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

MCHB-CG

29 December 2014

MEMORANDUM FOR LTG Patricia D. Horoho, The Surgeon General, Defense Health Headquarters, 7700 Arlington Boulevard, Falls Church, VA 22041-3258

SUBJECT: Army Institute of Public Health Technical Report, Deployment and Environmental Health Surveillance Investigation of 1/24 Battalion Stryker Brigade Combat Team, Mosul, Iraq 2004-2005, 29 December 2014

1. The enclosed report details the assessment of the Deployment and Environmental Health Surveillance Investigation to examine and address health and environmental exposure concerns expressed by a group of Soldiers from the 1/24 Battalion (BN) Stryker Brigade Combat Team (SBCT) during their deployment to Mosul, Iraq in 2004-2005.

2. In summary, there is little objective information available regarding potential exposures incurred by Unit members. The 1/24 BN SBCT was deployed to Mosul during a time of heavy insurgent activity and engaged in numerous dangerous missions. There was limited environmental monitoring conducted during this period of high operational tempo. Incident reports specific to this unit were not identified. The health effects reported by Unit members did not have clear associations with potential exposures identified by the unit or to other known exposures. Although the available data are limited, long-term health effects are not expected based on the information available.

3. The point of contact for this report is Ms. Farhana Schickedanz, Deployment Environmental Surveillance Program, commercial (410) 436-6096 or farhana.schickedanz2.civ@mail.mil.

Encl

DEAN G. SIENKO
Major General, USA
Commanding

USAPHC
U.S. ARMY PUBLIC HEALTH COMMAND
5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5403

Deployment and Environmental Health Surveillance Investigation of 1/24 BN SBCT Mosul, Iraq 2004–2005 December 2014

Prepared by
Army Institute of Public Health

General Medical: 500A, Public Health Survey

ACKNOWLEDGEMENTS

PREPARED BY:

Farhana Schickedanz
Data Assessment Team Chief
Deployment Environmental Surveillance Program

Tim Schickedanz
Health Risk Communication Specialist
Health Risk Communication Program

Katie Riley, MPH, CPH, MCHES
Health Risk Communication Specialist
Health Risk Communication Program

Nathan Cook
Physical Scientist
Deployment Environmental Surveillance Program

Coleen P. Baird, MD, MPH, FACOEM
Program Manager,
Environmental Medicine Program

Charles McCannon, MD MPH, MBA, FACPM
Environmental Medicine Program

Ronald Teichman MD MPH, FACP, FACOEM
Environmental Medicine Program

Amy Jenness
Meteorologist
Deployment Environmental Surveillance Program

Denise Robinson
Environmental Engineer
Deployment Environmental Surveillance Program

REVIEWED BY:

Jeffrey S. Kirkpatrick
Portfolio Director, Health Risk Management

William A. Rice
COL, MC
Portfolio Director, Occupational and Environmental Medicine

APPROVED BY:

John J. Resta
Director, Army Institute of Public Health

Table of Contents

EXECUTIVE SUMMARY

Deployment and Environmental Health Surveillance Investigation 1/24 BN SBCT Mosul, Iraq 2004–2005 December 2014

In December 2013, a Request for Information from the Chief of Staff of the Army was provided to The Surgeon General regarding the deployment exposure concerns of a group of Soldiers from the 1/24 Battalion (BN) Stryker Brigade Combat Team (SBCT) who served in the vicinity of Mosul/Task Force Olympia, Iraq in 2004-2005. Health conditions identified in the request included liver cancer, liver disease, lymphoma, adverse reproductive and birth outcomes, and Crohn's disease. The U.S. Army Public Health Command, Army Institute of Public Health, conducted a Deployment and Environmental Health Surveillance Investigation to examine and address health and environmental exposure concerns expressed by the 1/24 BN SBCT during their 2004-2005 deployment to Mosul, Iraq.

The goals of the investigation were to: (1) identify potential environmental exposures to 1/24 BN SBCT personnel; (2) determine if historical data were available to characterize the frequency, magnitude, and duration of environmental exposures with a completed exposure pathway; and (3) determine if adverse health effects associated with such exposure were likely based on the available information.

The findings suggested that the health effects reported by Unit members did not have definitive associations with potential exposures identified by the Unit or to other known exposures. Although the available data were limited, long-term health effects were not expected based on the available information. Also, a cluster (pattern) of a specific disease or condition was not evident.

Deployment and Environmental Health Surveillance Investigation 1/24 BN SBCT Mosul, Iraq 2004–2005 December 2014

1 Summary

1.1 Purpose

The U.S. Army Public Health Command (USAPHC), Army Institute of Public Health (AIPH) conducted a Deployment and Environmental Health Surveillance Investigation to examine and address health and environmental exposure concerns expressed by a group of Soldiers from the 1/24 Battalion (BN) Stryker Brigade Combat Team (SBCT) during their deployment to Iraq in 2004-2005. The main goals were: (1) identify potential environmental exposures to 1/24 BN SBCT personnel, (2) determine if historical data were available to characterize the frequency, magnitude, and duration of environmental exposures with a completed exposure pathway, and (3) determine if adverse health effects were likely based on available information.

1.2 Background

In early December 2013, the USAPHC was made aware that multiple members of the 1/24 BN SBCT Headquarters and Headquarters Command (HHC) reported a variety of health conditions to include liver cancer, lymphoma, Crohn's disease, and undiagnosed symptoms and health concerns. Affected individuals served in the vicinity of Mosul/Task Force (TF) Olympia, Iraq in 2004-2005 as part of Operation Iraqi Freedom (OIF). Their major concern was whether or not the observed health outcomes represented an excess of disease in the unit. The Deployment Environmental Surveillance Program (DESP), Health Risk Communication Program (HRCP), and Environmental Medicine Program (EMP) engaged in fact finding in the areas of exposure and potential health implications as well as risk communication to assess health concerns and perceptions. All of these efforts are described in this report.

1.3 Methodology

The investigating team's objective was to identify exposures and potential exposures to members of the 1/24 BN SBCT deployed to Mosul, Iraq area in 2004-2005. Occupational and environmental health surveillance (OEHS) data were collected from environmental sampling, descriptive documents regarding incidents or releases, and historical operational/personnel data.

Next, the likelihood that an individual was actually exposed (also known as a "completed exposure pathway") was evaluated, which considered the source from which the harmful stressor could be emitted, whether or not there was a release mechanism and whether it involved air, water, or soil. If so, the method of contact with the exposure was identified: ingestion, inhalation (breathing) or contact with skin (dermal).

The team also conducted 16 personal interviews with former Soldiers, spouses, and leaders of the 1/24 BN SBCT to determine deployment exposure concerns, health status, health concerns, and current perceptions and beliefs. All individuals interviewed were asked about their deployment history, experiences during the deployment, major incidents of concern, environmental exposures,

in-theater injuries and illnesses, medical care, and health status before, during, and after their deployment to Mosul, Iraq 2004-2005.

Health conditions, symptoms, and health concerns identified from the interviews were utilized and medical records were reviewed. In addition, medical encounter data in the Department of Defense (DoD) electronic health record—Armed Forces Health Longitudinal Technology Application (AHLTA)—and the Department of Veterans Affairs' electronic health record were reviewed when personnel data were available. The goal was to identify health conditions that might be present in excess of their existence in the general population and to create case definitions for those conditions. The case definition described what was required for a person's injury or illness to be counted as a case in subsequent analyses. Next, a preliminary assessment determined whether an excess amount of cases had occurred (see Appendix C for Approach to Disease Clusters). If a cluster of cases was confirmed, the identified potential exposures were assessed for a biologically plausible relationship with this outcome. Finally, a decision was made as to whether an epidemiological study was feasible and warranted (references 1, 2, and 3).

1.4 Findings

Minimal objective information was available regarding potential exposures incurred by Unit members. The 1/24 BN SBCT was deployed to Mosul during a time of heavy insurgent activity and engaged in numerous dangerous missions. There was limited environmental monitoring conducted during this period of high operational tempo. Unit members were potentially exposed to products of combustion and incomplete combustion and an unknown mix of other potential hazards when detonating unexploded ordinance, during frequent improvised explosive device attacks, and when responding to burning Stryker vehicles.

In general, the health effects reported by Unit members did not have definitive associations with potential exposures identified by the Unit or to other known exposures. Although the available data were limited, long-term health effects were not expected based on the information available. Finally, a disease cluster (pattern) was not evident.

1.4.1 Reported Potential Exposures

An extremely limited amount of specific, quantitative, and applicable exposure information was identified in the review of available data sources. Ambient air quality was considered poor by many Soldiers. Exposure to ambient particulate matter (PM) and vehicle exhaust was highly likely. This is based on environmental monitoring conducted after 2005. Soldiers and the Unit surgeon were concerned about emissions from a burn pit. A burn pit used for waste control was determined to have been appropriately sited with respect to prevailing wind patterns. However, atypical events (such as atmospheric temperature inversions) may have occurred. These events have the potential to cause prolonged lingering of burn pit smoke near the ground. Exposure to other products of combustion from burning vehicles and uncharacterized burn pit emissions occurred at an unknown frequency, duration, and intensity.

While it is plausible that toxic industrial chemicals may have been present, there were no documented chemical releases or industrial accidents apart from a single ruptured canister incident at the "Ice Factory" discussed in the interviews. The impression of those interviewed for this investigation was that industrial facilities located in and around Mosul were generally not operational.

Soldiers were concerned about exposure to Halon discharged from the fire suppression systems, installed in Stryker vehicles. However, Halon was not the fire suppressing agent used in these vehicles. A burning Stryker would be expected to generate a variety of potentially hazardous combustion products. Magnitude and duration of hazardous exposures from burning vehicles were not known.

Unit members reported being near destroyed or disabled vehicles that may have been hit with depleted uranium (DU) rounds. Contact with vehicles hit by DU rounds may have resulted in limited incidental DU exposures (considered "Level III" exposures). Such exposures are not associated with significant health risks.

Individuals reported sporadic or potential exposure to sewage and human remains. The extent of barrier protection was variable between individuals. One individual reported an episode of what he considered "dysentery" from drinking water that was bottled; therefore, ingestion of contaminated water was not likely to have occurred. The lack of other reported acute episodes of infectious disease were evidence of a low level of risk for future health consequences of exposure to untreated sewage and human remains. The long-term risk of infectious disease risk was minimal.

Based on events as described by Unit members, some individuals likely incurred short-term exposures to irritants from Improvised Explosive Device (IEDs)/ Vehicle Borne Improvised Explosive Device (VBIEDs)/ Suicide Bomber Improvised Explosive Device (SBIEDs) and possibly at the "Ice Factory" or elsewhere. In no instance were these exposures quantified. Typically, however, acute health effects would have been apparent if exposures were of sufficient magnitude to be of long-term concern. Other hazards (such as propellants and accelerants) were mentioned by those interviewed, but it was not clear to what extent the exposure pathways were completed (i.e., item was inhaled, ingested or substantially absorbed through the skin). Some exposure concerns (such as the microwave "jammers") do not pose a health hazard under normal operating conditions.

The evaluation of the frequency, duration, and magnitude of specific exposures which could potentially result in long-term health effects did not provide evidence of a singular source of risk. However, there is substantial uncertainty about the risk posed by combinations of hazards and about exact exposures experienced at the individual level.

1.4.2 Reported Health Concerns and the Potential Exposures

Regarding health conditions and potential associations with deployment-related exposures, it could be stated with a high degree of certainty that self-reported post-traumatic stress disorder (PTSD), traumatic brain injury (TBI) and mild TBI (MTBI) were likely to have resulted from Unit activities during their deployment. The Unit operated for prolonged periods at high intensity with little "down time", and was exposed to deaths of Unit members, other human remains, and high-stress combat conditions. Likewise, hearing loss and combat injuries resulted from deployment activities. There were few complaints of respiratory disease from the interviewees—asthma, shortness of breath, and pulmonary nodules were reported—although inhalation exposures were likely. The association between respiratory symptoms and deployment to OIF has been noted, and asthma following deployment has been demonstrated in some published studies. Other non-cancer conditions (such as kidney stones, Crohn's disease, and non-infectious gastrointestinal disease and symptoms) do not have a clear relationship with potential exposures incurred during the Unit's deployment.

Biliary carcinoma is not associated with a specific environmental exposure. Two of the reported malignancies, follicular lymphoma and acute lymphoblastic leukemia (ALL), are associated with

ionizing radiation. Follicular lymphoma had also been associated with solvent exposure, although evidence for this relationship is considered limited/suggestive. While there are no quantitative measurements, exposure to incidental ionizing radiation is unlikely to result in development of either cancer. Cancer related to solvent exposure is limited to particular solvents and typically occurs in working populations with regular, recurring, long-term exposure. See Appendix P for details on the published literature regarding these opinions.

1.4.3 Disease Cluster Assessment

Overall, there is not a predominant and specific health condition of concern. No unifying case definition could be delineated. The presence of different cancer types in this small group was not evidence of a disease cluster, given that a cluster involves one specific type of disease. Likewise, singular occurrences of a specific disease type cannot be assessed as occurring in excess to what would be expected (references 1, 2, and 3). The age of onset for the noted cancers are somewhat atypical, but not wholly uncommon.

Since a unifying case definition cannot be established and because no known completed exposure pathway for a biologically plausible exposure can be identified, a formal epidemiological investigation would not be useful and is unfounded.

1.4.4 Rationale for Conducting Cancer Studies

The AIPH is planning to conduct a set of epidemiologic studies to evaluate whether a history of deployment in support of OIF/OEF was associated with subsequent incidence of primary cancer (from 2004–2013) among Active Duty Service Members and U.S. Veterans. Cases of primary melanoma, brain cancer, leukemia, lymphoma, thyroid cancer, testicular cancer, and breast cancer will be identified using DoD and VA medical records and cancer registry databases. Many of these cancers will have peak incidence during the young adult years and will have known or suspected environmental or occupational risk factors.

In responding to the concerns of the 1/24 BN SBCT Soldiers, Service Members and Veterans, a necessary first step is to evaluate whether the incidence of cancer among deployed personnel is greater than what would be expected. Thus, the objective of this study is to systematically identify cases of cancer among Active Duty Service Members and Veterans, evaluate their deployment experience in comparison to the deployment experience of a representative set of control subjects, and estimate the excess risk of cancer among deployed personnel. An understanding of the presence and magnitude of an excess risk of cancer among formerly deployed individuals – or the lack thereof – can be used to substantiate or alleviate concerns, support the public health and medical communities that care for formerly-deployed personnel and Veterans, and inform DoD and VA policy makers regarding the long-term effects of deployment-associated exposures.

1.5 Recommendations

1.5.1 The 1/24 BN SBCT Personnel

- Encourage all individuals to seek medical evaluation for unexplained, persistent, or concerning health conditions. Individuals should speak with their healthcare provider regarding potential exposures of concern. Providers with questions regarding deployment-related exposures and potential associations with health conditions may contact the AIPH Environmental Medicine Clinical Consult Service (usarmy.apg.medcom-

phc.mbx.emp@mail.mil). Questions and contact information may be emailed to this address and a provider will contact the requestor, typically within 48 hours.

- Foster a positive climate for seeking care for both physical and behavioral health injuries and concerns. A stigma against seeking care is still pervasive in some units. Given the nature of the missions and experiences of the 1/24th, they are at risk for PTSD. If still on Active Duty, they may seek assistance through their primary care manager or evaluate resources on the Defense Center of Excellence at: www.dcoe.mil Web page which also provides information, 24/7 access and other assistance. The PTSD may affect close relationships, particularly those with the Family. The Family may play an important role in encouraging individuals to seek help. The Family can access resources at: www.dcoe.mil. The VA Web site at: www.ptsd.va.gov provides resources for Family members, self-help online tools for those with PTSD, and information and telephone numbers for use when in crisis and how to seek help and get assessed in the VA system.

- Ensure Active Duty Soldiers from the 2004-2005 1/24 BN SBCT deployment contact their primary care manager for any TBI health concerns related to exposures from IEDs, VBIEDs, and SBIEDs. All individuals with a history of such trauma, particularly if they are exhibiting symptoms such as headaches, dizziness, memory loss and other cognitive difficulties, irritability, mood disorder or impact to their daily functioning should be evaluated. Some of these symptoms may be contributing to, overlapping with, or exacerbating other behavioral health issues such as PTSD. The DoD Defense Centers of Excellence for Psychological Health and Traumatic Brain Injury offers a 24/7 Outreach Center Web site at: www.dcoe.mil with access to phone center, live chat and email, as well as resources for the individual and the Family. The VA now has Polytrauma Care Facilities which have expertise in addressing all of the effects and symptoms of TBI in multiple organ systems. Resources and contact information may be found at: (http://www.polytrauma.va.gov/understanding-tbi/). In addition, any combat Veteran may bring their DD214 to a Veterans (VET) Center to speak to a counselor or therapist without an appointment and regardless of enrollment status with the VA. Information, Web links, and contact information on these programs, to take a self-assessment online, and other topics can be found at http://www.maketheconnection.net/resources

- Encourage all individuals with concerns regarding inhalational exposures or open burning of trash to register for the VA Airborne Hazards and Open Burn Pit Registry. The VA, in coordination with DoD, has established an Airborne Hazards and Open Burn Pit Registry to allow Military personnel and Veterans previously deployed in Afghanistan, Iraq, or 1990-1991 Gulf War with concerns regarding their exposure to various sources of air pollution (such as smoke from burn pits, oil-well fires, or pollution) during their deployment to provide detailed information regarding their exposure situation and health concerns. In addition, the registry offers an optional medical assessment, though it is not required to be in the registry. The VA Airborne Hazards and Open Burn Pit Registry can be accessed through the Web site below:
  https://veteran.mobilehealth.va.gov/AHBurnPitRegistry

- Inform former members of the 1/24 BN SBCT about the updated U.S. Army Medical Command (MEDCOM) Office of The Surgeon General (OTSG) Policy 14-021. The updated policy provides former and current Soldiers specific guidance and classification, for Soldiers who have or may have been exposed to DU during a deployment. The policy also provides specific information to request a DU urine bioassay through their primary care provider if warranted.

1.5.2 Department of the Army

- Coordinate with higher headquarters personnel from the Army, U.S. Central Command (CENTCOM), and DoD to establish the steps needed to review all sensitive data/information from this investigation and the OEF/OIF/Operation New Dawn (OND) campaigns for applicable declassification/redaction steps to allow inclusion in future investigative reports. This is particularly important with respect to exposure incidents and other information potentially relevant to health outcomes. The DoD VA Data Transfer Agreement requires DoD to provide such information to the VA for their use.

- Improve documentation of personnel locations for all Army military and Civilian personnel. At minimum, daily locations for each Soldier and Civilian should be captured and maintained. In the absence of individual monitoring and in order to appropriately associate a fixed potential hazard to potentially exposed personnel, their location in association with the hazard must be known. Although personnel locations are mission sensitive, these data should be made available to public health professionals in a timely manner.

- Ensure OEHS requirements identified in Army Regulation (AR) 11-35 (Deployment Occupational and Environmental Health Risk Management) are implemented and executed.

- Ensure prompt reporting of all exposure incidents in the Defense Occupational Environmental Health Readiness System (DOEHRS) Incident Module. This reporting allows for the reporting of descriptive information related to exposure incidents such as fires, releases, spills or other events even in the absence of sampling information. Additionally, rosters of the potentially exposed population are associated with this information, which is searchable by the individuals SSN, location or other key terms.

- Ensure all Soldiers properly complete the Post-Deployment Health Assessment (PDHA) and Post Deployment Health Assessment and Reassessment (PDHRA) and that they receive proper guidance and education on the importance of these assessments. Individuals should be encouraged to document on these forms exposures that are of concern as well reporting specific symptoms or health effects experienced in theatre in relation to such exposures.

- Ensure providers have access to current information on relevant potential hazards with an understanding of when a referral is warranted and when reassurance is appropriate. Risk communication is required at the time of the PDHA and PDHRA for exposure concerns if the Service member is not referred. Factual, understandable, and updated assessments of potential health risks associated with deployment exposures should be available to DoD providers, as well as VA providers, particularly those associated with the VA War-Related Illness and Injury Study Centers (WRIISCs).

- Ensure that the Army is prepared to handle additional future stakeholder groups coming forward with health outcomes perceived to be associated with deployment related activities from the OEF/OIF/OND campaigns. It is critical that investigating agencies have comprehensive, accessible, interpretable, relevant and useable data that affords subject matter experts and healthcare providers the information needed to better assess, care for, and educate Soldiers and Veterans.

- Ensure that the Army enhances environmental, occupational, and medical surveillance activities via state of the art technologies to realize comprehensive health surveillance.

1.6 Point of Contact

Ms. Farhana Schickedanz, DESP, MCHB-IP-RDE, DSN 312.584.6096, COM 410.436.6096, farhana.schickedanz2.civ@mail.mil and farhana.schickedanz2.civ@mail.smil.mil.

2 References

See Appendix A for a complete listing of references used in this report.

3 Appendices

The following are a list of appendices:

- Appendix B for Acronym List
- Appendix C for Approach to Disease Cluster Assessment
- Appendix D for Meteorological Data and Wind Patterns for Mosul
- Appendix E for the POEMS Factsheet and How to Request a POEMS
- Appendix F for Post Deployment Health Assessment and Reassessment Forms
- Appendix G for Health Effects associated with Chlorine and Chlorine IED's and Preventive Medicine Actions Fact Sheet
- Appendix H for Health Effects associated with Burn Pits and Burn Pits Fact Sheet
- Appendix I OTSG MEDOCM Policy 14-021 (Medical Management of Army Personnel Exposed to DU),
- Appendix J for additional information on DU
- Appendix K for Particulate Matter Factsheet
- Appendix L for handling of Human Remains Fact Sheet
- Appendix M for Infectious Diseases Presumptively Associated with Deployment
- Appendix N for Health Effects Associated with Ammonia Exposure
- Appendix O for Assessment of Health Outcomes
- Appendix P for Summary of Evidence Regarding Deployment and Respiratory Conditions

4 Introduction

4.1 Background

The 1st Battalion, 24th Infantry Regiment was assigned to the 1st Brigade, 25th Infantry Division "Lightning" (a Stryker brigade). The 1st Battalion, 24th Infantry (1/24 BN SBCT) equipped with Stryker wheeled armored vehicles were deployed to Mosul, Iraq from October 2004–September 2005. The 1/24 BN SBCT was responsible for the western half of Mosul where they faced constant insurgent attacks (reference 4).

The 1/24 BN SBCT organization consisted of HHC (referred to as Hatchet) and three infantry (or line) companies A (Apache), B (Bulldog), and C (Cobra). Each of the companies was assigned an Area of Operation (AOR) sector (reference 4).

The arrival of the 1/24 BN SBCT coincided with the upcoming Iraqi election in January 2005 and the offensive operations to eradicate the insurgents. The 1/24 BN SBCT played a major part in the Battle of Mosul in November 2004 where the insurgents were conducting coordinated attacks and

ambushes in an attempt to take over the city including the police stations. The Units from the 1/24 BN SBCT frequently fought against the insurgents in the vicinity of the Yarmuk traffic circle. The Iraqi Security forces and Iraqi National Police (now called the Iraqi Federal Police) were in a state of flux, and the 1/24 BN SBCT patrolled with and trained them (reference 4).

The Battalion personnel earned 5 Silver Stars, 31 Bronze Stars, and 181 Purple Hearts. The Unit was also awarded the Valorous Unit Award as being part of the 1st Brigade, 25th Infantry Division (SBCT).

The Unit reflagged as the 3rd Squadron, 2nd Stryker Cavalry Regiment and moved to Vilseck, Germany. The 1st Battalion, 24th Infantry Regiment replaced the 2nd Battalion, 1st Infantry Regiment of the now decommissioned 172nd Stryker Brigade Combat Team as of 14 December 2006 (reference 5).

Figure 1. Map of Iraq (reference 6)

5 Site Description

5.1 Mosul

Mosul is a city in northern Iraq and the capital of the Nineveh Province, some 400 kilometers (km) (250 mi) northwest of Baghdad (Figure 1). The 1/24 BN SBCT was responsible for half of the city west of the Tigris River, which was heavily industrialized and consisted of the oldest section of Mosul. Mosul is northern Iraq's major center for trade, industry, and communications. The Tigris River bisects the city, and the area is primarily agricultural, with most of the local infrastructure and industry supporting agricultural activities. The Yarmuk Traffic circle (Figure 2) and surrounding

neighborhoods were the center of most insurgent and counterinsurgent activities during the time the 1/24 BN SBCT was in Mosul (references 4, 7 and 8). See Appendix D for a discussion on air dispersion and meteorology for Mosul.

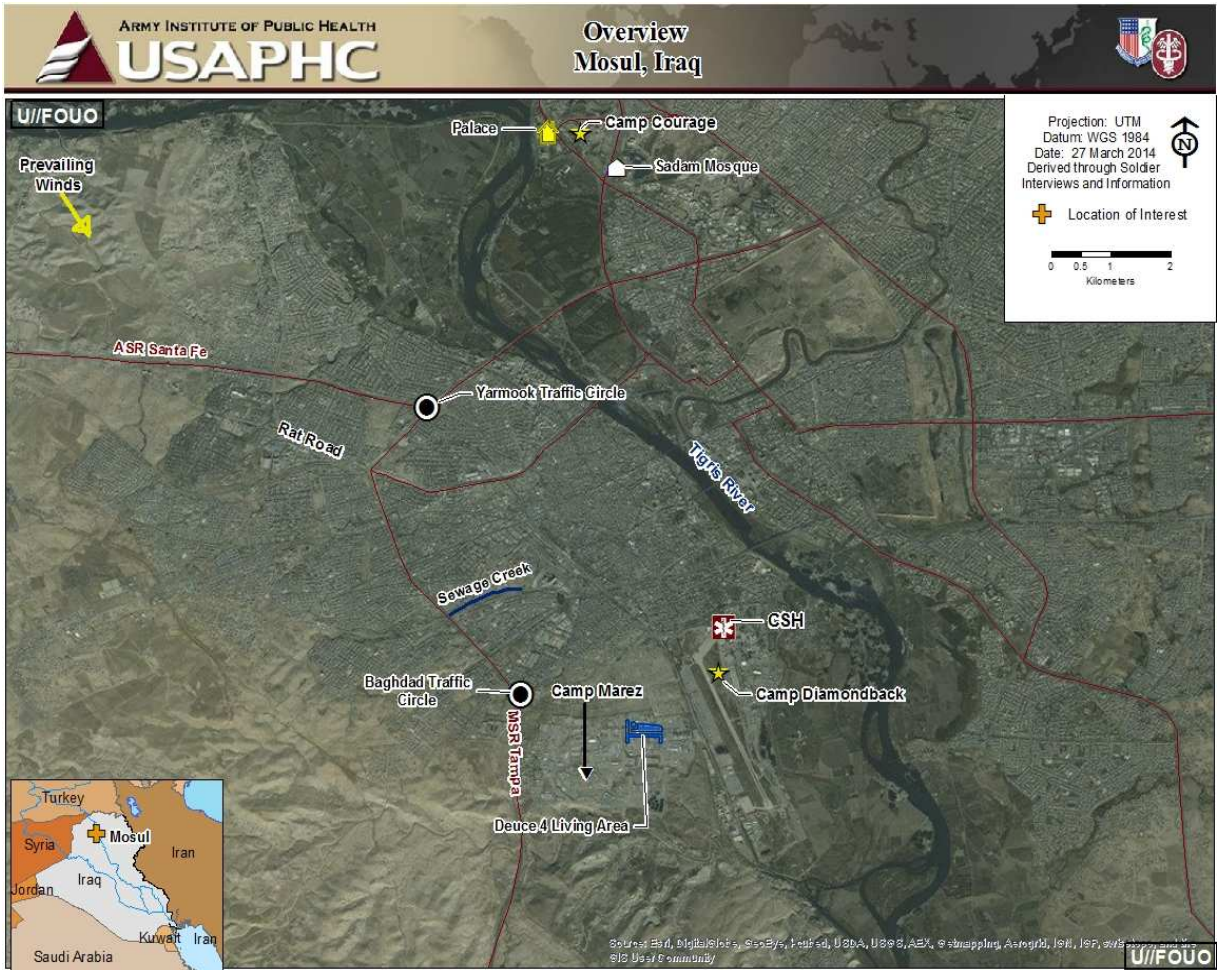


Figure 2. Map of Western Mosul

5.1.1 Major Routes

The majority of key roads intersect at the Yarmuk Traffic circle which is northwest of the old city. Iraqi national Route 1 known to U.S. Forces as Military Supply Route (MSR) Tampa runs north-south through western Mosul and intersects Yarmuk Traffic circle. Iraqi national Route 2 known to U.S. Forces as MSR Santa Fe proceeds west northwest from the Yarmuk Circle towards the Syrian border and to the city of Tal Afar (reference 4).

5.2 Forward Operating Base Marez

Forward Operating Base (FOB) Marez (aka Glory) was located along side of MSR Tampa (Figure 2). The 1/24 BN SBCT living quarters were located in the southern portion of FOB Marez. The FOB Marez also housed the U.S. military airfield, Mosul Airport (aka LSA Diamondback), on the east. The Combat Support Hospital (CSH) was located on LSA Diamondback. On 21 December 2004, 14 U.S. Soldiers, 4 American employees of Halliburton, and 4 Iraqi Soldiers were killed in a suicide attack on a dining hall at FOB Marez (references 4 and 5).

5.3 Camp Courage

The parent brigade of the 1/24 BN SBCT IN, the 1st Brigade, 25th Infantry Division, was headquartered at the former Saddam Hussein palace complex, also referred to as Camp Courage or Camp Freedom. Camp Courage was located in northern Mosul, east of the Tigris River.

6 Interviews 1/24 BN SBCT Personnel

The HRCP, in collaboration with the EMP and the DESP, conducted interviews with prior members of the 1/24 BN SBCT (Mosul, Iraq 2004-2005) to determine current perceptions, beliefs, health status, health concerns, and deployment exposure concerns. The primary purpose of interviewing various stakeholders of the 1/24 BN SBCT was to meet the critical need for human “on the ground” intelligence and information to support known data sources. In some situations, the interview became the only source of information for a specific incident or concern. The characterization of the actual health risk and risk communication efforts were more successful due to the interview process. The interviews became a road map for the DESP to be able to focus resources on investigating specific environmental exposure incidents and concerns. Interviewees also provided hard copy information (such as maps and photos), which were significant in proceeding with the investigation. In addition to the above purpose which supported the evaluation of available exposure information, an additional purpose was to assess the health conditions of concern and to assess whether or not there was a cluster or irregularity of a disease present.

The team conducted 16 fact finding interviews with former Soldiers, spouses, and leaders of the 1/24 BN SBCT from 06 January 2014 to 01 April 2014. Interview participants were identified by a spouse of a former 1/24 BN SBCT Soldier, who provided a list of members of the 1/24 BN SBCT they personally knew and believed may be interested in sharing their experiences with the investigation team. A former member of the 1/24 BN SBCT also communicated about the investigation on the Deuce 4, “1/24th BN SBCT” Facebook® Web site and collected names and contact information of individuals who were interested in being interviewed. (Facebook® is a registered trademark of Facebook, Inc.)

The HRCP contacted persons of interest to set up interviews with varying degrees of success. When contacted at scheduled interview times, a few individuals or their family members indicated they were no longer interested or able to participate in the interviews. Many interviewees kept a journal during the deployment. However, several former members of the 1/24 BN SBCT indicated that the memories were still too painful to go back and read and were not able to provide additional information.

The interview phase of the investigation officially ended on 01 April 2014, but interviews were still completed up until July 2014 as additional persons of interest came forward to volunteer information. Each interview was recorded (upon their approval) and a written summary was

created. All recordings and interview documents were secured in a locked container to protect the interviewee's privacy. Interview summaries were provided to EMP and DESP. The DESP used the information identified in the interviews to conduct more targeted database searches.

6.1 Overview of Interview Findings

The following health concerns were identified by members of the 1/24 BN SCBT during interviews. More detailed information can be found in section 10, Health Concerns.

- Follicular Lymphoma
- Acute Lymphoblastic Leukemia
- Biliary Carcinoma or Bile Duct Cancer
- Pulmonary Nodules
- Asthma
- Traumatic Brain Injury (and associated symptoms)
- Post-Traumatic Stress Disorder
- Panic Disorder
- Kidney Stones
- Crohn's disease
- Gastrointestinal Symptoms
- Hearing Loss
- Pilonidal Cyst
- Restless Leg Syndrome
- Rashes

The overall findings of environmental exposure concerns from interviews can be categorized into the following groups. More detailed information can be found in Section 9, Identified Environmental Exposures.

- IED/VBIED/Weapon Caches
- Equipment graveyards (potential DU)
- Burn Pit Exposures
- Burning Stryker Vehicles/"Halon" Fire Suppression System
- Air Quality (Dust storms/vehicle exhaust)
- Non-ionizing (microwave, radio frequency) Radiation
- Raw Sewage
- Human Remains
- One time unknown acute exposure from pierced tank known as the "Ice Factory" incident
- Industrial Facilities

Many of those interviewed also reported exposure to numerous blasts in firefights and from IED attacks. Many former members of the 1/24 BN SBCT reported having concussions that were not medically evaluated or documented in their medical records due to OPTEMPO. In addition, most personnel indicated they routinely did not seek medical attention for acute events. The 1/24 BN SBCT patrolled the city for long hours seven days a week. Members of the 1/24 BN SBCT interviewed indicated there was limited downtime and that they felt that they would be leaving their teams understaffed and at risk if they sought medical care which resulted in being put on quarters or temporary medical profile. Medical providers interviewed indicated it was common for Soldiers to continue to perform their duties without seeking care, or to have a quick evaluation by field

medics. When Soldiers did seek care, expedient field medical assessments were typically not documented. Limited documentation of deployment related illnesses, injuries, and potential exposures were one limiting factor of the investigation. A detailed explanation of the exposures identified by members of the 1/24 BN SBCT can be found in section 9, Identified Environmental Exposures. More detailed information about the health conditions and concerns of members of the 1/24 BN SBCT can be found in in section 10.

7 Occupational Environmental Health Surveillance Data Gathering

All relevant OEHS data were gathered from databases, open sources, email archives, and archived public folders. The OEH related information collected during interviews with prior 1/24 BN SBCT personnel were also researched. The sections below discuss the methods used to gather information needed to characterize environmental exposures.

7.1 Open Sources

The DESP evaluated historical archives and conducted open source searches on the Secret Internet Protocol Router Network (SIPRNET) and Non-Classified Internet Protocol Router Network (NIPRNET) specific to Mosul in the 2004-2005 timeframe. Specifically, email archives and DESP public folders were queried for any information about the 1/24 BN SBCT, Mosul, FOB Marez, LSA Diamondback, and the 2004-2005 timeframe.

All the open source searches were conducted on the SIPRNET and NIPRNET for any information about the “1/24 BN SBCT”, “Mosul”, “ FOB Marez”, “LSA Diamondback”, “Camp Courage”, and the “2004-2005 timeframe”. The team also looked for any exposure incidents (e.g., “Ice Factory”) that had been reported to better assess possible environmental exposures. Operational intelligence products generated on the SIPRNET, Significant Activities (SIGACTS), and Situation Report (SITREPS) were also reviewed for pertinent information that could identify any possible environmental exposure events. A separate classified report (available on the SIPRNET by request) provides information on the classified open sources that were used to conduct the SIPRNET searches.

All the information found was reviewed by DESP. The only relevant SIGACTS found contained information on IEDs attacks and finding weapon caches. The 1/24 BN SBCT interviewed personnel also stated coming in contact with IEDs/VBIEDS and weapon caches on routine basis. An intelligence product was found on the SIPRNET that discussed finding the biggest weapon caches in Mosul around the deployment timeframe of 1/24 BN SBCT. The report just provided the facts on what transpired, but no environmental exposures were discussed. From the OEHS data searches, no information was found on insurgents using chlorine IEDs in Mosul during the 1/24BN SBCT deployment timeframe. The use of Chlorine IEDs by insurgents was confirmed and documented by DoD from 2006 onwards.

The majority of the SITREPS found were Medical SITREPS that discussed medical distribution of medical assets. There was no information found on the SIPRNET about the “Ice Factory” incident. There was an intelligence report on fire at an oil storage tank in western Mosul and research facilities. The team could not find any other incident reports from open sources that could be linked to a specific environmental exposure.

One of interviewees had alluded to a Container Express (CONEX) which contained information on 1/24 BN SBCT Operations (paperwork/disks/cds) was transported to Germany (upon return from

their deployment, the 1/24 BN SBCT was reflagged to the 3/2 Stryker Cavalry Regiment in Vilsek, Germany). The regiment has been contacted through USAPHC Region Europe and they were not able to find this CONEX.

7.2 Databases

All relevant databases were researched to identify any information on Mosul, 1/24BN SBCT, and the deployment timeframe. The goal of the team was to identify any historical operational/ personnel data that can be used to characterize potential environmental exposures. The databases used are discussed below.

7.2.1 Defense Occupational and Environmental Health Readiness System-Industrial Hygiene (DOEHRS)

The team searched the DOEHRS for environmental samples related to locations LSA Diamondback, Camp Courage, FOB Marez, and Tall Afar, Iraq and collected between 2004-2005 timeframe. The DOEHRS is a Military Health System (MHS) managed by Defense Health Services Systems (DHSS) for entering, assessing, managing and reporting occupational and environmental exposures. The DOEHRS consists of multiple business areas; industrial hygiene (IH), environmental health (EH), radiation health (RH), and incident reporting. It is used for both garrison and deployed operations, is mandated by various DoD policies and public laws and is the exposure system for the DoD longitudinal health record. The DESP search of the DOEHRS database found that 10 environmental samples were collected at the aforementioned locations either during or close to the associated timeframe.

There were three Reverse Osmosis Water Purification Unit (ROWPU)-treated water samples, two well water samples, and two soil samples collected at Mosul area camps and analyzed by the U.S. Center for Health Promotion and Preventive Medicine (CHPPM) (now USAPHC) Main laboratory in 2004 and 2005. Treated water samples were analyzed for approximately 195 parameters while untreated water samples were analyzed for approximately 322 parameters. These parameters included herbicides, insecticides, metals, polycyclic aromatic hydrocarbon (PAH), polychlorinated biphenyl (PCB), semivolatile organic compounds (SVOC), volatile organic compounds (VOC) and characteristics such as color, conductivity, pH, total dissolves solids, and turbidity. Soil samples were analyzed for approximately 193 parameter that included fungicides, herbicides, insecticides, metals, PAH, PCB, SVOC and VOC. The sample results did not exceed military exposure guidelines (MEGs) in reference to USAPHC Technical Guide (TG) 230, Chemical Exposure Guidelines for Deployed Military Personnel, Version 1.3, May 2003; and the January 2004 addendum, which were standard at the time samples were taken. In addition, sample results were also screened in reference to USAPHC TG 230 “Environmental Health Risk Assessment and Chemical Exposure Guidelines for Deployed Military Personnel, 2013 Revision.” It was determined the sample results also did not exceed current MEGs, which were more stringent in comparison. [The MEGs are concentrations of chemicals in air, water, and soil that are designed as decision aids for health risk assessors to evaluate the significance of field exposures to chemical hazards during deployments.]

The reevaluated OEHS sample data using the updated MEGs were sent to the AIPH Health Physics Program to review the radionuclide results from deployment soil and water samples collected from the Mosul area. The Health Physics Program reviewed the results for these samples in February 2014 and determined the risk for exposure to the sampled waters is low and the soil sample results are indicative of natural background levels of radionuclides.

There was one canal water sample, two well water samples, and one ROWPU-treated water sample collected at Mosul area camps and analyzed by the CHPPM-Europe laboratory in 2004 and 2005. The well water samples were not analyzed for radionuclides due to visible solids that would interfere with analysis. The CHPPM Europe DESP reported the risk for exposure to the canal water and ROWPU-treated water was low.

7.2.2 Military Exposure Surveillance Library (MESL)

The MESL was searched for all documents related to location Diamondback (LSA for Mosul, Mosul Airfield), Camp Courage, FOB Marez, and Tall Afar, Iraq for 2004-2005. The MESL provided preventive medicine personnel with the ability to submit, search, view and download OEHS-related documents and data to include:

- Pre-deployment Site Surveys
- Basecamp Assessments
- Preventive Medicine Unit Reports
- Preventive Medicine Situational Reports
- Environmental Sampling Reports
- Raw Environmental Sampling Data
- Analytical Summaries
- OEHS Exposure Incident Reports
- After Action Reports
- Chemical, Biological, Radiological, Nuclear (CBRN) Incident Lesson Learned Reports
- Preventive Medicine Reports
- Photographs
- Entomology Surveillance/Control
- Rodent Surveillance/Control
- Sanitation Inspections (Public, Food, Housing, etc.)
- Industrial Hygiene Assessments
- Briefings (Medical Threat, OPD/NCOPD, etc.)
- Water Distribution Point Surveillance
- Periodic Occupational and Environmental Monitoring Summary (POEMS)

Documents found consisted of monthly pest management reports, reports for water samples, reports for soils samples, one PM air report, pesticide usage reports, an asbestos air sampling study, a 3ACR barber/beauty shop inspection and a basecamp assessment checklist. The pest management reports or barber/beauty shop inspection reports were not reviewed.

The location of the burn pit and summary of the burn pit were found in the POEMS report. A POEMS is an official, provider-focused, DoD technical document that describes OEH exposure and their associated health implications for a deployment location during a specific time. More background information on POEMS and information on how Military personnel/ personal healthcare provider can request POEMS for a deployments location can be found in Appendix E.

The open air burn pit on Camp Marez was used to dispose of solid waste/refuse. The burn pit was about 3 km southwest of the center of the airfield and about 1.5 km southeast of the equipment graveyard (see Figure 3). No source air samples specifically associated with the burn pit were taken. The open burn pit at FOB Marez was closed on 31 December 2010. See Section 8.3 for more information on burn pit exposure (reference 9).

Additionally, the POEMS described the environmental health surveillance data for ambient Particulate Matter (PM). Data for PM less than 10 micrometers in diameter (PM_{10}) was available for 2003, 2007, 2009, and 2010. PM less than 2.5 micrometers in aerodynamic diameter ($PM_{2.5}$) sampling occurred only in 2010. Both data sets were limited to samples collected by U.S. Forces.

For both PM_{10} and $PM_{2.5}$, levels were fairly consistent with those found through Iraq during the entire conflict. These values are, in many cases, higher than those observed anywhere within the United States. At the PM_{10} levels observed, specific subgroups of the deployed forces (e.g., those with pre-existing asthma or cardiopulmonary conditions) were at greatest risk of developing health effects. These were typical of dusty environments and probably included eye or respiratory irritation, increased mucous production or cough. For $PM_{2.5}$ levels, the development of chronic health conditions such as reduced lung function or exacerbated chronic bronchitis, chronic obstructive pulmonary disease, asthma, atherosclerosis, or other cardiopulmonary diseases is plausible in generally healthy troops. Personnel with a history of these conditions would be more likely to develop such chronic health conditions.

The MESL documents contained the air, water, and soil sample results that related to the samples results found in DOEHRS (mentioned previously). Concentrations of detected chemicals were below the MEGs and no other relevant or significant environmental exposures were identified from the documents reviewed.

7.2.3 Modernized Integrated Database

The Defense Intelligence Agency's (DIA) Modernized Integrated Database (MIDB) was used to identify all the industrial facilities in and around Mosul. The MIDB is a primary repository for data production and dissemination of military intelligence involving worldwide orders of battle, facilities, command and control networks, targeting, battle damage assessments, and other related information required for strategic assessments and national policy decision making (reference 10).

7.2.4 Troop Unit/Personnel Tracking

Since Operation Desert Storm, a major challenge of conducting OEHS has been determining the individual geographic locations of Service Members to then associate exposure data for assessing health risk and medical outcomes. During OIF and OEF, the USAPHC has obtained access to several software and data applications to obtain data for identifying individuals and/or Units and their recorded locations for the purpose of assessing and studying potential environmental exposures. The major data source was the CENTCOM SIPRNET based Command & Control Personal Computer (C2PC), which was a client application that provided unit names and near real-time geographic location data. Although C2PC was a tool designed for tracking tactical Units, it had limited capabilities in identifying individual personnel locations and command elements below the company level. No personnel social security number (SSN) records were available in C2PC. To help develop a working personnel roster in relation the recorded C2PC Unit locations, the USAPHC related the Unit Identification Code (UIC) from the C2PC to the deployment roster data from the DoD Defense Manpower Data Center (DMDC).

Daily data pulls of C2PC data were archived by the DESP from 12 March 2003 to 30 December 2005 in a Microsoft® Access® database. The DESP queried the access database to identify troop Unit location of the 1/24 BN SBCT UICs. The DESP expected to find the 1/24 BN SBCT UIC geographical coordinates (e.g., MGRS; latitude/longitude), dates, and possible individuals associated with leadership positions during the deployment timeframe. The DESP planned on

using these coordinates and dates to identify specific locations of 1/24 BN SBCT personnel and compare to any exposure incidents that have been reported to better assess possible health risks. Unfortunately, significant data gaps in C2PC data output existed. The DESP only found records on 1/24 BN SBCT personnel for three months of the deployment timeframe on random days and it was limited to key basecamp/leadership positions. The DESP based their analysis on the required assumption that all personnel will be accounted for by association with the documented key leadership positions recorded in the database. Graphics depicting the recorded C2PC based UIC locations for the 1/24 BN SBCT via Geographic Information Systems (GIS) technology are available in the supplementary classified report on SIPRNET (available by request). [Microsoft® and Access® are registered trademarks of Microsoft Corporation].

The DoD DMDC is the central repository for current and historic human resource information serving as the authoritative source of information on over 42 million people now and previously connected to DoD (reference 9). Its mission is to collect, provide and utilize this information for the benefit of members of the DoD and to support DoD decision makers and other government agencies. An application of the DMDC is the Contingency Tracking System (CTS), which is a SIPRNET-based system to track deployments of Active, Guard & Reserve members to OEF and OIF. The CTS is designed to track individuals as they move from assigned basecamp to assigned basecamp and redeploy. The CTS does not track daily movements related to the individual's mission responsibility (e.g., daily patrol assignments). The CTS is the primary data source for individuals demographic and location data for health surveillance programs during and after deployments (reference 10).

The C2PC UIC was used in CTS to obtain the deployment roster (including the SSN). The DESP received 625 records of individual's information on the SIPRNET: the SSN, name of individuals, deployment begin and end dates, assigned and attached UIC, service of branch, and location base name. After the data review, DESP had identified some of the fields were empty and that not all the 1/24 BN SBCT members were represented. This was due to limitations in the data that included; UIC assignment documentation and overall incompleteness of CTS data, especially in the early years of OIF/OEF. Due to the noted data gaps in the C2PC and some data gaps from the DMDC/CTS roster, the DESP were only able to locate approximately 50 percent of the 1/24 BN SBCT that were interviewed. These data/information were provided to AIPH physicians to review patient records in the AHLTA.

7.3 Geographic Information Systems (GIS)

Maps were created using the GIS software ArcGIS® 10.2. The unclassified map (Figure 3) provides pertinent information or locations and facilities identified by the interviewed 1/24 BN SBCT personnel, unclassified historical queries and information derived from unclassified imagery. The prevailing wind direction was determined by the creation of a wind rose for the site based on meteorological data. See Appendix D for the Wind Rose information. [ArcGIS® is a registered trademark of VMware, Inc].

The classified GIS maps that were created on the SIPRNET have pertinent operational information (e.g., location of IED/VBEID attacks and weapon cache), C2PC data output, locations identified by the interviewed 1/24 BN SBCT personnel, and classified historical queries. Classified imagery was used to identify the boundary of FOB Marez, LSA Diamondback, and Camp Courage. Pertinent operational information has not been declassified and the imagery itself is classified; as a result, information must remain on the SIPRNET. A separate supplementary classified report (available on the SIPRNET by request) provides all the classified GIS maps.

