REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	**3. DATES COVERED** *(From - To)*
22 June 2023	Final Draft	

4. TITLE AND SUBTITLE
Test Operations Procedure (TOP) 08-2-109A, Simulant Agent Resistance Test Manikin (SMARTMAN) Testing of Protective Masks

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Dugway Proving Ground
West Desert Test Center
(TEDT-DPW-CTC)
Dugway, UT 84022-5000

8. PERFORMING ORGANIZATION REPORT NUMBER
TOP 08-2-109A

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Policy and Standardization Division (CSTE-TM)
U.S. Army Test and Evaluation Command
2202 Aberdeen Boulevard
Aberdeen Proving Ground, MD 21005-5001

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
Same as item 8

12. DISTRIBUTION/AVAILABILITY STATEMENT
Distribution Statement A: Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES
Defense Technical Information Center (DTIC), AD No.
This TOP supersedes TOP 08-2-109 dated 16 September 2013.

14. ABSTRACT
This test operations procedure (TOP) is intended to furnish basic testing information to facilitate test planning, conducting and reporting, and to achieve standardized chemical protective performance testing of protective masks and accessories using the Simulant Agent Resistance Test Manikin (SMARTMAN). It describes test facilities, equipment, and procedures to be used for SMARTMAN testing and evaluating protective mask technical performance and safety aspects. Biological and radiological protective performance testing of the mask systems is not included in this TOP.

15. SUBJECT TERMS
CBR – chemical, biological, and radiological; SMARTMAN – Simulant Agent Resistance Test Manikin; CWA – chemical warfare agent; battlefield contaminants; contamination; preconditioning; adverse environments; reliability; chemical agent simulant, breakthrough; TIC – toxic industrial chemical

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER** (include area code)
Unclassified	Unclassified	Unclassified	SAR	44	

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

Test Operations Procedure 08-2-109A 22 June 2023

SIMULANT AGENT RESISTANCE TEST MANIKIN (SMARTMAN) TESTING OF PROTECTIVE MASK SYSTEMS

Page

This TOP supersedes TOP 08-2-109 dated 16 September 2013

1. SCOPE.

1.1 Background.

a. The Simulant Agent Resistance Test Manikin (SMARTMAN) fixture and exposure chamber were developed to test individual protection (IP) respiratory equipment as a system. IP respiratory equipment is placed on a human manikin head form inside an environmental control chamber. During testing, the IP equipment is made to function by means of artificial respiration and then challenged with liquid or vapor chemical warfare agents (CWAs) or simulants. The test fixture monitors the challenge concentration and the concentrations of agent or simulant that have broken through the IP respiratory equipment (from penetration, permeation, or both), thereby providing a measure of the ability of the equipment to protect the wearer from chemical exposure.

1.2 Purpose.

a. This test operations procedure (TOP) details whole-mask SMARTMAN testing with CWA or simulant liquid and vapor (LV) or vapor only challenges which are conducted on new, previously worn, or preconditioned IP masks and mask systems (hereafter referred to as masks). Any simulants used must have an approved agent/simulant correlation or relationship or testing with the simulant will not be performed. Data collected from the SMARTMAN test is used to determine the CWA resistance of the candidate mask and to evaluate protective performance in contaminated environments. **NOTE**: Although the main purpose is to describe acquisition and related testing in the SMARTMAN fixture, these procedures can be used for other whole-mask SMARTMAN testing in chemically contaminated environments with non-military or first responder applications.

b. SMARTMAN testing is a System Level Test per the Overarching IP Test and Evaluation (T&E) strategy [1*]. Even though SMARTMAN tests a component of a complete ensemble, it still tests a full mask system. The test items will be evaluated in accordance with (IAW) the requirements listed in the performance specification, the capabilities documents [the initial capability document (ICD), the capability development document (CDD), or the capability production document (CPD)], the concept of operations (CONOPS), and failure definition/scoring criteria (FD/SC). The operational test agency (OTA) system evaluation plan (SEP) and the test and evaluation master plan (TEMP) will be used to determine the overall test structure, data required, and criteria and analysis to be used.

1.3 Limitations.

a. This TOP does not cover chemical, biological, and radiological (CBR) protective mask testing using human participants, which is described in TOP 08-2-110[2].

*Superscript numbers and letters correspond to those in Appendix D.

b. This TOP describes standard procedures for SMARTMAN chemical protective performance testing of CBR protective masks and accessories. Biological and radiological protective performance testing of the entire mask systems are not included in this TOP.

c. Test data using simulants for agents cannot be used without establishment of the agent/simulant relationship.

d. Although not specifically described the test procedures in this TOP may be extended to SMARTMAN testing using toxic industrial chemicals (TICs), battlefield contaminants (BFCs), and emerging threat agents. Modifications (see Paragraph 1.3.e) may be required for tests with challenge materials other than CWAs.

e. These procedures may require modification for unique items or materials or to satisfy specific testing requirements as delineated in an OEP, performance specification, ICD/CDD, or a TEMP. However, alteration of this procedure will be made only after full consideration and customer/evaluator coordination of the possible effect the changes may have upon the reliability and validity of the data to be obtained.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

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

Item	Requirement
Chemical laboratory and chemical agent storage facility.	Constructed to ensure safe and secure storage, handling, analysis, and decontamination of research, development, test, and evaluation (RDT&E) quantities of chemical agents and/or simulants used for surety material.
SMARTMAN fixture and exposure chamber (test system).	Constructed to house the test item during agent or simulant dissemination. Will include the environmentally controlled test chamber, a SMARTMAN head form with a breather pump, agent/simulant liquid and vapor disseminators, and all instrumentation necessary to perform SMARTMAN testing, including sampling systems and data recorders.
Engineering control system.	Test areas in laboratories and chambers must be equipped with climatic controls that allow air temperatures and air-exchange rates to be maintained at prescribed levels throughout the testing period.

2.2 Instrumentation.

Permissible error measurement values are minimum requirements. Actual instrumentation may have greater precision and accuracy; actual values will be reported.

Parameter	Measuring Device	Permissible Error of Measurement
Chemical agent vapor detection.	Near real-time (NRT) instrumentation, e.g., monitor permeation with MINICAMS, (OI Analytical, a Xylem Brand, College Station, Texas); monitor challenge with Gasmet Fourier transform infrared (FTIR) gas analyzer (Gasmet Technologies Oy, Vantaa, Finland); sulfur and/or phosphorus analyzers; or equivalents of these instruments.**	Quality control (QC) challenge recovery must be within ±15 percent of the expected value.
Chemical agent liquid application.	Calibrated syringe pump dispenser or equivalent.	Actual dispensed mass must be within ±10 percent of the calculated value for the mass of the agent.
Vapor dissemination system.	A computer-controlled syringe pump or vapor tube used for dissemination into a heated source to introduce vaporized agent/simulant into the test chamber.	Concentration of disseminated agent must be within ±20 percent of the theoretical target concentration.
Chemical agent mass from vapor and liquid samples (μg).	Gas chromatograph (GC); liquid chromatograph (LC); flame ionization detector (FID); flame photometric detector (FPD); mass spectrometer (MS), or equivalent.	±15 percent of calibration standard.
Chamber air temperature.	Temperature sensor.	±0.5°C.
Relative humidity (RH).	Hygrometer.	±2 percent RH.

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

Photographs.	Still color camera.	Adequate to document any abnormalities or damage to the test items.

2.3 Test Controls.

Parameter	Tolerance
Positive control mask.	Must be a full-face mask or escape hood certified for use in industry for chemically contaminated areas, must provide brief protection (less than 8 hours) from chemical agents, and must show a consistent breakthrough curve for CWAs after an appropriate time (approximately 30 minutes to 8 hours) as identified in an applicable reference, such as the test plan.
High-performing control mask.	Must be a full-face protective mask certified for use in industry for chemically contaminated areas or well characterized military mask, must have a large eye lens, and must consistently provide protection against concentration levels lower than the minimum quantification level of the CWAs for an extended period of time (~ 8 hours to 24 hours) as defined in an applicable reference, such as the test plan.

3. REQUIRED TEST CONDITIONS.

a. SMARTMAN testing requires the handling and use of chemical agents. Chemical agent testing is strictly controlled by Army guidelines (e.g., Army Regulation (AR) 385-10[3], Department of the Army (DA) Pamphlet (PAM) 385-61[4], and Military Standard (MIL-STD)-882E[5]). Throughout testing, primary emphasis must be on operator and test personnel safety, but the importance of technical quality, completeness of test data, and conformance with specified test and operating procedures cannot be overemphasized.

3.1 Test Planning.

3.1.1 Familiarization.

a. The test-planning phase includes identifying potential problem areas by reviewing previous records and the results of similar tests. Relevant TOPs, standing (or standard) operating procedures (SOPs) and other pertinent procedures will be reviewed for applicability, as well as currency, adequacy, and completeness of information. Current methods will be used for execution of test plans; supporting documentation will be updated on an as-needed basis. The

development of test plans requires review of the applicable capabilities documents, requirements, specifications and other test guidance, familiarization with preceding development and test phases, study of test criteria, and selection of appropriate samples, methods, sequences, facilities, and test equipment. Data from previous similar tests will be considered to avoid duplication and to reduce the scope of further testing.

3.1.2 Documentation.

a. The project officer ensures availability of all pertinent documentation for planning and review pertaining to the test, including the following: government and manufacturers' publications, requirements documents, capabilities documents, OEP, safety documentation, test directive, record of environmental consideration (REC), operations security (OPSEC) documentation (if applicable), and other documentation, as necessary (e.g., TOPs and SOPs). These documents will contain test criteria, equipment or item specifications, and specific directions about the tests to be performed.

