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14. ABSTRACT
This test operations procedure (TOP) provides the standard method for preparing, planning, conducting, and reporting the agent-simulant technology relationship (ASTR) process for use in testing systems and components. An ASTR is a quantified relationship between a measurement collected with agent and the same measurement collected with simulant at the same conditions. This TOP addresses chemical, biological, and radiological (CBR) defense. Within chemical defense, the individual protection (IP), collective protection (CP), decontamination (decon), and contamination avoidance (CA) capability areas are addressed. Example ASTRs are presented from each capability area. The method identifies steps to determine a traceable, quantifiable, and defensible ASTR during testing of components and systems in realistic and operationally relevant scenarios. This procedure tailors ASTRs to the needs of specific tests in any capability area where testing with simulants is required.

15. SUBJECT TERMS
Agent-simulant technology relationship; ASTR; data processing; individual protection; collective protection; CP; decontamination; decon; contamination avoidance; CA; chemical biological radiological; CBR

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

*Test Operations Procedure 08-2-140 14 April 2017
DTIC AD No.

ESTABLISH AN AGENT-SIMULANT TECHNOLOGY RELATIONSHIP (ASTR)

Page

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1. SCOPE.

1.1 Purpose.

a. This TOP identifies steps to determine a traceable, quantifiable, and defensible agent-simulant technology relationship (ASTR) during testing of components and systems in realistic and operationally relevant scenarios. This TOP provides the standard method for preparing, planning, conducting, and reporting the ASTR process for use in testing components and systems. An ASTR is a quantified relationship between a measurement collected with agent and the same measurement collected with simulant at the same conditions. This TOP addresses chemical, biological, and radiological (CBR) defense. Within chemical defense, the individual protection (IP), collective protection (CP), decontamination (decon), and contamination avoidance (CA) capability areas are addressed. Appendix A presents example ASTRs from each capability area. This procedure tailors ASTR to the needs of specific tests in any capability area where testing with simulants is required. Specific details of laboratory, chamber, or field test are out of scope of this TOP, which describes how to establish a mathematical relationship.

b. A system intended for CBR defense is tested before the Warfighter uses it. Testing proceeds from component to system, from lab environment through chamber to field, and from developmental testing (DT) to operational testing (OT).

c. Testing may use chemical warfare agent (CWA), biological warfare agent (BWA), radiological agent, or simulant (surrogate). A simulant is a substance that mimics an agent with regard to test item performance and that may be used in testing. Simulants must be carefully selected (Paragraph 3.1.4). **NOTE**: A stimulator is not a simulant, but a compound that creates an alarm when applied to a detector [Appendix A, Paragraph 3a]. Stimulators are outside the scope of this TOP.

d. By executive order, agents may not be used for open-air field testing in the United States. Other countries can do limited trials of outdoor agent testing, which is outside the scope of the TOP. Therefore, system field performance with agents cannot be measured and must be predicted. The use of simulant during OT introduces risk that the system will perform differently with simulant than it would with agent. An ASTR may mitigate that risk. ASTR(s) are established during DT by adding simulant trials to the agent trial matrix. OT performance with simulant may be combined with ASTR(s) to predict performance with agent. Predicted performance with agent may be combined with toxicological data to predict the impact on the Warfighter, and thus the mission outcome. An ASTR may increase cost and schedule, to increase the likelihood that the fielded system will work with agent. The ASTR depends on the technology being tested and upon the technology used by the test center to perform the test. For example, an ASTR for an existing filter media technology cannot correlate with a new reactive filter medium. Planning should address the possibility that some planned trials may not pass data authentication and that an ASTR cannot be established for those conditions.

e. The Test and Evaluation Master Plan (TEMP) for the program will define the need for an ASTR. For acquisition tests, the overarching document is Department of Defense (DOD) Instruction 5000.02, *Operation of the Defense Acquisition System*[1**] as discussed in Paragraph 1.2.b. The TEMP may call out a qualitative OT assessment such as a visual inspection. Results from qualitative OT may not be usable to predict the effectiveness of the test item with agent. Furthermore, qualitative data cannot be compared with toxicological data to predict Warfighter impact. Therefore, Evaluators might not accept a TEMP that proposes qualitative OT. An ASTR need not be performed if Evaluators accept qualitative OT.

f. A component-level ASTR should be established and used to predict a system-level ASTR. The likelihood of program success increases with a validated ASTR. Cost increases if ASTR testing is not performed at the component level. The measurement may be test item performance, component performance, a physical parameter of the compound, or a parameter that describes the ability of the compound to be used in testing. An ASTR may also be determined for quantitative measures that characterize simulant performance in testing, such as the ability to be removed from surfaces. Component-level ASTRs must be verified, validated, and accredited (VV&A) before incorporation into a system level performance model, which must in turn be VV&A before operational test agency (OTA) use. Figure 1 presents responses to agent and simulant for a notional system under test (SUT). Details of VV&A methods and procedures are out of scope of this TOP. VV&A guidance can be found in U.S. Army Test and Evaluation Command (ATEC) Regulation 73-21[2] and Military Standard (MIL-STD)-3022[3].

** Superscript numbers correspond to Appendix C, References.

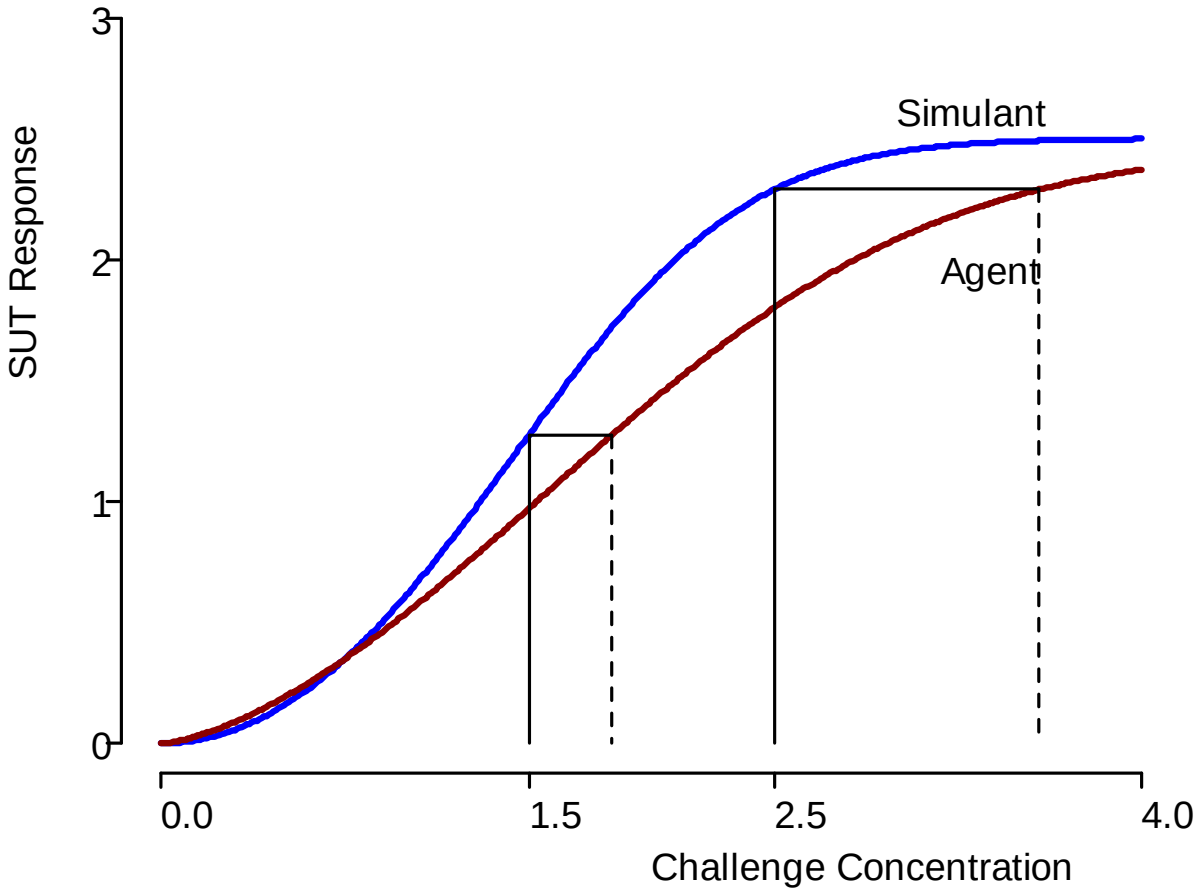


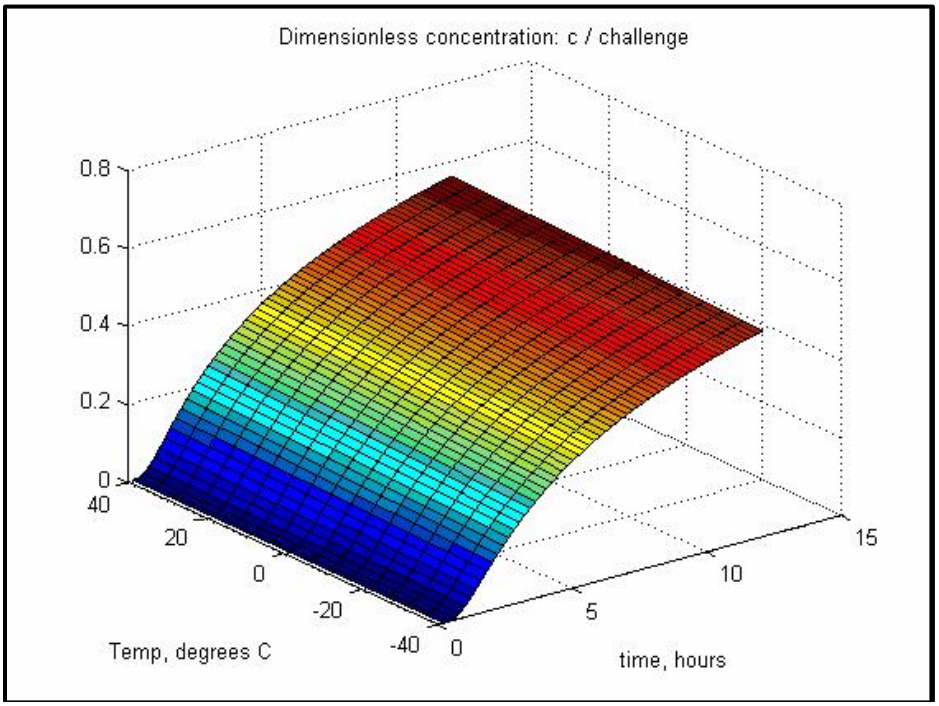
Figure 1. Notional responses to agent and simulant for a system under test (SUT).

g. It is preferable to choose the simplest ASTR that meets test program needs. A simple ASTR is the ratio of test item performance with agent to test item performance with simulant. Other ASTRs are discussed in Paragraph 3.1.4.g and Appendix A. The term agent-simulant ratio may be used in some test contexts. **NOTE**: The term simulant-agent relationship is sometimes used and may be understood as the inverse of ASTR. The term agent-simulant correlation (ASC) is also used. An ASC is more qualitative than an ASTR. Also, it may sometimes be useful to establish a simulant-to-simulant technology relationship.

h. The numeric value of an ASTR may depend on the units of measurement.

i. An ASTR is a mathematical model. Performance with agent may be predicted as part of a system performance model (SPM). An SPM may be established for a specific test item or for a capability.

j. Test-item performance may depend on environmental conditions and on test-item characteristics in different ways for the agent and simulant. Figure 2 plots notional system response as a function of temperature and time.



