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14. ABSTRACT

This TOP provides basic information to facilitate planning, conducting, and reporting testing of exterior surfaces of military materiel such as combat vehicles, vans, shelters, and large items of packaged materiel. This TOP provides standard methods for chemical, biological, and radiological contamination survivability (CBCS) testing of exterior surfaces of military materiel. It is designed to provide results to determine if large items of mission-essential (ME) equipment have met applicable CBCS requirements. This TOP describes facilities, equipment, and procedures used to execute contamination survivability testing and determine degradation of ME functions resulting from the contamination/decontamination (C/D) procedures. The procedures also allow a determination of crew/system under test (SUT) compatibility.

15. SUBJECT TERMS
CBR – chemical, biological, radiological; contamination; decontamination; survivability; hardness; decontaminability; compatibility; simulant; MOPP IV – mission-oriented protective posture, level IV; protective clothing; ME – mission-essential

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U.S. ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

*Test Operations Procedure 08-2-510B 13 March 2019
DTIC AD No:

CHEMICAL AND BIOLOGICAL CONTAMINATION SURVIVABILITY (CBCS); LARGE ITEM EXTERIORS

*This TOP supersedes TOP 08-2-510A, Chemical and Biological Contamination Survivability (CBCS), Large Item Exteriors, dated 21 March 2011.

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1. SCOPE.

1.1 Purpose.

This Test Operations Procedure (TOP) provides preparation, planning, conducting, and reporting procedures for chemical and biological contamination survivability (CBCS) testing of the exteriors of large mission-critical systems, such as combat vehicles, vans, shelters, and large items of packaged materiel. The TOP describes typical facilities, equipment, and procedures used to contaminate the test item; sample for contamination density and residual contamination; decontaminate the test item; and determine the degradation of selected mission-essential (ME) functions resulting from the contamination/decontamination (C/D) procedures.

1.2 Objectives.

a. The procedures are designed to provide results to demonstrate that the exteriors of large items of mission-critical systems or infrastructures have met the policies of Army Regulation (AR) 70-75[1**] as implemented by the Department of the Army (DA)-Approved Nuclear, Biological, and Chemical Contamination Survivability Criteria (NBCCS) for Army Materiel[2]. Department of Defense Instruction (DODI) 3150.09[3] outlines chemical, biological, radiological, and nuclear (CBRN) contamination survivability policy requirements for mission-critical systems.

b. If the Capability Development Document (CDD) or the Capability Production Document (CPD) requirements or procedures contradict procedures in this document the CDD or CPD takes precedence.

1.3 Limitations.

a. This TOP is limited to currently approved standards, methods, and procedures. Developments in practices, equipment, and analysis may necessitate new testing procedures. Additionally, test methods and standards must be adjusted as technologies advance. Test procedures and parameters listed in this TOP may require updating to accommodate new technologies or in test instrumentation. Any updates should be described in the specific test plan.

b. This TOP is not applicable to the testing of interiors of large items of mission-critical systems, which is addressed separately through TOP 08-2-509A[4].

c. The results obtained by using these test procedures under the controlled test environment conditions cannot be correlated with the full range of battlefield conditions.

d. Simulant testing requires an established agent/simulant relationship (ASR). An ASR may be established using TOP 08-2-140[5]. Test data must not be used without an ASR. Additional information on the physical parameters that are being simulated must be included in test reports. Overall, it must be noted that simulants do not represent chemical warfare agents/agents of biological origin (CWA/ABO) in many properties.

** Superscript numbers correspond to Appendix D, References.

2. FACILITIES AND INSTRUMENTATION.

Facilities, instrumentation, and safety procedures used for CBCS testing are strictly controlled. Additional discussion and requirements for facilities and instrumentation are included in the test procedures (Paragraph 4).

2.1 Facilities.

Item	Requirement
Chemical surety laboratory and CWA storage facility.	Constructed to ensure safe and secure storage, handling, analysis, and decontamination of CWAs and/or simulants used for surety materiel.
CWA test facility (chamber).	Constructed to house the system under test (SUT) during CWA or simulant C/D and sampling. The chamber should have sufficient volume to allow free air circulation around the SUT. Ability to control temperature, relative humidity (RH), and wind speed is required based on the SUT capability documents.
Fielded decontaminating apparatus as specified in the concept of operations (CONOPS).	Constructed to decontaminate the SUT as part of the test procedure. Must not increase the hazard or degrade safety protocols when used in a laboratory or chamber.
Fielded decontaminating apparatus.	Constructed to decontaminate the surety test facilities after test completion.
Biological analytical laboratories.	Required to store and prepare test quantities of biological contamination simulant materials, to charge disseminating devices, to prepare samplers, and to analyze all biological agent/simulant materials.
Chambers for biological 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 SUT. Biological surety regulations will be followed if biological surety material is used at any time. Ability to set and maintain temperature and RH is highly desirable.
Test range or appropriate operational test facility.	Required to allow the SUT to be operated and to perform all ME functions and tasks required to accomplish specific CONOPS as outlined in the capabilities documents. This includes tasks such as communications, aiming and tracking targets, firing weapons, using optical instruments, operating controls and switches, reading instruments, resupply, and

	decontamination. Observation and measurement of any degradation of the ME functions attributable to the C/D procedures or chemical and biological (CB) protective equipment that the SUT operators are required to wear must be recorded.

2.2 Equipment.

Item	Requirement
Apparatus for the application of liquid chemical contaminants.	Required to apply the contaminant in a controlled manner to meet challenge level requirements.
Apparatus for the application of biological contaminants.	Required to apply the contaminant in a controlled manner to meet challenge level requirements.
Apparatus for off-gassing chemical vapor from the SUT.	Required to measure residual vapor concentrations from the surfaces of the SUT.

2.3 Instrumentation.

The instrumentation choices are test and test location dependent. Permissible measurement uncertainty values are minimum requirements. Actual instrumentation may have greater precision. Actual values must be reported in the test report.

Test Parameter	Measuring Device	Permissible Measurement Uncertainty
Air temperature (-20 to 50 °Celsius (°C)).	Thermocouple or similar measuring instrument with digital recording capability.	±0.5 °C.
RH (0 to 90 percent).	Hygrometer or similar measuring instrument with digital recording capability.	±5 percent of the target value.
Wind speed (0 to 10 meters per second (m/sec)).	Anemometer or similar measuring instrument with digital recording capability.	±0.1 m/sec.

Test Parameter	Measuring Device	Permissible Measurement Uncertainty
Photographs.	Still color camera.	Adequate resolution and photographic size 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 with time stamp.	Adequate resolution and speed (frames/second) 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.

2.3.1 Chemical Test Instrumentation.

Test Parameter	Measuring Device	Permissible Measurement Uncertainty
Contamination density or challenge level (g/m^2).	A control coupon will also be used for the measurement of the actual contamination density applied. Filter papers or equivalent.	Contamination density, ±10 percent of challenge target.
CWA mass from liquid samples (µg).	Gas chromatograph (GC), high-performance liquid chromatograph (HPLC), liquid chromatograph (LC), spectrophotometer, or equivalent.	±15 percent of calibration standard.
CWA mass from vapor samples (µg).	MINICAMS®, GC, HPLC, LC, spectrophotometer, or equivalent.	±15 percent of calibration standard.

2.3.2 Biological Test Instrumentation.

Test Parameter	Measuring Device	Permissible Measurement Uncertainty
Contamination measurement (background, post-contamination, and post-decontamination).	Microscopes, swabs, or wipes placed in growth medium, automatic colony counters, or equivalent.	±10 percent colony forming unit (CFU)/sample.

2.3.3 CB Hardness Test Instrumentation.

Test Parameter	Measuring Device	Permissible Measurement Uncertainty
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 SUT and type of function but must allow for the measurement of 20 percent degradation in the ME performance characteristic after completion of each of the required C/D cycles.

2.3.4 CB Compatibility Test Instrumentation.

Test Parameter	Measuring Device	Permissible Error of Measurement
Operator performance.	Stop watches or equivalent. Operator/crew ME functions (e.g., setting up a shelter, conducting maintenance operations, etc.) are timed 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. The difference between the function performed with duty uniform and with CB-protective clothing allows a determination of the percent degradation.	Precision and accuracy requirements must be compatible with the nature of the SUT and type of function being studied, but must allow for the measurement of 15 percent degradation in the item/operator ME function performance.

3. REQUIRED TEST CONDITIONS.

3.1 Documentation.

3.1.1 Familiarization.

a. Potential problem areas must be identified by reviewing records and results of similar tests, if available.

b. Development of test plans requires familiarization with the applicable test planning and requirements documents such as:

(1) Safety release and approval from the authorizing agency (e.g., U.S. Army Test and Evaluation Command [ATEC]) to begin testing, if required.

