



DEPARTMENT OF THE ARMY  
US ARMY INSTITUTE OF PUBLIC HEALTH  
5158 BLACKHAWK ROAD  
ABERDEEN PROVING GROUND MARYLAND 21010-5403

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MCHB-IP-OHH

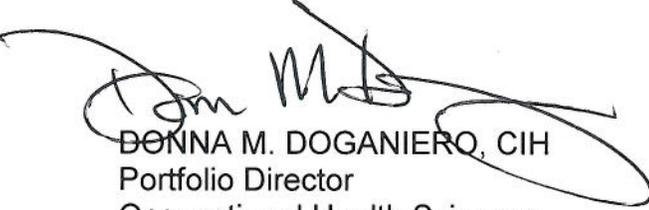
MEMORANDUM FOR Program Manager (RDAR-MEM-L/Mr. Ninh Vo), Multi-Role Anti-Armor Anti-Personnel Weapon System, Research Development Engineering Command-Armament Research, Development, and Engineering Center, Building 65 South, Picatinny Arsenal, New Jersey 07806-5000

SUBJECT: Health Hazard Assessment Report (RCS MED-388) No. S.0001938-13, Multi-Role Anti-Armor Anti-Personnel Weapon System Cannon Caliber Training System, 22 April 2013

1. This memorandum contains a copy of the subject report with an Executive Summary.
2. The Health Hazard Assessment Report (HHAR) contains an assessment of the health hazards identified during normal operation and maintenance of the materiel system, not resulting from a potential mishap or failure. Accordingly, safety or other Manpower and Personnel Integration (MANPRINT) domain assessments may conclude with different risk levels.
3. Provide the enclosed HHAR to System Safety, MANPRINT and Environment, Safety, and Occupational Health coordinators. Incorporate the identified health hazards and associated recommendations into MANPRINT and System Safety issue/hazard tracking logs. Use the HHAR to update the Programmatic Environment, Safety, and Occupational Health Evaluation (PESHE) and the Safety and Health Data Sheets (SHDS).
4. Provide the Army's Health Hazard Assessment (HHA) Program at this Institute with the results of risk mitigation and management decisions associated with the health hazards identified in this HHAR (e.g., SHDS, PESHE, MANPRINT Assessment, safety releases, and other appropriate documents).
5. Direct inquiries regarding the HHAR to the Army HHA Program Project Officer, Mr. David Segure, at commercial 410-436-2925, DSN 584-2925, or e-mail: david.s.segure.civ@mail.mil.

FOR THE DIRECTOR:

Encl

  
DONNA M. DOGANIERO, CIH  
Portfolio Director  
Occupational Health Sciences

MCHB-IP-OHH

SUBJECT: Health Hazard Assessment Report (RCS MED-388) No. S.0001938-13,  
Multi-Role Anti-Armor Anti-Personnel Weapon System Cannon Caliber Training  
System, 22 April 2013

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**U.S. ARMY PUBLIC HEALTH COMMAND**

5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5403

**HEALTH HAZARD ASSESSMENT REPORT (RCS MED-388)**

**NO. S.0001938-13**

**MULTI-ROLE ANTI-ARMOR ANTI-PERSONNEL WEAPON SYSTEM CANNON CALIBER  
TRAINING SYSTEM**

**22 APRIL 2013**

PHC FORM 433-E (MCHB-CS-IP), NOV 12

**Distribution authorized to U.S. Government Agencies only; protection of privileged information evaluating another command: Apr 13. Requests for this document must be referred to the Program Manager (RDAR-MEM-L), Multi-Role Anti-Armor Anti-Personnel Weapon System, Research Development Engineering Command-Armament Research, Development, and Engineering Center, Building 65 South, Picatinny Arsenal, New Jersey**

**Health Hazard Assessment Report: 500A**

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MCHB-IP-OHH

EXECUTIVE SUMMARY  
HEALTH HAZARD ASSESSMENT REPORT (RCS MED-388)  
NO. S.0001938-13  
MULTI-ROLE ANTI-ARMOR ANTI-PERSONNEL WEAPON SYSTEM CANNON  
CALIBER TRAINING SYSTEM  
22 APRIL 2013

1. PURPOSE. The Armaments Research Development and Engineering Center at Picatinny Arsenal, New Jersey, requested that the Army Institute of Public Health provide a Health Hazard Assessment Report (HHAR) for the Multi-Role Anti-Armor Anti-Personnel Weapon System Cannon Caliber Training System (MAAWS CCTS). This HHAR supports Milestone C and related procurement requirements associated with the U.S. Special Operations Command only.

