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14. ABSTRACT This TOP provides basic information to facilitate test planning, conducting, and reporting, and achieving standardized chemical, biological, and radiological (CBR) contamination survivability testing of small items of mission-essential (ME) military materiel.						
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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

*Test Operations Procedure 08-2-111B
DTIC AD No.

16 March 2016

CHEMICAL, BIOLOGICAL, AND RADIOLOGICAL (CBR) CONTAMINATION
SURVIVABILITY, SMALL ITEMS OF EQUIPMENT

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1. SCOPE.

1.1 Background.

a. The classified U.S. Government Accountability Office (GAO) Report, Chemical and Biological Defense: Sustained Leadership Attention Needed to Resolve Operational and System Survivability Concerns, 30 May 2003 (GAO-03-325C^{1**}), identified several issues related to the ability of key defense systems to survive after being contaminated by nuclear, biological, and chemical (NBC) agents and subsequent decontamination. In response to that report, a chemical and biological (CB) contamination survivability (CBCS) implementation plan was developed that was responsive to GAO concerns about the survivability of defense-critical systems and the need for increased management oversight to ensure system survivability. Subsequently, several key elements of that program plan were codified in the Fiscal Year 2005 National Defense Authorization Act (NDAA), Section 1053, Survivability of Critical Systems Exposed to Chemical or Biological Contamination [Public Law (PL) 108-375]².

b. Consistent with PL 108-375, on 31 August 2005, the Under Secretary of Defense (Acquisition, Technology, and Logistics) [USD (AT&L)] issued an interim Department of Defense (DOD) policy on CBCS³.

c. On 9 May 2005, USD (AT&L) issued a memorandum that established final DOD CBCS policy⁴. The final policy replaced the interim policy and included a process for identifying defense-critical systems that needed to be survivable, instructions on how CBCS should be addressed by the Military Departments, a process for DOD oversight, and definitions of decontamination, hardness, and compatibility.

d. Following the issuing of the DOD CBCS policy, details of how the CBCS policy is to be implemented were written into the DOD Instruction (DODI) 3150.09⁵, which includes specific responsibilities of all the organizations impacted by the policy and also expands the survivability requirement to include radiological and nuclear survivability.

e. Additionally, a chemical and biological materials effects (CBME) database⁶ was developed to address another requirement of PL 108-375².

** Superscript numbers correspond to Appendix F, References.

1.2 Purpose.

a. The purpose of this Test Operations Procedure (TOP) is to standardize chemical, biological, and radiological (CBR) contamination survivability (CBRCS) of small items of equipment.

b. Testing may be conducted on full-scale models, scaled models, components, mock-ups, or on representative materials. Testing on the actual items is most desirable because of the information that can be gained, whereas testing on models, components, or mock-ups reduces realism in testing and the data must be extrapolated to the full-scale item. If it is not feasible and/or cost effective to use the actual item to determine survivability, then based on coordination between the tester, the customer, and the evaluator, testing alternatives will be considered and a choice for testing made. The hierarchy or logic for selection of tests is:

(1) Full System Testing - complete information on the ability of a system to meet the criteria. The use of the actual, full-scale, test item is the most reliable and realistic method for analyzing all aspects of the item's survivability. These aspects include analyzing for agent trapped in cracks, crevices, between components, in angles, in small or odd shapes not easily decontaminable, interfaces between dissimilar materials, and analyzing the item's textures and geometry for ease of decontaminability. The limitation of this type of testing is in being able to determine if any single or multiple materials of construction contribute a greater share to failure to meet a criterion.

(2) Scaled-Down Testing - a smaller version (e.g., one-quarter scale, etc.) will be used in place of the full-size version of the test item. Analysis of the test results must take into account the reduced accessibility into small crevices, etc. The test methods described in this document will still be used.

(3) Component Testing - information on the ability of a component or components to meet the criteria. The data can be extrapolated to the full system by compilation or addition with appropriate planning. If the component method is selected for testing to represent a large item, the procedures in this TOP will be followed.

(4) Coupons/Panels Testing - information on the ability of a set of materials to meet the criteria. More difficult to extrapolate to the full system because the impact of crevices, small spaces, etc. must be estimated or ignored. If coupon or panel testing is selected, the panels must be made from the same materials with the same coatings as the large item being analyzed. The procedures in TOP 08-2-061A⁷ must be followed.

(5) Mock-up Testing - The mock-ups may be specially fabricated to simulate the test item or may be the actual test item with expensive optical, electronic, or other internal components replaced with appropriate substitutes or removed. Mock-ups must be fabricated of the same materials, have the same coatings, and have similar design features as the intended test item. The mock-ups must be furnished and/or approved by the materiel developer. The similarities and differences between the mock-up and the test item it simulates will be carefully analyzed and then documented.

(6) Analysis - an analysis of the expected ability of the system to meet the criteria with the possibility of little or no agent data available for consideration. No actual testing conducted on the test item.

c. CBRCS is the capability of a system and its operators to withstand a CBR-contaminated environment, including decontamination, without losing the ability to accomplish the assigned mission. Characteristics of CBRCS are decontaminability, hardness, and compatibility; these characteristics are defined in Paragraphs 1.4.a through 1.4.c. Chemical and biological agent must be used to measure decontaminability and hardness for the full cycle (contamination, decontamination, and re-issue to the Warfighter). Simulants may be used in testing. When simulants are used, hardness can only be determined based on effects from decontamination methods, solutions, and/or mixtures. CBRCS should be monitored throughout the materiel acquisition cycle and must be analyzed during developmental and operational testing.

d. This TOP provides basic information to facilitate planning, conducting, reporting, and standardizing CBR survivability testing of military materiel small items. It is designed to demonstrate that small items of mission-essential (ME) equipment have met the provisions of Army Regulation (AR) 70-75⁸ as implemented by the Department of the Army (DA)-Approved Nuclear, Biological, and Chemical Contamination Survivability (NBCCS) Criteria for Army Materiel⁹ and outlined in Quadripartite Standardization Agreement (QSTAG) 747, edition 1¹⁰. DODI 3150.09⁵ outlines CBRCS requirements for mission-critical systems. To survive CBR contamination, materiel must meet criteria for decontaminability, hardness, and compatibility⁹. This TOP describes typical facilities, equipment, and procedures used to contaminate test items, sample for contamination density, decontaminate test items, sample for residual contamination, determine degradation of selected ME functions resulting from the contamination and/or decontamination (C/D) procedures, and analyze individuals in protective personal equipment/test-item compatibility.

e. Neutron-induced gamma activity (NIGA) is not addressed in this TOP. Information on NIGA and initial-blast effects can be obtained from other sources (e.g., Field Manual (FM) 3-11.3¹¹, and Allied Tactical Publication (ATP) 45C¹²).

f. The acronyms, CB and CBR, are used in this document, rather than NBC, to reflect current terminology in use within the DOD. North Atlantic Treaty Organization (NATO) documentation still uses the term NBC, and this will be reflected in references within this document.

1.3 Limitations.

a. This TOP only provides standard procedures for testing the contamination survivability of small items of equipment, such as equipment carried by an individual warfighter and removable sensitive equipment.

b. When testing is conducted using simulants for chemical agents or agents of biological origin (ABOs), the test data must not be used without the establishment of an agent/simulant relationship.

c. The procedures for radiological decontamination in this TOP pertain only to removal of simulated radioactive fallout particles or fallout from a radiological dispersal device (RDD). Radiological contamination survivability testing of equipment and systems, as specified in the NBCCS criteria⁹, includes NIGA and activity resulting from fallout of radioactive dust and debris. The induced activity creates physical changes to materiel properties, which remain even after removal of the radioactive dust and debris. Therefore, when determining the radiological contamination survivability of an item, the contributions from both sources must be considered. However, induced radiation cannot be removed or reduced by present CBR-field decontamination materials and procedures, and induced activity hazard testing requires different facilities, instruments, and safety considerations from those described in this document. Survivability from immediate nuclear blast effects and NIGA are not covered in this TOP.

d. The only criteria for CBRCS as listed in this TOP are for the Department of the Army⁹. Although there is an AR⁸ and a DODI⁵ covering CBRCS policy, there are no additional criteria from other DOD components. For acquisition programs that have CBRCS requirements, the default is to use the DA criteria¹⁰. These criteria are not for use in determining decontamination efficacy, but only CBRCS.

e. There are many factors that can affect the performance and/or survivability of a system before and after the conduct of decontamination operations. Many of these factors cannot be analyzed for their effects. An example would be the age of the paint on the surface (aged, new, etc.).

f. The only current mechanism for converting vapor concentrations of chemical agent into dosages is to use a downwind hazard prediction model¹³. Once a decontamination system performance model is developed with the necessary toolset, then that model may replace the current model.

1.4 General Criteria Analysis.

The following procedures must be used to analyze the ability of the test item to meet the criteria for decontaminability, hardness, and compatibility.

1.4.1 Decontaminability.

a. Chemical.

(1) Vapor Hazard. The effective concentration of chemical agent vapor desorbed from the test item over time is C_e . The mission time, the time during which the warfighter will be exposed or near the test item, is t . Then $C_e t = \text{dosage}$, which must be compared with the appropriate criteria⁹.

(a) Traditional vapor samplers (bubblers and solid sorbent tube (SSTs)) sample vapor streams for discrete periods of time usually of 2, 4, 6, hours or longer defined by a sampling plan. The bubbler solvent containing chemical agent or the SSTs with chemical agent residing on the sorbent bed are analyzed and the mass of residual chemical agent vapors collected is quantified. The volume of agent-laden air is determined by using restriction orifices or mass flow controllers to restrict the airflow through the sample chamber. The average vapor concentration during the sampling period is calculated by multiplying the mass of the chemical agent collected by the vapor sampler times the volume of air that passes through the sample chamber. The dosage is calculated by multiplying the agent vapor concentration by the time of sampling. The total dose is calculated by adding the dosage for all sample periods.

(b) The MINICAMS*** (a miniature, continuous air-monitoring instrument manufactured by OI Analytical, division of OI Corporation, College Station, Texas) is a near-real time (NRT) analytical instrument that can report vapor concentrations in less than 15 minutes. The air-sampling rate is controlled by an internal mass flow controller to 0.5 liters per minute (L/min). The sampling times (sample then analysis and purge) range from 3 to 15 minutes. The total dose is calculated by multiplying each vapor concentration by the total sample time.

(c) The size of the enclosure or vapor off-gas box used on test items can significantly affect the vapor data collected and must be given consideration when designing the test. If a small test item is placed in a large off-gas box, then the chemical agent vapor can be diluted by the large volume of air in the box resulting in an underestimation in the calculation of the total dose. Likewise, if a small test item is placed in an off-gas box only slightly larger than the item, then the chemical agent vapor has a large presence in the smaller volume of air, which can result in an overestimation in the calculation of the total dose.

(d) In order to deal with the issue of the results being influenced by the volume of the off-gas box, new methodology has been developed that normalizes the volume of the off-gas box used. Instead of reporting only a concentration or total dose, the toxic load of the airflow is calculated and used to characterize the test item emission rate. The emission rate can then be used to develop multiple scenarios with the test item and determine if any of the scenarios represent a vapor hazard. This methodology can be found in the Baseline Source Document Chemical Decontaminant Performance Evaluation Testing¹⁴ and TOP 08-2-060 Post-Decontamination Vapor Sampling and Analytical Test Methods¹⁵.

(2) Contact Hazard.

(a) The contact hazard is measured by analyzing a sampler for the mass of chemical agent that is absorbed from the contaminated surface. The mass of chemical agent per unit area of the sampler must be adjusted to the entire area of the test item that may be contacted by the warfighter to determine if a hazard exists.

*** The use of brand names does not constitute endorsement by the Army or any other agency of the Federal Government, nor does it imply that it is best suited for its intended application.

(b) This value must be compared with the appropriate mass value in Table 1 of the criteria for Army materiel⁹. This methodology does not take into account skin uptake rates and other toxicity factors.

b. Biological. Colony forming units (CFUs) are spores that have become viable cells. Biological decontaminability is determined by forming a ratio of the CFUs sampled after decontamination to the initial number of CFUs sampled when the test item was contaminated with the CFUs. This ratio is then expressed as the log reduction and compared with the appropriate criteria⁹.

(1) The ratio is calculated as follow:

$$\text{Log Reduction} = \text{Log}_{10}(\text{CFU}_{\text{final}} / \text{CFU}_{\text{initial}}) \quad \text{Equation 1}$$

(2) The criteria are based on spore count. It is impossible to realistically count individual spores, therefore, a CFU reduction of 6 logs (i.e., reduced by a factor of one million) is used as the pass/fail criteria. If the CFU reduction is ≥ 6 logs, then the test item has successfully met the criterion for biological decontaminability.

c. Radiological. Simulants are used for radiological testing. The simulants may include non-radioactive isotopes, short half-life isotopes, or a non-radioactive particulate. The method of analysis is to use the value of the initial contamination sample and subtract the value of the post-decontamination sample. The resulting difference is divided by the value of the initial contamination sample and multiplied by 100 to determine the decontaminability. When using particulate matter as a radiological simulant, this is calculated as follows:

$$\text{Result} = [(\text{Initial Number} - \text{Final Number}) / \text{Initial Number}] \times 100 \quad \text{Equation 2}$$

(1) If the value for decontamination efficacy for short half-life isotopes is less than or equal to the criterion⁹, then the item is considered to have successfully met the criterion for radiological decontaminability⁹.

