



EDGEWOOD

CHEMICAL BIOLOGICAL CENTER

U.S. ARMY SOLDIER AND BIOLOGICAL CHEMICAL COMMAND

ECBC-TR-030

MAN IN SIMULANT TESTING (MIST)
OF DOMESTIC PREPAREDNESS SUITS
KAPPLER MODEL 42483
RESPONDER CSM® LEVEL A SUIT

19990707 045

Victor J. Arca

RESEARCH AND TECHNOLOGY DIRECTORATE

May 1999



Approved for public release; distribution is unlimited.

Aberdeen Proving Ground, MD 21010-5424

Disclaimer

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorizing documents.

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave Blank)	2. REPORT DATE 1999 May	3. REPORT TYPE AND DATES COVERED Final; 97 Jun - 97 Sep		
4. TITLE AND SUBTITLE Man in Simulant Testing (MIST) of Domestic Preparedness Suits; Kappler Model 42483, Responder CSM® Level A Suit			5. FUNDING NUMBERS None	
6. AUTHOR(S) Arca, Victor J.				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) DIR, ECBC,* ATTN: AMSSB-RRT-PR, APG, MD 21010-5424			8. PERFORMING ORGANIZATION REPORT NUMBER ECBC-TR-030	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES *When this work was conducted, the U.S. Army Edgewood Chemical Biological Center (ECBC) was known as the U.S. Army Edgewood Research, Development and Engineering Center (ERDEC).				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) Testing of the Responder CSM® Level A suit ensemble was conducted according to MIST test guidelines promulgated by the Joint Services Lightweight Integrated Suit Technology (JSLIST) test working group. This testing was conducted with the chemical agent simulant methyl salicylate (MS) to determine the protective capability of the suit against chemical warfare agents (CWA). This testing was to fill in data gaps on commercial protective suits (they are not certified by either NIOSH or OSHA for CWA) so they can be used by emergency personnel at sites that have been infiltrated by terrorist assailants with unknown chemical and/or biological weapons of mass destruction. The testing showed that the Responder CSM® suit, when worn in the Level A mode with self-contained breathing apparatus (SCBA), provided wearers with an overall protection factor of 1686.				
14. SUBJECT TERMS Chemical protective suits Natick sampler MIST PSD Body region hazard analysis Methyl salicylate SCBA Man in simulant testing Minimum required exposure dose Protection factor MRED Passive sampling device			15. NUMBER OF PAGES 55	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT UL	

Blank

PREFACE

The work described in this report was funded by the Domestic Preparedness Program. This work was started in June 1997 and completed in September 1997.

The use of either trade or manufacturers' names in this report does not constitute an official endorsement of any commercial products. This report may not be cited for purposes of advertisement.

This report has been approved for public release. Registered users should request additional copies from the Defense Technical Information Center; unregistered users should direct such requests to the National Technical Information Service.

Acknowledgments

The author gratefully acknowledges Brenda Cannon, Bill Ahearn, and Dennis Reeves for helping to conduct the tests; Dick Belmonte and Tony Saponaro, Domestic Preparedness Test Team, for helping with the test program; Dr. Paul Fedele, U.S. Army Edgewood Research, Development and Engineering Center,* for helping with the analysis techniques provided for this test program; and Dr. Don Riven, U.S. Army Natick Research, Development and Engineering Center,** for the development of the passive sampling devices used in this testing.

*Now known as the U.S. Army Edgewood Chemical Biological Center.

**Now known as the U.S. Army Soldier Systems Center.

Blank

CONTENTS

1.	INTRODUCTION	7
2.	SCOPE.....	10
3.	TEST EQUIPMENT AND PROCEDURES.....	10
3.1	Test Facility.	10
3.2	Air Sampling Devices for Measuring Concentration Inside Suit.	11
3.3	Applying PSDs to Test Subjects.	13
3.4	Procedure for Challenging the Suit.	14
3.5	Procedures for Removing PSDs.	15
3.6	Procedures for Analyzing Samples.	16
3.7	Quality Assurance/Quality Control Procedures.....	16
4.	METHOD OF ANALYSIS	17
4.1	PSD Concentrations and Protection Factors.	17
4.2	Calculation of Overall Protection Factors.	18
4.2.1	Systemic Effect - Nerve Agent (VX).....	19
4.2.2	Localized Effect - Blister Agent (HD)	19
5.	RESULTS AND DISCUSSION.....	20
	LITERATURE CITED	25
	APPENDIXES	
	A. MIRAN® AND GC CALIBRATION DATA	27
	B. PROTECTIVE SUIT TEST DATA	33

FIGURES

1.	The Responder CSM® Suit	8
2.	Test Subject Wearing Self-Contained Breathing Apparatus (SCBA).....	9
3.	Chamber and Clean-Room Layout	11
4.	Passive Sampling Device Developed by the NRDEC.	12
5.	PSD Sample Locations.	13
6.	Localized MRED Summary for the Kappler Model 42483 Responder CSM® Suit	24

TABLES

1.	Exercise Regimen.....	15
2.	Model Parameters used to Calculate the Overall Protection Factor	20
3.	Summary of Kappler Model 42483 Responder CSM® Suit MIST Testing ...	21
4.	Average Challenge and Clean Room Concentrations During Each Test	22
5.	Localized MRED Summary for the Kappler Model 42483 Responder CSM® Suit	23

Man In Simulant Testing (MIST) of Domestic Preparedness Suits Kappler Model 42483, Responder CSM® Level A Suit

1. INTRODUCTION

This testing has been performed to evaluate the protective capability of commercially available chemical suits. Most of the suits have been tested for resistance to various commercial chemicals, but have not been tested to determine the protection they provide against chemical warfare agents. The Man In Simulant Testing (MIST) is a set of tests designed to evaluate the protection provided by a complete protective garment/mask/boot/glove ensemble against chemical warfare agents through the use of non-toxic simulants. Complete modelling has been performed by Fedele and Nelson¹ to determine an appropriate method for evaluation of the protection based upon a Body Region Hazard Analysis. This method uses actual skin adsorption data on agents and simulants and is modelled to predict the Minimum Required Exposure Dosage (MRED) to which an individual must be exposed to in order to produce end-point reactions in the body for systemic (nerve agent) and localized (mustard) exposure to agents.

This report outlines testing performed on the commercially available Kappler Model 42483 suit by the Respiratory and Collective Protection Team of the U.S. Army Edgewood Research, Development and Engineering Center (ERDEC),* Chemical & Biological Defense Command,** in the MIST test chamber in August 1997. Similar testing was conducted on the Kappler First Responder© suit in July of 1995² when this suit was evaluated for possible use by emergency personnel in the event of a chemical agent release from the Tooele Army Depot's demilitarization facility. The testing described in this report consisted of four trials, each involving two to four test subjects. A short description of the suit tested is given below.

Description of the Responder CSM® Level A Suit.

The Kappler model 42483 Responder CSM® Level A Suit is a gastight protective suit that completely encapsulates the wearer. The garment and booties of the suit are constructed from the Responder CSM™ multi laminate film fabric material; the visor is constructed of 5 mil FEP/40 mil polished PVC material. The suit contains butyl rubber gloves (25 mil, MIL-G-12223, Type II, Gloves, protective, toxicological Agent) that are sealed into place at the wrists and also contains sealed leg booties and a hood that completely encapsulates the head and respiratory protection. All suits were tested when received to ensure that they met the test protocol standards. Testing involved a visual inspection for damage followed by pressurization of the suits with air. This involved using a pressure of 3 inches water guage (iwg) for three minutes, reducing the pressure to 2 iwg, and then waiting an additional three minutes. If the pressure does not drop below 1.6 iwg after this time the suit passes this test. The respiratory protection used with this suit is the Self-Contained Breathing Apparatus (SCBA) with a one-hour air tank that is worn on the back. Standard rubber Toxicological Agent Protective (TAP) boots are also worn with the suit. A picture of a test subject wearing the Responder CSM® suit is shown in Figure 1; Figure 2 shows a test subject wearing the SCBA.

*Now known as the U.S. Army Edgewood Chemical Biological Center (ECBC).

**Now known as the U.S. Army Soldier and Biological Chemical Command.



Figure 1. The Responder CSM® Suit

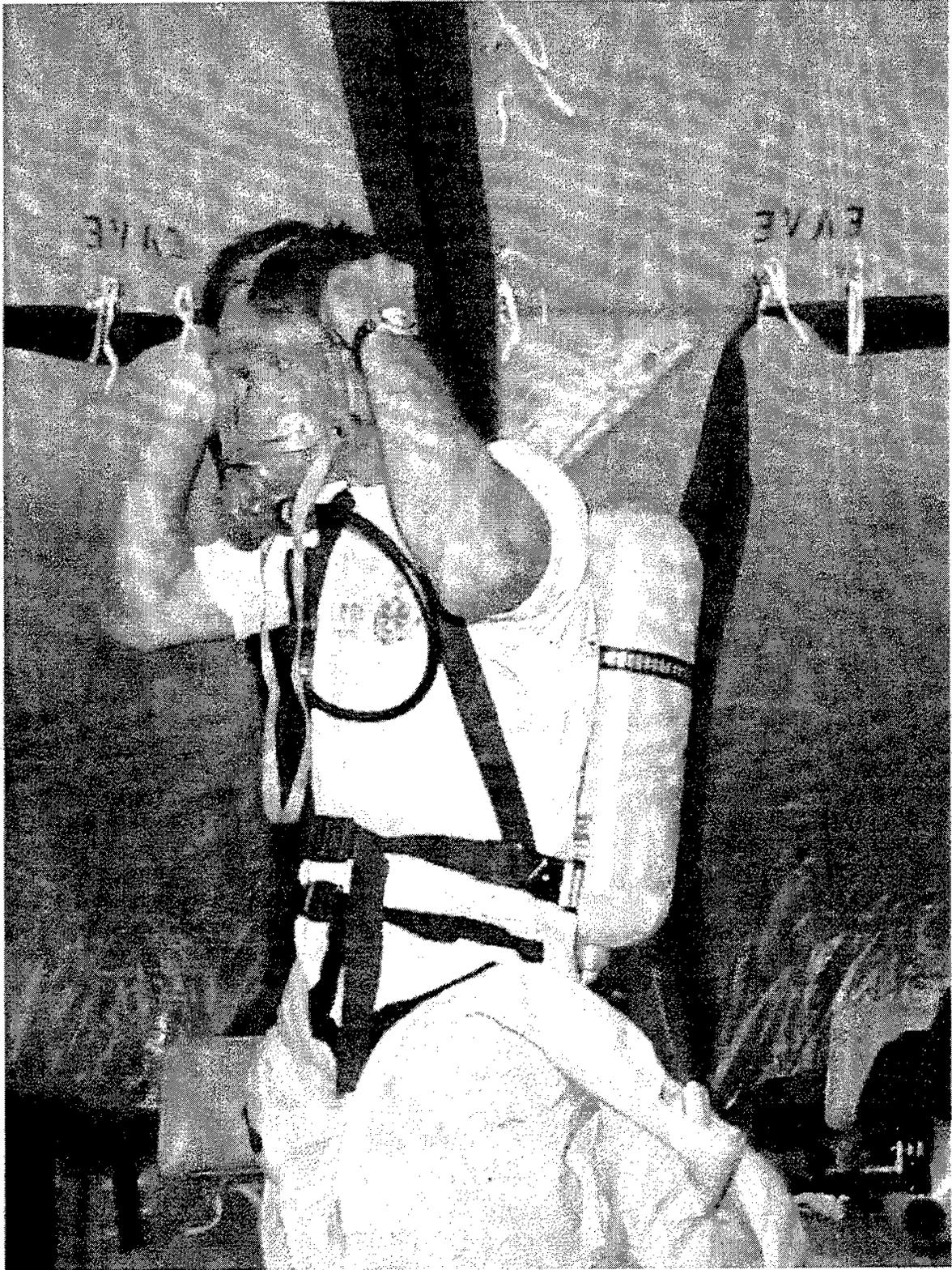


Figure 2. Test Subject Wearing Self-Contained Breathing Apparatus (SCBA)

2. SCOPE

This testing was conducted according to guidelines set forth by the Joint Services Lightweight Integrated Suit Technology (JSLIST) working group, specifying test methods capable of accurately measuring a protection factor (PF) greater than 1,000. The maximum PF that could accurately be measured in this testing was around 10,000. This involved the use of passive sampling devices mounted beneath the clothing of the test subjects to sample the vapors at a rate consistent with the body's uptake rate of agent, as determined in the JSLIST research study on passive sampling devices³. The sizes used for this testing were matched to the size of the test subject, a total of fourteen suits were used: three small, nine medium, and two large sizes. Similar testing was conducted on the Kappler First Responder[®] suit in July of 1995² when this suit was evaluated for possible use by emergency personnel in the event of a chemical agent release from the Tooele Army Depot's demilitarization facility.

In each of four trials, test subjects dressed in the Responder CSM[®] protective ensemble and were exposed to a high concentration of methyl salicylate (MS) vapor. Four subjects were tested in each trial, except in trial 3, where only two were tested. The JSLIST working group selected this simulant for the agent mustard (HD) for use in testing under the JSLIST program. Each trial exposed the test subjects to an MS concentration of 50 mg/m³ in a chamber for a total of 30 minutes. The test subjects performed a series of exercises while exposed to the MS vapors. Vapor concentrations were measured at several locations beneath the suit with passive sampling devices (PSDs). The PSDs contained the solid adsorbent Tenax, which the JSLIST working group had chosen as the best adsorbent for use with MS⁴. This testing showed that the Responder CSM[®] Level A suit configuration exhibited an overall protection factor (when used for brief time periods of 30 minutes) that was very high (when compared to non-Level A suit ensembles).

The configuration of the protective suit ensemble tested was as follows. The test subjects wore shorts and t-shirts underneath the Responder CSM[®] suit. PSDs were affixed to this clothing or directly on skin areas. Self Contained Breathing Apparatus was put on and then the Responder CSM[®] suit was donned and sealed up according to the manufacturer's specifications. All subjects were trained in the use of the suit according to the manufacturer's use instructions prior to testing.

3. TEST EQUIPMENT AND PROCEDURES

3.1 Test Facility.

The tests were conducted in the MIST test facility in building E5354 in the Edgewood Area of Aberdeen Proving Ground, MD. The exposure chamber is 40 ft by 20 ft by 14 ft high and contains an evaporative-blower vapor generator controlled by a data acquisition system (DAS) with feedback concentration readings generated by a Foxboro Miniature Infra-Red Gas Analyzer (MIRAN[®]). The challenge concentration in the chamber was measured during the exposure period with two MIRAN[®]s. The location of the MIRAN[®]'s sampling point were as follows: one sample was taken in the front of the chamber right in the area where the subjects performed the exercises, the other sample

point was in the rear of the chamber. All MIRAN® readings were recorded by the DAS and the average of the two was used in the data analysis.

A four-stage clean-room was erected in a bay area adjacent to the exposure chamber and was occupied by test subjects during application and removal of the sampling devices. This clean-room consisted of two airlocks and two 16-ft enclosures of the U.S. Army M28 shelter system. The enclosures, made of a chemically resistant plastic material, were pressurized with filtered air from Nuclear, Biological, and Chemical (NBC) filter units of the M28. A 600 cfm unit was used to pressurize the clean room area (Enclosure 4 of Figure 3), and two 200 cfm units were used to pressurize the doffing room area (Enclosure 2 of Figure 3), for a total clean airflow of 1000 cfm. A layout of the test area and apparatus is shown in Figure 3.