3.1.3 Environmental Considerations.

a. Compliance with all local, state, and federal regulations is required. Appropriate environmental documentation will be prepared and submitted, and approval will be received before testing begins. All hazardous waste generated by the execution of the test plan will be disposed of IAW federal, state, and local rules and regulations, the installation hazardous waste management plan, and all other applicable installation procedures.

3.1.4 Unique Personnel Requirements.

a. This test requires personnel trained in handling CWAs and simulants. The individuals must also be qualified to operate the analytical, referee, and/or other equipment associated with the SMARTMAN test systems.

b. Individuals who handle CWAs above the surety threshold level must be enrolled in the Chemical Personnel Reliability Program (CPRP), or other appropriate training program IAW DA PAM 385-61[4], DA PAM 40-11[9]; & AR 50-6 (Chemical Surety)[**].

3.1.5 Safety.

a. Applicable safety and surety regulations will be reviewed to ensure compliance of all test procedures. The test project officer and/or project scientist, in consultation with the installation safety office, will prepare safety procedures and Deliberate Risk Assessment Worksheet (DRAW) for inclusion with the test plan.

3.1.6 Surety.

a. All activities with CWAs must comply with surety regulations[3]. In addition, any operation that would not comply with surety regulations will require approval of an exemption.

3.2 Preparations for Test.

a. Test preparations include selecting and readying the test chamber, instruments, samplers, and equipment needed for the test execution, verifying CWA/simulant purity, and preparing the masks to be tested. Preparation may require certain preliminary activities to be specified in the Detailed Test Plan (DTP). New equipment training (NET) must be provided by the developer whenever necessary.

3.2.1 Masks and Mask Systems.

a. The masks will be tested in new condition and/or after they are subjected to various types of pretest conditioning. The number of masks chosen to represent each type of pretest conditioning will be divided (equally, insofar as possible) between the CWA or simulant challenges per the test matrix. Preconditioned masks will be cleaned IAW customer and/or manufacturer recommendation before being presented for SMARTMAN testing. **NOTE**: Some level of cleaning would be needed before a warfighter would don a mask that had sand, fuel, etc., on it. The mask also needs to be cleaned so that the mask will seal on the headform and the mask valves will work properly. This does not negate the pretest conditioning.

b. Masks undergoing BFC conditioning will be conditioned before being presented for SMARTMAN testing. The contaminants used will be detailed in the test plan and/or report. Different contaminants may include, but are not limited to, jet propulsion fuel type 8 (JP-8), gasoline, diesel (neat fluid and/or exhaust); reactive skin decontamination lotion (RSDL); hydraulic fluid; insect repellant; camouflage cream; and/or other contaminants specified by the requirements document.

c. Any environmental conditioning will be completed before the masks are presented for SMARTMAN testing. The environmental exposure conditioning performed will be detailed in the test plan and/or report. Adverse environmental conditioning may include exposure to combinations of any or all of the following: ozone, temperature shock, high temperature, high humidity, low temperature, low humidity, fungus, salt fog, blowing sand, blowing dust, solar radiation, rain, rough handling, simulated storage (aged), and/or other adverse environmental conditioning specified by the requirements document.

d. Masks may be presented in worn condition for SMARTMAN testing after developmental testing, expected life cycle rotation, etc.

3.2.2 SMARTMAN Test System and Instrumentation/Equipment Preparation.

a. The SMARTMAN test system is composed of an environmental chamber housing an agent disseminator, an agent detection system, and a SMARTMAN head form with a breather pump that draws air into the head form. It is recommended that the SMARTMAN chamber be constructed of material that does not absorb chemical vapor, for example, stainless steel. Chamber windows or doors must be constructed of transparent materials that can be replaced periodically. **NOTE**: The medium sized SMARTMAN head form represents a fiftieth percentile male from the mid-torso to the top of the head in all dimensions IAW the Army Anthropometric Survey Database[6].

b. The vapor portion of the LV chemical agent challenge will be created by disseminating liquid agent with a syringe pump disseminator or equivalent using metered infusion of liquid agent onto a heated surface, or by other means to create a true vapor (not an aerosol). Vapor will be formed, entrained in an air stream, and delivered to the chamber. The syringe pump disseminator will be operated IAW manufacturer's instructions, and/or the installation SOP.

c. NRT instruments capable of response times of at least every 2 minutes and the ability to measure chemical concentrations are used for determining the concentrations of the different CWA challenges in the airstream.

d. G-agent (Nerve Agent) and H-agent (Blister Agent) Challenges. A Gasmet, or equivalent, with a single-beam infrared spectrometer, will measure the G-agent and H-Agent concentration in the chamber. The spectrometer detector outputs will be digitized, stored, and analyzed in the data acquisition computer. Each instrument will be calibrated IAW manufacturer procedures by disseminating a minimum of five calculated concentrations of the agent and recording the detector counts for each point to establish a calibration curve covering the range specified by the project requirements (e.g., concentration range for calibration of 0 to 5000 mg/m^3 for sarin (GB)). The curve will have a coefficient of determination of 0.95 or greater, and each point will be within ±15 percent of the expected value. The calibration curve for each instrument will be QC challenged at a concentration equivalent to the maximum challenge concentration for the given agent as specified in the test plan (e.g., 4000-mg/m^3 for GB). The QC challenge will be performed after calibration, between phases of testing, and at the end of the program. The QC challenge recovery must be within ±15 percent of the expected value. The calibration points will be rerun, or the instrument will be recalibrated if any calibration points, the coefficient, or the QC challenge fall out of established ranges.

e. Low-Volatility Agent Challenges. Due to inconsistencies in the chamber concentration measurements of low-volatility agents (e.g., VX), vapor challenges of low-volatility agents will not be conducted. Instead, low-volatility agents will only have liquid challenges conducted.

f. Agent vapor breakthrough concentrations will be measured using two MINICAMS, or equivalent instrument, per SMARTMAN test fixture. One instrument will sample from the nose region, and the other will sample from the eye region. The outputs will be analyzed, digitized, and stored in the data acquisition computer. The MINICAMS uses an FPD detector with a phosphorus filter to detect G-agents and VX, and an FPD with a sulfur filter to detect H-agent. VX is converted to G-analog using silver fluoride (AgF) pads.

g. Before SMARTMAN testing, the minimum quantification limit (MQL) for each agent/simulant will be established for each instrument. After an acceptable calibration has been completed, a minimum detection limit (MDL) will be established for each analyte by analyzing seven replicate standard injections and one blank. The injections will be at a concentration near the lower end of the calibration range. The MDL will be calculated by multiplying the standard deviation of the seven (minimum required) sample results by the Student's *t*-test value at the 95-percent confidence interval. The MQL will be defined as 3 to 5 times the MDL. Based on this MQL, the time to reach the target cumulative concentration multiplied by time (CT) ($mg \cdot min/m^3$) specified in the requirements document will be calculated. Similarly, a minimum

measurable cumulative CT for 16 and 24 hours will be calculated. Concentrations and/or CT will be reported, but the CT may or may not be required depending upon the test program.

h. The MINICAMS flow rate, vapor collection times, MQL, and total cycle time for each agent will be recorded and presented in a table (see Table 1). The systems will begin monitoring for breakthrough in the mask when agent is disseminated.

i. Check shots for determining precision and accuracy of the recovery procedure for each agent or simulant used will be performed.

(1) The check shot sample injections will be made at the eye and nose ports of the SMARTMAN head form to confirm sample recovery at acceptable levels.

Table 1. EXAMPLE OF MINICAMS MINIMUM QUANTIFICATION LIMITS (MQLS) AND TEST PARAMETERS FOR AGENT VAPOR BREAKTHROUGH MEASUREMENTS.

Agent[a]	MQL (mg/m^3)	Flow (mL/min)	Sample Time (min)	Cycle Time (min)
GB	2.5×10^{-4}	200	1	3
GD	2.5×10^{-4}	200	1	3
HD	5.0×10^{-3}	100	2	5
VX	1.25×10^{-5}	500	8	10

[a]GB – sarin; GD – soman; HD – distilled mustard; VX – *S*-{2-[Di(propan-2-yl)amino]ethyl} *O*-ethyl methylphosphonothioate.

(2) Eight replicates of a low-range standard and eight replicates of a mid-range standard will be injected into the eye and nose ports. These injections will be analyzed with the calibrated MINICAMS. The percent recovery will be calculated and used to establish the precision and accuracy of injections for comparison with future injections (percent recovered = (recovered value/expected value) × 100). The amounts of standard injected and recovered, percent recovery, and the precision and accuracy of the injections will be recorded. **NOTE**: Eight replicates are considered sufficient for the Student's *t*-test statistical analysis.

j. Positive and high-performing control masks will be used to check the SMARTMAN fixture. Controls will be set up before the trials for record begin. Commercial off-the-shelf (COTS) masks certified as chemical environment protective masks by the National Institute for Occupational Safety and Health ((NIOSH), Centers for Disease Control and Prevention, Atlanta, Georgia), or well characterized military masks such as the M50 will be used for the control masks. The breakthrough times and concentrations will be recorded for reference. The average times until the MQL for the CWAs/simulants is reached will be calculated and recorded for reference. The control masks will also be used, if necessary, for failure analysis.

(1) Positive Control Mask. The mask selected for use as a positive control must provide brief protection from chemical agents and show a consistent breakthrough curve for CWAs after a short time. An emergency escape hood used in industry for chemically contaminated areas is a good candidate. A positive control will assess the ability of the test fixture to detect breakthrough within the trial period.

(2) High-Performing Control Mask. The mask selected for use as a high-performing control must have a large eye lens and must provide a level of protection lower than the MQL for an extended period. A full-face protective mask used in industry or military for chemically contaminated areas is a good candidate. A high-performing control will assess possible false positives in a system where the mask is not expected to have breakthrough within the trial period.

