C3mortarmen.org

Date: June 2024

From: C3M-Cohort of Chronically Concussed Mortarmen
144 Anterbury Dr.
Apex, NC 27502

Subj: Resolution for Change in Law: 2024 Amendment

The current process for establishing presumptive disability decisions involves four major entities: Congress, the VA, the Institute of Medicine (IOM), and other stakeholders, which include— among others—veterans service organizations (VSOs). In 2020 and 2024 C3M introduced a Resolution for Change in law and subsequent Amendment, we included four primary objectives:

I. Resolution 38 U.S.C. §§ 501(a)(1), 1110, 1113, 1116(b), and 38 C.F.R. §§ 3.303(a); 3.307 and 3.309, provides a framework upon which to add medical conditions associated with the excessive military occupational exposure to low-level blasts related to traumatic brain injury (TBI) and chronic post-concussive disorders:

   a. Whereby the Secretary of the Department of Veterans Affairs (VA) is empowered to:
      i. Establish a Working Group and Task Force for the consideration of presumptive conditions associated with Military Occupational Exposure from chronic and cumulative exposure to Blast Overpressure (BOP), from firing Mortars and other Tier 1 weapon systems[1,2].
      ii. Contract with the National Academies (Institute of Medicine and National Research Council) in order obtain IOM findings on the question.
      iii. Submit a final report to the Secretary of the Department of Veterans Affairs for consideration of publishing rule-making.

II. Resolution for the Commissioning of a Servicemember and Veteran Cohort Study

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[1] The Department [of Defense] developed a list of "Tier 1" weapon systems identified by the Services which was organized based on four different categories: shoulder-mounted, 50 caliber weapons, indirect fire systems and breaching charges.

[2] U.S. Department of Defense (2023, December 19). Longitudinal medical study on blast pressure exposure of ... https://health.mil/Reference-Center/Reports/2023/12/19/Longitudinal-Medical-Study-on-Blast-Pressure-Exposure

(SVCS) related to excessive occupational exposure to blast overpressure (BOP) from firing Mortars and other Tier 1 weapon systems.

III. Resolution for the Commissioning of a Servicemember and Veteran Commissioning of a Retrospective Analysis (SVRA) related to military occupational specialty (MOS) of combat arms personnel to include but not limited to U.S. Army and Marine Corps rifle infantry and infantry mortarmen, U.S. Army Rangers, Explosive Ordinance Disposal (EOD) breachers, members of the U.S. Army Special Operations Forces and Naval Special Warfare operations, tank and artillery crewmen, inclusive of all Tier 1 Weapons Systems Operators routine and cumulative exposure to blast overpressure (BOP), though years in service, estimate of exposures in training and in combat, and an ultimate statistical correlation to veteran and servicemember suicide.

IV. Resolution for coordinating the creation of a working group with the Department of Defense (DoD) to longitudinal effects of BOP, to review policy and guidance to further advance the protective posture, battlefield capability, efficiency, and safety of U.S. military occupational specialties exposed to BOP.

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Executive Summary:

In October 2020, we issued our original resolution which encompassed nearly 20 years of research to bring heightened understanding and awareness of the health effects of chronic mildTBI due to the cumulative occupational exposure of Low-Level Blast Exposure (LLB) noting, “repeated exposure may also have impacts on CNS structure, function, and development, as well as on the broader health of military service members[3]”. Since 2001, the key driver of such awareness has been the blast-related injuries suffered during combat operations in Iraq and Afghanistan resulting in traumatic brain injury and post-concussive mental and physical health conditions associated thereto - the “signature” injury for the most recent conflict affecting over 333,000 service members since 2002[,4].

From 2020 to present, studies suggest that cumulative low-level blast exposure over a service member’s career is often associated with acoustic trauma, high prevalence of mild-traumatic brain injury (mTBI) like symptoms, negative effects on microstructures within the brain[5], mental health symptoms, and a heightened risk for developing symptoms following occupational exposure[6].

Concern over repetitive forms of concussive low-level blast exposure during military service in combat and training has become increasingly relevant. Acknowledging, addressing, and mitigating its effects should be timely and leaders at all levels and systems should feel a responsibility to ensure its inclusion within the schema of Department of Defense (DoD) harm reduction and mitigation protocols as well as medical treatment and the extension of benefits administered by the Department of Veterans Affairs (VA) for those individuals chronically affected.

C3M has found merit in pursuing a remedy for those who would otherwise be entitled to medical treatment and other relief as afforded under veterans’ rules, regulations, and relief, as well as pursuing action which furthers the study of effects described herein and likewise provides adequate personal protective equipment (PPE) so as to protect infantry mortar crew and other Tier 1 weapon crews against concussive low-level blasts relevant to the requirements of their military occupation. Furthermore, any and all actions which serve to enhance policy that directly impact our Cohort under the auspices of the DoD and the VA. We therefore respectfully submit the following:

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[3] Magnuson, J., & Ling, G. (2018). Explosive Blast Mild Traumatic Brain Injury. *Traumatic Brain Injury - Pathobiology, Advanced Diagnostics and Acute Management*. https://doi.org/10.5772/intechopen.74035

[4] Simmons, M., Engel, C., Hoch, E., Orr, P., Anderson, B., & Azhar, G. (2020). Neurological Effects of Repeated Exposure to Military Occupational Levels of Blast: A Review of Scientific Literature. https://doi.org/10.7249/rr2350

[5] Kilgore, Madison O., and W. Brad Hubbard. “Effects of low-level blast on neurovascular health and cerebral blood flow: Current findings and future opportunities in neuroimaging.” International Journal of Molecular Sciences, vol. 25, no. 1, 4 Jan. 2024, p. 642, https://doi.org/10.3390/ijms25010642.

[6] Woodall, Julia L.a, et al. “Repetitive low-level blast exposure and neurocognitive effects in Army Ranger Mortarmen.” Military Medicine, vol. 188, no. 3–4, 24 Sept. 2021, https://doi.org/10.1093/milmed/usab394.

Issues:

I. Resolution 38 U.S.C. §§ 501(a)(1), 1110, 1113, 1116(b), and 38 C.F.R. §§ 3.303(a); 3.307 and 3.309, provides a framework upon which to add medical conditions associated with military occupational exposure from the excessive exposure of low-level blasts related to traumatic brain injury (TBI) and chronic post-concussive disorders:

   a. Whereby the Secretary of the Department of Veterans Affairs (VA) is empowered to:
      i. Establish a Working Group and Task Force for the consideration of presumptive conditions associated with Military Occupational Exposure from chronic and cumulative exposure to Blast Overpressure (BOP), from firing Mortars and other Tier 1 weapon systems[7,8].
      ii. Contract with the National Academies (Institute of Medicine and National Research Council) in order obtain IOM findings on the question.
      iii. Submit a final report to the Secretary of the Department of Veterans Affairs for consideration of publishing rule-making.

II. Resolution for the Commissioning of a Servicemember and Veteran Cohort Study (SVCS) related to excessive occupational exposure to blast overpressure (BOP) from firing Mortars and other Tier 1 weapon systems.

III. Resolution for the Commissioning of a Servicemember and Veteran Commissioning of a Retrospective Analysis (SVRA) related to military occupational specialty (MOS) of Indirect Fire Infantryman (11C), and MOS inclusive of other Tier 1 weapons crew's cumulative occupational exposure to blast overpressure (BOP)though years in service, estimate of exposures in training and in combat, and an ultimate statistical correlation to veteran and servicemember suicide.

Statutes and Regulations:

1. Section 501(a)(1) (Secretary's Rulemaking Authority) provides:

   Section 501(a)(1) of title 38, United States Code, provides that "[t]he Secretary has authority to prescribe all rules and regulations which are necessary or appropriate to carry out the laws administered by [VA] and are consistent with those laws, including…regulations concerning the nature and extent of proof and evidence and the method of taking and furnishing them to establish the right to benefits under such laws."

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[7]The Department [of Defense] developed a list of "Tier 1" weapon systems identified by the Services which was organized based on four different categories: shoulder-mounted, 50 caliber weapons, indirect fire systems and breaching charges.

[8] U.S. Department of Defense (2023, December 19). Longitudinal medical study on blast pressure exposure of ... https://health.mil/Reference-Center/Reports/2023/12/19/Longitudinal-Medical-Study-on-Blast-Pressure-Exposure

2. Section 1110 (Basic Entitlement) provides:

   For disability resulting from personal injury suffered or disease contracted in line of duty, or for aggravation of a preexisting injury suffered or disease contracted in line of duty, in the active military, naval, or air service, during a period of war, the United States will pay to any veteran thus disabled and who was discharged or released under conditions other than dishonorable from the period of service in which said injury or disease was incurred, or preexisting injury or disease was aggravated, compensation as provided in this subchapter, but no compensation shall be paid if the disability is a result of the veteran's own willful misconduct or abuse of alcohol or drugs[9]

   Likewise, Title 38 C.F.R. § 3.303(a) provides, "Service connection connotes many factors, but basically it means that the facts, shown by evidence, establish that a particular injury or disease resulting in disability was incurred coincident with service in the Armed Forces, or if preexisting such service, was aggravated therein. Service connection may be accomplished by affirmatively showing inception or aggravation during service or through the application of statutory presumptions (emphasis added). Each disabling condition shown by a veteran's service records, or for which he seeks a service connection must be considered based on the places, types, and circumstances of his service as shown by service records, the official history of each organization in which he served, his medical records and all pertinent medical and lay evidence.[10]"

3. Section 1113 (Presumptions Rebuttable) provides:

   (a) Where there is affirmative evidence to the contrary, or evidence to establish that an intercurrent injury or disease which is a recognized cause of any of the diseases or disabilities within the purview of section 1112, 1116, 1117, or 1118 of this title, has been suffered between the date of separation from service and the onset of any such diseases or disabilities, or the disability is due to the veteran's own willful misconduct, service-connection pursuant to section 1112, 1116, or 1118 of this title, or payments of compensation pursuant to section 1117 of this title, will not be in order.

   (b) Nothing in section 1112, 1116, 1117, or 1118 of this title, subsection 1. of this section, or section 5 of Public Law 98–542 (38 U.S.C. 1154 note) shall be construed to prevent the granting of service-connection for any disease or disorder otherwise shown by sound judgment to

[9] (Pub. L. 85–857, Sept. 2, 1958, 72 Stat. 1119, § 310; Pub. L. 101–508, title VIII, § 8052(a)(2), Nov. 5, 1990, 104 Stat. 1388–351; renumbered § 1110, Pub. L. 102–83, § 5(a), Aug. 6, 1991, 105 Stat. 406; Pub. L.105–178, title VIII, § 8202(a), June 9, 1998, 112 Stat. 492; Pub. L. 105–206, title IX, § 9014(a), July 22, 1998, 112 Stat. 865.)

[10] [26 FR 1579, Feb. 24, 1961]

have been incurred in or aggravated by active military, naval, or air service.[11]

4. Section 1116(b)(1) provides:

Whenever the Secretary determines, on the basis of sound medical and scientific evidence, that a positive association exists between (A) the exposure of humans to [a service incurred exposure] and (B) the occurrence of a disease in humans, the Secretary shall prescribe regulations providing that a presumption of service connection is warranted for that disease for the purposes of this section.

5. Title 38 C.F.R. § 3.307 (In pertinent part):

Evidentiary basis. The factual basis may be established by medical evidence, competent lay evidence, or both. Medical evidence should set forth the physical findings and symptomatology elicited by examination within the applicable period. Lay evidence should describe the material, and relevant facts as to the veteran's disability observed within such period, not merely conclusions based upon opinion. The chronicity and continuity factors outlined in §3.303(b) will be considered. The diseases listed in §3.309(a) will be accepted as chronic, even though diagnosed as acute because of insidious inception and chronic development, except: (1) Where they result from intercurrent causes, for example, cerebral hemorrhage due to injury, or active nephritis or acute endocarditis due to intercurrent infection (with or without identification of the pathogenic micro-organism); or (2) where a disease is the result of drug ingestion or a complication of some other condition not related to service. Thus, leukemia will be accepted as a chronic disease, whether diagnosed as acute or chronic. Unless the clinical picture is clear otherwise, consideration will be given as to whether an acute condition is an exacerbation of a chronic disease.

2. Prohibition of certain presumptions. No presumptions may be invoked on the basis of advancement of the disease when first definitely diagnosed for the purpose of showing its existence to a degree of 10 percent within the applicable period. This will not be interpreted as requiring that the disease be diagnosed in the presumptive period, but only that there be then shown by acceptable medical or lay evidence characteristic manifestations of the disease to the required degree, followed without unreasonable time lapse by definite diagnosis. Symptomatology shown in the prescribed period may have no particular significance when first observed, but in the light of subsequent developments, it may gain considerable significance.

[11] (Pub. L. 85–857, Sept. 2, 1958, 72 Stat. 1120, § 313; Pub. L. 102–4, § 2(b), Feb. 6, 1991, 105 Stat. 13; renumbered § 1113 and amended Pub. L. 102–83, § 5(a), (c)(1), Aug. 6, 1991, 105 Stat. 406; Pub. L. 103–446, title I, § 106(b), title V, § 501(b)(1), Nov. 2, 1994, 108 Stat. 4651, 4663; Pub. L. 105–277, div. C, title XVI, § 1602(b), Oct. 21, 1998, 112 Stat. 2681–744.)

Cases in which a chronic condition is shown to exist within a short time following the applicable presumptive period, but without evidence of manifestations within the period, should be developed to determine whether there was symptomatology, which in retrospect may be identified and evaluated as a manifestation of the chronic disease to the required 10-percent degree.