(2) The value for decontamination efficacy for non-radioactive isotopes will be compared with the particulate challenge to determine the reduction of particulate matter. This assumes that a reduction of 50 percent of the radioactivity⁹ is equivalent to a 50 percent reduction of particulate matter.

1.4.2 Hardness.

a. CBR hardness is “the capability of materiel to withstand the material-damaging effects of CBR contamination and relevant decontaminations”⁵. Hardness of mission-critical materials against CBR contamination and decontamination may be tested at the coupon level in accordance with (IAW) TOP 08-2-061A⁷. Changes in critical physical/performance parameters will provide insight as to how the system may function following one or more contamination/decontamination (C/D) cycles. When the system is tested with a CBR simulant, the only meaningful data will be the hardness of the material/system to the decontaminant.

- b. The ME function characteristics will be obtained from the material developer (i.e., voltage output, airflow, pressure, etc.).
- c. The ME function characteristics will be initially measured on the test item for baseline functional performance.
- d. The C/D cycles will be performed. The same item-specific performance parameters will be measured after each C/D cycle.
- e. The post-C/D measurements will be compared to the initial performance measurements to obtain the percent degradation due to each C/D cycle.
- f. When requested by the developer, long-term effects (i.e., 30 days or greater), will include additional measurements of the selected functional parameters at scheduled time intervals after the last C/D cycle was completed.
- g. Multiple C/D cycles (more than the usual five cycles) also need to be considered in situations related to biological contamination not related to biological agents and regular transits from the U.S. to outside the U.S. (usually aircraft). This consideration is intended for military materiel in a civilian environment.

1.4.3 Compatibility.

- a. The ability to obtain data during developmental or laboratory testing is extremely limited and may have to be obtained during operational testing. Functions relating to the operation of the system being tested are measured while wearing normal uniforms and mission-oriented protective posture, level IV (MOPP IV). The percent difference in times to complete a set of tasks with the test items is calculated. If the time is not increased by more than 15 percent, the system has successfully met the criterion for compatibility.
- b. The ME warfighter tasks will be obtained from the user for the equipment under analysis.
- c. Tasks (timed) will be performed in the operator's standard clothing.
- d. Tasks (timed) will be performed in the CBRN protective ensemble.
- e. Times and effectiveness of the operator(s) will be compared.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

Facilities, instrumentation, and safety procedures used for CB survivability testing are strictly controlled. Additional discussion and requirements for facilities and instrumentation are included in the test procedures (Paragraphs 4.1 through 4.5).

<u>Item</u>	<u>Requirement</u>
Chemical surety laboratory and chemical agent storage facility.	Constructed to ensure safe and secure storage, handling, analysis, and decontamination of chemical agents.
Chemical agent test facility or chamber.	Constructed to allow C/D and extended residual hazard sampling of small items of equipment deliberately contaminated with chemical agent/simulant in a temperature- and humidity-controlled environment. The chamber must have sufficient volume to allow free air circulation around the test item. Ability to control temperature, relative humidity (RH), and wind speed is required.
Fielded decontaminating apparatus, as specified in the concept of operations (CONOPS).	Constructed to decontaminate the test item as part of the test procedure. Must not increase the hazard or degrade safety protocols when used in a laboratory.
Biological analytical laboratories.	Required to store and prepare test quantities of biological agent/simulant materials, to charge disseminating devices, to prepare samplers, and to analyze the biological agent/simulant materials.
Radiological simulant/isotope analytical laboratories.	Required to store and prepare test quantities of radiological or simulant materials, to charge disseminating devices, to prepare samplers, and to analyze all radiological simulant/isotope materials.
Chambers for biological and radiological simulant testing.	The chamber must be equipped with an air intake and an exhaust system, and must have sufficient volume to allow free air circulation around the test item. Biological surety regulations will be followed if biological surety material is used. Ability to set and maintain temperature and RH is highly desirable.

2.2 Instrumentation.

These values are minimum requirements. Actual instrumentation may have greater precision, and actual values must be reported.

<u>Parameter</u>	<u>Measuring Device</u>	<u>Permissible Error of Measurement</u>
Air temperature (-20 to 50 °Celsius (C)).	Thermocouple with digital recording capability.	±0.5 °C.
Relative Humidity (0 to 90 percent).	Humidity probe with digital recording capability.	±2 percent.
Airflow (0 to 5 meters per second (m/sec)).	Anemometer or similar device with digital recording capability.	±0.1 m/sec.
Photographs.	Still color camera.	Adequate resolution to document typical test procedures, details of contamination techniques and contamination density [including mass median diameter (MMD) of drops], and any discrepancies from planned procedures necessitated by operational conditions.
Video.	Video camera.	Adequate resolution and frames/second speed to document typical test procedures, details of contamination techniques and contamination density (including MMD of drops), and any discrepancies from planned procedures necessitated by operational conditions.

2.2.1 Chemical Test Instrumentation.

These values are minimum requirements. Actual instrumentation may have greater precision, and actual values must be reported.

<u>Parameter</u>	<u>Measuring Device</u>	<u>Permissible Error of Measurement</u>
Contamination density or challenge level (grams per meter squared (g/m ²)).	A control coupon will be used for the measurement of the actual contamination density applied.	±15 percent of challenge target
Chemical agent mass from vapor samples (microgram (µg)).	MINICAMS [®] , gas chromatograph (GC), high-performance liquid chromatography (HPLC), liquid chromatography (LC), spectrophotometer, or equivalent.	Instrument must be ±15 percent of calibration standard.
Chemical agent mass from liquid samples (µg).	GC, HPLC, LC, spectrophotometer, or equivalent.	Instrument must be ±15 percent of calibration standard.

2.2.2 Biological Test Instrumentation.

These values are minimum requirements. Actual instrumentation may have greater precision, and actual values must be reported.

<u>Parameter</u>	<u>Measuring Device</u>	<u>Permissible Error of Measurement</u>
Background contamination.	Microscopes, swabs or wipes placed in growth medium, automatic colony counters, or equivalent.	±10 percent CFU/sample.
Post-contamination verification.	Microscopes, swabs or wipes placed in growth medium, automatic colony counters, or equivalent.	±10 percent CFU/sample.
Post-decontamination.	Microscopes, swabs or wipes placed in growth medium, automatic colony counters, or equivalent.	±10 percent CFU/sample.

2.2.3 Radiological (Simulant) Test Instrumentation.

These values are minimum requirements. Actual instrumentation may have greater precision, and actual values must be reported.

<u>Parameter</u>	<u>Measuring Device</u>	<u>Permissible Error of Measurement</u>
Contamination measurement (background, post-contamination, and post-decontamination).	Non-isotope challenge: Microscopes or equivalent. Isotope (non-radioactive or short half-live) challenge: GC/mass spectrometry (MS), radiation detector, or equivalent.	± 5 percent particles/m ² . To be determined based upon instrument used.

2.2.4 CBR Hardness Test Instrumentation.

<u>Parameter</u>	<u>Measuring Device</u>	<u>Permissible Error of Measurement</u>
ME functions as described in specific CONOPS.	As necessary (optical haze, transmittance, durometer, tensile strength, etc.).	Precision and accuracy requirements must be compatible with the nature of the test item and type of function, but must allow for the detection of 20 percent degradation in the ME performance characteristic after completion of each of the required C/D cycles.

2.2.5 CBR Compatibility Test Instrumentation.

<u>Parameter</u>	<u>Measuring Device</u>	<u>Permissible Error of Measurement</u>
Operator performance tests	Stop watches or equivalent. Operator/crew ME functions (e.g., operating a computer, conducting maintenance operations, etc.) are timed and/or accuracy-based functions. The standards for ME functions are outlined in system-specific doctrinal and training publications or are established by the combat developer for that system.	Precision and accuracy requirements must be compatible with the nature of the test item and type of function being studied, but must allow for the detection of 15 percent degradation in the item/operator ME function performance.

The difference between the function performed with duty uniform and with MOPP IV allows a determination of the percent degradation of the task.

3. REQUIRED TEST CONDITIONS.

a. CBRCS testing requires the handling and use of chemical agents. Such testing is strictly controlled by AR 385-10¹⁶ for general safety, DA Pamphlet (PAM) 385-61¹⁷ for work with chemical agents, and by DA PAM 385-69¹⁸ for work with biological materials. Throughout testing, primary emphasis must be on operator and equipment safety. The importance of technical quality, completeness of test data, and conformance with specified test and operating procedures must be emphasized.

b. The required test parameters⁹ are temperature of 30 ± 2.0 °C and airflow across the test item less than 1.0 m/sec. There is no requirement for RH.

3.1 Test Planning.

a. Each CBRCS test plan must be reviewed for technical accuracy and conformance to regulations. Standing operating procedures (SOPs) applicable to the specific item and tests being conducted must also be reviewed. In addition, the test plan must accurately reflect the requirements outlined in capabilities documents. Published test records, procedures, and the case files of similar test items must be reviewed to identify potential problem areas that may be difficult to decontaminate.

b. The capabilities documents [initial capabilities document (ICD), capability development document (CDD), or the capability production document (CPD)], the CONOPS, and failure definition/scoring criteria (FD/SC) will be reviewed. The operational test agency (OTA) evaluation plan (OEP) and the test and evaluation master plan (TEMP) will be used to determine the overall test structure, data required, criteria, and analysis to be used. The ME function, performance characteristics, and the ME warfighter tasks specified by the materiel developer and the combat developer, respectively, will be listed. These will be used to measure degradation in performance caused by CBR C/D and by the need for the operator to wear the CBR protective ensemble. Units of measurement and the accuracy and precision required for each measurable parameter will be identified. All issues concerning measurable performance and degradation will be identified and reviewed.

c. Based on the information collected from the capabilities document, the OEP, the TEMP, and in coordination with the customer, the number of test items and the number of C/D cycles that need to be conducted on the system under test (SUT) will be determined. The NATO QSTAG¹⁰ dictates that a default of five C/D cycles will be conducted on each test item to

accommodate one radiological cycle, one biological cycle, and three chemical agent cycles for the three classes of CWA. It is possible that less than or more than five cycles may be required.

d. A realistic test-item sample size will be determined through review and coordination with the assigned operational test-activity evaluator. The sample size may be determined by test-item availability, cost, or other factors and may be less than optimum. If sample size is less than optimum, a testing scheme will be devised to optimize test-item use and required data output. The use of design-of-experiment will be considered in developing the test matrix.

e. Representative areas of the test item to be sampled for residual contamination will be selected and identified. If the entire test item/system cannot be contaminated and decontaminated, then representative areas for contamination, decontamination, and sampling will be selected. Selection of the sample locations will depend on consideration of overall test-item size, geometry of the test item, materials of construction, surface texture, presence of joints and crevices, areas handled/touched by system operators, and the likelihood to contribute to producing a vapor or contact hazard. Because of the nature of contact sampling devices, sample locations need to be flat or nearly flat. An appropriate number of such areas will be selected to help assure the statistical validity of the resulting number of samples. The test plan will identify and explain the rationale for the areas selected and the statistical-analysis methodology used. The test report will identify any changes from the test plan. Each sample location selected must be described and photographed. No additional marks must be placed within the marked boundaries of the locations to be sampled.

f. C/D cycles will be conducted using CBR agents and/or simulants and fielded decontamination systems and procedures. Actual survivability can only be confirmed by using actual agents. The default⁹ chemical agents are persistent nerve agent (VX), distilled mustard (HD), and thickened soman (TGD). A biological simulant is typically used in place of an ABO. Decontamination systems and decontaminants include, but are not limited to: reactive skin decontamination lotion (RSDL); the M295 Individual Equipment Decontamination Kit (IEDK); the M100 sorbent decontamination system; the M12; the M26; hot soapy water (HSW); and supertropical bleach (STB). Field-expedient decontaminants include, but are not limited to: high-test hypochlorite (HTH); household bleach solutions (usually a ratio of one part bleach to ten parts water); alcohol-wetted cloth (for sensitive or electronic equipment); and low-pressure, high-volume water. A brief summary of these decontamination system procedures is found in Appendix C.

g. If the system consists of materials similar to other systems already tested (e.g., either systems' cases are constructed of the same thermoplastic, or both systems are radios with one being larger than the other), then consideration may be given to conducting a CBR materiel survivability analysis as a cost-saving measure. Coordination with the test sponsor and the OTA conducting the system evaluation must occur before implementing this option. The test-item design and the materials of construction will be examined. The materials of construction will be reviewed to see if any data can be found in the CBME⁶ database, and an analysis will be performed based on previous test experience and technical information concerning the material's ability to survive exposure to contamination, decontaminants, and the decontamination process. If there are material effects data in the CBME, then it can be reviewed for applicability to the

current system. Any areas where a CBR agent could pool or seep, such as cracks, crevices, hinges, joints, countersunk screw heads, or other difficult to decontaminate features, will be noted. Any identifiable vulnerabilities, or questionable design or materials must be adequately tested. If the examination of the system design and the materials of construction reveal any aspect of design or identify a material that appears to make test failure probable, testing of the system or material must be performed early in the test cycle. Preliminary results can often be determined from a pilot study and analysis of the collected information. The report of the survivability analysis will detail the expected ability of the system to meet the CBCS criteria⁹.

h. For tests involving the use of simulants, qualified and trained operators and standard equipment (decontamination, maintenance, and calibration, etc. that warfighters would use with the system) must be scheduled. Standard decontamination procedures will be developed for the test item, if required. Before testing begins, rehearsals must be held to familiarize the test team with the functioning of the test item, test procedures, and data requirements. The team must practice using simulants until CBR agent-dispensing, decontamination, and sampling become routine. The test item used during the actual test must not be used in rehearsals with simulants unless it is the only test item available and testing will be conducted outdoors. It is recommended that one or more dry-runs be performed to give operators an opportunity to demonstrate, standardize, and become proficient with test procedures.

i. For tests involving actual CBR agents, the appropriate laboratory will be scheduled to conduct the test, and laboratory technicians will receive appropriate system operating and safety training before testing begins.