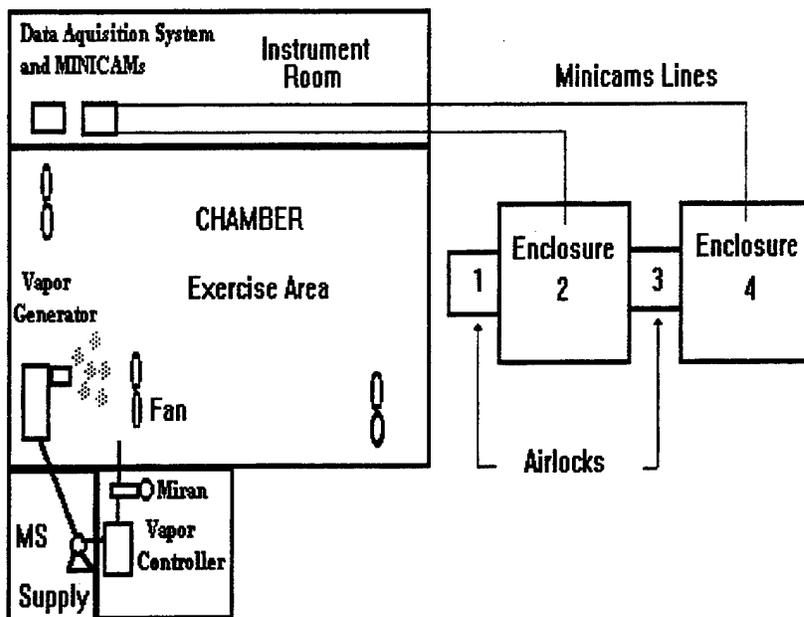


Figure 3. Chamber and Clean-Room Layout

3.2 Air Sampling Devices for Measuring Concentration Inside Suit.

PSDs developed by the Natick Research, Development and Engineering Center (NRDEC)* were used to sample for MS vapors beneath the suit. The Natick sampler (shown in Figure 4) is the passive sampler used in this testing and has been approved by the JSLIST committee for sampling individual protective equipment suits. This PSD contains the solid adsorbent material Tenax® TA in a small plastic pouch and samples air by capturing the MS vapors onto the adsorbent material. This device samples the air beneath the suit by diffusion (molecular transport) with the rate of diffusion into the adsorbent controlled by the exposed layer of polyethylene film. The sampling rate for the lot of PSDs used in this testing was determined experimentally; the average rate was found to be 14.6 ml/min with a standard deviation of 0.13 ml/min. The adsorption velocity, or uptake rate, of the PSDs (sampling rate divided by the effective sampling surface area of 3.78 cm²) was 3.86 cm/min. This adsorption velocity is very similar to the skin's adsorption rate of chemical agents.

*Now known as the U.S. Army Soldier Systems Center (SSC).

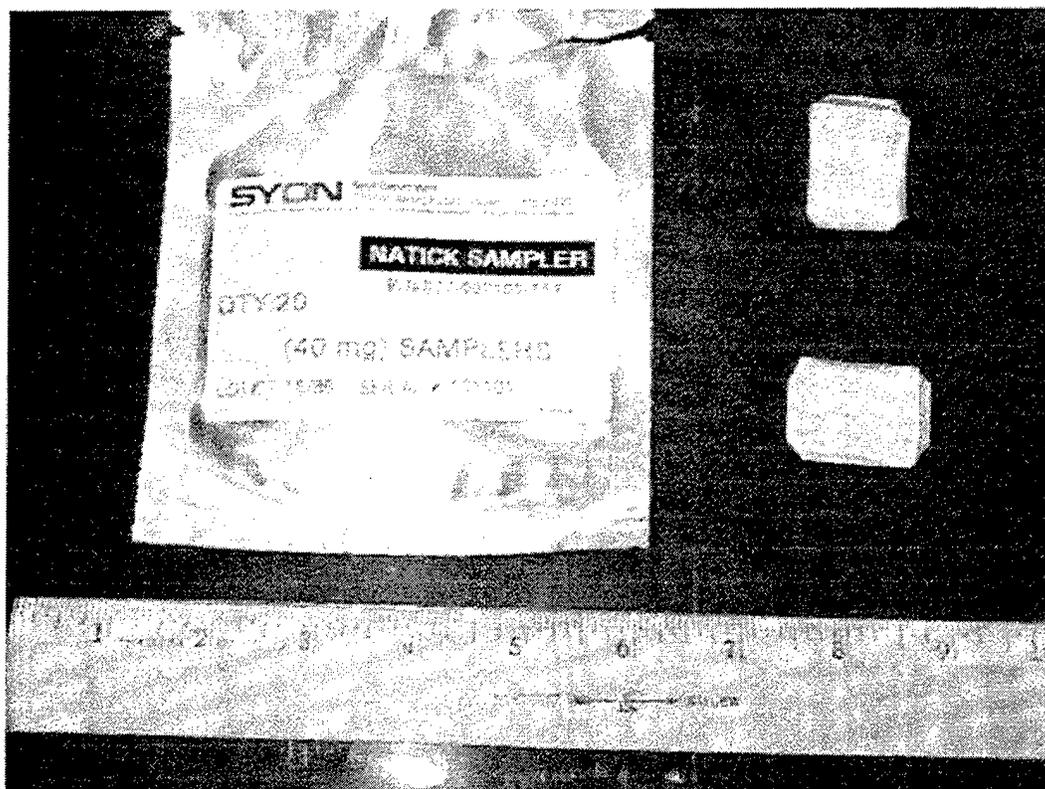


Figure 4. Passive Sampling Device Developed by the NRDEC.

The PSDs were handled with specific procedures to minimize the potential for contamination. The filter units that pressurized the clean room areas were run overnight to make sure that no trace levels of MS were present during the testing. The concentration in the clean room where the PSDs were applied to the subjects was monitored throughout the entire test period. Test technicians who worked in the clean room area washed their hands prior to handling any PSDs and were not allowed to come into any contact with the MS vapor generation equipment. They were applied to test subjects in the fourth stage of the clean-air room as the subjects put on the suit and were also removed in the fourth stage at the completion of each trial. After removing the PSD, the plastic pouch of the patch samplers was cut with a razor knife (on one end), and a sorbent tube connected to a vacuum pump was used to remove the adsorbent. One end of the tube was connected by hose to the vacuum pump and the other end was inserted into the opening of the PSD to draw out the loose sorbent. A fine mesh gauze screen was then inserted into the sorbent tube (with a special gauze loading rig) and analytical end caps were placed on both ends of the tube to preclude contamination of the sample. The tube ID was recorded to ensure accurate PSD sample identification. The tubes were then analyzed with a flame ionization detector (FID) on the Perkin Elmer Autosystems Gas Chromatograph (GC) and the ATD-400 thermal tube desorber according to guidelines determined in the JSLIST research study⁵. Background samples were also analyzed.

3.3

Applying PSDs to Test Subjects.

The PSDs were placed at 10 locations beneath the Responder CSM® suit of each test subject, as listed below and depicted in Figure 5. They were placed either directly on the skin at these locations or on top of the underclothing (T-shirts and shorts).

- (1) Center of back, between shoulder blades
- (2) Center of chest (3 duplicate PSDs used at this location)
- (3) Center of back, lumbar, at upper buttocks
- (4) Left axillae, on ribs
- (5) Right upper arm, outer dorsum
- (6) Right lower arm, outer dorsum
- (7) Center of abdomen, low, into the groin area
- (8) Mid-right, outer thigh
- (9) Mid-right, outer lower leg
- (10) Neck

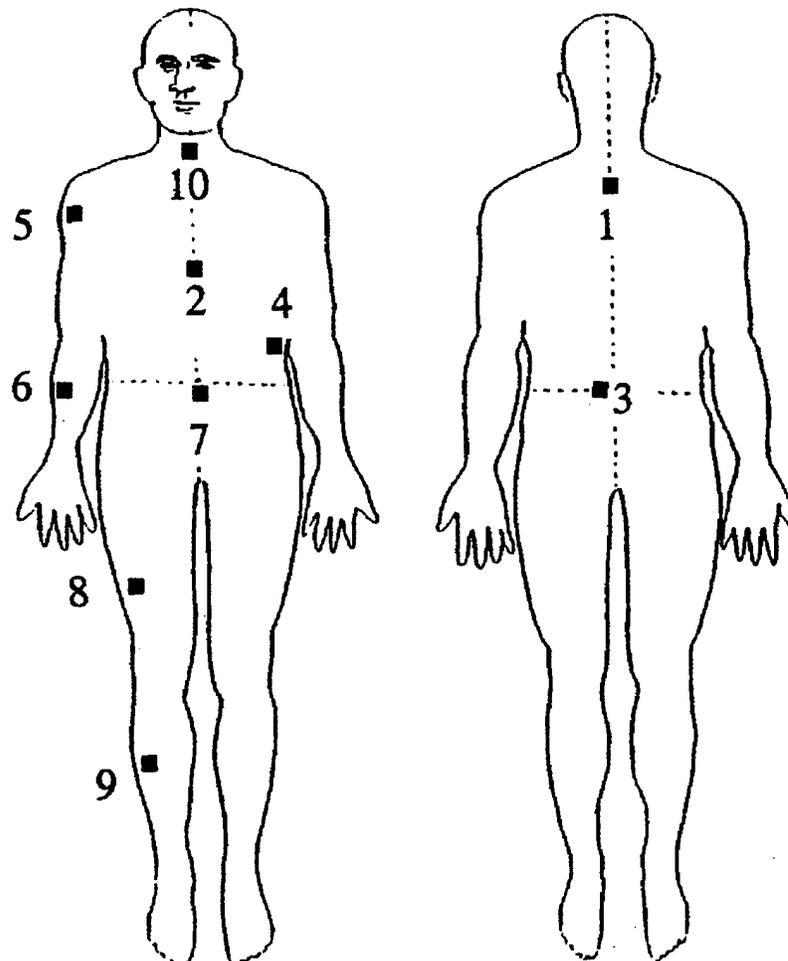


Figure 5. PSD Sample Locations.

The following procedures were used to apply the PSDs to test subjects to ensure minimum potential for contamination and allow measurement of the background levels of simulant during the analysis.

Dressing took place in the fourth (cleanest) stage of the clean room enclosure. Subjects operated in pairs during the testing because of the limitation of having no more than two people in the airlock at one time during purge operations upon re-entry to the clean room areas. Test subjects dressed in gym shorts and T-shirts before entering the clean room. When they entered the clean room, they were given new suits, SCBA mask, and overboots (which had been pre-positioned in the clean room). The PSDs, sealed in appropriate containers, and data forms were also pre-positioned.

The PSDs were removed from the storage containers and placed on the subjects at the 10 designated locations. The PSDs, which have adhesive backing, were applied directly to the skin, or to the gym shorts or T shirt (if worn). The identification number of each PSD was recorded for each location.

Once initiated, the application of the PSDs was completed as rapidly as possible. Normal application of samplers took about two minutes. Then the SCBA mask was donned, a one-hour tank for the SCBA was worn on the back, and the Responder CSM® suit was donned and sealed completely. Each subject was checked to ensure proper closure and fit of all of the gastight zipper closure and an exterior sampler was placed on the outside of the suit. The subjects then proceeded out the airlock and entered the exposure chamber. This total procedure generally took between five and ten minutes.

3.4 Procedure for Challenging the Suit.

The test involved a controlled sequence of steps performed to keep the samplers free of background contamination and ensure accuracy of the results. The procedure is described below.

Subjects were briefed on the test procedures and entered the clean room, enclosure 4 in Figure 3, to have the passive samplers applied and don the suit ensemble.

Once dressed, the subjects passed through the transition airlock (enclosure 3 of Figure 3), doffing room (enclosure 2 of Figure 3) and exited through the entry/exit airlock (enclosure 1 of Figure 3). The subjects were met by a test technician who escorted them into the chamber and recorded the time of entry.

The chamber was prepared by bringing the MS concentration to 50 mg/m³ before the subjects exited the clean room. Temperature, relative humidity, and concentration readings in the chamber and in both clean-air rooms were recorded on the DAS.

Once inside the chamber, subjects performed the activities listed in Table 1. Each of these exercises was performed twice during the 30-minute exposure interval. Subjects rested for about one minute after each exercise.

Table 1. Exercise Regimen

<u>Exercise</u>	<u>Time/Repetitions</u>
Stationary run	1 minute
Jumping jacks	2 times
Trunk twister	2 times
Bend and reach	2 times
Back stretcher	2 times
Bent knee leg lifts (left and right)	10 times
Vertical reach and grasp (left and right)	1 minute
Lifting box from ground to table and return	2 times
Squat down, kneel on one knee	3 times

3.5 Procedures for Removing PSDs.

Because the outer garments desorb significant amounts of MS in a clean area after prolonged exposure to high concentrations of vapor, doffing took place in stages in the clean room with the following procedures.

After completing the 30 minute exercise, the subjects were escorted from the chamber and processed into the clean room in four stages (see Figure 3):

- **Stage 1** -- Entry/exit airlock. The subjects exited the chamber, entered the 4 ft by 4 ft airlock (enclosure 1), and set the purge timer for 5 minutes. They remained fully dressed while airflow through the airlock purged any vapor brought in with them. This period also allowed for some desorption of MS vapor from the outer surfaces of the ensemble.
- **Stage 2** - Once inside this 16 ft by 20 ft shelter (enclosure 2), each subject removed their ensemble with the assistance of a technician. Suits, overboots, and masks were placed in plastic bags to minimize the quantity of MS introduced. The subjects proceeded without delay to the next stage for removal of the PSDs. This process was completed in approximately 2 minutes.
- **Stage 3** - Transition airlock. In this 4 ft by 4 ft airlock (enclosure 3), the subjects proceeded without delay to the final stage to remove the PSD samplers.
- **Stage 4** - In this 16 ft by 20 ft shelter (enclosure 4), the PSDs were removed from the subjects and placed on data sheets according to their position on the body of the subject. The subjects then exited the clean room through the transition airlock. Adsorbent was transferred from the passive samplers to individually numbered sorbent tubes. The sorbent tubes were capped to preserve each sample for analysis.

3.6 Procedures for Analyzing Samples.

Sorbent tube PSDs were analyzed on the Perkin Elmer Autosystem GC system, which includes the Automatic Thermal Tube Desorber (ATD-400) and the Turbochrom data acquisition system. Tubes were desorbed on the ATD-400 for 5 minutes at 250°C onto the cold trap of the ATD-400. The cold trap was then heated rapidly to 250°C and held there for 2 minutes to flush the sample from the cold trap and send it directly to the GC. The sample was separated on the GC column, which was a 15-m, 0.53 mm ID, 3.00 µm film thickness, fused Silica Capillary column Supelco model SPB-1. The column was held at 100°C for 1 minute, heated to 150°C at a rate of 10 °C/min, and then heated to 200 °C at a rate of 25°C/min (MS eluted from the column at 2.11 minutes). The gases from the column were sent to the detector, a Flame Ionization Detector (FID), which measured the number of ions given off (in millivolts) and transmitted the data to the Turbochrom computer data acquisition system, which graphs voltage (millivolts) versus time (minutes). The computer then integrated the area beneath the peaks to determine the mass of each individual component in terms of ng.

The Turbochrom data system was calibrated by injecting chemical standards of known concentrations (MS in isopropanol) onto cleaned sorbent tubes and analyzing them on the ATD-400/Autosystems GC system. The data system calibration uses a linear regression equation. A calibration graph is shown in Appendix A. Quality Control checks were performed each test day to ensure that the GC was functioning properly. Injections of standards were made throughout the mass range that was anticipated to be analyzed. Tubes were not analyzed if the QC checks showed a deviation greater than 10% from the mass injected.

3.7 Quality Assurance/Quality Control Procedures.

Tenax sorbent provided to the manufacturer of the PSDs was purified and certified clean by an independent laboratory at Pennsylvania State College. The purification process involved supercritical liquid extraction followed by heating and purging with carrier gas. The adsorbent was then sampled and analyzed by gas chromatograph analysis to ensure adequacy of the cleaning; strict purity protocol requirements were followed.

Following receipt of the samplers from the manufacturer, the sorbent was sampled again at the ERDEC lab. One sampler from each lot was analyzed for verification by removing the sorbent, placing it in a sorbent tube and analyzing the tube for residual levels of MS with the GC.

Quality control (QC) checks were performed each test day to ensure that the gas chromatograph was properly calibrated (calibration data are shown in Appendix A). Standard solutions containing known quantities of MS were used to verify that the mass of MS adsorbed by the PSDs was detected accurately.

The MIRAN© was used to control the level of MS vapor in the chamber and was calibrated before the testing. Calibration data for the MIRAN© is also included in Appendix A.

During each pre- and post-trial period in which the PSDs were being mounted, removed, and transferred to sorbent tubes in clean room area, three PSDs designated as "open blanks", were removed from their storage containers and exposed to the clean-room environment. These samples were analyzed to measure background levels of MS present during instrumentation, dressing, doffing, and removal of samplers and not related to the exposure in the chamber.

4. METHOD OF ANALYSIS

4.1 PSD Concentrations and Protection Factors.

The concentration of MS (C_{ms}) sampled by each interior PSD was calculated by dividing the total mass of MS on each PSD measured in the GC analysis (ng) by the product of the sampling rate of the PSDs (in ℓ/min) multiplied by the total sampling time of each PSD (in minutes) (see equation 1). The averaged mass from the open background PSD samples was subtracted from each samples' mass before calculating the concentration to correct for incidental exposure of the PSDs during donning, doffing, transfer, and storage. Background samples were exposed to the air inside the clean room during the entire dressing/undressing/PSD removal time. The PSD concentration for each body area was calculated using the following equation:

$$C_{ms} = \frac{\text{Mass of MS from PSD} - \text{Mass of MS from Background}}{\text{Sampling Rate of PSD} \times \text{Exposure Time}} \quad (1)$$

Each PSD concentration was converted to a dosage by multiplying by the exposure time. The concentration of MS in the chamber was averaged from the MIRAN® data file and the total exposure dosage during each trial was calculated by multiplying by the exposure time. This value was used in the calculations of the protection factor (PF) at each body area.

