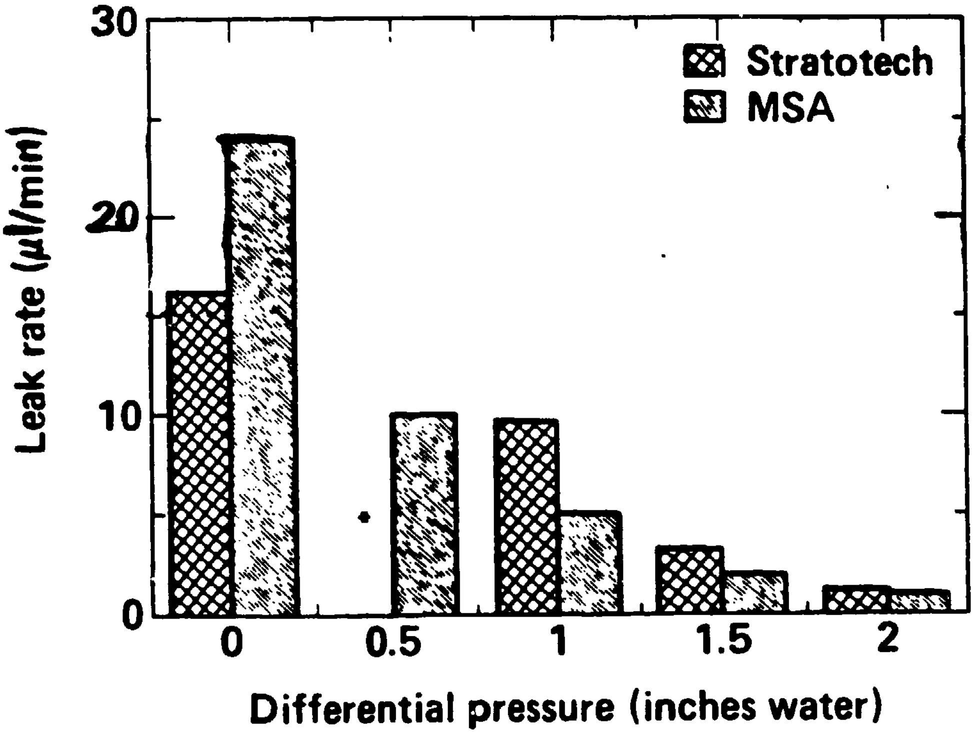


Side view of test apparatus

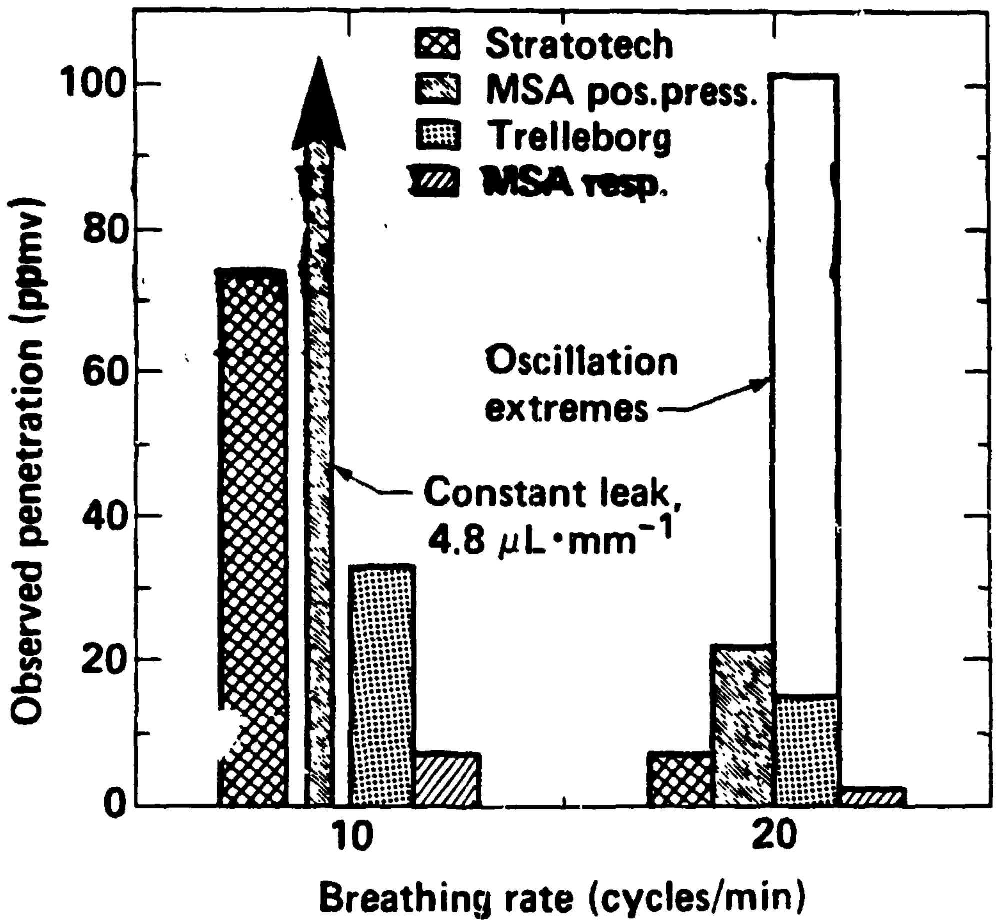
Top view of insert plate

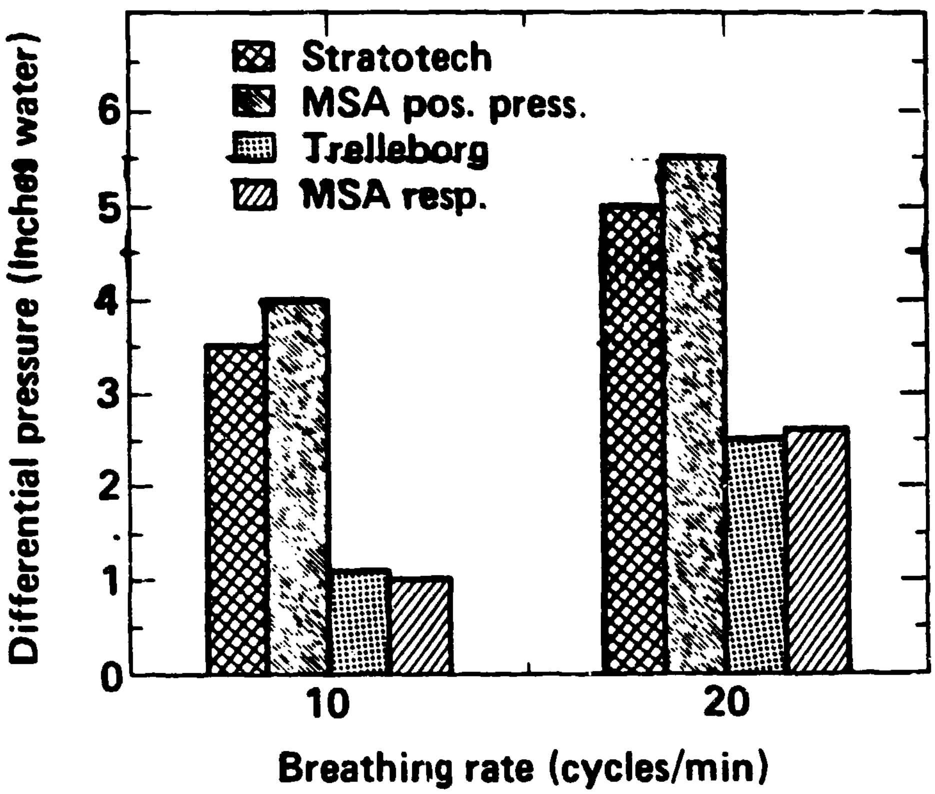

Cap
Nut
O ring
O ring
Valve


Mass
flow
controller
MNR
HCS 301
Infrared
Analysis
Flow,
temp,
RH
Gas
source
THC
Analyzer
Upper chamber
(inside)
Lower chamber
(outside)
Exhaust
Test box
Thermistor
temp probe
Pressure
transducer
Δ pressure
transducer



* Stratotech data not available


Stratotech
MSA pos.press.
Trelleborg
MSA resp.
Oscillation extremes
Constant leak, 4.8 μL·mm⁻¹
Observed penetration (ppmv)
0
20
40
60
80
100
10
20
Breathing rate (cycles/min)


Stratotech
MSA pos. press.
Trelleborg
MSA resp.
Differential pressure (inches water)
0
1
2
3
4
5
6
10
20
Breathing rate (cycles/min)

APPENDIX K

EVALUATION OF SUIT INTEGRITY IN PROTECTION FACTOR TESTS

(Contractor Report by Lawrence Livermore National Laboratory)

TECP SUIT TEST PROTOCOL

for

USCG/USFA PROJECT

Safety Science Group

Special Projects Division

Hazards Control Department

Lawrence Livermore National Laboratory

Introduction

The need to provide complete encapsulation of workers to allow them to carry out their jobs safely is becoming very commonplace. Such jobs as hazardous material response, toxic waste dump cleanup, and chemical manufacture and use require complete encapsulation of employees routinely or during accidents. With the increase use of complete encapsulation in the workplace, a high degree of performance is now expected from commercially available totally-encapsulating chemical protective (TECP) suits. This high degree of performance was also identified by John B. Moran, Head, Division of Safety Research, National Institute for Occupational Safety and Health, when he referred to chemical protective clothing as "the last line of defense" for the worker.

A TECP suit is made up of many components (Fig. 1). Many of these components are in themselves individual items of chemical protective clothing for which chemical permeation data is available. Some items however, such as suit closures, vent valves, lens material, suit membranes, and seams are unique to a TECP suit and therefore require individual chemical permeation testing. This type of data however, does not provide the user with a measure of complete TECP suit integrity. To measure the complete integrity and performance of TECP suits, quantitative chamber testing can be used. By simultaneously using both an aerosol and gas test agent one can determine the TECP suit leak rate accurately. If these measurements are made while the suit is being worn by a person performing a series of exercises, a good estimate of field TECP suit performance can be obtained.

Experimental Setup

To measure TECP suit leak rates accurately separate gas (Freon^{R} 12) and aerosol polyethylene glycol molecular weight 400 (PEG 400) detection systems will be used. The Freon^R 12 subsystem uses a man-test chamber concentration of 1000 ppm as determined by a Wilks Model 1A infrared spectrophotometer. The interior of the TECP suit is monitored for Freon^R 12 intrusion using a Varian Model 2700 gas chromatograph (GC) equipped with an electron capture detector (ECD). Since the GC/ECD detection limit for Freon^R 12 is 0.01 - 0.001 ppm, this measurement technique enables one to measure an intrusion coefficient of 100,000 to 1,000,000. A gas sampling valve is used to collect discrete samples from the interior TECP suit air approximately every two minutes.

To measure the aerosol concentrations in the man-test chamber (Fig. 2) and within the TECP suit a Phoenix Precision Instrument's Model JM 7000 forward light scattering photometer will be used. The test aerosol of PEG 400 will be generated using a Laskin nozzle generator which creates a mass median aerosol diameter aerosol of approximately 0.68)m, sg = 2.10. Aerosol concentrations within the man-test chamber will be 25 ± 5 mg/M^3. A sample of two liters per minute is withdrawn from the suit and passed through the photometer providing a real time measure of aerosol concentrations within the suit.

Sample line penetrations into the TECP suit will take advantage of existing penetrations for such things as airline cooling or communication. If these types of penetrations are not available a cuff ring with sampling port will be attached using a removable glove connection. If these methods are not applicable a hole will be cut in the suit and a sampling line will be sealed into the suit. The last method is the least desirable but necessary when no other sampling line penetration is available. The minimum number of connections necessary to connect the sampling line to the proper monitoring instrument will be used with a minimum length of sampling line. During a typical test, samples of both Freon® 12 and PEG 400 will be taken simultaneously and used to determine TECP suit performance.

A series of light exercises have been chosen to stress the suit in a manner similar to typical work routines. Each exercise is carried out for two minutes completing the prescribed number of repetitions.

- o Stand in place.
- o Raise hands from waist to above the head, completing at least 15 raising motions per minute.
- o Walk in place completing at least 15 raising motions of each leg per minute.
- o Touch the toes, making at least 10 complete motions of the arms from above the head to the toes per minute.
- o Perform deep knee bends, making at least 10 complete standing and squatting motions per minute.
- o Repeat complete exercise series.
- o Exit man-test chamber.

The exercise series requires approximately 20 minutes plus donning and doffing time. A 30-minute SCBA bottle will work some of the times, but a 60-minute bottle is preferred.

Two USCG/USFA TECP suits will be evaluated along with single suits from four commercial manufacturers.

Data Analysis

The output from the photometer, GC/ECD and infrared spectrophotometer will be collected on a DEC LSI 11/23 lab computer. Suit intrusion coefficients[1] will be calculated for both aerosol and Freon[R] 12 test agents and their results compared. Graphs showing these intrusion coefficients will be included in the final report.

To determine if various components of the TECP suit are leaking the internal samplings lines will be placed in close proximity to the component in question.

Final Report

A final report will be prepared summarizing the results of the various TECP suits along with any conclusions with reference to specific suit component performance.

[1] $\text{Intrusion Coefficient} = \dfrac{\text{Outside Concentration}}{\text{Interior Suit Concentration}}$

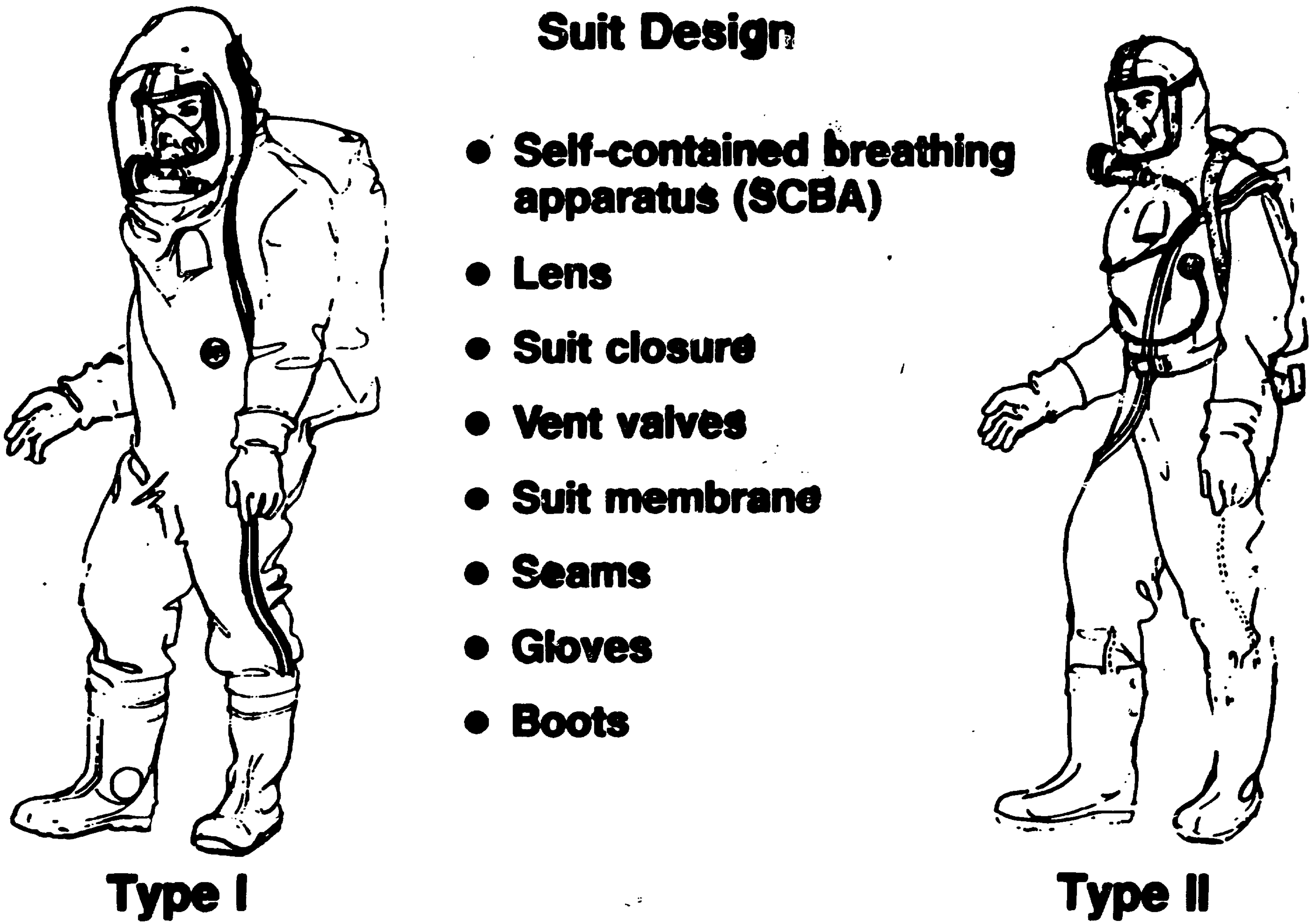
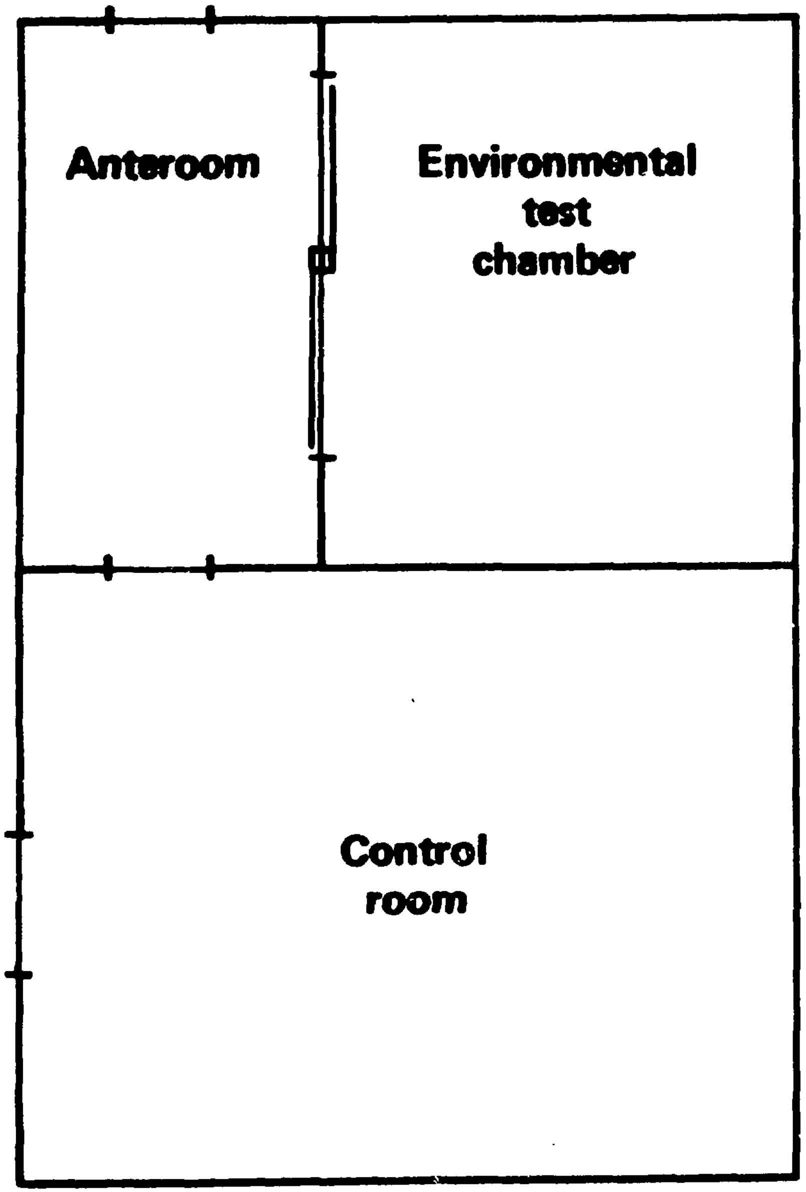


Figure 1. The configuration and design of Type I and Type II totally-encapsulating chemical-protective suits.

Safety science group environmental test facility



Test atmospheres:
Freon™ 12 (gas)
PEG 400 (aerosol)

Stress testing:
Treadmill

Monitoring:
- GC with electron capture detectors
- IR
- Photometer
- Optical particle sizer
- Size/charge particle counter
- Humidity monitor
- Air flow monitor
- Pressure monitor
- Heart rate monitor

Computer interface:
- DEC LSI 11/23

Figure 2. Safety Science Group man-test chamber layout and monitoring equipment.

TECP Suit Man-Test

Results for the USCG/USFA/OSHA

Project

Safety Science Group

Special Projects Division

Hazards Control Department

Lawrence Livermore National Laboratory

TABLE OF CONTENTS

Introduction

In our report titled, "TECP Suit Test Protocol for USCG/USFA Project" we discussed the general design of a totally encapsulating chemical protective (TECP) suit and the test method we have developed to evaluate the TECP suit performance. In this report we will summarize the results from our test on the new U.S. Coast Guard's TECP suit made from Teflon^{R}-coated Nomex^{R} fabric (Figure 1).

Human Subjects Approval

The Lawrence Livermore National Laboratory (LLNL) is operated by the University of California for the U. S. Department of Energy (DOE). DOE requires that all experiments involving human volunteers at LLNL must be reviewed by the Human Subjects Committee and found acceptable. The experimental test procedures described in this report have been reviewed and approved by the Human Subjects Committee.

Experimental Description

Freon Leak Detection System

To measure TECP suit leak rates accurately, a separate gas (Freon^{R} 12) and aerosol [polyethylene glycol molecular weight 400 (PEG 400)] detection systems is used. The Freon^{R} 12 subsystem uses a man-test chamber concentration of 1000 ppm as determined by a Wilks Model 1A infrared spectrophotometer. The interior of the TECP suit is monitored for Freon^{R}12 intrusion using a Varian Model 2700 gas chromatograph (GC) equipped with an electron capture detector (ECD). The sampling time for the GC sampling loop is two minutes. In an upgrade of this system a second sampling loop and ECD detector is being added. Thus, by alternating the sampling cycles, a sample can be collected approximately every minute. Since the GC/ECD detection limit for Freon[R] is 0.01 - 0.001 ppm, this measurement technique enables SSG to measure a suit intrusion coefficient of 100,000 to 1,000,000.

Aerosol Leak Detection System

The aerosol concentrations in the man-test chamber and within the TECP suit were measured using a Phoenix Precision Instrument's Model JM 7000 forward light scattering photometer. The test aerosol of PEG 400 was generated using a Laskin nozzle generator which created a mass median aerosol diameter of approximately 0.68 µm, sg = 2.10. Aerosol concentrations within the man-test chamber were 25 ± 5 mg/M^3. A sample of two liters per minute was withdrawn from the suit and passed through the photometer, providing a real time measure of aerosol concentrations within the suit.

Suit Modifications

Sample line penetrations into the TECP suit would normally take advantage of existing penetrations for such things as airline cooling or communication. Since no penetration was available in the U.S. Coast Guard TECP suit, a hole was cut in the suit to enable the mounting of a sealed sampling line. The hole was located in a reinforced section in the front waist area of the suit. The minimum number of connections necessary to connect the sampling line to the proper monitoring instrument were used with a minimum length of sampling line. During the TECP suit test, samples of both Freon[R] 12 and PEG 400 were taken simultaneously and used to determine TECP suit performance.

Exercise Protocol

A series of light exercises were chosen to stress the suit in a manner similar to typical work routines. Each of the following exercises was carried out for two minutes completing the prescribed number of repetitions. The exercises were carried out in the Safety Science Group's man-test chamber (Figure 2).

- Stand in place.
- Raise hands from waist to above the head, completing at least 15 raising motions per minute.
- Walk in place completing at least 15 raising motions of each leg per minute.
- Perform deep knee bends, making at least 10 complete standing and squatting motions per minutes.
- Touch the toes, making at least 10 complete motions of the arms from above the head to the toes per minute.
- Repeat complete exercise series.
- Exit man-test chamber.

The exercise series required approximately 20 minutes plus donning and doffing time. A 30-minute SCBA bottle provided enough experimental time, but a 60-minute bottle was used because of its additional weight and duration.

Internal Pressure Monitoring

The pressure inside the TECP suit was measured using a Validyne model, P24 pressure transducer with a range of ±15" water gauge (wg) and an accuracy ±0.08" wg.

Vent Volume Monitoring

The volume of air exhausted from the TECP suit was measured using a Kurtz Instruments, Inc. flow meter equipped with a probe for Model 505 which was placed in a specially designed tube.

Data Analysis

The output from the photometer, GC/ECD, infrared spectrophotometer, pressure transducer, and flow monitor was collected on a DEC LSI 11/23 lab computer at a sampling rate of 250 ms per entry. Suit intrusion coefficients[1] or protection factors were calculated for both aerosol and Freon[R] 12 test agents. Graphic output from the computer was plotted as the concentration of aerosol penetrating the suit interior (suit penetration) during the various exercises. Real time pressure and flow traces throughout the various exercises were also recorded. The actual results are presented in the Experimental Results Section and a discussion of their meaning is presented in the Discussion and Conclusion Sections.