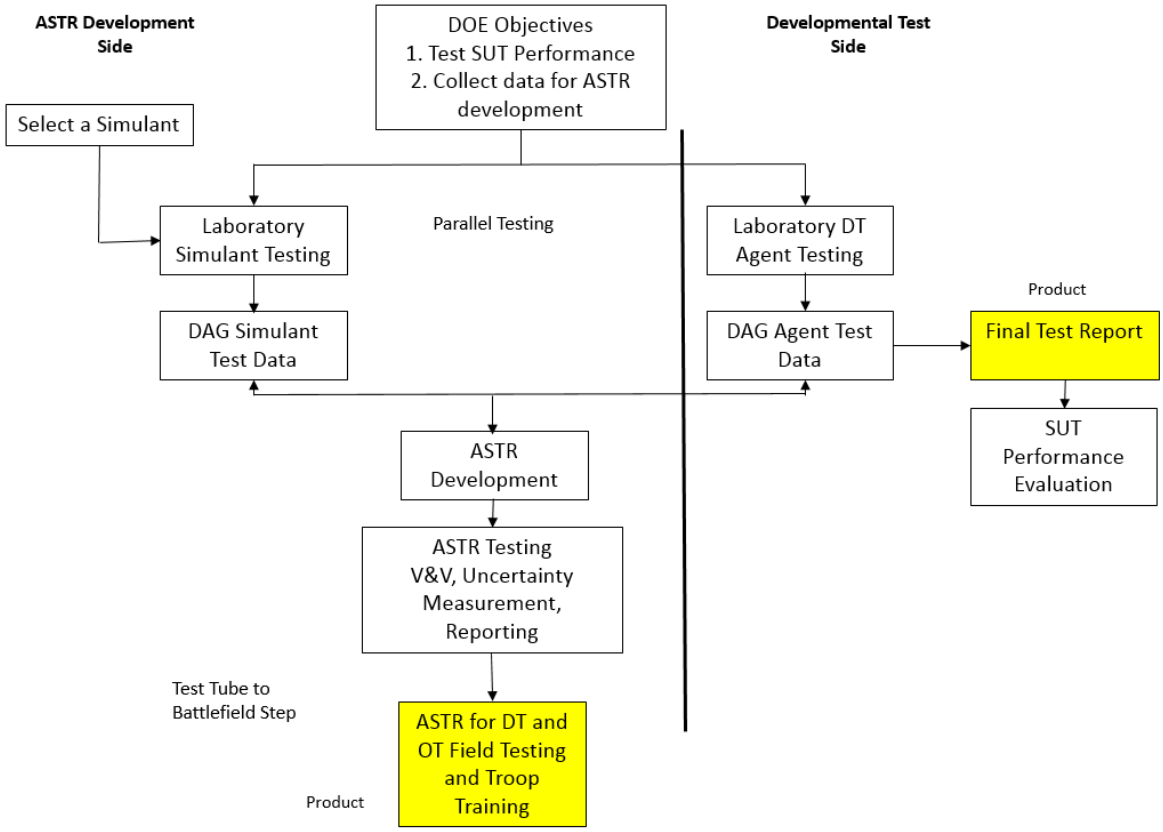
NOTE: Temp = temperature; degrees C = degrees Celsius.

Figure 2. Notional system response (measured challenge concentration) as a function of temperature and time.

k. The ASTR depends on environmental conditions, test-item characteristics, measurement instruments, and agent and simulant characteristics and concentrations. The ASTR may also depend on the elapsed time after the start of challenge dissemination. Across a limited range of conditions and times, the ASTR may be expressed as a constant value.

l. CBR protective equipment is often tested with toxic industrial materials (TIMs), toxic industrial chemicals (TICs), and toxic industrial biologics (TIBs). Some TICs/TIMs/TIBs may be disseminated in the field during OT to measure system performance directly, so it is not necessary to choose a simulant and develop an ASTR. However, the tester may want to develop an ASTR and use a simulant challenge if doing so is cheaper than performing TIC/TIM/TIB testing, or if the particular TIC/TIM/TIB is difficult to test directly.

m. Figure 3 shows the overall test and ASTR process.



NOTES: 1. Heavy vertical line represents the separation between ASTR development and DT.
2. DOE = design of experiment; SUT = system under test; DT = developmental test; DAG = data authentication group; V&V = verification and validation; OT = operational test.

Figure 3. Overall Test and Agent-Simulant Technology Relationship (ASTR) process.

1.2 Background.

a. Historically, many tests did not develop quantitative agent and simulant performance data for ASTRs. Table 1 lists guiding documents and tests that have produced an ASTR.

b. DOD Instruction 5000.02[1] may be interpreted to encourage the use of ASTRs; relevant sections are quoted in the following paragraphs. Acronym definitions have been added to the quoted text:

(1) Section 5.d.(8).a: "Milestone B requires final demonstration that all sources of risk have been adequately mitigated to support a commitment to design for production."

(2) Section 5.d.(9).(b).2: "Developmental Test and Evaluation (DT&E) also evaluates the ability of the system to provide effective combat capability, including its ability to meet its validated and derived capability requirements, including the verification of the ability of the system to achieve Key Performance Parameters (KPPs)."

NOTE: An ASTR combined with simulant system test data demonstrates the KPP for CBR functionality.

(3) Enclosure 3, Section 9: "The Program Manager will integrate modeling and simulation activities into program planning and engineering efforts."

NOTE: An ASTR contributes data to modeling and simulation.

(4) Enclosure 4, section 2.a: "Program managers use DT&E activities to manage and mitigate risks during development, to inform decision makers throughout the program life cycle, and to verify that products are compliant with contractual and operational requirements."

NOTE: An ASTR combined with simulant test data reduces the risk that the system will not work with agent.

(5) Enclosure 4, Section 4.b(1): "The DT&E program will … verify achievement of critical technical parameters and the ability to achieve KPPs … assess the system's ability to achieve the thresholds prescribed in the capabilities documents … validate system functionality … assess system specification compliance ... identify system capabilities, limitations, and deficiencies."

(6) Enclosure 4, Section 5.d(3): "The TEMP will …use scientific test and analysis techniques to design an effective and efficient test program that will produce the required data to characterize system behavior across an appropriately selected set of factors and conditions."

TABLE 1. AGENT-SIMULANT TECHNOLOGY RELATIONSHIP (ASTR) IN TESTS AND GUIDING DOCUMENTS

Capability	Document	Comment
All	International Organization for Standardization (ISO) Standard 17025[4].	General requirements for the competence of testing and calibration laboratories.
All	Joint Committee for Guides in Metrology (JCGM) 100:2008[5].	Evaluation of measurement data – Guide to the expression of uncertainty in measurement.
All	Simulant Selection Test Operations Procedure (TOP) 08-2-196[6].	TOP for systematic, traceable simulant selection.
Contamination avoidance (CA)	Joint Chemical Agent Detector (JCAD) reports[7,8].	Reports describe how West Desert Test Center (WDTC) generated ASTRs for JCAD detection performance as a function of test variables.
CA	Joint Services Lightweight Standoff Chemical Agent Detector (JSLSCAD) report[9].	Report describes ASTRs generated for performance of the JSLSCAD detector with chemical vapors.
Collective protection (CP)	Aberdeen Proving Ground (APG) report CRDEC-CR-88046, APG[10].	Report describes ASTRs generated for adsorption/desorption of agent/simulant vapor on fabrics. This work was intended to predict the vapor load from contaminated clothing when personnel entered a CP shelter.
CP	Simulants for Protective Equipment Testing Methodology Investigation Report[11].	Report from the Joint Science and Technology Office (JSTO) and Defense Threat Reduction Agency (DTRA) describes testing that selected chemical warfare agent (CWA)-vapor-permeation simulants and generated an ASTR from initial data.
CP	Joint Expeditionary Collective Protection (JECP) Production Qualification Test (PQT) Air-Purification System (APS) Testing of the Passive Air-Filtration System Final Test Report[12].	Report describes testing that measured CWA vapor permeation through swatches of CP filter material with systematically selected simulants. An ASTR is thoroughly described.

TABLE 1. AGENT-SIMULANT TECHNOLOGY RELATIONSHIP (ASTR) IN TESTS AND GUIDING DOCUMENTS (CONT'D)

Capability	Document	Comment
Decontamination (Decon)	Polluted Lizard Final Test Report[13].	Report describes an ASTR for percentage removal of persistent nerve agent (VX) or tripropyl phosphate (TPP) from coupons of aircraft construction material by air blast and washing.
Decon	Stryker decon methodology report[14].	Report provides a VX-TPP ASTR for post-decon contact hazard and off-gassing. In the Stryker production verification test (PVT) Nuclear, Biological, and Chemical Reconnaissance Vehicle (NBCRV) report[15], the ASTR is combined with Stryker simulant results to predict Stryker agent results.
Individual protection (IP)	IP system performance model (SPM) Version 2.0 meeting presentation[16].	An IP SPM has been developed[16]. Suit performance in agent vapor could be predicted by combining component ASTRs with Man-in-Simulant Testing (MIST) simulant data. Results could be validated using foreign man-in-agent test data.
IP and CP	Chemical Protection Testing of Sorbent-Based Air Purification Components (APCs) TOP 08-2-197[17].	TOP for vapor challenge of components intended to purify air.

(7) Enclosure 5, Section 5.e(3): "Every TEMP will include a table of independent variables (or 'conditions,' 'parameters,' 'factors,' etc.) that may have a significant effect on operational performance. Starting at Milestone B, the updated table of variables will include the anticipated effects on operational performance, the range of applicable values (or 'levels,' 'settings,' etc.), the overall priority of understanding the effects of the variable, and the intended method of controlling the variable during test (uncontrolled variation, hold constant, or controlled systematic test design)."

NOTE: For CBR defense, factors include the amount, type, and purity of the test challenge compound.

1.3 Application.

The test procedures described in this document must be referenced and/or incorporated into a DTP or similar document for each test in which an ASTR is used. These procedures may be modified in the DTP to accommodate specific testing requirements or objectives. Alterations, however, must be made only after a full consideration of how the changes may affect the reliability and validity of the resulting data. Any alteration, along with a description of the desired effect, and consequent changes in the assessment process must be fully described in the DTP.

1.4 Objectives.

This TOP specifies how to plan tests so that test data can be processed to yield an ASTR. This TOP also describes how to process the data. An ASTR should increase confidence that system performance with agent can be predicted from DT&E simulant results.

1.5 Recommendations and Limitations.

a. The procedures in this TOP do not specify performance criteria. Completion of the procedures in the TOP does not imply acceptance or rejection of test items. The TOP does not specify requirements, test conditions, or specific compounds. The test center must follow all applicable regulations, but compliance will not be discussed here.

b. Experimental approaches will not be discussed in this TOP but may be found in experimental TOPs such as *Test Operations Procedure for Chemical Protection Testing of Sorbent-Based Air Purification Components (APCs)* TOP 08-2-197[17]. This TOP will describe how to process data for an ASTR, but not how to do experimental work.

(1) Test fixture design verification and validation (V&V), receipt inspection, selection and application of battlefield contaminants (BFCs), selection and use of interferents for detector testing, test item preparation, safety, supporting instrumentation, data acquisition system, calibration, sensor verification, test site authorization, readiness check, clock synchronization, attainment of stable challenge conditions, trial completion, post-trial actions, and test retrograde are essential for testing but are not discussed here.

(2) The following items are essential for agent testing but are not described here: agent laboratory or appropriate biosafety level (BSL) and storage facility, compliance program, chamber, medical clinic, specialized personal protective equipment (PPE), and safety monitoring. Some tests may use materials subject to specific regulations, e.g., CWA surety.