3. Rebuttal of service incurrence or aggravation. (1) Evidence which may be considered in rebuttal of service incurrence of a disease listed in §3.309 will be any evidence of a nature usually accepted as competent to indicate the time of existence or inception of disease, and medical judgment will be exercised in making determinations relative to the effect of intercurrent injury or disease. The expression “affirmative evidence to the contrary” will not be taken to require a conclusive showing, but such showing as would, in sound medical reasoning and in the consideration of all evidence of record, support a conclusion that the disease was not incurred in service. As to tropical diseases, the fact that the veteran had no service in a locality having a high incidence of the disease may be considered as evidence to rebut the presumption, as may residence during the period in question in a region where the particular disease is endemic. The known incubation periods of tropical diseases should be used as a factor in rebuttal of presumptive service connection as showing inception before or after service.

(2) The presumption of aggravation provided in this section may be rebutted by affirmative evidence that the preexisting condition was not aggravated by service, which may include affirmative evidence that any increase in disability was due to an intercurrent disease or injury suffered after separation from service or evidence sufficient, under §3.306 of this part, to show that the increase in disability was due to the natural progress of the preexisting condition.[12]

6. National Defense Authorization Act (2018) (Public Law 115-91) sec. 734

(a) IN GENERAL. The Secretary of Defense shall conduct a longitudinal medical study on blast pressure exposure of members of the Armed Forces during combat and training, including members who train with any high overpressure weapon system, such as anti-tank recoilless rifles or heavy-caliber sniper rifles.

(b) ELEMENTS. The study required under subsection (a) shall—
(1) monitor, record, and analyze data on blast pressure exposure for any member of the Armed Forces who is likely to be exposed to a blast in training or combat;

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[12] (Authority: 38 U.S.C. 101(24), 501(a), 1116(a)(3), and 1821) [26 FR 1581, Feb. 24, 1961, as amended at 35 FR 18281, Dec. 1, 1970; 39 FR 34530, Sept. 26, 1974; 43 FR 45347, Oct. 2, 1978; 47 FR 11655, Mar. 18, 1982; 58 FR 29109, May 19, 1993; 59 FR 5106, Feb. 3, 1994; 59 FR 29724, June 9, 1994; 61 FR 57588, Nov. 7, 1996; 62 FR 35422, July 1, 1997; 67 FR 67793, Nov. 7, 2002; 68 FR 34541, June 10, 2003; 76 FR 4248, Jan. 25, 2011; 78 FR 54766, Sept. 6, 2013; 80 FR 35248, June 19, 2015; 82 FR 4184, Jan. 13, 2017]

(2) assess the feasibility and advisability of including blast exposure history as part of the service record of a member, as a blast exposure log, in order to ensure that, if medical issues arise later, the member receives care for any service-connected injuries; and

(3) review the safety precautions surrounding heavy weapons training to account for emerging research on blast exposure and the effects of such exposure on cognitive performance of members of the Armed Forces.

(c) REPORTS.

(l) INTERIM REPORT.-Not later than one year after the date of the enactment of this Act, the Secretary shall submit to the Committees on Armed Services of the Senate and the House of Representatives an interim report on the study methods and action plan for the study under subsection (a).[13]

(2) FINAL REPORT.-Not later than four years after the date the Secretary begins the study under subsection (a), the Secretary shall submit to the Committees on Armed Services of the Senate and the House of Representatives a report on the results of such study.[14]

[13] Government Printing Office , U. S. (2018). National Defense Authorization Act (2018) . https://www.govinfo.gov/app/details/PLAW-115publ91.
[14] *Id.*

Low Level Blast Research – Early 2000's to 2020:

The impulse noise produced by heavy weapons is called Blast Overpressure (BOP), the rapid and violent change in air pressure that occurs as a result of an explosion.

For the purpose of this resolution, Low-Level Blast (LLB) refers to the overpressure experienced by an infantry mortar crew member when that weapon is fired. As such, LLB is an expected part of their military occupational specialty (MOS).

Explosive blasts or explosions are physical phenomena that result in a sudden release of energy. This process causes a near instantaneous compression of the surrounding medium (e.g., air or water) and an increase in pressure ("overpressure") above atmospheric pressure, resulting in an overpressure wave (or blast wave)[15].

It also is key to note, the term "occupational blast exposure," "low-level blast," or "recurrent occupational overpressure exposure" is intended to denote repeated exposures to low-level explosive blast events that occur as part of training and operational activities experienced by personnel in designated roles in the military.[16,17]

Department of Defense - U.S. Army and Marine Corps Training and Doctrine Considerations – Mortar Gunnery, Range Safety and Nominal BOP Exposure

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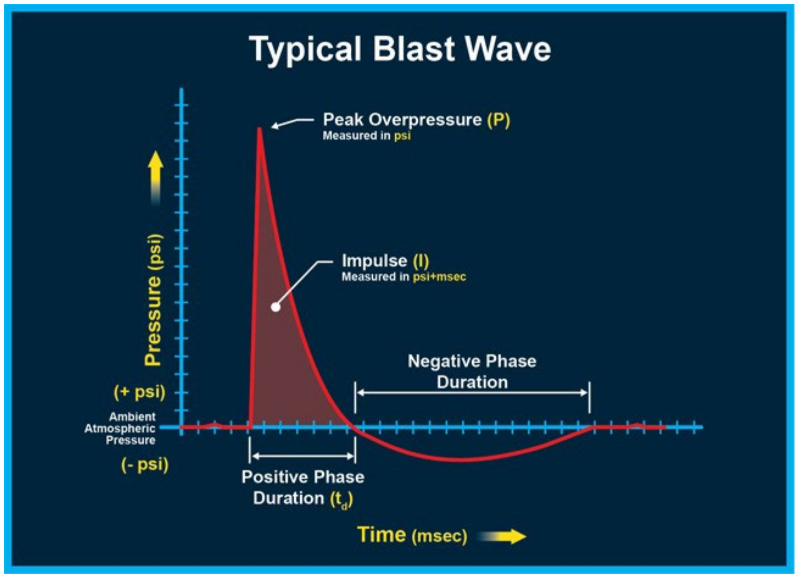
[15] Cernak I. Blast Injuries and Blast-Induced Neurotrauma: Overview of Pathophysiology and Experimental Knowledge Models and Findings. In: Kobeissy FH, editor. Brain Neurotrauma: Molecular, Neuropsychological, and Rehabilitation Aspects. Boca Raton (FL): CRC Press/Taylor & Francis; 2015. Chapter 45. PMID: 26269895.
[16] Kamimori, G. & Reilly, L. & LaValle, Christina & Silva, U.. (2017). Occupational overpressure exposure of breachers and military personnel. Shock Waves. 27. 10.1007/s00193-017-0738-4.
[17] Belding JN, Fitzmaurice S, Englert RM, Lee I, Kowitz B, Highfill-McRoy RM, Thomsen CJ, da Silva U. Blast Exposure and Risk of Recurrent Occupational Overpressure Exposure Predict Deployment TBIs. Mil Med. 2020 Jun 8;185(5-6):e538-e544. doi: 10.1093/milmed/usz289. PMID: 31665414.

According to Defense Explosive Safety Regulation (DESR) 6055.09, under the authority of the Secretary of Defense (2019), “personnel protection must limit incident blast overpressure to 2.3 psi [15.9 kPa].”

DESR 6055.09 policy directive is to, “provide the maximum possible protection to people and property from the potential damaging effects of DoD military munitions, and minimize exposures consistent with safe and efficient operations (i.e., expose the minimum number of people for the minimum time to the minimum amount of explosives). Applying the standards in this manual provides only the minimum protection criteria for personnel and property; greater protection should always be provided when practicable[9].”

In regulations as early as 1996 through 2001, a four (4) PSI incident overpressure exposure limit was assessed to be safe based on the threshold for gross injury to the human eardrum; the regulation does not address exposure to the non-incident components of primary blast exposure (e.g., dynamic pressure and shock front) or effects on operators below the 4-psi level[18].



The following are facts specific to Mortar Platoons and the C³M Cohort. The technique of inquiry and analysis provided herein can be replicated for all members of the exposed group.

DA-PAM 385-63 published to provide Range Safety guidance to commanders for live-fire training, provides, "All personnel who take part in mortar firing will wear, for the Army, a minimum of [Interceptor Body Armor] IBA and helmet; for the Marine Corps, PPE Level 1…When firing the 120mm mortar from the carrier, all crew members and personnel inside the carrier must wear double hearing protection. Double hearing protection is required regardless of the carrier ramp position (opened or closed). Double hearing protection is defined as any approved earplugs plus either a CVC helmet or a communication aural protective system/artillery communication aural protective system with personnel armored system for ground troops helmet. Personnel outside the carrier within 200 m must wear single hearing protection. Crew members and all personnel within 5 m of the 120mm mortar must wear double hearing protection when firing. When firing the 120mm ground mount and carrier mount configuration, using the M933E1 HE cartridge, all personnel within 5 m of the mortar are required to wear double hearing protection. Exposure is limited to 140 rounds in any 24 hours.[19]"

Other considerations are provided for 60mm and 81mm systems. This publication provides minimum requirements for the U.S. Army and Marine Corps Range Safety Programs."

The maximum and sustained rates of fire for the M252 and M120/121 per minute are

[18] Naval Explosive Ordnance Disposal Technology Division, D. O. D. (2003, December 17). EODB 60A-1-1-4 Procedures Revision 5 2003. https://www.scribd.com/doc/133544461/EODB-60A-1-1-4-EOD-Procedures-2003.
[19] *PAMPHLET 385-63, SAFETY: RANGE SAFETY (16-APR-2014)*, 11 Apr. 2014, armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/p385_63.pdf.

as follows on Table 1.6, per U.S. Army Field Manual (FM) 7-90/MCWP 3-15.2[20]: (See Appendix).

Of note, however, not all positions will be manned by the same personnel in real world and training scenarios. In accordance with Army FM 7-90, 6-22, unit leaders are advised, "be prepared to operate without their full complement of personnel and equipment. Personnel may be not available, vehicles may not be operable or restricted to certain areas, and equipment may be damaged. Leaders should cross-train their personnel so that they are proficient in more than one position.[21]"

Aside from battalion and brigade combined arms training, real world missions and deployed scenarios, mortar platoon leaders are required to certify their platoon's efficacy via the provisions of Technical Circular (TC) 3-20.33 (2017)[22], also known as MORTEP. This framework (the training strategy) provides all prerequisite and required events to build evaluate, and execute the critical tasks, culminating in qualification. The six "qualification gates" are outlined in in Table 4.2. (See Appendix)

Of these six gates, Table IV uses training ammunition to employ the skills practiced in table III, particularly the ability to do direct lay, direct alignment, hipshoot and to fire without an FDC[23]. (See Appendix)

Table V includes seven required tasks and eight advanced missions. The advanced missions can be chosen by the command, but at least four advanced missions must be fired to complete table V[24]. (See Appendix)

To account for Table 4.19, we will select coordinated illumination, traverse, quick smoke, simultaneous (SIMO) (See Appendix)

As with table V, table VI mandates seven required fire missions and provides a selection of eight advanced fire missions, of which at least four must be fired[25]. (See Appendix)

To account for Table VI, we will select Search, Traverse, Quick Smoke, (SIMO). (See Appendix)

Total round count for MORTEP gunnery qualification is nominally 224 rounds per exposed crew member.

Similarly, other training scenarios such as company, battalion and brigade level combined arms, and maneuver element exercises on both static and maneuver ranges, live fire exercises (LFX) throughout training cycles are conducted multiple times a year. These include rotations to National Training Center (NTC), Joint

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[20]ATP 3-21.90 MCTP 3-01D TACTICAL EMPLOYMENT OF MORTARS. https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/ARN19389_ATP%203-21x90%20FINAL%20WEB.pdf.

[21] Id.

[22] *TC 3-20.33 Training and Qualification of Mortars*. Army Publishing Directorate. https://armypubs.army.mil/ProductMaps/PubForm/Details.aspx?PUB_ID=1002900.

[23] Id.

[24] Id.

[25] Id.

Readiness Training Center (JRTC), and Combined Arms Training Center (CMTC). Live fires last from 18 to 36 hours[26].