Individual PFs were determined by dividing the exposure dosage by the dosage detected inside the suit at each location. The PF calculation is expressed mathematically in equation 2:

$$PF = \frac{\text{Average Exterior Concentration} \times \text{Time}}{\text{Average Concentration Inside Suit} \times \text{Time}} = \frac{\text{Exterior Dosage}}{\text{Dosage Inside Suit}} \quad (2)$$

The PF values were tabulated for each different body area.

The mass analyzed from each PSD was examined to determine if it was significantly different from the mass of the averaged background samples. This process was performed by subtracting the averaged background mass plus one standard deviation (of the average) from the mass of each PSD and determining if the result was greater than zero. If the resulting mass was greater than zero, then the analysis methods outlined above were performed. If the resulting mass was less than zero, then the PSD was considered not to have sampled any MS during the exposure period and the maximum PF for that test was assigned for that PSD sample. The maximum PF for each test was determined by dividing the challenge dosage that the test subjects were exposed to by the minimum dosage capable of being analyzed by the gas chromatograph.

The smallest detectable amount of MS that can be measured with the combined PSD/gas chromatograph system during these tests was determined by measuring the variability of analyzed samples. This variability was measured in a study that determined the overall background mass of MS on 25 unopened, unused PSDs. In this study, 25 unused PSDs were packed in sample tubes and analyzed. There was very little difference between the readings obtained in this background sample study and the average background masses determined in the MIST tests. The average background mass on these samples was 113.46 ng with a standard deviation of only 3.60 ng. The standard deviation of these samples is the value that was used as the smallest detectable mass of MS on the PSD/GC system. Based upon an average challenge concentration of 50 mg/m³, a 30-minute exposure period, and a PSD sampling rate of 14.6 cm³/min, the equations listed above yield a maximum detectable PF of around 8000. This value varied from test to test depending on the total exposure dosage each subject was exposed to. The range of maximum PFs calculated in these tests was between 6500 to 10000.

4.2 Calculation of Overall Protection Factors.

The overall PF of the suit was determined by using the Body Region Hazard Analysis (BRHA) process developed by Fedele and Nelson¹, which is based upon the amount of agent that must be absorbed percutaneously (through the skin) in each of 23 different body areas to produce mean, end-point reactions. In the model, the mean end-point reaction is taken as the first significant symptom that occurs as a result of exposure to the agent. For nerve agent (O-ethyl S-[2-diisopropylaminoethyl] methylphosphonothiolate - VX) exposure, it is miosis (constriction of the pupil of the eye) that occurs first. Reddening of the skin (similar to severe sunburn) is the mean, end-point reaction for exposure to blister agent mustard (Bis[2-chloroethyl] sulfide - HD). This model applies data obtained from adsorption studies on human skin with pesticides⁶ and the nerve agent VX⁷. A weighting factor is assigned to each of these values based on the dose and the total percentage of that skin area.

The overall PF for nerve and blister agents requires separate calculations. For nerve agent, the overall PF is based on a weighted average of the PF measurements from all individual body areas. This approach is used because nerve agents produce a systemic rather than a localized response in the individual. When the overall PF for nerve agents is multiplied by 10 mg-min/m³ (which is the minimum dosage of the nerve agent VX that an unprotected individual must adsorb through their skin to develop end-point reactions) the systemic Minimum Required Exposure Dosage (MRED) value is obtained.

The initial effects of blister agent are localized to specific body areas. Furthermore, the skin in each body area has a different level of sensitivity. Consequently, the overall PF for the blister agent HD is expressed as a localized MRED. This is calculated by multiplying a local exposure dosage, which quantifies the sensitivity of the skin at a particular body region, by the PF measured at that region. The *lowest* calculated localized MRED value is applied in evaluating the suit and is reported (along with the skin area affected) in evaluating the protective capability of the suit and areas of susceptibility.

A detailed description of both of these methods and equations used to calculate overall PF using the Fedele BRHA process is contained below.

4.2.1 Systemic Effect - Nerve Agent (VX).

The BRHA process quantifies the dosage required to cause a systemic nerve agent effect (end-point reaction) for each body area. These dosages are listed in Table 2 and are divided into the skin area to calculate the area/dosage (A/D) factor. The A/D factor equals the percentage of skin area divided by mass required to be absorbed at that area to produce the end-point reaction. The overall PF of the suit is determined by dividing the sum of the A/D factors by the sum of the A/(D*PF) factors (A/D factor divided by PF at each area).

The equations used to perform each of these calculations are as follows:

$$(A/D)_i = A_i \div D_i \quad (3)$$

$$(A/(D*PF))_i = A_i \div D_i \div PF_i \quad (4)$$

$$\text{Overall PF} = \frac{\sum (A/D)_i}{\sum A/(D*PF)_i} \quad (5)$$

where PF_i is the protection factor measured at location $i = 1, 2, \dots, 23$, and PF is the overall protection factor summed over $i = 1, 2, \dots, 23$ body areas. Because this portion of the Fedele model was developed using data taken from controlled human exposure to the nerve agent VX, the overall PF was then multiplied by the minimum dosage of VX that an unprotected individual must be exposed to in order to develop end-point reactions (miosis of the eyes occurs first). That dosage is 10 mg-min/m^3 . This factor is called the Systemic MRED, and is used to predict dosage exposure required for systemic nerve agent effects.

4.2.2 Localized Effect - Blister Agent (HD).

A second data set from the BRHA process was used to determine what exposure dosages are required to cause end-point reactions when the suit wearer is exposed to HD vapor (reddening of the skin occurs first, similar to severe sunburn). Since the effects of HD are not cumulative and generally affect only localized body regions, the model predicts MREDs for each body region (based upon the individual PF values); and the lowest value of all these dosages is used to predict the lowest response dosage for people using the Responder. Listed in Table 2 are the local exposure dosages for HD provided by the model. The Local Exposure Dosage column in Table 2 contains values of agent dosages (LEDs) to which each individual skin area must be exposed to in order to attain a localized skin reaction. These values were multiplied by the appropriate PF value to obtain the MRED required to cause localized skin reactions at each body location. Thus, the localized MRED for the Responder was calculated using the following equation:

$$\text{Localized MRED} = (\text{LED}_i * PF_i) \quad (6)$$

where LED is the localized exposure dosage for skin area $i = 1, 2, \dots, 23$, and PF is the protection factor measured at skin area $i = 1, 2, \dots, 23$. The site with the lowest value is used in the evaluation of the data for the tests, i.e., the site with the smallest MRED value was the area least protected by the Responder.

Table 2. Model Parameters used to Calculate the Overall Protection Factor

Sample Region	PSD Sample Number	Skin Area (cm ²)	VX Dose mg/ind	A/D Factor	Local Exposure Dosage for HD mg-min/m ³
1 - Chin & Neck	10	200	0.36	556	129
2 - Ears	10	50	0.46	109	164
3 - Cheeks & Neck	10	100	0.48	208	171
4 - Nape	10	100	1.72	58	614
5 - Scalp	10	350	0.76	461	271
6 - Abdomen	2,4	2858	2.23	1282	796
7 - Back	1,4	2540	2.65	958	946
8 - Buttocks	3	953	4.26	224	1521
9 - Arms(lower, volar)	6	487	2.8	174	1000
10 - Arms(upper, volar)	5	488	2.8	174	1000
11 - Elbows (back)	5	50	2.25	22	804
12 - Arms (lower, dorsum)	6	706	6.57	107	2346
13 - Arms (upper, dorsum)	5	706	6.57	107	2346
14 - Legs (plantar, lower)	9	948	2.8	339	1000
15 - Legs (plantar, upper)	8	1422	4.26	334	1521
16 - Legs (dorsum, lower)	9	1897	6.57	289	2346
17 - Legs (dorsum, upper)	8	2845	6.57	433	2346
18 - Knees (front)	9	200	7.14	28	2550
19 - Scrotum	7	200	0.11	1818	39
20 - Groin	7	300	1.22	246	436
21 - Axillae	4	200	2.07	97	739
22 - Popliteal Space	9	100	2.09	48	746
23 - Elbowfold	6	50	2.09	24	746
		17750		8095	

5. RESULTS AND DISCUSSION

Results of the testing of the Responder CSM® suit are summarized in Table 3. Table 4 lists the average challenge concentration and dosage during each trial for both pairs of subjects and the average concentration inside the clean room during each test. Complete test data (including the BRHA process calculation parameters and the summarized data from the DAS) are listed in Appendix B for the four trials conducted. Table 3 lists the test conditions, overall PF against nerve agent (VX), the systemic MREDs for nerve agent (VX), and the localized MREDs (for skin reactions to mustard) along with the skin area corresponding to the lowest localized MRED.

The Systemic MREDs correspond to the systemic dosage an individual must be exposed to in order to exhibit the first symptoms of agent exposure. This first symptoms are headache or miosis (pinpointing of the eyes) and are not severe reactions. It was suggested that the more severe reaction of nausea and vomiting be used in calculating the Systemic MREDs (this would use a value of 25 mg-min/m³ instead of 10 as

Table 3. Summary of Kappler Model 42483 Responder CSM® Suit MIST Testing

Suit Trial	Suit Size	Nerve Agent Data		Blister Agent Data	
		Overall PF	Systemic MRED	Localized MRED	Affected Skin Area
Suit 1	Small	1945.3	19453	134574	Chin & Neck
Suit 2	Medium	1321.9	13219	27102	Scrotum
Suit 3	Medium	1364	13640	123663	Chin & Neck
Suit 4	Medium	1235.5	12355	244484	Elbowfold
Suit 5	Medium	1748.5	17485	24342	Scrotum
Suit 6	Small	393	3930	9440	Scrotum
Suit 7	Small	2123.6	21236	255968	Popliteal Space
Suit 8	Medium	1583.8	15838	267592	Axillae
Suit 9	Medium	2648.2	26482	37731	Scrotum
Suit 10	Small	527.3	5273	5908	Scrotum
Suit 11	Large	1024.5	10245	62878	Chin & Neck
Suit 12	Large	1532.6	15326	55666	Scrotum
Suit 13	Medium	2137.1	21371	256835	Chin & Neck
Suit 14	Medium	4022.2	40222	285023	Scrotum
All Suit Sizes					
Average:		1686.3	16862.5	127943.3	
Standard Deviation:		877.3	8772.9	106320.5	
90% Confidence Interval:		316.5	3165.3	38360.7	
95% Confidence Interval:		648.3	6483.2	42401.2	
Average Data for Small Suit Sizes					
Average:		1247.3	12473.0	101472.5	
Standard Deviation:		791.1	7911.0	103159.0	
90% Confidence Interval:		647.9	6479.1	84487.2	
Average Data for Medium Suit Sizes					
Average:		2007.7	20076.5	158346.5	
Standard Deviation:		881.3	8812.7	109564.2	
90% Confidence Interval:		440.9	4408.8	54812.6	
Average Data for Large Suit Sizes					
Average:		1278.6	12785.5	59272.0	
Standard Deviation:		254.1	2540.5	3606.0	
90% Confidence Interval:		552.9	5529.3	7848.4	

the exposure dosage) so that a more realistic value (of what dosage a suit wearer must be exposed to before effects would occur) would be obtained. The original headache/miosis symptom was still used in these calculations, however, and this provides a very conservative estimate of exposure dosages that would cause effects. Multiplying the Systemic MRED by 2.5 will yield the value that the suit wearer must be exposed to in

Table 4. Average Challenge and Clean Room Concentrations During Each Test

Test	Date	Test Subject Pair	Average Challenge Concentration (mg/m ³)	Challenge Dosage (mg-min/m ³)	Average Clean Room Concentration (mg/m ³)
1	8/15/97	1	68.30	2117.	0.0002
		2	63.05	1955.	0.0002
2	8/18/97	1	63.16	1958	0.000025
		2	61.04	1892.	0.000025
3	8/19/97	1	60.45	1813.	0.000019
4	8/21/97	1	59.27	1837.	0.000016
		2	60.15	1865.	0.000016

order to develop the more severe reactions. The localized MRED data was analyzed to determine the most vulnerable areas in the protective ensemble, that is, the areas in which mustard would redden the skin first. All MRED values reported hereinafter have the units of mg-min/m³; PF values are unitless.

The average values for all the trials was calculated. Statistical data was analyzed to determine the standard deviation and the 90 and 95% confidence intervals for this data. This analysis indicates that the overall PF for 90% (or 95%) of the suits will fall between the average values plus or minus this value. The results of this testing on the Responder CSM® suit and SCBA respirator showed that the combined ensemble provided an average overall protection factor of 1686 ± 317 (90% confidence interval) when the data is analyzed for all sizes of the suit. The Systemic MRED was 16863 ± 3165. The Localized MRED was 127943 ± 38361.

The data from the individual suit sizes was analyzed independently to determine the protection of each size. This data showed that the small size suits had an average overall protection factor of 1247 ± 648 (90% confidence interval), a Systemic MRED of 12473 ± 6479, and a Localized MRED of 101473 ± 84487. The medium size suits had an average overall protection factor of 2008 ± 441 (90% confidence interval), a Systemic MRED of 20077 ± 4409, and a Localized MRED of 158347 ± 54813. The large size suits had an average overall protection factor of 1279 ± 553 (90% confidence interval), a Systemic MRED of 12786 ± 5529, and a Localized MRED of 59272 ± 7848.

The lowest values of the Localized MREDs are usually indicators of the skin areas that are most vulnerable while wearing the suit. The data from all 14 suit tests were summarized in order to calculate the average value of the Localized MRED for each body location throughout all of the trials. The minimum, the maximum, the sample standard deviation, and the 95% confidence interval were also calculated. The values for these calculations are listed in Table 5 below, and the summary is graphically presented in Figure 6. The body regions that were most vulnerable in this testing were predominantly very sensitive regions of the body, and included the Scrotum, the Chin & Neck, the Ears, and the Cheeks & Neck regions. Generally these areas were still very well protected, with

Table 5. Localized MRED Summary for the Kappler Model 42483 Responder CSM® Suit

Region # <u>Body Skin Region</u>	Average	Standard	95% Confidence Interval	Maximum	Minimum
	Local Eff Exposure mg-min/m ³	Deviation Local Eff Exposure mg-min/m ³			
1 Chin & Neck	581894	394164	206472	989993	62878
2 Ears	739772	501108	262491	1258596	79938
3 Cheeks & Neck	771348	522497	273695	1312316	83350
4 Nape	2769634	1876100	982742	4712060	299278
5 Scalp	1222428	828051	433751	2079753	132092
6 Abdomen	3716362	1734507	908572	5846404	867167
7 Back	4100661	2756930	1444140	7850052	403170
8 Buttocks	6615573	4627676	2424077	12621489	812780
9 Arms (lower, volar)	2905618	3107566	1627810	8298152	327727
10 Arms (upper, volar)	5592074	3083090	1614989	8298152	359508
11 Elbows (back)	4496028	2478805	1298451	6671714	289045
12 Arms (lower, dorsum)	6816580	7290349	3818843	19467465	768847
13 Arms (upper, dorsum)	13119006	7232930	3788765	19467465	843406
14 Legs (plantar, lower)	3674115	3266091	1710849	8298152	79760
15 Legs (plantar, upper)	7799817	5203453	2725681	15664474	326651
16 Legs (dorsum, lower)	8619474	7662249	4013652	19467465	187117
17 Legs (dorsum, upper)	12030486	8025838	4204108	24160984	503828
18 Knees (front)	9368993	8328531	4362665	21160288	203388
19 Scrotum	164428	132484	69398	323628	5908
20 Groin	1838218	1481108	775836	3617994	66052
21 Axillae	3524317	2436985	1276545	6132334	152144
22 Popliteal Space	2740890	2436504	1276293	6190421	59501
23 Elbowfold	2167591	2318244	1214346	6190421	244484

the average dosage required to cause effects at the most sensitive region (the Scrotum) while wearing the suit ensemble being over 164,000 mg-min/m³. There was really no significant difference between the other individual skin areas in this suit. The areas that did show the lowest MREDs are all very highly sensitive areas of the body and adsorb agent at higher rates than more durable skin areas (such as the forearm). This is the reason certain skin regions consistently have lower values, not because there is any significant vulnerability areas of this suit at these locations. Based on these test results, it is very unlikely that wearers would ever experience any effects while wearing these suits in chemically contaminated environments because all of the values, including the Overall PF, the Systemic and the Localized MREDs were very high. A wearer would have to be exposed to a very large amount of agent in order to be affected.

