Test Project No. 8-CO-410-000-065
WDTC Document No. WDTC-TR-02-072

FORMAL TEST REPORT FOR TACTICAL PERSONNEL BIOLOGICAL DECONTAMINATION VALIDATION

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AUGUST 2002

Period Covered: December 2001 to May 2002
Prepared for:
The Defense Threat Reduction Agency
Alexandria, VA 22310

U.S. Army Developmental Test Command
Aberdeen Proving Ground, MD 21005-5055

561720

DEPARTMENT OF THE ARMY
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REPLY TO
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18 August 2003

MEMORANDUM FOR Program Manager, The Defense Threat Reduction Agency, Special Operations Programs Branch, TDSF, Alexandria, VA 22310

SUBJECT: Formal Test Report for Tactical Personnel Biological Decontamination Validation, 8-CO-410-000-065

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REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 0704-0188*

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	August 2002	Formal Test Report December 20001 through May 2002

4. TITLE AND SUBTITLE
Formal Test Report for the Tactical Personnel Biological Decontamination Validation; Test Project No. 8-CO-410-000-065

5. FUNDING NUMBERS

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
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Dugway, UT 84022-5000

8. PERFORMING ORGANIZATION REPORT NUMBER
WDTC-TR-02-072

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Program Manager
The Defense Threat Reduction Agency
TDSF
6801 Telegraph Rd.
Alexandria, VA 22310

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
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12a. DISTRIBUTION/AVAILABILITY STATEMENT
Distribution authorized to U.S. Government agencies only; test and evaluation. All other requests for this document shall be referred to Program Manager, The Defense Threat Reduction Agency, TDSF, 6801 Telegraph Rd. Alexandria, VA 22310.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

During December 2001 and April 2002, the West Desert Test Center (WDTC) at U.S. Army Dugway Proving Ground (DPG), Utah, performed the Tactical Personnel Biological Decontamination Man-In-Simulant Test (MIST). Trials were conducted to evaluate and validate personnel decontamination methods in a biological warfare agent (BWA) environment. The first phase of this test developed the methodology to conduct biological MIST and personnel sampling for biological contamination. Phase two of testing determined the breakthrough level of biological warfare agent simulant on protective ensembles and compared the efficiency of two dress-down/ decontamination techniques using sodium hypochlorite. The results from these trials will provide operational decontamination methods for all forces in a biologically contaminated environment.

14. SUBJECT TERMS
Personnel decontamination; Man-In-Simulant Test; MIST; biological warfare; *Bacillus subtilis*, var. *niger*; *Bacillus globigii*; bleach; sodium hypochlorite; protective clothing; swab sampling

15. NUMBER OF PAGES
36

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAME AS REPORT

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SECTION 1. EXECUTIVE SUMMARY

1.1 SUMMARY

A man-in-simulant test (MIST) was conducted to evaluate and validate personnel decontamination methods in a biological warfare agent (BWA) environment. The first phase of this test developed the methodology to conduct biological MIST and personnel sampling for biological contamination. Phase two of testing determined the breakthrough level of biological warfare agent simulant on protective ensembles and compared the efficiency of two dress-down/ decontamination techniques using calcium hypochlorite. The results from these trials will provide operational decontamination methods for all forces in a biologically contaminated environment.

1.2 CONCLUSIONS

a. The procedures tested provide adequate decontamination for special warfare applications.

b. There was no appreciable difference between the two methods tested under the experimental conditions.

c. Methodology was developed to adequately contaminate and assay using particulate aerosol challenges during MIST.

1.3 RECOMMENDATIONS

Gross mitigation of the primary aerosol is recommended in a highly contaminated environment or during contact with a bulk biological hazard.

1.4 TEST OBJECTIVE

Use a BWA simulant, *Bacillus subtilis* var. *niger*, to validate personnel decontamination methods and obtain sufficient data to compare tactics, techniques, and procedures (TTPs) in a biological warfare environment.

1.5 TEST CONCEPT

1.5.1 Overview

A procedure for the decontamination of a chemically contaminated individual was developed and validated in August 1999 at WDTC/DPG (Reference 1). The chemical decontamination procedures validated were based on aggressive mitigation of gross liquid challenge and the surgical removal of personal protective clothing. The responses to liquid chemical threats and particulate BWA threats are significantly different. While the skin exposure to chemical agents is life threatening with an immediate physiological response, the immediate response of skin to most BWAs is not so acute. The exception is the T-2 mycotoxin that produces dermal activity; an individual contaminated with a T-2 mycotoxin would be treated using the same TTPs as a chemically contaminated individual. Therefore, biological decontamination requires an alternative approach to decontamination TTPs. The tactical biological decontamination procedures validated during this test will be available for use by all forces.

1.5.2 Assumptions

a. The end-users have determined that the full complement of tests described in the detailed test plan (DTP) (Reference 2) and in this report were required to address the requirements for validation of the personnel decontamination procedures.

b. Sample collection points were determined based on the most likely breakthrough points, as determined from the Naval Special Warfare Development Group (NSWDG) Chemical Protection MIST (Reference 1). Although dry biological agents and vaporous chemical agents behave differently, the least rugged points in the protective gear were selected, including closures and interfaces.

c. This concentration of organisms tested was limited by the achievable contamination density within the Defensive Test Chamber (DTC). The results of these tests are reported as empirical numbers; a linear relationship should be assumed in more highly contaminated environments.

1.5.3 MIST Procedures

a. Historically, MIST trials have been designed to evaluate protective ensembles in a chemical agent (simulant) vapor environment. This test deviated from the standard MIST protocol in that a dry biological agent (simulant) environment was maintained for the purpose of challenging personnel decontamination TTPs. Two decontamination methods were each tested eight times.

b. During the testing phase, strict measures were enforced to mitigate the spread of contamination through all pre-test and test areas. The antechambers of the DTC were the areas in which the personnel swab samples were collected prior to and after each decontamination procedure. The dressing trailer, test chamber, and all antechambers were thoroughly decontaminated with bleach water before and after each test iteration.

1.6 SYSTEM DESCRIPTION

1.6.1 Test Equipment

1.6.1.1 System Testing Chambers

a. This type of testing requires the use of specifically designed chambers. The Defensive Test Chamber (DTC) used for MIST is a self-contained test facility with all-stainless steel interior surfaces. It is large enough to accommodate eight test participants and one on-floor supervisor, with sufficient room for exercise equipment, physical activity, and other movement.

b. The test chamber contains fans capable of providing a directed flow of air to the test participants at 3.2 to 16.1 km/hr (2 to 10 mph). It is capable of providing an environmentally controlled temperature of 21.1 to 32.2°C (70° to 90°F) and a relative humidity (RH) of 50 to 80 percent. Temperature during this MIST was 27°C (80°F), with 50% RH.

1.6.1.2 Instrumentation

a. An Aerodynamic Particle Sizer® (APS®) was used to provide real-time measurement (RTM) of the challenge particle concentration. In addition, all-glass impingers (AGIs) were used to collect viable simulant concentration data at three stations in the chamber.

b. Slit-to-agar samplers were used to collect background simulant concentrations in all areas where personnel swabs were collected: dressing trailer, antechamber 2, and antechamber 3.

c. Liquid solutions of *Bacillus subtilis*, var. *niger* (BG) were disseminated into dry particles using a Chicago atomizer connected to a peristaltic pump.

1.7 UNIQUE TEST PERSONNEL REQUIREMENTS

Military participants were supplied by the users.

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SECTION 2. SUBTESTS

2.1 METHODOLOGY DEVELOPMENT

2.1.1 Objectives

Use a BW agent simulant, *Bacillus subtilis* var. niger (BG), to develop the methodology in order to validate personnel decontamination methods during the biological MIST.

2.1.2 Criteria

None.

2.1.3 Test Procedure

TOP 10-2-022 was used as the primary basis for the MIST protocol (Reference 3). This test deviated from the standard MIST protocol in that decontamination methods were challenged in a BW agent simulant environment.