While operational environments in deployed theatres will inevitably vary due to mission requirements and operational tempo, we can extrapolate from the known training data an estimated level of cumulative exposure to BOP over a period of time that infantry mortar crews may experience. This estimated total number of rounds fired exposing personnel to BOP then becomes the basis for U.S. military infantry MOS 11C/0341's to be in the hundreds at year 1, several thousand at years 2-7, and approximately tens of thousands at years 8-14.[27]

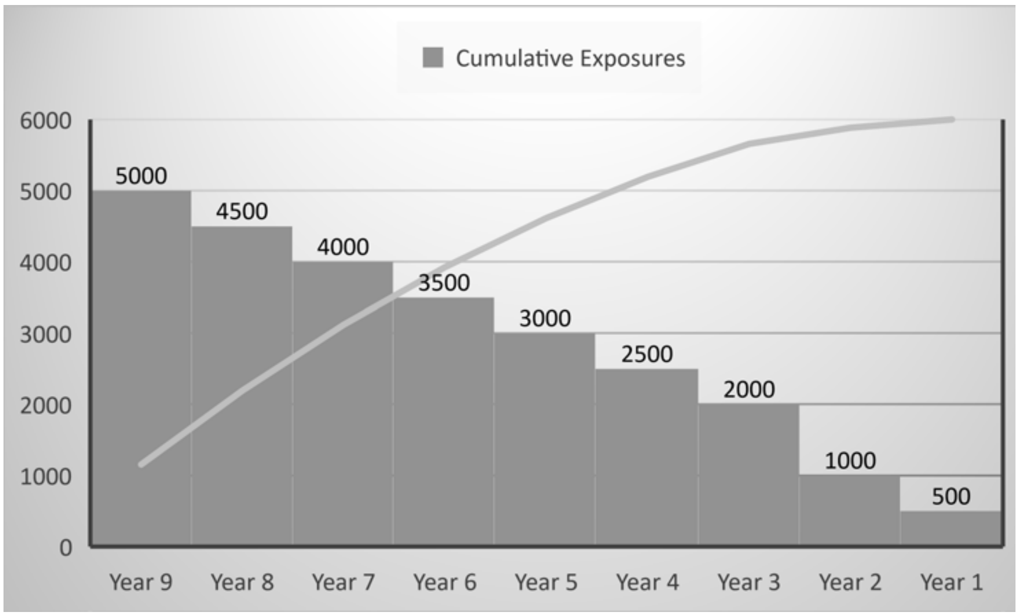

Figure 1 *Cumulative Exposures Diagram (Grossman & Strader, 2020)*

The Science of Blast Overpressure: Early Findings

In a first of its kind study, Kamimori *et al*. (2017), observe BOP exposure for various military and law enforcement sources in operational training environments. Peak overpressure and impulse data are presented including mortar fire missions and data is recorded via BlackBox Biometrics Blast Gauge Sensors. The authors note, "sheer number of rounds fired during training may result in an excessive cumulative exposure" reflects threshold considerations for injury and structural damage considerations while Tables 5,7,9 on the following pages reflect military occupational exposure to blast overpressure (BOP) by U.S. Army infantry mortar crews during training and in operations.[28]

[26] Fant, B. (2019). *Military*. SECTION II. COMBAT TRAINING CENTERS: IS LIVE-FIRE TRAINING NEEDED AT THE CTCs? https://www.globalsecurity.org/military/library/report/call/call_95-11_ctcs2-12.htm.
[27] Grossman and Strader (2020). These analyses can be duplicated across exposed groups to enhance the data above and beyond that which has already been collected herein.
[28] Kamimori, G.H., Reilly, L.A., LaValle, C.R. et al. Occupational overpressure exposure of breachers and military personnel. Shock Waves 27, 837–847 (2017). https://doi.org/10.1007/s00193-017-0738-4

Table 5.1. PSI: Injury and Structural Damage Thresholds

Pressure psi	Pressure kPa	Effect on Human (1-microsecond pulse duration)	Effect on Structure
0.3	2	140 dB (noise limit for unprotected hearing)	
0.5	3		Windows break
1	7		Studs and drywall crack
2	14		
3	20		Structural damage begins
4	28		Reinforced concrete walls crack
5	34	Threshold for eardrum rupture (15%)	
6	41		Collapse of wood frame structure
7	48		
8	54		Reinforced concrete wall displaced
9	61		
10	68		Shattered automotive glass, damaged buildings collapse
15	102	50% chance of eardrum rupture	
20	136		Reinforced concrete walls destroyed
30	204	Threshold for lung injury	
40	272		
50	340		4.5 ft from 50-lb bare explosive
100	680	Slight chance of death (pulmonary-related)	
150	1,020	50% chance of death (pulmonary-related)	
200	1,360	100% chance of death (pulmonary-related)	2.5 ft from 50-lb bare explosive

SOURCE: Kamimori, 2018.

Table 7 Summary statistics for crew-wide exposures from the 81 and 120 mm mortars during testing at Fort Benning, GA

	Overpressure (psi)		Impulse (psi * ms)	
	81 mm	120 mm	81 mm	120 mm
Mean	2.4	4.1	2.6	3.5
Med	2.4	3.8	2.6	3.5
Min	1.6	2.0	0.7	1.4
Max	3.5	9.3	5.4	6.4
SD	0.5	1.5	0.9	1.0
n	48	60	48	60

Squad Leader and Gunner positions during the 120 mm mortar exercises.

Table 9 Summary statistics for 120 mm mortar crew exposures (by position) during testing at Fort Benning, GA

		Overpressure (psi)					Impulse (psi * ms)				
Position	*n*	Mean	Med	Min	Max	SD	Mean	Med	Min	Max	SD
RSO	12	6.0	5.9	4.5	9.3	1.2	4.3	4.5	3.4	6.4	0.9
SL	12	5.2	4.9	4.1	6.4	0.8	4.0	4.1	2.5	5.3	0.8
G	12	3.7	3.7	2.5	5.5	0.7	3.8	3.5	2.8	5.3	0.8
AG	12	3.4	3.4	2.7	3.9	0.4	3.4	3.4	2.9	4.1	0.3
AB	12	2.4	2.4	2.0	3.1	0.3	2.0	2.1	1.4	2.6	0.4

RSO Range Safety Officer, *SL* Squad Leader, *G* Gunner, *AG* Assistant Gunner, *AB* Ammo Bearer

Kamimori *et al.* (2017) conclude, "[t]he results presented herein demonstrate the wide range of overpressure and impulse exposures among these groups…and mortar crews commonly fire hundreds of rounds during a single training session, they are also likely to receive high cumulative exposures[29]".

The trial identified and documented that personnel are exposed to potentially harmful blast effects in operational and non-operational combat related activities, with the latter being much more frequent[30].

This study being the first of its kind, was illustrative of the importance of biometric data which would be later borne out in other findings from Carr *et al* (2020), Yuan, et al (2019), and Belding, et al (2020).

In the follow up studies by Kamimori, *et al* (2017) the authors note, "It appears that maximum peak overpressure exposure correlates with crew members that are standing during weapon operation…so it follows that crew members that are standing would have their heads closer to the planar axis of the muzzle of the weapon and would receive higher exposure readings.[31]"

Likewise, Skotak, et al (2020) work on the effects of the blast waves using computational methods demonstrated that impulse loading of the head even when equipped with Kevlar-based Advanced Combat Helmet (ACH) and more recently, the Enhanced Combat Helmet (ECH) was introduced in 2013, which could lead to tissue level deformation (strain and stress), and by extension, lead to neurological effects[32]. The focus of study on blast overpressure (BOP) exposure from high-explosives and heavy weapon systems has resulted in questions concerning overpressure inside the helmet.

While Gupta & Przekwas (2013) addressed blast wave physics, injury biomechanics, and the neurobiology of brain injury as a foundation for a more detailed discussion of multiscale mathematical models of primary biomechanics and secondary injury via computer-generated image of a simulated shock wave traveling through the skull [33].

[29] Id.
[30] Id.
[31] Id.
[32] Skotak, Maciej, et al. "Factors Contributing to Increased Blast Overpressure inside Modern Ballistic Helmets." MDPI, Multidisciplinary Digital Publishing Institute, 15 Oct. 2020, www.mdpi.com/2076-3417/10/20/7193.
[33] Gupta, Raj K, and Andrzej Przekwas. "Mathematical Models of Blast-Induced TBI: Current Status, Challenges, and Prospects." Frontiers in neurology vol. 4 59. 30 May. 2013, doi:10.3389/fneur.2013.00059

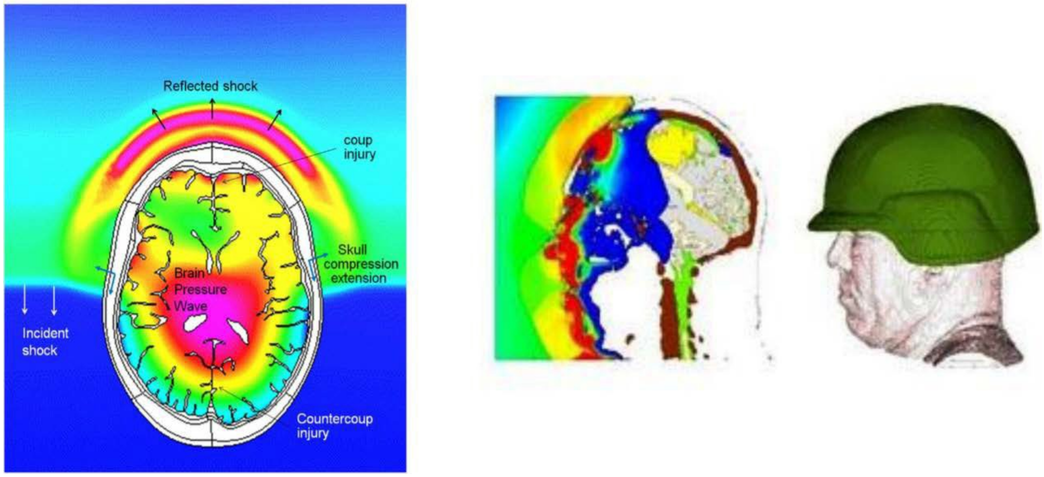

Figure 2 *Coupled simulations of CFD blast wave and FEM biomechanics of a human head. Pressure profiles in the air and in the brain during intracranial pressure wave penetration. Note that the intracranial pressure wave is faster than the incident shock wave in the air. Abstract (Gupta & Przekwas, 2013)*

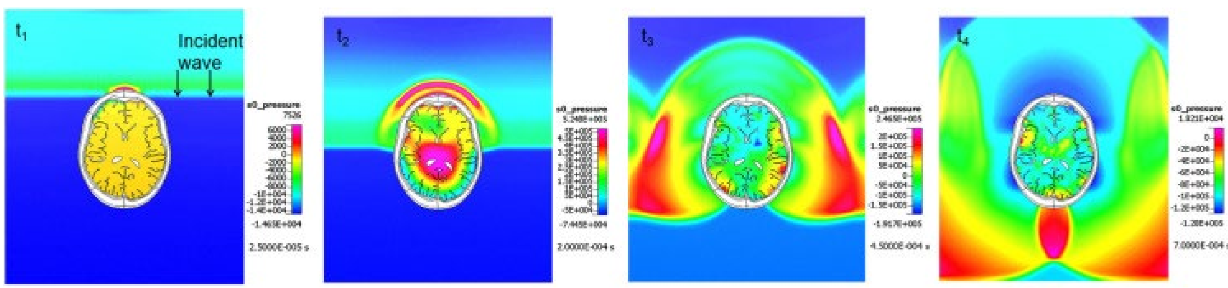

Figure 3 Example coupled CFD-FEM simulation results of a blast wave diffraction around, and transmission through a human head. A sequence of four time instances. Abstract (Gupta & Przekwas, 2013)

Given the aforementioned investigation into computational models of blast wave simulation and actual testing on currently issued PPE, Skotak, *et al.* (2020) continue, “frontal orientation consistently demonstrated the highest aggregate peak overpressure, and it was more than two times higher than for the back orientation (presumably due to the contribution of the eye mounted sensors). At the same time, we observed much smaller impulse variability. None of the helmets [tested] offer any protection compared to the bare headform. The sum of the peak overpressure for helmeted specimens was, in all cases, higher than for the unprotected headform[34]”.

Suggesting that standard issued equipment such as helmets worn by military personnel do little to nothing to reduce the peak overpressure experienced such as those peak overpressures experienced the routine employment of U.S. military mortar systems.

[34] Id at 27. Noting: It is possible that the discrepancies in the geometry between experimental and computational models: 1) the gap size between the helmet and the head, and 2) material models used for pad suspension systems could account for these differences.

Likewise, Kaminori, *et al*. (2017) caution, "In general, the data from multiple sites demonstrate that operator exposure is affected by proximity to the overpressure source as well as the environment of the operator during the exposure. Efforts should be made to reduce reliance on pure incident exposure models as they do not accurately reflect operator exposure in real environments [35]".

It follows, according to Carr *et al.* (2020), service members in occupations that likely include repeated exposure to blast are at some increased risk for neurosensory conditions that present in medical evaluations[36].

After years of repeated occupational exposure to "low-level blasts" or explosive events used in close proximity (high explosive or propellant combustion in heavy weapons), some individuals report symptoms consistent with a concussion (e.g., memory deficits, headache, dizziness, difficulty concentrating). Those symptoms are reported as experienced to a greater degree during periods of repeated exposure to blast in training[37].

The anecdotally reported occupational blast-related symptomology has been supported by a symptom survey among a blast-exposed professional community[38], by pilot study evidence that included cognitive performance and blood-based neurotrauma biomarkers collected during training programs involving explosives[39], and by symptom inventory in other field studies of operational training [40, 41, 42, 43] (incorporated by reference). In addition to symptom reporting, research observations of low-level blast-associated effects have included deficits in cognitive function[44].