Kappler Model 42583 Responder CSM Suit Average Localized MRED Values

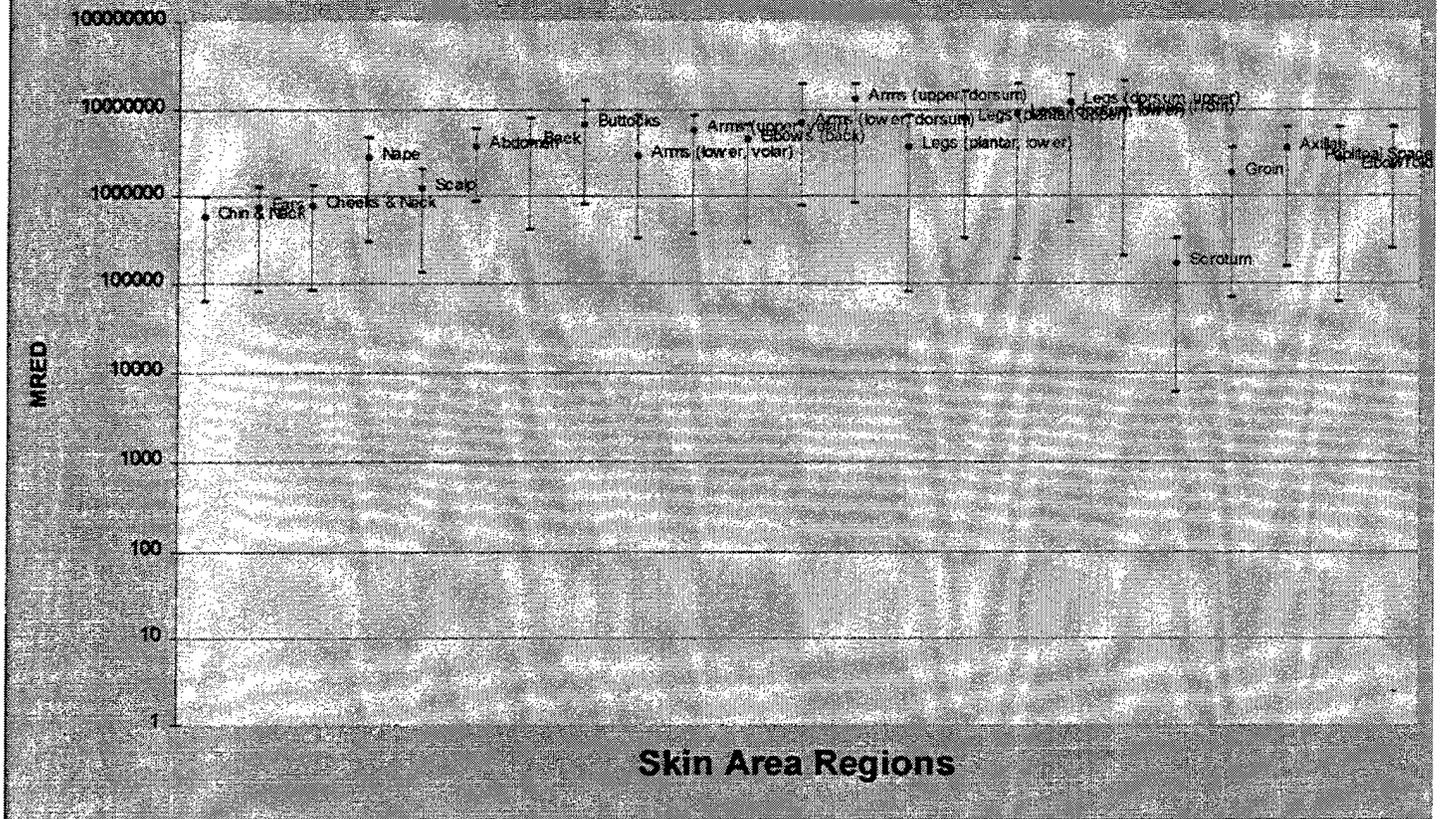


Figure 6. Localized MRED Summary for the Kappler Model 42483 Responder CSM® Suit

LITERATURE CITED

1. Fedele, Dr. Paul D., Nelson, Douglas C., *A Method of Assessing Full Individual Protective System Performance Against Cutaneous Effects of Aerosol and Vapour Exposures*, U.S. Army Edgewood Research, Development and Engineering Center, Aberdeen Proving Ground, Maryland, October, 1995; Section 1-3 "Body Region Hazard Analysis Process" included in report for the JSLIST Program: Cronin, Tracy D., *Final Report For The Development of the Man-In-Simulant Test (MIST) Methodology For Evaluation of Chemical/Biological (CB) Protective Garments*, TECOM Project No. 8-EI-825-ABO-004, U.S. Army Dugway Proving Ground, Dugway, Utah, April 1996.
2. Arca, V.J., Ramos, G.A., Reeves, D.W., Blewett, W.K., Fatkin, D.P., and Cannon, B.D., *Protection Factor Testing of the Responder Suit*, U.S. Army Edgewood Research, Development, and Engineering Center, ERDEC-TR-312, December, 1995.
3. Arca, V.J., *Evaluation of Passive Sampling Devices for Use With Methyl Salicylate*, U.S. Army Edgewood Research, Development and Engineering Center, ERDEC-TR-321, April 1996.
4. Arca, V.J., *Comparison of Adsorbents for Use With Methyl Salicylate*, U.S. Army Edgewood Research, Development and Engineering Center, ERDEC-TR-322, April 1996.
5. Arca, V.J., *Methodology for Analysis of Air Samples for Methyl Salicylate*, U.S. Army Edgewood Research, Development and Engineering Center, ERDEC-TR-335, May 1996.
6. Maibach et al, *Regional Variation in Percutaneous Penetration in Man*, Arch. Environ. Health, 23, pp 208-211, 1971.
7. Sim, V.S., *Variation of Different Intact Human-Skin Sites to the Penetration of VX*, U.S. Army Chemical Research and Development Laboratories, Technical Report CRDLR 3122, 1962.

Blank

APPENDIX A
MIRAN® AND GC CALIBRATION DATA

The MIRANs operated at a wavelength of 8.3 μm , a pathlength of 20.25 m, an absorbance range of 1.0, and a slit-width of 1 mm. The calibration data points, linear regression, and graphs showing the curve fit with the actual data points is provided below.

MIRAN 97169

	Calibration Concentration <u>(mg/m³)</u>	Meter Reading <u>(V dc)</u>	Calculated Concentration <u>(mg/m³)</u>
BK	-0.0172	0.0000	0.002836
L1	0.6114	0.0037	0.677359
L2	1.1188	0.0074	1.369672
L3	2.8875	0.0174	3.214636
L4	5.6956	0.0329	6.095155
L5	7.2540	0.0421	7.798478
L6	14.6300	0.0825	15.27400
L7	32.0422	0.1775	32.86784
L8	57.8697	0.3146	58.24923
L9	85.4613	0.4573	84.66758

Regression Output:

Constant	0
Std Err of Y Est	0.527172
R Squared	0.999674
No. of Observations	10
Degrees of Freedom	9
X Coefficient(s)	185.1355
Std Err of Coef.	0.891475

MIRAN 35172

	Calibration Concentration <u>(mg/m³)</u>	Meter Reading <u>(V dc)</u>	Calculated Concentration <u>(mg/m³)</u>
Bk Volt	0.00	0.0010	0.200229
L1 Volt	2.17	0.0091	1.864405
L2 Volt	5.77	0.0238	4.883066
L3 Volt	10.21	0.0523	10.72247
L4 Volt	120.00	0.5848	119.9950

Regression Output:

Constant	0
Std Err of Y Est	0.541484
R Squared	0.999890
No. of Observations	5
Degrees of Freedom	4
X Coefficient(s)	205.1880
Std Err of Coef.	0.921381

MIRAN 97169 Calibration for MS, 17 Jun 97

Meter	Conc	Meter	Conc	Meter	Conc
Volts	mg/m3	Volts	mg/m3	Volts	mg/m3
0.01	1.85	0.36	66.65	0.71	131.45
0.02	3.70	0.37	68.50	0.72	133.30
0.03	5.55	0.38	70.35	0.73	135.15
0.04	7.41	0.39	72.20	0.74	137.00
0.05	9.26	0.40	74.05	0.75	138.85
0.06	11.11	0.41	75.91	0.76	140.70
0.07	12.96	0.42	77.76	0.77	142.55
0.08	14.81	0.43	79.61	0.78	144.41
0.09	16.66	0.44	81.46	0.79	146.26
0.10	18.51	0.45	83.31	0.80	148.11
0.11	20.36	0.46	85.16	0.81	149.96
0.12	22.22	0.47	87.01	0.82	151.81
0.13	24.07	0.48	88.87	0.83	153.66
0.14	25.92	0.49	90.72	0.84	155.51
0.15	27.77	0.50	92.57	0.85	157.37
0.16	29.62	0.51	94.42	0.86	159.22
0.17	31.47	0.52	96.27	0.87	161.07
0.18	33.32	0.53	98.12	0.88	162.92
0.19	35.18	0.54	99.97	0.89	164.77
0.20	37.03	0.55	101.82	0.90	166.62
0.21	38.88	0.56	103.68	0.91	168.47
0.22	40.73	0.57	105.53	0.92	170.32
0.23	42.58	0.58	107.38	0.93	172.18
0.24	44.43	0.59	109.23	0.94	174.03
0.25	46.28	0.60	111.08	0.95	175.88
0.26	48.14	0.61	112.93	0.96	177.73
0.27	49.99	0.62	114.78	0.97	179.58
0.28	51.84	0.63	116.64	0.98	181.43
0.29	53.69	0.64	118.49	0.99	183.28
0.30	55.54	0.65	120.34	1.00	185.14
0.31	57.39	0.66	122.19	1.01	186.99
0.32	59.24	0.67	124.04	1.02	188.84
0.33	61.09	0.68	125.89	1.03	190.69
0.34	62.95	0.69	127.74	1.04	192.54
0.35	64.80	0.70	129.59	1.05	194.39

MIRAN 35172 Calibration for MS, 17 Jun 97

Meter	Conc	Meter	Conc	Meter	Conc
Volts	mg/m3	Volts	mg/m3	Volts	mg/m3
0.01	2.05	0.36	73.87	0.71	145.68
0.02	4.10	0.37	75.92	0.72	147.74
0.03	6.16	0.38	77.97	0.73	149.79
0.04	8.21	0.39	80.02	0.74	151.84
0.05	10.26	0.40	82.08	0.75	153.89
0.06	12.31	0.41	84.13	0.76	155.94
0.07	14.36	0.42	86.18	0.77	157.99
0.08	16.42	0.43	88.23	0.78	160.05
0.09	18.47	0.44	90.28	0.79	162.10
0.10	20.52	0.45	92.33	0.80	164.15
0.11	22.57	0.46	94.39	0.81	166.20
0.12	24.62	0.47	96.44	0.82	168.25
0.13	26.67	0.48	98.49	0.83	170.31
0.14	28.73	0.49	100.54	0.84	172.36
0.15	30.78	0.50	102.59	0.85	174.41
0.16	32.83	0.51	104.65	0.86	176.46
0.17	34.88	0.52	106.70	0.87	178.51
0.18	36.93	0.53	108.75	0.88	180.57
0.19	38.99	0.54	110.80	0.89	182.62
0.20	41.04	0.55	112.85	0.90	184.67
0.21	43.09	0.56	114.91	0.91	186.72
0.22	45.14	0.57	116.96	0.92	188.77
0.23	47.19	0.58	119.01	0.93	190.82
0.24	49.25	0.59	121.06	0.94	192.88
0.25	51.30	0.60	123.11	0.95	194.93
0.26	53.35	0.61	125.16	0.96	196.98
0.27	55.40	0.62	127.22	0.97	199.03
0.28	57.45	0.63	129.27	0.98	201.08
0.29	59.50	0.64	131.32	0.99	203.14
0.30	61.56	0.65	133.37	1.00	205.19
0.31	63.61	0.66	135.42	1.01	207.24
0.32	65.66	0.67	137.48	1.02	209.29
0.33	67.71	0.68	139.53	1.03	211.34
0.34	69.76	0.69	141.58	1.04	213.40
0.35	71.82	0.70	143.63	1.05	215.45