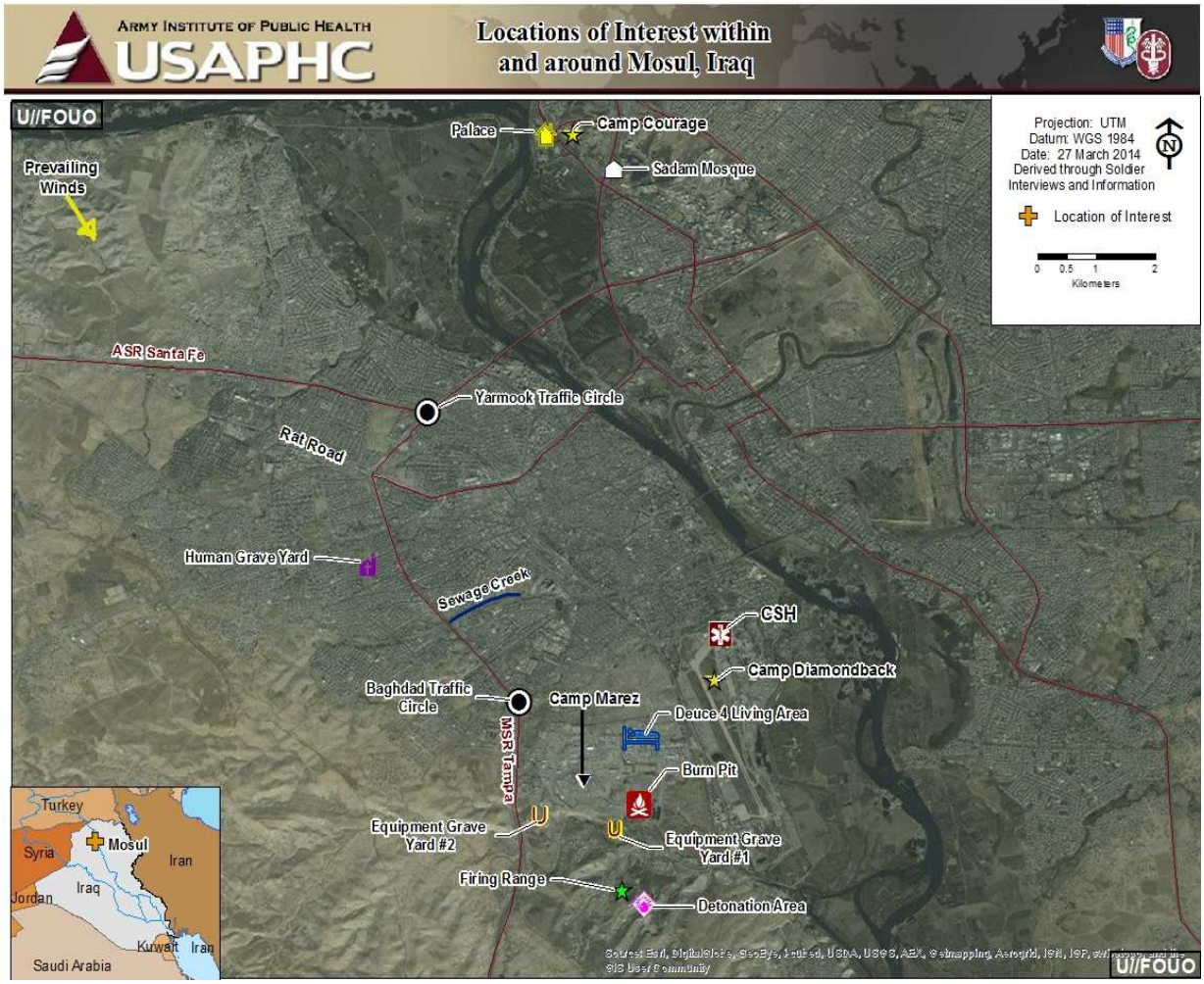


Figure 3. Western Mosul Area of Operations

8 Evaluation of a Suspected Disease Cluster

8.1 Background

In the evaluation of any chronic disease or medical condition, there is rarely a one cause/one effect relationship. Health outcomes are a result of the complex interplay of a chain and/or web of individual or host factors (the "who"), disease agent factors (the "what"), and environmental factors over a person's lifetime (the "where"). This is known as the epidemiological triad. Individual factors, or the "who," include a person's biological adaptation and physiological responses, general health status, nutrition status and body mass index, immune responses, genetics, microbiota, personal behaviors, habits and activities, and other unique susceptibilities. This complex constellation of conditions comprising the "who" can change daily, hourly, or even by the minute. Agent factors, or the "what," can be divided into biological agents such as food, viruses, bacteria, parasites, chemicals, physical and natural ambient agents, as well as social and psychological

stressors. Environmental factors, or the "where," influence the probability and circumstances of the interaction between individual and agent (completed exposure pathway) such as breathing in or ingesting the agent as well as having direct contact with the agent via the skin. No matter what the hazard, without a completed exposure pathway, there is no risk of associated disease. Other factors that characterize an exposure are the duration, frequency, and/or the concentration/ magnitude of the exposure. These equate to how much of an exposure occurs. Additionally, exposure to a substance does not equate to internalized dose, which may be dependent upon a variety of host or substance factors. For example, if an agent has contact with the skin or is inhaled, but is not absorbed into the body, the only health effects possible would be localized effects and not systemic effects, which might occur elsewhere in the body. It is important to recall that for any exposure to have a health effect, it must interact with the body, not simply occupy the same space or even just come in contact with the body. To further complicate matters, any one factor or combination of factors can cancel (attenuate) or augment the effects of another factor or combination of factors. Also, effects may be summative or synergistic, desirable or undesirable, intended or unintended, etc.

When health conditions appear to occur more commonly than expected within any social, employment, or military Unit, or group, it is normal for members of that group to ask questions and/or request assistance to determine if this perceived "cluster" of health effects is actually occurring in excess of what is expected and whether there is a common cause. Gastrointestinal disease as a result of food poisoning in individuals who ate food contaminated with bacteria or viruses often appears as an outbreak or cluster. Epidemiologic investigation can often identify the common food and then the source of that food, therefore preventing further cases of the poisoning from occurring. This same process also applies to cancers which occur in work groups. In the 1960s, a cluster of a rare type of lung cancer, called mesothelioma, was identified in asbestos-exposed shipyard workers, further investigation revealed asbestos' causative relationship with mesothelioma. Cancer clusters may be suspected when people notice several individuals with cancer in a group, be it family, neighbors, or coworkers. Typically to be labeled a true cluster, the cases should all have the same, or very similar, type of condition, such as red blotchy rash on exposed skin. Some cases of red blotchy rash on exposed skin, some male pattern baldness, some eczema, and some acne is not likely to be indicative of a true cluster (references 1, 2, and 3).

Suspected clusters of cancer or other specific diseases are often investigated by public health physicians and epidemiologists who study the frequency, distribution, causes and control of disease in populations. These specialists have identified circumstances that may lead them to suspect a cancer cluster and to look for a potential common source or cause. Clusters are suspected when there are a large number of cancers of one type (rather than several different types), the cancers are of a rare type, or there are an increased number of cases of a certain type of cancer in an age group that is typically not affected by that type of cancer. Epidemiologists will try to establish whether the suspected exposure (if there is one) is plausibly associated with the cancer of concern. If such a cluster is suspected, a case definition, or a description of the criteria necessary for a case to be counted, is then formulated. The time period of concern for exposure as well as the population at risk is also considered. Different types of cancers have differing latencies, meaning they occur at different times following an exposure. Generally speaking, cancers of the blood and lymph systems develop more quickly after a possible cancer-causing exposure than solid tumors, such as lung cancer. Therefore, the relationship between the exposure of interest and the time of onset of the cancer is evaluated. The population at risk (or sometimes called population of interest) includes all of those who were at risk of exposure. For example, in the evaluation of a workplace cluster, non-workers would not be included. If the exposure was limited to individuals in a certain location or doing a specific job, everyone in that location or doing that job should ideally be

included, while workers in other areas and doing others jobs might be excluded from the population at risk (references 1, and 2).

When a cluster investigation is conducted, the expected rate of the specific condition in a reference population is calculated. This could be the U.S. population in the appropriate age range, or a rate from a more local population may be used, if one is available. The reference population is selected to be as representative of the population at risk as possible in terms of age, gender and other demographics. For example, a general U.S. population of both sexes and all ages (including the elderly and children) would not be an appropriate comparison population for a military population. The expected cases (based on the reference population) are then compared to the observed cases (in the population at risk). Statistical tests are performed to determine if the number of cancers that have occurred in the population at risk is significantly greater than would be expected, indicating a true cluster (reference 11).

At the onset of this investigation, the population at risk was unclear and the case definition (the disease of interest and its characteristics), was uncertain. The initial population identified was an approximate 25-member reconnaissance platoon. In this instance, a review of health conditions was conducted to determine if there was a disease cluster. Such an evaluation was performed with respect to those individuals in the 1/24 SBCT who reported health concerns, about half of the platoon. We did not have contact information to interview the entire platoon, and not all those who were contacted completed a telephone interview. Interviews were utilized to identify the case definition and the population at risk, with the assumption that the "exposure" was the Mosul deployment in 2004, or a more specific aspect of that deployment. A descriptive analysis based on those who were interested and available for interview follows. This analysis served as the basis for consideration of whether or not to conduct an epidemiologic study of a potential disease cluster. Details regarding considerations relevant to the decision of whether to conduct an epidemiological analysis may be found at Appendix C, "Approach to Disease Cluster Assessment".

9 Identified Environmental Exposures

The exposure evaluation included OEH data searches for evidence of hazards and their sources, whether or not there was a release, and if and under what circumstances contact or a completed exposure pathway may have occurred. The potentially exposed population and the route of exposure were evaluated. In addition, data quality and representativeness was assessed. Frequency, magnitude and duration of exposure were estimated to the extent possible. This process identifies hazards that should be further evaluated. In the absence of quantitative objective information, interviews were reviewed to determine exposures of concern and exposure circumstances. These included improvised explosive devices, weapon caches, open burning of trash, equipment graveyards and DU, burning Stryker vehicles/halon fire suppression system (actually was heptafluoropropane), high frequency jammers and other non-ionizing radiation, raw sewage, human remains, an incident at the "Ice Factory"; industrial facilities and air quality. The PDHAs for the individuals assigned to the UIC where reviewed. This represented approximately 600 individuals who were identified as part of the 1/24 BN SBCT deployed during the period of interest. The reported exposures were similar to those exposures reported in interviews, with the exception of the report of exposure to oil well fires. This finding was not reported by any of the individuals who were interviewed and so was not further assessed. See discussion at Appendix F.

9.1 IEDs/VBIEDs/SBVIEDs

Iraqi insurgent attacks on this Unit utilized Improvised explosive devices, roadside bombs, and suicide car bombs. The interviewees cited this exposure most frequently. The 1/24 BN SBCT routinely came into contact with explosive devices. Many Unit members suffered associated concussion, blast, shrapnel and other injuries and reported multiple exposures. SITREPS documented the increased use of this form of warfare. From the interviews, the 1/24 BN SBCT identified IEDs containing chemicals such as fertilizer, chlorine or visible white powder (possibly propellant), which were irritating or made it hard for Soldiers to breath. It was generally noted that individuals did not seek care after these incidents, and that TBI screening after IED/VBIED attacks was not consistent. Some individuals mentioned the term “Fougasse” during the interviews. This is a World War II term to refer to combinations of gases/mixtures that are not clearly identifiable, but can include accelerants, propellants, explosives, and/or other combustibles.

An IED is characterized as a low-technology exploding mine, usually "homemade”, that is hidden beside a roadway and set off using a variety of trigger mechanisms. Methods of detonation included simple pull-wires and mechanical detonators, cell-phones, garage-door openers, cable, radio control, children’s remote-control toys, and infrared lasers among others. In addition to attacking the Stryker vehicles, the vehicle-borne IEDs (VBIEDs) and car bombs are also used to strike police stations, markets, and mosques, with the intent to kill local citizens as well as U.S. troops and coalition troops. These IEDs convert several types of potential energy into forces that cause a high rate of complex injuries to the body, particularly to the head and extremities, which are regions of the body less protected by body armor.

An explosion from an IED/VBIED might cause blunt-force trauma, blast effects, concussions, TBI, and injury from projectiles, heat, and fire, or a combination of these effects. For example, one member of the Unit sustained a tibia fracture and burns to several parts of his body following an IED explosion as documented in his medical record. An IED/VBIED explosion could also result in an unquantifiable, complex combination of the following:

- Non-combusted and partially combusted explosives, propellants, accelerants and their respective combustion products;
- Carbon monoxide (CO), carbon dioxide (CO_2), nitric oxide (NO) and nitrogen dioxide (NO_2) which are produced by the explosion;
- Burning and/or dispersion of hydraulic fluids, fuel, and other combustible material within the Stryker; and
- Burning and/or dispersal of engine oil, brake fluid, transmission fluid, and other combustible material from the vehicle (VBIEDs)

Some of these components might be very irritating to the skin, eyes, and respiratory system, even to the point of partial or total incapacitation. Occupants of the Stryker could be exposed to any or all of these substances if the vehicle is breached during a catastrophic VBIED event. Because of these complex combinations of hazards, with differing degrees of effect, concentration, duration of exposure, and individual breathing response, it is difficult to determine, with any degree of certainty, the short- or long-term health effects of this type of event. If there are any long-term health effects, it is difficult, if not impossible, to determine which exposure or combination of exposures may have caused or contributed to these effects.

The addition of chlorine and other substances to IEDs was identified by an interviewed member of 1/24 BN SBCT. From the OEHS data searches, no information was found on insurgents using chlorine IEDs in Mosul during the 1/24BN SBCT deployment timeframe. The use of chlorine in

IEDs by insurgents was confirmed and documented by DoD from 2006 onwards. While most of these additions pose acute effects, it was not possible to completely identify all potential additions and subsequent health effects. Even though chlorine IEDs were not documented during the 1/24 BN SBCT deployment timeframe, it was identified by an interviewee. See Appendix G, Health Effects Associated with Chlorine, as well as a Fact Sheet on Chlorine Improvised Explosive Devices and Preventive Medicine Actions.

9.1.1. Weapons Caches

The 1/24 BN SBCT aggressively sought out weapons caches which included ammunition and unexploded live ordnance. Due to the high OPTEMPO, the Explosive Ordnance Disposal (EOD) team was often unable to keep up with the platoon's discoveries to destroy them. Eventually, EOD personnel conducted informal training with several Soldiers in the platoon so that they could disarm/destroy ordnance and weapons on their own. Depending on OPTEMPO and the quantity of weapons found, they were either destroyed onsite or brought back to FOB Marez where EOD would destroy them. Figure 3 shows the potential area used by EOD as the detonation area. Prevailing winds should have taken any smoke or combustion products from detonation away from the camp and the living areas. There is no information, classified or other, to suggest that these caches included chemical agents, as well as no information regarding other potential exposures from weapons caches. One location was reported to have a very large quantity of white powder in storage, which was characterized as "possibly propellant". There was no information regarding the nature, magnitude and frequency of exposure to this substance and; thus, there was no assessment of potential health effects offered.

9.2 Open Burning of Trash/Burn pits

About two thirds of the Unit reported exposure concerns related to burning trash. In addition, the Unit surgeon at the time pointed to the burn pit as the most concerning environmental exposure since it burned "24/7/365". Interviewed personnel described the smoke from the burn pit as a constant fog over FOB Marez. The interviewees also stated that it was located 1,000-1,500 feet from the sleeping quarters. Review of a 2006 site assessment by preventive medicine personnel included a recommendation to move the burn pit further south due to concerns of smoke near the living quarters, particularly in the morning when inversion conditions where present.

During the OEH data gathering, DESP found information on the FOB Marez burn pit in the POEMS for FOB Marez. [The POEMS are unclassified summaries of the site description, available environmental sampling results, potential vectors and infectious disease risks, results of radiation surveys, and so forth for the location for a specified period of time.] See Appendix E for the background information on POEMS and the process for requesting a POEMS. Potential health risk from open burning could be associated with burning plastics, petroleum products, non-medical waste, metal, and other chemicals (paints, solvents, and so forth). There was no documentation of the degree of waste segregation or of the waste stream for the burn pit at FOB Marez in 2004. Burn pit workers or tower guards (if any) or other personnel that work at or in proximity to the burn pits would have a higher risk of exposure to contaminants emitted from the burn pits than the general population at Mosul Airfield (and the associated camps) (reference 7).

The wind rose for FOB Marez indicated that the predominant wind direction emanates from the North/Northwest. Since the burn pit was located in the southeast of the camp (see Figure 3), the predominant wind direction should have taken the smoke away from the living areas and the camp, although under certain conditions, such as an atmospheric inversion, the smoke might linger over

the area. Per interviews, inversions occurred. Also, as noted, a 2006 site assessment recommended moving the burn pit further south due to morning inversions.

During OIF, onsite open burning was used as an available and expedient means to dispose of solid waste to improve the overall sanitary conditions of the camp by eliminating potential food and harborage for rodents and potential vectors of infectious disease. In addition, burning onsite minimized contact of Service Members to hostile action when hauling the waste outside of the secured perimeter. At many locations, smoke emissions from open burning were a visible contributor to air quality and have often been noted as a primary concern among Service members. Other air pollution sources including flight operations, vehicular emissions, generators, blown sand, and off-site sources were present and likely contributing to the pollutant levels. See Appendix H for a discussion of the assessment of health effects associated with open burning.

The DoD recognizes that acute, mild to more serious short-term health effects due to smoke exposure may occur (e.g., eye, nose or throat and lung irritation, including reddened eyes, irritated respiratory passages, and cough that may persist for some time). For inhalational exposure to high levels of dust, PM_{10} and $PM_{2.5}$, such as exposure to burn pit smoke and during high winds or dust storms, the DoD considers it plausible that some otherwise healthy personnel who were exposed for a long-term period to dust and PM could develop certain long-term health conditions (e.g., reduced lung function, cardiopulmonary disease, to include asthma), possibly due to combined exposures (such as sand/dust, industrial pollutants smoke, and other compounds) associated with deployment to Southwest Asia. In addition, individual susceptibilities (such as preexisting health conditions or genetic factors) may play a role. For example, personnel with a history of asthma or cardiopulmonary disease could potentially be more likely to develop chronic health conditions. According to the Institute of Medicine's review of the Long-term Health Consequences of Burn Pit Exposure, they consider there to be limited/suggestive evidence that such exposure might be associated with a reduction in pulmonary function. Thus far, there has not been sufficient evidence of associations with other conditions (such as neurological, liver toxicity, cancers, respiratory toxicity, kidney toxicity, blood effects, cardiovascular toxicity or reproductive or developmental effects). However, there are limited studies of these endpoints in similarly exposed populations. (See Appendix H regarding this review).

9.3 Equipment Graveyards and Depleted Uranium

The 1/24 BN SBCT interviewees expressed concern regarding possible DU exposure from the vehicle graveyard and the tank graveyard (two areas with old Iraq and U.S. armored vehicles in varying degrees of deterioration and disrepair) and that this exposure may have caused or contributed to their medical conditions and/or the medical conditions of other Unit members. This area was confirmed and is identified on the map in Figure 3. Some of these vehicles might have been destroyed or disabled by DU armor-piercing munitions (such as 30 millimeter (mm) rounds or a penetrator from an armor-piercing munition). Even though command instructed Soldiers to stay away from the equipment graveyards due to potential DU exposure, it was identified through the interviews that individuals took pictures and walked through graveyards and most drove on a road that was near or passed through the graveyard. Some Soldiers reported that they entered or climbed on or in vehicles possibly damaged by DU munitions on an infrequent basis. This possible DU exposure concern was unknown by officers who we interviewed who may have not been aware that troops were in the area looking around, taking pictures and just generally exploring the "graveyards." This type of reported potential exposure to DU would be characterized as a Level III "incidental" exposure. An example of a Level III incidental DU exposure would be individuals who have driven through smoke from a fire involving DU munitions or who have entered or climbed on

or in a battle damaged vehicle on an infrequent basis (not as a first responder and not as a job requirement) or Soldiers that may have been exposed to buried DU.

Uranium is a weakly radioactive element and is found in soil, water, and mineral deposits. It contains U238 (99%), U235, and U234 isotopes. The DU is made from natural uranium that has had most of the radioactive isotope removed by the uranium enrichment process. It has the same chemical properties as natural uranium and has about 60 percent of the radioactivity of natural uranium.

The MEDCOM has an established policy that provides guidance for the medical management of Army personnel exposed to DU. This policy is reviewed and updated approximately every 2 years. A copy of the latest policy can be found in Appendix I. All personnel with actual or potential exposure to DU should be identified and assigned a potential exposure Level (I, II, III). A urine bioassay test is available to help with the initial assessment of a person who has been exposed to DU or has a suspected exposure to DU. This test is based on the analysis of a urine sample collected over a 24-hour period and is not part of a routine urinalysis. The sample is obtained as soon as practical after a DU exposure and may be repeated at follow-up assessments if the initial urine uranium level is significantly above normal. It is not required for personnel with Level III exposures, though a physician may choose to preform one based on medical indications or at the potentially exposed individual's request. As of this report, elevated urine uranium levels which have been identified as DU have been found only in Service Members with embedded fragments, or those who were in a vehicle during a friendly fire incident (personal communication with VA DU Follow-up Program).

Service Members who have the most extensive exposure to DU are characterized as a Level I exposure (i.e., those who were in or on a vehicle when it was hit by DU munitions and/or have imbedded DU fragment(s)). Service Members with Level I exposure have been closely monitored for over 20 years in a formal research protocol, the DU Follow-up Program at the Baltimore VA Hospital, and to date have not experienced any long-term adverse health effects related to DU exposure. Thus, long-term adverse health effects would not be expected from a Level III exposure to DU.

According to the Agency for Toxic Substances and Disease Registry (ATSDR), "No health effects, other than kidney damage, have been consistently found in humans after inhaling or ingesting uranium compounds or in Soldiers with uranium metal fragments in their bodies". No renal abnormalities have been consistently seen in the DU exposure cohort enrolled in the DU Follow-up Program at the Baltimore VA, who have had retained DU metal fragments for many years. There is no definitive evidence regarding genotoxicity, mutagenicity, or reproductive effects. However, based on questionnaire data, there have been no birth defects noted in over 80 children born to Gulf War veterans in DU Follow-up Program (including those with retained fragments). Without an ongoing exposure to DU (such as an embedded fragment or inhaled particles), detectable increases in uranium levels in the urine resulting from a DU exposure would be indistinguishable from the normal urine uranium levels after several days or weeks from that exposure. Some Soldiers with injuries or retained fragments have had symptoms related to those injuries and the physical presence of a fragment. However, in the absence of more significant contact with a source of DU exposure, the members of the brigade would not likely to have had any adverse health consequences from DU. Those that have separated and still have concerns are eligible for a 24-test for urine uranium test, which may be requested from their VA primary care provider. Appendix J contains more information about the DU Follow-up Program.

9.4 Burning Stryker Vehicles/Halon Fire Suppression System

Some Soldiers mentioned exposure to "halon" when the Stryker vehicle that they were in was hit by a VBIED. While halon and the halon FSS is used in the Abrams Main Battle Tank and the Bradley Fighting Vehicle, the FSS in the Stryker vehicles uses 1,1,1,2,3,3,3-Heptafluoropropane (CAS: 431-89-0) (also known as heptafluoropropane, HFC-227ea, FM 200®, FE-227™). The chemical in the Stryker vehicle FSS is not halon, even though the Soldiers referred to the agent as halon and the system as the halon FSS. If the FSS in the Stryker stays intact and is working properly, long-term adverse health effects would not be expected from an exposure to the discharged HFC-227 as described by these Soldiers. If conditions are such that exposure to high levels of HFC -227 were to occur, individuals likely experienced a cold sensation which may have actually progressed to frostbite. Other acute effects include dizziness, headache, and confusion with the potential for cardiac arrhythmias and loss of consciousness. These effects are similar to those of anesthetic agents and will reverse upon cessation of exposure.

The HFC-227 is a non-flammable, non-explosive, and non-oxidizing gas. It is colorless and odorless, but may have a slight ether-like odor. In addition to its use as a fire suppressant, HFC-227 is also used as a refrigerant (alone or in combination with other similar substances) and as a Food and Drug Administration (FDA) approved propellant in medical use metered dose inhalers used in the treatment of asthma and chronic obstruction pulmonary disease (COPD). The HFC-227 can be rapidly absorbed by the body when inhaled and is rapidly cleared from the body once the HFC-227 is removed or the individual moves to areas of fresh air.

The HFC-227 has been used in Army vehicles since 2001. The HFC-227 is used as a fire suppressant and replaced halon-1301 for use as a fire extinguishing agent in crew occupied spaces of military ground vehicles. The HFC-227 is effective against Class A, B, & C fire hazards and was determined to be a suitable substitute for halon-1301 and has zero Ozone Depleting Potential (zero-ODP). The fire suppression agent in the Stryker vehicle's Automatic Fire Extinguishing Systems (AFES) is HFC-227BC, a blend of HFC-227ea (heptafluoropropane) and sodium-bicarbonate-based dry chemical, and has essentially the same environmental and safety properties as the HFC-227ea. The sodium-bicarbonate-based dry chemical reduces thermal decomposition products generated during a fire suppression event. The HFC-227BC is also used for fire suppression in the Mine Resistant Ambush Protected (MRAP) and other military ground vehicles.

The HFC-227BC and AFES have met certain performance criteria that allow for improved survivability, expeditious egress from a damaged vehicle, and should not significantly contribute to incapacitation or injuries that vehicle occupants may receive during an attack or fire. In addition to fragment injuries produced by projectiles formed when an armored vehicle in penetrated by munitions and VBIEDs, crew may experience non-fragment hazards from blast overpressure, toxic gases, burns, etc. The HFC-227 performance criteria and exposure limits have been adopted from the National Fire Protections Association and include not exceeding the lowest-observed adverse effect level (LOAEL) while still achieving the minimum HFC-227 concentration to effectively suppress a fire, as well as minimizing overpressure, minimizing acid/toxic gases (combustion products of HFC-227 - hydrofluoric acid, hydrobromic acid, carbonyl fluoride), and maintaining acceptable oxygen levels for five minutes when the AFES is properly functioning, is intact, and not overmatched by the fire. The HFC-227 performance criteria also require suppression of a fire in less than 250 milliseconds to maintain acceptable levels of oxygen, decrease the risk of burns to occupants, and decrease the production of combustion products, carbon monoxide (CO), carbon dioxide (CO_2), and smoke. There is no available information to determine whether or not systems were operating optimally. While exposure to HFC-227 usually does not cause skin, eye, or

respiratory system irritation; exposure to its combustion products, hydrofluoric acid, hydrobromic acid, and carbonyl fluoride, even in small amounts, will result in eye and respiratory irritation if not wearing protective equipment.

In animal studies, inhalation of high concentration of HFC-227 can result in death and may result in the heart becoming temporarily sensitized to adrenaline (epinephrine) leading to cardiac arrest. However, this is based on animal studies at very high doses creating blood levels of epinephrine ten times greater than would be seen in humans under normal conditions or periods of physical and emotional stress. In surviving animals long-term health effects, including genetic and reproductive effects, were not observed.

9.5 Non-Ionizing Radiation (High Frequency Jammers, Microwaves, Radar)

During the interviews with the 1/24 BN SBCT, some Soldiers mentioned exposure to radio frequency (RF) jammers. Additionally, some members of the Unit gave positive responses about exposure or concerns about exposure to non-ionizing radiation on their PDHAs and PDHRAs. No adverse health effects would be expected from typical operational exposures to non-ionizing radiation generated by RF jammers.

The RF radiation, microwaves, visible light, and infrared radiation are all examples of non-ionizing electromagnetic radiation. In addition to RF jammers, mobile/cell/cordless phones, radios, radars, lasers, and spotlights are sources of non-ionizing radiation. Overexposure to non-ionizing radiation could result in the heating of body tissues to the point of discomfort, pain, or body tissue damage (such as burns). For this reason, all sources of non-ionizing radiation (including RF jammers) are assessed for potential health hazards and Soldiers are trained to follow the standing operating procedures associated with each source.

Ionizing radiation (alpha particles, beta particles, gamma rays, and neutrons) can ionize atoms, resulting in severe damage to tissue and DNA. Any exposure to ionizing radiation can damage tissue. Radioactive materials are a primary source of ionizing radiation. The term “radioactivity” describes the emission of ionizing radiation and does not apply to non-ionizing radiation sources. Potential adverse health effects commonly associated with high doses of ionizing radiation include radiation sickness, certain cancers, and birth defects. These health effects are not caused by exposure to non-ionizing radiation, because non-ionizing radiation cannot ionize atoms.

Soldiers are protected from adverse health effects associated with non-ionizing radiation emitted by RF jammers by following procedures and maintaining their systems. All RF jammers were assessed by healthcare professionals to ensure that Service Members were protected from RF radiation exposure above the maximum permissible exposure (MPE) limits. These MPE limits were established by the Institute of Electrical and Electronics Engineers, Inc. (IEEE) and incorporated a margin of safety to ensure that no-adverse health effects would result from exposure to the RF jammers. Use of the IEEE MPE limits is directed by DoDI 6055.11 (2009), Protecting Personnel from Electromagnetic Fields. A copy of the IEEE radiofrequency standards can be downloaded at: http://standards.ieee.org/getieee/C95/download/C95.1-2005.pdf.

Additionally, DoDI 6055.11 (1995), Protection of DoD Personnel from Exposure to Radiofrequency Radiation and Military Exempt Lasers, which was in effect in 2004–2005, directed that no practice will be adopted or operation conducted involving planned exposure of personnel to radiofrequency levels in excess of the applicable permissible exposure limit (PEL). No-adverse health effects would be expected to occur with RF exposures within PEL, even with repeated or long-term exposures. The radio frequency PELs in 2004–2005 were derived from the recommended

exposure levels in American National Standards Institute (ANSI®)/IEEE C95.1-1992. (ANSI® is a registered trademark of the American National Standards Institute, Inc.)

9.6 Air Quality

Service Members deployed to the CENTCOM AOR (e.g., Iraq, Afghanistan, Kuwait) were exposed to sand and dust storms, pollutant emissions from vehicles, and other airborne hazards. [The PM is the term for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets. Particles can be suspended in the air for long periods of time. Some particles are large or dark enough to be seen as soot or smoke. Others are so small that they can be detected individually only with specialized microscopes. Small PM that is less than 10-micrometers in diameter can be breathed in (inhaled) into the lungs. A 10-micrometer particle is roughly one-sixth the width of a human hair. This is called the PM_{10} size range. A 2.5 micrometer in diameter particle is called $PM_{2.5}$. In some areas, PM can be very heavy because of high levels of industrial activity or natural environmental conditions (e.g., dry, dusty climates)].

The POEMS report identified PM_{10} sampling results from 2003, 2007, 2009, and 2010. The range of 24-hour PM_{10} concentrations in 33 samples collected from May 2003 to March 2010 was 65 to 1768 µg/m3 (where the average was 374 µg/m3). The comparison 24-hour guideline value is 250µg/m3. Since the average PM concentration exceeded the 24-hour level, on those days irritation and cough were likely. However, the PM levels varied, and so typical exposures ranged from low in 2003 to moderate risk in 2010. During the period of Shamal winds, the PM_{10} levels may be extremely high and skew the average which is why the range in levels is large. Dust storms may result in high levels of ambient PM for short periods. This could irritate the eyes and respiratory passages. Overall, the risk was low on 96 percent of the days with sampling results, and high on 4 percent of the days sampled. The risk was indeterminate for all other years due to insufficient data.

The POEMS report also identified sampling for $PM_{2.5}$ in 2010. $PM_{2.5}$ is smaller and more easily inhaled deeply into the lungs. [It is also the fraction of PM that is linked to long-term health effects. The range of 24-hour $PM_{2.5}$ concentrations in the 25 samples collected in 2010 was 70 to 113 µg/m3 (with an average of 101 µg/m3). The comparison 24-hour guideline level is 65 µg/m3. This indicates that on average, the $PM_{2.5}$ levels were higher and exposed individuals may have experienced cough, or other symptoms. The long-term risk is based on a comparison of the average sample concentration to the long-term guideline level of 15 µg/m3 resulting in what would be categorized as a moderate risk. Chronic exposure to elevated levels of $PM_{2.5}$ is associated with some long-term respiratory conditions such as chronic obstructive pulmonary disease and cardiovascular health consequences.]

Exposure to high levels of PM might cause or exacerbate chronic lung conditions including chronic bronchitis and asthma, with effects dependent on the size of the PM, the degree and duration of exposure, as well as characteristics of the population being exposed (healthy, young individuals versus older individuals or those with pre-existing medical conditions. Appendix K includes a PM fact sheet created by the USAPHC.

9.7 Human Remains

Five interviewees reported exposure to Iraqi and U.S. Soldier corpses, and in some instances, this contact was without the benefit of gloves. Hepatitis B and HIV may be transmitted by direct contact with human blood and body fluid. Service Members are immunized before deployment against the first of these two viruses and have annual blood tests to evaluate for the presence of HIV. In the

absence of any symptoms of an acute infection or the development of any serum indicator of such an infection after the deployment, it I would be extremely unlikely that any members of the brigade had a health impacting exposure to human remains or human blood or body fluids. Observation of or contact with human remains would be a traumatic event, and the individual response to such an event would be variable. Such events might contribute to the development of PTSD. Appendix L is a fact sheet addressing Handling of Human Remains.

9.8 Raw Sewage

Four individuals reported a stream mixed with raw sewage. In some instances, it was reported that the stream of raw sewage splashed onto individuals. There was a report of a young specialist falling into the sewage and one of the interviewees sat near him for several hours in the Stryker. Two primary areas of health concern related to exposure to raw sewage were chemical hazards and bio-hazards. Without knowing any specifics of what was in the sewage in regards to specific toxic chemicals, it would not be possible to comment directly about their potential toxicities. However, most common urban and rural sewage would contain mostly non-toxic substances. When hazardous materials might be injected into the waste stream, they are usually sufficiently diluted that they become innocuous.

The larger health concern involved with being exposed to waste streams and to human waste and body fluids would be the risk of transmission of infectious agents and/or infectious disease. Raw sewage might carry bacteria, viruses, protozoa (parasitic organisms), helminthes (intestinal worms), and borroughs (inhaled molds and fungi). The diseases they might cause range in severity from mild to moderate gastroenteritis (causing stomach cramps and diarrhea) to life-threatening ailments (such as cholera, dysentery, infectious hepatitis, and severe gastroenteritis). The majority of the bacteria that might be transmitted from person to person or waste stream to person would likely cause infection right away, within hours to days. Viruses (such as rotaviruses, adenoviruses, Norwalk virus and others) also could cause an acute illness, characterized by watery diarrhea, vomiting, headache, fever, and abdominal cramps. These would tend to have an onset within 48 hours of exposure and run their course in 1 to 10 days. The parasites, intestinal worms, and mold and fungi might take a little longer to begin causing symptoms, but generally if they are going to cause infections, the symptoms will present within days to weeks. Many of these infections could result in dermatologic or gastrointestinal illness, a significant number of which could be self-limited. The VA has determined that nine infectious diseases, including three gastrointestinal conditions, are considered presumptively associated with military deployment under certain conditions. These three conditions are salmonella, shigella and campylobacter jejuni infections. See Appendix M for a discussion of these conditions and the eligibility criteria.

The other primary virus of concern with sewage exposure is Hepatitis A. Hepatitis A vaccination is a requirement for deployment to the CENTCOM area of operations. Hepatitis A is a liver disease caused by the Hepatitis A virus (HAV) which is transmitted mainly via the fecal-oral route by person to person contact or ingestion of contaminated food or water. Symptoms generally begin 28 days following infection and include fever, tiredness, nausea, abdominal discomfort, dark urine, and jaundice (skin and whites of eyes turn yellow in color). Most people recover within 2 months of the onset of symptoms, although about 10 percent might have prolonged symptoms or a severe case. Interestingly, when infection occurs in those less than 6 years of age, there will typically be no symptoms.

9.9 "Ice Factory"

Five Soldiers described being present at a one-time acute exposure at the "Ice Factory", and several others recalled the incident. They explained that buildings were given nicknames that did not necessarily match the buildings' function. Thus, the actual use of the building and the materials which might be on hand were not known. It was stated that on a rainy day in the western Mosul industrial area, there was heavy gunfire and firefight inside a building. A container was pierced and released an unknown gas/substance inside the building. The canisters were reported to be 6-8 feet tall. Approximately 10 Soldiers were involved. One individual stated that they had to egress because they could not breathe. Another stated that there was a strong smell, possibly ammonia mixed with something decaying, and they left the building due to the smell. Others reported no smell and no breathing difficulty. One Soldier described a white gas cloud after a sound like a "tea kettle going off" and the odor of Freon or a refrigerant. He also described the smell as possibly eggs or ammonia. The Unit surgeon did not specifically recall an event that resulted in an acute exposure that came to medical attention. Interviewees agreed that the building was off MSR Tampa close to Yarmuk traffic circle. No information was provided or found regarding what substances were in the canisters. Therefore, it was not possible to comment about the potential toxicities. No SITREPS or other documentation of the incident were found in open sources or in classified reports. As noted earlier, an assessment of potential chemicals that may have been stored in the Mosul area based on industry type was conducted, but the contents of the canister remained unknown. There was no information that suggests any specific chemicals were released at any other time, or any other exposures.

Since some individuals reported an ammonia smell associated with the "Ice Factory", the health effects of exposure to ammonia are discussed in Appendix N.

9.10 Industrial Facilities

The 1/24 BN SBCT interviewed personnel identified Mosul as being a highly industrialized area. The DESP used the SIPRNET based MIDB to identify all the facilities around the Mosul, Iraq during the 2004–2005 timeframe. An industrial hazard assessment (IHA) was performed by extracting non-industrial facilities from the list and grouping the remaining facilities into industry categories (e.g., research facilities, petroleum product storage, food production facilities, thermal power plants, water treatment plants, etc.) and identifying the chemicals associated with them. The MIDB database does not identify if the facility is still operational and nor describe their manufacturing process. For the IHA, it was assumed that the manufacturing process in Iraq would be the same as in the United States when the chemical list was extracted. See the separate supplementary classified report (available on the SIPRNET by request) for a listing of industries in the Mosul area. However, as stated previously, there were no specific exposure incidents reported with the exception of the "Ice Factory" incident.

There were no specific concerns in the interviews regarding industrial facilities, except one interviewee described a strong odor from a fertilizer plant that caused him to experience nausea and vomiting. As stated, there were industries in the area, but it was not known if they were operational. One Soldier described guarding a factory that stored tanks of chlorine to keep insurgents from the tanks, but he did not recall any incidents. Interviewees stated that there was a food production facility and cement factory close to FOB Marez. There was no information to suggest any accidental or intentional acute releases or exposures from any other facilities apart from the "Ice Factory".

10 Reported Health Concerns

As noted earlier, members of the 1/24 BN SBCT became concerned when two cases of cancer developed among individuals in the Unit. Through communications with other members, other health conditions were identified, and the question of the relationship with potential deployment exposures and these outcomes was raised. One response to these concerns was to evaluate potential exposures related to the deployment and to assess the potential for adverse health effects resulting from these potential or known exposures. Health effects associated with identified levels of exposure were identified if sufficient information exists.

Apart from the assessment of the health implications of known or suspected exposures, reported health concerns were reviewed to look for a cluster of disease in response to the concern about a potential cluster. Initially, this was done by interview. The health concerns, diagnoses, and symptoms identified by interviewees were varied and included malignancies and conditions in the musculoskeletal system, the respiratory system, the gastrointestinal system, the skin, the neurological system, the genito-urinary system as well as some behavioral and mental health complaints. This information was obtained from individuals who came forward to be interviewed, as well as two spouses who served as proxy. In one of these two cases, the actual Soldier was then also interviewed. Individuals self-reported symptoms, conditions and concerns. The specific diagnoses reported were follicular lymphoma, acute lymphoblastic leukemia, biliary carcinoma or bile duct cancer, skin cancer, Crohn's disease, kidney stones, asthma, pulmonary nodules, PTSD, TBI or MTBI, anxiety attacks and hearing loss. There were a few additional ill-defined or non-specific complaints. The number of clinical issues raised per Soldier ranged from one (4 individuals) to four (1 individual). Medical records for all individuals with cancer were provided and reviewed and confirmed the diagnoses. An additional medical board was provided for review and confirmed two diagnoses. For the 10 remaining individuals, 8 were no longer on Active Duty, but the DoD and Veteran's administration electronic health record system was queried. Available medical records tended to confirm the self-reported conditions, although not all symptoms were represented in the records with a diagnosis. While there was obviously incomplete capture of objective medical outcomes, these were reviewed to determine if a cluster of a specific disease was present, and to identify which, if any, might be associated with known, or potential environmental exposures sustained during the 1/24 BN SBCTs deployment to the Mosul area from 2004–2005. These conditions and assessments are discussed briefly below and in Appendix O.

10.1 Follicular Lymphoma

There was one reported case of follicular lymphoma (FL), which was a common form of non-Hodgkin's lymphoma (NHL). Lymphoma and leukemia are cancers of the blood system. Leukemia is a disease of circulating blood cells while lymphoma can include tumors or solid masses. FL is rare in young individuals and the average age at diagnosis is 60. Just over 14,000 cases of FL are anticipated to be diagnosed in the U.S. in 2014 (reference 12). Approximately 1 in 50 Americans will develop NHL during their lifetime and about 20 percent of these are FL; thus, the risk of developing FL is about 1 in 250 people. The major risk factors for NHL (and FL) include increasing age, male sex and Caucasian race. Ionizing radiation exposure was linked to NHL, and some studies suggest that exposure to benzene and certain herbicides and pesticides might be linked to NHL (reference 13). See Appendix O, Section 10.1 for further discussion of the etiology of FL.

10.2 Acute Lymphoblastic Leukemia (ALL)

Leukemia is a cancer of the white blood cells. There are several different types of white blood cells, and therefore, there are several different types of leukemia. Acute Lymphoblastic Leukemia (ALL), also referred to as Acute Lymphocytic Leukemia, is a cancer that originates in the lymphocytes, usually arising in the bone marrow. The American Cancer Society® reports that only approximately one third of cases of ALL occur in adults. Children under the age of 5 are at the highest risk of developing ALL. The risk then declines until the third decade of life, stays fairly stable, and then slowly increases after the age of 50. The lifetime risk of developing ALL is about 1 in 750 people (reference 14). (American Cancer Society® is a registered trademark of the American Cancer Society, Inc.)

Known and suspected risk factors for ALL include exposure to high levels of ionizing radiation. Survivors of exposure to the Atomic Bomb in Hiroshima and Nagasaki developed ALL (among other cancers) 6–8 years following the exposure at higher rates than non-exposed persons. Exposure to chemicals (such as benzene) has not been associated with an increased risk of ALL (references 15, 16, and 17). Several viral infections and certain inherited conditions have been associated with an increased risk of ALL, as is male gender, being Caucasian, and having a twin with ALL (reference 14). See Appendix O, Section 10.2 for further discussion of the etiology of ALL.

10.3 Biliary Carcinoma or Bile Duct Cancer

Biliary Carcinoma or Bile Duct Cancer (BDC) includes cancer of the bile ducts within the liver and outside the liver. The American Cancer Society estimates that about 2,000-3,000 people will be diagnosed with BDC in 2014, making it relatively rare. The average age at diagnosis is in the seventies. Almost 65 percent of people are over the age of 65 when diagnosed (reference 18). Regarding the case in the 1/24 BN SBCT, during his evaluation, a geneticist found no evidence of a genetic predisposition and considered the etiology “environmental”. One provider considered a potential role of DU or oil well fires.

Known and suspected risk factors include increasing age, increased weight, and certain conditions which result in inflammation of the liver or bile duct. Exposure to a radioactive contrast substance used for X-rays up to the 1950s has some association to bile duct cancer. However, at this time there are no strong associations between common environmental exposures and bile duct cancer (references 19 and 20), except for heavy alcohol consumption (reference 18). See Appendix O, Section 10.3 for further of the etiology of BDC.

10.4 Pulmonary Nodules

Pulmonary nodules are small round or oval-shaped growths in the lung that are generally less than 3 centimeters (cm) in diameter. They may also be referred to as spots on the lung. Growths that are larger than 3 cm are usually referred to as pulmonary masses; these are more likely to be malignant than nodules (reference 21). Estimates are that between 0.09 percent and 0.20 percent of all chest X-rays reveal a solitary pulmonary nodule and that 150,000 of these nodules are identified each year (reference 22). Pulmonary nodules may be caused by a wide variety of clinical situations and conditions. Often blood vessels viewed 'on end' may appear on a routine chest X-ray as nodules. Prior infections (such as anything from community acquired pneumonia to tuberculosis to several different fungal infections) may leave small scars in the lungs which appear as pulmonary nodules. Accumulations of inflammatory cells, called granulomas (such as are seen in conditions like sarcoidosis or reactions to infections) may appear as pulmonary nodules. Some

infections, including tuberculosis, non-malignant conditions and malignant cancer, whether primary pulmonary or metastatic from elsewhere, may also present as pulmonary nodules.

Pulmonary nodules may present as solitary lesions or multiple spots on the lungs, they may be unilateral or bilateral, they may be uni-lobular or multi-lobular, they may be round or irregularly shaped and they may have smooth contours or they may have spikey surfaces. Given the frequency of pulmonary nodules on chest X-rays in the general population, the wide range of possible etiologies, and the variability at presentation it is not possible to make any definitive statement regarding the cause of pulmonary nodule(s) in any given Service member, without having much more information.

10.5 Asthma

Asthma is a chronic lung disease characterized by inflammation and narrowing of the airways, and by intermittent spasms of the airways. Asthma can affect people of all ages, but most often begins in childhood. More than 25 million people in the United States have asthma, and more than a quarter of these are children (reference 23). When the airways are inflamed, they are swollen and tend to be extremely sensitive to a variety of inhaled substances which can then trigger spasms of the muscles surrounding the airways, called bronchospasm.

Scientists are not sure what causes asthma, but most believe that it involves an interaction between genetic and environmental factors. These factors may include: an inherited tendency to develop allergies; a family history of asthma; certain respiratory infections during childhood; and contact with some airborne allergens or exposure to some viral infections in infancy or in early childhood, when the immune system was still immature (reference 23). Individuals with a predisposition to develop asthma are often more sensitive to non-specific airborne irritants. Some workplace exposures were associated with the development of asthma.

Various researchers have studied the relationship between deployment and respiratory symptoms and respiratory conditions to include asthma. These studies as a group appear to show an increase in asthma symptoms associated with deployment to Iraq or Afghanistan. See Appendix O, Section 10.5, for further discussion of the etiology of asthma, including in relationship to military deployment.

10.6 Post-Traumatic Stress Disorder (PTSD)

The PTSD is a frequent result of being in combat, with estimates for OEF/OIF Veterans running from 5-30 percent (references 24, 25, 26, and 27). PTSD is a mental health condition that may be caused by a terrifying or traumatic event. Symptoms may include flashbacks, nightmares and severe anxiety, as well as uncontrollable thoughts about the event. Symptoms typically start within a few months of the trauma but sometimes do not appear until years after the event. Symptoms may cause problems in social or work settings and in relationships. Other symptoms include guilt and shame, irritability, self-destructive behavior, trouble concentrating, sleeping and hyper arousal. All of these PTSD symptoms may vary over time and may be worse when an individual is stressed or reminded of the event. Some of the symptoms overlap with mood disorders. PTSD is also a risk factor for suicide.

It is believed that fear of hazardous consequences of an environmental exposure may result in PTSD, much the same way that fear of hostile activity, even without actually being in combat may do so. There are no known links between environmental chemical exposure and the development

of PTSD, other than from the fear and anxiety of being exposed. Anyone with symptoms of PTSD that interfere with any aspect of his/her life, should seek help. The VA has many programs for Veterans with PTSD, including a Veterans Crisis Hotline at 1-800-273-8255. Anyone with thoughts of harming themselves should seek help immediately (reference 28).