For example, in a randomized controlled trial, studying the "Impact of low-level blast on brain function after a One Day Tactile Training and the Ameliorating Effect of a Jugular Vein Neck Collar Device," Yuan *et al.* (2019) provided, "[k]ey findings from the working memory analysis include significantly increased fMRI brain activation in

35 Id.
36 Carr, W., Kelley, A. L., Toolin, C. F., & Weber, N. S. (2020). Association of MOS-Based Blast Exposure With Medical Outcomes. Frontiers in Neurology, 11. https://doi.org/10.3389/fneur.2020.00619
37 Id.
38 Carr W, Polejaeva E, Grome A, Crandall B, LaValle C, Eonta SE, et al. Relation of repeated low-level blast exposure with symptomology similar to concussion. *J Head Trauma Rehab.* (2015) 30:47–55. doi: 10.1097/HTR.0000000000000064
39 Tate CM, Wang KK, Eonta S, Zhang Y, Carr W, Tortella FC, et al. Serum brain biomarker level, neurocognitive performance, and self-reported symptom changes in repeatedly exposed to low-level blast: a breacher pilot study. J Neurotrauma. (2013) 30:1620–30. doi: 10.1089/neu.2012.2683
40 Carr W, Taylor M, LoPresti M, Aurich L, Walilko T, Yarnell A, et al. Symptomology observed in humans following acute exposure to explosive blast. *J Neurotrauma.* (2015) 32:A109–A.
41 Carr W, Stone JR, Walilko T, Young LA, Snook TL, Paggi ME, et al. Repeated low-level blast exposure: a descriptive human subjects study. *Mil Med.* (2016) 181(5 Suppl.):28–39. doi: 10.7205/MILMED-D-15-00137
42 Carr W, Yarnell AM, Ong R, Walilko T, Kamimori GH, da Silva U, et al. Ubiquitin carboxy-terminal hydrolase-l1 as a serum neurotrauma biomarker for exposure to occupational low-level blast. Front Neurol. (2015) 6:49. doi: 10.3389/fneur.2015.00049
43 Boutté AM, Thangavelu B, LaValle CR, Nemes J, Gilsdorf JS, Shear DA, et al. Brain-related proteins as serum biomarkers of acute, subconcussive blast overpressure exposure: a cohort study of military personnel. PLoS ONE. 14:e0221036. doi: 10.1371/journal.pone.0221036
44 LaValle CR, Carr WS, Egnoto MJ, Misistia AC, Salib JE, Ramos AN, et al. Neurocognitive performance deficits related to immediate and acute blast overpressure exposure. *Front Neurol.* (2019) 10:949. doi: 10.3389/fneur.2019.00949

the right insular, right superior temporal pole, right inferior frontal gyrus, and pars orbitalis post-training for the non-collar group[45]". The authors provide the data obtained through an MRI provided initial evidence of the impact of low-level blast on working memory and auditory network connectivity, which is consistent with previous studies.

Carr *et al.* (2020) opine, "[t]his growing body of evidence is *suggestive* of an association between occupations that have a likelihood of repeated exposure to explosive blast and negative effects on health[46]".

Of note, in this report, "[t]he group occupationally exposed to blasts had a slightly shorter term of service until evaluation for disability (aRR = 0.98, 95% CI = 0.97–0.99) and had a higher risk of being evaluated for a nervous system-or sense organ-related disability between their 1st and 7th year of military service (aRR = 1.15, 95% CI = 1.07–1.25) than the Unexposed group[47]".

Disability disease/disorder subcategory	First 12 months				Years 1–7				Years 8–14			
	Exposed	Unexposed	aRR*	95% CI	Exposed	Unexposed	aRR*	95% CI	Exposed	Unexposed	aRR*	95% CI
	(*n* = 263)	(*n* = 229)			(*n* = 3,779)	(*n* = 3,401)			(*n* = 715)	(*n* = 705)		
	%	%			%	%			%	%		
Psychiatric	6.46	3.49	1.58	0.89–2.81	26.07	25.05	1.01	0.93–1.09	55.66	48.65	1.10	0.94–1.27
Nervous system/sense Organs	7.60	7.42	1.04	0.64–1.68	20.40	15.32	1.15	1.07–1.25	29.37	23.40	1.15	0.97–1.35
Digestive	1.14	0.44	1.14	0.36–3.67	1.93	1.88	0.99	0.78–1.25	2.80	1.84	1.21	0.76–1.93
Respiratory	3.04	3.06	1.07	0.52–2.23	4.42	5.23	0.97	0.83–1.14	2.24	3.69	0.87	0.52–1.43
Circulatory	1.90	1.75	1.15	0.46–2.88	1.69	2.09	0.94	0.73–1.21	1.40	2.70	0.69	0.37–1.30
Endocrine/immunity	2.28	2.18	1.02	0.41–2.50	1.19	1.59	0.92	0.68–1.23	1.26	1.84	0.90	0.46–1.75

Adjusted models control for race and education at military entry.

Equally, in Carr *et al.* (2020) reports, "regarding tinnitus…there is clear biological plausibility for a causal relationship between exposure and endpoint. The risk was higher among exposed Soldiers at every period of follow-up. Further investigation of tinnitus (see Supplemental Tables and Figure) was conducted to assess the overall risk of tinnitus diagnosis, regardless of the diagnosis order (hospitalization or ambulatory encounter). This supplemental analysis similarly found that exposed Soldiers are at an increased risk of being diagnosed with tinnitus during service [relative risk (RR), 1.75; 95% CI, 1.65–1.85], and an analysis of exposure time found the highest period of the risk of diagnosis at 3–4 years of service (RR, 1.89; 95% CI, 1.62–2.18). Among those Soldiers diagnosed with tinnitus, the Exposed group was more likely to be disability discharged (RR, 1.59; 95% CI, 1.45–1.76) or attrit from service (RR, 2.42; 95% CI, 2.17–2.70) than the Unexposed group[48].

[45] Yuan W, Barber Foss KD, Dudley J, Thomas S, Galloway R, DiCesare C, Leach J, Scheifele P, Farina M, Valencia G, Smith D, Altaye M, Rhea CK, Talavage T, Myer GD. Impact of Low-Level Blast Exposure on Brain Function after a One-Day Tactile Training and the Ameliorating Effect of a Jugular Vein Compression Neck Collar Device. J Neurotrauma. 2019 Mar 1;36(5):721-734. doi: 10.1089/neu.2018.5737. Epub 2018 Oct 3. PMID: 30136637.
[46] Carr, W., Kelley, A. L., Toolin, C. F., & Weber, N. S. (2020). Association of MOS-Based Blast Exposure With Medical Outcomes. Frontiers in Neurology, 11. https://doi.org/10.3389/fneur.2020.00619
[47] Id.
[48] Id.

Supplemental Table 1: Analysis of Exposure to Combat and Occupation in Tinnitus vs No Tinnitus, Cox Proportional Hazards

	Tinnitus (n= 4,893)		No Tinnitus (n= 95,615)		cRR	95% CI
	N	%	N	%		
Exposure to Blast						
Exposed**	2,987	61.0	47,267	49.4	1.75	(1.65 - 1.85)
Unexposed (ref)	1,906	39.0	48,348	50.6	1.00	-
MOS						
Cannon crewmember**	1,476	30.2	20,372	21.3	1.65	(1.56 - 1.76)
Combat engineer**	488	10.0	9,756	10.2	1.13	(1.02 - 1.24)
EOD specialist**	278	5.7	6,199	6.5	1.09	(0.97 - 1.24)
Indirect fire infantry**	125	2.6	1,503	1.6	1.26	(1.05 - 1.50)
Special Forces**	620	12.7	9,437	9.9	1.25	(1.15 - 1.36)
FA radar operator/surveyor	21	0.4	489	0.5	0.84	(0.55 - 1.30)
CBRN specialist	46	0.9	1,080	1.1	0.86	(0.64 - 1.15)
Dog handler	6	0.1	276	0.3	0.50	(0.23 - 1.12)
Motor transport operator	311	6.4	5,241	5.5	1.06	(0.94 - 1.18)
Engineers other than combat	39	0.8	951	1.0	1.42	(1.03 - 1.94)
Military intelligence	145	3.0	5,379	5.6	0.54	(0.45 - 0.63)
Military police	213	4.4	3,464	3.6	1.25	(1.09 - 1.44)
Psychological operations	12	0.2	191	0.2	0.85	(0.48 - 1.50)
Quartermaster	499	10.2	14,139	14.8	0.59	(0.54 - 0.65)
Field mechanical maintenance	393	8.0	10,350	10.8	0.63	(0.57 - 0.70)
Signal	221	4.5	6,788	7.1	0.66	(0.57 - 0.75)

** Exposed Group

Carr *et al.* (2020) continued in their report, by way of univariate statistical analysis, The group occupationally exposed to blasts had a slightly shorter term of service until evaluation for disability (aRR = 0.98, 95% CI = 0.97–0.99) and had a higher risk of being evaluated for a nervous system or sense organ-related disability between their 1st and 7th year of military service (aRR = 1.15, 95% CI = 1.07–1.25) than the Unexposed group.

Supplemental Table 2: Disability Evaluation Related to Neurological or Sense Organ Condition by VASRD

	Exposed	**Unexposed**
First 12 months	**n=20**	**n=17**
Migraine	15.00	17.65
Long thoracic nerve, paralysis	10.00	0.00
Sciatic nerve, paralysis	10.00	0.00
Hearing loss	5.00	0.00
Residuals of TBI	5.00	5.88
Years 2 to 7	**n=771**	**n=521**

Residuals of TBI	23.74	22.46
Migraine	18.16	16.12
Sciatic nerve, paralysis	11.54	14.59
Hearing loss	9.08	4.41
Neuritis, sciatic nerve	3.89	4.22
Years 8 to 14	**n=210**	**n=165**
Residuals of TBI	36.19	26.06
Migraine	28.10	24.85
Sciatic nerve, paralysis	16.19	18.79
Neuritis, sciatic nerve	5.71	4.85
Epilepsy, grand mal	4.76	4.85

Listed the top 5 VASRDs for Exposed group, then found the % for the same conditions in Unexposed (not necessarily top 5 VASRDs for Unexposed group).

Notably, Carr *et al*. (2020) continue, "[t]he findings regarding TBI are an echo of the hospitalization findings, in that there is an elevation of risk that occurs with more years of service and, assumedly, more years of exposure in the MOSs selected for occupational blast. There is an interesting difference in the ambulatory encounter data on TBI. A concussion is the most frequently appearing code, but the code for post-concussion syndrome also appears in the top three occurring codes for the majority of Soldiers with TBI. This seems reasonable because the post-concussion syndrome is unlikely to result in hospitalization, but this may also be the evidence of a medical outcome associated with chronic exposure to blast[49]."

Of equal importance, Belding *et al*. (2020) predict that recurrent occupational overpressure exposure (ROPE) was more likely to sustain a TBI from a high-intensity blast. Concluding primarily that blast exposure and recurrent occupational overpressure (ROPE) or LLB's and blast exposures were independently associated with mTBI's[50,51].

Carr *et al.* (2020) continue, "[p]ost-concussion syndrome is associated with a specific traumatic event rather than chronic exposure, but the post-concussion syndrome is divorced in time from the traumatic event, with symptoms that can be present weeks or months after injury. Furthermore, those symptoms are consistent with symptoms reported by Soldiers exposed to occupational blast (e.g., headache, dizziness, sleep difficulty, concentration difficulty). Greater frequency of post-concussive syndrome was also observed in the hospitalization data in the Exposed group for the longest time period of service, but the low number of persons in those data did not warrant standalone inference[52]".

[49] Id.

[50] Belding JN, Fitzmaurice S, Englert RM, Koenig HG, Thomsen CJ, da Silva UO. Self-reported concussion symptomology during deployment: differences as a function of injury mechanism and low-level blast exposure. J Neurotrauma. (2020). doi: 10.1089/neu.2020.6997. [Epub ahead of print].

[51] Belding JN, Fitzmaurice S, Englert RM, Lee I, Kowitz B, Highfill-McRoy RM, et al. Blast exposure and risk of recurrent occupational overpressure exposure predict deployment TBIs. Mil Med. (2019) 185:e538–44. doi: 10.1093/milmed/usz289

[52] Id.

Carr *et al.* (2020) further acknowledge, "[o]ur use of multiple MOSs instead of a single MOS did likely introduce further limitations in precision for blast exposure history. The detonation of high explosives in training with hand grenades or in explosive breaching yields a different blast overpressure wave than does the combustion of propellant in artillery or heavy weapons. However, for the purposes of the present study, we adopted the position that the differences in exposures between types of blast events were small relative to differences between our categories of MOSs, Exposed vs. Unexposed[53]."

Carr et al, (2020) finally state, "[t]aken together, these findings suggest particular attention to tinnitus, TBI, and post-concussion syndrome by medical personnel in evaluations of Soldiers with some routine exposure to explosives and heavy weapons, in both combat and training environments.[54]"

Low Level Blast Research – 2020 to Present:

Effect of the National Defense Authorization Act (2018) (Public Law 115-91) sec. 734:

Established in 2007, the Blast Injury Research Program Coordinating Office (PCO), redesignated Department of Defense (DoD) Blast Injury Research Coordinating Office (BIRCO) in 2018, "works with a diverse community of medical and non-medical researches within the DoD, other federal agencies, academia, private sector, and international communities"[55].

BIRCO is responsible for responding to National Defense Authorization Act for Fiscal Year 2018 (FY18 NDAA) Section 734, which mandates that the Secretary of Defense conduct a Longitudinal Medical Study on Blast Pressure Exposure of Members of the Armed Forces. In 2020, BIRCO led and coordinated with internal, external and academic partners Blast Overpressure Studies (BOS) Working Group addressing the requirements of FY18 NDAA Section 734, FY 2019 NDAA Section 253, and FY 2020 NDAA Sections 717 and 742, which expand on the FY18 mandate[56].

In June 2022, the DoD in launched the Warfighter Brain Health Initiative to bring together the operational and medical communities in a more unified approach toward tracking and optimizing service member brain health and countering traumatic brain injuries. Likewise, the program provides information to the public and private sector medical community on the effects of LLB to include symptoms associated with LLB and military occupations which may expose service members to low level blasts[57].