[1] $$\text{Intrusion Coefficient} = \frac{\text{Outside Concentration}}{\text{Interior Suit Concentration}}$$

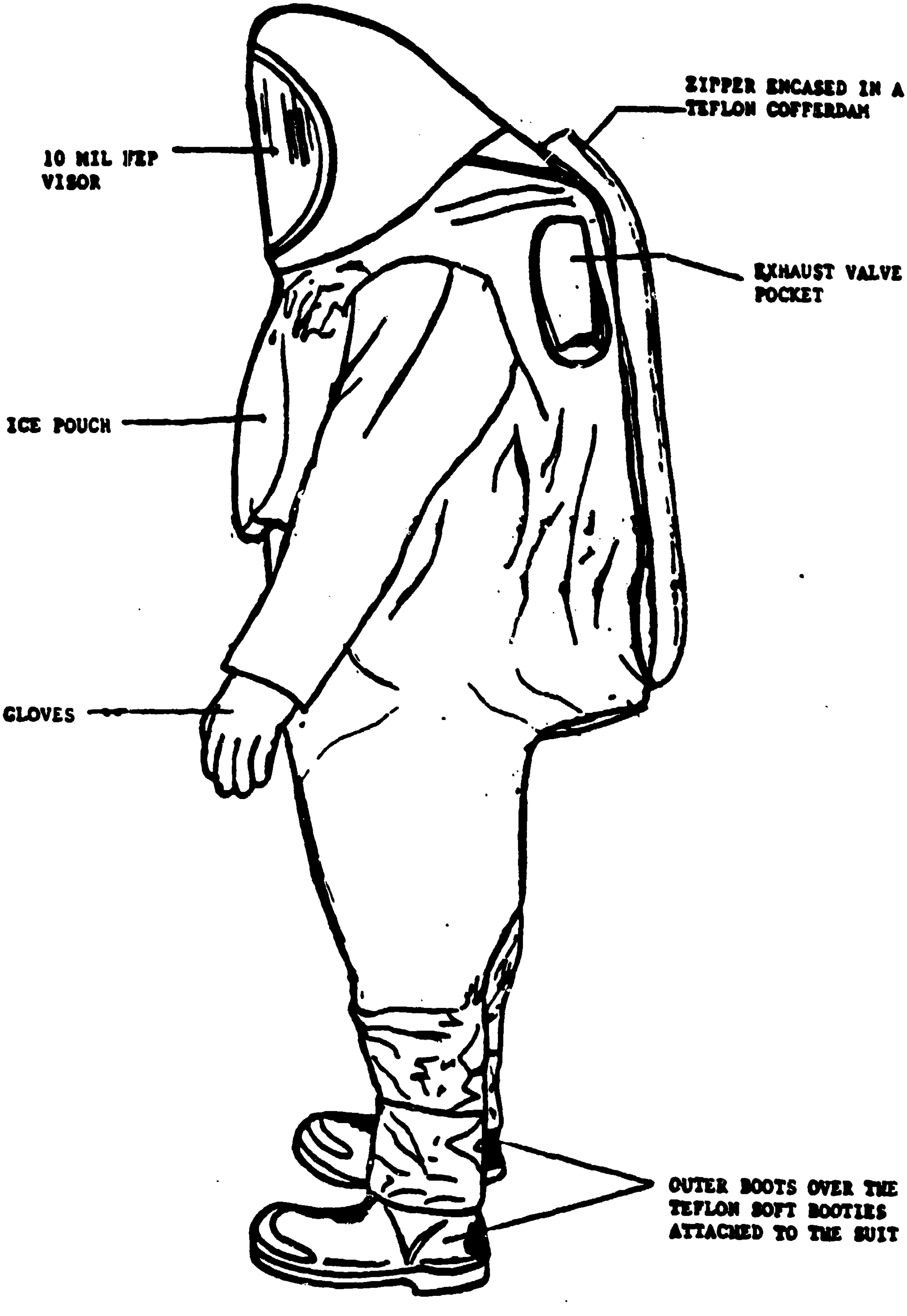
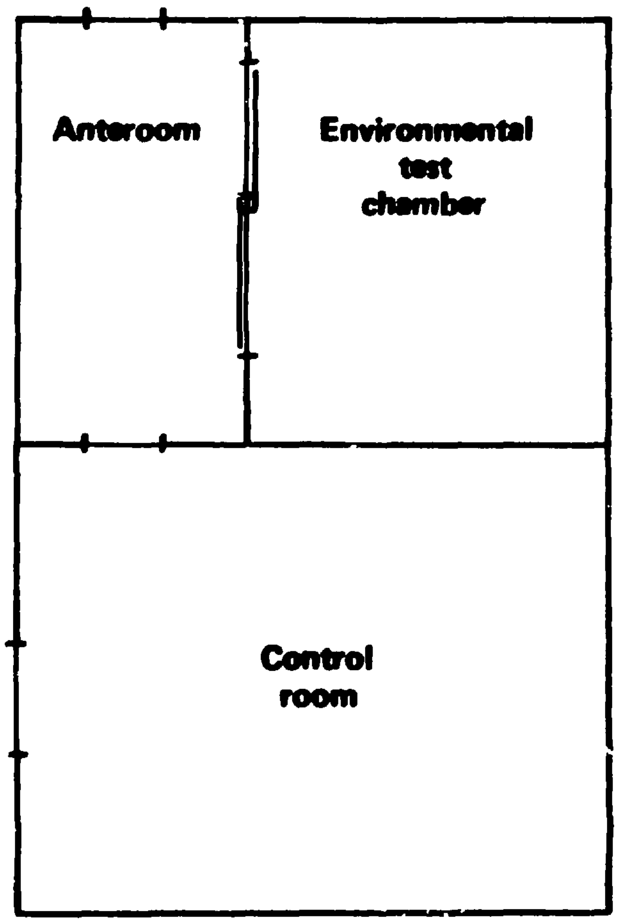


Figure 1. United States Coast Guard's totally encapsulating chemical protective suit design.



Test atmospheres:
Freon™ 12 (gas)
PEG 400 (aerosol)

Stress testing:
Treadmill

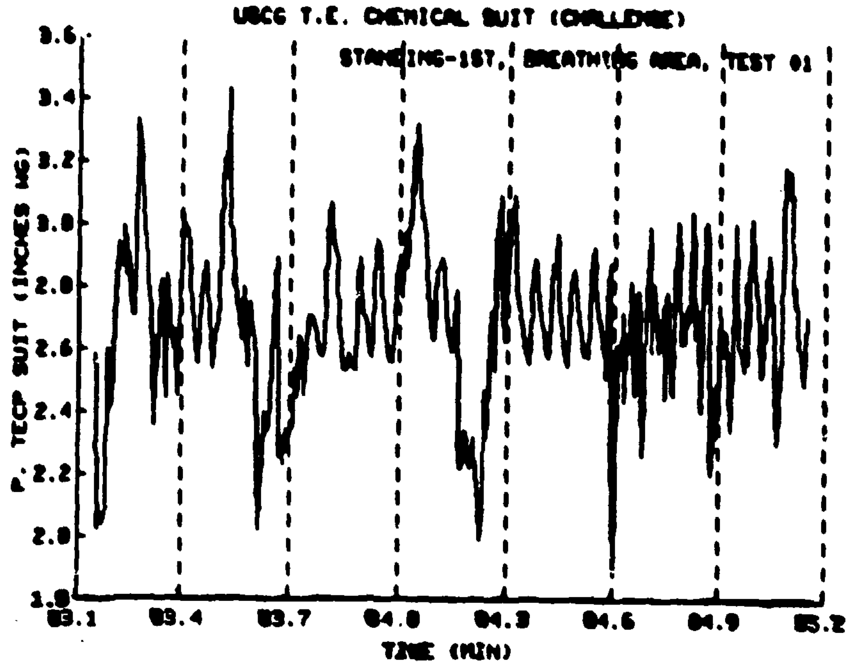
Monitoring:
- GC with electron capture detectors
- IR
- Photometer
- Optical particle sizer
- Size/charge particle counter
- Humidity monitor
- Air flow monitor
- Pressure monitor
- Heart rate monitor

Computer interface:
- DEC LSI 11/23

Figure 2. Saftey Science Group man-test chamber.

Experimental Results

Figures 3 through Figure 39 and Table 1 present the various experimental parameters recorded during each of the three test runs. Due to start up conditions and monitoring or recording failures, some experimental parameters were not recorded. All experimental data which was collected is presented, nothing has been omitted by the investigator.



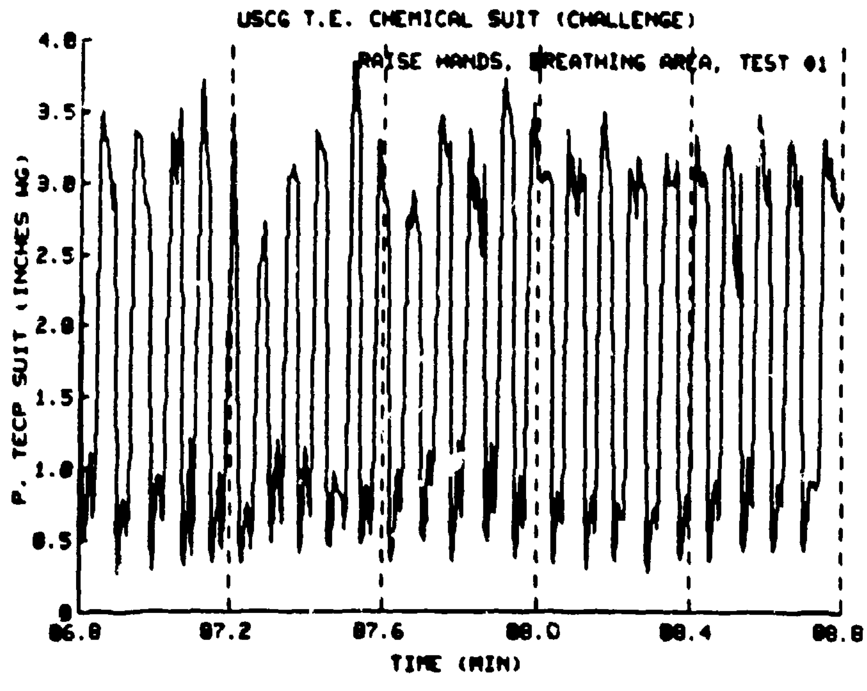
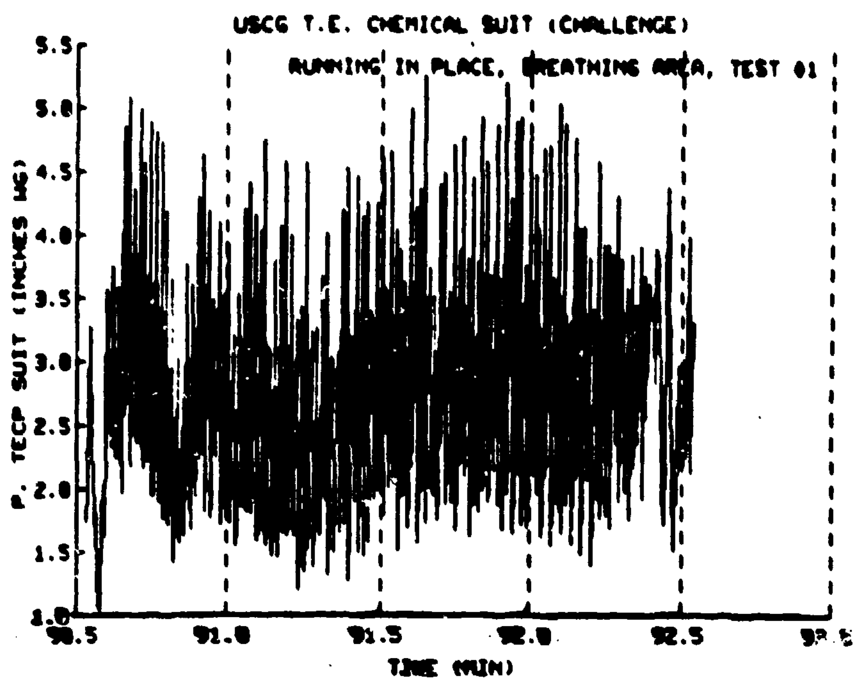


Figure 3. Internal TECP suit pressure for standing in place and rasing the hands above the head.



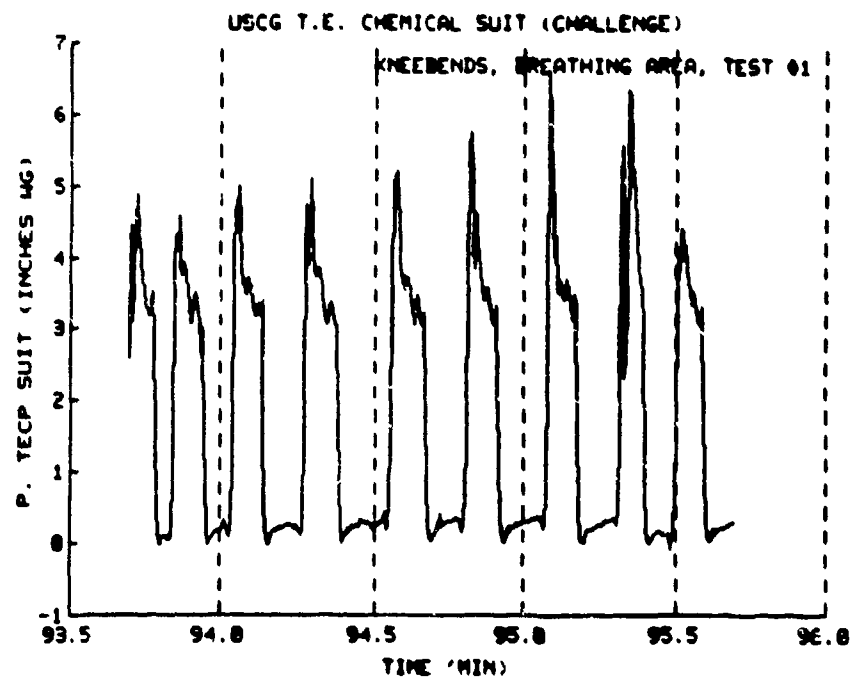
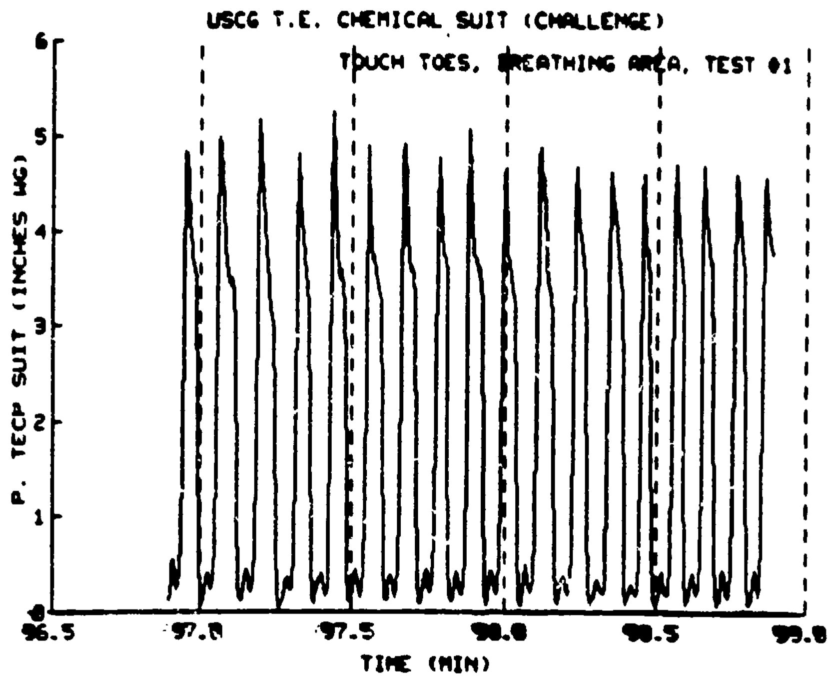


Figure 4. Internal TECP suit pressure for running in place and during kneebends.



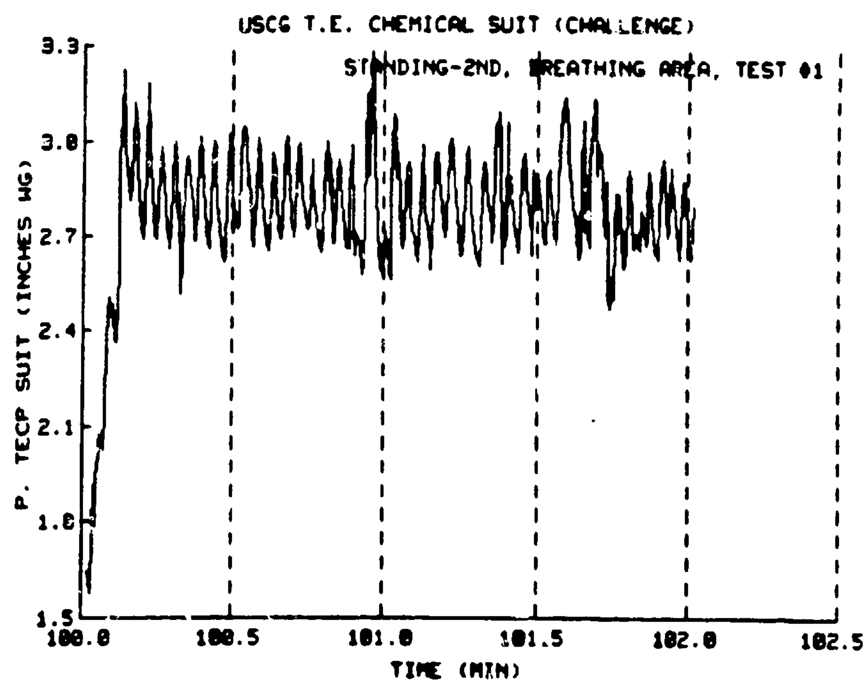
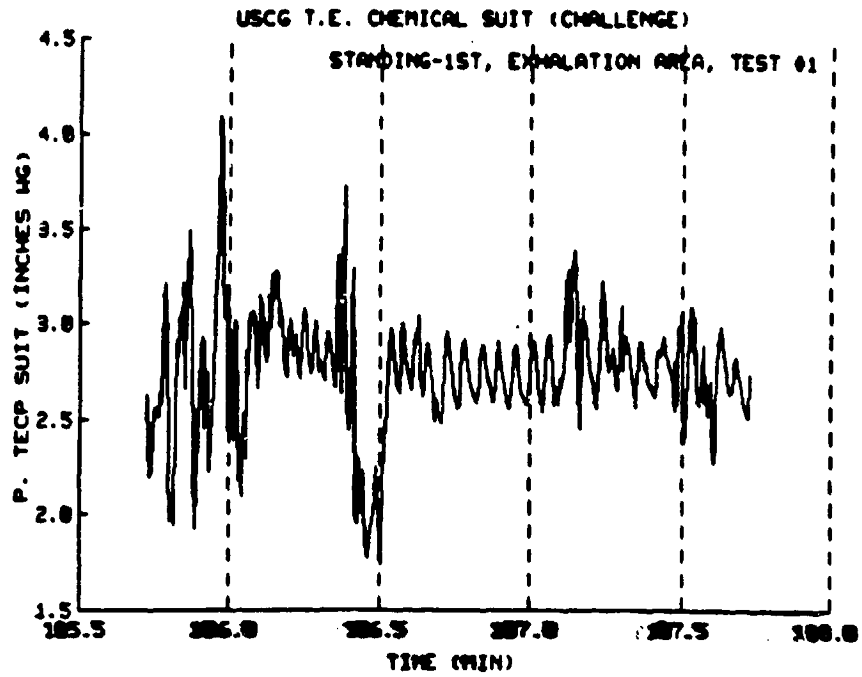


Figure 5. Internal TECP suit pressure for touching the toes and standing in place.



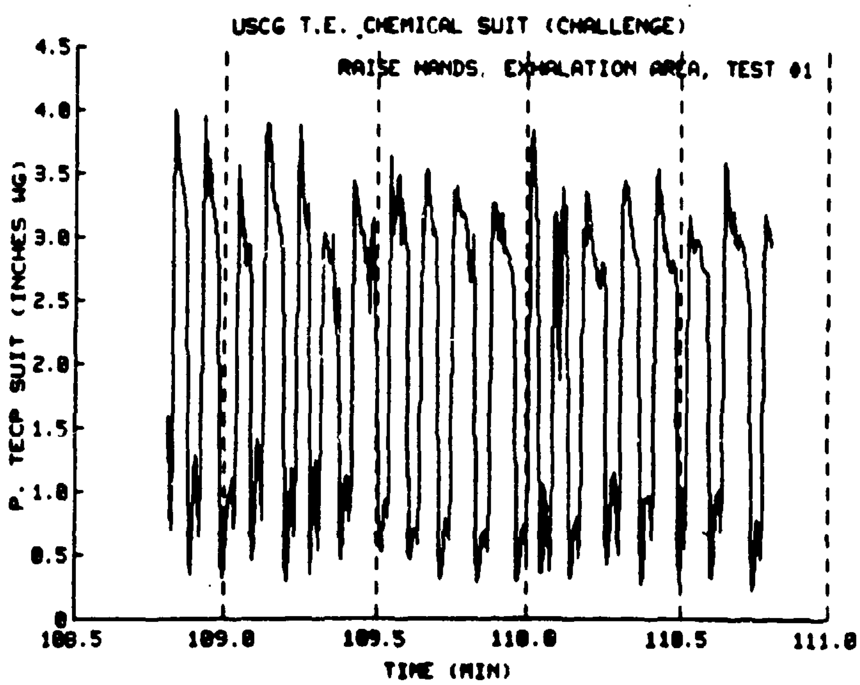
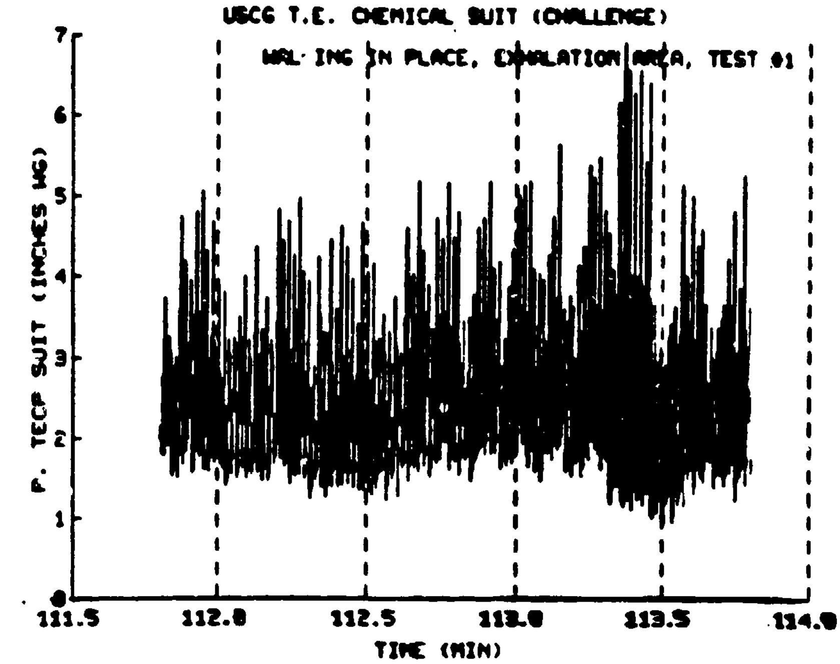


Figure 6. Internal TECP suit pressure for standing in place and rasing the hands above the head.



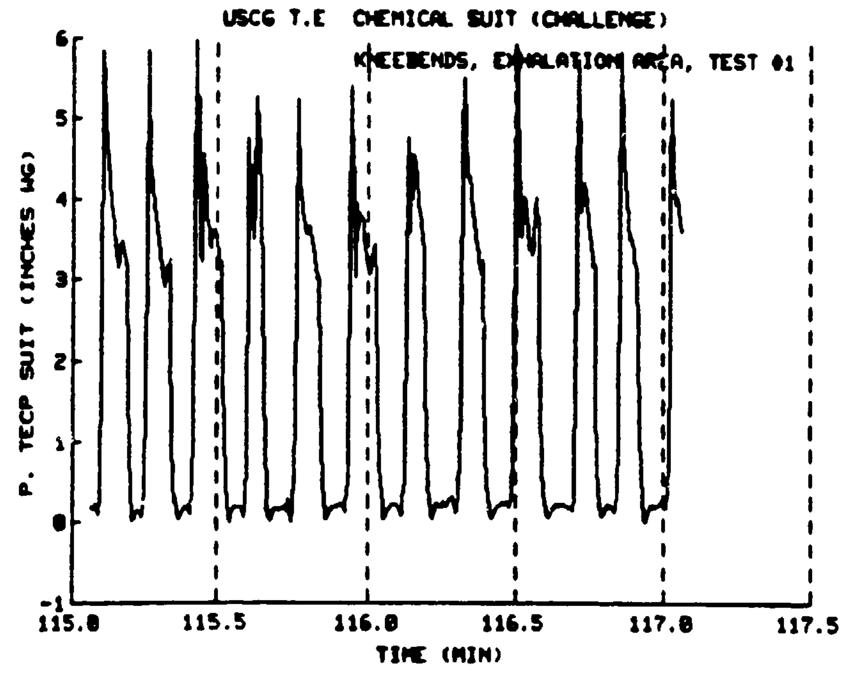


Figure 7. Internal TECP suit pressure for walking in place and during kneebends.