10.7 Traumatic Brain Injury (TBI)

Traumatic Brain Injury (TBI) as the name implies is an injury to the brain due to a bump, blow or jolt to the brain or a penetrating head injury, which disrupts the normal brain function. Much has been learned about mild TBI (m-MTBI) and TBI in the years since the beginning of OEF/OIF. Research has shown that there are several mechanisms of potential brain injury including penetrating trauma, direct non-penetrating trauma, acceleration/deceleration injury, and blast or concussive waves. Injury can range from mild to severe, with the majority of cases being concussions or mTBI. Symptoms of brain injury include headaches, dizziness, cognitive impairment, fatigue, irritability, vision changes, balance problems, mood changes, and sleep difficulty. With mTBI or concussion, these symptoms may resolve in minutes to days. Most individuals with concussions recover fully within weeks, but others may develop chronic symptoms. There are no known links between environmental chemical exposure and the development of TBI.

Many of the interviewees reported concussions, head trauma, and blasts severe enough that they were thrown in the air. One individual suffered bilateral rupture of his eardrums and a concussion. These were not universally evaluated screened due to OPTEMPO. Some interviewees complained of memory difficulties which interfere with ability to hold a job and other functioning. Mood changes and sleep difficulty were also common. As noted, some of these symptoms overlap with PTSD, and this Unit was at high risk for both. Soldiers are encouraged to seek care as approaches to these conditions change regularly and may have significant impact on improving the quality of life for these individuals.

10.8 Panic Disorder

Anxiety attacks, also known as panic attacks, are part of a condition called Panic Disorder, which affects approximately one out of every 75 people (reference 29). Anxiety attacks often first occur during the teens or early adulthood. Frequently there is a connection with major stressful life experiences. There is also some evidence for a genetic predisposition. The symptoms of anxiety attacks are well known and may include any of these, among others: tachycardia, palpitations, air hunger, paralyzing terror, dizziness, lightheadedness, sweating, shaking, chest pain, tingling in fingers or toes, and fear of imminent death. The primary difference between panic attacks and appropriate response to a stimulus (such as an enemy attack) is that the former occur suddenly in seemingly harmless situations and can even occur while sleeping. Anxiety attacks typically pass within a few minutes but can recur repeatedly for hours (reference 29).

In a study of almost 10,000 individuals in the United States, anxiety disorder was the most prevalent DSM-IV mental diagnosis, with a prevalence rate of 18.1 percent (reference 30). This was almost double the rate of the next most common diagnosis, mood disorder, which was found in 9.5 percent of the sample. The National Institute of Mental Health estimates that panic disorder affects about 6 million American adults and is twice as common in women as men (reference 31). Anxiety is also one of the potential manifestations associated of both TBI and PTSD. See Appendix O, Section 10.8 for further discussion of the etiology of panic disorder, including in relationship to environmental exposures.

10.9 Kidney Stones

Among the interviewees, there was one report of kidney stones. Kidney stones are pieces of solid matter that form in the kidney when there are high levels of certain substances, normally found in the urine at lower concentrations. One or more stones may form at the same time and these may stay where they formed in a particular part of kidney, or they may travel further down the urinary tract. Kidney stones vary in size; small stones may pass out of the body on their own, while larger ones may get stuck along the urinary tract.

According to data from National Health and Nutrition Examination Survey 2007–2010 (NHANES) in the United States the prevalence of kidney stones was 8.8% (95% confidence interval [CI], 8.1-9.5) (reference 32). This represents 27,995,035 individuals (reference 33). Obesity and diabetes were strongly associated with a history of kidney stones in multivariable models. There seems to be a correlation between stone occurrence and weight gain, body mass index (BMI) and diabetes mellitus (references 34 and 35). After milk products in China were tainted with melamine, there was a significant increase in the number of babies and children diagnosed with kidney stones, leading to belief that melamine, known to be able to cause kidney stones in rats can also do so, under the correct conditions, in humans (reference 36). It has been known for decades that there is an increased risk of kidney stone is workers occupationally exposed to Cadmium (references 37, 38, 39, and 40). Despite extensive review of the medical and scientific literature, no occupational or environmental exposures were identified that were strongly associated with an increased risk of kidney stones.

10.10 Crohn's disease

One individual had Crohn's Disease (CD) which was diagnosed in theatre; CD is a form of Inflammatory Bowel Disease (IBD), which can affect any part of the gastrointestinal track. CD is a chronic disease, which involves inflammation of the gut, most commonly at the end of the small bowel and the beginning of the colon. According to the Crohn's and Colitis Foundation of America, 700,000 Americans may have CD (reference 41), with an equal risk in men and women. The onset is usually between the age of 15 and 35; however, it may occur at any age.

The causes of CD are unknown, although some research suggests hereditary, genetics, infections, smoking, and/or environmental factors may contribute to the development of CD. Individuals living in urban or industrial areas and people in northern climates are at higher risk of developing CD than those in rural communities, less developed countries or more southern climates (references 41 and 42). Most research indicates that the body's immune system plays a major role in the development of CD (references 42 and 43). Diet and stress may aggravate CD, but do not cause it. The CD runs in families and is more common in people of Eastern European descent, although four out of five patients do not have a close relative with CD and it is found in people of other backgrounds (references 41 and 42).

The Institute of Medicine conducted an extensive review of the literature that looked at solvent and pesticide exposure and a variety of clinical outcomes (reference 44). This review failed to identify a single study that found an increased incidence of CD with solvent or pesticide exposure. There is some evidence that some solvent exposures may be linked to immune system effects (reference 45), however, based on a review of the literature, there are no currently published studies indicating an increase in CD related to any known chemical exposure.

10.11 Gastrointestinal Symptoms

Gastrointestinal (GI) symptoms were reported in three individuals excluding the case of CD. These complaints included rectal bleeding in two individuals (one who reports it for approximately two years), "stomach issues", and sporadic bowl movements. One individual was diagnosed with gastritis which was service-connected. The descriptions of some of these symptoms sound as if they may represent Irritable Bowel Syndrome (IBS). This is a completely different clinical condition than CD, which is an IBD. Without further information, the diagnosis of IBS is obviously speculative. IBS is a problem with the motility of the intestines for which no cause has yet been found, but there are treatments that are highly effective. In order to be diagnosed with IBS, all other causes for the symptoms must be excluded from possibility. That includes various tests that can be ordered or performed by most primary care providers and/or by a gastroenterologist. Rectal bleeding may indicate anything from hemorrhoids to colon cancer, and certainly warrants evaluation by primary care physician if not done already. Without a specific diagnosis, it is difficult to consider environmental exposures, although some GI symptoms are related to stress. As noted earlier, there are three infectious gastrointestinal conditions which are presumptively related to deployment by the VA, and these are discussed in Appendix O.

10.12 Hearing Loss

Three interviewees reported hearing loss; it was bilateral in two cases and one individual uses hearing aids. Military service has been associated with hearing loss, and this Unit was exposed to continuous noise as well as sudden explosions with associated noise and blast overpressure.

10.13 Miscellaneous Conditions

There were a variety of conditions identified where the cause is obvious or well-established (such as burns, fractures, sprains, strains, torn ligaments, low back pain, shrapnel wounds and other injuries). The following are some other reported medical conditions or symptoms with a brief discussion of each. These conditions are found in military and Civilian populations.

- Headaches were reported by a few Unit members. Headaches are associated with a variety of conditions and have a variety of causes. Persistent headaches; frequently re-occurring headaches; or headaches that have increased in duration, frequency, and intensity; as well as having "the worst headache of my life," should be assessed by a healthcare professional.

- Pilonidal Cyst: At least one individual developed a symptomatic pilonidal cyst (a cyst that usually occurs in the buttock area near the "tailbone") requiring treatment. This pilonidal cyst became symptomatic several years after the 2004-2005 deployment. Individuals can have an asymptomatic pilonidal cyst for many years, but it can become more noticeable, painful, inflamed and/or infected (becomes an abscess) with prolonged pressure or irritation in the area of the cyst, such as sitting for long periods of time. A pilonidal cyst is not a result of an environmental exposure. Soldiers with any cysts or abscesses should see their healthcare provider for assessment and possible treatment.

- Frequent Urination: At least one individual reported that he began to experience frequent urination after deployment. A persistent increase in urinary frequency, and well as other persistent or chronic changes in urination habits such as urinary urgency, urinary hesitancy, painful urination, and so forth, are usually a symptom of another medical condition but can be just a normal variation in urination. Urinary frequency is not associated with any known

environmental exposure. Soldiers should see their healthcare provider if they are having these types of urinary symptoms or other unexplained changes in their urination habits.

- Restless Leg Syndrome: At least one individual reported that he had restless leg syndrome (RLS). RLS usually involves an urge to move your legs and the voluntary movement of the legs at rest or while trying to sleep. Involuntary movement and jerking of the legs while sleeping is called periodic leg movements of sleep (PLMS). These conditions may be difficult to distinguish and some movement of the arms and legs is normal. Each condition may occur by itself or can be associated with other sleep disturbances and/or other medical conditions. However, there is not any known environmental exposure associated with RLS. Soldiers should see their healthcare provider for persistent bothersome symptoms, if the symptoms interfere with getting a good night's sleep, or for other health related concerns.

- Rashes: A few Soldiers reported rashes or other skin conditions but did not have a specific diagnosis. Without a specific diagnosis, it is difficult to determine whether a particular exposure or suspected exposure might have caused or contributed to the rash. Likewise, without a specific exposure, it is difficult to determine a specific cause of the rash. Soldiers should see their healthcare provider for persistent skin rashes or other skin conditions.

11 Findings

Minimal objective information was available regarding potential exposures incurred by Unit members. The 1/24 BN SBCT was deployed to Mosul during a time of heavy insurgent activity and engaged in numerous dangerous missions. There was limited environmental monitoring conducted during this period of high operational tempo. Unit members were potentially exposed to products of combustion and incomplete combustion and an unknown mix of other potential hazards when detonating unexploded ordinance, during frequent improvised explosive device attacks, and when responding to burning Stryker vehicles.

In general, the health effects reported by Unit members did not have definitive associations with potential exposures identified by the Unit or to other known exposures. Although the available data were limited, long-term health effects were not expected based on the information available. Finally, a disease cluster (pattern) was not evident.

11.1 Reported Potential Exposures

An extremely limited amount of specific, quantitative, and applicable exposure information was identified in the review of available data sources. Ambient air quality was considered poor by many Soldiers. Exposure to ambient particulate matter (PM) and vehicle exhaust was highly likely. This is based on environmental monitoring conducted after 2005. Soldiers and the Unit surgeon were concerned about emissions from a burn pit. A burn pit used for waste control was determined to have been appropriately sited with respect to prevailing wind patterns. However, atypical events (such as atmospheric temperature inversions) may have occurred. These events have the potential to cause prolonged lingering of burn pit smoke near the ground. Exposure to other products of combustion from burning vehicles and uncharacterized burn pit emissions occurred at an unknown frequency, duration, and intensity.

While it is plausible that toxic industrial chemicals may have been present, there were no documented chemical releases or industrial accidents apart from a single ruptured canister incident at the "ice factory" discussed in the interviews. The impression of those interviewed for this

investigation was that industrial facilities located in and around Mosul were generally not operational.

Soldiers were concerned about exposure to Halon discharged from the fire suppression systems, installed in Stryker vehicles. However, Halon was not the fire suppressing agent used in these vehicles. A burning Stryker would be expected to generate a variety of potentially hazardous combustion products. Magnitude and duration of hazardous exposures from burning vehicles were not known.

Unit members reported being near destroyed or disabled vehicles that may have been hit with depleted uranium (DU) rounds. Contact with vehicles hit by DU rounds may have resulted in limited incidental DU exposures (considered "Level III" exposures). Such exposures are not associated with significant health risks.

Individuals reported sporadic or potential exposure to sewage and human remains. The extent of barrier protection was variable. One individual reported an episode of what he considered "dysentery" from drinking water that was bottled; therefore, ingestion of contaminated water was not likely to have occurred. The lack of other reported acute episodes of infectious disease were evidence of a low level of risk for future health consequences of exposure to untreated sewage and human remains. The long-term risk of infectious disease risk was minimal.

Based on events as described by Unit members, some individuals likely incurred short-term exposures to irritants from IEDs/VBIEDs/SBIEDs and possibly at the "ice factory" or elsewhere. In no instance were these exposures quantified. Typically, however, acute health effects would have been apparent if exposures were of sufficient magnitude to be of long-term concern. Other hazards (such as propellants and accelerants) were mentioned by those interviewed, but it was not clear to what extent the exposure pathways were completed (i.e., item was inhaled, ingested or substantially absorbed through the skin). Some exposure concerns (such as the microwave "jammers") do not pose a health hazard under normal operating conditions.

The evaluation of the frequency, duration, and magnitude of specific exposures which could potentially result in long-term health effects did not provide evidence of a singular source of risk. However, there is substantial uncertainty about the risk posed by combinations of hazards and about exact exposures experienced at the individual level.

11.2 Reported Health Concerns and the Potential Exposures

Regarding health conditions and potential associations with deployment-related exposures, it could be stated with a high degree of certainty that self-reported PTSD, TBI and MTBI were likely to have resulted from Unit activities during their deployment. The Unit operated for prolonged periods at high intensity with little "down time", and was exposed to deaths of Unit members, other human remains, and high-stress combat conditions. Likewise, hearing loss and combat injuries resulted from deployment activities. There were few complaints of respiratory disease from the interviewees—asthma, shortness of breath, and pulmonary nodules were reported—although inhalation exposures were likely. The association between respiratory symptoms and deployment to OIF has been noted, and asthma following deployment has been demonstrated in some published studies. Other non-cancer conditions (such as kidney stones, Crohn's disease, and non-infectious gastrointestinal disease and symptoms) do not have a clear relationship with potential exposures incurred during the Unit's deployment.

Biliary carcinoma is not associated with a specific environmental exposure. Two of the reported malignancies, follicular lymphoma and ALL, are associated with ionizing radiation. Follicular lymphoma had also been associated with solvent exposure, although evidence for this relationship is considered limited/suggestive. While there are no quantitative measurements, exposure to incidental ionizing radiation is unlikely to result in development of either cancer. Cancer related to solvent exposure is limited to particular solvents and typically occurs in working populations with regular, recurring, long-term exposure. See Appendix P for details on the published literature regarding these opinions.

11.3 Disease Cluster Assessment

Overall, there is not a predominant and specific health condition of concern. No unifying case definition could be delineated. The presence of different cancer types in this small group was not evidence of a disease cluster, given that a cluster involves one specific type of disease. Likewise, singular occurrences of a specific disease type cannot be assessed as occurring in excess to what would be expected (references 1, 2, and 3). The age of onset for the noted cancers are somewhat atypical, but not wholly uncommon.

Since a unifying case definition cannot be established and because no known completed exposure pathway for a biologically plausible exposure can be identified, a formal epidemiological investigation would not be useful and is unfounded.

11.4 Rationale for Conducting Cancer Studies

The AIPH is planning to conduct a set of epidemiologic studies to evaluate whether a history of deployment in support of OIF/OEF was associated with subsequent incidence of primary cancer (from 2004–2013) among Active Duty Service Members and U.S. Veterans. Cases of primary melanoma, brain cancer, leukemia, lymphoma, thyroid cancer, testicular cancer, and breast cancer will be identified using DoD and VA medical records and cancer registry databases. Many of these cancers will have peak incidence during the young adult years and will have known or suspected environmental or occupational risk factors.

In responding to the concerns of the 1/24 BN SBCT Soldiers, Service Members and Veterans, a necessary first step is to evaluate whether the incidence of cancer among deployed personnel is greater than what would be expected. Thus, the objective of this study is to systematically identify cases of cancer among Active Duty Service Members and Veterans, evaluate their deployment experience in comparison to the deployment experience of a representative set of control subjects, and estimate the excess risk of cancer among deployed personnel. An understanding of the presence and magnitude of an excess risk of cancer among formerly deployed individuals – or the lack thereof – can be used to substantiate or alleviate concerns, support the public health and medical communities that care for formerly-deployed personnel and Veterans, and inform DoD and VA policy makers regarding the long-term effects of deployment-associated exposures.

12 Recommendations

12.1 1/24 BN SBCT Personnel

- Encourage all individuals to seek medical evaluation for unexplained, persistent, or concerning health conditions. Individuals should speak with their healthcare provider

regarding potential exposures of concern. Providers with questions regarding deployment-related exposures and potential associations with health conditions may contact the AIPH Environmental Medicine Clinical Consult Service (usarmy.apg.medcom-phc.mbx.emp@mail.mil). Questions and contact information may be emailed to this address and a provider will contact the requestor, typically within 48 hours.

- Foster a positive climate for seeking care for both physical and behavioral health injuries and concerns. A stigma against seeking care is still pervasive in some units. Given the nature of the missions and experiences of the 1/24th, they are at risk for PTSD. If still on Active Duty, they may seek assistance through their primary care manager or evaluate resources on the Defense Center of Excellence at: www.dcoe.mil Web page which also provides information, 24/7 access and other assistance. The PTSD may affect close relationships, particularly those with the Family. The Family may play an important role in encouraging individuals to seek help. The Family can access resources at: www.dcoe.mil. The VA Web site at: www.ptsd.va.gov provides resources for Family members, self-help online tools for those with PTSD, and information and telephone numbers for use when in crisis and how to seek help and get assessed in the VA system.

- Ensure Active Duty Soldiers from the 2004-2005 1/24 BN SBCT deployment contact their primary care manager for any TBI health concerns related to exposures from IEDs, VBIEDs, and SBIEDs. All individuals with a history of such trauma, particularly if they are exhibiting symptoms such as headaches, dizziness, memory loss and other cognitive difficulties, irritability, mood disorder or impact to their daily functioning should be evaluated. Some of these symptoms may be contributing to, overlapping with, or exacerbating other behavioral health issues such as PTSD. The DoD Defense Centers of Excellence for Psychological Health and Traumatic Brain Injury offers a 24/7 Outreach Center Web site at: www.dcoe.mil with access to phone center, live chat and email, as well as resources for the individual and the Family. The VA now has Polytrauma Care Facilities which have expertise in addressing all of the effects and symptoms of TBI in multiple organ systems. Resources and contact information may be found at: (http://www.polytrauma.va.gov/understanding-tbi/). In addition, any combat Veteran may bring their DD214 to a VET Center to speak to a counselor or therapist without an appointment and regardless of enrollment status with the VA. Information, Web links, and contact information on these programs, to take a self-assessment online, and other topics can be found at http://www.maketheconnection.net/resources

- Encourage all individuals with concerns regarding inhalational exposures or open burning of trash to register for the VA Airborne Hazards and Open Burn Pit Registry. The VA, in coordination with DoD, has established an Airborne Hazards and Open Burn Pit Registry to allow Military personnel and Veterans previously deployed in Afghanistan, Iraq, or 1990-1991 Gulf War with concerns regarding their exposure to various sources of air pollution (such as smoke from burn pits, oil-well fires, or pollution) during their deployment to provide detailed information regarding their exposure situation and health concerns. In addition, the registry offers an optional medical assessment, though it is not required to be in the registry. The VA Airborne Hazards and Open Burn Pit Registry can be accessed through the Web site below: https://veteran.mobilehealth.va.gov/AHBurnPitRegistry

- Inform former members of the 1/24 BN SBCT about the updated MEDCOM OTSG Policy 14-021. The updated policy provides former and current Soldiers specific guidance and classification, for Soldiers who have or may have been exposed to DU during a deployment. The policy also provides specific information to request a DU urine bioassay through their primary care provider if warranted.

12.2 Department of the Army (DA)

- Coordinate with higher headquarters personnel from the Army, CENTCOM, and DoD to establish the steps needed to review all sensitive data/information from this investigation and the OEF/OIF/OND campaigns for applicable declassification/redaction steps to allow inclusion in future investigative reports. This is particularly important with respect to exposure incidents and other information potentially relevant to health outcome. The DoD VA Data Transfer Agreement requires DoD to provide such information to the VA for their use.

- Improve documentation of personnel locations for all Army military and Civilian personnel. At minimum, daily locations for each Soldier and Civilian should be captured and maintained. In the absence of individual monitoring, in order to appropriately associate a fixed potential hazard to potentially exposed personnel, their location in association with the hazard must be known. Although personnel locations are mission sensitive, these data should be made available to public health professionals in a timely manner.

- Ensure OEHS requirements identified in AR 11-35 (Deployment Occupational and Environmental Health Risk Management) are implemented and executed.

- Ensure prompt reporting of all exposure incidents in the DOEHRS Incident Module. This reporting allows for the reporting of descriptive information related to exposure incidents such as fires, releases, spills or other events even in the absence of sampling information. Additionally rosters of the potentially exposed population are archived with this information, which is searchable by the individuals SSN, location, or other key terms.

- Ensure all Soldiers properly complete the PDHA and PDHRAs and that they receive proper guidance and education on the importance of these assessments. Individuals should be encouraged to document on these forms exposures that are of concern as well reporting specific symptoms or health effects experienced in theatre in relation to such exposures.

- Ensure providers have access to current information on relevant potential hazards with an understanding of when a referral is warranted and when reassurance is appropriate. Risk communication is required at the time of the PDHA and PDHRA for exposure concerns if the Service member is not referred. Factual, understandable and updated assessments of potential health risks associated with deployment exposures should be available to DoD providers, as well as VA providers, particularly those associated with the VA WRIISCs.

- Ensure that the Army is prepared to handle additional future stakeholder groups coming forward with health outcomes perceived to be associated with deployment related activities from the OEF/OIF/OND campaigns. It is critical that investigating agencies have comprehensive, accessible, interpretable, relevant and useable data that affords subject matter experts and healthcare providers the information needed to better assess, care for and educate Soldiers and Veterans.

- Ensure that the Army enhances environmental, occupational, and medical surveillance activities via state of the art technologies to realize comprehensive health surveillance.

13 Point of Contact

Ms. Farhana Schickedanz, DESP, MCHB-IP-RDE, DSN 312.584.6096, COM 410.436.6096, farhana.schickedanz2.civ@mail.mil and farhana.schickedanz2.civ@mail.smil.mil.

Appendix A

References

References

References Cited

1. Agency for Toxic Substances and Disease Registry. Public Health Assessment Guidance Manual (Update). January 2005. U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Atlanta, Georgia.

2. Centers for Disease Control and Prevention: http://www.cdc.gov/nceh/clusters/about.htm

3. Morbidity and Mortality Weekly Report 1990: Guidelines for Investigating Clusters of Health Events, MMWR, 39 (RR-11); 1-16. 07/27/1990; http://wonder.cdc.gov/wonder/prevguid/m0001797/m0001797.asp

4. Between the Rivers Combat Action in Iraq, 2003-2005, John J. McGrath, USACAC. http://usacac.army.mil/cac2/cgsc/carl/download/csipubs/BetweenTheRivers_McGrath.pdf

5. Wikipedia. http://en.wikipedia.org/wiki/Mosul

6. ABC news http://abcnews.go.com/International/simple-guide-understanding-conflict-iraq/story?id=24113794

7. Military Deployment Periodic Occupational and Environmental Monitoring Summary (POEMS): Mosul Airfield (Camp Marez, Camp Diamondback, Camp Courage), Iraq: 2003 to 2010 https://iphc.amedd.army.mil/sites/POEMS/POEMSWorkspace/Casebooks%20and%20POEMS/IRQ%20Mosul%20Airfield%202003%20to%202010/2002-2010%20Version/U_IRQ_Mosul%20Airfield%202002-2010_POEMS%20(9%20June%202011)%20w.%20Signatures.pdf

8. The fight for Mosul, March 2003-2008 by Eric Hamilton, Publication of the Institute Study of War Weeklystandard.com

9. MIDB - Joint Interoperability Test Command http://jitc.fhu.disa.mil/gccsiop/interfaces/midb.pdf

10. Defense Manpower Data Center https://www.dmdc.osd.mil/appj/dwp/getLinks.do?category=about&tab=6&clOn=about&rowNumb=6, accessed 25 July 2014.

11. Statistical appendix to MMWR 1990: Guidelines for Investigation Clusters of Health Events – APPENDIX. Summary of Methods for Statistically Assessing Clusters of Health Events; http://www.cdc.gov/mmwr/preview/mmwrhtml/00001798.htm

12 American Cancer Society. Non-Hodgkin Lymphoma. What is non-Hodgkin lymphoma? Topics. http://www.cancer.org/cancer/non-hodgkin lymphoma/detailedguide/non-hodgkin-lymphoma-types-of-non-hodgkin-lymphoma

13. Ambinder AJ, Shenoy JP, Malik N, et al. Review Article - Exploring Risk Factors for Follicular Lymphoma. Advances in Hematology 2012, Volume 2012, Article ID 626035, 13 pages

14. American Cancer Society. Leukemia - Acute Lymphocytic. What is leukemia - Acute Lymphocytic Leukemia (ALL) in adults? Topics. http://www.cancer.org/cancer/leukemia-acutelymphocyticallinadults/detailedguide/leukemia-acute-lymphocytic-what-is-all

15. Raabe GK, Wong O. Leukemia mortality by cell type in petroleum workers with potential exposure to benzene. Environ Health Perspect. 1996 Dec;104 Suppl 6:1381-92.

16. Rushton L, Romaniuk H. A case-control study to investigate the risk of leukaemia associated with exposure to benzene in petroleum marketing and distribution workers in the United Kingdom. Occup Environ Med. 1997 Mar;54(3):152-66.

17. Schnatter AR, Rosamilia K, Wojcik NC. Review of the literature on benzene exposure and leukemia subtypes. Chem Biol Interact. 2005 May 30;153-154:9-21.

18. American Cancer Society - Bile Duct (Cholangiocarcinoma) Cancer. What is Bile Duct Cancer? Topics. http://www.cancer.org/cancer/bileductcancer/detailedguide/bile-duct-cancer-what-is-bile-duct-cancer

19. Kumagai S, Kurumatani N, Arimoto A, Ichihara G. Short report - Cholangiocarcinoma among offset colour proof-printing workers exposed to 1,2-dichloropropane and/or dichloromethane. Occup Environ Med 2013;70:508-510

20. The Committee on Gulf War and Health of the Institutes of Medicine. National Research Council. Gulf War and Health: Volume 2. Insecticides and Solvents. Washington, DC. The National Academies Press, 2003

21. Cleveland Clinic. Diseases and Conditions - Pulmonary Nodules. http://my.clevelandclinic.org/disorders/pulmonary_nodules/hic_pulmonary_nodules.aspx

22.Ost D, Fein AM, Feinsilver SH. The Solitary Pulmonary Nodule. N Engl J Med 2003. 348: 2535-42

23. National Heart, Lung, Blood Institute at the National Institutes of Health. What is Asthma? Accessed at: http://www.nhlbi.nih.gov/health/health-topics/topics/asthma/

24. Seal KH, Daniel Bertenthal D, Miner CR, et al. Bringing the War Back Home Mental Health Disorders Among 103 788 US Veterans Returning From Iraq and Afghanistan Seen at Department of Veterans Affairs Facilities Arch Intern Med. 2007;167(5):476-482.

25 Pittman JOE, Goldsmith AA, Lemmer JA, et al. Post-traumatic stress disorder, depression, and health-related quality of life in OEF/OIF veterans. Quality of Life Research. Feb 2012; 21(1):99-103)

26. Hoge CW, Castro CA, Messer SC, et al. Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. The New England J of Med. 2004. 351(1), 13–22.

27. Tanielian T, Jaycox LH (Eds.). Invisible wounds of war: Psychological and cognitive injuries, their consequences, and services to assist recovery. Santa Monica, CA: Rand Corporation 2008.

28. VA Health Care Utilization Among Operation Enduring Freedom, Operation Iraqi Freedom, and Operation New Dawn Veterans. Cumulative from 1st Qtr FY 2002-1st Qtr FY 2014. Washington, DC, Department of Veterans Affairs, Veterans Health Administration, Office of Public Health, Released March 2014

29. American Psychological Association. Answers to Your Questions about Panic Disorders. http://www.apa.org/topics/anxiety/panic-disorder.aspx

30. Kessler RC, Chiu WT, Demler O, et al. Prevalence, Severity, and Comorbidity of Twelve-month DSM-IV Disorders in the National Comorbidity Survey Replication (NCS-R). Arch Gen Psychiatry. Jun 2005; 62(6): 617–627.

31. National Institute of Mental Health. Anxiety Disorder. http://www.nimh.nih.gov/health/publications/anxiety-disorders/index.shtml?ct=39988#pub1

32. Scales CD Jr1, Smith AC, Hanley JM, et al. Prevalence of kidney stones in the United States. Eur Urol. 2012 Jul;62(1):160-5

33. U.S. and World Population Clock. U.S. Census Bureau. Accessed on 5/28/2014 at 5:53 PM. Accessed at: http://www.census.gov/popclock/

34. Taylor EN, Stampfer MJ, Curhan GC. Obesity, weight gain, and the risk of kidney stones. JAMA.2005;293:455–62.

35. Taylor EN, Stampfer MJ, Curhan GC. Diabetes mellitus and the risk of nephrolithiasis. Kidney Int. 2005;68:1230–5.

36. Hau AK, Kwan TH, Li PK. Melamine Toxicity and the Kidney. J Am Soc Nephro. 2009; 20(2):245-250

37. Järup L and Elinder CG. Research Article: Incidence of renal stones among cadmium exposed battery workers. Br J Ind Med 1993;50:598-602

38. Järup L. Hazards of heavy metal contamination. Br Med Bull (2003) 68 (1): 167-182.

39. Friberg L. Health hazards in the manufacture of alkaline accu-mulators with special reference to chronic cadmium poisoning. Acta Med Scand. 1950; 138 (suppl 240), 1–154.

40. Ahlmark A, Axelsson B, Friberg L, et al. In: Proceedings of the 13th International Congress on Occupational Health, New York, 1960. 1961; pp. 201–203

41. Crohn's and Colitis Foundation of America. What is Crohn's Disease? http://www.ccfa.org/what-are-crohns-and-colitis/what-is-crohns-disease/

42. Mayo Clinic. Diseases and Conditions. Crohn's disease. http://www.mayoclinic.org/diseases-conditions/crohns-disease/basics/definition/con-20032061

43. National Digestive Diseases Information Clearinghouse (NDDIC), National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), National Institutes of Health (NIH). Crohn's Disease. http://digestive.niddk.nih.gov/ddiseases/pubs/crohns/

Deployment and Environmental Health Surveillance Investigation of 1/24 BN SBCT Mosul, Iraq 2004-2005, December 2014

44. The Committee on Gulf War and Health of the Institutes of Medicine. National Research Council. Gulf War and Health: Volume 2. Insecticides and Solvents. Washington, DC. The National Academies Press, 2003

45. Cooper GS, Makris SL, Nietert PJ, Jinot J. Evidence of Autoimmune-Related Effects of Trichloroethylene Exposure from Studies in Mice and Humans. Env Hlth Perspectives May 2009. 117;(5):696-702

Related References

Abhyankar A, Bhambure N, Kamath NN, et al. Six month follow up of 14 victims with short term exposure to chlorine gas. J Soc Occup 1989; Med 39:131–132.

Abraham JH, DeBakey SF, Reid L, et al. Does Deployment to Iraq and Afghanistan Affect Respiratory Health of US Military Personnel? JOEM 2012 June; 54(6):740-745

Agabitia N, Anconaa C, Forastierea F, et al. Short term respiratory effects of acute exposure to chlorine due to a swimming pool accident. Occup Environ Med 2001;58:399-404
Michigan Department of Community Health. Chlorine – Public Fact Sheet. Accessed at: http://www.michigan.gov/documents/Chlorine_factsheet_82357_7.pdf

Agency for Toxic Substances and Disease Registry (ATSDR). 2004. Toxicological profile for Ammonia. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

A l Smith B, Wong CA, Boyko EJ, et al. The Effects Of Exposure To Documented Open-Air Burn Pits On Respiratory Health Among Deployers Of The Millennium Cohort Study. JOEM 2012 June; 54(6):708-

Ammonia Solution (UN 3318); Ammonia Anhydrous (UN 1005) : Lung Damaging Agent. Accessed at http://www.cdc.gov/niosh/ershdb/EmergencyResponseCard_29750013.html:

Albatanony MA, El-Shafie MK. Work-related health effects among wastewater treatment plants workers. Int J Occup Environ Med. 2011 Oct;2(4):237-44.

August 28, 1995 correspondence from Ruth E. McCully, Director, Office of Health Enforcement, OSHA, to David L. Trimble, President, Milieu Systems Corporation. Accessed at: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21904

Centers for Disease Control and Prevention. Emergency Preparedness and Response. Facts about Chlorine. Accessed at: http://www.bt.cdc.gov/agent/chlorine/basics/facts.asp

Das R1, Blanc PD. Chlorine gas exposure and the lung: a review. Toxicol Ind Health. 1993 May-Jun; 9(3):439-55.

Deployment Health and Family Readiness Library. Chlorine gas exposure for Service Members. Accessed at: http://deploymenthealthlibrary.fhp.osd.mil/Product/RetrieveFile?prodId=300

Emmen HH, et al. Human safety and pharmacokinetics of the CFC alternative propellants. HFC 134a (1,1,1,2-tetrafluoroethane) and HFC 227 (1,1,1,2,3,3, 3-heptafluoropropane) following whole-body

exposure. Regul Toxicol Pharmacol. 2000 Aug;32(1):22-35.
(http://www.epa.gov/rpdweb00/docs/cleanup/402-r-06-011.pdf

General information about IEDs may be found at: http://www.history.navy.mil/library/online/ied.htm

Hasan FM, Gehshan A, Fuleihan FJ. Resolution of pulmonary dysfunction following acute chlorine exposure. Arch Environ Health 1983; 38:76–80.

Hines SE, et al. Pulmonary Health Effects in Gulf War I Service Members Exposed to Depleted Uranium. J Occup Environ Med. Volume 55, Number 8, August 2013, 937-944

Hodges SE, McCormick SJ. 2010. Fire extinguishing agents for protection of occupied spaces in military ground vehicles. NFPA SUPDET 2010
(http://www.nfpa.org/~/media/Files/Research/Research%20Foundation/foundation%20proceedings/fire_extinguishing_agents_for_protection_of_occupied_spaces_.pdf)

Kidde Fire Systems, Material Safety Data Sheet (MSDS), FM-200 (Fire Extinguishing Agent). Revision: February 9, 2012.

Indiana State Department of Health. Diseases Involving Sewage. Accessed at:
http://www.in.gov/isdh/22963.htm

Institute of Medicine 2011. *Long-Term Health Consequences of Exposure to Burn Pits in Iraq and Afghanistan* Washington, DC: The National Academies Press. Access online at:
http://books.nap.edu/openbook.php?record_id=13209&page=R2
or
http://www.iom.edu/Reports/2011/Long-Term-Health-Consequences-of-Exposure-to-Burn-Pits-in-Iraq-and-Afghanistan.aspx

Leroyer C, Malo JL, Infante-Rivard C, et al. Changes in airway function and bronchial responsiveness after acute occupational exposure to chlorine leading to treatment in a first aid unit. Occup Environ Med 1998; 55:356–359.

McDiarmid, MA, Gaitens, JM, Hines, S, et al. “The Gulf War Depleted Uranium Cohort at 20 Years: Bioassay Results and Novel Approaches to OTSG/MEDCOM Policy Memo 14-021, Medical Management of Army Personnel Exposed to Depleted Uranium

More Information on DU exposures can be accessed at:
Force Health Protection & Readiness (FHP&R), http://fhp.osd.mil/du/;
Deployment Health Clinical Center, http://www.pdhealth.mil/du.asp;
Veterans Administration,
http://www.warrelatedillness.va.gov/warrelatedillness/education/exposures/depleted-uranium.asp,

Morris MJ, Zacher LL, Jackson DA: Investigating the Respiratory Health of Deployed Military Personnel. Military Medicine, 2011 October; 176 (10) 1157-1168

N Abraham, J. H., A. Eick-Cost, et al. (2014). "A retrospective cohort study of military deployment and postdeployment medical encounters for respiratory conditions." Mil Med 179(5): 540-6.

National Pollutant Discharge Elimination System (NPDES), U.S. Department of Environmental Protection. Sanitary Sewer Overflows and Peak Flows - Frequently Asked Questions. Accessed at: http://cfpub.epa.gov/npdes/faqs.cfm?program_id=4#72

New York State Department of Health. The Facts About Ammonia. Technical Information. Accessed at: https://www.health.ny.gov/environmental/emergency/chemical_terrorism/ammonia Tech.htm

Ripple GR, Mundie TG. 1989. Medical Evaluation of Nonfragment Injury Effects in Armored Vehicle Live Fire Tests. Walter Reed Army Institute of Research. AD-A233 058.

Robin ML. Review of thermal decomposition product formation from halocarbon fire suppression agents: suppression of class A fires. West Lafayette, IN 1999. (http://www.nist.gov/el/fire_research/upload/R9902751.pdf)

Smith B, Wong CA, Smith TC, et al. Newly reported respiratory symptoms and conditions among military personnel deployed to Iraq and Afghanistan: a prospective population-based study. Am J Epidemiol. 2009;170:1433–1442.

Szema AM, Peters MC, Weissinger KM, et al. New-onset asthma among soldiers serving in Iraq and Afghanistan. Allergy and Asthma Proceedings 2010 Sep;31 (5):67-71

Szema AM, Salihi W, Savary K, et al. Respiratory Symptoms Necessitating Spirometry Among Soldiers With Iraq/Afghanistan War Lung Injury. JOEM 2011 September; 53(9): 960-965

Schneidermann A, Walters T. Letter to the Editor: Respiratory Symptoms Necessitating Spirometry Among Soldiers With Iraq/Afghanistan War Lung Injury JOEM 2011 December; 53(12): 1356-1357

U.S. DHHS, Public Health Service, Agency for Toxic Substances and Disease Registry. Public Health Statement: Uranium. Atlanta GA, February 2013. (http://www.atsdr.cdc.gov/ToxProfiles/tp150-c1-b.pdf

U.S. EPA, Office of Solid Waste and Emergency Response. Depleted Uranium Technical Brief, EPA 402-R-06-011. Washington, DC, December 2006. (http://www.epa.gov/rpdweb00/docs/cleanup/402-r-06-011.pdf)

White CW, Martin JG. Chlorine Gas Inhalation: Human clinical evidence of toxicity and experience in animal models. Proc Am Thor Soc 2010; July 1; 7(4):257-263

Appendix B

Acronym List

Acronyms

A – Apache

ADS – Ambulatory Data System

AFES - Automatic Fire Extinguishing Systems

AHLTA – Armed Forces Health Longitudinal Technology Application

AIDS – Acquired Immunodeficiency Syndrome

AIPH – Army Institute of Public Health

ALL - Acute Lymphoblastic Leukemia

ANSI - American National Standards Institute

AOR – Area of Operation

AR - Army Regulation

ASD (HA) – Assistant Secretary of Defense, Health Affairs

ATSDR - Agency for Toxic Substances and Disease Registry

B – Bulldog

BDC - Bile Duct Cancer

BN – Battalion

BUN – Blood Urea Nitrogen

C – Cobra

C2PC - Command & Control Personal Computer

CBRN - Chemical, Biological, Radiological, Nuclear

CD – Crohn's Disease

CDC – Center for Disease Control and Prevention

CENTCOM - U.S. Central Command

CHPPM - Center for Health Promotion and Preventive Medicine

CO – Carbon Monoxide

CO_2 – Carbon Dioxide

COCOM – Combatant Command

COPD - chronic obstruction pulmonary disease

CSH - Combat Support Hospital

CTS - Contingency Tracking System

DESP - Deployment Environmental Surveillance Program

DHSS - Defense Health Services Systems

DIA - Defense Intelligence Agency

DMDC – Defense Manpower Data Center

DoD - Department of Defense

DOEHRS - Defense Occupational and Environmental Health Readiness System

DU - Depleted Uranium

EH – Environmental Health

EMP - Environmental Medicine Program

EOD - Explosive Ordnance Disposal

ESIP – Environmental Surveillance Integration Program

FDA – Food and Drug Administration

FHP&R - Force Health Protection & Readiness

FL – Follicular Lymphoma

FOB - Forward Operating Base

FSS – Fire Suppression System

GI – Gastrointestinal

GIS - Geographic Information Systems

HAV - Hepatitis A Virus

HHC - Headquarter and Headquarters Command

HIV – Human Immunodeficiency Virus

HRCP - Health Risk Communication Program

IBD – Inflammatory Bowel Disease

IBS – Irritable Bowel Syndrome

IED - Improvised Explosive Device

IEEE - Institute of Electrical and Electronics Engineers

IH – Industrial Hygiene

IHA – Industrial Hazard Assessment

JBB – Joint Base Balad

JTTR – Joint Theater Trauma Registry

KE – Kinetic Energy

LOAEL - Lowest-Observed Adverse Effect Level

MEDCOM - U.S. Army Medical Command

MEGs - Military Exposure Guidelines

MESL – Military Exposure Surveillance Library

MHS - Military Health System

MIDB - Modernized Integrated Database

MPE – Maximum Permissible Exposure

MRAP - the Mine Resistant Ambush Protected

MSDS - Material Safety Data Sheet

MSR – Military Supply Route

MTBI - Mild Traumatic Brain Injury

MTF – Medical Treatment Facilities

NCI – National Cancer Institute

NDDIC - National Digestive Diseases Information Clearinghouse

NHL – Non-Hodgkin's Lymphoma

NIDDK – National Institute of Diabetes and Digestive and Kidney Diseases

NIH – National Institutes of Health

NIPRNET - Non-classified Internet Protocol Router Network

NO – Nitrogen Oxide

NO_2 – Nitrogen Dioxide

NPDES - National Pollutant Discharge Elimination System

OEF - Operation Enduring Freedom

OEHS - Occupational and Environmental Health Surveillance

OEHSA – Occupational and Environmental Health Site Assessment

OEM - occupational and environmental medicine

OIF - Operation Iraqi Freedom

OND - Operation New Dawn

OPTEMPO - Operational Tempo

OTSG - Office of The Surgeon General

PAH - Polycyclic Aromatic Hydrocarbon

PCB - Polychlorinated Biphenyl

PDHA - Post-Deployment Health Assessment

PDHRA - Post Deployment Health Assessment and Reassessment

PEL – Permissible Exposure Limit

PLMS – Periodic Leg Movements of Sleep

PM - Particulate Matter

POEMS - Periodic Occupational and Environmental Monitoring Summary

PTSD - Post-Traumatic Stress Disorder

RF – Radio Frequency

RH – Radiation Health

RLS- Restless Leg Syndrome

ROWPU - Reverse Osmosis Water Purification Unit

RTD – Return To Duty

SARS – Severe Acute Respiratory Syndrome

SBCT – Stryker Brigade Combat Team

SBIED - Suicide Bomber Improvised Explosive Device

SIGACTS - Significant Activities

SIPRNET - Secret Internet Protocol Router Network

SITREPS - Situation Report

SSN – Social Security Number

SVOC - Semivolatile Organic Compounds

TBI - Traumatic Brain Injury

TF - Task Force

TG - Technical Guide

UIC – Unit Identification Code

USAPHC – United States Army Public Health Command

VA - Veteran's Administration

VBIED - Vehicle Borne Improvised Explosive Device

VET – Veteran

VOC – Volatile Organic Compounds

WRIISCs - War-Related Illness and Injury Study Centers

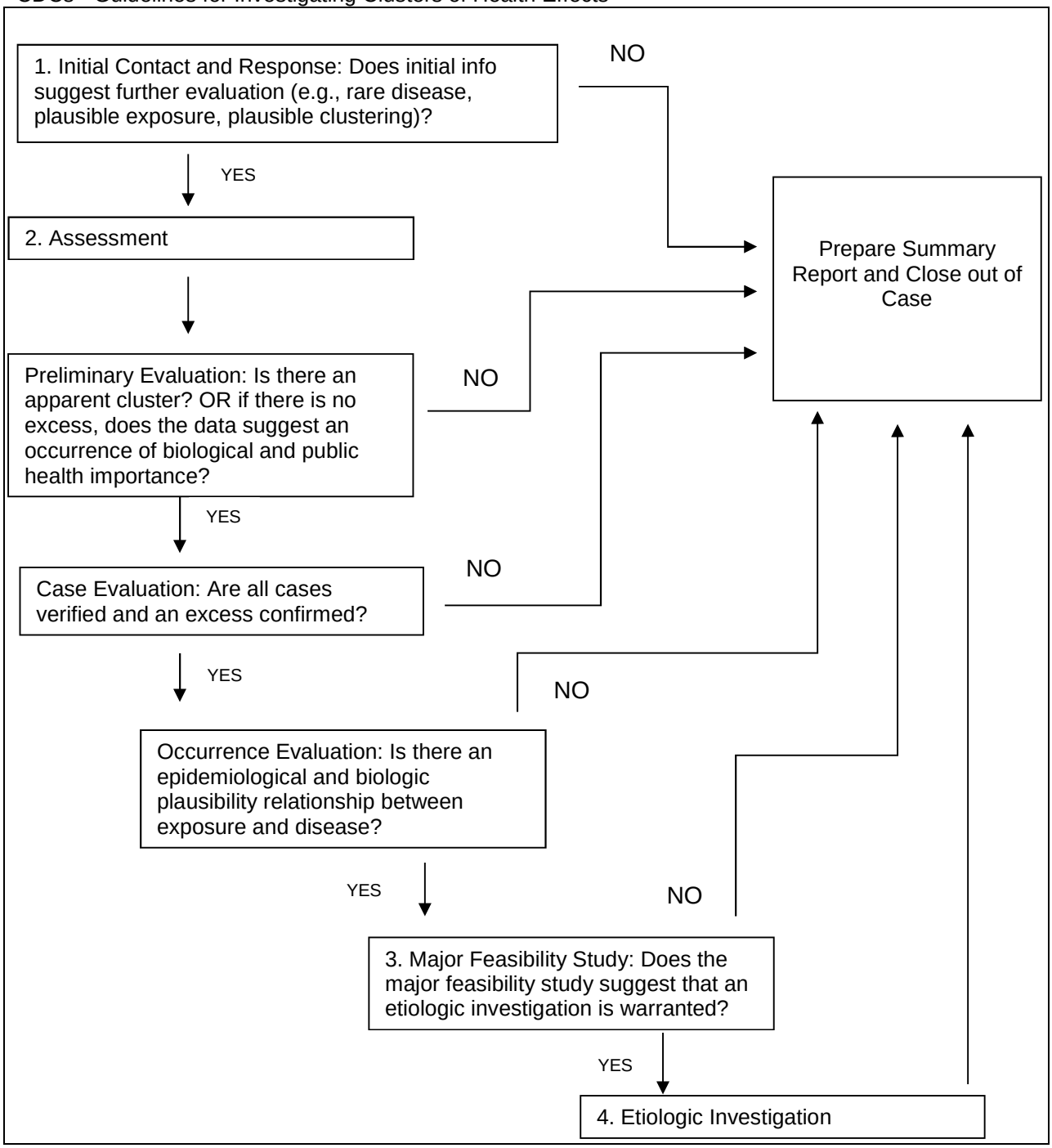
Zero-ODP - zero Ozone Depleting Potential

(U) Appendix C

Approach to Disease Cluster Assessment

Disease Clusters – USAPHC Environmental Medicine Program

This document was created for use by the USAPHC Environmental Medicine Program based on the CDCs "Guidelines for Investigating Clusters of Health Effects"



Introduction.

Army populations living on military installations and/or working in Army workplaces may perceive and be concerned about excess disease, such as cancer, in the population. They may also feel that the excess is likely due to some occupational or environmental exposure(s) related to past or present Army activities. Many times, they will bring their concerns up to leadership, management or other responsible parties. Local and/or regional installation and/or medical assets (such as safety, IH, PM, OEM) may or may not be engaged and respond, or attempt a response. At some point, if the concerned population is not satisfied with the response, or local assets are recognized as limited in personnel and/or expertise, USAPHC may be requested to investigate and respond to these concerns.

What are disease clusters?

A disease cluster "is the occurrence of a greater than expected number of cases of a particular cancer or disease within a group of people, a geographic area, or a period of time" (National Cancer Institute, 2006). For example, recent disease clusters have included: pneumonia among homosexual men in the 1980s, which led to the discovery of human immunodeficiency virus (HIV) and acquired immunodeficiency syndrome (AIDS); the 2003 outbreak of severe acute respiratory syndrome (SARS); and a 1960s cancer cluster linking asbestos exposure to mesothelioma (National Cancer Institute, 2006).