2. CONCLUSIONS. This HHAR identifies one high risk (acoustic energy: impulse noise) and one low risk (acoustic energy: blast overpressure) potential health hazard associated with the use and/or maintenance of the MAAWS CCTS.

3. RECOMMENDATIONS.

a. Acoustic Energy: Impulse Noise. A risk assessment code (RAC) of High (hazard severity (HS) 2, hazard probability (HP) B) is assigned. A residual RAC of Medium (HS 2, HP E) is assigned for compliance with the following:

(1) Require all personnel within 224 meters (approximately 735 feet) of a firing MAAWS CCTS wear single hearing protection.

(2) For personnel wearing single hearing protection, allow no more than 31 firings per day of the MAAWS CCTS. When wearing double hearing protection, allow for 620 firings per day.

(3) Post warning signs at the training facilities where the MAAWS CCTS will be used.

(4) Each service should follow internal practices with regard to training, user warnings, and participation in hearing programs. Ensure all Army personnel involved in firing of the weapon will be enrolled in the Army Hearing Program.

(5) Include the preceding recommendations in all user and training materials and operating manuals describing the noise hazard and the mitigating actions necessary to make the operation safe.

b. Acoustic Energy: Blast Overpressure. A RAC of Low (HS 4, HP E) is assigned to all conditions used in this test. A residual RAC is not assigned due to the low injury risks associated with the initial RAC.

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HEALTH HAZARD ASSESSMENT REPORT (RCS MED-388)  
NO. S.0001938-13  
MULTI-ROLE ANTI-ARMOR ANTI-PERSONNEL WEAPON SYSTEM CANNON  
CALIBER TRAINING SYSTEM  
22 APRIL 2013

1. REFERENCES. Appendix A contains a list of references used in this Health Hazard Assessment Report (HHAR).

2. PURPOSE. To determine the potential health hazards associated with the Multi-Role Anti-Armor Anti-Personnel Weapon System (MAAWS) Cannon Caliber Training System (CCTS). This HHAR supports Milestone C and related procurement requirements associated with the U.S. Special Operations Command (USSOCOM) only.

3. AUTHORITY. The Army's Health Hazard Assessment (HHA) Program is an Army Medical Department initiative in cooperation with and in support of the Army acquisition process. The primary objective of the program is to identify and eliminate or control potential health hazards associated with the life cycle management of weapons, equipment, clothing, training devices, and other materiel systems. The proponent of the HHA Program is The Surgeon General (TSG) of the Army; however, TSG has designated the Army Institute of Public Health (AIPH) as the Lead Agent. The HHA Program provides support to materiel acquisition programs to ensure compliance with requirements contained in references 1 through 6.

4. BACKGROUND (references 7 through 21).

a. System Purpose. The USSOCOM has a requirement for a sub-caliber training version of the MAAWS. The requirement is for a system that approximates the ballistic flight of a full caliber 84 millimeter (mm) cartridge as well as the noise and blast effects from firing, minus any target effects (e.g. penetration or explosion). The current Sub-Caliber Adapter 553B (which utilizes a 7.62 mm cartridge) lacks the realism of the live tactical MAAWS rounds. The new MAAWS CCTS is designed to fulfill this requirement, and it is expected to reduce training costs and help MAAWS gun teams maintain their proficiency.

b. System Description.

