

Audit



Report

M41 PROTECTION ASSESSMENT TEST SYSTEM CAPABILITIES

Report No. 99-061

December 24, 1998

Office of the Inspector General
Department of Defense

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Acronyms

CBDCOM	U.S. Army Chemical and Biological Defense Command
CS	O-chlorobenzylidene malononitrile
JSMTWG	Joint Service Mask Technical Working Group
NBC	Nuclear, Biological, and Chemical
PATS	Protection Assessment Test System
PMCS	Preventive Maintenance Checks and Services
TMDE	Test, Measurement, and Diagnostic Equipment



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December 24, 1998

MEMORANDUM FOR DEPUTY ASSISTANT TO THE SECRETARY OF
DEFENSE (NUCLEAR AND CHEMICAL AND
BIOLOGICAL DEFENSE PROGRAMS)
(COUNTERPROLIFERATION/CHEMICAL AND
BIOLOGICAL DEFENSE)
AUDITOR GENERAL, DEPARTMENT OF THE ARMY

SUBJECT: Audit Report on the M41 Protection Assessment Test System Capabilities
(Report No. 99-061)

We are providing this report for review and comment. We considered management comments on a draft of this report in preparing the final report.

DoD Directive 7650.3 requires that all recommendations be resolved promptly. As a result of management comments, we revised draft Recommendations A.1., B.2., and C.1. We deleted draft Recommendation B.1.c. and added Recommendation C.2. to the final report. Recommendations B.1., C.1.a., C.2., D.1., and D.2. remain unresolved. We request that the Deputy Assistant to the Secretary of Defense (Nuclear and Chemical and Biological Defense Programs)(Counterproliferation/Chemical and Biological Defense) provide additional comments on Recommendation B.1 and provide planned corrective actions and a completion date for Recommendations A.1., A.2., A.3., and B.2. We request that the Commander, U.S. Army Chemical and Biological Defense Command provide additional comments on Recommendations C.1.a. and D.2. We request that the Commandant, Army Chemical Center and School provide additional comments on Recommendation D.1. We request that the Chief, Chemical and NBC Defense Division, Office of the Deputy Chief of Staff for Operations and Plans, Department of the Army comment on Recommendation C.2. We request that additional comments on all recommendations be provided by February 24, 1999.

We appreciate the courtesies extended to the audit staff. For additional information on this report, please contact Mr. Robert K. West at (703) 604-8983 (DSN 664-8983), email <rwest@dodig.osd.mil>, or Ms. Eleanor A. Wills at (703) 602-1613 (DSN 332-1613), email <ewills@dodig.osd.mil>. See Appendix E for the report distribution. The audit team members are listed inside the back cover.

A handwritten signature in black ink that reads "Robert J. Lieberman".

Robert J. Lieberman
Assistant Inspector General
for Auditing

→

Office of the Inspector General, DoD

Report No. 99-061
(Project No. 7AD-0060)

December 24, 1998

M41 Protection Assessment Test System Capabilities

Executive Summary

Introduction. The M41 Protection Assessment Test System is a portable instrument designed for face-fit-testing nuclear, biological, and chemical protective masks. The Army has procured 5,954 M41 Protection Assessment Test Systems for the Army, Navy, Air Force, Marine Corps, and surety sites. The Army has fielded 2,255 M41 Protection Assessment Test Systems. The Air Force and Marine Corps have purchased and fielded the M41 Protection Assessment Test System with limited use.

Audit Objectives. The audit objective was to evaluate the capabilities and limitations of the M41 Protection Assessment Test System and its intended use as the combat-readiness tester of chemical protective masks.

Audit Results. Management and employment of the M41 Protection Assessment Test System within the DoD need to be improved.

- The Joint Service Mask Technical Working Group may have overstated the capabilities of the M41 Protection Assessment Test System fit tester by contending that it is a combat-readiness tester. The M41 tester does not test to operational conditions and other limitations have not been fully considered. (Finding A).
- The Joint Service Materiel Group has not finalized fit-factor criteria for the M41 Protection Assessment Test System. There is risk that the fit-factor criteria currently used by the Army are insufficiently rigorous (Finding B).
- The M41 Protection Assessment Test System fit testers are not being returned for calibration in a timely manner. As a result, many of the M41 Protection Assessment Test Systems returned for calibration are out of tolerance; therefore, their fit factors may be imprecise (Finding C).
- More effort is needed to ensure that the Services' Nuclear, Biological, and Chemical commissioned officers and noncommissioned officers receive the necessary training to operate the M41 Protection Assessment Test System. Many of the M41 Protection Assessment Test Systems are sitting on shelves and not being used, which could mean the "soldier-mask" fit may be questionable (Finding D).

Summary of Recommendations. We recommend:

- operational testing using the M40 chemical masks and the M41 Protection Assessment Test System and changing M41 Protection Assessment Test System policy if the test results so warrant;
- updating the "Protective Mask Requirements Analysis Methodology," September 29, 1986, and validating or changing the current fit factor criteria;
- establishing procedures to ensure that all M41 Protection Assessment Test Systems are turned in as required and authorizing the purchase of additional M41 Protection Assessment Test Systems to be used as floats; and
- revising the M41 Protection Assessment Test System program of instruction to ensure that each operator has adequate hands-on experience; developing a training certification program for M41 Protection Assessment Test System operators; and establishing a requirement for the M41 Protection Assessment Test System to display a pass or fail after each exercise.

Management Comments. The Deputy Assistant to the Secretary of Defense (Nuclear and Chemical and Biological Defense Programs)(Counterproliferation/Chemical and Biological Defense) suggested rewording and redirecting several recommendations, but otherwise concurred with the findings and recommendations. The Commander, U.S. Army Chemical and Biological Defense Command nonconcurred with several recommendations. He stated that calibration turn-in procedures initiated in October 1997 have shown dramatic increases in the return of M41 Protection Assessment Test Systems, that a certification program would produce a logistical burden, and that the M41 Protection Assessment Test System should not be programmed to display an actual fit-factor number and pass or fail reading after each exercise. The Commandant, Army Chemical Center and School suggested rewording one recommendation. See Part I for the complete discussion of management comments and Part III for the complete text of management comments.

Audit Response. Comments from the Deputy Assistant to the Secretary of Defense (Nuclear and Chemical and Biological Defense Programs)(Counterproliferation/Chemical and Biological Defense) were responsive. Comments from the Army were mostly nonresponsive to the recommendations. As a result of comments received, we modified some recommendations and made other technical changes. We request additional management comments by February 24, 1999.

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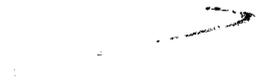
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Part I - Audit Results



Audit Background

Description of M41 PATS. The M41 Protection Assessment Test System (PATS) is a portable instrument designed for face-fit-testing nuclear, biological, and chemical protective masks. The M41 PATS is the military version of a commercial device (PortaCount Plus) with the addition of an accessory kit, supplies, and a carrying case.

History. In 1984, a concept development program was awarded to TSI, Inc., to design, develop, and fabricate a portable instrument that could quantitatively measure and verify mask fit. The advancement to full-scale development was suspended due to funding shortfalls. Before November 1994, the M41 PATS was called the Protective Mask Fit Validation System. In early 1989, the Protective Mask Fit Validation System was transitioned to full-scale development through a non-developmental item program and, in November 1990, was Type Classified Limited Production-Urgent with Department of Army authorization to procure the device in support of Operation Desert Shield/Storm.

Contract Summary. In December 1990, the Army awarded a letter contract to TSI, Inc., St. Paul, Minnesota, for the accelerated procurement of 120 commercial versions of the XM41 Protective Mask Fit Validation System. After the initial procurement, TSI, Inc., made further improvements and developed a militarized version. The Army has procured 5,954 M41 PATS for the Army, Navy, Air Force, Marine Corps, and surety sites. The Army has fielded 2,255 M41 PATS. The Air Force and Marine Corps have purchased and fielded their M41 PATS with limited use. The Army issues two per battalion and one per separate company, Air Force plans to issue two per base, and the Marine Corps will field down to the battalion or selective squadron level. See Appendix B for details.

Origin of Audit. We conducted the audit of the M41 PATS because of concerns raised during the Inspector General, DoD, audit of Defense Hotline allegations about fielding the chemical protective masks. The Inspector General, DoD SECRET Report No. 95-021, "Defense Hotline Allegations Regarding DoD Fielding of Chemical Protective Masks," November 2, 1994, recommended that the Commandant, Army Chemical Center and School, establish and document approved standards and criteria to test the serviceability of fielded assets. The Army nonconcurred with the finding and stated that it was confident that the M41 Protection Assessment Test System could be used to test both the fit and the integrity of the soldier-mask system and that the Army would use that system to assess mask readiness. Our response to management comments was that the M41 PATS was designed as a fit tester and that

battlefield protection would be best assured by conducting Preventive Maintenance Checks and Services (PMCS)¹, testing the serviceability of the mask, and testing the soldier for proper mask fit.

The Office of the Assistant Secretary of Defense for Chemical and Biological Matters and the Assistant Inspector General for Auditing signed an agreement in June 1995 on an approach to focus additional technical expertise and management emphasis on the issues raised in Report No. 95-021. The Office of the Assistant Secretary of Defense for Chemical and Biological Matters tasked the Joint Service Materiel Group to form a working group to address readiness of fielded protective masks. The Joint Service Mask Technical Working Group (JSMTWG) was directed to “establish criteria for evaluating fielded protective masks, identify equipment to be used in such an evaluation, and determine the statistical level required for an evaluation.” The JSMTWG was composed of representatives of the Office of the Secretary of Defense, the Army, the Navy, the Air Force, and the Marine Corps. The JSMTWG report is discussed under Finding A.

In our opinion, despite the commendable efforts of the JSMTWG, the capabilities of the M41 PATS remained an open issue. As a result, we initiated this audit to help clarify the M41 PATS capabilities.

Audit Objective

The audit objective was to evaluate the capabilities and limitations of the M41 PATS and its intended use as the tester for combat readiness of chemical protective masks. See Appendix A for the coverage of audit scope and methodology and a summary of prior audit coverage.

¹Preventive Maintenance Checks and Services (PMCS) of the protective mask is an integral step that must be accomplished before performing the M41 PATS fit test. Without adequate PMCS, the protective mask would not pass the M41 PATS fit test.

Finding A. Capabilities of the M41 Protection Assessment Test System

The Joint Service Mask Technical Working Group may have overstated the capabilities of the M41 PATS fit tester by contending that it is a combat-readiness tester. The M41 PATS does not test to operational conditions and the JSMTWG did not fully consider other limitations of the M41 PATS. As a result, personnel may be inadequately protected in a chemical or biological environment.

M41 Operating Manual

The Department of the Army Operator's Manual for the M41 PATS, January 1996, describes the M41 PATS as a fit tester. The manual states that, "The fit tester is a portable instrument designed for face-fit-testing of nuclear, biological, and chemical (NBC) protective masks by testing the soldier in a sitting or standing position during a mask fit test." The manual states that, "The measurement provided by this instrument is an assessment of mask fit during a fit test only. Mask fit at other times will vary. The fit-factor value is not intended for use in calculating an individual's actual exposure to hazardous substances."

Army Position

In response to Inspector General, DoD, Report No. 95-021, "Defense Hotline Allegations Regarding Fielding of Chemical Protective Masks," the Army stated that if a soldier has performed PMCS on the protective mask and received a good mask fit with the M41 PATS fit test, it was confident that the soldier would be combat ready.

Designation of the M41 as the Combat Readiness Tester

As a result of mediation efforts on Inspector General, DoD, Report 95-021, the Office of the Secretary of Defense formed the JSMTWG to establish the criteria to evaluate fielded protective masks, identify equipment to be used in such an evaluation, and determine the statistical level required for an evaluation. On November 1, 1995, the JSMTWG published a summary report entitled, "Mask Criteria Analysis and Test Requirements," which stated that the M41 PATS was appropriate for testing the combat readiness of negative pressure masks (M40 and MCU2/P) and that the M14, M4A1, Q204, and Q179 were appropriate production acceptance testers for wholesale and retail surveillance. The summary report states that PMCS and a good mask fit with the M41 PATS are sufficient to verify combat readiness. The report also defines the readiness

Finding A. Capabilities of the M41 PATS Protection Assessment Test System

criterion for protective masks as the level of protection needed to meet battlefield requirements, which can be determined only through combat assessments that analyze the threat, probability of attack, and casualty assessments.

Operational Readiness Conditions

The JSMTWG overstated the capabilities of the M41 PATS by contending that it is a combat-readiness tester. The M41 PATS is intended to provide a quick and easy quantitative assessment of the fit of a protective mask, but the Army, as the Executive Agent for chemical and biological defense programs, is using the M41 PATS fit tester to determine whether a soldier is combat ready, even though it does not test to operational readiness conditions and the rigors of the battlefield.

M41 PATS Mask Fit Test. During the M41 PATS fit test, the protective mask is attached to the M41 PATS at the drink tube and the soldier performs the following five exercises while sitting or standing: normal breathing, deep breathing, side-to-side head movement, up-and-down head movement, and circular jaw movement. The fit factor while the soldier is performing those five exercises would be different from the fit factor when the soldier is under battlefield conditions. Under battlefield conditions, the fit factor will change based on heavy breathing and exaggerated movements. Situations such as hitting the ground under fire and sharp movements are unavoidable during battlefield situations. Exaggerated, extreme, or jerky movements increase the risk of compromising protection by momentarily breaking the seal between the mask and face. The Operational Requirements Document, Appendix A "Rationale," February 26, 1992, states that the higher the fit-factor reading, the better the fit. Because the soldier is sitting or standing during an M41 fit test, the soldier may obtain a higher fit factor than he would on the battlefield. A lower fit factor may not be sufficient for battlefield conditions.



M41 PATS and M40 Chemical Protective Mask

Finding A. Capabilities of the M41 PATS Protection Assessment Test System

Air Force Test. Although a limited sample size was used, the results of an Air Force Air Warfare Center study conducted during March and April 1992 supports the position that the M41 PATS does not test to operational conditions. During the Desert Storm deployment, operational commanders were concerned that the protective masks were not fitted to provide the necessary protection level should the Iraqi forces initiate a chemical attack. The Commanders' concerns increased because they could not positively determine how much protection the masks provided. In January 1992, a meeting of the Joint Panel on Chemical and Biological Defense, Aeronautical Systems Division, requested that the Air Warfare Center, Eglin Air Force Base, Florida, design and accomplish a "Quick-Look Study" on the usefulness of a M41 PATS mask fit test device.

Although not an original test objective, the test team performed a test that compared the protection factor results of someone who was sitting to the protection factor results of someone who was lifting, bending, and twisting. The results showed that of the 34 civil engineering personnel who participated in the M41 PATS fit test exercises, 23.5 percent met the protection factor criterion while sitting but failed while working.

Other Limitations of the M41 PATS

Several other M41 PATS issues also call into question its value as a combat-readiness tester. The issues of concern relate to the M41 testing criteria, the location of the probe, the extent of sampling of air particles in the mask, and the way in which the M41 PATS is programmed to display test results.

M41 PATS Interim Criterion. As of May 1998, the Services still had not agreed on standardized fit-factor criteria for the fielded protective mask, despite the recommendations in Inspector General, DoD, Report No. 95-021, and the direction to the Joint Service Materiel Group to form a working group to develop such criteria. As a result, the Services agreed to an interim minimum fit factor of 1,667.

Army. The Army uses a fit factor of 1,667 for fielded use and 3,000 for surety sites and the Chemical Defense Training Facility.

Marine Corps. Until recently, the Marine Corps set the pass or fail criterion at 6,667 for fielded masks, but changed it to 3,000 to be consistent with surety sites and the Chemical Defense Training Facility.

Air Force. The Air Force used a fit factor of 2,000 during a Pacific Air Forces pilot program from March 15, 1998, through September 30, 1998. The Air Force plans to continue using a minimum fit factor of 2,000, but will also use the M41 PATS as a training aide to achieve the highest fit factor possible.

Navy. The Navy has not purchased the M41 PATS for fielding; therefore, no doctrine has been developed.

Finding A. Capabilities of the M41 PATS Protection Assessment Test System

These differences indicate uncertainty about the minimum fit-factor requirements. Therefore, we are concerned that the Services are willing to accept a minimum fit-factor criterion of 1,667 in determining whether a soldier is combat ready.

In Fit Testing of Respiratory Facepieces, published by Respiratory Support Services, April 1990, a respiratory consultant stated that establishing fit-factor acceptance criteria at or slightly above the assigned protection factor reflects a poor understanding of how fit test results differ under test conditions. During mask fit testing, soldiers are not breathing as heavily or moving as much as they would be in an operational environment. The fit obtained under these artificial conditions is likely to be the optimum and not truly representative of the fit experienced in other conditions. The study states that an artificial margin of error must be factored in because testing is done under unrealistic conditions that often do not exist in operational conditions.

Probe Location. The probe is a small plastic tube that is attached inside the mask at the drink tube. It is used to collect air particles inside the mask for sampling. The probe may not provide an adequate sample or detect air leakage because it is located in the eye region as opposed to the mouth-nose region. If the probe is located in the mouth-nose region, the sample will provide a more accurate detection of chemicals. If the probe is located in the eye region, the bulk of the airflow is coming through the canister representing outside air and any leakage from the nose-cup area could go unnoticed. For those reasons, the contractor and the industry recommend sampling at the mouth-nose region. Furthermore, a representative of the National Institute of Occupational Health and Safety stated that the contaminant may not be found if the probe is located in the wrong place. The Air Force is currently conducting an M41 PATS pilot test program at Headquarters, Pacific Air Forces; the sample is taken directly from the drink tube rather than from the sample tube extension by the eye region.

During the M41 PATS test, the Army positions the probe in the eye region rather than the mouth-nose region. The operating manuals for industry suggest that the probe should be in the mouth-nose location. However, a Department of the Army memorandum, March 11, 1998, to Army, Air Force, and Marine Corps organizations indicated that the sample probe will no longer be used for sampling particles inside the mask. Instead, the air sample will be taken directly from the drink tube.

Displaying Test Results. Another limitation of the M41 PATS as a combat-readiness tester is in how the test results are programmed to be displayed on the M41 tests. The Army programmed the M41 PATS to display an overall pass or fail based on an average of the five exercises, rather than to display the actual fit factor number and pass or fail readings after each exercise. If a result is not displayed after each exercise, the soldier could break seal, fail one or more of the exercises, still pass the overall M41 PATS fit test, and a potential fitting problem would go unnoticed. This issue is discussed in more detail in Finding D.

Finding A. Capabilities of the M41 PATS Protection Assessment Test System

Operator Concerns

We met with and surveyed 188 operators from four Army installations. In general, the M41 PATS and the o-chlorobenzylidene malononitrile (CS) chamber provide additional confidence to the soldier, but do not ensure combat readiness; the M41 PATS does not test to operational conditions; and the M41 PATS should be set to display more detailed test results. See Finding D for additional operator comments on training and the use of the M41 PATS.

