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14. ABSTRACT
This Test Operations Procedure (TOP) provides basic information to facilitate planning, conducting, and reporting of material effects testing. This TOP provides standard methods for chemical, biological, and radiological (CBR) contamination survivability (CS) coupon testing of materials for use in military systems. The procedure is designed to provide material effects data for changes in critical properties after exposure to CBR contaminants, simulants, and decontaminants. This TOP describes typical facilities, equipment, and procedures used to contaminate and decontaminate material coupon samples for measured changes in material critical properties and sample for residual contamination. A process for including the data in the Department of Defense (DOD) Chemical Biological Material Effects (CBME) Database is also provided.

15. SUBJECT TERMS
chemical; biological; radiological; CBR; nuclear, biological, chemical; NBC; contamination; decontamination; survivability; hardness; decontaminability; compatibility; simulant; fallout; material effects, Chemical Biological Material Effects database; CBME

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

*Test Operations Procedure 08-2-502A 10 December 2019
DTIC AD No.

CHEMICAL, BIOLOGICAL, AND RADIOLOGICAL CONTAMINATION SURVIVABILITY: MATERIAL EFFECTS TESTING

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* This TOP supersedes TOP 08-2-502 Chemical, Biological, and Radiological Contamination Survivability: Material Effects Testing, dated 22 June 2012.

1. SCOPE.

1.1 Purpose.

a. The primary focus of the material effects Test Operations Procedure (TOP) is to ensure that Department of Defense (DOD) mission-critical systems have a standard procedure for determining the effects of Chemical, Biological, and Radiological (CBR) contamination and decontamination and the handling and archiving of the data collected. The requirement for a procedure to determine CBR survivability is derived from DOD Instruction (DODI) 3150.09, The Chemical, Biological, Radiological, and Nuclear (CBRN) Survivability Policy[1**] and in accordance with (IAW) the requirement in the Ronald Reagan National Defense Authorization Act for Fiscal Year (FY) 2005, Public Law No. 108- 375, 28 October 2004[2].

b. This TOP describes procedures for material testing for CBR Contamination Survivability (CS) and the transfer of data into the Chemical and Biological Material Effects (CBME) database. This TOP will establish procedures for gathering test data in order to assist designers, engineers, testers, and evaluators in determining changes in material properties after exposure to CBR contamination and decontamination. It is the design engineer's responsibility to evaluate the material effects data as applied to each particular system tested. Assessment of the data by the design engineer is to ensure material degradation by Chemical and Biological (CB) contamination and decontamination does not significantly degrade system performance.

c. This TOP will describe the procedures for generating information on the effects of CBR contaminants, stimulants, and decontaminants on materials used in the design, construction, and manufacture of mission-critical systems. System developers can use this information to make material selection decisions during the system acquisition process.

1.2 Limitations.

a. These procedures will aid in assessing how materials of construction, not systems or system components, respond to CBR contaminants and decontaminants. This TOP will not provide a list of materials suitable for use in DOD systems.

b. This TOP will not address inherent variability in materials and coatings. The only means to address this limitation is by documenting, to the extreme, all the details of what the material is, where it is procured, what the coating is, how the coating is applied, etc.

c. This TOP will not address the correlation between materials tests and mission-essential component functions.

** Superscript numbers correspond to those in Appendix D.

d. This TOP will not address the variability in test results that may occur because of the shape of the materials. Although results from this TOP will be derived from flat coupons, the materials may contain crevices, nooks, etc., when incorporated into fielded systems.

e. The results obtained from materials effects testing must be interpreted by system developers based on the needs and requirements of the specific system under development. Therefore, both the material and system performance specifications should be reviewed before test planning and execution.

1.3 Method of Analysis.

a. The method of analysis is to determine the degree of change in material properties between uncontaminated materials and those contaminated by CBR agents, simulants, and/or subsequent decontaminants.

b. Test results produced may be used for materials screening to ensure appropriate materials are selected for a given application.

c. Test data compiled by following the procedures in this TOP may be used to assist the system engineer/designer in determining if the resulting reaction from exposure to specific challenges produces desirable or undesirable physical characteristics, requires changes for materials selection, or for properties optimization.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

Item	Requirement
Chemical surety laboratory and chemical agent storage facility.	Constructed to ensure safe and secure storage, handling, analysis, and decontamination of chemical agents and simulants used for test and evaluation.
Chemical agent test facility (chemical agent test chamber).	To house the test item during agent or simulant contamination, decontamination, and sampling. The chamber should have sufficient volume to allow free air circulation around and underneath the test item. The test facility/chamber must have the ability to control temperature, Relative Humidity (RH), and wind speed.
Fielded and/or experimental decontaminants.	To decontaminate the test item/material as part of the test procedure.