(3) An ASTR is only effective if simulants are chosen per Paragraph 3.1.4.

c. Domestic testing is usually performed with domestic agents. Domestic agents may have different percentage purity, impurities, and delivery systems than threat agents. Therefore, an ASTR determined using a domestic agent may not fully predict performance with a threat agent. An ASTR should be developed for each variety of the agent to be tested e.g., pure, weapons-grade, etc.

d. Similar challenges exist with variability in BWAs. Growth protocols, refining techniques and quality control (QC) and quality assurance (QA) procedures must be documented to characterize BWAs in the event that variability produces spurious test results.

e. Modeling and simulation (M&S) are used to generate data that support testing. However, this TOP will only consider ASTR generation from the processing of experimental data.

f. A component-level ASTR inherently has some risk as the ASTR cannot be validated with agent in its intended use (e.g., agent outdoor release is prohibited and effects from the system or environment cannot be fully addressed). So a component-level ASTR cannot be directly validated using agent at the system level. Using simulant, the component and system level results can be compared within their combined uncertainty. M&S can reduce this risk.

g. The quality and uncertainty of the ASTR depend on the quality and uncertainty of the data from which the relationship was calculated (Paragraph 3.2). An ASTR cannot overcome limitations in the test item or limitations in tactics, techniques, and procedures (TTPs). If an ASTR is extended beyond the range of the conditions of measurement, results must be flagged and the ASTR used with caution. An ASTR is interpolated to conditions between those at which the original data were measured (Paragraph 6.j).

h. If a comparison with previous data is planned, special caution must be taken to test at conditions similar to the desired comparison test. Results obtained by using this TOP may be compared with results from other test items tested during the same test or from those tested previously under the same conditions.

i. To verify the ASTR, the test team may run additional agent trials under the same conditions as the simulant trials for which the ASTR was derived, and then see how well the ASTR predicts performance with agent. ASTR verification must assess whether the results obtained from the ASTR provide the precision, accuracy, and uncertainty required by the test data quality objectives (DQOs) (e.g., if the ASTR predicts an agent response with an uncertainty low enough to meet the test needs). The details of ASTR verification are test-specific and are out of scope of this TOP.

j. Agent performance predicted using the ASTR must be validated. If the test item contains multiple technologies, or the test center uses multiple technologies to determine concentration, an ASTR may have to be developed for each technology. The exact validation requirements are not defined in this TOP. Any trials that are run for validation must be run at conditions within the range covered by the ASTR. Validation approaches may include but are not limited to the following:

(1) Before producing the ASTR, agent-simulant trial pairs may be randomly selected. The quantity of trial pairs is based on the statistical statement required by the program [e.g., 90 percent confidence and 99 percent probability of detection (Pd) for a detection system.] Selected pairs are then withheld from the data used to produce the ASTR. The remaining trial pairs may be used to produce the ASTR. Each withheld simulant trial may be fed into the ASTR, which will predict an agent result. If the ASTR can be used to predict each agent trial result to within the precision, accuracy, and uncertainty determined by the DQOs, then the ASTR is validated. If the ASTR is not validated, it may be advisable to reconsider the DOE or to perform additional trials, if time and budget permit. **NOTE**: Enough data should be held back for validation, but not so much that the ASTR is weakened. The percentage of data to be held back should be determined by a statistician. Data to be held back must be flagged in the DOE (Paragraph 3.1.2.b).

(2) Agent and simulant trial pairs may be added and used to further evaluate the ASTR at the same level, e.g. component. If the ASTR predicts each new agent result from the corresponding simulant results, then the ASTR is validated at the same level, e.g. component.

(3) An independent panel of qualified subject matter experts (SMEs) may be convened to peer-review the ASTR.

k. Toxicological modeling and assessment of mission consequence is not covered in this TOP. Toxicological data must be available before conducting an ASTR study to plan appropriate challenge levels and avoid unnecessary costs. The results obtained using this TOP might not be correlated to the full range of battlefield conditions because ASTR testing is conducted in a controlled environment. However, the ASTR should cover a wide range of battlefield conditions.

l. Agent results, simulant results, the ASTR, and the identity of the simulant must be handled in accordance with (IAW) the security classification guide of the test as detailed in the test plan. Performance data for any fielded item are almost always classified. Performance data for any item to be fielded may also be classified. Obtaining the ASTR together with simulant results may allow hostile forces to infer agent results and perhaps the vulnerability of the test items. Knowing the simulant identity and simulant test results may allow hostile forces to release the simulant to confound or overwhelm a system.

2. FACILITIES AND INSTRUMENTATION.

No specific facility, instrumentation, test controls, or software is required to perform a test whose data may be processed to yield an ASTR. An agent-certified facility is required to collect agent data. For the test but not for the ASTR, the test must be done IAW the applicable TOP and test

plan at a validated facility using validated test methods and fixtures with qualified, trained, and certified operators. The test facility must be certified for agent operations with appropriate safety protocols to conduct the agent testing required.

3. REQUIRED TEST CONDITIONS.

3.1 Preparations for Testing.

No specific preparations are required to calculate an ASTR. Paragraphs 3.1.1 through 3.1.5 describe preparations for testing to generate data for an ASTR.

3.1.1 Familiarization.

Documentation from similar tests previously conducted and preceding development and test phases of the current program must be reviewed to identify potential problem areas, avoid duplication, and reduce the scope of further testing. Development of test plans requires familiarization with the applicable test planning and requirements documents. Each of the following types of documents will be reviewed and updated as required:

a. Safety release and approval from the authorizing agency (e.g., ATEC) to begin testing, if required.

b. Human Research Review (HRR) approval or exemption and notification, if required.

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

d. Program-specific requirements documents: CDD, CPD, System Performance Specification (SPS), System Evaluation Plan (SEP), Safety Assessment Report (SAR), Test Support Order, Event Design Plan (EDP), System Support Package (SSP) and SSP list (SSPL), and TEMP.

e. Chemical hygiene plan (CHP).

f. Chemical surety compliant standing operating procedures (SOPs).

g. Familiarization with the relevant SOPs and other procedures for applicability, completeness, and adequacy will be required.

3.1.2 Experimental Planning and Design.

a. An ASTR is specific to a given SUT and applicable only to the agent, simulant, technology, environmental conditions and other relevant factors under which the ASTR was developed. The ASTR is determined by the performance characteristics of the SUT when challenged by the agent and the simulant. A necessary condition to develop an ASTR is that the SUT be consistent in its responses to both the agent and the simulant. In the simplest case, an SUT is challenged with the agent under various conditions and then challenged with the simulant under the same conditions. All the SUT responses are then used to derive a mathematical

function that correlates the agent responses with the simulant responses. In general mathematical terms, the responses of the SUT to agents and to simulants under a variety of environmental conditions can be mapped as two multidimensional surfaces (Figure 2). The surfaces can be thought of as multidimensional calibration curves. The ASTR is a mathematical function or relationship that is used to correlate the points on the two surfaces. In mathematical terms, the ASTR is an operator that maps one surface onto the other. For a measured SUT response to a simulant under known conditions, one can use the ASTR to predict the response of the SUT to agent under those same conditions and vice versa.

b. During the planning stage before simulant selection and ASTR development, the desired performance specifications for the ASTR must be identified. These performance specifications include desired level of accuracy, allowable level of uncertainty, challenge concentration range required, range of environmental conditions to be used during testing, and other factors critical to SUT performance. In testing projects, performance specifications are frequently called DQOs.

c. Once the performance specifications have been identified, a test matrix which covers all of the critical factors or parameters can be designed[18] to obtain the necessary data to build the ASTR. After a full test matrix is developed, statistical DOE techniques can be used to reduce the number of trials needed to obtain the critical data and control the uncertainty within acceptable levels (see Figure 4 for an illustration of power vs sample size). The performance characteristics (DQOs) of the testing process and the test system/fixture must be considered, together with the specifications for the simulant as part of the DOE effort. At the beginning, this is an iterative process and may require the collection of some preliminary data.

d. In the normal course of developmental testing ASTR development takes place as a parallel effort during the early stages of laboratory and chamber testing. To save cost, the simulant test matrix and the agent test matrix are integrated. This integration can be rather complex and can easily lead to confusion. The test data from the agent and simulant trials are used for two purposes: firstly, to measure the performance of the SUT, and secondly, to build the ASTR. Test data from simulant trials at this point are typically used to build the ASTR. In addition some agent and simulant trials will be used to test the performance of the ASTR and validate its use after it has been developed. Some additional confusion is caused by the fact that the data are being used for two purposes at this point. Firstly, the SUT is being tested for performance and secondly it is being used as a type of referee to measure the appropriateness of the simulant, i.e., the simulant is being assessed for resemblance to agent using the SUT as a measurement instrument.

e. Once a reliable ASTR has been developed, the simulant now switches roles and can be used to test the performance of the SUT in situations where agent is either too expensive or prohibited (i.e., in field testing).

f. Factors that may affect SUT performance and thus the ASTR for different capability areas are listed in Table 2. Factors were collated from previous test reports and from MIL-STD-810G[19]. While there are many factors, only a few will typically affect an ASTR. Each factor must be considered and, if appropriate, included in the DOE. If a factor is included in the DOE, then its value must be recorded during testing.

g. While two trials are rarely performed at identical conditions, two trials are deemed to have similar conditions if the test conditions of each trial meet the test DQO. If conditions are similar, the difference in test item performance caused by test condition variation is smaller than other sources of uncertainty. More detail for each capability area is presented in Appendix A.

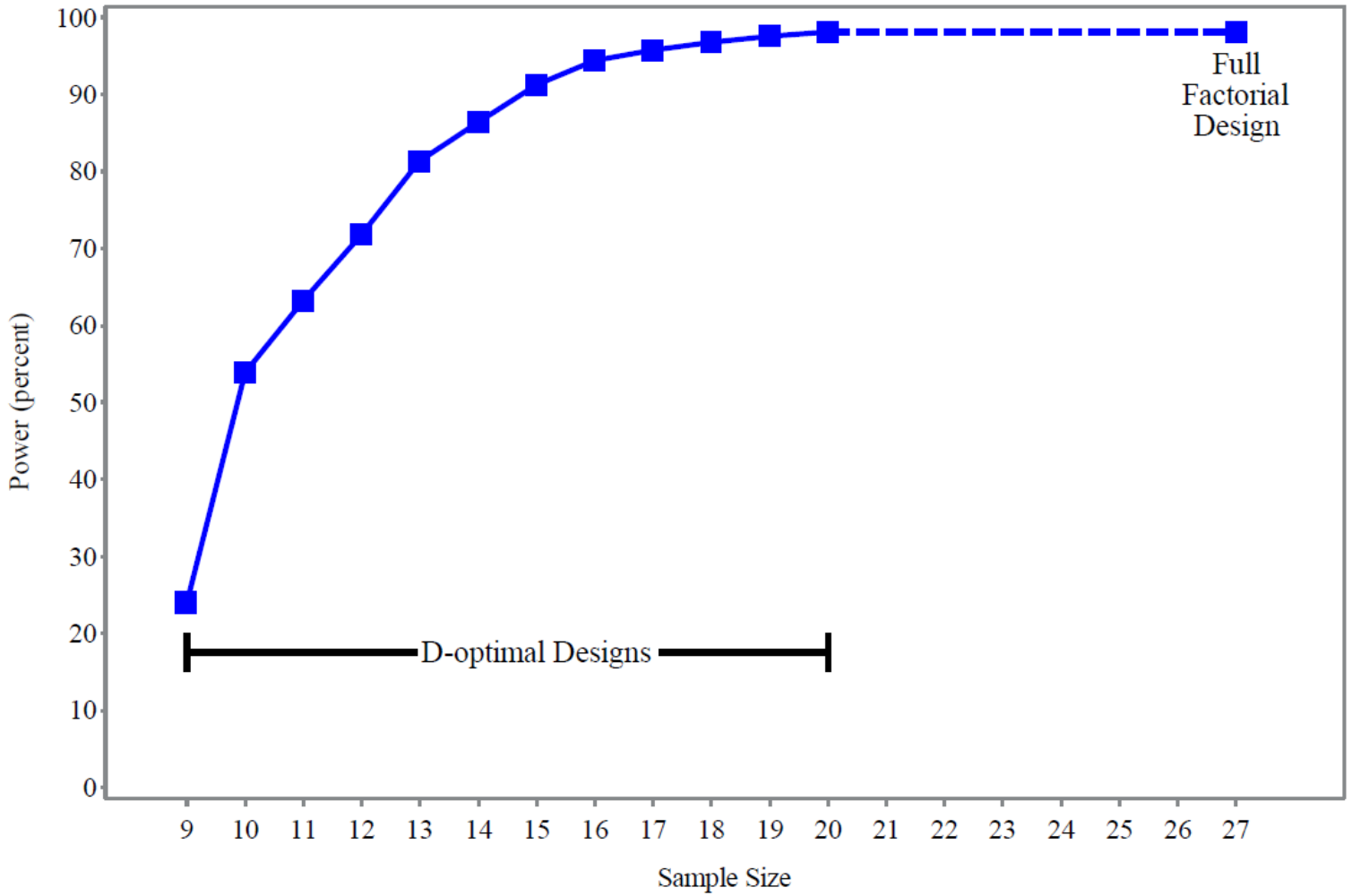


Figure 4. D-optimal design of experiments (DOE) requires fewer trials to identify data trends than full-factorial DOE.