(1) The MAAWS CCTS is part of the Carl Gustaf System which includes the M3 Recoilless Rifle and a family of 84 mm rounds which have been previously qualified for use. The MAAWS CCTS consists of a Sub-Caliber Adapter, a 20 mm tracer cartridge,

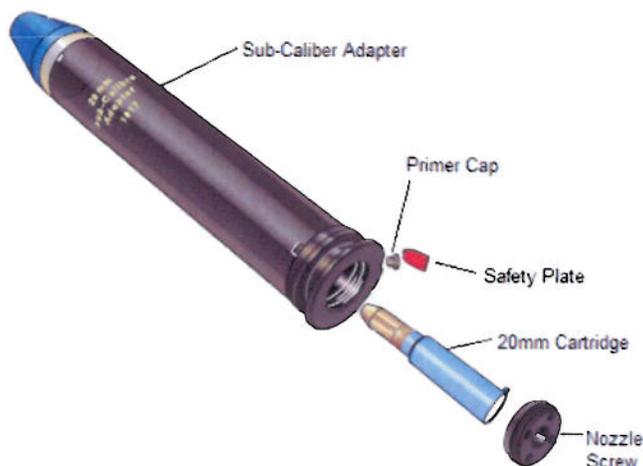


Figure 1. MAAWS CCTS

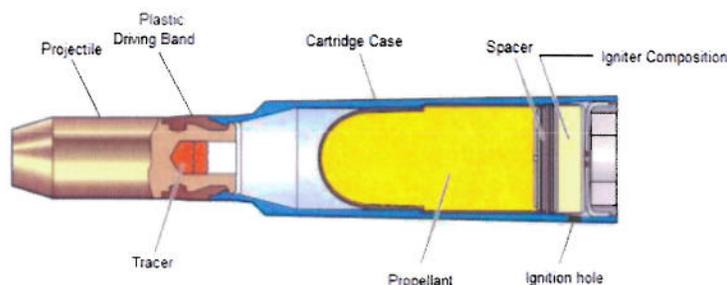


Figure 2. 20 mm Tracer Cartridge

primer cap, safety plate, and nozzle screw (see Figure 1). The 20 mm tracer cartridge is loaded into the Sub-Caliber Adapter, which in turn is loaded into the Carl Gustaf Recoilless Rifle. The CCTS Sub-Caliber Adapter is approximately 21 inches long and weighs approximately 9.9 pounds. The 20 mm tracer cartridge (see Figure 2) weighs approximately 0.34 ounces and consists of a projectile, tracer composition, cartridge case, propellant, and igniter composition. The spacer is made of plastic to separate the ignition charge and propellant charge. It allows for pressure build up for the initiation of the propellant charge. The cartridge case has a plastic body and an aluminum base plate that is scored to break up upon initiation, allowing ignition gases to expel through the nozzle screw and balance the recoil forces.

(2) Once the 20 mm tracer cartridge is loaded into the Sub-Caliber Adapter, the adapter will be loaded into the Carl Gustaf Recoilless Rifle. A three-man crew consisting of a gunner, assistant gunner, and ammo bearer will employ this system. Only the gunner and assistant gunner will be in the immediate vicinity of the MAAWS

CCTS while the ammo bearer will be three meters (m) away and forward of the gun. There will be no other personnel near the gun crew. The MAAWS CCTS will only be fired outdoors and will be fired from sitting, standing, kneeling, and prone positions by the gunner and assistant gunner. Once fired, the tracer cartridge will be projected forward and will be visible up to 300 m.

c. Previous Assessments. No previous HHARs on the MAAWS CCTS have been completed. However, previous HHARs were completed for the MAAWS and other shoulder-fired training systems (references 12 through 21).

5. IDENTIFICATION OF HEALTH HAZARD ISSUES. Data requirements, health effects, medical criteria, and references specific to the health hazard types identified in this HHAR may be found at the following website:

<http://phc.amedd.army.mil/topics/workplacehealth/hha/Pages/default.aspx>.

- a. Acoustic Energy: Impulse Noise.
- b. Acoustic Energy: Blast Overpressure.