Only 31 of 188 operators felt that PMCS and the M41 PATS alone can render the soldier combat ready. Additionally, 65 operators suggested using the CS chamber in addition to or instead of the M41 PATS fit tester to increase the soldiers' confidence in their masks. However, the CS chamber is no longer an Army annual requirement; it is left to the discretion of the unit commander. Of the 188 operators surveyed, 113 were asked whether they liked the M41 PATS and if they would recommend using it; 83 did like or would recommend using the M41 PATS. Of the 188 operators surveyed, 10 stated that testing in non-battlefield conditions is a limitation of the M41 PATS and 4 suggested using the M41 PATS in a simulated combat environment. Finally, 26 of 188 operators suggested setting the M41 PATS to display test results after each exercise. Results of the operator surveys are summarized in Appendix C.

Views of Chemical School Instructors

Eight Chemical School instructors (five from the Army and one each from the Navy, Marine Corps, and Air Force) and one civilian responsible for the protective mask laundry facility at the Chemical Defense Training Facility believed that the M41 PATS does not ensure combat readiness. Furthermore, the instructors stated that the fit-factor criterion should be consistent throughout the Army. The Army uses an M41 PATS fit-factor criterion of 3,000, as opposed to 1,667, before entering the Chemical Defense Training Facility. An argument against a lower fit-factor criterion for soldiers in the field is that the Chemical Defense Training Facility and surety sites know the types of agents that people will potentially be exposed to, but the Services do not know which agents will be used during a chemical or biological conflict.

Conclusion

The limitations of the M41 PATS create doubt that it is the combat readiness tester. Although adequate fit is a part of determining the readiness status of the "soldier-mask" interface, the M41 PATS cannot be relied upon as the sole combat-readiness tester, and its categorization as such is inappropriate. The M41 PATS does not test to battlefield conditions, but, instead, tests mask fit while the soldier is sitting or standing. Several other factors, such as training the M41 PATS operator to adequately size the mask to the soldier, ensuring that the soldier is experienced enough to put on the protective mask correctly, and

Finding A. Capabilities of the M41 PATS Protection Assessment Test System

ensuring that adequate PMCS has been performed on the protective mask, should be considered in determining combat readiness. The physiological and psychological effects that occur once the soldier puts the mask on also should be considered.

Using the M41 PATS as a combat-readiness tester goes beyond the capabilities of testing mask fit. Reliance on the M41 PATS as a combat-readiness tester could lead to inadequately protected military personnel who possess a false sense of readiness.

Clear differences of opinion exist between the M41 PATS as a fit tester and as a combat-readiness tester. The M41 PATS should be operationally tested to resolve the issue and clarify its capabilities. The Deputy Assistant to the Secretary of Defense (Nuclear and Chemical and Biological Defense Programs) (Counterproliferation/Chemical and Biological Defense) could task the Army as the Executive Agent to perform an operational test using the M40 chemical protective mask and the M41 PATS fit tester in battlefield conditions, using force-on-force training in desert and swamp conditions. The Army should include representatives from each of the Services; the Center for Health Promotion and Preventive Medicine; the Army Research Institute of Chemical Defense; the Edgewood Research, Development, and Engineering Center; and the test community in the test. The operational test is feasible and can be accomplished as part of scheduled training. The Deputy to the Assistant Secretary of Defense (Nuclear, Chemical, and Biological Defense Programs) could task the Secretariat of the Joint Nuclear, Biological, and Chemical Defense Board to oversee and review the operational test results and change the M41 PATS policy if the test results so warrant.

Recommendations, Management Comments, and Audit Response

Revised Recommendation. As a result of comments from the Deputy Assistant to the Secretary of Defense, we revised draft Recommendation A.1. to incorporate suggested word changes.

A. We recommend that the Deputy Assistant to the Secretary of Defense (Nuclear and Chemical and Biological Defense Programs) (Counterproliferation/Chemical and Biological Defense):

1. Task the Army, as the Executive Agent, to attempt to determine the combat effectiveness of the current fit test regime by performing an operational test using the M40 chemical protective mask and the M41 Protection Assessment Test System fit tester or similar device against simulated battlefield conditions using force on force training in both desert and swamps conditions.

2. Task the Army to include representatives from each of the Services; the Army Center for Health Promotion and Preventive Medicine;

Finding A. Capabilities of the M41 PATS Protection Assessment Test System

the Army Research Institute of Chemical Defense; the Edgewood Research, Development, and Engineering Center; and the test community in the operational test.

3. Task the Secretariat of the Nuclear, Biological, and Chemical Defense Board to oversee and review operational fit-test results and change the M41 Protection Assessment Test System policy if the test results so warrant.

Deputy Assistant to the Secretary of Defense Comments. The Deputy Assistant to the Secretary of Defense suggested rewording Recommendation A.1., but otherwise concurred with the findings and recommendations. The complete set of comments is in Part III.

Audit Response. The Deputy Assistant to the Secretary of Defense comments were responsive. We have revised the report to incorporate the suggested word changes. The Deputy Assistant to the Secretary of Defense requested the addition of “attempt to” into Recommendation A.1. because it may not be possible to determine the effectiveness of the M41 PATS through operational testing; however, the Deputy Assistant to the Secretary of Defense agreed to perform an operational test. The Deputy Assistant to the Secretary of Defense defines “simulated” as the attempt to imitate/mimic the battlefield environment during training exercises while conducting operational tests. In response to the final report, we request that the Deputy Assistant to the Secretary of Defense provide estimated implementation dates for the agreed-upon recommendations.

Army Comments. Although not required to comment, the U.S. Army Chemical and Biological Defense Command (CBDCOM) stated that an M41 PATS mask fit test during combat or immediately after will provide information on the effects of combat degradation and not on the combat readiness of the system. CBDCOM also stated that an operational test is not appropriate to test the reliability or effectiveness of a combat-readiness tester for the mask and that a long-term monitoring program to track mask fit and condition over time is more likely to provide actual combat-readiness data. The complete set of comments is in Part III.

Audit Response. The Army’s comments did not resolve and clarify the capabilities of the M41 PATS. This report does not address combat degradation; it addresses the need to monitor mask fit during a force-on-force training scenario. In addition to long-term monitoring, an operational test using the M41 PATS fit tester and the M40 chemical protective mask will determine the effects on mask fit when a soldier is running, jumping, and breathing heavily in situations such as hitting the ground under fire and moving quickly during force-on-force battlefield situations. Without a force-on-force operational test, reliance on the M41 PATS could lead to inadequate protection for military personnel and could provide a false sense of readiness. Soldiers must maintain an adequate mask fit for their protection throughout their involvement in battlefield conditions.

Finding B. M41 Protection Assessment Test System Fit-Factor Criteria

The Joint Service Materiel Group has not finalized fit-factor criteria for the M41 Protection Assessment Test System because it has not implemented recommendations by the JSMTWG on criteria for testing fielded protective masks. In addition, the existing fit-factor criterion was developed using an out-of-date "Protective Mask Requirements Analysis Methodology," September 29, 1986, (1986 Requirements Analysis) and does not consider a safety factor. As a result, there is risk that the fit-factor criterion currently used by the Army may be insufficiently rigorous.

Background

Interim Fit Factor. Although the JSMTWG recommended an interim minimum standard fit factor of 1,667, the Services are using different fit-factor criteria for fielded chemical protective masks. A fit factor is a quantitative measurement of the particle concentration outside the protective mask divided by the particle concentration inside the protective mask.

Service Fit Factors. The Army uses a fit factor of 1,667 for fit testing fielded masks. Surety sites and the Chemical Defense Training Facility at Fort McClellan use a fit factor of 3,000. The Marine Corps recently switched from a fit factor of 6,667 to a fit factor of 3,000 to be consistent with surety sites and the Chemical Defense Training Facility. The Marine Corps is waiting for a decision on the standard fit factor. The Air Force used a fit-factor requirement of 2,000 during a Pacific Air Forces pilot program from March 15, 1998, through September 30, 1998. The Air Force plans to continue using a minimum fit-factor requirement of 2,000. However, it plans to also use the M41 PATS as a training aid to help Air Force personnel maximize their chemical and biological mask protection by attaining the highest fit factor possible. A quantitative fit program will be implemented for all active duty Major Commands by May 1, 1999, and for all Air Reserve Major Commands by October 1, 1999.

Joint Service General Purpose Mask Fit-Factor. The March 1998 operational requirements document for the Joint Service general purpose mask required the mask to provide a fit factor greater than 6,667.

Joint Service Mask Technical Working Group

Inspector General, DoD Report Number 95-021. On November 2, 1994, the Inspector General, DoD, issued Report No. 95-021, which stated that the DoD lacked serviceability standards or criteria for testing fielded assets. The report

Finding B. M41 Protection Assessment Test System Fit-Factor Criteria

recommended that the Commandant, Army Chemical Center and School, establish and document approved standards for testing fielded chemical protective masks. As a result of the mediation efforts on that report, on May 4, 1995, the Office of the Secretary of Defense (Deputy for Chemical/Biological Matters) tasked the Joint Service Materiel Group to form a working group to “establish criteria for evaluating fielded protective masks, identify equipment to be used in such an evaluation, and determine the statistical level required for an evaluation.” The Joint Service Materiel Group formed the JSMTWG on July 27, 1995, to develop a unified Service response to the tasking.

Joint Service Mask Technical Working Group Summary Report. The JSMTWG published a summary report, “Mask Criteria Analysis and Test Requirements,” on November 1, 1995, which states that the M41 PATS is the appropriate combat-readiness test for negative pressure masks with a drink system. The summary report also notes that the mask analysis developed in 1986 by the Deputy Under Secretary of the Army (Operations Research) should be the standard methodology for establishing mask requirements, but that the Services should conduct their own Service-specific analysis. The summary report states that the interim minimum standard fit factor should be 1,667, with a desirable value of 6,667.

Joint Service Mask Technical Working Group Recommendations. The JSMTWG summary report made the following recommendations:

- The Joint Service Materiel Group should conduct a study to determine the impacts of raising the fit factor requirement from 1,667 to 6,667.
- The Joint Service Materiel Group should evaluate the effectiveness of the M41 PATS by conducting a field study.

Joint Service Materiel Group Response. The Joint Service Materiel Group concurred with the summary report findings, but did not concur with funding development of Service-specific threat scenarios and a field evaluation of the M41 PATS. Additionally, the Joint Service Materiel Group stated that many of the issues, such as a minimum standard fit factor of 1,667 and Service-specific threat scenarios, are “User” related and should be coordinated with and approved by the Joint Service Integration Group.

Actions Taken. Little action has been taken by the Joint Service Materiel Group and the Joint Service Integration Group relating to fit-factor criteria. Results of M41 PATS tests have been collected at a few sites; however, as of November 1998, the interim fit-factor criterion of 1,667 remains.

1986 Requirements Analysis

The interim fit factor of 1,667 resulted from the 1986 Requirements Analysis requested and approved by the Deputy Under Secretary of the Army (Operations Research). The 1986 Requirements Analysis summarizes the approach of the Army Chemical Center and School in quantifying the protective

Finding B. M41 Protection Assessment Test System Fit-Factor Criteria

mask requirements. The document uses knowledge of the battlefield environment and the distribution of protection factors and dose responses to determine a casualty response distribution. The Chemical School has proposed and the Marine Corps has agreed that no more than 1 percent of a unit will require medical treatment or die and no more than 15 percent will experience miosis, which is treatable with self/buddy aid.

Threat Analysis. The 1986 Requirements Analysis is based on an attack of Sarin delivered by multiple rocket launchers. The document uses weapon systems and dosage distributions cited in Defense Intelligence Agency-authored threat documents. The target coverage generated by this attack was derived from a 1971 document (Secret). The 1986 Requirements Analysis has not been updated to reflect threat analyses recently published by National Intelligence Agencies. The updated threats include emerging agents and delivery systems such as dusty and microencapsulated agents.

We met with the Defense Intelligence Agency, Office of Counterproliferation Support, and intelligence analysts at the Army Chemical Center, to discuss and review the 1986 Requirements Analysis. Officials from both organizations agreed that Sarin delivered by multiple rocket launchers may be the most challenging threat for the protective mask because it is a good mix between volatility and toxicity. However, Defense Intelligence Agency officials stated that the 1986 Requirements Analysis should be updated to include a review of emerging agents and delivery systems such as dusty and microencapsulated agents. The Defense Intelligence Agency officials stated that documents, such as the 1986 Requirements Analysis, which contain threat analysis should be updated every 5 years. In addition, they stated that biological agents are the most dangerous threat, while chemical agents are the most likely threat.

Toxicity Estimates. The 1986 Requirements Analysis uses toxicity estimates that were developed during the 1950s and 1960s for chemical warfare agents and offensive purposes. The 1986 Requirements Analysis uses the following effective dosages of Sarin:

- Miosis: 3 Ct (mg-min/m³)
- Incapacitation: 35 Ct (mg-min/m³)
- Lethality: 70 Ct (mg-min/m³)

Three studies performed after 1986 attempted to quantify toxicity estimates for chemical warfare agents. These studies are the Reutter-Wade Study, the National Research Council Review, and the U.S. Army Center for Health Promotion and Preventive Medicine Study. All three studies recommend effective dosages equal to or lower than the ones used in the 1986 Requirements Analysis.

Reutter-Wade Study. The Reutter-Wade study, "Review of Existing Toxicity Data and Human Estimates for Selected Chemical Agents and Recommended Human Toxicity Estimates Appropriate for Defending the Soldier," March 1994, represents a major effort to present a set of human

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toxicity estimates for defending the soldier. The study reviews the existing human toxicity estimates, recommends documented human toxicity estimates for defending the soldier, and provides a foundation upon which future estimates can be based. Toxicity levels used in the 1986 Requirements Analysis may be underestimated because existing toxicology data were not generated to develop human toxicity estimates. U.S. policy now focuses on a defensive posture that is based on avoidance, protection, and decontamination. Toxicity estimates for offensive calculations are based upon the conditions of a resting person. For defensive purposes, protective equipment should function under the most adverse conditions, such as battlefield movements and high breathing rates. The study addresses the threat of chemical agents only; the biological threat is not addressed. The Reutter-Wade study shows that other chemicals are more toxic than Sarin; however, Sarin is the most persistent chemical and is believed to be the biggest threat.

The Reutter-Wade study recommends the following effective dosages for Sarin:

- Miosis: 0.5 Ct (mg-min/m³)
- Severe Effects: 25 Ct (mg-min/m³)
- Lethality: 35 Ct (mg-min/m³)

National Research Council. The National Research Council reviewed the Reutter-Wade study in 1997 and concluded in its report, "Review of Acute Human-Toxicity Estimates for Selected Chemical-Warfare Agents," that some of the existing human toxicity estimates were too high and inappropriate to protect soldiers. By current standards of toxicology, the toxicity database developed from the 1930s through 1960s is inadequate and is a major obstacle to the Army's developing risk-management strategies and human-toxicity estimates with statistical confidence.

Regarding the Reutter-Wade toxicity estimates, the National Research Council concluded that:

- some estimates were scientifically valid;
- other estimates were adequate to serve as interim estimates until further research is conducted;
- some estimates needed to be lowered, and a few estimates needed to be raised; and
- the Sarin toxicity estimate for miosis needed to be raised, and the Sarin toxicity estimates for severe and lethal effects needed to be lowered.

The National Research Council states that while it is possible to estimate, on a fairly logical basis, a lethal concentration for a resting man, it is not possible to give a single figure for the lethal concentration that would apply to all other

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states of activity. The actions of soldiers in combat are so varied and unpredictable that the respiratory volume per minute at the moment of chemical attack would be impossible to determine.

The Army Center for Health Promotion and Preventive Medicine Study. "Information for Combat Developers on Performance Degrading Effects from Exposure to G-Nerve Agents," December 16, 1997, is an effort to present the most reliable, quantitatively based information on the performance degrading effects of chemical agents. It is intended to assist combat developers, modelers, doctrine writers and commanders by providing a better understanding of the effects of various agent dosages on military units in operational scenarios. The Army Center for Health Promotion and Preventive Medicine study provides the following effective dosage ranges for vapor inhalation of Sarin:

- Incapacitation: 25 - 35 Ct (mg-min/m³)
- Lethality: 35 - 70 Ct (mg-min/m³)

Toxicity Integrated Product Team. The Deputy Under Secretary of the Army (Operations Research) tasked the Joint Nuclear, Biological, and Chemical Defense Board, November 3, 1997, to review the chemical agent toxicity estimates that were based on the results of the Reutter-Wade Study and the National Research Council. The Deputy Under Secretary of the Army (Operations Research) memorandum, "Guidelines for Application of Toxicity Estimates," November 3, 1997, recommended the establishment of a small integrated product team of subject-matter experts to prepare a guideline for the resulting estimates. The integrated product team was composed of representatives from the operational and requirements, the medical and toxicology, and the modeling and simulations communities. Draft guidelines titled, "Report of the Workshop on Chemical Agent Toxicity Held at the Institute for Defense Analysis, May 11-12, 1998," were completed in August 1998. However, the guidelines will not be finalized until a review of the toxicity estimates from prior studies is completed.

Safety Factor

Although the Army requires 100 percent of users to achieve a 1,667 fit factor, instead of 88 percent as required by the operational requirement document for the M40 series protective masks, the fit factor of 1,667 does not consider the error rate of the M41 PATS or the testing conditions of the fit test.

Error Rate. The Army uses an M41 PATS error rate of plus or minus 10 percent up to a fit factor of 50,000 and plus or minus 20 percent for fit factors above 50,000 for the M41 PATS. The Army requires that M41 PATS returned to the Test, Measurement, and Diagnostic Equipment (TMDE) Activity at Redstone Arsenal be within plus or minus 20 percent of the actual fit factor.

Finding B. M41 Protection Assessment Test System Fit-Factor Criteria

About 35 percent of the M41 PATS turned into Redstone Arsenal for calibration were not within plus or minus 20 percent; therefore, fit factors provided by the M41 PATS may be imprecise. See Finding C for more details.

Testing Conditions. The Army is testing mask fit in a nonoperational situation. Fit factors achieved in nonoperational testing are not representative of the fit factor that will be achieved on the battlefield. Respiratory Support Services published, *Fit Testing of Respiratory Facepieces*, April 1990, which states that establishing acceptance fit-factor criteria at or slightly above the assigned protection factor reflects a poor understanding of how fit test results differ under test conditions. During a fit test, the soldier performs five exercises in a standing or sitting position. The fit obtained under these artificial conditions is very likely to be the best possible and does not represent the fit experienced in other conditions. In an operational environment, the soldier will experience heavy breathing, running, and jumping. The study states that an artificial margin of error or safety factor must be factored in because testing is done under unrealistic conditions that often do not otherwise exist. The Army states that no safety margin is needed because the fit factor is based on a worst-case scenario and requires 100 percent of personnel to pass rather than 88 percent as required in the operational requirements document.