(2) Human use committee approval or exemption and notification, if required.

(3) Government and manufacturer's publications, including the current safety data sheets (SDSs) for all materials used in the test.

(4) Program-specific requirements documents: CDD, CPD, system performance specification, system evaluation plan, safety assessment report (SAR), test support order, event design plan, system support package (SSP), and SSP list.

(5) Industrial hygiene plan.

(6) Familiarization with test reports of similar and related programs to avoid unnecessary duplication of effort.

c. Test personnel must familiarize themselves with the relevant standing operating procedures (SOPs) and other procedures and instructions for applicability, completeness, and adequacy. These documents will be updated as required.

d. All applicable/available safety documents such as the SAR and health hazard assessments should be reviewed to determine if any safety or health issues require special test protocols.

3.1.2 Environmental Compliance.

a. All local, state, and federal regulations will be followed, appropriate documentation prepared and submitted, and approval will be received before testing begins.

b. Test personnel and participants must receive and understand environmental documentation before the test begins.

3.1.3 Detailed Test Plan (DTP).

The DTP will be written before test execution and will address objectives of the test center statement of work and include inputs from subject matter experts. Amendments shall be documented and approved by test center management in concurrence with the customer. DTP format can be test-center specific with customer agreement but the content will address all elements required for test conduct. The following elements shall be considered.

a. The DTP shall refer to the data management plan that describes data collection and reduction analytical procedures and reporting procedures. With customer concurrence, the data management plan may be included in the DTP.

b. The DTP shall include safety procedures addressing hazard analysis, operations, and decontamination.

c. A test readiness review and operational readiness inspection shall be performed before testing begins.

d. The DTP shall define the required challenge and breakthrough concentration ranges of the contaminants, accounting for the trial conditions and the contaminant's physical and chemical properties, analytical limitations, and safety considerations.

e. The DTP shall identify suitable challenge systems and referee instrumentation based on the contaminant(s), concentration, and environmental conditions. The DTP shall specify whether the system will be operated under its own power or under shore power.

f. The data obtained from computational flow dynamics modeling and atmospheric dispersion modeling may be used to determine the optimal location and placement of the SUT and the instrumentation.

3.1.4 Simulant Selection.

a. Simulants are often employed in lieu of agents during testing and evaluation of CB systems to mitigate the risks associated with the use of agents. Simulants may have chemical or physical properties that closely mimic those of agents. Simulants may have an ability to mimic the chemical or physical mechanisms of interest for agents in a given environment. Simulants may be less toxic, less expensive, and have less environmental impact than agents. In addition, simulants do not have surety restrictions. No simulant will completely match the agent in all respects.

b. Simulants should be verified and validated before use. Selection of simulants should be conducted in accordance with (IAW) TOP 08-2-196[6]. The objective will be framed, potential simulants will be identified and screened, simulants that best mimic the desired agents will be selected, verified, and validated.

3.2 Test Planning.

a. Testing may be performed 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 testing alternatives may be considered based on coordination between the tester, the customer, and the evaluator.

b. Each CBCS test plan must be reviewed for technical accuracy and conformance to regulations. SOPs applicable to the specific item and tests being conducted must be referenced. In addition, the test plan must accurately reflect the requirements outlined in capabilities documents. Published test records, procedures, and the reports of similar SUTs must be reviewed to identify potential areas that are difficult to decontaminate.

c. The capabilities documents [Initial Capability Document (ICD), CDD, or the CPD)], the CONOPS, and Failure Definition/Scoring Criteria (FD/SC) must be reviewed (if available). 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 CB C/D and by the need for the operator to wear the CB protective ensemble. Units of measurement and the accuracy and precision required for each parameter measured will be identified. All issues concerning measurable performance and degradation will be reviewed.

d. Based on the information collected from the capabilities documents, the OEP, and the TEMP, and in coordination with the customer, the number of SUTs and the number of C/D cycles that need to be conducted on the SUT will be determined. The DA Approved NBCCS Criteria[2] dictates that a default of five C/D cycles should be conducted on each SUT to accommodate a radiological cycle, a biological cycle, and three cycles for the three classes of CWAs outlined. Because there are no radiological procedures in this TOP, more biological or chemical cycles may be added. It is possible that less than or more than five cycles may be required.

e. A realistic sample size (based on test cost, as well as SUT size, value, and availability) will be determined. The sample size may be determined by SUT availability, cost, or other factors which may cause it to be less than optimum. If sample size is less than optimum, a testing scheme will be devised to optimize SUT use and required data output. The use of a design of experiment will be considered in developing the test matrix.

f. Decontamination systems and decontaminants include, but are not limited to: the Reactive Skin Decontamination Lotion; the M295 individual equipment decontamination kit; the M100 sorbent decontamination system; the M12; the M26; hot soapy water (HSW); and super tropical bleach (STB). Field expedient decontaminants include but are not limited to: high-test hypochlorite (a STB substitute); sodium hypochlorite solutions (usually a ratio of one part bleach

to ten parts water); Joint Sensitive Equipment Wipe; Joint Biological Agent Decontamination System (specific to air craft at this time); and low-pressure, high-volume water.

g. If the SUT consists of materials similar to other systems already tested [i.e., both systems chassis are CWA resistant coating painted steel or both systems are bulldozers with one being larger than the other], then consideration may be given to conducting a CBCS assessment (CBCSA) as a cost-saving measure. Before implementing this option, coordination must occur with the test sponsor and the OTA conducting the system evaluation. The basic steps of a CBCSA are:

(1) The test-item design and the materials of construction will be examined. The materials of construction will be reviewed to see if any data pertaining to those materials can be found in the Chemical and Biological Materials Effects Database[7] (CBME). 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 the data can be reviewed for applicability to the current system.

(2) Any areas where CB agent could pool or seep, such as cracks, crevices, hinges, joints, countersunk screw heads, or other difficult to decontaminate features, will be noted. The manufacturer's operation manual or preliminary instructions, if available, will be reviewed for any cleaning/decontamination instructions.

(3) The CBCSA will recommend that any identifiable vulnerabilities or questionable design or materials should be adequately tested.

(4) Preliminary results can often be determined from a pilot study and analysis of the collected information. The report of the survivability assessment will detail the expected ability of the system to meet the nuclear, biological, and chemical (NBC) contamination survivability criteria[2].

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

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

3.3 Safety.

a. All test operators must read, understand, and have available the SDS associated with each chemical used in the test. The operator is expected to be familiar with the operation of the SUT and to have read and understood the test plan. The test plan will be available to the operators at the test site.

b. CBCS testing requires the handling and use of CB agents. Such testing is strictly controlled by U.S. Army Regulations [e.g., AR 385-10[8], DA Pamphlet (PAM) 385-61[9], and DA PAM 385-69[10]]. 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 cannot be overemphasized.

c. The required SDSs, testing protocols, and safety procedures will be available at the test site.

d. When appropriate, the test personnel will wear required personal protective equipment (PPE). PPE must be approved by the Office of the Director of the Army Safety (Fort Belvoir, Virginia) or meet certification standards from Occupational Safety and Health Administration (Washington D.C.) and National Institute for Occupational Safety and Health (Atlanta, Georgia) CBRN certification standards.

e. Medical examinations of test participants may be required to determine physical ability to perform specified tasks. Medical examinations will be conducted before the test begins. If applicable, a medical record will be maintained on each participant. Work/rest cycles will be strictly followed to minimize the possibility of heat stress.

f. Test personnel will be informed of potential safety and health hazards involved in test conduct and the precautions required to prevent accidents and over-the-limit exposure to the chemicals used in the test. A safety survey will be conducted before test execution. Other health risks may include exposure to heat or cold, slips, trips, falls, and exposure to hot or cold surfaces or liquids.

g. Test personnel must submit to a physical examination and must be certified by onsite medical personnel for eligibility to perform test assignments.

h. Daily safety checks and briefings will be conducted to ensure that all identified safety hazards have been addressed before testing proceeds.

i. For tests that involve carrying or lifting, test personnel and participants will be instructed in the proper lifting techniques.

3.3.1 Chemical Toxicity.

These procedures may be used with toxic chemicals such as CWAs and toxic industrial chemicals (TICs). Even simulants, which are less toxic than CWAs, may be used during testing at concentrations that may be hazardous to personnel. All handling of toxic chemicals should be

performed within well-ventilated areas. The operator must wear PPE, including but not limited to ocular, dermal, and respiratory protection IAW applicable SOPs.

