DEPARTMENT OF THE ARMY
US ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND MD 21010-5403

MCHB-TS-RDE

20 SEP 2009

MEMORANDUM FOR Office of the Command Surgeon (MAJ (b) (6)), US Central Command,7115 South Boundary Boulevard, MacDill Air Force Base, FL 33621-5101

SUBJECT: Deployment Occupational and Environmental Health Risk Characterization, Ambient Air Particulate Matter Samples, Ramadi, Iraq, 15-21 June 2009, U_IRQ_RAMADI_CM_A25_20090621

1. The enclosed assessment details the risk characterization for six ambient air particulate matter samples collected by 2nd Battalion, 23rd Battlefield Area Support personnel at Ramadi, Iraq, 15-21 June 2009.

2. The occupational and environmental health risk estimate for exposure to particulate matter less than 2.5 micrometers in diameter ($PM_{2.5}$) and metals in the ambient air at Ramadi, Iraq is **moderate** due to elevated levels of $PM_{2.5}$. Exposure to the ambient air may have a significant impact on unit readiness if the hazard occurs during the mission.

FOR THE COMMANDER:

(b) (6)

Director, Health Risk Management

Encl

CF: (w/encl)
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MCHB-TS-RDE
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U.S. Army Center for Health Promotion and Preventive Medicine

DEPLOYMENT OCCUPATIONAL AND ENVIRONMENTAL
HEALTH RISK CHARACTERIZATION
AMBIENT AIR PARTICULATE MATTER SAMPLES
RAMADI, IRAQ
15-21 JUNE 2009
U_IRQ_RAMADI_CM_A25_20090621

Preventive Medicine Survey: 40-5f1

USCHPPM

Readiness Thru Health

DEPLOYMENT OCCUPATIONAL AND ENVIRONMENTAL
HEALTH RISK CHARACTERIZATION
AMBIENT AIR PARTICULATE MATTER SAMPLES
RAMADI, IRAQ
15-21 JUNE 2009
U_IRQ_RAMADI_CM_A25_20090621

1. REFERENCES.

a. Department of the Army, Field Manual (FM) 5-19, Composite Risk Management, 21 August 2006.

b. U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) Technical Guide (TG) 230, Chemical Exposure Guidelines for Deployed Military Personnel, Version 1.3, May 2003 with the January 2004 addendum.

c. USACHPPM Reference Document (RD) 230, Chemical Exposure Guidelines for Deployed Military Personnel, Version 1.3, May 2003 with January 2004 addendum.

d. Memorandum, USACHPPM (MCHB-TS-RDE), 27 April 2007, Subject: Deployment Operational Risk Characterization Method for Particulate Matter (PM).

2. PURPOSE. According to U.S. Department of Defense medical surveillance requirements, this occupational and environmental health (OEH) risk characterization documents the identification and assessment of chemical hazards that pose potential health and operational risks to deployed troops. Specifically, the samples and information provided on the associated field data sheets were used to estimate the operational health risk associated with exposure to identified chemical hazards in the air at Ramadi, Iraq.

3. SCOPE. This assessment addresses the analytical results for six ambient air PM samples collected from Ramadi, Iraq, 15-21 June 2009. These samples are limited in time, area, and media. Therefore, this report should not be considered a complete assessment of the overall OEH hazards to which troops may be exposed at Ramadi, Iraq. However, this assessment has been performed using operational risk management (ORM) doctrine FM 5-19 and the relatively conservative (protective) assumptions and methods provided in TG 230 to facilitate decision making that can minimize the likelihood of significant risks.

4. BACKGROUND AND EXPOSURE ASSUMPTIONS. The samples were collected to assess the potential for adverse health effects to troops routinely and continuously breathing the ambient air at Ramadi, Iraq. The samples were collected near the dining facility and burn pit at Ramadi, Iraq. The field data sheets indicated it is unknown if there was active industry present in the area during sampling. Field notes indicate a sandstorm and rain on 16 June 2009 during

sample collection. No other significant weather conditions were reported. All personnel are expected to remain at Ramadi, Iraq for less than 1 year. A conservative (protective) assumption is that all personnel inhale the ambient air for 24 hours/day for 365 days (1 year). In addition, it is assumed that control measures and/or personal protective equipment are not used.