Item	Requirement
Fluorescent Particle (FP) and biological assay laboratories.	Required to store and prepare test quantities of biological and residual radiological contamination simulant materials, charge disseminating devices, prepare samplers, and analyze all biological agent simulant and radiological simulant materials.
Chambers for residual biological and radiological simulant testing.	Equipped with an air intake and an exhaust system that exhausts through high-efficiency particulate filters (capable of retaining 99.7 percent of particles, 0.3 micron (μm) or greater in diameter), into an exhaust system. The chamber should have sufficient volume to allow free air circulation around the test item. Biological surety regulations will be followed when using Biological Warfare Agents (BWA).

2.2 Instrumentation.

Parameter	Measuring Device	Permissible Error of Measurement
Air temperature (30 °Celsius (°C) desired).	Thermocouple or other.	± 0.5 °C.
Relative humidity (40 percent desired).	Hygrometer or other.	± 2 percent.
Wind or air speed desired (<1 meters per second (m/s)).	Anemometer.	± 0.1 m/s.
Photographs and video.	Still color camera and video camera.	Adequate to document typical test procedures, details of contamination techniques, and any discrepancies from planned procedures necessitated by operational conditions.

2.3 Chemical Test Instrumentation.

Parameter	Measuring Device	Permissible Error of Measurement
Contamination density or challenge level (grams per meter squared (g/m^2)).	A control coupon will be used for the calculation of the actual contamination density applied.	Contamination density, ± 10 percent.

Parameter	Measuring Device	Permissible Error of Measurement
Drop size (on the material surface) in millimeters (mm)).	Digital imaging device for digitally measuring the diameter of the drops.	Drop size diameter, ± 10 percent.
Residual chemical agent mass from vapor samples (micrograms per milliliter (µg/mL)).	Gas Chromatography (GC), High-Performance Liquid Chromatography (HPLC), Liquid Chromatography (LC), spectrophotometer, or equivalent.	± 15 percent of calibration curve except when the lower calibration standard is at or near the method detectable limit, the permissible error is ± 25 percent.
Residual chemical agent mass from liquid samples (microgram (µg)).	Chemical agent mass from the sampling medium, such as silicone rubber or latex. Liquid extraction of the coupons under test.	± 15 percent of calibration curve except when the lower calibration standard is at or near the method detectable limit, then the permissible error is ± 25 percent.

2.4 Biological Test Instrumentation.

Parameter	Measuring Device	Permissible Error of Measurement
Contamination.	Collision atomizer or equivalent.	Not applicable (NA).
Background contamination.	Microscopes, automatic colony counters (or equivalent), or swabs or wipes placed in growth medium.	± 10 percent Colony-Forming Units (CFU)/sample.
Post-contamination verification.	Microscopes, automatic colony counters (or equivalent), or swabs or wipes placed in growth medium.	± 10 percent CFU/sample.
Post-decontamination.	Microscopes, automatic colony counters (or equivalent), or swabs or wipes placed in growth medium.	± 10 percent CFU/sample.

2.5 Radiological Test Instrumentation.

Parameter	Measuring Device	Permissible Error of Measurement
Contamination.	Collision atomizer or equivalent.	NA.
Background contamination.	Alpha, beta, or gamma-spectrometry, liquid scintillation counting, neutron flux.	± 5 becquerel (Bq)/g and ± 5 centigray (cGy)
FP background contamination	Microscope	± 10 percent
Post-contamination verification.	Alpha, beta, or gamma- spectrometry, liquid scintillation counting, neutron flux.	± 5 Bq/g and ± 5 cGy
Post-decontamination.	Alpha, beta, or gamma-spectrometry, liquid scintillation counting, neutron flux.	± 5 Bq/g and ± 5 cGy

2.6 Chemical, Biological, and Radiological (CBR) Material Effects Test Instrumentation.

a. The system engineer will choose system materials based on specific material properties. The properties of interest to the system engineer should be communicated to the testing facility. These specific properties will frame the scope of the material effects testing. Appendix A references potential material effects properties. It is impractical to list all potential equipment necessary for specific material effects testing. The tester(s) should refer to industrial standards (i.e., the ASTM International (formerly known as American Society for Testing and Materials (ASTM)) when planning material effects tests.

b. The CBR material effects information section should include all instrumentation necessary to properly evaluate the material effects to be tested. The list should include all equipment, both general and specific, with parameters and permissible error of measurement for the material properties being tested.