To determine if a disease outbreak is indeed a disease cluster, health officials must follow a methodology that distinguishes a statistically significant excess from the natural variability of disease occurrence. A methodology based on the CDC's "Guidelines for Investigating Clusters of Health Effects 1990" is presented below. When following these guidelines, however, the analysis of statistical significance will vary based on available data. If a disease outbreak is confirmed to be a statistically significant disease cluster, it may be appropriate to carry out etiologic and epidemiological studies to determine if there is a possible occupational/environmental exposure causing the disease.

A disease cluster may not always be the consequence of an environmental or occupational exposure. "The occurrence of a disease may be random, but the distribution may not be uniform, and clusters of disease may arise by chance alone" (NIOSH, 2009).

Why are disease clusters important?

Scientifically, true clusters are important because they contribute to the scientific wealth of knowledge necessary to understand and prevent disease. Many epidemiological studies have successfully shown a connection between an exposure and a disease or adverse health outcome in a population. For public health reasons, true clusters are important because when a true cluster is present and recognized, intervention may be possible to interdict the exposure or cause, or secondarily prevent disease. Perceptions of clusters are also important to the people who perceive them and must be addressed for this reason. Populations become alarmed when they either perceive an excess of an exposure, or an excess of disease. In the former, they fear the consequences of the exposure, and in the latter, they want to know the cause.

Cancer Clusters

Cancer is many diseases with a variety of causes and, in general, is common. What first appears to be a cancer cluster may not; a review of the situation may show that the number of new cancer cases is in the expected range for the population and therefore that the cases do not represent a cancer cluster. Cases are more likely to represent a cancer cluster if they involve: 1) one type of a cancer, 2) a rare type of

cancer, or 3) a type of cancer in a group not usually affected by that cancer, such as cancer in children that is normally seen in adults (CDC, 1990).

People who "converge" for part of their lives into a particular neighborhood or workplace may not necessarily develop cancer while at the neighborhood or workplace *because* of something in that neighborhood or workplace. There are many risk factors associated with the development of cancer that have nothing to do with occupational/environmental exposures, such as age, gender, race, family genetics/history, and lifestyle decisions (e.g., tobacco/alcohol use, nutrition, physical inactivity, obesity), or exposures that occurred at some past point in their lives.

The primary public health purpose of investigating reports of excess cancer in workplaces is to identify and control the cause. Objectives of an investigation should be to answer the following questions: Is there an actual excess of cases? Are cases occurring independently or are they related? Are there any occupational factors that might be part of the causal pathway?

Epidemiologists must also determine if the cancer cases could have occurred by chance. They often test for "statistical significance," which is a mathematical measure of the difference between groups. The difference is said to be statistically significant if it is greater than what would be expected to happen by chance alone. In common practice, a statistically significant finding means that the probability that the observed number of cases could have happened by chance alone is 5% or less. For instance, if one examines the number of cancer cases in 100 neighborhoods, and cancer cases are occurring by chance alone, one should expect to find about 5 neighborhoods with a statistically significant elevation in the number of cancer cases. In other words, some amount of clustering within the same family or neighborhood may occur simply by chance. (NCI, 2006)

What are the difficulties in determining whether or not a disease cluster exists?

Accurately defining the group of people who should be considered at risk is important when investigating a possible cancer cluster. One of the greatest problems in defining clusters is the tendency to expand the geographic borders of the cluster to include additional cases of the suspected disease as they are discovered. The tendency to define the borders of a cluster on the basis of where known cases are located, rather than to first define the population and geographic area and then determine if the number of cancers is excessive, creates 'clusters' that are not real. (NCI, 2006)

Among the pitfalls epidemiologists face in determining whether a cluster exists, is defining the numerator and denominator when determining the rate in the population of concern; migration in and out of the area over time; ascertainment differences; and determining comparable background rates. The numerator cases counted will ultimately depend on the "case definition" of the disease(s) of concern which must be clear and consistent.

Determining the denominator can be much more problematic. Denominators should truly be determined by a commonality of exposure, but more often are defined by a geographic area where the cases are located. There should be a biological, as opposed to statistical definition of a cluster, as "a geographically and/or temporally bounded group of occurrences related to each other through some social or biological mechanism, or having a common relationship with some other event or circumstance." However, this is rarely the case at the small population (e.g., neighborhood) level, where, when examining a single cluster, the boundaries are often ill-defined, and the dimension (geographic, occupational) is rarely obvious. A major pitfall for epidemiologists is defining a denominator for a perceived cluster by what has already been recognized. Suspicion of a cluster often begins with the identification of a group of cases, and only after is the underlying population from which the cases arose defined.

This pre-selection bias can shape the outcome of the investigation. There is an inherent danger of overestimating the disease rate through "boundary shrinkage" of the population from which the cases are assumed to have arisen or to extend the geographic borders of the cluster to include additional cases of the suspected disease as they are discovered. There is also a tendency to include all the years in which cases were reported, thereby maximizing and magnifying any effect which may be present. "Perceived cluster" analyses end up being done "post hoc", and not as a result of a prior hypothesis. It is difficult to apply statistical procedures without a clear hypothesis in advance. The tendency to define the borders of a cluster on the basis of where known cases are located, rather than to first define the population and then determine if the number of cancers is excessive, creates many "clusters" which are not genuine.

Further issues are those of migration, latency, differential ascertainment, and comparison rates. Migration into or out of the area over time – both of the well and the ill - can affect case finding for numerator cases or determining the denominator in a particular neighborhood or workplace. Examples are change of residences, discharge from the military, or leaving work due to illness. This can lead to data collection problems such as having difficulty identifying other previous exposures; and difficulty in finding the records on alleged cases of cancer/disease

Differential ascertainment of data can lead to difficulties comparing an "exposed" population rate with a background or control rate. Ideally, ascertainment of data should be the same between the concerned population and the comparison population. Pitfalls such as this which are classic issues with epidemiological investigations in general, can be much more problematic in a cluster investigation for a small population. For example, if interviews are conducted with the concerned population, information must be ascertained from a control population by interview and not medical record review.

Variance and large confidence intervals in small populations

A major issue in applying statistical tests to small populations in cluster investigations is that of variance and large confidence intervals. In small populations, a rate of disease can vary greatly and each case can swing the rate widely. A high rate at any particular point in time may be due purely to this local variation in a small population. As another side of this issue, a calculated rate will be accompanied by large confidence intervals which may well overlap those of the comparison population. Therefore, it can be very difficult to show, and have confidence in, a statistical excess rate in a small population. Over the course of time, and with increasing data points, this wide variation in rate, especially if there appears to be an excess at a particular point in time, would be expected to regress back to the true rate and become less variable. This is one reason why health departments, and others investigating a cluster, may opt to continue surveillance in the population for a time, rather that judge the existence of a cluster, when the results are too uncertain.

When Results of the Investigation are Positive: Randomness and Clustering, and Chance

When a "cluster" is determined statistically by an investigation, even if well done, there is still the likely explanation that it was a chance occurrence and not a true cluster. Because of this and the likelihood of many of the pitfalls discussed above, the results of cluster investigations are often not fruitful. NCI and CDC state that confirmation of a cluster doesn't necessarily mean that there is any single, external cause or hazard that can be addressed. It may be the results of chance, miscalculation of the expected number of cases (e.g., not considering a risk factor within the population at risk), or differences in the case definition between observed cases and expected cases, known risk factors for cancer (e.g., smoking), or unknown risk factors for cancer.

The NIOSH website observes that the cases of cancer in a cluster may have a common etiology or may be the coincidental occurrence of unrelated causes. Although the occurrence of a disease may be

random, the distribution of that disease may not be uniform, and clusters of disease may arise by chance alone. Disease or tumor rates are very variable in small populations and rarely match the overall rate for a larger area such as the State, so that for any given time period some populations have rates above the overall rate and others have rates below. Even when there is an excess, this may be completely consistent with the expected random variability. Statistical significance states that there is a 5% or less chance that the observed number of cases could have happened by chance. However, ATSDR notes that: “unusual events such as clusters occur all the time, especially in large populations…When first noticed, such clusters are often regarded as resulting from some specific predictable process, rather than as events with independent causes that happen to have occurred by chance in one particular place (such as a coin toss).”

Thun and Sinks believe that despite the value of statistical testing, chance remains the most plausible explanation for many confirmed cancer clusters, especially that involve common types of cancer or all cancers combined. Spatial clustering of cancer is inevitable. The fact that boundaries of a suspected cluster are defined based on when and where the cases actually occurred increases the likelihood that random variation will appear to give rise to clusters.

Investigating Disease Clusters

This section outlines a four stage approach for managing and reporting a cluster; from original contact to final disposition. The section does not speak directly to the particular outcome of concern (e.g., cancer or birth defects), to the types of data available (e.g., mortality, hospital, discharge, or disease registries), or to the specific analytic techniques (see section 4 and appendix). Usually these particulars will be determined by local resources and circumstances. The four stages may be viewed as a series of filters that provide appropriate responses to the reported problem. An assessment of feasibility should be made before the actual study is begun, and the issue of increased frequency of occurrence should be separated from the issue of potential etiologies. (MMWR 1990)

Once the decision has been made to proceed with an assessment, an important step is to separate two concurrent issues: whether an excess has actually occurred and whether that excess can be linked etiologically to some exposure. The first issue usually has precedence and it may or may not lead to the second. (MMWR 1990)

A methodology for investigating disease clusters was put forth by the CDC (Guidelines for investigating Clusters of Health Effects, 1990). This guidance presents a four step process: 1) an initial response, 2) an assessment, 3) a major feasibility study, and 4) an etiologic investigation. Initial contact and response includes getting the initial information from the concerned people and other knowledgeable sources. Assessment includes analyzing the initial information to determine if there are indications to move on to more extensive study. A major feasibility study is a formal scientific process for design of an epidemiologic investigation to address the community concerns. An etiologic investigation is a scientific investigation of the causes of a disease cluster, using epidemiological methods. For a study of any perceived disease cluster, there is an additional set of technical criteria for determining when detailed epidemiological investigation beyond the initial response and assessment phase is indicated

The CDC states that in many instances, the health agency will not be able to demonstrate an excess of the condition in question or establish an etiologic linkage to an exposure. Nevertheless, a systematic, integrated approach is needed for responding to reports of clusters. Besides the purely epidemiologic and statistical expertise needed, there are social dimensions. The protocol involves four stages and each provides opportunities for collecting data and making decisions. This is a systematic plan with points at which the decision may be made to either terminate or continue the investigation. (See flow chart)

These stages are a series of filters that provide appropriate responses to the reported problem. An assessment of feasibility should be made before the actual study begins and the issue of finding if there is an increased frequency of occurrence (of the health event) should be separated from the issue of if there are potential etiologies (e.g. exposures).

1. Initial Contact and Response. This is the best educational opportunity for communication with the caller about the nature of clusters. Collect identifying information from the persons or groups first reporting a perceived cluster: name, address, telephone #, organization affiliation, if any. Follow-up with data on the potential cluster: the suspected health event(s), the suspected exposure(s), the number of cases, the geographic area of concern, the time period of concern, how the caller learned about the cluster. It is important to collect identifying information on the persons affected (that the informant is aware of – they should not be sent out to find new cases): name, sex, age (or birthdate, age at diagnosis), occupation, race, the disease outcome or diagnosis for each case being reported [if cancer, which site(s)] , vital status of the cases, date of diagnosis, date of death, address (or approximate geographic location), telephone #, length of time in residence at the site, contact person (family, friend) and method for contact. If the initial contact suggests further evaluation is needed (for example, a single and rare disease entity, plausible exposure, plausible clustering), proceed to stage 2.

2. Assessment. Again, the issue of an excess of a health event should be separate from whether it can be linked etiologically with an exposure.

a. Preliminary evaluation – assess quickly from available data whether an excess may have occurred, assuming all the cases reported are real. Look at the observed vs expected rate (reference population and denominator issues), geographic area, time and latency periods. Outcome: if there is a possible excess, go to 2b. If not, make a judgment whether to stop here or not (depending on if the data suggest biological and public health importance). Respond to the stakeholder (s) with findings if not proceeding.

b. Case evaluation –Assure that a biological basis exists for further work, and verify the diagnosis (contact the cases or family, HCP, pathology reports, registries, etc.). Outcome: if the cases are verified and there appears to be an excess, go to 2c. If excess is not substantiated, make a judgment to stop here or not (depending on if there is biological plausibility and if the data is suggestive). Respond to the stakeholder with findings, if not proceeding.

c. Occurrence evaluation – Determine if an excess has occurred and to describe the epidemiological characteristics. Determine the “boundaries” and consider applying statistical and epidemiological procedures for analysis. It is also a time, if needed, to review the scientific literature. Assess the likelihood that an event-exposure relationship may be established. Assess stakeholder perceptions, reactions and needs. Outcome: if an excess of a health event is confirmed and it appears epidemiologically and biologically plausible (“compelling”), proceed. If the excess is confirmed but there is no link to an exposure, terminate the investigation and explain to the stakeholder(s). If there is no excess, terminate and report findings to the stakeholders.

3. Major Feasibility Study: Determine the feasibility of performing an epidemiological study linking the health event and a putative exposure. Outcome: if warranted, go to stage 4; if little is to be gained by etiologic investigation, summarize and report to concerned parties.

4. Etiologic investigation: attempt to establish a potential disease- (or injury-) exposure relationship. Investigate the epidemiological and public health issues that the cluster generated (as opposed to the specific cluster). This is should be a standard epidemiological study. Develop a protocol and implement

the study. The outcome is expected to contribute to epidemiological and public health knowledge that an association does or does not exist, or confirmation of previous findings.

(NCI - National Cancer Institute, 2006): http://www.cancer.gov/cancertopics/factsheet/Risk/clusters

(NIOSH, 2009): http://www.cdc.gov/niosh/topics/cancer/

(CDC): http://www.cdc.gov/nceh/clusters/about.htm

(MMWR 1990): Guidelines for Investigating Clusters of Health Events, MMWR, 39 (RR-11); 1-16 07/27/1990; http://wonder.cdc.gov/wonder/prevguid/m0001797/m0001797.asp

STAT APPENDIX TO MMWR 1990: Guidelines for Investigation Clusters of Health Events – APPENDIX. Summary of Methods for Statistically Assessing Clusters of Health Events; http://www.cdc.gov/mmwr/preview/mmwrhtml/00001798.htm

Michigan Department of Community Health: Chemical Illness Response- Guidelines for Public Health Investigations of Acute Onset Illness Clusters for Chemical Etiology. September 28, 2007.

http://www.michigan.gov/documents/mdch/Chemical_Illness_Response_final_210418_7

Sharkey JM, Hauschild VD. Addressing Cancer Clusters in the US Army. Army Med Dept J. April-June 2013:31-34.

(U) Appendix D

Meteorological Data and Wind Patterns for Mosul

Meteorological Data and Wind Patterns for Mosul

Atmospheric conditions, governed by meteorological factors, have a crucial influence on the dispersion of air pollutants released from industrial operations. Dispersion is predominately affected by three main factors; the topography and characteristics of the land surface, atmospheric stability and inversions, and wind speed and direction.

Mosul, Iraq is a city on the banks of the Tigris River about 148 km northwest of Kirkuk, and 350 km northwest of Baghdad. Mosul is situated between the Taurus Mountain Range to its north and the Zagreb Mountain Range to its east. These mountains generally dampen the overall wind flow in the area resulting in calm conditions most of the year. When prevailing winds are evident they are generally from the north northwest year round. These winds are often referred to as Shamals. Shamals result from strong northwest winds that are funneled into the Persian Gulf by the mountains of Turkey and Iraq to the northeast and the high plains of Saudi Arabia to the southwest. The winds are generally strongest in the spring and summer. During the summer months the polar jet stream to the north moves southward and becomes close to the subtropical jet to the south. The proximity of these two jet streams promotes the formation of strong fronts which help create the Shamal. Shamals normally last about three to five days at a time. The result of this strong wind in the desert like region of Mosul is severe dust or sandstorms. Therefore, contaminants in the sand can become airborne and may result in an inhalation exposure.

To assist with the understanding of wind direction with respect to living areas on the basecamp/forward operating locations and industrial facilities, burn pits, etc., historical meteorological data that includes wind speed and wind direction are used to generate a wind rose. The wind rose is a graphical tool that can be used to provide a succinct view of how wind speed and direction are typically distributed for an identified timeframe for a particular location. The length of each spoke around the circle is related to the frequency the wind emanates (i.e., blows from) a particular direction. The color coded spokes show the wind speed ranges with each color corresponding to an average wind speed range. There is a meteorological station at the airfield in Mosul (Station # ORBM). Figure D-1 depicts the annual wind rose for the Mosul Airfield. Mosul has a predominant north northwest wind direction year round based on the historical data. See Table 1 for meteorological information for Mosul in tabular form (reference 1). Meteorological data from January 1973 through August 2011 was used in developing the wind rose and data from January 2004 through July 2012 was used in developing this Table. Since industrial facilities are scattered throughout Mosul and the airfield is on the southeastern side of Mosul, any release to the northwest of basecamps/forward operations could result in higher concentrations of contaminants (or would result in potential exposure to the base camp of the emissions).

Table D-1. Monthly Climatological Averages for Mosul, Iraq (reference D-1)

UNCLASSIFIED												
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Average High Degree Fahrenheit (°F)	55	59	69	79	NA	104	110	109	100	87	69	60
Average Low (°F)	37	41	47	55	NA	77	82	81	72	62	47	39
Average Precipitation inches (in)	2.5	2.7	2.4	2.1	0.8	Trace	Trace	Trace	Trace	0.4	1.7	2.4
Prevailing Wind Direction	NNW	NNW	NNW	NNW	NNW	NNW	NNW	NNW	NNW	NNW	NNW	NNW
Mean Wind Speed (KTS)	3.1	3.3	3.7	4.5	5.1	5.6	5.2	5.2	3.9	3.1	2.5	2.5

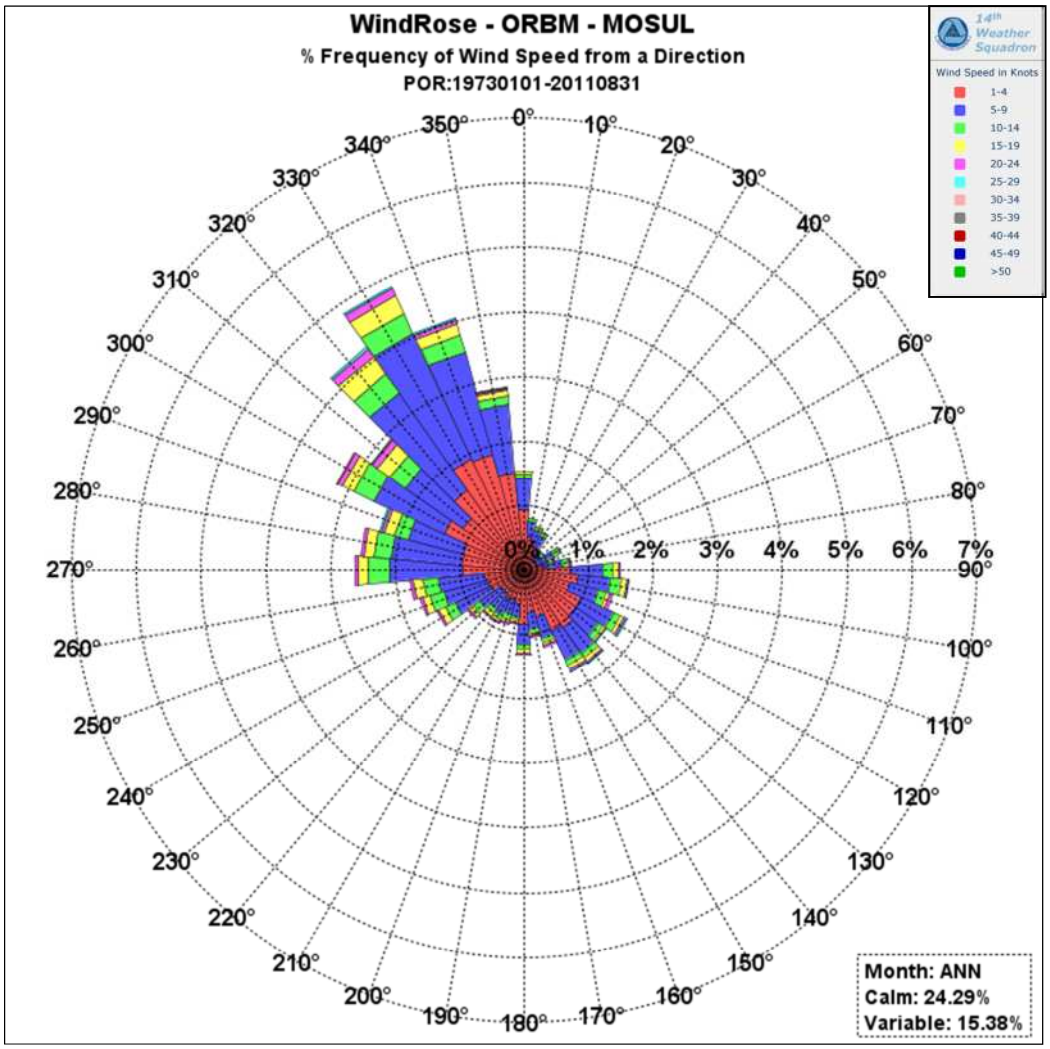


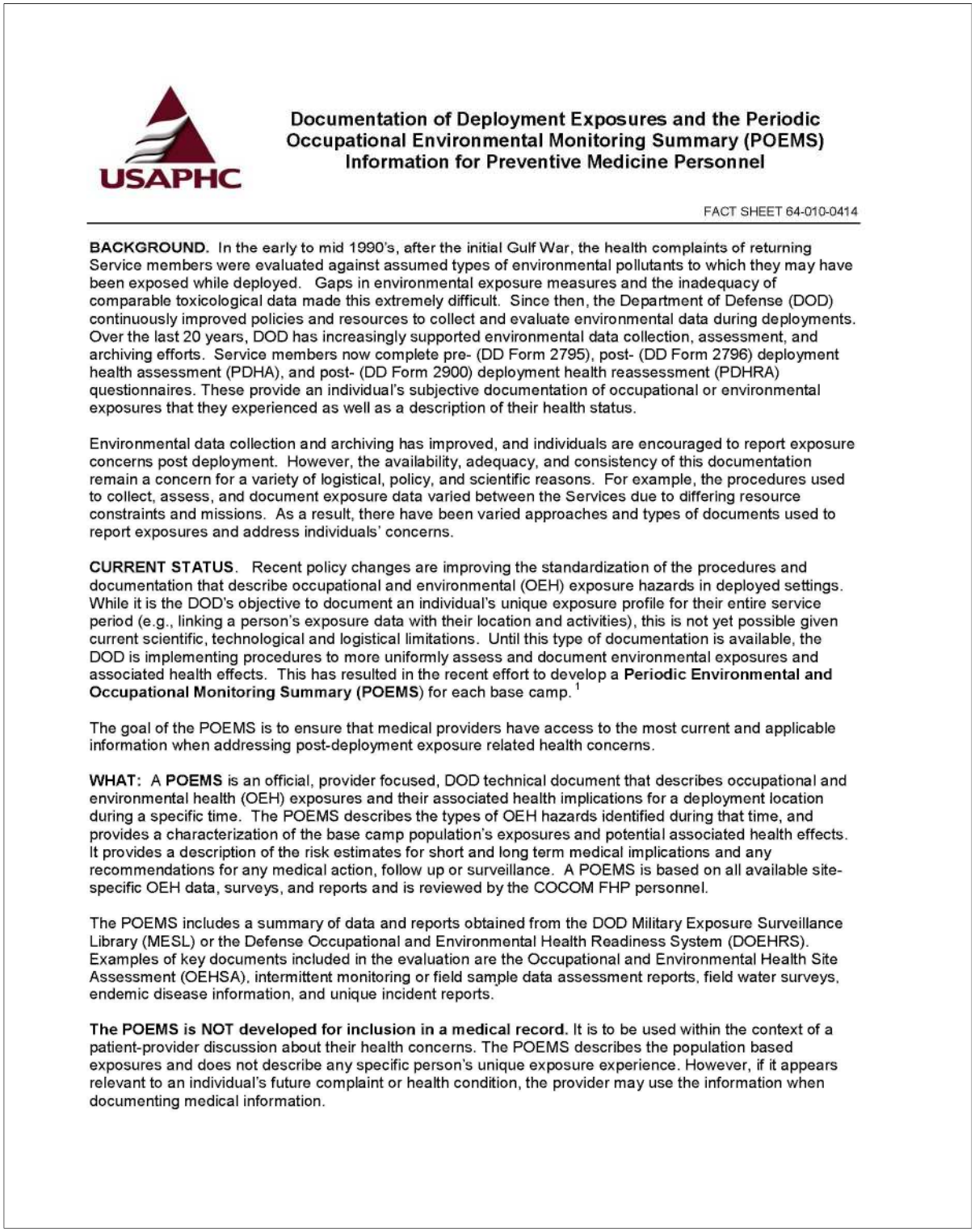
Figure D-1. Annual Wind Rose for Mosul, Iraq (reference 1)

References:

D-1. (U) Climate Services, 14th Weather Squadron, Mosul, Iraq, https://notus2.afccc.af.mil/SCIS/prodloc.asp (accessed 24 March 2014)

Appendix E

Poems Factsheet and How to Request a Poems



USAPHC

Documentation of Deployment Exposures and the Periodic Occupational Environmental Monitoring Summary (POEMS) Information for Preventive Medicine Personnel

FACT SHEET 64-010-0414

BACKGROUND. In the early to mid 1990's, after the initial Gulf War, the health complaints of returning Service members were evaluated against assumed types of environmental pollutants to which they may have been exposed while deployed. Gaps in environmental exposure measures and the inadequacy of comparable toxicological data made this extremely difficult. Since then, the Department of Defense (DOD) continuously improved policies and resources to collect and evaluate environmental data during deployments. Over the last 20 years, DOD has increasingly supported environmental data collection, assessment, and archiving efforts. Service members now complete pre- (DD Form 2795), post- (DD Form 2796) deployment health assessment (PDHA), and post- (DD Form 2900) deployment health reassessment (PDHRA) questionnaires. These provide an individual's subjective documentation of occupational or environmental exposures that they experienced as well as a description of their health status.

Environmental data collection and archiving has improved, and individuals are encouraged to report exposure concerns post deployment. However, the availability, adequacy, and consistency of this documentation remain a concern for a variety of logistical, policy, and scientific reasons. For example, the procedures used to collect, assess, and document exposure data varied between the Services due to differing resource constraints and missions. As a result, there have been varied approaches and types of documents used to report exposures and address individuals' concerns.

CURRENT STATUS. Recent policy changes are improving the standardization of the procedures and documentation that describe occupational and environmental (OEH) exposure hazards in deployed settings. While it is the DOD's objective to document an individual's unique exposure profile for their entire service period (e.g., linking a person's exposure data with their location and activities), this is not yet possible given current scientific, technological and logistical limitations. Until this type of documentation is available, the DOD is implementing procedures to more uniformly assess and document environmental exposures and associated health effects. This has resulted in the recent effort to develop a **Periodic Environmental and Occupational Monitoring Summary (POEMS)** for each base camp. [1]

The goal of the POEMS is to ensure that medical providers have access to the most current and applicable information when addressing post-deployment exposure related health concerns.

WHAT: A **POEMS** is an official, provider focused, DOD technical document that describes occupational and environmental health (OEH) exposures and their associated health implications for a deployment location during a specific time. The POEMS describes the types of OEH hazards identified during that time, and provides a characterization of the base camp population's exposures and potential associated health effects. It provides a description of the risk estimates for short and long term medical implications and any recommendations for any medical action, follow up or surveillance. A POEMS is based on all available site-specific OEH data, surveys, and reports and is reviewed by the COCOM FHP personnel.

The POEMS includes a summary of data and reports obtained from the DOD Military Exposure Surveillance Library (MESL) or the Defense Occupational and Environmental Health Readiness System (DOEHRS). Examples of key documents included in the evaluation are the Occupational and Environmental Health Site Assessment (OEHSA), intermittent monitoring or field sample data assessment reports, field water surveys, endemic disease information, and unique incident reports.

The POEMS is NOT developed for inclusion in a medical record. It is to be used within the context of a patient-provider discussion about their health concerns. The POEMS describes the population based exposures and does not describe any specific person's unique exposure experience. However, if it appears relevant to an individual's future complaint or health condition, the provider may use the information when documenting medical information.

Figure E-1. POEMS Information

The POEMS is NOT a medical disability document. Determinations regarding disability are based on an individual's specific disease or condition as diagnosed by a medical provider and the determination of an established medical review board.

WHY (REQUIREMENT): A POEMS provides a health care provider or returning deployed Service Member an official summary of what is known about OEH exposures at a particular location. The POEMS addresses the requirements of DoD Instructions (DoDIs) 6490.03, 6055.05, and the Joint Chiefs of Staff Memorandum MCM 0028-07 ** "*to ensure that appropriate environmental exposure information is available should Service Members as well or their providers have exposure-related concerns (such as those that might be documented on PDHA).*" [2-4]

WHO (AUDIENCE): POEMS are developed as a resource for Medical Providers and available for Service Members (Active duty, NG, and RC), Veterans and retirees.

RESPONSIBLE PARTIES AND PROCESS: POEMS are the responsibility of the COCOM but usually produced at the Service health surveillance centers such as the Army Public Health Center, Air Force School of Aerospace Medicine or the Navy and Marine Corps Public Health Center. They are reviewed by an Occupational and Environmental Medicine Physician and approved by the COCOM Force Health Protection (FHP) officer.

ACCESS/AVAILABILITY: Personnel with deployment-related exposure concerns and their health care providers can request a POEMS from USAPHC. Service members can submit a request at the "Request USAPHC Services" web link at https://usaphcapps.amedd.army.mil/MSRV/ServiceRequest.aspx. Select "POEMS" from the category list. Providers who are not in the DOD or VA health care systems should also use this process to request a POEMS.

DOD and VA medical staff may get direct access to all of the available POEMS at the Military Exposure Surveillance Library at https://mesl.apgea.army.mil/mesl/. POEMS are available as they are produced and currently available for many of the large troop locations in Iraq and Afghanistan. More recent time periods may not be available but are in the production process. Other hazard-specific or unique incident information may also be available to DOD and VA providers on the MESL (e.g., fact sheets describing the sulfur fire incident of 2003[7], or medical concerns regarding burn pits [8]).

References:

1 The Periodic Occupational and Environmental Monitoring Summary (POEMS)—History, Intent, and Relationship to Individual Exposures and Health Outcomes; Technical Information Paper No. 64-002-0909 (Dec 2009).
2 Department of Defense (DoD) Instructions 6490.03, Deployment Health, 2006.
3 Department of Defense (DoD) Instruction, 6055.05, Occupational and Environmental Health, 2008.
4 Chairman's Memorandum (MCM) 0028-07, *Procedures for Deployment Health Surveillance,* 2007.
5 CENTCOM Regulation 220-1: Deployment Health Deployment Health Surveillance and Force Health Protection (Feb 2012).
6 Military Deployment Periodic Occupational and Environmental Monitoring Summary; for Sea Port of Debarkation/Embarkation (SPOD/E), Shuaiba Port, Kuwait; 11 June 2009.
7 USACHPPM Factsheet 64-007-0707; Health Assessment of Al Mishraq Sulfur Fire Incident Status as of 1 July 2007.
8 USAPHC (Prov) Factsheet Medical Concerns Regarding Use of Burn Pits to Dispose of Solid Waste, April 2010.

* *While these other documents may describe exposures and health risks in some fashion, they do not represent the final overall site assessment of health effects or medical implications as described by the POEMS. Inconsistencies are possible, as these other documents are limited in scope (time, location, and context). Concerns should be staffed through the COCOM FHP officer.*

** *The POEMS satisfies the DoDI 6490.03 requirement to prepare "periodic occupational and environmental monitoring summaries on an SF 600 for each permanent or semi-permanent basing location." This clarification is being made to a future DODI revision. In the interim, use of POEMS to replace the use of SF600s for documentation of this type of information in individual's medical records is specified for CENTCOM in a Feb 2010 CENTCOM Force Health Protection regulation.* [5]

If you have questions regarding this document please contact:
U.S. Army Public Health Command, Environmental Medicine Program,
DSN 584-2714; COMM 410-436-2714; or email usarmy.apg.medcom-phc.mbx.emp@mail.mil
or the Environmental Health Risk Assessment Program
DSN 584-2953; COMM 410-436-2953; or email to USAPHC-EHRAP@amedd.army.mil
5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5403

Figure E-1. POEMS Information

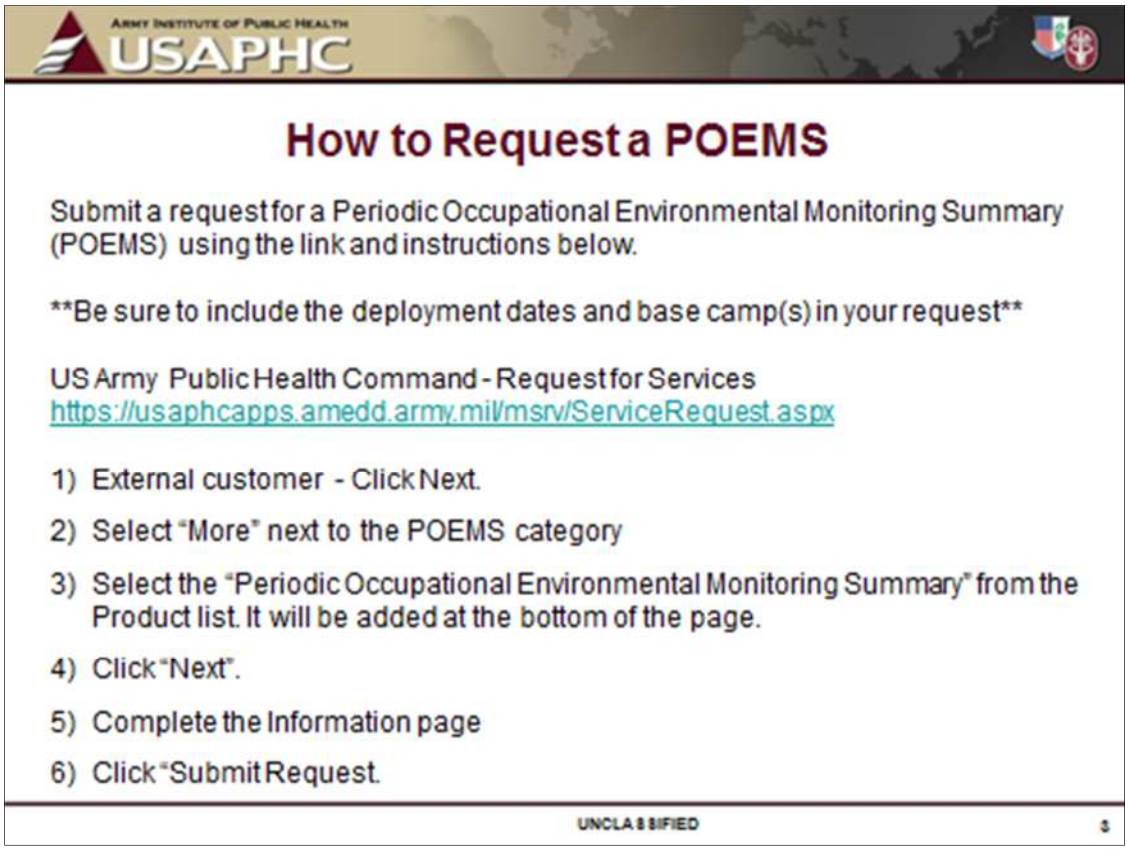


Figure E-2. How to Request POEMS

POEMS documents are available by contacting the applicable Service Surveillance Center for most pertinent documentation [U.S. Army Public Health Command (USAPHC) (800) 222-9698; Navy and Marine Corps Public Health Center (NMCPHC) Phone: (757)953-0700; U.S. Air Force School of Aerospace Medicine (USAFSAM) Phone: (888) 232-3764].

ACCESS/AVAILABILITY:
Personnel with deployment-related exposure concerns and their health care providers can request a POEMS from USAPHC. Service Members can submit a request at the "Request USAPHC Services" web link at https://usaphcapps.amedd.army.mil/MSRV/ServiceRequest.aspx. Select "POEMS" from the category list. Providers who are not in the DoD or VA health care systems should also use this process to request a POEMS. Service Members, Veterans, and DoD and VA medical staff may get direct access to all of the available POEMS at the Military Exposure Surveillance Library at https://mesl.apgea.army.mil/mesl/. POEMS are available as they are produced and currently available for many of the large troop locations in Iraq and Afghanistan. More recent time periods may not be available but are in the production process.

Appendix F

Discussion on Post Deployment Health Assessment and Reassessment forms

Post Deployment Health Assessment and Reassessment

Reported exposure concerns and potential exposures were identified following a review of all classified and unclassified information, telephone interviews and review of the Post Deployment Health Assessment (PDHA) and Reassessment (PDHRA) forms. The PDHA was instituted in April 2003. The PDHRA was mandated in March 2005. DoD Instruction 6490.03 and Health Affairs Policy 05-011 describe these post-deployment health activities.

One of the purposes for the Post Deployment Health Assessment is to identify occupational and environmental exposures and to provide a forum for discussion of deployment-related health concerns with medical providers. The questionnaire could be completed during in-theater medical out-processing or within 30 days after redeployment. Designed to identify health concerns that emerged over time since the end of deployment or to capture and address persistent health concerns that Service Members were reluctant to report immediately following redeployment, the PDHRA should be completed by all Service Members 90-180 days after deployment.

For the PDHA and PDHRA, we obtained a roster of those individuals associated with the UIC for the 1/24 BN SBCT as described in Section 7.2.4. There were 593 individuals with SSNs on this roster. As noted, the rosters were not complete and some of the individuals who came forward to be interviewed were not on the roster of personnel associated with the UIC. Social security numbers for medical data collection were available only for those who were listed on the roster. However, as a hypothesis generating step, in addition to interviews, we reviewed the Post-Deployment Health Assessments (PDHA; DD Form 2796) and the Post-Deployment Health Reassessments (PDHRA, DD Form 2900) of those associated with the UIC to identify exposure concerns identified when unit members redeployed in 2005 from the deployment of interest. This was done with the awareness that although the interviewees came from the larger UIC, they may not be representative of the larger UIC and findings from the UIC may not align with the smaller group of those interviewed. As stated, there were 593 individuals assigned to this UIC as compared to an approximate 25 in the platoon, and fourteen individuals interviewed regarding their health and exposure concerns. This includes two Soldiers' spouses who were interviewed as proxy although one Soldier was subsequently interviewed directly and this was combined with his wife's interview to count as one. The fifteenth contact was the unit surgeon at the time but he was not queried regarding personal health issues.

Post-Deployment Health Assessments (PDHAs)

A total of 593 social security numbers were assigned to the UIC. Post-Deployment Health Assessments (PDHA; DD Form 2796) were obtained from the Armed Forces Health Surveillance Center and reviewed. For the deployment of interest, Service Members identified the following exposures during deployment as occurring "sometimes" or "often":

Table G-1 lists the self-reported exposures in the order found on the questionnaire. The percentage of individuals who answered "sometimes" or "often" combined, in rank order follows. As might be expected, the most frequently reported exposure was sand/dust, which is ubiquitous in theatre (89%), followed by smoke from burning trash or feces (83.5%), loud noises (83.3%), vehicle or truck exhaust fumes (79.1%), JP-8 or other fuels (69.6%), industrial pollution (39%), excessive vibration (38.9%), smoke from oil fire (34.5%), radar/microwaves and lasers (16.7%), tent heater smoke (15.4%), paints (14.8%), solvents

(14.7%), environmental pesticides (14.5%), fog oil (8.3%), “other exposures” (1.3%), ionizing radiation (1%), and depleted uranium (0.8%)

More than half (313/593, 52.8%) of the questionnaires reviewed had a positive response to the following item: “Were you in or did you enter or closely inspect any destroyed military vehicles?” When asked, “Do you think you were exposed to any chemical, biological, or radiological warfare agents during this deployment?” one Service member (0.2%) responded yes, while 139 (23.4%) responded don’t know. During the healthcare provider interview section of the PDHA, 18% (104/592) of Service Members said they had concerns about possible exposures or events during this deployment that they felt may affect their health.

Table F-1. Identified Post Deployment Health Assessments

	Sometimes		Often	
	n=593			
Concern	Count	Percent	Count	Percent
environmental pesticides	69	11.6%	17	2.9%
smoke from oil fire	158	26.6%	47	7.9%
smoke from burning trash or feces	231	39.0%	264	44.5%
vehicle or truck exhaust fumes	182	30.7%	287	48.4%
tent heater smoke	73	12.3%	20	3.4%
JP8 or other fuels	194	32.7%	219	36.9%
fog oils	39	6.6%	10	1.7%
solvents	61	10.3%	26	4.4%
paints	79	13.3%	9	1.5%
ionizing radiation	5	0.8%	1	0.2%
radar/microwaves	70	11.8%	34	5.7%
lasers	70	11.8%	34	5.7%
loud noises	185	31.2%	303	51.1%
excessive vibration	100	16.9%	167	28.2%
industrial pollution	109	18.4%	122	20.6%
sand/dust	53	8.9%	482	81.3%
depleted uranium	5	0.8%	0	0.0%
other exposures	3	0.5%	5	0.8%

Based on the original 593 PDHA's, a total of 534 (90.1%) Service Members had subsequent Post-Deployment Health Reassessments (PDHRA; DD Form 2900). With two missing observations, 77/532 or 15% of individuals replied affirmatively to the question "Do you have any persistent major concerns regarding the health effects of something you believe you may have been exposed to or encountered while deployed?" The following specific concerns were identified by Service Members in rank order: smoke from burning trash or feces (61/534, 11.4%), loud noises (60/534, 11.2%), sand/dust (58/534, 10.9%),vehicle or truck exhaust fumes (49/534, 9.2%), JP8 or other fuels (42/534, 7.9%), smoke from oil fire (39/534, 7.3%), industrial pollution (39/534, 7.3%), excessive vibration (36/534, 6.7%), solvents (20/534, 3.7%), lasers (19/534, 3.6%), other (18/534, 3.4%), depleted uranium (13/534, 2.4%),radar/microwaves (14/534, 2.6%), paints (12/534, 2.2%), environmental pesticides (9/534, 1.7%), tent heater smoke (8/534, 1.5%)fog oils (6/534, 1.1%), and radiation (3/534, 0.6%).After the interview with the Service member and review of the PDHRA form, healthcare providers indicated a need for further evaluation and follow-up for identified exposure concerns for 7.8% of the 40/516 who reported persistent concerns. Twenty-nine Service Members (5.4%) were considered to have a minor concern and 11 Service Members (2.1%) with a major exposure concern. Of the original 77/534 (15%) with persistent major concerns by self-report, 38 were identified by the provider as having concerns requiring further evaluation whereas 36 were not; the information was missing on three individuals.

Table F-2. Identified Post Deployment Health Reassessments Exposures

	N=593	
Concern	**Count**	**Percent**
Post Deployment Health Reassessments	534	90.1%
	N=534	
Positive response	77	15%
Environmental pesticides	9	1.7%
Smoke from oil fire	39	7.3%
Smoke from burning trash or feces	61	11.4%
Vehicle or truck exhaust fumes	49	9.2%
Tent heater smoke	8	1.5%
JP8 or other fuels	42	7.9%
Fog oils	6	1.1%
Solvents	20	3.7%
Paints	12	2.2%
Ionizing radiation	3	0.6%
Radar/microwaves	14	2.6%
Lasers	19	3.6%
Loud noises	60	11.2%
Excessive vibration	36	6.7%
Industrial pollution	39	7.3%
Sand/dust	58	10.9%
Depleted uranium	13	2.4%
Other exposures	18	3.4%
Minor concern	29	5.4%
Major concern	11	2.1%

The PDHA was modelled after exposure concerns from the first Gulf War (for example, oil well fire exposure and pesticides/repellents such as DEET and permethrin) and so some of the exposure concerns are less relevant to OIF/OEF/OND. Questionnaire responses in this population indicate that while the percentage of some self-reported exposure concerns increased (DU and other exposures); the relative rank orders did not change substantially. Concerns regarding most exposures decreased or remained stable over time (environmental pesticides, smoke from oil fire, smoke from burning trash or feces, vehicle or truck exhaust fumes, tent heater smoke, JP8 or other fuels, fog oils, solvents, paints, radiation, radar/microwaves, lasers, loud noises, excessive vibration, industrial pollution, and sand/dust). Responses indicate that the percentage of Service Members with exposure concerns also decreased slightly between the completion of the PDHA and the completion of the PDHRA in this population (17.5% on PDHA versus 14.5% on PDHRA respectively). The observed decrease in exposure concerns is not typical of what has been previously reported.

Burning oil wells were a visible hazard during the first Gulf War; however, there has been little discussion of burning oil wells in this conflict. Nearly a third of re-deployers in this unit reported this exposure on the PDHA which was reduced to about 7% at the time of the PDHRA, although the relative rank of this concern did not change. Interestingly, although not mentioned in the interviews, there was a report of an oil storage tank which caught on fire in 2004 47 km southwest of FOB Marez, which might have been mistakenly reported. There is no other information about duration of fire or potentially exposed population, if any. There has not been much indication of the use of fog oil, yet it is cited as a concern initially by 8.3% which had decreased to 1.1% by the PDHRA. Additionally, some exposures became common in the latter conflicts, such as the use of IEDs/VBIEDs/SBIEDs which are not listed on the PDHAs.

The forms changed in 2012 so that individuals no longer check from a “pick list” of exposures as above. At present, the form asks if the individual has an exposure of concern, if they think that they were exposed to a chemical, biological or radiological during the deployment, and if they think that they had an exposure to DU. The provider follows up during the interview and checks off the “pick list” which is essentially the same as the one individuals completed on the earlier version. Chlorine gas is added, as are chemical, biological and radiation exposures. There is a section marked “other toxic chemicals that the provider must fill in that lists ammonia and nitric acid as the example. At the end of this exposure section, with respect to whatever exposures have been checked, the provider must indicate the need for referral. If “no” is marked, the provider is instructed to provide risk communication, and choose the reason for non-referral. These include already under care, already has referral, no significant impairment, and other, which must be explained. The DU portion requires the provider to assess the need for referral for urinalysis.

(U) Appendix G

Health Effects Associated with Chlorine Exposure and Chlorine IEDS and Preventive Medicine Actions

Health Effects Associated with Exposure to Chlorine Gas

While no quantitative measurements are available regarding chlorine, potential exposure to chlorine has been reported in association with IEDs. From the OEHS data searches, no information was found on insurgents using chlorine IED's in Mosul during the 1/24BN SBCT deployment timeframe. The use of Chlorine IED's by insurgents was confirmed and documented by DoD from 2006 onwards. It may have been used prior to 2006, but not confirmed and documented. One interviewee remembers many IEDs having chemicals such as fertilizers or chlorine that made it hard for the Soldiers to breath.

According to the Centers for Disease Control and Prevention (CDC) chlorine is one of the most common chemicals manufactured in the United States (reference G-1). Chlorine gas can be pressurized and cooled to change it into a liquid so that it can be shipped and stored. When liquid chlorine is released, it quickly turns into a gas and because of its density it stays close to the ground and can spread rapidly. It can be recognized by its pungent, irritating odor, which is like the odor of bleach. Chlorine can react explosively or form explosive compounds with chemicals such as turpentine and ammonia. Chlorine is used in a variety of everyday products and processes, including paper manufacturing, swimming pool treatments, household/industrial/healthcare cleaning operations and pesticide manufacturing.

Chlorine gas can be detected by humans at airborne concentration below those believed to be toxic. The detection limit for chlorine gas odor ranges from 0.1-0.3 ppm. At 1-3 ppm there is mild mucous membrane irritation which can usually be tolerated for about an hour. Moderate mucous membrane irritation occurs at 5-15 ppm. Exposure to levels of 30 ppm and above will cause immediate substernal chest pain, shortness of breath and cough. Exposures to 40-60 ppm are associated with the development of toxic pneumonitis and/or pulmonary edema (reference G-2). Thus, individuals with an exposure of a magnitude to cause long term health effects are likely to be aware of the exposure at the time of its occurrence.