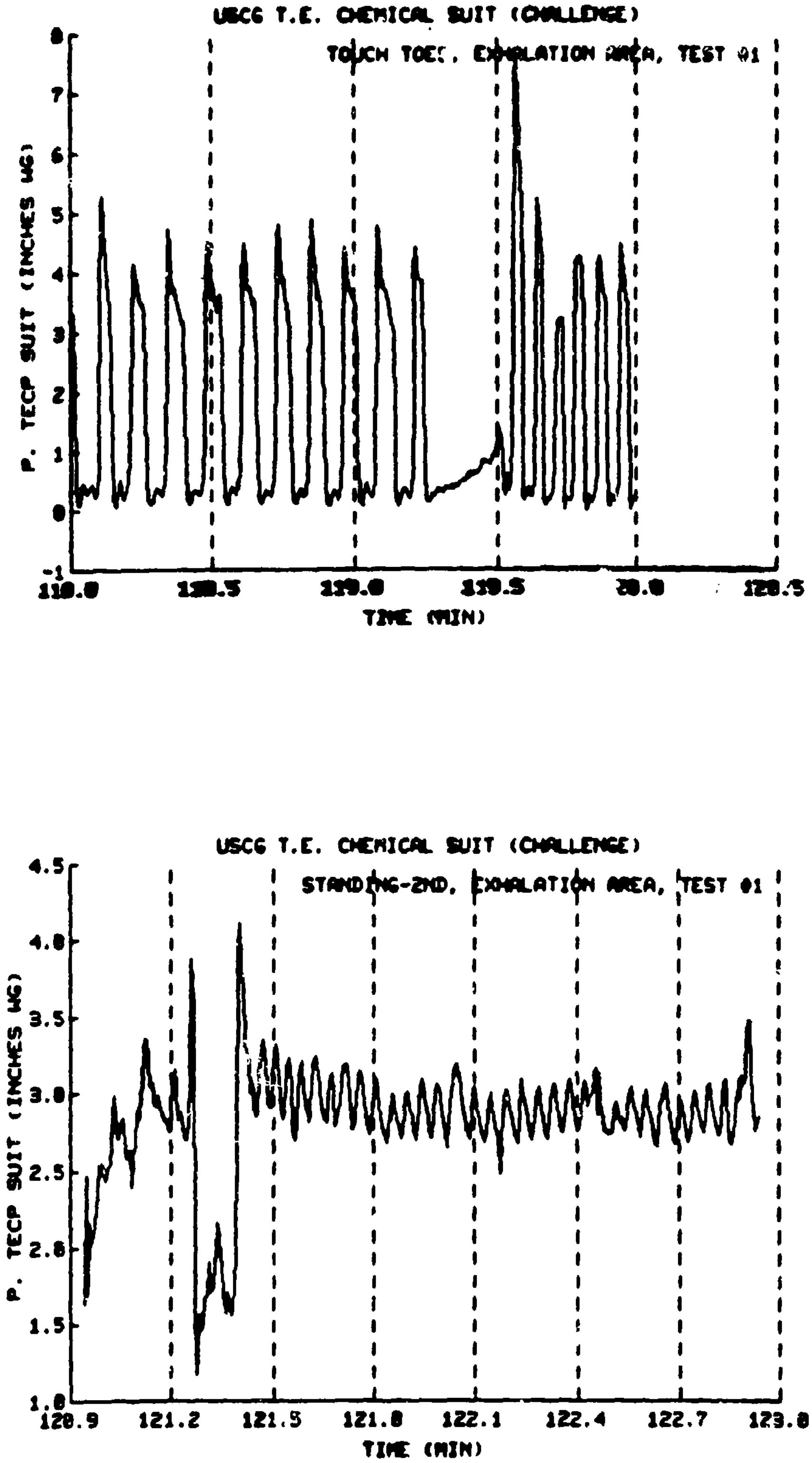
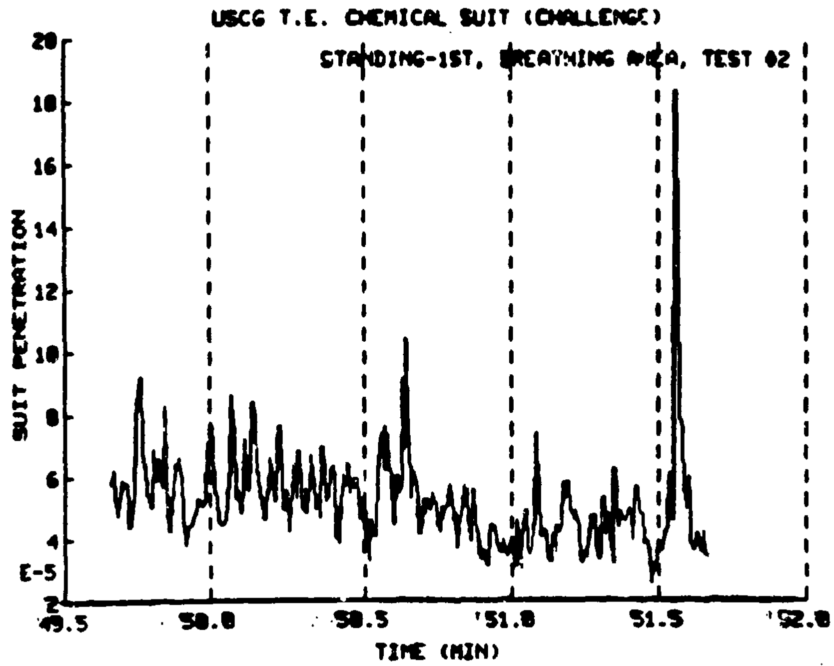


Figure 8. Internal TECP suit pressure for touching the toes and standing in place.



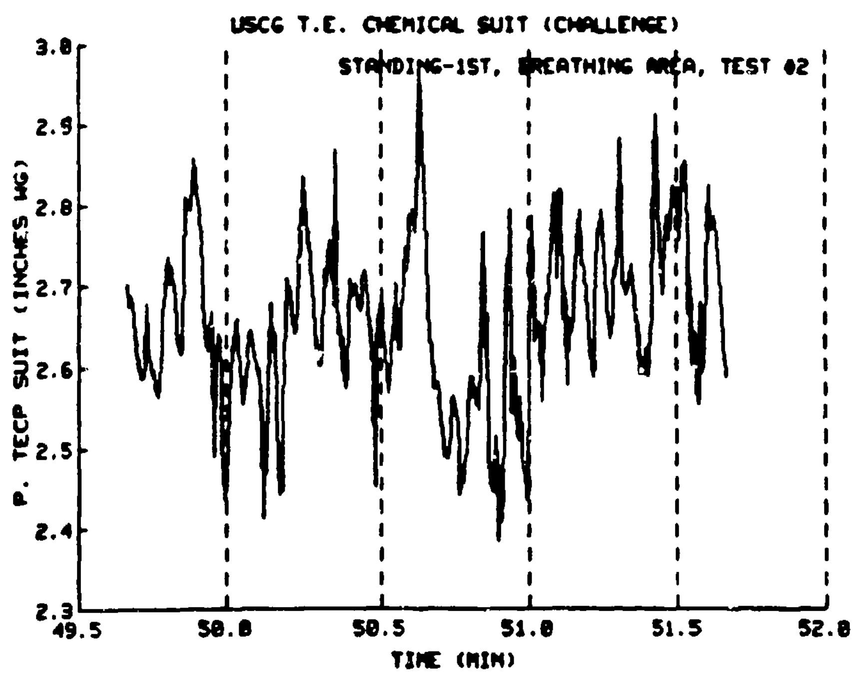
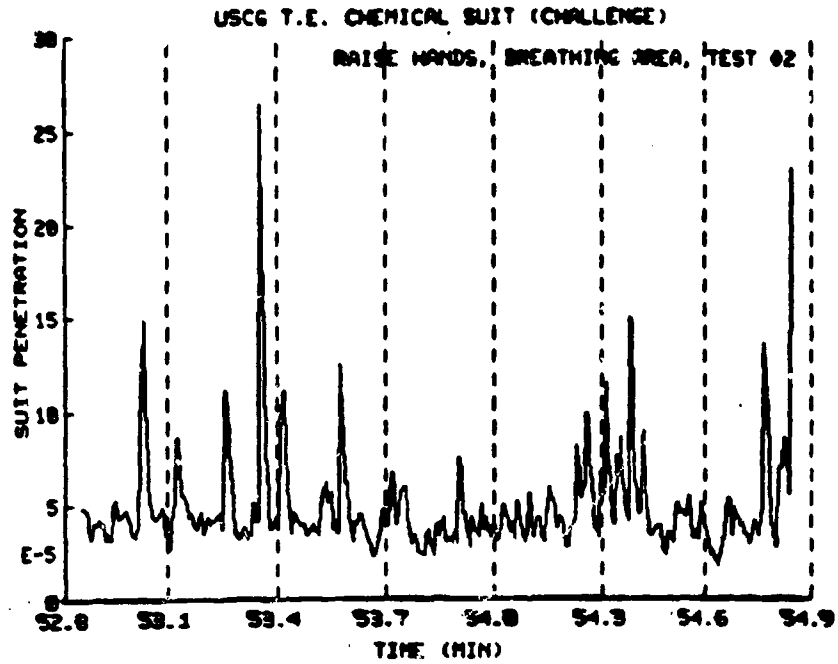


Figure 9. TECP suit aerosol penetration (BZ) and pressure plots for standing in place.



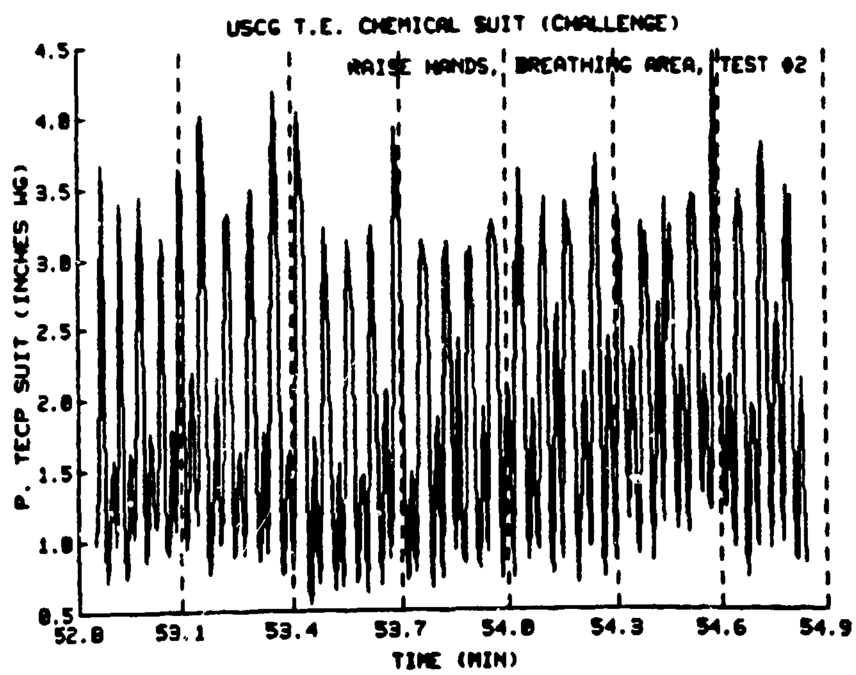
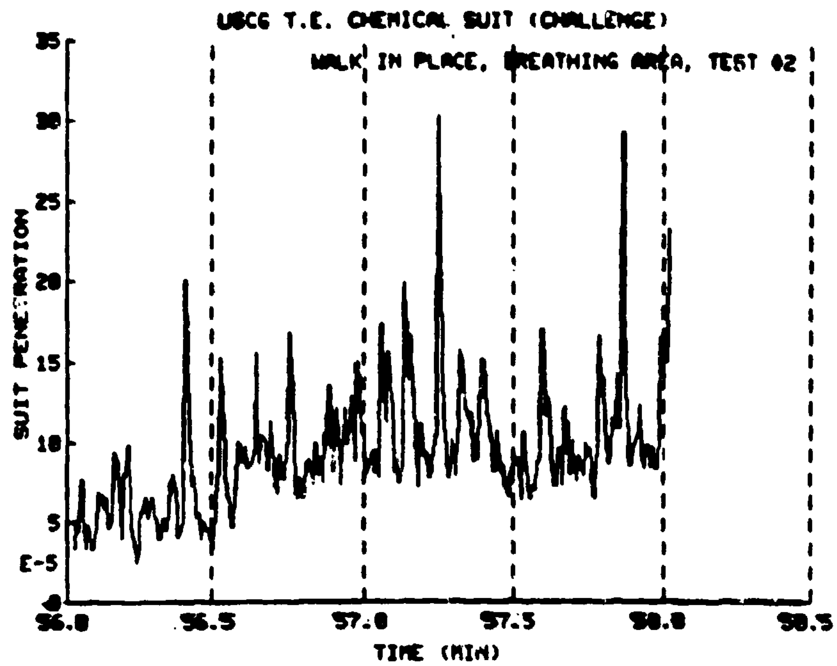


Figure 10. TECP suit aerosol penetration (BZ) and pressure plots for rasing the hands above the head.



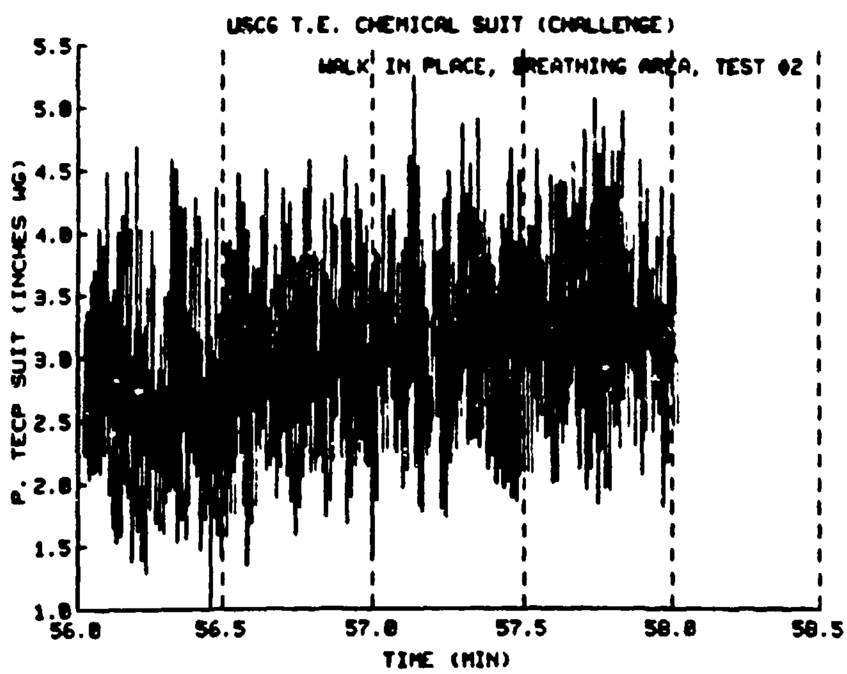
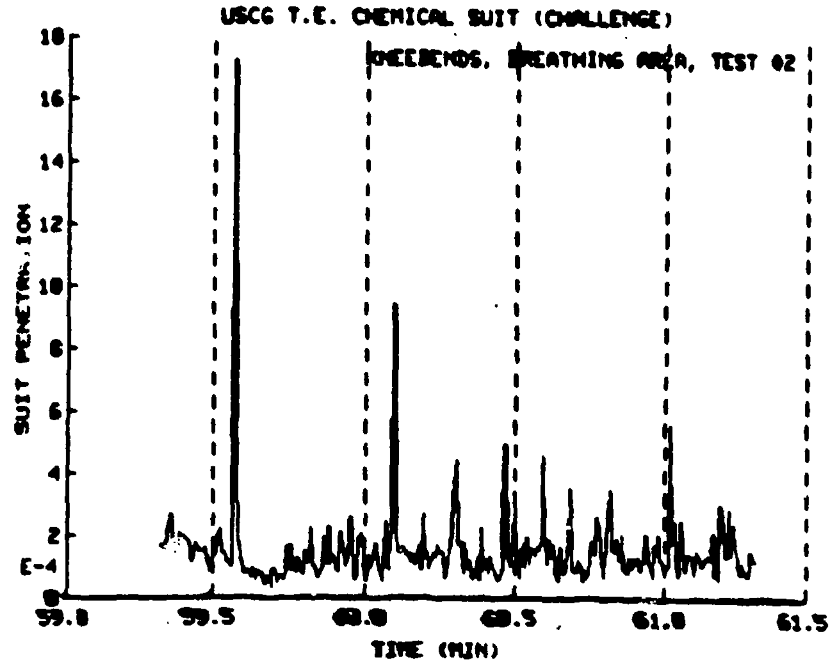


Figure 11. TECP suit aerosol penetration (BZ) and pressure plots for walking in place.



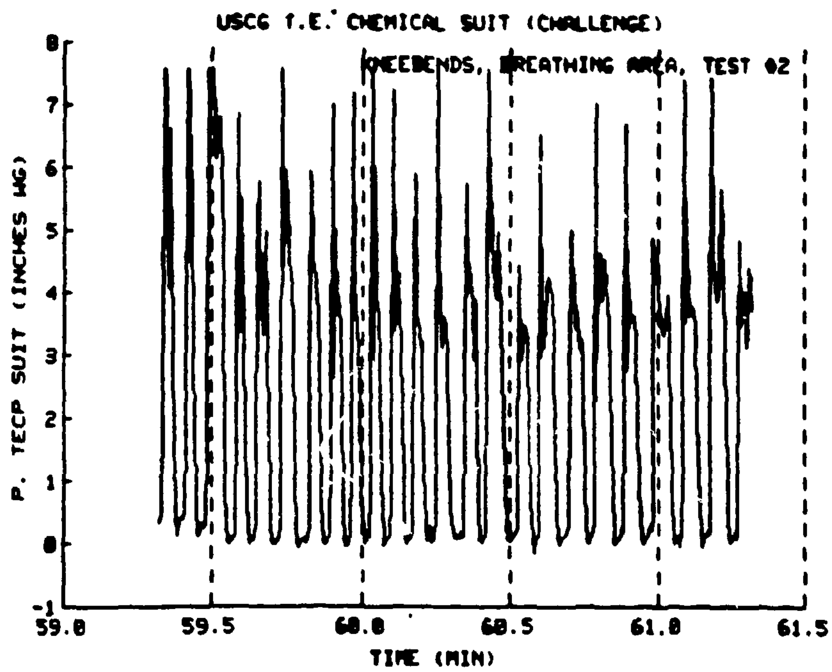
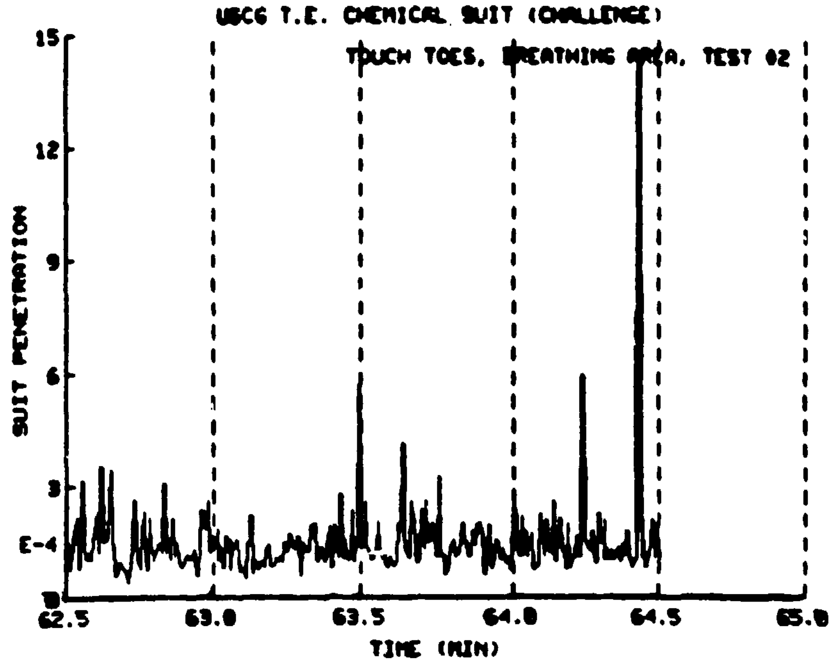


Figure 12. TECP suit aerosol penetration (BZ) and pressure plots during kneebends.



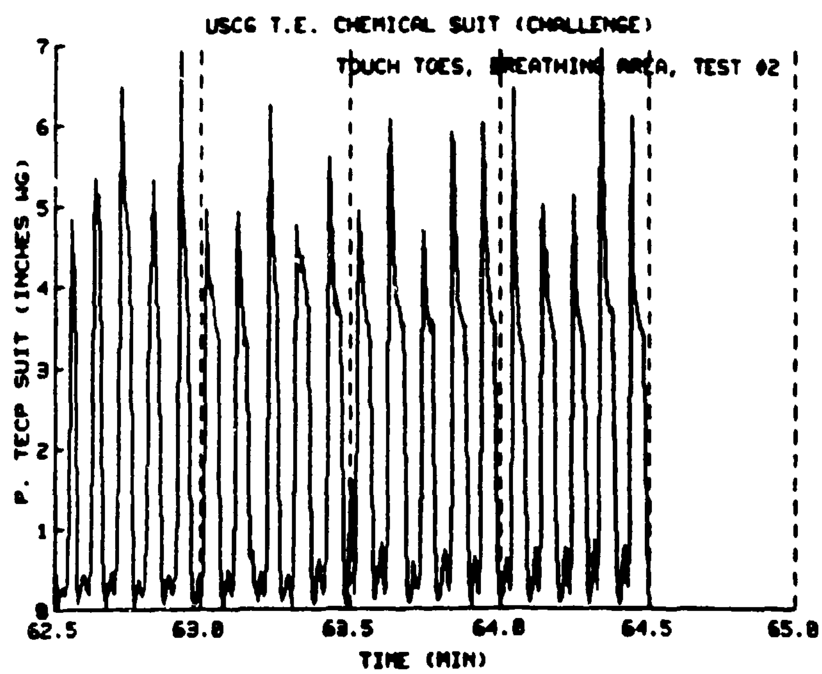
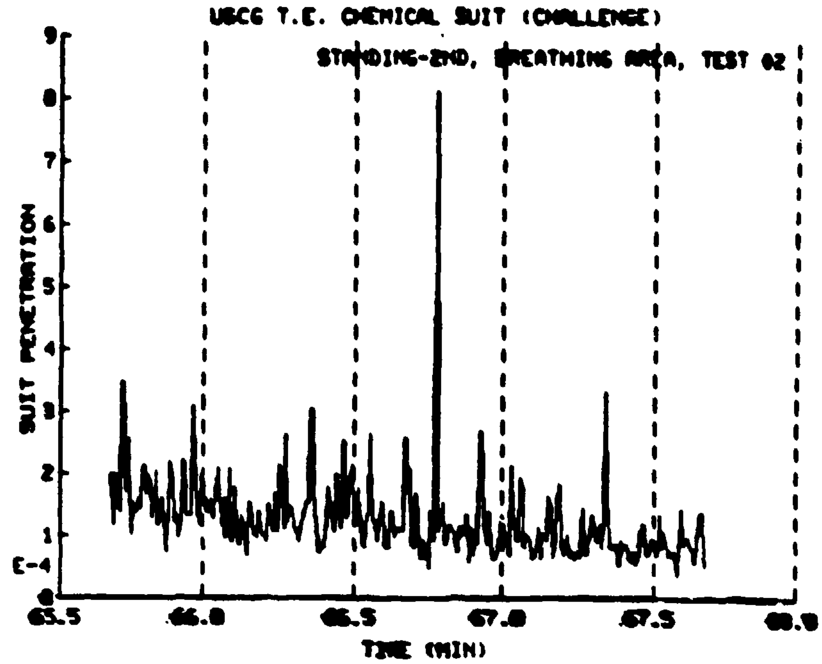


Figure 13. TECP suit aerosol penetration (BZ) and pressure plots for touching the toes.