3.2 Environmental Documentation (United States Only).

An environmental assessment (EA) must be on file covering the storage, use, and disposal of the simulants, hazardous and contaminated materials, and chemical and biological agents used in CBRCS testing. The assessment must fully address the potential environmental impact of the specific survivability testing planned. The test plan must cite the EA and/or a record of environmental consideration (REC) that cites the EA and the appropriate categorical exclusion. The REC must be approved before testing begins. If the planned survivability testing is not adequately addressed in the existing EA, an EA specifically addressing the survivability testing to be conducted must be prepared, as required by the National Environmental Policy Act of 1969 (NEPA), PL 91-190¹⁹ and AR 200-2²⁰.

3.3 Safety.

Applicable safety, SOPs, and surety regulations will be reviewed to ensure all test procedures are in compliance. If military personnel are required, ensure a Test Schedule and Review Committee (TSARC) request is submitted one year prior to the start of testing, or as early as possible. A Safety Release (SR) and Human Resource Protection Plan (HRPP) must be obtained from the U.S. Army Evaluation Center (AEC) prior to using military personnel as test participants.

3.4 Quality Assurance (QA).

Controls and limitations applicable to a specific subtest are presented in Paragraph 4 as part of the procedure to which they apply.

a. A QA plan must be prepared for each test program to ensure that all variables that can be controlled are controlled and that appropriate records are kept throughout the duration of testing. Variables that cannot be controlled must be identified in the test plan. Test variables include, but are not limited to: purity and stability of CBR agents and simulants used, purity and stability of decontaminants, calibration and maintenance of instrumentation and disseminators, accuracy and precision of the laboratory instruments, and quality and uniformity of all test samples.

b. The condition of the test item at the time of testing is an important test variable. Unless receipt inspection was part of a subtest completed before CBRCS testing, the test item must be inspected IAW TOP 08-2-500²¹. Inspection data, certificates of compliance, or similar documentation, must be reviewed to ensure that exterior surfaces, finishes, and packaging meet specifications. The item must be tested in as-received condition, matching its condition when issued to warfighters in the theater of operations as closely as possible. CBRCS testing may be required periodically throughout the equipment life cycle if the effect of normal wear is a major factor in survivability.

c. Decontamination. Existing system-specific decontamination procedures using fielded decontaminants or developmental decontaminants must be reviewed and incorporated into the planned test as much as possible. Any deviations from existing procedures in the test plan must be documented in the test report.

d. Test Conduct. Testing must always be conducted IAW approved test documentation, such as technical manuals, field manuals, equipment operating instructions, SOPs, the approved test planning directive, OEP, TEMP, and the test plan. Deviations from test documentation will be put in writing and approved by the appropriate authority as part of the test plan and report.

4. TEST PROCEDURES.

The CBR components of CBR contamination survivability testing are addressed separately in Paragraphs 4.1 through 4.3. Although the test methods are similar, subtle but important differences exist. Long-term CBR hardness and CBR compatibility are discussed in Paragraphs 4.4 and 4.5.

4.1 Chemical Agent Contamination Survivability.

4.1.1 Objectives.

a. Decontaminability. Determine the ability of a system to be rapidly (less than 75 minutes)⁹ and effectively decontaminated following chemical agent exposure. Measure the vapor and percutaneous or contact residuals, including eye effects, associated with warfighter use

of equipment that has been contaminated with chemical agent and decontaminated using standard and/or item-specific decontamination procedures. Use the residuals to determine if a hazard exists.

b. **Hardness.** Determine the capability of a system to withstand the material damaging effects of chemical agent and relevant decontamination processes. Measure the degree of performance degradation in ME functions of military ME materiel after each C/D cycle by standard and/or item-specific procedures.

c. **Compatibility.** Determine the degree of degradation in ME warfighter tasks as a result of operating a piece of equipment in CBR protective ensemble (e.g., MOPP IV).

NOTE: The process for identifying mission-critical equipment is outlined by DODI 3150.09⁵. ME functions are those functions that define the successful completion of a mission for the system or equipment being tested as defined by the test sponsor and/or combat developer in the FD/SC.

4.1.2 Criteria and Conditions.

4.1.2.1 Criteria.

a. Mission-critical equipment shall be hardened to ensure that exposure to the specified C/D cycle does not degrade the operational ME performance of the equipment more than 20 percent (or that specified by the combat developer) measured over a 30-day period⁹, or as defined by the capabilities documents.

NOTE: As an example, if the faceplate of a protective mask had a transmittance of 99 percent and after five cycles of decontamination the transmittance is measured as 97 percent, then the degradation is calculated as $[(99 - 97)/99] \times 100 = 2$ percent.

b. The exterior surfaces of materiel developed to perform ME functions shall be designed so that chemical contamination remaining on or in the item or desorbed from the surface following decontamination shall not result in more than a negligible risk (5 percent mild incapacitation) to unprotected individuals using the equipment or within 1 meter of the item/equipment after a chemical agent C/D as stated in the criteria⁹.

4.1.2.2 Conditions.

General conditions are as follows:

a. Selected exterior areas will be initially contaminated (random drop pattern over the selected area) to a uniform contamination density as specified in the system threat assessment and capability documents (default of 10 g/m²) with 5 to 10 μL sized drops of TGD and 2 to 5 μL sized drops of HD, or VX. The chemical agents VX, HD, and TGD, are required for testing by the DA-Approved NBCCS Criteria for Army Materiel⁹. The selection of areas to be contaminated is based upon the concept that there will be a “rain” of airborne contamination onto

the item. The “rain” is usually considered to come at a 30-degree angle from the vertical. Therefore, there is an expectation that only the top and two adjacent sides of the test item will become contaminated.

b. The purity of the chemical agents must be known (preferably 85% or greater) and recorded as test data. A purity certification must be provided with the chemical agent used for testing. The quantity applied may be adjusted to achieve the required pure agent contamination density. If weapons-grade agent is used, the purity must be measured and recorded as test data. If simulant testing is necessary, a simulant/agent correlation must be fully documented.

c. The amount of time between contamination and the start of decontamination operations (often called weathering or age time) will depend on requirements in the capability documents. The default weathering time is 60 minutes. Given changes in battlefield doctrine, the default weathering time may not be representative of the actual travel time from a contamination site to a decontamination site. Weathering time must be coordinated with the test sponsors and combat developers. Standard field and/or item-specific decontaminants, equipment, and procedures will be used if they exist and are available. The decontamination procedure conducted and time between C/D cycles will be included in the test plan for each system or equipment item. The decontamination process time (excluding point detector monitoring during operational testing) will be recorded.

d. When CBRCS testing is conducted in a chamber housing the test item, the chamber and item surface temperature will be 30 °C, and wind speed over the test item will be no greater than 1 m/sec⁹.

4.1.2.3 Controls and Limitations.

The controls and limitations for chemical agent/simulant contamination survivability testing are:

a. Surface of the test item.

(1) Surface areas selected for contact sampling must be representative of the surface materials, texture, paint, and areas where the user will have direct contact.

(2) Before each trial, the surfaces of the test item must be inspected and sampled (vapor and contact) for background contamination. Any foreign substances on the test item surface that could interfere with sampling the surface or with analytical instrumentation must be removed before testing.

b. Analysis control data include standard analytical controls (see Paragraph 4.1.4.6). The instrument calibration need not be composed of standards at equal concentration intervals. Rather, the standards must be spaced closer together near the low-concentration end of the calibration curve.

c. Test controls (vapor and contact) must include:

(1) Vapor only: When using a SST, bubbler, or similar sampler, a non-operated sampler control (a sampler taken into the area surrounding the test item but not used, opened, or aspirated).

(2) Vapor only: Operated sampler control (a sampler taken into the area surrounding the test item and used, opened, or aspirated, but not exposed to CBR agent or simulant) or a background sample.

(3) Positive control, which is a test item or coupon contaminated but not decontaminated.

(4) Negative control, which is a test item or coupon that is not contaminated, but is decontaminated.

d. Instrument calibration will be recorded as part of the test record and will include the calibration requirement (yearly, semiannual, etc.).

4.1.3 Data Required.

The following data will be reported in the units indicated:

- a. Test Chamber/Fume Hood.
 - (1) Temperature in °C.
 - (2) RH in percent.
 - (3) Wind speed (airflow) in m/sec.
- b. Agent or Simulant.
 - (1) Name and control number.
 - (2) Purity in percent.
 - (3) Viscosity after adding thickener in centistokes (cSt).
 - (4) Age since thickened, if thickened.
 - (5) Name, product identity, and manufacturer of dye, if used.
 - (6) Quantity of dye and/or thickener in g/L, if thickened.
 - (7) Quantity of agent/simulant dispensed in g.
 - (8) Agent/simulant contamination density in g/m².

- (9) Agent/simulant drop volume in μL .
- c. Results of each post-decontamination agent/simulant vapor (collected during the 12-hour sampling period) and contact sample in $\mu\text{g}/\text{sample}$.
 - d. Results of the sampling and analysis controls and standards in $\mu\text{g}/\text{sample}$.
 - e. Sample history with elapsed time to analysis in days.
 - f. Complete description of the contact sampler used (material type, manufacturer, diameter, thickness, and any other pertinent information). Description of any contact sampler efficacy and/or solvent extraction efficacy studies conducted on the contact sampler and solvent used for extraction.
 - g. Contamination, weathering, decontamination, and sampling times in minutes.
 - h. Description of the decontamination solutions (i.e., formulation, active ingredients, lot number, and age), methods, equipment, and item-specific procedures used.
 - i. Description and photographs of the test-item exterior surface condition (pretest), including construction materials, paint type, paint thickness (number of coats), paint condition, and surface cleanliness (e.g., mud, grease, and other).
 - j. Pretest (baseline) and posttest (30 days after the first contamination and/or other defined long-term time interval) ME functional performance data, recorded to the highest level of accuracy and precision commensurate with the parameter being measured.
 - k. Descriptions and photographs of test-item cracks, crevices, and other features that could allow contaminants or decontaminants to penetrate below the surface and may be difficult to decontaminate.
 - l. The stain size on the surface, if any, caused by the agent and decontaminants, if safety procedures permit and if this information is desired.
 - m. A description of the required contact-sampling times specified.
 - n. Description and photographs of any materials degradation (e.g., corrosion).
 - o. Identification of the C/D cycle event.
 - p. Relevant safety findings as a result of testing.
 - q. Test-item description.

r. Locations of contaminated surfaces, the contamination area, and total surface area contaminated.

s. Interior volume of vapor sampling boxes.

4.1.4. Methods and Procedures.

4.1.4.1 Test Method Outline.

a. Receipt inspection will be conducted to document initial test item conditions. Receipt inspection may include functional performance tests to establish baseline performance parameters (e.g., computer is operational, aircraft avionics are operational). Paragraph 4.1.4.7 describes further details.

b. The agents/simulants will be prepared for application as described in Paragraph 4.1.4.8.

c. Test item will be prepared for testing, to include sample location, identification and documentation, marking of sample areas; etc. Paragraph 4.1.4.9 describes further details.

d. Laboratory hood or test chamber operation will be verified and environmental conditions for the test stabilized. Environmental conditions are monitored, the test item is allowed to equilibrate with the ambient conditions, and any required background samples are taken before contamination IAW Paragraph 4.1.4.10.

e. Agents/simulants are applied to the item under test. Paragraph 4.1.4.11 describes further details.

f. Decontamination operations will be conducted on the item under test as described in Paragraph 4.1.4.12.

g. Post-decontamination vapor and liquid (contact) sampling and sample analysis will be conducted as described in Paragraph 4.1.4.13.

h. Sample analysis will be performed as described in Paragraph 4.1.4.14.

i. Hardness determination, including post-decontamination functional performance measurements, will be performed IAW Paragraph 4.1.4.15.

j. Data presentation and hazard determination will be performed IAW Paragraph 6.2.

4.1.4.2 Significance and Use.

a. The sample data collected from this test allow a determination of contact and vapor hazards to unprotected personnel from decontaminated military materiel.

b. The functional performance and/or material effects data collected allow a determination of the amount of physical or functional degradation of the system resulting from CB C/D procedures and materials to determine if there is a hardness issue.

4.1.4.3 Interferences.

There are no interferences when the test method is conducted under laboratory controlled conditions.