People can be exposed via inhalation of chlorine gas, ingestion of food contaminated with chlorine liquid and dermal/mucous membrane exposure to chlorine gas, liquid chlorine or water containing chlorine. When chlorine gas comes into contact with moist tissues such as the eyes, throat, and lungs, an acid is produced that can damage these tissues (reference G-1).

Signs and symptoms of exposure to dangerous levels of chlorine include the immediate development of: blurred vision; burning pain, redness, and blisters on the skin if exposed to gas; burning sensation in the nose, throat, and eyes; cough; chest tightness; nausea and vomiting; watery eyes; and wheezing. Difficulty breathing, shortness of breath and pulmonary edema (fluid accumulation in the lungs) may appear immediately with high levels of exposure or they may be delayed several hours if the exposure level is lower. The vast majority of exposures to chlorine, both gas and liquid, do not cause any adverse health effects. Long term complications are much more likely to occur if there are significant immediate symptoms, such as pulmonary edema (reference G-1).

Many studies have shown that pulmonary effects after an acute exposure to chlorine disappear after a few weeks; however there are reports that have documented longer term effects, such as asthmatic reactions, bronchial hyper-responsiveness, and reduced lung function (references G-2-8). Those long-term, persistent effects may be obstructive or restrictive pulmonary deficits or increased nonspecific airway reactivity (references G-3,5). There is also some evidence that longer term hyper-responsiveness is more common in older individuals, smokers and those with pre-existing lung problems (references G-2,5). No reports were located of long-term sequelae in individuals that had asymptomatic or minimally symptomatic exposures, and many authors acknowledge the unlikelihood of this occurring (references G-

2-9). Therefore, in the absence of any members of the 1/24BN SBCT reporting acute chlorine exposure symptoms, they should anticipate no problems from this exposure nine years or more after leaving Mosul.

References:

G-1. Centers for Disease Control and Prevention. Emergency Preparedness and Response. Facts about Chlorine. Accessed at: http://www.bt.cdc.gov/agent/chlorine/basics/facts.asp

G-2. White CW, Martin JG. Chlorine Gas Inhalation: Human clinical evidence of toxicity and experience in animal models. Proc Am Thor Soc 2010; July 1; 7(4):257-263

G-3. Deployment Health and Family Readiness Library. Chlorine gas exposure for Service Members. http://deploymenthealthlibrary.fhp.osd.mil/Product/RetrieveFile?prodId=300

G-4. Hasan FM, Gehshan A, Fuleihan FJ. Resolution of pulmonary dysfunction following acute chlorine exposure. Arch Environ Health 1983; 38:76–80.

G-5. .Das R1, Blanc PD. Chlorine gas exposure and the lung: a review. Toxicol Ind Health. 1993 May-Jun;9(3):439-55.

G-6. Abhyankar A, Bhambure N, Kamath NN, et al. Six month follow up of 14 victims with short term exposure to chlorine gas. J Soc Occup 1989; Med 39:131–132.

G-7. Leroyer C, Malo JL, Infante-Rivard C, et al. Changes in airway function and bronchial responsiveness after acute occupational exposure to chlorine leading to treatment in a first aid unit. Occup Environ Med 1998; 55:356–359.

G-8. Agabitia N, Anconaa C, Forastierea F, et al. Short term respiratory effects of acute exposure to chlorine due to a swimming pool accident. Occup Environ Med 2001;58:399-404

G-9. Michigan Department of Community Health. Chlorine – Public Fact Sheet. Accessed at: http://www.michigan.gov/documents/Chlorine_factsheet_82357_7.pdf

USAPHC

Chlorine Improvised Explosive Devices and Preventive Medicine (PVNTMD) Actions

FACT SHEET 36-015-1014

Purpose. This fact sheet is a PVNTMD reference tool and checklist (see back) for pre-deployment and response actions.

Background: Chlorine (Chemical Abstract Services (CAS) No. 7782-50-5) is an acutely toxic industrial compound (TIC) that can cause severe coughing, pulmonary, eye, and skin irritation, and even death at higher concentrations. Because of its toxic properties and wide availability, insurgents in Iraq have increasingly used chlorine in improvised explosive device (IED) attacks. Though attacks thus far have resulted in limited releases, more sophisticated efforts involving chlorine as well as other TICs could result in more devastating effects.

Uses: Chlorine is used extensively in common commercial industries to include water treatment processes (e.g., swimming pools, drinking water) and paper and cloth manufacturing. It is often stored at commercial facilities in 1 and 2 ton cylinders or large tanks and is frequently transported via truck and rail. Chlorine cylinders are often, but not always yellow; color coding should NOT be used to identify contents.

Physical and Chemical Characteristics: In most conditions, chlorine is a yellow-green gas with a suffocating bleach-like odor. If present, liquid solutions will likely volatize quickly. Chlorine gas is heavier than air and will generally move downhill and downwind. It may concentrate in poorly ventilated, enclosed, or low lying areas. The gas should generally dissipate to levels below health concern within an hour if released outside, though extremely large volumes, colder climates, and confined areas can require longer periods of time. Chlorine is also a strong oxidizer that can react explosively with compounds such as acetylene, fuel gas, ammonia, and hydrogen.

Exposure Signs and Symptoms: Liquid can produce skin burns/frostbite and eye irritation/conjunctivitis/corneal burns. Effects from exposures to chlorine gas depend on the dose and health condition of the exposed individuals (for example, asthmatics may be more sensitive to exposure than others). The latency is immediate to hours depending on dose. The severity of acute effects associated with approximately one hour of exposure is generalized below in conjunction with the military exposure guidelines (MEGs) provided in USACHPPM Technical Guide (TG) 230:

No adverse effects 1-8 hrs at < 0.5 ppm	Minimal effects 1-hr at 0.5 - 2 ppm	Significant effects 1-hr at 2 - 20 ppm	Severe effects (1-hr at > 20 ppm)	Very severe effects (1-hr exposure at ≥ 34 ppm)
Bleach-like odor is possible but no irritation anticipated in most personnel	strong odor, slight irritation of nose/throat/eyes	burning of eyes or throat, some cough and choking sensation	sense of suffocation, chest pain, shortness of breath (dyspnea), nausea, vomiting, hoarseness	pulmonary edema, sudden death bronchospasm (closure of larynyx)
1-hr and 8-hr MEGs are 0.5 ppm	1- hr minimal MEG 0.5 ppm (1.5 mg/m^3)	1-hr significant MEG 2 ppm (5.8 mg/m^3)	1-hr severe MEG 20 ppm (58 mg/m^3)	Lethality has been reported after 1 hour 34-51 ppm

After non-fatal exposures, recovery is generally rapid; however, symptoms such as a cough may last for up to two weeks. Long-term medical monitoring is not necessary for most persons who recover from minimal to marginal effect. Persons who are treated/recover from severe illness could possibly develop chronic pulmonary problems.

Protection against exposures: If there is a release, **MASK AND MOVE** as far upwind as possible, ideally to a minimum distance of 240 meters (the Emergency Response Guideline protection distance), then **REASSESS.**
Though the M40 will likely be effective at the "severe effects" level for a brief duration, the M40 should only be considered an escape device. Normal combat uniform will provide skin protection against chlorine vapors. The Joint Service Lightweight Integrated Suit Technology (JSLIST) and the collective protection M48A1 Gas Particulate Filter (GPF) protect against chlorine but performance limits have not yet been tested. For occupational/long term exposures to chlorine, personnel may need to obtain Level A fully encapsulated suits and NIOSH-approved respirators (e.g., self-contained breathing apparatus (SCBA)).

Decontamination and Treatment: Victims exposed only to chlorine gas who have no skin or eye irritation do not need decontamination. If skin or eyes are affected, flush with water or saline. There is no specific medical test for chlorine injury. After being removed from exposure, limit exertion of all exposure victims. Provide supportive care (oxygen) and monitor (e.g., pulse oximetry) symptomatic individuals, and treat more severe effects accordingly; particularly securing airway. Asymptomatic patients should be directly observed for one hour and under lesser observation for 6 hours before being medically cleared because symptoms may be delayed and bronchospasm may appear later.

U.S. Army Public Health Command, Health Information Ops, 5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5403
http://phc.amedd.army.mil/
DSN 584-5217; CM (410) 436-5217; FAX -8492

Figure G-1. Chlorine IEDs and Preventive Medicine Actions Fact Sheet

Preventive Medicine Actions for Chlorine IED Attacks

Pre-deployment Preventive Medicine Planning Actions:

→ be aware of potential chlorine exposure scenarios and/or sites within the scope of your mission (e.g., water treatment plants, industrial facilities, railroad cars) – contact The Armed Forces Medical Intelligence Center (http://www.afmic.detrick.army.mil/), USAPHC (http://phc.amedd.army.mil/), and your intelligence staff

→ train personnel to be aware of chlorine and other TIC gases of opportunity and how to avoid potential hazards

→ train personnel to appropriately respond to chlorine/TIC attacks (See Response Actions below)

→ ensure personnel maintain the M40 protective mask and are proficient in donning all protective equipment

→ be familiar with detection capabilities available in theater and know how to use the equipment

→ plan egress routes and know weather conditions while on patrols

→ know how to document exposure data (See Documentation Requirements below)

Response Actions and Considerations:

If an attack occurs and chlorine is identified (via odor and/or visual cues):

→ **MASK AND MOVE**

→ don M40 mask and evacuate the area immediately

NOTE: The M40 protective mask provides limited protection against chlorine and should only be considered an escape device.

→ move as far away as possible upwind from the release – at least 240 meters; if this is not possible consider other options e.g., move to higher ground or up to a second story or rooftop as chlorine will concentrate along the ground

→ move away from and report any unexploded canisters or cylinders in the area as these may detonate in a collateral fire

→ Reassess conditions: determine need for mask or additional evacuation

→ if the eyes or skin are irritated flush with water

→ ensure appropriate medical treatment for those more severely affected

→ replace the canister (C2A1) on mask worn during a chlorine gas event

→ notify higher headquarters per unit standard operating procedure (SOP)

Documentation Requirements:

DoD policy requires that exposure to hazardous substances like chlorine be documented to support medical surveillance and follow-up treatment efforts:

→ Document the following exposure incident information:

- ☐ unit name
- ☐ unit rosters of all personnel involved (affected or possibly exposed)
- ☐ summary of treatment provided to any individuals (list names of treated)
- ☐ personal protective equipment or countermeasures used; effectiveness of and compliance with countermeasures; any other exposure incident response activities
- ☐ results of any chemical sampling/monitoring including type of monitor and sample location
- ☐ description of any health risk communication materials provided

→ In coordination with the Joint Task Force and Combatant Command Surgeons, forward all the above documentation to the USAPHC Environmental Surveillance Integration Program (ESIP) using either classified or unclassified channels:

Secure e-mail:	oehsdata@usachppm.army.smil.mil	Unsecured e-mail:	oehs@apg.amedd.army.mil
Secure FAX:	DSN: 312.584.4244 COMM: 410.436.4244	Unsecured phone:	DSN: 312.584.4230 COMM: 410.436.4230

Classified Mail:
USAPHC; ATTN: MCHB-CS-OCP (OEHS Data Archive)
5158 Blackhawk Road, Building E1930
Aberdeen Proving Ground, MD 21010-5403

Unclassified Mail:
USAPHC; ATTN: MCHB-TS-RDD
5158 Blackhawk Road, Building E1675
Aberdeen Proving Ground, MD 21010-5403

References:

- USACHPPM Technical Guide 273. "Diagnosis and Treatment of Diseases of Tactical Importance to US Central Command" October, 2003.
- USACHPPM Technical Guide 230 "Chemical Exposure Guidelines for Deployed Military Personnel" October, 2003.
- Emergency Response Guidebook, 2006; Department of Transportatation
- Bartlett JG & Greenberg MI. Physician's Desk Ref (PDR) Guide to Terrorism Response. Thomson PDR, Montvale NJ. 2005.
- Weinstein RS & Alibek K. Biological and Chemical Terrorism: A Guide for Health Care Providers and First Responders. Thieme Medcl Pblshrs, NY. 2003.
- ATSDR Medical Management Guidelines for Chlorine and ToxFAQs; Rtrvd 3/5/ 2007, 2007: http://www.atsdr.cdc.gov
- CDC Facts about Chlorine, Rtrvd 3/5/ 2007: http://www.bt.cdc.gov/agent/chlorine/basics/facts.asp
- OSHA, Occupational Safety and Health Guideline for Chlorine, , Rtrvd 3/5/ 2007: http://www.osha.gov/SLTC/healthguidelines/chlorine/recognition.html
- Department of Defense Instruction (DoDI) Number 6490.03, Deployment Health, August 11, 2006

Figure G-1. Chlorine IEDs and Preventive Medicine Actions Fact Sheet (2007)

Appendix H

Burn Pit Fact Sheets

USAPHC

Frequently Asked Questions about
BURN PIT EXPOSURES

FACT SHEET 64-027-0514

This fact sheet is one in a series designed to address questions frequently asked by Soldiers about potentially hazardous exposures in the deployed environment. It has been prepared by the Environmental Medicine Program of the U.S. Army Public Health Command. The effects of exposure to any hazardous substance depend on the dose, the duration, how you were exposed, personal traits and habits, and whether you have experienced other hazardous exposures. Therefore, it is important that you discuss any specific health concerns with your health care provider.

HIGHLIGHTS:
Burn pits are a method of solid waste disposal used by the military in field settings. Acute symptoms due to burn pit smoke exposure may occur, including reddened eyes, irritated respiratory passages, and persistent cough. Epidemiologic studies have not identified long-term health risks specifically associated with burn pit smoke exposure among deployed personnel, but a history of deployment to Southwest Asia has been associated with increased risk of persistent respiratory symptoms and asthma. Because health effects from burn pit emissions exposure are biologically plausible, DOD and the Institute of Medicine continue to study health risks that may exist.[1] U.S. military use of burn pits is being minimized in Southwest Asia (e.g., Iraq and Afghanistan), where possible. For DOD personnel supporting burn pit operations, recent CENTCOM policy guidance for voluntary use of N95 respirators provides an additional measure of protection.

What are burn pits? Burn pits have been a commonly used form of solid waste management during Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) in Southwest Asia. An "open-air burn pit" is defined as "an area, not containing …an incinerator or other equipment specifically designed …for burning of solid waste, designated for the purpose of disposing of solid waste by burning in the outdoor air at a location with more than 100 attached or assigned personnel and that is in place longer than 90 days." Prior to 2010, burn pit operations were less regulated. While samples were obtained from many base camps with burn pits, the largest burn pits (e.g., Joint Base Balad (JBB)) were the focus of evaluation. Though studies of the smoke did not identify specific health threats from burn pits, DOD has, nevertheless, been decreasing its reliance on burn pits.[1]

How might I be exposed to smoke from burn pits?
When smoke rises from a burn pit fire, it forms a plume. The fate of the plume depends on weather conditions, and may travel to areas where people live and work. Smoke in the air may be breathed in by personnel. The smoke can also come into contact with eyes and nose. Burn pit soot and ashes may also contact skin (or food); however, inhalation is the major route of exposure for burn pit smoke.

What are the immediate and short-term effects of burn pit smoke exposures?
Acute symptoms due to burn pit smoke exposure may occur, including reddened and irritated eyes, irritated respiratory passages (nose, throat, lungs), and cough that may persist.[2] These effects begin immediately or shortly after exposure starts, and typically resolve after exposure ceases.

If you have questions regarding this document please contact:
U.S. Army Public Health Command, Environmental Medicine Program,
DSN 584-2714; COMM 410-436-2714; or email usarmy.apg.medcom-phc.mbx.emp@mail.mil
5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5403

Figure H-1. Frequently Asked Questions, Burn Pit Exposure

What are the long-term effects of burn pit exposures on lung health?
It is possible that some Service members may experience long-term health effects of burn pit smoke exposure, possibly due to combined exposures (such as sand/dust, industrial pollutants, tobacco, and smoke from other sources) and individual susceptibilities (such as preexisting health conditions or genetic factors). Deployment to locations with a burn pit has been associated with respiratory symptoms. Deployment, generally, has been associated with increased risk of asthma, although these associations are not specific to burn pit locations. Constrictive bronchiolitis, a rare, chronic progressive lung disease, has been identified in a small number of formerly deployed Soldiers; although exposure to burn pit smoke has been hypothesized as a risk factor for this condition, its cause(s) have not been identified. The Institute of Medicine reviewed the potential long-term health effects of burn pit smoke exposure by assessing surrogate populations. They concluded that there is limited/suggestive evidence of an association between exposures to combustion products and reduced pulmonary function, and found inadequate/insufficient evidence of an association between exposures to combustion products and respiratory disease. The DOD continues to study inhalational exposures, including burn pit smoke exposure, in order to evaluate long-term health risks and protect Service members.[2]

Is there a medical test for burn pit exposure? There is no medical test specific for burn pit exposure. However, your physician may conduct various medical tests to evaluate your health condition or symptoms if you have any (e.g., shortness of breath). It is DOD position that all personnel who believe they have been harmed by burn pit smoke get the care they need, deserve, and to which they are entitled.[2]

What is DOD doing to protect me and others from burn pit smoke? Prior to 2010, burn pits were commonly used for waste management, especially in Iraq and Afghanistan. They were not well regulated. Recently, DOD has been reducing burn pit smoke exposure. Recent policies and directives to Commanders minimize reliance on burn pits and require better management to minimize exposures. Requirements include: locating burn pits as far downwind as possible from working personnel, troop locations, and living areas; minimizing the size and contents of the waste stream, decreasing the duration of burning, and specifying burn times (beginning 3 hours after sunrise; ceasing 3 hours before sunset).

What can deployed persons do to protect themselves from burn pits?
Personnel deployed to a location with a burn pit should avoid activities in areas of heavy smoke and avoid burning inappropriate or excess waste. A 2011 CENTCOM policy provides for **voluntary** use of NIOSH-certified N95 filtering facepiece respirators as an additional measure of protection and comfort for those involved in burn pit operations or working in proximity to one. The respirator program includes evaluation by medical personnel to ensure safety and train personnel in their proper use.[3]

Where can I get more information? If you have health concerns regarding burn pit exposures, we recommend discussing them with your physician or other health care provider. If your provider wants additional information, he/she may contact the Environmental Medicine Clinical Consult Service or visit our website.
http://phc.amedd.army.mil/organization/institute/doem/Pages/EnvMed.aspx
Our environmental medicine staff will do their best to assist you and your provider.

[1] DoDI 4715.19. Use of Open-Air Burn Pits in Contingency Operations, 15 February 2011 with 27 March 2014 change 2; Glossary Part 2. Definitions, http://www.dtic.mil/whs/directives/corres/pdf/471519_2011_ch2.pdf

[2] May 2011 Dr. Craig Postlewaite's Current DOD Public Health Statement on Burn Pit Exposures (insert reference) http://www.dtic.mil/dtic/tr/fulltext/u2/a556388.pdf

[3] CENTCOM FRAGO 07-759 Implementation of CENTCOM Policy Guidance and Provisioning for Use of Voluntary Respiratory Protection by DOD Personnel Supporting Burn Pit Operations. May 2011

Figure H-1. Frequently Asked Questions, Burn Pit Exposure

Appendix I

OTSG MEDOCM Policy 14-021
Medical Management of Army Personnel Exposed to DU

DEPARTMENT OF THE ARMY
HEADQUARTERS, UNITED STATES ARMY MEDICAL COMMAND
2748 WORTH ROAD
JBSA FORT SAM HOUSTON, TEXAS 78234-6025

REPLY TO ATTENTION OF

OTSG/MEDCOM Policy Memo 14-021

14 MAR 2014

MCPO-SA

Expires 14 March 2016

MEMORANDUM FOR Commanders, MEDCOM Major Subordinate Commands

SUBJECT: Medical Management of Army Personnel Exposed to Depleted Uranium (DU)

1. References. See Annex A to the enclosure.

2. Purpose. To clarify established policy, expand responsibilities and procedures, and provide additional guidance for the medical management of Army personnel exposed to DU (see enclosure).

3. Proponent. The proponent for this policy is G-3/5/7, Health and Wellness Directorate.

4. Background.

a. This policy directs implementation of the 9 April 2004, Department of Defense Health Affairs memorandum and the 30 May 2003, Department of Defense Health Affairs Policy 03-012, for Depleted Uranium (DU) Medical Management (References 3 and 4, respectively, Annex A), supports the 6 February 2004, Department of Defense Health Affairs Policy 04-004, for Bio-monitoring Policy and Approved Bioassays for Depleted Uranium and Lead (Reference 5, Annex A), recognizes embedded fragment analyses data submission changes based on current operations (References 1 and 2, Annex A), and provides further policy, responsibilities, procedures, and guidance for medical management of patients exposed to DU.

b. All personnel with actual or potential exposures to DU will continue to be identified, assigned a potential exposure Level (I, II, or III), assessed, and treated (if indicated). Identified personnel will then be monitored and tracked according to the responsibilities, procedures, and guidance provided in the enclosure. Personnel exposed to DU will be treated (if indicated) and their information entered into the Joint Theater Trauma Registry (JTTR).

*This policy memo supersedes OTSG/MEDCOM Policy Memo 11-047, 10 June 2011, subject as above.

MCPO-SA
SUBJECT: Medical Management of Army Personnel Exposed to Depleted Uranium (DU)

c. Required medical treatment or evaluations will not be delayed because of the possible presence of DU (on the skin or internalized).

d. DU bioassays will be administered to all personnel in the Level 1 exposure category, as defined in the enclosure. This category includes personnel with imbedded metal fragments that might include DU or who were in, on, or near (less than 50 meters) an armored vehicle at the time (or shortly after) it was struck with a DU munition.

e. DU bioassays will be administered to all personnel in the Level II exposure category, as defined in the enclosure. This category includes personnel who routinely enter damaged vehicles as part of their military occupation or who fight fires involving DU munitions.

f. DU bioassays are not required for personnel in the Level III exposure category, as defined in the Enclosure. This category includes personnel with incidental exposure to DU. However, a physician may choose to perform one based on medical indications or if a Soldier with incidental exposure requests to be tested.

g. Bioassays (urine specimens) are not required to be collected in Theater.

h. Urine specimens collected for DU bioassays and fragments potentially containing DU will be sent to the US Army Public Health Command for analysis.

i. The case management process has worked well to provide potentially exposed Soldiers with one-on-one health risk communication and information related to any results from DU bioassays. Annex B to the enclosure recommends assignment of a case manager for Soldiers submitting urine specimens for DU bioassay.

FOR THE COMMANDER:

ULDRIC L. FIORE, JR.
Chief of Staff

Encl
as

CF (w/encl):
Assistant Secretary of Defense (Health Affairs), Pentagon, Room 3E1082, Washington, DC 20301-1200
Assistant Secretary of the Army (Manpower and Reserve Affairs), Pentagon, Room 2E468, Washington, DC 20310-0111

2

MCPO-SA
SUBJECT: Medical Management of Army Personnel Exposed to Depleted Uranium (DU)

CF (CONT):
Chief, Bureau of Medicine and Surgery, Surgeon General of the Navy, 7700 Arlington Blvd., Suite 5113, Falls Church, VA 22042-5113
Commander, Air Force Medical Operations Agency, AFMOA/CC, 110 Luke Avenue, Room 400, Bolling Air Force Base, DC 20332-7050
HQDA (DACS-SF), 200 Army Pentagon, Washington, DC 20310-0200
HQDA (DAMO-TRC), 400 Army Pentagon, Washington, DC 20310-0400
Director, National Guard Bureau (Surgeon), 111 South George Mason Drive, Arlington, VA 22204-1382
Commander, US Army Reserve Command (Surgeon), 1401 Deshler St, SW, Fort McPherson, GA 30330-5000
Commander, US Army Training and Doctrine Command (Surgeon), Fort Monroe, VA 23651-5000
Commander, US Army Forces Command (Surgeon), 1777 Hardee Avenue, SW, Fort McPherson, GA 30330-6000
Commander, US Army Materiel Command (Surgeon), 9301 Chapek Road, Fort Belvoir, VA 22060-5527
Commander, US Army Special Operations Command (Surgeon), Fort Bragg, NC 28307-5200
Uniformed Services University of the Health Sciences, Chair, Department of Military and Emergency Medicine, 4301 Jones Bridge Road, Bethesda, MD 20814
Director, Armed Forces Radiobiology Research Institute, 8901 Wisconsin Avenue, Bethesda, MD 20889-5603
Commander, Defense Medical Readiness Training Institute, 1706 Stanley Road, Suite 91, JBSA Fort Sam Houston, TX 78234
Commandant, US Army Chemical, Biological, Radiological, and Nuclear School, Fort Leonard Wood, MO 65473

3

Procedures/Guidance for the Medical Management of Army Personnel Exposed to Depleted Uranium (DU)

1. References. See Annex A to this enclosure.

2. Responsibilities. Annex B to this enclosure defines the responsibilities for Army medical personnel.

3. General.

a. The procedures in this document outline the methods to be used to identify, assign a potential exposure Level (I, II, or III), assess, and treat (if needed) all personnel with actual or potential exposure to DU, regardless of the source. In addition, these procedures detail required monitoring and tracking of all Army personnel with retained metal fragments and/or suspected inhalation or incidental exposure to DU. Level III exposures are annotated in the Soldier's medical record. Upon the Soldier's departure from Federal service, the medical record is archived in the National Personnel Records Center for future access.

b. The procedures will also be used to ensure the appropriate use of urine bioassay for DU exposure assessment and bio-monitoring.

c. Annex C to this enclosure contains a short questionnaire to assist the healthcare provider in assessing potential DU exposure. Annex D to this enclosure provides access to the Department of Defense (DD) Form 2872 Test, DU Questionnaire and DD Form 2872-1 Test, Health Survey, which is completed for all personnel submitting specimens for DU bioassays. Annex E provides packing and shipping requirements for DU bioassay and fragment specimens. Annex F to this enclosure summarizes these procedures in a checklist format for the healthcare providers (HCP). Annex G summarizes these procedures in a flow chart format.

d. If required, a DU bioassay (24-hour urine collection) will be performed as soon as practical upon the Soldier's return to home station. Medical units located in a theater of operations and higher Role Medical Treatment Facilities (MTF), acting as enroute processing points for redeploying Soldiers, should not collect the 24-hour urine specimen for the DU bioassay. The collection requirements are documented on the Soldier's DD Form 2796, Post-Deployment Health Assessment, and other medical records (e.g., DD Form 2766, sections 5 and 7 (block 20)) ensuring collection of the 24-hour urine specimen and documentation by the Soldier's home station or demobilization site MTF.

4. Definitions of potential DU exposure Levels.

a. Level I. Personnel who may exceed occupational safety levels by taking in a sufficient amount of DU into the body.

(1) This Level includes personnel who were struck by DU munitions or who were in, on or near (less than 50 meters) a combat vehicle struck by DU munitions or DU armor when it is breached by any munitions and to first responders who entered these vehicles to render aid to the crewman, or to those with retained fragments that contain DU.

(2) DU bioassays are administered to all personnel within this Level.

(3) Bioassays are performed as soon as medical condition permits a urine collection at the Soldier's home station or demobilization site MTF. Non-hospitalized Level I personnel will have their medical records annotated that a 24-hour urine collection is required and these bioassays will be performed as soon as possible (e.g., upon return to home station).

b. Level II. Personnel who are routinely exposed to DU damaged vehicles or fires involving DU munitions.

(1) Personnel in this Level have a very slight potential to exceed occupational safety levels. This Level includes personnel who routinely enter vehicles containing DU dust to perform maintenance and recovery operations (other than first responder), intelligence operations, or battle damage assessment. This Level also includes personnel whose occupation involves firefighting involving DU munitions.

(2) DU bioassays are administered to all personnel within this Level. Specimen collection should be done as soon as possible when the Soldier returns to his/her home station or demobilization site MTF. The type of personal protective equipment worn during potential DU exposure situations should be annotated in the remarks section of the DoD DU questionnaire.

(3) Medical records are annotated (e.g., DD Form 2766, Sections 5 and 7 (block 20) with the requirement to collect a 24-hour urine specimen for DU bioassay.

c. Level III. Personnel with "incidental" exposures to DU.

(1) Examples of personnel in this Level include individuals who have driven through smoke from a fire involving DU munitions or who have entered or climbed on or in a battle damaged vehicle on an infrequent basis (not as a first responder and not as a job requirement) or Soldiers, DoD Civilians and Contractors that may have been exposed to buried DU.

(2) Bioassays are not required for personnel in this Level, though a physician may choose to perform one based on medical indications or on the potentially exposed individual's request. If the individual indicates that he was cut, scraped, or sustained a puncture type wound while in, on or around a potentially contaminated vehicle, then it is strongly recommended that a urine bioassay be obtained. The individual may have

an embedded fragment that contains DU. NOTE: Paradoxically, this group may require more health risk communication than those in Levels I and II. Level I personnel may know they have retained fragments or were potentially exposed to a relatively high level of DU while those in Level III may have various signs and symptoms not attributable to a single cause and so feel that DU may be the causative agent.

5. Treatment considerations for wounded personnel with suspected DU exposure.

a. Follow these standard procedures when treating wounded personnel.

(1) Embedded fragments should be removed using standard surgical criteria (reference 12, Annex A, provides guidance) except that large fragments (greater than 1 cm) should be more aggressively removed unless the medical risk to the patient is too great. The short-term consequence of retained DU fragments does not justify an aggressive approach during the early treatment of wounds. Appropriate treatment of the wound with removal of any easily accessible fragments is performed. In the care of acute wounds, surgical judgment is used to avoid the risk of harm in removal of other fragments, even when known to be DU. DU fragments may always be removed at a later date.

(2) Monitoring of the kidney function is recommended for patients who have contaminated wounds, embedded depleted uranium fragments, or who are acutely wounded. Monitoring should follow the protocol developed and in use by the Baltimore Veterans Affairs (VA) Depleted Uranium Program.

(a) The kidney is one of the organs most sensitive to uranium exposure. The VA protocol recommends the following kidney function tests: urinalysis, 24-hour urine for uranium bioassay, blood urea nitrogen (BUN), creatinine, beta-2-microglobulin, and creatinine clearance.

(b) Chelation therapy is not recommended based upon current estimates of depleted uranium exposure health effects.

b. Medical treatment or evaluations immediately required shall not be delayed because of the possible presence of DU on skin or clothing, for the determination of the presence of DU on a patient, or for DU bioassay specimen collection.

c. The presence of DU fragments in a patient's body presents no risks to the HCP or other individuals. As with other heavy metals retained in the body, DU in all body fluids (urine, blood, sweat, saliva, and semen), tissues, and excrement (feces) is not categorized as hazardous material waste and no special precautions related to DU are required for handling or disposal.

d. Specimens for urine DU bioassays or fragment collection are ideally obtained early at the home station or demobilization site MTF where risk communication can be

provided once the results of the analysis is available. Specimens obtained in a theater of operations in emergency situations or under medical orders may be evaluated by following the procedures in Annex E even though not required by this policy. Specimens are potentially collected during redeployment/demobilization in CONUS when feasible and when the patient's clinical condition permits; however, specimen collection must occur at home station if not accomplished and documented during redeployment and demobilization.

6. Identifying personnel with potential exposure to DU during deployments.

a. Assistant Secretary of Defense, Health Affairs (ASD (HA)) guidance (Reference 3, Annex A to this enclosure) reminds all services of the requirement to identify potential DU exposures in various ways including unit personnel mission and post-deployment assessments. Tier 1, DU awareness training (Reference 10, Annex A) requires notification of DU-related incidents through command channels. HCPs, too, have a major role in the identification process.

b. DU will be retained by the Soldier for a considerable amount of time with the amount excreted in the urine decreasing as the time from the exposure increases. Bioassay results from relatively high exposures remain precise enough to allow accurate dose assessments to be made even if the bioassay is taken after a long or extended deployment. Lower exposures expected at the Level II and III categories may be difficult to differentiate from normal environmental uranium uptake as the time from exposure increases. Urine specimens are collected on all Level I and Level II personnel potentially exposed to DU regardless of the length of time since exposure since it is impossible to predict the magnitude of the exposure by Level alone. A Level III potentially exposed Soldier does not require DU bioassay; however, a physician may choose to perform one based on medical indications or on the potentially exposed individual's request.

c. Indicators of potential exposure. There are several indicators of potential exposure to DU above the current peacetime occupational levels.

(1) Indicators of DU exposure that are obtained directly from the patient or the patient's field medical card include:

(a) Patient's vehicle was struck by a Kinetic Energy (KE) munition. (KE munitions are usually made from either tungsten or DU.)

(b) Patient's vehicle was struck by DU munitions either from US tanks or aircraft.

(c) Patient reports observing burning fragments (like a Fourth of July sparkler) while the vehicle was being penetrated (DU is pyrophoric [i.e., may ignite spontaneously in air] and can ignite when fine particles are formed).

(d) Patient was a first responder and entered the vehicle to rescue or evacuate personnel or retrieve sensitive material immediately after the vehicle was struck.

(e) Patient was wounded by DU munitions. Similar to lead, tungsten, and steel, DU fragments are readily visible on radiographic images. Radiography alone, however, is not sufficient to determine the presence or absence of DU. If readily available, a RADIAC meter (AN/VDR-2, with the beta shield open or equivalent) may potentially be used to monitor surgically removed fragments, wounds, burns, surfaces, or sites with suspected DU contamination or embedded fragments. This will indicate the likely presence of DU and can assist in wound cleaning or surface decontamination. Under no circumstances should medical treatment be delayed to obtain a RADIAC meter.

(2) It is unlikely that environmental measurements or dose assessments will be available in all situations, especially in combat. However, if field survey monitoring indicates the presence of radioactive material on the patient, or in the vicinity of his activities when injured, then include the survey results, the time and date of the survey, and the type and serial number of the RADIAC meter and detection probe on the field medical card or other patient records. The clinician should alert preventive medicine if other individuals have been exposed so that an exposure assessment can be performed.

d. Suspected DU exposure.

(1) If DU exposure is suspected at Roles 1 and 2, medical personnel should annotate the Field Medical Card (DD Form 1380), Block 13 (Diagnosis) or patient's clinical record (SF 504 or other) with the statement: "SUSPECTED DEPLETED URANIUM (DU) EXPOSURE", and the time, date, and other pertinent information (e.g., in Block 9 state the circumstances, what was he doing when injured?"). Ensure completion of DA 2173 for all Soldiers.

(2) If DU exposure is suspected at Roles 3 and 4, medical personnel should record the information in the medical record on the DD Form 2766 and code the information into the Ambulatory Data Management (ADM) (previously called Ambulatory Data System (ADS)) and the Composite Healthcare System (CHCS) or Armed Forces Health Longitudinal Technology Application (AHLTA) Electronic Health Record. A hospital staffed and equipped to provide resuscitation, initial wound surgery, and post-operative treatment provides the care at Role 3. A hospital staffed for general and specialized medical and surgical care and rehabilitation for return to duty (RTD) provides the care at Role 4.

(3) For personnel who are suspected of having exposure to DU and who are not expected to re-deploy immediately, DU exposure levels (I-III) are assigned and bioassay procedures should begin for Level I and II personnel. While bioassay procedures need not be instituted in-theater or at intermediate stops enroute to

d. Documenting the assigned Level (I-III) of potential DU exposure on the DD Form 2796. Refer all individuals assigned a Level I or II potential DU exposure to their PCM at the MTF for further assessment and a 24-hour urine uranium analysis as soon as possible. The level of exposure and referral, if indicated, will be documented on the DD Form 2796, the individual health record, and on the DD Form 2766 and then transferred into the permanent medical record during reconciliation/update.

8. DU Bioassay specimen collections and management.

a. Metal fragments removed from Level I patients.

(1) Suspected DU metal fragments removed from Level I patients will be considered clinical laboratory specimens and forwarded to USAPHC for composition analysis. Information provided with the fragment specimen shall include: a completed Standard Form 557, Miscellaneous, with the ordering physician's contact information; the injury date; and the date the fragment was removed from the patient. A copy of the completed DoD DU Questionnaire will accompany all metal fragments sent to USAPHC for analysis. USAPHC requires the DD Form 2872 Test and DD Form 2872-1 Test for each specimen and fragment from a Level I patient.

(2) Documentation accompanying each metal fragment specimen should indicate if it is suspected that similar fragments remain embedded in the patient. It would also be helpful to know if urine bioassays were collected from the Soldier (in and out-of theater MTF) before or after fragment removal. If urine bioassays were collected, then the dates and times of collection need to be provided.

(3) The local medical laboratory will maintain a roster of metal fragment specimens shipped with patient identification. The local medical laboratory will receive the results and is responsible for ensuring that results are entered into the individual's medical record and into the local automated clinical information system (e.g., CHCS or AHLTA). Upon completion of that action, requests for DU bioassay may be submitted on line and the results will be posted similar to current standard medical tests.

b. Urine specimens.

(1) The HCP or PCM at the supporting MTF will refer all Army personnel assigned a Level I or II DU potential exposure category to the clinical laboratory for 24-hour urine specimen collection.

(a) A 24-hour urine specimen results in a more accurate dose estimate than would result from a spot urine specimen and will provide sufficient volume for additional analyses when required.

(b) A 24-hour urine specimen is required for subsequent US Army Medical Department (AMEDD) and Department of Veterans Affairs (DVA) follow-up for all Level

I and II exposure category personnel.

(c) Post-exposure urine specimens should be collected when practicable after suspected DU exposure. In accordance with DoD policy, an identified Level I or Level II Soldier will have a urine specimen collected; a Level III potentially exposed Soldier does not require DU bioassay; however, a physician may choose to perform one based on medical indications or on the potentially exposed individual's request.

(2) The local clinical laboratory will collect and manage 24-hour urine specimens according to the following procedures:

(a) Specimens will be collected using the containers specified in Annex E.

(b) Instruct the patient to collect urine beginning after first morning void of Day 1 and end collection after first morning void of Day 2 (the next day). Document the beginning time, the ending time and the total volume of this 24-hour collection.

(c) After an aliquot is taken from it for a creatinine test, the 24-hour urine specimen will be packaged for shipment to the USAPHC.

(d) The laboratory will complete a urine creatinine analysis on an aliquot from each 24-hour specimen. For measurement of urine creatinine level, the patient's age, sex, height, weight, and potential exposure Levels (I, II or III) must be provided on the laboratory request, Standard Form 557, Miscellaneous. The laboratory will submit a copy of the creatinine results when submitting the specimen to USAPHC.

(e) All 24-hour urine specimens for DU bioassay will be forwarded to USAPHC following the guidance in Annex E. Each urine specimen will be shipped with a completed Standard Form 557, Miscellaneous, a copy of the completed DoD DU Questionnaire, a copy of the Health Survey, and the results of the urine creatinine analysis.

c. All laboratories that collect or receive specimens will maintain a registry of specimens (fragments and urine).

d. The USAPHC will continue to provide DU bioassay and fragment analysis results and interpretations to the requesting MTFs and copies with all related documents to the DoD Deployment Health Clinical Center (DHCC) and the U.S. Army Dosimetry Center. For Electronic Patient Records input and retrieval, the use of the Composite Health Care System I and II (CHCS I and II) has not been feasible for USAPHC.

9. Other Heavy Metals/Alloys fragment specimen collection and management.

a. The packing and shipping requirements and instructions are contained in Annex E. The fragment should be clearly identified as a metal fragment and NOT as a DU

fragment.

b. The shipper, Role 3 or higher MTF, is responsible for entering into CHCS or AHLTA the patient data, circumstances of injury, and other relevant data as prescribed by CHCS or AHLTA.

c. The USAPHC, upon receipt of the metal fragment, will record the receipt of the fragment, the shipper's organization, and points of contact.

(1) The USAPHC Laboratory Sciences Portfolio (LSP) will analyze the fragment for tungsten alloy and other metal content in accordance with OTSG/MEDCOM Policy Memo 12-055, Management of Metal Fragments Removed from Army Personnel (Reference 7, Annex A).

(2) If the fragment contains a tungsten alloy, the USAPHC LSP will forward the data to the requesting MTF for entry into the CHCS or AHLTA and archive the fragment.

d. The MEDCOM G 3/5/7, Ancillary Health Services Division, will provide staff oversight of the clinical laboratory support for the collection, identification, and processing of extracted fragments for proper identification of the metal.

10. Laboratory procedures.

a. The USAPHC LSP will provide Army bioassay and metal fragment identification services. All specimens (metal fragments and urine) will be sent to USAPHC.

(1) All analyses performed by LSP are within a Quality System that is certified as compliant to ISO/IEC 17025, "General Requirements for the Competence of Testing and Calibration." All elements of the LSP Quality System are documented and conformance ensured by external audits.

(2) The LSP meets all of the requirements for and maintains the following technical certifications: Commission on Office Laboratory Accreditation (COLA) and Clinical Laboratory Improvement Program (CLIP) for all radiobioassay measurements for uranium. These certifications provide validation of the LSP quality processes through external third party review by trained auditors.

(3) All analytical certifications require laboratory participation in a proficiency evaluation (PE) study, if available. To meet this requirement for uranium bioassay work, LSP participates in the Oak Ridge PE program for uranium concentration in natural urine matrix.

(4) Continual improvement is an integral part of the LSP Quality System requiring periodic actions to identify trends and areas requiring improvement.

exposures is health risk communication. The HCP is the key individual in this activity. The HCP must inform the patient about the results of the DU bioassay, and ensure that this communication and the health risk assessment and its interpretation are documented in the medical record. The HCP must also discuss any need for additional medical follow-up.

b. The patient needs to be told that the laboratory result may not be available until after the patient leaves the MTF. The patient should be given contact information for the DHCC, which he or his future healthcare provider may contact to obtain a copy of his laboratory results and interpretation.

c. Information is available to help the HCP effectively communicate the DU exposure assessment and its interpretation to the patient.

(1) Fact sheets for HCPs and Soldiers which explain potential DU exposure and health implications can be found at the USAPHC's web site. (NOTE: The DU Fact Sheet number for Depleted Uranium – Individual is 26-003-0809 and for Depleted Uranium – Medical is 26-004-0110.) Other useful information includes the USAPHC Fact Sheet entitled Urine Testing for Depleted Uranium, February 2010 and DHCC web page on DU which contains DU policies, forms, fact sheets, and clinical guidance which can be accessed at http://www.pdhealth.mil/du.asp. The DoD Health Affairs Policy 03-012 (reference 4, Annex A) also contains information and references for HCP to help in communication with patients.

(2) Information and consultation on ionizing radiation dosimetry, dose estimation, and ionizing radiation health risk implications of DU exposure are available from the, USAPHC Health Physics Program at (410) 436-3502 or DSN 584-3502. During non-duty hours, contact USAPHC at (800) 222-9698 or Staff Duty at (410) 436-4375.

(3) Information and consultation on potential chemical and radiological health risks of DU; need for medical treatment, long-term medical surveillance, and follow-up are available from the USAPHC Occupational Medicine Program at (410) 417-2865, or DSN 867-2865.

d. Normal values.

(1) There are no current US population reference values for DU in urine. There are current US population reference levels for natural uranium.

(2) The United States Nuclear Regulatory Commission (NRC) has set an action level for uranium in urine to protect workers occupationally exposed to uranium. This urine uranium level is 15 micrograms/liter (238U), which is well above the 95th percentiles for urine uranium levels given in CDC, National Center for Environmental Health, Fourth National Report on Human Exposure to Environmental Chemicals,

National Health and Nutrition Examination Surveys (NHANES), March 2013.

(3) The NHANES IV report notes that it is unknown if the population urine uranium levels reported in the NHANES 2013 data represent cause for health concern and state that more research is needed. The 95th percentile is 0.036 micrograms/liter urine in the same sub sample of the US population. If a urine specimen is found to have urine uranium levels higher that the reference population norms, or if there are other questions that might help the interpretation process, then USAPHC may contact the ordering physician for further guidance and instruction.

(4) The National Report on Human Exposure to Environmental Chemicals is an ongoing assessment of the exposure of the US population to environmental chemicals using biomonitoring. The first national report on 27 chemicals was issued in 2001. A second report released in January 2003 presented blood and urine levels of 116 environmental chemicals from a sample of people that represent the non-institutionalized, civilian US population during the 2-year period 1999-2000. The third report, for 148 chemicals, released in July 2005 presents updated information for uranium for the years 2001-2002. The fourth report released in 2009 uses a new procedure to estimate percentiles. The section of this report that presents the results of uranium in urine analyses is found at http://www.cdc.gov/exposurereport/pdf/FourthReport.pdf.

(5) As of September 2013 USAPHC had evaluated approximately 2500 urine uranium bioassay results from Operation Iraqi Freedom (OIF) Soldiers. The majority of these results (92.5%) have been < 50 nanograms (ng) of uranium (U) per liter (L). There were approximately 100 specimens (7.4%) with an initial value >50 ng /L; however, only 2 (0.1%) have been confirmed as DU at that level. A value of 36 ng /L urine is the 95th percentile for the US population aged 6 years and older as reported in the CDC and Prevention, National Center for Environmental Health, Fourth National Report on Human Exposure to Environmental Chemicals, National Health and Nutrition Examination Surveys, March 2013 (NHANES). The values reported in the NHANES Report have no prognostic value; they are not associated with any adverse health effects (Reference 7, Annex A to this enclosure).

12. Medical and other records.

a. HCP must clearly document all cases of wounded personnel with embedded metal fragments.

b. The MEDCOM G-3/5/7, Patient Care Integration Directorate, Patient Administration is responsible for identifying coding requirements to ensure that patients with retained fragments, post-conflict, have their medical records coded appropriately. Coders will input as accurately as possible the ICD-9-CM diagnosis that best fits the patient's condition, but ensuring that the coded diagnosis indicates "retained shrapnel." Patient Administration will provide quality assurance of coding

patient encounters to ensure accuracy and completeness.

c. Patient care entries:

(1) If a Soldier, either inpatient or outpatient, has any retained fragments, the medical record, DD Form 2766 (Adult Preventive and Chronic Care Flow Sheet), item 20, will be annotated with an appropriate entry. Entries may include; embedded metal fragment, retained metal fragment, or suspected retained shrapnel. If the metal type (e.g., DU) is known at the time, this is annotated.

(2) Patients medically evacuated (both in and outpatient) require a TRACES entry in the Patient Movement Request type injury code.

(3) Patients followed up or evaluated per treatment guidelines at all MTFs must have the appropriate Standard Ambulatory Data Record entry. Since in most cases, potential exposure to DU is a deployment-related condition, the DoD-Unique V-Code for Deployment Assessment should be used for the patient visit in accordance with the Uniform Biostatistical Utility, Professional Services and Specialty Coding Guidelines, which can be found at http://www.tricare.mil/ocfo/bea/ubu/coding_guidelines.cfm

d. There is no specific code for suspected inhalation exposure to DU, but this diagnosis should be annotated on the medical record, DD Form 2766, item 20.

e The Standard Form 557, Miscellaneous, will identify whether the patient is Level I, II or III for suspected DU exposure, and whether the patient has a retained fragment or suspected inhalation exposure. All Standard Form 557, Miscellaneous, will have the name and contact information for the ordering physician.

f. The MTF clinical laboratory will retain a registry of all specimens (fragments and urine) sent to USAPHC for DU analysis. The MTF requesting laboratory and the requesting HCP will receive the results in hardcopy. The local medical laboratory is responsible for ensuring that results are entered into the individual's medical record and into the local automated clinical information system (e.g., CHCS or AHLTA).

g. A DoD DU Questionnaire and Health Survey will be completed for all personnel who will provide either fragment or urine specimens for bioassays. The original completed DoD DU Questionnaire and Health Survey will be placed in the individual medical record and a copy will accompany any specimens sent to USAPHC for analysis.

h. The MTFs need to maintain patient contact information when patients with possible DU exposure PCS or leave Active Duty. Use the DU Exposure Questionnaire for the patient to provide a permanent Home of Record/address, and telephone number. This information is critical for follow-up of patients who test positive for DU exposure.