MIRAN 97169 MS Calibration

July 11, 1997

— Regression Line
◆ 97169 Data Points

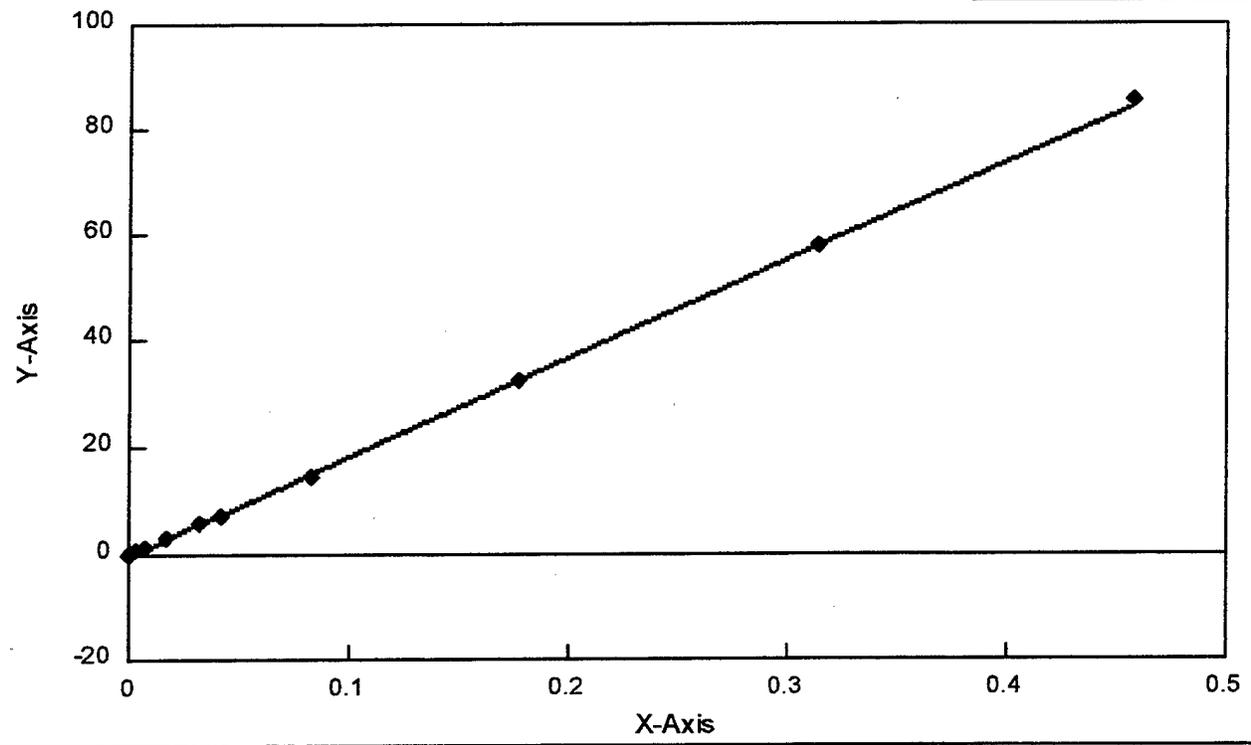


Figure A-1. MIRAN 97169 Calibration

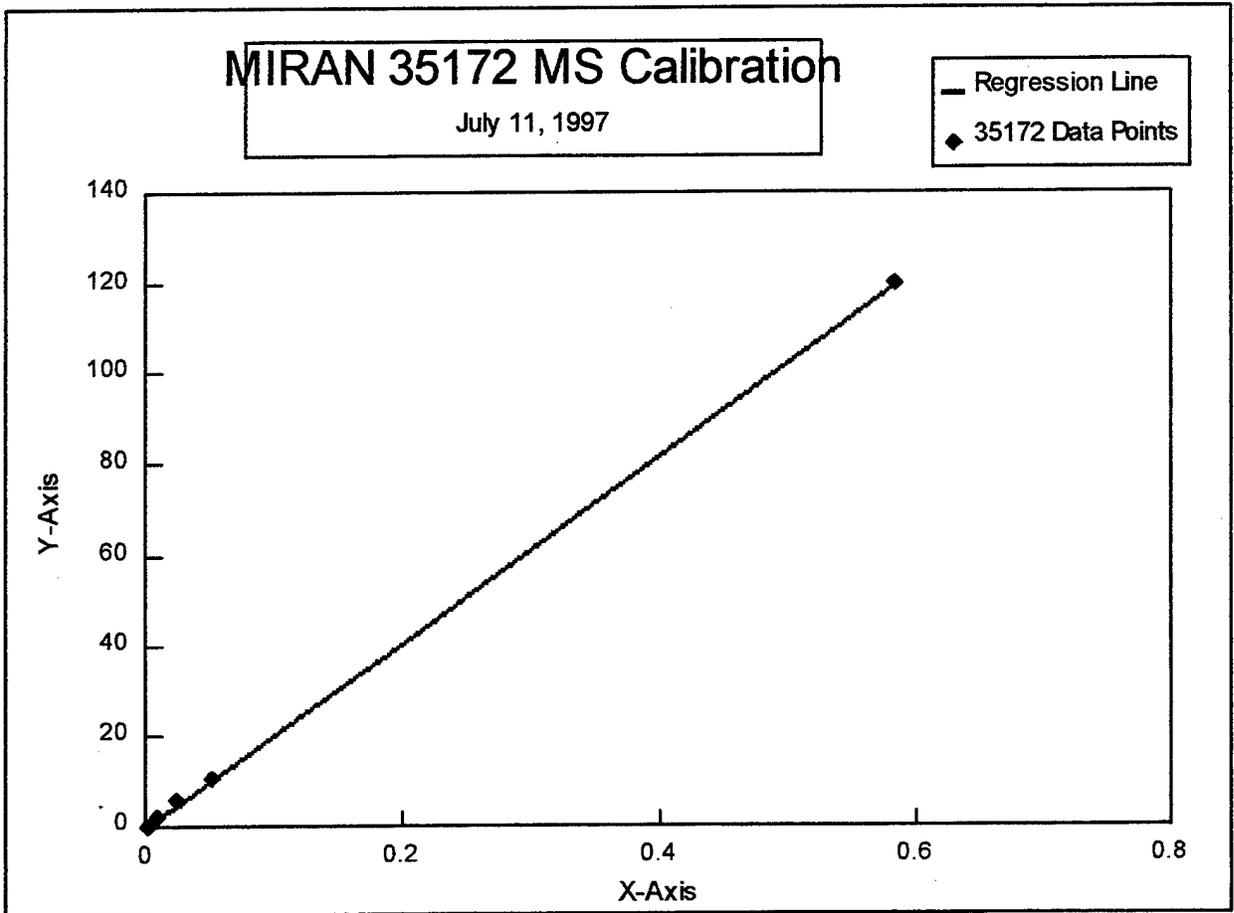


Figure A-2. MIRAN 35172 Calibration

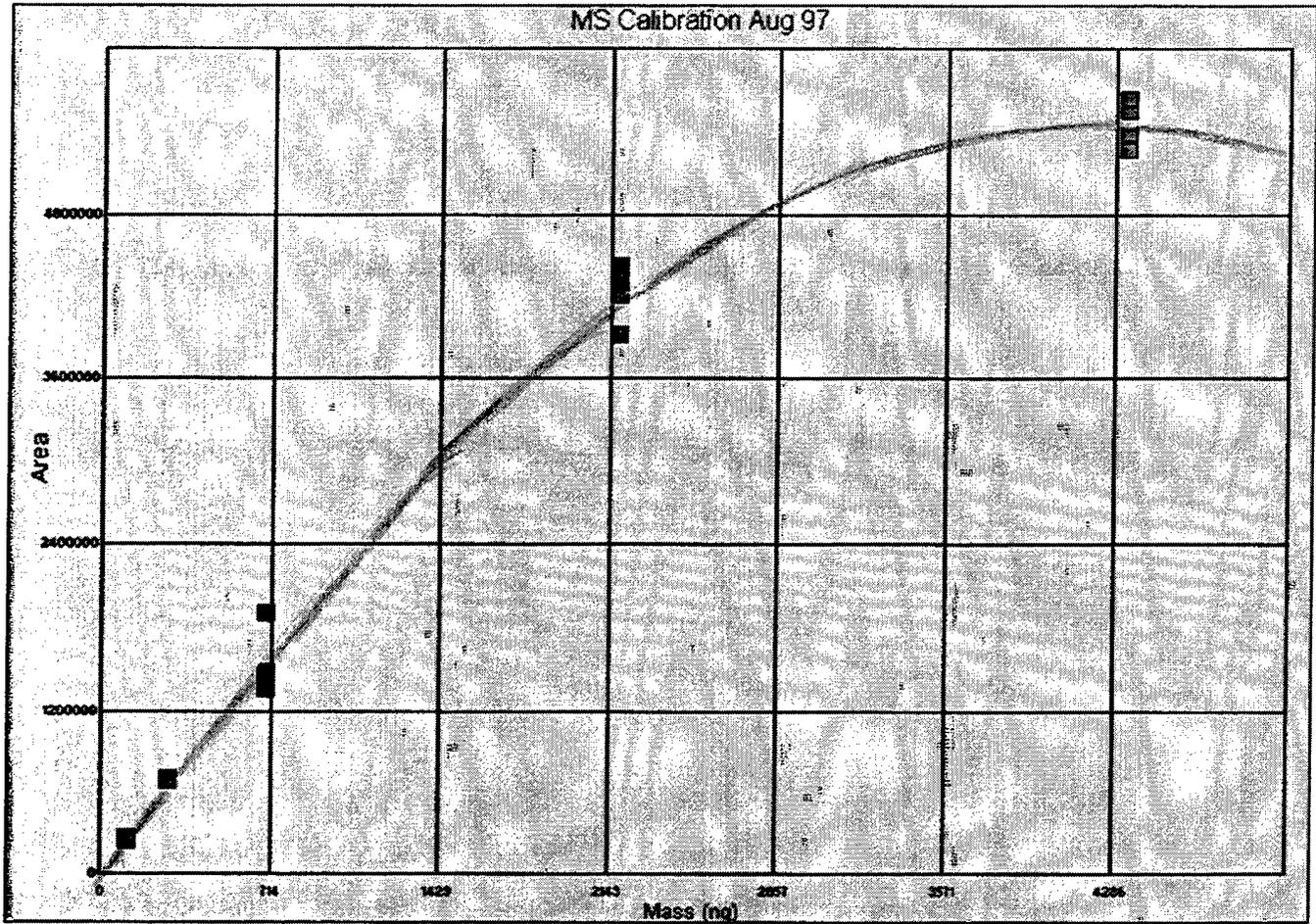


Figure A-3. Calibration Used For GC Analysis of PSD Samples.

**APPENDIX B
PROTECTIVE SUIT TEST DATA**

1. Protection Factor Test Summary.

Kappler Model 42583 Suit MIST Test Data Summary 15-21 August 97

Suit Trial	Suit Size	Nerve Agent Data		Blister Agent Data	
		Overall PF	Systemic MRED	Localized MRED	Affected Skin Area
Suit 1	Small	1945.3	19453	134574	Chin & Neck
Suit 2	Medium	1321.9	13219	27102	Scrotum
Suit 3	Medium	1364	13640	123663	Chin & Neck
Suit 4	Medium	1235.5	12355	244484	Elbowfold
Suit 5	Medium	1748.5	17485	24342	Scrotum
Suit 6	Small	393	3930	9440	Scrotum
Suit 7	Small	2123.6	21236	255968	Popliteal Space
Suit 8	Medium	1583.8	15838	267592	Axillae
Suit 9	Medium	2648.2	26482	37731	Scrotum
Suit 10	Small	527.3	5273	5908	Scrotum
Suit 11	Large	1024.5	10245	62878	Chin & Neck
Suit 12	Large	1532.6	15326	55666	Scrotum
Suit 13	Medium	2137.1	21371	256835	Chin & Neck
Suit 14	Medium	4022.2	40222	285023	Scrotum

All Suit Sizes

Average:	1686.3	16862.5	127943.3
Standard Deviation:	877.3	8772.9	106320.5
90% Confidence Interval:	316.5	3165.3	38360.7
95% Confidence Interval:	648.3	6483.2	42401.2

Average Data for Small Suit Sizes

Average:	1247.3	12473.0	101472.5
Standard Deviation:	791.1	7911.0	103159.0
90% Confidence Interval:	647.9	6479.1	84487.2

Average Data for Medium Suit Sizes

Average:	2007.7	20076.5	158346.5
Standard Deviation:	881.3	8812.7	109564.2
90% Confidence Interval:	440.9	4408.8	54812.6

Average Data for Large Suit Sizes

Average:	1278.6	12785.5	59272.0
Standard Deviation:	254.1	2540.5	3606.0
90% Confidence Interval:	552.9	5529.3	7848.4

Kappler Model 42583 Suit MIST Test 1 15 August 97

Suit 1 Small		MS					
Sample		Flow	Total	Mass	Conc	Dosage	PF
<u>Location</u>	<u>Tube</u>	<u>(L/min)</u>	<u>(min)</u>	<u>(µg)</u>	<u>(mg/m³)</u>	<u>mg-min/m³</u>	
1 Back	ST3	0.0146	30.00	0.086	0.0487	1.462	1447.8
2 Chest	ST11	0.0146	30.00	0.101	0.0818	2.453	863.2
3 Chest	A8	0.0146	30.00	0.109	0.1013	3.038	696.8
4 Chest	B2	0.0146	30.00	0.076	BBL	BBL	8298.2
5 Buttocks	14	0.0146	30.00	0.086	0.0478	1.434	1476.1
6 Axillae	ST5	0.0146	30.00	0.118	0.1216	3.647	580.5
7 Upper Arm	A2	0.0146	30.00	0.083	BBL	BBL	8298.2
8 Lower Arm	A10	0.0146	30.00	0.065	BBL	BBL	8298.2
9 Crotch	BC	0.0146	30.00	0.057	BBL	BBL	8298.2
10 Thigh	A6	0.0146	30.00	0.079	BBL	BBL	8298.2
11 Lower Leg	ST1	0.0146	30.00	0.099	0.0779	2.338	905.4
12 Neck	A4	0.0146	30.00	0.095	0.0676	2.029	1043.2
Overall:							1945.28

Suit 2 Medium		MS					
Sample		Flow	Total	Mass	Conc	Dosage	PF
<u>Location</u>	<u>Tube</u>	<u>(L/min)</u>	<u>(min)</u>	<u>(µg)</u>	<u>(mg/m³)</u>	<u>mg-min/m³</u>	
1 Back	T5	0.0146	30.00	0.081	BBL	BBL	8298.2
2 Chest	H12	0.0146	30.00	0.080	BBL	BBL	8298.2
3 Chest	H18	0.0146	30.00	0.083	BBL	BBL	8298.2
4 Chest	C12	0.0146	30.00	0.086	0.0484	1.452	1458.0
5 Buttocks	H5	0.0146	30.00	0.081	BBL	BBL	8298.2
6 Axillae	CH8	0.0146	30.00	0.058	BBL	BBL	8298.2
7 Upper Arm	CH12	0.0146	30.00	0.100	0.0795	2.386	887.2
8 Lower Arm	CH1	0.0146	30.00	0.099	0.0779	2.336	906.5
9 Crotch	A7	0.0146	30.00	0.110	0.1016	3.047	694.9
10 Thigh	H11	0.0146	30.00	0.095	0.0688	2.063	1026.2
11 Lower Leg	CA7	0.0146	30.00	0.067	BBL	BBL	8298.2
12 Neck	5	0.0146	30.00	0.094	0.0664	1.992	1062.9
Overall:							1321.94
Patch BK	X4			0.0524	Avg ug:	0.0651	
Patch BK	C10			0.0505	St Dev:	0.01931	
Patch BK	CH7			0.0924			

# Mins	Avg Conc	Dosage	Avg Temp
30.00	68.30	2117.15	66.89

Minimum detectable mass = stnd dev = 0.00360
 Minimum Detectable Conc = 0.00823
 Maximum PF = 8298
 Overall Suit A PF: 1945.28
 Overall Suit B PF: 1321.94

Suit 3 Medium		MS					
Sample		Flow	Total	Mass	Conc	Dosage	
<u>Location</u>	<u>Tube</u>	<u>(L/min)</u>	<u>(min)</u>	<u>(µg)</u>	<u>(mg/m³)</u>	<u>mg-min/m³</u>	<u>PF</u>
1 Back	H16	0.0146	30.00	0.087	0.0502	1.506	1297.8
2 Chest	H15	0.0146	30.00	0.100	0.0792	2.377	822.2
3 Chest	R4	0.0146	30.00	0.090	0.0566	1.699	1150.7
4 Chest	N10	0.0146	30.00	0.103	0.0873	2.618	746.5
5 Buttocks	CH26	0.0146	30.00	0.085	0.0458	1.375	1421.2
6 Axillae	C2	0.0146	30.00	0.088	0.0512	1.536	1272.3
7 Upper Arm	CH4	0.0146	30.00	0.047	BBL	BBL	7661.4
8 Lower Arm	T	0.0146	30.00	0.086	0.0472	1.416	1380.0
9 Crotch	T65	0.0146	30.00	0.078	BBL	BBL	7661.4
10 Thigh	H09	0.0146	30.00	0.074	BBL	BBL	7661.4
11 Lower Leg	H3	0.0146	30.00	0.136	0.1611	4.832	404.5
12 Neck	T4	0.0146	30.00	0.095	0.0680	2.039	958.6
Overall:							1363.99

Suit 4 Medium		MS					
Sample		Flow	Total	Mass	Conc	Dosage	
<u>Location</u>	<u>Tube</u>	<u>(L/min)</u>	<u>(min)</u>	<u>(µg)</u>	<u>(mg/m³)</u>	<u>mg-min/m³</u>	<u>PF</u>
1 Back	1	0.0146	30.00	0.076	BBL	BBL	7661.4
2 Chest	4	0.0146	30.00	0.122	0.1293	3.880	503.8
3 Chest	N2	0.0146	30.00	0.090	0.0566	1.699	1150.7
4 Chest	N4	0.0146	30.00	0.073	BBL	BBL	7661.4
5 Buttocks	A4	0.0146	30.00	0.077	BBL	BBL	7661.4
6 Axillae	CH5	0.0146	30.00	0.080	BBL	BBL	7661.4
7 Upper Arm	ST1	0.0146	30.00	0.082	BBL	BBL	7661.4
8 Lower Arm	R18	0.0146	30.00	0.152	0.1988	5.964	327.7
9 Crotch	H3	0.0146	30.00	0.077	BBL	BBL	7661.4
10 Thigh	1	0.0146	30.00	0.161	0.2198	6.595	296.4
11 Lower Leg	R8	0.0146	30.00	0.152	0.1981	5.942	328.9
12 Neck	R19	0.0146	30.00	0.081	BBL	BBL	7661.4
Overall:							1235.50
Patch BK	X4			0.0524	Avg ug:	0.0651	
Patch BK	C10			0.0505	St Dev:	0.01931	
Patch BK	CH7			0.0924			

	# Mins	Avg Conc	Dosage	Avg Temp
Data Acquisition Data	30.00	63.05	1954.69	66.89

Minimum detectable mass = stnd dev = 0.00360
 Minimum Detectable Conc = 0.00823
 Maximum PF = 7661
 Overall Suit A PF: 1363.99
 Overall Suit B PF: 1235.50

<u>Skin Area Region</u>	Suit 1 Values Small Size			Suit 2 Values Medium Size		
	<u>PF</u>	<u>A</u> <u>(D*PF)</u>	<u>Localized*</u> <u>Exposure</u> <u>mg-min/m³</u>	<u>PF</u>	<u>A</u> <u>(D*PF)</u>	<u>Localized</u> <u>Exposure</u> <u>mg-min/m³</u>
1 Chin & Neck	1043.2	0.5	134574	1062.9	0.5	137120
2 Ears	1043.2	0.1	171087	1062.9	0.1	174323
3 Cheeks & Neck	1043.2	0.2	178389	1062.9	0.2	181763
4 Nape	1043.2	0.1	640533	1062.9	0.1	652647
5 Scalp	1043.2	0.4	282711	1062.9	0.4	288058
6 Abdomen	1933.3	0.7	1538876	7158.1	0.2	5697874
7 Back	1462.0	0.7	1383021	8298.2	0.1	7850052
8 Buttocks	1476.1	0.2	2245210	8298.2	0.0	12621489
9 Arms (lower, volar)	8298.2	0.0	8298152	906.5	0.2	906463
10 Arms (upper, volar)	8298.2	0.0	8298152	887.2	0.2	887210
11 Elbows (back)	8298.2	0.0	6671714	887.2	0.0	713317
12 Arms (lower, dorsum)	8298.2	0.0	19467465	906.5	0.1	2126562
13 Arms (upper, dorsum)	8298.2	0.0	19467465	887.2	0.1	2081394
14 Legs (plantar, lower)	905.4	0.4	905401	8298.2	0.0	8298152
15 Legs (plantar, upper)	8298.2	0.0	12621489	1026.2	0.3	1560913
16 Legs (dorsum, lower)	905.4	0.3	2124071	8298.2	0.0	19467465
17 Legs (dorsum, upper)	8298.2	0.1	19467465	1026.2	0.4	2407562
18 Knees (front)	905.4	0.0	2308773	8298.2	0.0	21160288
19 Scrotum	8298.2	0.2	323628	694.9	2.6	27102
20 Groin	8298.2	0.0	3617994	694.9	0.4	302989
21 Axillae	580.5	0.2	428972	8298.2	0.0	6132334
22 Popliteal Space	905.4	0.1	675429	8298.2	0.0	6190421
23 Elbowfold	8298.2	0.0	6190421	906.5	0.0	676221
		4.2			6.1	
Overall PF:			1945.3			1321.9
Systemic MRED:			19452.8			13219.4
Localized MRED:			134574			27102

*The lowest value for the Localized MRED is in bold on this page and on all pages hereafter.