TABLE 2. FACTORS THAT MAY AFFECT THE SYSTEM UNDER TEST (SUT) AND AGENT-SIMULANT TECHNOLOGY RELATIONSHIP (ASTR) FOR DIFFERENT CAPABILITY AREAS

Factor	Capability Areas	Summary of Rationale
Barometric pressure	All.	Pressure may affect test item performance. Pressure will affect the correction of concentration data between volumetric and standard units.
Challenge type and amount	All.	Challenge affects test item performance. Type includes test substance identity, purity, and state of matter. For aerosol, particle morphology, moisture content, and charge are important. Amount may be defined as mass, surface density, liquid concentration, vapor concentration, vapor concentration integrated over time (Ct), mass flow rate, etc.
Differential pressure (ΔP)	Collective protection (CP) and individual protection (IP).	If the test item has two sides (such as a fabric swatch), then the ΔP between the air on either side may affect test item performance.
Elapsed time since start of challenge	All.	Test item performance and the behavior of agent and simulant are affected by many time-dependent processes.
Flow near test item	All.	Air or liquid flow affects how agent or simulant is delivered to or removed from the test item. Flow rate should be considered. Flow velocity (speed and direction) near any part of the test item that contacts agent should be considered.
Illumination at wavelengths of interest	Contamination avoidance (CA) and optical detectors.	Ambient lighting, range, and view angle to a challenge surface will affect the performance of optical detector SUTs. Illumination may include infrared, visible, and ultraviolet wavelengths.
Location, geometry, orientation, accessories, and operating mode of test item and test hardware	All.	Test factors may affect test item performance. Accessories may include such items as mounts, sample path and line, power supplies and cords, test system hoses, and environmental control units (ECUs). Orientation affects whether a liquid test compound, decontaminant, or rinse will drain off a test item.

TABLE 2. FACTORS THAT MAY AFFECT THE SYSTEM UNDER TEST (SUT) AND AGENT-SIMULANT TECHNOLOGY RELATIONSHIP (ASTR) FOR DIFFERENT CAPABILITY AREAS (CONT'D)

Factor	Capability Areas	Summary of Rationale
Operator interaction with test item, operator dissemination of agent or simulant.	All.	Human factors may affect test item performance. Details of operation may affect liquid dissemination. Operators should be trained to be consistent or dissemination may be automated.
Outdoor environment: time of day, day of year, disseminator or munition type, release rate, location, elevation, rate of spread with distance, distance and direction from disseminator to test item, BWA type (toxin, pathogen, or simulant), BWA state (dry powder or wet slurry), wind speed and direction, terrain contours, ground cover (sand grass brush or trees), atmospheric stability (Pasquill stability category, inversion height, or temperature lapse rate), cloud cover, airflow around test item, initial viability, rate of decay of viability because of sunlight and other processes, temperature profile along the beam line (for a standoff detector), and virulence (BWA).	All (those marked BWA apply to biological testing only).	These factors affect test item performance in field testing and are considered in modeling. Some of these factors may not be testable in the lab or chamber with agent.
Photodegradation	CA and decontamination.	Ambient light and ultraviolet radiation may degrade challenge agent. Some decontamination protocols may use an ultraviolet source to try to degrade agent.

TABLE 2. FACTORS THAT MAY AFFECT THE SYSTEM UNDER TEST (SUT) AND AGENT-SIMULANT TECHNOLOGY RELATIONSHIP (ASTR) FOR DIFFERENT CAPABILITY AREAS (CONT'D)

Factor	Capability Areas	Summary of Rationale
Purity, identity, and physical state of agent, simulant, impurities, and contaminants.	All.	The amount, type, and physical state of impurities may affect test item performance. Thickener will likely affect test item performance. Agent purity designations include Chemical Agent Standard Analytical Reference Material (CASARM) and weapons-grade. High-performance liquid chromatography (HPLC), analytical standard, puriss. (i.e., 98%), specialty, and industrial are purity designations for commercial compounds. Aerosol morphology and size distribution will affect the performance of aerosol detectors. For radiological work the natural background should be considered. Battlefield contaminants (BFCs) may interact with agent, simulant, or the SUT.
Radiation challenge type/activity/energy distribution, age of challenge since creation.	Radiological.	Radiation challenges decay steadily. Data should be corrected for the elapsed time since the sample was created, typically in a nuclear reactor.
Region of test item.	CP, decontamination, IP, biological, and radiological.	Different regions of the test item may perform differently.
Relative humidity (RH) at test item.	All.	Humidity usually affects the behavior of the test item, agent, and simulant. The water vapor content (WVC) may be used instead of RH. If condensation does not occur, behavior may be more correlated to WVC than to RH.
Residual challenge.	All.	Design the test to minimize leftover challenge from the previous trial.
Routing of detector exhaust.	CA.	If the detector does not destroy test compound during operation, the exhaust will contain test compound that must be ducted away from the intake and from personnel.
Routing of engine exhaust.	CP, decontamination.	If the SUT contains an engine that is operated during test, the exhaust will contain substances that may affect health, SUT performance, or instrument performance. Vehicle exhaust must be ducted away from the SUT and from personnel.

TABLE 2. FACTORS THAT MAY AFFECT THE SYSTEM UNDER TEST (SUT) AND AGENT-SIMULANT TECHNOLOGY RELATIONSHIP (ASTR) FOR DIFFERENT CAPABILITY AREAS (CONT'D)

Factor	Capability Areas	Summary of Rationale
Settings and data processing of challenge detector, effluent detector, and the test item if it is a detector.	All.	Any detector settings and data processing will affect characterization of the test item performance. If the test item is a detector, then detection settings will affect its performance.
Technology of the test item and technology used by the test center to measure concentration of agent or simulant	All.	Different technologies will require different similarities to the agent for which the ASTR is being developed
Temperature and other relevant environmental conditions of and around the test item.	All.	Environmental conditions affect the behavior of the test item, agent, and simulant.
Test item treatment before challenge.	All.	Test item history will affect its performance.
Test item velocity (speed and direction).	CA of portable detector, CP of vehicles or ships.	Velocity affects vibration spectrum and relative airflow.
Time: age of test item, trial duration, sampling interval.	All.	Trial duration affects test item performance. Sampling interval affects the perception of performance caused by aliasing effects.

h. Trials in which the test item appeared to fail or displayed an error must be reviewed internally. If a trial is rejected by internal or Data Authentication Group (DAG) review, then an ASTR cannot be formed using that trial's data. The DAG must meet during the test. Sufficient time must be planned to allow for trial repetition as required during the test and after each DAG meeting.

i. For each referee instrument, the upper limit of quantification (ULOQ) must exceed the upper calibration limit (UCL), which must exceed the highest value expected to be measured during testing. The lowest value to be measured during testing must exceed the lower calibration limit (LCL), which must exceed the lower limit of quantification (LLOQ). If an instrument can be calibrated over three decades, the UCL is 1000 times the LCL. The DAG may reject any measurements below the LCL or above the UCL. Processing of results below the LCL is described in Paragraph 6.i(4).

j. Both simulant and agent results must be calibrated and must lie between the LCL and the UCL (i.e., ULOQ>UCL>results>LCL>LLOQ). That restriction limits the range of possible ASTR values to the range LCL/UCL≤ASTR≤UCL/LCL. For example, if an instrument can be calibrated over three decades, then 0.001≤ASTR≤1000.

k. The test plan must include enough detail to ensure that the results are repeatable by the same operator on different days, reproducible by different operators in the same test center, and comparable among different test centers (i.e., results from the same trial performed at different times and locations must agree within the test DQO).

l. When all trials in the DOE are executed, the resulting ASTR must have a sufficiently low uncertainty and sufficiently high confidence to meet the needs of the test community. Further discussion is provided in Appendix A.

3.1.3 Documentation.

The following must be documented and traceable:

a. Test data and results in a format approved by the sponsor and the test agency.

b. The rationale to choose a particular form of an ASTR.

c. How the ASTR calculation is performed.

d. The uncertainty of the SUT response to agent, as predicted by the ASTR.

3.1.4 Simulant Selection.

a. A simulant is a compound chosen by the test team to resemble the agent and be usable in each testing environment where it will be used. No simulant meets all requirements. Only the agent itself exactly meets all agent properties. Such strict correlation is not necessary, because the key parameters are just those that are directly relevant to the test. The selection of optimal simulants is a complex process and must be performed IAW TOP 08-2-196, *Simulant Selection*[6]. If the agent is expected to react with the test item, it may be advisable to choose a simulant that

matches the chemical properties of the agent better than it matches the physical properties of the agent.

b. As a necessary first step, the SME may match the simulant to agent using physical properties relevant to test item performance. The ratio of appropriate physical properties can be calculated for agent and simulant. However, this ratio does not consider hardware and software factors that may make the ASTR differ from the ratio of physical properties. Therefore, the ASTR must be determined experimentally. For example, a simulant for a mass spectrometer detector may be matched to agent by matching the ions used for quantification. But the simulant may react more with the sampling path than does the agent, leading to an ASTR that differs from the expected ASTR.

c. Briefly, a simulant must be usable in testing without damaging the test item or test assets. The cost, toxicity, odor, and environmental impact of the compound must be minimal. The compound must be readily available in the quantity needed for OT from several domestic vendors and not restricted by the Drug Enforcement Administration or listed on a Chemical Weapons Convention (CWC) schedule. The flash point of the compound must be high to reduce the risk of accidental ignition. The compound must survive exposure to air, heat, water, and light during storage and testing. However, the compound must also be easily and swiftly removable from test assets and the SUT by evaporation, photolysis, water, oxidizing agent, or basic or acidic solutions.

d. It must be possible to quantify test item performance detecting simulant and agent in order to form an ASTR. If a new simulant is selected, then laboratory methods for testing with that simulant need to be developed, verified and validated before the simulant is used in test programs and documented with uncertainty results IAW the International Organization for Standardization (ISO, Geneva, Switzerland) Standard 5725[20].

e. If different simulants are used in the laboratory, chamber, or field environment, then an ASTR must be established for each simulant. An ASTR must be developed for each agent-simulant pair.

f. If different subtests are performed, then an ASTR must be established for each subtest to allow for variations in parameters. For example, one subtest may use a vapor challenge and another subtest may use a liquid challenge.

g. The simulant must be selected to yield a usable ASTR:

(1) Mathematically, an ASTR may be defined between any paired agent and simulant results, no matter the difference in values. Practically, test item performance with agent and with simulant must be measured using the same instrumentation calibrated in the same range. Ideally, the simulant will perform similarly to agent (i.e., the ASTR should be close to 1).

(2) If the simulant is a good match for an agent, the ASTR will vary little with elapsed time or experimental conditions. Ideally, the ASTR will be a constant value.

(3) As far as can be estimated, the ASTR should not vary between the field and the laboratory or chamber. This is based on SME analysis to determine if factors are present in a field test that would invalidate an ASTR developed in a laboratory or chamber.

3.1.5 Final Preparations.

Stakeholders must review the data to be used for establishing an ASTR. The ASTR must not be calculated until the community has approved the input data, validation data, and proposed ASTR approach.

3.2 Quality Control and Quality Assurance.

a. QC and QA requirements to produce test data of the required quality may be found in the appropriate experimental TOP(s).

b. The testing organization may comply with ISO Standard 17025[4]. The following parts of ISO Standard 17025 are particularly important for tests leading to an ASTR:

(1) Part 5.3. Accommodation and Environmental Conditions.

(2) Part 5.4. Test and Calibration Methods and Method Validation.

(3) Part 5.5. Equipment.

(4) Part 5.6. Measurement Traceability.

(5) Part 5.7. Sampling.

(6) Part 5.8. Handling of Test and Calibration Items.

(7) Part 5.9. Assuring the Quality of Test and Calibration Results.