Conclusion

The interim-fit factor criterion of 1,667 should be reassessed. The fit factor is based on the oldest and highest of the four toxicity estimates. Additionally, it does not consider the error rate of the M41 PATS or the difference between the required battlefield protection factor and the fit factor achieved during nonoperational testing.

The Deputy Assistant to the Secretary of Defense (Nuclear and Chemical and Biological Defense Programs) (Counterproliferation/Chemical and Biological Defense) needs to exercise his oversight responsibility on Joint Service chemical and biological matters to ensure that criteria for fielded chemical protective masks are finalized.

Recommendations, Management Comments and Audit Response

Renumbered, Revised, and Deleted Recommendations. As a result of management comments, we have changed the order of draft Recommendations B.1. and B.2. We also revised Recommendation B.1. for clarification. The recommendation now refers to the "Protective Mask Requirements Analysis Methodology," September 29, 1986, instead of a 1986 threat document to specify the document used to generate the fit factor criterion of 1,667. We also deleted draft Recommendation B.1.c.

Finding B. M41 Protection Assessment Test System Fit-Factor Criteria

B. We recommend that the Deputy Assistant to the Secretary of Defense (Nuclear and Chemical and Biological Defense Programs) (Counterproliferation/Chemical and Biological Defense):

1. Task the Commandant, Army Chemical Center and School, to update the “Protective Mask Requirements Analysis Methodology,” September 29, 1986, using current Defense Intelligence Agency threat documents and current toxicology estimates.

2. Task the Joint Service Materiel Group and Joint Service Integration Group to collectively review the updated “Protective Mask Requirements Analysis” and validate the current fit-factor criteria of 1,667 or establish the appropriate standard fit-factor criteria for fielded protective masks. The fit-factor criteria should consider the following items:

a. the error rate of the M41 Protection Assessment Test System fit test, and

b. the nonoperational testing conditions of the M41 Protection Assessment Test System.

Deputy Assistant to the Secretary of Defense Comments. The Deputy Assistant to the Secretary of Defense (Nuclear and Chemical and Biological) (Counterproliferation/Chemical and Biological Defense) suggested changing the order of the recommendations, rewording the recommendations, and redirecting the draft recommendation to update the 1986 threat document from the Army Chemical Center and School to the Defense Intelligence Agency. The Deputy Assistant to the Secretary of Defense recognizes that the Warsaw Pact threat scenario, which was the basis for the 1,667 mask-fit criteria, may be outdated, and that the System Threat Assessment Reports for the M41 Program should be reevaluated and updated as needed by the Defense Intelligence Agency. The complete set of comments is in Part III.

Audit Response. Comments from the Deputy Assistant to the Secretary of Defense were responsive. We changed the order of the recommendations and reworded Recommendation B.2. However, we did not redirect the recommendations to update the 1986 threat document because the “Protective Mask Requirements Analysis Methodology,” September 29, 1986, was prepared by the Army Chemical Center and School. We replaced “1986 threat document” with “Protective Mask Requirements Analysis Methodology,” September 29, 1986, to clarify the actual document used to derive the fit factor of 1,667. We request that the Deputy Assistant to the Secretary of Defense provide additional comments on Recommendation B.1. and provide estimated completion dates for it and for Recommendation B.2.

Chemical School Comments. Although not required to comment, the Army Chemical Center and School stated that the threat is current, validated, and officially documented in accordance with regulations. The Chemical School stated that the threat used for derivation of the mask fit-factor criteria is current and clearly documented in the Chemical and Biological Warfare Defense Systems, “Nonmedical Capstone System Threat Assessment Report (STAR),”

Finding B. M41 Protection Assessment Test System Fit-Factor Criteria

approved May 30, 1997. The Chemical School also stated that the toxicity estimates used to quantify protective mask requirements are based on the best toxicity data currently available. The Chemical School referred to the Army Center for Health Promotion and Preventive Medicine Report, "Information for Combat Developers on Performance Degrading Effects from Exposure to G-Nerve Agents," December 16, 1997.

Audit Response. The 1,667 fit-factor requirement is derived from the "Protective Mask Requirements Analysis Methodology," and not the "Nonmedical Capstone STAR." The Capstone STAR, dated May 30, 1997, is designed to prevent and reduce casualties from chemical and biological exposure by providing detection, physical protection, and decontamination equipment for defense against the most probable current and emerging chemical and biological warfare threats. The Capstone STAR identifies the most probable chemical and biological warfare threats, but it does not assess the strength of the threats or specific threats to the M40 mask or M41 PATS. The Capstone STAR states that proliferation of chemical warfare and biological warfare programs and advances in related technology, along with growing availability of delivery systems, presents an increasing threat to U.S. forces. As a result, the "Protective Mask Requirements Analysis Methodology" should be updated and threats that have emerged since 1986 should be assessed. We revised our finding discussion to refer more specifically to the "Protective Mask Requirements Analysis Methodology" or 1986 Requirements Analysis instead of making reference to a 1986 "threat document."

This report identified several toxicity studies that recommend different toxicity estimates; however, the "Protective Mask Requirements Analysis Methodology" uses the oldest and highest toxicity estimate of the studies identified. For example, the Reutter-Wade Study recommends toxicity estimates that are significantly lower than the toxicity estimates used in the "Protective Mask Requirements Analysis Methodology." The Chemical School should consider all toxicity studies while determining which thresholds to use in the "Protective Mask Requirements Analysis Methodology."

CBDCOM Comments. Although not required to comment CBDCOM stated that the Joint Service Materiel Group agreed to keep 1,667 as an interim criterion because the threat has not changed.

Audit Response. The "Protective Mask Requirements Analysis Methodology," September 29, 1986, established the 1,667 fit-factor requirement using a worst-case scenario threat of Sarin delivered by multiple rocket launchers. Several threat analyses have been published since 1986. The Chemical School should update the 1986 Requirements Analysis using recent threat analyses to verify and document that Sarin and multiple rocket launchers are still the worst-case scenario. Additionally, the toxicity estimates for Sarin should be updated and the fit-factor requirement should consider the accuracy of the M41 PATS and the testing conditions.

Finding C. Calibration

The M41 Protection Assessment Test System (PATS) fit testers were not being returned for calibration in a timely manner because the M41 PATS operators were uncertain as to which organization would perform the calibration and what the turn-in procedures were. Also, no oversight was performed to ensure that the M41 PATS were turned in. As a result, 108 of the 311 M41 PATS returned for calibration were out of tolerance; therefore, the fit factors provided by those M41 PATS may be imprecise.

Description of M41 PATS

The M41 PATS fit tester is based on a miniature condensation nucleus counter that operates by continuously sampling and counting microscopic particles that occur naturally in the air. Particles pass through a sensor nozzle and the optics in the sensor focus a laser light into a small sensing area just above the nozzle. Each particle passing through the sensing area scatters the light beam. The M41 PATS measures the concentration of these particles inside and outside the mask and calculates a fit factor from the values. Common problems found during calibrations relate to cracked casings, the switching valve, the pump's airflow, and the laser.

Calibration Requirements

During the development and fielding of the M41 PATS, TSI, Inc., recommended that the machine should be calibrated every 12 months. The Army increased the requirement from 12 months to 18 months, or 500 hours for fielded units, whichever comes first, when the Program Manager realized many of the M41 PATS sat for 6 to 8 months before being fielded. As a result, part of the 1-year warranty lapsed by the time some operators received the machines.

Army Requirements. The Army requires M41 PATS to be calibrated every 18 months or after 500 hours of operation, whichever comes first. The Edgewood Research, Development, and Engineering Center established the requirement based on a best guess. Other activities, such as surety sites, the Chemical Defense Training Facility, and the industry use the contractor-recommended interval of 12 months.

Surety Sites and the Chemical Defense Training Facility. According to the "M41 Recalibration Requirement Changes" memorandum from the Army Edgewood Research, Development and Engineering Center, November 2, 1996, the M41 PATS at the surety sites and the Chemical Defense Training Facility are calibrated every 12 months or 1,000 hours of operation.

Finding C. Calibration

Industry. According to TSI, Inc., the industry uses 12 months as its turn-in date for calibration.

Timeliness of Submission

The M41 PATS fit testers are not being returned in a timely manner. Information provided by the Army TMDE Activity located at Redstone Arsenal showed that a significant number of the M41 PATS that were turned in for calibration exceeded the Army requirement of 18 months. This situation existed because operators were unclear about who would perform the calibration and what the turn-in procedures were. The XVIII Airborne Corps Chemical Officer sent a memorandum, "M41 Protection Assessment Test System (PATS) Support System Changes," October 17, 1997, to subordinate units with instructions to turn in the M41 PATS to the local TMDE Activity for calibration. However, several M41 PATS operators at different bases continue to be unfamiliar with turn-in procedures.

TSI Calibrations. Before October 1997, TSI, Inc., calibrated the M41 PATS fit tester and recommended that the M41 PATS should be calibrated every 12 months. The M41 PATS Program Office reported that about 2,255 units were fielded as of April 1998. Of the 2,255 units, 1,124 were due to be returned for calibration. However, from January 1996 through September 1997, TSI, Inc., received only 91, or about 8 percent, of the M41 PATS that were due for calibration.

Redstone Arsenal Calibrations. The TMDE Activity began calibrating M41 PATS for the Army in October 1997. As of March 1998, 311 M41 PATS have been returned to the TMDE at Redstone Arsenal with 84.9 percent exceeding the 18-month turn-in requirement.

Floats. Authorization of M41 floats on Army installations would improve the units' ability to test protective masks when M41 PATS are turned in for calibration. As a result, the number of M41 PATS turned in for calibration would increase.

M41 PATS Turned In for Calibration

Fielded M41 PATS. The Army procured 5,954 M41 PATS. Once an M41 PATS is returned for calibration, the TMDE Activity logs the M41 PATS into the calibration management information system. The TMDE Activity will then notify the unit when the M41 PATS is due for calibration again. Therefore, it is important for the M41 PATS to receive the initial calibration so that it can be entered into the calibration management information system.

"As Found" Test. The Army TMDE Activity calibrates and repairs all M41 PATS fit testers for the Army. The TMDE Activity performs an "as found" test on the M41 PATS using a calibration machine. The calibration machine

generates two air flows with known particle concentrations. One air flow represents ambient air and the other simulates air inside a mask. The two air flows are connected to the M41 PATS with sampling tubes. Fit factors for the known airflow and the M41 PATS are compared and a percentage variance is calculated by dividing one fit factor by the other. The results are compared to the calibration bench standard, then the out-of-tolerance information is recorded.

The M41 PATS with an error rate or variance greater than plus or minus 20 percent is considered to be out of tolerance. Once the "as found" tests are performed, parts are replaced as necessary and the M41 PATS is calibrated to a plus or minus 10 percent before being returned to the submitting unit. The contractor states that the machine should be within plus or minus 15 percent of the calibration bench before it is sent back to the unit; however, the TMDE Activity will not ship the machine back until the tolerance is within plus or minus 10 percent of the calibration bench.

Out-of-Tolerance M41 PATS. Of the 311 M41 PATS that Redstone Arsenal had calibrated as of March 1998, 34.7 percent were out of tolerance. According to the TMDE, the most common problems are cracked cases, pump failures, and switching valve failures. See Appendix E for a complete listing of the "as found" calibration test results. According to personnel at the Chemical and Biological Command, the operators of the M41 PATS would not know whether the equipment is out of tolerance.

Conclusion

Based on the documentation obtained and discussions with contractor and Government personnel, policies and procedures to include oversight need to be established to ensure the M41 PATS are turned in on time. However, the units must first turn in the M41 PATS for calibration before the information is included in the database notification process. In addition, the high percentage of out-of-tolerance M41s casts doubt on the accuracy of fit factors and raises questions on the reliability of the M41. If M41 fit factors are imprecise, the test results may be questionable; therefore, the Program Manager needs to closely monitor the M41 PATS calibration results from the TMDE Activity at Redstone Arsenal. Once the data are analyzed, the Program Manager should reassess the current calibration interval and evaluate the reliability of the M41 PATS fit-test results and the causes of the out-of-tolerance units.

Recommendations, Management Comments, and Audit Response

Revised, Added, and Renumbered Recommendations. We revised draft Recommendation C.1. to clarify that the M41 PATS are not being turned in as required. We added Recommendation C.2. as a result of comments from the

Finding C. Calibration

Deputy Assistant to the Secretary of Defense. Draft Recommendations C.1. and C.2. have been renumbered as Recommendations C.1.a. and C.1.b., respectively.

C.1. We recommend that the Commander, U.S. Army Chemical and Biological Defense Command, task the M41 PATS Program Manager to

a. Establish procedures to help ensure that all M41 PATS are turned in to the Redstone Arsenal Test, Measurement, and Diagnostic Equipment Activity every 18 months as required.

Army Comments. CBDCOM nonconcurred with the draft recommendation to establish procedures for all M41 PATS to be turned in for calibration so they can be tracked and units can be notified when they are due again. CBDCOM stated that since establishing procedures for the M41 PATS to be turned directly into the TMDE in October 1997, the return of M41 PATS has increased dramatically. CBDCOM also stated that the M41 PATS Program Office will continue to monitor the return of the M41 PATS to assure continued success in this regard. The complete set of comments is in Part III.

Audit Response. CBDCOM comments were nonresponsive. TMDE testing shows that 34.7 percent of the M41 PATS turned in for calibration were out-of-tolerance. This indicates that a large number of M41 PATS being used in the field may be providing inaccurate results. Until these machines are returned to and tested by the TMDE, the Army is relying on fit factors generated by inaccurate machines to determine whether a soldier has a good mask fit and will be protected from a chemical attack. The Army should take actions to ensure that the PATS are providing accurate test results by returning them to the TMDE and testing them against the calibration bench. We revised our recommendation to clarify that the M41 PATS are not being turned in as required and asked the Army to comment on the revised recommendation in responding to the final report.

b. Evaluate the M41 PATS calibration data collected from the Test, Measurement, and Diagnostic Equipment Activity, and adjust the calibration requirement if the calibration interval of 18 months or 500 hours of operation is not considered appropriate.

Army Comments. CBDCOM nonconcurred, but stated that the M41 PATS Program Office will continue to monitor and evaluate the calibration data collected at the Redstone Arsenal TMDE.

Audit Response. CBDCOM met the intent of the recommendation by agreeing to monitor and evaluate the calibration data collected at the Redstone Arsenal TMDE. We believe that the Army will significantly reduce the number of out-of-tolerance M41 PATS by following Recommendation C.1.a. and monitoring and evaluating the data collected by the TMDE.

C.2. We recommend that the Chief, Chemical and NBC Defense Division, Office of the Deputy Chief of Staff for Operations and Plans, Department of the Army authorize buying additional M41 PATS to be stationed and positioned on Army installations as floats.

Finding D. M41 Protection Assessment Test System Training

The Services' NBC commissioned officers and NBC noncommissioned officers are not receiving sufficient training on the M41 PATS. The following factors contributed to the situation:

- o the Chemical School and base-level training does not provide sufficient hands-on training on the M41 PATS,
- o the Services have no operator certification requirement on the M41 PATS,
- o the Services lack an overall command emphasis on Nuclear, Biological, and Chemical training, and
- o the Services have an insufficient number of personnel assigned to Nuclear, Biological, and Chemical duties.

As a result, many of the M41 PATS are sitting on shelves and not being used, which means that the "soldier-mask" fit may be questionable. An improper mask fit could compromise the safety of military personnel during a chemical or biological encounter.

Background

The JSMTWG interim report, "Joint Service Retail Mask Surveillance," March 1998, discusses observations made during the first year of the mask surveillance pilot program. The report states that Army and Marine Corps equipment surveillance units testing the protective masks observed that, within the Army, the M41 PATS were not being used as recommended in Training Circular 3-41. The Air Force and Marine Corps have purchased and fielded the M41 PATS with limited use.

Training Circular. Headquarters, Department of the Army, Protection Assessment Tests System Training Circular 3-41, provides the techniques and procedures for validating the fit of the M17, M40 and M42 series chemical protective masks. The Training Circular states that the M41 PATS should be tested at initial issue, annual verification, mask issue replacement, and for changes in facial structure.

Joint Service Integration Group Tasking. On February 4, 1998, the Joint Service Integration Group Mask Surveillance Process Action Team met to address the operational issues (training and maintenance processes and command emphasis) noted in the JSMTWG Summary Report. The Joint Service Integration Group Process Action Team issued an interim report, "JSIG Mask Surveillance Process Action Team Interim Report," April 9, 1998, to the

Finding D. M41 Protection Assessment Test System Training

Chairman, Joint NBC Defense Board, recommending that the mask fit test should be mandatory for each soldier similar to the monthly 20-percent mandatory property inventories that commanders are responsible for executing. The Joint Service Integration Group report also recommends that monthly checks be sufficiently random and include a cross section of the entire population. The mandatory property inventories will cause leadership to become involved with caring for the masks. The Joint NBC Defense Board has not responded to the "JSIG Mask Surveillance Process Action Team Interim Report." The Army Chemical Center and School agreed with the recommendation to make the M41 PATS checks a mandatory requirement. The Chemical School stated that linking this recommendation and the recommendation to develop procedures to provide commanders feedback on the effectiveness of preventive maintenance with the Unit Status Reporting would result in meaningful feedback for the unit commander and senior leadership.

New Equipment Training

Based on the February 26, 1992, operational requirements document for the M41 PATS, new equipment training on the M41 PATS will require operation and maintenance training for instructors and key personnel during the testing and fielding phases. The Army Program Office provided new equipment training when the M41 PATS was fielded; however, the loss of NBC commissioned officers to rotation and the tasking of non-NBC soldiers with the additional NBC responsibilities have resulted in a lack of experience, knowledge, and enthusiasm for the M41 PATS.

Training of the Services

Army. Although M41 PATS training is included in the Army program of instruction for its chemical personnel, hands-on training is limited due to time constraints, the number of available M41 PATS, and the number of soldiers in the class. As of August 1997, use of the M41 PATS at the Chemical School is mandatory. Lesson Plan One states that the M41 PATS will serve as a tool for the unit commander to test a soldier's ability to properly fit the mask and provide the commander with critical information to assess the unit's NBC readiness posture. The M41 PATS fit test can help screen for unserviceable masks and help determine whether PMCS has been conducted properly. Each soldier is fit tested with the M41 PATS before going into the Chemical Defense Training Facility.

Navy. The Navy procured only five M41 PATS for diagnostic testing and is not planning to field the fit tester; therefore, Navy NBC classes do not include M41 PATS training in their program of instruction.