3.3.2 Training.

Test personnel must be trained in the use of the SUT, test scenarios, and test conditions including a demonstration of the test item operation, training for operation of the test item, and discussion of any special characteristics and differences from comparable test item(s).

3.4 Quality Assurance (QA) and Quality Control (QC).

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

b. A QA plan should be prepared for each test program to ensure that all relevant 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 CWAs and simulants used; purity and stability of decontaminants; calibration and maintenance of instrumentation and disseminators; accuracy and precision of the laboratory analysis; and quality and uniformity of all test samples.

c. The condition of the SUT at the time of testing is an important test variable. Unless receipt inspection was part of a subtest completed before CBCS testing, the SUT should be inspected IAW TOP 08-2-500[11]. Inspection data, certificates of compliance, or similar documentation, should be reviewed to ensure that exterior surfaces, finishes, and packaging meet specifications. Generally, the item should be tested in as-received condition, matching its condition when issued to warfighters in the theater of operations as closely as possible.

d. Decontamination. Existing system-specific decontamination procedures, using fielded decontaminants or developmental decontaminants, should 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.

e. Test Conduct. Testing must always be conducted following approved test documentation, such as technical manuals, field manuals, equipment operating instructions, SOPs, this TOP, 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.

4.1 General.

a. The required test parameters[2] are temperature (30 C ±3.0 °C) and airflow across the SUT of less than 1.0 m/sec. There is no requirement for control of RH. Operational requirements may necessitate other environmental test conditions (temperature and humidity) and these may be accommodated as coordinated with test sponsors and evaluators (see paragraph 1.2.b).

b. Representative areas of the SUT to be sampled for residual contamination will be selected and identified. If the entire SUT 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 SUT size, geometry of the SUT, materials of construction, surface texture, presence of joints and crevices, areas handled/touched by system operators, and the likelihood to contribute to crew vapor and contact hazard. Because of the nature of sampling devices, sample locations need to be flat or nearly flat. Coupons of the same material (including any paint, anodizing, etc.) can also be used by attaching the coupons on the sample location and removing them for liquid extraction of residual contaminant. Additional consideration must be given to any areas that might allow contaminating agents and/or simulants and decontaminating solutions to seep into and degrade delicate or vulnerable equipment. An appropriate number of such areas will be selected to help ensure the statistical validity of the resulting sample size. The test plan will identify and explain the rationale for the areas selected and any statistical analysis methodology used. The test report will identify any changes from the test plan. Each sample location selected should be described and photographed. No additional marks should be placed within the marked boundaries of the locations to be sampled.

c. C/D cycles will be conducted using CB agents and/or simulants, and fielded decontamination systems and procedures. Actual survivability can only be confirmed by using actual CWAs and ABOs. The default CWAs are persistent nerve agent (VX), distilled mustard (HD), and thickened soman (TGD); and the ABO is *Bacillus anthracsis.*

d. Paragraphs 4.2 through 4.3 address chemical survivability testing and biological survivability testing separately. Although the test methods are similar, subtle but important differences exist. Long-term CB hardness is discussed in Paragraph 4.4.

4.2 Chemical Contamination Survivability Testing.

4.2.1 Objectives.

a. Decontaminability. The ability of a system to be rapidly and effectively decontaminated (less than 75 minutes; which includes step 1 pre-wash through step 4 final rinse of the asset for thorough decontamination)[2] following CWA exposure will be determined. Vapor and percutaneous hazards, including eye effects, associated with warfighter use of equipment that has been contaminated with CWA and decontaminated using standard and/or item-specific decontamination procedures will be determined by measuring vapor concentrations and residual contact transfer quantities.

b. Hardness. The capability of a system to withstand the material damaging effects of CWA and relevant decontaminations will be determined. The degree of performance degradation in ME functions of military ME materiel after C/D by standard and/or item-specific procedures will be measured.

4.2.2 Criteria and Conditions.

a. Criteria.

(1) Decontaminability. The exterior surfaces of materiel developed to perform ME functions shall be designed so that chemical contamination remaining on, or desorbed from, the surface following decontamination shall not result in more than a negligible risk (values to be developed through coordination with toxicology studies and program requirements) to unprotected individuals working inside, on, or 1 meter (m) from the item/equipment after CWA C/D as stated in the criteria[2].

(2) Hardness. Mission-critical equipment shall be hardened to ensure that exposure to the specified C/D cycles does not degrade the operational ME performance of the equipment more than 20 percent (or that specified by the combat developer) over a 30-day period[2] or as defined by the capabilities documents.

NOTE: As an example, if a howitzer is consistently able to fire 25 rounds per 30 minutes before decontamination and can only fire 20 rounds per 30 minutes after five cycles of decontamination, then the degradation is measured as (25-20)/25 × 100 = 20 percent. Another example would be the faceplate of the protective mask that had a transmittance of 99 percent and after five cycles of decontamination the transmittance is measured as 97 percent. The degradation is calculated as (99-97)/99 × 100 = 2 percent.

b. Conditions.

(1) General conditions are as follows:

(a) Selected exterior areas will be initially contaminated in a random drop pattern over the selected area, to a uniform contamination density as specified in the system threat assessment and capability documents. If no contamination density is defined, then the default of 10 g/m² will be used. If no operationally relevant drop size has been defined, the default size will be 5 to 10 µL sized drops of TGD, or 2 to 5 µL sized drops of unthickened HD or VX. The CWAs, VX, HD, and TGD are required for testing by the DA Approved NBCCS Criteria for Army Materiel[2]. The selection of areas to be contaminated is based upon the concept that there will be a rain of airborne contaminant onto systems. The rain is usually defined as coming from a 30-degree angle from vertical. Therefore, there is an expectation that only the top, one side, and one end of the SUT will become contaminated. Because of the potential for large areas to be contaminated and the difficulty in working with a large item, areas are also selected for contamination that are identified as representative of areas that would be handled or touched by the system operators, or areas that would impact operations of SUT (e.g., air inlets or air supplies, hatch handles, vision blocks, and climbing rungs).

(b) The purity of the CWAs used must be known and recorded as test data. Ensure that a purity certification is provided with the CWA used for testing and that the certificate has been issued within the last 12 months (except for VX, which must be within 90 days of use). The

quantity applied may be adjusted to achieve the required pure CWA contamination density. If weapons-grade CWA is used, the purity must be measured and recorded as test data. If simulant testing is necessary, an ASR must be fully documented.

(c) The amount of time between contamination and the start of decontamination operations (often called weathering or aging time) will depend on requirements in capability documents. The default weather time is 60 minutes[2]. 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 should be coordinated with the test sponsors and combat developers. Standard field and/or item-specific decontaminants, equipment, and procedures will be used as much as possible. The decontamination procedure conducted and the time between C/D cycles will be included in the test plan for each SUT. The decontamination process time (excluding point detector monitoring) should be recorded.

(2) The chamber (if used) and item surface temperature will be 30 °C and chamber wind speed (if used) no greater than 1 m/sec[2].

(3) Residual dosage levels for vapors will be calculated assuming an exposure time, based on the mission profile specified for the item by the combat developer. The vapor exposure scenario for assessing health effects is exposure for a defined mission timeframe (asset specific) to the asset in an outdoor environment with no more than 1 m/sec wind speed at 30 °C after the asset has been decontaminated within 60 minutes of initial contamination.

4.2.3 Controls and Limitations.

a. Controls and limitations for CWA/simulant contamination survivability. Testing may be performed with simulants on system-level interiors, or CWAs testing may be performed on representative panels, components, mock-ups, or scale models.

(1) Surface areas selected for 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 SUT must be inspected and sampled (vapor and contact) for background contamination. Any foreign substances on the SUT that could interfere with sampling the surface or interfere with analytical instrumentation must be removed (e.g., with inert solvent or HSW) or identified before testing.

b. Analysis control data includes standard analytical controls. The standards need not be at equal concentration intervals; rather, they should be spaced closer together near the low-concentration end of the calibration curve.

c. Test controls should include:

(1) When using a solid sorbent tube (SST), bubbler, or similar vapor sampler, a non-operated sampler control (a sampler taken into the area surrounding the SUT but not used, opened, or aspirated).

(2) Operated sampler control (a sampler taken into the area surrounding the SUT and used, opened, or aspirated, but not exposed to CWA or simulant).

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

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

d. Instrumentation calibration information will be recorded as part of the test record.

e. CWA tests will be conducted inside a surety test facility (chamber) approved for use with CWAs.

4.2.4 Data Required.

a. The following data in the units indicated will be reported.

(1) Test Chamber/Hood.

(a) Temperature in °C.