5. METHOD.

a. General. The USACHPPM Deployment Environmental Surveillance Program uses the TG 230 methodology and associated military exposure guidelines (MEGs) to assess identified hazards and estimate risk in a manner consistent with doctrinal risk management procedures and terminology. This method includes identification of the hazard(s), assessment of the hazard severity, probability, determination of a risk estimate, and associated level of confidence. As part of the hazard identification step, the long-term (1-year) MEGs are used as screening criteria to identify those hazards that are potential health threats. These 1-year MEGs represent exposure concentrations at or below which no significant health effects (including delayed or chronic disease or significant increased risk of cancer) are anticipated even after 1 year of continuous daily exposures. Short-term MEGs are used to assess one time or intermittent exposures. The underlying toxicological basis for the MEGs is addressed in the RD 230. Since toxicological information about potential health effects varies among different chemicals, the determination of severity of effects when MEGs are exceeded involves professional judgment. Hazards with exposure concentrations greater than MEGs are identified as potential health threats, carried through the hazard assessment process, and assigned a risk estimate consistent with ORM methodology. Hazards that are either not detected or are present only at levels below the 1-year MEGs are not considered health threats and, therefore, are automatically assigned a low operational risk estimate.

b. Assessment of Ambient Air Particulate Matter. Particulate matter is one of six air pollutants for which the U.S. Environmental Protection Agency (USEPA) has promulgated National Ambient Air Quality Standards (NAAQS) in the interest of protecting public health. In addition, the USEPA developed the Air Quality Index (AQI) to communicate daily air quality to the public using six descriptive categories ranging from “good” to “hazardous.” The AQI categories for PM are based on concentration ranges that are grouped according to the severity of health concerns. The USACHPPM uses the AQI categories to characterize the operational risk from PM. If any PM sample concentration is above the threshold of the AQI “good” quality air category, it is identified as a hazard. Hazard severity is determined by comparing the average PM concentration for a specific location and timeframe to PM concentration ranges identified as either negligible or marginal. Negligible concentration levels correspond to mild respiratory effects among generally healthy troops, with more significant effects among sensitive persons, such as asthmatics or those with existing cardiopulmonary disease. Marginal concentration levels are expected to pose more significant health effects among both healthy personnel, and

those with pre-existing sensitivities. Hazard probability is based on the frequency that anticipated exposures are above a threshold that is representative of the hazard severity category.

6. HAZARD IDENTIFICATION.

a. Sample Information. Six PM less than 2.5 micrometers in diameter ($PM_{2.5}$) samples were collected using a DPS™ apparatus. (DPS™ is a trademark of SKC, Inc.)

b. Laboratory Analysis. All valid samples were analyzed for $PM_{2.5}$ and metals. Detected metals identified above the laboratory reportable limit were compared to MEGs presented in TG 230, while $PM_{2.5}$ concentrations were assessed using the process described in the Method, section 5. Appendix A shows a summary of the samples assessed in this report. Appendix B shows a sample results summary table. Appendix C shows complete analytical results for individual samples.

c. Assessment.

(1) Particulate Matter. The average $PM_{2.5}$ sample concentration was 239 micrograms per cubic meter ($\mu g/m^3$). Since the $PM_{2.5}$ was measured at concentrations above the AQI "good" range, $PM_{2.5}$ is identified as a potential health threat requiring further assessment. Particulate air pollutants include solid particles and liquid droplets emitted directly into the air by sources, such as, power plants, motor vehicles, aircraft, generators, construction activities, fires, and natural windblown dust. Airborne particulates can include dust, silica, soil, metals, organic compounds, allergens, and compounds; for example, nitrates or sulfates that are formed by condensation or transformation of combustion exhaust. Particulate matter chemical composition and size vary considerably depending on the source. Primary sources of $PM_{2.5}$ at the specified location are assumed to be windblown dust and sand.

(2) Cadmium. Cadmium was measured in one sample at 0.314 $\mu g/m^3$, which is above its 1-year MEG of 0.24 $\mu g/m^3$. Cadmium is a by-product in the production of other metals. Cadmium is used in batteries, pigments, metal coatings, plastics, and some metal alloys. Cadmium compounds are often found in or attached to small particles present in air. Food and cigarette smoke are the biggest sources of cadmium exposure for people in the general population.

(3) Other Metals. No other detected metals were found at concentrations greater than their respective MEGs. Therefore, the OEH risk estimate for exposure to metals completed in the lab analysis in the ambient air at this location is considered **low**.

7. HAZARD ASSESSMENT.

a. Hazard Severity.