4.1.4.4 Apparatus.

a. The term apparatus will be used to cover the test fixture in which a test method may be conducted, as well as the equipment used in conducting testing, sampling, and analytical instrumentation.

b. Special fixtures may be required for vapor sampling because of the wide variety of sizes and shapes of systems that could be tested. Some fixtures will have to be manufactured to fit the size of the test system and still remain in an agent-capable fume hood or chamber. Each fixture should be capable of maintaining airflow around the test item, allowing operators to easily reach the test item for agent application, decontamination, and to perform contact or residual liquid sampling. Additional methodology may be required to perform vapor sampling (see Paragraph 4.1.4.13).

c. The instrumentation used in test method conduct, sampling for residual liquid and vapor, and the analytical equipment for sample analysis are found in Paragraphs 2.2 and 2.2.1.

4.1.4.5 Hazards.

a. Identified safety hazards are those associated with testing using chemical agents as well as simulants and decontaminant chemicals that are hazardous in and of themselves (e.g., chlorine, hydrogen peroxide). Chemical agent safety guidelines are found in DA PAM 385-61¹⁶.

b. A test plan must be developed with a safety section identifying and addressing all safety concerns for each test conducted using these methods IAW AR 385-10¹⁵. The safety section of the test plan will be coordinated with the test site's safety office.

4.1.4.6 Analytical Instrument Calibration.

a. The following chemical analytical calibration guidelines can be used for most chemical analytical equipment (e.g., GCs, LCs). A sample sequence will be created that includes the following:

- (1) A solvent blank to analyze method interferences.
- (2) Calibration standards (ranked low to high or high to low) with at least five standards.

- (3) A solvent blank to analyze instrument carryover from sample to sample.
 - (4) Quality control (QC) sample to validate the calibration curve, at least one sample per detector (if multiple detectors are installed on the same instrument) including control samples.
 - (5) Another solvent blank.
- b. The same method will be used to analyze all samples.
 - c. Using the instrument software (where available), the calibration curve should be built from lowest to highest.
 - d. Calibration plot information will be analyzed as follows:
 - (1) The appropriate curve fit type (linear, quadratic, etc.) will be selected.
 - (2) The appropriate point weighting (equal, inverse, etc.) will be selected.
 - (3) If correlation value (R^2) is greater than 0.995, then test sample analysis will proceed.
 - (4) If R^2 is less than 0.995, then the standard solution producing the calibration point with the largest deviation will be replaced. A new calibration curve will be generated before processing test samples.
 - e. If all criteria are met, the QC sample will be loaded and processed against the calibration curve.
 - f. The calculated values for the QC sample must be within ± 15 percent of the expected value.
 - g. If the QC calculated value passes, then the sample analysis will proceed.
 - h. If the QC calculated value fails, then a second QC sample will be run.
 - i. If the second QC calculated value passes, then the sample analysis will proceed.
 - j. If the second QC calculated value fails, then corrective actions and the instrument will be recalibration.
 - k. After any maintenance action to the instrument, two QC samples must pass the ± 15 percent criteria or corrective actions and recalibration must be performed.

4.1.4.7 Receipt Inspection and Functional Performance.

a. Test items must be inspected for shipping damage, completeness of assembly, required accessories, and necessary manuals, logbooks, etc. Any missing components, damage, or other discrepancies noted will be documented.

b. Surfaces will be inspected for foreign materials normally not present on the item (e.g., dust, mud, grease, or marking). Foreign materials may be removed by brushing, vacuum cleaning, or washing with soapy water and sponge. The removal of foreign materials will minimize the bias that could create an over/under estimate of the true contamination survivability of the system being tested. The surface condition, surface cleanliness, corrosion, materials of construction, variance from standard painting, and paint condition will be recorded.

c. The test item will be operated IAW the operator's manual. ME functional performance characteristics (e.g., electronic functions, shelter setup) identified by the combat developer (e.g., in the failure definition/scoring criteria) must be measured and recorded. Based on the selected functional performance characteristics, each functional performance characteristic must be designated as either a functional performance attribute (go or no-go) or as a functional performance variable measured over a continuous range of values. Each parameter must be measured at least twice and must be recorded to the smallest significant unit of measure. If any damage, surface condition, or ME functional performance characteristic falls outside developer specifications, then testing will not proceed.

4.1.4.8 Agents/Simulants.

a. The chemical agents to be used are as follows:

(1) Neat VX with a purity greater than 85 percent, unless weapons-grade is desired.

(2) Neat soman (GD) with a purity greater than 85 percent unless weapons-grade is desired, and thickened with 5 percent (weight/volume) of Rohm and Haas Acryloid™ K125 poly(methyl methacrylate). This should provide thickened agent with a viscosity of roughly 1,000 cSt at 20 °C. During preparation, batch-to-batch variability in viscosity may be greater than 10 percent. This large variability can be reduced by slowly adding the thickener over long periods of time. Complete solution of the polymer in GD is slow; therefore, mixing must continue until the measured viscosity varies less than 10%.

(3) Neat HD with a purity greater than 85 percent, unless weapons-grade is desired.

(4) The minimum quantification level for HD is 50 µg, for GD is 2.5 µg, and for VX is 250 ng.

(5) Any of the chemical agents may be prepared with approximately 0.5 percent (weight/volume) of a suitable dye.

(6) Other approved contaminants [e.g., toxic industrial chemicals (TICs), toxic industrial materials (TIMs), etc.] as specified in requirements documents and the TEMP.

b. Simulants to be used are specified in the test plan. Simulants may be prepared with a suitable dye or thickener.

4.1.4.9 Test Item Preparation.

Sample locations will be marked to ensure samples are taken from the same area. The area markings must outline the total area. Sample location identifiers must be outside the marked area.

4.1.4.10 Fume Hood/Test Chamber Operation.

The test chamber will be operated using the procedures, controls, and SOPs used to approve the chamber and/or those approved for the agent. Some general technical data requirements for the test chamber are:

a. The test chamber environmental conditions must be computer-monitored and data will be recorded at least every 15 minutes. The environmental conditions will include air temperature, RH, wind speed, test-item surface temperature, and pressure (chamber interior versus chamber exterior).

b. The test item will be placed in the chamber and the chamber stabilized at the environmental conditions specified for the test. The test item will be permitted to reach equilibrium with the chamber. Temperature and RH will be recorded continuously throughout the test.

c. Before agent contamination, background swab and vapor samples must be taken from or near areas designated for contamination testing. The sampling and analysis must be tailored to detect materials that could interfere with the chemical analysis for the agent to be used.

4.1.4.11 Agent/Simulant Application and Weathering.

a. The mechanism for determining the actual amount of agent or simulant used to contaminate the test item is called a baseline contamination sample or dose confirmation sample. The data collected from these samples will provide confidence that the agent/simulant dissemination method performed well and also provide the value for initial contamination (C_i) when calculating the decontamination efficacy (in percent) using the formula $[(C_i - C_d)/C_i] \times 100$; where C_d is the residual contamination after decontamination operations. Baseline samplers will be placed adjacent to the test item for actual contamination density analysis. The samplers will be contaminated before contamination of the test item.

b. The selected areas of the test item will be contaminated with agent or simulant. The contaminant will be applied with a suitable dissemination device that has been calibrated and operated at the flow rate and pressure to achieve the drop size and contamination density specified in Paragraph 4.1.2.2.a and/or the test plan. Precision dissemination device (e.g.,

pipette) calibration must be current and compliant with the required performance specifications listed in the most current versions of the International Organization for Standardization (ISO) 8655 Parts 1 and 2²² or American Society for Testing and Materials (ASTM) E 1154-89²³ for the volumes being delivered.

c. Contamination density samplers will be removed and placed into a container with the appropriate type and quantity of solvent, sealed tightly, labeled, and transported to a chemical laboratory for analysis.

4.1.4.12 Decontamination of the Test Item.

a. Standard procedures, decontaminants, and equipment (see Paragraph 2 of FM 3-11.5²⁴ and Appendix B) and/or any test item-specific procedures, when supplied as part of the test-documentation package (e.g., technical manual), will be used. A summary of decontamination procedures is in Appendix C.

b. A C/D cycle consists of the contamination event, the weathering period (representing travel time), and the decontamination procedure.

c. Decontamination of the test item will proceed when any required weathering time is complete (e.g., 60 minutes).

d. Decontamination will begin with areas contaminated first, proceed in the same sequence as the agent was applied, and end with areas contaminated last.

e. If a test item is considered personal equipment (e.g., weapon, rucksack, etc.) or sensitive equipment (e.g., electronics, optics, etc.), then an immediate decontamination procedure may be required (see FM 3-11.5²⁴). Personal equipment will be decontaminated using the M295 IEDK. There is no fielded decontamination system for sensitive equipment, but an alcohol-wetted cloth can be used (see FM 3-11.5²⁴).

f. The thorough decontamination process includes the following steps:

(1) Equipment preparation, usually consisting of a HSW wash-down.

(2) Application of the decontaminant. Application of all currently fielded decontaminants requires brushing or scrubbing (see FM 3-11.5²⁴).

(3) Decontaminant contact time (default is 30 minutes, but varies by decontaminant; some decontaminants may require continual application to remain wet throughout the contact time) (see FM 3-11.5²³).

(4) Post-decontamination clean water rinse to remove residual decontaminant and contaminant.

(5) Point detector monitoring for residual contamination.

g. All times for each phase of the procedure must be recorded, except the time to monitor for residual contamination.

h. Decontamination procedures must be performed as if the entire surface of the test item has been contaminated. The contaminated sampling areas will receive no more or no less attention, time, or effort than uncontaminated areas. Appropriate time will be spent on angles and areas that are difficult to decontaminate.

i. Decontamination procedures must be documented. Video documentation is recommended, but still photographs can be used.

4.1.4.13 Post-Decontamination Sampling.

a. Agent Contact Sampling.

(1) Contact samplers [a thin disk of latex dental dam (1 mm thick) or other suitable material] will be prepared with a nominal size of 10 to 25 cm². Any material used for a contact sampler must be free of powder. The contact sampler must be backed by aluminum foil (Figure 1) to prevent contamination of the weight. When the sampling area is not even or contains irregularities, a material such as sponge rubber is inserted between the aluminum foil and the weight to force contact with all surface irregularities. The assembled sampler will be placed on the selected area creating a pressure of 0.05 to 0.07 kg/cm² (or 0.7 to 1.0 psi) evenly applied for 15 minutes. For the 2-inch diameter sampler, this is equivalent to a 2-inch diameter cylindrical mass of 1 kg. Additional contact samplers can be sequentially placed on the same area, for selected intervals of time up to a total of 60 minutes.

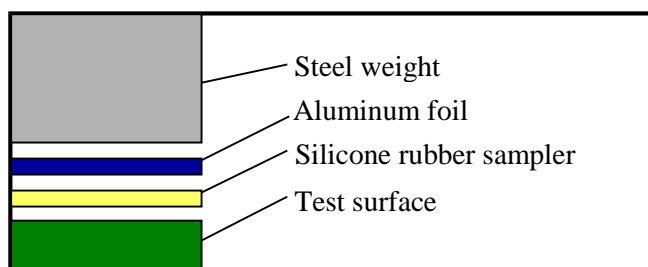


Figure 1. Diagram showing arrangement of test surface, silicone rubber disk, and steel weight for residual chemical agent liquid sampling.

(2) After reaching the appropriate time interval established by the test plan, the contact sampler will be immediately removed. The sampler and aluminum foil will be placed in a sample jar filled with the appropriate type and quantity of solvent. The jar will then be sealed and transported to a chemical laboratory for analysis.

(3) If possible, two contact samples will be taken from each area selected for contact sampling. The 0-hour sample shall be taken immediately after the decontamination rinse has dried. Samples shall be taken at intervals determined in the test plan as necessary for the specific CONOPS of the test item (e.g., how long a human might be expected to lean on, touch, or hold the area sampled).

b. Vapor Sampling.

(1) When the surfaces of the sampling areas are no longer visibly wet after the clean water rinse, vapor sampling can begin. To determine residual vapor hazard, the decontaminated item must be placed in a temperature-controlled sampling box, or other enclosure of appropriate size to fit the item. For reproducible results, the box must have the following characteristics or features:

(a) It must have interior surfaces made of stainless steel or other material that is non-sorptive for agent/simulant.

(b) The box must generally fit the item with unobstructed airflow around the item but without excessive free air space that will allow pockets of agent/simulant vapor to remain for long periods of time.

(c) The box must be vented to allow it to be initially flushed, on command, with clean outside air (approximately one air exchange per minute for 4 minutes), and constructed to provide air (agent/simulant vapor) sampling ports.

(d) The interior of the box will be sampled for residual agent/simulant vapor before being used.

(2) Exact box shape and dimensions must be calculated when the size and shape of the test item are known.

(3) A minimum of two vapor samples (three samples are desirable) must be obtained for any time interval unless a NRT sampler is used. A vapor-sampling sequence must be specified in the test plan.

(4) Contaminated air will be aspirated through the sampling equipment at the appropriate rate and for the desired length of time (typically up to 12 hours). Typically, MINICAMS[®] are aspirated at a rate of 0.5 L/min; SSTs may be aspirated from 0.5 to 1.2 L/min; and glass impingers (bubblers) are aspirated at a rate of 1.0 L/min.