(b) RH in percent.

(c) Wind speed (airflow) in m/sec.

(2) CWA or Simulant.

(a) Name and control number.

(b) Purity in percent.

(c) Name, product identity, and manufacturer of thickener, if thickened.

(d) Quantity of thickener, if thickened in g/L.

(e) Viscosity after adding thickener in centistokes (cSt), if thickened.

(f) Time since thickening, if thickened.

(g) Name, product identity, and manufacturer of dye, if used.

(h) Quantity of dye in g/L.

(i) Quantity of CWA/simulant dispensed in g.

(j) Contamination density in g/m^2.

(k) Drop volume in µL.

b. Results of each post-decontamination CWA/simulant vapor µg/sample volume and contact sample (collected during the sampling period) in µg/sample area.

c. Complete description of the contact sampler used (material type, lot number, 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.

(1) Total number and location of contact samplers.

(2) A description of the required contact-sampling times specified.

(3) Results of sampling and analysis controls and standards in µg/sample area or volume as appropriate.

(4) Sample history with elapsed time to analysis in days.

(5) Contamination, weathering, decontamination, and sampling elapsed times in minutes.

d. Description of decontamination solutions (i.e., formulation, active ingredients, lot number, and age).

e. Description of decontamination methods, equipment, and system-specific procedures used during decontamination.

f. Description and photographs of SUT exterior surface condition (pretest), including construction materials, paint type, paint thickness (number of coats), paint condition, and surface cleanliness (e.g., mud and grease).

g. Description and photographs of SUT joints, cracks, crevices, and other features that could allow contaminants or decontaminants to enter below the surface and may be difficult to decontaminate.

h. 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 that is commensurate with the parameter being measured.

i. The stain size, on the surface if any, caused by the CWA drops (if safety procedures permit, and if these data are desired).

j. Description and photographs of any materials degradation (e.g., corrosion).

k. Identification of the C/D cycle event.

l. Any relevant safety findings as a result of testing.

4.2.5 Methods and Procedures.

a. Test Method Outline.

(1) Receipt inspection will be 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 and aircraft avionics are operational).

(2) The CWA/simulants will be prepared for application.

(3) SUT will be prepared for testing, to include sample location, identification, documentation, marking of sample areas, etc.

(4) Test chamber operation will be verified and environmental conditions for the test stabilized (if test is conducted in a chamber). If an item is too large to fit properly in a chamber, testing may be conducted outdoors (with the understanding that it may be unlikely to meet the temperature requirement). Environmental conditions are monitored, the SUT is allowed to equilibrate with the ambient conditions, and any required background samples are taken before contamination.

(5) CWAs/simulants are applied to the SUT.

(6) Decontamination operations (including the required decontaminant contact time) will be conducted on the SUT.

(7) Post-decontamination vapor and liquid (contact) sampling and sample analysis will be conducted.

(8) Hardness determination, including post-decontamination functional performance measurements.

(9) Data analysis and hazard determination will be performed.

b. Significance and Use.

(1) The sample data collected from CBCS testing allow a determination of contact and vapor hazards to unprotected personnel from decontaminated military materiel.

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

(3) Exact repeatability is lost with outdoor testing because of the variable and uncontrollable natural environmental conditions, such as wind speed, sun exposure, etc.

c. Interferences.

(1) There are no interferences when the test method is conducted under laboratory-controlled conditions.

(2) Outdoor testing has inherently uncontrolled variances in temperature or humidity. These variances are properties that will create test conduct interferences.

d. Apparatus.

(1) The term apparatus will be used to cover the test fixture or chamber in which a test method may be conducted as well as the equipment used in conducting testing, sampling, and analyzing samples.

(2) Special fixtures may be required because of the wide variety of systems that could be tested (e.g., a vehicle component to a small missile). Each fixture will have to be manufactured to fit the size of the SUT and still remain in a CWA capable chamber. Each fixture should be capable of maintaining an airflow around the SUT, allowing operators to easily reach the SUT for CWA application, decontamination, and to perform contact sampling.

e. Hazards.

(1) Identified safety hazards are those associated with testing using chemical surety materials, simulants, and decontaminant chemicals that are hazardous in and of themselves (e.g., chlorine and hydrogen peroxide). CWA safety guidelines are found in DA PAM 385-61[9].

(2) Testing conducted on large items of equipment may also have slipping or falling hazards when attempting to conduct decontamination operations on the equipment.

(3) 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 385-10[8]. The safety section of the test plan will be coordinated with the test site's safety office.

f. Calibration and Standardization.

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

(a) A solvent blank to evaluate method interferences.

(b) Calibration standards (preferably ranked low to high concentration) with at least five standards.

(c) A solvent blank to evaluate instrument carryover.

(d) 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.

(e) Another solvent blank.

(2) The same analytical method will be used to analyze all test samples.

(3) Plot information will be evaluated as follows:

(a) The appropriate curve fit type (linear, quadratic, etc.) will be selected.

(b) The appropriate point weighting (equal, inverse, etc.) will be selected.

(c) If the correlation value (R^2) is greater than 0.995, then test sample analysis will proceed.

(d) The found values for standards and QC samples must be within ±15 percent of the expected value.

(4) If all criteria are met, the QC sample will be loaded and processed against the calibration curve.

(5) If the QC calculated value passes, then the analysis method will proceed.

(6) If the QC calculated value fails, then a second QC sample will be run.

(7) If the second QC calculated value passes, then the test method will proceed.

(8) If the second QC calculated value fails, then corrective actions will be taken and the instrument recalibrated.

(9) After any maintenance action to the instrument, two QC samples must pass the ±15 percent criteria or corrective actions and recalibration must be performed.

g. Receipt Inspection and Functional Performance.

(1) SUTs should 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.

(2) Surfaces will be inspected for foreign materials normally not present on the item (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 SUT. The surface condition, surface cleanliness, corrosion, materials of construction, variance from standard painting, and paint condition will be recorded.

(3) Any functional SUT will be operated IAW the operator's manual. ME functional performance characteristics (e.g., electronic functions and shelter setup) identified by the combat developer (e.g., in the FD/SC) must be measured and recorded. Based on the selected functional performance characteristics, each functional performance characteristic should 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 units of measure. If any damage, surface condition, or a ME functional performance characteristic falls outside developer specifications, then testing will not proceed.

h. CWAs/Simulants Preparation.

(1) The CWAs to be used are as follows:

(2) Neat VX with a purity greater than 85 percent.

(3) Neat soman (GD) with a purity greater than 85 percent (before thickening) unless weapon-grade is desired, and thickened with 5 percent (weight/volume) of Rohm and Haas Acryloid™ K125 (Philadelphia, Pennsylvania) poly (methyl methacrylate). This should provide thickened GD with a viscosity of 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 dissolving of the polymer in GD is slow; therefore, mixing should continue until the measured viscosity is constant.

(4) Neat HD with a purity greater than 85 percent. The HD may be prepared with approximately 0.5 percent (weight/volume) of a suitable dye.

(5) Other approved threat contaminants [e.g., non-traditional agents, TICs, and toxic industrial materials] as specified in the test documentation.

(6) Any CWA may be prepared with approximately 0.5 percent (weight/volume) of a suitable dye.

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

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

j. Test Chamber Operation.

(1) The test chamber will be operated using the procedures, controls, and SOPs approved for the CWA in use. Some general technical data requirements for the test chamber are as follows:

(2) The test chamber environmental conditions should be computer-monitored, and data should be recorded at least every 15 minutes. The environmental conditions will include air temperature, RH, wind speed or air speed, and SUT surface temperature.

(3) The SUT will be placed in the chamber and the chamber stabilized at the environmental conditions specified for the test. The SUT will be conditioned until it has

stabilized at 30 C±3 °C. Temperature and RH should be recorded continuously throughout the test.

(4) If an item is too large to fit properly in a chamber, testing may be conducted outdoors. Temperature, RH, and wind speed will be recorded throughout the test; however, they cannot be controlled. Testing will be conducted when meteorological conditions are as close to the optimum conditions as possible.

(5) Before CB agent application, background liquid and vapor samples should be taken from or near areas designated for post-contamination and post-decontamination sampling.

k. CWA/Simulant Application and Weathering.

(1) The mechanism for determining the actual amount used to contaminate the SUT is called baseline contamination samples or baseline confirmation samples. The data collected from these samples will provide confidence that the dissemination method performed well and also provide the value for initial contamination. The selection of the appropriate baseline contamination density samplers is dependent on a test site's capability for providing and analyzing the samplers. Baseline samplers will be placed adjacent to the sampling locations. The samplers will be contaminated at the same time as the sampling location of the interior surface.