#### 6. HEALTH HAZARD ISSUES: ASSESSMENT AND RECOMMENDATIONS.

Department of Defense Instruction 6055.1 and Army Regulation 40-5 require that personnel not be exposed to health hazards in excess of the limits specified in the Department of Defense safety and occupational health standards or specialized standards applicable to military-unique equipment, systems, or operations (references 22 and 23). Every effort should be made to eliminate or control hazards through design.

- a. Acoustic Energy: Impulse Noise.

(1) Assessment. The MAAWS CCTS exposes personnel to high-level impulsive pressure generated by the propelling charge pressure wave that expands outward from both ends of the Carl Gustaf tube (muzzle blast and back blast) when the weapon is fired.

(a) Information about the noise levels at the three crew positions (gunner, assistant gunner, and ammo bearer) and at 3 and 5-m distances at 60, 90 and 120 degrees from the center of the weapon during firing of this weapon system were reported in reference 24. Data was obtained in accordance with Military Standard 1474D for rounds fired from the standing, kneeling, sitting and prone positions. Three conditioning temperatures (hot: 140 degrees Fahrenheit (F), ambient: 70 degrees F, and cold: minus 22 degrees F) were evaluated for the standing posture, and the worst-case of these (hot) was used as the conditioning temperature for the remaining tests.

Contour data was obtained from radial measurements conducted at 90, 120 and 180 degrees relative to the line of fire at distances of 30 and 50 m.

(b) Worst-case crew position data is summarized in Table 1 for the firing postures. This establishes the Allowable Number of Rounds (ANOR) per day that can be safely fired at each position.

Table 1. Worst-Case Noise Levels Associated With Firing the MAAWS CCTS

Crew	Posture	Conditioning Temperature	Peak Level, dBP	B-duration, ms	ANOR with Single Hearing Protection
Gunner	Standing	Hot	175.7	11	86
Gunner	Standing	Ambient	177.5	8	52
Gunner	Standing	Cold	177.0	8	69
Asst Gunner	Standing	Hot	173.1	13	228
Asst Gunner	Standing	Ambient	174.4	11	248
Asst Gunner	Standing	Cold	174.6	8	219
Ammo Bearer	Standing	Hot	160.9	21	>1000
Ammo Bearer	Standing	Ambient	160.2	16	>1000
Ammo Bearer	Standing	Cold	161.4	14	>1000
Gunner	Prone	Hot	179.5	6	31
Gunner	Prone	Ambient	177.1	14	32
Gunner	Prone	Cold	175.7	9	108
Asst Gunner	Prone	Hot	178.3	8	39
Asst Gunner	Prone	Ambient	175.6	7	165
Asst Gunner	Prone	Cold	174.8	8	211

Table 1. Worst-Case Noise Levels Associated With Firing the MAAWS CCTS (continued)

Crew	Posture	Conditioning Temperature	Peak Level, dBP	B-duration, ms	ANOR with Single Hearing Protection
Ammo Bearer	Prone	Hot	160.7	13	>1000
Ammo Bearer	Prone	Ambient	163.3	13	>1000
Ammo Bearer	Prone	Cold	166.1	6	>1000
Gunner	Sitting	Hot	177.1	14	32
Asst Gunner	Sitting	Hot	175.6	7	165
Ammo Bearer	Sitting	Hot	163.3	13	>1000
Gunner	Kneeling	Hot	175.7	9	108
Asst Gunner	Kneeling	Hot	174.8	8	211
Ammo Bearer	Kneeling	Hot	168.5	10	>1000

Legend:

Asst Gunner= Assistant Gunner

dBP= Peak decibels

ms= Milliseconds

(c) Based on the information in Table 1, at least 31 rounds per day can be safely fired as long as single hearing protection is worn. When double hearing protection is used, twenty times the ANOR used for single hearing protection can be fired. This means that at least 620 rounds per day can be fired with double hearing protection. Since the tactical MAAWS rounds have extremely high impulse noise levels, double hearing protection is required for firing. Accordingly, it is expected that the users, as part of the training, may wear double hearing protection in order to fulfill the “train as we fight” concept.