2.1.3.1 General

a. The primary emphasis in testing was placed on safety. Tests with BG were conducted IAW the guidelines in the Biological Agent Safety Sheet and the procedures specified in the Tactical Personnel Decontamination Validation DTP (Reference 4). The procedures in the DTP were reviewed and approved by all responsible organizations before the testing began.

b. Test participants were provided by the users. Each test participant was dressed in the same protective gear, consisting of battle dress uniform (BDU), M45 mask, gloves, hood, socks, and designated footwear.

c. All aspects of the testing were performed with emphasis on acquiring high quality, credible, and verifiable results.

d. Separate sets of gear were used for each trial to limit the spread of contamination. Participants showered prior to background sampling and gear donning, in addition to after the completion of each trial. Gear was laundered after each trial.

e. The MIST trials were limited to 1 hour; the safety and health of all test participants took precedence throughout testing.

2.1.3.2 System Testing Chambers

a. The Defensive Test Chamber (DTC) that was used for the MIST is a self-contained chamber with all-stainless steel interior surfaces (Reference 5). The chamber is 7.6 by 4.9 by 2.4 m (25 by 16 by 8 ft) (Appendix B).

b. Temperature during this MIST was 27°C (80°F), with 50% RH. Wind speed was 2 m/sec.

2.1.3.3 Test Instrumentation

a. An Aerodynamic Particle Sizer® (APS®) was used to provide real-time measurement (RTM) of the challenge particle concentration. In addition, all-glass impingers (AGIs) were used to collect viable simulant concentration data. AGIs were placed at three stations in the chamber; data were collected for two of every ten minutes during the course of each trial.

b. A liquid solution of BG ($7x10^8$ cfu/mL) was disseminated into dry particles using a Chicago atomizer connected to a peristaltic pump.

c. Test participants used the existing communications systems at the DTC. The test director (TD) was in constant contact with the floor supervisor through this system. The supervisor relayed instructions to each test participant, as required.

c. Personal Vital Signs Monitoring System (PVSMS) was used to monitor each test participant (in the BG environment) for heat stress and other physiological signs of distress. The PVSMS heart rate monitor strap was attached to the chest of each participant, inside the protective clothing. The personal data collection instrument package was maintained in a pocket on the test participant's left arm in a manner that minimized interference with the test. The system measured:

(1) Core body temperature by use of a small, pill-sized monitor (which was swallowed).

(2) Heart rate by use of a heart monitor that it strapped around the test participant's chest.

(3) Skin temperature taken by a probe attached to the skin next to the heart monitor.

2.1.3.4 Test Conduct

a. Daily, test participants underwent a physical evaluation and were administered the PVSMS at least two hours prior to the trial start. Once test participants completed the daily pretest actions and showered in, they entered the dressing area.

b. Background swab samples were taken from eight designated skin sampling points (Appendix F). Each participant was marked in each sampling area using a defined template of 4x4 in; Calginex™ swabs with water were used for swabbing the skin. After sampling, each swab was placed into a solution of phosphate buffered saline (PBS)/200 mM sodium thiosulfate.

c. The BG challenge was administered and maintained at a target of 1×10^5 particles per liter of air as determined by the APS.

d. Once the specified BG challenge concentration was established, the test participants dressed in the protective ensembles, and the test officer had verified that all systems are operating correctly, the on-floor supervisor (dressed in Tyvek® suit, a protective mask, and hood) entered the test chamber. The test participants entered the test chamber from the antechamber singly at 5-minute intervals, and followed the exercise protocol in Appendix E.

e. The activities of the test participants were visually monitored by the on-floor supervisor, test operators, and video cameras.

f. Emergency medical technicians (EMTs) with life support equipment were present during every trial. Before each trial, the EMTs recorded the physiological signs (pulse, blood pressure, body temperature, etc.) of each test participant. All test participants were informed that they could terminate their participation during any trial at any time in the event of excessive discomfort.

g. Each participant remained in the chamber for 1 hour. At the conclusion of the defined exercise protocol for each participant, he exited the test chamber and entered the second antechamber where he dressed down.

h. A mid-point swab was sampled from each participant IAW Para. 2.1.3.4.b; the left half of each pre-marked area was sampled.

i. After obtaining a mid-point sample, each test participant underwent the decontamination TTP using 0.5% sodium hypochlorite (1:10 diluted household bleach). After the decon procedure each participant was swabbed again on the right half of the predetermined areas. This procedure was continued until all test participants exited the chamber.

j. Swab samples were suspended in 5 mL of PBS containing 200 mM sodium thiosulfate to quench the chlorine action, plated onto standard nutrient agar in triplicate, and incubated at 34°C for at least 18 hours.

2.1.4 Test Results

2.1.4.1 Aerosol Challenge

The total challenge concentration monitored by the APS included viable BG particles as well as non-biological material. AGI data resulted in an average of 5.6×10^4 particles of BG per liter of air over the three sampling stations during each trial. Appendix C summarizes the challenge concentrations for each trial.

2.1.4.2 Personnel Data

Table 1 summarizes the decontamination efficiencies from each test participant. Standard deviations were calculated for each sample; if the standard deviations of the mid- and post-swabs were within one log, there was no significant difference.

Table 1: Personnel swab data for trials 1 and 2 utilizing the same dress down and decontamination procedure, four entries per trial.

Trials 1 and 2 13 Dec 01 Dress down/skin decontamination							
		PRE		MID		POST	
Entry	Sample Area	*avg cfu/sample*	*StDev*	*avg cfu/sample*	*StDev*	*avg cfu/sample*	*StDev*
1	1- Left Wrist	**8**	14	**18**	19	**38**	18
	2- Right Wrist	**2**	3	**62**	94	**127**	46
	3- Shoulder	**3**	3	**5**	5	**122**	20
	4- Front Neck	**7**	8	**340**	76	**105**	30
	5- Abdomen	**13**	8	**77**	23	**25**	5
	6- Right Front Ankle	**5**	9	**853**	319	**55**	17
	7- Left Back Ankle	**32**	29	**152**	91	**43**	3
	8- Lower Back	**0**	0	**23**	15	**5**	5
2	1- Left Wrist	**3**	6	**192**	156	**383**	14
	2- Right Wrist	**0**	0	**1210**	1408	**78**	21
	3- Shoulder	**0**	0	**18**	10	**20**	15
	4- Front Neck	**8**	8	**55**	26	**18**	8
	5- Abdomen	**2**	3	**543**	33	**317**	159
	6- Right Front Ankle	**27**	31	**925**	114	**120**	35
	7- Left Back Ankle	**35**	0	**90**	35	**23**	8
	8- Lower Back	**7**	8	**27**	10	**40**	20
3	1- Left Wrist	**18**	6	**73**	10	**78**	49
	2- Right Wrist	**8**	10	**85**	91	**102**	16
	3- Shoulder	**7**	3	**20**	5	**5**	0
	4- Front Neck	**8**	8	**188**	141	**22**	18
	5- Abdomen	**2**	3	**17575**	368	**38**	10
	6- Right Front Ankle	**87**	40	**3**	3	**7**	3
	7- Left Back Ankle	**42**	15	**40**	22	**2**	3
	8- Lower Back	**3**	3	**28**	15	**18**	6
4	1- Left Wrist	**32**	10	**72**	64	**10**	10
	2- Right Wrist	**5**	9	**110**	119	**42**	20
	3- Shoulder	**2**	3	**23**	40	**8**	3
	4- Front Neck	**62**	10	**1713**	1333	**162**	63
	5- Abdomen	**3**	3	**87**	33	**43**	8
	6- Right Front Ankle	**0**	0	**508**	43	**10**	10
	7- Left Back Ankle	**7**	8	**610**	177	**12**	6
	8- Lower Back	**2**	3	**30**	15	**7**	3

Table 1 Continued.