(8) Part 5.10. Reporting the Results.

c. A quality system covering these areas greatly increases confidence that results will meet DAG and DQO objectives.

d. Instrument calibration must be traceable to standards maintained by a reliable source, e.g., the National Institute of Standards and Technology (NIST, Gaithersburg, Maryland). Instruments must be operated by trained, certified operators IAW the instrument manufacturer's recommended operating parameters or approved laboratory SOPs.

e. Commercial, off-the-shelf (COTS) software packages are used to create tools such as spreadsheets, scripts, code, and macros. Any one of these tools can be used to calculate an ASTR.

(1) COTS software packages are considered to be validated when used for their intended purpose. The software name, developer, and version number must be stated in the

report. The following software packages*** are often used to process experimental data: Microsoft® Excel® (Microsoft®, Redmond, Washington), MATLAB® (MathWorks, Natick, Massachusetts), Origin (OriginLab Corporation, Northampton, Massachusetts), IGOR Pro (WaveMetrics, Inc., Portland, Oregon), LabVIEW™ (National Instruments, Austin, Texas), and SAS® (SAS Institute Inc., Cary, North Carolina).

(2) Any ASTR tool created using COTS software must be verified, validated, and documented IAW the approved procedures and QA plan of the facility that will perform the calculations. An ASTR tool to be used to generate repetitive results or produce output for multiple tests, customers, or regulatory bodies must be reviewed more thoroughly. Documentation for the ASTR tool must include its location, file name(s), revision number date and history, user instructions, input equations and parameters, steps of calculation, output parameters, sample input and output, verification and validation test case(s) and results, and references. Results from the ASTR tool must be reviewed to ensure the ASTR tool is producing mathematically valid results. The reviewer will run test cases provided and/or generate and run validation test cases. The ASTR tool must accept input values in the expected range. The tool must reject values that lie outside the expected range or are nonnumeric. Checking that the tool output corresponds with the reviewer's answer is considered validation of the tool. Graph data references within the ASTR tool should be checked. Tests and reports will reference the version and date of the ASTR tool used.

4. TEST PROCEDURES.

This TOP describes data processing and not the performance of a physical test so no test procedures are specified here. Procedures for data processing are described in Paragraph 6. Methods not documented in this TOP will be detailed in the test plan. Trials must be conducted IAW the test plan. Data will be analyzed IAW the data management plan (DMP). Data will be reviewed by the DAG or equivalent designated independent reviewers. Only data that have passed review may be used to establish an ASTR and support its validation.

5. DATA REQUIRED.

Data collection must be adequate for correlation with test data on the same or similar items obtained at different times or locations. The same data must be recorded for agent trials and for corresponding simulant trials using the same measurement units. Required data are test item identifier, test item history (including whether and how BFC was applied), challenge conditions, environmental conditions, SUT configuration, agent and simulant certificate of analysis (CoA), agent and simulant Chemical Abstracts Service® number, and test item performance data. An ASTR may be established from many different kinds of data. Therefore, no specific form to record test data is given in this TOP.

*** 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.

6. PRESENTATION AND PROCESSING OF DATA.

A general approach is presented here. Data management must be defined to deliver traceable data through the testing process. Results and interpretation must correspond to the test objectives and be presented in the final test report. Examples of ASTRs are presented in Appendix A.

a. Test reports must contain all the data necessary to demonstrate that the test item was challenged correctly. Test documents must state explicitly which measurement units and test items were used.

b. Precision and accuracy must be assessed IAW ISO Standard 5725[20].

c. The final test report for the test program must contain all the data necessary to evaluate the performance of the test item. However, the test report need not contain all data collected. Some types of data may be useful to the program manager (PM) or other members of the testing community without being necessary to the ASTR. Useful data may be compiled in the same way as necessary data.

d. Trial conditions will be reported. ASTR calculation requires agent and simulant purity with CoA, time of measurement, target and mean for temperature, humidity, challenge, time to achieve target challenge, and trial duration. Barometric pressure should be included for vapor challenges to allow calculation of the mass of agent presented to the test item. The amount of agent or simulant will be corrected for percentage purity. The ASTR will also be reported, together with the steps used to derive it. The SUT performance and ASTR may be reported in the same report or separately at the discretion of the test program.

e. Environmental and challenge conditions will be plotted showing the required tolerance for each parameter in the data package. Selected plots may be published in the report. Example tables and figures are given in Appendix A and in *TOP for Chemical Protection Testing of Sorbent-Based Air Purification Components* (APCs) (TOP 08-2-197[17]).

f. For each test item, performance data together with error messages or observations suggesting failure will be provided in the data package. Selected plots and tables will be included in the report. Data known to be invalid must be removed. It may then be appropriate to average the results from test items tested at the same conditions. If test substance lingers between trials and cannot readily be removed without compromising test item performance, test item performance data will be corrected mathematically to remove background concentrations. If a data correction is performed, the correction will be described, and both the corrected and uncorrected values will be presented in the report.

g. Test item performance data may be processed using a variety of methods (e.g., a median smooth or time-weighted average). Processing will be described, and both processed and unprocessed values will be presented in the report.

h. Test item performance data may be fitted to a known functional form. Interpolated data (also called fitted data) may be used instead of actual data to smooth out experimental

variability and because actual data are not available at all time points. An ASTR is a mathematical relationship between the functional form for agent and that for simulant. The functional form used is preferably based on understanding of SUT performance and agent properties, or it may be chosen arbitrarily to best fit the data. The function used must fit the data with a minimum R^2 of 0.9.

i. The ASTR between any two trials is defined and calculated IAW test requirements. The ASTR should be defined (normalized) so that an ASTR of 1 indicates perfect correlation. The ASTR may also be expressed as a continuous function of time and other experimental factors:

(1) The simplest ASTR is the ratio of test item performance with agent to that with simulant as shown in Equation 1.

$$\text{ASTR} = a/s \qquad \textit{Equation 1}$$

Where:

a = measured agent value

s = corresponding measured simulant value

Both *a* and *s* are collected at the same conditions and elapsed time. If the raw data set is a spectrum or an image, *a* and *s* could be individual values from the data set.

(2) A null result may occur (i.e., the test item may not respond to the test compound at all). If the test item does not respond to the agent, *a* = zero and the ASTR will be 0. If the test item does not respond to the simulant, *s* = zero and the ASTR will be undefined. Null results may be seen for tests of permeation through barrier materials or for decontamination testing. For example, if a well-designed and well-manufactured barrier material effectively excludes agent or simulant, an ASTR calculation may yield a null result. In such trials, either *a* or *s* is below the LCL and is poorly determined. With null results, it may be difficult to assess the results in such a way as to determine an ASTR.

(3) If the test item responds to the simulant in the same way it responds to the agent (e.g., complete permeation or decontamination), an ASTR of unity is established. However, it may be useful to repeat the trial with a reduced challenge so that a partial response is obtained, leading to a more informative ASTR.

(4) If the DOE includes matched pairs of trials, then an ASTR may be derived from a set of trials as a rank correlation coefficient (RCC)[21]. In this scenario, simulant trials are ranked by test item performance. A corresponding set of agent trials is also ranked by test item performance. The ASTR is the correlation coefficient between the two rankings.

(a) One RCC is the Kendall RCC (KRCC)[21]. If the agreement between the two rankings is perfect (i.e., the two rankings are the same) the KRCC = 1. If the disagreement between the two rankings is perfect (i.e., one ranking is the reverse of the other) the KRCC = -1.

(b) If the lists are independent, then the KRCC is approximately zero. To produce a range from 0 to 1, the ASTR may be defined as 0.5 × KRCC + 0.5.

(5) Other ASTR forms are covered in Appendix A.

j. An ASTR may be generalized over the range of experimental conditions that affect test item performance. An ASTR may be interpolated between conditions if the ASTR is approximately linear between conditions. An ASTR cannot be extrapolated beyond the range of conditions with any degree of significance. The ASTR may be plotted as a function of one experimental parameter. In general, the ASTR depends on many parameters (Figure 2). Only those parameters that are statistically significant at the 0.05 level of significance should be included.

k. Test item performance often changes with time during the trial, in a way that is usually different for agent and for simulant. The ASTR must be derived from agent and simulant performance data measured at similar times. The ASTR will usually depend on time. The ASTR may be expressed as a time series at time points corresponding to the original data. The ASTR may be obtained at intermediate time points by interpolation. For times before the first measurement and after the last measurement, the ASTR is undefined.

l. The required level of uncertainty will be specified by the test customer. The test must be designed to yield an uncertainty low enough to meet test and community needs. Combining simulant results with an ASTR to predict agent results will increase the uncertainty of predicted agent results. An ASTR is used because some tests cannot be performed with agent (Paragraph 1.1.d). Uncertainty in the ASTR must be evaluated and expressed IAW JCGM 100:2008[5]. The uncertainty is the parameter that characterizes the dispersion of values that could reasonably be attributed to the measured ASTR. The uncertainty consists of several components. The combined uncertainty (U_c) must be characterized by a numerical value. An example is provided in Appendix A, Paragraph 1.d.

m. The ASTR must be reviewed by the PM, evaluator, and authorities during VV&A (Paragraphs 1.1.f).

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APPENDIX A. EXAMPLE ASTRS FOR DIFFERENT CAPABILITY AREAS.

FIGURE LIST

APPENDIX A. EXAMPLE ASTRS FOR DIFFERENT CAPABILITY AREAS.

NOTE: The examples in this Appendix use notional data values that do not necessarily correspond to any real mission, SUT, or agent.

A.1. ASTR CONCEPTS FOR ALL CAPABILITY AREAS.

a. A test DQO may be used to deem two trials equivalent. For example, the DAG accepts a trial if the measured mean temperature is within ±1 °C of the target temperature. The target trial temperature is 15 °C for both a simulant and an agent trial. The measured mean trial temperature was 14.1 °C for the simulant trial and 15.6 °C for the agent trial. Both trials are accepted and deemed to be at similar conditions. The two trials may be compared for an ASTR.

b. Figure A.1 plots an ASTR as a function of time. Considering the error bars, the ASTR is <1 for all times before approximately 2 h. This means that before that time, more simulant than agent is needed to achieve similar results. After approximately 2 h there will be less simulant than agent.

c. Figure A.2 plots a notional performance curve for CWA and for two candidate simulants. Simulant 1 has similar performance to the CWA (ASTR close to 1 at all times). Simulant 2 has lower performance than CWA (ASTR >1).

d. The uncertainty must be calculated IAW JCGM 100:2008[5]. For example, the mean agent reading is 3.0. The mean simulant reading is 2.0. The ASTR is 3.0/2.0, or 1.5. Combining the variation of agent and simulant signals, the statistical (Type A) variance of the ASTR is 0.09. Considering all factors that affect the ASTR, an SME estimates the Type B variance to be 0.16. The combined variance is 0.09+0.16 or 0.25. The standard uncertainty is $\sqrt{}0.25$ or 0.5. The result should be expressed: "ASTR = 1.5 with combined uncertainty (U_C) = 0.5".

e. If the ASTR is presented as a mathematical expression, then the uncertainty must be given for each parameter in the expression. For example, "ASTR = B exp (-C/T), where B = 2.3×10^{-7} with $U_C = 6.0\times10^{-8}$, C = 5500 with U_C = 1000, and T is the absolute temperature in K".

APPENDIX A. EXAMPLE ASTRS FOR DIFFERENT CAPABILITY AREAS.

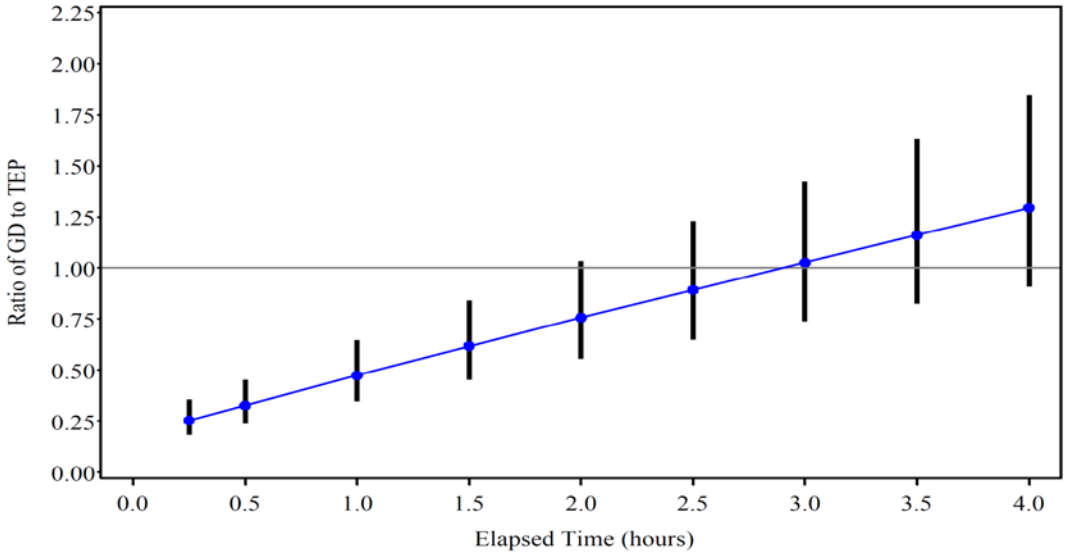

Figure A.1. An ASTR plotted against time with bars to show the standard error.