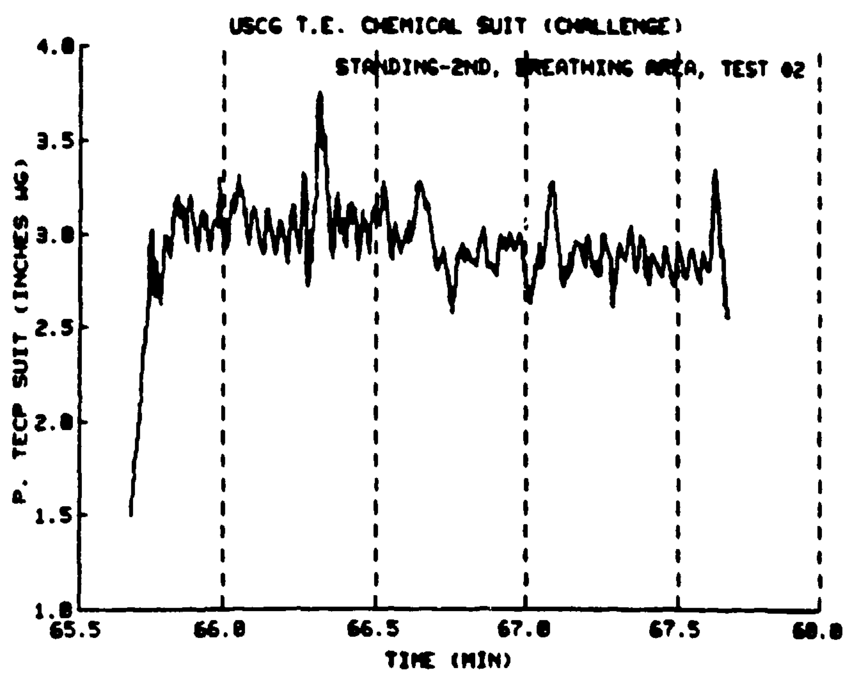
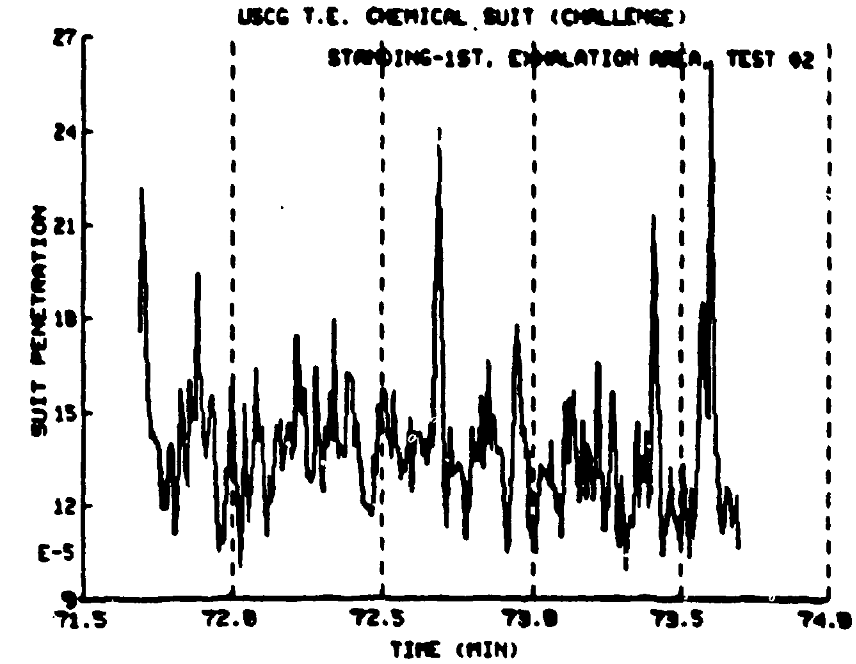


Figure 14. TECP suit aerosol penetration (BZ) and pressure plots for standing in place.



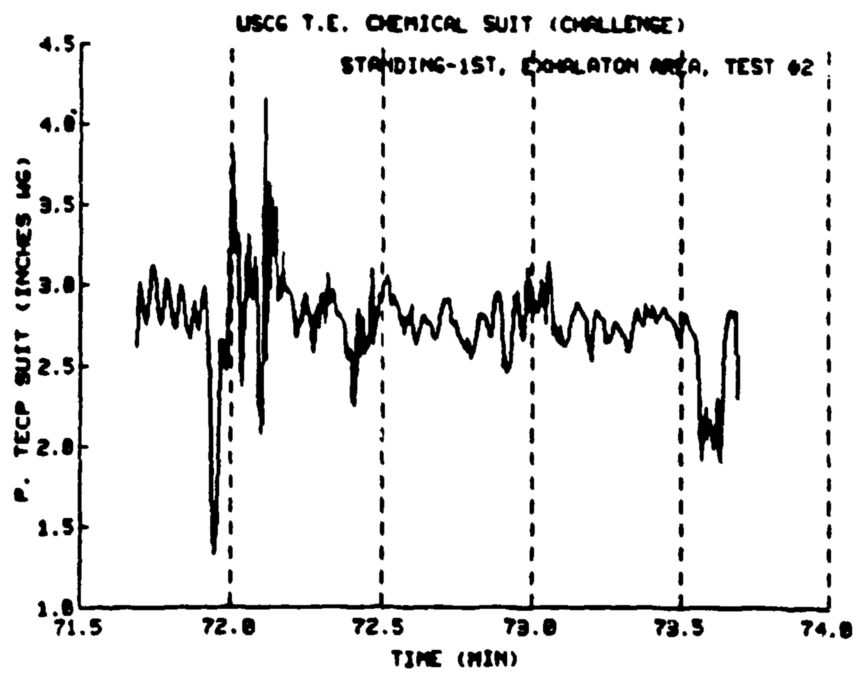
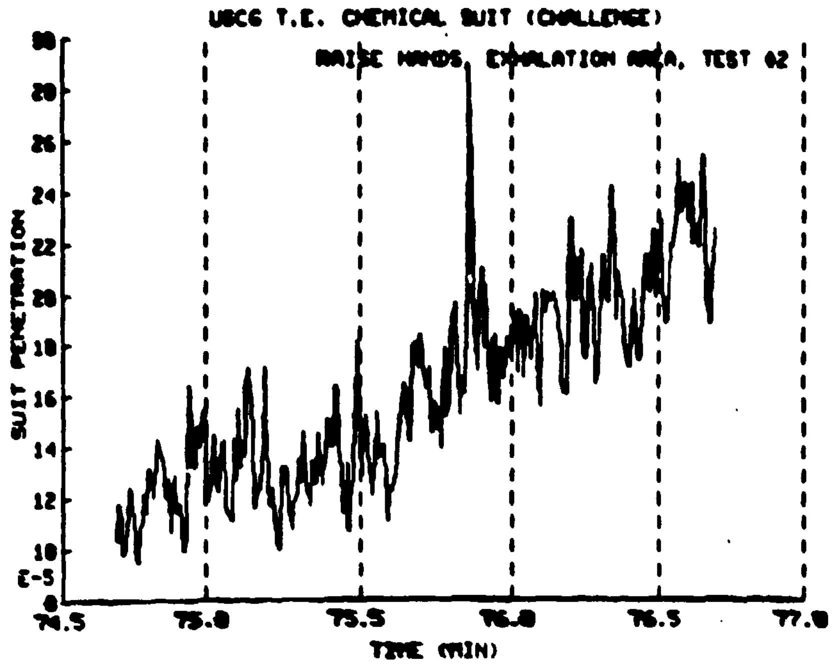


Figure 15. TECP suit aerosol penetration (VVZ) and pressure plots for standing in place.



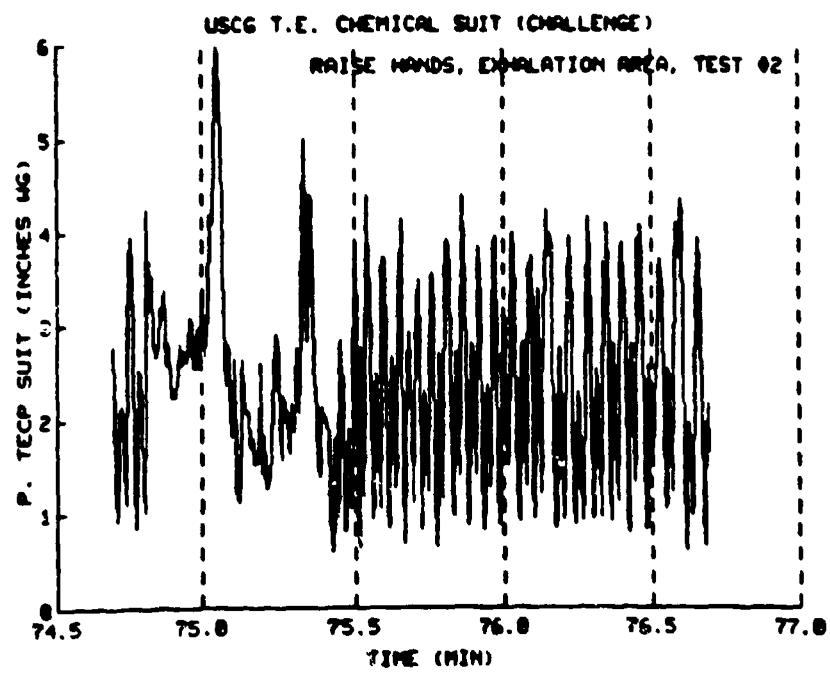


Figure 16. TECP suit aerosol penetration (VVZ) and pressure plots for raising the hands above the head.

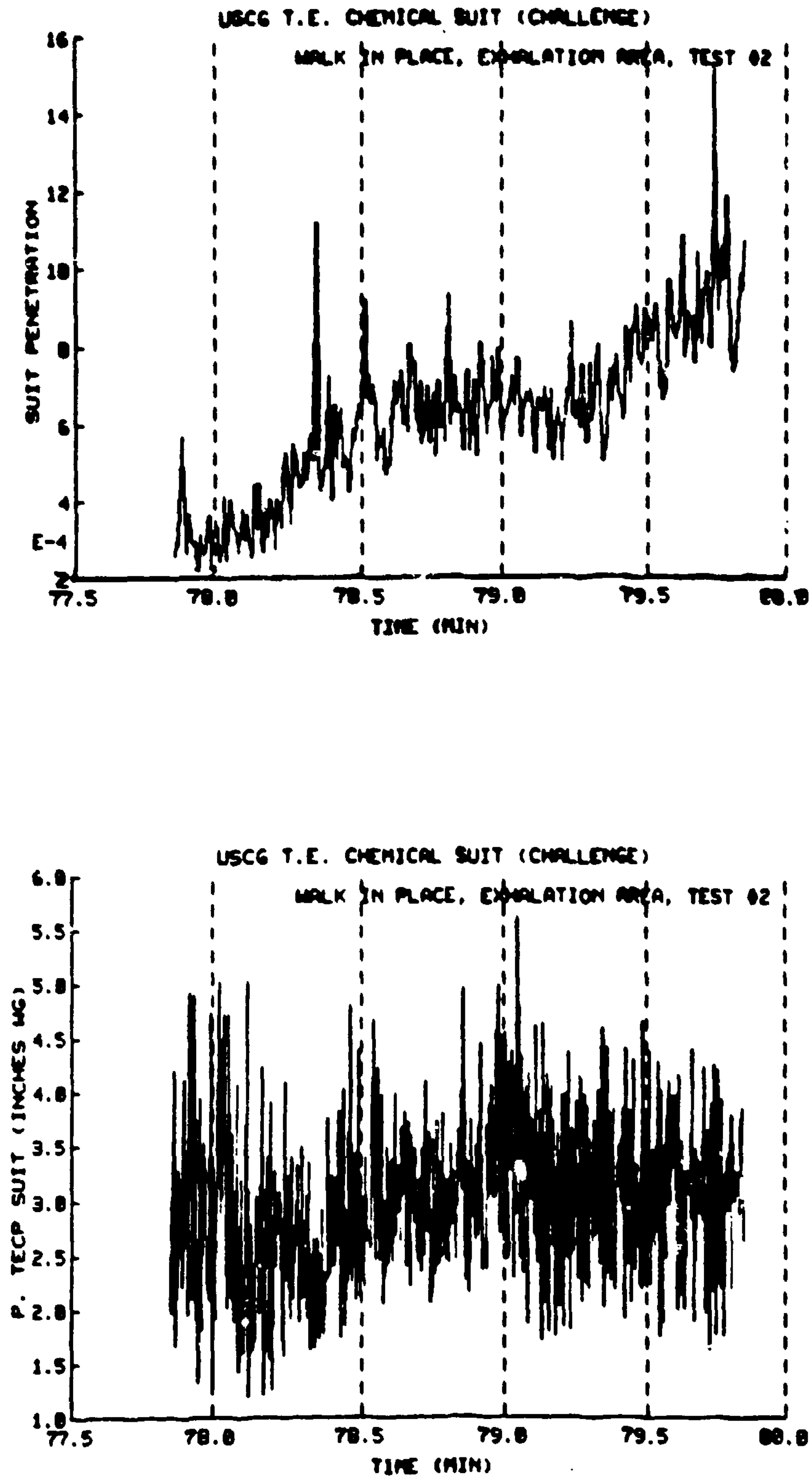
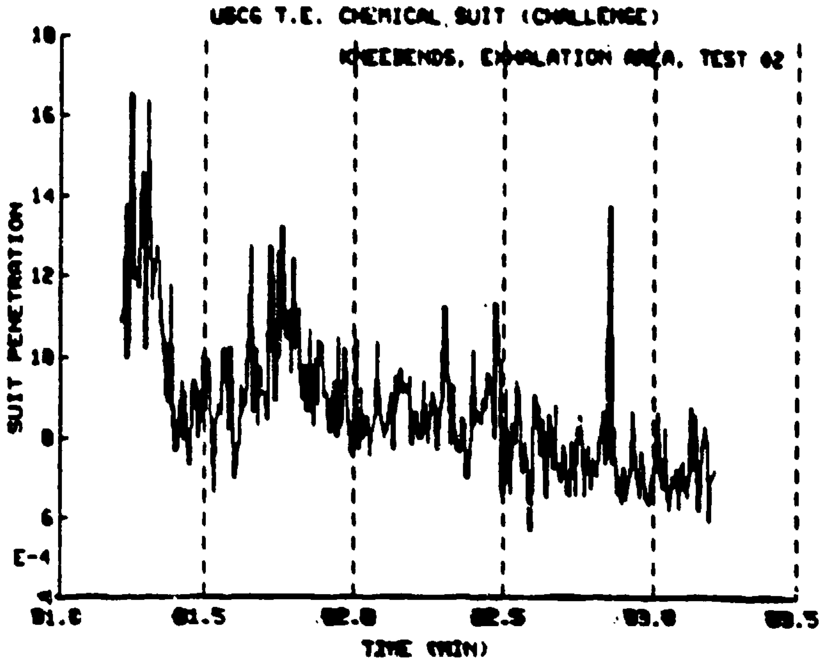


Figure 17. TECP suit aerosol penetration (VVZ) and pressure plots for walking in place.



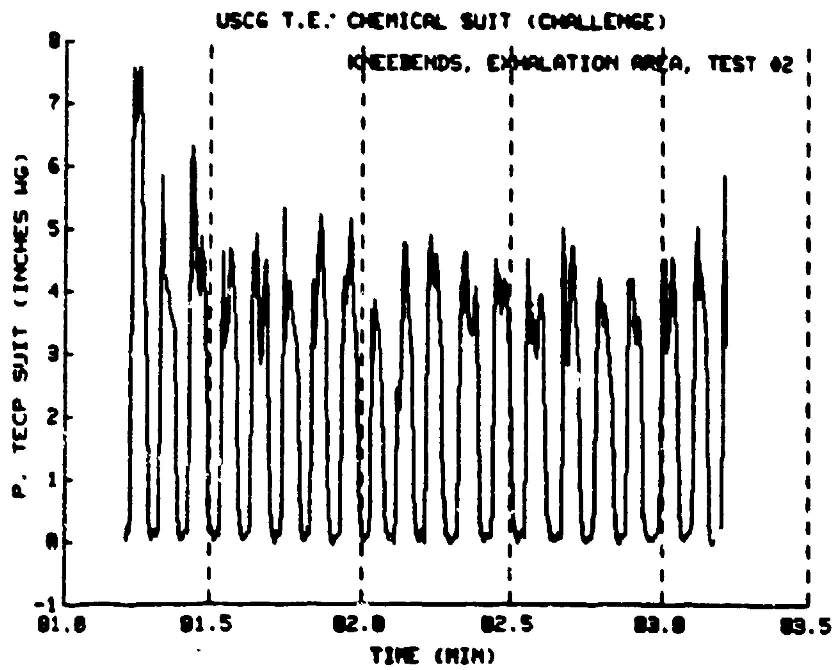


Figure 18. TECP suit aerosol penetration (VVZ) and pressure plots during kneebends

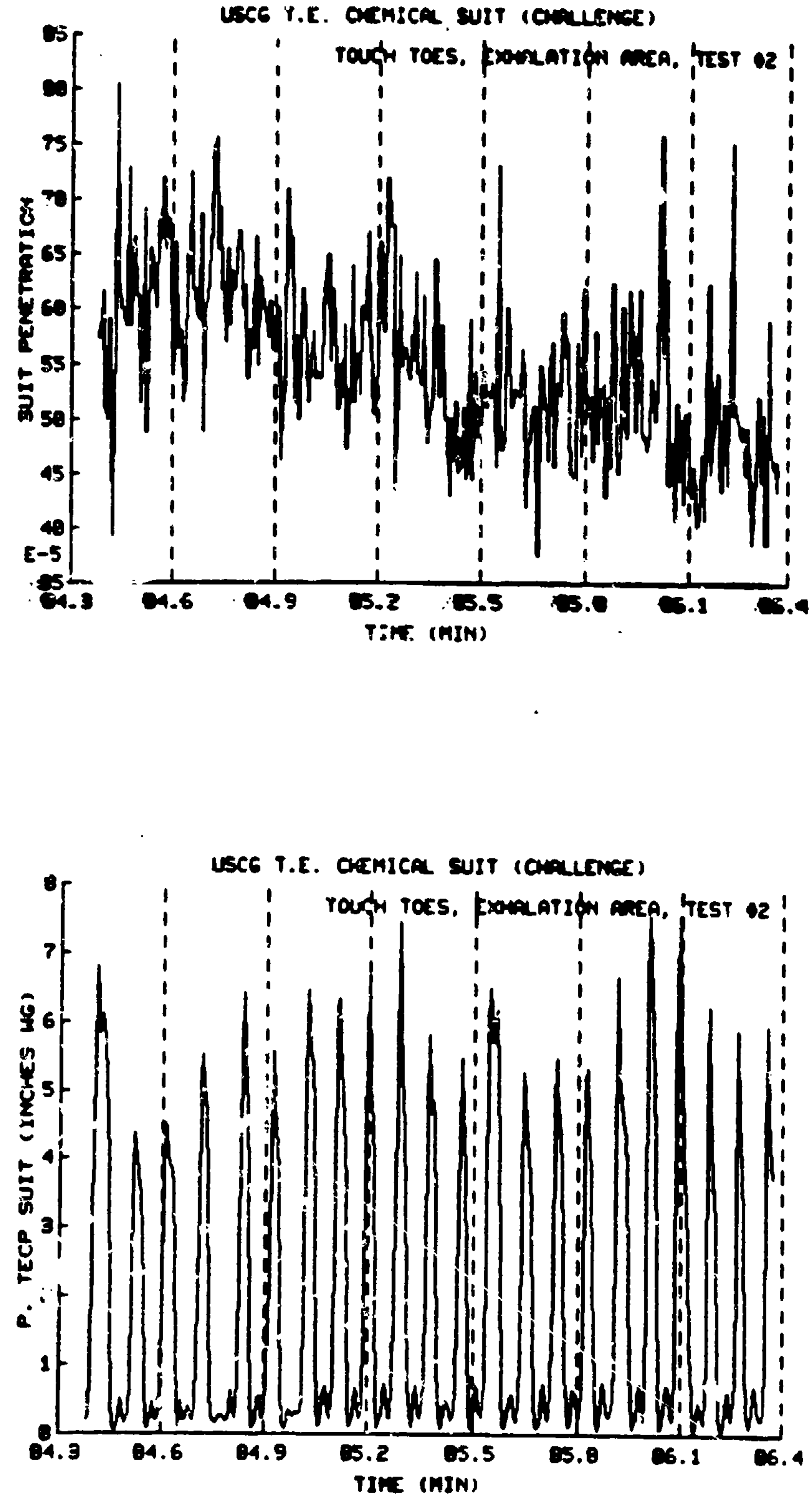
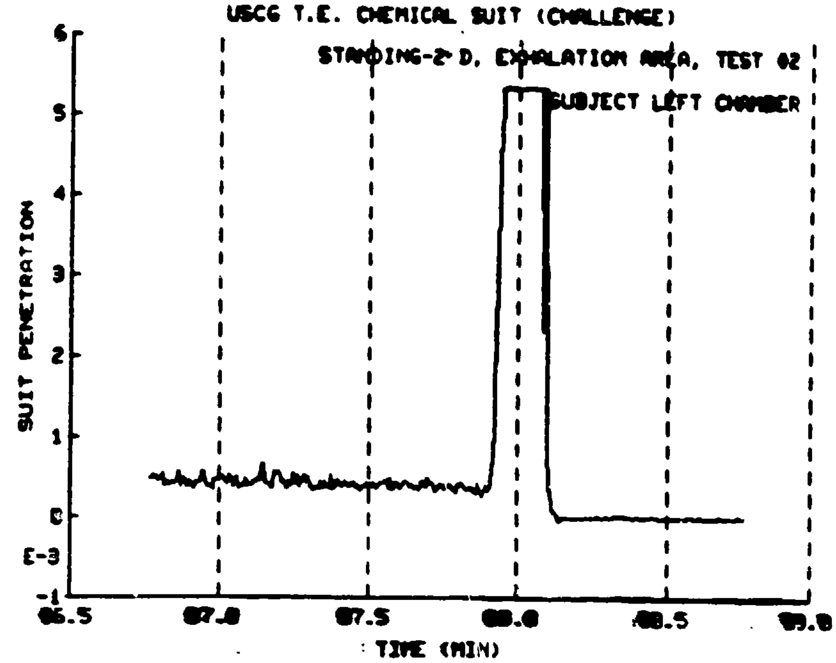


Figure 19. TECP suit aerosol penetration (VVZ) and pressure plots for touching the toes.



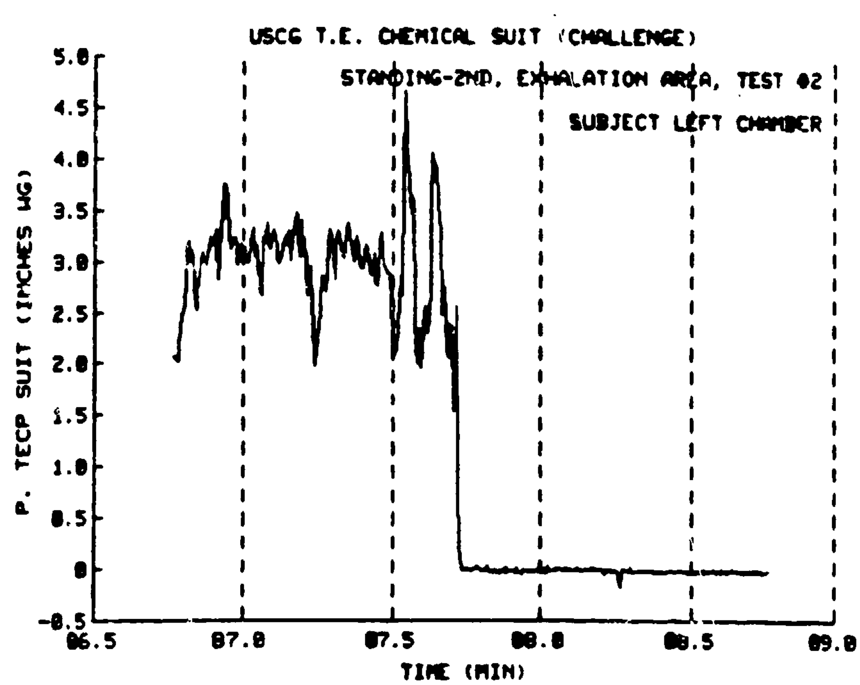
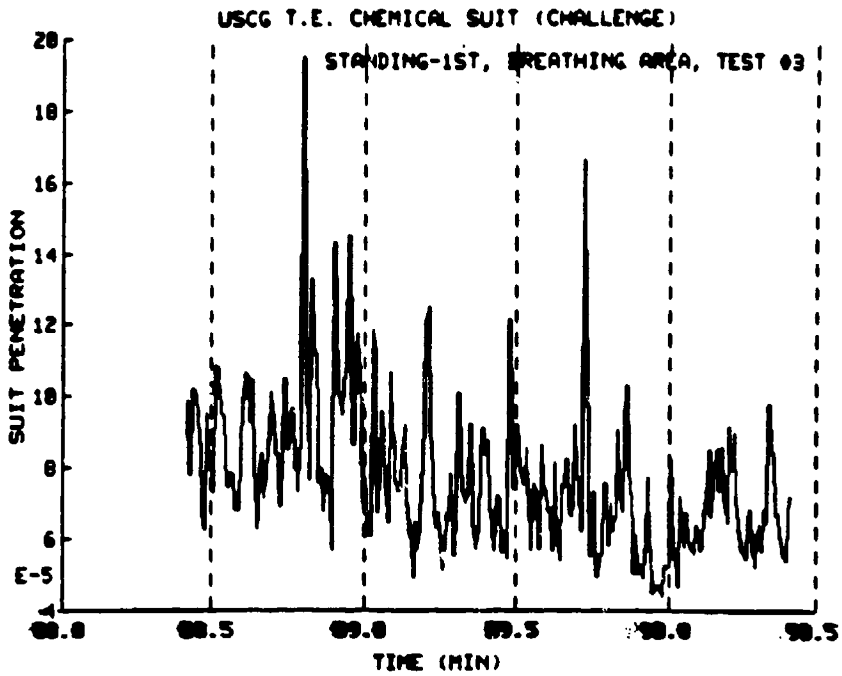


Figure 20. TECP suit aerosol penetration (VVZ) and pressure plots for standing in place.