(5) Samples will be taken at appropriate intervals (as coordinated in the test plan) that total the duration of the mission time described in the CONOPS. Generally, more agent vapor will be given off during the first few hours of sampling and slowly decrease over time. Thus, sampling intervals must be short in the beginning and longer sampling intervals later, when using cumulative sampling devices (e.g., bubblers or SSTs). This will avoid saturating any sampling device. A minimum of two SSTs must be obtained for any time interval (three samples are

desirable), with the second sampler serving as a backup to the first sampler. A vapor-sampling sequence must be specified in the test plan. MINICAMS[®] are NRT samplers, and the sample time setting selected will be determined to avoid saturating the detector.

4.1.4.14 Sample Analysis.

Sample analysis must use test instruments and methods that give precise and accurate values for the primary data parameters (see Paragraph 4.1.4.6). Data from military chemical alarms, detectors, detector papers, and kits (provide only qualitative yes/no answers) may be used to complement data obtained from more precise analytical instruments.

4.1.4.15 Hardness Determination.

a. After completion of all decontamination and sampling procedures, all surfaces of the test item will be inspected for visible evidence of leakage and degradation caused by the agents, decontaminants, and decontaminating procedures. Signs of material degradation may include corrosion, peeling paint, discoloration, brittleness of rubber components, hazing or yellowing of plastic components, etc. Any degradation must be described and documented with photographs.

b. The test item must be operated IAW the appropriate manual. ME functional performance characteristics must be measured and recorded. Each parameter must be measured at least twice. Any visible evidence of operational degradation will be recorded. The hardness and ME performance data collected must be comparable with the pretest values recorded (Paragraph 4.1.4.7.c).

c. Hardness data collection must be performed after each C/D cycle and 30 days (or the specified time interval in the test plan) after the first contamination. Hardness data must be sufficiently accurate and precise to define any degradation after each C/D cycle and the specified time period.

4.2 Biological Contamination Survivability.

4.2.1 Objectives.

a. Decontaminability. Determine the ability of a system to be rapidly (less than 75 minutes)⁹ and effectively decontaminated following exposure to an ABO or simulant. Measure the associated hazards with warfighter use of equipment that has been contaminated with biological agent and decontaminated using standard and/or item-specific decontamination procedures.

b. Hardness. Determine the capability of a system to withstand the material damaging effects of biological agent and/or relevant decontaminations. Measure the degree of performance degradation in ME functions of military mission-critical materiel after biological agent C/D by standard and/or item-specific procedures.

4.2.2 Criteria and Conditions.

4.2.2.1 Criteria.

a. Materiel developed to perform ME functions shall be hardened to ensure that exposure to the specified CBR C/D cycles does not degrade the ME performance of the equipment more than 20 percent or that specified by the combat developer measured over a specified time or mission duration. The number of C/D cycles for biological survivability must consider pandemic events and the requirements imposed by the affected countries.

b. After decontamination, residual contamination levels for the equipment must constitute a negligible risk to unprotected users of the equipment (see QSTAG 747¹⁰). In the determination of biological survivability, the following CBRCS test conditions apply.

4.2.2.2 Conditions.

a. General Conditions. The time frame to start decontamination depends on the CDD, CPD, or test plan requirements. Standard field and/or item-specific decontaminants, equipment, and procedures will be used.

b. Detailed Conditions. If not already specified in the capabilities document, then the detailed conditions⁹ for biological contamination survivability testing are as follows:

- (1) Chamber temperature: 30 ± 3 °C.
- (2) RH: ambient ± 2 percent.
- (3) Test chamber air speed: < 1 m/sec.
- (4) Exterior contamination density: $1 \pm 0.5 \times 10^7$ CFU/m².
- (5) Particle size: 1 to 5 μ m.

4.2.2.3 Controls and Limitations.

The controls and limitations for the test items and sample analysis controls of biological agent contamination survivability testing are as follows:

a. Test Item Controls.

(1) Paint type, specifications, and application must comply with the system specification for the test item.

(2) Surface areas selected for sampling must be representative of the surface materials, texture, paint, and areas where the user will have direct contact.

b. Sample and Analysis Controls.

- (1) Swab control (unused swab).
- (2) Swab of a non-contaminated surface.
- (3) Diluent control.
- (4) Plate control.
- (5) A maximum of 18 hours between sample collection and culturing.

4.2.2.4 Data Required.

a. Test Chamber/Hood.

- (1) Temperature in °C.
- (2) RH in percent.
- (3) Wind speed (airflow around the test item) in m/sec.

b. Agent or Simulant.

- (1) Name, control number, and spore manufacturer.
- (2) Diluent used.
- (3) Percent solids.
- (4) Date prepared and/or reconstituted.
- (5) Date used.
- (6) CFU per mL.
- (7) Dissemination equipment used.
- (8) Quantity of agent/simulant suspension disseminated in mL.
- (9) Disseminator air pressure in pounds per square inch (psi).
- (10) Dissemination time in seconds.
- (11) Still color photographs and written description of each area contaminated.

(12) Contamination results for each sampling area (including background) before and after decontamination, expressed in CFU/sample.

c. Chamber air concentration level (calculated) immediately after dissemination, expressed in CFU/L of air.

d. Sample history with elapsed time to analysis in hours.

e. Elapsed time required to complete contamination, weathering time before decontamination, decontamination time, and time each sample will be taken in minutes.

f. Description of decontaminating solutions (i.e., formulation, active ingredients, and age), methods, equipment, lot number, and item-specific procedures used.

g. Description of test item surface condition (pretest and posttest), materials of construction, paint type, and surface cleanliness (e.g., mud, grease, decontamination materials, and other). Photographs must be made of joints, crevices, textures, or other areas that may be difficult to decontaminate or allow liquid to penetrate.

h. Pretest and posttest ME functional performance characteristics used as the measure of the test item's mission performance before and after exposure to contaminants, decontaminants, and decontamination procedures.

i. Description of any safety issues.

4.2.3 Methods and Procedures.

4.2.3.1 Test Method Outline.

a. The agents/simulants are prepared for application. Paragraph 4.2.3.6 describes further details.

b. Receipt inspection is conducted on the SUT to document as tested material conditions. Receipt inspection may include functional performance tests to establish baseline performance parameters (e.g., computer is operational, aircraft avionics are operational, etc.). Paragraph 4.2.3.7 describes further details.

c. Test item is prepared for testing to include: sample location, identification, and documentation; marking of sample areas; etc., as described in Paragraph 4.2.3.8.

d. Disseminator Preparation. Paragraph 4.2.3.9 describes further details.

e. Test Chamber Operations. Test chamber operation will be verified and environmental conditions for the test stabilized. Environmental conditions are monitored, the test item allowed to equilibrate with the ambient conditions, and background samples are taken before contamination. Paragraph 4.2.3.10 describes further details.

- f. Agents/simulants are applied to the item under test IAW Paragraph 4.2.3.11.
- g. Post-contamination samples (contamination density verification) will be taken as described in Paragraph 4.2.3.12.
- h. Decontamination operations will be conducted on the item under test IAW Paragraph 4.2.3.13.
- i. Post-decontamination sampling will be conducted IAW Paragraph 4.2.3.14.
- j. Sample analysis will be performed IAW Paragraph 4.2.3.15.
- k. Hardness and post-decontamination functional performance measurements will be performed IAW Paragraph 4.2.3.16.
- l. Data presentation and hazard determination will be performed IAW Paragraph 6.3.

4.2.3.2 Significance and Use.

- a. The sample data collected from this test allows a determination of biological spore hazards to unprotected personnel from decontaminated military materiel.
- b. The functional performance and/or material effects data collected will allow a determination of the amount of physical or functional degradation of the system resulting from CBR contamination, decontamination procedures, and materials, to determine if there is a hardness issue.

4.2.3.3 Interferences.

There are no interferences when the test method is conducted under laboratory controlled conditions.

4.2.3.4 Apparatus.

- a. The term apparatus will be used to cover the test fixture in which a test method may be conducted as well as the equipment used in conducting testing, sampling, and analytical instrumentation.
- b. Special vapor fixtures may be required because of the wide variety of systems that could be tested (e.g., night vision goggles, laptops, a mockup of a larger item). Each fixture will have to be manufactured to fit the size of the test system. Each fixture must be capable of maintaining airflow around the test item, allowing operators to easily reach the test item for agent application, decontamination, and to perform sampling.

c. The instrumentation used in test method conduct, sampling for residual biological organisms, and the analytical equipment for sample analysis are found in Paragraphs 2.2 and 2.2.2.

4.2.3.5 Hazards.

a. To address any hazards in working with the selected biological simulants, all safety protocols will be followed. Biological safety guidelines are found in DA PAM 385-69¹⁷.

b. There are safety issues using decontaminants that are hazardous¹⁷ (e.g., chlorine, hydrogen peroxide, etc.).

c. A test plan must be developed with a safety section identifying and addressing all safety concerns for each test conducted using these methods IAW AR 385-10¹⁵. The safety section of the test plan will be coordinated with the test site's safety office.

4.2.3.6 Biological Agent/Simulant Preparation.

a. The rationale for the selection and use of any biological simulants and the agent/simulant relationship must be documented in the test report.

b. Procedure controls and SOPs in effect at the time the chamber was approved for biological simulant testing must always be followed.

c. The biological organism (agent or simulant) used for testing will be characterized for proper particulate size profile (1 to 5 μm) and quality of spore preparation (greater than 95 percent spores).

d. As new decontaminants are developed, a live agent efficacy test must be conducted for screening purposes. In addition, it is possible that biological simulants currently used will not be appropriate and a new simulant must be selected. If a new simulant is selected, an agent/simulant relationship must be established. The rationale for simulant selection, agent/simulant relationship, and live-agent efficacy test results must be documented in the test report.

4.2.3.7 Receipt Inspection and Functional Performance.

A receipt inspection and a pretest ME functional performance test, as described in Paragraph 4.1.4.7, will be performed if not previously performed as part of another phase of the CBRC test.

4.2.3.8 Test Item Preparation.

Sample locations must be marked to ensure samples are taken from the same area. For biological contamination survivability, three closely located 25 cm^2 sample areas for each location selected must be marked (Figure 2). At each sampling location, three samples will be

collected: (1) background, (2) post-contamination, and (3) post-decontamination. Only the boundary of the area must be marked. No markings must be made within the boundary. Sample location numbering or other designation must be marked outside the boundary.

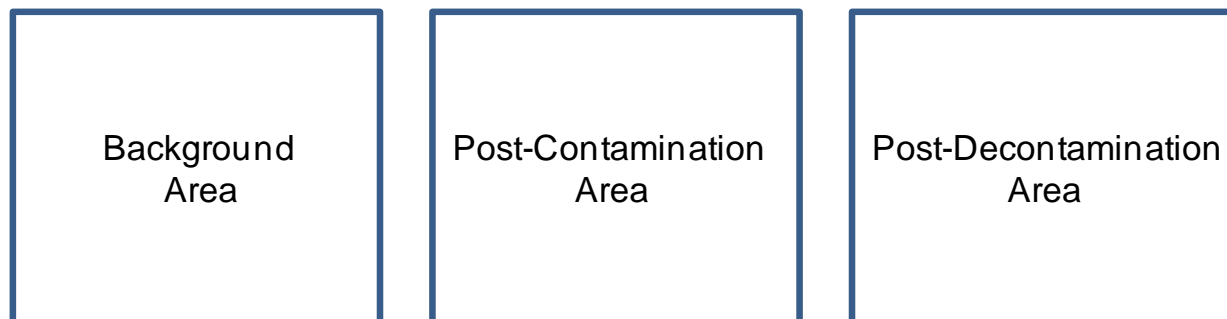


Figure 2. Example of three closely located sampling areas with sampling sequence indicated.

4.2.3.10 Test Chamber Operations.

a. The test chamber will be brought to the environmental conditions specified for the test, and the test item will be placed into the chamber. The test item will be temperature-conditioned for a minimum of 2 hours. The temperature, RH, and wind speed will be recorded for the duration of the test.

b. Before proceeding to contamination of the test item, the first 25 cm² sampling area at each sampling location must be swab sampled to determine the background contamination level and residual substances (decontaminant) that could interfere with sample assay.

4.2.3.11 Agent/Simulant Application.

The dry powder disseminator will be used to apply the contaminant to the test item. One hour must be allotted for contamination to settle on the test item. After the settling, the chamber will be air-washed for 1 hour to reduce chamber contamination.

4.2.3.12 Contamination Density Sampling.

Immediately after the air-wash, the second 25 cm² area in each sampling location will be swab sampled to determine the contamination density at that location.

4.2.3.13 Decontamination of the Test Item.

a. Decontamination will begin immediately after contamination density sampling. Standard decontamination procedures, solutions, and equipment, or any test item-specific procedures furnished as part of the test documentation package will be used. Typically, a diluted

bleach/water solution (1 liter bleach mixed into 9 liters water, which gives a 10 percent dilute bleach solution) is used.

b. Decontamination procedures must be performed as if the entire surface of the test item has been uniformly contaminated. Appropriate time must be spent on rough surfaces, joints, angles, and hard-to-clean areas.

c. All decontamination procedures, equipment, tools, and time used in the decontamination process, including item-specific procedures, must be recorded.