Parameter	Measuring Device	Permissible Error of Measurement
Material properties as related to mission-essential functions.	As necessary.	Precision and accuracy requirements must be compatible with the nature of the test material, test methods, and must allow detection of degradation of physical properties after completion of each Contamination/Decontamination (C/D) cycle.

3. REQUIRED TEST CONDITIONS.

a. CBR material effects testing requires the use of CBR agents. Such testing is strictly controlled by Army Regulation (AR) 385-61, Toxic Chemical Agent Safety Standards[3]. Throughout testing, primary emphasis must be on operator safety. Nevertheless, the importance of technical quality, scientific integrity, completeness of test data, and conformance with specified test and operating procedures cannot be overemphasized.

b. Each test plan must be reviewed for technical accuracy and conformance to regulations and Standing Operating Procedures (SOPs) or other standard methods applicable to the specific material tests being conducted. In addition, the test plan should describe the material properties to be tested. The test plan must reflect the overall purpose of establishing the effects of C/D on the material as it pertains to the system being evaluated, not as a means to evaluate the overall system.

c. For DOD-specific application material testing, the capabilities documents [e.g., Initial Capability Document (ICD), Capability Development Document (CDD), or Capability Production Document (CPD)] are to be reviewed. The Operational Test Agency (OTA) Evaluation Plan (OEP) and the Test and Evaluation Master Plan (TEMP) will be used to determine the overall test structure, data required, criteria, and analysis to be used. Critical physical properties to be tested for each material will be identified in order to determine if those properties being tested are affected as a result of C/D (see Appendix A). The units of measurement, as well as the precision and tolerance required for each parameter being measured, will be identified. All issues concerning measurable performance and degradation will be identified.

d. Historically, five cycles of C/D have been conducted on each test item to accommodate one radiological cycle, one biological cycle, and three chemical agent cycles for the three classes (nerve, persistent nerve, and blister) of Chemical Warfare Agents (CWAs). The exact number of C/D cycles shall be determined through coordination between the tester, customer, and evaluator.

3.1 Preparations for Test.

a. All test site SOPs and procedures should be current and reviewed for safety.

b. Receipt inspection of the test material/test sample must be conducted. TOP 08-2-500A[4] outlines one method of conducting receipt inspection. Inspection data, certificates of compliance, or similar documentation should be reviewed to ensure that surfaces and finishes meet specifications. When packaging is damaged, the test material/test sample must be carefully examined to determine the extent of any damage. All receipt inspection information will be recorded and described in any test reports.

c. All materials selected for testing will be prepared for the selected procedures. This may involve cutting the materials (e.g., metals, plastics, etc.) into coupons, small panels, or large panels.

d. Test planning should consider the conditions and rationales listed in Table 1.

TABLE 1. MATERIALS TESTING CONSIDERATIONS

TEST CONDITION	RATIONALE FOR TESTING
Uncontaminated materials.	Baseline for all properties comparison.
Agent-contaminated materials.	Compare to uncontaminated materials.
Decontaminated materials (decontaminants).	Compare to uncontaminated materials or agent-contaminated materials.
Agent-contaminated and subsequently decontaminated materials.	Compare to uncontaminated materials, agent-contaminated materials, and decontaminated materials.

3.2 Environmental.

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

3.3 Safety.

Applicable safety and surety regulations will be consulted to ensure compliance of all test procedures.

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

a. The quality of instrument data produced depends on appropriate instrument maintenance, periodic calibration, QC measures, and careful documentation procedures. Calibration will be conducted IAW the validated calibration protocol of the test facility. In the absence of a validated protocol, calibration will be conducted as recommended by the instrument manufacturer.

b. All analysis results and calculations will be peer reviewed to ensure that random errors in transcribing data or in performing analysis are eliminated, as required by the test facility or the test program.

c. All test samples will be marked with unique identification numbers for sample tracking. The sample coding will be placed to not interfere with testing. Use of a chain of custody tracking system will enhance data tracking.