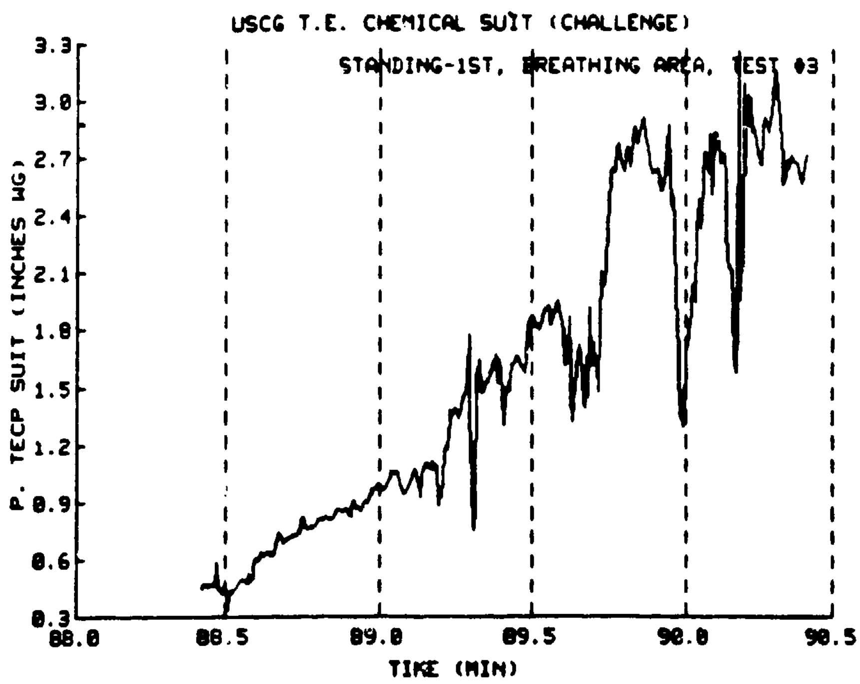
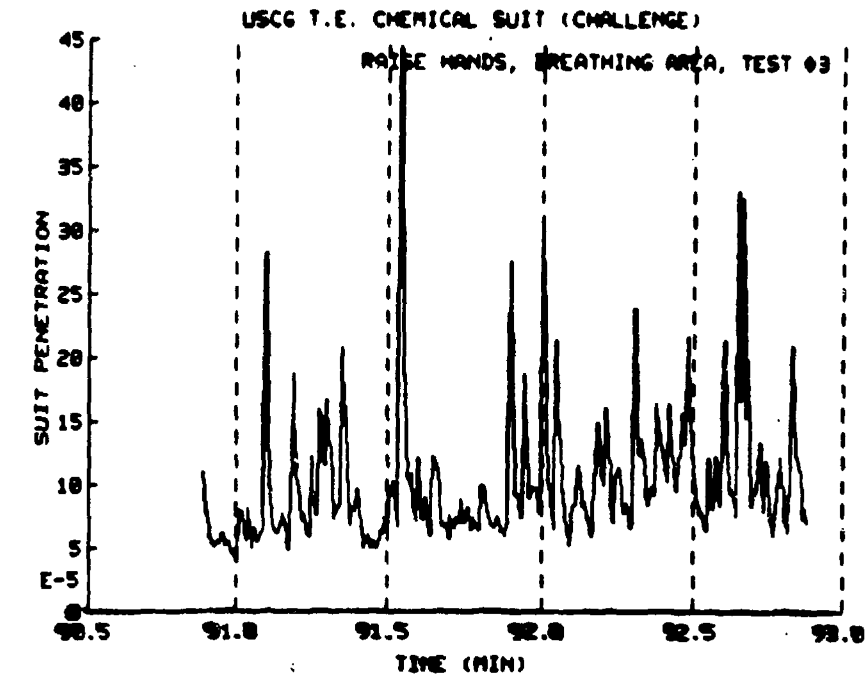


Figure 21. TECP suit aerosol penetration (BZ) and pressure plots for standing in place.



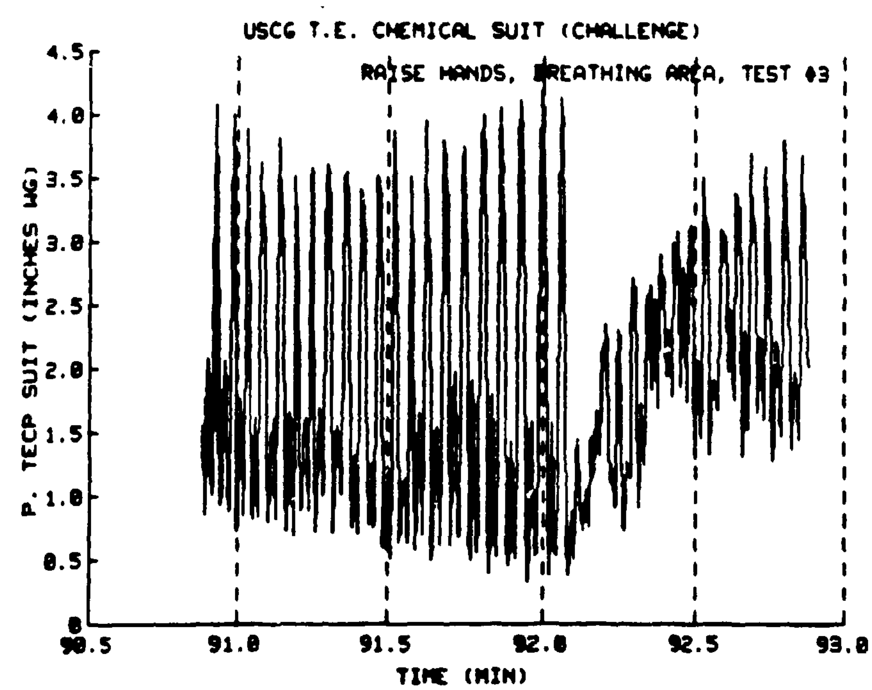
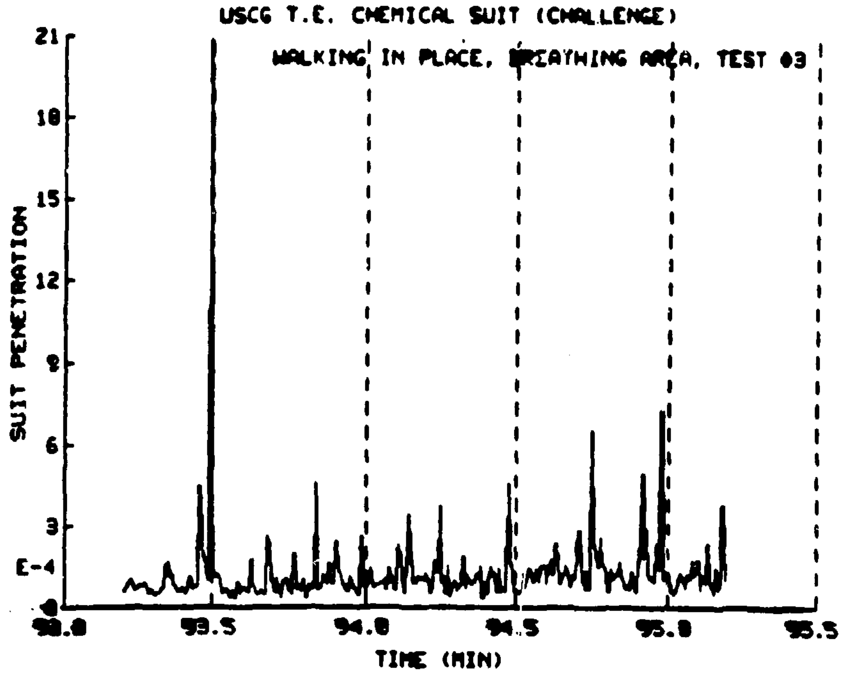


Figure 22. TECP suit aerosol penetration (BZ) and pressure plots for raising the hands above the head.



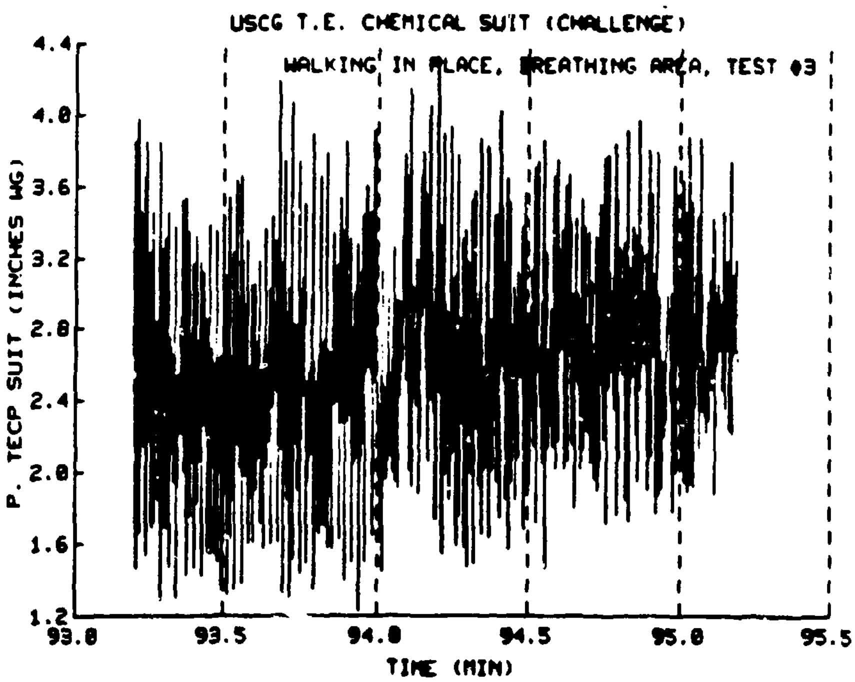
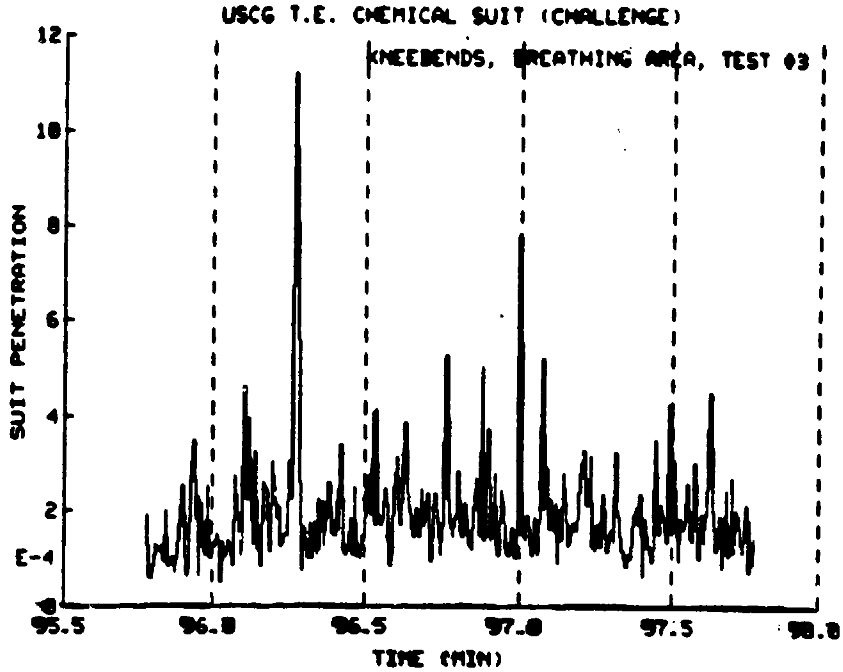


Figure 23. TECP suit aerosol penetration (BZ) and pressure plots for walking in place.



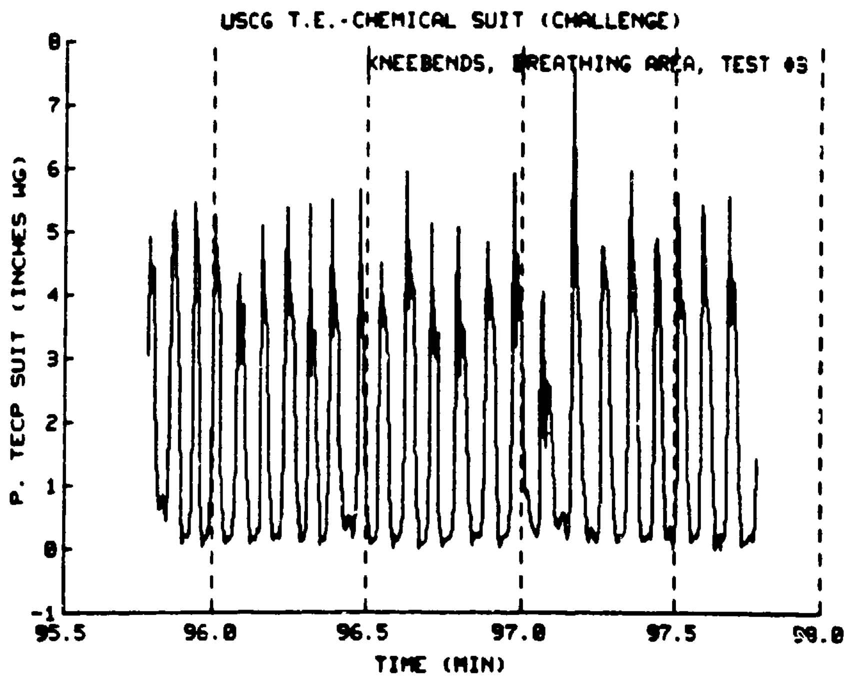


Figure 24. TECP suit aerosol penetration (BZ) and pressure plots during knecbends.

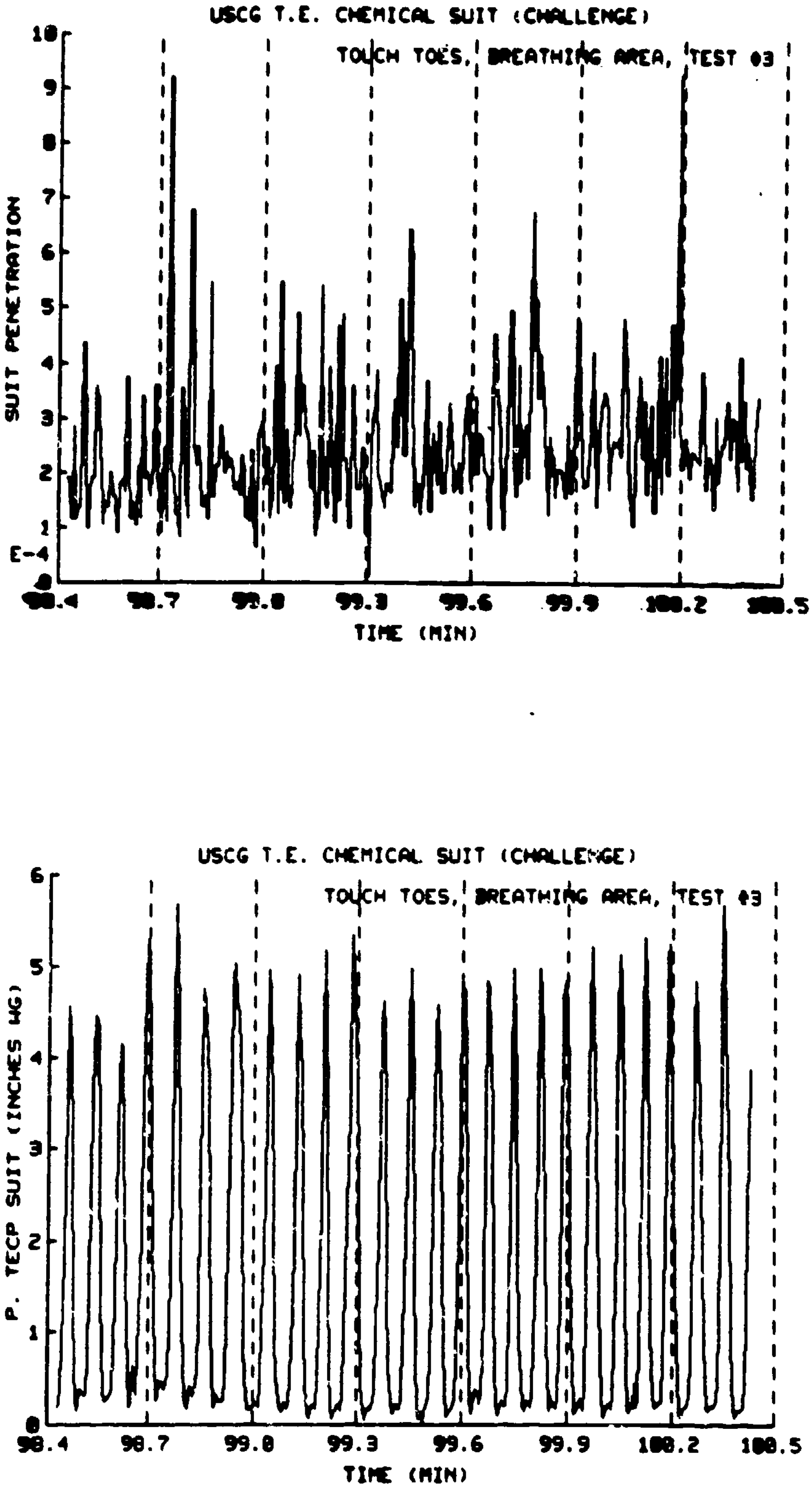
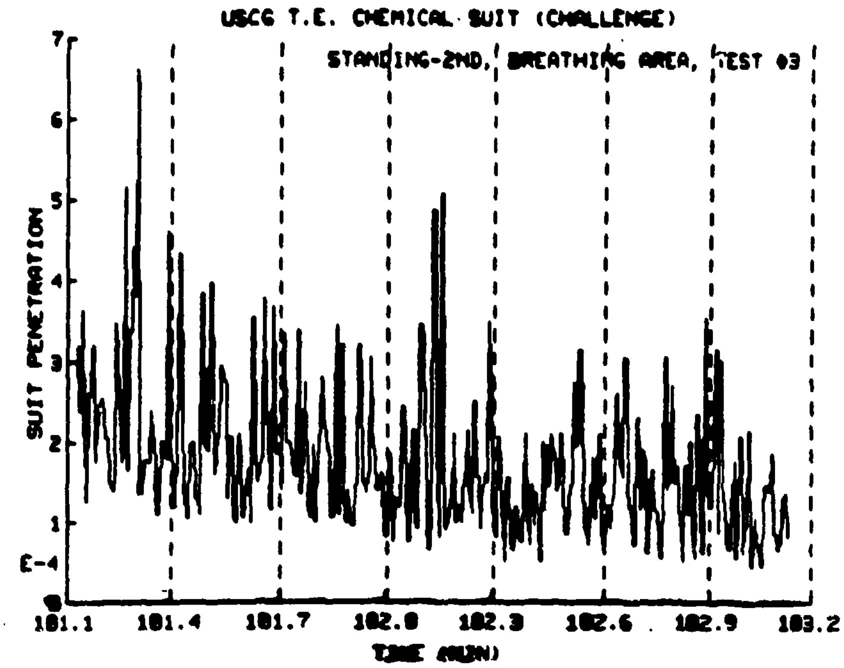


Figure 25. TECP suit aerosol penetration (BZ) and pressure plots for touching the toes.



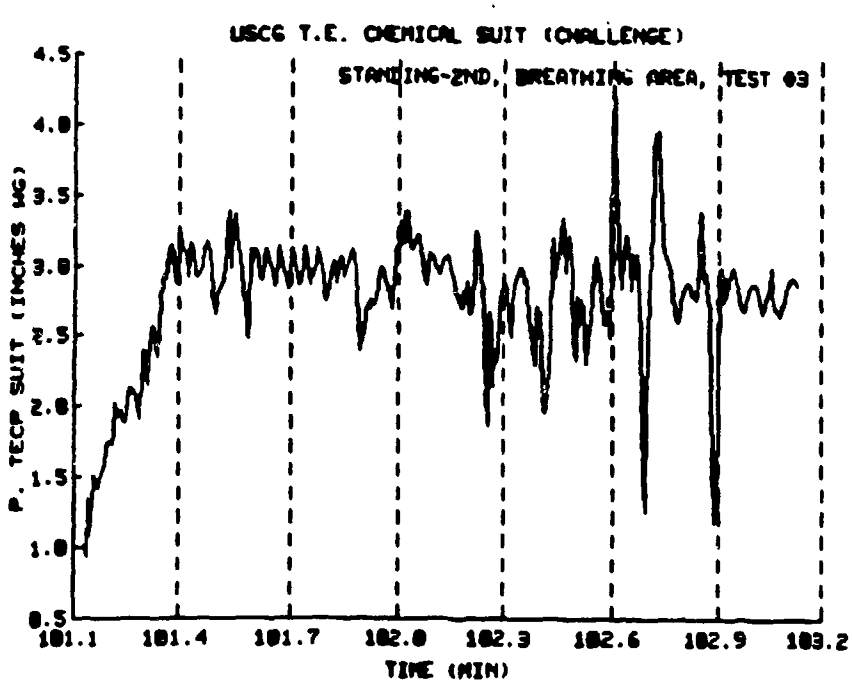
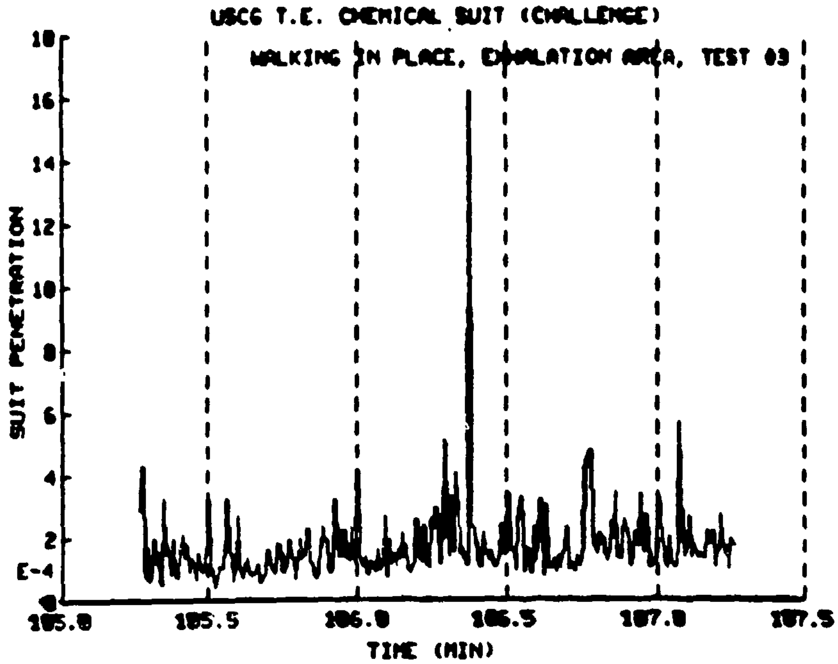


Figure 26. TECP suit aerosol penetration (BZ) and pressure plots for standing in place.



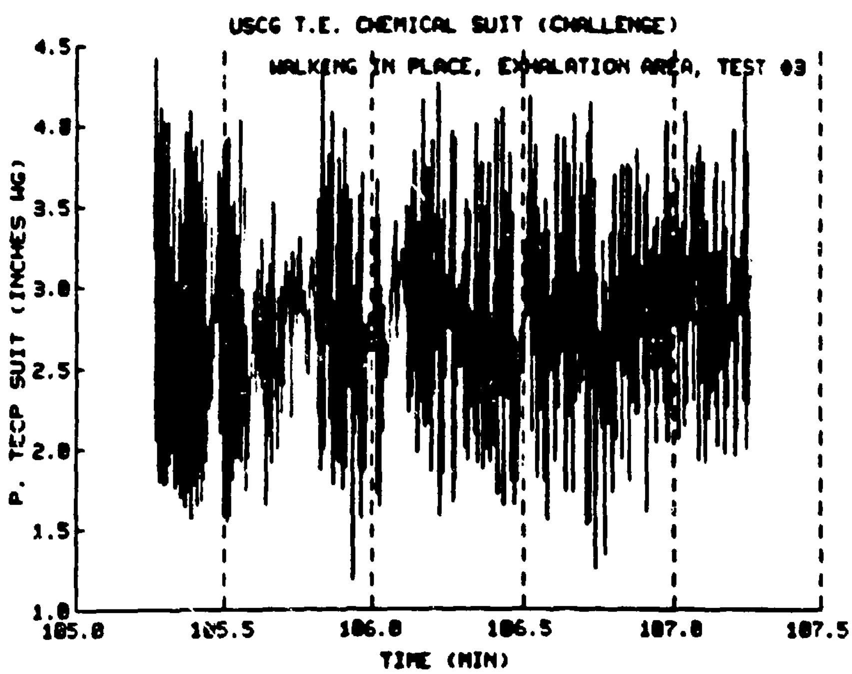
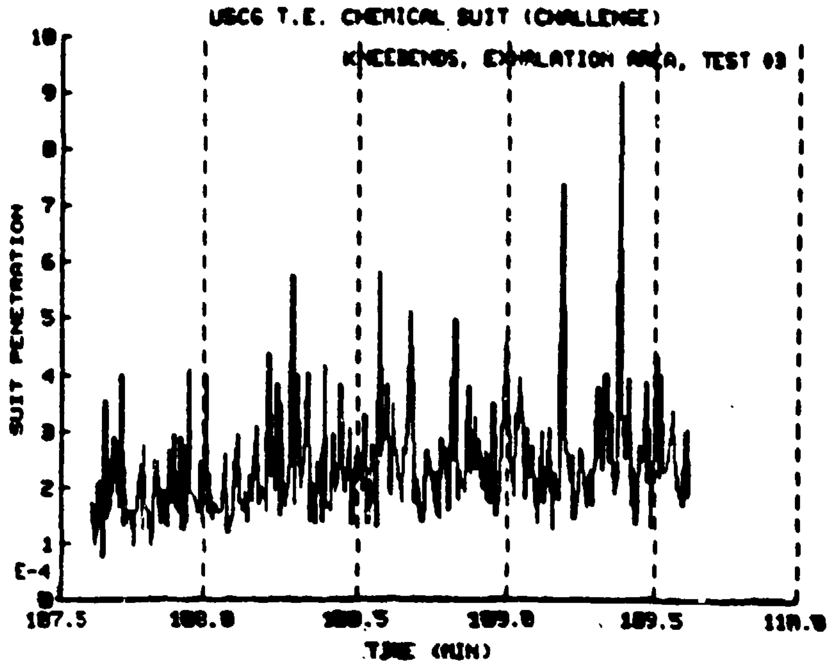


Figure 27. TECP suit aerosol penetration (VVZ) and pressure plots for walking in place.