4.2.3.14 Post-Decontamination Sampling.

When the test-item surface is dry following decontamination, the third 25 cm² area in each sampling location will be swab sampled to determine the residual contamination remaining on the test item.

4.2.3.15 Sample Analysis.

Analysis of biological samples will be conducted IAW test site SOP.

4.2.3.16 Hardness Determination.

a. After biological decontamination is complete and the final set of swab samples has been taken, the test item will be visually inspected for evidence of degradation (e.g., corrosion, paint peeling, yellowing of plastics, etc.) caused by the test procedures. The test item will be operated, and all ME functional performance characteristics will be measured and recorded. Each parameter will be measured at least twice, depending on the inherent difficulty in reproducing a specific value. Post-C/D values will be compared with pretest values.

b. Any visible indication of operational degradation attributable to the biological C/D cycle(s) will be recorded.

c. After completion of the simulant or agent exposure, all surfaces of the item will be inspected for visible evidence of agent ingress or degradation caused by the agents. Degradation will be described and documented with video or photographs. The test item will be operated in protective ensemble IAW the appropriate manual. ME functional performance characteristics will be measured and recorded. Each parameter will be measured at least twice. Test operators will be interviewed, and all evidence of operational degradation will be recorded. The hardness data collected must be comparable with the pretest values recorded (Paragraph 4.1.4.7.c).

4.3 Radiological Contamination Survivability.

4.3.1 Objectives.

a. Decontaminability. Determine the capability of a system to be rapidly (less than 75 minutes)⁹ and effectively decontaminated following exposure to radioactive particulates.

Measure hazards associated with the warfighters' use of equipment contaminated with radioactive particulates and decontaminated using standard and/or item-specific decontamination procedures. **NOTE:** The activity considered in this test would result from residual radioactive particulates such as fallout from a nuclear weapon or radiological dispersal device.

b. Hardness. Determine the capability of a system to withstand the material-damaging effects of radioactive particulate and/or relevant decontaminations. Measure the degree of performance degradation in ME functions of military mission-critical materiel after a radioactive particulates C/D cycle by standard and/or item-specific procedures.

4.3.2 Criteria and Conditions.

4.3.2.1 Criteria.

a. Decontaminability. The exterior surfaces of materiel developed to perform ME functions shall be designed so that radioactive contamination remaining on, or desorbed from, the surface following decontamination shall not result in more than a negligible risk to unprotected users of the item⁹. In the determination of risk level, the conditions listed in Paragraph 4.3.2.2 apply.

b. Hardness. Mission-critical equipment shall be hardened to ensure that exposure to radiological C/D cycles does not degrade the operational ME performance of the equipment more than 20 percent or as specified by the combat developer when measured over a 30-day period⁹ or as defined by the capabilities documents.

4.3.2.2 Conditions.

a. General Conditions.

(1) The sequence of events for the decontamination process will be IAW the CDD or test plan requirements. Standard field and/or item-specific decontaminants, equipment, and procedures will be used, if available.

(2) Hazard levels will be calculated assuming an exposure time, based on the CONOPS/concepts of employment (COEs), as specified by the combat developer.

b. Detailed Conditions⁹.

(1) Test chamber: temperature 30 ± 5 °C.

(2) Ambient RH.

(3) Airflow (air circulation over the test item): <1 m/sec.

(4) Radioactive fallout simulant. Short half-life isotope must have no more than 185 Gigabecquerel (GBq)/m² gamma activity.

- (5) Fallout simulant particle size: 37 to 200 μm .
- (6) Exterior target simulant contamination density: 4 g/m^2 .
- (7) Sampling and counting controls: test-item background control, laboratory control, and sample-counting control.
- (8) Surface areas selected for sampling must be representative of the surface materials, texture, paint, and the areas where the user will have contact with the item.
- (9) Contamination weathering time before decontamination begins will be 1 hour after completion of contamination.

4.3.3 Controls.

Instruments must be properly calibrated.

4.3.4 Data Required.

- a. Description of the test-item exterior materials of construction, paint type, and surface condition, including cleanliness (e.g., mud, grease, and other). Photographs of joints, crevices, textures, or other objects that may prove difficult to decontaminate.
- b. Photograph and written description of each area selected for sampling.
- c. Chamber: temperature in $^{\circ}\text{C}$, RH in percent, and airflow in m/sec .
- d. Complete simulant description, including (as applicable): source, lot number, particle count/g, and particle size range in μm .
- e. Disseminator used, operating air pressure in psi, dissemination time in seconds, mass of simulant disseminated (in grams), and calculated chamber-air contamination density in particles/L of air.
- f. Test-item background particle counts, test-item surface contamination density counts, test-item residual contamination (post-decontamination) in particles/ cm^2 , and QC values.
- g. All pertinent test event times and sample times in minutes.
- h. Description of decontamination equipment, methods, and solutions (if used), and any item-specific decontamination procedures and special devices used.
- i. Results of the visual inspection of the test-item surfaces after each C/D cycle.

j. Pretest (baseline) and posttest ME functional performance data used to determine test-item hardness (degradation).

k. Description of any safety issues.

4.3.5 Methods and Procedures.

Simulants that are used must have documentation provided with the rationale for selection and particle size range.

4.3.5.1 Test Method Outline.

a. Receipt inspection and pretest ME function baseline measurements are conducted to document as-tested system interior conditions. These procedures are in Paragraph 4.3.5.6.

b. Test item preparation procedures will include sample location, identification, documentation, and marking of sample areas (Paragraph 4.3.5.7).

c. Background sampling procedures are in Paragraph 4.3.5.8.

d. Test chamber operations procedures are in Paragraph 4.3.5.9.

e. Simulant application procedures are in Paragraph 4.3.5.10.

f. Post-contamination samples (contamination verification) taken are listed in Paragraph 4.3.5.11.

g. Decontamination operations on the item under test are listed in Paragraph 4.3.5.12.

h. Post-decontamination sampling procedures are in Paragraph 4.3.5.13.

i. Sample analysis will be conducted IAW Paragraph 4.3.5.14.

j. Hardness determination procedures are in Paragraph 4.3.5.15.

k. Data presentation procedures are in Paragraph 6.4.

4.3.5.2 Significance and Use.

The sample data collected from this test allow a determination of radiological hazards from decontaminated military materiel to unprotected personnel.

4.3.5.3 Interferences.

None.

4.3.5.4 Apparatus.

Testing may be conducted in a variety of chambers such as the one described in Paragraph 4.2.3.4 for the biological C/D phase of testing.

4.3.5.5 Hazards.

Short half-life isotopes are a personnel hazard and will require proper licensing, storage, monitoring, handling, and disposal procedures. Non-radioactive isotopes do not require similar licensing and monitoring procedures, and would not present radiological hazards to personnel.

4.3.5.6 Receipt Inspection.

A receipt inspection and pretest ME functional performance test, as described in Paragraph 4.1.4.7, will be performed if not previously performed as part of another phase of CBRCS testing.

4.3.5.7 Test-Item Preparation.

Sample area preparation will depend upon the type of simulant used.

a. For non-isotope sampling, three closely located 4-cm² sampling areas (see Figure 2) will be identified and marked. Only the boundary of the area must be marked. No markings must be made within the boundary. Sample location numbering or other designation must be marked outside the boundary.

b. When using non-radioactive isotopes or short half-life isotopes, sampling areas, especially where particulates may collect, such as crevices, rough surfaces, and corners, will be identified and marked. These same areas may be used for background, post-contamination, and post-decontamination sampling.

4.3.5.8 Background Samples.

a. For non-isotope counting only, before contamination, the first of the three collocated sampling areas will be sampled to determine if a background contamination level exists that could interfere with sample analysis. Sample collection methodology must be described in the test plan.

b. For non-radioactive or short half-life isotopes, a background sample will be taken at each sample location. The short half-life isotope sampling will be conducted using a quantifying radioactivity detector. The detector capabilities and limitations will be described in the test plan.

4.3.5.9 Test Chamber Operation.

The test chamber will be brought to the environmental conditions specified for the test, and the test item will be placed into the chamber. The test item will be permitted to reach thermal equilibrium with the chamber for a minimum of 2 hours.

4.3.5.10 Simulant Application.

- a. The disseminating apparatus will be calibrated for the simulant application.
- b. The simulant will be disseminated onto the test item(s).
- c. One hour will be allowed for contaminant settling.

4.3.5.11 Contamination Density Sampling.

- a. For non-isotope counting only, after contamination, the second of the three collocated sampling areas will be sampled following the procedure in Paragraph 4.3.5.8.
- b. For non-radioactive or short half-life isotopes, a post-contamination sample will be taken at each sample location following the procedure in Paragraph 4.3.5.8.

4.3.5.12 Decontamination Procedures.

- a. Decontamination will begin immediately after contamination density sampling. Standard decontamination procedures, solutions, and equipment or any test item-specific procedures, furnished as part of the test documentation package, will be used.
- b. Decontamination procedures will be performed over the entire surface of the test item. Appropriate time must be spent on rough surfaces, joints, angles, and hard-to work areas.

4.3.5.13 Post-Decontamination Sampling.

- a. For non-isotope counting only, after decontamination, the third of the three collocated sampling areas will be sampled following the procedure in Paragraph 4.3.5.8.
- b. For non-radioactive or short half-life isotopes, a post-contamination sample will be taken at each sample location following the procedure in Paragraph 4.3.5.8.

4.3.5.14 Sample Analysis.

Non-radioactive isotopes will be submitted for analysis using appropriate techniques and instrumentation that will be described in the test plan. Any rationale for selection of the analytical methodology will be included.

4.3.5.15 Hardness Determination.

a. After radiological decontamination is complete and the final set of samples has been taken, the test item will be visually inspected for evidence of degradation (e.g., corrosion, paint peeling, yellowing of plastics, etc.) caused by the test procedures. The test item will be operated, measured, and all ME functional performance characteristics will be recorded. Each parameter will be measured at least twice, depending on the inherent difficulty in reproducing a specific value. The post-C/D values will be compared with pretest values.

b. Any indications of operational degradation attributable to the radiological C/D cycle will be recorded.

4.4 Long-Term Chemical, Biological, Radiological (CBR) Hardness.

4.4.1 Objective.

Determine the long-term (as specified in the capabilities documents, but greater than 30 days⁹) effects of CBR contamination and CBR decontamination procedures following all C/D cycles.

4.4.2 Criterion.

None. There is no criterion for hardness determination for a time period greater than 30 days.

4.4.3 Long-Term Hardness Determination.

At the conclusion of the long-term period, the test item will be visually inspected for evidence of degradation caused by the combination of all test procedures. The test item will be operated, and all ME functional performance characteristics will be measured and recorded. Each parameter will be measured at least twice, depending on the inherent difficulty in reproducing a specific value. The posttest values will be compared with pretest values. Procedures and data required are the same as those described for chemical hardness in Paragraph 4.1.4.15.

4.5 CBR Compatibility.

4.5.1 Objective.

Determine the capability of a system to be operated, maintained, and re-supplied by persons wearing a full protective ensemble (MOPP IV). Measure the degree of degradation in ME warfighter tasks pertaining to operating a piece of equipment in MOPP IV or equivalent CBR-protective ensemble.

4.5.2 Criteria.

The combination of equipment and CBR protective clothing shall permit performance of ME operations, communications, maintenance, resupply, and decontamination tasks by trained and

acclimatized troops over a typical mission profile in a contaminated environment not to exceed 12 hours within the following conditions:

- a. In meteorological conditions of areas of intended use.
- b. With no degradation, excluding heat stress, degradation of crew performance of ME tasks will be no greater than 15 percent below levels specified for these tasks when accomplished in a similar non-NBC environment⁹.

4.5.3 Controls and Limitations.

- a. The protective gloves used as part of the laboratory protective equipment are very similar to fielded gloves that are part of the CBR protective equipment or MOPP IV worn by warfighters. The test operator will record any compatibility issues based on loss of tactility or ability to manipulate buttons, knobs, or dials in the use or operation of the test item.
- b. Testing laboratories cannot truly replicate the meteorological conditions of a variety of operational environments.

4.5.4 Data Required.

- a. A listing of ME tasks identified by the combat developer for the equipment undergoing CBR compatibility testing must indicate how each task is to be measured and whether the function is to be classified as an attribute (go, no-go) or a variable measured over a specified range.
- b. Baseline ME performance characteristics for the equipment must be determined.
- c. ME tasks and equipment performance must be measured with operators attired with and without laboratory or CBR protective equipment.
- d. Out-of-tolerance performance, breakdowns, or other anomalous performance occurring during compatibility tests will be documented.

4.5.5 Methods and Procedures.

4.5.5.1 Test Method Outline.

- a. Each test item operation will be conducted at least once with the operator dressed in normal clothing (Paragraph 4.5.5.7.b).
- b. Each test item operation will be conducted at least once with the operator dressed in protective clothing (Paragraph 4.5.5.7.b).
- c. The time required to conduct the operation or each distinct portion of a total operation (Paragraph 4.5.5.7.c) will be measured.

d. Compatibility degradation will be determined and the data presented as shown in Paragraph 6.6.

4.5.5.2 Significance and Use.

This testing will acquire data that will allow a determination of the impact of wearing MOPP IV ensemble on the ability of warfighters to perform operations and/or maintenance functions on the SUT.

4.5.5.3 Interferences.

None.