Marine Corps. According to an instructor at the Chemical School, the Marine Corps has purchased the fit testers but is not using them in training because of

Finding D. M41 Protection Assessment Test System Training

the disagreement among the Services on the fit-factor criterion. The Marine Corps soldiers attending the Chemical School are tested on the M41 PATS before entering the Chemical Defense Training Facility.

Air Force. An instructor at the Chemical School stated that NBC personnel have limited hands-on mask PMCS experience and that the NBC noncommissioned officers will have 3 hours of instruction on the M41 PATS. The Air Force uses the train-the-trainer concept. From March through September 1998, the Air Force performed an M41 PATS pilot test program at Headquarters, Pacific Air Forces. The Air Force plans to use a minimum fit factor of 2,000, but will also use the M41 PATS as a training aid to achieve the highest fit factor possible.

Results of Site Visits

We discussed the M41 PATS with a cross section of M41 PATS operators (airborne, cavalry, infantry, special operations, and Headquarters support personnel) at four Army installations and the Army Chemical School. After the discussions, the operators completed a questionnaire on the M41 PATS. The questionnaire addressed M41 PATS training, external training guidance, experience, advantages, limitations, and improvement suggestions.

Although the Army Chemical Center and School program of instruction includes the M41 PATS, the program of instruction does not allow sufficient time and hands-on experience with the M41 PATS. The NBC schools at Fort Bragg, Fort Campbell, and Fort Lewis have incorporated the M41 PATS training into their 2-week NBC training classes. We attended the first class at Fort Campbell, Kentucky. The instructor showed a 45-minute video and the soldiers used hands-on instruction to operate the M41 PATS to perform the mask-fit test.

Feedback from Interviews. We met with operators of the M41 PATS. The M41 PATS operators expressed the following concerns.

- Because of the shortage of chemical personnel (54 Bravos), it is difficult to do an initial fit test. This condition is compounded because the M41 PATS are fielded at the battalion level rather than the company level.
- It is sometimes difficult to locate the chemical officers at the battalion level to sign the machine out.
- Sometimes only a few M41 PATS at the sites are functional at any one time.

Finding D. M41 Protection Assessment Test System Training

- Many NBC personnel believe that it takes too long to do a fit test, especially when the individual fails because the test must be redone.
- Many NBC noncommissioned officers have been tasked with NBC responsibilities in addition to their full-time jobs.

As a result, in many cases, the M41 PATS are sitting on shelves or they remain in the original packing. The majority of operators expressed concern that NBC defense lacks command emphasis at all levels.

Summary of Questionnaire Results. We met with 188 operators of the M41 PATS and distributed questionnaires on operator training. The operators identified the following general concerns relating to the M41 PATS:

- NBC noncommissioned officers lack training.
- NBC noncommissioned officers have no experience with the equipment.
- The PATS is fielded at too high a level.
- The lack of command emphasis and oversight in NBC defense resulted in training on NBC equipment not being incorporated into the soldiers' combat exercises.

The M41 PATS operators from the Army Chemical School and the four bases also stated that many of the M41 PATS fit testers were sitting on shelves or remained in the original packing. Appendix C of this report contains the questionnaire and summary of responses.

M41 PATS Operator's Certification. No certification requirement exists on the M41 PATS within the Services. However, the Defensive Chemical Test Equipment Division at Pine Bluff Arsenal, Arkansas, certifies Marine Corps operators who use the functional testers, such as the M14, M4A1, Q179, and Q204.

During our site visits, the M41 PATS was not being used consistently between the units, within units at the installations, or in installations throughout the Services. A certification program for the M41 PATS would ensure that operators maintain the proficiency they need to manage the M41 PATS program efficiently and effectively and would promote consistent use among the Services.

Preventive Maintenance Checks and Services

“The Joint Service Integration Mask Surveillance Process Action Team Interim Report” states that the soldiers are not adequately trained on the NBC equipment during enlisted and officer entry level basic training. Specifically, training lacks instructions on the proper care and maintenance of protective

Finding D. M41 Protection Assessment Test System Training

masks despite the training manuals and technical orders. Adequate PMCS must be performed because it is crucial to the functioning of the protective mask and the success of an M41 PATS fit. Basic training on mask PMCS should include sufficient time to ensure that the soldier is able to break down and reassemble mask components once assigned to a unit. For a mask to be effective, the soldier must perform adequate PMCS, the soldier should be able to achieve a good peripheral seal (mask fit), and the mask must be fully serviceable. The report also recommends that procedures be developed that provide commanders at all levels with a feedback tool on the effectiveness of PMCS and that hold commanders accountable. Services must require mandatory NBC training and education at all levels. Commanders need to integrate NBC defense operations into their training and field exercises.

M41 PATS as a Training Tool

The Services may not be fully realizing the training benefits of the M41 PATS because it is not programmed to display an actual fit-factor number and a pass or fail reading after each exercise. The Army, as the lead agent, programmed the M41 PATS to display a pass or fail reading based on an overall average of five exercises, rather than after each exercise. The M41 PATS can be programmed to display numeric results and a pass or fail reading after each exercise as well as an overall fit factor and pass or fail reading. Industry, surety sites, and the Chemical Defense Training Facility all display both a numeric fit factor and pass or fail reading after each exercise as well as overall numeric result and pass or fail reading.

Many M41 PATS operators believe that the M41 PATS should be used as a training tool by displaying pass or fail after each exercise to help identify problem areas and the masks with poor PMCS. Also, it would provide additional training to the individual on how to properly adjust the mask.

Training Circular 3-41. According to Training Circular 3-41, understanding the numerical quantitative fit factors can help to analyze problems or faults with the specific mask. The production qualification testing at Dugway, "Initial Operational Test and Evaluation," June 12, 1992, found that the M41 PATS could help to identify the particular movements that cause the fit-factor readings to fail. The test results allowed the M41 PATS operators to more precisely adjust or change the head harness for proper fit and to instruct mask wearers on possible problem areas by showing them which movement broke the mask seal. If the M41 PATS is not programmed to display a result after each exercise, the individual could break the seal and fail one or more of the exercises; however, the individual could pass the overall M41 PATS fit test and a potential fitting problem could go unnoticed.

Contractor's View. The contractor stated that the M41 PATS fit tester is a training tool to determine whether the individual performs adequate PMCS on the mask and to determine whether the interface of the "soldier-mask system" provides an adequate mask-face seal. Both PMCS and the M41 PATS test are needed to ensure the safety of the individual.

Finding D. M41 Protection Assessment Test System Training

Conclusion

The deficiencies in training on the M41 PATS are closely linked to the overall lack of command emphasis on NBC training within the Services. Commanders need to integrate NBC defense operations into their training and field exercises. The lack of command emphasis and oversight in NBC defense has resulted in training on NBC equipment not being incorporated into combat exercises, which is a readiness issue for our military forces. Specifically, the lack of training on the M41 PATS is contributing to many of the M41 PATS fit testers not being used. As a result, "soldier-mask" fit may be questionable, which could compromise the safety of military personnel during a chemical or biological encounter.

Recommendations, Management Comments, and Audit Response

D.1. We recommend that the Commandant, Army Chemical Center and School, revise the M41 Protection Assessment Test System program of instruction to allot sufficient time to ensure that each operator has adequate hands-on experience and the proficiency to teach others in the units that are responsible for chemical tasks.

Chemical School Comments. The Army Chemical Center and School recommended that Recommendation D.1. be revised to omit "program of" from "program of instruction" and that the phrase "and the proficiency to teach others in the units that are responsible for chemical tasks," be omitted.

Audit Response. The Chemical School comments were partially responsive. We reemphasize the need to revise the program of instruction to allot sufficient time to ensure that each operator has adequate hands-on experience and the proficiency to teach others in the units that are responsible for chemical tasks. Proficiency on the M41 is needed to effectively train the trainers. We request that the Commandant, Army Chemical Center and School, reconsider the recommendation and provide additional comments in response to the final report.

CBDCOM Comments. Although not required to comment, CBDCOM stated that the M41 PATS Program Office has been operating under a train-the-trainer philosophy since initial fielding.

Audit Response. The program of instruction must allot sufficient time to ensure that each operator has adequate hands-on experience to effectively train the trainers.

Finding D. M41 Protection Assessment Test System Training

D.2. We recommend that the Commander, U.S. Army Chemical and Biological Defense Command:

a. Develop a certification program for M41 Protection Assessment Test System operators to ensure reinforcement of knowledge and skills.

b. Establish a requirement that the M41 Protection Assessment Test System display a pass or fail after each exercise.

CBDCOM Comments. CBDCOM nonconcurred, stating that a certification program would represent a logistics burden to the program at every installation or unit with an M41 PATS. Also, CBDCOM stated that it is only possible to display a pass or fail reading after each exercise with the associated fit factor number displayed at the same time. CBDCOM stated that the soldier may be confused and misunderstand the significance of the actual fit factor numbers if they are displayed. The complete set of comments is in Part III.

Audit Response. The CBDCOM comments were nonresponsive. A certification program would ensure proficiency and continued use of the M41 PATS fit tester and any related administrative burden would be offset by increased assurance of troop safety. Although the M41 PATS program office did provide initial training to the operators, the train-the-trainer concept has not been effective within the Army due to rotation of NBC personnel; non-NBC soldiers performing NBC duties; and a lack of training, command emphasis, and oversight in NBC Defense.

Setting the M41 PATS tester to show the actual fit-factor number and a pass or fail reading after each exercise would enhance combat readiness. Displaying test results after each exercise will provide training reinforcement on the correct donning of the mask and identify which movement caused the seal to break.

We request that the Commander, CBDCOM reconsider Recommendations D.2.a. and b. in additional comments on the final report.

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Part II - Additional Information



Appendix A. Audit Process

Scope and Methodology

We conducted this program audit from August 1997 through April 1998, in accordance with the auditing standards issued by the Comptroller General of the United States as implemented by the Inspector General, DoD. The audit was temporarily suspended from October 1997 to January 1998 to do a Congressionally requested project. We conducted meetings with Government and industry personnel, distributed and analyzed M41 PATS training questionnaires (See Appendix C of this report), reviewed Army M41 PATS documentation, and analyzed technical data. We visited the units of the Army Forces Command, Army Materiel Command, and Army Training and Doctrine Command. We visited only Army units because the Navy has not purchased the M41 PATS and the Marine Corps and Air Force have only fielded the M41 PATS with limited use. The scope of the audit was limited in that we did not review the management control program.

DoD-wide Corporate Level Government Performance and Results Act Goals. In response to the Government Performance and Results Act, the Department of Defense has established 6 DoD-wide corporate level performance objectives and 14 goals for meeting these objectives. This report pertains to achievement of the following objective and goals.

Objective: Maintain highly ready joint forces to perform the full spectrum of military activities.

- **Goal:** Maintain high military personnel and unit readiness. (DoD-5.1)
- **Goal:** Maintain highly ready joint forces to perform the full spectrum of military activities by improving force management procedures throughout DoD. (DoD-5.3)

Use of Computer-Processed Data. We did not use computer-processed data to perform this audit.

Use of Technical Assistance. Personnel from the Analysis, Planning, and Technical Support Directorate assisted us during the audit. An operations research analyst reviewed the rationale used to generate fit-factor criteria for the M41 PATS. The Chief of the Mechanical Engineering Branch reviewed the M41 PATS and two alternative fit testers, the CNP 3000 Tester and the TDA-99M.

Contacts During the Audit. We visited four Army installations, two surety sites, three quasi-government organizations, five contractors, two respiratory consultants, and contacted other organizations and individuals within DoD. Further details are available on request.

Summary of Prior Coverage

Other than the previously discussed Inspector General, DoD, Report No. 95-021, "Defense Hotline Allegations Regarding DoD Fielding of Chemical Protective Masks," November 2, 1994, there has been no related audit coverage of the M41 PATS in the last 5 years.

Appendix B. Contract Summary

M41 PATS Contract Summary			
<u>Date</u>	<u>Contract Number</u>	<u>Purchaser</u>	<u>Number of Units</u>
March 16, 1984	DAAA15-84-C-0100	Army Prototype	60
December 4, 1990	DAAA15-91-C-0016	Urgency - Desert Storm	120
April 22, 1993	DAAA15-93-C-0028	Army & Marines	1,669
July 31, 1995	DAAE20-95-C-0354	Army	500
December 1, 1995	DAAE20-95-C-0354	Army	1,097
September 27, 1996	DAAE20-95-C-0354	Navy, Air Force, & Surety Sites	244
November 25, 1996	DAAE20-95-C-0354	Army	1,351
November 25, 1997	DAAE20-98-D-0016 ¹	Army	912
August 7, 1998	DAAE20-98-D-0016	Navy	<u>1</u>
TOTAL			5,954

¹This contract is for five ordering periods of 1 year each. The ordering periods are from November 1997 through September 2002. There are no requirements for the fourth and fifth ordering periods yet. The unit price for periods two through five has been negotiated and is dependent on quantity.

Appendix C. M41 Protection Assessment Test System Operator Questionnaire Results

Name _____

Phone _____

**Audit of the M41 PATS Capabilities and Limitations
Project No. 7AD-0060**

M41 PATS Operator/User Questionnaire

1. What training did you receive as an operator of the M41 PATS? Please circle the forms of training that you have received.

	Classroom	Refresher or Periodic	Video Tape	Operator's Manual	On the Job
Location	_____	_____	_____	_____	_____
Date	_____	_____	_____	_____	_____

Have you had any other training? If yes, briefly explain:

2. What guidance (regulations, instructions, operating procedures, etc.) are you required to follow as an operator of the M41 PATS?
3. Have you used the M41 PATS? Please Circle **Y** or **N**
(If you have not used the M41 PATS then go to Question 7)
Approximately how many times have you performed the fit test on a soldier?
4. Do you ensure that the proper preventive maintenance checks and services (PMCS) are performed prior to the M41 PATS test? If not, Why?
5. Have there been any maintenance problems with the M41 PATS? If yes, briefly explain.
6. Are you required to maintain a database of fit test results? If not, do you personally maintain the database.

Appendix C. M41 Protection Assessment Test System Operator Questionnaire Results

7. As an operator, do you feel that PMCS and the M41 PATS fit test alone can render the soldier combat ready? Why or why not?

8. How do you like the M41 PATS? Do you recommend using it?

9. Comment on the advantages and limitations of the M41 PATS and provide any suggestions to improve testing of protective masks.

Advantages

Limitations

Suggestions for Improvement

Appendix D. "As Found" Calibration Test Results

No.	Serial Number	Calibration Date	Last Calibrated	Months Used	Percentage Differences			
					Leak 1	Leak 2	Leak 3	Leak 4
1	221513	30-Mar-98	Mar-97	12.9	-10.3	-9.0	-5.1	0
2	23798	27-Mar-98	Nov-96	16.8	11.3	15.7	16.7	14.8
3	21184	26-Mar-98	Jan-94	50.7	-61.6	0	0	0
4	20503	23-Mar-98	Nov-94	40.6	-23.3	-17.5	-14.4	-14.3
5	23196	20-Mar-98	Jun-94	45.5	-100.0	-100.0	-100.0	-96.3
6	23192	19-Mar-98	Nov-94	40.5	8.6	6.7	8.2	7.4
7	20893	18-Mar-98	Sep-93	54.4	-18.9	0	0	0
8	21678	18-Mar-98	Jun-94	45.4	-12.3	1.0	7.4	7.4
9	22083	18-Mar-98	Oct-94	41.4	-12.2	0	0	0
10	20900	18-Mar-98	Nov-94	40.4	-4.0	-1.0	1.1	0
11	20979	18-Mar-98	Oct-93	53.4	-11.7	-12.5	2.1	3.6
12	20808	18-Mar-98	Sep-93	54.4	-100.0	-100.0	-100.0	-96.4
13	20906	18-Mar-98	Nov-94	40.4	-4.0	-1.0	1.1	0
14	21008	16-Mar-98	Oct-93	53.3	-6.1	0	2.1	-3.6
15	21694	16-Mar-98	Jun-94	45.4	-13.9	-11.0	-9.0	-3.6
16	22080	16-Mar-98	Nov-94	40.4	-18.0	-15.7	-16.2	-7.1
17	21699	16-Mar-98	May-94	46.4	-13.9	-11.0	-9.0	-3.6
18	21719	16-Mar-98	Jun-94	45.4	-13.9	-11.0	-9.0	-3.6
19	21790	13-Mar-98	Jul-94	44.3	0	0	0	0
20	21815	10-Mar-98	Jul-94	44.2	0	0	0	0
21	22959	10-Mar-98	Mar-96	24.2	3.1	6.2	8.1	7.1
22	22963	10-Mar-98	Mar-96	24.2	6.5	6.2	2.0	-3.6
23	23163	10-Mar-98	May-96	22.2	-6.9	-0.4	-2.0	-3.6
24	18094	09-Mar-98	Sep-96	18.2	-26.2	0	0	0
25	18089	09-Mar-98	Sep-96	18.2	-20.0	0	0	0
26	18093	09-Mar-98	Sep-96	18.2	-55.8	0	0	0
27	21512	09-Mar-98	Apr-94	47.1	-7.3	11.7	17.9	22.2
28	20227	09-Mar-98	Sep-96	18.2	-26.2	0	0	0
29	17640	05-Mar-98	Sep-96	18.0	-11.7	8.6	11.5	11.1
30	21286	04-Mar-98	Feb-94	48.9	-7.4	4.9	-3.1	7.4
31	21188	04-Mar-98	Jan-94	49.9	3.2	1.6	3.1	3.7
32	21374	04-Mar-98	Mar-94	48.0	-99.7	-98.9	-100.0	-100.0
33	21270	04-Mar-98	Feb-94	48.9	-11.5	-12.7	-11.3	-3.7
34	22056	04-Mar-98	Oct-94	41.0	-3.6	3.9	7.2	3.6
35	21163	04-Mar-98	Jan-94	49.9	-57.0	-46.2	-48.5	-48.1
36	21660	04-Mar-98	May-94	46.0	0.1	8.0	7.2	3.6
37	21352	04-Mar-98	Feb-94	48.9	3.8	7.7	9.4	7.4
38	21388	04-Mar-98	Mar-94	48.0	5.4	13.9	16.7	14.8
39	21166	04-Mar-98	Jan-94	49.9	-57.0	-46.2	-48.5	-48.1
40	21378	04-Mar-98	Mar-94	48.0	-99.7	-98.9	-100.0	-100.0
41	21393	04-Mar-98	Mar-94	48.0	5.4	13.9	16.7	14.8
42	21195	04-Mar-98	Jan-94	49.9	3.2	1.6	3.1	3.7
43	21379	04-Mar-98	Mar-94	48.0	-99.7	-98.9	-100.0	-100.0