Notably, a systemic review conducted by Belding, et al. (2021) stated, "blast exposure has been recognized as a significant source of morbidity and mortality in military populations" also stating, "our understanding of the effects of blast exposure,

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[55] Id.
[53] Id.
[54] Id.
[55] Blast Injury Research Coordinating Office (BIRCO). "History." Blast Injury Research Coordinating Office (BIRCO) - History, 26 Sept. 2022, blastinjuryresearch.health.mil/index.cfm/about_us/history.
[56] Id.
[57] Defense Health Agency. "Low-Level Blast Exposure." *Military Health System*, 21 Sept. 2023, www.health.mil/Military-Health-Topics/Warfighter-Brain-Health/Brain-Health-Topics/Low-Level-Blast-Exposure.

particularly low-level blast (LLB) exposure, on health outcomes remains limited.[58]" Belding, *et al*. (2021) provide a comprehensive review of the peer-reviewed literature that has been published on blast exposure over the past two decades, with specific emphasis on LLB spanning two decades of research on both human and animal subjects[59].

Belding, *et al* .(2021) provide, "more than 3,000 articles on blast overpressure have been published since 2000, fewer than 2% of these articles specifically examined health outcomes that may be associated with LLB…the majority of studies examining the effects of LLB on humans attempted to determine if exposure is associated with acute and long-term effects, such as impaired neurological functioning, neurochemical evidence of brain damage, damage to auditory, vestibular, or visual systems, and self-reported symptoms[60]".

Of the 20 published peer-reviewed studies on humans,16 were conducted in training environments, 11 were exclusively related to military personnel, 3 were conducted in corporate settings, and there was a single online survey. The sample sizes were relatively small ranging from 14 to 357 participants with an average of 83[61].

"Although research on LLB is growing rapidly, it still presents a tiny fraction of research on blast injury. Specifically, our review located only 51 peer-reviewed published articles on LLB across the past 20 years, including both animal and human research. (Belding, et al, 2021)[62]"

Nonetheless, "These findings contribute to a growing body of research linking overpressure exposure with adverse health and wellbeing outcomes. As with previous research, the most consistent findings emerged primarily for conditions that were neurological, hearing-related, or mental health-related. Specifically, these findings provide yet more evidence of the association between overpressure exposure (including single HLB, repeated HLB, and occupational LLB exposure) and hearing loss and tinnitus diagnosis.[63]"

The authors conclude,

> "Taken together, the findings herein suggest that overpressure exposure increases the likelihood of several self-reported diagnoses including PTSD, hearing loss, chronic fatigue syndrome, tinnitus, neuropathy-caused reduced sensation in the hands and feet, depression, vision loss, sinusitis, reflux, and anemia. Furthermore, the data reported herein provide additional support for the idea that the combination of HLB and LLB exposure may be associated with greater risk of migraines, PTSD, and impaired fecundity, and may adversely affect performance. These findings provide further evidence of the potential adverse consequences associated with overpressure exposure and underscore

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58 Belding, J. N., Englert, R. M., Fitzmaurice, S., Jackson, J. R., Koenig, H. G., Hunter, M. A., Thomsen, C. J., & da Silva, U. O. (2021). Potential Health and performance effects of high-level and low-level blast: A scoping review of two decades of research. Frontiers in Neurology, 12. https://doi.org/10.3389/fneur.2021.628782
59 Id.
60 Id.
61 Id.
62 Id.
63 Id.

> the necessity of public health surveillance initiatives for blast exposure and/or safety recommendations for training and operational environments (Belding, et al, 2021)[64]."

Neurocognitive effects were studied on a cohort of U.S. Army Rangers, Woodall, *et al* (2021), in their work they note, "nearly 500 rounds were fired during the study, resulting in a high cumulative blast exposure for all mortarmen…exceeding the 4 psi threshold…[resulting in] high prevalence of mTBI like symptoms among all mortarmen, with over 70% experiencing headaches, ringing in the ears, forgetfulness/poor memory, and taking longer to think during the training week.[65]"

The authors explain, "The mortar systems used in the U.S. Army are the 60 mm, the 81 mm, and the 120 mm. When a mortar round is fired, explosive charges ignite within the mortar tube, launching the round to its target. This process exposes mortarmen to an LLB every time a round is fired.[66]" Continuing, "there is limited research on the LLB exposure of mortarmen, and, to the best of our knowledge, there are no publications to date on the physiological effects of blast exposure within the mortarmen population" (Woodall, et al, 2021)[67].

Referencing earlier research from Kamimori et al. (2017), finding that BOP exceeded 4 psi while using the 120mm mortar system, the authors expand in the previous research using The Blast Guage System© (BlackBox Biometrics Rochester NY), noting, "These gauges measure both reflected and incident pressure—capturing true environmental exposure—and have been used to measure LLB in numerous other studies" (citations incorporated herein by reference)[68]." Blast measurements for this study were obtained using BlackBox Biometrics, Gen 7, with three devices placed on each participant.

Mortarmen self-reported symptoms immediately before and after firing each day using a modified Rivermead post-concussion symptom questionnaire to rank each symptom from 0 (not experienced) to 4 (a severe problem)"..."Questionnaire results were analyzed to identify the prevalence of symptoms among all subjects and test the hypothesis that mortarmen experience more symptoms than controls. The most common symptoms were further analyzed by mortarmen classifications: mortar crew and average BOP above or below 4 psi"[69]. The PLR-3000 pupillometer (NeurOptics, Irvine, CA) was used to collect PLR measurements during the study. The results of which are captured in the following graphic models, figures or diagrams[70].

[64] Id.
[65] Woodall, J. l.a, Sak, J. a, Cowdrick, K. R., Bove Muñoz, B. m, McElrath, J. h, Trimpe, G. r, Mei, Y., Myhre, R. l, Rains, J. k, & Hutchinson, C. r. (2021). Repetitive low-level blast exposure and neurocognitive effects in Army Ranger Mortarmen. Military Medicine, 188(3–4). https://doi.org/10.1093/milmed/usab394
[66] Id.
[67] Id.
[68] Id.
[69] Id.
[70] Id.

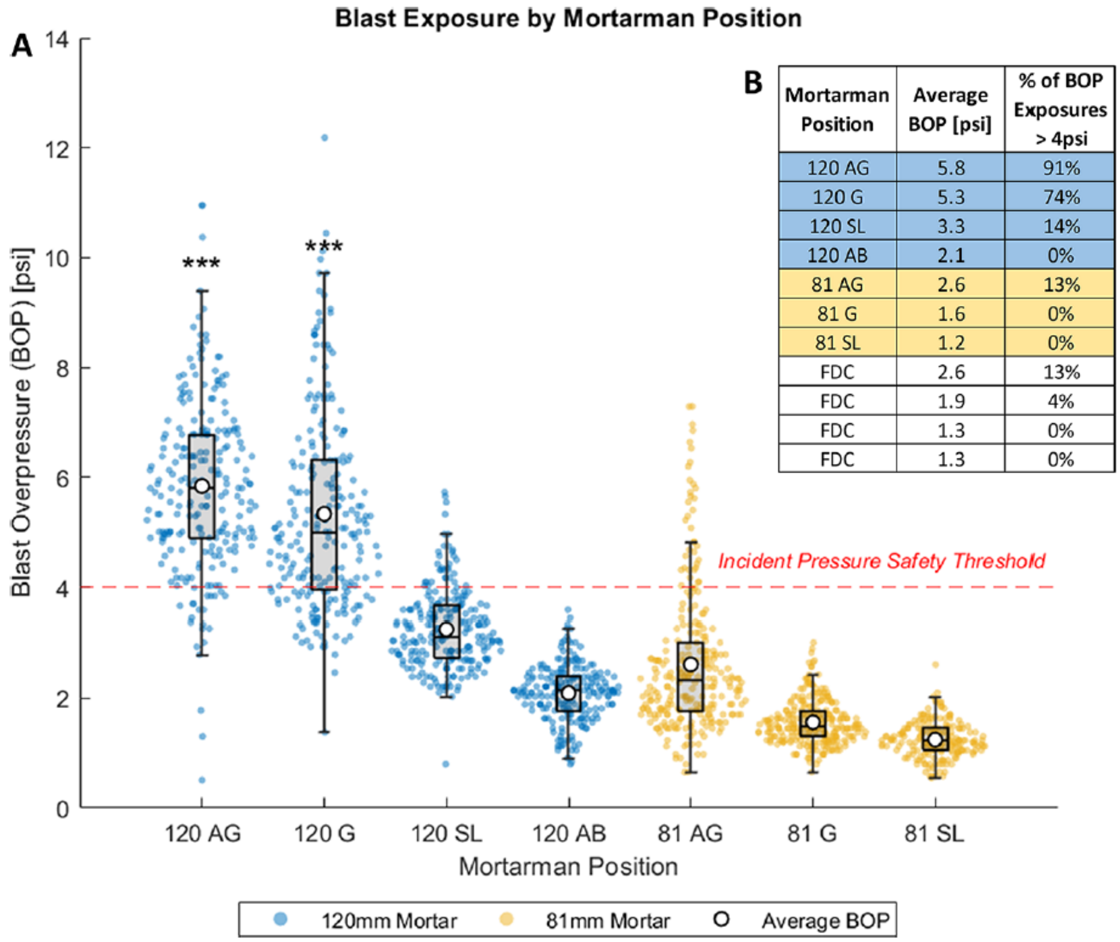

Figure 4 Swarm scatter chart displaying all blast events for each mortarman on the 120 mm and 81 mm mortars (AG=assistant gunner, G=gunner, SL=squad leader, AB=ammunition bearer). Overlaid with box plots for each. Subjects with means significantly greater than 4 psi are indicated with ***$P < 0.001$. (B) Blast overpressure (BOP) exposure values for all mortarmen, including FDCs (FDC=fire direction center). Abstract from Woodall, et al, (2021).

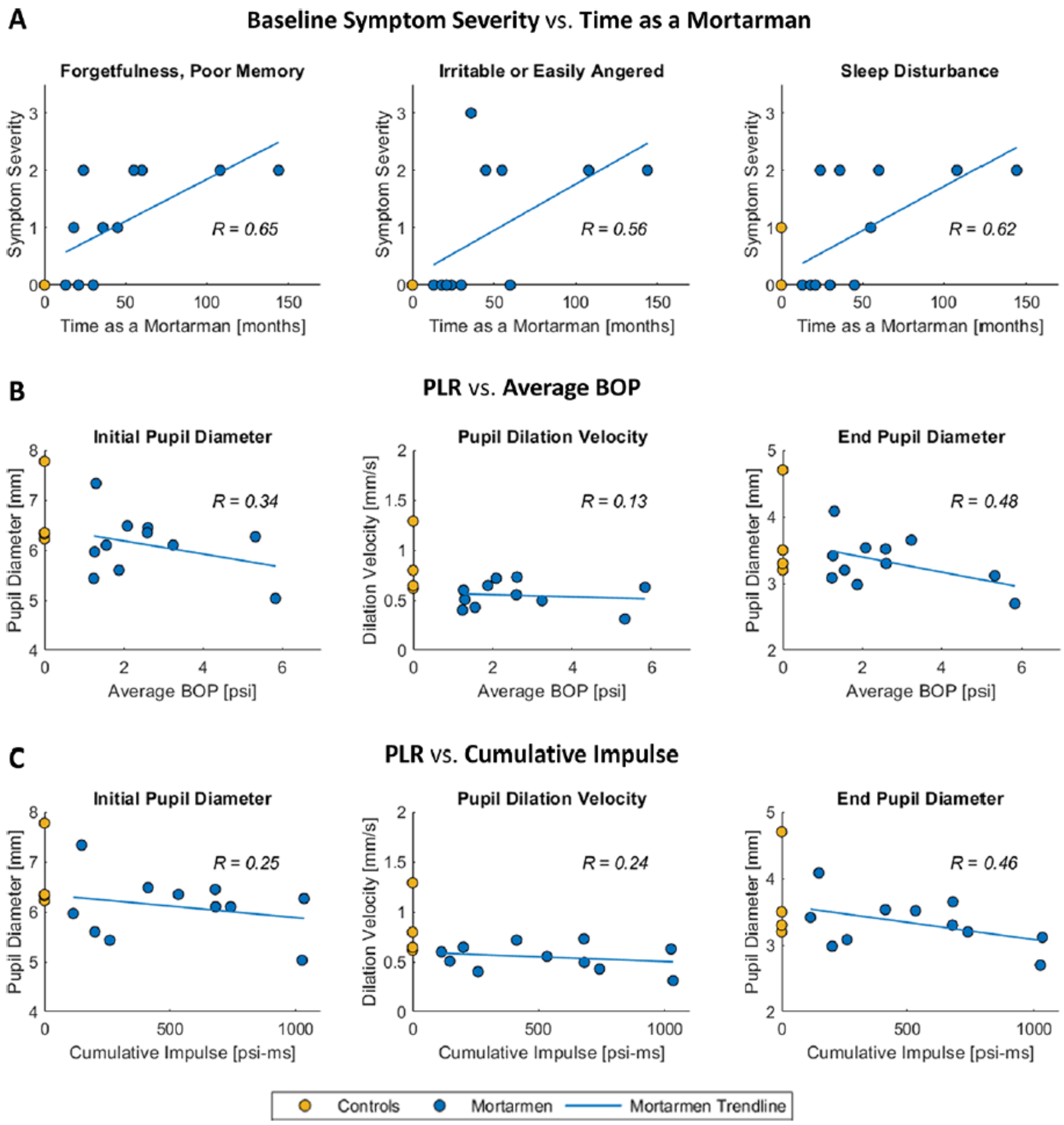

Figure 5 Cross comparison of symptoms, blast history, and blast exposure. Trendlines of mortarmen data, excluding controls from calculations. Pearson correlation coefficients displayed as R. (A) Baseline symptom severity scores compared to time as a mortarmen (*n*=3 controls, *n*=12 mortarmen). (B) Pupillary light reflex (PLR) measures compared to average blast overpressure (BOP) (B-C: *n*=4 controls, *n*=11 mortarmen). (C) PLR measures compared. to cumulative impulse. Abstract from Woodall, et al, (2021).