4. TEST PROCEDURES.

a. In general, material properties tests will first be conducted on uncontaminated specimens, and the results will be recorded. Establishment of a baseline is vital for the accuracy in the comparison of changes in the material effects due to the exposure of CB contaminants, decontaminants, and decontamination processes.

b. Test considerations include whether the procedures are destructive or non-destructive testing to the test materials. Destructive testing is defined as those test methods used to examine

an object to the point of specimen failure. Non-destructive testing is defined as those test methods used to examine an object without impairing its future usefulness.

c. Whenever possible, ASTM International, Association of Official Analytical Chemists (AOAC) International, or American Society of Metals (ASM) International standard methods shall be used. Test method selection will be based on the type of material being tested (e.g., light transmission properties for glass and clear plastics).

d. Contaminated specimens may be allowed to sit for an extended period of time (aging or weathering) to simulate operational scenarios before decontamination is conducted.

e. Contaminants to consider: CWAs, Non-Traditional Agents (NTAs), Pharmaceutical Based Agents (PBAs), BWAs, or radioisotopes. The detailed test plan should outline the contaminants to be used.

f. Chemical liquid contamination densities or challenge levels to consider: exterior standard challenge shall be 10 g/m^2 with a 2 to 5 microliter (µL) drop for neat agents or 5 to 10 µL drop for thickened agents. There are no standard levels for solid or particulate chemical challenges. The detailed test plan should outline the actual challenge levels to be used.

g. Biological contamination density or challenge level to consider: Aerosol suspension with a default value of 1 to 5 µm particle size to achieve a contamination density of 1×10^8 CFU on the test sample surface or liquid suspension with a default value of 1 to 5 µL to achieve a contamination density of 1×10^8 CFU on the test sample surface. The detailed test plan should outline the actual challenge levels to be used.

h. Radiological contamination density or challenge level to consider: Aerosol suspension with a default value of 4 g/m^2 of insoluble radioactive contaminants, 37-200 µm in size, and 185 gigabecquerel (GBq)/m^2 gamma activity. The detailed test plan should outline the actual challenge levels to be used.

i. Decontaminants to consider: bleach solution, high-test hypochlorite, super tropical bleach, Joint Service Equipment Wipe, Joint Service General Purpose Decontaminant for Hardened Military Equipment, etc. The detailed test plan should describe the decontaminants to be used.

j. Decontamination processes may be dependent on the system of interest, the service that fields the system, personal equipment, and other factors. The detailed test plan should outline the processes to be used.

k. Material Effects Testing.

(1) Execute the test methods for the test materials and the selected physical properties on new samples (pretest).

(2) Record the pretest data (baseline).

(3) Execute the test methods on the contaminated and/or the decontaminated test materials.

(4) Record the data.

(5) Execute the test methods for the total number of C/D cycles outlined in the test plan.

(6) Record all test data.

5. DATA REQUIRED.

a. Receipt inspection data.

b. Size (centimeter (cm)) and shape of material undergoing testing.

c. Material properties test(s) performed.

d. Materials property data from testing the uncontaminated specimens.

e. Materials property data from the contaminated specimens.

f. Materials property data from the decontaminated specimens.

g. Chemical agent properties (includes CWAs, NTAs, and PBAs):

h. Name and control number.

i. Purity in percent.

j. Viscosity (if thickened) in centistokes (cSt) as measured at 20 °C.

k. Age since thickened, if thickened.

l. Quantity of dye and/or thickener (if thickened) in grams per liter (g/L).

m. Quantity of agent dispensed in grams.

n. Agent contamination density in g/m^2.

o. Agent droplet diameter in mm.

p. Dwell time allowed on material before decontamination begins.

q. Dilution of agent, if applicable.

r. BWA properties:

(1) Strain name.

(2) Lot or control numbers.

(3) Exterior contamination density: $1 \pm 0.5 \times 10^7$ CFU/m^2.

(4) Particle size: 1 to 5 µm.

s. Radiological properties:

(1) Radioactive isotope used (when appropriate).

(2) Simulant used (when appropriate).

(3) Lot number, if applicable.

(4) Particle size range in µm.

t. Decontaminants:

(1) Name, National Stock Number (NSN), and lot number.

(2) Manufacturer's directions for use.

(3) Active ingredient determination, if necessary.