Appendix D. "As Found" Calibration Test Results

No.	Serial Number	Calibration Date	Last Calibrated	Months Used	Percentage Differences			
					Leak 1	Leak 2	Leak 3	Leak 4
44	22150	03-Mar-98	Nov-94	39.9	-3.4	1.0	5.2	7.4
45	22064	03-Mar-98	Oct-94	41.0	3.3	6.7	6.2	7.4
46	20526	03-Mar-98	May-92	69.9	-7.5	1.0	3.1	3.7
47	21669	03-Mar-98	May-94	46.0	-17.6	-23.0	-14.6	-14.8
48	23033	03-Mar-98	Mar-96	24.0	-8.8	1.0	3.2	0
49	22943	03-Mar-98	Mar-96	24.0	-44.7	-8.6	1.0	0
50	20524	02-Mar-98	Oct-92	64.9	-0.9	8.8	8.0	7.1
51	22316	02-Mar-98	Jan-95	37.9	-25.9	-25.2	-27.0	-25.0
52	23041	02-Mar-98	Mar-96	24.0	-7.1	0	1.1	-11.1
53	18092	02-Mar-98	Sep-96	17.9	-20.6	-12.6	-8.3	-7.4
54	22118	02-Mar-98	Nov-94	39.9	-0.5	5.8	329.5	251.9
55	18091	27-Feb-98	Sep-96	17.8	-5.9	3.9	-4.2	7.4
56	21664	26-Feb-98	Jun-94	44.8	-9.8	-9.1	-8.2	3.7
57	21661	26-Feb-98	Jun-94	44.8	-9.8	-9.1	-8.2	3.7
58	22165	26-Feb-98	Nov-94	39.8	-6.6	-3.9	0	0
59	20588	26-Feb-98	Nov-92	63.7	5.5	2.2	5.2	7.4
60	20590	26-Feb-98	Nov-92	63.7	5.5	2.2	5.2	7.4
61	22200	24-Feb-98	Nov-94	39.7	0	0	0	0
62	21896	23-Feb-98	Aug-94	42.7	0	0	0	0
63	21628	19-Feb-98	May-94	45.6	-17.6	-17.3	-13.5	0
64	21106	19-Feb-98	Dec-93	50.5	-10.4	-6.6	-3.1	3.7
65	21060	19-Feb-98	Nov-93	51.5	-14.6	-14.2	-6.2	-3.7
66	23195	17-Feb-98	May-96	21.5	0	0	0	0
67	21504	17-Feb-98	Apr-94	46.5	0	0	0	0
68	23152	17-Feb-98	May-96	21.5	-17.1	-16.0	-12.4	-3.7
69	23148	13-Feb-98	Apr-94	46.4	-13.2	-11.3	-9.3	-7.4
70	23198	13-Feb-98	May-96	21.4	-98.8	-93.8	-89.7	-88.9
71	23125	12-Feb-98	May-96	21.4	-6.4	-6.0	-4.1	-3.7
72	21525	11-Feb-98	Jun-94	44.3	-38.0	-35.8	-29.2	-7.4
73	23223	11-Feb-98	May-96	21.3	-1.8	3.8	5.2	7.4
74	22196	10-Feb-98	Nov-94	39.2	-17.6	-11.8	-11.5	-10.7
75	22016	10-Feb-98	Oct-94	40.3	4.9	3.1	5.3	3.7
76	21299	09-Feb-98	Apr-94	46.2	-23.4	-25.1	-33.0	-33.3
77	21256	09-Feb-98	May-96	21.3	-38.4	-30.6	-18.9	-14.8
78	21476	05-Feb-98	Apr-94	46.1	-6.2	-3.7	-3.1	-3.7
79	22014	05-Feb-98	Oct-94	40.1	-7.6	-6.4	-10.4	0
80	22015	05-Feb-98	Oct-94	40.1	-13.8	-16.1	-25.0	-11.1
81	21480	05-Feb-98	Apr-94	46.1	-98.7	-95.1	-96.9	-92.6
82	20585	05-Feb-98	Nov-92	63.0	-100.0	-99.9	-100.0	-100.0
83	21003	05-Feb-98	Oct-93	52.1	-4.1	-3.8	-3.1	-11.5
84	21501	05-Feb-98	Apr-94	46.1	-98.7	-95.1	-96.9	-92.6
85	21494	05-Feb-98	Apr-94	46.1	-98.7	-95.1	-96.9	-92.6
86	22219	04-Feb-98	Dec-94	38.1	3.3	9.8	9.3	7.1
87	22109	04-Feb-98	Nov-94	39.0	18.0	16.8	19.6	10.7
88	22144	04-Feb-98	Nov-94	39.0	14.6	10.3	10.4	7.4
89	22156	04-Feb-98	Nov-94	39.0	-25.8	-20.3	-17.9	-18.5
90	22103	04-Feb-98	Nov-94	39.0	-100.0	-99.9	-99.0	-96.3
91	22145	04-Feb-98	May-94	45.1	-0.3	1.5	8.4	7.4

Appendix D. "As Found" Calibration Test Results

No.	Serial Number	Calibration Date	Last Calibrated	Months Used	Percentage Differences			
					Leak 1	Leak 2	Leak 3	Leak 4
92	21171	03-Feb-98	Jan-94	49.0	-14.6	-5.6	-1.0	0
93	21207	03-Feb-98	Jan-94	49.0	-4.7	-1.0	1.0	0
94	23025	03-Feb-98	Mar-96	23.1	-21.3	-21.7	0	0
95	23137	03-Feb-98	May-96	21.1	-20.3	-19.1	-4.2	-3.7
96	23069	03-Feb-98	Mar-96	23.1	-7.9	2.0	5.3	3.7
97	23098	03-Feb-98	Mar-96	23.1	-7.9	2.0	5.3	3.7
98	22929	02-Feb-98	Mar-96	23.0	-7.4	-6.8	-7.1	0
99	21302	02-Feb-98	Feb-94	47.9	-4.2	-1.3	1.0	3.6
100	23459	02-Feb-98	Aug-96	18.0	-4.4	-5.0	-1.0	3.6
101	21269	02-Feb-98	Feb-94	47.9	12.2	12.0	8.1	3.6
102	22931	29-Jan-98	Mar-96	22.9	-27.4	-22.0	-17.2	-14.3
103	21350	29-Jan-98	Feb-94	47.8	-14.1	-12.3	-3.1	0
104	21897	29-Jan-98	Nov-96	14.9	-27.0	-9.2	0	0
105	23237	28-Jan-98	Jun-96	19.9	-1.8	-3.2	-1.0	3.6
106	22745	27-Jan-98	Jan-96	24.8	-2.2	4.7	5.1	7.4
107	23713	27-Jan-98	Oct-96	15.8	-5.8	0	2.1	3.7
108	23650	27-Jan-98	Oct-96	15.8	-12.0	-2.8	0	3.7
109	20530	27-Jan-98	Oct-92	63.7	-0.4	-1.0	2.1	3.7
110	21260	26-Jan-98	Jan-94	48.7	-18.8	-10.8	-6.1	0
111	21848	22-Jan-98	Jul-94	42.7	-31.3	-30.6	-30.0	-28.6
112	23023	20-Jan-98	Mar-96	22.6	-4.6	-8.5	2.1	0
113	22960	20-Jan-98	Mar-96	22.6	-1.2	-2.9	-2.1	0
114	22961	20-Jan-98	Mar-96	22.6	-98.3	-86.8	-40.0	-22.2
115	22962	20-Jan-98	Mar-96	22.6	-4.4	1.0	8.4	7.4
116	22971	20-Jan-98	Mar-96	22.6	-6.3	4.9	8.4	7.4
117	22970	20-Jan-98	Mar-96	22.6	-80.0	-31.2	1.1	3.7
118	22899	20-Jan-98	Feb-96	23.6	2.2	3.9	7.4	3.7
119	21358	20-Jan-98	Mar-94	46.6	0	-2.9	2.1	7.7
120	21722	16-Jan-98	Jun-94	43.4	-25.9	-20.9	-16.0	-15.4
121	22081	16-Jan-98	Oct-94	39.4	-4.8	-16.9	-2.1	0
122	21301	15-Jan-98	Feb-94	47.3	-15.9	-9.1	-6.4	-7.7
123	22552	15-Jan-98	Oct-95	27.4	-19.0	-23.6	-13.7	0
124	22104	15-Jan-98	Nov-94	38.4	-28.9	-26.1	-21.3	-11.5
125	22097	14-Jan-98	Jan-97	12.4	-8.6	0	0	0
126	20796	13-Jan-98	Sep-96	16.4	-8.6	-4.4	-2.1	3.8
127	20591	12-Jan-98	Feb-97	11.3	-11.6	-5.4	-2.1	3.7
128	23438	12-Jan-98	Jul-96	18.4	1.4	1.9	7.3	7.4
129	23328	12-Jan-98	Apr-96	21.3	-0.8	0	2.1	7.4
130	20774	09-Jan-98	Aug-93	53.2	-18.3	-15.6	-11.5	-7.4
131	23370	09-Jan-98	Jul-96	18.3	-8.2	-3.8	6.2	7.4
132	20788	09-Jan-98	Aug-93	53.2	-100.0	-99.9	-100.0	-100.0
133	22038	08-Jan-98	Oct-94	39.2	-32.2	-33.5	-26.8	-18.5
134	21198	07-Jan-98	Jan-94	48.1	-1.1	9.6	11.6	11.1
135	20909	05-Jan-98	Oct-93	51.0	0.5	2.0	3.1	0
136	21405	05-Jan-98	Mar-94	46.1	-21.0	-10.3	-4.2	-3.7
137	21382	05-Jan-98	Mar-94	46.1	-45.9	-23.5	-25.0	-22.2
138	21386	05-Jan-98	Mar-94	46.1	-45.9	-23.5	-25.0	-22.2
139	21383	05-Jan-98	May-94	44.1	-45.9	-23.5	-25.0	-22.2

Appendix D. "As Found" Calibration Test Results

No.	Serial Number	Calibration Date	Last Calibrated	Months Used	Percentage Differences			
					Leak 1	Leak 2	Leak 3	Leak 4
140	21417	30-Dec-97	Mar-94	45.9	-4.9	0	5.2	3.7
141	20593	30-Dec-97	Feb-97	10.9	-1.7	5.8	5.9	3.4
142	22523	30-Dec-97	Sep-95	27.9	-7.1	-4.9	0	3.6
143	21927	30-Dec-97	Aug-94	40.9	4.4	1.9	2.0	3.6
144	20567	30-Dec-97	Jun-92	66.8	-5.1	2.9	6.9	6.9
145	20555	30-Dec-97	Dec-92	60.8	-0.9	-1	2.0	3.6
146	20800	29-Dec-97	Sep-93	51.8	-15.9	-12.1	-13.1	-10.7
147	20583	23-Dec-97	Jan-97	11.7	-19.3	-11.9	-10.0	-10.3
148	18006	23-Dec-97	Jul-96	17.7	-13.5	-12.0	-8.2	-3.6
149	21988	23-Dec-97	Sep-94	39.6	-6.2	-1.0	4.0	3.6
150	21561	23-Dec-97	May-94	43.7	2.8	5.7	6.1	3.6
151	21387	23-Dec-97	Mar-94	45.7	-15.5	-8.9	-10.1	-3.6
152	21401	23-Dec-97	Mar-94	45.7	-45.6	-23.1	-20.0	-17.9
153	17954	23-Dec-97	Jul-96	17.7	-3.3	-4.3	-3.1	-7.1
154	23395	23-Dec-97	Jul-96	17.7	-19.8	-11.6	-5.2	-3.7
155	22078	19-Dec-97	Oct-94	38.5	-5.1	-1.7	6.5	7.7
156	22059	19-Dec-97	Oct-94	38.5	-3.5	3.0	4.3	3.8
157	22074	19-Dec-97	Oct-94	38.5	-5.1	-1.7	6.5	7.7
158	21353	19-Dec-97	Feb-94	46.5	-7.5	-3.2	-2.1	-3.7
159	20981	19-Dec-97	Oct-93	50.5	-15.3	-14.0	-8.6	-7.7
160	23718	19-Dec-97	Oct-96	14.6	-6.0	-4.5	2.2	0
161	22071	19-Dec-97	Oct-94	38.5	-54.9	-44.9	-39.8	-38.5
162	22286	19-Dec-97	Dec-94	36.5	6.1	6.0	7.5	3.7
163	22293	19-Dec-97	Dec-94	36.5	6.1	6.0	7.5	3.7
164	21268	18-Dec-97	Feb-94	46.4	0	1201.3	0	0
165	23111	18-Dec-97	Apr-96	20.5	-4	-0.5	3.3	7.7
166	20972	18-Dec-97	Oct-93	50.5	16.8	-12.2	12.2	14.8
167	22953	18-Dec-97	Mar-96	21.5	-100.0	-100.0	-99.0	-96.3
168	23200	18-Dec-97	May-96	19.5	-0.6	1.0	1.1	3.7
169	21773	18-Dec-97	Jan-94	47.2	-30.1	-22.8	-20.7	-23.1
170	21855	18-Dec-97	Jul-94	41.5	2.4	6.4	10.5	11.1
171	23377	18-Dec-97	Jul-96	17.5	-7.1	-4.9	-2.1	-10.7
172	21264	18-Dec-97	Feb-94	46.4	0	1201.3	0	0
173	22819	15-Dec-97	Feb-96	22.4	-2.5	-1.3	1.0	0
174	22748	15-Dec-97	Jan-96	23.4	-11.2	-6.8	-5.0	0
175	21811	15-Dec-97	Jul-94	41.4	-100.0	-100.0	-99.0	-100.0
176	21584	15-Dec-97	May-94	43.4	-5.8	-3.3	0	3.6
177	22755	15-Dec-97	Jan-96	23.4	-2.5	-1.3	1	0
178	21448	15-Dec-97	May-95	31.4	-1.1	5.1	1.0	7.1
179	21586	15-Dec-97	May-94	43.4	-13.2	-6.8	-5.3	-3.8
180	21589	15-Dec-97	May-94	43.4	-100.0	-100.0	-100.0	-92.6
181	22996	11-Dec-97	Mar-96	21.3	-9.4	-8.3	-6.2	-14.8
182	22922	11-Dec-97	Feb-96	22.3	-99.5	-98.2	-95.7	0
183	22153	11-Dec-97	Nov-94	37.2	-5.5	1.0	4.1	3.6
184	23162	10-Dec-97	May-96	19.3	-18.6	-16.3	-13.5	-11.1
185	23154	10-Dec-97	May-96	19.3	-18.6	-16.3	-13.5	-11.1
186	21879	10-Dec-97	Aug-94	40.2	-100.0	-100.0	-100.0	-96.6
187	21860	10-Dec-97	Aug-94	40.2	-7.2	-2.6	-4.0	-6.9

Appendix D. "As Found" Calibration Test Results

No.	Serial Number	Calibration Date	Last Calibrated	Months Used	Percentage Differences			
					Leak 1	Leak 2	Leak 3	Leak 4
188	21879	10-Dec-97	Aug-94	40.2	-100.0	-100.0	-100.0	-96.6
189	21560	09-Dec-97	May-94	43.2	-18.1	-12.1	-6.7	-3.3
190	21594	09-Dec-97	Feb-98		-20.7	0	0	0
191	20500	08-Dec-97	Jan-96	23.1	-100.0	0	0	0
192	22977	05-Dec-97	Mar-96	21.1	-29.2	-24.5	-24.0	-24.1
193	22746	05-Dec-97	Jan-96	23.1	-23.0	-20.9	-17.0	-10.3
194	22976	05-Dec-97	Mar-96	21.1	-8.7	-2.8	4.0	0
195	20912	05-Dec-97	Oct-96	14.1	-14.9	-12.5	-9.0	-6.9
196	21427	04-Dec-97	Mar-94	45.0	-5.2	-3.3	-9.9	0
197	21186	04-Dec-97	Jan-94	47.0	-12.1	-9.9	-9.9	-6.9
198	23385	04-Dec-97	Jul-96	17.1	-4.1	8.2	9.4	11.1
199	23330	04-Dec-97	Jul-96	17.1	6.0	10.2	11.5	11.1
200	22882	03-Dec-97	Feb-96	22.0	-2.5	4.0	5.3	7.4
201	23386	03-Dec-97	May-96	19.0	1.5	3.0	6.3	3.7
202	22872	03-Dec-97	Feb-96	22.0	-12.0	-3.7	5.3	7.4
203	23376	03-Dec-97	Jul-96	17.0	-65.7	-17.8	-4.2	3.7
204	22297	02-Dec-97	Dec-94	36.0	-4.6	-2.8	-4.6	3.3
205	21019	02-Dec-97	Nov-93	48.9	-18.8	-12.4	-3.7	-3.3
206	22299	02-Dec-97	Dec-94	36.0	-4.6	-2.8	-4.6	3.3
207	22967	01-Dec-97	Mar-96	21.0	-15.8	-12.2	-12.0	-6.5
208	21070	01-Dec-97	Nov-93	48.9	-36.7	-70.4	-22.4	-29.0
209	20782	01-Dec-97	Aug-93	51.9	-22.3	-15.4	-28.0	-16.1
210	22306	01-Dec-97	Dec-94	35.9	-74.4	-46.9	-39.8	-32.3
211	17510	26-Nov-97	Mar-97	8.9	0	0	0	0
212	21568	26-Nov-97	May-94	42.8	2.7	1.0	2.9	3.4
213	21611	26-Nov-97	May-94	42.8	-10.9	-1.9	-1.9	3.4
214	20596	25-Nov-97	Nov-92	60.7	-10.7	-6.7	0	0
215	22614	25-Nov-97	Nov-95	24.8	-8.3	-10.6	-8.7	-6.7
216	16197	25-Nov-97	Jan-97	10.8	2.9	0.9	1.9	0
217	23209	25-Nov-97	May-94	42.8	-24.5	-13.7	-9.2	0
218	22138	24-Nov-97	Oct-95	25.7	-100.0	-100.0	-100.0	-100.0
219	21362	24-Nov-97	Mar-94	44.7	-15.4	-10.6	-8.2	-3.6
220	20663	24-Nov-97	Aug-93	51.7	-7.4	-0.2	2.0	3.6
221	21915	24-Nov-97	Aug-94	39.7	-17.3	-12.0	-5.1	-3.6
222	23206	24-Nov-97	May-96	18.8	-2.3	4.7	7.1	7.1
223	22131	24-Nov-97	Dec-94	35.7	-100.0	-100.0	-100.0	-100.0
224	22010	24-Nov-97	Mar-94	44.7	-12.2	-8.9	-7.1	0
225	23110	21-Nov-97	Jan-96	22.5	1.5	-1.0	4.0	3.4
226	23201	21-Nov-97	May-96	18.7	-7.3	-7.6	-1.0	3.6
227	21007	20-Nov-97	Nov-93	48.5	1.6	-1.0	-4.0	-3.6
228	22984	20-Nov-97	Mar-96	20.6	-4.6	-3.3	-2.0	0
229	22731	20-Nov-97	Jan-96	22.6	-3.6	1.0	6.1	7.1
230	21281	20-Nov-97	Feb-94	45.5	-100.0	-99.9	-100.0	-96.4
231	22516	20-Nov-97	Sep-95	26.6	-20.6	-8.3	-3.2	0
232	21071	20-Nov-97	Nov-93	48.5	-28.5	-18.4	-12.6	-11.1
233	21958	20-Nov-97	Sep-94	38.6	-95.6	-84.9	-78.1	-70.4
234	21284	20-Nov-97	Feb-94	45.5	-100.0	-99.9	-100.0	-96.4
235	21162	19-Nov-97	Aug-95	27.6	-100.0	-100.0	-99.0	-100.0