Skin Area Region	Suit 3 Values Medium Size			Suit 4 Values Medium Size		
	PF	A (D*PF)	Localized Exposure mg-min/m ³	PF	A (D*PF)	Localized Exposure mg-min/m ³
1 Chin & Neck	958.6	0.6	123663	7661.4	0.1	988318
2 Ears	958.6	0.1	157215	7661.4	0.0	1256467
3 Cheeks & Neck	958.6	0.2	163926	7661.4	0.0	1310096
4 Nape	958.6	0.1	588599	7661.4	0.0	4704088
5 Scalp	958.6	0.5	259789	7661.4	0.1	2076234
6 Abdomen	1089.4	1.2	867167	5383.3	0.2	4285138
7 Back	1359.5	0.7	1286100	7661.4	0.1	7247667
8 Buttocks	1421.2	0.2	2161701	7661.4	0.0	11652961
9 Arms (lower, volar)	1380.0	0.1	1380002	327.7	0.5	327727
10 Arms (upper, volar)	7661.4	0.0	7661382	7661.4	0.0	7661382
11 Elbows (back)	7661.4	0.0	6159751	7661.4	0.0	6159751
12 Arms (lower, dorsum)	1380.0	0.1	3237484	327.7	0.3	768847
13 Arms (upper, dorsum)	7661.4	0.0	17973601	7661.4	0.0	17973601
14 Legs (plantar, lower)	404.5	0.8	404514	328.9	1.0	328935
15 Legs (plantar, upper)	7661.4	0.0	11652961	296.4	1.1	450841
16 Legs (dorsum, lower)	404.5	0.7	948989	328.9	0.9	771683
17 Legs (dorsum, upper)	7661.4	0.1	17973601	296.4	1.5	695380
18 Knees (front)	404.5	0.1	1031510	328.9	0.1	838785
19 Scrotum	7661.4	0.2	298794	7661.4	0.2	298794
20 Groin	7661.4	0.0	3340362	7661.4	0.0	3340362
21 Axillae	1272.3	0.1	940254	7661.4	0.0	5661761
22 Popliteal Space	404.5	0.1	301767	328.9	0.1	245386
23 Elbowfold	1380.0	0.0	1029481	327.7	0.1	244484
		5.9				6.6
	Overall PF:		1364.0			1235.5
	Systemic MRED:		13639.9			12355.0
	Localized MRED:		123663			244484

Kappler Model 42583 Suit MIST Test 1 Data Acquisition System Data

	Time	Chamber 1 Conc mg/m ³	Chamber 2 Conc mg/m ³	Chamber Avg Conc mg/m ³	Clean Room Conc mg/m ³
	16:45:07	73.3	73.9	73.6	0.0003
	16:46:07	70.4	70.5	70.4	0.0003
	16:47:07	67.3	67.4	67.3	0.0001
	16:48:07	64.4	64.7	64.5	0.0002
	16:49:07	61.7	61.4	61.6	0.0004
	16:50:07	58.3	58.7	58.5	0.0002
	16:51:07	55.3	57.0	56.2	0.0000
	16:52:07	52.9	57.4	55.2	0.0000
	16:53:07	52.4	64.9	58.6	0.0003
	16:54:07	54.9	71.4	63.1	0.0004
Start Pair 1	16:55:07	59.1	76.9	68.0	0.0001
	16:56:07	64.2	85.0	74.6	0.0000
	16:57:07	70.2	86.8	78.5	0.0004
	16:58:07	74.7	88.7	81.7	0.0004
	16:59:07	77.7	87.7	82.7	0.0001
Pair 1 Enters Chamber	17:00:07	78.9	84.7	81.8	0.0000
	17:01:07	78.9	82.4	80.6	0.0004
Start Pair 2	17:02:07	77.5	79.3	78.4	0.0003
	17:03:07	75.2	75.6	75.4	0.0002
	17:04:07	72.8	72.7	72.8	0.0003
	17:05:07	70.3	69.9	70.1	0.0002
	17:06:07	67.0	66.9	67.0	0.0002
Pair 2 Enters Chamber	17:07:07	63.9	63.9	63.9	0.0002
	17:08:07	60.4	60.9	60.6	0.0000
	17:09:07	57.3	58.0	57.7	0.0002
	17:10:07	54.3	55.3	54.8	0.0003
	17:11:07	50.8	53.0	51.9	0.0003
	17:12:07	48.6	52.3	50.5	0.0002
	17:13:07	47.2	55.5	51.3	0.0004
	17:14:07	47.8	59.3	53.6	0.0004
	17:15:07	50.1	67.7	58.9	0.0003
	17:16:07	56.0	76.6	66.3	0.0000
	17:17:07	62.3	79.6	70.9	0.0002
	17:18:07	67.5	83.2	75.4	0.0003
	17:19:07	71.0	82.3	76.6	0.0002
	17:20:07	72.4	80.2	76.3	0.0000
	17:21:07	72.5	78.2	75.4	0.0003
	17:22:07	71.9	75.5	73.7	0.0003
	17:23:07	69.8	72.7	71.3	0.0002
	17:24:07	67.9	69.7	68.8	0.0003
	17:25:07	65.4	67.2	66.3	0.0003
	17:26:07	62.8	64.3	63.6	0.0004

Kappler Model 42583 Suit MIST Test 1 Data Acquisition System Data (continued)

	Time	Chamber 1 Conc mg/m ³	Chamber 2 Conc mg/m ³	Chamber Avg Conc mg/m ³	Clean Room Conc mg/m ³
	17:27:07	59.9	61.5	60.7	0.0000
	17:28:07	57.3	59.0	58.1	0.0000
	17:29:07	54.5	56.3	55.4	0.0002
Pair 1 Exits	17:30:07	51.9	54.6	53.2	0.0002
Chamber	17:31:07	49.9	54.7	52.3	0.0002
	17:32:07	48.7	58.6	53.6	0.0001
	17:33:07	51.0	67.9	59.4	0.0002
	17:34:07	56.0	73.1	64.5	0.0003
Pair 1 Doffs	17:35:07	61.0	81.5	71.2	0.0002
	17:36:07	67.6	86.9	77.2	0.0000
Pair 2 Exits	17:37:07	73.3	90.3	81.8	0.0003
Chamber	17:38:07	78.5	100.9	89.7	0.0004
	17:39:07	85.9	108.8	97.3	0.0000
	17:40:07	97.0	104.9	101.0	0.0001
	17:41:07	100.3	73.0	86.6	0.0002
Pair 2 Doffs	17:42:07	81.6	47.5	64.6	0.0003
	17:43:07	57.5	33.4	45.4	0.0001
	17:44:07	37.8	24.8	31.3	0.0002
All out of	17:45:07	24.9	19.5	22.2	0.0004
Doff Room	17:46:07	16.8	16.0	16.4	0.0003
	17:47:07	11.7	13.9	12.8	0.0002
	17:48:07	8.5	12.4	10.5	0.0002
	17:49:07	6.8	12.1	9.5	0.0003
	17:50:07	6.2	12.6	9.4	0.0002
	17:51:07	5.9	13.3	9.6	0.0001
	17:52:07	6.5	13.9	10.2	0.0000
	17:53:07	7.0	14.3	10.7	0.0003
	17:54:07	7.6	15.0	11.3	0.0003
	17:55:07	7.8	15.1	11.5	0.0004
	17:56:07	8.4	15.5	11.9	0.0003
	17:57:07	8.7	15.8	12.2	0.0002
	17:58:07	9.3	16.3	12.8	0.0003
	17:59:07	9.3	16.4	12.8	0.0004
All Samples	18:00:07	9.9	16.5	13.2	0.0000
Finished	18:01:07	10.3	16.7	13.5	0.0002

Kappler Model 42583 Suit MIST Test 2 18 August 97

Suit 5 Medium

Sample Location	Tube	Flow (L/min)	Total (min)	Mass (µg)	MS Conc (mg/m ³)	Dosage mg-min/m ³	PF
1 Back	CHL2	0.0146	30.00	0.081	BBL	BBL	7674.4
2 Chest	CH27	0.0146	30.00	0.121	BBL	BBL	7674.4
3 Chest	C5	0.0146	30.00	0.131	BBL	BBL	7674.4
4 Chest	C8	0.0146	30.00	0.199	0.1269	3.807	514.3
5 Buttocks	C13	0.0146	30.00	0.131	BBL	BBL	7674.4
6 Axillae	C16	0.0146	30.00	0.075	BBL	BBL	7674.4
7 Upper Arm	CA1	0.0146	30.00	0.195	0.1172	3.516	556.8
8 Lower Arm	CA3	0.0146	30.00	0.126	BBL	BBL	7674.4
9 Crotch	CA6	0.0146	30.00	0.190	0.1046	3.137	624.2
10 Thigh	*N	0.0146	30.00	0.132	BBL	BBL	7674.4
11 Lower Leg	*H	0.0146	30.00	0.134	BBL	BBL	7674.4
12 Neck	*1	0.0146	30.00	0.137	BBL	BBL	7674.4
Overall:							1748.45

Suit 6 Small

Sample Location	Tube	Flow (L/min)	Total (min)	Mass (µg)	MS Conc (mg/m ³)	Dosage mg-min/m ³	PF
1 Back	R12	0.0146	30.00	0.249	0.2391	7.173	273.0
2 Chest	R15	0.0146	30.00	0.207	0.1430	4.290	456.4
3 Chest	R20	0.0146	30.00	0.127	BBL	BBL	7674.4
4 Chest	R22	0.0146	30.00	0.236	0.2110	6.331	309.3
5 Buttocks	R24	0.0146	30.00	0.193	0.1126	3.379	579.4
6 Axillae	T2	0.0146	30.00	0.096	BBL	BBL	7674.4
7 Upper Arm	T3	0.0146	30.00	0.099	BBL	BBL	7674.4
8 Lower Arm	T44	0.0146	30.00	0.146	BBL	BBL	7674.4
9 Crotch	ST2	0.0146	30.00	0.262	0.2696	8.089	242.1
10 Thigh	6	0.0146	30.00	0.148	BBL	BBL	7674.4
11 Lower Leg	N15	0.0146	30.00	0.502	0.8183	24.549	79.8
12 Neck	A3	0.0146	30.00	0.074	BBL	BBL	7674.4
Overall:							393.04
Patch BK	B3			0.1237	Avg ug:	0.1439	
Patch BK	B4			0.1550	St Dev:	0.01430	
Patch BK	?			0.1529			

	# Mins	Avg Conc	Dosage	Avg Temp
Data Acquisition Data	30.00	63.16	1958	68.84

Minimum detectable mass = stnd dev = 0.00360
 Minimum Detectable Conc = 0.00823
 Maximum PF = 7674
 Overall Suit A PF: 1748.45
 Overall Suit B PF: 393.04

Suit 7 Small

Sample	Flow	Total	Mass	MS Conc	Dosage	PF	
<u>Location</u>	<u>Tube</u>	<u>(L/min)</u>	<u>(min)</u>	<u>(µg)</u>	<u>(mg/m³)</u>	<u>mg-min/m³</u>	<u>PF</u>
1 Back	HL1	0.0146	30.00	0.112	BBL	BBL	7416.1
2 Chest	HL2	0.0146	30.00	0.139	BBL	BBL	7416.1
3 Chest	H1	0.0146	30.00	0.555	0.9390	28.170	67.2
4 Chest	H2	0.0146	30.00	0.424	0.6386	19.157	98.8
5 Buttocks	H4A	0.0146	30.00	0.123	BBL	BBL	7416.1
6 Axillae	H07	0.0146	30.00	0.111	BBL	BBL	7416.1
7 Upper Arm	H08	0.0146	30.00	0.138	BBL	BBL	7416.1
8 Lower Arm	H8	0.0146	30.00	0.209	0.1492	4.475	422.8
9 Crotch	H9	0.0146	30.00	0.142	BBL	BBL	7416.1
10 Thigh	H10	0.0146	30.00	0.140	BBL	BBL	7416.1
11 Lower Leg	H11	0.0146	30.00	0.224	0.1838	5.514	343.1
12 Neck	H14	0.0146	30.00	0.127	BBL	BBL	7416.1
						Overall:	2123.63

Suit 8 Medium

Sample	Flow	Total	Mass	MS Conc	Dosage	PF	
<u>Location</u>	<u>Tube</u>	<u>(L/min)</u>	<u>(min)</u>	<u>(µg)</u>	<u>(mg/m³)</u>	<u>mg-min/m³</u>	<u>PF</u>
1 Back	CH2	0.0146	30.00	0.119	BBL	BBL	7416.1
2 Chest	CH3	0.0146	30.00	0.132	BBL	BBL	7416.1
3 Chest	CH3A	0.0146	30.00	0.073	BBL	BBL	7416.1
4 Chest	CH4	0.0146	30.00	0.111	BBL	BBL	7416.1
5 Buttocks	CH5	0.0146	30.00	0.106	BBL	BBL	7416.1
6 Axillae	CH6	0.0146	30.00	0.220	0.1742	5.225	362.1
7 Upper Arm	CH7	0.0146	30.00	0.146	BBL	BBL	7416.1
8 Lower Arm	CH8	0.0146	30.00	0.160	0.0378	1.134	1668.2
9 Crotch	CH9	0.0146	30.00	0.153	BBL	BBL	7416.1
10 Thigh	CH12	0.0146	30.00	0.273	0.2937	8.810	214.8
11 Lower Leg	CH13	0.0146	30.00	0.118	BBL	BBL	7416.1
12 Neck	CH14	0.0146	30.00	0.148	BBL	BBL	7416.1
						Overall:	1583.80
Patch BK	B3			0.1237	Avg ug:	0.1439	
Patch BK	B4			0.1550	St Dev:	0.01430	
Patch BK	?			0.1529			

	# Mins	Avg Conc	Dosage	Avg Temp
Data Acquisition Data	30.00	61.04	1892.10	68.84

Minimum detectable mass = stnd dev = 0.00360
 Minimum Detectable Conc = 0.00823
 Maximum PF = 7416
 Overall Suit A PF: 2123.63
 Overall Suit B PF: 1583.80

<u>Skin Area Region</u>	Suit 5 Values Medium Size			Suit 6 Values Small Size		
	<u>PF</u>	<u>A</u> <u>(D*PF)</u>	<u>Localized</u> <u>Exposure</u> <u>mg-min/m³</u>	<u>PF</u>	<u>A</u> <u>(D*PF)</u>	<u>Localized</u> <u>Exposure</u> <u>mg-min/m³</u>
1 Chin & Neck	7674.4	0.1	989993	7674.4	0.1	989993
2 Ears	7674.4	0.0	1258596	7674.4	0.0	1258596
3 Cheeks & Neck	7674.4	0.0	1312316	7674.4	0.0	1312316
4 Nape	7674.4	0.0	4712060	7674.4	0.0	4712060
5 Scalp	7674.4	0.1	2079753	7674.4	0.1	2079753
6 Abdomen	6481.0	0.2	5158897	5243.9	0.2	4174115
7 Back	7674.4	0.1	7259949	426.2	2.2	403170
8 Buttocks	7674.4	0.0	11672709	579.4	0.4	881243
9 Arms (lower, volar)	7674.4	0.0	7674365	7674.4	0.0	7674365
10 Arms (upper, volar)	556.8	0.3	556813	7674.4	0.0	7674365
11 Elbows (back)	556.8	0.0	447678	7674.4	0.0	6170189
12 Arms (lower, dorsum)	7674.4	0.0	18004060	7674.4	0.0	18004060
13 Arms (upper, dorsum)	556.8	0.2	1306284	7674.4	0.0	18004060
14 Legs (plantar, lower)	7674.4	0.0	7674365	79.8	4.2	79760
15 Legs (plantar, upper)	7674.4	0.0	11672709	7674.4	0.0	11672709
16 Legs (dorsum, lower)	7674.4	0.0	18004060	79.8	3.6	187117
17 Legs (dorsum, upper)	7674.4	0.1	18004060	7674.4	0.1	18004060
18 Knees (front)	7674.4	0.0	19569630	79.8	0.4	203388
19 Scrotum	624.2	2.9	24342	242.1	7.5	9440
20 Groin	624.2	0.4	272136	242.1	1.0	105536
21 Axillae	7674.4	0.0	5671356	7674.4	0.0	5671356
22 Popliteal Space	7674.4	0.0	5725076	79.8	0.6	59501
23 Elbowfold	7674.4	0.0	5725076	7674.4	0.0	5725076
		4.6			20.6	
	Overall PF:		1748.4			393.0
	Systemic MRED:		17484.5			3930.4
	Localized MRED:		24342			9440