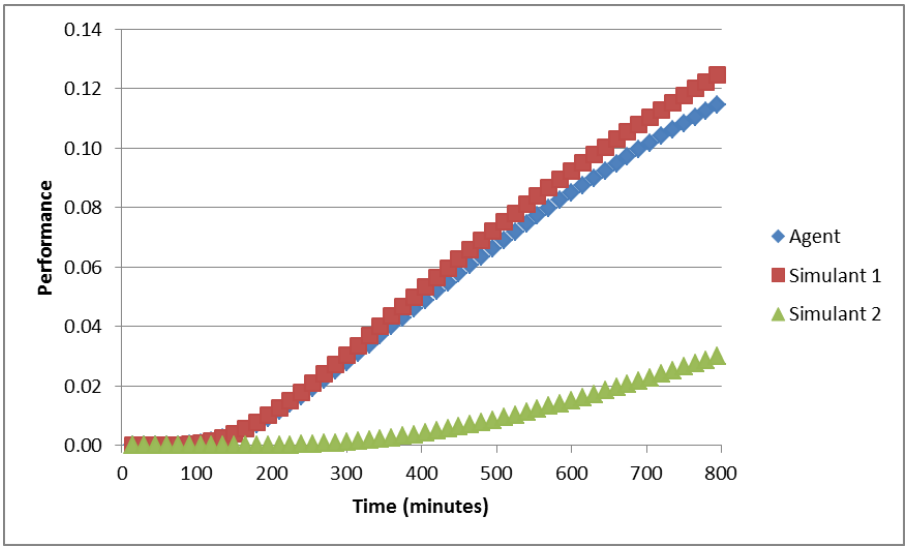

Figure A.2. Notional performance curve for CWA and for two candidate simulants.

APPENDIX A. EXAMPLE ASTRS FOR DIFFERENT CAPABILITY AREAS.

A.2. COLLECTIVE PROTECTION.

a. A CP SUT (a shelter) excludes CWAs from the interior space using barrier material. Fresh air enters the SUT through a filter that removes CWAs. The test item is either a shelter or a component that can be a swatch of fabric or a filter.

(1) In laboratory testing, a component is challenged with a flow of agent or simulant vapor. In chamber and field testing, an SUT is challenged with a flow of agent or simulant vapor. The performance of a CP SUT depends on the performance of each component. Challenge vapor concentration (VC) is measured upstream from the test item (shelter or component). Effluent VC is measured on the clean side of the test item.

(2) Fabric, filters, and other items are sealed by closures. Agent may permeate through a fabric or filter or penetrate through a closure. From an ASTR perspective, a closure is effectively a hole that admits as many agent molecules as simulant molecules. The hole is relatively large, so molecular size has no impact. The ASTR of a closure is 1 when the concentration is measured in units of molecules/volume, moles/volume (molar), or volume/volume (v/v). If SUT performance is limited by closure performance, the ASTR for the SUT will approach 1. The ASTR of a closure equals the ratio of molecular masses if concentration is expressed in units of mass per volume e.g., mg/m^3.

b. For a CP program, data were processed and an ASTR was determined as follows.

(1) In the laboratory, stable vapor challenge conditions were established and vapor was flowed through a filter. Effluent VC was measured every 5 minutes.

(2) Effluent VC measurements were processed by discarding invalid data, mathematically correcting valid data to subtract residual vapor background, and fitting the data to a rising exponential.

(3) The rising exponential was used to predict the effluent VC every 30 minutes.

(4) Challenge conditions were varied to complete all trials in the test matrix. The steps in paragraphs A.2.b(1) through (3) were repeated for every trial.

(5) All trial data were combined. For each 30-minute prediction, the natural logarithm of predicted effluent VC was fitted to a linear function of all experimental parameters: challenge VC, challenge flow rate, RH, and temperature. Other factors for CP testing are listed in Table 2. Statistical analysis determined that other experimental parameters did not significantly impact effluent VC. Therefore, effluent VC could be predicted for any condition and at any time within the range of the original tests. The ASTR was defined as the ratio of predicted effluent agent VC to predicted effluent simulant VC at the same conditions and time.

APPENDIX A. EXAMPLE ASTRS FOR DIFFERENT CAPABILITY AREAS.

(6) An analysis similar to the following was performed. Representative values are used for operational security.

(7) After a vapor challenge, the barrier material admitted two times more agent vapor than simulant vapor; its measured ASTR was 2.

(8) The filter material admitted as much agent vapor as simulant vapor; its measured ASTR was 1.

(9) A simulant trial of the SUT at the same conditions measured a VC of 0.0010 mg/m^3 inside the SUT.

(10) A mathematical model of airflow around and through the SUT considered the performance of filter and barrier material. The model predicted that the SUT would admit 20 percent more agent than simulant; the predicted SUT ASTR was 1.2.

(11) Based on a combination of experimental and model data, an agent trial would have produced a VC of 0.0012 mg/m^3 inside the SUT.

(12) A toxicological model showed a 0.98 probability that a Warfighter would experience no exposure effects at this agent VC during the simulated mission.

(13) The mission required six healthy Warfighters to be inside the SUT. Considering vapor exposure, the probability of mission success was 0.98 raised to the power of 6, which equals 0.89.

(14) The program TEMP[22] required a mission success probability of at least 0.8, so the SUT CWA vapor performance at these conditions was predicted to be acceptable. With a realistic estimate of uncertainty, the probability is uncertain; there is still some chance of mission failure.

A.3. CONTAMINATION AVOIDANCE.

a. Contamination avoidance deals with the testing of CWA detectors. A CWA detector is challenged with either agent or simulant. A detector uses sophisticated algorithms to detect, classify or identify, and quantify CWAs while discriminating against natural and manmade interferences. A detector transduces a chemical signal (amount of CWA) to a reading. The reading may be from a signal or the output of an algorithm. The simulant may be recognized either as the agent (which would be a false alarm) or as another nonagent compound. It may be necessary to modify the detector library and algorithm.

NOTE: It has been recommended that detectors be tested using a stimulator. A stimulator creates an alarm whenever sampled by a detector, and cannot

be used as a simulant for establishing an ASTR. One type of stimulator sends a signal to the alarm circuit, similar to the button on a smoke detector. Another type of stimulator is a compound that creates a false alarm.

b. Factors that affect detector performance are listed in Table 2. A more complete list of factors is provided in Principles of Instrumental Analysis[23]. Chemical point detector testing is further discussed in TOP 08-2-188 *Chemical Point Detection*[24]. Each factor that affects detector performance will influence an ASTR. The test plan must describe which of these factors will be measured and which will be controlled.

c. An ASTR may be defined as in Paragraph 6.i. In Equation 1, 'a' denotes the mean CWA reading during a trial and 's' denotes the mean simulant reading. For detectors, 'a' may be the Pd for CWA at given conditions and detector settings. The value of 's' is the Pd for simulant at the same conditions and detector settings. Another performance metric is the time to alarm. One more metric is the time to clear down (the time to stop alarming after the challenge is removed).

d. Military detectors are often configured to show a state of alarm or of no alarm. The state of alarm may be indicated by a sound, or a colored light, bars or an image on a display. An alarm may also be indicated by a transmission on a communications system. The Pd or other performance metric may be used for a detector that only provides an alarm instead of a reading. **NOTE**: The detector software determines whether to alarm by comparing a reading with a threshold value. The ASTR concept may be applied to the reading, which may be available during DT through an electronic interface provided by the vendor.

e. The Joint Services Lightweight Standoff Chemical Agent Detector (JSLSCAD) is a ruggedized standoff passive real-time infrared CWA vapor detector. Once it detects a CWA cloud, the JSLSCAD should generate an alert that indicates the CWA class, the azimuth to the cloud centroid, and the extent of the cloud. The challenge is defined by the parameters concentration pathlength (CL) and temperature difference (ΔT), where CL = the product of the mean VC and optical pathlength and ΔT = the temperature difference between the vapor cloud and the background against which the cloud is observed. Detector sensitivity increases with increasing CL and ΔT. The JSLSCAD algorithm uses a neural network.

(1) In chamber testing[9], simulant or agent was disseminated. For each compound, Pd was assessed at the 80 percent confidence level. ASTRs were established by comparing performance with simulant coefficients in the chamber to performance with agent coefficients in the chamber. Triethyl phosphate (TEP) was used as a simulant for sarin (GB). Acetic acid (AA) was used as a simulant for distilled mustard (HD). The ASTR established the CL value of the simulant that produced an equivalent Pd to the CL value of the agent at the same ΔT.

APPENDIX A. EXAMPLE ASTRS FOR DIFFERENT CAPABILITY AREAS.

(2) In outdoor testing, AA, TEP, and sulfur hexafluoride (SF_6) were disseminated and performance was determined. Data were gathered to derive a unified JSLSCAD performance model that described Pd as a function of multiple variables including compound (agent or simulant). The same coefficients were used to detect simulant in the field and chamber. A correlation was presented to the National Academy of Sciences[25]. Some issues were encountered in establishing an ASTR. It was unclear how to determine an ASTR in the presence of interferents such as water vapor. The BFC would interfere differently with the agent and with the simulant. For example, absorption band(s) of interferent might overlap with an absorption band of agent but not with the simulant band. Some interferents could not be produced at sufficient CL in chamber to emulate the CL expected in field. To address these questions, simulated spectra of agent or simulant were combined with interferent spectra and fed to the algorithm.

f. The Joint Chemical Agent Detector (JCAD) is a handheld point detector designed to detect, classify, and alarm for CWAs or TICs.

(1) Older JCAD increments used surface acoustic wave (SAW) technology. Eleven candidate simulants were reviewed for JCAD field testing[26]. Candidates were recommended. The SAW ASTR was estimated from the properties of the molecule and of the sensor. Experimental ASTR could not be derived because detector performance had not yet been measured.

(2) The current JCAD increment uses ion mobility spectrometry (IMS). A chamber test[7,27] was performed to determine the relationship between JCAD responses to CWAs or to simulants at representative threat concentrations. The test also quantified the amount of a CWA simulant necessary to replicate an expected CWA response during OT. The test determined a model to estimate detector performance in a nerve agent environment based on correlated data from a nerve simulant environment. The model was applicable to a range of testing conditions. The model included type of compound (agent or simulant) and therefore the ASTR was part of the model. A logistic model was used: $O = 1 / \{1 + \exp(-\Sigma f(X_i))\}$, where O is the output parameter, Σ denotes summation over the index i, f is a mathematical function, and X_i is a model input. Three different output parameters were modeled: time to alarm, Pd after a thirty-second challenge, and time to clear down. Some coefficients modeled the effect of temperature and water VC. Changing the value of a model coefficient predicted either simulant or agent performance. Comparing simulant and agent data at the same conditions allowed the ASTR to be determined. Testing showed that the JCAD serial number and the position in the test fixture were insignificant.

g. No ASTR has yet been developed for an aerosol or surface detector, but the same concepts apply.