(2) The selected areas of the exterior surface will be contaminated with the CWA/simulant. CWA/simulant 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 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 8655 Parts 1 and 2[12] or American Society for Testing and Materials E1154-89[13] for the volumes being delivered. If possible, photographs will be taken of drops on the contaminated test surface to record the deposition effects.

(3) Immediately after contamination, the contamination density samplers will be removed and placed into sample jars with the appropriate solvent for analytical processing.

l. Decontamination of the SUT Exterior.

(1) Standard procedures, decontaminants, and equipment [see Army Technical Publication (ATP) 3-11.32[14]] and/or any SUT-specific procedures, when supplied as part of the test-documentation package (e.g., technical manual), will be used. If the decontamination process degrades the material or functionality, the effects must be documented.

(2) A C/D cycle consists of the contamination event, the weathering period (representing travel time), and a thorough decontamination process. The thorough decontamination process consists of the following:

(a) SUT preparation consisting of high pressure, low volume HSW wash.

(b) Application of the decontaminant.

(c) Decontaminant contact time IAW specific procedures included in the test documentation package.

(d) Post-decontamination rinse consisting of a low pressure, high volume water rinse.

(e) Vapor point-detector monitoring (if applicable) for residual contamination after the thorough decontamination process.

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

(4) Decontamination will begin with areas contaminated first and end with areas contaminated last.

(5) All times for each step of the procedure should be recorded, except the time to monitor for residual contamination.

(6) Decontamination procedures should be performed as if the entire surface of the test item was contaminated. The contaminated sampling areas should receive no more or no less attention, time, or effort than uncontaminated areas. Appropriate time should be spent on angles and hard-to-work areas.

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

m. Post-decontamination Sampling.

(1) Point Detector Sampling. Operational post-decontamination sampling is conducted with point detectors or detector tape (M8). Fielded point detectors may be used for qualitative data purposes.

(2) Liquid (Contact) Sampling. Liquid contact sampling procedures found in Test and Evaluation Capabilities and Methodologies Integrated Process Team TOP (TTOP) 08-2-061A[15] should be followed to accomplish this sampling.

(3) Vapor Sampling.

(a) When the surfaces of the sampling areas are no longer visibly wet after the clean water rinse, vapor sampling can begin. Because it is difficult to sample the vapor from the entire surface of a large item, vapor samples can be taken at representative locations for extrapolation to the total surface area of the SUT.

(b) Samples will be taken at appropriate intervals that total the duration of the mission time described in the CONOPS. Generally, more CWA/simulant vapor will be given off during the first few hours of sampling and slowly decrease over time. Thus, sampling intervals should be short in the beginning and longer sampling intervals later, when using cumulative sampling

devices (bubblers or SSTs). This will avoid saturating any sampling device. A minimum of two SSTs should 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 near real-time samplers, and the sample time setting selected will be determined to avoid saturating the detector.

(c) The sampling methods and or methodology must be detailed in the test plans and reports. Sampling methodology should consider the following items (this list is not exhaustive):

(1) Area of vapor sampling.

(2) Distance from the surface.

(3) Sampling frequency.

(4) Collection material (i.e., proper sorbent for collection).

(5) Sampler enclosure.

(6) Type of detector used and detector settings.

(d) Contaminated air will be aspirated through the SST (or other apparatus) at the appropriate rate and for the desired length of time (determined to minimize contaminant breakthrough) to trap contaminant vapor. Typically, MINICAMS® are aspirated at a rate of 0.5 L/min, SSTs may be aspirated from 0.5 to 1.0 L/min, and glass impingers (bubblers) are aspirated at a rate of 1.0 L/min.

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

n. Hardness Determination.

(1) After completion of all decontamination and sampling procedures, all surfaces of the SUT will be inspected for visible evidence of degradation caused by the CWAs, decontaminants, and decontaminating procedures. Other signs of material degradation may include corrosion, peeling paint, discoloration, brittleness of rubber components, hazing, yellowing, or stress cracking of plastic components, etc. Any degradation must be described and documented with photographs.

(2) ME functions are those functions that define the successful completion of a mission for the system or infrastructure being tested as outlined by the test sponsor and/or combat developer in the FD/SC. The SUT will be operated IAW the instruction manual, 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, and compared with pretest values.

(3) Hardness data collection should 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) The hardness and ME performance data collected will be compared with the pretest values recorded.

4.2.6 Adapting to Simulant Testing.

a. Generally, the data requirements, facilities, and procedures for simulant testing will be similar to those used for CWA testing. The major differences will be in the level of required safety and environmental protection restrictions as well as the reduced approval requirements for test chamber work using simulant rather than those required for CWA work. Simulants must be used when a test is performed by soldier, operator, maintainer, tester, and evaluator personnel; when toxic test facilities are not available; when the nature of the equipment being tested makes the use of CWAs impractical; or when an out-of-doors test setting is required. However, testing with simulants will only determine the effects of the decontaminant and the decontamination procedures. Any adverse effects that could be caused by CWAs would not be determined or subject to evaluation.

b. Many SUTs that fail hardness testing fail not because of the contamination, but because of the wetting and/or corrosive action of the decontamination solutions and/or decontamination procedures on delicate optical, electronic, and mechanical components. Coordination with the test sponsor and the OTAs must be conducted for the specific combination of SUT, simulant, and decontamination procedure to determine if simulant testing adequately demonstrates survivability.

c. Facilities and Instrumentation.

(1) The facilities required for simulant testing are the same as for CWA testing, except for the test chamber and personnel protection requirements. The chamber size, environmental controls, and instrumentation will be the same; however, simulant testing usually requires less stringent safety and environmental protection equipment. Approval for testing will be needed.

(2) Although the instrumentation required for simulant testing will generally be the same as for CWA testing, different sampling equipment and procedures may be required.

(3) Simulant use makes outdoor testing possible. Under these conditions, the requirement for a test chamber is eliminated, but the need for other facilities and instrumentation remains unchanged.

(a) Outdoor testing will require that the acceptable temperature, RH, and wind speed limits are expanded to cover the variability expected during the test period. Deviations from requirements in Paragraph 2.2 should be documented. In addition, other environmental parameters will have to be included in the test plan, such as limits on precipitation, dew, solar radiation (sunshine), and cloud cover.

(b) Outdoor testing will result in more realistic environmental test conditions, but will complicate data analysis and comparison of test data sets.

d. Procedures. Most aspects of simulant testing procedures will be the same as for CWA testing. These include objectives, criteria, controls, and limitations, data required, receipt inspection, pretest preparation, test-chamber operation, SUT contamination, and SUT sampling. Safety procedures may be somewhat relaxed when working with simulants; however, test controls, test procedures, and data collection should be emphasized just as rigorously as when conducting CWA testing.

e. CWA/Simulant Selection.

(1) The selection of chemical compounds to simulate CWAs is a critical step in testing with simulants. The SUT materials of construction and candidate simulant will be examined and compared with the CBME database[7] to ensure materials compatibility, i.e., that no degradation will be caused by the simulant that would not be caused by CWA. The simulants selected should be safe to handle and require minimum protective gear, equipment, and procedures; cause little or no environmental concern; and require minimum handling and storage problems.

(2) Simulants selected for hardness testing should have volatility, viscosity, and surface tension values similar to the simulated CWA; require approximately the same mechanical energy to remove from surfaces; and be easily seen when applied in the appropriate drop size. Selected simulants must have similar chemical interactions with the decontaminants used, solubility in the decontamination solution, and a sensitive laboratory analysis procedure. Decontaminability and residual hazard data lose relevance without adequate ASR comparison data to confirm test procedure validity. Such ASR comparison data must be obtained in a laboratory study. Experience has demonstrated that no single compound will simulate all of the important properties of the respective CWA. Performing replicate decontaminability tests using two or more simulants with different properties on each test may be needed to meet selected data requirements.

f. Simulant Decontamination. The procedures used during decontamination will be the same as those used for CWA testing; however, the chemical reaction between the simulant and the decontaminating solution will not be the same or may not proceed at the same rate as with the actual CWA.

g. Simulant Sampling and Analysis. The sampling devices used to sample the simulant should be selected to be as sensitive as those used in CWA testing. The analytical procedure must be able to identify and measure the simulant to the same sensitivity as the CWA for which the simulant is a surrogate.

4.3 Biological Contamination Survivability Testing.

4.3.1 Objectives.

a. Decontaminability. The ability of a system to be rapidly (less than 75 minutes)[2] and effectively decontaminated will be determined following exposure to an ABO or simulant. The associated data will be measured on equipment that has been contaminated with biological contaminant 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 ABO and/or relevant decontaminations. Measure the degree of performance degradation in ME functions of military mission-critical materiel after ABO C/D by standard and/or item-specific procedures.