(4) Decontaminant application method.

(5) Contact time in minutes.

u. Sample history indicating any time delays between contamination, decontamination, and analysis.

v. Contamination, dwell time, decontamination time, weathering time, and sampling times in minutes.

w. Description of test specimen [i.e., surface condition (pretest), paint type, paint thickness (number of coats), paint condition, and surface cleanliness], with photographs.

x. Description and photographs of any materials degradation (e.g., corrosion) after each C/D cycle.

y. Monitored environmental conditions, recorded at least every 15 minutes. The environmental conditions include air temperature, RH, and airflow (if applicable).

6. PRESENTATION OF DATA.

a. The degree of change will be determined between the:

(1) Uncontaminated samples and the contaminated samples.

(2) Uncontaminated samples and the decontaminated samples.

(3) Contaminated samples and the decontaminated samples.

(4) Uncontaminated samples and the contaminated/decontaminated samples.

b. Any anomalies occurring during testing will be recorded.

c. All raw data and calculations of degree of change will be placed in spreadsheet format.

APPENDIX A. MATERIAL PROPERTIES MATRIX AND DATA TEMPLATE.

A.1. The material properties matrix provides a useful tool for Program Managers (PMs), testers, and database developers to acquire the information needed to ensure that defense systems are survivable to the effects of the CBR C/D process. This matrix (Table A-1) details the critical properties of materials that PMs and testers may consider when determining if mission-critical systems are survivable in a CBR environment by measuring any significant degradation to these critical properties. While survivability determinations are not limited to the materials and properties listed in this matrix, it provides a framework for data that PMs and testers should provide to the CBME database so that appropriate survivable materials can be selected during the design of new systems or system upgrades.

A.2. For government-sponsored testing, test reports will be forwarded to the Defense Technical Information Center (DTIC) and/or the Homeland Defense Information Analysis Center (HDIAC). For industry-sponsored testing, request from the test sponsor or customer permission to allow test methods and data be forwarded to HDIAC with a document reference so the information can be placed in the CBME database (https://cbme.apgea.army.mil). Data submission should follow the CBME test data templates (see paragraphs A.4 through A.6 of Appendix A). A separate submission of the data to HDIAC in a spreadsheet may expedite data entry into the CBME database.

A.3. Table A-1 describes materials and properties of interest.

APPENDIX A. MATERIAL PROPERTIES MATRIX AND DATA TEMPLATE.

TABLE A-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/cm² absorbed per time period) and agent desorption (μg/cm² 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
	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

APPENDIX A. MATERIAL PROPERTIES MATRIX AND DATA TEMPLATE.

TABLE A-1. MATERIALS AND PROPERTIES OF INTEREST (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 (POLs)	Textiles	Ceramics
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	
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 A. MATERIAL PROPERTIES MATRIX AND DATA TEMPLATE.

A.4. The CBME database elements are listed below. Each element corresponds to a column in the database with rows being the data values.

a. Sample information.

(1) Report number.

(2) Material.

(3) Sample number or lot number.

(4) Test personnel and titles.

(5) Material property.

(6) Material property units.

(7) Challenge material (agent, simulant, or decontaminant).

(8) Material trade name.

b. Material information.

(1) Material manufacturer.

(2) Material composition.

(3) Material form.

(4) Material characteristics.

(5) Material specifications.

(6) Material fabrication method.

(7) Material treatments.

(8) Material remarks.

c. Challenge properties and conditions.

(1) Challenge composition.

(2) Challenge purity.

(3) Challenge preparation method.

(4) Challenge amount.

(5) Challenge remarks.

d. Test specimen and conditions.

(1) Test specimen preparation method.

(2) Test specimen type.

(3) Test specimen dimensions.

(4) Test specimen count.

(5) Test specimen preconditions.

(6) Test equipment used.

(7) Test procedure used.

(8) Test sample count.

(9) Test exposure state.

(10) Test exposure conditions.

(11) Test exposure temperature.

(12) Test sample exposure history.

(13) Test exposure remarks.

(14) Test exposure time operator.

(15) Test exposure time.

(16) Test specification.

e. Test value.

(1) Test initial value operator.

(2) Test initial value.

(3) Test initial value standard deviation.

(4) Test initial value low.

(5) Test initial value high.

(6) Test value control operator.

(7) Test control value.

(8) Test control value standard deviation.

f. Results.