Appendix D. "As Found" Calibration Test Results

No.	Serial Number	Calibration Date	Last Calibrated	Months Used	Percentage Differences			
					Leak 1	Leak 2	Leak 3	Leak 4
236	21873	19-Nov-97	Aug-94	39.5	0	0	0	0
237	23418	18-Nov-97	Jul-96	16.6	-18.1	-12.3	-8.5	-7.4
238	22126	18-Nov-97	Nov-94	36.5	-23.9	-19.5	-9.4	0
239	22278	18-Nov-97	Dec-94	35.5	-7.3	-5.7	-1.0	0
240	21577	18-Nov-97	May-94	42.5	0	0	0	0
241	21578	18-Nov-97	May-94	42.5	0	0	0	0
242	21211	13-Nov-97	Jan-94	46.3	-16.6	-9.1	-5.2	-3.7
243	21172	13-Nov-97	Jan-94	46.3	-10.7	-6.5	1.0	3.7
244	22065	12-Nov-97	Oct-94	37.3	0	-1.9	2.0	3.7
245	21430	12-Nov-97	Mar-94	44.3	-20.0	-15.0	-9.4	-11.1
246	22110	10-Nov-97	Mar-94	44.3	-16.7	-12.3	-1.0	0
247	21262	07-Nov-97	Feb-94	45.1	-17.1	-14.5	-11.5	-7.4
248	21247	07-Nov-97	Jan-94	46.1	-20.7	-14.9	-7.1	-3.7
249	21274	07-Nov-97	Feb-94	45.1	-17.4	-16.2	-8.3	-7.4
250	21274	07-Nov-97	Feb-94	45.1	-17.4	-16.2	-8.3	-7.4
251	21356	07-Nov-97	Feb-94	45.1	-75.3	-56.9	-52.0	-37.0
252	21253	07-Nov-97	Jan-94	46.1	-20.7	-14.9	-7.1	-3.7
253	23477	06-Nov-97	Aug-96	15.1	-99.8	-97.6	-88.5	0
254	23513	06-Nov-97	Aug-96	15.1	-0.9	2.9	7.3	7.4
255	20877	05-Nov-97	Sep-93	50.0	-15.0	-8.6	-5.2	-3.7
256	23364	05-Nov-97	Jul-96	16.1	-21.9	-16.7	-8.2	-7.4
257	23406	05-Nov-97	Sep-96	14.1	-100.0	-99.9	-100.0	-96.3
258	20865	04-Nov-97	Sep-93	50.0	-100.0	-99.9	-99.0	-96.3
259	20886	04-Nov-97	Sep-93	50.0	-100.0	-99.9	0	0
260	20959	04-Nov-97	Oct-93	49.0	-13.4	-9.6	0	0
261	23139	03-Nov-97	May-96	18.1	-14.8	-12.3	-12.1	-10.7
262	21736	03-Nov-97	Jun-94	41.0	-21.5	-14.8	-9.5	-3.7
263	22162	31-Oct-97	Nov-94	35.9	-57.4	-52.0	-47.9	-44.4
264	21884	31-Oct-97	Aug-94	38.9	-21.0	-18.4	-13.5	-22.2
265	21507	31-Oct-97	Apr-94	42.9	-37.7	-22.3	-16.7	-14.8
266	20515	31-Oct-97	Dec-92	58.9	-100.0	-100.0	-100.0	-100.0
267	23225	31-Oct-97	May-96	18.0	-3.8	-3.8	3.1	3.7
268	20626	31-Oct-97	Mar-97	8.0	-100.0	-100.0	-100.0	-100.0
269	22192	31-Oct-97	Nov-94	35.9	-10.4	-3.8	-1.1	0
270	22160	31-Oct-97	Nov-94	35.9	-57.4	-52.0	-47.9	-44.4
271	20625	28-Oct-97	Mar-97	7.9	-11.1	-4.0	2.0	3.6
272	17513	28-Oct-97	Feb-97	8.8	3.3	2.8	9.2	7.1
273	17509	28-Oct-97			5.6	5.8	7.0	7.1
274	22029	27-Oct-97	Oct-94	36.8	-24.9	-13.2	-16.8	-21.4
275	22032	27-Oct-97	Oct-94	36.8	-24.9	-13.2	-16.8	-21.4
276	21874	27-Oct-97	Aug-94	38.8	0.7	2.9	3.0	0
277	22269	27-Oct-97	Dec-94	34.8	-7.7	-5.6	-2.9	0
278	22029	27-Oct-97	Oct-94	36.8	-24.9	-13.2	-16.8	-21.4
279	21602	27-Oct-97	May-94	41.8	-8.2	1.9	4.0	7.1
280	21647	23-Oct-97	Oct-94	36.7	-17.2	-10.0	-6.2	-3.7
281	21296	21-Oct-97	Feb-94	44.5	-29.5	-21.4	0	0
282	21724	20-Oct-97	Jun-94	40.6	-18.7	-21.3	-9.8	-10.3
283	22566	20-Oct-97	Oct-95	24.6	-23.4	-19.4	-13.4	-7.4

Appendix D. "As Found" Calibration Test Results

No.	Serial Number	Calibration Date	Last Calibrated	Months Used	Percentage Differences			
					Leak 1	Leak 2	Leak 3	Leak 4
284	20599	20-Oct-97	Nov-96	11.6	-19.6	-11.6	0	3.7
285	21871	17-Oct-97	Aug-94	38.5	-26.4	-21.6	-20.6	-7.4
286	22092	17-Oct-97	Oct-94	36.5	-12.2	-9.0	0	3.7
287	20550	17-Oct-97	Feb-97	8.5	-5.0	-7.5	1.0	0
288	21294	17-Oct-97	Feb-94	44.4	-22.9	-17.7	-5.2	0
289	21867	17-Oct-97	Aug-94	38.5	-26.4	-21.6	-20.6	-7.4
290	21024	17-Oct-97	Nov-93	47.4	-99.3	-93.5	-56.7	-29.6
291	22090	17-Oct-97	Oct-94	36.5	-12.2	-9.0	0	3.7
292	20569	17-Oct-97	Mar-97	7.5	-17.3	-16.1	-12.2	-11.1
293	21314	17-Oct-97	Feb-94	44.4	-11.2	-10.2	1.0	0
294	20539	17-Oct-97			-23.4	-17.9	-9.4	0
295	22193	15-Oct-97	Nov-94	35.4	-59.0	-30.1	-30.5	-19.2
296	22277	15-Oct-97	Dec-94	34.4	-99.6	-91.6	-62.9	-51.9
297	23003	15-Oct-97	Mar-96	19.4	-100.0	-100.0	-100.0	-96.3
298	23211	15-Oct-97	May-96	17.4	-12.3	-8.3	-2.1	0
299	22935	15-Oct-97	Mar-96	19.4	-99.9	-65.3	-2.0	-3.7
300	22964	15-Oct-97	Mar-96	19.4	-100.0	-100.0	-100.0	-100.0
301	22612	15-Oct-97	Nov-95	23.4	-10.0	-8.3	-6.1	-7.1
302	22117	14-Oct-97	Nov-94	35.3	3.7	1.0	2.1	3.7
303	23605	14-Oct-97	Sep-96	13.4	-12.1	-6.4	2.1	3.7
304	23419	14-Oct-97	Jul-96	15.4	-18.1	-15.7	0	0
305	23606	14-Oct-97	Sep-96	13.4	-6.8	-4.7	0	3.7
306	23529	14-Oct-97	Sep-96	13.4	-14.6	-8.3	0	0
307	23321	14-Oct-97	Jul-96	15.4	-23.3	-10.6	0	-3.7
308	23106	14-Oct-97	Apr-96	18.4	-13.1	-10.6	-2.1	3.7
309	22107	09-Oct-97	Nov-94	35.2	-85.0	-21.5	3.2	-3.7
310	21677	03-Oct-97	Nov-94	35.0	-16.3	-10.3	-7.3	-14.8
311	22908	03-Oct-97	Feb-96	20.0	-31.2	-21.1	-6.2	-3.7

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Committee on Government Reform and Oversight
House Committee on National Security

Part III - Management Comments

Deputy Assistant to the Secretary of Defense (Nuclear and Chemical and Biological Defense Programs)(Counterproliferation/Chemical and Biological Defense) Comments



NUCLEAR AND CHEMICAL
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PROGRAMS

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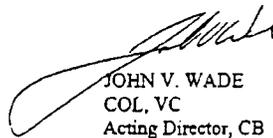
MEMORANDUM FOR OFFICE OF THE INSPECTOR GENERAL, DoD

SUBJECT: Audit Report on the M41 Protection Assessment Test System Capabilities
(PATS) (Project No. 7AD-0060)

The DATSD (NCB)(CP/CBD) has reviewed the subject report and has provided comments at the attachment. We will continue to evaluate and address these M41 PATS issues and coordinate necessary actions with the DoDIG.

We appreciate the opportunity to comment on this draft audit report.

The Point of Contact for this action is Mr. Mark Smith, OATSD(CB/CBD), 703-326-8572, e-mail - mark.smith@osia.mil.


JOHN V. WADE
COL, VC
Acting Director, CB

Deputy Assistant to the Secretary of Defense (Nuclear and Chemical and Biological Defense Programs)(Counterproliferation/Chemical and Biological Defense) Comments

AUDIT NOTES
FOLLOW ON
PAGES (73-76)

Final Report Reference

COMMENTS TO AUDIT REPORT ON THE M41 PROTECTION ASSESSMENT TEST SYSTEM

FINDING A

1. Page 8, **Operator Concerns**. Paragraph 2, First Sentence, "Although 83 of the 188 M41 PATS operators recommend or liked the M41 PATS, only 31 thought that the M41 PATS should be used as a combat readiness tester.

1

Revised

Comment: Recommend modifying or deleting this sentence.

Rationale: Accuracy. According to Appendix C, the question on the survey regarding whether the operators like/recommend the M41 PATS was not posed to the 75 combined operators at Fort Lewis and Fort Campbell. Consequently, this question was only included on surveys for 113 operators, not 188. Of the 113 operators, 83 liked/recommend the PATS. As currently written this statement implies that 105 operators did not like/recommend the M41 PATS which may not be accurate. The 31 operators who thought that the PATS should be used as a combat tester did include the operators at Fort Lewis and Fort Campbell.

2. Page 9/10. **Recommendations for Corrective Action**

Revised

Comment: Recommend that indicated portions of Item A.1. be reworded to read as follows:

"We recommend that the Deputy Assistant to the Secretary of Defense (Nuclear and Chemical and Biological Defense Programs)(Counterproliferation/Chemical and Biological Defense):

1. Task the Army, as the Executive Agent, to attempt to determine the combat effectiveness of the current fit test regime by performing an operational test using the M40 Chemical Protective Mask and the M41 Protection Assessment Test System against simulated battlefield conditions using force on force training in both desert and swamps conditions. "

DATSD (NCB) (CP/CBD) concurs with Items A.2. and A.3. as written.

Rationale: This modification clarifies the intent and conditions under which the operational test will be conducted.

FINDING B.

1. Page 11, **Background**

2

Revised

Comment: Recommend these paragraphs be modified to indicate that the JSMTWG recommended an interim minimum standard of 1,667.

Deputy Assistant to the Secretary of Defense (Nuclear and Chemical and Biological Defense Programs)(Counterproliferation/Chemical and Biological Defense) Comments

Final Report Reference

Pages 17-18

Rationale: Accuracy.

2. Page 16, Recommendations for Corrective Action

Comment: Recommend paragraph B. be reworded to read as follows:

B. We recommend that the Deputy Assistant to the Secretary of Defense (Nuclear and Chemical and Biological Defense Programs)(Counterproliferation/Chemical and Biological Defense):

1. Task the Defense Intelligence Agency to reassess the STAR for the M41 PATS program and update the document as needed.

If significant changes are made to the threat document, then we also recommend the DATSD(NCB)(CP/CBD)

2. Task the Joint Service Material Group and Joint Service Integration Group to collectively review updated threat data and validate the current fit-factor criteria of 1,667 or establish the appropriate standard fit-factor criteria for fielded protective masks. The fit-factor criteria should consider the following items:

- a. the error rate of the M41 Protective Assessment Test System fit test,
- b. the nonoperational testing conditions of the M41 Protective Assessment Test System, and
- c. the effect of raising or lowering the fit factor.

Rationale:

The 1667 fit-factor criteria were established in the absence of a regular and rigorous fit test regime. With the M41 PATS there should be a higher level of assurance that the mask/soldier system is fully functional and ready for entrance into a combat situation. This office recognizes that the Warsaw Pack threat scenario which was the basis for the 1667 mask fit criteria may be out dated and that the STARS for the M41 Program should be reevaluated and updated as needed. However the Defense Intelligence Agency updates threat documents; not the U.S. Army Chemical School. The order of the taskings for Finding B were reversed because fit-factor criteria should follow the threat assessment.

FINDING C

No comment

FINDING D

Revised

Deleted

**Deputy Assistant to the Secretary of Defense (Nuclear and Chemical and Biological
Defense Programs)(Counterproliferation/Chemical and Biological Defese)**

No comment

Department of the Army Comments

Final Report
Reference

AUDIT NOTES
FOLLOW ON
PAGES (73-76)



REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR OPERATIONS AND PLANS
400 ARMY PENTAGON
WASHINGTON DC 20310-0400

DAMO-FDB

10 September 1998

MEMORANDUM THROUGH ^{et} DIRECTOR OF THE ARMY STAFF ^{RKC/11} RODNEY K. PRICE, LTC, GS, DDECC
ASSISTANT SECRETARY OF THE ARMY (RESEARCH,
DEVELOPMENT, AND ACQUISITION) ^{BN 25 SEP 98}

FOR INSPECTOR GENERAL, DEPARTMENT OF DEFENSE (AUDITING)

SUBJECT: Audit Report on the M41 Protection Assessment Test System (PATS)
Capabilities (Project No. 7AD-0060)

1. References.

- a. IG, DOD memorandum (with draft report), M41 Protection Assessment Test System (PATS) Capabilities, Project No. 7AD-0060, dated 01 Jul 98.
- b. Army Audit Agency Memorandum, SAAG-PMO-L (36-3b), 24 Jul 98, SAB.
- c. Headquarters, Army Materiel Command Memorandum, AMCIR-A (36-2a), 18 Aug 98, Subject: DODIG Draft Report, M41 PATS Capabilities, Project 7-AD-0060 (AMC No. D9756) (enclosure 1).
- d. Headquarters, U.S. Army Training and Doctrine Command Memorandum (1st End), ATIR (ATZN-CMC/28 Jul 98) (36-2b), Subject: Draft Audit Report on the M41 PATS (Project No. 7AD-0060), 07 Aug 98 (enclosure 2).

2. The Chemical Division, Office of the Deputy Chief of Staff for Operations and Plans, reviewed the draft capabilities report on the M41 PATS. We concur with the HQ, AMC (Chemical and Biological Defense Command (CBDCOM)) and HQ, TRADOC (U.S. Army Chemical School and Fort McClellan) comments at enclosures 1 and 2, respectively.

3. DAMO-FDB also coordinated with HQ, U.S. Army Forces Command, and their subordinate units. Comments include two issues: (1) correction of calibration procedures; and (2) authorization for floats on the installation. Units feel calibration problems, i.e., turn-in procedures and specific calibration requirements, can improve with training. Additional M41 PATS as floats on the installation will improve the units' ability to test more protective mask when organic PATS are turned in for calibration.

3

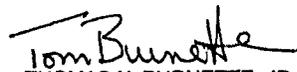
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Page 20

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DAMO-FDB
SUBJECT: Audit Report on the M41 Protection Assessment Test System (PATS)
Capabilities (Project No. 7AD-0060)

4. The ODCSOPS point of contact for this action is MAJ Johnson, DAMO-FDB, at 697-6600.

2 Encls


THOMAS N. BURNETTE, JR.
Lieutenant General, GS
Deputy Chief of Staff
for Operations and Plans

CF:
DAIG

Final Report
Reference

AUDIT NOTES
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U.S. ARMY CHEMICAL AND BIOLOGICAL DEFENSE COMMAND

COMMAND REPLY

DoDIG Draft Report, M41 Protective Assessment Test System (PATS) Capabilities,
Project 7AD-0060

General Comments. The following are submitted for accuracy and correction to
nomenclature.

- Revised - Replace "M41 Protective Assessment Test System" with "M41 Protection Assessment Test System" throughout the report. 4
- Revised - Replace "U.S. Army Chemical and Biological Command" and "U.S. Chemical and Biological Command" with "U.S. Army Chemical and Biological Defense Command" throughout the report. 5
- Revised - Page i, Introduction, change "the Army has contracted for 4,104 M41 Protective Assessment Test Systems" to "the Army has contracted for 6,864 M41 Protection Assessment Test Systems". 6
- Revised - Page 2, Contract Summary, same change as above. 7
- Revised Pages 38-44 - Pages 34-40, Appendix D, remove the column "Hours Used" from the table "As Found Calibration Test Results". This column should be removed for accuracy and fairness. The data found in this column is misleading. The hour meter associated with the data is nonfunctional as to accuracy. During slight power surges at shut down and start up of the unit, the hour meter may zero out, erasing all previous usage data. There is no way to verify whether this situation has occurred or not. The contractor has stated that the hour meter cannot be used to determine system use, and there is no requirement for the M41 PATS to have an internal usage monitor. 8

Specific Comments on Findings and Recommendations.

FINDING A - Capabilities of the M41 Protective Assessment Test System

Finding. Joint Service Mask Technical Working Group may be overstating the capabilities of the M41 PATS fit tester by contending that it is a combat-readiness tester. The situation exists because the M41 PATS does not test to operational readiness conditions and the JSMTWG is not fully considering other limitations of the M41 PATS. As a result, personnel may be inadequately protected in a chemical or biological environment.