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

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

a. A QA plan must be prepared for each test program to ensure that variables are controlled and that appropriate records are kept throughout the duration of testing. Test variables include purity and stability of agents and simulants used, humidity and temperature, breathing rate, calibration and maintenance of instrumentation and disseminators, accuracy and precision of the laboratory analysis, and quality and uniformity of all test samples.

b. The condition of the test item at the time of testing is an important test variable. As part of SMARTMAN testing, receipt inspection of the test items will be conducted IAW TOP 8-2-500A[6] before SMARTMAN trials begin. Inspection data, certificates of compliance, or similar documentation, will be reviewed to ensure that exterior surfaces, finishes, and packaging meet specifications. Generally, the item will be tested in as-received condition, which will simulate likely mask condition as closely as possible when issued to warfighters in the theater of operations. SMARTMAN testing may be required periodically throughout the equipment life cycle if the effects of normal wear or storage conditions are a major factor in survivability.

c. Testing must always be conducted IAW approved test documentation, such as technical manuals, field manuals, equipment operating instructions, SOPs, the approved test directive, OEP, TEMP, and the test plan. Deviations from approved test documentation will be documented and approved by the appropriate authority.

4. TEST PROCEDURES.

4.1 Test Methods and Procedures Overview.

4.1.1 Test Method Outline.

a. Receipt inspection will be conducted on the system under test to document as-received material conditions. Receipt inspection may include functional performance tests to establish baseline performance parameters (if applicable). Paragraph 4.2 describes the details for this step of the test method.

b. The agents/simulants will be prepared for application as described in Paragraph 4.3.

c. After pretrial preparations are completed for the SMARTMAN test system and instrumentation/equipment (Paragraph 3.2.2), test execution will follow the steps in Paragraph 4.4.

(1) Masks will be prepared for testing, to include pretrial inspection, identification, and documentation (Paragraph 4.4.1.a).

(2) A qualitative leak check will be conducted on each mask (Paragraphs 4.4.1.b through 4.4.1.e).

(3) Test chamber operation will be initiated and environmental conditions for the test will be stabilized. Environmental conditions will be monitored and recorded (Paragraph 4.4.1.f).

(4) Liquid agents/simulants will be applied to the item under test, and liquid droplet application locations, amounts, etc. will be recorded. Agent/simulant vapor will be generated, monitored, and sampled. The details of this step are described in Paragraphs 4.4.1.g through 4.4.1.k.

(5) Vapor sampling, monitoring, and sample analysis will be conducted as described in Paragraphs 4.4.1.l through 4.4.1.n.

d. Posttest inspection (optional) will be performed as described in Paragraph 4.5.

e. Data analysis will be performed IAW Paragraph 6.2.

4.1.2 Significance and Use.

a. The sample data collected from this test allow a determination of vapor hazards to protected personnel from a CWA-contaminated environment.

b. The data collected from preconditioned masks allow a determination of the amount of physical and/or functional degradation of the system that result from various adverse conditions, exposure to contaminants, aging of the item, etc.

4.1.3 Interferences.

There are no expected interferences when the test method is conducted under laboratory-controlled conditions. In the unlikely event of a potential interference, that will be documented, and the level of interference characterized with a pre-trial test.

4.1.4 Apparatus.

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

4.1.5 Hazards.

a. Identified safety hazards are those associated with testing using toxic chemical surety materials, simulants, and decontaminant chemicals that are hazardous in and of themselves (e.g., chlorine, hydrogen peroxide, etc.).

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

4.1.6 Calibrations and Standards.

a. Calibration of the primary equipment and instruments used in SMARTMAN testing will be performed during test preparations. Specific information and procedure summaries are given in Paragraph 3.2.2. All equipment and instruments should be on a preventative maintenance and/or calibration program (where applicable), and calibration must be current at the time of testing.

b. Certified standards may be purchased but must be used before the expiration date. The chemical supplier must provide a certificate/guarantee of purity, and the supplier's name, manufacturer name, certificate number, purity, and dates (manufacture and expiration) must be provided in the final report.

c. General chemical analytical calibration best practices can be used for most chemical analytical equipment (e.g., GCs, LCs). Before analytical calibration, a sample sequence will be created that includes the following:

(1) A blank sample to evaluate analytical method interferences.

(2) Calibration standard samples (ranked low to high or high to low by concentration) with at least five standards. Calibration standards may either be prepared or purchased:

(a) Preparations for standards should be described in local SOPs.

(b) Certified standards may be purchased but must be used within the expiration date. For chemicals purchased from a chemical supplier, the purity must be certified and/or guaranteed, and the information supplied on the certificate will be included in the final report.

(3) A blank sample to evaluate carryover.

(4) A QC sample to validate the calibration curve, at least one sample per detector (if multiple detectors are installed on the same instrument) including control samples.

(5) Another blank sample.

d. The same method will be used to analyze all samples.

e. Using the instrument software (where available), the calibration curve will be built from lowest to highest concentration.

f. Plot information will be evaluated as follows:

(1) Curve fit type (linear, quadratic, etc.) will be selected.

(2) Point weighting method (equal, inverse, etc.) will be selected.

(3) If the coefficient of determination (R^2) is greater than 0.95 (if not otherwise specified) for all instruments except breakthrough MINICAMS (R^2=0.99), then analysis will proceed.

(4) If R^2 is less than 0.95 (if not otherwise specified) for all instruments except breakthrough MINICAMS (R^2=0.99), then data points may be removed or rerun, and the calibration curve recalculated. No more than one data point may be removed without calibrations being rerun if at least five points remain in the curve. If data points are removed and/or calibration curve recalculated, the reason(s) will be noted in the laboratory logbook.

(5) If correlation still fails, each data point will be evaluated to determine any errors.

(6) Method adjustments will be made, and the calibration repeated.

(7) If correlation fails, troubleshooting assistance will be requested from within the organization.

g. If the R^2 criterion is met without removing more than one data point, the QC sample will be loaded and processed against the calibration curve.

h. The measured values for the QC sample must be within ±15 percent of the expected value.

(1) If the QC measured value meets the criteria, then the test method will proceed.

(2) If the QC measured value does not meet the criteria, then a second QC sample will be run.

(3) If the second QC measured value meets the criteria, then the test method will proceed.

(4) If the second QC measured value does not meet the criteria, then corrective actions and recalibration will be performed to the instrument.

i. After any maintenance is performed on the instrument, two QC samples must show an analyzed value within ±15 percent of the expected value or corrective actions and recalibration must be performed.

4.2 Receipt Inspection.

4.2.1 Receipt Inspection Method.

a. Receipt inspection must be conducted on all test items and will be conducted IAW TOP 08-2-500A[7].

b. Receipt inspection data will be entered into the individual data tracking system used at the installation. Test item control numbers (TICNs), to be used throughout testing, will be assigned by the test item control officer. Preconditioned/worn masks presented for additional testing may already have a TICN assigned for use throughout all testing stages; therefore, it is possible that the TICN will be assigned before the masks arrive at the installation performing the SMARTMAN testing. The serial number (SN), TICN, and configuration for each mask will be recorded.

c. The initial receipt inspection will be performed immediately after the masks are received.

(1) Test items and external packaging will be inspected for damage. In addition, the test items will be inspected and compared with the original order and shipping information to ensure proper quality and quantities.

(2) Masks and mask components (such as filter cartridge, nose cup, neck dam, etc.) will be inspected for surface degradation, damage, and faulty workmanship, including tears, rips, cuts, abrasions, punctures, color variation, blemishes, splits, cracks, excess flash, component separation, foreign matter, and contamination such as dirt, grease, or oil.

(3) Receipt inspection will include functional performance tests, if applicable, to establish baseline performance parameters (e.g., blower is operational, etc.) of any mechanical/electronic components of a mask system. To ensure the mask is functioning properly it will be tested with a JSMLT (Joint Service Mask Leak Tester) (Air Techniques International, Baltimore, Maryland).

(4) Photographs (with metric scale) will be taken of any damage found.

(5) Inspectors will make note of the pretest condition of any area(s) specified (e.g., eye lens condition) for comparison and use in the optional posttest inspection, if required.

d. Receipt inspection will be performed on all masks presented for SMARTMAN testing, including the conditioned/worn masks received for additional testing.

e. Individual canister/filter containers will be removed from their hermetically sealed outer containers only immediately before the items are to be used in the specific subtests.

f. Any test item or test item component with an obvious defect that will cause a protection failure or a safety hazard to a wearer will be removed from further testing and replaced if possible.

4.2.2 Receipt Inspection Data Required.

a. SN, TICN, and configuration of each test item.

b. Any abnormalities or problems with the test materials.

c. Photographs (with metric scale) taken of any abnormalities or damage.

4.3 Chemical Purity Analysis and Preparation.

a. Unless otherwise stated, the required chemical purity of CWAs and simulants used in SMARTMAN testing must be at least 90 percent. The required chemical purity for any TICs, emerging threats, etc., will be determined by the requirements document.

b. Vapor challenges do not require a thickener. Liquid challenges may require a thickener if specified in the test plan. The agents to be used during SMARTMAN testing are as follows:

(1) Neat VX with purity greater than 90 percent is required, unless a weapons-grade mixture is desired.

(2) Neat G-agent with purity greater than 90 percent is required, unless a weapons-grade mixture is desired. If specified in the test plan, G-agent may be thickened with Rohm and Haas Acryloid™ K125 (Philadelphia, Pennsylvania) poly(methyl methacrylate).

(3) Neat HD with a purity greater than 90 percent is required, unless a weapons-grade mixture is desired.

(4) Other approved contaminants (e.g., emerging threats, TICs) as specified in the TEMP.

c. Simulants to be used are specified in the test plan. Simulants may be prepared with a suitable dye or thickener, if needed.