(1) General. The hazard severity is based on an approximation of the percentage of personnel anticipated to exhibit health effects when exposed to hazard concentrations at or above an exposure guideline. In addition, the hazard severity depends on the nature of the health effects and the magnitude of the estimated exposure concentration relative to the comparison guideline. The hazard severity for metals is determined by comparing the estimated exposure concentration to MEGs published in TG 230 and by using TG 230, Table 3-1, as a guide. The hazard severity for $PM_{2.5}$ in determining the potential health threat of concern was determined by comparison of $PM_{2.5}$ concentrations to the AQI and using the process described in the Method, section 5.

(2) Particulate Matter. The hazard severity for the potential health threats of concern was determined by comparison of $PM_{2.5}$ concentrations to the AQI and using the process described in the Method, section 5. The average concentration of $PM_{2.5}$ was 239 $\mu g/m^3$. This concentration falls within the ranges of concentrations that are believed to pose significant health concerns to susceptible groups, which in the military can include asthmatics or persons with preexisting cardiopulmonary disease. Otherwise, generally healthy troops may have some eye, nasal, or throat irritation causing little or no impact on unit readiness. Therefore, the hazard severity for $PM_{2.5}$ is considered marginal.

(3) Cadmium. The average cadmium concentration for the sampling events was 0.067 $\mu g/m^3$. Inhalation of cadmium can be harmful. Breathing air with very high levels of cadmium can severely damage the lungs and may cause death. Breathing air with lower levels of cadmium over long periods of time (years) results in a build-up of cadmium in the kidney, and if sufficiently high, may result in kidney disease. However, it is emphasized that these effects are associated with levels notably higher than the 1-year MEG (.024 $\mu g/m^3$). Effects to adults would be anticipated after repeated and/or prolonged exposures above 0.24 $\mu g/m^3$. Since only one detected concentration was above the 1-year MEG and the average concentration was below the 1-year MEG, and few if any health effects to adults would be anticipated at exposures less than 0.24 $\mu g/m^3$, exposure to cadmium is considered a negligible hazard severity.

b. Hazard Probability.

(1) Particulate Matter. Although the average $PM_{2.5}$ sample concentration was within the marginal severity range, it is important to examine the individual samples to determine whether the average concentrations are dominated by outliers or if it they are representative of typical exposures. The hazard probability reflects the likelihood that the exposures at the location are represented by the concentrations used to determine the hazard severity. The probability that the

severity of a hazard is negligible is based on a comparison of individual sample concentrations to the $PM_{2.5}$ 24-hour NAAQS of 150 µg/m^3. During this sampling event, the range of $PM_{2.5}$ concentrations was 42-507 µg/m^3, therefore, three of six (50 percent) $PM_{2.5}$ samples were above 150 µg/m^3. Since the assumption is that all or most personnel at this location are equally exposed to the ambient air, the probability that personnel will be exposed to $PM_{2.5}$ concentrations above 150 µg/m^3 is considered occasional.

(2) Cadmium. Since it is assumed that all personnel are equally exposed to the ambient air and the daily cadmium concentration was above the MEG in 1 of 6 (17 percent) samples, the probability that personnel will be exposed to concentrations of cadmium above the 1-year MEG is considered unlikely.

c. Risk Estimate and Confidence. The hazard severity and probability levels described above were used with the ORM matrix in TG 230, Table 3-3, or FM 5-19 to provide a risk estimate for exposure to each identified hazard. Table 1 summarizes the risk estimate for each identified hazard. The risk estimate for exposure to the ambient air at Ramadi, Iraq is considered **moderate** due to elevated levels of $PM_{2.5}$. The risk estimate for exposure to the ambient air at this location is based on the highest identified hazard risk estimate ($PM_{2.5}$). Confidence in the risk estimate is considered medium because it was indicated that a sandstorm occurred during the sampling period during which the highest $PM_{2.5}$ concentration was observed. In general, the confidence level in risk estimates is usually low to medium due to consistent lack of specific exposure information associated with troop movement and activity patterns; other routes/sources of potential OEH hazards not identified; and uncertainty regarding impacts of multiple chemicals present, particularly those affecting the same body organs/systems.