Entry	Sample Area	PRE avg cfu/sample	PRE StDev	MID avg cfu/sample	MID StDev	POST avg cfu/sample	POST StDev
5	1- Left Wrist	**13**	8	**863**	147	**338**	86
	2- Right Wrist	**2**	3	**3750**	0	**13**	19
	3- Shoulder	**110**	13	**130**	44	**53**	23
	4- Front Neck	**82**	19	**248**	31	**82**	49
	5- Abdomen	**3**	3	**150**	30	**145**	17
	6- Right Front Ankle	**2**	3	**120**	18	**25**	0
	7- Left Back Ankle	**18**	3	**3750**	0	**133**	3
	8- Lower Back	**3**	3	**33**	30	**5**	0
6	1- Left Wrist	**40**	26	**187**	50	**327**	101
	2- Right Wrist	**38**	8	**170**	44	**140**	9
	3- Shoulder	**2**	3	**115**	30	**2**	3
	4- Front Neck	**68**	15	**253**	64	**0**	0
	5- Abdomen	**15**	5	**152**	16	**52**	10
	6- Right Front Ankle	**8**	6	**38**	13	**3**	3
	7- Left Back Ankle	**5**	9	**70**	30	**15**	5
	8- Lower Back	**2**	3	**42**	18	**5**	5
7	1- Left Wrist	**90**	56	**457**	85	**20**	9
	2- Right Wrist	**38**	14	**393**	26	**100**	30
	3- Shoulder	**70**	20	**40**	10	**3**	3
	4- Front Neck	**40**	20	**23**	18	**2**	3
	5- Abdomen	**60**	13	**712**	224	**43**	15
	6- Right Front Ankle	**10**	9	**18**	14	**5**	5
	7- Left Back Ankle	**2**	3	**15**	5	**23**	20
	8- Lower Back	**3**	3	**23**	12	**5**	5
8	1- Left Wrist	**22**	10	**175**	22	**10**	5
	2- Right Wrist	**22**	14	**390**	63	**35**	26
	3- Shoulder	**7**	8	**20**	5	**0**	0
	4- Front Neck	**23**	15	**307**	114	**2**	3
	5- Abdomen	**7**	3	**42**	21	**13**	8
	6- Right Front Ankle	**48**	25	**697**	135	**0**	0
	7- Left Back Ankle	**207**	16	**652**	184	**30**	30
	8- Lower Back	**3**	3	**18**	10	**2**	3

2.1.5 Conclusions

2.1.5.1 This methodology study demonstrated viable techniques for aerosol contamination of individuals in addition to valid swab sampling procedures to measure skin contamination.

2.1.5.2 Preliminary indications suggested that this trial decontamination methodology was capable of reducing personnel surface contamination. Additional tests were required to validate the procedures.

2.2 TEST PHASE

2.2.1 Objectives

Use a BW agent simulant, *Bacillus subtilis* var. niger (BG), to validate personnel decontamination methods and determine BWA simulant contamination.

2.2.2 Criteria

None.

2.2.3 Test Procedure

The procedures developed during Phase I, Methodology Development were used during the test phase.

2.2.3.1 General

a. Strict measures were enforced to mitigate the spread of contamination through all pre-test and test areas. Non-essential test personnel were limited to the control room; no entry was made into either the dressing trailer or antechambers unless the personnel were showered in. The dressing trailer, test chamber, and all antechambers were thoroughly decontaminated with bleach water before and after each test iteration. In addition, "clean" and "dirty" vehicles were designated for the transport of test participants before and after each iteration, respectively. Rather than entering the test chamber from the antechamber, each test participant entered via the outside door.

b. Two sets of gear were used for each trial to limit the spread of contamination. Participants showered prior to background sampling and gear donning, in addition to after the completion of each trial. Gear was laundered after each trial.

2.2.3.2 Test Instrumentation

a. As in Phase I, an Aerodynamic Particle Sizer® (APS®) was used to provide real-time measurement (RTM) of the challenge particle concentration. In addition, all-glass impingers (AGIs) were used to collect viable simulant concentration data. AGIs were placed at three stations in the chamber; data were collected for two of every ten minutes during the course of each trial.

b. Slit-to-agar samplers were used to collect background simulant concentrations in all areas where personnel swabs were collected: dressing trailer, antechamber 2, and antechamber 3.

c. A liquid solution of BG ($1x10^9$ cfu/mL) was disseminated into dry particles using a Chicago atomizer connected to a peristaltic pump.

2.2.3.3 Test Conduct

a. This test was conducted IAW the procedures used during Phase I.

b. Prior to the test start, training and validation of swab procedures was conducted with Life Sciences and Special Programs personnel (Reference 6). Samples were collected by wet swabbing in both the horizontal and vertical directions. The results from each sample collector agreed to within at least one log. Four of the five certified samplers were utilized during the test; two sample collectors were stationed in each antechamber. All sample collectors showered in and out of the testing areas

c. Separate trials were conducted to compare two decontamination techniques (Appendix B). Eight personnel participated in each iteration. The first TTP utilized a full body spray-down procedure prior to dress down and skin decontamination. The second iteration eliminated the spray-down procedure and each test participant proceeded directly to the dress down and skin decontamination procedures.

d. For the first trial, as each test participant exited the test chamber, he entered antechamber 1, where he was sprayed from head to toe with a 0.5% sodium hypochlorite solution. He then proceeded to antechamber 2, where he dressed down and the mid-point swab was collected IAW para. 2.1.3.4.b.

e. After collection of the mid-point swab, each test participant performed the skin decontamination procedure then proceeded to antechamber 3 for collection of the final (Post) swab.

2.2.4 Test Results

2.2.4.1 Aerosol Challenge

The total challenge concentration monitored by the APS included viable BG particles as well as non-biological material. AGI data resulted in an average of $2.5x10^4$ particles of BG per liter of air over the three sampling stations during each trial. Appendix C summarizes the challenge concentrations for each trial.

2.2.4.2 Personnel Data

Tables 2 and 3 summarize the decontamination efficiencies from each test participant. Standard deviations were calculated for each sample; if the standard deviations of the mid- and post-swabs were within one, there was no significant difference.

Assays were utilized to identify contamination and only BG was counted as results during these trials. Other contamination included *Pseudomonas dermatitis*, a normal flora of human skin. *P. dermatitis* was not enumerated during these trials.

Table 2. Personnel swab data for trial 1 utilizing a gross spray down procedure followed by dress down and decontamination procedure, eight entries per trial.

Trial 1 23 April 02 Gross spray-down/dress down/skin decontamination							
		PRE		MID		POST	
Entry	Sample Area	*avg cfu/sample*	*StDev*	*avg cfu/sample*	*StDev*	*avg cfu/sample*	*StDev*
1	1- Left Wrist	**8**	14	**8**	14	**0**	0
	2- Right Wrist	**117**	101	**0**	0	**8**	14
	3- Shoulder	**0**	0	**0**	0	**0**	0
	4- Front Neck	**175**	43	**0**	0	**0**	0
	5- Abdomen	**100**	25	**0**	0	**0**	0
	6- Right Front Ankle	**0**	0	**0**	0	**0**	0
	7- Left Back Ankle	**8**	14	**0**	0	**0**	0
	8- Lower Back	**42**	14	**0**	0	**0**	0
2	1- Left Wrist	**0**	0	**0**	0	**8**	14
	2- Right Wrist	**0**	0	**0**	0	**0**	0
	3- Shoulder	**8**	14	**0**	0	**0**	0
	4- Front Neck	**8**	14	**8**	14	**0**	0
	5- Abdomen	**8**	14	**0**	0	**0**	0
	6- Right Front Ankle	**0**	0	**0**	0	**0**	0
	7- Left Back Ankle	**0**	0	**0**	0	**0**	0
	8- Lower Back	**0**	0	**0**	0	**0**	0
3	1- Left Wrist	**0**	0	**58**	80	**0**	0
	2- Right Wrist	**0**	0	**167**	76	**0**	0
	3- Shoulder	**0**	0	**0**	0	**0**	0
	4- Front Neck	**0**	0	**0**	0	**0**	0
	5- Abdomen	**25**	25	**8**	14	**0**	0
	6- Right Front Ankle	**0**	0	**0**	0	**0**	0
	7- Left Back Ankle	**0**	0	**8**	14	**0**	0
	8- Lower Back	**8**	14	**17**	14	**0**	0
4	1- Left Wrist	**0**	0	**0**	0	**8**	14
	2- Right Wrist	**0**	0	**17**	14	**8**	14
	3- Shoulder	**0**	0	**0**	0	**0**	0
	4- Front Neck	**0**	0	**0**	0	**0**	0
	5- Abdomen	**25**	25	**8**	14	**0**	0
	6- Right Front Ankle	**0**	0	**0**	0	**0**	0
	7- Left Back Ankle	**0**	0	**0**	0	**0**	0
	8- Lower Back	**0**	0	**8**	14	**0**	0

Table 2 Continued.