(d) Reference 24 also provided information about location of the 140-dBP contour. Using the worst-case data for the 180-degree radial for the hot conditioned rounds fired from a standing position yielded a distance of 223.3 m (732.6 feet) from the weapon.

(2) Recommendations. A Risk Assessment Code (RAC) of High (hazard severity (HS) 2, hazard probability (HP) B) is assigned due to the nature of the hazard and the levels encountered. A residual RAC of Medium (HS 2, HP E) is assigned for compliance with the following recommendations:

(a) Require all personnel within 224 m (approximately 735 feet) of a MAAWS CCTS firing wear single hearing protection.

(b) Allow 31 firings per day of the MAAWS CCTS when wearing single hearing protection. When wearing double hearing protection, allow for 620 firings per day.

(c) Post warning signs at the training facilities where the MAAWS CCTS is used.

(d) Include information in all training materials and operating manuals describing the hazard and the mitigating actions necessary to make the operation safe.

(e) Each service should follow internal practices with regard to training, user warnings, and participation in hearing programs. Ensure all Army personnel involved in the firing of the weapon will be enrolled in the Army Hearing Program.

b. Acoustic Energy: Blast Overpressure.

(1) Assessment. Non-auditory injuries resulting from occupational exposures to blast overpressure (BOP) are most likely to occur in the air-containing organ systems of the body. These systems include the upper respiratory tract, lungs, and gastrointestinal tract. Lung injuries can range from mild surface hemorrhage to death (reference 25). Injury can result from exposure to a single high energy blast or from repeated exposures to low-intensity blast waves. This Institute uses the Blast Overpressure-Health Hazard Assessment version 2.0 (BOP-HHA v 2.0) analysis software to assess the non-auditory health hazard associated with exposure to BOP energy. The BOP-HHA v 2.0 tool is a biomechanical model that uses time-pressure data from weapon system tests to compute the probability and severity of lung contusion resulting from exposure to blast within a given 24-hour period. This data is only valid for the specific test scenario evaluated. No inferences can be made about lung injury resulting from multiple BOP exposures. The data cannot be reliably interpolated to estimate exposures at locations other than those at which Blast Test Devices (BTDs) were located. Due to differences in reflection, this data cannot reliably predict injury inside an enclosure that is constructed of different materials, has different contents or has a different geometry. Based on the weapon test data obtained from Aberdeen Test Center, BOP-HHA v 2.0 predicted probabilities of lung injury for each BTD location and used these probabilities to estimate the ANOR that can be fired in one day without damaging 1 percent or more of the surface area of the lung.

(a) The occupational exposure risks of a Soldier firing a MAAWS CCTS was tested by collecting data from BTDs placed at locations with respect to the weapon that correspond to the following crew positions: gunner, assistant gunner and ammunition bearer. Six conditions were tested using various firing postures and rounds conditioned to three different temperatures. Table 2 lists the variables used for each condition (posture and round temperature) and number of samples taken.

Table 2. MAAWS CCTS Test Conditions

Condition	Posture	Temperature	Sample Size
1	Standing	Hot	10
2	Standing	Ambient	10
3	Standing	Cold	10
4	Prone	Hot	10
5	Sitting	Hot	10
6	Kneeling	Hot	10

(b) Aberdeen Test Center conducted the test and provided data that was analyzed by the BOP-HHA v 2.0. The software determined ANORs for all occupied positions and all RAC levels. Table 3 summarizes these findings and displays the BOP-HHA v 2.0 calculations for the average work that the blast wave imparts to the thorax that is used to estimate probabilities of lung injury.