13. Medical follow-up. The need for subsequent DU bioassays for medical follow-up is based upon uranium levels found in the initial and subsequent specimen(s). Patients with confirmed positive urine DU bioassay results will be offered referral to the Baltimore VA DU Follow-up Program (Reference 3, Annex A). All referrals to the VA must be coordinated through the DHCC. Periodic assessment and medical management will be provided through the VA Program at 2-year intervals. The PCM will continue to provide ongoing medical management for Service Member health concerns through standard primary care services provided in accordance with the Post-Deployment Health Clinical Practice Guideline (Reference 19, Annex A). In addition, reported health concerns and progress of care through the VA DU Program will be assessed during regularly scheduled Periodic/Preventive Health Assessments and Physical Exams. Consultation with USAPHC may be obtained anytime during the course of patient assessment and care.

14. Reporting and archiving.

a. The USAPHC will archive and will report results of fragment analysis and urine bioassay results to the MTF laboratory that submitted the specimen with interpretation and comparison to referent norms as appropriate.

b. The USAPHC will send dose interpretation and laboratory results to the US Army Radiation Standards and Dosimetry Laboratory, Ionizing Radiation Dosimetry Branch, TMDE, Redstone Arsenal, AL, for archiving. Copies for members of the other Military Services will also be furnished, if identified, to their appropriate Dosimetry Center, for archiving.

c. The USAPHC will forward a copy of all DU assessment and testing results to the DHCC at Walter Reed National Military Medical Center. The DHCC serves as the central archive for all DoD patient information related to DU exposure, testing, and follow-up for active duty and reserve personnel. PCMs will forward copies of all referrals and narrative summaries from DU follow-up care to the DHCC for archiving.

d. USAPHC will provide a semi-annual summary report of the results and data from DU urine bioassay and metal fragment analyses to MEDCOM G-3/5/7, Health and Wellness. These reports, covering the 1 October-31 March and 1 April-30 September time frames, must be provided to Health and Wellness NLT the first Friday of May and November IAW current DoD reporting requirements (References 1 and 2, Annex A).

15. Training.

a. All HCPs (Physicians, Physician Assistants, Nurse Anesthetists, and Nurse Practitioners) will complete the Tier 1 DU General Awareness Training and the AMEDD Center and School's developed training on procedures to implement this policy. Newly assigned providers will complete the Army one-time DU Awareness Training and the AMEDD Center and School's training on procedures to implement this policy within

three months of assignment to the first duty station. References 8 thru 10, Annex A to this enclosure provide information on how to obtain support materials for DU Awareness Training.

b. HCPs will repeat the training on procedures to implement this policy at least biennially.

c. The MEDCOM G-3/5/7 Healthcare Operations will track the training of HCP and provide an annual report on the status of training within the US Army Medical Command.

Annex A – REFERENCES
Annex B – RESPONSIBILITIES FOR ARMY MEDICAL PERSONNEL
Annex C – SHORT QUESTIONNAIRE TO ASSESS POTENTIAL DU EXPOSURE
Annex D – DOD DU QUESTIONNAIRE AND DOD HEALTH SURVEY QUESTIONNAIRE
Annex E – PACKING AND SHIPPING REQUIREMENTS FOR DU BIOASSAY SPECIMENS
Annex F – HEALTHCARE PROVIDER CHECKLIST AND PROCEDURES FOR DU MEDICAL MANAGEMENT
Annex G – USE OF BIOASSAY IN SUSPECTED DU EXPOSURE SITUATIONS

ANNEX A
REFERENCES

1. Memorandum, Assistant Secretary of Defense for Health Affairs, 18 June 2012, subject: Clarification of the Requirement for Continuation of Semi-Annual Reporting of Results of Embedded Fragment Analyses.

2. Memorandum, Assistant Secretary of Defense for Health Affairs, 23 January 2012, subject: Operation IRAQI FREEDOM/Operation NEW DAWN Depleted Uranium Bioassay Results – 16th Semi-Annual Report and Policy on Future Data Submissions.

3. Memorandum, Assistant Secretary of Defense for Health Affairs, 9 April 2004, subject: Operation Iraqi Freedom Depleted Uranium Medical Management.

4. Memorandum, Assistant Secretary of Defense for Health Affairs, HA Policy 03-012, 30 May 2003, subject: Policy for the Operation Iraqi Freedom Depleted Uranium (DU) Medical Management.

5. Memorandum, Under Secretary of Defense for Personnel and Readiness, HA Policy 04-004, 6 February 2004, subject: Biomonitoring Policy and Approved Bioassays for Depleted Uranium and Lead.

6. Memorandum, US Army Medical Command, OTSG/MEDCOM Policy Memo 11-047, 10 June 2011, subject: Medical Management of Army Personnel Exposed to Depleted Uranium (DU).

7. Memorandum, US Army Medical Command, OTSG/MEDCOM Policy Memo 12-055, 6 June 2012, subject: Management of Metal Fragments Removed from Army Personnel.

8. Centers for Disease Control and Prevention, Fourth National Report on Human Exposure to Environmental Chemicals, 2009.

9. Centers for Disease Control and Prevention, Fourth National Health and Nutrition Examination Surveys, 2013.

10. Audiovisual product number 711231, Policy for the Treatment of Personnel Wounded by Depleted Uranium Munitions, 28 December 1998.

11. Audiovisual product number 806486, Medical Management of Depleted Uranium Casualties, 14 January 2000. This is a US Navy Bureau of Medicine and Surgery sponsored tape.)

12. Audiovisual product number 711314, TVT 3-120, Tier 1 Depleted Uranium (DU) General Awareness Training, 19 June 2000.

13. Army Regulation (AR) 40-5, Preventive Medicine, 25 May 2007.

ANNEX A (cont)
REFERENCES

14. North Atlantic Treaty Organization (NATO) Standardization Agreement (STANAG) 2068, "Emergency War Surgery," 12 September 2005.

15. American National Standards Institute (ANSI), HPS N13.22-1995, Bioassay Programs for Uranium, 1996.

16. Department of Defense Directive (DODD) 6200.04, Force Health Protection, 9 October 2004.

17. DODD, 6490.02E, Comprehensive Health Surveillance, 8 February 2012.

18. Department of Defense Instruction (DODI) 6490.03, Deployment Health, 11 August 2006.

19. Presidential Review Directive (PRD) 5, Planning for Health Preparedness for and Readjustment of the Military, Veterans, and Their Families After Future Deployments, August 1998.

20. AR 385–10, Ch 7, The Army Safety Program, 24 August 2007.

21. AR 600-8-4, Line of Duty Policy, Procedures, and Investigations, Headquarters Department.

22. Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological Profile for Uranium (Update) and Public Health Statement, September 99.

23. AR 40-400, Patient Administration, 27 January 2010.

24. DOD/VA Clinical Practice Guideline for Post-Deployment Health Evaluation and Management, December 2001.

25. AR 700-48, Logistics: Management of Equipment Contaminated with Depleted Uranium or Radioactive Commodities, 16 September 2002.

26. Department of the Army Pamphlet (DA Pam) 700-48, Logistics: Handling Procedures for Equipment Contaminated with Depleted Uranium or Radioactive Commodities, 27 September 2002.

27. Logistics Management Institute, Final Draft: Candidate Biomarkers of Exposure, prepared for USACHPPM, 4 December 2002.

28. McDiarmid MA, Engelhardt SM, Dorsey CD, Oliver M, Gucer P, Wilson PD, Kane R, Cernich A, Kaup B, Anderson L, Hoover D, Brown L, Albertini R, Gudi R, Squibb KS. 2009. "Surveillance Results of Depleted Uranium-Exposed Gulf War I Veterans: Sixteen Years of Follow-Up." J. Toxicol. Envir. Health Part A, 72(1):14-29.

ANNEX B
RESPONSIBILITIES FOR ARMY MEDICAL PERSONNEL

1. G-3/5/7, Healthcare Operation (HCO), will include the Depleted Uranium (DU) training requirements identified in this memorandum in the Annual MEDCOM Command Training Guidance. HCO will top load the requirements in the Digital Training Management System (DTMS) in order to facilitate tracking of the initial implementation across the MEDCOM. HCO will monitor compliance by including the requirements as an item in the Organizational Inspection Program (OIP) checklist as well as monitor the US Army Medical Department (AMEDD) Center and School's development of a web based training module designed to educate health care providers on procedure to implement this policy.

2. G-3/5/7, Healthcare Delivery, Clinical Policy Services, will ensure that:

a. The clinical consultants are aware of and comply with this policy and the specified procedures.

b. The G-3/5/7, Ancillary Health Services Division provides oversight of the clinical laboratory support for the specified DU bioassay procedures.

3. Commanders, Regional Medical Commands (RMC), will:

a. Provide oversight and guidance to their health service area to implement this policy and its specified procedures, to include support planning for redeployment, demobilization, training of MTF and medical demobilization personnel on this policy.

b. Ensure the medical records of patients with retained DU fragments are properly coded according to the procedures specified in the enclosure to the basic policy memorandum.

c. Document DU Training in the DTMS. Ensure newly assigned healthcare providers (HCPs) complete the Army DU Awareness Training and the training on procedures to implement this policy within three months of assignment. Ensure HCPs repeat training on procedures to implement this policy at least biennially.

4. Commander, US Army Public Health Command (USAPHC), will:

a. Provide the Army bioassay and metal fragment identification processes and the archiving of all laboratory results and interpretations.

b. Provide the results of urine and fragment analyses to the clinical laboratory and the physician submitting the specimens consistent with approved USAPHC protocols and procedures with a goal of 45 calendar days.

B-1

ANNEX B (cont)
RESPONSIBILITIES FOR ARMY MEDICAL PERSONNEL

c. Serve as the Army lead for coordination of the laboratory procedures and sample management procedures between the Army, the other Military Services, and the Department of Veterans Affairs.

d. Provide a semi-annual summary report of the results and data from DU urine bioassay and metal fragment analyses to MEDCOM G-3/5/7, Health and Wellness. These reports, covering the 1 October-31 March and 1 April-30 September time frames, must be provided to Health and Wellness NLT the first Friday of May and November In Accordance With (IAW) current DoD reporting requirements (References 1 and 2).

e. Provide consultative assistance regarding the dose assessment/estimations and health implications of exposure to DU or metal fragments.

5. Commander, USAMEDD Center and School, will maintain and update as necessary training materials (to include web-based material) suitable for use by both Table of Organization and Equipment (TO&E) and Table of Distribution and Allowances (TDA) medical elements of the Active and Reserve Components worldwide. The training must encompass medical policies from both DoD and MEDCOM but with an emphasis on this MEDCOM policy.

6. Commanders/Officers In Charge of MTFs will ensure that:

a. This policy and its specified procedures are implemented for all encounters through their MTFs with patients with retained DU metal fragments and/or suspected inhalation exposure to DU.

b. DU Awareness training and training on the procedures specified in this policy are provided to their HCPs and documented IAW RMC guidance.

c. Consideration is given to appointing a single case manager for patients submitting urine specimens for DU bioassay.

7. HCPs or case managers at medical demobilization stations will:

a. Ensure the completion of the DD Form 2796, Post-Deployment Health Assessment, for all Army personnel processing through the stations.

b. Ensure the completion of the short DU exposure assessment questionnaire (see Annex C), when indicated by the DD Form 2796. Ensure completion of DA 2173 for all positive responses.

c. Assign a DU potential exposure Level (I, II, or III) to Soldiers with potential exposure, documenting the assigned Level on the DD Form 2796. The HCP must inform the patient about the results of the DU bioassay, and ensure that this

ANNEX B (cont)
RESPONSIBILITIES FOR ARMY MEDICAL PERSONNEL

communication and the health risk assessment and its interpretation are documented in the medical record. The HCP must also discuss any need for additional medical follow-up.

d. Refer all Soldiers assigned a potential DU exposure Level I or II to a primary care manager at the supporting MTF for further evaluation and/or bioassay, documenting the referral on the DD Form 2796.

8. Primary care managers (PCM) or case manager at MTFs will:

a. Review the DD Form 2796; the completed short questionnaire; and the assigned exposure Level for completeness. Assign and document an exposure Level category if one has not been assigned.

b. Refer the patient to the clinical laboratory for a 24-hour urine specimen collection and creatinine analysis. Inform the Soldier that results of laboratory tests may not be available until after he/she leaves the MTF. Inform the Soldier that the results will be sent to the Deployment Health Clinical Center (DHCC) and that they may be obtained by contacting the DHCC either on-line (www.pdhealth.mil), by telephone at (301) 400-1517, Fax: (301) 400-2907, or Toll **Free Help Line: (866) 559-1627.**

c. Complete the DoD DU Questionnaire and Health Survey (DD Form 2872 Test DU and DD Form 2872-1 Test, respectively), ensuring that the originals are placed in the individual medical record and a copy accompanies any specimens (fragments or urine) sent to USAPHC.

d. If the Soldier is available when the PCM receives the results of the DU bioassay, inform the Soldier of the results and document this communication, including the health risk assessment and its interpretation, in the medical record.

e. For patients with positive DU results, in coordination with the MTF DU Case Manager, communicate with the DHCC to arrange referral to the VA DU Follow-Up Program.

9. HCP in field medical units will:

a. Identify Army personnel with retained metal fragments and suspected inhalation or incidental exposure to DU. The initial HCP does this by:

(1) Reviewing and ensuring the completion of the DD Form 2796 for all redeploying/demobilizing Soldiers.

(2) Identifying wounded individuals and individuals with suspected DU exposure who provided a positive response on the DD Form 2796, Post-Deployment Health Assessment, to Questions 17, 18, or 19 regarding potential DU Exposure.

ANNEX B (cont)
RESPONSIBILITIES FOR ARMY MEDICAL PERSONNEL

(3) Ensuring completion of DA 2173 for all Soldiers with a positive response on DD 2796 Post-Deployment Health Assessment to questions 17, 18, or 19.

(4) Using the short exposure assessment questionnaire provided in Annex 3 to complete the potential exposure assessment; assigning a DU potential exposure Level (I, II, or III); and determining the need for bioassay for potentially exposed Soldiers.

(5) Documenting the assigned Level (I, II or III) of potential DU exposure on the DD Form 2796 and entering data into the JTTR.

b. Refer all individuals assigned a Level I or Level II potential DU exposure to their PCM at the MTF for further assessment and a 24-hour urine uranium analysis as soon as possible.

10. The DU Case Manager, will:

a. Adhere to the guiding principles and practices of the case management process.

b. Act as the single point of contact in the MTF on DU issues.

c. Facilitate the risk communication process including the transmittal bioassay results, coordination of potential referrals to the VA Long-Term DU Follow-up Program, and communication with the Deployment Health Clinical Center.

d. Ideally be appointed from one of the clinical specialties

11. Local Medical Laboratory Manager at MTFs will:

a. Collect and manage 24-hour urine specimens and fragments for DU analysis in accordance with procedures in this policy.

b. Maintain a roster of metal fragment specimen shipped with patient identification.

c. Be responsible for ensuring that results are entered into the individual's medical record and into the local automated clinical information system (e.g., CHCS or AHLTA).

ANNEX C

QUESTIONNAIRE TO ASSESS POTENTIAL DU EXPOSURE

Health Care Provider/Interviewer's Name:_____

Location & Date:_____

Patient's Name & Unit:_____

Conclusion/Exposure Level Assigned:_____

QUESTIONS	CIRCLE RESPONSE	
1. Were you in, on, or near (within 50 meters) an armored vehicle at the time the vehicle was struck by depleted uranium munitions?	Yes	No
2. Were you in a vehicle struck by armor-piercing munitions?	Yes	No
3. If you were in a vehicle struck by armor-piercing munitions, were the munitions DU or did you observe burning fragments (like a Fourth of July sparkler) when the vehicle was hit?	Yes	No
4. Were you in, on, or near (within 50 meters) a vehicle with depleted uranium armor (Abrams tank) at the time the armor was breached by DU or non-DU munitions?	Yes	No
5. Were you within 50 meters of a burning Abrams tank, British tank, Bradley Fighting Vehicle or any vehicle known to contain DU, DU armor or DU munitions?	Yes	No
6. Did your deployment duties involve repeated entry or recovery of vehicles likely damaged by munitions from an Abrams tank, British tank, Bradley Fighting Vehicle or USAF A-10 ("Warthog") aircraft?	Yes	No
7. Did you have any other reason to believe you were exposed to DU?	Yes	No
8. Do you currently retain fragments in your body from enemy or friendly fire?	Yes	No

FOR HEALTHCARE PROVIDER USE

DU Exposure Decision Matrix*

Yes Response to Question:	Exposure Level
1	I
2	Go to question 3
3	I
4	I
5	II
6	II
7	III Clinician's judgment on bioassay
8	Coded for fragments

C-1

ANNEX D

DoD DU QUESTIONNAIRE
AND
DoD HEALTH SURVEY QUESTIONNAIRE

The DD Form 2872 Test, DU Questionnaire, and DD Form 2872-1 Test, Health Survey, forms can be found on the Deployment Health Clinical Center (DHCC) website http://www.pdhealth.mil/du.asp. AMEDD personnel through local reproduction will use the DU questionnaire and the Health Survey forms until a standardized SF 600 overprint is approved and provided to the field.

There are versions in Adobe Acrobat as well as a link to a ProForm or FormFlow versions also available at DHCC. These versions should allow electronic completion.

ANNEX E

PACKING AND SHIPPING REQUIREMENTS FOR DU BIOASSAY & OTHER HEAVY METAL ALLOY SPECIMENS

1. Request your MTF stock these items for your use in shipping bioassay specimens (items 1a through 1e) and metal fragments (items 1e and 1f) to US Army Public Health Command (USAPHC). For your first-time collections, USAPHC may be able to ship by Federal Express a limited number of these items for your use.

a. Bottles used for collecting and mailing urine specimens are Fisher one liter wide-mouth plastic bottles (Cat #: 02-896-2F from Fisher Scientific, www.fishersci.com (1-800-640-0640)).

b. Two 5.6 quart, round, metal (Cat#: C-680, HAZMATPAC, www.hazmatpac.com (1-800-923-9123)).

c. Absorbent Packing Material (Cat#: SP-U100, 50/pack, HAZMATPAC, www.hazmatpac.com (1-800-923-9123)).

d. Shipping Boxes (Lynchburg Sheltered Industries NSN#183-9491 12x12x12, www.lsiworks.org (1-434-847-4488)).

e. Use "Ziploc" type freezer bags to protect memoranda, laboratory slips, and other documents and sample information sent with the urine specimens or metal fragments.

f. Plastic specimen cups for shipping metal fragments.

2. Collect 24-hour urine specimen in one liter Fisher Wide mouthed bottles.

a. Label bottles with SS# and Name, and number them #1, #2.

b. Remove a 1-2 mL sample aliquot from the total specimen for creatinine analysis and perform the analysis (one result for the entire 24-hour specimen).

c. Place specimens in the 5.6 quart metal can, wrap each can with absorbent material (i.e., baby diaper), place in shipping box and send specimen, creatinine results, DU questionnaires, SF557 slips, and analysis requests by FEDEX, DHL, or best available means to USAPHC.

3. For shipment of metal fragments, place the fragment specimen(s) in a small plastic specimen cup to maintain the integrity of the specimen(s).

ANNEX E (cont)
PACKING AND SHIPPING REQUIREMENTS FOR DU BIOASSAY & OTHER HEAVY METAL ALLOY SPECIMENS

a. Clearly label the cup with the MTF lab order number, patient name and Social Security Number, date of collection, and requesting physician's name.

b. Do not place fragments from different patients in the same sample cup (very important). If there is a desire to distinguish multiple fragments (from the same patient) removed from different parts of the body, use separate fragment cups for each fragment.

c. DO NOT preserve a fragment specimen by any means (no formalin). Preservation of metal fragments is not necessary and creates an unnecessary hazardous waste.

d. Place the plastic specimen cup in an appropriately sized shipping box. Include the supporting paperwork (enclosed in a freezer bag for protection).

4. Mail or ship (FEDEX, DHL or best available means) the packages of urine specimens or metal fragments to the following address:

U.S. ARMY PUBLIC HEALTH COMMAND
ATTN: MCHB-TS-LOD Sample Management Lab
Building E-2100
Bush River Road
ABERDEEN PROVING GROUND, MARYLAND 21010-54035.

5. Before shipping any urine specimens or metal fragments to USAPHC, please contact the USAPHC Laboratory by telephone and/or e-mail. Contact information is as follows:

Chief, Inorganic-Radiochemistry Section, (410) 436-8244, DSN 584-8244, or Thomas.e.beegle.civ@mail.mil.

USAPHC Sample Alert email Address (also known as the Sample News Bulletin), usarmy.apg.medcom-phc.mbx.dls-sampnews@mail.mil (410-436-8356)

(If needed) The USAPHC EOC Current Operations' SIPRNET address is: usachppm-eoc@usachppm.army.smil.mil.

E-2

ANNEX F

HEALTHCARE PROVIDER CHECKLIST AND PROCEDURES FOR DU MEDICAL MANAGEMENT

____ If the individual is wounded, has been identified by unit or chain of command as potentially exposed to DU, completes DD Form 2796 indicating a DU exposure, or has already been identified by DOD as possibly DU-exposed, an individual DU exposure assessment questionnaire and examination needs to be completed. Annex G is a flow diagram of this process.

____ Complete the short exposure assessment questionnaire (see Annex C) to identify potential exposure level of individuals. See definitions of three Levels of DU exposure in paragraph 4 of the current DU Policy.

____ Order 24-hour urine collection and urine creatinine level for all Level I and II individuals. A urine creatinine test must be performed on urine specimens. NOTE: Urine collection is not required in a theater of operations. Higher Role medical facilities acting as enroute processing points for redeploying Soldiers should **not** collect specimens on Soldiers; **however, when a urine specimen for DU bioassay is required, based upon the potential DU exposure level, the medical treatment facility (MTF) should document on the DD Form 2796, Post-Deployment Health Assessment, and other medical records (e.g., DD Form 2766, sections 5 and 7 (block 20) that a 24-hour urine specimen for DU bioassay should be collected by the Soldier's home station MTF.** In addition, code the information into the Ambulatory Data Management (ADM) (previously called Ambulatory Data System (ADS)) and the Composite Healthcare System (CHCS).

____ Complete the DD Form 2872 Test, DU Questionnaire, and DD Form 2872-1 Test, Health Survey, (Annex D) for all individuals who provide fragments and/or a 24-hour urine specimen for uranium bioassay analysis. Retain a copy of these forms in the medical record.

____ Order 24-hour urine collection for uranium bioassay for Level III individuals, only if based on other medical indications from the assessment or on the potentially exposed individual's request.

____ Send the 24-hour urine specimen with a completed Standard Form 557, Miscellaneous; a copy of the completed DoD DU Questionnaire and Health Survey; and results of a urine creatinine analysis, using an aliquot of the 24-hour urine collection, to USAPHC for DU analysis.

____ For corroboration of the urine creatinine measurement level and for input into the dose assessment, the patient's age, sex, height, and weight must also be provided on the laboratory request, Standard Form 557, Miscellaneous. Any pertinent clinical findings, such as patient hydration status (e.g., increased fluid intake) that may affect interpretation of laboratory results should be included.

____ Instructions for urine collection, type of collection containers, shipping instructions, and mailing addresses can be found in Annex E.

____ All metallic fragments removed surgically from patients classified as Level I must be sent to USAPHC for analysis. Instructions and mailing addresses are at Annex E. Metal fragments removed from other than potentially DU-exposed patients should be sent to USAPHC for analysis in accordance with OTSG/MEDCOM Policy Memo 12-055, Management of Metal Fragments Removed from Army Personnel.

____ Inform the soldier of the results of the DU bioassay and document this communication, including the health risk assessment and its interpretation, in the medical record.

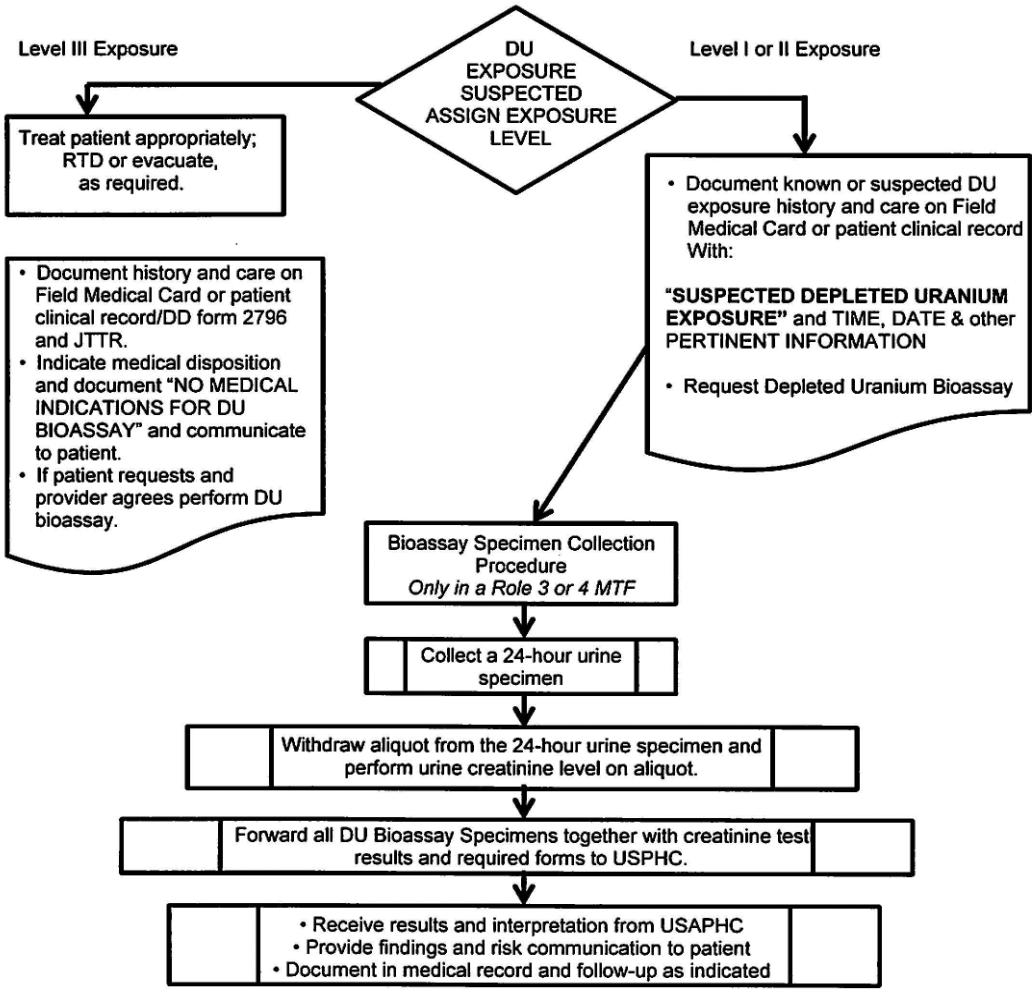
____ For patients with positive DU results, in coordination with the MTF DU Case Manager, communicate with the DHCC to arrange referral to the VA DU Follow-Up Program

ANNEX G

USE OF BIOASSY IN SUSPECTED DU EXPOSURE SITUATIONS*

*Note: There is no requirement to collect urine in Theater.

1. Determine the DU exposure level category (Levels I, II, or III)
2. Document suspected DU exposure on the field medical card for Roles 1 and 2, or in the medical record on the DD Form 2766 for Roles 3 and 4, or on DD Form 2796 for re-deploying personnel.
3. Send 24-hour urine specimen, urine creatinine test results, Miscellaneous SF 557, and Supplemental DU exposure questionnaire to USAPHC laboratory for all personnel assigned a Level I and II exposure Category



G-1

Appendix J

Additional information on DU

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

NATURAL AND DEPLETED URANIUM

CAS # 7440-61-1

Division of Toxicology and Human Health Sciences ToxFAQs™ **February 2013**

This fact sheet answers the most frequently asked health questions (FAQs) about natural and depleted uranium. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Natural uranium is a naturally occurring chemical substance that is mildly radioactive. Depleted uranium is an adjusted mixture of natural uranium isotopes that is less radioactive. Everyone is exposed to low amounts of uranium through food, water, and air. Exposure to high levels of natural or depleted uranium can cause kidney disease. Uranium has been found in at least 67 of 1,699 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is uranium?

Uranium is a naturally occurring radioactive element. It is naturally present in nearly all rocks, soils, and air; can be redistributed in the environment through wind and water erosion; and more can be released into the environment through volcanic eruptions. Natural uranium is a mixture of three isotopes: ^{234}U, ^{235}U, and ^{238}U. The most common isotope is 238U; it makes up over 99% of natural uranium. All three isotopes behave the same chemically, but they have different radioactive properties. The half-lives of uranium isotopes (the amount of time needed for half of the isotope to give off its radiation and change into a different element) is very long. The least radioactive isotope is ^{238}U with a half life of 4.5 billion years. Depleted uranium is a mixture of the same three uranium isotopes except that it has very little ^{234}U and ^{235}U. It is less radioactive than natural uranium. Enriched uranium is another mixture of isotopes that has more ^{234}U and ^{235}U than natural uranium. Enriched uranium is more radioactive than natural uranium.

Uranium is almost as hard as steel and much denser than lead. Natural uranium is used to make enriched uranium; depleted uranium is the leftover product. Enriched uranium is used to make fuel for nuclear power plants. Depleted uranium is used as a counterbalance on helicopters rotors and airplane control surfaces, as a shield to protect against ionizing radiation, as a component of munitions to help them penetrate enemy armored vehicles, and as armor in some parts of military vehicles.

What happens to uranium when it enters the environment?

- Natural and depleted uranium that exist in the dust in the air settle onto water, land, and plants. Uranium deposited on land can be reincorporated into soil, washed into surface water, or stick to plant roots. Uranium in air, surface water, or groundwater can be transported large distances.

How might I be exposed to uranium?

- Food and drinking water are the primary sources of intake for the general public. Very low levels of uranium are found in the air.
- Root crops such as potatoes, parsnips, turnips, and sweet potatoes contribute the highest amounts of uranium to the diet. Because uranium in soil can stick to these vegetables, the concentrations in these foods are directly related to the concentrations of uranium in the soil where the foods are grown.
- In most areas of the United States, low levels of uranium are found in the drinking water. Higher levels may be found in areas with elevated levels of naturally occurring uranium in rocks and soil.
- People may be exposed to higher levels of uranium if they live near uranium mining, processing, and manufacturing facilities. People may also be exposed if they live near areas where depleted uranium weapons are used..

How can uranium enter and leave my body?

Most of the uranium you breathe or ingest is not absorbed and leaves the body in the feces. Absorbed uranium is deposited throughout the body. The highest levels are found in the bones, liver, and kidneys; 66% of the uranium in the body is found in your bones. It can remain in the bones for a long time; the half-life of uranium in bones is 70–200 days. Most of the uranium that is not in bones leaves the body in the urine in 1–2 weeks.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, Public Health Service
Agency for Toxic Substances and Disease Registry

Figure J-1. ATSDR Natural and Depleted Uranium

Page 2

NATURAL AND DEPLETED URANIUM
CAS # 7440-61-1

ToxFAQs™ Internet address is http://www.atsdr.cdc.gov/toxfaqs/index.asp

How can uranium affect my health?
Natural uranium and depleted uranium have the identical chemical effect on your body. Kidney damage has been seen in humans and animals after inhaling or ingesting uranium compounds. However, kidney damage has not been consistently found in soldiers who have had uranium metal fragments in their bodies for several years. Ingesting water-soluble uranium compounds will result in kidney effects at lower doses than following exposure to insoluble uranium compounds.

Studies in animals have shown that inhalation exposure to insoluble uranium compounds can result in lung damage. In male rats and mice, exposure to uranium has been shown to decrease fertility. Uranium compounds on the skin caused skin irritation and mild skin damage in animals.

Health effects of natural and depleted uranium are due to chemical effects and not to radiation.

How likely is uranium to cause cancer?
Neither the National Toxicology Program (NTP), the International Agency for Research on Cancer (IARC) nor the EPA have classified natural uranium or depleted uranium with respect to carcinogenicity.

How can uranium affect children?
The health effects seen in children from exposure to toxic levels of uranium are expected to be similar to the effects seen in adults.

Exposure of animals to high levels of uranium during pregnancy, which caused toxicity in the mothers, has induced early deaths and birth defects in the young. It is not clear if this can happen in the absence of effects on the mother. We do not know whether uranium can cause birth defects in people. There are some studies that suggest that exposure to depleted uranium increased the frequency of birth defects, but the studies are deficient to allow valid conclusions.

How can families reduce the risk of exposure to uranium?
- Avoid eating root vegetables grown in soils with high levels of uranium. Consider washing fruits and vegetables grown in that soil and discard the outside portion of root vegetables.
- Consider having your water tested if you suspect that your drinking water might have elevated levels of uranium; if elevated levels are found, consider using bottled water.

Is there a medical test to determine whether I've been exposed to uranium?
Natural uranium is in your normal diet, so there will always be some level of uranium in all parts of your body. If depleted uranium is present, it adds to the total uranium level. Uranium can be measured in blood, urine, hair, and body tissues. Most tests are for total uranium; however, expensive tests are available to estimate the amounts of both natural and depleted uranium that are present.

Has the federal government made recommendations to protect human health?
The government has made recommendations for uranium which apply to natural and depleted uranium combined.

The EPA established a maximum drinking water contaminant level of 0.03 mg/L.

The Occupational Safety and Health Administration has limited workers' exposure in air to an average of 0.05 mg U/m^3 for soluble uranium and 0.25 mg U/m^3 for insoluble uranium over an 8-hour workday.

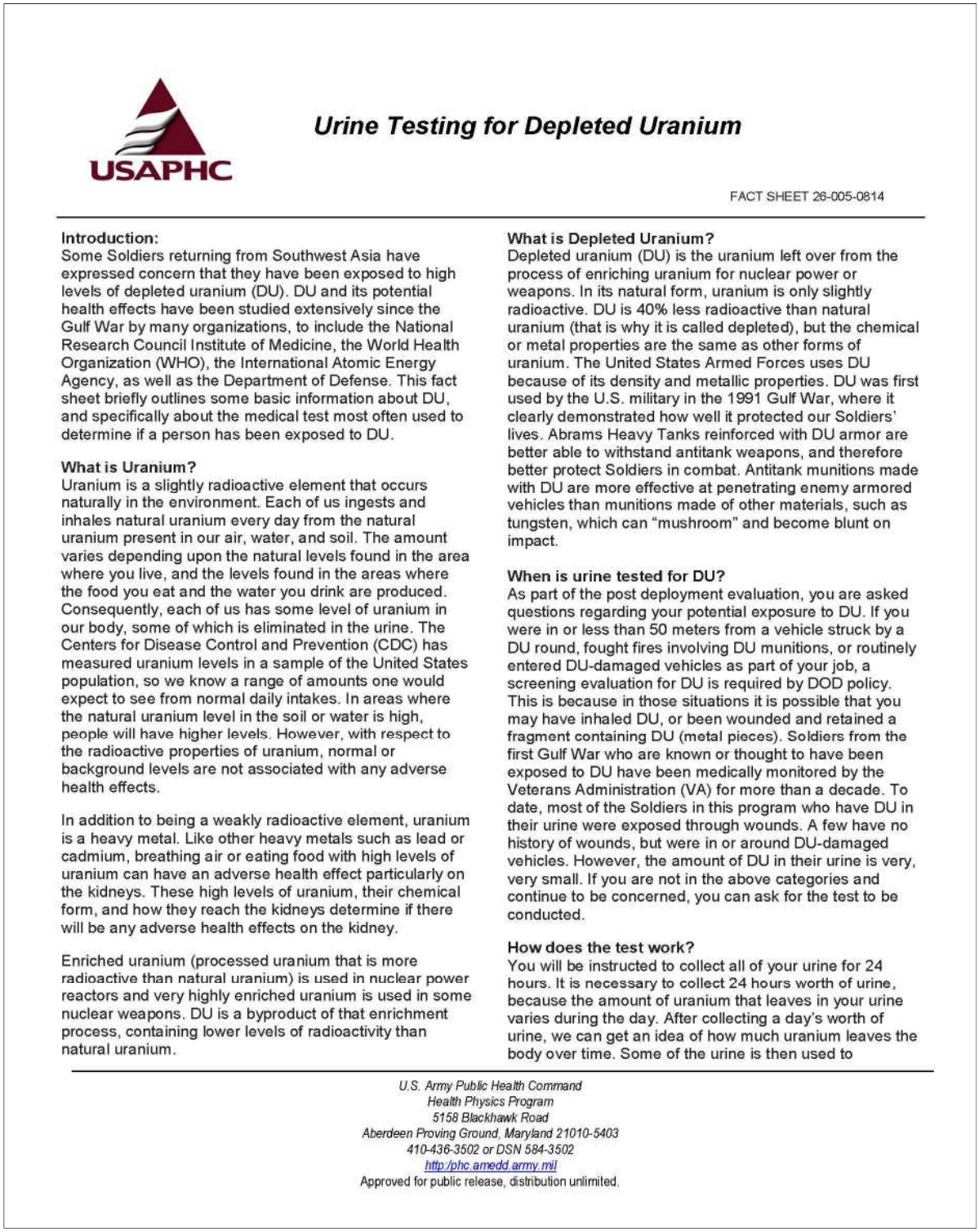
The National Institute for Occupational Safety and Health recommends workers exposure be limited to 0.05 mg U/m^3 of air for soluble uranium and 0.2 mg U/m^3 for insoluble uranium averaged over a 10-hour workday and recommends that exposure to soluble uranium not exceed 0.6 mg U/m^3 for more than 15 minutes.

The Nuclear Regulatory Commission has established air concentration limits for uranium and its individual isotopes that apply to occupational exposure and releases from facilities.

References
Agency for Toxic Substances and Disease Registry (ATSDR). 2013. Toxicological Profile for Uranium. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30333. Phone: 1-800-232-4636, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Figure J-1. ATSDR Natural and Depleted Uranium



USAPHC

Urine Testing for Depleted Uranium

FACT SHEET 26-005-0814

Introduction:
Some Soldiers returning from Southwest Asia have expressed concern that they have been exposed to high levels of depleted uranium (DU). DU and its potential health effects have been studied extensively since the Gulf War by many organizations, to include the National Research Council Institute of Medicine, the World Health Organization (WHO), the International Atomic Energy Agency, as well as the Department of Defense. This fact sheet briefly outlines some basic information about DU, and specifically about the medical test most often used to determine if a person has been exposed to DU.

What is Uranium?
Uranium is a slightly radioactive element that occurs naturally in the environment. Each of us ingests and inhales natural uranium every day from the natural uranium present in our air, water, and soil. The amount varies depending upon the natural levels found in the area where you live, and the levels found in the areas where the food you eat and the water you drink are produced. Consequently, each of us has some level of uranium in our body, some of which is eliminated in the urine. The Centers for Disease Control and Prevention (CDC) has measured uranium levels in a sample of the United States population, so we know a range of amounts one would expect to see from normal daily intakes. In areas where the natural uranium level in the soil or water is high, people will have higher levels. However, with respect to the radioactive properties of uranium, normal or background levels are not associated with any adverse health effects.

In addition to being a weakly radioactive element, uranium is a heavy metal. Like other heavy metals such as lead or cadmium, breathing air or eating food with high levels of uranium can have an adverse health effect particularly on the kidneys. These high levels of uranium, their chemical form, and how they reach the kidneys determine if there will be any adverse health effects on the kidney.

Enriched uranium (processed uranium that is more radioactive than natural uranium) is used in nuclear power reactors and very highly enriched uranium is used in some nuclear weapons. DU is a byproduct of that enrichment process, containing lower levels of radioactivity than natural uranium.

What is Depleted Uranium?
Depleted uranium (DU) is the uranium left over from the process of enriching uranium for nuclear power or weapons. In its natural form, uranium is only slightly radioactive. DU is 40% less radioactive than natural uranium (that is why it is called depleted), but the chemical or metal properties are the same as other forms of uranium. The United States Armed Forces uses DU because of its density and metallic properties. DU was first used by the U.S. military in the 1991 Gulf War, where it clearly demonstrated how well it protected our Soldiers' lives. Abrams Heavy Tanks reinforced with DU armor are better able to withstand antitank weapons, and therefore better protect Soldiers in combat. Antitank munitions made with DU are more effective at penetrating enemy armored vehicles than munitions made of other materials, such as tungsten, which can "mushroom" and become blunt on impact.

When is urine tested for DU?
As part of the post deployment evaluation, you are asked questions regarding your potential exposure to DU. If you were in or less than 50 meters from a vehicle struck by a DU round, fought fires involving DU munitions, or routinely entered DU-damaged vehicles as part of your job, a screening evaluation for DU is required by DOD policy. This is because in those situations it is possible that you may have inhaled DU, or been wounded and retained a fragment containing DU (metal pieces). Soldiers from the first Gulf War who are known or thought to have been exposed to DU have been medically monitored by the Veterans Administration (VA) for more than a decade. To date, most of the Soldiers in this program who have DU in their urine were exposed through wounds. A few have no history of wounds, but were in or around DU-damaged vehicles. However, the amount of DU in their urine is very, very small. If you are not in the above categories and continue to be concerned, you can ask for the test to be conducted.

How does the test work?
You will be instructed to collect all of your urine for 24 hours. It is necessary to collect 24 hours worth of urine, because the amount of uranium that leaves in your urine varies during the day. After collecting a day's worth of urine, we can get an idea of how much uranium leaves the body over time. Some of the urine is then used to

U.S. Army Public Health Command
Health Physics Program
5158 Blackhawk Road
Aberdeen Proving Ground, Maryland 21010-5403
410-436-3502 or DSN 584-3502
http://phc.amedd.army.mil

Figure J-2. Urine Testing Depleted Uranium

measure the total uranium level. This level measures both natural and depleted uranium if present. This level is compared to the amount of uranium we would expect to see in people based just on diet and the general environment around them without any unusual or additional DU exposure. This is our screening process. If your urine contains more uranium than what is considered typical, it will be tested further to see if it is DU.

What does the screening level of uranium mean?
Based on the population sampling discussed in the first question, scientists know the average amount of uranium Americans have in their urine from eating and drinking. This range represents what is called "background" levels of uranium, and is considered normal. It is not associated with any known health effects. We also know that the kidney is the organ most sensitive to very high amounts of uranium, and we know the amount of uranium in urine that can damage the kidneys. Based on experience from the first Gulf War, the amount of DU in the urine of any deployed Soldier will most likely be many thousands of times less than the amount that would have any measurable effect on the kidney or its functioning. Soldiers from the first Gulf War with embedded fragments containing DU continue to be followed and do not show any measurable decline in kidney or reproductive functions. However, we have chosen to use the "normal background" level of uranium as our screening level since it is not associated with any known health effects.

What does it mean if my urine results show uranium at higher than background levels?
If your urine uranium is higher than the "normal background," further testing of your urine will be done to see how much of it is naturally occurring uranium and how much is DU. Even though these are very low amounts of uranium, DU does not occur naturally and lab tests can confirm whether the uranium is natural or man-made. If DU is found in your urine, you should not have any health effects based on what we know from those with embedded fragments containing DU, and the extremely low levels we are measuring. However, as a precaution, you will be referred to the medical monitoring program (see final question).

Should I be concerned if you find depleted uranium?
Most likely not, but it depends on the amount. To date, the amount of uranium, depleted or not, measured in those individuals with fragments containing DU are many, many times lower than a level which could harm your kidneys, a very sensitive organ. These individuals have been followed for more than a decade and have not shown any adverse health effects related to DU exposure. Therefore, we are confident that anyone whose urine shows minimal DU will not develop any related kidney problems. The potential risk of cancer from radiation is also extremely small, since DU is less radioactive than natural uranium.

What will happen next?
Your urine analysis result will be compared to "normal background" levels to see if it is significant in any way. A radiation dose due to the measured DU is also estimated. So far, we have not seen any levels that have any radiation health risk of concern at all.

Why do you refer to the VA Depleted Uranium Follow-up Program?
Since we were originally unsure about the health effects from any fragments containing DU that were not removed, the Baltimore VA has and will continue to follow these soldiers from the first Gulf War very carefully. Some fragments could not be removed due to location or the damage that the surgery to remove them might cause. Although we have seen no health effects of concern, these soldiers with retained DU fragments continue to be followed very closely as a precaution. We refer individuals with DU levels consistent with injuries from fragments containing DU to the VA for additional, voluntary, long-term medical surveillance.

Where can I get more information about DU?

ATSDR Uranium Toxicological Profile and Public Health Statement http://www.atsdr.cdc.gov/toxprofiles/tp150.html

DU Library: Depleted Uranium Information Page
Deployment Health Support Directorate
http://fhpr.osd.mil/du/index.jsp

Deployment Health Clinical Center (DHCC)
Phone: 866-559-1627
http://www.pdhealth.mil/

US Army Public Health Command
http://phc.amedd.army.mil
Phone: 800-222-9698

Department of Veterans Affairs
http://www.va.gov/gulfwar

Figure J-2. Urine Testing Depleted Uranium

USAPHC

Depleted Uranium - Individual

FACT SHEET 26-003-0814

GENERAL INFORMATION	Uranium is an element found naturally in soil, water, and mineral deposits. It is a slightly radioactive substance composed of 3 naturally occurring isotopes (isotopes are atoms that differ only in their number of neutrons; they have similar physical properties), 238U, 235U, and 234U. All three isotopes are found together in Uranium ore. Depleted uranium is what remains after the more radioactive isotopes, 234U and 235U, are removed from uranium ore in order to make enriched uranium. Enriched uranium, which contains the more radioactive isotopes, is primarily used as fuel in nuclear reactors. All uranium, not just DU, is made up of almost all 238U. Natural and depleted uranium differ only in their radioactivity. Depleted uranium is roughly half (60%) as radioactive as natural uranium because there are less of the more radioactive isotopes (234U and 235U). The chemical properties of the isotopes are the same. It is the chemical properties that are responsible for many of the health effects of concern, such as possible kidney effects. Depleted uranium also contains trace amounts of 236U and other trace substances such as plutonium, americium and technetium. These amounts are so small that they are very difficult to measure and have no affect on health or the environment. Everyone has some exposure to natural uranium that can be measured in the urine.
ROUTINE USES IN THE DEPLOYED SETTING	The United States Armed Forces have used DU in the manufacture of munitions, armor, and armor-piercing projectiles. DU projectiles are capable of readily penetrating armor. Armor constructed with DU provides a high degree of shielding and resistance to penetration. During the 1991 Gulf War (GW), depleted uranium containing munitions were used on a large scale for the first time. In the manufacture of projectiles and armor, depleted uranium is alloyed with small amounts of other metals.
EXPOSURE SCENARIOS	When a vehicle is impacted and perforated by a DU projectile, the projectile forms particles of various sizes down to very fine aerosols. The bulk of a DU projectile may pass directly through the vehicle. The inside of the damaged vehicle remains contaminated with particles of DU and its oxides after the impact. In the event of a vehicular fire, the heat of the fire can cause any onboard DU ammunition to oxidize. Personnel in, on, or near (less than 50 meters) an armored vehicle when the vehicle is being penetrated by a depleted uranium munition may have exposures to DU and are categorized as Level (Category) I. In addition to breathing or swallowing DU, some crew members may be left with multiple tiny fragments of DU or DU-containing fragments in their bodies. Other Soldiers may be exposed to DU during operations to salvage combat vehicles that have been disabled by DU rounds or fight fires involving DU; these Soldiers are categorized as Level II. Level II personnel are expected to have lower exposures to DU than personnel in Level I. While Soldiers followed from the first Gulf War with retained DU or DU-containing fragments have not shown ill health effects, DOD and Army policies requires that any Soldier in either of these categories submit a urine specimen for analysis so that exposure to DU can be determined. Depending on the amount measured, these Soldiers may be followed over time. Simply riding in a vehicle with intact DU munitions or DU shielding will not result in significant intakes of DU. These and other similar scenarios are categorized as exposure Level (Category) III. For personnel in Level III, submitting a urine specimen for analysis is optional based on health care provider and patient concerns. If you are in this category and have concerns, please discuss them with your health care provider. DU Awareness Training explains how to avoid unnecessary exposure to DU in damaged vehicles.