4.3.1 Chemical Purity Analysis Method.

a. For chemicals of unknown purity (e.g., weapons grade), or those needing further verification, the following procedures will be performed before testing begins:

(1) Purity analysis will be performed IAW TOP 08-2-073[8].

4.3.2 Chemical Purity Analysis Data Required.

a. Source and/or supplier.

b. Pertinent dates (e.g., date of purchase, date opened, date analyzed, and expiration date, if applicable).

c. Lot number, Chemical Abstracts Service (CAS) number, name of chemical.

d. Purity analysis results or supplier-certified/guaranteed purity of that lot.

4.4 SMARTMAN Test Execution.

4.4.1 SMARTMAN Test Execution Method.

a. Before each challenge, the mask configuration, SN, TICN and/or other identification will be recorded. The unit pack will be opened IAW user instructions, and the mask will be visually inspected for observed problem areas, compatibility issues, damage, and/or surface degradation. Masks should be leakage performance tested before agent resistance testing on the SMARTMAN fixture.

(1) The mask will not be cleared for testing until readings on the leak tester are at least the minimum qualitative fit factor (FF) value. The minimum qualitative FF value will be the test assets' threshold FF value required by the mask's capability document or the performance specification for the mask, or minimum FF value will be 50,000, whichever is lower.

(2) The approximate FF will be calculated by dividing the oil aerosol concentration on the inside of the mask by the oil aerosol concentration on the outside of the mask. The leak tester first generates the oil aerosol from a dispenser wand and then measures the oil aerosol concentration inside the mask through a sample line that returns to the instrument.

b. The SMARTMAN test system is composed of an environmental chamber housing an agent disseminator, an agent detection system, and a SMARTMAN head form with a breather pump that draws air into the head form. **NOTE**: The medium sized SMARTMAN head form represents a fiftieth percentile male from the mid-torso to the top of the head in all dimensions IAW the Army Anthropometric Survey Database[6].

c. Each mask will be placed on the test head form in the exposure chamber IAW user donning instructions. All masks will have at least one or a combination of the nose cup, face, or neck dam sealing features.

d. A pre-trial qualitative leak check will be performed on each mask using a JSMLT, while the mask is in operational mode, i.e., with breathing pump operational, blowers and supplied air if configured. The results will be recorded as a pass/fail when the readings on the instrument stay below 0.001 ppb throughout the leak check. This leak check is performed with the leak tester modified to sample from the SMARTMAN sample ports and the tester set in leak check mode.

(1) For masks that require a complete seal on the nose cup for proper operation (e.g., flight masks), the nose cup (oronasal area) will be isolated from the rest of the mask and the hood cavity with the use of a face gasket (constructed and supplied by U.S. Army Combat Capabilities Development Command Chemical Biological Center (DEVCOM-CBC)) and Tacky Tape® (Schnee-Morehead, Inc., Irving, Texas), or equivalent laboratory sealant. A leak check using JSMLT will be performed to test the nose cup seal. A nose cup seal check may be accomplished by introducing oil aerosol from the JSMLT into the eye area via the eye sampling line or the forehead port and measuring the oil aerosol concentration inside the nose cup via one of the nose sampling lines. This is done with the mask in a stagnant state, without the breather

pump or blowers in operation. The nose cup seal is verified with readings on the leak tester less than 0.001 ppb.

(2) After the nose cup seal is verified, a qualitative leak test using the modified JSMLT will be conducted to ensure that the mask is adequately sealed to the head form, the outlet valve is functioning properly, and the mask has no leaks. This test will be conducted with the breathing pump running and all other mask components functioning. The leak tester probe will be passed over all the mask surfaces. If a leak is detected, the mask or valves will be adjusted until the mask passes the leak test, if possible. Measurements will be made in the eye- and nose-cup regions.

(3) Face seal masks must have the SMARTMAN face seal bladder expanded to the recommended pressure of 4- to 6-psi before performing a leak check.

(4) Neck dam masks need to have the neck dam flattened, without any rolls or folds, against the neck portion of the SMARTMAN headform before performing a leak check.

(5) If a mask is unable to meet the qualitative leak test readings required, the customer program office will be contacted for further guidance.

e. The test will be conducted at a flow rate specified in the requirements documents/test plan and with a simulated breather flow rate within the range of human breathing rates. If not otherwise specified, the simulated breather flow rate will be around the average human breathing rate of 33±1 cycles/min. The head form breather pump, which is adjustable, and has a standard volume of 1.5 L/breath, will be powered on for the full duration of the test. The mask blower (if applicable) will run for the time specified in the test plan, which can be part or all of the test duration. Temperature and RH will be controlled at the levels specified in the requirements documents or test plan and recorded. The mask will not be pre-equilibrated unless otherwise specified.

f. After the mask passes leak checking and the chamber is at operational conditions, then the liquid agent/simulant will be applied to the mask for the liquid portion of the LV test and agent/simulant vapor will be generated.

g. The vapor portion of the LV chemical agent challenge will be created by disseminating liquid agent with a syringe pump disseminator or equivalent using metered infusion of liquid agent onto a heated surface, or other means to create a true vapor (not an aerosol). Vapor will be formed, entrained in an air stream, and delivered to the chamber. Values recorded below the MQL (see Table 1) will be set to 0 when calculating the chamber CT and/or concentration challenge. The minimum chamber concentration detection limit for the agents or simulants will be stated in the report.

h. For CWA/simulant vapor testing, the challenge concentration will start at 0 mg/m^3 and increase to a high concentration that is within the threshold and optimal high-concentration ranges stated in the requirements document. The high-challenge concentration will be maintained for a specified amount of time. The challenge will then be decreased to low concentrations and be maintained for specified times, before being allowed to naturally decay for the remainder of

the trial. If required by the test program, the calculation of an overall challenge for the cumulative CT in mg·min/m^3 within the range specified in the requirements document is obtained by multiplying the concentration achieved for the duration of the trial time. The actual challenge concentration, elapsed time, and cumulative CT (if applicable) will be recorded.

i. For the liquid portion of LV testing, the mask system, including the hoses, will be spiked with 10- or 20-µL drops of liquid agent applied at a standard contamination density of 10 g/m^2 (unless otherwise specified in the requirements document) to achieve the desired challenge concentration. A table summarizing the liquid droplet application locations, and the droplet dissemination pattern diagrams, preferably using photograph(s) of the test item with locations indicated, will be included in the report.

j. The vapor challenge concentration from the applied liquid will be measured and allowed to decay for the remainder of the minimum trial time or until the desired cumulative CT (if used) is achieved. The maximum trial time set by the requirements document or test plan will not be exceeded, even if the target cumulative CT (if applicable) is not achieved during that time. The actual challenge concentration, elapsed time, and cumulative CT (if applicable) will be recorded.

k. In-mask agent vapor concentration above MQL will be measured for the duration of each trial, through the eye and nose ports of the SMARTMAN test fixture and recorded. In-mask agent concentration levels above criterion will be noted and recorded.

l. Any other pertinent observations or remarks will be recorded. Posttest inspection, if required by the customer and included in the test plan, or if necessary, failure analysis will be conducted and recorded. Posttest inspection or failure analysis may include the following:

(1) Posttest leak check involving a close inspection of the mask can be completed before it is removed from the head form if the seal is in question. Areas inspected will include, but are not limited to, the peripheral seal, outlet valve, drink tube, or any other pertinent parts that may have come loose.

(2) Close inspection of specified areas of the mask for damage from agent. These could include eye lens area, hoses, material interface connections, etc.

(3) Inspection of potential fixture connection problems (e.g., loose sample lines, face bladder).

(4) Photographs of any problem areas will be taken to record pertinent observations.

m. Charts comparing in-mask concentration will be prepared with time and the breakthrough time for the eye and nose regions of the mask. Other charts and tables as mentioned in Paragraphs 6.2.2, 6.2.4, and 6.2.5 will also be prepared for data comparison and analysis.

4.4.2 SMARTMAN Test Execution Data Required.

a. Mask SN.

b. TICN or other identification.

c. Any pretest conditioning and configuration of the mask.

d. Concentration of vapor in the exposure chamber for the duration of the test.

e. Amount of liquid agent or simulant deposited on the test items (if applicable).

f. Results of JSMLT (or equivalent instrument) leak tests and FF tests.

g. Charts comparing in-mask concentration above MQL with the elapsed trial time and the time until any vapor concentration above test criterion occurs for both the eye and nose regions for the duration of the trial.

h. Breathing rate of breather pump and flow rate of system blower (if applicable). The mask blower run time (if applicable) will be noted in the test plan and report.

i. Environmental Conditions.

(1) Required: chamber temperature (°C) and RH (percent).

(2) Optional: differential pressure (ΔP) between the fume hood and the chamber in inches water gauge (iwg), and the ΔP between the respirator and the chamber (iwg).

j. CWA, simulant, emerging threat, or TIC challenge concentration (mg/m^3).

k. Chemical challenge CT ($mg \cdot min/m^3$), if required in the test plan.

l. Chemical sample masses (ng) and CTs ($mg \cdot min/m^3$) from the nose port and the eye port.

m. The MINICAMS® (or equivalent) calibrations, parameter settings, MQL, MDL, sample flow rate (L/min), the sample flow duration (min), CWA results, and the cycle duration (min).

n. The Gasmet® (or equivalent) calibrations, parameter settings, MQL, MDL, sample flow rate (L/min), the sample flow duration (min), CWA results, and the cycle duration (min).

o. Phosphorus and/or sulfur analyzer data.

p. Failure analysis (if applicable).

q. Any other pertinent observations or remarks (for example, any observed problem areas, compatibility problems, or damages).

4.5 Posttest Inspection (Optional).

4.5.1 Posttest Inspection Method.

a. This subtest will be conducted IAW customer request.

b. The outer surface of the mask, especially areas such as the eye lens, will be visually inspected following agent/simulant SMARTMAN testing, and any physical degradation will be noted. Any abnormalities or damage will be described and noted, and photographs will be taken that show the TICN for the test item.