Table 1. Risk Estimate Summary for Exposure to the Ambient Air PM at Ramadi, Iraq, 15-21 June 2009

Parameter	Hazard Severity	Hazard Probability	Hazard-Specific Risk Estimate	Operational Risk Estimate	Confidence
$PM_{2.5}$	MARGINAL	OCCASIONAL	MODERATE	MODERATE	MEDIUM
Cadmium	NEGLIGIBLE	UNLIKELY	LOW		
Other Metals	None detected above a MEG		LOW		

8. CONCLUSION. The OEH risk estimate for exposure to $PM_{2.5}$ and metals in the ambient air at Ramadi, Iraq is **moderate** due to elevated levels of $PM_{2.5}$. The $PM_{2.5}$ was measured at concentrations above the USEPA AQI index's "good" quality air category. Exposure to the ambient air may have a significant impact on unit readiness if the hazard occurs during the mission. Cadmium was also detected above its 1-year MEG. However, it is expected that

cadmium levels are not consistently above the MEG for 1 year. Therefore, the OEH estimate for cadmium in the ambient air is considered **low**. Confidence in the risk estimate is considered medium.

9. RECOMMENDATIONS AND NOTE.

a. Recommendations.

(1) Continue to collect samples from this location at least once every 6 days for the deployment duration (or as long as possible) to better characterize the $PM_{2.5}$, PM_{10}, and metals ambient air concentrations to which personnel are typically exposed.

(2) Restrict outdoor physical activities where possible during periods of visibly high particulate levels.

(3) Inform preventive medicine and medical personnel of potential health effects resulting from exposures to the measured levels of ambient PM and associated heavy metals. Disease Non-Battle Injury (DNBI) rates of respiratory diseases, particularly asthma, should be followed and assessed during periods of high PM levels. If elevated DNBI respiratory illness rates (that is, above two standard deviations), or an increase in the incidence or severity of asthma, are noted during periods of high PM levels, ensure appropriate medical surveillance-related items are documents. If assistance and/or information are needed on environmental health effects and/or medical implications from exposure to PM and associated heavy metals, please contact the USACHPPM-Headquarters Environmental Medicine Program at commercial 001-410-436-2714.

b. Note. This OEH risk assessment is specific to the exposure assumptions identified above and the sample results assessed in this report. If the assumed exposure scenario changes, provide updated information so that the risk estimate can be reassessed. If additional samples from this site and/or area are collected, a new OEH risk assessment will be completed.

10. POINTS OF CONTACT. The USACHPPM points of contact for this assessment are Ms. (b) (6) and Mr. (b) (6). Ms. (b) (6) may be contacted at e-mail (b) (6) and Mr. (b) (6) may be contacted at e-mail (b) (6), or DSN (b) (6) or commercial (b) (6).

(b) (6)
Environmental Scientist
Deployment Environmental Surveillance Program

Approved by:

(b) (6)
MAJ, MS
Program Manager
Deployment Environmental Surveillance

APPENDIX A

SAMPLING SUMMARY
AMBIENT AIR PARTICULATE MATTER SAMPLES
RAMADI, IRAQ
15-21 JUNE 2009

DOEHRS Sample ID	Field/Local Sample ID	Site	Start Date/Time	Sample Duration	Filter ID
000010BF	IRQ RAMADI 09166 PM25DPS	Dining Facility	2009/06/15 1844	1410.0 minutes	47-04-0315
000010BJ	IRQ RAMADI 09167 PM25DPS	Dining Facility	2009/06/16 1917	1440.0 minutes	47-04-0321
000010BM	IRQ RAMADI 09169 PM25DPS	Dining Facility	2009/06/18 0601	1454.0 minutes	47-04-0330
000010BO	IRQ RAMADI 09170 PM25DPS	Burn Pit	2009/06/19 1220	1440.0 minutes	47-04-0333
000010BS	IRQ RAMADI 09171 PM25DPS	Burn Pit	2009/06/20 1353	1442.0 minutes	47-04-0343
000010BQ	IRQ RAMADI 09172 PM25DPS	Burn Pit	2009/06/21 1349	1453.0 minutes	47-04-0338

LEGEND:
DOEHRS Sample ID = Deployment Occupational and Environmental Health Readiness System Sample Identification Number

APPENDIX B

SAMPLE RESULTS SUMMARY
AMBIENT AIR PARTICULATE MATTER SAMPLES
RAMADI, IRAQ
15-21 JUNE 2009

Parameter[1]	Units	Concentration		# > Reporting Limit	USACHPPM TG230 Military exposure Guidelines (MEGs)	
					1-year	
		Maximum	Average		# > MEG	MEG
Antimony	µg/m^3	1.8663	0.34111	1	0	12
Cadmium	µg/m^3	0.31467	0.067473	1	1	0.24
Chromium	µg/m^3	0.044401	0.022444	1	0	12
Lead	µg/m^3	0.82465	0.17433	2	0	12
Manganese	µg/m^3	0.29865	0.10995	1	0	3.4
Nickel	µg/m^3	0.068941	0.026533	1	0	37
$PM_{2.5}$	µg/m^3	507	239	6	6	15
Zinc	µg/m^3	0.43113	0.22213	1	0	2400