U.S. Army Public Health Command
Health Physics Program
5158 Blackhawk Road
Aberdeen Proving Ground, Maryland 21010-5403
410-436-3502 or DSN 584-3502
http://phc.amedd.army.mil/
Approved for public release, distribution unlimited.

Figure J-3. Depleted Uranium-Individual

SIGNS AND SYMPTOMS OF ACUTE AND CHRONIC EXPOSURE	DU is a heavy metal, like lead and others, and when there are large amounts in the body; heavy metals can damage the kidneys. The kidneys filter the blood, and waste products from the blood are passed to the urine and eliminated from the body. If DU is found in the urine, this is a signal that DU has been taken in to the body. In all but very rare cases, there will be no immediate noticeable effects from DU. However, the concern is that over time filtering the DU could damage the kidneys. For this reason, if the Soldier has a higher chance for DU exposure (Level I or II), then we measure the amount of DU in the urine. Based on the amount measured, it is then decided whether to recommend referral of the soldier to the VA long term monitoring program. This Soldier doesn't need to get any special treatment. Fragments containing DU retained in the body slowly release DU. This DU continues to pass in to the urine at amounts that can be easily measured. Soldiers who have retained fragments are followed because their exposures (and amounts of DU in the urine) are representative of continued internal exposure and require long term monitoring of the kidneys. Since the amount of radioactivity in DU is low, it is not thought that there is any concern for cancer from radiation. All people have some exposure to naturally occurring radioactive materials, including uranium.
MEDICAL TREATMENT	If you are wounded with a DU or DU-containing fragment, the treatment will be based on removal of the fragment, just as if the wound was from a bullet. Some bullets are stuck in places that make it hard to remove and the surgeons decide to leave them in place rather than damage tissue trying to dig them out. If that happens, we do look at how much DU is leaving the body to decide if the kidneys should be watched closely. DU fragments will show up on X-rays just like bullets. Someone with a retained DU or DU-containing fragment is not "radioactive" and does not pose a risk to others. Individuals who have only breathed in or swallowed DU should not have any acute symptoms and could be required to submit a urine specimen depending on how they were exposed. If you have a chronic DU exposure, your health care providers will refer you to the Department of Veterans Affairs (VA) for additional follow up.
LONG TERM MEDICAL SURVEILLANCE REQUIREMENTS OF HEALTH EFFECTS MONITORING	Since 1993, the VA has been following a number of Gulf War veterans who were seriously injured in fratricide incidents involving depleted uranium. The current cohort of Gulf War veterans contains 77 individuals. These veterans are being monitored at the Baltimore VA Medical Center. About half of this group still has fragments containing depleted uranium in their bodies. Those veterans with retained depleted uranium fragments have shown higher than normal levels of uranium in their urine since monitoring began in 1993. These veterans are being followed very carefully and numerous medical tests are being done to determine if the depleted uranium fragments are causing any health problems. For all veterans in the program (including those with retained depleted uranium fragments), all tests for kidney function have been normal (though small differences in some urinary biomarkers have been detected in the higher urinary DU group). In addition, the reproductive health of this group appears to be normal in that all babies fathered by these veterans between 1991 and 1997 had no birth defects.
SPECIAL RISK COMMUNICATION INFORMATION	Exposure to DU (as an aerosol or as part of an embedded fragment) is only one of many potentially hazardous substances that Soldiers may be exposed to during deployment and combat operations. There are two potential hazards when large amounts of DU are taken in to the body. The first concern is related to the effects associated with heavy metal toxicity, much like that seen with tungsten, lead, and cadmium on the kidney. The second area of concern is related to the possible long-term effects related to DU's low-level radioactivity. Follow up of individuals with retained DU fragments has not shown evidence of adverse health effects related to internalized DU. Those individuals who show elevated DU in the screening urine bioassay are being followed as a precaution.

Figure J-3. Depleted Uranium-Individual

USAPHC

Depleted Uranium - Medical

FACT SHEET 26-004-0814

GENERAL INFORMATION	Uranium is an element found naturally in soil, water, and mineral deposits. It is a slightly radioactive substance composed of 3 naturally occurring isotopes (isotopes are atoms that differ only in their number of neutrons; they have similar physical properties), 238U, 235U, and 234U. All three isotopes are found together in Uranium ore. Depleted uranium is what remains after the more radioactive isotopes, 234U and 235U, are removed from uranium ore in order to make enriched uranium. Enriched uranium, which contains the more radioactive isotopes, is primarily used as fuel in nuclear reactors. All uranium, not just DU, is made up of almost all 238U. Natural and depleted uranium differ only in their radioactivity. Depleted uranium is roughly half (60%) as radioactive as natural uranium because there are less of the more radioactive isotopes (234U and 235U). The chemical properties of the isotopes are the same. It is the chemical properties that are responsible for many of the health effects of concern, such as possible kidney effects. Depleted uranium also contains trace amounts of 236U and other trace substances such as plutonium, americium and technetium. These amounts are so small that they are very difficult to measure and have no affect on health or the environment.
ROUTINE USES IN THE DEPLOYED SETTING	The United States Armed Forces have used DU in the manufacture of munitions, armor, and armor-piercing projectiles. DU projectiles are capable of readily penetrating armor. Armor constructed with DU provides a high degree of shielding and resistance to penetration. During the 1991 Gulf War (GW), depleted uranium containing munitions were used on a large scale for the first time. In the manufacture of projectiles and armor, depleted uranium is alloyed with small amounts of other metals.
EXPOSURE SCENARIOS	When a vehicle is impacted and perforated by a DU projectile, the projectile forms particles of various sizes down to very fine aerosols. The bulk of a DU projectile may pass directly through the vehicle. The inside of the damaged vehicle remains contaminated with particles of DU and its oxides after the impact. In the event of a vehicular fire, the heat of the fire might cause any onboard DU projectiles to oxidize. Personnel in, on, or near (less than 50 meters) an armored vehicle when the vehicle is being impacted by a depleted uranium projectile are considered at risk for exposure to DU that requires evaluation by urine bioassay. These types of exposure are categorized as Level (Category) I. Personnel in Level I have the highest potential for DU intakes that might exceed occupational exposure limits and guidelines. Level I personnel may internalize depleted uranium through inhalation, ingestion, wound contamination, and wounds (embedded fragments). Some crew members may be left with multiple tiny fragments of DU or DU-contaminated fragments embedded in their muscle and soft tissue. Other Soldiers may also be exposed to DU during operations to salvage combat vehicles that have been disabled by DU rounds. Personnel who routinely enter damaged vehicles in recovery operations or fight fires involving DU are categorized as exposure Level (Category) II and also require a urine bioassay. Simply riding in a vehicle with intact DU munitions or DU shielding will not result in significant intakes of DU. These and other similar scenarios are categorized as exposure Level (Category) III and urine bioassay are optional based on health care provider and patient concerns.

U.S. Army Public Health Command
Health Physics Program
5158 Blackhawk Road
Aberdeen Proving Ground, Maryland 21010-5403
410-436-3502 or DSN 584-3502
http://phc.amedd.army.mil
Approved for public release, distribution unlimited.

Figure J-4. Depleted Uranium-Medical

SIGNS AND SYMPTOMS OF ACUTE AND CHRONIC EXPOSURE	The major health concerns about internalized depleted uranium relate to its chemical properties as a heavy metal rather than to its radioactivity, which is very low. As with all heavy metals, the hazard depends mainly upon the chemical form, the amount taken into the body and the solubility of the DU particles within the body fluids. It has been recognized that very high uranium intakes can cause kidney damage. Chronic exposure by inhalation represents potential radiological hazard to the lung. Uranium miners have an increased risk of lung cancer after long term exposures to natural uranium and its radioactive progeny (including radon); however, this increase in lung cancer risk is attributed to radon and not to the radioactivity of uranium. DU is less radioactive than natural uranium. There are no acute health effects for Level I and II expected; however, in rare instances Level I exposures could cause acute effects to the kidney.
MEDICAL TREATMENT	Casualties may have depleted uranium contamination on their clothing and skin. Under no circumstances should casualty extraction, treatment, or evacuation be delayed due to the presence of depleted uranium. Standard aidman procedures for treating wounded personnel should be followed. Wounds and burns should be cleaned and debrided using standard surgical procedures. Normal "universal precautions" (surgical gloves, surgical mask, and throwaway surgical gowns) are more than adequate to protect medical personnel from accidental contamination with depleted uranium. Items contaminated with depleted uranium should be disposed of using standard universal precaution procedures. Embedded depleted uranium fragments should be removed using standard surgical criteria except that large fragments (greater than 1 cm) should be more aggressively removed unless the medical risk to the patient is too great. The short-term consequences of retained DU fragments do not justify an aggressive approach during the early treatment of wounds. Appropriate treatment of the wound with removal of any easily accessible fragments should be performed. In the care of acute wounds, surgical judgment should avoid the risk of harm in removal of other fragments -even when known to be DU. DU fragments may always be removed at a later date. Fragment sizes can vary from very small (several millimeters) to large (1 to 2 cm) and are readily discernible by x-ray examination. Individuals who have been potentially exposed to DU by inhalation should not have any acute symptoms and should be treated only if injured. Urine bioassay to assess exposure should be performed in accordance with existing Army and DOD policies. Individuals with chronic DU exposure will be referred to the Department of Veterans Affairs (VA) for additional surveillance.
LONG TERM MEDICAL SURVEILLANCE REQUIREMENTS OF HEALTH EFFECTS MONITORING	Since 1993, the VA has been following a number of Gulf War veterans who were seriously injured in fratricide incidents involving depleted uranium (Category I). The current cohort of Gulf War veterans contains 77 individuals. These veterans are being monitored at the Baltimore VA Medical Center. About half of this group still has fragments containing depleted uranium in their bodies. Those veterans with retained depleted uranium fragments have shown higher than normal levels of uranium in their urine since monitoring began in 1993. These veterans are being followed very carefully and numerous medical tests are being done to determine if the depleted uranium fragments are causing any health problems. For all veterans in the program (including those with retained depleted uranium fragments), all tests for kidney function have been normal (though small differences in some urinary biomarkers have been detected in the higher urinary DU group). In addition, the reproductive health of this group appears to be normal in that all babies fathered by these veterans between 1991 and 1997 had no birth defects.
SPECIAL RISK COMMUNICATION INFORMATION	Depleted uranium aerosols are only one of many potentially hazardous substances that Soldiers may be exposed to during deployment and combat operations. There are two potential hazards associated with exposure to large amounts of DU aerosols or retained fragments. The primary concern is the effect associated with heavy metal toxicity, much like that seen with tungsten, lead, and cadmium on the kidney. The second area of concern is with DU's low-level radioactivity. Follow-up of individuals with retained DU fragments have not shown evidence of adverse health effects related to internalized DU. Those individuals who show elevated DU in the screening urine bioassay are being followed as a precaution.

Figure J-4. Depleted Uranium-Medical

Long-Term Health Effects Associated in Service Members with Level I DU Exposure

Health effects of depleted uranium are typically related to chemical (heavy metal) toxicity rather than any radiological effects. Most information about the known health effects of DU exposures are derived from studies of natural uranium exposure on miners and millers who have chronic exposures, more intense exposures; longer duration of exposures; and have additional exposures to radon & other potentially toxic substances.

Exposure to depleted uranium can occur by external exposure or internal (inhalation, ingestion, and breaks in the skin) exposure. External exposures are usually not a significant risk, because DU is an alpha particle emitter. Alpha particles travel a short distance in air (a few centimeters) and have poor penetration into any nearby materials. Clothing and intact skin, even a sheet of paper, provide adequate protection from DU and any residual DU can be washed off.

Inhalation of any DU dust and fumes can cause irritation to the lungs, but long term health effects are not expected from an acute exposure. Most inhaled or ingested uranium in not absorbed systemically and is cleared from the body. There can be some systemic absorption of DU from an acute exposure. However, there is no evidence of any health effects from this type of internal exposure, including effects on the kidneys (the organ most sensitive to DU), which tends to be the target organ for heavy metals. DU may also be found in the liver and the bones. According to the Agency for Toxic Substances and Disease Registry, “No health effects, other than kidney damage, have been consistently found in humans after inhaling or ingesting uranium compounds or in soldiers with uranium metal fragments in their bodies.” Some human and animal studies of cancer effects of uranium (which is more radioactive) have demonstrated increases in lung cancer. The human studies involved uranium miners whose long-term exposures differ substantially from military exposure to depleted uranium, and in addition, these studies have some methodological problems. These studies have not found increases in kidney or bone cancer.

The Depleted Uranium Follow-Up Program is an ongoing clinical surveillance program started in1993 at the Baltimore VA Medical Center. It began with 33 Soldiers with retained DU who were involved in DU friendly fire incidents. As of 2009, 79 cases have been evaluated from Gulf War I and 4 cases have been evaluated from Operation Iraqi Freedom. In 1998, the urine uranium testing portion was added. As expected, Soldiers with retained DU fragments have higher urine uranium levels than average. Some Soldiers with injuries or retained fragments have symptoms related to those injuries and the physical presence of a fragment. These Veterans have been being followed for 18 years with thorough medical evaluations every two years. Otherwise, there is no difference in health measures when compared to non-exposed GW Veterans.

Out of an additional 3246 Veterans who had a 24 urine collection tested for uranium under the DU screening program, four were identified as having an elevated amount of urine Uranium and all four were involved in friendly fire incidents and/or have DU shrapnel. These are the two groups considered to have had a high level of exposure, i.e., level I, and thus far, there are no specific adverse health effects reported in these Veterans. No renal abnormalities have been consistently seen; no evidence indicating that DU is genotoxic, mutagenic, or that it has reproductive effects. Additionally, based on questionnaire data, there have been no birth defects noted in over 80 children born to Gulf War veterans in DU Follow-up Program (including those with retained fragments).

The article discussing long-term follow-up may be found at:
(http://www.publichealth.va.gov/exposures/depleted_uranium/followup_program.asp

Appendix K

Particulate Matter Fact Sheet

USAPHC

Particulate Matter (PM) Air Pollution Exposures During Military Deployments

FACT SHEET 64-009-0414

Background. Particulate matter (PM) air pollutants are a complex mixture of extremely small solid particles and liquid droplets in the air. When breathed in, these particles can reach deep into the lungs and cause various health effects. There are generally two size ranges of particles in the air that are of health concern. These include: 1) particles with a diameter less than or equal to 10 microns (PM_{10}), and 2) even smaller particles [less than a diameter of 2.5 microns ($PM_{2.5}$)]. The smaller particles ($PM_{2.5}$) have recently become an increasing concern since medical research shows that particles of this size are most likely responsible for the harmful health effects attributed to PM. Many variables influence the nature and probability of health outcomes. The key variables are the size-fraction and chemical-make up of the PM, the concentration levels, the duration of exposures, and various human factors to include age, health status and existing medical conditions, and genetics. These variables combined with scientific data gaps limit the medical community's ability to estimate health impacts to relatively healthy troops, especially as most studies have been on older or less healthy groups.

Sources of Particulate Matter Air Pollution

PM emissions are from natural and manmade sources. These sources include windblown dusts, fires, construction activities, factories, power plants, incinerators, and automobiles. In the U.S., the European Union, and certain other industrialized regions of the world, fossil fuel combustion and vehicle emissions are the primary sources of these pollutants. In some deployment regions, notably Southwest Asia, the PM levels are higher and the sources of PM are different:

- Primary sources are short-term dust storms and dust from motor vehicle disturbance of the desert floor.
- Dust storm levels often exceed typical levels in the U.S. (as much as 10 times higher than at U.S. sites).
- Distribution of particle size and $PM_{10}/_{2.5}$ ratio differs with location, though typically the PM_{10} is higher.
- Emissions from local industries (e.g., brick factories) near base camps and military operations (e.g., burn pits, vehicles) may increase localized concentration of $PM_{2.5}$ and other potentially toxic air pollutants.

Health Effects to Deployed Soldiers and Current Military Exposure Guidelines (MEGs)

Most studies relate PM exposure data to respiratory and cardiopulmonary health effects in specific susceptible general population subgroups to include young children, the elderly, and especially those with existing asthma or cardiopulmonary disease. In addition, studies of PM-related health effects have been based/conducted primarily in U.S. and Europe urban settings where the PM particle size and composition tends to be substantially different from that in deployment settings in Southwest Asia. PM from these deployment settings is generally less influenced by combustion products, acid aerosols, and other potentially toxic pollutant PM components that come from the industrial-sources and vehicle emissions in highly urbanized areas. As a result, direct use of the available data to estimate health effects to troops in Southwest Asia has been problematic. Several ongoing studies will increase our knowledge regarding the potential relationship between PM exposures to deployed troops and health effects/outcomes. In the interim, USAPHC recommends the use of the Military Exposure Guidelines (MEGs) described in Tables 1 and 2 below to assess the severity of potential short term (acute) and long term (chronic) effects. These MEGs are based on criteria from the U.S. Environmental Protection Agency (EPA) National Ambient Air Quality Standards (NAAQS) and the EPA Air Quality Index (AQI) reporting system (adjusted to reflect the generally health military population). The MEGs are based on professional judgment reflecting the current consensus opinion of USAPHC subject matter experts. Due to the substantial scientific

If you have questions regarding this document please contact:
U.S. Army Public Health Command, Environmental Medicine Program,
DSN 584-2714; COMM 410-436-2714; or email usarmy.apg.medcom-phc.mbx.emp@mail.mil
5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5403

Figure K-1. PM Air Pollution Exposure During Military Deployment

uncertainty in estimating acute and especially chronic health outcomes amongst relatively healthy troops to exposures involving very unique PM compositions, these MEGs are protective estimates for which there is relatively low confidence. This should be reflected in PM exposure health effects risk estimates.

Table 1. Short-Term (24-hour) Particulate Matter Air-MEGs*

Hazard Severity	$PM_{2.5}$	PM_{10}	Description of Military Health and Operational Effects
Critical	500 $\mu g/m^3$	600 $\mu g/m^3$	Above these levels, most if not all personnel are expected to experience very notable eye, nose, and throat irritation and respiratory effects. Visual acuity is impaired, as is overall aerobic capacity. Significant aerobic activity will increase risk. Some personnel will not be able to perform assigned duties. Lost duty days are expected at this concentration and potentially more as concentrations increase. Those with a history of asthma or cardiovascular disease will experience more severe symptoms.* Conditions may also result in adverse, non-health related materiel/logistical impacts (e.g., vehicles, equipment).
Marginal	250 $\mu g/m^3$	420 $\mu g/m^3$	Above these levels up to the Critical level, many personnel are expected to experience notable eye, nose, and throat irritation and some respiratory effects. Some lost duty days are expected. Significant aerobic activity will increase risk. Those with a history of asthma or cardiovascular disease are expected to experience increased symptoms.**
Negligible	65 $\mu g/m^3$	250 $\mu g/m^3$	Above these levels up to the Marginal level, a few personnel may experience notable mild eye, nose, or throat irritation; most personnel will experience only mild effects. Pre-existing health conditions (e.g., asthma, or cardiovascular diseases) may be exacerbated.*

* MEG values are low-confidence effects range estimates considered protective bounds of the hazard severity concentration ranges
** A diagnosis of some pulmonary or cardiovascular disease may prevent deployment but individuals may have mild or undiagnosed conditions. A small percentage of deployed personnel fall into this sensitive group.

Table 2. Long-Term (1-year) Particulate Matter Air-MEGs*

Hazard Severity	$PM_{2.5}$	PM_{10}	Description of Military Health and Operational Effects
Marginal	65 $\mu g/m^3$	**Not defined	With repeated exposures above this level it is increasingly plausible that some personnel may be at increased risk for developing chronic health conditions such as reduced lung function or exacerbated chronic bronchitis, chronic obstructive pulmonary disease (COPD), asthma, atherosclerosis, or other cardiopulmonary diseases. Those with a history of asthma or cardiopulmonary disease are considered to be at more notable risk.
Negligible	15 $\mu g/m^3$	**Not defined	With repeated exposures above this level up to the Marginal level, it is considered possible that a small percentage of susceptible personnel *may* be at increased risk for developing chronic conditions such as reduced lung function or exacerbated chronic bronchitis, COPD, asthma, atherosclerosis, or other cardiopulmonary diseases. Those with a history of asthma or cardiopulmonary disease are considered to be at more notable risk. Exposures below this level are not expected to result in chronic health conditions in generally healthy troops.

* MEG values are low-confidence effects range estimates considered protective bounds of the hazard severity concentration ranges
** No long term health effects can be estimated from data – the EPA has retracted its long-term standard (NAAQS) for PM_{10}.

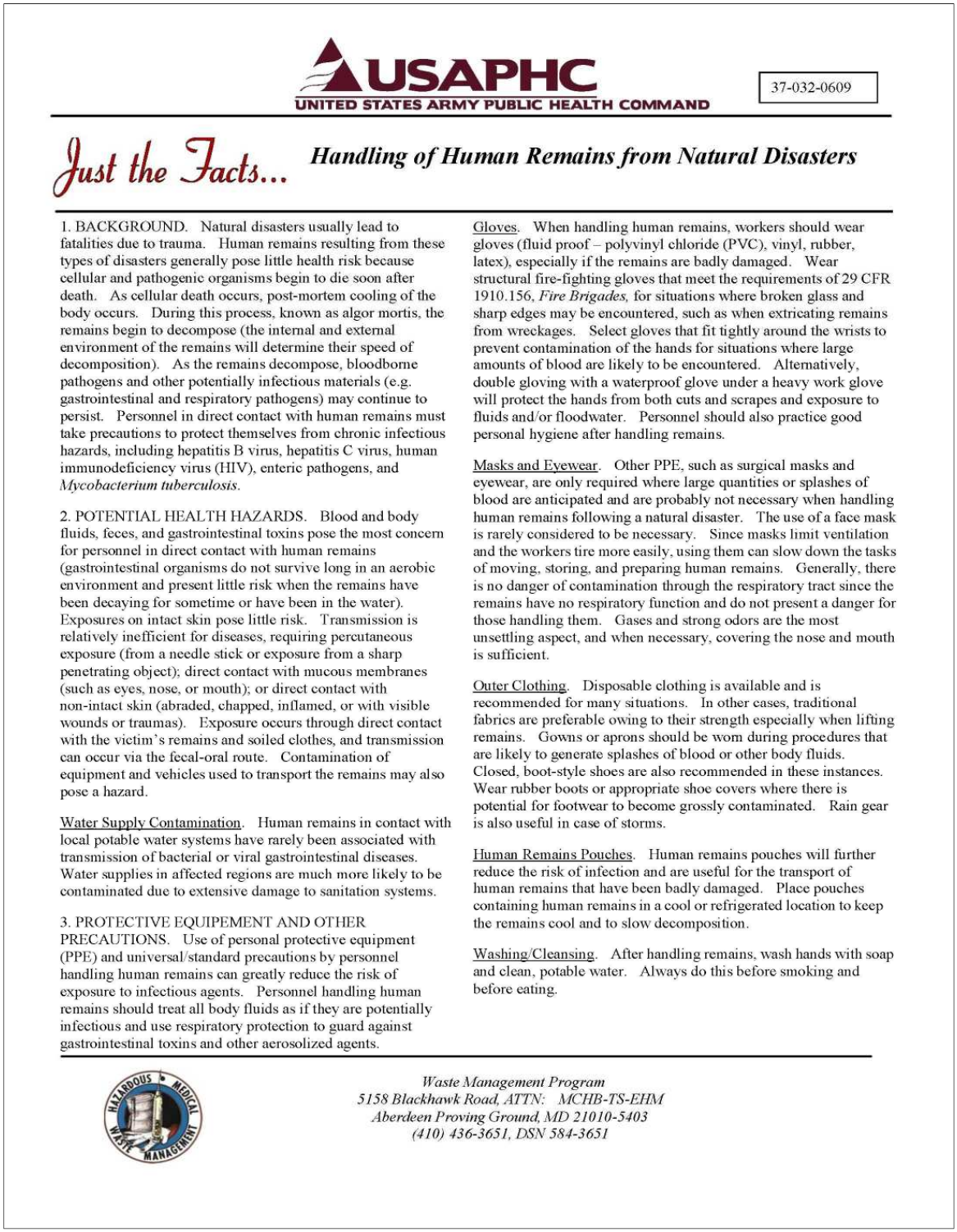
Preventive Medicine and Surveillance Recommendations.

While specific individual assessments cannot be determined given current data gaps, the USAPHC is currently documenting/archiving site-specific PM exposure data for future research and medical surveillance purposes. Other than the sampling and documentation of the population-based exposure data, there are limited preventive measures to mitigate PM exposures. The primary measure is to limit outdoor activity during periods of high PM levels; especially limit physical exertion since higher breathing rates increase the amount of inhaled PM. Minimize PM from outside sources by shutting windows, doors, and closing tent flaps. Some limited exposure may be mitigated through the use of cravats/handkerchiefs, though this is not likely to provide substantial reduction, particularly for $PM_{2.5}$ exposures. If continued exposures to very high levels cannot be avoided, use of N-95 filtering facepieces may be considered but requires a respiratory protection program, appropriate fit testing and handling of masks, and may not be feasible for extended periods due to mask clogging, discomfort, and interference with operations.

Figure K-1. PM Air Pollution Exposure During Military Deployment

Appendix L

Handling of Human Remains Fact Sheet



USAPHC
UNITED STATES ARMY PUBLIC HEALTH COMMAND

37-032-0609

Just the Facts...

Handling of Human Remains from Natural Disasters

1. BACKGROUND. Natural disasters usually lead to fatalities due to trauma. Human remains resulting from these types of disasters generally pose little health risk because cellular and pathogenic organisms begin to die soon after death. As cellular death occurs, post-mortem cooling of the body occurs. During this process, known as algor mortis, the remains begin to decompose (the internal and external environment of the remains will determine their speed of decomposition). As the remains decompose, bloodborne pathogens and other potentially infectious materials (e.g. gastrointestinal and respiratory pathogens) may continue to persist. Personnel in direct contact with human remains must take precautions to protect themselves from chronic infectious hazards, including hepatitis B virus, hepatitis C virus, human immunodeficiency virus (HIV), enteric pathogens, and *Mycobacterium tuberculosis*.

2. POTENTIAL HEALTH HAZARDS. Blood and body fluids, feces, and gastrointestinal toxins pose the most concern for personnel in direct contact with human remains (gastrointestinal organisms do not survive long in an aerobic environment and present little risk when the remains have been decaying for sometime or have been in the water). Exposures on intact skin pose little risk. Transmission is relatively inefficient for diseases, requiring percutaneous exposure (from a needle stick or exposure from a sharp penetrating object); direct contact with mucous membranes (such as eyes, nose, or mouth); or direct contact with non-intact skin (abraded, chapped, inflamed, or with visible wounds or traumas). Exposure occurs through direct contact with the victim's remains and soiled clothes, and transmission can occur via the fecal-oral route. Contamination of equipment and vehicles used to transport the remains may also pose a hazard.

Water Supply Contamination. Human remains in contact with local potable water systems have rarely been associated with transmission of bacterial or viral gastrointestinal diseases. Water supplies in affected regions are much more likely to be contaminated due to extensive damage to sanitation systems.

3. PROTECTIVE EQUIPEMENT AND OTHER PRECAUTIONS. Use of personal protective equipment (PPE) and universal/standard precautions by personnel handling human remains can greatly reduce the risk of exposure to infectious agents. Personnel handling human remains should treat all body fluids as if they are potentially infectious and use respiratory protection to guard against gastrointestinal toxins and other aerosolized agents.

Gloves. When handling human remains, workers should wear gloves (fluid proof – polyvinyl chloride (PVC), vinyl, rubber, latex), especially if the remains are badly damaged. Wear structural fire-fighting gloves that meet the requirements of 29 CFR 1910.156, *Fire Brigades,* for situations where broken glass and sharp edges may be encountered, such as when extricating remains from wreckages. Select gloves that fit tightly around the wrists to prevent contamination of the hands for situations where large amounts of blood are likely to be encountered. Alternatively, double gloving with a waterproof glove under a heavy work glove will protect the hands from both cuts and scrapes and exposure to fluids and/or floodwater. Personnel should also practice good personal hygiene after handling remains.

Masks and Eyewear. Other PPE, such as surgical masks and eyewear, are only required where large quantities or splashes of blood are anticipated and are probably not necessary when handling human remains following a natural disaster. The use of a face mask is rarely considered to be necessary. Since masks limit ventilation and the workers tire more easily, using them can slow down the tasks of moving, storing, and preparing human remains. Generally, there is no danger of contamination through the respiratory tract since the remains have no respiratory function and do not present a danger for those handling them. Gases and strong odors are the most unsettling aspect, and when necessary, covering the nose and mouth is sufficient.

Outer Clothing. Disposable clothing is available and is recommended for many situations. In other cases, traditional fabrics are preferable owing to their strength especially when lifting remains. Gowns or aprons should be worn during procedures that are likely to generate splashes of blood or other body fluids. Closed, boot-style shoes are also recommended in these instances. Wear rubber boots or appropriate shoe covers where there is potential for footwear to become grossly contaminated. Rain gear is also useful in case of storms.

Human Remains Pouches. Human remains pouches will further reduce the risk of infection and are useful for the transport of human remains that have been badly damaged. Place pouches containing human remains in a cool or refrigerated location to keep the remains cool and to slow decomposition.

Washing/Cleansing. After handling remains, wash hands with soap and clean, potable water. Always do this before smoking and before eating.

Waste Management Program
5158 Blackhawk Road, ATTN: MCHB-TS-EHM
Aberdeen Proving Ground, MD 21010-5403
(410) 436-3651, DSN 584-3651

Figure L-1. Handling of Human Remains from Natural Disasters

Vaccinations. Hepatitis B vaccination will help prevent infection and will be 70% to 80% effective within one week of exposure. Those with a prior bacille Calmette-Guérin (BCG) vaccination may have some protection against tuberculosis, and tuberculin testing may be an appropriate follow-up measure. A Tetanus booster is highly recommended.

4. DISPOSAL OF PPE. Remove used gloves and place them in a bag designated for disposal of PPE. (In some States, these items are classified as regulated medical waste. Check your local regulations for appropriate guidelines.) Where non-disposable gloves or PPE are used, place them in a separate bag for appropriate treatment (e.g. steam sterilization, chemical disinfection) to render them non-infectious. Clean, disinfect, and dry all reusable items between uses. To avoid cross-contamination, do not use personal items, such as pens or combs, while wearing soiled gloves. Change out gloves as often as necessary to minimize the risk of contaminating personal items. Make gloves readily available during the removal and processing of human remains so that personnel can quickly and easily replace soiled gloves.

5. DISINFECTING EQUIPMENT. Carefully wash all equipment, including clothes, stretchers, and vehicles used in the handling of remains with an EPA-approved disinfectant after use or before reuse (listing available at http://www.epa.gov/oppad001/chemregindex.htm). Place contaminated reusable PPE and clothing into leak-resistant bags or containers immediately upon removing the articles. Never wash contaminated PPE and clothing with personal laundry. Wash and dry reusable PPE and clothing according to the instructions on their labels, in hot water at least 160°F and detergent for 25 minutes, or with chemicals at the proper concentration for low temperature washing. Use an EPA-approved disinfectant to decontaminate reusable gloves, protective eyewear, face shields, and similar PPE. Follow the manufacturer's recommendations for disinfectant concentrations and contact times. Brush scrub contaminated boots and leather goods with soap and hot water. Place contaminated disposable PPE and clothing that is saturated, dripping, or caked with dried blood into a regulated medical waste container for appropriate disposal.

6. PERSONAL EFFECTS. Leave personal effects on the remains. (Alternatively, place all items in a plastic bag and secure them to the remains.) Mortuary affairs personnel should use the appropriate forms to inventory personal effects. Safeguarding personal effects for final processing is just as critical as safely and carefully handling the human remains. Follow local regulatory guidance to ensure blood-soaked or soiled personal effects are appropriately treated, disinfected and processed along with the remains.

7. SAPONIFICATION. Human remains found in water or moist soil readily undergo saponification (the hydrolysis of fat and other soft tissues into adipocere, or mortuary wax). This occurs when the amount of fatty tissue is high, the surrounding environment is alkali, and there is an absence or minimal presences of agents of decomposition. Under these conditions, personnel handling remains must wear PPE and be extremely careful when handling remains as skin slippage may occur.

8. TRAINING. The Occupational Safety and Health Administration (OSHA) establishes personal protective and training guidelines in 29 CFR 1910.1030. Under this regulation, mortuary affairs personnel handling human remains must receive bloodborne pathogen training within 90 days of employment. This training should include appropriate precautions for these persons, use of personal protective gear (e.g. gloves, Tyvek-type suits, and respirators), use of human remains pouches, and vaccinations for hepatitis B and tuberculosis.

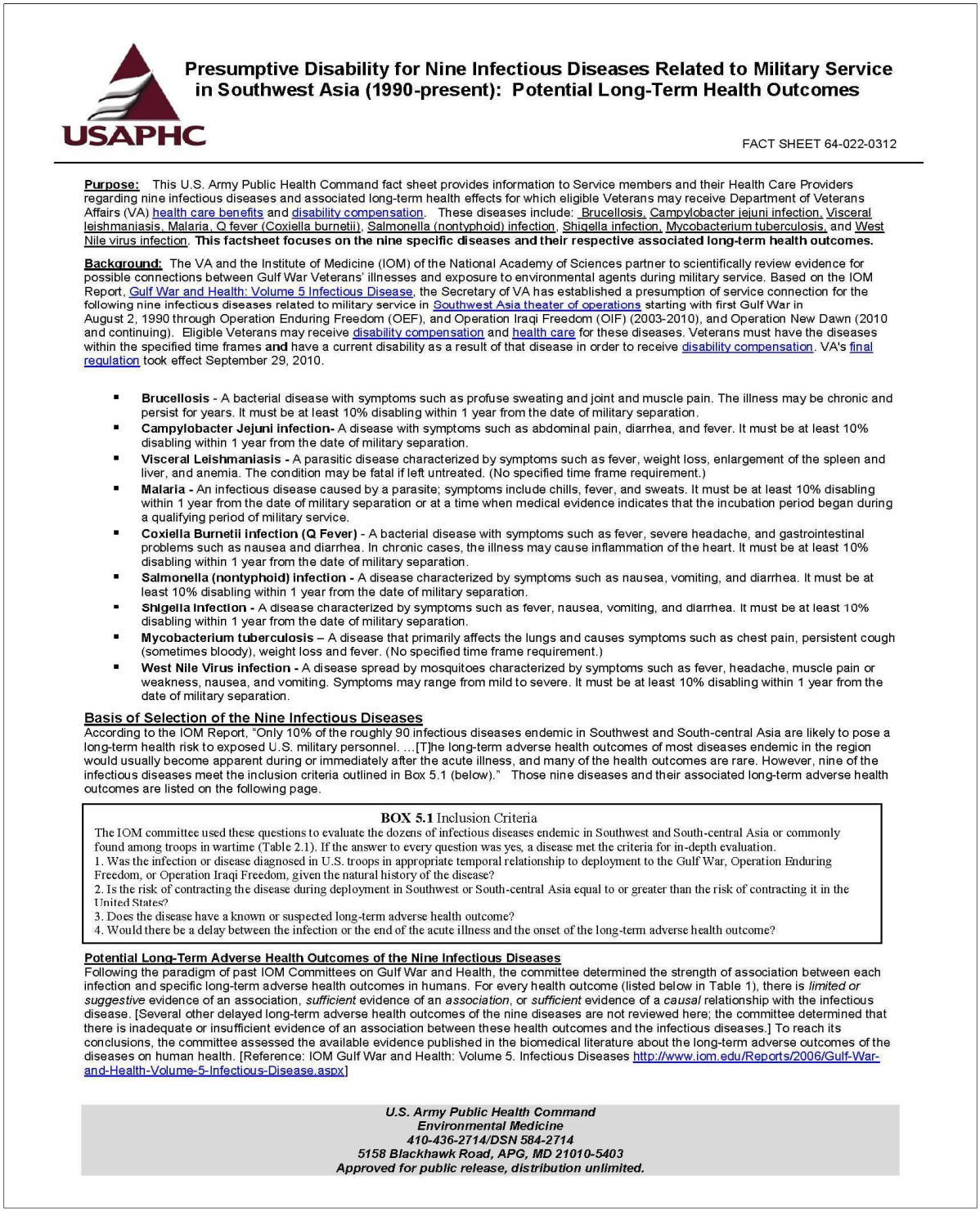
9. REFERENCES. Technical and consultative assistance may be requested from on-site morgue and/or mortuary affairs teams that may be assigned to the area of the natural disaster. The following references were reviewed and incorporated into this fact sheet, and may prove useful for further review.

- Healing, T.D., P. N. Hoffman, and S. E. J. Young. 28 April 1995. *The Infection Hazards of Human Cadavers*. Communicable Disease Report, Volume 5, Review Number 5. (http://www.hpa.org.uk/cdr/archives/CDRreview/1995/cdrr0595.pdf)
- Morgan, Oliver. 2004. *Infectious Disease Risks from Dead Bodies Following Natural Disasters*. Revista Panamericana de Salud Publica/Pan American Journal of Public Health 15(5): 307-12. (http://publications.paho.org/english/dead_bodies.pdf)
- Pan American Health Organization. Disaster Manuals and Guidelines Series, N° 5. 2004. *Management of Dead Bodies in Disaster Situations*. Washington, D.C. (http://www.paho.org/English/dd/ped/DeadBodiesBook.pdf)
- United Kingdom Defense Medical Services Department. 4 Jan 05. *MEDINTSUM – South East Asian Tsunami Potential Health Impacts*.
- U. S. Army. 12 October 2011. *Joint Publication 4-06, Mortuary Affairs* (http://www.dtic.mil/doctrine/new_pubs/jp4_06.pdf)
- U.S. Army Center for Health Promotion and Preventive Medicine. May 2009. *Technical Guide 195, Safety and Health Guidance for Mortuary Affairs Operations: Infectious Materials and CBRN Handling*. (https://www.us.army.mil/suite/doc/18150941)

Figure L-1. Handling of Human Remains from Natural Disasters

Appendix M

Infectious Diseases Presumptively Associated with Deployment



USAPHC

Presumptive Disability for Nine Infectious Diseases Related to Military Service in Southwest Asia (1990-present): Potential Long-Term Health Outcomes

FACT SHEET 64-022-0312

Purpose: This U.S. Army Public Health Command fact sheet provides information to Service members and their Health Care Providers regarding nine infectious diseases and associated long-term health effects for which eligible Veterans may receive Department of Veterans Affairs (VA) health care benefits and disability compensation. These diseases include: Brucellosis, Campylobacter jejuni infection, Visceral leishmaniasis, Malaria, Q fever (Coxiella burnetii), Salmonella (nontyphoid) infection, Shigella infection, Mycobacterium tuberculosis, and West Nile virus infection. **This factsheet focuses on the nine specific diseases and their respective associated long-term health outcomes.**

Background: The VA and the Institute of Medicine (IOM) of the National Academy of Sciences partner to scientifically review evidence for possible connections between Gulf War Veterans' illnesses and exposure to environmental agents during military service. Based on the IOM Report, Gulf War and Health: Volume 5 Infectious Disease, the Secretary of VA has established a presumption of service connection for the following nine infectious diseases related to military service in Southwest Asia theater of operations starting with first Gulf War in August 2, 1990 through Operation Enduring Freedom (OEF), and Operation Iraqi Freedom (OIF) (2003-2010), and Operation New Dawn (2010 and continuing). Eligible Veterans may receive disability compensation and health care for these diseases. Veterans must have the diseases within the specified time frames **and** have a current disability as a result of that disease in order to receive disability compensation. VA's final regulation took effect September 29, 2010.

- **Brucellosis** - A bacterial disease with symptoms such as profuse sweating and joint and muscle pain. The illness may be chronic and persist for years. It must be at least 10% disabling within 1 year from the date of military separation.
- **Campylobacter Jejuni infection-** A disease with symptoms such as abdominal pain, diarrhea, and fever. It must be at least 10% disabling within 1 year from the date of military separation.
- **Visceral Leishmaniasis -** A parasitic disease characterized by symptoms such as fever, weight loss, enlargement of the spleen and liver, and anemia. The condition may be fatal if left untreated. (No specified time frame requirement.)
- **Malaria -** An infectious disease caused by a parasite; symptoms include chills, fever, and sweats. It must be at least 10% disabling within 1 year from the date of military separation or at a time when medical evidence indicates that the incubation period began during a qualifying period of military service.
- **Coxiella Burnetii infection (Q Fever)** - A bacterial disease with symptoms such as fever, severe headache, and gastrointestinal problems such as nausea and diarrhea. In chronic cases, the illness may cause inflammation of the heart. It must be at least 10% disabling within 1 year from the date of military separation.
- **Salmonella (nontyphoid) infection -** A disease characterized by symptoms such as nausea, vomiting, and diarrhea. It must be at least 10% disabling within 1 year from the date of military separation.
- **Shigella infection -** A disease characterized by symptoms such as fever, nausea, vomiting, and diarrhea. It must be at least 10% disabling within 1 year from the date of military separation.
- **Mycobacterium tuberculosis** – A disease that primarily affects the lungs and causes symptoms such as chest pain, persistent cough (sometimes bloody), weight loss and fever. (No specified time frame requirement.)
- **West Nile Virus infection -** A disease spread by mosquitoes characterized by symptoms such as fever, headache, muscle pain or weakness, nausea, and vomiting. Symptoms may range from mild to severe. It must be at least 10% disabling within 1 year from the date of military separation.

Basis of Selection of the Nine Infectious Diseases

According to the IOM Report, "Only 10% of the roughly 90 infectious diseases endemic in Southwest and South-central Asia are likely to pose a long-term health risk to exposed U.S. military personnel. …[T]he long-term adverse health outcomes of most diseases endemic in the region would usually become apparent during or immediately after the acute illness, and many of the health outcomes are rare. However, nine of the infectious diseases meet the inclusion criteria outlined in Box 5.1 (below)." Those nine diseases and their associated long-term adverse health outcomes are listed on the following page.

BOX 5.1 Inclusion Criteria

The IOM committee used these questions to evaluate the dozens of infectious diseases endemic in Southwest and South-central Asia or commonly found among troops in wartime (Table 2.1). If the answer to every question was yes, a disease met the criteria for in-depth evaluation.

1. Was the infection or disease diagnosed in U.S. troops in appropriate temporal relationship to deployment to the Gulf War, Operation Enduring Freedom, or Operation Iraqi Freedom, given the natural history of the disease?
2. Is the risk of contracting the disease during deployment in Southwest or South-central Asia equal to or greater than the risk of contracting it in the United States?
3. Does the disease have a known or suspected long-term adverse health outcome?
4. Would there be a delay between the infection or the end of the acute illness and the onset of the long-term adverse health outcome?

Potential Long-Term Adverse Health Outcomes of the Nine Infectious Diseases

Following the paradigm of past IOM Committees on Gulf War and Health, the committee determined the strength of association between each infection and specific long-term adverse health outcomes in humans. For every health outcome (listed below in Table 1), there is *limited or suggestive* evidence of an association, *sufficient* evidence of an *association*, or *sufficient* evidence of a *causal* relationship with the infectious disease. [Several other delayed long-term adverse health outcomes of the nine diseases are not reviewed here; the committee determined that there is inadequate or insufficient evidence of an association between these health outcomes and the infectious diseases.] To reach its conclusions, the committee assessed the available evidence published in the biomedical literature about the long-term adverse outcomes of the diseases on human health. [Reference: IOM Gulf War and Health: Volume 5. Infectious Diseases http://www.iom.edu/Reports/2006/Gulf-War-and-Health-Volume-5-Infectious-Disease.aspx]

U.S. Army Public Health Command
Environmental Medicine
410-436-2714/DSN 584-2714
5158 Blackhawk Road, APG, MD 21010-5403

Figure M-1. Presumptive Disability for Nine Infectious Diseases Related to Military Service in Southwest Asia

Table 1. The Nine Infectious Diseases Studied for Strength of Association with Specific Long-Term Adverse Health Outcomes:

Infectious Disease	Long-Term Adverse Health Outcomes Evaluated for Strength of Association
Brucellosis	Arthritis Cardiovascular system infections Ophthalmologic manifestations Genito-urinary tract manifestations Hepatic abnormalities Neurologic manifestations Respiratory system infections Other symptoms (fatigue, inattention, amnesia, depression)
Campylobacter infection	Guillain-Barré syndrome Reactive arthritis Uveitis
Leishmaniasis	Delayed presentation of visceral leishmaniasis (VL)[a] Reactivation of VL in the context of future immunosuppression Post-kala-azar dermal leishmaniasis
Malaria	Clinical relapse Late presentation or recrudescence of disease Hematologic manifestations Ophthalmologic manifestations Nephrologic disease Neurologic and neuropsychiatric disease
Coxiella burnetii infection (Q fever)	Chronic hepatitis Endocarditis Osteomyelitis Post-Q fever fatigue syndrome Vascular infection
Salmonella (nontyphoid) infection	Reactive arthritis
Shigella infection	Hemolytic uremic syndrome Reactive arthritis
Tuberculosis[b]	Activation of latent tuberculosis infection Late manifestations of pulmonary and extrapulmonary tuberculosis
West Nile virus infection[c]	Persistent deficits in cognition, movement, and daily functioning

[a] Viscerotropic leishmaniasis is considered a subset of VL for the purposes of this discussion.
[b] Tuberculosis (TB) does not meet inclusion criterion 1 (Box 5.1), because there have been no published reports of military personnel who developed active TB while deployed to the Gulf War, Operation Enduring Freedom (OEF), or Operation Iraqi Freedom (OIF). However, in a presentation to the committee, Kilpatrick (2005) indicated that 2.5% of military personnel deployed to OEF and OIF and given predeployment and postdeployment skin tests for TB seroconverted during their deployment; that is, they acquired new TB infections. Immunocompetent people who are infected with TB have a 10% lifetime risk of developing active TB; this risk increases dramatically in people who become immunosuppressed. Therefore, the committee decided to evaluate TB in depth.
[c] West Nile virus infection does not meet inclusion criterion 4 (Box 5.1), because its health outcomes usually are manifested at the time of the acute illness. However, dramatic changes in the epidemiology of West Nile virus infection since the middle 1990s led the committee to decide to review it in depth.

Additional Information from the Veterans Administration:

This fact sheet is based on information provided by the VA located at: http://www.publichealth.va.gov/exposures/gulfwar/infectious_diseases.asp

Service members and veterans who previously received a diagnosis or those who may have any of the infectious diseases that may be presumed connected with their service can contact the following the VA directly for further assistance:

By Telephone
- Toll-free Helpline: 1-800-749-8387 or 1-800-829-4833 (TDD – for hearing impaired)
- Health Care and Gulf War Registry Health Exam: 1-877-222-8387 (Ask to speak to Environmental Health Coordinator or Patient Care Advocate)
- Compensation and Other Benefits: 1-800-827-1000

In Person
- Health Care and Gulf War Registry Health Exam: Go to your nearest VA health care facility.
- Compensation Benefits and Other Benefits: Go to your nearest VA benefits office.

Also see the USAPHC factsheet:
"Presumptive Disability for Infectious Diseases Related to Military Service in Southwest Asia (1990-present): Criteria Eligibility and Risks"
If you have other questions - please contact the
U.S. Army Public Health Command's
Environmental Medicine Program (EMP)
USAPHC-EnvironmentalMedicineProgram@AMEDD.army.mil
5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5403
DSN 584-2714; COMM (410) 436-2714; FAX Extension-4117

Figure M-1. Presumptive Disability for Nine Infectious Diseases Related to Military Service in Southwest Asia

USAPHC

Presumptive Disability for Infectious Diseases Related to Military Service in Southwest Asia (1990-present): Criteria, Eligibility, and Risks

FACT SHEET 64-021-0312

Purpose: This U.S. Army Public Health Command factsheet provides information regarding nine infectious diseases for which eligible veterans may receive Department of Veterans Affairs (VA) health care benefits and disability compensation. These diseases include: Brucellosis, Campylobacter jejuni infection, Q fever (Coxiella burnetii), Malaria, Mycobacterium tuberculosis, Salmonella (nontyphoid) infection, Shigella infection, Visceral leishmaniasis, and West Nile virus infection. **This fact sheet summarizes the criteria used to determine the diseases of concern and summarizes the presumed risk relative to actual risk based on reported disease in military personnel.**

Background: The VA, with the Institute of Medicine (IOM) of the National Academy of Sciences, partner to scientifically review evidence for possible connections between Gulf War Veterans' illnesses and exposure to environmental agents during military service. Based on the IOM Report, Gulf War and Health: Volume 5 Infectious Disease, the Secretary of VA has established a presumption of service connection for nine infectious diseases related to military service in Southwest Asia theater of operations starting with the first Gulf War on August 2, 1990 through Operation Enduring Freedom (OEF), and Operation Iraqi Freedom (OIF) (2003-2010), and Operation New Dawn (2010 and continuing). The VA's final regulation took effect September 29, 2010.