APPENDIX A. EXAMPLE ASTRS FOR DIFFERENT CAPABILITY AREAS.

h. Detector performance is often characterized by a receiver operating characteristic curve (ROC). ROCs have been used to assess the performance of radar systems, medical tests, and detectors[28]. Many detectors express the amount of agent as a single number that is compared to a threshold. As the threshold is increased, true positives (correctly detecting agent that is truly present) become less frequent. False positives (false alarms) also become less frequent. A plot of true positive rate against false positive rate is a ROC curve. The threshold is chosen to meet operational requirements for acceptable true positive rate and false positive rate. Figure A.3[28] shows a ROC curve for a selective detector and for a poor detector that performs no better than random chance. The ROC curve may be summarized by a single metric, the area under curve (AUC). The AUC varies from 0.5 for a poor detector to 1 for an excellent detector. The AUC of a real detector will lie between 0.5 and 1. The AUC for agent is *a* and the AUC for simulant is *s*. To produce a range between 0 and 1, the ASTR may be defined as $2(a/s - 0.5) / 3$.

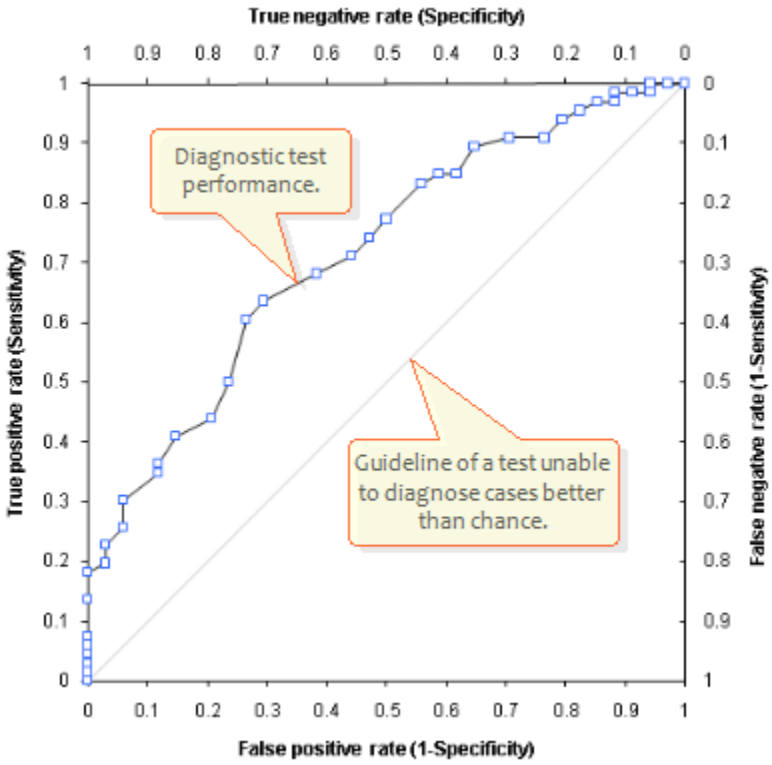

Figure A.3. Receiver operating characteristic (ROC) curves.

APPENDIX A. EXAMPLE ASTRS FOR DIFFERENT CAPABILITY AREAS.

A.4. INDIVIDUAL PROTECTION.

The strategy of the IP capability area is to qualify swatches of material and components by testing with agent. An IP system (a CB protective suit) made of qualified components is then fitted on a manikin and challenged with agent. Because an IP system can be tested with agent, it is not necessary to do simulant testing and to form an ASTR. Some ASTRs have been defined, but no current programs are known that plan to yield an ASTR. If SUT performance is limited by closure performance, the ASTR for the SUT will approach 1 [Paragraph A.2.a(2)]. The authors recommend that the IP capability area conduct more simulant testing at the component level so that ASTRs can be developed.

A.5. DECONTAMINATION.

a. One metric of decontamination is the percentage removal efficiency of chemical from a surface. For example, a decontamination procedure at certain conditions may remove 45 percent of agent or 88 percent of simulant from a coupon of material. The ASTR is 0.45 / 0.88, or 0.51.

(1) Factors affecting decontamination performance and thus ASTR are given in Table 2. A more complete discussion is found in ECBC-TR-980 Chemical Contaminant and Decontaminant Test Methodology Source Document[29] and in TOP 08-2-061A Chemical Decontaminant Testing[30]. The test plan must describe which of these factors will be measured and which controlled.

(2) For liquid-coated surfaces the ASTR should not be time-dependent as the volatility of the materials remains constant. For off-gassing of absorbed material the ASTR will be time-dependent as agent and simulant will off-gas at different rates.

b. The Stryker program performed a decontamination ASTR.

(1) The Stryker NBCRV PVT[15] contaminated the Stryker NBCRV with 10 g/m² of tripropyl phosphate (TPP) droplets. Decontamination was performed and then the residual contact hazard was measured.

(2) In the laboratory, a methodology study was performed[14]. Coupons of metal painted with chemical agent resistant coating (CARC) were contaminated with 10 g/m² of either TPP or persistent nerve agent (VX) droplets. One of three decontaminants was applied. Some coupons were contact-sampled with silicone rubber; the mass of compound solvent-extracted from silicone was measured. A VX-TPP ASTR was developed for CARC contact hazard.

(3) The contact hazard from a Stryker vehicle tested with TPP was combined with the decontamination ASTR to predict the contact hazard if a Stryker had been tested with VX.

APPENDIX A. EXAMPLE ASTRS FOR DIFFERENT CAPABILITY AREAS.

c. Coupons from a C-141 aircraft and C-17 composite material were contaminated with either TPP or VX[13]. Each coupon was contaminated with 5 g/m², weathered, subjected to a simulated flight, and decontaminated with hot soapy water (HSW) using Type IV soap. Aircraft type, compound, weathering time, and number of decontamination cycles were varied. For the purposes of video imaging, the TPP was dyed red, and droplet movement across the surface was videotaped during dissemination, weathering, and flight. Results were presented from which an ASTR could be derived as the ratio of agent to simulant reading. Each coupon was processed using either extraction or off-gassing.

(1) Extraction: after each decontamination cycle, part of the coupon was snapped off and extracted in solvent. The percentage of compound removed was determined.

(2) Off-gassing was measured as described in Appendix A, Section d(2)(b).

A.5.1 Radiological Decontamination.

a. Radiological decontamination testing is discussed in the Multinational Test Operating Procedure (MTOP) for Radiation Decontamination[31]. Decontamination is discussed in the CBRN Tactics, Techniques, and Procedures for Decontamination[32]. Radiological and nuclear concepts are discussed in the Defense Threat Reduction Agency (DTRA) effects manual (EM-1)[33]. EM-1 is an authoritative source reference document on nuclear weapons phenomenology and effects that is available to all branches of the United States government.

(1) The agent threat is residual radioisotope (radionuclide) from a radiological dispersion device or fallout from a nuclear weapon. Each radioisotope emits characteristic radiation (alpha, beta, gamma, or neutron) with a characteristic energy spectrum, measured in MeV. Radiation may affect civilian, military, and test personnel and hardware. Common units of measurement for activity include disintegrations per second (becquerel, Bq), disintegrations per minute (dpm), and nanocurie (nCi). Each radioisotope decays with a distinct half-life. Radioisotopes of most concern are ^{60}Co, ^{90}Sr, ^{131}I, ^{137}Cs, ^{192}Ir, and ^{241}Am with a half-life ranging from days to centuries. Most radioisotopes used in testing are created in a cyclotron reactor and sold commercially.

(2) A simulant radioisotope must be selected considering the following criteria. The contribution of each criterion to the ASTR must be considered. Cost and availability must be considered but do not directly affect the ASTR. The simulant must have a much shorter half-life than agent so that test waste does not pose a radiological hazard. ^{24}Na (half-life 0.63 days) simulates ^{137}Cs (half-life 30.1 years). Test results are corrected for the radioactive decay of the isotope during the trial. For example, if the activity halves during a decontamination trial, the reduction caused by decontamination must be separated from the reduction that would have occurred from decay. The decay correction will differ for simulant and for agent. The simulant must have a similar chemistry to the agent isotope. For example, ^{82}Sr (half-life 25 days) simulates ^{90}Sr (half-life 28.5 years) with identical chemistry. After decay correction, there will

be a 1:1 ratio between decontamination efficacy measured using ^{82}Sr or ^{90}Sr. Solid simulant and agent must have similar particle size distribution so that they are disseminated similarly and interact similarly with the test item. Liquid simulant and agent should have similar viscosity. The simulant must have a similar radiation type and energy to the agent isotope.

(3) Any factors that affect the behavior of sample or the measurement of radiation in test may affect simulant and agent differently and must be considered in the ASTR. Factors are listed in Table 2.

A.6. BIOLOGICAL MEASUREMENTS.

a. If agent is released outdoors, the measured bio threat at a given location and time may be expressed as particles per liter (ppL) of air, agent-containing particles per liter of air (ACPLA), or colony forming units (CFU) per liter of air. It is usually assumed that one CFU of simulant equals one CFU of agent. Knowing the mean particle mass, the bio threat concentration may be expressed as mg/m^3. It is important to recognize that ACPLA alone provides no information of particle size or composition and therefore cannot be linked to health hazard assessment. Bio concentration may be expressed by population of different size bins, for example from 1.0 to 2.0 μm aerodynamic diameter. Bio threat may be integrated over time to yield a concentration integrated over time (Ct) value. For evaluation within a well-mixed chamber, a concentration can be assumed homogeneous and therefore equal across all exposed surfaces. For outdoor testing, homogeneity is lost and a concentration location must be defined. For a biological point detector, concentration is usually defined at the point of collection.

b. Factors are listed in Table 2 and used as inputs to atmospherically model CBR releases, as in the JECP Threat Challenge Modeling report[34] and references therein. Models may be run using a design-of-experiment (DOE) approach for different input parameters. A distribution of input values leads to a distribution of possible results. The customer may choose to use a percentile (e.g., the 90th percentile) of possible results to estimate bio risk. Any factors that differ between agent and simulant trials must be considered in an ASTR.

c. Simulants may be selected to match several characteristics of the agent: viability, vegetative/spore status, species, genus, nucleic acid composition, genomic size, cell wall, ability to be disseminated by existing disseminators, detector response, particle diameter for infectivity and removal by filters, etc. Agents and simulants may contain residual growth media, salts, waste, and flowing additives. Simulant references include the West Desert Test Center (WDTC) 2012 Capabilities Report[35] and the Bioaerosol Testing Capabilities white paper[36]. A harmless simulant for each category of agent is described in the preceding references. Living pathogens are deactivated or killed by gamma irradiation. Deactivation is defined as a 6-log reduction in viability. For living pathogens, the term agent-like organism (ALO) denotes a material with properties similar to those of a corresponding biological warfare agent that presents a reduced risk of infection:

APPENDIX A. EXAMPLE ASTRS FOR DIFFERENT CAPABILITY AREAS.

(1) For small ribonucleic acid (RNA) virus agents, male specific bacteriophage type 2 (MS2) is used as a field simulant.

(2) For toxin agents that are proteins, simulants may be the toxins inactivated by formaldehyde, protein subunits, and other proteins such as ovalbumin.

(3) For bacterial agents, the following simulants may be used in decreasing order of resemblance to agent: inactivated agent, killed agent, a different natural strain of agent, a different species of the same genus, another bacterium of the same Gram type (positive or negative), or a mineral particle of similar size such as 2-µm diameter kaolin with 5 to 10 percent (by weight) of Cab-o-sil® (Cabot Corporation, Tuscola, Illinois) as a flowing additive.

A.7. SUPPORTING MEASUREMENTS.

An ASTR may be determined for relevant physical properties that guide testing but do not directly correspond to the performance of a test item. For example, DPG[37] measured the evaporation and contact transfer of thickened agents and simulants from surfaces. Two Journal of Chemical and Engineering Data articles[38,39] published physical properties of agents and simulants, from which an ASTR can be derived.

APPENDIX B. ABBREVIATIONS.