4.5.2 Post-test Inspection Data Required.

a. TICN, SN, or other identification of each test item.

b. Any posttest observations of abnormalities or problems with the test materials.

c. Photographs taken (with metric scale) of any posttest abnormalities or damage.

5. DATA REQUIRED.

The data required are listed in Paragraph 4 under each subtest (Paragraphs 4.2.2, 4.3.2, 4.4.2 and 4.5.2).

6. PRESENTATION OF DATA.

6.1 Data Analysis/Procedures.

6.1.1 Calculations.

6.1.1.1 In-Mask Vapor Concentration Calculations.

Data analysts will perform the following calculation procedures for the nose- and eye-port samples of in-mask vapor concentrations above MQL as separate sets of measurements:

a. Divide the mass recovered (ng) by the flow rate (L/min) and the sample flow duration (min), and then divide the resulting quotient by $(m^3 \cdot ng)/(L \cdot mg)$ to convert to the concentration for the sample period.

b. If CT is required in the test plan or program, multiply the concentration by the chromatographic cycle duration (min) to get the CT $(mg \cdot min/m^3)$ for the sample period. Sum the CT values for each sample period over the duration of the trial to determine the cumulative CT.

6.1.1.2 Challenge Concentrations.

Data analysts will perform the following challenge concentration calculation procedures:

a. Compute the average of the challenge concentration measurements (mg/m^3) for each sampling interval for the duration of the trial.

b. If CT is required in the test plan or program, multiply the sampling interval average concentration values (mg/m^3) by the sampling interval (min) to get the challenge CT ($mg \cdot min/m^3$) for each sample period. Sum the CT values for each sample period over the duration of the trial to determine the cumulative challenge CT.

6.1.2 Tables.

a. The concentrations in the chamber and in-mask above MQL will be reported.

b. If CT is required by the test program, The cumulative CT values ($mg \cdot min/m^3$) will be tabulated for the nose and eye ports and challenge concentration samples. All cumulative breakthrough CT values must be below the required levels specified in the requirements document for the test criteria stated in the requirements document to be met. Any mask with a cumulative breakthrough CT value above the criterion level for that CWA will be examined to determine the source of penetration.

c. Example tables, which can be used or modified for data reporting, are in Appendix A, Tables A1 and A.2. Contents in the example tables are for example purposes only.

6.1.3 Photographs.

a. Photographs of any abnormalities or damages will be included in the report and/or the data package supplied to the customer. Each photograph will have proper item identification included in the caption or filename for ease of reference to the provided narrative, report, and/or laboratory records.

b. Photographs of the test item are appropriate for use as a base layer to show the liquid agent dissemination pattern on the mask(s) being tested. An example is given in Appendix A, Figure A.1. Contents in the example figures are for example purposes only.

c. Photographs will be taken of the liquid contamination to document exact location and potential spreading/interactions on the substrate.

6.1.4 Graphs.

a. The following data will be plotted on graphs:

(1) The concentration as a function of elapsed time (min) for the samples taken from the nose and eye ports.

(2) If required, the cumulative CT as a function of elapsed time (min) for the samples taken from the nose and eye ports.

(3) The challenge concentration as a function of elapsed time (min).

(4) If required, the cumulative challenge CT as a function of elapsed time (min).

(5) The environmental conditions (temperature and humidity) over time.

b. Example graphs from two trials, one trial using a GB challenge and the other trial using an HD challenge, are included in Appendix A, Figures A.2 through A.17. Contents in the example figures are for example purposes only.

6.1.5 Comparison of Data.

a. The data will be compiled for analysis. Physical characteristics and limiting factors of tested masks will be evaluated for use in a risk reduction effort for entering developmental testing. For example, physical characteristics and limiting factors relating to the test specimens include mask size and possibly any conditions, such as how well a mask facepiece (oronasal area) sealed onto the head form, respiration anomalies peculiar to one specimen or to the population, or other observations that demonstrate weakness in the entire mask system. Such evaluations and/or comparisons will be correlated in relation to observed CT values and their differentials. The data or representations therein can be recorded for display on any suitable engineering risk assessment tool such as a risk cube, tabular range summary in order of severity, or matrix table. Charts may be used where appropriate or convenient.

APPENDIX A. EXAMPLE TABLES, PHOTOGRAPHS, AND GRAPHS FOR DATA PRESENTATION

TABLE PAGE

FIGURE

Table A.1. EXAMPLE OF SARIN VAPOR (GBV) SIMULANT AGENT RESISTANCE TEST MANIKIN (SMARTMAN) TEST INFORMATION.

Mask Tracking Number	Trial Number	Conditioning	Size	SMARTMAN Test Chamber	MINICAMS® MDL[a] (mg/m^3)	Chamber MDL (mg/m^3)
TBXQ-23	TBXQGN023	New	X-Large	1	0.00025	100
TBXQ-05	TBXQGN005	New	Large	2	0.00025	100
TBXQ-17	TBXQGJ017	Diesel; jet propulsion fuel, type 8 (JP-8); gasoline	Medium	3	0.00025	100
TBXQ-03	TBXQGJ003	Diesel; jet propulsion fuel, type 8 (JP-8); gasoline	Large	4	0.00025	100
TBXQ-10	TBXQGR010	Reactive Skin Decontamination Lotion (RSDL)	Large	2	0.00025	100

[a]Minimum detection limit.

Table A.2. EXAMPLE OF SARIN VAPOR (GBV) SIMULANT AGENT RESISTANCE TEST MANIKIN (SMARTMAN) TEST RESULTS.

Trial Number	Trial Start Date	Cumulative Challenge CT[a] (mg·min/m^3)	16-Hour Cumulative Eye CT (mg·min/m^3)	16-Hour Cumulative Nose CT (mg·min/m^3)	24-Hour Cumulative Eye CT (mg·min/m^3)	24-Hour Cumulative Nose CT (mg·min/m^3)	Trial Comments[b]
TBXQGN023[c]	19 December 2012	20143	0.06	0.09	0.20	0.14	None
TBXQGJ003	20 December 2012	20150	0.05	0.07	0.18	0.13	(1)

[a]Concentration multiplied by time.

[b]See Table B.x for text of numbered comments. (TOP users: Notations in this column are for example only. Comments would be listed by number in the comment table, which is referred to as Table B.x and not included for these example tables.)

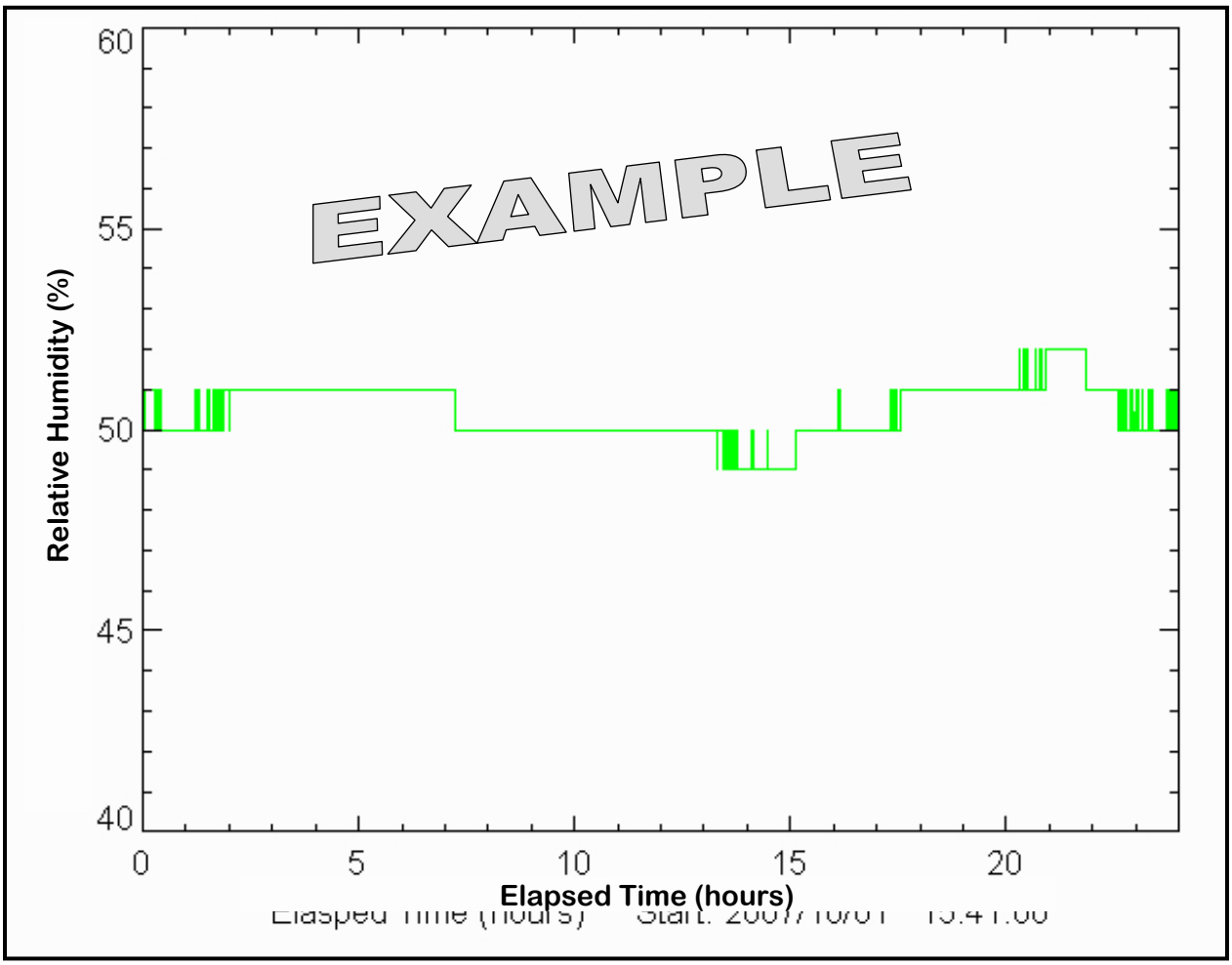
NOTE: The MINICAMS® (a miniature, automatic, continuous air-monitoring system) detection limit for each sample was 0.000025 mg/m^3 for sarin (GB). If an individual sample value was at or below 0.000025 mg/m^3, it was reported as zero. If an individual sample value was 0.00006 mg/m^3 or above, that value was added to the cumulative CT calculation.