(1) Property value operator.

(2) Property value.

(3) Property value standard deviation.

(4) Property value low.

(5) Property value high.

(6) Percent change operator.

(7) Percent change.

(8) Percent change standard deviation.

(9) Percent change low.

(10) Percent change high.

(11) Result remarks.

(12) Post testing photographs.

A.5. The data template for information submitted to the CBME database needs to be in the same format as the database for ease of integration. The best method of submission is to use a spreadsheet where the rows are the sets of data (e.g., row one is data for test sample 1, row two is for test sample 2, etc.).

A.6. The columns are individual data elements. It is unlikely that a test sample will produce data that requires more than a small set of the data elements, but the full set of data elements are required in the spreadsheet for integration into the CBME. The data elements are:

a. Challenge Information.

(1) Sample name/Product number.

APPENDIX A. MATERIAL PROPERTIES MATRIX AND DATA TEMPLATE.

(2) Agent/simulant/decontaminant.

(3) Application/delivery method (e.g., immersion, droplet, film, etc.).

(4) Challenge density (e.g., g/m^2).

(5) Purity.

(6) Temperature.

(7) RH.

(8) Exposure time.

b. Decontamination Information.

(a) Method (e.g., weathering, wet soak, wet scrub, etc.).

(b) Decontamination time duration.

(c) Residual chemical vapor dosage.

(d) Residual biological contamination.

(e) Residual radiological contamination.

c. Agent Effects.

(1) Agent absorption and desorption.

(2) Permeation (time to agent breakthrough) for vapors or liquids.

(3) Weight change.

(4) Density change.

(5) Vapor off gassing.

(6) Liquid contact hazard.

d. Mechanical Properties (cite test method used).

(1) Elastic Modulus.

(2) Tensile properties (yield, strength, ductility, etc).

(3) Hydrogen embrittlement.

(4) Ultimate strength for tension (flexural).

(5) Compressive strength.

(6) Shear strength.

(7) Fracture toughness (compression, bending, shear, impact, etc.).

(8) Hardness (indentation, durometer, scratch resistance, etc.).

(9) Resilience (capacity to absorb energy).

(10) Fatigue strength (includes adhesives for structural bonds).

(11) Puncture resistance.

(12) Creep strength (rupture).

(13) Compressive spring constants.

(14) Bond strength.

e. POLs Properties (cite test method used).

(1) Thermal stability.

(2) Chemical compatibility.

(3) Lubricity.

(4) Solubility.

(5) Melting point/Boiling point.

(6) Viscosity.

f. Physical Properties (cite test method used).

(1) Dimensional change.

(2) Color change (discoloration or surface finish).

(3) Optical clarity/distortion (haze, transmittance, reflectance, etc.).

(4) Acoustic dampening.

(5) Glass transition temperature.

(6) Rubber property - effects of liquids.

(7) Peel/lap shear strength change.

(8) Adhesion (loss of), blistering, or spalling.

(9) Corrosion rate.

g. Thermal Properties (cite test method used).

(1) Thermal conductivity.

(2) Flame.

(3) Flash point/ignition temperature.

h. Electrical Properties (cite test method used).

(1) Insulative properties (including dissipative factor).

(2) Dielectric constant.

(3) Electrical conductivity.

(4) Impedance.

(5) Relative permittivity.

(6) Polarizability (effect on radar signals).

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APPENDIX B. GLOSSARY.

Term	Definition
Contamination survivability	Contamination survivability revolves around three concepts; decontaminability, hardness, and compatibility.
Decontaminability	This concept covers the ability of a system (e.g., personal equipment or vehicles) to be decontaminable from a contamination event. The contamination event could be a chemical weapon, a biological weapon, or a radiological weapon.
Hardness	This concept covers the ability of a system and its materials of construction to resist the effects of a contaminant, a decontaminant, or a decontamination process.
Compatibility	This concept covers the ability of a Warfighter to perform system mission functions in a contaminated environment while wearing the individual protective garments (including gloves). The CBME does not include data collected from this type of testing.
CBME	This database is a repository for decontaminability and hardness data to provide information for system developers, program managers, and testers. System developers can use the database to determine if materials of construction will be affected by a contamination event and subsequent decontamination. Program managers and testers can query the CBME to determine if test results exist that can be used to reduce the use of test resources and trial conduct.
Materials testing	All materials used in the development and construction of a Warfighter system will have mission essential functions. A simple example of such a function is: if the camouflage paint used on almost all vehicles were to peel off of the vehicle after a decontamination event using a fielded decontamination system, then the system would be vulnerable to enemy detection and potential destruction. There are tests available to detect and measure such mission essential functions and the changes from baseline values to post-contaminated or post-decontaminated values. The degree of such changes can then be used to determine the appropriateness in using that material for developing that particular system.