TABLE I. Summary Statistics for Pupillary Light Reflex (PLR)

	Mortarmen ($n = 11$)	Controls ($n = 4$)	
Pupillary response	*Mean ± SD*	*Mean ± SD*	*P*
Dim light pulse (10 μW)			
Initial pupil diameter (mm)	6.29 ± 0.66	6.82 ± 0.89	0.28
End pupil diameter (mm)	3.76 ± 0.48	4.22 ± 0.79	0.25
Constriction latency (s)	0.23 ± 0.03	0.23 ± 0.02	0.85
Constriction velocity (mm/s)	3.15 ± 0.49	3.50 ± 0.35	**0.09**
Max constriction velocity (mm/s)	5.69 ± 2.29	6.05 ± 0.78	0.55
Dilation velocity (mm/s)	1.02 ± 0.28	1.33 ± 0.23	**0.04***
Bright light pulse (121 μW)			
Initial pupil diameter (mm)	6.10 ± 0.68	6.71 ± 0.74	0.16
End pupil diameter (mm)	3.33 ± 0.41	3.73 ± 0.66	0.23
Constriction latency (s)	0.22 ± 0.03	0.24 ± 0.05	0.85
Constriction velocity (mm/s)	3.20 ± 0.48	3.60 ± 0.41	**0.06**
Max constriction velocity (mm/s)	5.99 ± 2.54	6.26 ± 0.53	0.62
Dilation velocity (mm/s)	0.55 ± 0.29	0.87 ± 0.45	**0.02***

Figure 6 Mean and standard deviation (SD) of pupillary responses measured at night from controls (n=4) without blast exposure and from mortarmen (n=11) immediately after mortar firing. Includes responses from both dim and bright light pulses. Significant values of $P < 0.10$ are in bold, and $P < 0.05$ is indicated with *. Abstract from Woodall, et al, (2021)

Woodall, et al (2021) report, "Mortarman had smaller pupil diameters and slower pupillary responses than controls (Figure 3, Table I). Dilation velocity was significantly slower in mortarmen than controls for both dim (P=0.04) and bright (P=0.02) light pulses. Constriction velocity was also significantly slower in mortarmen for both dim (P=0.09) and bright (P=0.06) light pulses when increasing the significance threshold (α=0.10).[71]"

In their discussion and findings, the authors note,

> "Multiple mortarmen had blast exposure exceeding the 4-psi incident pressure safety threshold. This included the AG, G, and SL on the 120 mm mortar and the AG on the 81 mm mortar.[72]" BOP as high as 5.8 was observed affecting members of the 120mm mortar system. Likewise, within just 3 days of training, the highest cumulative BOP was 1,361 psi, more than double that of instructors' cumulative exposure. This, in comparison to other studies over six days of breaching training wherein the average cumulative impulse to be 51 psi for students and 43 for instructors. The difference lies in the sheer amount of rounds fired by mortar crews with averages of "89 and 78 rounds fired per day during our study and even lower when compared to the hundreds of rounds fired per day in other training events or combat.[73]"

[71] Id.
[72] Id.
[73] Id.

As a result, reported symptoms include, “headaches, ringing in the ears, forgetfulness/poor memory, taking longer to think, sleep disturbance, and being irritable or easily angered were reported by over 60% of mortarmen during the training week.[74]”

Woodall, et al, (2021) conclude,

> *“The symptoms exhibited by mortarmen expectedly paralleled symptoms experienced by breachers and aligned with some of the symptoms typical of post-concussive and mTBI patients. This supports the theory that repetitive LLB can lead to subconcussive injuries, similar to repetitive head impact in sports. Increased symptom severity in those with longer history as mortarmen suggests there is an accumulation of repetitive, subconcussive effects over mortarmen’s careers, resulting in cumulative neurodegeneration presented as delayed onset and increased severity of post-concussive symptoms”[75].*

Similar to earlier studies in Kamimori, *et al.* (2017), Wiri, Suthee, *et al* (2023), return to examining to effects of blast overpressure through gathering biometric data under the CONQUER pilot blast monitoring program. The authors report,

> “Overpressure exposure data was collected using the BlackBox Biometrics (B3) Blast Gauge System (BGS, generation 7) sensors mounted on the body during training. To date, the CONQUER program has recorded 450,000 gauge triggers on monitored service members. The subset of data presented here has been collected from 202 service members undergoing training[76].”

For the purpose of this resolution, we brightline the overpressure data obtained for the Mortar systems (60, 81 and 120mm). As an overview, 25 subjects captured 2,828 waveforms, with an average of 113 per subject[77].

Wri, Suthee, et al (2023) explain, “The mortar systems have impulses that are less than about 21 kPa-ms (~3 psi-ms). However, a large number of peak overpressures exceeding ~28 kPa (4.0 psi) are present with some blast exposure magnitudes up to 53.6 kPa (7.8 psi).”

The following chart reflects gathered information relative to the gunner and assistant gunner positions:

impulse, and number of exposures is not yet known”.

Figure 7 Photo of the gunner (standing) and assistant gunner (bending down) around a 120 mm mortar. The plot of overpressure vs. time histories for gunner (top) and assistant gunner (bottom) for 120 mm mortar with 1 M230 propelling charge. (Abstract Wri, Suthee, et al, 2023)

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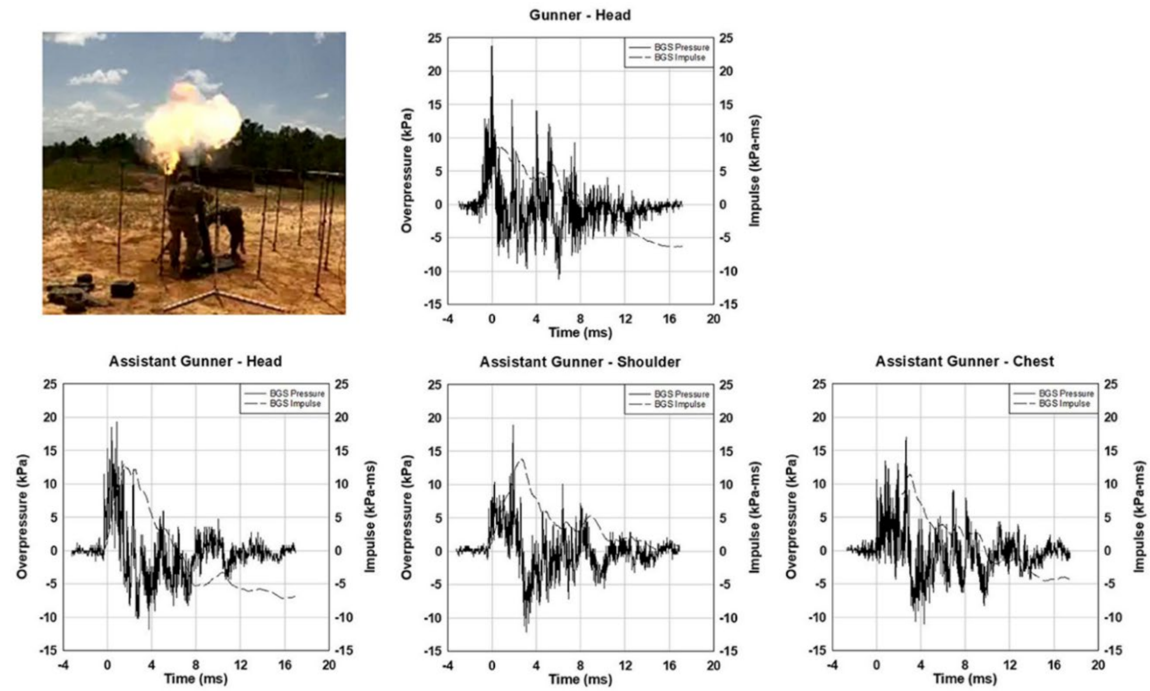
[74] Id.
[75] Id.
[76] Wiri, Suthee, et al. “Dynamic monitoring of service members to quantify blast exposure levels during combat training using BlackBox biometrics blast gauges: Explosive breaching, shoulder-fired weapons, artillery, mortars, and 0.50 caliber guns.” Frontiers in Neurology, vol. 14, 25 May 2023, https://doi.org/10.3389/fneur.2023.1175671.
[77] Id.



Wiri, Suthee *et al*, (2023) conclude, “Both peak overpressure and peak overpressure impulse (a measure of blast energy) data are presented since both could be important for correlation with physiologic changes. All overpressure waveforms include the negative phase overpressure and impulse. The number of blast exposures over time (within a day, month, or year) is expected to have an effect on adverse neurologic outcomes, but the relationship between peak overpressure, peak overpressure remains unclear.

In another study, Hunfalvay, et al, (2023) note, “[r]ecent findings suggest that chronic exposure to low-level blasts may be implicated in neurological alterations and elevated biomarkers associated with traumatic brain injury.[78]” Assessing for oculomotor effects, the results of this study “revealed significant differences in SPEM, saccades, and fixations between the blast exposure group and control group.”

The authors explain,

> “Concussed individuals have higher fixation percentages as they are constantly falling behind the target, requiring their eyes to saccade to catch up to the target…The saccadic system includes several brain structures including the brain stem, pons, midbrain, and cerebral cortex. Saccades are generated by burst neuron circuits in the brain stem, which activate motor signals that control the extraocular muscles in the eye. Multiple studies have shown that saccadic impairment is associated with TBI. (citations incorporated by reference)[79]”.

The blast exposure group stopped moving their eyes significantly more often when compared to the controls. This dysfunction is implicated in frontal lobe planning and decision-making activities, only evident when a decision is required”, providing a

[78] Hunfalvay, M., Murray, N. P., Creel, W. T., & Carrick, F. R. (2022). Long-term effects of low-level blast exposure and high-caliber weapons use in military special operators. Brain Sciences, 12(5), 679. https://doi.org/10.3390/brainsci12050679
[79] Id.

"clearer understanding of the impact that chronic low-level blast exposure has on the CSP fixation percentages of military personnel" (Hunfalvay, et al, 2023).

In an exploratory analysis of data from 138,949 members of the Millennium Cohort Study, Belding, et al, (2023), estimated associations between single HLB, repeated HLB, and occupational risk of LLB on newly-reported diagnoses. For the purpose of this report, we will focus on occupational risk of LLB exposure. The authors note,

> "LLB was significantly associated with 11 of the 45 diagnoses examined, including 6 of the 11 conditions hypothesized a priori to be affected by blast. The highest magnitudes of association were observed for PTSD (1.45), significant hearing loss (1.34), chronic fatigue syndrome (1.24), tinnitus (1.20), neuropathy-caused reduced sensation in the hands and feet (1.19), significant vision loss (1.12), and depression (1.11)[80]"

Among the conclusions, further research should be conducted which may inform our understanding of the possible associations between overpressure and suicide that has been posited elsewhere[81]".

In a first of its kind review, Kilgore & Hubbard (2024), discuss LLB on cerebral blow flow, stating, "(LLB) exposure can lead to alterations in neurological health, cerebral vasculature, and cerebral blood flow (CBF). The development of cognitive issues and behavioral abnormalities after LLB, or subconcussive blast exposure, is insidious due to the lack of acute symptoms. One major hallmark of LLB exposure is the initiation of neurovascular damage followed by the development of neurovascular dysfunction.[82]"

The authors note, previous work has shown that repeated LLB can lead to transient symptomatology as well as conditions that persist throughout a service member's military career. Specifically noting, "high occupational risk of LLB not only correlates with diagnoses of mild to moderate TBI but also with an increased likelihood of experiencing symptoms similar to those experienced after TBI, such as memory loss. These include cognitive issues, headaches, hearing problems, non-headache pain, sleep disturbances, and behavioral health conditions such as anxiety, drug and alcohol dependence, and post-traumatic stress disorder (PTSD)" (Belding et al, 2021; Carr et al, 2015; Carr et al, 2016; as cited in Kilgore & Hubbard, 2024)[83].

Citing two earlier studies, Kilgore & Hubard (2024) note,

> *"Veterans with a history of blast exposure not only showed a similar graded association via DTI but also demonstrated a more rapid decline in white matter integrity with age compared to unexposed individuals, indicating that cumulative blast exposure may contribute to an accelerated aging process" (Trotter, et al, 2015; as cited in Kilgore & Hubbard 2024). The authors continue, "repeated LLB*

[80] Belding, J. N., Kolaja, C. A., Rull, R. P., & Trone, D. W. (2023). Single and repeated high-level blast, low-level blast, and new-onset self-reported health conditions in the U.S. Millennium Cohort Study: An exploratory investigation. Frontiers in Neurology, 14. https://doi.org/10.3389/fneur.2023.1110717

[81] Id.

[82] Kilgore, Madison O., and W. Brad Hubbard. "Effects of low-level blast on neurovascular health and cerebral blood flow: Current findings and future opportunities in neuroimaging." International Journal of Molecular Sciences, vol. 25, no. 1, 4 Jan. 2024, p. 642, https://doi.org/10.3390/ijms25010642..