ΔP	differential pressure
ΔT	temperature difference
AA	acetic acid
ACPLA	agent-containing particles per liter of air
ALO	agent-like organism
APC	air purification components
APG	U.S. Army Aberdeen Proving Ground
APS	Air-Purification System
ASC	agent-simulant correlation
ASTR	agent-simulant technology relationship
ATEC	U.S. Army Test and Evaluation Command
AUC	area under curve
BFC	battlefield contaminant
Bq	becquerel
BSL	biosafety level
BWA	biological warfare agent
CA	contamination avoidance
CARC	Chemical Agent Resistant Coating
CASARM	Chemical Agent Standard Analytical Reference Material
CBR	chemical, biological, and radiological
CDD	capability development document
CFU	colony forming unit
CHP	chemical hygiene plan
CL	product of mean vapor concentration and optical path length

APPENDIX B. ABBREVIATIONS.

CoA	certificate of analysis
COTS	commercial off the shelf
CP	collective protection
CPD	capability production document
Ct	concentration integrated over time
CWA	Chemical Test Division
CWC	chemical warfare agent
DAG	Data Authentication Group
Decon	decontamination
DMP	data management plan
DOD	Department of Defense
DOE	design of experiment
dpm	disintegrations per minute
DQO	data quality objective
DT	developmental testing
DT&E	Developmental Test and Evaluation
DTIC	Defense Technical Information Center
DTP	detailed test plan
DTRA	Defense Threat Reduction Agency
ECU	environmental control unit
EDP	event design plan
GB	sarin
HD	distilled mustard
HPLC	high-performance liquid chromatography

APPENDIX B. ABBREVIATIONS.

HRR	human research review
HSW	hot soapy water
IAW	in accordance with
IMS	ion mobility spectrometry
IP	individual protection
ISO	International Organization for Standardization
JCAD	Joint Chemical Agent Detector
JCGM	Joint Committee for Guides in Metrology
JECP	Joint Expeditionary Collective Protection
JSLSCAD	Joint Services Lightweight Standoff Chemical Agent Detector
JSTO	Joint Science and Technology Office
KPP	key performance parameter
KRCC	Kendall rank correlation coefficient
LCL	lower calibration limit
LLOQ	lower limit of quantification
M&S	modeling and simulation
MIST	Man-in-Simulant Testing
molar	moles/volume
MS2	male specific bacteriophage type 2
MTOP	Multinational Test Operating Procedure
NBCRV	Nuclear, Biological, and Chemical Reconnaissance Vehicle
nCi	nanocurie
NIST	National Institute of Standards and Technology
OT	operational testing

APPENDIX B. ABBREVIATIONS.

OTA	operational test agency
Pd	probability of detection
PM	program manager
PPE	personal protective equipment
ppL	particles per liter
PQT	production qualification test
PVT	production verification test
QA	quality assurance
QC	quality control
RCC	rank correlation coefficient
RH	relative humidity
RNA	ribonucleic acid
ROC	receiver operating characteristic
SAR	safety assessment report
SAW	surface acoustic wave
SDS	safety data sheet
SEP	system evaluation plan
SF_6	sulfur hexafluoride
SME	subject matter expert
SOP	standing operating procedure
SPM	system performance model
SPS	system performance specification
SSP	system support package
SSPL	system support package list

APPENDIX B. ABBREVIATIONS.

SUT	system under test
TECMIPT	Test and Evaluation Capabilities and Methodologies Integrated Process Team
TEMP	test and evaluation master plan
TEP	triethyl phosphate
TIB	toxic industrial biologic
TIC	toxic industrial chemical
TIM	toxic industrial material
TOP	Test Operations Procedure
TPP	tripropyl phosphate
TTP	tactics, techniques, and procedures
U_C	combined uncertainty
UCL	upper calibration limit
ULOQ	upper limit of quantification
US	United States
V&V	verification and validation
v/v	volume/volume
VC	vapor concentration
VV&A	verification, validation, and accreditation
VX	persistent nerve agent
WDTC	West Desert Test Center
WVC	water vapor content

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APPENDIX D. APPROVAL AUTHORITY.

CAPABILITY AREA PROCESS ACTION TEAM (CAPAT) ENDORSEMENT

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY UNDER SECRETARY OF THE ARMY
102 ARMY PENTAGON
WASHINGTON, DC 20310-0102

MEMORANDUM FOR

Chemical, Biological, Radiological and Nuclear Defense Test and Evaluation Executive, Office of the Deputy Under Secretary of the Army, Taylor Building, Suite 8070, 2530 Crystal Drive, Arlington, VA 22202

SUBJECT: Recommendation for Test and Evaluation Capabilities and Methodologies Integrated Product Team (TECMIPT) Test Operations Procedure (TTOP) 08-2-140 to Establish an Agent-Simulant Technology Relationship (ASTR)

1. The Collective Protection Capability Area Process Action Team (CAPAT) has completed its review of the subject TTOP in accordance with the Chemical and Biological Program Test and Evaluation Process, 5 November 2014. All signatory members of the CAPAT have provided their concurrences to the TTOP (enclosed).

2. Based on the concurrence of the CAPAT, I recommend the CBRN Defense T&E Executive endorse this TTOP as a Department of Defense Test and Evaluation Standard.

OBRIEN.SEAN.P.1230553501
Digitally signed by OBRIEN.SEAN.P.1230553501
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=OBRIEN.SEAN.P.1230553501
Date: 2017.03.30 08:31:39 -04'00'

Encl

SEAN P. O'BRIEN
TECMIPT Chair

APPENDIX D. APPROVAL AUTHORITY.

CAPABILITY AREA PROCESS ACTION TEAM (CAPAT) ENDORSEMENT

TECMIPT Test Operations Procedure (TOP) to Establish an Agent-Simulant Technology Relationship (ASTR) 08-2-140

Multi-Capability Area Process Action Teams (CAPATs):

Darren Jolley, U.S. Army Dugway Proving Ground (DPG)

CAPAT Review & Concurrence: January 2017

Test and Evaluation Capabilities and Methodologies Integrated Process Team (TECMIPT) Participants:

DISTRIBUTION A. Approved for public release: distribution unlimited.

REFERENCES:
(a) *Chemical and Biological Defense Program (CBDP) Test and Evaluation (T&E) Standards Development Plan*, dated 19 July 2010.
(b) *Memorandum of Understanding (MOU) Among the Department of National Defence of Canada the Secretary of State for Defense of the United Kingdom of Great Britain and Northern Ireland and the Secretary of Defense on Behalf of the Department of Defense of the United State of America concerning the Research, Development and Acquisition of Chemical, Biological and Radiological Defense Materiel*, dated June 2000. Amendment One, dated August 2006.

APPENDIX D. APPROVAL AUTHORITY.

CAPABILITY AREA PROCESS ACTION TEAM (CAPAT) ENDORSEMENT

TECMIPT Test Operations Procedure (TOP) to Establish an Agent-Simulant Technology Relationship (ASTR) 08-2-140 Concurrence Sheet

The Collective Protection CAPAT recommends approval of the TECMIPT Test Operations Procedure (TOP) to Establish an Agent-Simulant Technology Relationship (ASR) 08-2-140. If a representative non-concurs, a dissenting position paper will be attached.

Organization	Signature	Date
Deputy Under Secretary of the Army Test and Evaluation (DUSA-TE)	OBRIEN.SEAN.P.1230553501 Digitally signed by OBRIEN.SEAN.P.1230553501 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=OBRIEN.SEAN.P.1230553501 Date: 2016.0627 10:32:?7 -04'00' Sean P. O'Brien	
Joint Program Executive Office of Chemical Biological Defense (JPEO-CBD) Test & Evaluation	GRAHAM.GORDON.LEE.1056545677 Gordon L. Graham	3 March 2017
Joint Requirements Office for Chemical, Biological, Radiological and Nuclear Defense (JRO-CBRND)	Lt. Col. Christopher J. Leonard,	3 MAR 2017
Joint Science and Technology Office (JSTO)	Digitally signed by ROBERTS.MICHAEL.A.1228803371 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=DTRA, cn=ROBERTS.MICHAEL.A.1228803371 Date: 2017.02.08 12:37:21 -05'00' Michael A. Roberts	02-08-2017
US Army Evaluation Center (AEC)	BUCK.SEAN.K.1263975754 Sean K. Buck	
Operational Test and Evaluation Force (OPTEVFOR)	Jeffrey L. Bobrow	7 FEB
Air Force Operational Test and Evaluation Center (AFOTEC)	for Col Matthew Magness, USAF	13 Oct 16
Marine Corps Operational Test & Evaluation Activity (MCOTEA)	LtCol J. E. Smith, USMC	
Naval Surface Warfare Center Dahlgren Division (NSWC-DD)	Linda Beck	28 Feb 17
Edgewood Chemical Biological Center	Eugene Vickers	28 Feb 17
ColPro CAPAT Co-Chair	JOLLEY.DARREN.MANNING.1157816469 Darren Jolley	
ColPro CAPAT Co-Chair	Robert Snodgrass	21 Nov 16

APPENDIX D. APPROVAL AUTHORITY.

CBRN DEFENSE T&E EXECUTIVE ENDORSEMENT

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY UNDER SECRETARY OF THE ARMY
102 ARMY PENTAGON
WASHINGTON, DC 20310-0102

DUSA-TE

MEMORANDUM FOR DISTRIBUTION

SUBJECT: Endorsement of Test and Evaluation Capabilities and Methodologies Integrated Process Team (TECMIPT) Test Operations Procedure (TTOP) 08-2-140 to Establish an Agent-Simulant Technology Relationship (ASR)

1. Reference: Memorandum, DUSA-TE, 04 November 14, subject: Chemical and Biological Defense Program (CBDP) Test and Evaluation (T&E) Standards Development Plan.

2. The Collective Protection (ColPro) Capability Area Process Action Team (CAPAT) developed, coordinated and approved TTOP 08-2-140 in accordance with the reference.

3. I endorse this TTOP as a DoD T&E Standard for chemical defense in the areas of Collective Protection, Individual Protection, Decontamination, and Contamination Avoidance and encourage its broad use across all test phases. All T&E Standards are for government associated program access and use. You can access DoD T&E Standards via the following links: Army Knowledge Online (AKO), (https://www.us.army.mil/suite/files/22142943), and the TECMIPT site (http://www.amsaa.army.mil/TECMIPT/Standards.html).

4. My point of contact for this action is Ms. Deborah Shuping, (703) 545-1119, deborah.f.shuping.civ@mail.mil.

JIMENEZ.DAVID.1228753455
Digitally signed by JIMENEZ.DAVID.1228753455
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=JIMENEZ.DAVID.1228753455
Date: 2017.04.11 14:15:40 -04'00'

Encl

DAVID JIMENEZ
CBRN Defense T&E Executive

APPENDIX D. APPROVAL AUTHORITY.

CSTE-TM 14 April 2017

MEMORANDUM FOR

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

SUBJECT: Test Operations Procedure (TOP) 08-2-140 Establish an Agent-Simulant Technology Relationship (ASTR), Approved for Publication

1. TOP 08-2-140 Establish an Agent-Simulant Technology Relationship (ASTR), has been reviewed by the U.S. Army Test and Evaluation Command (ATEC), the Test and Evaluation Capabilities and Methodologies Integrated Process Team, and the Capability Area Process Action Team. 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 identifies steps to determine a traceable, quantifiable, and defensible ASTR during testing of components and systems in realistic and operationally relevant scenarios. An ASTR is a quantified relationship between a measurement collected with agent and the same measurement collected with simulant at the same conditions. This TOP addresses chemical, biological, and radiological defense, and is tailored to the needs of specific tests where testing with simulants is required.

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), 2202 Aberdeen Boulevard-Third Floor, Aberdeen Proving Ground, MD 21005-5001; or e-mailed to usarmy.apg.atec.mbx.atec-standards@mail.mil.

HUBNER.MICHAEL.WINFRIED.1042880147

MICHAEL W. HUBNER
Associate Director, Test Management Directorate (G9)

FOR

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

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Forward comments, recommended changes, or any pertinent data, which may be of use in improving this publication to the Policy and Standardization Division (CSTE-TM), U.S. Army Test and Evaluation Command, 2202 Aberdeen Boulevard, Aberdeen Proving Ground, Maryland 21005-5055. Technical information may be obtained from the preparing activity: Commander, West Desert Test Center, U.S. Army Dugway Proving Ground, ATTN: TEDT-DPW, Dugway, UT 84022-5000. Additional copies can be requested through the following website: http://www.atec.army.mil/publications/topsindex.aspx, 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.