Table 3. ANORs For All Positions At All Five RAC Levels

Condition	Position	Average Work	RAC 1	RAC 2	RAC 3	RAC 4	RAC 5
1	Gunner	0.0000015	1000+	1000+	1000+	1000+	1000+
1	Asst Gunner	0.0000010	1000+	1000+	1000+	1000+	1000+
1	Ammo Bearer	0.0000003	1000+	1000+	1000+	1000+	1000+
2	Gunner	0.0000014	1000+	1000+	1000+	1000+	1000+
2	Asst Gunner	0.0000009	1000+	1000+	1000+	1000+	1000+
2	Ammo Bearer	0.0000003	1000+	1000+	1000+	1000+	1000+
3	Gunner	0.0000011	1000+	1000+	1000+	1000+	1000+
3	Asst Gunner	0.0000006	1000+	1000+	1000+	1000+	1000+
3	Ammo Bearer	0.0000002	1000+	1000+	1000+	1000+	1000+
4	Gunner	0.0000049	1000+	1000+	1000+	1000+	1000+
4	Asst Gunner	0.0000020	1000+	1000+	1000+	1000+	1000+
4	Ammo Bearer	0.0000003	1000+	1000+	1000+	1000+	1000+
5	Gunner	0.0000014	1000+	1000+	1000+	1000+	1000+
5	Asst Gunner	0.0000015	1000+	1000+	1000+	1000+	1000+
5	Ammo Bearer	0.0000003	1000+	1000+	1000+	1000+	1000+
6	Gunner	0.0000015	1000+	1000+	1000+	1000+	1000+

Table 3. ANORs For All Positions At All Five RAC Levels (continued)

Condition	Position	Average Work	RAC 1	RAC 2	RAC 3	RAC 4	RAC 5
6	Asst Gunner	0.0000013	1000+	1000+	1000+	1000+	1000+
6	Ammo Bearer	0.0000004	1000+	1000+	1000+	1000+	1000+

(c) Based upon the average work calculated by BOP-HHA v 2.0, when a MAAWS CCTS cartridge is fired from standing, prone, sitting or kneeling postures using rounds conditioned to cold, ambient, or hot temperatures, the risk of lung injury for the gunner, assistant gunner, and ammunition bearer is low.

(2) Recommendations. A RAC of Low (HS 4, HP E) is assigned to all conditions used in this test. A residual RAC is not assigned due to the low injury risks associated with the initial RAC.

7. PREPARER IDENTIFICATION. The AIPH, Aberdeen Proving Ground, MD, prepared this HHAR. The point of contact in the Army Health Hazard Assessment Program is Mr. David Segure, commercial 410-436-2925, DSN 584-2925, or e-mail: david.s.segure.civ@mail.mil. This Institute's Ergonomics Program (Mr. Donald Goddard) and Army Hearing Program (Mr. Charles Jokel) contributed to this HHAR. This Institute's Occupational Medicine Program reviewed the medical aspects of this assessment.



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 Manager  
 Health Hazard Assessment Program

APPENDIX A

REFERENCES

1. Army Regulation 40-10, Health Hazard Assessment Program in Support of the Army Acquisition Process, 27 Jul 07.
2. Army Regulation 70-1, Army Acquisition Policy, 22 Jul 11.
3. Army Regulation 385-10, The Army Safety Program, 23 Aug 07 (Rapid Action Revision 4 Oct 11).
4. Army Regulation 602-2, Manpower and Personnel Integration (MANPRINT) in the System Acquisition Process, 1 Jun 01.
5. Department of Defense Instruction 5000.02, Operation of the Defense Acquisition System, 8 Dec 08.
6. Memorandum, Under Secretary of Defense, Acquisition, Technology, and Logistics, 23 Sep 04, subject: Defense Acquisition System Safety.
7. Memorandum, Research, Development, and Engineering Command-Armament Research, Development, and Engineering Center (RDECOM-ARDEC), RDAR-MEM-L, 12 Apr 12, subject: Request for Health Hazard Assessment for the Multi-Role Anti-Armor Anti-Personnel Weapon System Cannon Caliber Training System.
8. Multi-Role Anti-Armor Anti-Personnel Weapon System (MAAWS) 20 mm Cannon Caliber Training System Joint Safety Review Presentation for Hazard Test Program, RDECOM-ARDEC, RDAR-MEM-L, 5 Apr 12.
9. United States Special Operations Command Safety Data Package for the MAAWS Cannon Caliber Training System, RDECOM-ARDEC, RDAR-MEM-L, 7 Mar 12.
10. Email, RDECOM-ARDEC, RDAR-MEM-L, Mr. Ninh Vo, 19 Jul 12, subject: RE: Training Procedures for the MAAWS CCTS (Unclassified).
11. Detailed Test Plan, Foreign Comparative Tests, Multi-Role Anti-Armor Anti-Personnel Weapon System Cannon Caliber Training System, Aberdeen Test Center, Jun 12.