APPENDIX A. EXAMPLE TABLES, PHOTOGRAPHS, AND GRAPHS FOR DATA PRESENTATION

NOTE: This mask is a face seal mask. The hood was not challenged with agent.

Figure A.1. Example of distilled mustard (HD) droplet contamination pattern illustration using a test item photograph for the base image.

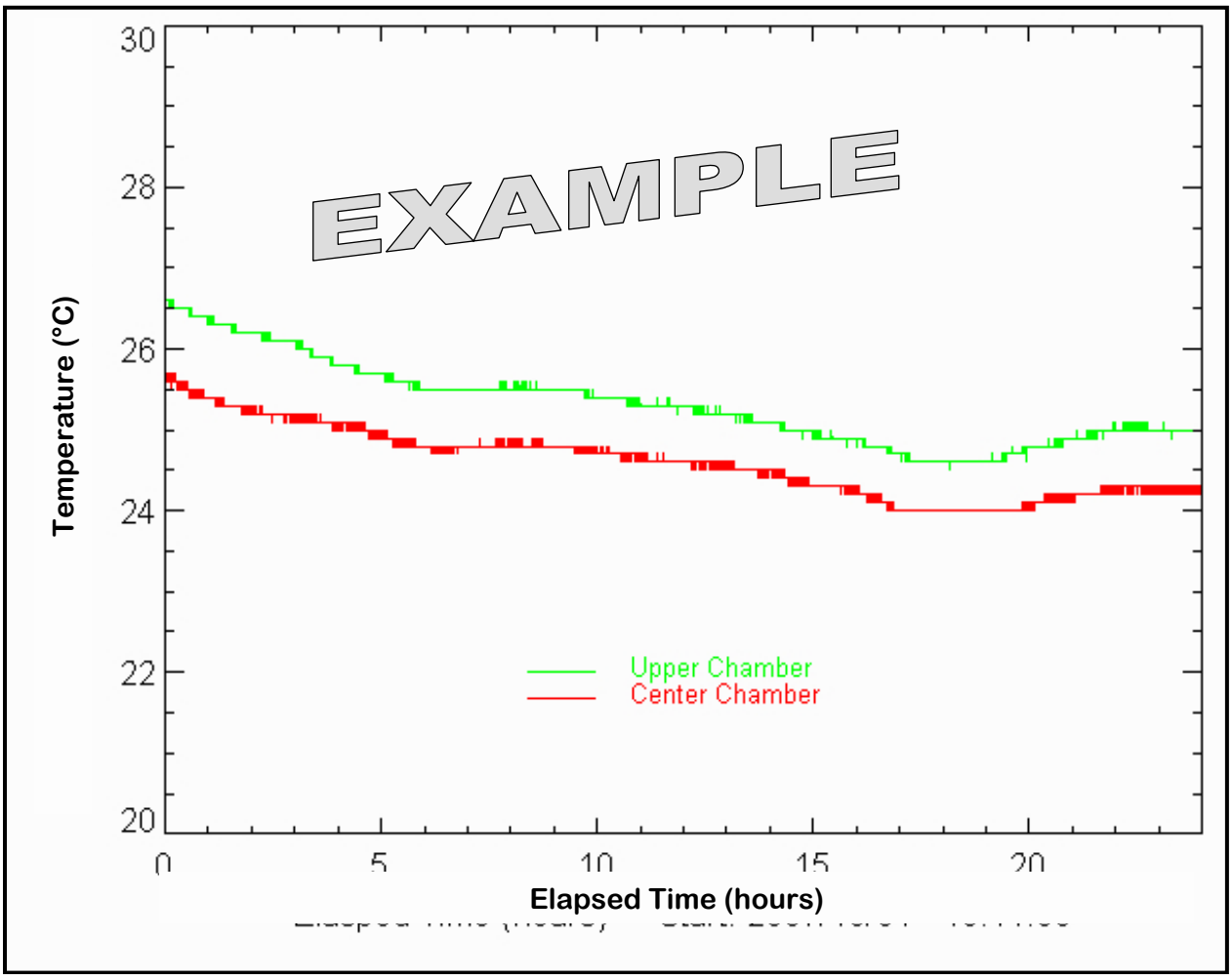
APPENDIX A. EXAMPLE TABLES, PHOTOGRAPHS, AND GRAPHS FOR DATA PRESENTATION



NOTE: Mask treated with insect repellent/camouflage cream and contaminated with sarin (GB).

Figure A.2. Example Trial A chamber relative humidity.

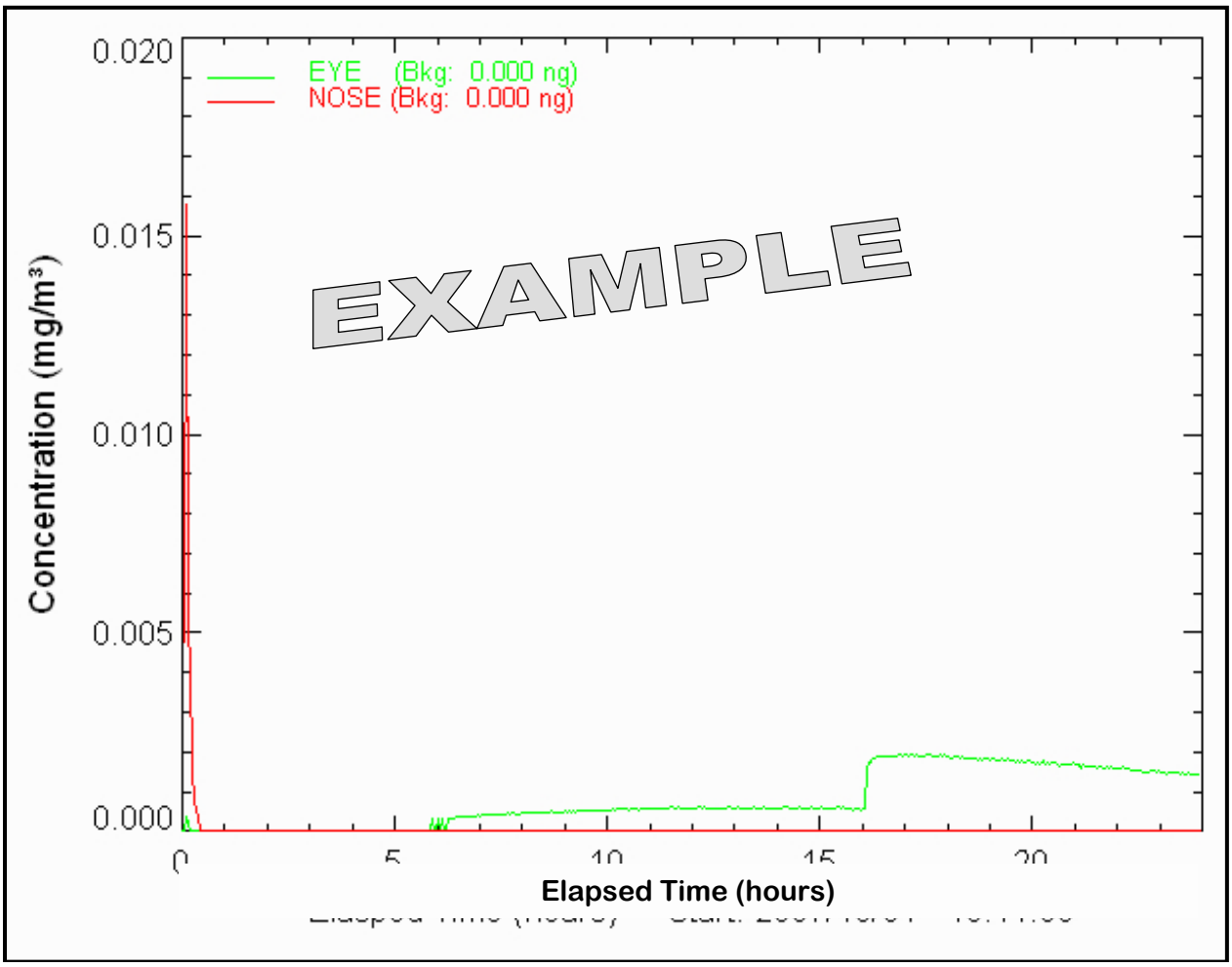
APPENDIX A. EXAMPLE TABLES, PHOTOGRAPHS, AND GRAPHS FOR DATA PRESENTATION



NOTE: Mask treated with insect repellent/camouflage cream and contaminated with sarin (GB).

Figure A.3. Example Trial A chamber temperature.