4.3.2 Criteria and Conditions.

a. Criteria.

(1) Decontaminability. After decontamination, residual contamination levels for the equipment must constitute a negligible risk to unprotected users of the equipment (see DA Approved NBCCS Criteria[2]). In the determination of biological survivability, the following CBCS test conditions apply.

(2) Hardness. Materiel developed to perform ME functions shall be hardened to ensure that exposure to the specified CB 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 should consider pandemic events and the requirements imposed by the affected countries.

b. Conditions.

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

(2) Detailed Conditions. If not already specified in the capabilities document, the detailed chamber conditions for biological contamination survivability testing will be as follows:

(a) Chamber temperature: 30 C ±5 °C.

(b) RH: ambient.

(c) Test chamber air circulation: ≤1 m/sec.

(d) Exterior contamination density: $1 \pm 0.5 \times 10^7$ CFU/m^2, or at least 2×10^4 CFU/ 25 cm^2.

(e) Particle size: 1 to 5 µm.

c. Controls and Limitations. The controls and limitations for the SUT and sample analysis controls of ABO contamination survivability testing are as follows:

(1) SUT Controls.

(a) Paint type, specifications, and application must comply with system specification for the SUT.

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

(2) Sample and Analysis Controls.

(a) Swab control (unused swab).

(b) Swab of a uncontaminated surface.

(3) Diluent control.

(4) Plate control.

(5) A maximum of 18 hours between sample collection and culturing.

4.3.3 Data Required.

a. Test Chamber/Hood or Outdoor Environmental Conditions.

(1) Temperature in °C.

(2) RH in percent.

(3) Wind speed (airflow around the SUT) in m/sec.

b. ABO 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) Quality of spore preparation (greater than 90 percent viability desired).

(7) CFU per mL.

(8) Dissemination equipment used.

(9) Dissemination time in seconds.

(10) Quantity of ABO/simulant suspension disseminated in mL.

(11) Disseminator air pressure in pounds per square inch (psi).

(12) Still color photographs and written description of each area contaminated.

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

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

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

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

f. Description of SUT exterior materials of construction, paint type, and surface condition (pretest and posttest), including cleanliness (mud, grease, and other). Photographs should be made of joints, crevices, textures, or other areas that may be difficult to decontaminate or allow liquid to penetrate.

g. Pretest and posttest ME functional performance characteristics used as the measure of the SUT's mission performance before and after exposure to contaminants, decontaminants, and decontaminating procedures.

h. Description of any safety issues.

4.3.4 Methods and Procedures.

a. General.

(1) The ABOs/simulants are prepared for application.

(2) Receipt inspection is conducted on the SUT to document as tested material condition. Receipt inspection may include functional performance tests to establish baseline performance parameters (e.g., computer is operational and aircraft avionics are operational). Paragraph 4.3.4.g describes the details of this step.

(3) SUT is prepared for testing to include: sample location, identification, and documentation; marking of sample areas; etc., as described in Paragraph 4.3.4.h.

(4) The disseminator is prepared for operation. Paragraph 4.3.4.i describes the details of this step.

(5) Test chamber operation will be verified and environmental conditions for the test stabilized (if test is conducted in a chamber). If a SUT is too large to fit properly in a chamber, testing may be conducted outdoors. Environmental conditions are monitored, the SUT allowed to equilibrate with the ambient conditions, and background samples are taken before contamination. Paragraphs 4.3.4.j and k describes the details of this step.

(6) ABOs/simulants are applied to the SUT test IAW Paragraph 4.3.4.l.

(7) Post-contamination samples (contamination density verification) will be taken as described in Paragraph 4.3.4.m.

(8) Decontamination operations will be conducted on the item under test IAW Paragraph 4.3.4.n.

(9) Post-decontamination sampling will be conducted IAW Paragraph 4.3.4.o.

(10) Hardness and post-decontamination functional performance measurements will be performed as described in Paragraph 4.3.4.p.

(11) Sample analysis will be performed as described in Paragraph 4.3.4.q.

(12) Data analysis and hazard determination will be performed.

b. Significance and Use.

(1) The sample data collected from this test allow a determination of biological spore hazards to unprotected personnel from decontaminated military materiel.

(2) The functional performance and/or material effects data collected allow a determination of the amount of physical or functional degradation of the SUT resulting from CB contamination, decontamination procedures, and materials, to determine if there is a hardness issue.

c. Interferences.

(1) There are no interferences when the test method is conducted under laboratory-controlled conditions.

(2) Outdoor testing is inherently uncontrolled or has variances in temperature and humidity. These are constituents or properties that will create test conduct interferences.

d. Apparatus.

(1) 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.

(2) If a large SUT cannot fit within an existing test chamber, then testing will be conducted outdoors.

(3) 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.

e. Hazards.

(1) Follow all safety protocols to address any hazards in working with the selected biological simulants. Biological safety guidelines are found in DA PAM 385-69[10].

(2) There are safety issues when testing with decontaminant chemicals that are hazardous (e.g., chlorine and hydrogen peroxide).

(3) Testing conducted on large items of equipment may also have slipping or falling hazards[10] when attempting to conduct decontamination operations on the equipment.

(4) 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 385-10[8]. The safety section of the test plan will be coordinated with the test site's safety office.

f. ABO/Simulant Preparation.

(1) The rationale for the selection and use of any biological simulants and the ASR must be documented in the test report.

(2) Procedure controls and SOPs in effect at the time for biological simulant testing must always be followed.

(3) The biological organism (ABO 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 viable spores).

(4) As new decontaminants are developed, an ABO 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 ASR must be established. The rationale for simulant selection, ASR, and ABO efficacy test results must be documented in the test report.

g. Receipt Inspection and Functional Performance. A receipt inspection and pretest ME functional performance test, as described in Paragraph 4.2.5.7, will be performed if not previously performed as part of another test phase.

h. SUT Preparation. Sampling locations will be marked to ensure samples are taken from the same area. For biological contamination survivability, three closely located 25-cm^2 sample areas will be marked for each location selected (see Figure 1). 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.

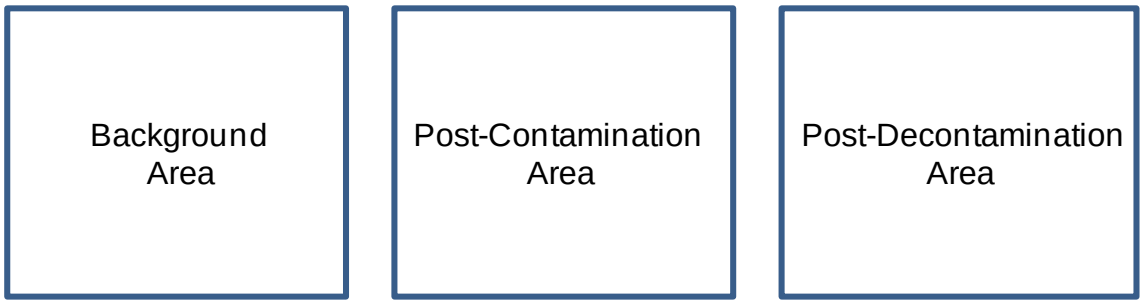

Figure 1. Example of three closely located sampling areas with sampling sequence indicated.

i. Biological Disseminator Preparation. A disseminator (air driven or liquid slurry) will be calibrated to disperse the test organism containing particles in the 1 to 5 μm size range. The appropriate operating time, air pressure, and slurry concentration will be determined for the disseminator. The exact slurry count, the generator air pressure, the duration of generator operation, and the number of CFU/L of chamber air to meet the SUT-contamination target of the SUT contamination target of 1×10^7 CFU/m^2 or 2×10^4 CFU/25 cm^2.

j. Biological Test Chamber Operation.

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

(2) If an item is too large to fit properly in a chamber, testing may be conducted outdoors. Temperature, RH, and wind speed will be recorded; however, they cannot be controlled.

k. Background Sampling. Before proceeding to contamination of the SUT, the first 25-cm^2 sampling areas at each sampling location should be swab sampled to determine the

background contamination level and residual substances (decontaminant) that could interfere with sample assay. The sampling swab will be placed in a solvent filled tube.

l. ABO/Simulant Application.

(1) Chamber Testing. The disseminator will be used to apply the contaminant to the SUT. One hour should be allotted for contamination to settle on the SUT. After the settling, the chamber will be air-washed for 1 hour to reduce chamber contamination. The 1-hour air wash can also serve as the 1-hour weathering time.