Entry	Sample Area	PRE avg cfu/sample	PRE StDev	MID avg cfu/sample	MID StDev	POST avg cfu/sample	POST StDev
5	1- Left Wrist	**0**	0	**0**	0	**0**	0
	2- Right Wrist	**0**	0	**17**	29	**0**	0
	3- Shoulder	**0**	0	**0**	0	**0**	0
	4- Front Neck	**0**	0	**17**	29	**0**	0
	5- Abdomen	**0**	0	**33**	29	**0**	0
	6- Right Front Ankle	**0**	0	**0**	0	**0**	0
	7- Left Back Ankle	**8**	14	**0**	0	**0**	0
	8- Lower Back	**0**	0	**0**	0	**0**	0
6	1- Left Wrist	**0**	0	**0**	0	**0**	0
	2- Right Wrist	**0**	0	**100**	0	**0**	0
	3- Shoulder	**0**	0	**0**	0	**0**	0
	4- Front Neck	**0**	0	**0**	0	**0**	0
	5- Abdomen	**0**	0	**0**	0	**0**	0
	6- Right Front Ankle	**8**	14	**0**	0	**0**	0
	7- Left Back Ankle	**0**	0	**0**	0	**0**	0
	8- Lower Back	**17**	14	**0**	0	**0**	0
7	1- Left Wrist	**0**	0	**0**	0	**0**	0
	2- Right Wrist	**0**	0	**0**	0	**0**	0
	3- Shoulder	**0**	0	**0**	0	**0**	0
	4- Front Neck	**0**	0	**0**	0	**0**	0
	5- Abdomen	**0**	0	**25**	25	**0**	0
	6- Right Front Ankle	**0**	0	**0**	0	**0**	0
	7- Left Back Ankle	**0**	0	**0**	0	**0**	0
	8- Lower Back	**0**	0	**8**	14	**0**	0
8	1- Left Wrist	**0**	0	**8**	14	**0**	0
	2- Right Wrist	**0**	0	**167**	95	**0**	0
	3- Shoulder	**8**	14	**0**	0	**0**	0
	4- Front Neck	**0**	0	**0**	0	**0**	0
	5- Abdomen	**0**	0	**8**	14	**0**	0
	6- Right Front Ankle	**8**	14	**0**	0	**0**	0
	7- Left Back Ankle	**0**	0	**0**	0	**17**	29
	8- Lower Back	**0**	0	**17**	29	**8**	14

Table 3. Personnel swab data for trial 2 utilizing the dress down and decontamination procedure without spray down procedure, eight entries per trial.

Trial 2 23 April 02 Dress down/skin decontamination							
		PRE		MID		POST	
Entry	Sample Area	*avg cfu/sample*	*StDev*	*avg cfu/sample*	*StDev*	*avg cfu/sample*	*StDev*
9	1- Left Wrist	**0**	0	**0**	0	**0**	0
	2- Right Wrist	**0**	0	**0**	0	**0**	0
	3- Shoulder	**0**	0	**0**	0	**0**	0
	4- Front Neck	**0**	0	**0**	0	**0**	0
	5- Abdomen	**0**	0	**0**	0	**0**	0
	6- Right Front Ankle	**0**	0	**0**	0	**0**	0
	7- Left Back Ankle	**0**	0	**0**	0	**0**	0
	8- Lower Back	**0**	0	**0**	0	**0**	0
10	1- Left Wrist	**0**	0	**0**	0	**0**	0
	2- Right Wrist	**0**	0	**0**	0	**0**	0
	3- Shoulder	**0**	0	**0**	0	**0**	0
	4- Front Neck	**0**	0	**8**	14	**8**	14
	5- Abdomen	**0**	0	**0**	0	**0**	0
	6- Right Front Ankle	**17**	14	**0**	0	**0**	0
	7- Left Back Ankle	**0**	0	**0**	0	**0**	0
	8- Lower Back	**0**	0	**0**	0	**0**	0
11	1- Left Wrist	**33**	38	**25**	25	**0**	0
	2- Right Wrist	**0**	0	**8**	14	**0**	0
	3- Shoulder	**0**	0	**0**	0	**0**	0
	4- Front Neck	**0**	0	**0**	0	**0**	0
	5- Abdomen	**0**	0	**0**	0	**0**	0
	6- Right Front Ankle	**0**	0	**0**	0	**0**	0
	7- Left Back Ankle	**0**	0	**0**	0	**0**	0
	8- Lower Back	**0**	0	**0**	0	**0**	0
12	1- Left Wrist	**0**	0	**0**	0	**0**	0
	2- Right Wrist	**0**	0	**17**	14	**0**	0
	3- Shoulder	**0**	0	**0**	0	**0**	0
	4- Front Neck	**50**	25	**8**	14	**0**	0
	5- Abdomen	**0**	0	**8**	14	**0**	0
	6- Right Front Ankle	**17**	29	**8**	14	**0**	0
	7- Left Back Ankle	**0**	0	**0**	0	**0**	0
	8- Lower Back	**0**	0	**0**	0	**0**	0

Table 3 Continued.

Entry	Sample Area	PRE avg cfu/sample	PRE StDev	MID avg cfu/sample	MID StDev	POST avg cfu/sample	POST StDev
13	1- Left Wrist	**0**	0	**0**	0	**0**	0
	2- Right Wrist	**17**	14	**8**	14	**0**	0
	3- Shoulder	**0**	0	**0**	0	**0**	0
	4- Front Neck	**0**	0	**0**	0	**0**	0
	5- Abdomen	**0**	0	**0**	0	**0**	0
	6- Right Front Ankle	**0**	0	**100**	50	**0**	0
	7- Left Back Ankle	**0**	0	**0**	0	**0**	0
	8- Lower Back	**0**	0	**0**	0	**0**	0
14	1- Left Wrist	**0**	0	**0**	0	**0**	0
	2- Right Wrist	**0**	0	**33**	38	**0**	0
	3- Shoulder	**0**	0	**0**	0	**0**	0
	4- Front Neck	**0**	0	**8**	14	**0**	0
	5- Abdomen	**0**	0	**0**	0	**0**	0
	6- Right Front Ankle	**0**	0	**0**	0	**0**	0
	7- Left Back Ankle	**0**	0	**0**	0	**0**	0
	8- Lower Back	**0**	0	**0**	0	**0**	0
15	1- Left Wrist	**0**	0	**0**	0	**0**	0
	2- Right Wrist	**0**	0	**0**	0	**0**	0
	3- Shoulder	**0**	0	**0**	0	**0**	0
	4- Front Neck	**0**	0	**0**	0	**0**	0
	5- Abdomen	**0**	0	**108**	58	**0**	0
	6- Right Front Ankle	**0**	0	**0**	0	**0**	0
	7- Left Back Ankle	**0**	0	**0**	0	**0**	0
	8- Lower Back	**0**	0	**0**	0	**0**	0
16	1- Left Wrist	**0**	0	**8**	14	**0**	0
	2- Right Wrist	**0**	0	**0**	0	**0**	0
	3- Shoulder	**0**	0	**0**	0	**0**	0
	4- Front Neck	**0**	0	**0**	0	**0**	0
	5- Abdomen	**0**	0	**8**	14	**0**	0
	6- Right Front Ankle	**0**	0	**0**	0	**0**	0
	7- Left Back Ankle	**0**	0	**0**	0	**0**	0
	8- Lower Back	**0**	0	**33**	14	**0**	0

2.2.5 Conclusions

2.2.5.1 These results indicate that an individual operating in a biological particulate aerosol environment can be efficiently decontaminated to minimize the threat to themselves and other personnel.

2.2.5.2 There was no appreciable difference between the two decontamination procedures tested under these experimental conditions. It can be assumed that the first procedure (gross mitigation, washdown) would be more robust and applicable to a wider range of contaminated conditions.

SECTION 3. APPENDICES

APPENDIX A. TEST CRITERIA

None.