Criteria Linking Nine Infectious Diseases to Service in the Gulf War, OEF, and/or OIF

There are roughly 90 infectious diseases endemic to southwest and south-central Asia that can potentially cause long-term health risks to exposed Service members. Scientific evidence was reviewed to determine the strength of relationship between the infection and long-term adverse health outcomes. The nine infectious diseases met the following inclusion criteria:

1. Was the infection or disease diagnosed in U.S. troops in appropriate temporal relationship to deployment to the Gulf War, OEF, or OIF, given the natural history of the disease?
2. Is the risk of contracting the disease during deployment in southwest or south-central Asia equal to or greater than the risk of contracting it in the United States?
3. Does the disease have a known or suspected long-term adverse health outcome?
4. Would there be a delay between the infection or the end of the acute illness and the onset of the long-term adverse health outcome?

Eligibility Requirements for VA Services

To qualify for presumptive healthcare and/or disability compensation from the VA, the disease must be the cause of current disability (at least 10%) present within a year of military separation, except for tuberculosis and visceral leishmaniasis, for which there is no time constraint.

Presumed Risk

The National Center for Medical Intelligence (NCMI) judges deployment in Iraq and Afghanistan as an intermediate risk for infectious diseases, with an overall disease risk that may adversely impact mission effectiveness unless force health protection measures are implemented. The table below outlines specific risks by location, level, time points, severity, and potential attack rates by disease.

Disease	Risk Location	Risk Level*	Typical Risk Period	Typical Severity**	Potential Attack Rates per Month in the Absence of Countermeasures (e.g., Consumption of Local Food/Water)
Bacterial Diarrhea (includes Shigella, Salmonella, & Campylobacter)	Iraq & Afghanistan	High	Year-round	Mild	Potentially over 50%
Brucellosis	Iraq & Afghanistan	Intermediate	Year-round	Severe	Rare cases (less than 0.1%)
Leishmaniasis	Iraq	Intermediate	Seasonal (Apr - Nov)	Severe	Rare cases (less than 0.1%)
	Afghanistan	Intermediate	Seasonal (Mar-Nov)	Severe	Disease assessed as present - rare cases possible
Malaria	Afghanistan	High	Seasonal (Mar-Nov)	Moderate	A small number (less than 1%) (risk varies by location). Under conditions particularly conducive to vector breeding, rates could temporarily exceed 1 % per month in some locations.
Q fever	Iraq	Intermediate	Year-round	Moderate	Rare cases (less than 0.1%)
	Afghanistan	Intermediate	Year-round	Moderate	Disease assessed as present - rare cases possible
Tuberculosis	Iraq & Afghanistan	Intermediate	Year-round	Mild	Potential elevation in positive TB test results
West Nile Virus	Iraq	Low	Seasonal (Apr - Nov)	Moderate	Disease assessed as present - rare cases possible
	Afghanistan	Low	Seasonal (Mar-Nov)	Moderate	Disease assessed as present - rare cases possible

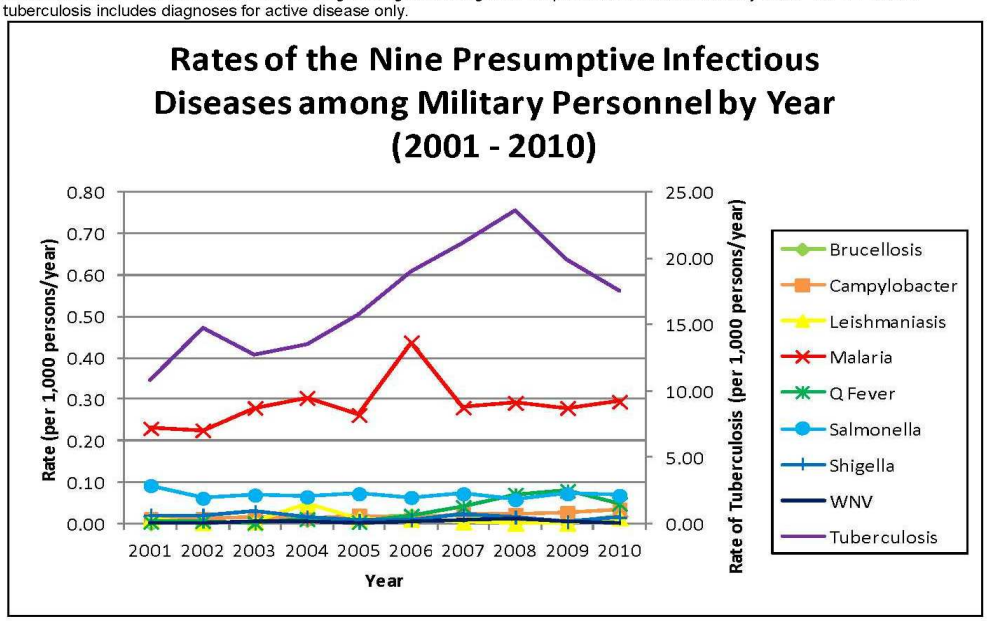
*Risk Level
High: Potentially high impact on operations because disease affects large percentage of personnel or causes severe illness.
Intermediate: Intermediate impact on operations because disease affects smaller number of personnel or causes mild symptoms.
Low: Minimal impact on operations due to low likelihood of cases.
**Typical Severity:
Mild: Less than 72 hours sick in quarters or limited duty, no hospitalization.
Moderate: 1-7 days of inpatient or supporting care required, followed by return to duty.
Severe: Hospitalization or convalescence over 7 days, typically evacuated.
Very Severe: Intensive or tertiary care required, significant morbidity or mortality, or delayed mortality.
https://www.intelink.gov/ncmi/product/idra_db.php?co=AFG; https://www.intelink.gov/ncmi/product/idra_db.php?co=IRQ

U.S. Army Public Health Command
Environmental Medicine
410-436-2714/DSN 584-2714
5158 Blackhawk Road, APG, MD 21010-5403

Figure M-2. Presumptive Disability for Nine Infectious Diseases Related to Military Service in Southwest Asia

Actual Risk

The Defense Medical Epidemiology Database (DMED) contains up-to-date and historical data on diseases and medical events relevant to personnel characteristics and deployment experiences for all active duty service members. Queries were performed in order to determine the burden of the nine infectious diseases possibly related to Gulf War, OEF, and/or OIF service. The medical encounter rates in the chart below include diagnoses given during both hospitalizations and ambulatory visits. NOTE: Rate of tuberculosis includes diagnoses for active disease only.



In October 2010, the U.S. Army adopted the Disease Reporting System-internet (DRSi) as the official reportable medical events program. Facilitated by the use of this new program, Army preventive medicine personnel now have the ability to access the system and report events from Afghanistan and Iraq. The table at right displays in-theater case counts reported between October 2010 and June 2011.

	Iraq	Afghanistan
Leishmaniasis	3	3
Malaria	3	32
Q Fever	3	2
Salmonella	1	1
Shigella	2	4

Additional Information from the Veterans Administration

This fact sheet is based on information provided by the VA located at:
http://www.publichealth.va.gov/exposures/gulfwar/infectious_diseases.asp

Service members and veterans who previously received a diagnosis for any of the infectious diseases presumed to have a connection with service in the Gulf War, OEF, and/or OIF and are not currently receiving compensation OR those who may have any of these diseases that could qualify for compensation can contact the VA directly for further assistance:

By Telephone

- Toll-free Helpline: 1-800-749-8387 or 1-800-829-4833 (TDD – for hearing impaired)
- Health Care and Gulf War Registry Health Exam: 1-877-222-8387
- Compensation and Other Benefits: 1-800-827-1000

In Person

- Health Care and Gulf War Registry Health Exam: Go to your nearest VA health care facility.
- Compensation Benefits and Other Benefits: Go to your nearest VA benefits office.

Also see the USAPHC factsheet:
"Presumptive Disability for Infectious Diseases Related to Military Service in Southwest Asia (1990-present): Potential Long Term Health Outcomes"

If you have other questions - please feel free to contact the
U.S. Army Public Health Command's
Environmental Medicine Program (EMP)
USAPHC-EnvironmentalMedicineProgram@AMEDD.army.mil
5158 Blackhawk Road, Aberdeen Proving Ground, Maryland 21010-5403
DSN 584-2714; COMM (410) 436-2714; FAX Extension-4117

Figure M-2. Presumptive Disability for Nine Infectious Diseases Related to Military Service in Southwest Asia

Appendix N

Health Effects Associated with Exposure to Ammonia

Health Effects Associated with Exposure to Ammonia

Ammonia, either as a gas or as a liquid, when concentrated (usually greater than 50%), can be immediately corrosive to tissues upon contact. High enough levels of exposure to ammonia in sufficient quantities can be fatal. Ammonia is another of the most common chemicals manufactured in the U.S. Concentrated ammonia is used in manufacturing, refrigeration, and agriculture (as a fertilizer). Household ammonia is much less concentrated (approximately 5-10% or less); it rarely causes burns, but it does cause irritation. The lowest level at which humans can detect the odor of ammonia (odor threshold) generally provides sufficient warning of exposure; however, persons with prolonged exposure to ammonia will lose their ability to detect the odor (olfactory fatigue) (reference N-1,2).

Ammonia exists naturally in humans and in the environment. It is essential for many biological processes and serves as a precursor for amino acid and nucleotide synthesis. In the environment, ammonia is part of the nitrogen cycle and is produced in soil from bacterial processes. Ammonia is also produced naturally from decomposition of organic matter, including plants, animals and animal wastes. Ammonia is used in industry and commerce, as well as many household uses (references N-1,2).

Human exposure to ammonia is usually via inhalation of gas or vapor or dermal/mucous membrane exposure. The distinctive odor and taste of ammonia renders ingestion an uncommon route of exposure. It is irritating to the eyes and causes severe caustic injuries and spasmodic blinking, thus absorption through the eyes is very limited. Ammonia can be introduced into the air, indoor or outdoor, as a liquid spray (aerosol) or as a vapor. It can contaminate water and as a liquid has the potential to contaminate agricultural products.

Unlike chlorine gas, ammonia gas is lighter than air and therefore when released it will dissipate quickly. However, when released into humid air the anhydrous ammonia will form ammonia vapor which is heavier and will settle and spread along the ground and into low lying areas (reference N-2).

When ammonia comes into contact with moisture in the skin and mucous membranes it immediately reacts and forms the very caustic ammonium hydroxide. Ammonium hydroxide causes the necrosis of tissues through disruption of cell membrane lipids leading to cell death. As cells break down, an inflammatory response is initiated that causes further damage. Due to this immediate reaction, exposure to high concentrations of ammonia in air causes immediate burning of the nose, throat and respiratory tract, which may result in bronchiolar and alveolar edema, and airway destruction, further resulting in respiratory distress or failure. Cough and nose, mouth and throat irritation may result from inhalation of lower concentrations. Exposure to low concentrations of ammonia in air or solution may produce rapid skin or eye irritation. Higher concentrations of ammonia may cause severe injury and burns. Contact with concentrated ammonia solutions such as industrial cleaners may cause corrosive injury including skin burns, permanent eye damage or blindness, with the full extent of eye injuries sometimes not apparent for up to a week after the exposure. Swallowing high concentrations of ammonia solution does not generally cause systemic poisoning, but will result in corrosive damage to the upper GI track (reference N-2).

In an inhalation scenario, most of the ammonia inhaled will be exhaled unchanged. The ammonia that is retained from inhalation, as well as most ammonia that is ingested, forms non-toxic substances, such as ammonium compounds, which are then carried throughout the body in seconds. The rest of the ingested ammonia leaves the body in urine within a couple of days. Ammonia causes its effect on the body surfaces that it directly contacts, and is not known to cause remote effects (reference N-3). Long term damage may be seen after initial corrosive injury. No reports were identified in the literature that described long term effects in the absence of initial immediate corrosive damage. Therefore, in the

absence of any members of the 1/24BN SBCT reporting acute ammonia exposure symptoms, they should anticipate no problems from this exposure nine years or more after leaving Mosul.

References

N-1. Ammonia Solution (UN 3318); Ammonia Anhydrous (UN 1005): Lung Damaging Agent. Accessed at http://www.cdc.gov/niosh/ershdb/EmergencyResponseCard_29750013.html:

N-2. New York State Department of Health. The Facts About Ammonia. Technical Information. Accessed at: https://www.health.ny.gov/environmental/emergency/chemical_terrorism/ammonia Tech.htm

N-3. Agency for Toxic Substances and Disease Registry (ATSDR). 2004. Toxicological profile for Ammonia. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Appendix O

Assessment of Health Outcomes

This appendix discusses, in greater detail, some of the health conditions and concerns discussed in Section 10, regarding relationship between known environmental exposures and specific health conditions, including specific malignancies.

Follicular Lymphoma

There was one reported case of follicular lymphoma (FL), which is a common form of non-Hodgkin's lymphoma (NHL). The American Cancer Society reports that approximately 20% of NHL cases are FL (reference O-1). It is rare in young individuals and the average age at diagnosis is 60. About one third of cases of FL turn into fast growing diffuse B-Cell lymphomas. NHL accounts for about 4% of all cancer cases diagnosed in the US. Just over 14,000 cases of FL are anticipated to be diagnosed in the US in 2014. Approximately 1 in 50 Americans will develop NHL during their lifetime, thus the risk of developing FL is about 1 in 250 people.

Known and suspected risk factors for NHL include age, gender, and race among others. The risk for most types of NHL increases with increasing age. NHL occurs more commonly in males than in females, more often in Caucasians and there are higher rates in developed countries, with the US and Europe having the highest rates. There is an association with prior treatment for cancer, yet it is still not clear if the development of NHL in survivors of Hodgkin's lymphoma is because of the treatment or a function of the Hodgkin's lymphoma itself. Other risk factors include radiation exposure, immune deficiency (whether disease induced, e.g., AIDS and genetic immune system disorders, or treatment induced, e.g., immuno-suppression post organ transplant) and autoimmune disease such as rheumatoid arthritis and systemic lupus erythematosis. Additional risk factors include certain infections, elevated body mass index, and diet, with some studies showing a link between high fat and high red meat diets (references O-1, 2).

Much has been studied and written about whether there is a relationship between exposure to various solvents and/or pesticides and an increased risk of NHL or FL. The medical and scientific literature is still highly unclear about this question with conflicting studies. The US Environmental Protection Agency reports a likely relationship between Trichloroethylene (TCE) and NHL and Perchloroethylene (PERC) and NHL, but not with Benzene (BZ) and NHL (references O-3,4,5). A 2002 study, (reference O-6), demonstrated an increased risk of leukemia and multiple myeloma in BZ exposed workers, but not an increase in NHL. A study published in 2007(reference P-7) found a barely statistically significant (95% CI of 1.0-4.8) relationship between high level of exposure to TCE and NHL. These researchers also did not find a relationship between BZ and NHL.

Many authors speak of increased risk of NHL in immunosuppressed individuals (references O-8,9) and of the increased incidence of NHL in the US over the past several decades (references O-9,10). Despite a large number of studies looking into this increase and its causes, few consistent relationships with exposures have been identified. Bassig and his colleagues at the National Cancer Institute state "Specifically, positive associations with NHL have been reported for the use of hair dye before 1980, diets high in fat and some dairy products, higher BMI, smoking for FL, as well as exposure to certain solvents and chemicals. However, the inconsistency in some of these associations across studies precludes their consideration as established NHL risk factors, and the associated risk estimates have generally been only marginally elevated"(reference O-9). A recent large study (reference O-11) found no increased risk of NHL after either any exposure or substantial exposure to either of two chemical families or any of six chlorinated solvents.

A study in Italy (reference O-12), found that subjects with a medium or high level of exposure to benzene, toluene and xylene, either individually or combined, had statistically significant increased risks of developing NHL. Cocco, et al, (reference O-13) found that three independent metrics of

exposure to benzene, toluene and xylene combined and to styrene alone increased the risk of FL. An Australian study (reference O-14) found a statistically significant increased risk of FL in subjects with substantial exposure to any pesticide, organophosphate pesticides, and other (non-Phenoxy) herbicides, but not in subjects exposed to organochlorine pesticides, phenoxy herbicides or other pesticides. A study in Sweden (reference O-15) found no statistically increased risk of FL in subjects exposed to a variety of herbicides, either alone or excluding some, no increased risk of FL in subjects exposed to any of several fungicides and rodenticides, but did find increases in those exposed to DDT or mercurial seed dressings.

Therefore it is not clear whether and which solvents can cause or increase the risk of developing NHL and/or FL. What does seem clear is that if there is such a relationship it is only after significant exposure to the solvent over a prolonged period of time and not causal, infrequent, short time, or minimal exposure. The existence of a relationship between pesticide exposure and the risk of developing NHL or FL, is also still unclear, with studies available that identify such a link and studies that fail to find a positive relationship. As best as can be determined, the members of the 1/24 BN SBCT were not subject to any exposures in Iraq that would increase their risk of developing FL.

Acute Lymphoblastic Leukemia

Leukemia is a cancer of the white blood cells. There are several different types of white blood cells and therefore there are several different types of leukemia. In all types the cells look abnormal and behave abnormally. When cancer develops in lymphocytes it is called lymphocytic leukemia and when it develops in monocytes or granulocytes it is called myelocytic or myelogenous leukemia. Leukemias are also classified by whether they are acute, in which the immature, abnormal cells, called blasts, remain not fully developed and their number increases rapidly and the acute leukemia progresses rapidly. In chronic leukemias most of the cells develop further and can perform some of the function of normal cells. While there are still some blasts present, the overall number of cells increases much more slowly and as a result the disease progresses less rapidly.

Based on the type of white blood cell seen under the microscope leukemias are classified into four main categories: acute lymphocytic leukemia (ALL); acute myelogenous leukemia (AML); chronic lymphocytic leukemia (CLL) and chronic myelogenous leukemia (CML). Each of these types has different epidemiologic and etiologic profiles and they each require very different treatment regimens. Although they are all leukemia they are very clearly not the same disease.
Acute Lymphoblastic Leukemia (ALL), also referred to as Acute Lymphocytic Leukemia, is a cancer that originates in the lymphocytes, usually arising in the bone marrow. The American Cancer Society reports that only approximately about one third of cases of ALL occur in adults, but three quarters of the deaths from ALL are in adults (reference O-16). Children under the age of 5 are at the highest risk of developing ALL. The risk then declines until the third decade of life, stays fairly stable, and then slowly increases after the age of 50. The lifetime risk of developing ALL is about 1 in 750 people.

Known and suspected risk factors for ALL include: Radiation exposure; certain viral infections, e.g. human T-cell lymphoma virus -Type 1 (HTLV-1) and Epstein-Barr Virus (EBV); certain inherited conditions, e.g., Down syndrome, Klinefelter syndrome, Neurofibromatosis, and others; race/ethnicity - ALL is more common in Caucasians than in African Americans; gender - ALL is slightly more common in males than in females; and having an identical twin with ALL - if one twin develops ALL within the first year of life the other twin is at increased risk of developing the disease as well.

While there are some studies that have shown a link between exposure to benzene and both non-Hodgkins lymphoma and multiple myeloma, those that have specifically looked at ALL and benzene exposure have failed to find a correlation (references O-17,18,19). The medical and scientific literature supports a positive relationship between trichloroethylene (TCE) and perchloroethylene (PERC) with the development of non-Hodgkin's lymphoma, but once again, neither of these has been shown to be associated with an increased risk of ALL.

Therefore, as best as can be determined, the 1/24 BN SBCT were not subject to any exposures in Iraq that would increase their risk of developing ALL.

Biliary Carcinoma or Bile Duct Cancer

Biliary Carcinoma or Bile Duct Cancer (BDC) includes cancer of the bile ducts within the liver (approximately 10%) and outside the liver (reference 7). The American Cancer Society estimates that about 2,000-3,000 people will be diagnosed with BDC in 2014. The average age at diagnosis is in the seventies. Almost 65% of people are over the age of 65 when diagnosed (reference O-20).

Known and suspected risk factors for BDC include:

- Certain diseases of the liver or bile ducts - people with chronic inflammation of the bile duct have an increased risk of developing BDC, examples include primary sclerosing cholangitis, bile duct stones, liver fluke infections, cirrhosis, and others;
- Inflammatory bowel disease - including both ulcerative colitis and Crohn's disease;
- Age - the risk of being diagnosed with BDC goes up with age;
- Obesity - the risk of developing BDC (and gallbladder cancer) is elevated in overweight and obese individuals;
- Exposure to Thorotrast - this is a radioactive substance that was used as a contrast agent for x-rays until the 1950s;
- Family history;
- Diabetes;
- Viral hepatitis - both hepatitis B virus and hepatitis C virus infections increase the risk of intra-hepatic BDC; and
- Alcohol - heavy drinkers are at increased risk of developing intra-hepatic BDC (reference O-20).

A study in Japan found that individuals with bile duct cancer had a history of exposure to dichloropropane (for 7-17 years) and dichloromethane (for 1-13 years) 7-20 years prior to being diagnosed, while working in a printing company (reference O-21). There were many more cases of cholangiocarcinoma than expected in the workforce as a whole. However, the Institute of Medicine conducted an extensive review of the literature which looked at insecticide and solvent exposure and an increased risk of cancer (reference O-22). This review committee was unable to locate a single study that identified a statistically significant link between insecticide exposure and an increased risk of developing BDC or between solvent exposure and an increased risk of developing BDC. Therefore, as best as can be determined, the 1/24 BN SBCT were not subject to any exposures in Iraq that would increase their risk of developing biliary cancer or bile duct cancer.

Asthma

Asthma is a chronic lung disease characterized by inflammation and narrowing of the airways, and by intermittent spasms of the airways. Asthma can affect people of all ages, but most often begins in childhood. More than 25 million people in the United States have asthma, more than a quarter of

these are children (reference O-23). When the airways are inflamed they are swollen and tend to be extremely sensitive to a variety of inhaled substances which can then trigger spasms of the muscles surrounding the airways, called bronchospasm.

Scientists are not sure what causes asthma, but most believe that it involves an interaction between genetic and environmental factors. These factors may include: an inherited tendency to develop allergies; a family history of asthma; certain respiratory infections during childhood; and contact with some airborne allergens or exposure to some viral infections in infancy or in early childhood, when the immune system was still immature (reference O-24). Individuals with a predisposition to develop asthma are often more sensitive to non-specific airborne irritants.

Many things can serve as triggers which can initiate an episode (attack) of bronchospasm and inflammation. Some common triggers include:

- Allergens from dust, animal fur, cockroaches, mold, and pollens from trees, grasses, and flowers;
- Irritants such as cigarette smoke, air pollution, chemicals or dust in the workplace, compounds in home décor products, and sprays (such as hairspray);
- Medicines such as aspirin or other nonsteroidal anti-inflammatory drugs and nonselective beta-blockers;
- Sulfites in foods and drinks;
- Viral upper respiratory infections, such as colds;
- Physical activity, including exercise (reference O-24)

Occupational asthma (OA) is asthma caused by inhalation exposure to certain gases, fumes, dusts, and other substances while at work. Hydrochloric acid, sulfur dioxide and ammonia are three examples of irritants which may be found in the workplace and which are known to cause OA when people are exposed to high doses (reference O-25). There are other substances, such as isocyanates, which are known to cause OA in people after even extremely low level of exposures. OA may occur in individuals with no previous history of asthma. If workplace irritants worsen already existing asthma it is referred to as work-exacerbated asthma. Symptoms of OA are frequently worse during work and get better between shifts, on weekends and during vacations. As many as 11% of spray painters exposed to diisocyanate-based paints have bronchial hyper-reactivity. Approximately 5% of workers in the lumber industry exposed to western red cedar dust developed asthma. As many as 2.5% of all workers exposed to natural rubber latex and up to 20% of bakers or warehouse workers exposed to flour have been reported to have occupational asthma.

In addition, farmers, painters, and cleaners have been reported to have the greatest risk for developing occupational asthma (reference O-25). The U.S. Occupational Safety and Health Administration (OSHA) estimates that 11 million workers in the United States are occupationally exposed to at least one substance known to be associated with OA (reference O-26). OSHA further estimates that up to 15 percent of cases of disabling asthma in the US are associated with occupational factors.

Various researchers have studied the relationship between deployment and respiratory symptoms and respiratory conditions. In 2009, Smith, et al, reported that deployers had a higher rate of newly reported respiratory symptoms, relative to non-deployers (14% vs. 10%), while observing similar rates of diagnosed chronic bronchitis or emphysema (1% vs. 1%) and asthma (1% vs. 1%) (reference O-27). In their survey-based study of Millennium Cohort Study participants, the authors found that deployment length was significantly associated with increased respiratory symptom reporting among Army personnel.

In October 2010, Szema and his colleagues reported on an increased incidence rate of new onset asthma in US Service Members deployed to Iraq versus those not deployed (6.6% versus 4.3%; with a crude odds ratio, 1.58; 95% CI, 1.18, 2.11) (reference O-28). They go on to state that "Deployment to Iraq and Afghanistan is associated with new-onset asthma." In September 2011, Szema, et al. reported that Veterans at their VA Medical Center, on Long Island, NY, that had deployed in support of OEF and/or OIF had higher rates of pulmonary symptoms and of spirometry testing than Service Members deployed elsewhere (reference O-29). When tested, the ratio of forced expired volume in 1 second/forced vital capacity was similar in both groups of Veterans. The authors introduce the term “Iraq/Afghanistan war lung injury (IAW-LI) to describe pulmonary complaints related to exposures which occurred in South West Asia during the current and recent wars.

A Letter to the Editor regarding the latter article raised some interesting and valid points about the paper's findings, not the least of which is, that Veterans Administration hospital clinicians, being sensitized to the fact that Veterans returning from deployment to OEF and OIF were having increased respiratory complaints and were therefore likely to have a lower threshold to request additional tests, including spirometry (reference O-30).

A paper published in October 2011, reviewed the extant studies conducted by the US military and the planned research efforts of the military to investigate the possibility of deployment related pulmonary disease (reference O-31). The authors conclude that there is an increase in respiratory symptoms post deployment, but not clinical diagnoses and that although there is some evidence of a higher rate of new-onset asthma in deployed versus non-deployed military personnel there is no data that deployment is a definitive cause of new-onset asthma.

In the June 2012 issue of the Journal of Occupational and Environmental Medicine (JOEM), an issue dedicated to Health Effects of Deployment to Afghanistan and Iraq, Smith and her colleagues reported on respiratory symptoms and respiratory illness among Millennium Cohort participants who deployed to Iraq or Afghanistan (reference O-32). The authors looked at newly reported chronic bronchitis or emphysema, newly reported asthma, and self-reported respiratory symptoms and possible burn pit exposure within 2, 3, or 5 miles, among Army and Air Force deployers surveyed in 2004 to 2006 and 2007 to 2008 (n = 22,844). Burn pit exposure within 3 or 5 miles was not associated with respiratory outcomes after statistical adjustment. Increased symptom reporting was observed among Air Force deployers located within 2 miles of Joint Base Balad; however, this finding was marginally significant with no evidence of trend. In general, these findings do not support an elevated risk for respiratory outcomes among personnel deployed within proximity of documented burn pits in Iraq.

In the same issue of JOEM, Abraham and his colleagues reported on an assessment of pre- and post-deployment rates of medical encounters for obstructive pulmonary disease among a group of Active Duty military personnel who had been deployed to OEF/OIF (reference O-33). Overall, the rate of respiratory system encounters decreased after deployment, a finding driven largely by a statistically significant drop in acute respiratory infections. The vast majority of obstructive pulmonary disease encounters were either for asthma (46%) or bronchitis (50%). They reported statistically significant increases in the encounter rates for obstructive respiratory diseases from the pre- to post-deployment periods for single deployers, but not multiple deployers. The same group published a study demonstrating that respiratory symptoms and new-onset asthma are increased in those who deployed versus those who were deployment eligible but had not yet deployed (reference O-34). This finding was demonstrated in cohorts at all four locations studied- two with and two without burn pits.

In summary, there has been a documented increase in symptoms of obstructive pulmonary disease post deployment, and this disease category includes asthma, following deployment to Iraq and/or Afghanistan.

Panic Disorder

Anxiety attacks, also known as panic attacks, are part of a condition called Panic Disorder, which affects approximately one out of every 75 people (reference O-35). Anxiety attacks often first occur during the teens or early adulthood. Frequently there is a connection with major stressful life experiences. There is also some evidence for a genetic predisposition. The primary difference between panic attacks and appropriate response to a stimulus, such as an enemy attack, is that the former occur suddenly in seemingly harmless situations and can even occur while sleeping (reference O-35).

A purported relationship between chemical exposure and panic disorder was prevalent in various groups in the late 1980's and early 1990's, often as part of the multiple chemical sensitivities (MCS) episode. One such group was a cohort 53 aircraft manufacturing facility composite-materials workers who had filed claims for illness labeled by the media as the "aerospace syndrome' (reference O-36). The investigators acknowledged that they could not "absolutely exclude" that the outbreak of anxiety in these workers was due to some as yet unknown neurotoxic effect of mixed chemicals at very low levels of exposure, they nevertheless felt that this explanation "seems unlikely." Idiopathic Environmental Intolerance (IEI), another term for MCS was claimed to be a cause of panic disorder, however Binkley, et al, showed in their small sample that there was a neurogenetic commonality between the two indicating that IEI was not causative (reference O-37) However, most investigators came to the conclusion that MCS was not causative for panic disorder.

There was a published report in 1987 of three workers who had idiosyncratic panic attack reactions to solvent exposures (reference O-38). However, no additional such reports were located in the published literature and all three had their initial attack during exposure. Therefore, in the absence of a member of the 1/24 BN SCBT who had a panic attack during exposure to solvent while deployed, and whose attacks have continued ever since, it is unlikely that solvent induced panic attacks will occur to members of the brigade. Panic attacks precipitated by memories or fears of occurrences from Iraq are beyond the scope of this discussion.

References

O-1. American Cancer Society. Non-Hodgkin Lymphoma. What is non-Hodgkin lymphoma? Topics. http://www.cancer.org/cancer/non-hodgkin lymphoma/detailedguide/non-hodgkin-lymphoma-types-of-non-hodgkin-lymphoma

O-2. Ambinder AJ, Shenoy JP, Malik N, et al. Review Article - Exploring Risk Factors for Follicular Lymphoma. Advances in Hematology 2012, Volume 2012, Article ID 626035, 13 pages

O-3. US Environmental Protection Agency Integrated Risk Information System - Tetrachloroethylene (Perchloroethylene) - http://www.epa.gov/IRIS/subst/0106.htm

O-4. US Environmental Protection Agency Integrated Risk Information System - Trichloroethylene - http://www.epa.gov/iris/subst/0199.htm

O-5. US Environmental Protection Agency Integrated Risk Information System - Benzene - http://www.epa.gov/iris/subst/0276.htm

O-6. Rinsky RA, Hornung RW, Silver SR, et al. Benzene exposure and hematopoietic mortality: A long-term epidemiologic risk assessment. Am J Ind Med 2002. 42(6):474-480.

O-7. Seidler A, Matthias Möhner1, Jürgen Berger, et al. Solvent exposure and malignant lymphoma: a population-based case-control study in Germany. Journal of Occupational Medicine and Toxicology 2007, 2:2

O-8. Müller AMS, Ihorst G, Mertelsmann R. Epidemiology of non-Hodgkin's lymphoma (NHL): trends, geographic distribution, and etiology. Annals of Hematology. January 2005; 84(1):1-12

O-9. Bassig BA, Lan Q, Rothman N, et al. Current Understanding of Lifestyle and Environmental Factors and Risk of Non-Hodgkin Lymphoma: An Epidemiological Update. J Cancer Epidemiol. 2012; 2012: 978930. Published online 2012 September 12.

O-10. Clarke CA, Glaser SL. Changing incidence of non-Hodgkin lymphomas in the United States. Cancer. 2002; 94(7);2015–2023.

O-11. Christensen KY, Vizcaya D, Richardson H, et al. Risk of selected cancers due to occupational exposure to chlorinated solvents in a case-control study in Montreal. J Occup Environ Med. 2013 Feb;55(2):198-208.

O-12. Miligi L, Costantini AS, Benvenuti A. Occupational Exposure to Solvents and the Risk of Lymphomas. Epidemiology. 2006 Sep; 17(5):552-561.

O-13. Cocco P, t'Mannetje A, Fadda D. Occupational exposure to solvents and risk of lymphoma subtypes: results from the Epilymph case-control study. Occup Environ Med. 2010 May;67(5):341-7

O-14. Fritschi L, Benke G, Hughes AM, et al. Occupational Exposure to Pesticides and Risk of Non-Hodgkin's Lymphoma. Am. J. Epidemiol. 2005 Nov; 162(9):849-857.

O-15. Eriksson M, Hardell L, Carlberg M and Åkerman M. Pesticide exposure as risk factor for non-Hodgkin lymphoma including histopathological subgroup analysis. Int. J. Cancer 2008; 123:1657–1663.

O-16. American Cancer Society. Leukemia - Acute Lymphocytic. What is leukemia - Acute Lymphocytic Leukemia (ALL) in adults? Topics. http://www.cancer.org/cancer/leukemia-acutelymphocyticallinadults/detailedguide/leukemia-acute-lymphocytic-what-is-all

O-17. Raabe GK, Wong O. Leukemia mortality by cell type in petroleum workers with potential exposure to benzene. Environ Health Perspect. 1996 Dec;104 Suppl 6:1381-92.

O-18. Rushton L, Romaniuk H. A case-control study to investigate the risk of leukaemia associated with exposure to benzene in petroleum marketing and distribution workers in the United Kingdom. Occup Environ Med. 1997 Mar;54(3):152-66.

O-19. Schnatter AR, Rosamilia K, Wojcik NC. Review of the literature on benzene exposure and leukemia subtypes. Chem Biol Interact. 2005 May 30;153-154:9-21.

O-20. American Cancer Society - Bile Duct (Cholangiocarcinoma) Cancer. What is Bile Duct Cancer? Topics.http://www.cancer.org/cancer/bileductcancer/detailedguide/bile-duct-cancer-what-is-bile-duct-cancer

O-21. Kumagai S, Kurumatani N, Arimoto A, Ichihara G. Short report - Cholangiocarcinoma among offset colour proof-printing workers exposed to 1,2-dichloropropane and/or dichloromethane. Occup Environ Med 2013;70:508-510

O-22. The Committee on Gulf War and Health of the Institutes of Medicine. National Research Council. Gulf War and Health: Volume 2. Insecticides and Solvents. Washington, DC. The National Academies Press, 2003 Also cited twice above (BDC-3 and CD-4)

O-23. National Heart, Lung, Blood Institute at the National Institutes of Health. What is Asthma? http://www.nhlbi.nih.gov/health/health-topics/topics/asthma/

O-24. American Academy of Allergy, Asthma and Immunology. Occupational Asthma. Accessed at: http://www.aaaai.org/conditions-and-treatments/conditions-a-to-z-search/occupational-asthma.aspx

O-25. Cowl CT. Occupational asthma: review of assessment, treatment, and compensation. Chest. 2011;139:674-681

O-26. Occupational Safety and Health Administration, U.S. Department of Labor. Safety and Health Topics- Occupational Asthma. https://www.osha.gov/SLTC/occupationalasthma/

O-27. Smith B, Wong CA, Smith TC, et al. Newly reported respiratory symptoms and conditions among military personnel deployed to Iraq and Afghanistan: a prospective population-based study. Am J Epidemiol. 2009;170:1433–1442.

O-28. Szema AM, Peters MC, Weissinger KM, et al. New-onset asthma among soldiers serving in Iraq and Afghanistan. Allergy and Asthma Proceedings 2010 Sep;31(5):67-71

O-29. Szema AM, Salihi W, Savary K, et al. Respiratory Symptoms Necessitating Spirometry Among Soldiers With Iraq/Afghanistan War Lung Injury. JOEM 2011 September; 53(9): 960-965

O-30. Peterson MR, Schneidermann A, Walters T. Letter to the Editor: Respiratory Symptoms Necessitating Spirometry Among Soldiers With Iraq/Afghanistan War Lung Injury JOEM 2011 December; 53(12): 1356-1357

O-31. Morris MJ, Zacher LL, Jackson DA: Investigating the Respiratory Health of Deployed Military Personnel. Military Medicine, 2011 October; 176 (10) 1157-1168

O-32. Smith B, Wong CA, Boyko EJ, et al. The Effects Of Exposure To Documented Open-Air Burn Pits On Respiratory Health Among Deployers Of The Millennium Cohort Study. JOEM 2012 June; 54(6):708-716

O-33. Abraham JH, DeBakey SF, Reid L, et al. Does Deployment to Iraq and Afghanistan Affect Respiratory Health of US Military Personnel? JOEM 2012 June; 54(6):740-745

O-34. Abraham, J. H., Eick-Cost, A. et al. (2014). A retrospective cohort study of military deployment and postdeployment medical encounters for respiratory conditions. Mil Med 179(5): 540-6.

O-35. American Psychological Association. Answers to Your Questions about Panic Disorders. http://www.apa.org/topics/anxiety/panic-disorder.aspx

O-36. Sparks PJ, Simon GE, Katon WJ, et al: An outbreak of illness among aerospace workers. West J Med 1990 Jul; 153:28-33

O-37. Binkley K, King N, Poonai N, et al. Idiopathic environmental intolerance: Increased prevalence of panic disorder–associated cholecystokinin B receptor allele 7. J Allergy and Clin Immunology. May 2001; 107(5):763-764

O-38. Dager SR, Holland JP, Cowley DS, et al. Panic disorder precipitated by exposure to organic solvents in the workplace. Am J Psychiatry. 1987; 144:1056-1058

Appendix P

Summary of Evidence Regarding Deployment and Respiratory Conditions

EPIDEMIOLOGIC EVIDENCE SUMMARY STATEMENT
Military Deployment and Chronic Respiratory Conditions

PURPOSE: This document is intended to provide technical audiences with a summary of the current scientific evidence regarding potential associations between deployment-related exposures and post-deployment chronic respiratory conditions. This information may be used by healthcare professionals to brief leaders and assist in counseling individual Service Members and their family members.

WHY is this information needed? The health and well-being of personnel is a top priority of the Department of Defense (DoD). Some military personnel are returning from Iraq and Afghanistan with persistent respiratory symptoms, and are concerned that exposures sustained during deployment have made them sick. The DoD shares this concern. Evaluations of associations between deployment and incidence of persistent post-deployment respiratory symptoms and specific chronic lung conditions are being performed. The DoD is continually evaluating the strengths and limitations of the available science. This communication represents what the US Army Public Health Command (USAPHC) considers to be factually supported statements that reflect the most current scientific information.

WHO is the population of concern? U.S. personnel deployed to the Central Command (CENTCOM) Area of Operation (AOR) (i.e., Southwest Asia –Iraq, Afghanistan, and Kuwait), from 2002 to present.

WHAT do we know? Personnel deployed to the CENTCOM AOR are exposed to dust and ambient particulate matter, often in conjunction with airborne emissions from vehicles, waste burning, and local industry. For years, DoD has conducted environmental sampling to characterize these exposures, focusing on particulate matter (PM). The data demonstrate variable conditions including occasions where pollutant levels exceed health guidelines (Engelbrecht, McDonald et al. 2009). When these conditions occur, high levels of ambient particulate matter and other air pollutants can irritate the eyes and respiratory passages. Acute exposure can also exacerbate pre-existing respiratory conditions like asthma and COPD. More persistent health effects of air pollutant exposures are dependent on the type of pollutant(s), the duration of exposure, and characteristics of the population being exposed (Pope and Dockery 2006). With respect to particulate matter air pollution, persons with underlying disease, the elderly, and the very young are most likely to be susceptible to short-term exposures to elevated PM. There may be more broad susceptibility to long-term PM exposure, although significant effects of cumulative exposure are most likely to be observed in older age groups with repeated exposures and higher baseline risks of health events. (Pope 2000) Susceptibility to exposures of intermediate length typical among deployed personnel is not well characterized.

Medical surveillance data for the U.S. Service member population indicate that the overall rates of chronic respiratory diseases after deployment have been either stable or slightly decreasing over the last 10 years (Baird, ATS 2011; Abraham, Clark et al. 2014) However, the rate of diagnoses of “bronchitis, not specified as acute or chronic,” increased between 2001 and 2009, before reversing course, and decreasing since 2009. Interpretation of this information is complicated because the rates are based on medical encounter diagnosis codes and selected diagnostic codes may be too general or may not correspond to a clinical definition of a disease, limiting their validity.

The scientific studies evaluating the association between deployment and respiratory health that have been completed indicate a range of different findings. These include: (a) no evidence of an association between deployment and chronic respiratory conditions (AFHSC 2010; Abraham and Baird 2012); (b) an association between specific respiratory diseases and deployment (Szema et al. 2010; Barth et al. 2014; Abraham et al. 2014) *;* and (c) evidence of increased respiratory symptoms but not a specific diagnosed disease (Roop et al. 2007; Smith et al. 2009; Szema et al. 2011; Abraham et al. 2012). Additional conditions (i.e. acute eosinophilic pneumonia (Shorr et al. 2004) and constrictive bronchiolitis (King et al. 2011) are described in case series from which epidemiologic associations cannot be directly estimated. Although all of these studies have methodological limitations that constrain the strength of the conclusions being drawn, their findings warrant continued investigation.

In conclusion, the evidence to date does not clearly support the inference of a specific association between deployment and chronic respiratory conditions among deployed personnel, or the absence of such an association. Chronic respiratory conditions and other severe effects of air pollution are generally not expected in a relatively young and healthy adult population. However, susceptibility to health effects of intermediate duration exposure remains a substantial gap in current knowledge. Some previously deployed Service Members may experience persistent effects due to their combined deployment exposures in conjunction with unique experiences, smoking habits, and/or individual susceptibilities associated with existing health conditions or genetics.

WHY is it so difficult to get a clear answer? Arriving at weight of the evidence-based conclusions regarding associations between deployment environmental exposures and long-term respiratory health of military personnel is challenging for several reasons. Key complicating factors include:

- **This is a relatively new area of scientific investigation**. A small but growing number of assessments evaluating the association between military deployment to Southwest Asia and chronic respiratory conditions have been published in the peer-reviewed scientific literature. This current body of evidence shows a range of observations that are not consistent. Multiple, well-conducted studies with consistent results are typically needed to support a strong conclusion regarding an exposure-disease relationship. Current work is ongoing to fill this need.

- **The data used to represent both exposure and medical outcomes are surrogates for actual conditions.** Though the relationship between *deployment-related environmental exposures* and *chronic respiratory disease* is the concern, the "exposure" is often defined only as deployment status (e.g., number, timeframe, and location of deployment(s)), rather than by quantified environmental exposure data. Similarly, medical outcomes are often identified using diagnostic codes that may, or may not, reflect properly diagnosed disease.

- **No single study presents a definitive answer.** The significance of a study's contribution to the overall body of evidence should be based on a consideration of both its strengths and limitations. Findings should be balanced against limitations regarding study design to include adequacy of comparison groups, exposure assumptions, how outcomes are assessed, latency periods, confounding and other epidemiological biases, and low statistical power.

- **Reports of individual cases may be newsworthy but can also easily distort or distract from the interpretation of available scientific evidence**. Such cases are often compelling and

deserving of the public's attention, and may serve as clues to the scientific community for their hypothesis generating potential. However, individual case-reports alone do not provide strong scientific evidence of an association between deployment-related exposures and the condition. Further studies are needed to explore any potential relationships.

WHAT are we looking at more closely? The DoD has established a Pulmonary Research Working Group with members from the VA, academia, and other Civilian research organizations to help determine prioritized areas of focus. New research has been submitted for publication while other work is ongoing and in the planning stages. In addition to exposure risk assessments, epidemiologic studies are evaluating chronic respiratory diseases and dypsnea on exertion.

Summary: *The evidence to date is inconclusive regarding increased risk of chronic respiratory conditions associated with military deployment to the CENTCOM AOR. However, some previously deployed personnel may experience persistent symptoms or develop chronic respiratory conditions which may be due to their combined deployment exposures, unique experiences, and/or individual susceptibilities. DOD acknowledges the concern regarding potential respiratory health effects associated with deployment, and is collaborating with the VA and independent researchers to further evaluate and quantify potential long-term health risks related to deployment exposures.*

Service members with medical concerns should consult with their healthcare providers. Providers may consult with the USAPHC Environmental Medicine Program.

USAPHC-EnvironmentalMedicineProgram@AMEDD.army.mil ***Tel:*** **410-436-2714**

References Cited:

Abraham, J. H., Clark L.L., et al. (2014). "Trends in rates of chronic obstructive conditions among U.S. military personnel, 2001-2013." Mil Med. Accepted for Publication.

Abraham, J. H. and C. P. Baird (2012). "A case-crossover study of ambient particulate matter and cardiovascular and respiratory medical encounters among US military personnel deployed to southwest Asia." J Occup Environ Med 54(6): 733-9.

Abraham, J. H., DeBakey S. F., et al. (2012). "Does deployment to Iraq and Afghanistan affect respiratory health of US military personnel?" J Occup Environ Med 54(6): 740-5.

Abraham, J. H., Eick-Cost A., et al. (2014). "A retrospective cohort study of military deployment and post-deployment medical encounters for respiratory conditions." Mil Med. Accepted for Publication.

AFHSC (2010). Epidemiological Studies of Health Outcomes among Troops Deployed to Burn Pit Sites. Silver Spring, MD, Armed Forces Health Surveillance Center.

Barth S.K., Dursa E.K, et al. (2014) Prevalence of respiratory diseases among veterans of operation enduring freedom and operation iraqi freedom: results from the national health study for a new generation of U.S. Veterans. Mil Med. 179(3): 241-245.

Engelbrecht, J. P., E. V. McDonald, et al. (2009). "Characterizing mineral dusts and other aerosols from the Middle East--Part 1: ambient sampling." Inhal Toxicol 21(4): 297-326.

King, M. S., R. Eisenberg, et al. (2011). "Constrictive bronchiolitis in soldiers returning from Iraq and Afghanistan." N Engl J Med 365(3): 222-30.

Pope, C. A., 3rd (2000). "Epidemiology of fine particulate air pollution and human health: biologic mechanisms and who's at risk?" Environ Health Perspect 108 Suppl 4: 713-23.

Pope, C. A., 3rd and D. W. Dockery (2006). "Health effects of fine particulate air pollution: lines that connect." J Air Waste Manag Assoc 56(6): 709-42.

Roop, S. A., A. S. Niven, et al. (2007). "The prevalence and impact of respiratory symptoms in asthmatics and nonasthmatics during deployment." Mil Med 172(12): 1264-9.

Shorr, A. F., S. L. Scoville, et al. (2004). "Acute eosinophilic pneumonia among US Military personnel deployed in or near Iraq." JAMA 292(24): 2997-3005.

Smith, B., C. A. Wong, et al. (2009). "Newly reported respiratory symptoms and conditions among military personnel deployed to Iraq and Afghanistan: a prospective population-based study." Am J Epidemiol 170(11): 1433-42.

Szema, A. M., M. C. Peters, et al. (2010). "New-onset asthma among soldiers serving in Iraq and Afghanistan." Allergy Asthma Proc 31(5): 67-71.

Szema, A. M., W. Salihi, et al. (2011). "Respiratory symptoms necessitating spirometry among soldiers with Iraq/Afghanistan war lung injury." J Occup Environ Med 53(9): 961-5.