Skin Area Region	Suit 7 Values Small Size			Suit 8 Values Medium Size		
	PF	A (D*PF)	Localized Exposure mg-min/m ³	PF	A (D*PF)	Localized Exposure mg-min/m ³
1 Chin & Neck	7416.1	0.1	956673	7416.1	0.1	956673
2 Ears	7416.1	0.0	1216236	7416.1	0.0	1216236
3 Cheeks & Neck	7416.1	0.0	1268148	7416.1	0.0	1268148
4 Nape	7416.1	0.0	4553467	7416.1	0.0	4553467
5 Scalp	7416.1	0.1	2009755	7416.1	0.1	2009755
6 Abdomen	4971.7	0.3	3957476	3889.1	0.3	3095712
7 Back	7416.1	0.1	7015603	7416.1	0.1	7015603
8 Buttocks	7416.1	0.0	11279843	7416.1	0.0	11279843
9 Arms (lower, volar)	422.8	0.4	422848	1668.2	0.1	1668156
10 Arms (upper, volar)	7416.1	0.0	7416070	7416.1	0.0	7416070
11 Elbows (back)	7416.1	0.0	5962521	7416.1	0.0	5962521
12 Arms (lower, dorsum)	422.8	0.3	992001	1668.2	0.1	3913494
13 Arms (upper, dorsum)	7416.1	0.0	17398101	7416.1	0.0	17398101
14 Legs (plantar, lower)	343.1	1.0	343121	7416.1	0.0	7416070
15 Legs (plantar, upper)	7416.1	0.0	11279843	214.8	1.6	326651
16 Legs (dorsum, lower)	343.1	0.8	804962	7416.1	0.0	17398101
17 Legs (dorsum, upper)	7416.1	0.1	17398101	214.8	2.0	503828
18 Knees (front)	343.1	0.1	874958	7416.1	0.0	18910979
19 Scrotum	7416.1	0.2	289227	7416.1	0.2	289227
20 Groin	7416.1	0.0	3233407	7416.1	0.0	3233407
21 Axillae	7416.1	0.0	5480476	362.1	0.3	267592
22 Popliteal Space	343.1	0.1	255968	7416.1	0.0	5532388
23 Elbowfold	422.8	0.1	315445	1668.2	0.0	1244444
		3.8			5.1	
Overall PF:			2123.6			1583.8
Systemic MRED:			21236.3			15838.0
Localized MRED:			255968			267592

Kappler Model 42583 Suit MIST Test 2 Data Acquisition System Data

	<u>Time</u>	<u>Chamber 1 Conc mg/m³</u>	<u>Chamber 2 Conc mg/m³</u>	<u>Chamber Avg Conc mg/m³</u>	<u>Clean Room Conc mg/m³</u>
Start Pair 1	16:40:55	62.3	60.4	61.4	0
	16:41:55	58.7	56.7	57.7	0
	16:42:55	54.8	53.6	54.2	0.0001
	16:43:56	51.2	50.3	50.8	0
	16:44:56	47.6	48.8	48.2	0
	16:45:55	47.5	55.4	51.5	0.0001
	16:46:55	55.1	71.6	63.4	0.0001
	16:47:56	66.1	83.2	74.7	0
Pair 1 Enters Chamber	16:48:56	73.8	85.7	79.8	0
	16:49:56	78.2	84.3	81.3	0
Start Pair 2	16:50:56	79	81.1	80.1	0
	16:51:56	78.2	77	77.6	0
	16:52:56	76	72.7	74.4	0
	16:53:56	72.4	68.8	70.6	0.0002
	16:54:55	68.6	64.6	66.6	0
	16:55:56	64.5	60.8	62.7	0
	16:56:55	60.2	57.3	58.8	0
	16:57:55	56.1	54.1	55.1	0.0001
	16:58:56	52.5	50.9	51.7	0
	16:59:55	48.9	47.8	48.4	0
	17:00:56	45.4	47.6	46.5	0
	17:01:56	47.2	55.7	51.5	0.0001
	17:02:56	53.4	66.9	60.2	0
	17:03:55	59.4	71.4	65.4	0
	17:04:55	63.9	71.3	67.6	0
	Pair 2 Enters Chamber	17:05:56	65.7	70.2	68.0
17:06:55		65.3	67	66.2	0
17:07:56		63.4	63.3	63.4	0.0001
17:08:56		60.8	59.9	60.4	0
17:09:56		57.9	56.3	57.1	0
17:10:56		54.3	53.1	53.7	0
17:11:55		50.4	49.8	50.1	0
17:12:56		47.4	48.3	47.9	0
17:13:56		47.4	56.3	51.9	0
17:14:56		54.4	68.3	61.4	0.0001
Pair 1 Exits Chamber	17:15:56	61.8	74.7	68.3	0
	17:16:56	67	75.3	71.2	0.0001
	17:17:55	68.9	73.4	71.2	0.0001
	17:18:56	69.3	70.4	69.9	0
	17:19:56	67.1	66.7	66.9	0.0001
	17:20:55	64.2	63	63.6	-0.0001

Kappler Model 42583 Suit MIST Test 2 Data Acquisition System Data (continued)

	<u>Time</u>	<u>Chamber 1 Conc mg/m³</u>	<u>Chamber 2 Conc mg/m³</u>	<u>Chamber Avg Conc mg/m³</u>	<u>Clean Room Conc mg/m³</u>
	17:21:56	60.7	59.6	60.2	0.0001
	17:22:55	57.4	56	56.7	0
Pair 1 Doffs	17:23:56	53.8	52.6	53.2	0
	17:24:56	50.3	49.9	50.1	0
	17:25:55	48.1	50.9	49.5	0
	17:26:56	50.5	59.8	55.2	0
	17:27:56	57.2	70.6	63.9	0
	17:28:56	63.6	73.7	68.7	0
	17:29:56	66.6	73.4	70.0	0
	17:30:55	68.1	70.9	69.5	0
	17:31:56	66.7	67.4	67.1	0
	17:32:56	64.9	64	64.5	0
	17:33:55	61.9	60.7	61.3	0
	17:34:56	58.3	57.1	57.7	0
Pair 2 Exits	17:35:55	54.6	53.6	54.1	0
Chamber	17:36:56	51.3	50.5	50.9	0
	17:37:55	47.7	47.7	47.7	0.0001
	17:38:56	45.7	40.3	43.0	0.0001
	17:39:55	40.6	25.4	33.0	0.0001
Pair 2 Doffs	17:40:55	30	17.1	23.6	0
	17:41:55	19.4	12.8	16.1	0
	17:42:56	13.2	10.3	11.8	0
All out of	17:43:55	8.3	8.6	8.5	0.0001
Doff Room	17:44:56	5.5	7.7	6.6	0
	17:45:56	4.3	7.2	5.8	0
	17:46:55	3.1	7	5.1	0.0001
	17:47:55	2.5	6.7	4.6	0
	17:48:56	1.7	6.5	4.1	0
	17:49:56	1.4	6.9	4.2	0
	17:50:55	2	7.5	4.8	0
	17:51:55	2	7.8	4.9	0
	17:52:56	2.3	8.2	5.3	0
	17:53:55	2.4	8.3	5.4	0
	17:54:55	3	8.6	5.8	0
	17:55:55	3.1	8.6	5.9	0
	17:56:56	3.2	8.7	6.0	0
	17:57:56	3.3	8.7	6.0	0
	17:58:55	3.7	8.9	6.3	0.0001
All Samples	17:59:55	3.4	8.7	6.1	0
Finished	18:00:56	3.5	8.6	6.1	0

Suit 9 Medium

Sample Location	Tube	Flow (L/min)	Total (min)	Mass (µg)	MS Conc (mg/m ³)	Dosage mg-min/m ³	PF
1 Back	C1	0.0146	30.00	0.156	0.0678	2.033	892.2
2 Chest	C3	0.0146	30.00	0.109	BBL	BBL	7344.7
3 Chest	C9	0.0146	30.00	0.095	BBL	BBL	7344.7
4 Chest	C11	0.0146	30.00	0.086	BBL	BBL	7344.7
5 Buttocks	C14	0.0146	30.00	0.076	BBL	BBL	7344.7
6 Axillae	C15	0.0146	30.00	0.108	BBL	BBL	7344.7
7 Upper Arm	C16	0.0146	30.00	0.102	BBL	BBL	7344.7
8 Lower Arm	CH2	0.0146	30.00	0.050	BBL	BBL	7344.7
9 Crotch	CHL2	0.0146	30.00	0.154	0.0625	1.874	967.5
10 Thigh	CH28	0.0146	30.00	0.129	BBL	BBL	7344.7
11 Lower Leg	CA2	0.0146	30.00	0.034	BBL	BBL	7344.7
12 Neck	CA10	0.0146	30.00	0.028	BBL	BBL	7344.7
Overall:							2648.17

Suit 10 Small

Sample Location	Tube	Flow (L/min)	Total (min)	Mass (µg)	MS Conc (mg/m ³)	Dosage mg-min/m ³	PF
1 Back	R2	0.0146	30.00	0.105	BBL	BBL	7344.7
2 Chest	R3	0.0146	30.00	0.043	BBL	BBL	7344.7
3 Chest	R6	0.0146	30.00	0.103	BBL	BBL	7344.7
4 Chest	R11	0.0146	30.00	0.034	BBL	BBL	7344.7
5 Buttocks	R13	0.0146	30.00	0.176	0.1131	3.394	534.4
6 Axillae	R17	0.0146	30.00	0.079	BBL	BBL	7344.7
7 Upper Arm	R21	0.0146	30.00	0.064	BBL	BBL	7344.7
8 Lower Arm	R23	0.0146	30.00	0.165	0.0885	2.655	683.1
9 Crotch	B3	0.0146	30.00	0.301	0.3990	11.970	151.5
10 Thigh	H1	0.0146	30.00	0.102	BBL	BBL	7344.7
11 Lower Leg	2	0.0146	30.00	0.038	BBL	BBL	7344.7
12 Neck	7	0.0146	30.00	0.001	BBL	BBL	7344.7
Overall:							527.29

Patch BK 370 0.1249 Avg ug: 0.1267
 Patch BK SH8 0.1243 St Dev: 0.00294
 Patch BK HHH 0.1308

Mins Avg Conc Dosage Avg Temp
 Data Acquisition Data 30.00 60.45 1813.45 68.80

Minimum detectable mass = stnd dev = 0.00360
 Minimum Detectable Conc = 0.00823
 Maximum PF = 7345
 Overall Suit A PF: 2648.17
 Overall Suit B PF: 527.29

Skin Area Region	Suit 9 Values Medium Size			Suit 10 Values Small Size		
	PF	A (D*PF)	Localized Exposure mg-min/m ³	PF	A (D*PF)	Localized Exposure mg-min/m ³
1 Chin & Neck	7344.7	0.1	947470	7344.7	0.1	947470
2 Ears	7344.7	0.0	1204536	7344.7	0.0	1204536
3 Cheeks & Neck	7344.7	0.0	1255949	7344.7	0.0	1255949
4 Nape	7344.7	0.0	4509664	7344.7	0.0	4509664
5 Scalp	7344.7	0.1	1990422	7344.7	0.1	1990422
6 Abdomen	7344.7	0.2	5846404	7344.7	0.2	5846404
7 Back	4118.4	0.2	3896049	3939.6	0.2	3726815
8 Buttocks	7344.7	0.0	11171333	534.4	0.4	812780
9 Arms (lower, volar)	7344.7	0.0	7344729	683.1	0.3	683144
10 Arms (upper, volar)	7344.7	0.0	7344729	7344.7	0.0	7344729
11 Elbows (back)	7344.7	0.0	5905162	7344.7	0.0	5905162
12 Arms (lower, dorsum)	7344.7	0.0	17230734	683.1	0.2	1602655
13 Arms (upper, dorsum)	7344.7	0.0	17230734	7344.7	0.0	17230734
14 Legs (plantar, lower)	7344.7	0.0	7344729	7344.7	0.0	7344729
15 Legs (plantar, upper)	7344.7	0.0	11171333	7344.7	0.0	11171333
16 Legs (dorsum, lower)	7344.7	0.0	17230734	7344.7	0.0	17230734
17 Legs (dorsum, upper)	7344.7	0.1	17230734	7344.7	0.1	17230734
18 Knees (front)	7344.7	0.0	18729059	7344.7	0.0	18729059
19 Scrotum	967.5	1.9	37731	151.5	12.0	5908
20 Groin	967.5	0.3	421816	151.5	1.6	66052
21 Axillae	7344.7	0.0	5427755	7344.7	0.0	5427755
22 Popliteal Space	7344.7	0.0	5479168	7344.7	0.0	5479168
23 Elbowfold	7344.7	0.0	5479168	683.1	0.0	509625
		3.1			15.4	
Overall PF:			2648.2			527.3
Systemic MRED:			26481.7			5272.9
Localized MRED:			37731			5908

Kappler Model 42583 Suit MIST Test 3 Data Acquisition System Data

	<u>Time</u>	<u>Chamber 1 Conc mg/m³</u>	<u>Chamber 2 Conc mg/m³</u>	<u>Chamber Avg Conc mg/m³</u>	<u>Clean Room Conc mg/m³</u>
Start Pair 1	16:37:19	67.3	69.8	68.6	0
Pair 1 Enters	16:38:17	67.8	67.4	67.6	0
Chamber	16:39:16	66.6	64.2	65.4	0.0001
	16:40:17	64.7	60.8	62.8	0
	16:41:16	62	57.2	59.6	0
	16:42:16	58.4	53.6	56.0	0
	16:43:16	55	50.5	52.8	0
	16:44:16	51.4	47.5	49.5	0
	16:45:16	48.8	47.2	48.0	0
	16:46:16	49.1	54.2	51.7	0
	16:47:16	55	65.3	60.2	0
	16:48:17	61.6	70	65.8	0
	16:49:17	66.4	70.6	68.5	0
	16:50:16	67.7	68.8	68.3	0
	16:51:16	67.5	66.2	66.9	0
	16:52:16	65.6	62.7	64.2	0
	16:53:17	63.4	59	61.2	0.0001
	16:54:16	60.1	55.7	57.9	0
	16:55:16	56.6	52.3	54.5	0
	16:56:17	53	49.3	51.2	0
	16:57:17	50.3	47.1	48.7	0
	16:58:16	49.2	51	50.1	0
	16:59:16	52.7	60.8	56.8	0
	17:00:17	59.5	68.5	64.0	0
	17:01:16	64.9	71.4	68.2	0.0001
	17:02:16	67.5	70.5	69.0	0
	17:03:16	68	67.8	67.9	0
	17:04:16	67.1	64.5	65.8	0
	17:05:17	64.8	61.3	63.1	0.0001
	17:06:16	62	57.7	59.9	0
Pair 1 Exits	17:07:17	58.5	54.3	56.4	0
Chamber	17:08:16	55	51	53.0	0
	17:09:17	51.6	48.2	49.9	0.0002
	17:10:17	48.6	45.3	47.0	0
	17:11:17	45.4	42.8	44.1	0
Pair 1 Doffs	17:12:17	42.5	40.2	41.4	0
	17:13:17	40	38.2	39.1	0
	17:14:16	37.5	36.3	36.9	0.0001
All out of	17:15:17	35.2	34.1	34.7	0
Doff Room	17:16:17	32.6	31.7	32.2	0
	17:17:17	30.8	20.1	25.5	0

Kappler Model 42583 Suit MIST Test 3 Data Acquisition System Data (continued)