APPENDIX B. DECONTAMINATION PROCEDURES

1. Using Chemlites, establish the Hot line and Contamination Control Line (CCL).
2. Prepare the decon media bags by mixing 0.5% calcium hypochlorite (HTH) in water. Ensure that the contents are thoroughly mixed and add decon liquid to the shuffle pits, while reserving liquid in the media bag for hand and tool decontamination
3. Prior to crossing the Hot Line, remove and segregate recoverable and expendable gear. The list of gear for recovery should be predetermined and directed by the station manager.
4. Proceed into first shuffle pit containing decontaminant. Decon feet/boots.
5. Decon line personnel will thoroughly sponge down contaminated personnel, starting at the top of the hood down to the bottom of the hood skirt, occasionally re-wetting the sponge in decon medium.
6. Cut the hood shoulder straps and remove. Place in expendable bag.
7. Cut up the front of the hood and around the mask or second skin. Remove the hood and place in the expendable bag. Cutter decon hands and cutting utensils.
8. Move out of the shuffle pit into the contamination control area, remove boots and proceed to the second shuffle pit containing decontaminant. Deconee decon hands.
9. Perform and unassisted down-dress to shorts. At no time will any gear be removed over the head. Fold clothing in on itself to prevent tracking of contamination. Deconee decon hands.
10. If a T-shirt is worn, cut it with a knife hook and remove it without going over the head.
11. Strip off socks while remaining in the shuffle pit.
12. Remove gloves and fold in on themselves.
13. After all clothing is removed, sponge down with assistance as required with 0.5% HTH and water solution, starting at the top of the head and working down to the feet. Occasionally re-wet the sponge in decon medium.
14. Once a complete wash-down and scrub has been accomplished, move to the CCL. Perform an unassisted mask removal by pulling crown tag on mask using a breath hold/eyes closed technique.
15. Drop the mask and move up wind to the re-dress/ ex-filtration area.

APPENDIX C. TEST DATA

FIGURE LIST

FIGURE — PAGE

Figure C.1 Challenge concentration obtained during methodology development phase (AM trial on 13 Dec 01). Total particle counts resulted from the Aerodynamic Particle Sizer; viable particles were determined from all-glass impinger samplers. C-2

Figure C.2 Challenge concentration obtained during methodology development phase (PM trial on 13 Dec 01). Total particle counts resulted from the Aerodynamic Particle Sizer; viable particles were determined from all-glass impinger samplers. C-2

Figure C.3 Challenge concentration obtained during test conduct phase (AM trial on 23 Apr 02). Total particle counts resulted from the Aerodynamic Particle Sizer; viable particles were determined from all-glass impinger samplers. C-3

Figure C.4 Challenge concentration obtained during test conduct phase (PM trial on 23 Apr 02). Total particle counts resulted from the Aerodynamic Particle Sizer; viable particles were determined from all-glass impinger samplers. C-3

Figure C.5 Background concentration of BG resulting from slit-to-agar samplers during test conduct phase (AM trial on 23 Apr 02). Sectors represent 2-minute time segments over the course of collection in each chamber: dressing trailer (0815-0915); antechamber 2 (0950-1050); antechamber 3 (0950-1050) C-4

Figure C.6 Background concentration of BG resulting from slit-to-agar samplers during test conduct phase (PM trial on 23 Apr 02). Sectors represent 2-minute time segments over the course of collection in each chamber: dressing trailer (1300-1400); antechamber 2 (1450-1550); antechamber 3 (1450-1550) C-5

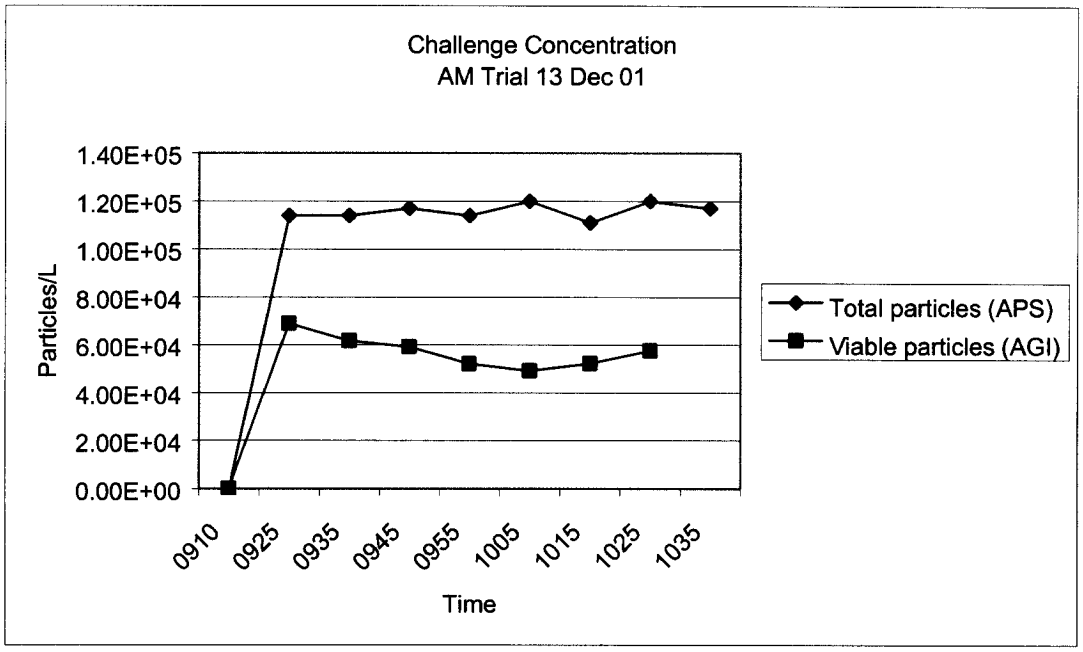

Figure C.1 Challenge concentration obtained during methodology development phase (AM trial on 13 Dec 01). Total particle counts resulted from the Aerodynamic Particle Sizer; viable particles were determined from all-glass impinger samplers.

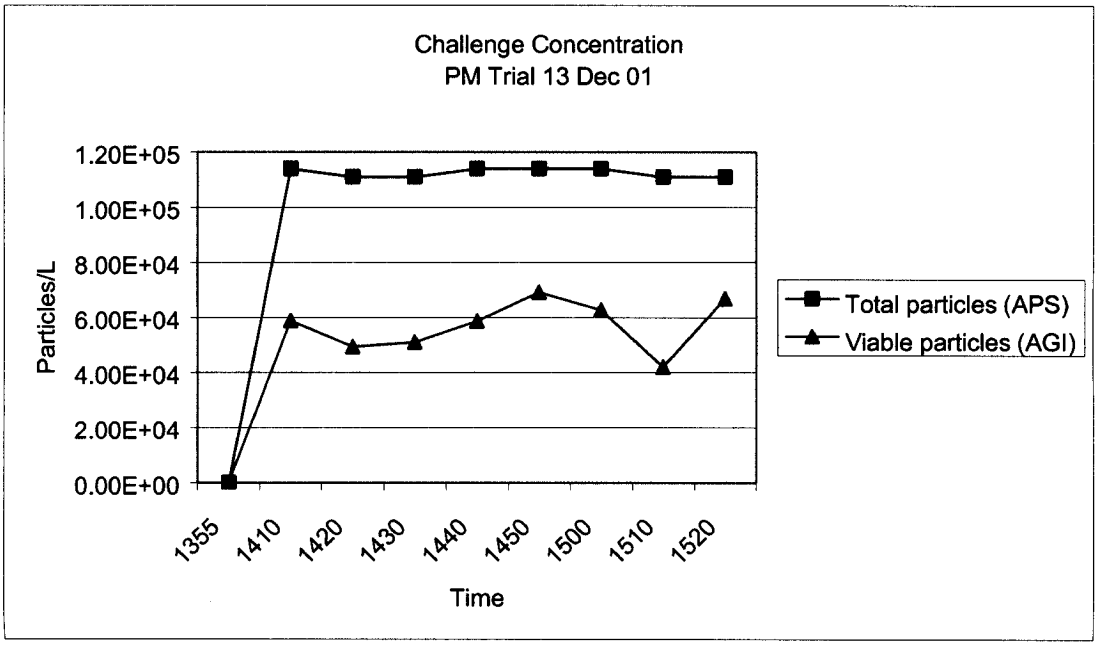

Figure C.2 Challenge concentration obtained during methodology development phase (PM trial on 13 Dec 01). Total particle counts resulted from the Aerodynamic Particle Sizer; viable particles were determined from all-glass impinger samplers.