Encl 1

CBDCOM Command Reply SUBJECT: M41 Protection Assessment Test System (PATS) Capabilities, Project 7AD-0060	AUDIT NOTES FOLLOW ON PAGES (73-76)	<u>Final Report Reference</u>
Additional Facts.		
a. Page 5, Operational Readiness Conditions. "The M41 PATS is intended to provide a quick and easy quantitative assessment of the fit of a protective mask, but the Army, as the Executive Agent for chemical and biological defense programs, is using the M41 PATS fit tester to determine whether a soldier is combat ready, even though it does not test to operational readiness conditions and the rigors of the battlefield." Change this sentence to read "The M41 PATS is intended to provide a quick and easy quantitative assessment of the fit and condition of a protective mask."	9	
Reason: The "operational readiness conditions" that the M41 fails to test to are not defined. The Army does not consider the M41 PATS as an indicative indicator of fit results under "the rigors of the battlefield."		
b. Page 5, M41 PATS Mask Fit Test, "The fit factor is lower when a person is breathing deeply in a static position." Delete this sentence in its entirety.	10	Revised
Reason: This is not a true statement. The fit factor will be lower when an individual is moving their head or during the jaw movement exercise when the face seal is more likely to be broken. Reference P.P Meunier and L.R Constantine, "Evaluation of a Miniature Condensation Nucleus Counter for Quantitative Fit Testing", Defense Research Establishment Ottawa, July 1990, page 7.		
c. Page 6, Air Force Test, this paragraph should be deleted in its entirety.	11	Revised
Reason: Accuracy and fairness. The data cited by this report is not statistically accurate and does not test to operational conditions as stated. The focus of the test was mask fitting procedures. The cited report itself states that the limited number of individuals tested can provide "no true conclusions." Reference "Protective Mask Fit Validation System (PMFVS) Initial Report", Headquarters USAF Air Warfare Center, Eglin AFB, FL, 3 June 1992, page 9.		
d. Page 7, Probe Location, this paragraph should be deleted in its entirety	12	Revised
Reason: Accuracy and fairness. As stated in the audit report "a Department of the Army memorandum, March 11, 1998, to Army, Air Force, and Marine Corps organizations indicated that the sample probe will no longer be used for sampling particles inside the mask. Instead, the air sample will be taken directly from the drink tube." The drink tube is located in the mouth-nose region and this change will be effective with the issuance of the Joint Service Technical Manual for the M41 PATS.		
e. Page 7, Sampling of Air Particles, this paragraph should be deleted in its entirety	13	Deleted
Reason: This statement is erroneous and false The contractor, TSI Inc., requested written minutes of discussions held with the DODIG for documentary purposes but none		
2		

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were ever provided. The M41 PATS grows submicrometer particles to supermicrometer alcohol droplets. The M41 PATS is sensitive to particles having diameters as small as 0.02 microns, but insensitive to variations in particle size, shape, composition, and refractive index. The M41 PATS can perform quantitative fit testing with virtually any aerosol. The mean diameter of ambient air particles is typically about 0.08 microns. The M41 PATS fit test is conducted in an ambient air environment in which there are typically no particles larger than 0.1 micron. Reference is not provided for the statement that the M41 PATS "samples only 10 percent of the air particles" or to what dangerous particles exist in the 3 to 10 micrometer range during a fit test. The M41 PATS uses a diaphragm vacuum pump operating at a flow rate of 0.7 liter per minute. The flow enters the M41 PATS through either the ambient port or the sample port. The switching valve determines which port is used. The outlet of the switching valve leads to the saturator end cap where the flow splits. A flow rate of 0.1 liters per minute enters the saturator and passes through the condenser, nozzle, and sensing volume. The remaining flow passes through the excess air line and is recombined with sample flow down-stream of the sensing volume. This results in a sample rate of 100 cm³/min for each exercise or an overall nominal rate of 700 cm³/min.

Revised
Page 7

f. Page 8, Displaying Test Results, delete in its entirety. 14

Reason: Since the report states that this issue will be addressed later in the report it should not be introduced at this point since it is not clear whether actual fit factor numbers or pass/fail readings are being referred to.

Revised

g. Page 8, Operator Concerns, this paragraph should be more specific and avoid generalities such as "some. . . operators doubt" and "operators frequently commented." 15

Reason: The M41 Program Office provides a questionnaire with the issuance of each M41. Of the total respondents from 14 separate installations, 73.8 percent answered in the affirmative to the question "Does the M41 PATS provide the user additional confidence in the mask?"; 11.9 percent answered "No."

h. Page 9, Conclusion, this section should be rewritten to clarify what is meant by "combat readiness tester." 16

Reason: A combat readiness tester does not test a piece of equipment to the rigors of the battlefield, rather it provides a level of assurance that the piece of equipment under consideration is fully functional and ready for entrance into a combat situation. The report consistently confuses combat readiness with combat degradation.

Recommendation A. We recommend that the Deputy Assistant to the Secretary of Defense (Nuclear and Chemical and Biological Defense Programs) (Proliferation/Chemical and Biological Defense).

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1. Task the Army, as the Executive Agent, to perform an operational test using the M40 chemical protective mask and the M41 Protective Assessment Test System fit tester against battlefield conditions using force on force training in both desert and swamp conditions.

2. Task the Army to include representatives from each of the Services; the U.S. Army Center for Health Promotion and Preventive Medicine; the U.S. Army Research Institute of Chemical Defense; the Edgewood Research, Development, and Engineering Center; and, the test community in the operational test.

3. Task the Secretariat of the Nuclear, Biological and Chemical Defense Board to oversee and review operational fit test results and change the M41 Protective Assessment Test System policy if the test results so warrant.

Action Taken. Nonconcur. These three recommendations should be eliminated in their entirety. The operational test described and recommended does not provide information on combat readiness. Checking soldiers with the M41 PATS either during combat or immediately after would provide information on the effects of combat degradation to the mask/soldier system and not on the combat readiness of that system.

An operational test is not appropriate to test the reliability or effectiveness of a combat readiness tester for masks. A long term monitoring program to track the fit and condition of the mask over time (thus readiness) would be more likely to provide data as to the actual combat readiness detection capabilities of the M41 PATS.

FINDING B - M41 Protective Assessment Test System Fit-Factor Criteria

Finding. The Joint Service Materiel Group has not formalized fit-factor criteria for the M41 Protective Assessment Test System because it has not implemented recommendations by the JSMTWG on criteria for testing fielded protective masks. In addition, the existing fit-factor criterion was developed using an out-of-date 1986 threat document, and it does not consider a safety factor. Finally, the interim fit-factor criterion of 1,667 is based on outdated toxicity estimates. As a result, the fit-factor criterion currently used by the Army may be underestimated and the Army could exceed its acceptable casualty criteria during a chemical or biological attack.

Additional Facts.

a. Page 13, Safety Factor Error Rate, modify this paragraph with regard to our comments to Finding C, Additional Facts, comment e.

17

Page 15

Reason: Accuracy.

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Page 19

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- b. Page 13, Safety Factor Testing Conditions, delete this paragraph in its entirety. 18

Reason: The M41 PATS is not an operational tester but a readiness tester. Nowhere does the Army differ with the statement that, "Fit factors achieved in nonoperational testing are not representative of the fit factor that will be achieved on the battlefield." This section should be eliminated because of lack of relevance.

Recommendation B. We recommend that the Deputy Assistant to the Secretary of Defense (Nuclear and Chemical and Biological Defense Programs) (Proliferation/Chemical and Biological Defense):

1. Task the Joint Service Materiel Group to establish standard fit-factor criteria for fielded protective masks. The fit-factor criteria should consider the following items:

- a. the error rate of the M41 Protective Assessment Test System fit test,
- b. the nonoperational testing conditions of the M41 Protective Assessment Test System, and
- c. the effect of raising or lowering the fit factor.

Action Taken. Nonconcur. The Joint Service Materiel Group met in October 1995 regarding fit factor. It was agreed to keep 1667 as an interim criteria (no threat change/no rationale to change). The criteria would be reevaluated if there was a threat change.

FINDING C - Calibration

Finding. The M41 Protective Assessment Test System (PATS) fit testers are not being returned for calibration in a timely manner because the M41 PATS operators were uncertain as to which organization would perform the calibration and what the turn-in procedures were. Also, no oversight was performed to ensure that the M41 PATS were turned in. As a result, 108 of the 311 M41 PATS returned for calibration were out of tolerance; therefore, the fit factors provided by those M41 PATS may be imprecise.

Additional Facts.

- a. Page 17, Calibration Requirements Army Requirements, the sentence "Other activities, such as surety sites, the Chemical Defense Training Facility, and the industry use different recalibration requirements" should be changed to read "Other activities, such as surety sites, the Chemical Defense Training Facility, and the industry use the contractor recommended maintenance interval of 12 months."

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<p>CBDCOM Command Reply SUBJECT: M41 Protection Assessment Test System (PATS) Capabilities, Project 7AD-0060</p>	<p>AUDIT NOTES FOLLOW ON PAGES (73-76)</p>	<p><u>Final Report</u> <u>Reference</u></p>
<p>Reason: Clarity and accuracy. It should be noted that the Army intends to eliminate the hour usage requirement in the Joint Service Manual because there is no known data limiting the functional hours of the M41 PATS.</p>		
<p>b. Page 18, Timeliness of Submission, paragraph 1, the sentence "The M41 PATS fit testers are not being returned in a timely manner" should read "The M41 PATS fit testers were not being returned in a timely manner prior to its reclassification as TMDE."</p>	20	Page 20
<p>Reason: Since the reclassification of the M41 as TMDE on 1 October 1997, the return rate has increased 1000 percent.</p>		
<p>c. Page 18, Timeliness of Submission, paragraph 1, the sentence "Also, the M41 PATS Program Office did not perform oversight to ensure that the M41 PATS were turned in for calibration" should be deleted in its entirety. Paragraph 2, the sentence "The instructions on where the machines should be sent for calibration may not have filtered down to all units" should be deleted.</p>	21	<p>Revised Page 20</p>
<p>Reason: The M41 Program Office does not have responsibility or capability for oversight of maintenance surveillance for all MACOM, Reserve and National Guard installations receiving the M41 PATS. Oversight responsibility falls under the Item Manager, Rock Island, U S. Army Materiel Command. The Item Manager issued numerous maintenance bulletins and circulars informing all recipients of their responsibility to return the M41 PATS for periodic maintenance. The operators manual provided with each M41 PATS provides instructions and notices for return of the M41 PATS for periodic maintenance. Return of the M41 PATS is mentioned in the operators manual on pages 6, 35, 44, 53, 67, and 74.</p>		
<p>d. Page 19, Out-of-Tolerance M41 PATS, paragraph 1, this paragraph should include information provided on the cracked case material defect.</p>	22	<p>Revised Page 21</p>
<p>Reason: Accuracy and fairness. The original 1200 M41 PATS produced in 1994 had a latent manufacturing defect that could result in an out of calibration unit. A structural weak spot existed in the cabinet wall around the filter well. This defect was corrected by the manufacturer who has replaced all cabinet cases on units turned in for calibration and being in the group of 1200. After the replacement of the cabinet case in these units, the amount of units being returned out of calibration should drop dramatically. These cases continue to be replaced on an as need basis and this policy will continue until the out-of-tolerance units are eliminated.</p>		
<p>e. Page 19, Out-of-Tolerance M41 PATS, paragraph 2, this paragraph should be rewritten to accurately depict the resultant fit factor from an out-of-tolerance M41 PATS.</p>	23	Deleted
<p>Reason: Accuracy and fairness. If the M41 PATS is out of tolerance due to a cracked case, leaking valve, or malfunctioning pump, the likely result will be the addition of unwanted particles into the particle stream or a failure in the self test and a totally</p>		
6		

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nonfunctional unit. Additional particles will skew the fit factor downwards because the fit factor is determined by taking the concentration of particles outside of the mask and dividing that number by the number of particles inside the mask. If a leak occurs these numbers will come closer together because of the addition of unwanted particles, and the resultant fit factor will approach 1, nowhere near the 1000s that a typical fit factor test would give. The DoDIG didn't consider the effect of individual generated aerosol particles that are indistinguishable from leaking particles during fit testing when considering the significance of the plus or minus 10 percent calibration requirement. The only false fit factor that can be given under is an extremely low fit factor. Reference A. H. Biermann, et. al., UCRL-CR-105696, "LLNL Evaluation of the Portacount for Determining Respirator Fit Factors", Lawrence Livermore National Laboratory, October 1991, pages 1-14.

Recommendation C. We recommend that the Commander, U.S. Army Chemical and Biological Command, task the M41 PATS Program Manager to:

1. Establish procedures for all M41 PATS to be turned in for initial recalibration, so that the Test, Measurement, and Diagnostic Equipment calibration management information system can track and notify the units when the equipment is to be returned for service.

Action Taken. Nonconcur. The current procedures initiated in October 1997 have shown dramatic increases in the return of M41 PATS. The return of M41 PATS through the TMDE system will be monitored by the M41 PATS Program Office to assure continued success in this regard. Any further increase above the 1000 percent increase already under way may inadvertently hamper the ability of the Army Primary Lab to efficiently calibrate and repair current M41 PATS.

2. Evaluate the M41 PATS calibration data collected from the Test, Measurement, and Diagnostic Equipment Activity and adjust the calibration requirement, if the calibration interval of 18 months or 500 hours of operation is not considered appropriate.

Action Taken. Nonconcur. The M41 PATS Program Office will continue to monitor and evaluate the calibration data collected by the Army. The Joint Service Manual will maintain the 18-month maintenance cycle while dropping the 500-hour requirement. Current data indicate that most units should be trouble free for 18 months regardless of hours accumulated.

FINDING D – M41 Protective Assessment Test System Training

Finding. The Services' Nuclear, Biological, and Chemical Commissioned Officers (NBC CO) and NBC Non-Commissioned Officers (NBC NCO) may not be receiving sufficient training to operate the M41 PATS. The following factors contributed to the situation:

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SUBJECT: M41 Protection Assessment Test System (PATS) Capabilities, Project
7AD-0060

- o Chemical School and base-level training does not provide sufficient hands-on training on the M41 PATS,
- o the Services have no operator certification requirement on the M41 PATS, and
- o the Services lack an overall command emphasis on Nuclear, Biological, and Chemical training and have an insufficient number of personnel assigned

As a result, many of the M41 PATS are sitting on shelves and not being used, which means that the "soldier-mask" fit may be questionable. An improper mask fit could compromise the safety of military personnel during a chemical and biological encounter.

Recommendation D.1. We recommend that the Commandant, U.S. Army Chemical Center and School, revise the M41 Protective Assessment Test System program of instruction to allot sufficient time to ensure that each operator has adequate hands-on experience and the proficiency to teach others in the units that are responsible for chemical tasks.

Action Taken. Although this recommendation does not affect this command, we offer the following comment. Nonconcur Field training conducted by the Army out of the M41 Program Office has been operating under a train-the-trainer philosophy since initial fielding.

Recommendation D.2. We recommend that the Commander, U.S. Army Chemical and Biological Command:

- a. Develop a certification program for M41 Protective Assessment Test System operators to ensure reinforcement of knowledge and skills.

Action Taken. Nonconcur. No special MOS is required to operate or train the M41 PATS. A certification program would merely represent a logistics burden to the program and every installation or unit with an M41 PATS in their equipment list.

- b. Establish a requirement that the M41 Protective Assessment Test System display a pass or fail after each exercise

Action Taken. Nonconcur. It is only possible to display a pass/fail after each exercise with the associated fit factor number displayed at the same time. The recognized training benefit must be weighed against the possibility of confusion and misunderstanding of the significance of the actual numbers displayed. Whether it would be possible to convince a soldier that the difference between a fit factor of 20,000 and 100,000 is completely insignificant is questionable. The difference between these two fit factors is actually 0.05 particles per milliliter. Reference Roy T. McKay, Ph D., "Fit Testing and Use of Negative Pressure Respirators for Protecting Military

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SUBJECT: M41 Protection Assessment Test System (PATS) Capabilities, Project
7AD-0060

Personnel Against Chemical Warfare Agents", University of Cincinnati Medical Center,
March 18, 1998, page 25.

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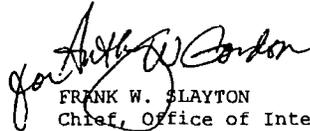
ATIR (ATZN-CMC/28 Jul 98) (36-2b) 1st End Mr. Gordon/ag/
DSN 680-2292
SUBJECT: Draft Audit Report on the M41 Protection Assessment
Test System (Project No.7AD-0060)

Commander, U.S. Army Training and Doctrine Command, Fort
Monroe, VA 23651-5000 7 Aug 98

FOR Headquarters, Department of the Army, ATTN: DAMO-FDB,
The Pentagon, Washington, DC 20310

1. Concur with the U.S. Army Chemical School and Fort
McClellan command reply to subject draft audit report.
2. TRADOC point of contact is Mr. Anthony Gordon, DSN
680-2292.

FOR THE COMMANDER:



FRANK W. CLAYTON
Chief, Office of Internal Review
and Audit Compliance

Department of the Army Comments



REPLY TO
ATTENTION OF:

DEPARTMENT OF THE ARMY
US ARMY CHEMICAL SCHOOL
FORT MCCLELLAN, ALABAMA 36205-5020

ATZN-CMC

28 July 1998

MEMORANDUM THRU Commander, TRADOC, ATTN: ATIR (Mr. Gordon), Bldg. P-247,
Fort Monroe, VA 23651-5000

FOR Headquarters, Department of the Army, ATTN: DAMO-FDB, The Pentagon,
Washington, DC 20310

SUBJECT: Draft Audit Report on the M41 Protection Assessment Test System (Project No.
7AD-0060)

1. References:

- a. Memorandum, DODIG Acquisition Management Directorate, 1 Jul 98, subject: Audit Report on the "Protective" Assessment Test System Capabilities (Project 7AD-0060).
- b. Memorandum, US Army Chemical School, ATZN-CMC, 12 Jun 98, subject: Discussion Draft Audit Report on the M41 Protection Assessment Test System (Project No. 7AD-0060)
- c. Memorandum, US Army Chemical School, ATZN-CMC, 17 Jun 98, subject: Discussion Draft Audit Report on the M41 Protection Assessment Test System (Project No. 7AD-0060)

2. The purpose of this memorandum is to provide comments on audit findings contained in reference 1a.

a. The draft audit report postulates that the quantification of protective mask requirements is based on an outdated threat. This postulate is erroneous. The threat is current, validated and officially documented in accordance with regulations in the Chemical and Biological Warfare Defense Systems - Nonmedical Capstone System Threat Assessment Report (STAR) dated 30 May 97.

b. The draft audit report postulates that the toxicity estimates used to quantify protective mask requirements are outdated. This postulate is erroneous. The categories used in the mask analyses are extrapolations based on the best toxicity data currently available.

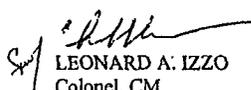
c. Many factors, such as blast, shrapnel and jerky movements, during a chemical attack will result in casualties in combat. This has been known for years. The proposed operational test is not technically feasible nor required

ATZN-CMC

SUBJECT: Draft Audit Report on the M41 Protection Assessment Test System (Project No. 7AD-0060)

3. Detailed comments were provided in references 1b and 1c.
4. The mask protection factor analysis is in the process of revalidation in support of the Joint Service General Purpose Mask (JSGPM).
5. US Chemical School POC is Dr. Charles E Kirkwood, DSN 865-6476.