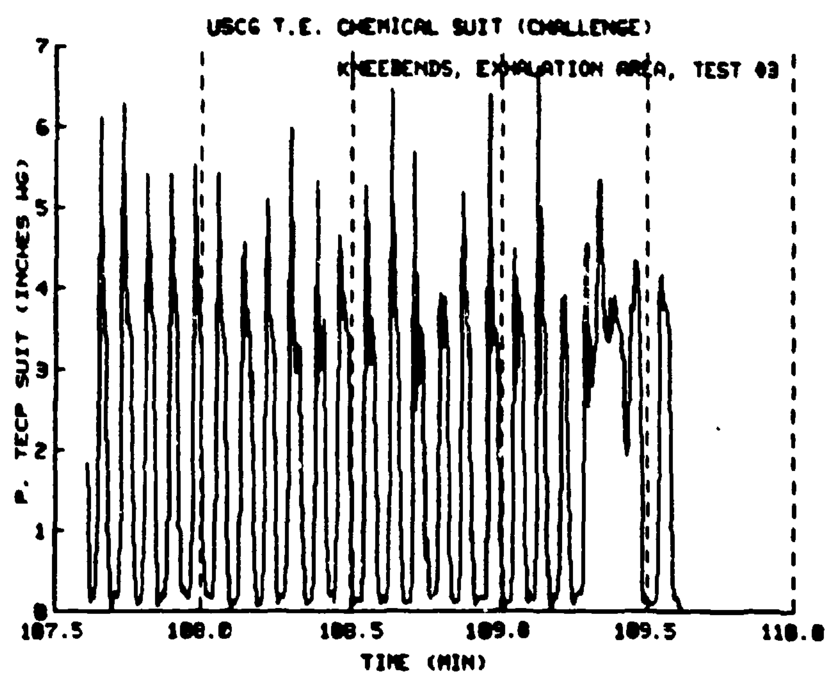


Figure 28. TECP suit aerosol penetration (VVZ) and pressure plots during kneebends

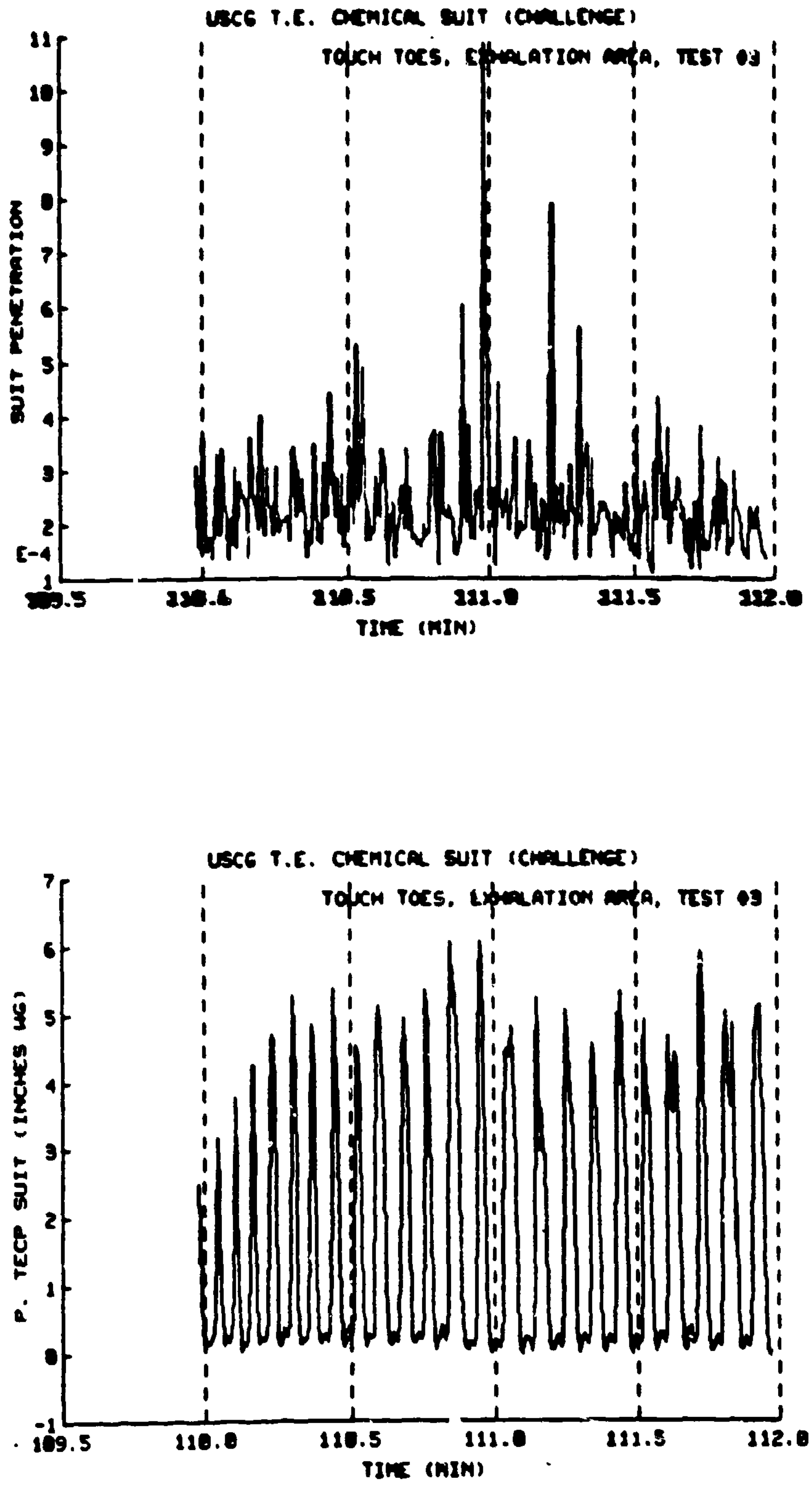


Figure 29. TECP suit aerosol penetration (VVZ) and pressure plots for touching the toes.

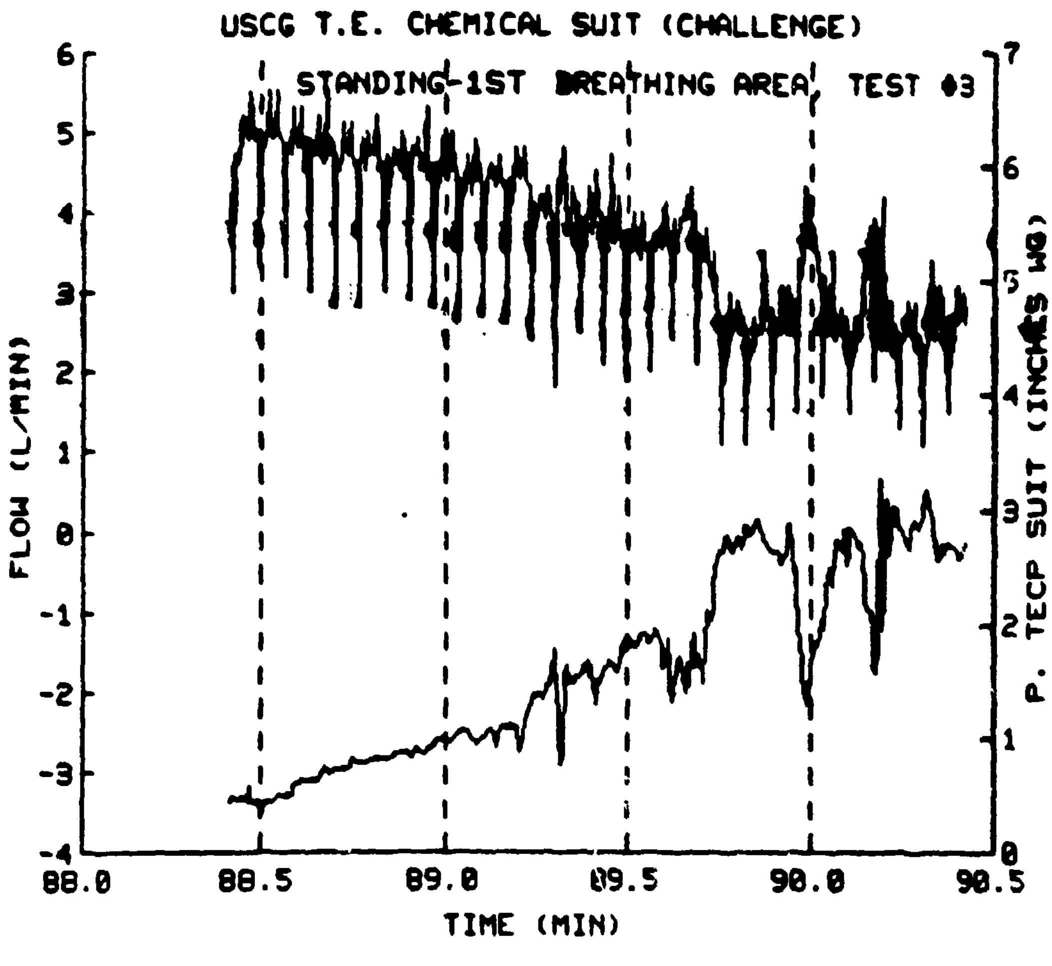


Figure 30. TECP suit pressure and flow plots for standing in place.

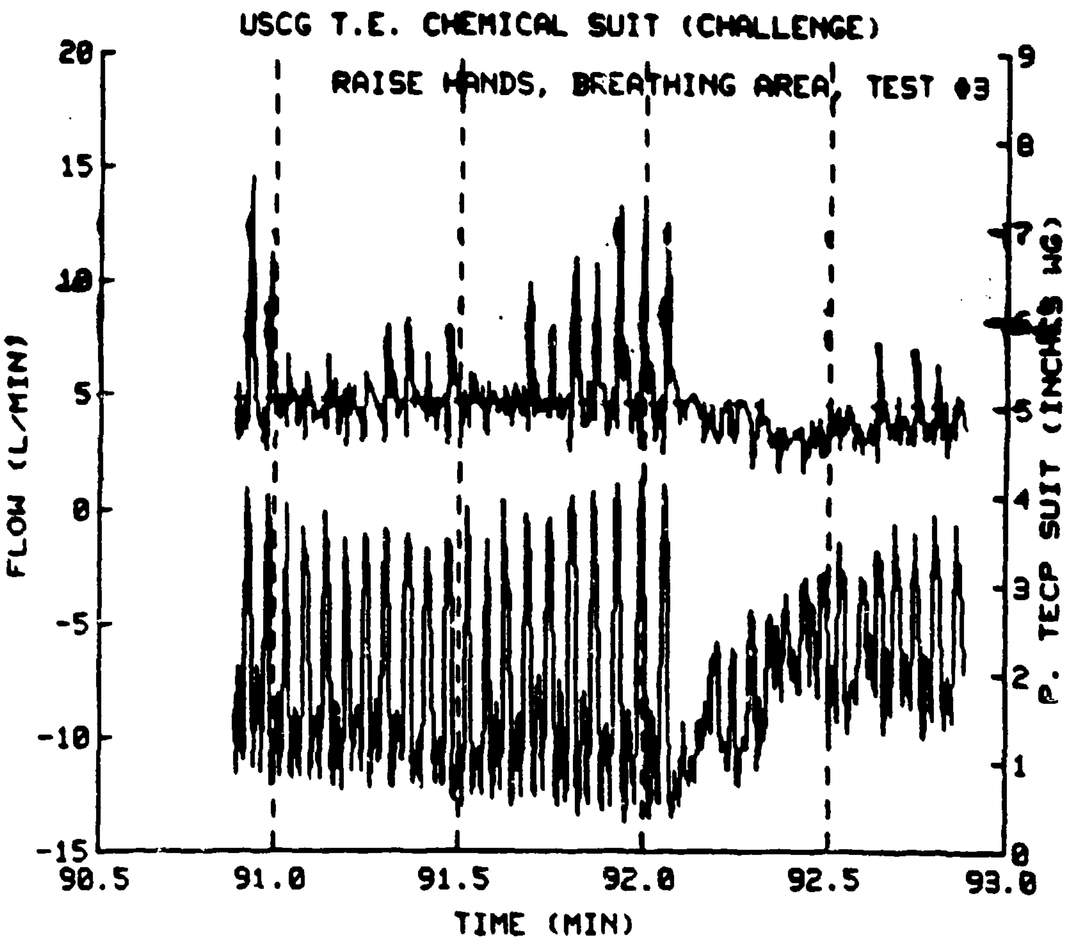


Figure 31. TECP suit pressure and flow plots for raising the hands.

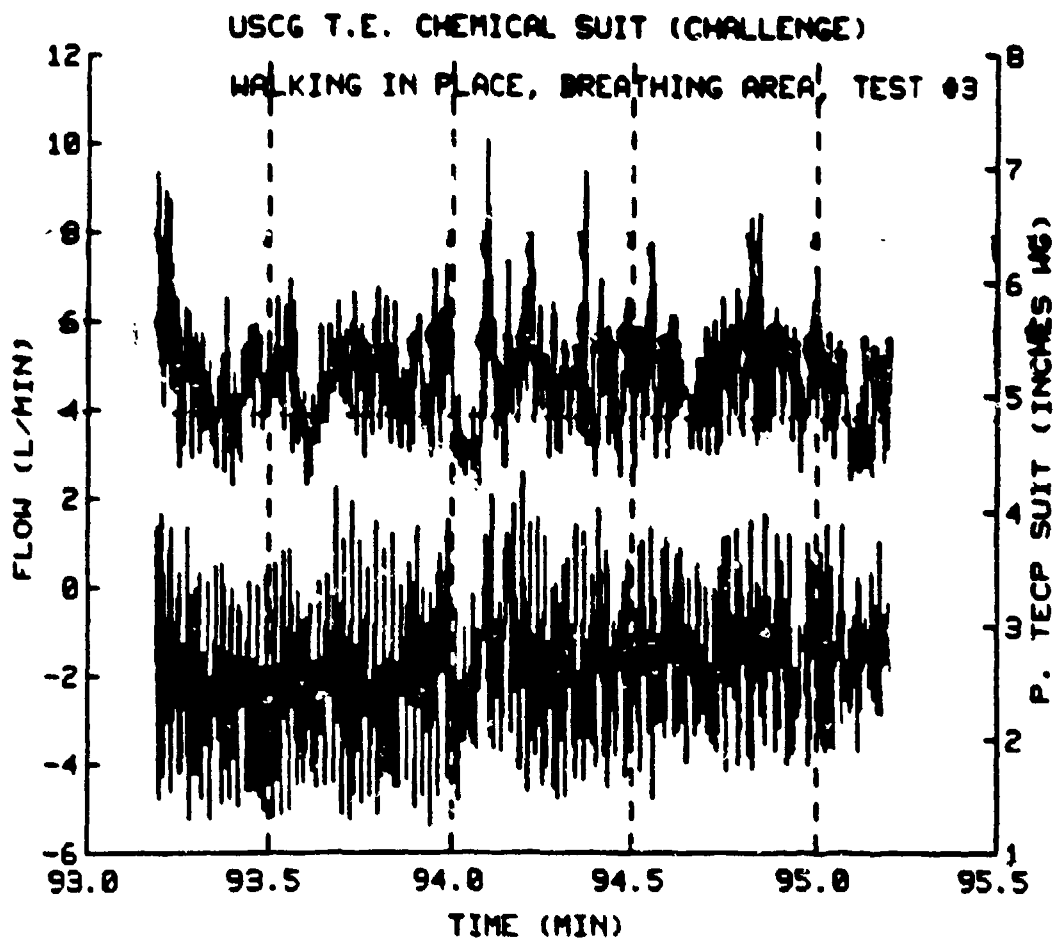


Figure 32. TECP suit pressure and flow plots for walking in place.

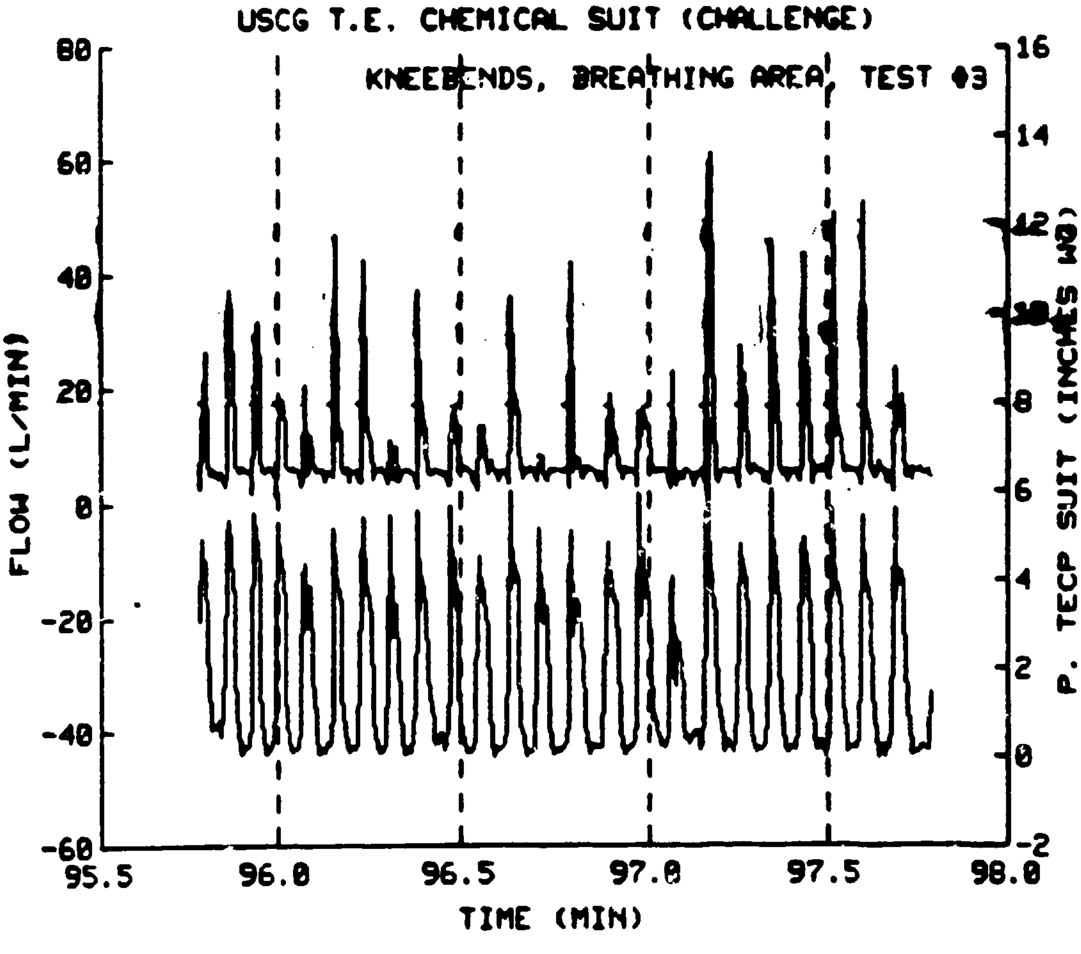


Figure 33. TECP suit pressure and flow plots during kneebends.

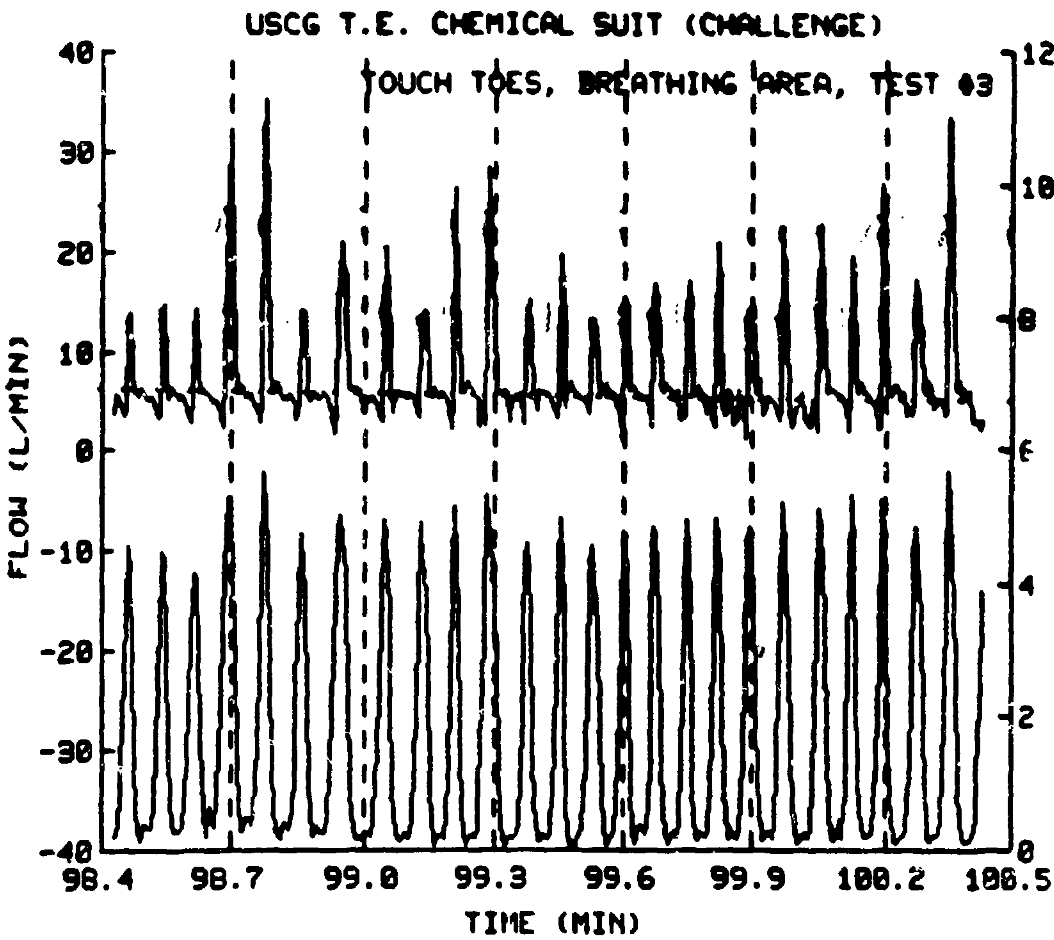


Figure 34. TECP suit pressure and flow plots for touching the toes.

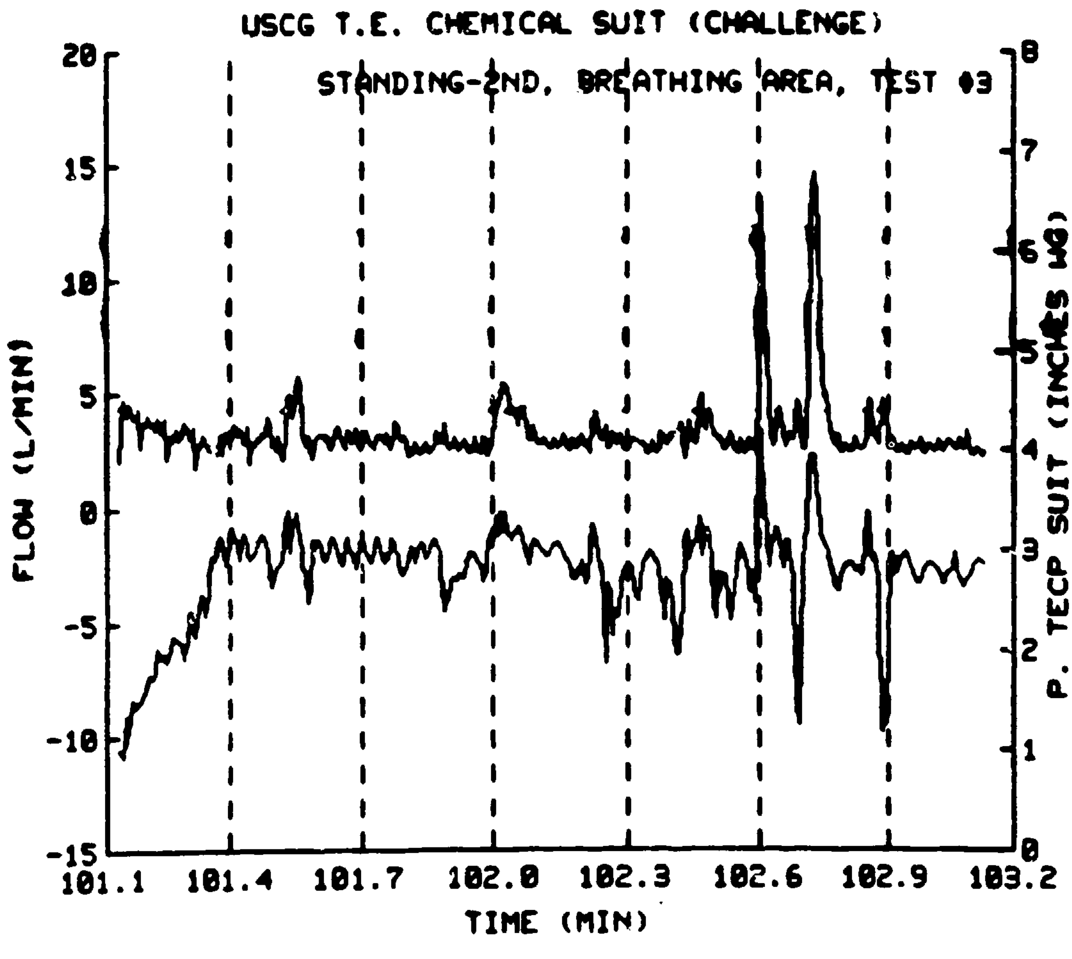


Figure 35. TECP suit pressure and flow plots standing in place.