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APPENDIX C. ABBREVIATIONS.

AD No	Accession Number
AOAC	Association of Official Analytical Chemists
AR	Army Regulation
ASM	American Society of Metals
ASTM	American Society for Testing and Materials
ATEC	US Army Test and Evaluation Command
ATTN	attention
BWA	Biological Warfare Agent
Bq	becquerel
°C	degrees Celsius
CB	Chemical and Biological
CBME	Chemical Biological Material Effects
CBR	Chemical, Biological, and Radiological
CBRN	Chemical, Biological, Radiological, and Nuclear
C/D	Contamination/Decontamination
CDD	Capability Development Document
CFU	Colony Forming Unit
cGy	centigray
cm	centimeter
CPD	capability production document
CS	Contamination Survivability
cSt	centistokes
CWA	Chemical Warfare Agent
DOD	Department of Defense
DODI	Department of Defense Instruction
DTIC	Defense Technical Information Center
FP	Fluorescent Particle
FY	Fiscal Year
g/l	grams per liter
g/m^2	grams per meter squared
GC	Gas Chromatography
GBq	gigabecquerel
HDIAC	Homeland Defense Information Analysis Center
HPLC	High-Performance Liquid Chromatography
IAW	in accordance with
ICD	Initial Capability Document

APPENDIX C. ABBREVIATIONS.

LC	Liquid Chromatography
µg	microgram
µg/mL	micrograms per milliliter
µl	microliter
µm	micron
m/s	meters per second
mm	millimeter
NA	not applicable
NSN	National Stock Number
NTA	Non-Traditional Agent
OEP	OTA Evaluation Plan
OTA	Operational Test Agency
PBA	Pharmaceutical Based Agent
PM	Program Manager
POL	Petroleum, Oil, and Lubricants
QA	Quality Assurance
QC	Quality Control
RH	Relative Humidity
SOP	Standing Operating Procedure
TEMP	Test and Evaluation Master Plan
TOP	Test Operations Procedure

APPENDIX D. REFERENCES.

1. Department of Defense Instruction (DODI) 3150.09, The Chemical, Biological, Radiological, and Nuclear (CBRN) Survivability Policy, 31 August 2018.

2. Ronald Reagan National Defense Authorization Act for Fiscal Year (FY) 2005, Public Law No. 108- 375, 28 October 2004.

3. AR 385-61, Toxic Chemical Agent Safety Standards, 1 November 2018.

4. TOP 08-2-500A, Receipt and Inspection of Chemical - Biological (CB) Materiel, 31 August 2017.

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APPENDIX E. APPROVAL AUTHORITY.

CSTE-CI 10 December 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 08-2-502A Chemical, Biological, and Radiological Contamination Survivability: Material Effects Testing, Approved for Publication

1. Test Operations Procedure (TOP) 08-2-502A Chemical, Biological, and Radiological Contamination Survivability: Material Effects Testing, has been reviewed by the U.S. Army Test and Evaluation Command (ATEC) Test Centers, the U.S. Army Operational Test Command, and the U.S. Army Evaluation Center. All comments received during the formal coordination period have been adjudicated by the preparing agency. The scope of the document is as follows:

This TOP provides basic information to facilitate planning, conducting, and reporting of material effects testing. Standard methods for chemical, biological, and radiological contamination survivability coupon testing of materials for use in military systems are provided. This TOP describes typical facilities, equipment, and procedures used to contaminate and decontaminate material coupon samples for measured changes in material critical properties and sample for residual contamination.

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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MICHAEL J. ZWIEBEL
Director, Directorate for Capabilities Integration (DCI)

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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-CI-P), U.S. Army Test and Evaluation Command, 6617 Aberdeen Boulevard, Aberdeen Proving Ground, Maryland 21005-5001. Technical information may be obtained from the preparing activity: Commander, West Desert Test Center, U.S. Army Dugway Proving Ground, ATTN: TEDP-DPW, Dugway, UT 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.