NOTE:
[1] Highlighted values indicate the parameter was detected at a concentration above a MEG
LEGEND
µg/m^3 = micrograms per cubic meter

APPENDIX C

DETAILED SAMPLE RESULTS
AMBIENT AIR PARTICULATE MATTER SAMPLES
RAMADI, IRAQ
15-21 JUNE 2009

DOEHRS Sample ID			000010BF	000010BJ	000010BM	000010BO	000010BQ	000010BS
Field/Local Sample ID			IRQ RAMADI 09166 PM25DPS	IRQ RAMADI 09167 PM25DPS	IRQ RAMADI 09169 PM25DPS	IRQ RAMADI 09170 PM25DPS	IRQ RAMADI 09172 PM25DPS	IRQ RAMADI 09171 PM25DPS
Site			Dining Facility	Dining Facility	Dining Facility	Burn Pit	Burn Pit	Burn Pit
Start Date/Time			2009/06/15 1844	2009/06/16 1917	2009/06/18 0601	2009/06/19 1220	2009/06/21 1349	2009/06/20 1353
Parameter	Class	Units	Concentration[1,2]					
Antimony	Metals	$\mu g/m^3$	< 0.073877	< 0.071963	< 0.071641	1.8663	< 0.071691	< 0.071493
Arsenic	Metals	$\mu g/m^3$	< 0.036939	< 0.035982	< 0.035821	< 0.036169	< 0.035845	< 0.035746
Beryllium	Metals	$\mu g/m^3$	< 0.036939	< 0.035982	< 0.035821	< 0.036169	< 0.035845	< 0.035746
Cadmium	Metals	$\mu g/m^3$	< 0.036939	< 0.035982	< 0.035821	0.31467	< 0.035845	< 0.035746
Chromium	Metals	$\mu g/m^3$	< 0.036939	0.044401	< 0.035821	< 0.036169	< 0.035845	< 0.035746
Lead	Metals	$\mu g/m^3$	< 0.073877	0.077001	< 0.071641	0.82465	< 0.071691	< 0.071493
Manganese	Metals	$\mu g/m^3$	< 0.14775	0.29865	< 0.14328	< 0.14468	< 0.14338	< 0.14299
Nickel	Metals	$\mu g/m^3$	< 0.036939	0.068941	< 0.035821	< 0.036169	< 0.035845	< 0.035746
$PM_{2.5}$		$\mu g/m^3$	99	507	225	498	42	64

Deployment OEH Risk Characterization, Ambient Air PM Samples, Ramadi, Iraq,
15-21 Jun 09, U_IRQ_RAMADI_CM_A25_20090621

DOEHRS Sample ID			000010BF	000010BJ	000010BM	000010BO	000010BQ	000010BS
Field/Local Sample ID			IRQ RAMADI 09166 PM25DPS	IRQ RAMADI 09167 PM25DPS	IRQ RAMADI 09169 PM25DPS	IRQ RAMADI 09170 PM25DPS	IRQ RAMADI 09172 PM25DPS	IRQ RAMADI 09171 PM25DPS
Site			Dining Facility	Dining Facility	Dining Facility	Burn Pit	Burn Pit	Burn Pit
Start Date/Time			2009/06/15 1844	2009/06/16 1917	2009/06/18 0601	2009/06/19 1220	2009/06/21 1349	2009/06/20 1353
Parameter	Class	Units	Concentration[1,2]					
Vanadium	Metals	µg/m^3	< 0.14775	< 0.14393	< 0.14328	< 0.14468	< 0.14338	< 0.14299
Zinc	Metals	µg/m^3	< 0.36939	< 0.35982	< 0.35821	0.43113	< 0.35845	< 0.35746

NOTES:
[1]< X.XX = Below laboratory reporting limit (X.XX)
[2]Laboratory reporting limit is parameter and sample specific

LEGEND:
DOEHRS Sample ID = Deployment Occupational and Environmental Health Readiness System Sample Identification Number
µg/m^3 = micrograms per cubic meter