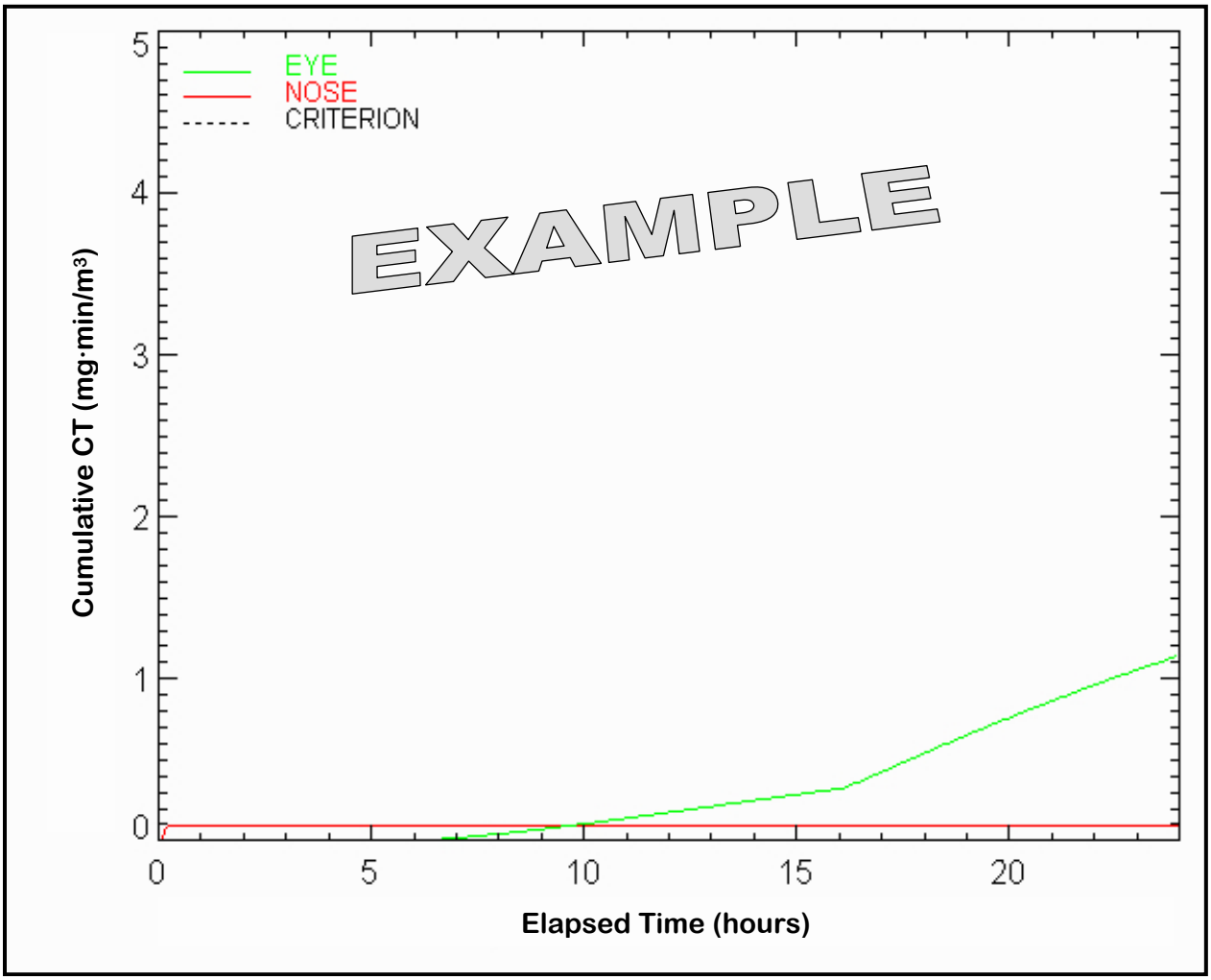
APPENDIX A. EXAMPLE TABLES, PHOTOGRAPHS, AND GRAPHS FOR DATA PRESENTATION



NOTE: Mask treated with insect repellent/camouflage cream and contaminated with sarin (GB).

Figure A.4. Example Trial A mask breakthrough 24-hour challenge GB concentration.

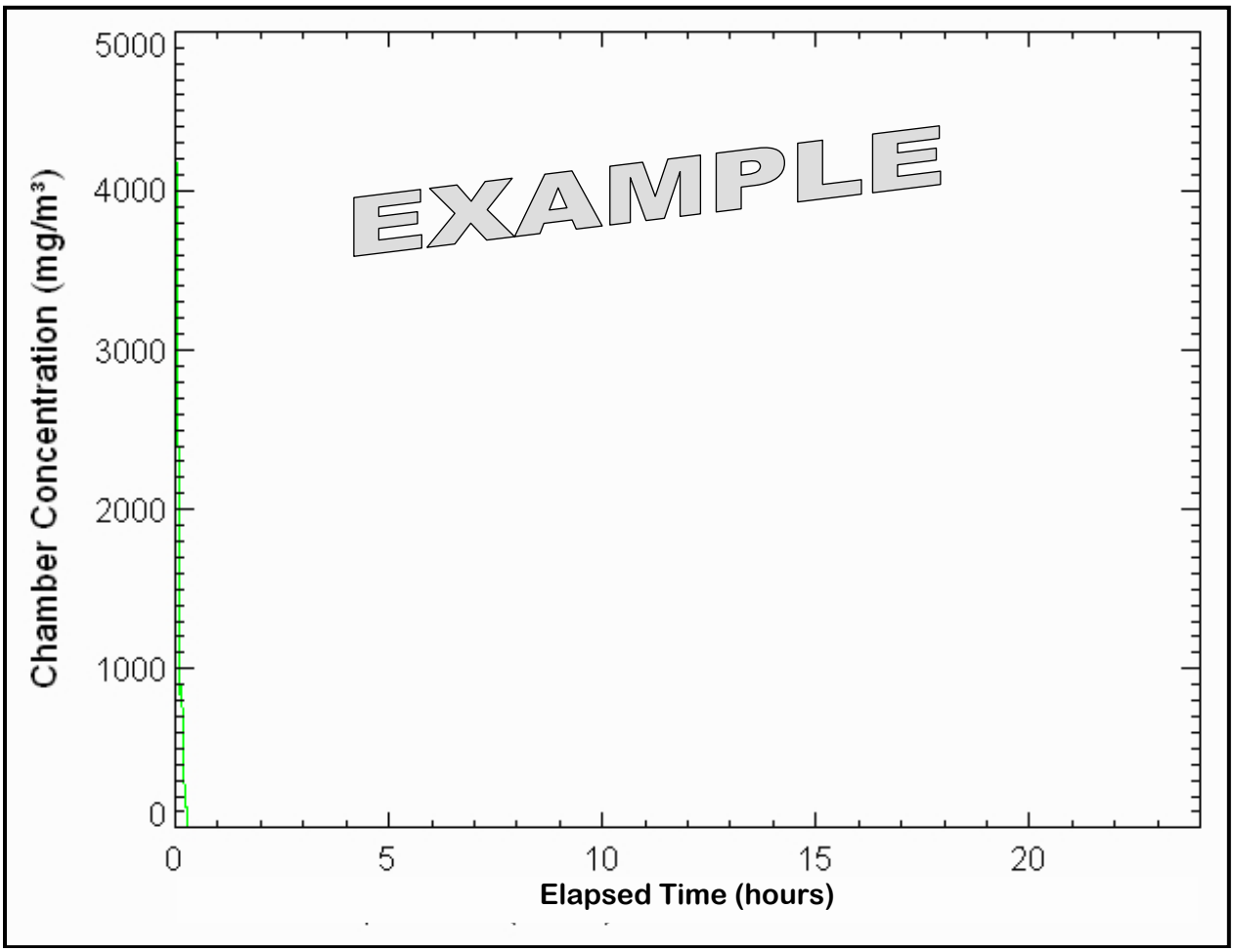
APPENDIX A. EXAMPLE TABLES, PHOTOGRAPHS, AND GRAPHS FOR DATA PRESENTATION



NOTE: Mask treated with insect repellent/camouflage cream and contaminated with sarin (GB).

Figure A.5. Example Trial A mask breakthrough 24-hour challenge GB cumulative concentration × time (CT).