4.5.5.4 Apparatus.

No specialized apparatus is needed for compatibility testing.

4.5.5.5 Hazards.

None.

4.5.5.6 Test Planning and Preparation.

a. Only limited compatibility testing can be conducted in a laboratory. The majority of this testing and data collection will occur during operational testing.

b. A scenario specifying functions and operations to be analyzed during a typical mission profile must be prepared. It will include a list of the test item to be used and the sequence of tasks to be measured. The exact measurements to be taken, the sequence in which they are taken, and the instrument or measuring device used will be clearly specified. The scenario must ensure that all functions or tasks identified as essential are executed and analyzed.

c. A sufficient number of rehearsals must be performed to ensure that equipment familiarization is not a factor in the compatibility determination.

4.5.5.7 Test Conduct.

a. Equipment to be tested will be operated and maintained in strict compliance with operating manuals, instructions, and SOPs. When performing maintenance tasks, only tools and repair procedures specified for the equipment will be used.

b. The scenario must be performed once in normal clothing and another time in protective clothing.

c. The time required to conduct the operation or each distinct task of a total operation will be measured.

5. DATA REQUIRED.

The data requirements for each of the specific subtests are identified along with each of the subtests described in Section 4.

6. PRESENTATION OF DATA.

Test information must be placed in the Automated Test Incident Reporting System (ATIRS) or other data collection system format for review by all interested parties. Test-item failures will be scored by the information included in the ATIRS and the FD/SC.

6.1 Receipt Inspection.

Decontaminability data must include a description of the test item or mock-up, identifying any damage and specific conditions of the surface to be exposed to chemical agents, biological spores, or radiological fallout simulant. Receipt inspection photographs are important. Differences between the mock-up and the test item must be described. Receipt inspection photographs of exterior materials, construction, paint, cleanliness, joints, and crevices will be required.

a. All data on item damage, missing components, surface condition, other discrepancies, and test-item history must be reported. Results will be summarized and presented in tabular form, including surface cleaning or maintenance performed, and emphasizing deviations from developer specifications.

b. Mock-up receipt-inspection data will be reported, noting differences between the mock-up and the test item.

c. Data pertaining to surface materials and their finishes will be reported in a form that can be compared with pretest and posttest hardness functional performance data.

6.2 Chemical Contamination Survivability.

a. Chemical decontaminability will be determined by comparing posttest residual chemical agent with established criteria for each chemical agent (Paragraph 4.1.2.1). The item will be considered chemical agent decontaminable if residual vapor and contact hazard are reduced to levels at or below the established decontamination criteria⁹.

b. Each sampling area, including the location, material of construction, surface geometry, and surface texture, will be described. Each description will cite the contaminant, contamination procedure, decontaminant, and the decontamination procedures used, including item-specific procedures and time expended on each procedure. A description of pertinent information will be

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included in the test report. Decontamination operation video coverage and/or still photographs will be made.

c. A summary of the fume hood/chamber conditions during the test period will be tabulated. The chemical agent physical properties, contamination density, and the drop size on each item or sampling area, will be presented, and deviations from specified values will be identified.

d. The quantity of chemical agent recovered from each contact sampler, identified by the location and time at which the sample was taken, will be tabulated.

e. The quantity of chemical agent recovered from each contact sampler, identified by the location and time at which the sample was taken, will be tabulated.

f. The average concentration of chemical agent vapor recovered from each test-item sampling location identified by time period must be represented in table format.

g. The downwind hazard prediction model¹³ will be used and the calculated dosages will be compared with the DA approved NBCCS criteria for Army materiel⁹.

(1) No simple procedure exists for determining vapor hazard to the test-item operator(s). The credible dosage received is a function of chemical agent desorption from the decontaminated test item, worst-case or other selected scenarios that have almost unlimited variables, and the established “no effects” criteria.

(2) One newly developed approach^{14, 15} would be to calculate toxic load from the chemical agent vapor dosages measured from a test item. This approach allows the toxic load calculations to be transferred to exposure scenarios on a case-by-case basis, depending on the test item and its expected use in the field.

h. If an item fails the decontaminability criterion, an attempt should be made to identify the material composition responsible for the failure. Failure of the decontaminability criterion may necessitate the testing of individual materials.

i. When three or more identical test items are used in any C/D cycle, statistical analyses conducted on all test results will be presented.

j. All ME function performance data, identified by test-cycle number, agent, and decontaminant, will be summarized and tabulated.

k. ME function performance data for each C/D cycle will be compared with the receipt inspection performance data. The ME performance data and operator interview data will be used to determine whether more than 20 percent degradation in item performance (or that specified by the combat developer) has occurred (Paragraph 4.1.2.1.a). Significant results will be highlighted and discussed.

1. A sample analysis table of chemical agent and decontaminant effects is provided as Table 1.

TABLE 1. SAMPLE DATA FORM.

ANALYSIS OF CHEMICAL AGENT AND DECONTAMINATION EFFECTS ON THE WIDGET X			
Component	Material	Agent Effects	Decontaminant Effects
Plate	Sheet titanium, grade 2	Not expected to have any effect.	Not expected to have any effect.
Foam element no. 1	Cushioning material, packing closed cell foam planks	Expected to absorb and desorb chemical agents and trap nuclear and biological agents. May disintegrate when exposed to chemical agents.	May disintegrate when exposed to decontaminants.
Sealant	Manganese dioxide cured polysulfide compound	There is no data in the CBME database for manganese dioxide. Polysulfide is expected to absorb and desorb chemical agents.	There is no data in the CBME database for manganese dioxide.
Sealant	Aerospace Sealant, part no. ABCD-12	Will sequester chemical agents and may pose an off-gassing hazard with agent vapors if directly contaminated with chemical agents.	May cause hardening or swelling of the sealant, which may weaken the seal.
Rivet	Stainless steel	Not expected to have any effect.	Not expected to have any effect.

6.3 Biological Contamination Survivability.

a. Each sampling area will be described (inclusion of photographs is encouraged), including the location, materials of construction, surface geometry, and surface texture. The decontaminant, decontamination time, and decontamination procedures used, including item-specific procedures furnished by the materiel developer, will be recorded.

b. The chamber conditions during the test period will be summarized and described. A description of the test organism's physical property data and aerosol disseminator operating data will be recorded. Any deviations from target values will be identified and explained.

c. For each material/location, the following will be summarized: the CFU recovered from the control samples, the chamber air-contamination level, the test item contamination level, and the residual sample level after decontamination, including any residual sample values obtained after subsequent decontaminations.

d. The decontamination reduction ratio achieved by the decontamination process (the item challenge contamination level divided by the residual contamination level) for each sampling location will be calculated. The CFUs (spores that have become viable cells) that are sampled after decontamination will be divided by the number of CFUs sampled after contamination of the test item. This reduction ratio will be expressed as the log reduction. The reduction ratio and the raw challenge and residual data will be presented in tabular form. The item will successfully meet the criterion⁹ for biological decontaminability and be considered decontaminable for biological agent if the contamination of the system has a 6 or greater log reduction.

e. The biological hardness determination will be the same as for chemical hardness and the procedures are the same as those described in Paragraph 4.1.4.15.

6.4 Radiological Contamination Survivability.

a. In the test report, each sampling area will be described (photographs are desirable), including the location, materials of construction, surface geometry, and surface texture. The decontaminant, decontamination time, and the decontamination procedures used, including item-specific procedures furnished by the materiel developer, will be recorded.

b. The chamber environmental conditions will be presented.

c. Complete simulant description will be recorded.

d. Disseminator operating data will be recorded. Any deviations from target values will be identified and explained.

e. The data for each sample location (background, post-contamination, and post-decontamination) will be presented in tabular form.

f. For the non-isotope or non-radioactive isotope data, the reduction ratio achieved (i.e., the item challenge contamination level divided by the residual contamination level) will be calculated and included in the data table. If the reduction ratio is 50 percent or greater, the system will be considered decontaminable.

g. For the short half-life isotope data, the calculated decontamination values will be compared with the CBRCS criterion and included in the data table. The item will be considered decontaminable for radiological particles if the contamination is reduced to levels below the established criterion⁹.

6.5 Long-Term CBR Hardness.

Hardness data will be presented in a format to show direct comparison of pretest and post-test exposure ME function performance of the test item. Any visible effects will be recorded. The long-term hardness determination will be performed in the same manner as the same as chemical hardness as described in Paragraph 4.1.4.15.

6.6 CBR Compatibility.

a. Test-item performance data will be summarized and presented in tabular form. The time taken to perform the operation with protective clothing will be subtracted from the time taken to perform the operation without the same protective clothing. The differences in performance attributable to type of clothing worn will be highlighted.

b. Any operational difficulties attributed to the wearing of laboratory protective clothing by operators will be recorded.

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APPENDIX A. GLOSSARY.

<u>Term</u>	<u>Definition</u>
Capability Document	A document that captures the capabilities specific to the initial concept, development, or production of a program.
Capability Development Document (CDD)	A document that captures the information necessary to develop a proposed program(s), normally using an evolutionary acquisition strategy. The CDD outlines an affordable increment of militarily useful, logistically supportable, and technically mature capability.
Capability Production Document (CPD)	A document that addresses the production elements specific to a single increment of an acquisition program.
Chemical, Biological, and Radiological (CBR) Compatibility	The capability of a system to be operated, maintained, and re-supplied by persons wearing a full complement of individual protective equipment, in all climates for which the system is designed and for the period specified in the CDD or CPD.
CBR Decontaminability	The ability of a system to be rapidly and effectively decontaminated to reduce the hazard to personnel operating, maintaining, and resupplying it.
CBR Decontamination	The process of making material safe by absorbing, destroying, neutralizing, rendering harmless, or removing chemical or biological agents and radiological contamination.
CBR Environment	The environment created by chemical, biological, or radiological contamination.
CBR Hardness	The capability of material to withstand the material-damaging effects of CB contamination and relevant decontaminations.
CBR Contamination Survivability (CBRCS)	The capability of a system to withstand CBR contaminated environments, decontaminants, and decontamination processes, without losing the ability to accomplish the assigned mission. A CBR-contaminated survivable system is hardened against CB agent(s) or radiological contamination and decontaminants. It can be decontaminated, and is compatible with individual protective equipment. CBRCS may be accomplished by hardening, timely re-supply, redundancy, mitigation techniques (to include operational techniques), or a combination thereof. The elements of CBRCS covered by this TOP are compatibility, decontaminability, and hardness.

APPENDIX A. GLOSSARY.

<u>Term</u>	<u>Definition</u>
Chemical, Biological, and Radiological (CBR) Survivability	The capability of a system to avoid, withstand, or operate during and/or after exposure to a CBR environment (and relevant decontamination), without losing the ability to accomplish the assigned mission. CBR survivability is divided into CBR survivability, which is concerned with CBR contamination to include fallout, and nuclear survivability, which covers initial nuclear weapon effects including Electromagnetic Pulse (EMP).
Combat Developer	A category of sponsor responsible for drafting, staffing, and revising capabilities documents.
Initial Capabilities Document (ICD)	Documents the need for a materiel approach or an approach that is a combination of materiel and non-materiel to satisfy a specific capability gap(s). It defines the capability gap(s) in terms of the functional area, the relevant range of military operations, desired effects, time, and doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF) and policy implications and constraints. The ICD summarizes the results of the DOTMLPF analysis and approaches (materiel and non-materiel) that may deliver the required capability. The outcome of an ICD could be one or more joint DOTMLPF change recommendations or CDDs.
Material Developer	The organization responsible for research, development, and acquisition of material systems in response to capabilities documents.
Mission-Critical System	A system whose operational effectiveness and operational suitability are essential to successful mission completion or to aggregate residual combat capability. If this system fails, the mission will not likely be completed. Such a system can be an auxiliary or supporting system, as well as a primary mission system.
Neutron-Induced Gamma Activity	The radioactivity of elements, typically in soil, induced by neutrons produced by a nuclear burst. The induced radioactivity produces gamma and beta radiation.
Sponsor	The organization responsible for drafting, staffing, and revising capabilities documents. For this document, sponsors include combat developers.

APPENDIX A. GLOSSARY.

Term

System Threat
Assessment

Definition

A predecessor document that is used to summarize in a CDD the projected threat environment and the specific threat capabilities to be countered. The summary includes the nature of the threat, threat tactics, and projected threat capabilities (both lethal and nonlethal) over time.

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APPENDIX B. TEST EQUIPMENT.

Following is a list of equipment typically used during testing.

- a. Thermocouple.
- b. Humidity probe.
- c. Anemometer.
- d. Still color camera.
- e. Video camera.
- f. Bubblers, MINICAMS[®] (a miniature, automatic, continuous air-monitoring system), solid sorbent tubes (SSTs), or equivalent.
- g. Gas chromatograph (GC), high-performance liquid chromatograph (HPLC), liquid chromatograph (LC), spectrophotometer, or equivalent.
- h. Silicone rubber, latex dental dam or equivalent.
- i. Compressed air dry powder disseminator.
- j. Air-driven liquid-slurry disseminator.
- k. Microscopes, automatic colony counters, or equivalent, swabs or wipes placed in growth medium.
- l. Radioactivity detector.
- m. Stop watches or equivalent.

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APPENDIX C. SUMMARY OF DECONTAMINATION SYSTEM PROCEDURES.