(2) Outdoor Testing. The disseminator will be used to apply the contaminant to the SUT. After application of a liquid slurry, continue the trial when the slurry has dried. This time will vary depending on ambient environmental conditions.

m. Post-Contamination Sampling. Immediately after the air-wash, the second 25-cm^2 area in each sampling location should be swab sampled to determine the biological contamination density on the SUT.

n. Decontamination of the SUT.

(1) Decontamination must begin immediately after post-contamination sampling. Standard decontamination procedures, solutions, and equipment, or any SUT-specific procedures furnished as part of the test documentation package, should be used.

(2) Decontamination procedures should be performed as if the entire surface of the SUT were uniformly contaminated. Appropriate time should be spent on rough surfaces, joints, angles, and hard-to-clean areas.

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

o. Post-decontamination Sampling. When the SUT surface is dry following decontamination, the third 25-cm^2 area in each sampling location will be swab sampled to determine the residual contamination remaining on the SUT.

p. Hardness Determination.

(1) After biological decontamination is complete and the final set of swab samples have been taken, the SUT will be visually inspected for evidence of degradation (e.g., corrosion, paint peeling, and yellowing of plastics) caused by the test procedures. The SUT should be operated, and all ME functional performance characteristics will be measured and recorded. Each parameter should 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.

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

q. Sample Analysis. Analysis of the biological samples is done as follows:

(1) The swab extraction solvent is placed on appropriate plates.

(2) The prepared plates are incubated for 14 to 18 hours at 37 °C.

(3) After incubation, count and record the number of colonies on the plates.

4.4 Long-Term CB Hardness.

4.4.1 Objective.

Determine the long-term hardness effects (as specified in the capabilities documents, but greater than 30 days[2] after decontamination of the asset.

4.4.2 Criterion.

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

4.4.3 Hardness Determination.

At the conclusion of the long-term period, the SUT will be visually inspected for additional evidence of corrosion caused by the test procedures. The SUT 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. Posttest values will be compared with pretest values. Procedures and data required are the same as those described for chemical hardness.

4.4.4 Data Reduction and Analysis.

The long-term hardness determination will be the same as for chemical hardness, and procedures are the same.

5. DATA REQUIRED.

The data requirements for each specific subtest are identified in Paragraph 4.

6. PRESENTATION OF DATA.

6.1 Receipt Inspection Data.

This data must include a description of the as-received SUT or mock-up, identifying any damage and specific conditions of the surface to be exposed to CWAs and biological spores. Receipt inspection photographs are important. Differences between the mock-up and the SUT 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 SUT 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 SUT.

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 Decontaminability Data.

a. Chemical decontaminability will be determined by comparing posttest residual contaminant with established criteria for each CWA (Paragraph 4.2.2.1). The item will be considered CWA decontaminable if residual vapor and contact hazard are reduced to levels at or below the established decontamination criteria[2]. The established criteria may be the referenced DA criteria or program specific criteria.

b. Each sampling area, including the location, material of construction, surface geometry, and surface texture, will be reported. Photographs will be included in the test report.

c. A summary table of the hood/chamber/outdoor conditions during the test period will be reported. The CWA/simulant contamination density will be reported for each sample location and deviations from specified values will be identified.

d. The liquid mass of contaminant recovered from each contact sampler, identified by the location at which the sample was taken, will be tabulated. Conversion to mass per area will be included in the report.

e. A 70 kg man is estimated to have 1.8 m^2 of skin surface and the palms of two hands to be 200 cm^2 of skin surface. An item will be deemed to be decontaminable if the total mass transferred to contact samplers, scaled to the surface of two human hands and multiplied by one or two touches, falls below the 16% mild percutaneous liquid dose (as determined from appropriate toxicological data) or the referenced DA approved criteria[2]. The resulting data and hazard determination will be presented in the report.

f. The average concentration of contaminant vapor recovered from each SUT sampling location (component, if used) identified by time period should be reported.

g. Use of small items up to 20 inch × 20 inch × 10 inch allows for vapor sampling of the test SUT. When the item is larger, sample areas will need to be defined and then the CWA vapor concentration may be run through the downwind hazard prediction model[16] and the calculated dosages will be compared with the DA-approved NBCCS criteria for Army materiel[2].

(1) No simple procedure exists for determining vapor hazard to the SUT operator(s). The credible dosage received is a function of CWA desorption from the decontaminated SUT,

worst-case or other selected scenarios that have almost unlimited variables, and the established "no effects" criteria.

(2) One approach[17] would be to calculate toxic load values from the CWA vapor dosages measured from a SUT. This approach allows the toxic load calculations to be transferred to exposure scenarios on a case-by-case basis, depending on the SUT and its expected use in the field.

h. Failure of the decontaminability criterion may necessitate the testing of individual materials because the failure of the SUT cannot be attributed to a specific material or combination of materials. When individual materials are tested for changes in materials properties, the properties matrix in Appendix B will be used.

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

6.2.1 Hardness Data.

a. Hardness data will be presented in a format to show direct comparison of pre- and post-exposure ME function performance of the SUT.

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

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

6.3 Biological Contamination Survivability Data.

6.3.1 Decontaminability Data.

a. For each biological organism or simulant used, the contamination density (CFU), chamber temperature, humidity, and airflow conditions will be reported. Also, decontamination solutions, equipment, procedures, and decontamination time will be reported. The results (i.e., residual contamination in CFU) will be compared with the contamination density and tabulated. A 6-log reduction from the contamination density will be the minimum acceptable level[2].

b. Each sampling area will be described (photographs are preferable), including the location, material of construction, surface geometry, and surface texture.

c. The decontaminant, decontamination time, and decontaminating procedures used, including item-specific procedures furnished by the materiel developer, will be reported.

d. The chamber conditions during the test period will be summarized.

e. Test organism physical property data and aerosol disseminator operating data will be described. Any deviations from target values will be identified and explained.

f. For each sample location, the CFU recovered from the control samples, the test-item contamination level, and the residual sample level after decontamination will be tabulated.

g. 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 SUT. 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 criterion[2] for biological decontaminability and be considered decontaminable for ABO if the contamination of the system has a 6 log or greater reduction.

6.3.2 Hardness Data.

The biological hardness determination will be the same as for chemical hardness.

6.4 Long-Term CB Hardness.

Hardness data will be presented in a format to show direct comparison of pre-exposure and long-term post-exposure ME function performance of the SUT.

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APPENDIX A. GLOSSARY.

Capability Development Document (CDD)	A CDD (includes the Information System CDD variant) specifies capability requirements in terms of developmental Key Performance Parameters (KPPs), Key System Attributes (KSAs), Additional Performance Attributes (APAs), and other related information necessary to support development of one or more increments of a materiel capability solution.
Capability Production Document (CPD)	Specifies capability requirements in terms of production KPPs, KSAs, APAs, and other related information necessary to support production of a single increment of a materiel capability solution.
Chemical Biological (CB) Compatibility	The capability of a system to be operated, maintained, and resupplied 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.
CB Decontaminability	The ability of a system to be rapidly and effectively decontaminated to reduce the hazard to personnel operating, maintaining, and resupplying it.
CB Decontamination	The process of making material safe by absorbing, destroying, neutralizing, rendering harmless, or removing CWAs and ABOs contamination.
CB Environment	The environment created by chemical or biological contamination.
CB Hardness	The capability of material to withstand the material-damaging effects of CB contamination and relevant decontaminations.
Chemical, Biological, Radiological, Nuclear (CBRN) Contamination Survivability (CBRCS)	The capability of a system to avoid, withstand, or operate during and after exposure to a CBRN environment (and relevant decontamination process) without losing the ability to accomplish the assigned mission.

APPENDIX A. GLOSSARY.

Combat Developer	Command or agency that formulates doctrine, concepts, organization, materiel requirements, and objectives. May be used generically to represent the user community role in the materiel acquisition process.
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 and policy implications and constraints.
Materiel Developer	A command or agency responsible for research and development, production, and fielding of a new materiel system.
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 likely will not be completed. Such a system can be an auxiliary or supporting system, as well as a primary mission system.
System Threat Assessment	An authoritative, system-specific threat assessment report (threat to be countered/projected threat environment).

APPENDIX B. MATERIAL PROPERTIES MATRIX AND DATA TEMPLATE.

The material properties matrix 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 CB contamination and the decontamination process. This matrix details the critical properties of materials that program managers and testers should test to determine if mission-critical systems are survivable in a CB 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 should provide to the CBME database[7] so that appropriate survivable materials can be selected during the design of new systems or system upgrades.