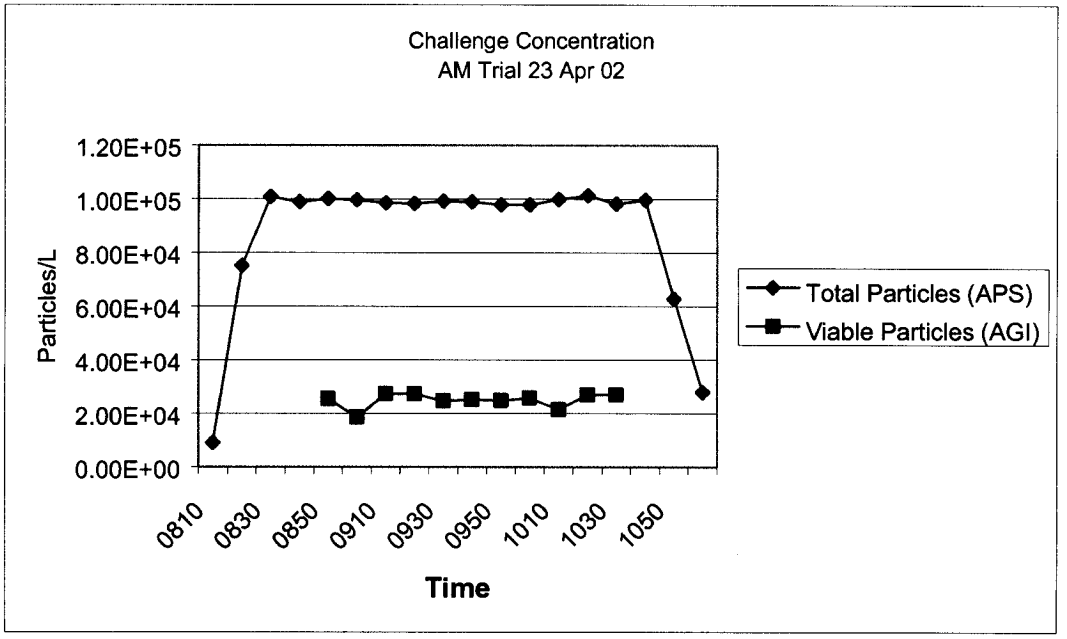

Figure C.3 Challenge concentration obtained during test conduct phase (AM trial on 23 Apr 02). Total particle counts resulted from the Aerodynamic Particle Sizer; viable particles were determined from all-glass impinger samplers.

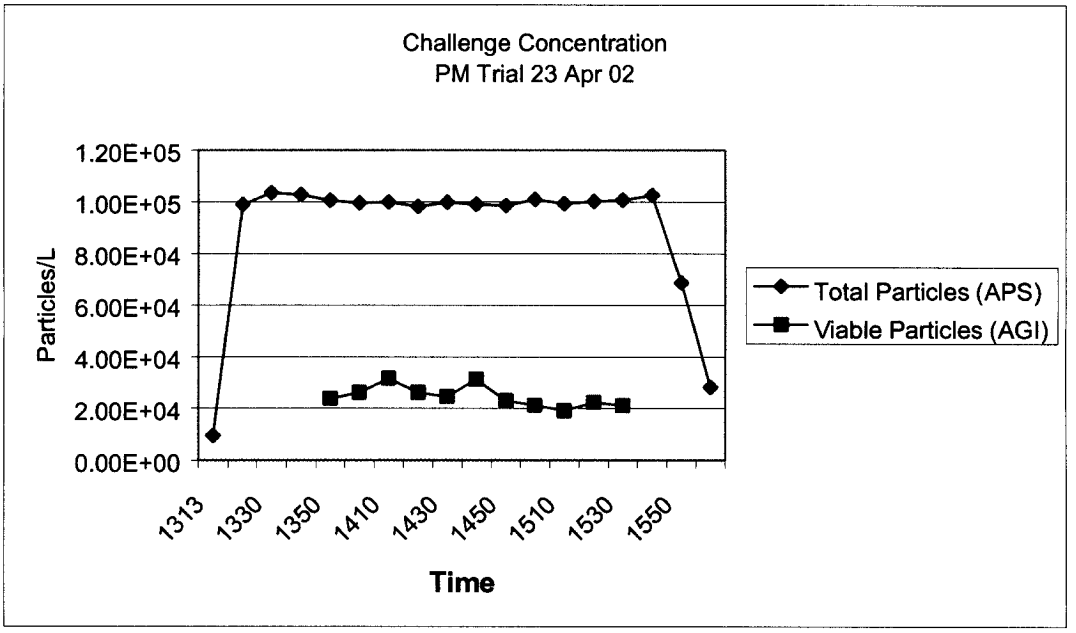

Figure C.4 Challenge concentration obtained during test conduct phase (PM trial on 23 Apr 02). Total particle counts resulted from the Aerodynamic Particle Sizer; viable particles were determined from all-glass impinger samplers.

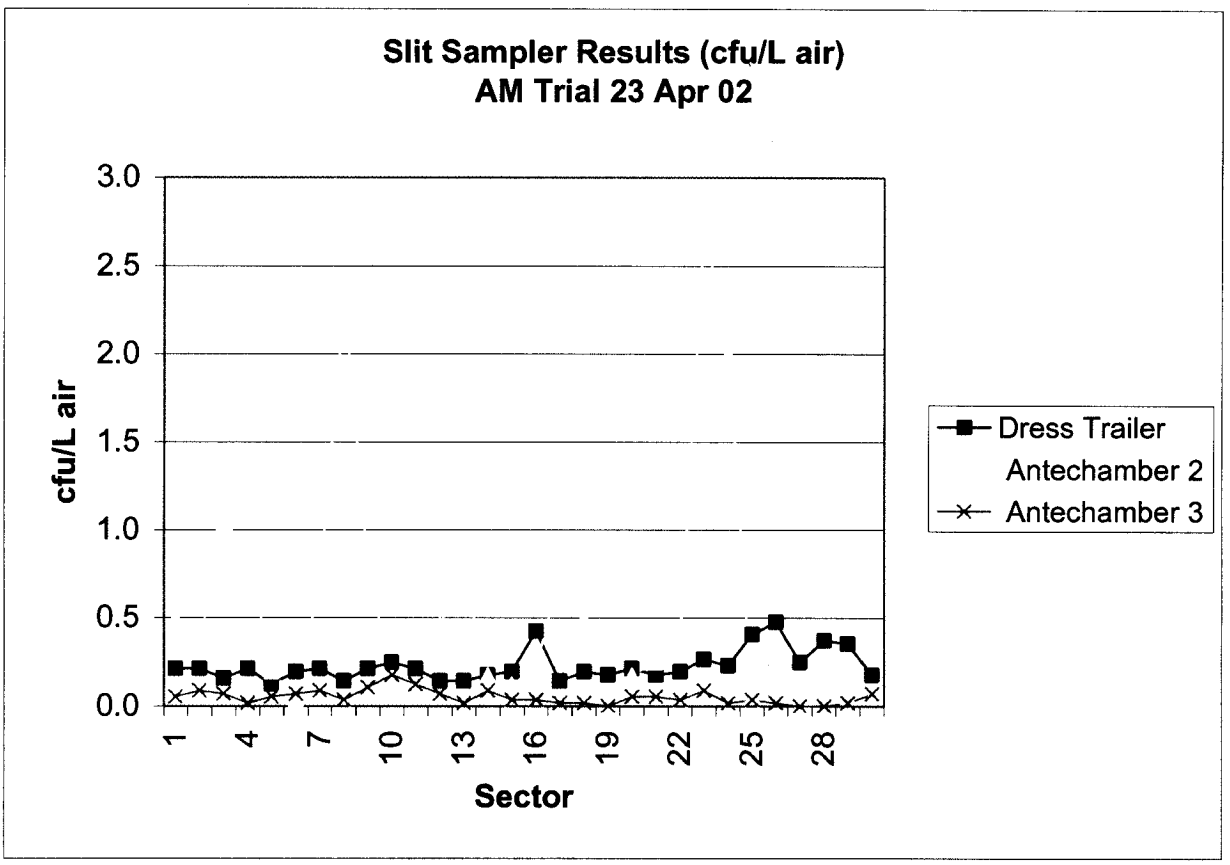

Figure C.5 Background concentration of BG resulting from slit-to-agar samplers during test conduct phase (AM trial on 23 Apr 02). Sectors represent 2-minute time segments over the course of collection in each chamber: dressing trailer (0815-0915); antechamber 2 (0950-1050); antechamber 3 (0950-1050).