12. Memorandum, United States Army Public Health Command, MCHB-IP-OHH, 20 Sep 11, subject: Health Hazard Assessment Report (RCS MED-388) No. 69-MP-0F15-11, 84 Millimeter Carl Gustav Multi-Target 756.

13. Memorandum, United States Army Center for Health Promotion and Preventive Medicine (USACHPPM), MCHB-TS-OHH, 1 Jun 00, subject: Health Hazard Assessment Report on the High Energy Anti-Tank 551C Improved Munition and Target Practice with Tracer 141 Cartridges for the Multi-Role Anti-Armor Anti-Personnel Weapon System, No. 69-37-2297-00.

14. Memorandum, USACHPPM, MCHB-TS-OHH, 11 Oct 00, subject: Updated Health Hazard Assessment Report on the Area Denial Munition 401 Cartridge for the Multi-Role Anti-Armor Anti-Personnel Weapon System, No. 69-37-2297-01.

15. Memorandum, USACHPPM, MCHB-TS-OHH, 12 Oct 00, subject: Updated Health Hazard Assessment Report on the High Energy Anti-Tank 551C Improved Munition Cartridge for the Multi-Role Anti-Armor Anti-Personnel Weapon System, No. 69-37-2297-01.

16. Memorandum, USACHPPM, MCHB-TS-OHH, 13 Oct 00, subject: Updated Health Hazard Assessment Report on the Target Practice with Tracer 141 Cartridge for the Multi-Role Anti-Armor Anti-Personnel Weapon System, No. 69-37-2297-01.

17. Memorandum, USACHPPM, MCHB-TS-OHH, 10 Feb 98, subject: Updated Health Hazard Assessment Report on the Multi-Role Anti-Armor Anti-Personnel Weapon System, No. 69-37-2297-98.

18. Memorandum, USACHPPM, MCHB-TS-OHH, 8 Dec 08, subject: Health Hazard Assessment Report (RCS MED-388) No. 69-MP-0A94-09, Multi-Role Anti-Armor Anti-Personnel Weapon System Multi-target 756 Cartridge.

19. Memorandum, United States Army Environmental Health Agency, HSHB-MO-A, 19 Mar 90, subject: Updated Health Hazard Assessment Report (RCS MED 388) on the Ranger Anti-Armor Anti-Personnel Weapon System (RAAWS), No. 69-37-4785-90.

20. Memorandum, USACHPPM, MCHB-TS-OHH, 22 Aug 07, subject: Health Hazard Assessment Report (RCS MED-388) No. 69-MP-06L4-07, Multi-Role, Anti-Armor, Anti-Personnel Weapon System, Anti-Structure Munition 509.

Health Hazard Assessment Report (RCS MED-388) No. S.0001938-13, 22 April 2013

21. Memorandum, USACHPPM, MCHB-TS-OHH, 28 Jun 06, subject: Health Hazard Assessment Report (RCS MED-388) No. 69-MP-2297-06, M3 Multi-Role Anti-Armor Anti-Personnel Weapon System, Illumination 545C Cartridge.
22. Department of Defense Instruction 6055.1, DOD Safety and Occupational Health (SOH) Program, 19 Aug 98.
23. Army Regulation 40-5, Preventive Medicine, 25 May 07.
24. Multi-Role Anti-Armor Anti-Personnel Weapon System (MAAWS) Cannon Caliber Training System, DTC Test Report 12-ADA-129, 12 Dec 12.
25. Jaycor Technical Report J2997.24-01-158, subject: Lung Injury Criteria for Air Blast Trauma, JAYCOR, 9775 Towne Centre Drive, San Diego, California 92121, 1996.