	Time	Chamber 1 Conc mg/m ³	Chamber 2 Conc mg/m ³	Chamber Avg Conc mg/m ³	Clean Room Conc mg/m ³
	17:18:16	24.3	13.2	18.8	0
	17:19:17	17	9.1	13.1	0
	17:20:17	11.9	7.4	9.7	0
	17:21:16	8.8	6.5	7.7	0.0001
	17:22:16	6.8	6	6.4	0.0001
	17:23:17	5.1	5.6	5.4	0
	17:24:16	4.6	6	5.3	0
	17:25:17	4.7	6.6	5.7	0.0001
	17:26:16	4.8	7	5.9	0
	17:27:16	4.8	7	5.9	0
	17:28:16	5	7.3	6.2	0
All Samples	17:29:17	5.4	7.6	6.5	0
Finished	17:30:16	5.5	7.7	6.6	0

Kappler Model 42583 Suit MIST Test 4 21 August 97

Sample		Flow	Total	Mass	MS Conc	Dosage	PF
Location	Tube	(L/min)	(min)	(μg)	(mg/m^3)	$\text{mg}\cdot\text{min}/\text{m}^3$	
1 Back	CH1	0.0146	30.00	0.138	0.0730	2.190	839.0
2 Chest	CH4	0.0146	30.00	0.110	0.0109	0.328	5607.9
3 Chest	CH5	0.0146	30.00	0.251	0.3317	9.952	184.6
4 Chest	CH5A	0.0146	30.00	0.135	0.0663	1.989	923.6
5 Buttocks	CH7	0.0146	30.00	0.131	0.0590	1.769	1038.4
6 Axillae	CH8	0.0146	30.00	0.236	0.2975	8.924	205.9
7 Upper Arm	CH15	0.0146	30.00	0.087	BBL	BBL	7201.3
8 Lower Arm	CH26	0.0146	30.00	0.175	0.1576	4.729	388.5
9 Crotch	CHL2	0.0146	30.00	0.120	0.0331	0.994	1848.3
10 Thigh	C5	0.0146	30.00	0.114	0.0186	0.558	3294.1
11 Lower Leg	ST3	0.0146	30.00	0.110	0.0100	0.301	6105.7
12 Neck	ST11	0.0146	30.00	0.161	0.1256	3.769	487.4
Overall:							1024.50

Sample		Flow	Total	Mass	MS Conc	Dosage	PF
Location	Tube	(L/min)	(min)	(μg)	(mg/m^3)	$\text{mg}\cdot\text{min}/\text{m}^3$	
1 Back	1	0.0146	30.00	0.147	0.0943	2.830	649.3
2 Chest	4	0.0146	30.00	0.114	0.0190	0.569	3226.7
3 Chest	5	0.0146	30.00	0.107	BBL	BBL	7201.3
4 Chest	11	0.0146	30.00	0.142	0.0832	2.497	735.7
5 Buttocks	*H	0.0146	30.00	0.122	0.0382	1.147	1602.1
6 Axillae	H3	0.0146	30.00	0.125	0.0433	1.299	1414.5
7 Upper Arm	H7	0.0146	30.00	0.129	0.0528	1.585	1159.1
8 Lower Arm	H09	0.0146	30.00	0.129	0.0531	1.592	1154.1
9 Crotch	H12	0.0146	30.00	0.124	0.0429	1.287	1427.3
10 Thigh	H16	0.0146	30.00	0.128	0.0519	1.558	1179.4
11 Lower Leg	H18	0.0146	30.00	0.119	0.0300	0.900	2040.9
12 Neck	H19	0.0146	30.00	0.120	0.0333	0.998	1840.7
Overall:							1532.59
Patch BK	T1			0.1045	Avg ug:	0.1056	
Patch BK	T2			0.1092	St Dev:	0.00260	
Patch BK	B2			0.1031			

	# Mins	Avg Conc	Dosage	Avg Temp
Data Acquisition Data	30.00	59.27	1837.3	66.23

Minimum detectable mass = stnd dev = 0.00360
 Minimum Detectable Conc = 0.00823
 Maximum PF = 7201
 Overall Suit A PF: 1024.50
 Overall Suit B PF: 1532.59

Sample		Flow	Total	Mass	MS Conc	Dosage	PF
Location	Tube	(L/min)	(min)	(μg)	(mg/m^3)	$\text{mg}\cdot\text{min}/\text{m}^3$	
1 Back	CA1	0.0146	30.00	0.109	0.0072	0.215	8688.2
2 Chest	CA3	0.0146	30.00	0.101	BBL	BBL	7308.3
3 Chest	CA7	0.0146	30.00	0.115	0.0211	0.634	2942.0
4 Chest	N*	0.0146	30.00	0.104	BBL	BBL	7308.3
5 Buttocks	N2	0.0146	30.00	0.112	0.0154	0.461	4049.1
6 Axillae	N4	0.0146	30.00	0.118	0.0281	0.844	2209.1
7 Upper Arm	N12	0.0146	30.00	0.181	0.1729	5.187	359.5
8 Lower Arm	N14	0.0146	30.00	0.152	0.1061	3.183	585.8
9 Crotch	B3	0.0146	30.00	0.105	BBL	BBL	7308.3
10 Thigh	B4	0.0146	30.00	0.119	0.0300	0.901	2069.7
11 Lower Leg	B5	0.0146	30.00	0.125	0.0444	1.331	1400.8
12 Neck	R8	0.0146	30.00	0.119	0.0312	0.937	1991.0
Overall:							2137.13

Sample		Flow	Total	Mass	MS Conc	Dosage	PF
Location	Tube	(L/min)	(min)	(μg)	(mg/m^3)	$\text{mg}\cdot\text{min}/\text{m}^3$	
1 Back	A6	0.0146	30.00	0.152	0.1068	3.205	581.8
2 Chest	A7	0.0146	30.00	0.107	BBL	BBL	7308.3
3 Chest	A8	0.0146	30.00	0.113	0.0160	0.480	3881.6
4 Chest	A10	0.0146	30.00	0.109	0.0088	0.263	7101.7
5 Buttocks	X1	0.0146	30.00	0.112	0.0142	0.426	4381.4
6 Axillae	X2	0.0146	30.00	0.103	BBL	BBL	7308.3
7 Upper Arm	H8	0.0146	30.00	0.098	BBL	BBL	7308.3
8 Lower Arm	H9	0.0146	30.00	0.118	0.0286	0.859	2170.3
9 Crotch	H08	0.0146	30.00	0.094	BBL	BBL	7308.3
10 Thigh	H07	0.0146	30.00	0.108	0.0060	0.181	10298.8
11 Lower Leg	T44	0.0146	30.00	0.121	0.0355	1.065	1750.3
12 Neck	ST2	0.0146	30.00	0.114	0.0192	0.576	3235.7
Overall:							4022.21

Patch BK	T1		0.1045	Avg ug:	0.1056
Patch BK	T2		0.1092	St Dev:	0.00260
Patch BK	B2		0.1031		

	# Mins	Avg Conc	Dosage	Avg Temp
Data Acquisition Data	30.00	60.15	1864.60	66.23

Minimum detectable mass = stnd dev =	0.00360
Minimum Detectable Conc =	0.00823
Maximum PF =	7308
Overall Suit A PF:	2137.13
Overall Suit B PF:	4022.21

Skin Area Region	Suit 11 Values Large Size			Suit 12 Values Large Size		
	PF	A (D*PF)	Localized Exposure mg-min/m ³	PF	A (D*PF)	Localized Exposure mg-min/m ³
1 Chin & Neck	487.4	1.1	62878	1840.7	0.3	237445
2 Ears	487.4	0.2	79938	1840.7	0.1	301869
3 Cheeks & Neck	487.4	0.4	83350	1840.7	0.1	314753
4 Nape	487.4	0.1	299278	1840.7	0.0	1130166
5 Scalp	487.4	0.9	132092	1840.7	0.3	498819
6 Abdomen	1222.3	1.0	972948	2567.9	0.5	2044033
7 Back	938.7	1.0	887981	1125.7	0.9	1064913
8 Buttocks	1038.4	0.2	1579362	1602.1	0.1	2436802
9 Arms (lower, volar)	388.5	0.4	388518	1154.1	0.2	1154076
10 Arms (upper, volar)	7201.3	0.0	7201282	1159.1	0.2	1159063
11 Elbows (back)	7201.3	0.0	5789831	1159.1	0.0	931887
12 Arms (lower, dorsum)	388.5	0.3	911463	1154.1	0.1	2707463
13 Arms (upper, dorsum)	7201.3	0.0	16894208	1159.1	0.1	2719162
14 Legs (plantar, lower)	6105.7	0.1	6105747	2040.9	0.2	2040927
15 Legs (plantar, upper)	3294.1	0.1	5010256	1179.4	0.3	1793940
16 Legs (dorsum, lower)	6105.7	0.0	14324081	2040.9	0.1	4788014
17 Legs (dorsum, upper)	3294.1	0.1	7727851	1179.4	0.4	2766985
18 Knees (front)	6105.7	0.0	15569654	2040.9	0.0	5204363
19 Scrotum	1848.3	1.0	72083	1427.3	1.3	55666
20 Groin	1848.3	0.1	805846	1427.3	0.2	622323
21 Axillae	205.9	0.5	152144	1414.5	0.1	1045352
22 Popliteal Space	6105.7	0.0	4554887	2040.9	0.0	1522531
23 Elbowfold	388.5	0.1	289834	1154.1	0.0	860941
		7.9			5.3	
Overall PF:			1024.5			1532.6
Systemic MRED:			10245.0			15325.9
Localized MRED:			62878			55666

Skin Area Region	Suit 13 Values Medium Size			Suit 14 Values Medium Size		
	PF	A (D*PF)	Localized Exposure mg-min/m ³	PF	A (D*PF)	Localized Exposure mg-min/m ³
1 Chin & Neck	1991.0	0.3	256835	3235.7	0.2	417407
2 Ears	1991.0	0.1	326519	3235.7	0.0	530657
3 Cheeks & Neck	1991.0	0.1	340455	3235.7	0.1	553307
4 Nape	1991.0	0.0	1222454	3235.7	0.0	1986730
5 Scalp	1991.0	0.2	539552	3235.7	0.1	876879
6 Abdomen	4031.0	0.3	3208646	6702.7	0.2	5335384
7 Back	6368.6	0.2	6024743	2481.6	0.4	2347586
8 Buttocks	4049.1	0.1	6158616	4381.4	0.1	6664124
9 Arms (lower, volar)	585.8	0.3	585780	2170.3	0.1	2170329
10 Arms (upper, volar)	359.5	0.5	359508	7308.3	0.0	7308284
11 Elbows (back)	359.5	0.1	289045	7308.3	0.0	5875861
12 Arms (lower, dorsum)	585.8	0.2	1374240	2170.3	0.0	5091592
13 Arms (upper, dorsum)	359.5	0.3	843406	7308.3	0.0	17145235
14 Legs (plantar, lower)	1400.8	0.2	1400849	1750.3	0.2	1750310
15 Legs (plantar, upper)	2069.7	0.2	3147980	10298.8	0.0	15664474
16 Legs (dorsum, lower)	1400.8	0.2	3286391	1750.3	0.2	4106228
17 Legs (dorsum, upper)	2069.7	0.2	4855464	10298.8	0.0	24160984
18 Knees (front)	1400.8	0.0	3572164	1750.3	0.0	4463291
19 Scrotum	7308.3	0.2	285023	7308.3	0.2	285023
20 Groin	7308.3	0.0	3186412	7308.3	0.0	3186412
21 Axillae	2209.1	0.0	1632506	7308.3	0.0	5400822
22 Popliteal Space	1400.8	0.0	1045033	1750.3	0.0	1305732
23 Elbowfold	585.8	0.0	436992	2170.3	0.0	1619065
		3.8			2.0	
Overall PF:			2137.1			4022.2
Systemic MRED:			21371.3			40222.1
Localized MRED:			256835			285023

Kappler Model 42583 Suit MIST Test 4 Data Acquisition System Data

	<u>Time</u>	<u>Chamber 1 Conc mg/m³</u>	<u>Chamber 2 Conc mg/m³</u>	<u>Chamber Avg Conc mg/m³</u>	<u>Clean Room Conc mg/m³</u>
Start Pair 1	16:29:30	57.55	56.2	56.9	0
	16:30:30	54.65	53.4	54.0	0
	16:31:30	51.9	50.9	51.4	0
	16:32:30	49.05	48.2	48.6	0
	16:33:30	49.85	51.1	50.5	0
	16:34:30	56.7	60.8	58.8	0
	16:35:30	63.95	68.3	66.1	0.0001
	16:36:30	67.4	70.1	68.8	0
	16:37:30	68.15	69.5	68.8	0
	16:38:30	67.35	67.2	67.3	0
Pair 1 Enters Chamber	16:39:30	65.75	65	65.4	0
	16:40:30	62.6	61.3	62.0	0
	16:41:30	59.8	58.2	59.0	0
Start Pair 2	16:42:30	56.4	55	55.7	0
	16:43:30	53.75	52.3	53.0	0
	16:44:30	50.6	49.6	50.1	0
	16:45:30	48.9	48.8	48.9	0
	16:46:30	52.8	55.4	54.1	0
	16:47:30	60.45	64.7	62.6	0.0001
	16:48:30	66.1	70	68.1	0
	16:49:30	68	70.1	69.1	0
Pair 2 Enters Chamber	16:50:30	67.65	68.5	68.1	0
	16:51:30	66.5	66.2	66.4	0
	16:52:30	64	62.9	63.5	0
	16:53:30	60.95	59.5	60.2	0
	16:54:30	57.7	56.2	57.0	0
	16:55:30	54.9	53.5	54.2	0
	16:56:30	51.5	50.3	50.9	0
	16:57:30	49.1	48.7	48.9	0.0001
	16:58:30	51.15	53	52.1	0.0001
	16:59:30	58.65	63.1	60.9	0.0002
	17:00:30	64.35	68.4	66.4	0
	17:01:30	67.75	70.2	69.0	0
	17:02:30	68.1	69.2	68.7	0
	17:03:30	66.8	66.6	66.7	0
	17:04:30	64.65	63.8	64.2	0
	17:05:30	61.75	60.4	61.1	0
	17:06:30	58.65	57.4	58.0	0
	17:07:30	55.7	54.2	55.0	0.0001
	17:08:30	52.45	51.3	51.9	0

Kappler Model 42583 Suit MIST Test 4 Data Acquisition System Data (continued)

	<u>Time</u>	<u>Chamber 1 Conc mg/m³</u>	<u>Chamber 2 Conc mg/m³</u>	<u>Chamber Avg Conc mg/m³</u>	<u>Clean Room Conc mg/m³</u>
Pair 1 Exits	17:09:30	49.85	48.9	49.4	0
Chamber	17:10:30	49.9	50.6	50.3	0
	17:11:30	56.4	60.2	58.3	0
	17:12:30	63.65	68.7	66.2	0
	17:13:30	67.15	70.2	68.7	0
	17:14:30	68.45	70.1	69.3	0
Pair 1 Doffs	17:15:30	67.95	68.2	68.1	0.0001
	17:16:30	66	65.4	65.7	0
	17:17:30	63.05	61.9	62.5	0
	17:18:30	60.25	58.7	59.5	0
	17:19:30	56.8	55.7	56.3	0
Pair 2 Exits Chamber	17:20:30	52.85	51.9	52.4	0
	17:21:30	49.6	48.9	49.3	0
	17:22:30	44.85	41.3	43.1	0
	17:23:30	35.3	25.8	30.6	0.0001
Pair 2 Doffs	17:24:30	25.2	17.3	21.3	0
	17:25:30	17.5	12.6	15.1	0
	17:26:30	12.8	10.2	11.5	0
	17:27:30	10.15	9	9.6	0.0001
	17:28:30	8.35	8	8.2	0.0001
All out of Doff Room	17:29:30	7.2	7.4	7.3	0
	17:30:30	6.55	7.1	6.8	0
	17:31:30	6.3	7	6.7	0
	17:32:30	5.8	6.7	6.3	0
	17:33:30	5.55	6.5	6.0	0
	17:34:30	5.3	6.3	5.8	0
	17:35:30	5.3	6.4	5.9	0.0001
	17:36:30	5	6.1	5.6	0
	17:37:30	4.7	5.9	5.3	0
	17:38:30	4.65	5.8	5.2	0
	17:39:30	4.8	5.9	5.4	0
	17:40:30	4.35	5.6	5.0	0
	17:41:30	4.35	5.5	4.9	0
17:42:30	4.35	5.6	5.0	0	
17:43:30	4.4	5.6	5.0	0	
All Samples Finished	17:44:30	4.2	5.4	4.8	0
	17:45:30	4.15	5.4	4.8	0