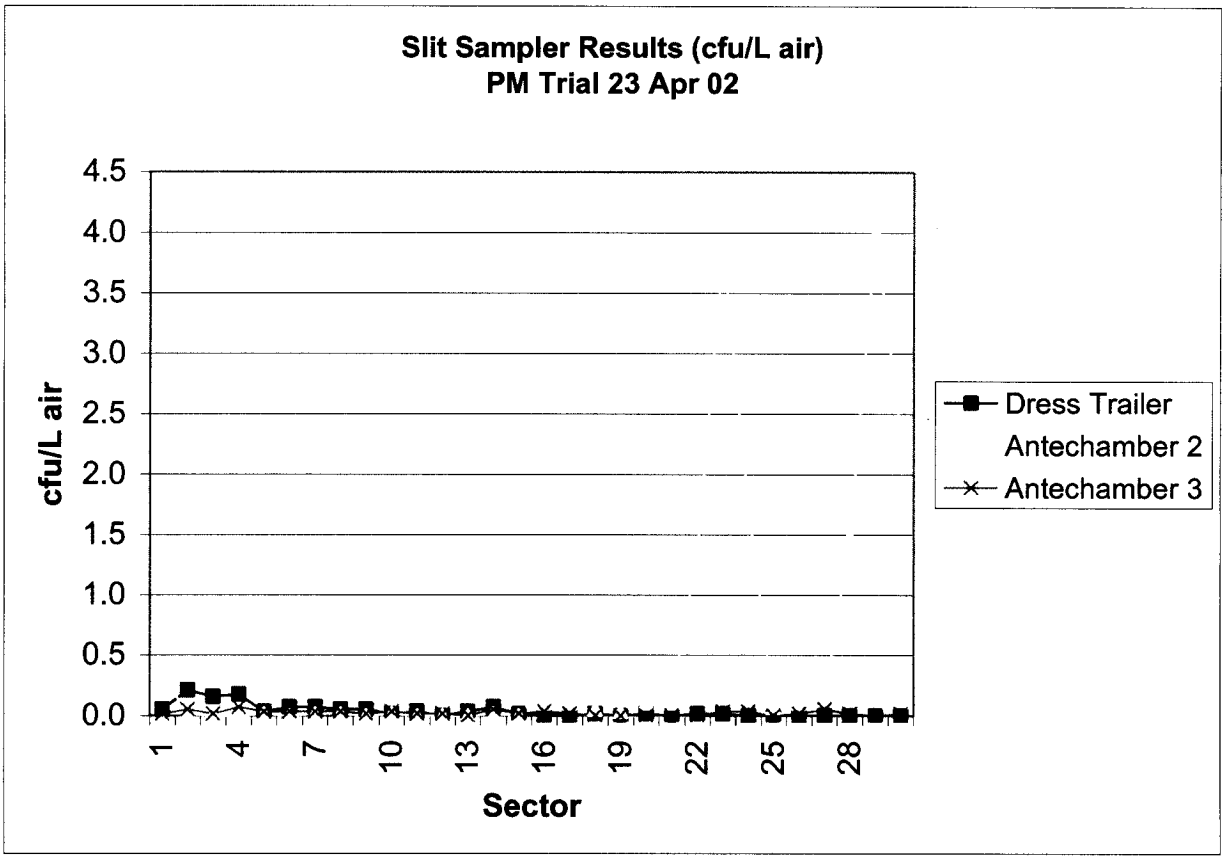

Figure C.6 Background concentration of BG resulting from slit-to-agar samplers during test conduct phase (PM trial on 23 Apr 02). Sectors represent 2-minute time segments over the course of collection in each chamber: dressing trailer (1300-1400); antechamber 2 (1450-1550); antechamber 3 (1450-1550).

APPENDIX D. MIST CHAMBER LAYOUT

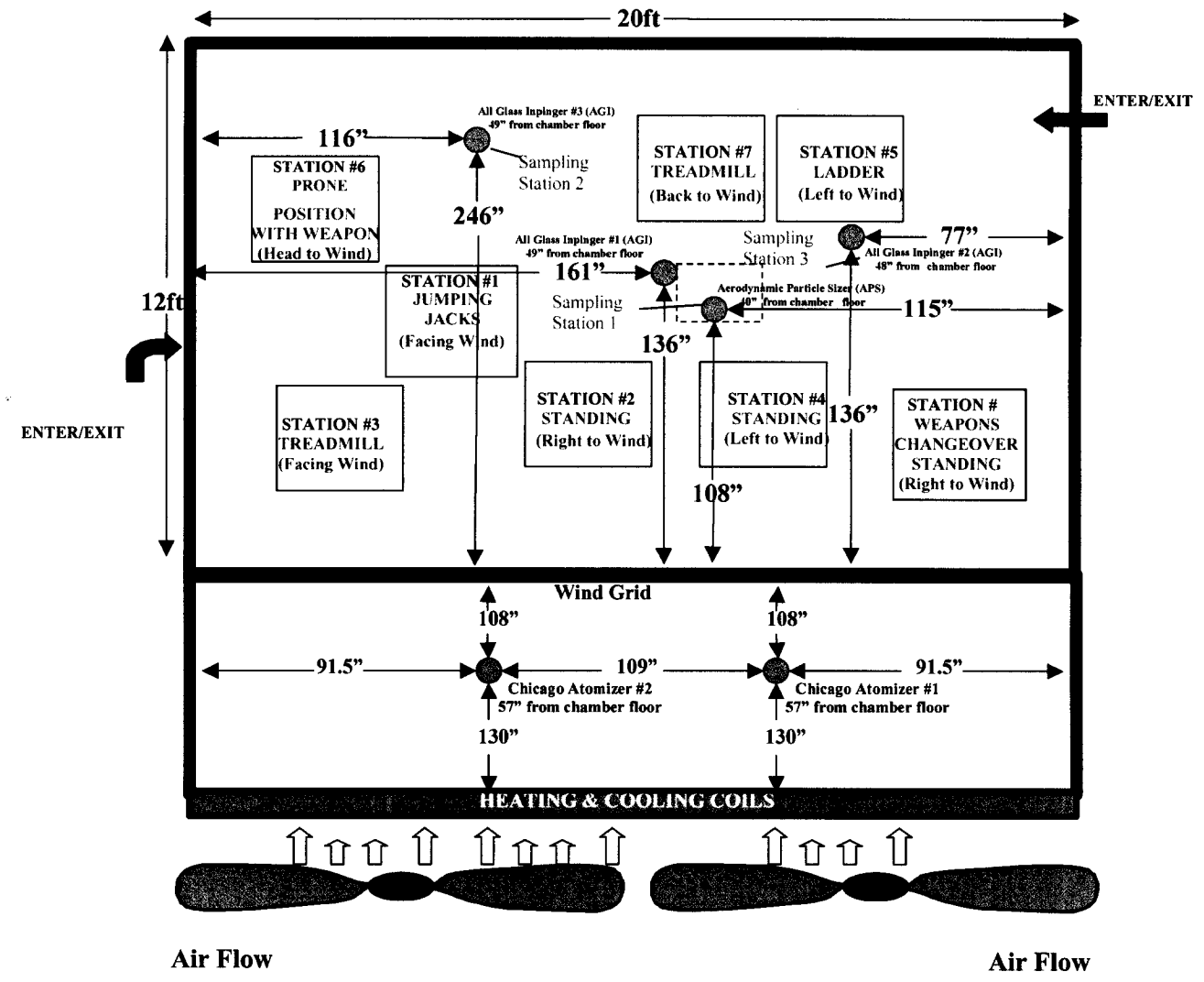

Figure D.1 Layout of DTC, sampling stations (1-3) and exercise stations (1-8)

APPENDIX E. PRELIMINARY DETERMINATION OF DEFICIENCIES, SHORTCOMINGS, AND SUGGESTED IMPROVEMENTS

1. PRELIMINARY DEFICIENCIES

   None

2. PRELIMINARY SHORTCOMINGS

   None

3. CORRECTED DEFICIENCIES AND SHORTCOMINGS

   None

4. SUGGESTED IMPROVEMENTS

   None.