APPENDIX B. MATERIAL PROPERTIES MATRIX AND DATA TEMPLATE.

TABLE B.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 (POL)	Textiles	Ceramics
Agent Effects	1	Agent absorption (μg/cm^2 absorbed per time period) and agent desorption (μg/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	X
	4	Density	X	X	X	X	X				X			X
	5	Off gassing (vapor)	X	X	X	X	X	X	X	X	X		X	X
	6	Contact hazard (liquid)	X	X	X	X	X	X	X	X	X		X	X
Mechanical Properties	7	Elastic modules	X	X	X				X	X	X			
	8	Tensile Properties (yield strength, ductility)	X	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			X
	14	Hardness (indentation, durometer, scratch resistance)	X	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 B. MATERIAL PROPERTIES MATRIX AND DATA TEMPLATE.

TABLE B-1. CONT'D

		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 (POL)	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	X
	28	Color change (discoloration, surface finish)	X	X	X	X	X	X	X	X	X		X	X
	29	Optical clarity/distortion (haze, transmittance, reflectance)				X		X		X				X
	30	Crazing, stress, corrosion, cracking	X	X	X	X	X	X		X				X
	31	Acoustic dampening		X		X					X			
	32	Glass transition temperature		X	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	X
	39	Flash point/ignition temperature			X	X						X	X	

APPENDIX B. MATERIAL PROPERTIES MATRIX AND DATA TEMPLATE.

TABLE B-1. CONT'D

		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 (POL)	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 C. ABBREVIATIONS.

ABO	agents of biological origin
AD No.	accession number
APA	additional performance attribute
APG	Aberdeen Proving Ground
AR	Army Regulation
ARL	U.S Army Research Laboratory
ASR	agent/simulant relationship
ATEC	U.S. Army Test and Evaluation Command
ATP	Army Technical Publication
°C	degree Celsius
CAS®	Chemical Abstract Service®
CB	chemical and biological
CBCS	chemical and biological contamination survivability
CBCSA	CBCS assessment
CBME	chemical and biological materials effects (database)
CBR	chemical, biological, and radiological
CBRCS	CBR contamination survivability
CBRN	chemical, biological, radiological, and nuclear
C/D	contamination/decontamination
CDD	Capability Development Document
CFU	colony forming unit
CONOPS	concept of operations
CPD	Capability Production Document
cSt	centistokes
CWA	chemical warfare agent
DA	Department of the Army
DPG	U.S. Army Dugway Proving Ground
DODI	Department of Defense Instruction
DTIC	Defense Technical Information Center

APPENDIX C. ABBREVIATIONS.

DTP	detailed test plan
FD/SC	Failure Definition/Scoring Criteria
GC	gas chromatograph
GD	soman (CAS® number 96-64-0)
HD	distilled mustard (CAS® number 69020-37-7)
HPLC	high-performance liquid chromatograph
HSW	hot soapy water
IAW	in accordance with
ICD	Initial Capability Document
KPP	Key Performance Parameter
KSA	Key System Attribute
LC	liquid chromatograph
m	meter
ME	mission-essential
MMD	mass median diameter
m/sec	meters per second
NBC	nuclear, biological, and chemical
NBCCS	nuclear, biological, and chemical contamination survivability
OEP	OTA Evaluation Plan
OTA	Operational Test Agency

APPENDIX C. ABBREVIATIONS.

PAM	pamphlet
POL	petroleum, oil, and lubricants
PPE	personal protective equipment
psi	pounds per square inch
QA	quality assurance
QC	quality control
R^2	correlation value
RH	relative humidity
SAR	Safety Assessment Report
SDS	safety data sheet
SOP	standing operating procedure
SSP	system support package
SST	solid sorbent tube
STB	super tropical bleach
SUT	system under test
TEMP	Test and Evaluation Master Plan
TGD	thickened soman
TIC	toxic industrial chemical
TOP	Test Operations Procedure
TTOP	Test and Evaluation Capabilities and Methodologies Integrated Process Team TOP
VX	persistent nerve agent (CAS® number 70938-84-0)

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15. Test and Evaluation Capabilities and Methodologies Integrated Process Team (TECMIPT) Test Operation Procedure (TTOP) 08-2-061A, Chemical Decontaminant Testing, 20 October 2010.

16. L. Salomon, R.K. Dumbauld, and J.F. Bowers, Paper Presented at Test Technology Symposium, The John Hopkins University, Laurel, Maryland, Dugway Proving Ground (DPG) Test Procedures for Assessing Compliance With the Chemical Decontamination Requirement of Army Regulation (AR) 70-71, 26 to 28 January 1988.

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APPENDIX E. APPROVAL AUTHORITY.

CSTE-TM 13 March 2019

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) 08-2-510B Chemical and Biological Survivability (CBCS); Large Item Exteriors, Approved for Publication

1. TOP 08-2-510B Chemical and Biological Survivability (CBCS); Large Item Exteriors, 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 preparation, planning, conducting, and reporting procedures for CBCS testing of the exteriors of large mission-critical systems, such as combat vehicles, vans, shelters, and large items of packaged materiel. The TOP describes typical facilities, equipment, and procedures used to contaminate the test item; sample for contamination density and residual contamination; decontaminate the test item; and determine the degradation of selected mission-essential functions resulting from the contamination/decontamination procedures.

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://vdls.atc.army.mil/.

3. Comments, suggestions, or questions on this document should be addressed to U.S. Army Test and Evaluation Command (CSTE-TM), 6617 Aberdeen Boulevard-Third Floor, Aberdeen Proving Ground, MD 21005-5001; or e-mailed to usarmy.apg.atec.mbx.atec-standards@mail.mil.

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RAYMOND G. FONTAINE
Associate Director, Test Management Directorate (G9)

FOR

MICHAEL J. ZWIEBEL
Director, Test Management Directorate (G9)

APPENDIX E. APPROVAL AUTHORITY.

TECMIPT Test Operations Procedure (TTOP) 08-2-510B, Chemical and Biological Contamination Survivability (CBCS): Large Item Exteriors Concurrence Sheet

The Decontamination CAPAT recommends approval of TTOP 08-2-510B. If a representative non-concurs, a dissenting position paper will be attached.

Organization	Signature	Date
Deputy Under Secretary of the Army Test and Evaluation (DUSA-TE)	OBRIEN.SEAN.P.1230553501 Digitally signed by OBRIEN.SEAN.P.1230553501 Date: 2018.03.19 08:53:36 -04'00' Sean P. O'Brien	
Joint Program Executive Office of Chemcal Biological Defense (JPEO-CBD) Test & Evaluation	Joseph M. Rybak	27 July 18
Joint Requirements Office for Chemical, Biological, Radiological and Nuclear Defense (JRO-CBRND)	Digitally signed by MORISSETTE.GREGORY.A.1012347924 Date: 2018.07.17 08:05:56 -04'00' LtCol Greg Morissette, USAF	07/17/2018
Joint Science and Technology Office (JSTO)	Eric J. Lowenstein Digitally signed by LOWENSTEIN.ERIC.JASON.1276026239 Date: 2018.06.04 14:28:22 -04'00' Adobe Acrobat version: 2017.011.30078 Eric J. Lowenstein	06/04/2018
US Army Evaluation Center (AEC)	YOST.EMILY.D.1245776124 Digitally signed by YOST.EMILY.D.1245776124 Date: 2018.04.03 10:24:37 -04'00' Emily D. Yost	04/03/2018
Operational Test and Evaluation Force (OPTEVFOR)	BOBROW.JEFFREY.L.1229647110 Digitally signed by BOBROW.JEFFREY.L.1229647110 Date: 2018.04.05 11:29:44 -04'00' Jeffery L. Bobrow	
Air Force Operational Test and Evaluation Center (AFOTEC)	for Col Matthew Magness, USAF	28 Mar 18
Marine Corps Operational Test & Evaluation Activity (MCOTEA)	LtCol J.E. Smith, USMC	02 APR 2018
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Forward comments, recommended changes, or any pertinent data which may be of use in improving this publication to the following address: Policy and Standardization Division (CSTE-TM), U.S. Army Test and Evaluation Command, 6617 Aberdeen Boulevard, Aberdeen Proving Ground, MD 21005-5001. Technical information may be obtained from the preparing activity: Commander, U.S. Army Dugway Proving Ground (TEDT-DPW-TT), Dugway, Utah 84022-5000. Additional copies can be requested through the following website: https://www.atec.army.mil/publications/documents.html, or through the Defense Technical Information Center, 8725 John J. Kingman Rd., STE 0944, Fort Belvoir, VA 22060-6218. This document is identified by the accession number (AD No.) printed on the first page.