FOR THE COMMANDANT:


LEONARD A. IZZO
Colonel, CM
Director of Combat Developments

CF:
HQ TRADOC (ATCD-SB)
Ft. McClellan IRAC (ATZN-IR)

Department of the Army Comments



REPLY TO
ATTENTION OF:

DEPARTMENT OF THE ARMY
US ARMY CHEMICAL SCHOOL
FORT MCCLELLAN, ALABAMA 36205-5020

ATZN-CMC

12 June 1998

MEMORANDUM THRU Headquarters, Department of the Army, ATTN: DAMO-FDB,
The Pentagon, Washington, DC 20310

FOR Department of Defense Inspector General, ATTN: Assistant Inspector General
for Auditing, The Pentagon, Washington, DC 20310

SUBJECT: Discussion Draft Audit Report on the M41 Protection Assessment Test System
(Project No. 7AD-0060)

1. References:

a. Finding B and Finding D of subject report, undated, received by FAX on 9 Jun 98
(enclosure 1)

b. Memorandum, HQ TRADOC, ATIN-I, 30 May 97, subject: Chemical and Biological
Warfare Defense Systems - Nonmedical Capstone System Threat Assessment Report (STAR),
(Report is classified SECRET.)

c. U.S. Army Center for Health Promotion and Preventive Medicine Report, TR-1605-10B,
"Information for Combat Developers on Performance Degrading Effects from Exposure to G-
Nerve Agents", dated 16 December 1997.

2. The purpose of this memorandum is to provide comments on audit findings contained in
Finding B of reference 1a. Comments are substantial in nature. It appears that the draft may
have been prepared well before the visit of the audit team to Fort McClellan in February 1998.

a. The draft audit report postulates that the quantification of protective mask requirements is
based on an outdated threat. This postulate is erroneous. The threat is current, validated and
officially documented in accordance with regulations in reference 1b. A copy of reference 1b,
dated 30 May 97, has been provided to the audit team.

b. The draft audit report postulates that the toxicity estimates used to quantify protective mask
requirements are outdated. This postulate is erroneous. The categories used in the mask analyses
are extrapolations based on the best toxicity data currently available. A copy of reference 1c,
dated 16 December 1997, has been provided to the audit team.

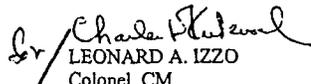
ATZN-CMC

SUBJECT: Discussion Draft Audit Report on the M41 Protection Assessment Test System
(Project No. 7AD-0060)

3. The updated information in paragraph 2 renders the conclusion and recommendations in Finding B, as well as Finding B, of the subject report invalid.
4. More detailed comments on Finding B are at enclosure 2.
5. Finding D is still undergoing review. Resulting comments will be forwarded as soon as available.

FOR THE COMMANDANT:

2 encls


LEONARD A. IZZO
Colonel, CM
Director of Combat Developments

CF:
HQ TRADOC (ATCD-SB)
Ft. McClellan IRAC (ATZN-IR)

Department of the Army Comments

Final Report
Reference

AUDIT NOTES
FOLLOW ON
PAGES (73-76)

11 June 1998

U.S. Army Chemical School comments on an undated discussion draft of Finding B, M41 Protective [sic] Assessment Test System Criteria received by FAX from Ms. Wills, Office of the DODIG, 9 June 1998.

Revised
Pages 11-16

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1. Pages 10 through 15, Finding B. In this finding and throughout the document, all references to an outdated "1986 threat document" must be deleted and specific reference to the "**Chemical and Biological Warfare Defense Systems – Nonmedical Capstone System Threat Assessment Report (STAR), approved 30 May 1997**" must be included. Recommendations and conclusions based on the erroneous statements that the threat used in derivation of mask protection factors/fit factors is not current must be deleted.

Reason.

a. The threat is current, validated and officially documented in accordance with regulations.

b. Three members of the DODIG team visited Fort McClellan in February 1998. There were detailed discussions during this visit concerning the currency of the threat used in deriving protection factor requirements for the mask. They are aware that the threat used for derivation of required protection factor/fit factor for the mask is current and is clearly documented in the Chemical and Biological Warfare Defense Systems – Nonmedical Capstone System Threat Assessment Report (STAR), approved 30 May 1997. This reference contains current intelligence from the National Ground Intelligence Center; Office of the Deputy Chief of Staff for Intelligence, Department of the Army; Office of Naval Intelligence; Marine Corps Intelligence Activity and National Air Intelligence Center. The following are quotes from the STAR:

"The Capstone System Threat Assessment for Chemical and Biological Warfare Defense Systems – Nonmedical is approved in accordance with AR 381-11, Threat Support to U.S. Army Force, Combat, and Materiel Development and TRADOC Reg 381-1, Threat Management."

"A CAPSTONE System Threat Assessment (STAR) is the DOD intelligence community's official assessment of the principle threat and capabilities that an adversary might reasonably bring to bear in an attempt to defeat or degrade a specific U.S. system. It is the authoritative reference describing the threat environment in which a U.S. system may be expected to operate."

c. The chemical challenge distributions used for the detailed calculations in the assessment of mask requirements and mask performance were created from attacks with a multiple rocket launcher system filled with nerve agent GB. This system delivers a high volume of agent in a rapid manner and presents a severe challenge to protective systems. These delivery systems are widely proliferated and are expected to remain in wide spread use for several years. The technology and knowledge required to deliver a chemical agent using this system present no barriers to any group desiring to do so.

Enclosure 2

AUDIT NOTES
FOLLOW ON
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Final Report
Reference

The multiple rocket launcher was a valid threat system in 1986 and has remained a valid threat continuously until the present.

d. In the case of protective equipment, including the mask, an extremely severe threat challenge is used to develop the requirements. If the mask can provide adequate protection against the extremely severe threat, it will provide adequate protection against less severe threats. Vapor and small aerosol particles provide a more difficult challenge than larger particles. An agent with high volatility and high toxicity provides a more severe challenge than an agent with low volatility and lower toxicity. We refer to these less severe threats as lesser included threats. In the case of mask protection, the threats posed by dusty and microencapsulated particles fall in the category of lesser included threats when compared to a heavy shoot using GB nerve agent. There are thousands of lesser included threats. We do not address each of the lesser included threats individually; this approach provides efficiency and economy in the utilization of resources.

2. Pages 10 through 15, Finding B. In this finding and throughout the document, delete all references to outdated toxicity estimates. Recommendations and conclusions based on the unsupported premise that inappropriate toxicity estimates have been used in derivation of mask protection factors/fit factors must be deleted

25

Revised
Pages 11-16

Reason.

a. The categories used in the mask analyses are extrapolations based on the best toxicity data currently available

b. To objectively apply information from a highly technical report, the user has an obligation to thoroughly study the entire report in depth including a review of the key references in the specific areas of interest to achieve an understanding. Many of the numerous inaccuracies, on pages 13 and 14 of Finding B, introduced in an attempt to paraphrase technical subject matter contained in ERDEC-SP-018, dated March 1994, "Review of Existing Toxicity Data and Human Estimates for Selected Chemical Agents and Recommended Human Toxicity Estimates Appropriate for Defending the Soldier" (SECRET Document), authored by Dr Sharon A. Reutter and Dr. John V. Wade, could possibly be eliminated by citing exact quotations which are included in quotation marks.

c. The points which the section on "Toxicity Estimates" attempts to make are based totally on inappropriate apples and oranges type comparisons. In large measure, the fallacy of the logic and conclusions in this discussion draft of Finding B is based on not considering and applying the following information contained in the cited Reutter and Wade report:

page 210, "As with all (human) toxicity estimates, the recommended estimates are valid only for the given exposure conditions – the specified ambient temperature, wind speed, humidity, respiratory MV and exposure duration. If the given assumptions are violated the estimates may no longer be valid."

page 29, "Ct means concentration times time. It should be noted that Ct ≠ k, e.g. a 2-minute exposure to a concentration of 100 mg/m³ (Ct = 200 mg min/m³) does NOT necessarily produce the same toxicological effects as a 50 minute exposure to a concentration of 4 mg/m³ (Ct = 200 mg min/m³)."

Department of the Army Comments

Final Report
Reference

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d. The following report prepared by the U.S. Army Center for Health Promotion and Preventive Medicine represents an extensive review of currently available toxicity information for G-Nerve agents. Report, TR-1605-10B, "Information for Combat Developers on Performance Degrading Effects from Exposure to G-Nerve Agents", dated 16 December 1997 was provided to the DODIG auditors during their visit to Fort McClellan in February 1998. Toxicity information was discussed with the auditors during this visit. The toxicity information provided in the report is not "outdated" – the report was published 16 December 1997.

Revised
Page 11

26

3 Page 10, Joint Service General Purpose Mask Fit Factor. The ORD has not been finalized or approved. It is still in a draft status.

Revised
Page 15

27

4. Page 12, Safety Factor. Delete the statement, "The Army's fit factor requirement of 1,667 does not include a safety factor."

Reason.

There actually is a significant safety margin included in the agent challenge; therefore, it has been the judgement that no additional safety factor is required.

Revised

28

5 Page 16. Delete paragraph 2.

Reason.

Based on the current information presented in paragraphs 1, 3 and 4 above, this is not required.



REPLY TO
ATTENTION OF:

DEPARTMENT OF THE ARMY
US ARMY CHEMICAL SCHOOL
FORT MCCLELLAN, ALABAMA 36205-5020

ATZN-CMC

17 June 1998

MEMORANDUM THRU Headquarters, Department of the Army, ATTN: DAMO-FDB,
The Pentagon, Washington, DC 20310

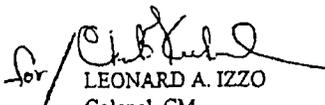
FOR Department of Defense Inspector General, ATTN: Assistant Inspector General
for Auditing, The Pentagon, Washington, DC 20310

SUBJECT: Discussion Draft Audit Report on the M41 Protection Assessment Test System
(Project No 7AD-0060)

1. Reference: Finding D of subject report, undated, received by FAX on 9 Jun 98 (enclosure 1)
2. The purpose of this memorandum is to provide comments on audit findings contained in reference 1a
5. Comments are at enclosure 2.

FOR THE COMMANDANT:

2 encls

for 
LEONARD A. IZZO
Colonel, CM
Director of Combat Developments

CF:
HQ TRADOC (ATCD-SB)
✓ Ft McClellan IRAC (ATZN-IR)

15 June 1998

U.S. Army Chemical School comments on undated discussion of Finding D, M41 Protective [sic] Assessment Test System Criteria received by FAX from Ms. Wills, Office of the DODIG, 9 June 1998.

1 Page 23, Results of Site Visits, Feedback from Interviews, Line 11, delete "and promote" the M41 PATS. The M41 requires no promotion and marketing from the users

2 Recommendation 1 is the only corrective action specified for the Chemical School in Finding D (page 26). This recommendation should be modified by deleting "program of" in line 2, and placing a period in line 3 after the word "experience." The recommendation should read: We recommend that the Commandant, U S. Army Chemical School revise the M41 PATS instruction to allot sufficient time to ensure each operator has adequate hands-on experience.

Reason. line 2 change. The M41 PATS is included in multiple courses and a Program of Instruction for each of those courses. It does not have its own POI Line 3 change the phrase "and the proficiency to teach others in the units that are responsible for chemical tasks" has no bearing on PATS training.

Revised
Page 26

ε. 2

Audit Notes

The following audit notes address most of the Deputy Assistant to the Secretary of Defense and the Department of the Army comments to the M41 PATS draft report. However, the audit response to management comments on the recommendations is in the body of the report.

1. We revised this report to state that 83 of 113 operators liked or recommend the M41 PATS. Additionally, only 31 of 188 operators felt that PMCS and the M41 PATS fit test alone can render the soldier combat ready. Based on these two questionnaire responses and discussions with M41 PATS operators, we believe that the soldiers like using the M41 PATS in addition to the CS chamber, but the M41 PATS alone does not give them confidence in their mask fit.
2. We revised the report to state that the JSMTWG recommended an interim **minimum** fit factor of 1,667.
3. We revised the report to include the U.S. Army Forces Command concern over calibration turn-in procedures and floats.
4. We replaced "M41 Protective Assessment Test System" with "M41 Protection Assessment Test System" throughout the report.
5. We replaced "U.S. Army Chemical and Biological Command" and "U.S. Chemical and Biological Command" with "U.S. Army Chemical and Biological Defense Command" throughout the report.
6. We revised the report to state that the Army procured "5,954" M41 Protection Assessment Test Systems.
7. We revised the Contract Summary to state that the Army procured "5,954" M41 Protection Assessment Test Systems.
8. We agree that no reliance can be placed on the M41 PATS hour meter and, therefore, no basis exists for an hourly calibration requirement. We revised Appendix D accordingly.
9. We reemphasize that the M41 PATS is intended to provide a quick and easy quantitative assessment of mask fit and that an adequate fit is part of determining the readiness status of the "soldier-mask" interface. The Army did not define what constitutes operational readiness conditions or combat readiness despite several requests. The Army's position was that the M41 PATS is the combat-readiness tester.
10. We have revised the report to state, "The fit factor while the soldier is performing those five exercises would be different from the fit factor when the soldier is under battlefield conditions. Under battlefield conditions, the fit factor will change based on heavy breathing and exaggerated movements."

Audit Notes

11. We included the Air Force test results in our report because they support our position that the Army may be overstating the capabilities of the M41 PATS by stating that it is a combat-readiness tester. Of 34 participants, 8 met the protection factor criterion while sitting but failed while working. As a result of management comments, we revised the report to state that a limited sample size was used. Additionally, we reworded the sentence to read "Although not an original test objective, the test team performed a test that compared the protection factor results of someone who was sitting to the protection factor results of someone who was lifting, bending, and twisting."

12. We acknowledged the Department of the Army memorandum, March 11, 1998, which states that that the sample probe will no longer be used for sampling particles inside the mask and that the air sample will be taken directly from the drink tube. We revised the second paragraph slightly.

13. We deleted this paragraph in its entirety. We did not receive the TSI request for written minutes referred to in the management comments.

14. One limitation of the M41 PATS is that the Army displays the mask fit test results as an overall pass or fail. Programming the M41 PATS test results to show both an actual fit factor number and a pass or fail reading after each exercise will enable the operator to identify specific problem areas. The operator would then discuss the problem(s) with the soldier, while reinforcing training on correct donning procedures and on proper mask cleaning. We have clarified the report to state that the actual fit factor number and pass or fail readings are being referred to.

15. We revised the report. The generalities and conclusions reached in the first paragraph are supported by the second paragraph, which contains results from our questionnaire. Differences between the M41 Program Office questionnaire results and the audit team's questionnaire results exist because the questions were different. The Program Office questionnaire asked whether the M41 PATS provide the user additional confidence in the mask, while the audit team's questionnaire asked whether the M41 PATS alone could render the soldier combat ready.

16. This report does not discuss combat degradation but clearly discusses that an adequate fit, as determined by the M41 PATS, is part of determining the readiness status of the "soldier-mask" interface. The M41 PATS is used to determine mask fit, and should not be categorized or relied upon as the combat-readiness tester. A separate FY 1993 Army study, "Cane Studies," showed the effects of combat degradation during a chemical attack scenario on the battlefield.

17. We did not modify the report to include management comments from Finding C, Additional Facts, comment e. CBDCOM states that 35 percent of M41 PATS were out-of-tolerance because a cracked case, leaking valve, or malfunctioning pump will result in a lower fit factor than the actual fit factor. The Army should return M41 PATS with cracked cases, leaking valves, or malfunctioning pumps to the TMDE so they can be fixed. The TMDE does both calibrations and maintenance functions, such as replacing cracked cases.

18. The difference between fit factors achieved in nonoperational testing and on the battlefield is relevant. To achieve a protection factor of 1,667 on the battlefield, the soldier should have a higher fit factor during nonoperational testing.

19. We revised the report to state that "Other activities, such as surety sites, the Chemical Defense Training Facility, and industry use the contractor-recommended interval of 12 months."

20. As of March 31, 1998, the M41 PATS were still not being returned every 18 months as required. The Army fielded 2,255 M41 PATS; however, only about 400 were returned for calibration by March 31, 1998. Although the M41 PATS return rate increased, a brief analysis shows that the M41 PATS are still not being returned as required. With 2,255 M41 PATS fielded, 125 (2,255/18 months) should be returned to the TMDE each month. However, only 311 M41 PATS were returned to the TMDE over a 6-month period.

21. We revised the report by removing the two sentences identified in the management comments.

22. We revised the paragraph to identify the three most common problems causing M41 PATS to be out of tolerance. It is true that many of the M41 PATS are out of tolerance because they have cracked cases. However, the TMDE stated that "about 10-20 percent of the units have pump failures or switching valve failures" and "many of the units which have cracked cases also fail for other reasons." As of April 16, 1998, the TMDE had replaced only 138 bottom cases. If the M41 PATS are turned in every 18 months as required, the TMDE will be able to replace the cracked cases and the number of out-of-tolerance M41 PATS should decrease.

23. We deleted this paragraph in its entirety. However, the Army should not rely on M41 PATS with defects that provide lower fit factors to ensure that soldiers meet the 1,667 protection factor requirement. The M41 PATS need to be calibrated to provide accurate fit factors.

24. The "1986 threat document" referred to in the draft report is the "Protective Mask Requirements Analysis Methodology," September 29, 1986. That report, not the Nonmedical Capstone STAR, was the basis for the fit-factor requirement of 1,667. We revised the report to clarify that we are referring to the "Protective Mask Requirements Analysis Methodology."

25. The toxicity estimates used in the "Protective Mask Requirements Analysis Methodology" were developed in the 1950s and 1960s, and since then, several toxicity studies have been performed. The Chemical School should consider all toxicity studies in determining which thresholds to use in the "Protective Mask Requirements Analysis Methodology."

26. The report has been revised accordingly.

27. The Army's fit factor requirement of 1,667 does not take into account the precision of the M41 PATS or its testing conditions. The Army needs to

Audit Notes

recognize that the M41 PATS provides a fit factor that is within only 20 percent of the TMDE calibration bench and that the fit factor achieved in nonoperational testing will be higher than the fit factor achieved on the battlefield.

28. The "Protective Mask Requirements Analysis Methodology," September 29, 1986, has not been updated. The Army's fit-factor requirement of 1,667 does not take into account the precision of the M41 PATS or its testing conditions. The fit-factor requirement derived from the "Protective Mask Requirements Analysis Methodology" uses toxicity estimates that were developed in the 1950s and 1960s. These toxicity estimates are equal to or higher than all three recent studies identified in this report.



Audit Team Members

The Acquisition Management Directorate, Office of the Assistant Inspector General for Auditing, DoD, produced this report.

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