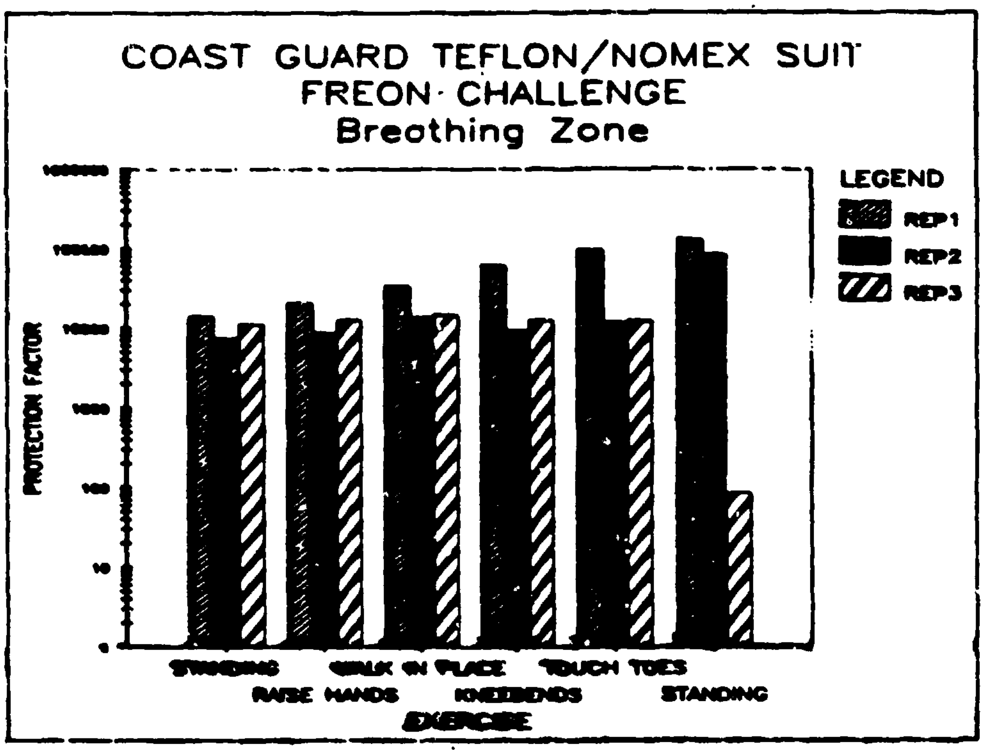


Figure 36. Bar chart showing achieved protection factors for various exercises while wearing the Coast Guard's Teflon[R]/Nomex[R] TECP suit and sampling in the breathing zone for Freon[R].

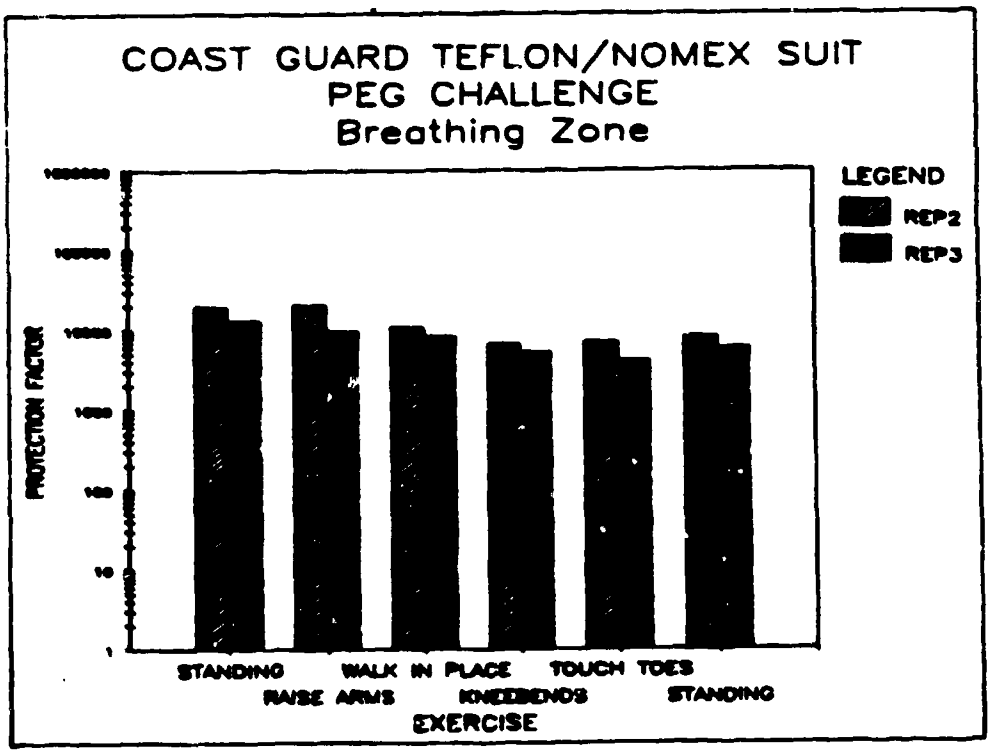


Figure 37. Bar chart showing achieved protection factors for various exercises while wearing the Coast Guard'sTeflon[R]/Nomex[R] TECP suit and sampling in the breathing zone for PEG 400.

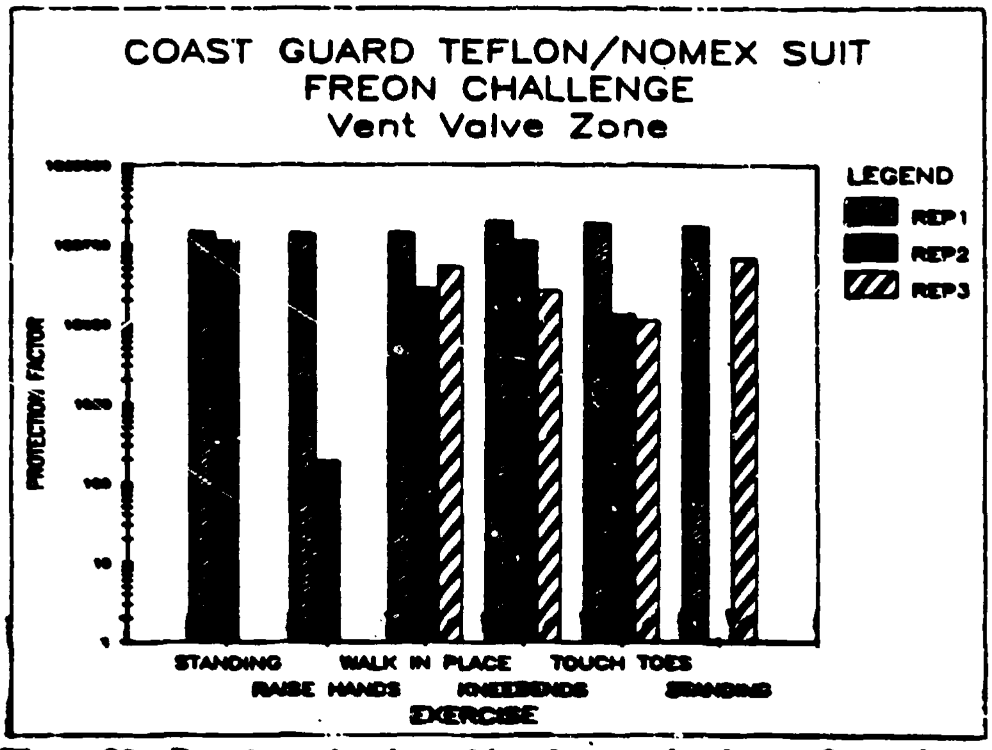


Figure 38. Bar chart showing achieved protection factors for various exercises while wearing the Coast Guard'sTeflon^R/Nomex^R TECP suit and sampling at the vent valve zone for Freon^R.

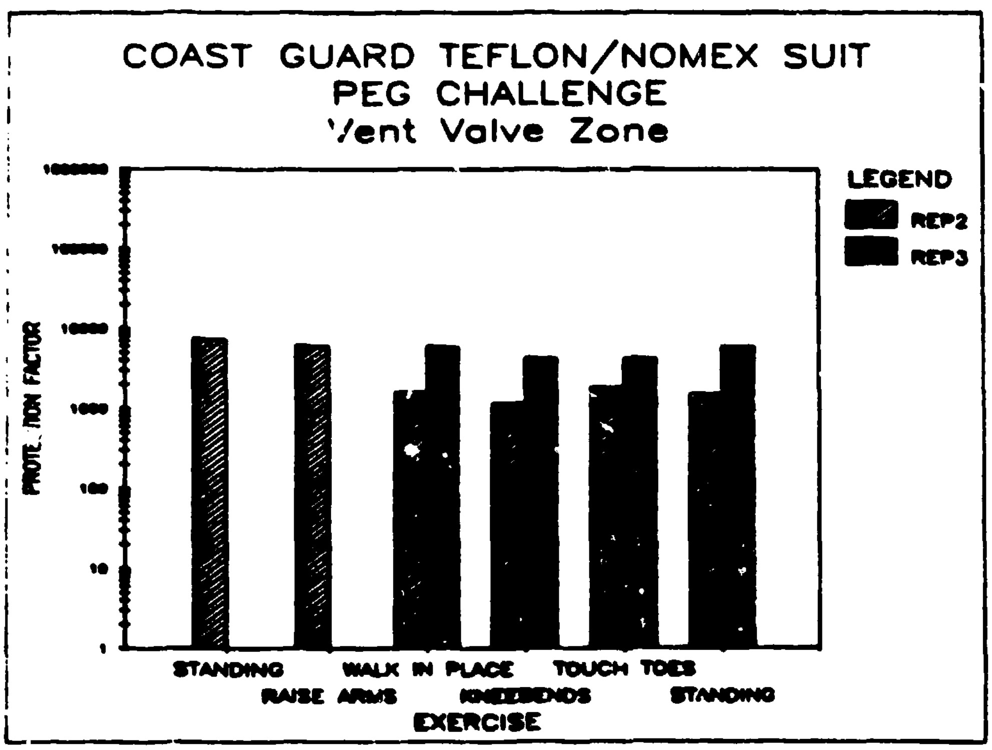


Figure 39. Bar chart showing achieved protection factors for various exercises while wearing the Coast Guard'sTeflon^R/Nomex^R TECP suit and sampling at the vent valve zone for PEG 400.

Table 1. Approximate internal suit pressure variation (positive inches water gauge) during man tests.

	Test 1		Test 2		Test 3	
	min	max	min	max	min	max
Standing	1.9	3.4	2.4	3.0	0.3	3.3
Raise hands	0.25	3.8	0.5	4.5	0.5	4.2
Walking in place	1.0	5.3	1.0	5.3	1.2	4.3
Knee bends	0.1	6.8	0.1	7.5	0.1	7.6
Touch toes	0.1	5.3	0.1	6.9	0.1	5.8
Standing	2.5	3.3	2.7	3.7	1.3	4.2
Standing	1.8	4.2	1.4	4.1	Not taken	
Raise hands	0.3	4.0	0.6	6.0	Not taken	
Walking in place	1.0	7.0	1.2	5.7	1.2	4.4
Knee bends	0.1	6.0	0.1	7.5	0.1	6.8
Touch toes	0.1	7.8	0.1	7.6	0.1	6.0
Standing	1.2	4.2	2.0	4.7	1.9	4.1
lowest min	(+) 0.1		(+) 0.1		(+) 0.1	
highest max		(+) 7.8		(+) 7.6		(+) 7.6

Discussion

The actual leak rate of TECP suits has not been measured accurately in hazardous material accidents. This lack of monitoring data is mainly due to the complicated nature of most accidents along with their unknown schedule. To obtain a reasonable estimate of TECP suit performance in "HazMat" operations a laboratory experiment has been designed to measure simulated TECP suit intrusion coefficients of the Coast Guard's new Teflon[R]-coated Nomex[R] suit. A man-test chamber equipped with both aerosol and gas leak-rate monitoring equipment was used. A series of light exercises designed to stress the various parts of the TECP suit was followed. The pressure inside the TECP suit was monitored continuously during the various exercises. The venting flow rate was also measured during one of the test runs.

Until this evaluation, there has been no information available describing the variation in internal pressure and venting flow rate of a TECP suit during actual use. Table 1 summarizes the various pressure extremes in the suit. They range from + 0.1 to + 7.8 inches w.g This indicates that the positive pressure vent valves do function as planned. The restrictions to movement due to suit tightness from being pressurized was found to be acceptable. The actual value of the positive pressure however, at reducing leak rates into the suit, is still unproven. This information was also useful background information for establishing the inflation pressures of ASTM's "Standard Practice for Pressure Testing of Gas Tight Totally Encapsulating Chemical Protective Suits" (ASTM F 1052). It also provides a measure of the minimum strength suit materials, seams, and components must have. The venting flow rate, on the other hand, provides an accurate measure of the volume of air vented from the suit during the various exercises.

If one examines the plot of TECP suit pressure vs time for standing in place in Figs. 3, 5, 6, and 8, a measure of the positive pressure vent valve performance can be obtained. An eyeball average of the peaks produces an average cracking pressure of between 2.8 to 3.0 inches w.g. The pattern is somewhat irregular because it is dependent on the breathing patterns of the human subject and body movements which depress the suit volume. The pressure plot for standing in place in Fig. 8 however, illustrates the relatively small operational range under which the valves can open and close (ΔP approximately 1/2 inch w.g.). Since there were three vent valves in the suit during this test series, one cannot identify pressure variations due to individual valve cracking pressure differences. It can be said qualitatively from the vent valve sounds that only one valve was venting most of the time, especially during the standing in place exercise. The need for more than one valve is also questionable from this observation and the corresponding pressure traces. The ability of the Stratotech one-way vent valve to operate at a adjusted cracking pressure of 2 inches w.g. is also questionable due to the 2.8 to 3.0 inches w.g. operational range which was observed throughout this experiment.

By comparing aerosol suit penetration vs time to the pressure variation vs time, a measure of the effect of suit leakage to pressure variation can be obtained. A careful review of Figs. 9 - 14 and 21 - 26 where aerosol penetration in the breathing zone vs time is compared to internal suit pressure vs time does not produce an obvious relationship. The lack of pressure vs leak rate relationship for the vent valve zone (VVZ) in Figs. 15 - 20 and 27 - 29 can also be seen. Additional experiments will have to be made on a more detailed basis before this relationship can be completely understood.

In Figs. 36 and 37 the average protection factors for the various exerci es are illustrated as measured by Freon[R] 12 and PEG penetration in the breathing zone area of the suit. There is a minimum of variability between the two methods in this sampling area. This is indicative of good mixing of the challenge agents before they reach the sensors and general agreement with reference to the existence and magnitude of the TECP suit leaks. Since the Freon monitoring system uses grab samples to analyze, it can be expected to miss leak rate peaks, especially if they are short in duration.

The PEG monitoring system operates on a continuous basis and gives a better measure of the overall suit leak rate. The large variability between the protection factors as measured by Freon[R] 12 and PEG are therefore understandable if the challenge agent occurs in pulses which are not mixed well. Thus, a more accurate measurement of VVZ leakage is provided by the PEG system which indicates the possibility of a significant leak from the vent valves. A more detailed evaluation of the leak rate of vent valves will be needed to determine if they present a significant leak source as they are used in the new Coast Guard TECP suit. This evaluation should examine valve performance during actual suit use and valve performance utilizing a laboratory test fixture.

Conclusion

A series of test exercises have been carried out wearing the new U.S. Coast Guard's Teflon^R-coated Nomex^R totally-encapsulating chemical protective (TECP) suit. The leak rate of this new TECP suit was measured using both an aerosol (PEG 400) and gas (Freon^R 12) during a prescribed series of test exercises. The internal suit pressure was also monitored and found to range from 0.1 to 7.8 inches of water gauge during the entire exercise series. This indicates that the positive pressure vent valves do function as planned, and keep the TECP suit positive. The need for more than one vent valve should be examined more closely since it appeared that only one valve was operating in an effective manner during the three tests. Protection factor/intrusion coefficient valves for PEG 400 and Freon^R 12 within the breathing zone area of the TECP suit were found to agree generally. Larger variations between the two challenge agents were found in the vent valve zone. This may be indicative of back streaming through the vent valves as venting takes place to relieve internal suit pressure. Additional studies which measure challenge concentrations inside the suit at various sampling locations are necessary to better quantify this preliminary observation. Laboratory experiments measuring the leak rates of TECP suit vent valves in an isolation test fixture are also necessary to better understand valve performance.

APPENDIX L

EVALUATION OF SUIT INTEGRITY BY FIELD EXPOSURE TO HYDROGEN FLUORIDE VAPOR

(Report by Lawrence Livermore National Laboratory)

HYDROGEN FLUORIDE TESTING OF

THE U. S. COAST GUARD'S

TOTALLY-ENCAPSULATING

CHEMICAL PROTECTIVE SUIT

Safety Science Group

Special Projects Division

Hazards Control Department

Lawrence Livermore National Laboratory

L-1

HYDROGEN FLUORIDE EXPOSURE TESTING OF U.S. COAST GUARD'S TOTALLY-ENCAPSULATING CHEMICAL PROTECTIVE SUIT

ABSTRACT: The U. S. Coast Guard Chemical Response Suit was field tested at the Department of Energy's Nevada Test Site in controlled releases of hydrogen fluoride. Two suits were placed on specially designed mannequins in two separate tests and subjected to hydrogen fluoride vapor concentrations up to 12,000 ppm for a 6 minute period. The mannequins contained a pulsed breathing air supply to simulate normal operation of the suit's exhaust valves and four different hydrogen fluoride detection systems. The analytical results of the two tests indicated no penetration of hydrogen fluoride into the suit.

KEYWORDS: Totally-encapsulated chemical protective suit, Fluoropolymer Materials, Overall Protective Suit Testing, Suit Integrity, Hydrogen Fluoride

INTRODUCTION:

The U. S. Coast Guard has developed a new totally-encapsulated chemical protective suit for protection of personnel during chemical spill response. This suit involves a novel fluoropolymer (Teflon)/aramid composite material which has demonstrated a high level of chemical resistance relative to existing commercial protective materials. Most of the suit's exterior components and materials have been evaluated for chemical resistance.[1] Furthermore, the overall physical integrity of the Chemical Response Suit has been assessed using several different methods.[2] However, the ability of the entire suit to maintain its chemical resistance integrity during realistic field exposure conditions has not been tested. Documented evidence from suit failures in a dimethyl amine accident at Benicia, California demonstrate that chemical protective suit components can fail, exposing the wearer to hazardous chemicals.[3]

The U. S. Department of Energy has constructed a large-scale spill test facility for liquified gaseous fuels and other hazardous materials in the Frenchman Flat Basin on the Nevada Test Site. The Lawrence Livermore National Laboratory (LLNL) assists the Department of Energy with the operation of this facility which provides data for public safety by studying the controlled spills of hazardous substances. In 1983, large scale releases of ammonia and nitrogen tetroxide were carried out to measure the atmospheric dispersion of the spilled chemicals.[4] In the summer of 1986, releases of hydrogen fluoride and liquified petroleum gas of similar magnitude were conducted. Proposed future activities at the spill facility will involve chlorine and other gases.

The U. S. Coast Guard funded the Safety Science Group of Lawrence Livermore National Laboratory to carry out a small experiment to evaluate the chemical protection of their new Chemical Response Suit in high concentrations of highly corrosive hydrogen fluoride. This evaluation was done as part of the hydrogen fluoride spill series sponsored independently by AMOCO Corporation to develop and test atmospheric dispersion models. This spill test series afforded the Coast Guard and Lawrence Livermore National Laboratory the opportunity to determine if the new Chemical Response Suit provided protection against high vapor concentrations of hydrogen fluoride. The tests also assessed the feasibility of using high concentrations of hazardous materials to test the performance of chemical protective clothing.

EXPERIMENTAL

Coast Guard Chemical Response Suit. Two different Coast Guard Chemical Response Suits were tested in separate hydrogen fluoride spills. The Chemical Response Suit is a totally-encapsulating chemical protective suit developed to provide a high level of protection in chemical spill response. This suit is designed to fully enclose both the wearer and his or her breathing apparatus (Figure 1). Features of this suit include a full body garment with a hood and visor, internal positive pressure operation, a gas-tight zipper, and integral gloves and boots. The suit uses fluoropolymer based materials for the garment, visor, and gloves; non-fluoropolymer components include the suit zipper and exhaust valves. Only the garment material has been tested against hydrogen fluoride in laboratory testing and showed no permeation in a three hour period.[5] The suit exhaust valves are protected by an inverted pocket to reduce the likelihood of direct contact with chemical splashes. The suit closure is protected by a cofferdam arrangement with two flaps of garment material which are temporarily heat-sealed over the zipper (Figure 2). Positive pressure is achieved within the suit by the exhaust air from a self-contained breathing apparatus. This exhaust air is vented through suit exhaust valves adjusted to maintain an internal suit pressure of 3.8 mm Hg (2.0 inches water).

Suit Mannequin and Instrumentation Package. A mannequin was constructed out of wood to both support the Chemical Response Suit in an upright position and house the instrumentation package (see Figure 3). Figure 4 shows the relative position of equipment on the mannequin. The instrumentation package included analytical devices to measure hydrogen fluoride intrusion, and an air supply system to keep the suit inflated and cool during the experiment. Four separate techniques were used to measure hydrogen fluoride vapor concentrations with the suits. The reason for a four-fold analytical system was to provide redundancy that would assure data collection even if one or more of the individual analytical devices failed. Two techniques were recommended by AMOCO; these included the AMOCO Integrated Field Sampler (IFS) and the GMD Systems AUTOSTEP Model 930 Portable Monitor. Both of these devices were used by the AMOCO spill site team to analyze hydrogen fluoride concentrations in the spill zone. Two other techniques were added by the Safety Science Group to provide additional analytical information: the Sensidyne SS2000 portable HF monitor and silica gel sorbent tubes. The characteristics of each analytical devices are described below.

AMOCO Integrated Field Sampler. The AMOCO IFS is a proprietary air sampling device. The instrument sequentially pulls air through each of 10 commercial Air-Sampling Field Monitors (Fisher Scientific: Gelman 4339 styrene filter holder, PN 01-038; Gelman MetricelR membrane filters, Grade GN-4, PN 09-730-47). The field monitors contain membrane filters pretreated with a proprietary method specific for retention of hydrogen fluoride. The flow volume through each cassette was precalibrated with an AMOCO data logger designed for used with the IFS. The time of flow through the cassettes is adjustable on a group basis, however, once a time interval is selected, every cassette in the series uses the same one. The interval used during this study was 66.6 seconds. Following use of the IFS, the cassettes were removed and each membrane was analyzed for HF content by use of ion selective electrodes. The measured detection limit for HF vapor was 0.03 ppm_v. The specific time hydrogen fluoride was first detected is indicated by the number of the cassette which first showed a measurable content.

GMD Systems AUTOSTEP Monitor. This system uses a colorimetric principle in an automatic incremental mode. Color producing chemicals specific for hydrogen fluoride are impregnated into a paper tape that is stored in a removable cassette. A pump pulls a calibrated air volume sample of the test atmosphere through the tape. The tape is monitored by a L.E.D. photodiode combination which translates color intensity into a readout. After a programmed interval, the tape is stepped forward and the next sample is taken. At the start of each measuring sequence, a reading is taken of the tape background color intensity, which is stored in memory, and then subtracted from the reading at the end of the sampling interval. The analog output from the AUTOSTEP monitor was sent to a chart recorder within the instrumentation package and also transmitted by field wire to a telemetry station. During each of the suit tests, the instrument was operated in the 0-30 ppm_v range. The detection limit calibrated for the specific paper taped used was nominally 3 ppm_v.

Sensidyne SS2000 Portable Toxic Monitor. This device uses an amperometric electrochemial sensor and responds to concentrations of analyte that diffuse across a semipermeable membrane. Calibration of the instrument indicated a repeatable linear response for hydrogen fluoride with a detection limit of 0.4 ppm_v and usable upper range to 10 ppm_v. Sensor response was found to be within the 10 seconds specified by the manufacturer. During this project, an analog output from the Sensidyne was continuously monitored by telemetry in the control room. The signal was also monitored by a strip chart recorder within the suit instrumentation package.

Silica Gel Sorbent Tubes. Four separate SKC, Inc. (Cat. No. 226-10-03) sorbent tubes, two on each side of the mannequin, were used during the tests. A Gillian sampling pump drew air through the tubes at a calibrated flow rate for each tube of 0.2 liters/minute. Subsequent to the collection period, the tubes were desorbed with eluant solution and analyzed for fluoride by ion chromatography. The measured instrumental detection limit was 1.0 ug. With a controlled flow period of 10 minutes, the hydrogen fluoride vapor concentration would have to exceed 0.6 ppm_v on a continuous basis to be measured.

Suit Pressurization and Cooling System. Since these experiments were conducted under the high temperature conditions of the desert, the suit was cooled before and after the experiment to protect the instrumentation package inside the suit. A second requirement was to simulate the operation of a self-contained breathing apparatus inside the suit. First, the cooling was achieved by an air flow from four cylinders of compressed air plumbed together in series underground near the suit. Then, the breathing simulation requirement was met by using remotely operated standard sized (2700 psi) breathing air cylinders inside the suit. Figure 5 shows a schematic of the control system for the analytical instruments and air supply (The entire experimental set-up is illustrated in Figure 6). When the experiment began, the cooling air was shut off, while internal suit cylinder air was pulsed periodically for the duration of the experiment. At the end of the experiment, the interior cylinder was shut off, and the exterior cylinders reopened to provide cooling air and to flush the interior of the suit.