[83] Id.

exposure show elevated PET neuroinflammation, a characteristic of neurovascular dysfunction and contributor to the progression of neurodegenerative diseases such as Alzheimer's disease (AD), Parkinson's disease (PD), and amyotrophic lateral sclerosis (ALS)" (Stone, et al. 2024, as cited in Kilgore & Hubbard, 2024)[84]".

The authors hypothesize that "early brain CBF changes and secondary neurovascular deficits can lead to chronic perfusion alterations after LLB[85]"

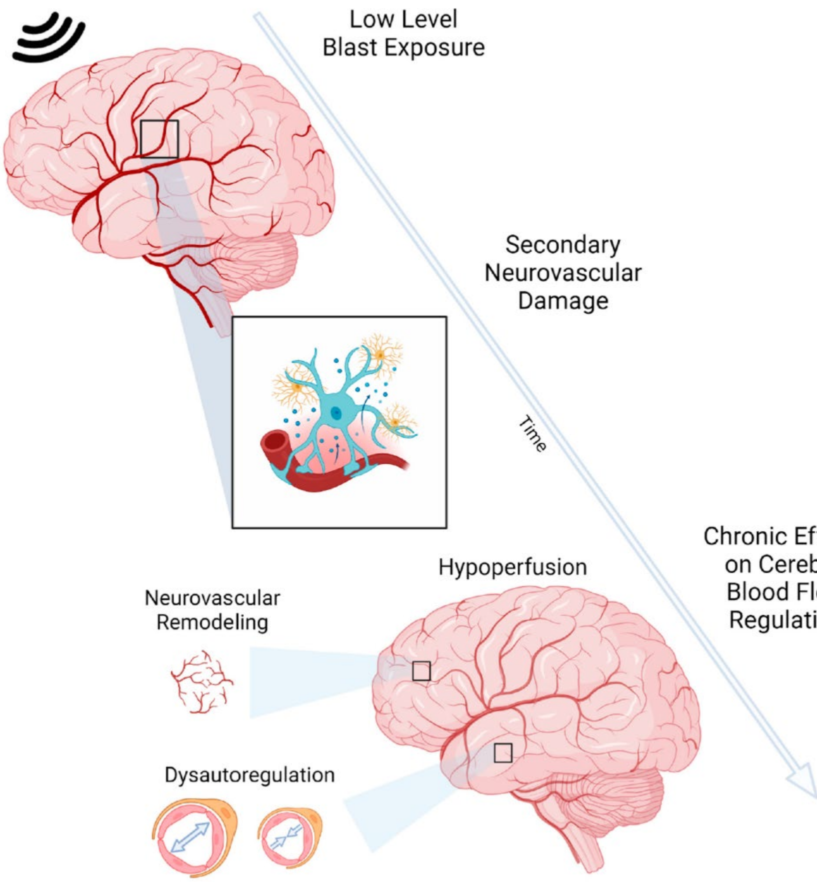


Figure 8 Development of Neurovascular dysfunction over time following cumulative LLB exposure results in secondary neurovascular damage, including BBB breakdown, astrocytic alterations, inflammation, and pericyte loss. Ongoing neurovascular damage can lead to chronic effects on CBF and the regulation of cerebral perfusion, including hypoperfusion, neurovascular remodeling, and dysautoregulation. These consequences of cumulative LLB exposure contribute to neurological dysfunction and acceleration of brain aging mechanisms.

Kilgore & Hubbard (2024), note:

"[E]vidence suggests that blast overpressure is linked to changes in cerebrovascular function. Examining the long-term ramifications of exposure to LLB is particularly significant due to its potential to contribute to chronic deficits in cerebral perfusion by accelerating aging-related mechanisms in cerebrovascular dysfunction, such as reductions in nitric oxide (NO) availability and neurovascular oxidative stress [108]. Notably, preclinical investigations have demonstrated that

[84] Id.
[85] Id.

> *blast exposure triggers acute oxidative stress and alters NO production, linking both to disruptions in [Brain Blood Barrier] permeability"*[86].

Through these and other ongoing initiatives into BOP and LLB research, a body of evidence continue to suggest the potential for lasting effects of LLB within the military community, in particular those within military occupations where cumulative exposure to peak overpressures above 4 psi is part and parcel to their assigned activities.

Analysis:

Since at least 2003 the Department of Defense (DoD) has provided a known standard that protective equipment must be provided to limit the effects of blast overpressure to 2.3 PSI. The data herein reflects that military service members have been routinely exposed to pressures well above that without adequate personal protective equipment (PPE).

On December 11, 2023, the U.S. Army through Training and Doctrine Command Proponent Office, Ft. Eustis, Virginia referencing interim guidance for Army Range Safety dated November 4, 2022, stated, "current research provides evidence of adverse health and performance effects from acute and repetitive exposures to blast overpressure (BOP). DoD has existing guidelines and standards that provide occupational BOP exposure thresholds for the prevention of lung injury, eardrum rupture, and potential health impacts from repetitive exposure. However, DoD admits there are no current BOP guidelines and standards for the protection of brain health since related brain health effects are not yet 'fully understood'.[87]"

Further, based on the most recent guidance, we posit no attempts have been made to adjust the minimum PPE requirement specific to BOP, or rather PPE designed t mitigate BOP exposures while maintaining operational efficiency in training and combat environments.

The objective evidence continues to show that service members may well suffer from deleterious effects of routine exposure to low level blast overpressure, and that these service members experience on the order of thousands to tens of thousands of exposures in a career.

The plain language of U.S.C. § 501(a) provides the Secretary broad authority to consider the consolidated evidence and then to § 1110-1113 provides that disability resulting from personal injury suffered, or disease contracted in line of duty will be service-connected unless clearly and unmistakably (A) pre-existed service and was not aggravated therein, (B) due to willful misconduct or (B) due to intercurrent injury which post-dated service and is the recognized cause of the injury or disease.

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[86] Id.

[87] Kozielsky, Cory. *Army Range Safety Message on Interim Guidance for Managing Brain Health Risk from Blast Overpressure".* ATIC-LTR: MEMORANDUM THRU TRADOC Proponent Office, Ranges, 11 December 2023.

Title 38 C.F.R. § 3.303(a) provides,

> *"Service connection connotes many factors, but basically it means that the facts, shown by evidence, establish that a particular injury or disease resulting in disability was incurred coincident with service in the Armed Forces, or if preexisting such service, was aggravated therein. This may be accomplished by affirmatively showing inception or aggravation during service or through the application of statutory presumptions (emphasis added)."*

The law continues to provide that "each disabling condition shown by a veteran's service records, or for which he seeks a service connection must be considered based on the *places*, *types* and *circumstances* of [their] service as shown by service records, the official history of each organization in which [they] served, [their] medical records and all pertinent medical and lay evidence."

However, the latter part is often vague in its application and guided merely by VA's internal guidance; it's M21-1 rewrite or adjudication procedures. It is left to the discretion of often changing policy guidance.

Nonetheless, in considering "circumstances," this language is not dispositive to that which is sought under the relief provided by allowing for a presumption of service connection for identified conditions herein for affected those military occupational specialties (MOS) including those who fire heavy mortars in both regular and special operations careers, but not limited to all occupations who have been thus affected and which the science bears out that an occupational hazard exists;

And, which has therein exposed a claimant to a level of injury which has precipitated a known cluster of disabilities, illnesses, or injuries.

The Institute of Medicine's (IOM) "sufficient evidence" standard indicates that the evidence fulfills the criteria for sufficient evidence of a causal association in which chance, bias, and confounding can be ruled out with reasonable confidence, and is supported by several of the other considerations used to assess causality: the strength of association, dose-response relationship, consistency of association, temporal relationship, the specificity of association, and biological plausibility.[56]

The evidence of record is "suggestive" of an association between military service and on low-level blast exposure (LLB) disorders such as tinnitus, headaches, vertigo, residuals of TBI, and chronic post-concussive syndrome as proximately due to the concussive effects of occupational BOP exposure.

Resolution I:

Therefore, we resolve that Title 38 C.F.R. § 3.307 be amended to read:

(8) Diseases associated with low-level blast exposure. Indirect Fire Infantryman (11C) veteran, or any veteran who by virtue of their military occupational specialty requirement were exposed to low-level blasts during service at or above 2.3 PSI shall be presumed to have been chronically exposed to such occupational low-level blasts sufficient to support a finding of service connection subject to the provisions of paragraph (a) of this Section, Title 38 C.F.R. §§ 3.309(g) and 3.303 (inclusive):

Therefore, we request Title 38 C.F.R. § 3.309 be amended to read:

(g) *Diseases associated with occupational low-level blast exposure*. If a veteran is diagnosed at any time following discharge subject to the provisions of Title 38 C.F.R. § 3.307(8):

- Hearing loss, bilateral, or unilateral
  Note: “Hearing loss” means hearing loss pursuant to 38 C.F.R. § 4.85

- Tinnitus, recurrent

- Headache Disorders to include Migraines

- Residuals, Traumatic Brain Injury

- Post Concussive Disorders, Chronic
  Note: Rate by analogy to affected body system under Part 4, Title 38 C.F.R.

Resolution II:

In May 2018 the Center for a New American Security published an article titled “Protecting Warfighters from Blast Injury,” which described high blast pressure exposures of members of the Armed Forces. Integration of interests from both the public and private sectors resulted in section 734 of the National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2018 (Public Law 115–91), which requires that the Secretary of Defense conduct a longitudinal medical study on blast pressure exposure of members of the Armed Forces during combat and training.

Likewise, in FY2020, Sec. 716 of the NDAA now requires DoD to document a servicemember’s blast exposure history in their medical record, including the date, duration, and circumstances, of such exposure.

While these legislative measures are welcome and needed, C3M believes that servicemembers, veterans within the military occupational specialty 11C/0341, SOCOM Operators, and other Tier 1 weapon system crew who occupationally engage in firing heavy weapons be included within the parameters of such legislation for the purposes of medical research, study, and tracking of disease or illness development associated with LLB.

It is important to note, as is the case with mTBI and other illnesses related to LLB. are on the milder end of severity, meaning the short window for detection is often missed. It has been known since the early 2000's that severe exposure to explosive blast waves can cause permanent and debilitating brain trauma, but only recently has evidence begun to emerge showing that LLB is capable of causing symptoms associated mTBI, psychological, and biological symptoms.

Precedent has been set with all manner of other occupational hazards and illness studies related to military service and we respectfully see this issue as being no different.

Resolution III:

C3M resolves for the Commissioning of a Retrospective Analysis to be included in the National Veteran Suicide Prevention Annual Report by the Secretary of the VA and DoD in a joint effort to account for and acknowledge any correlation between military occupational specialty (MOS) of combat arms personnel who employ Tier 1 weapon systems, routine and cumulative exposure to blast overpressure (BOP) statistical correlation to veteran and servicemember suicide.

Army Times Reporter Davis Winkie (2024) provided, "Members of both houses of Congress are calling for the Defense Department to comply with federal law and submit overdue suicide-related reports to legislative committees…according to Senate staff, the Defense Department has missed its deadline on three mandatory reports from the fiscal year 2023 defense policy bill that were due in December 2023. One report called for post-9/11 suicide numbers broken down by occupational specialty and military component.[88]"

Likewise, through Freedom of Information Act (FOIA) requests, Wilkie (2024) obtained more than 1250 Defense Department Form (DDF) 1300, Report of Casualty, a document which contains demographic information for the deceased service member. Wilkie reported there were only light redactions, and the analysis was tailored to Regular Army (the service's all-active-duty component) casualties whose casualty forms identified their manner of death as 'self-inflicted', excluding accidental deaths, homicides, illnesses and those whose manner could not be determined[89]".

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[88] Winkie, Davis. "Lawmakers Push Pentagon for Overdue Data on Tanker Suicide Rates." Army Times, Army Times, 15 Mar. 2024, www.armytimes.com/news/your-army/2024/03/15/lawmakers-push-pentagon-for-overdue-data-on-tanker-suicide-rates/.

[89] Winkie, Davis. "Broken Track: How Army Times Discovered High Tank Unit Suicide Rates." Army Times, Army Times, 11 Mar. 2024, www.armytimes.com/news/your-army/2024/03/11/broken-track-how-army-times-discovered-high-tank-unit-suicide-rates/.

Notably, the data from Winkie's limited investigation is telling:

Average annual suicide rate (per 100,000) for the Army's 20 largest active duty enlisted occupational specialties, 2019-2021

	Primary Military Occupational Speciality	Suicides, 2019-2021	Average Strength	Average annual suicide rate per 100k
1	19K M1 ARMOR CREWMAN	16	5,953	89.6
2	13B CANNON CREWMEMBER	16	7,822	68.2
3	74D CBRN SPECIALIST	11	5,542	66.2
4	11C INDIRECT FIRE INFANTRYMAN	11	5,894	62.2
5	19D CAVALRY SCOUT	20	11,449	58.2
6	25U SIGNAL SUPPORT SYSTEM SPEC	13	8,241	52.6
7	12B COMBAT ENGINEER	14	8,931	52.3
8	11B INFANTRYMAN	67	49,629	45.0

Figure 9 Average annual suicide rate (per 100,000) for the Army's 20 largest active duty enlisted occupational specialties, 2019-2021. Abstract from Winkie (2024).