The following decontamination system procedures are a summary from FM 3-11.5 (Reference 21) for Army and Marine Corps. The M291 skin decontamination kit (SDK) is not described in this Appendix because it is only fielded for use on skin, and this is not pertinent to CBRCS.

<u>Decontamination System</u>	<u>General Procedure for Use</u>	<u>General Equipment Procedures</u>
M295 Individual Equipment Decontamination Kit (IEDK)	The mitt is to be placed on the hand and patted on the surface of the equipment being decontaminated. Scrubbing motions must not be used because it may clog the mitt material and prevent distribution of the sorbent powder. The powder must be removed from the equipment by brushing, wiping, or high-pressure air.	This kit is only issued for use on a warfighter's individual equipment. The sorbent powder in this kit will absorb all liquids, including lubricants. Any lubricated personal equipment (e.g., rifle) will need to be cleaned and lubricated before use. This kit is for immediate decontamination.
M100 Sorbent Decontamination System	When the kit is opened, there are two packets with sorbent powder and two mitts included. A sorbent powder packet must be carefully opened, and the contents placed onto the mitt palm. The mitt is then used to apply sorbent powder onto equipment using patting or scrubbing motions. Additional powder is applied to the mitt as necessary. The second packet may be necessary for continued decontamination efforts.	This system is issued to vehicles and other systems, not to personnel. The sorbent powder in this kit will absorb all liquids including lubricants. Any lubricated equipment will need to be cleaned and lubricated before use. This system is to be used for operational decontamination.
M17	This system is used to apply hot soapy water (HSW) and/or a high-pressure clean water rinse.	This system is most likely to be used at a thorough decontamination site.

APPENDIX C. SUMMARY OF DECONTAMINATION SYSTEM PROCEDURES.

<u>Decontamination System</u>	<u>General Procedure for Use</u>	<u>General Equipment Procedures</u>
M12	<p>This system is used to apply low-pressure high-volume water for equipment pre-rinse, supertropical bleach (STB) slurry, HSW and high-test hypochlorite (HTH) solution. The low-pressure high-volume pre-rinse will be performed before decontaminant application. The STB slurry or HTH solution will be applied to vehicles or equipment and an individual with a scrubbing brush will follow closely so that the slurry/solution is not allowed to dry. This operation is conducted on both sides of a vehicle simultaneously, using two M12s. If the air temperature is too high, additional applications of the slurry/solution may need to be applied to maintain decontaminant/agent contact.</p>	<p>An M12 is only used at a thorough decontamination site. Before the decontamination procedures begin, each equipment system that goes through thorough decontamination may require components to be removed and/or components (e.g., lenses) protected (covered) from the effects of decontaminants. After decontamination has been verified, components that have been removed will most likely need to be replaced with new components. Protected components must be separately decontaminated with the appropriate decontamination for that component.</p>
M26 Joint Service Transportable Decontamination System-Small Scale (JSTDS-SS)	<p>This system will be used to apply water and HSW to perform operational decontamination missions and support thorough decontamination operations. It may also be used to support clearance decontamination missions, limited facility decontamination, and/or terrain decontamination.</p>	<p>This system is most likely to be used at the site of a system's operational decontamination.</p>

APPENDIX D. MATERIAL PROPERTIES MATRIX AND DATA TEMPLATE.

The Material Properties Matrix (Table D-1) provides a useful tool for program managers, testers, and database developers to acquire the information needed to ensure that defense systems are survivable to the effects of CBR contamination and the decontamination process. This matrix details the critical properties of materiel that program managers and testers must test to determine if mission-critical systems are survivable in a CBR environment by measuring any significant degradation to these critical properties. While survivability determinations are not limited to the materials and properties listed in this matrix, it provides a minimum framework for data that program managers and testers must provide to the CBME database so that appropriate survivable materials can be selected during the design of new systems or system upgrades.

APPENDIX D. MATERIAL PROPERTIES MATRIX AND DATA TEMPLATE.

TABLE D-1. MATERIALS AND PROPERTIES OF INTEREST

Properties		Metals	Laminates	Adhesives/Sealants/ Joints (Including Welds)	Coatings	Potting Compounds	Optical Materials (Metal Oxides, Plastics, etc.)	Elastomers	Plastics	Composite Materials	Petroleum, Oil, and Lubricants	Textiles	Ceramics
Agent Effects	1	Agent absorption ($\mu\text{g}/\text{cm}^2$ absorbed per time period) and agent desorption ($\mu\text{g}/\text{cm}^2$ desorbed per time period)	X	X	X	X	X	X	X	X		X	X
	2	Permeation (time to breakthrough of agent)/penetration of vapors and liquids			X	X	X	X	X			X	X
	3	Weight change	X	X	X	X	X	X	X	X		X	X
	4	Density	X	X	X	X	X			X			X
	5	Off gassing (vapor)	X	X	X	X	X	X	X	X		X	X
	6	Contact hazard (liquid)	X	X	X	X	X	X	X	X		X	X
Mechanical Properties	7	Elastic modulus	X	X	X			X	X	X			
	8	Tensile Properties (yield strength, ductility)	X	X	X		X	X	X	X		X	X
	9	Hydrogen embrittlement	X	X	X	X							
	10	Ultimate strength for tension (flexural)		X	X								
	11	Compressive strength	X	X	X			X		X	X		X
	12	Shear strength	X	X	X		X		X	X			X
	13	Fracture toughness (compression, bending, tensile, shear, impact)	X	X	X	X	X	X	X	X			X
	14	Hardness (indentation, durometer, scratch resistance)	X	X	X	X	X	X	X	X		X	X
	15	Resilience (capacity to absorb energy elastically)	X	X				X	X	X			X
	16	Fatigue strength (includes adhesives for structural bonds)	X	X	X				X	X			X

APPENDIX D. MATERIAL PROPERTIES MATRIX AND DATA TEMPLATE.

TABLE D-1. CONTINUED

Properties		Metals	Laminates	Adhesives/Sealants/ Joints (Including Welds)	Coatings	Potting Compounds	Optical Materials (Metal Oxides, Plastics, etc.)	Elastomers	Plastics	Composite Materials	Petroleum, Oil, and Lubricants	Textiles	Ceramics
Mechanical Properties	17	Puncture resistance						X	X	X		X	X
	18	Creep (rupture) strength	X	X	X				X	X			
	19	Compressive spring constant						X		X			
	20	Bond strength	X	X	X					X			X
POL Properties	21	Thermal stability									X		
	22	Chemical compatibility									X		
	23	Lubricity									X		
	24	Solubility									X		
	25	Melting point/boiling point									X		
	26	Viscosity									X		
Physical Properties	27	Dimensional change	X	X	X	X	X	X	X	X		X	X
	28	Color change (discoloration, surface finish)	X	X	X	X	X	X	X	X		X	X
	29	Optical clarity/distortion (haze, transmittance, reflectance)				X		X					X
	30	Crazing, stress, corrosion, cracking	X	X	X	X	X		X				X
	31	Acoustic dampening		X		X				X			
	32	Glass transition temperature		X	X			X	X	X			X
	33	Rubber property-effects of liquids						X					
	34	Peel/lap shear strength change		X	X	X				X			
	35	Adhesion (loss of), blistering, spalling		X	X	X	X			X			X
	36	Corrosion rate	X	X	X					X			X
Thermal Properties	37	Thermal conductivity	X	X	X	X	X		X	X			X
	38	Flame resistance		X	X			X	X	X		X	X
	39	Flash point/ignition temperature			X	X					X	X	

APPENDIX D. MATERIAL PROPERTIES MATRIX AND DATA TEMPLATE.

TABLE D-1. CONTINUED

Properties		Metals	Laminates	Adhesives/Sealants/ Joints (Including Welds)	Coatings	Potting Compounds	Optical Materials (Metal Oxides, Plastics, etc.)	Elastomers	Plastics	Composite Materials	Petroleum, Oil, and Lubricants	Textiles	Ceramics
Electrical Properties	40	Insulative properties (including dissipation factor)	X		X	X		X	X	X			X
	41	Dielectric constant	X	X	X	X	X	X	X	X			X
	42	Electrical conductivity	X	X	X	X	X	X	X	X			
	43	Impedance	X	X	X	X	X	X	X	X			
	44	Relative permittivity		X		X			X	X			X
	45	Polarizability (effect on radar signals)		X		X			X	X			X

APPENDIX E. ABBREVIATIONS.

μL	microliter
μg	microgram
ABO	agent of biological origin
AD No	accession number
AEC	U.S. Army Evaluation Center
AR	Army Regulation
ASTM	American Society for Testing and Materials
AT&L	acquisition, technology, and logistics
ATEC	U.S. Army Test and Evaluation Command
ATIRS	Automated Test incident Reporting System
ATP	Allied Tactical Publication
C/D	contamination/decontamination
C	Celsius
CB	chemical and biological
CBCS	chemical and biological contamination survivability
CBME	chemical and biological materials effects
CBR	chemical, biological, and radiological
CBRCS	chemical, biological, and radiological contamination survivability
CBRN	chemical, biological, radiological, and nuclear
CDD	capability development document
CFU	colony forming unit
cm	centimeter
COE	concept of employment
CONOPS	concept of operations
CPD	capability product document
cST	centistoke
DA	Department of the Army
DOD	Department of Defense
DODI	Department of Defense Instruction
DOTMLPF	doctrine, organization, training, materiel, leadership and education, personnel and facilities
DPG	U.S. Army Dugway Proving Ground
DTIC	Defense Technical Information Center
EA	environmental assessment
ECBC	U.S. Army Edgewood Chemical Biological Center
EMP	electromagnetic pulse

APPENDIX E. ABBREVIATIONS.

FD/SC	failure definition/scoring criteria
FM	Field Manual
g/m^2	grams per meter squared
g	gram
GAO	U.S. Government Accountability Office
GBq	Gigabecquerel
GC	gas chromatograph
GD	soman
HD	distilled mustard
HPLC	high-performance liquid chromatography
HRPP	Human resource Protection Plan
HSW	hot soapy water
HTH	high-test hypochlorite
IAW	in accordance with
ICD	initial capabilities document
IEDK	Individual Equipment Decontamination Kit
ISO	International Organization for Standardization
JSTDS-SS	Joint Service Transportable Decontamination System-Small Scale
kg	kilogram
L/min	liters per minute
LC	liquid chromatograph
m/sec	meters per second
ME	mission essential
MIL-STD	Military Standard
MINICAMS [®]	a miniature, continuous air-monitoring instrument
mm	millimeter
MMD	mass median diameter
MOPP IV	mission-oriented protective posture, level IV
MS	mass spectrometry
NATO	North Atlantic Treaty Organization
NBC	nuclear, biological, and chemical
NBCCS	nuclear, biological, and chemical contamination survivability
NDAA	National Defense Authorization Act
NEPA	National Environmental Policy Act
NIGA	neutron-induced gamma activity
NRT	near-real time

APPENDIX E. ABBREVIATIONS.

OEP	operational test agency evaluation plan
OTA	operational test agency
PAM	pamphlet
PL	public law
psi	pounds per square inch
QA	quality assurance
QC	quality control
QSTAG	Quadripartite Standardization Agreement
R ²	correlation value
RAR	Rapid Action Revision
RDD	radiological dispersal device
REC	record of environmental consideration
RH	relative humidity
RSDL	reactive skin decontamination lotion
SDK	skin decontamination kit
SOP	standing operating procedure
SR	safety release
SST	solid sorbent tube
STB	supertropical bleach
SUT	system under test
TEMP	test and evaluation master plan
TGD	thickened soman
TIC	toxic industrial chemical
TIM	toxic industrial material
TOP	Test Operations Procedure
TSARC	Test Schedule a Review Committee
USD	Under Secretary of Defense
VX	persistent nerve agent

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APPENDIX G. APPROVAL AUTHORITY.

MEMORANDUM FOR

Commanders, All Test Centers
Technical Directors, All Test Centers
Directors, U.S. Army Evaluation Center
Commander, U.S. Army Operational Test Command

SUBJECT: Test Operations Procedure (TOP) 08-2-111B Chemical, Biological, and Radiological (CBR) Contamination Survivability, Small Items of Equipment, Approved for Publication

1. TOP 08-2-111B Chemical, Biological, and Radiological (CBR) Contamination Survivability, Small Items of Equipment, has been reviewed by the U.S. Army Test and Evaluation Command (ATEC) Test Centers, the U.S. Army Operational Test Command, and the U.S. Army Evaluation Center. All comments received during the formal coordination period have been adjudicated by the preparing agency. The scope of the document is as follows:

This TOP provides basic information to facilitate test planning, conducting, and reporting standardized CBR contamination survivability testing of small items of mission-essential military materiel. Small items are considered equipment carried by an individual Warfighter, and removable sensitive equipment.

2. This document is approved for publication and will be posted to the Reference Library of the ATEC Vision Digital Library System (VDLS). The VDLS website can be accessed at <https://vdl.s.atc.army.mil/>.

3. Comments, suggestions, or questions on this document should be addressed to U.S. Army Test and Evaluation Command (CSTE-TM), 2202 Aberdeen Boulevard-Third Floor, Aberdeen Proving Ground, MD 21005-5001; or e-mailed to usarmy.apg.atc.mbx.atc-standards@mail.mil.

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