Exposure Conditions. The facility's experimental test plan outlined a series of four hydrogen fluoride spills at different release rates and humidity conditions. Lawrence Livermore chose the two exposure conditions where 1000 gallons of hydrogen fluoride were released over a 6 minute period to separately expose the Coast Guard's Chemical Response Suits. One suit exposure was conducted under ambient humidity conditions. The second suit was exposed to the hydrogen fluoride under more humid conditions. Local lake bed flooding and a humidity generation apparatus were used to artificially humidify the environment. However, the overall effect on relative humidity was small. The suited mannequin was placed near a spill zone instrument tower located approximately 300 meters directly downwind from the chemical release point. This location offered the nearest site to the acid spill nozzle which had hydrogen fluoride monitoring equipment in place, was adjacent to a photographic tower for film recording, and had access to a telemetry station for data transmission. Data from the instrument tower were used to measure the exterior exposure of hydrogen fluoride received by the suit. The actual exposure conditions to which each suit was subjected are given in Table 1.

Procedure. The suit mannequin assembly was placed on a suspension stand at the exposure site (Figure 7). Following the release of the hydrogen fluoride, an operater in the Test Facility control room activated the interior suit sampling equipment before the cloud reached the suit. This sampling was continued until the hydrogen fluoride cloud dissipated. Once the test director determined the site safe for entry, a two-person retrieval team decontaminated the suit and related hardware with a dilute ammonia washdown, followed by a water washdown. The effectiveness of this decontamination technique was verified by checking the wetted surfaces with pH paper for trace acidity. The exterior of the suit was then inspected before the mannequin was disassembled. Interior suit samplers were collected and sent off for analysis.

RESULTS AND DISCUSSION

Table 2 shows that only the AMOCO IFS detected any hydrogen fluoride. This instrument has the lowest detection limit and the amounts indicated are close to that limit. There are two reasons which mitigate against these data indicating a real concentration of HF inside the suit. The first reason is that the cassettes in the first two positions (first 2.2 minutes of experiment) showed some small quantities of acid as di˙ those in the later positions (last 2.2 minutes of experiment). This indicates a high 'blank' (zero) value because there was no hydrogen fluoride vapor outside the suit at initial stage of the experiment. It is known that silica dust will give a false positve for HF on this method. At an average wind velocity of 3-5 meters/second, the cloud has insufficient time to move 300 meters downwind to the suit location. This observation was confirmed visually for each of the two tests. The second reason against this data showing a suit leak, is the observation of IFS precision: measurements appear random throughout its overall operation cycle. For these reasons we feel that the values are so close to the detection limit that they are merely a 'blank' reading. If a worse case position was taken in that the values were true, the measure maximum concentration (0.20 ppm_v) of hydrogen fluoride would still be well below the ACGIH TWA level (3 ppm_v) or Short Term Exposure Limit (6 ppm_v).[6] This indicates that the protection offered by the suit is quite high.

The other three analytical techniques showed no measurable hydrogen fluoride at any time during the two field tests. The Sensidyne instrument had the second most sensitive detection limit and in each test, no measurable signal was generated (in the first test by telemetry, and in the second test by both telemetry and on the chart recorder). The consistency of this data supports our analysis of the IFS data as being variable within the analytical method. Our various monitoring data indicate that the suit maintained complete integrity against a very high external hydrogen fluoride vapor challenge.

CONCLUSIONS

Our experience with conducting field tests of chemical protective suits under controlled hazardous material spill conditions indicates the feasibility of performing this test for other protective garments and chemicals. These methods appear useful for determining the performance of protective clothing under actual exposure conditions. While it would be both time consuming and costly to test a garment against several chemicals, field tests of this type could be conducted on a smaller scale and under more controlled conditions to assess the usefulness of related laboratory garment material testing. Furthermore, this technique offers a means to test the entire garment as used in the field.

REFERENCES

(1) Stull, J. O., Jamke, R. A., and Steckel, M. G., "Evaluating a New Materials for Use in Totally-Encapsulating Chemical Protective Suits," Paper submitted to 2nd International Symposium on the Performance of Protective Clothing, Tampa, Florida, January 1987.

(2) Johnson, J. S., Swearengen, P. M., Sackett, C., and Stull, J. O., "Laboratory Performance Testing of Totally-Encapsulating Chemical Protective Suits," Paper submitted to 2nd International Symposium on the Performance of Protective Clothing, Tampa, Florida, January 1987.

(3) Howard, H. A., "Protective Equipment Fails," Fire Command, March 1984, pp. 40-3.

(4) Koopman, R. P., "A Facility for Large-Scale Hazardous Gas Testing Including Recent Test Results," Technical Report UCRL-93424, Lawrence Livermore National Laboratory, Livermore, CA, September 1985.

(5) Garland, Charles E., Private Communication, June 1986.

(6) "Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment with Intended Changes for 1982," American Conference of Governmental Industrial Hygenists, Cincinnati, 1982.

TABLE 1 - Test Hydrogen Fluoride Exposure Conditions

Test 1 (8/14/86)			Test 2 (8/20/86)		
	Concentration (ppm)[a]			Concentration (ppm)	
Time (min.)[b]	1 Meter[c]	3 Meter	Time (min.)	1 Meter	3 Meter
0.00	0	0	0.00	0	0
1.11	1400	950	1.10	8600	3400
2.22	20000	16000	2.20	12000	2500
3.33	18000	30000	3.30	13000	3900
4.44	6800	15000	4.40	17000	4100
5.55	7800	8100	5.50	11000	3200
6.66	13000	0	6.60	13000	3800
7.77	300	22000	7.70	4200	2900
8.88	210	6200	8.80	960	1600
9.99	0	0	9.90	270	133
			11.00	200	110
Maximum Conc. (Time)	20000 (2.22)/30000 (3.33)			17000(4.40)/4100(4.40)	
Average Conc.	12000			9000	
Test Relative Humidity	10-12%			16-18%	

[a]Hydrogen fluoride concentrations measured by AMOCO IFS. These concentrations represent the average of the integrated sample measurement over the sampling interval.

[b]This time represents the end of sampling interval.

[c]Spill site tower concentrations were measured at a one meter and three meter height. The Chemical Response Suit was held upright at a height of 1.5 meters.

TABLE 2 - Summary of Hydrogen Fluoride Measurements Inside Chemical Response Suit

Detection Method	Detection Limit (ppm)	Test 1 Results (ppm)	Test 2 Results (ppm)
AMOCO IFS	0.03	High: 0.20 Low: 0.04 Avg.: 0.08	High: 0.10 Low: 0.03[a] Avg.: 0.05
Sensidyne SS2000	0.2	ND[b]	ND
GMD Systems AUTOSTEP	3.0	ND	ND
Silica Gel Sorbent	0.6[c]	ND	ND
Protection Factor	9000 with all detection methods		

[a]low concentration below detection limit of analytical device

[b]ND - no hydrogen fluoride detected by method

[c]actual detection limit is 1 ug mass by ion chromatograph; effective detection limit is 0.6 ppm based on integrated sample over sampling interval

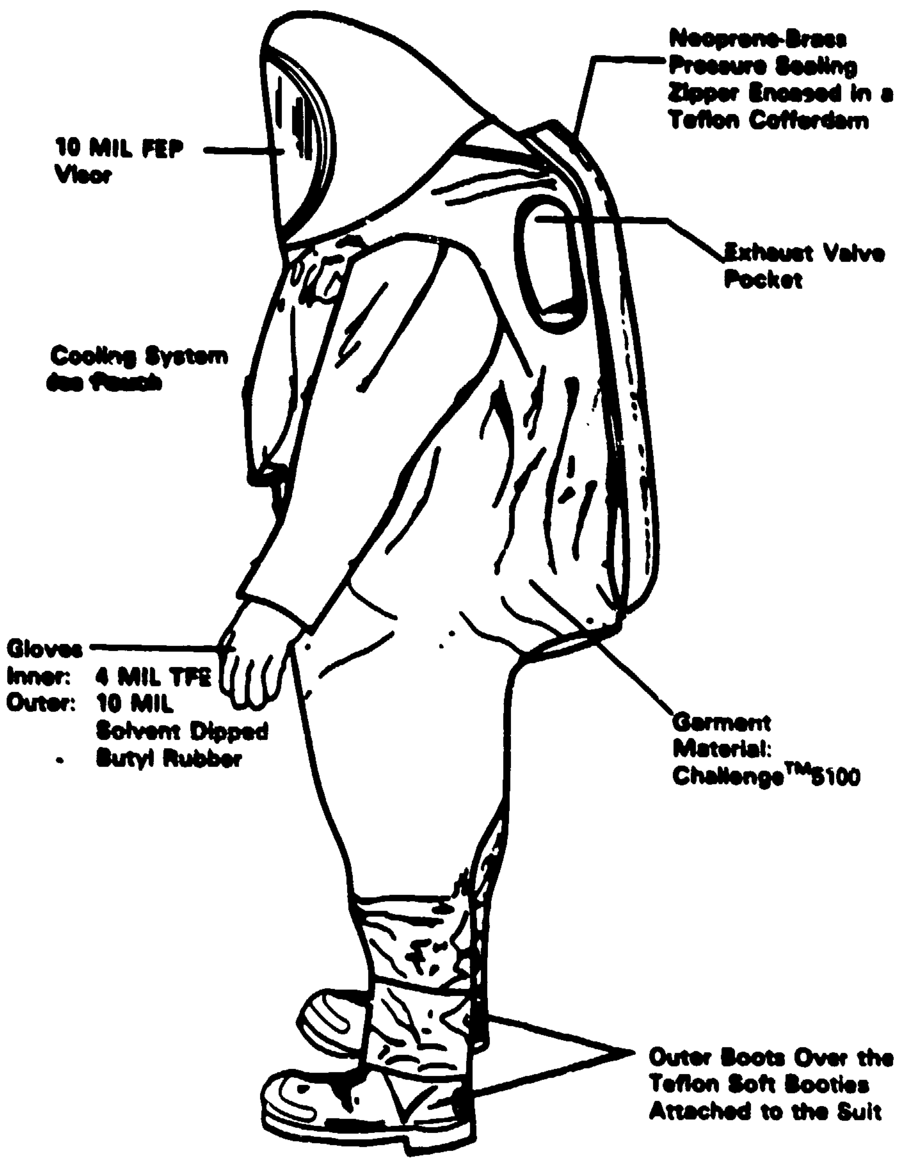


Figure 1. Coast Guard Chemical Response Suit

Figure 2. Heat Sealed Closure of Chemical Response Suit

Lawrence Livermore National Laboratory

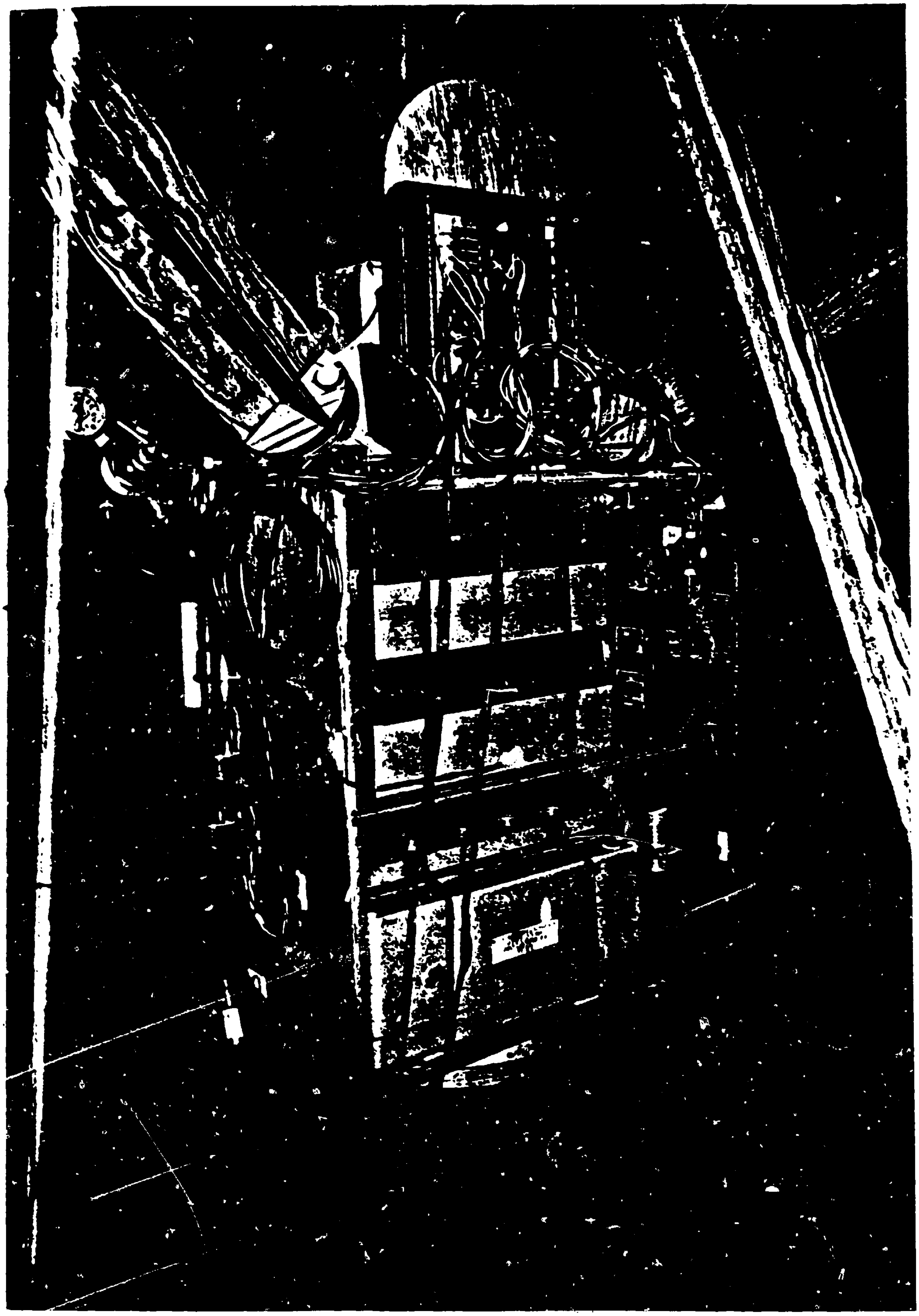


Figure 3. Photograph of instrumented test mannequin.

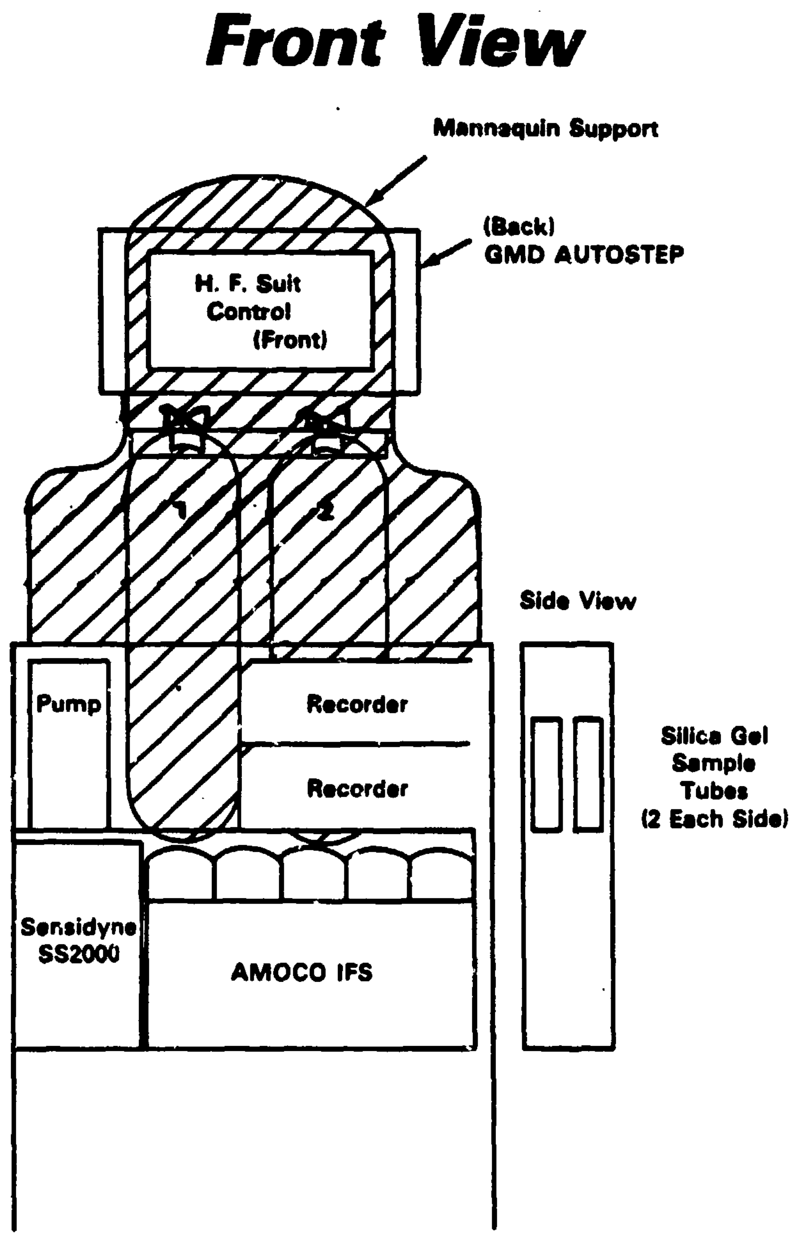


Figure 4. Diagram of Mannequin Equipment Layout

L-15

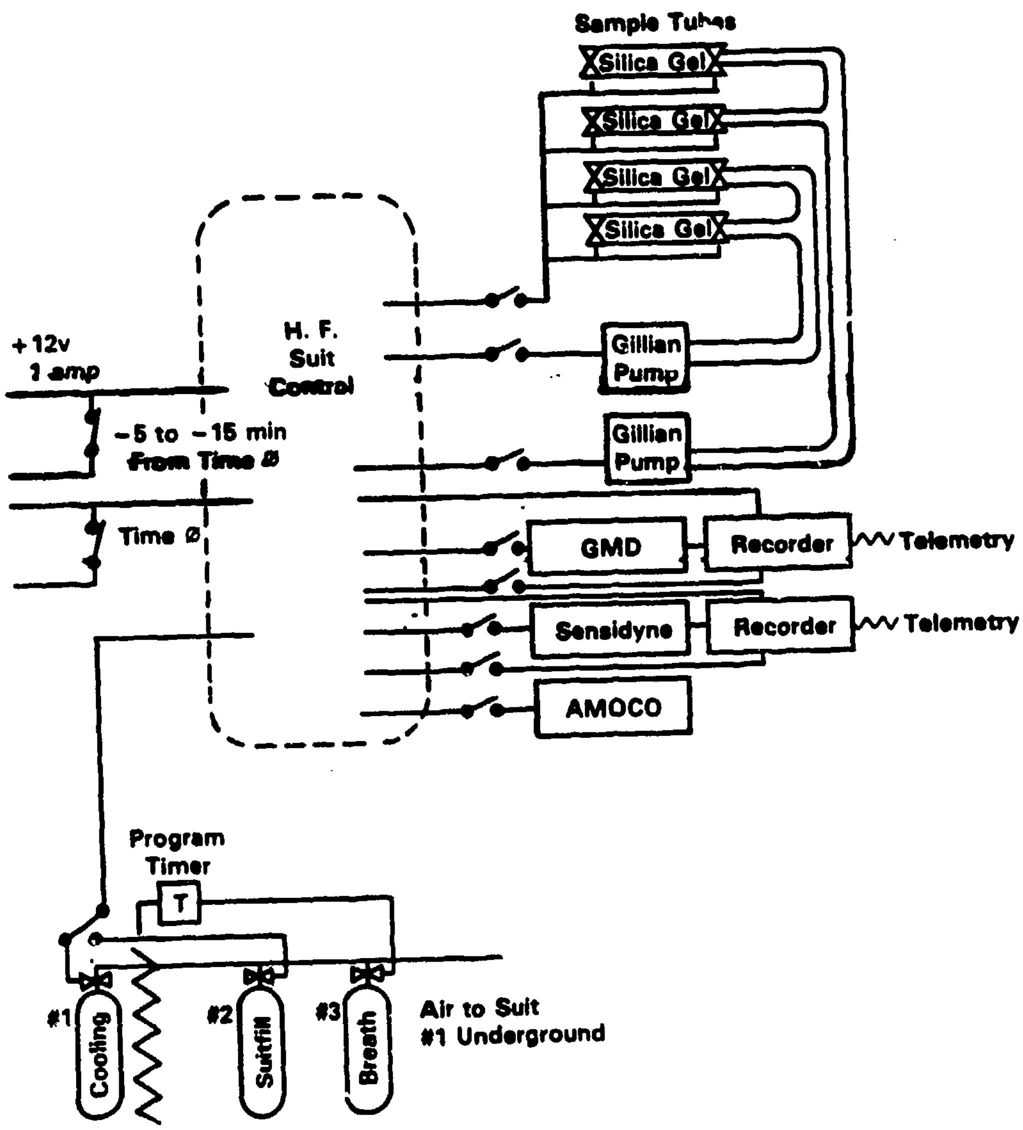


Figure 5. Suit Instrumentation Control Package

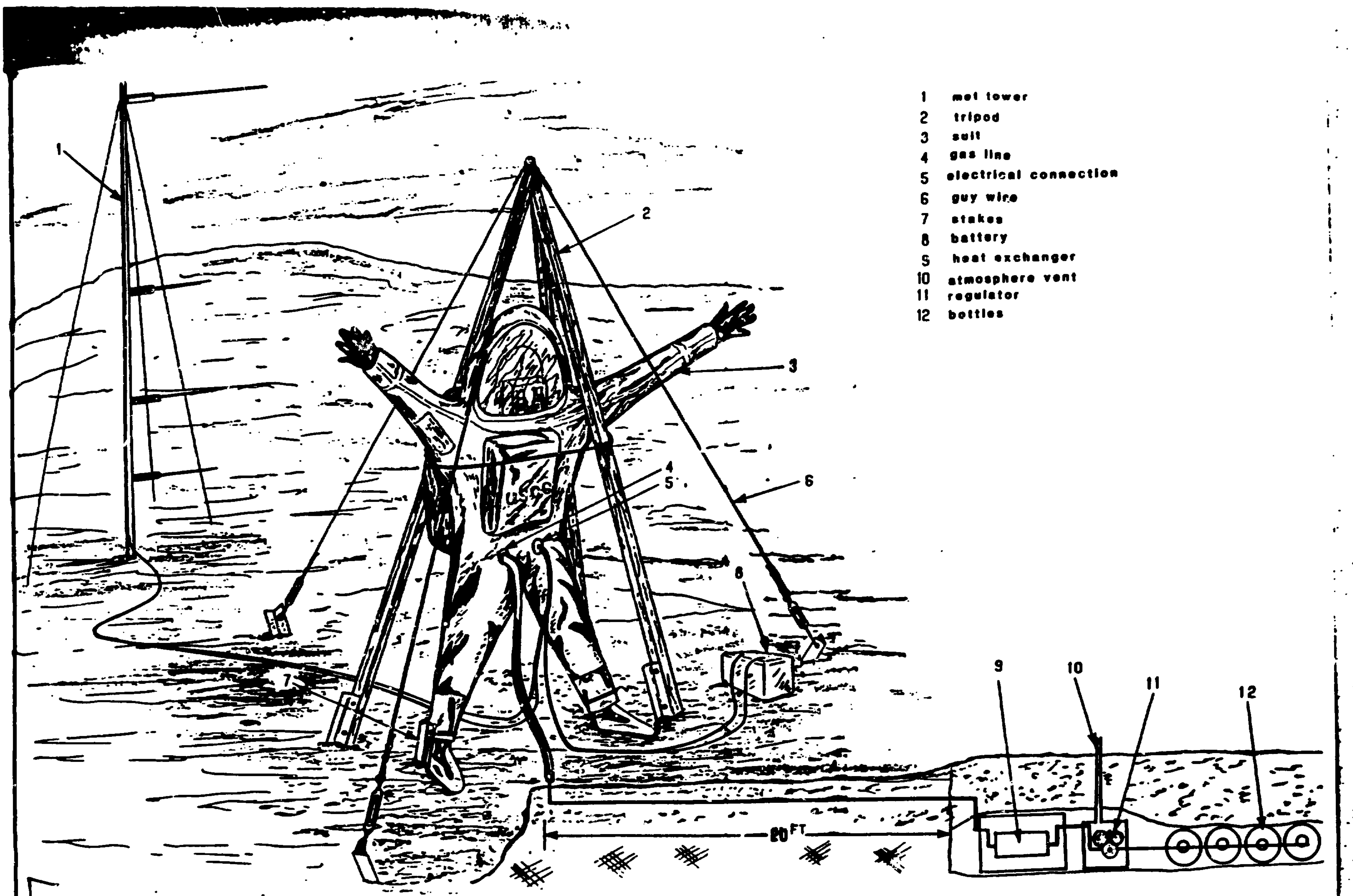


Figure 6. Field installation of TECP suit and related hardware.

Figure 7. Inflated suit on suspension stand.