The current methodology contained within VA's National Veteran Suicide Prevention Annual Report states:

> *"Data is combined from multiple sources, including Veterans Health Administration (VHA) clinical, administrative, and enrollment records compiled by SMITREC; the United States Veterans Eligibility Trends and Statistics (USVETS) database maintained by the VA Office of Enterprise Integration; and service-era rosters and registry files maintained by the VA Health Outcomes Military Exposure (HOME) Program. To this data, DMDC staff adds records of all current and former service members from DoD personnel files[90]".*

A review of the VA National Suicide Prevention Annual Report, as robust as it maybe be, is notably silent regarding MOS. It's is the position of C3M, that MOS, cumulative exposure to LLB, and the neurophysiological effect experienced therein may be a comorbid factor attributing to the prevalence of suicide within this population. To wit, this missing information may prove to be a valuable indicator, as one of several variables for higher at-risk populations of currently living veterans and therefore may provide insights to modeling treatment and care for this population of warfighters.

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[90] 2023 National Veteran Suicide Prevention - VA Mental Health, www.mentalhealth.va.gov/docs/data-sheets/2023/2023-National-Veteran-Suicide-Prevention-Annual-Report-Methods-Summary_508.pdf. Accessed 23 June 2024.

Resolution IV:

C3M resolves a working group or advisory committee must be created to enhance the DoD's mission to enhance the battlefield capability, efficiency, and safety of our cohort into the future.

Comprehensive Strategy for Special Operations Forces Warfighter Brain Health policy memorandum is an existing policy that should be expanded immediately. Within it, Special Forces Command recognizes the potential health consequences of excessive occupational exposure to low level blast overpressure firing shoulder fired weapons. We know through Woodall's study on heavy mortars, that heavy mortar crews are exposed to overpressure levels that greatly exceed that of shoulder fire weapons. The policy also calls for the immediate and urgent implementation of equipment to monitor exposure, neurocognitive assessment tools and health record interaction.

Should we be successful, we would be honored to attend all appropriate meetings and roundtables as an enterprise stakeholder considering the application of DoD Instruction and Policy, Congressional Reports, down to Technical Manual and Platoon, Squad and Individual Soldier Tasks.

We believe our past experience as Infantrymen gives us a unique perspective on these issues both in combat and garrison settings, in light and mechanized infantry units both as leaders and enlisted personnel.

Conclusions:

The methodology used in creating this resolution consists of the following:

- The relevant rules, laws, and regulations were identified.
- Databases and recognized medical journals were such as PubMed, Frontiers in Neurology, and other peer-reviewed reputable sources for studies on low-level blast exposure (LLB) or variants in the veteran and military population.

The articles were identified, and copies were obtained. Next, C3M assessed the studies for methodologic rigor and for evidence of the association between service in the military and development of injuries, illnesses, and/or mechanisms of injury associated with low-level blast exposure (LLB). Accordingly, C3M's conclusions and findings provided herein are based on categories that qualitatively rank the strength of the evidence of an association between injuries and illnesses that provide "limited suggestive evidence" or "suggestive evidence" sufficient to conclude that the following medical conditions should be added to the relevant sections of Part 3, Title 38 Code of Federal Regulations.

Equally, to provide such relief is within the purview of both the Secretary and Congress as the case may be. C^{3}M appreciates, as has the Court recognized

> *"Congress has expressed special solicitude for the veterans' cause. A veteran, after all, has performed an especially important service for the Nation, often at the risk of his or her own life. And Congress has made clear that the VA is not*

> *an ordinary agency.[91]" This agency, above all, is to uphold the promise President Lincoln during his second inaugural address, "With malice toward none, with charity for all, with firmness in the right as God gives us to see the right…to care for him who shall have borne the battle and for his widow, and his orphan[92]".*

Equally so, "[t]he Department of Defense's enduring mission is to provide combat-credible military forces needed to deter war and protect the security of our nation. The Department provides a lethal and effective Joint Force that, combined with our network of allies and partners, sustains American influence and advances shared security and prosperity[93]".

Our infantry is the tip of the spear of this mission on many fronts. If we do little to ensure the combat readiness, effectiveness, and sustainment of our forces, then we run the risk of unnecessary injury to assets and attrition.

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[91] Shinseki v. Sanders, 556 U.S. 396 (2009)

[92] U.S. Dept., V. A. (2007). *The Origin of the VA's Motto*. https://www.va.gov/opa/publications/celebrate/vamotto.pdf.

[93] General Services Administration & the Office of Management and Budget, U. S. (2020, September). Department of Defense. Performance.Gov. https://www.performance.gov/defense/#:~:text=The%20Department%20of%20Defense's%20enduring,the%20security%20of%20our%20nation.

With these ideals, these facts, and these known occupational hazards and associated illnesses and conditions that have befallen our brothers and sisters-in-arms, we see the right as God gives us that sight. With this vision, we honor our time-honored ethos, the Blue Cord, and Cross Rifles we earned and stand by the infantryman's obligation to lead the charge and so commit ourselves to lead the way. Wherever there is a battle that must be won, we are there! This is why we say, "I am the Infantry, Follow Me!"

Thank you, Sir's and Ma'am's, in advance for your time and attention to this important resolution, for your joining us in championing change, and for your vigor and spirit. Equally so, for your intellect and talent.

Sincerely,

Todd Strader
Founder, Chief Executive Officer (CEO)
Cohort of Chronically Concussed Mortarmen (C3M)

Timothy J. Grossman
President,
Cohort of Chronically Concussed Mortarmen (C3M)

C3mortarmen.org

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Appendix:

Table 1-6. U.S. mortar characteristics*

Type	Crew	Weight (Lbs)	Range† (Meters) Min	Max	Rates of Fire Round/Min.	Projectiles	Fuzes
M224 60-mm Conventional Mode	3	47	70	3,520	Maximum 30/4 Sustained 20/1	HE Smoke, WP ILLUM IR ILLUM	Multioption (prox, PD, NSB, Delay) Point Detonating Time Mechanical Time Superquick
M224 60-mm Hand-Held Mode	3	18	75	1,340	No Limit at charge 0 or 1	Same as Conventional	Same as Conventional
M252 81-mm	4 (Army) 6 (USMC)	93	83	5,792	Maximum 30/2 Sustained 15/1	HE Smoke, WP Smoke, RP ILLUM IR ILLUM	Multioption (prox, PD, NSB, Delay) Point Detonating Time Mechanical Time Superquick
M120/121 120-mm	4	320	200	7,200	Maximum 16/1 Sustained 4/1	HE Smoke, WP Smoke, RP ILLUM IR ILLUM	Multioption (prox, PD, NSB, Delay) Point Detonating Time Mechanical Time Superquick
RMSL-6 120-mm	5	1,466	180	6,700	Same as M120/121	Same as M120/121	Same as M120/121

Legend
ILLUM: illumination
IR: infrared
NSB: near surface burst
PD: point detonating (surface burst)
prox: proximity
superquick: point detonating (surface burst)
*Mortar characteristics are taken from the tabulated data for each mortar system in FM 3-22.90.
† Range is a function of the ammunition and charge used. Refer to the mortar system's firing table for more information.

Table 4-2. Progressive training events for mortar elements

	Table I	Table II	Table III	Table IV	Table V	Table VI
Purpose:	Prerequisite	Prerequisite	Drills	Basic Skills	Reinforce Skills	Performance Evaluation
Method:	Crawl	Crawl	Walk	Walk	Run	Run
Environment:	Live	Live or Virtual	Live	Live	Live	Live
Conditions:	Hands On	Hands On	TADSS or Dry	Live Fire	Live Fire	Live Fire
Audience:	Individual	Squad	Squad	Squad / Section / Platoon	Section / Platoon	Section / Platoon
Tier 3 Mortars	A – GST (GNR Exam)	Pre-Live Fire Simulations	Drills	Basic	Practice	Qualification
Tier 3 Fire Direction Center (FDC)	B – GST	Pre-Live Fire Simulations	Drills	Basic	Practice	Qualification

Table 4-18. Table V, required live fire tasks

	Mission	Minimum Rounds per tube
Minimum requirements	Mark center sector	1 FRTC / 1 HE
	Registration	7 FRTC / 7 HE
	Grid	6 FRTC / 6 HE
	Shift	6 FRTC / 6 HE
	Polar	6 FRTC / 6 HE
	Immediate suppression/smoke	3 FRTC / 3 HE / 3 WP / 3 RP
	Illumination (ILL)	4 ILL / 4 IR

Legend: FRTC = full range training cartridge, HE = high explosive, IR = infrared, RP = red phosphorus, WP = white phosphorus

Table 4-19. Table V, advanced mission commander option tasks

	Mission	Minimum Rounds per tube
Advanced missions	Coordinated Illumination (ILL)	4 ILL / 4 IR and 5 HE
	Final protective fire (FPF)	8 FRTC / 8 HE
	Search	8 FRTC / 8 HE
	Traverse	8 FRTC / 8 HE
	Quick smoke	2 FRTC / HE 13+ WP / RP
	Simultaneous (SIMO)	6 FRTC / 6 HE
	Spilt section	6 FRTC / 6 HE
	Time on target (TOT)	6 FRTC / 6 HE
Legend: FRTC = full range training cartridge, HE = high explosive, IR = infrared, RP = red phosphorus, WP = white phosphorus		

Table 4-19. Table V, advanced mission commander option tasks

	Mission	Minimum Rounds per tube
Advanced missions	Coordinated Illumination (ILL)	4 ILL / 4 IR and 5 HE
	Final protective fire (FPF)	8 FRTC / 8 HE
	Search	8 FRTC / 8 HE
	Traverse	8 FRTC / 8 HE
	Quick smoke	2 FRTC / HE 13+ WP / RP
	Simultaneous (SIMO)	6 FRTC / 6 HE
	Spilt section	6 FRTC / 6 HE
	Time on target (TOT)	6 FRTC / 6 HE
Legend: FRTC = full range training cartridge, HE = high explosive, IR = infrared, RP = red phosphorus, WP = white phosphorus		

ADVANCED MISSION ROUND CALCULATOR

NUMBER OF CANNONS: 1

MINIMUM ROUNDS FOR MISSION

	TYPE OF ADVANCED MISSION	HE or FRTC ROUNDS	ILL or IR ROUNDS	WP or RP ROUNDS	HE or FRTC TOTAL	ILL OR IR TOTAL	WP or RP TOTAL
☑	Coordinated Illumination	5	4	0	5	0	0
☐	Final Protective Fire (FPF)	8	0	0	0	0	0
☐	Search	8	0	0	0	0	0
☑	Traverse	8	0	0	8	0	0
☑	Quick Smoke	2	0	13	2	13	13
☑	Simultaneous (SIMO)	6	0	0	6	0	0
☐	Split Section	6	0	0	0	0	0
☐	Time on Target	6	0	0	0	0	0

TYPE OF MORTAR SYSTEM

○	60MM
○	81MM
◉	120MM

ROUND TYPE	TOTAL	HE DODIC	FRTC DODIC
HE or FRTC	21	CA04	CA09
		ILL DODIC	ILL IR DODIC
ILL or IR	13	C625	N/A
		WP DODIC	RP DODIC
WP or RP	13	CA03	N/A

Table 4-23. Table VI, Required basic live fire tasks

	Mission	Minimum Rounds per tube
Minimum requirements	Mark center sector	1 FRTC / 1 HE
	Registration	7 FRTC / 7 HE
	Grid	6 FRTC / 6 HE
	Shift	6 FRTC / 6 HE
	Polar	6 FRTC / 6 HE
	Immediate suppression/smoke	3 FRTC / 3 HE / 3 WP / 3 RP
	Illumination	4 ILL / 4 IR
Legend: ILL = illumination; IR = infrared, FRTC = full range training cartridge, HE = high explosive, RP = red phosphorus, WP = white phosphorus		

Table 4-24. Table VI, Advanced mission commander option tasks

	Mission	Minimum Rounds per tube
Advanced missions	Coordinated Illumination	4 ILL / 4 IR and 5 HE
	Final protective fire (FPF)	8 FRTC / 8 HE
	Search	8 FRTC / 8 HE
	Traverse	8 FRTC / 8 HE
	Quick smoke	2 FRTC / HE 13 + WP / RP
	Simultaneous (SIMO)	6 FRTC / 6 HE
	Spilt section	6 FRTC / 6 HE
	Time on target (TOT)	6 FRTC / 6 HE
Legend: ILL = illumination; IR = infrared, FRTC = full range training cartridge, HE – high explosive, RP = red phosphorus, WP = white phosphorus		

ADVANCED MISSION ROUND CALCULATOR

NUMBER OF CANNONS: 1

MINIMUM ROUNDS FOR MISSION

	TYPE OF ADVANCED MISSION	HE or FRTC ROUNDS	ILL or IR ROUNDS	WP or RP ROUNDS	HE or FRTC TOTAL	ILL OR IR TOTAL	WP or RP TOTAL
☐	Coordinated Illumination	5	4	0	0	0	0
☐	Final Protective Fire (FPF)	8	0	0	0	0	0
☑	Search	8	0	0	8	0	0
☑	Traverse	8	0	0	8	0	0
☑	Quick Smoke	2	0	13	2	13	13
☑	Simultaneous (SIMO)	6	0	0	6	0	0
☐	Split Section	6	0	0	0	0	0
☐	Time on Target	6	0	0	0	0	0

TYPE OF MORTAR SYSTEM

○	60MM
○	81MM
◉	120MM

ROUND TYPE	TOTAL	HE DODIC	FRTC DODIC
HE or FRTC	24	CA04	CA09
		ILL DODIC	ILL IR DODIC
ILL or IR	13	C625	N/A
		WP DODIC	RP DODIC
WP or RP	13	CA03	N/A