APPENDIX F. EXERCISE ROTOCOL

1. Exercise equipment was placed in the test chamber at eight numbered positions. Test participants moved from station to station, in numerical order and performed the exercise required at each station (listed below).

Station 1:

Jumping jacks, facing wind

Station 2:

Standing rest, right side to wind

Station 3:

Treadmill, facing wind

Station 4:

Standing rest, left side to wind

Station 5:

Ladder, remove and replace blocks, left side to wind

Station 6:

Prone position with weapon

Station 7:

Treadmill, back to wind

Station 8:

Weapon changeovers, standing

2. The first participant entered the test chamber at station 1, and performed those exercises. After 5 minutes elapsed, the test participant advanced to the next station and the second test participant entered at station 1. This procedure continued until all test participants were in the chamber. The total time for each test participant was 60 minutes.

APPENDIX G. PERSONNEL SAMPLING LOCATIONS

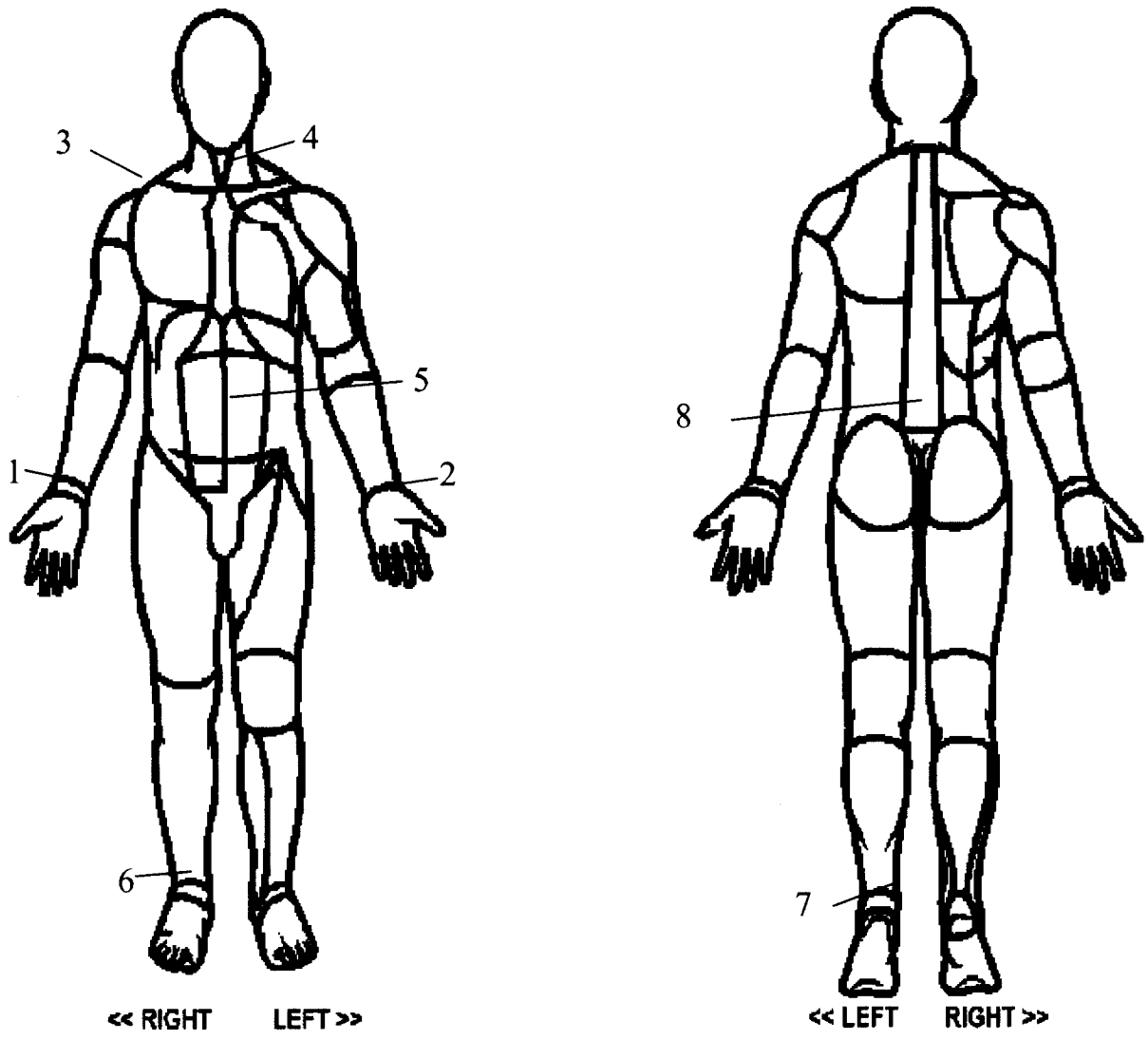

Figure G.1. Personnel swab sample points, each 4 x 4 in.

APPENDIX H. REFERENCES

1. U.S. Army Dugway Proving Ground (DPG), Utah, Formal Test Report (TR), WDTC-TR-99-081, Expedient Personnel Decon Procedure Validation, June 1999.

2. U.S. Army Dugway Proving Ground (DPG), Utah, Detailed Test Plan (DTP) WDTC-TP-01-114, Tactical Personnel Biological Decontamination Validation, December 2001.

3. U.S. Army Developmental Test Command (DTC), Aberdeen Proving Ground, Maryland, Test Operations Procedure (TOP) 10-2-022, Man-in-Simulant Test, September 2001.

4. U.S. Army Dugway Proving Ground (DPG), Utah, Biological Agent Summary Sheet, *Bacillus subtilis*, var. niger. Internet Site http://140.196.6.154/biosafety/agents/BASS_BG.txt.html

5. U.S. Army Dugway Proving Ground (DPG), Utah, Standing Operating Procedure (SOP) DP-0000-S-121, Operations of the Defensive Test Chamber, September 2001.

6. U.S. Army Dugway Proving Ground (DPG), Utah, Technical Report, WDTC-TR-00-018, Comparison of Swab-Sampling Techniques for Recovery of Bacterial Spores from Three Surfaces, June 2001.

APPENDIX I. ABBREVIATIONS

AGI – all-glass impinger

APS® – Aerodynamic Particle Sizer®

BWA – biological warfare agent

BDU – battledress uniform

BG – *Bacillus subtilis*, var. *niger*

CCL – contamination control line

cfu – colony forming unit

DPG – U.S. Army Dugway Proving Ground

DTC – Defensive Test Chamber

DTP – detailed test plan

EMT – emergency medical technician

HTH – high test hypochlorite

IAW – in accordance with

MIST – man-in-simulant test

NSWDG – Naval Special Warfare Development Group

PBS – phosphate-buffered saline

PVSMS – personal vital signs monitoring system

RH – relative humidity

RTM – real-time measurement

SOP – standing operating procedure

TD – test director

TOP – test operations procedure

TTPs – tactics, techniques, and procedures

WDTC – West Desert Test Center

APPENDIX J. DISTRIBUTION LIST

Addressee	Test Plan	Test Report
Applied Marine Technology Inc. (Mike Suter) 11166 Main Street Suite 302 Fairfax, VA 22030	1	1
U.S. Army Developmental Test Command (CSTE-DTC-TT-S) Aberdeen Proving Ground, MD 21005-5055	1	1
Defense Threat Reduction Agency Special Operations Programs Branch (TDSF) 6801 Telegraph Road Alexandria, VA 22310	2	2
Defense Technical Information Center 8725 John J. Kingman Road, Suite 0944 (OCC) Ft. Belvoir, VA 22060-6218	0	2
CBIAC Battelle Edgewood Operations P.O. Box 196 (Collection) Gunpowder Branch Aberdeen Proving Ground, MD 21010-0196	2	2
U.S. Army Dugway Proving Ground		
(CSTE-DTC-DP-WD-L/B. Harper)	2	2
(WD-JC/Technical Library)	2	2
(WD-S/M. Glass)	2	2
(CM-SA)	1	0
(PO) Dugway, UT. 84022-5000	1	0