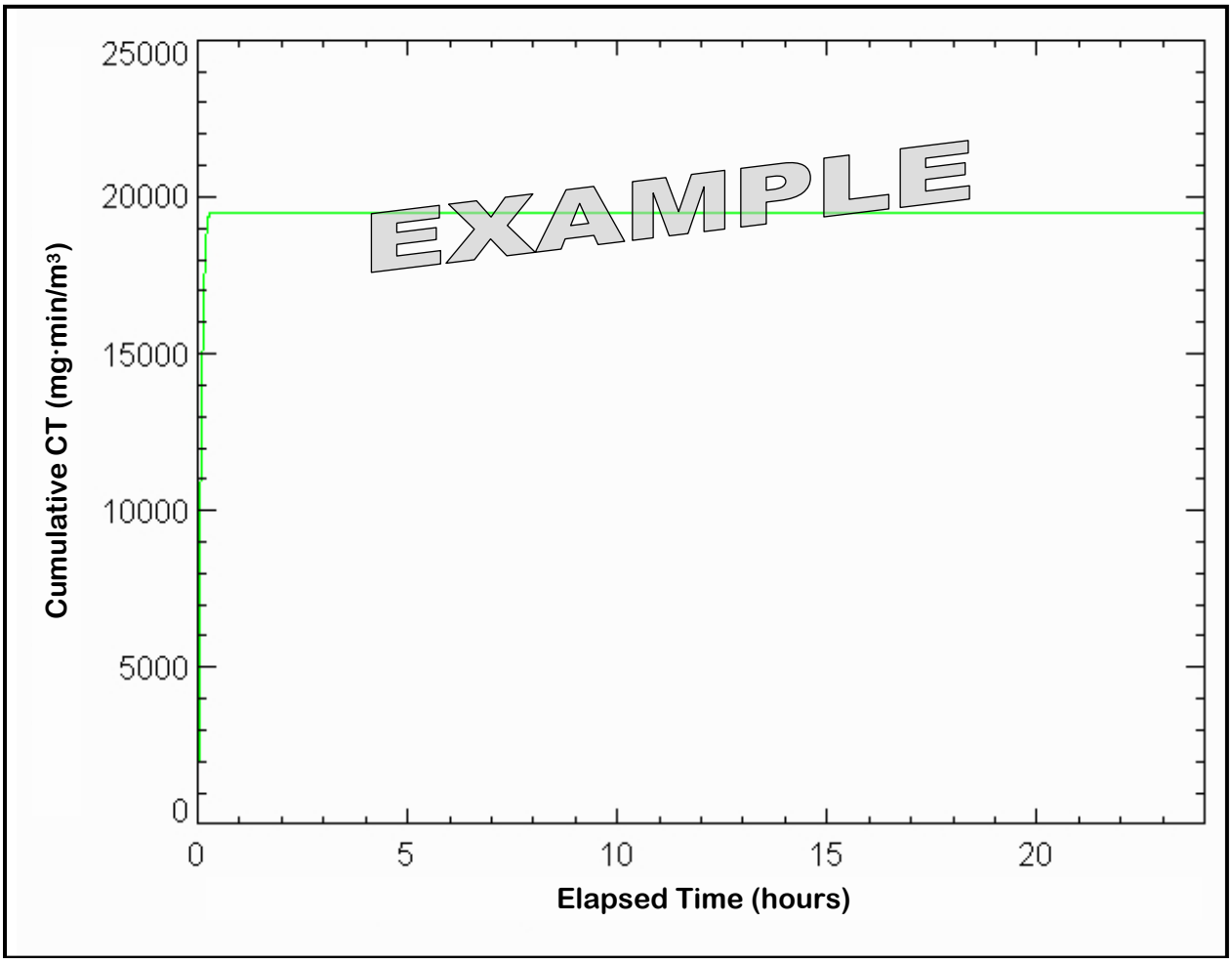
APPENDIX A. EXAMPLE TABLES, PHOTOGRAPHS, AND GRAPHS FOR DATA PRESENTATION



NOTE: Mask treated with insect repellent/camouflage cream and contaminated with sarin (GB).

Figure A.6. Example Trial A chamber 24-hour challenge GB concentration.

APPENDIX A. EXAMPLE TABLES, PHOTOGRAPHS, AND GRAPHS FOR DATA PRESENTATION



NOTE: Mask treated with insect repellent/camouflage cream and contaminated with sarin (GB).

Figure A.7. Example Trial A chamber 24-hour challenge GB concentration × time (CT).

APPENDIX B. TEST EQUIPMENT

1. Thermocouple or equivalent.

2. Hygrometer or equivalent.

3. Anemometer or equivalent.

4. Calibrated syringe pump dispenser or equivalent. Computer-controlled calibrated syringe pump dispenser or equivalent.

5. Still color camera.

6. JSMLT mask leakage testers (Air Techniques International, Baltimore, Maryland) or equivalent instruments.

7. MINICAMS® (a miniature, automatic, continuous air-monitoring system, OI Analytical, division of OI Corporation, College Station, Texas), sulfur/phosphorus analyzer, or equivalents of these instruments.

8. Simulant Agent Resistance Test Manikin (SMARTMAN) fixture and exposure chamber, which is constructed to house the test item during agent or simulant dissemination. The fixture/chamber combination will include the environmentally controlled test chamber, agent/simulant liquid and vapor disseminators, manikin head form with breather pump control, and all other instrumentation necessary to perform SMARTMAN testing, including sampling systems and data recorders.

9. 48-mm Teflon® polytetrafluoroethylene (PTFE) coupons (DuPont™, E.I. du Pont de Nemours and Company, Wilmington, Delaware), or equivalent.

10. Software for calculations and data recording.

11. Gas chromatograph (GC), flame photometric detector (FPD), flame ionization detector (FID), liquid chromatograph (LC), mass spectrometer (MS), or equivalents of these instruments.

APPENDIX B. TEST EQUIPMENT

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APPENDIX C. ABBREVIATIONS

ΔP	differential pressure
AD No.	accession number
AgF	silver fluoride
AR	Army Regulation
ATEC	U.S. Army Test and Evaluation Command
BFC	battlefield contaminant
CAS	Chemical Abstract Service
CBR	chemical, biological, and radiological
CDD	capability development document
CONOPS	concept of operations
COTS	commercial off-the-shelf
CPD	capability production document
CPRP	Chemical Personnel Reliability Program
CT	concentration multiplied by time
CWA	chemical warfare agent
DA	Department of the Army
DEVCOM-CBC	U.S. Army Combat Capabilities Development Command Chemical Biological Center
DRAW	Deliberate Risk Assessment Worksheet
DTP	detailed test plan
FD/SC	failure definition/scoring criteria
FF	fit factor
FID	flame ionization detector
FPD	flame photometric detector
FTIR	Fourier transform infrared

APPENDIX C. ABBREVIATIONS

G-agent	nerve agent
G-analog	G-series agent from VX breakdown products
GB	sarin
GBV	sarin vapor
GC	gas chromatograph
GD	soman
H-agent	blister agent
HD	distilled mustard
IAW	in accordance with
ICD	initial capabilities document
IP	individual protection
ITOP	international TOP
iwg	inches water gauge
JP-8	jet propulsion fuel type 8
JSMLT	Joint Service Mask Leak Tester
LC	liquid chromatograph
LV	Liquid and vapor
MDL	minimum detection limit
MIL-STD	Military Standard
MQL	minimum quantification limit
MS	mass spectrometer
MTOP	multinational TOP
NET	new equipment training
NIOSH	National Institute for Occupational Safety and Health
NRT	near real time

APPENDIX C. ABBREVIATIONS

OPSEC	operations security
OTA	operational test agency
PAM	pamphlet
PTFE	polytetrafluoroethylene
QA	quality assurance
QC	quality control
R^2	coefficient of determination
RDT&E	research, development, test and evaluation
REC	record of environmental consideration
RH	relative humidity
RSDL	reactive skin decontamination lotion
SEP	system evaluation plan
SMARTMAN	Simulant Agent Resistance Test Manikin
SN	serial number
SOP	standing operating procedure
T&E	test and evaluation
TEMP	test and evaluation master plan
TIC	toxic industrial chemical
TICN	test item control number
TOP	test operations procedure
VDLS	VISION Digital Library System
VISION	Versatile Information Systems Integrated Online Nationwide
VX	*S*-{2-[Di(propan-2-yl)amino]ethyl} *O*-ethyl methylphosphonothioate

APPENDIX C. ABBREVIATIONS

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APPENDIX D. REFERENCES

1. Headquarters, Department of the Army (DA), Washington, DC, Army Regulation (AR) 73-1, Test and Evaluation Policy, 1 August 2006.

2. U.S. Army Test and Evaluation Command (ATEC), Aberdeen Proving Ground, Maryland, Test Operations Procedure (TOP) 08-2-110, Masks, Protective, 1 August 1997.

3. Headquarters, Department of the Army (DA), Washington, DC, Army Regulation (AR) 385-10, The Army Safety Program, 23 August 2007 [Rapid Action Revision (RAR) 004, 4 October 2011].

4. Headquarters, Department of the Army (DA), Washington, DC, Pamphlet (PAM) 385-61, Toxic Chemical Agent Safety Standards, 17 December 2008.

5. Department of Defense (DoD), Washington, DC, Military Standard (MIL-STD)-882E, Standard Practice for System Safety, 11 May 2012.

6. U.S. Army Soldier Systems Command, U.S. Army Natick Research Development and Engineering Center, Natick, Massachusetts, Army Anthropometric Survey Database, NATICK/TR-89/044, Downsizing, Demographic Change and Validity of the 1988 Data in 1996, October 1996.

7. U.S. Army Test and Evaluation Command (ATEC), Aberdeen, Maryland, Test Operations Procedure (TOP) TOP 8-2-500A, *Receipt Inspection of Chemical and Biological (CB) Material*.

8. U.S. Army Test and Evaluation Command (ATEC), Aberdeen, Maryland, Test Operation Procedure (TOP) TOP 8-2-073, *Standard Policies for Determination of Neat Agent Purity*.

9. Headquarters, Department of the Army (DA), Washington, DC, Pamphlet (PAM) 40-11 Army Public Health Program, 18 May 2020

**

For information only (related publications)

a. Headquarters, Department of the Army, Washington, D.C., Army Regulation (AR) 50-6, Nuclear and Chemical Weapons and Materiel, Chemical Surety, 28 July 2008.

b. Headquarters, Department of the Army, Washington, D.C., Army Regulation (AR) 190-59, Military Police, Chemical Agent Security Program, 11 September 2006.

APPENDIX D. REFERENCES

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CSTE-CIP (73-1jj) 22 June 2023

MEMORANDUM FOR

Commander, U.S. Army White Sands Missile Range
Executive Director, U.S. Army Evaluation Center
Commander, U.S. Army Operational Test Command
Commander, U.S. Army Yuma Proving Ground
Commander, U.S. Army Dugway Proving Ground
Commanders, U.S. ATEC Test Centers
Director, U.S. ATEC Tropic Regions Test Center
Director, U.S. ATEC West Desert Test Center

SUBJECT: Test Operations Procedure 08-2-109A

1. Test Operations Procedure (TOP) 08-2-109A, Simulant Agent Resistance Test Manikin (SMARTMAN) Testing of Protective Masks 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.

2. Scope of the document. This TOP is intended to furnish basic testing information to facilitate test planning, conduct, and reporting to achieve standardized chemical protective performance testing of protective masks and accessories using the Simulant Agent Resistance Test Manikin (SMARTMAN).

3. This document is approved for publication and has been posted to the Reference Library of the ATEC Vision Digital Library System (VDLS). The VDLS website can be accessed at https://vdls.atec.army.mil/.

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

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Date: 2023.06.22 08:33:50 -04'00'

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