THE ASSISTANT SECRETARY OF DEFENSE

WASHINGTON, D. C. 20301-1200

HEALTH AFFAIRS

MAY 30 2003

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (M&RA)
ASSISTANT SECRETARY OF THE NAVY (M&RA)
ASSISTANT SECRETARY OF THE AIR FORCE (SAF/MR)
DIRECTOR, JOINT STAFF

SUBJECT: Policy for the Operation Iraqi Freedom Depleted Uranium (DU) Medical Management

The 1991 Gulf War was the first conflict in which the United States used DU munitions. Since the Gulf War, considerable controversy has surrounded the environmental and medical implications of depleted uranium exposures. The guidance below is the most current for clinical management of personnel exposed to depleted uranium. In addition, I will request that the Deployment Health Clinical Center, located at Walter Reed Army Medical Center, evaluate, promulgate, and implement a revised depleted uranium medical program based on the attached materials.

The DoD's strategy for depleted uranium medical concerns consists of a set of activities addressing DU training and education, clinical treatment and medical surveillance, post-deployment screening, robust health risk communications, and medical follow-up through the military health care system in conjunction with the Department of Veterans Affairs (VA).

Depleted uranium exposures have been broadly divided into three categories: Level I – personnel who were in, on, or near combat vehicles at the time they were struck by DU rounds (to include wounded), or who entered immediately after to attempt rescue; Level II – personnel who routinely entered DU-damaged vehicles as part of their military occupation or who fought fires involving DU munitions; and Level III – personnel involved in all other exposures (incidental in nature, e.g. driving by a vehicle struck by DU.)

The military Services will identify all Operation Iraqi Freedom servicemembers who had Level I and Level II DU exposures. Any servicemember who indicates on the DoD Form 2796, "Post-Deployment Health Assessment," a possible DU exposure while deployed will be referred to a health care provider to determine the exposure level. DU bioassays are required for all personnel with Level I and II exposures (Attachment 1). For Level III, DU bioassays are not required, but medical providers may order a bioassay for medical management or to address concerns of the individual. In the interim, the military Services should use or adapt the Army Surgeon General Policy, "Policy for the Treatment of Personnel Wounded by Depleted Uranium," April 9, 1999 (Attachment 2) for DU casualty care.

The VA has had an ongoing embedded DU fragment-monitoring program since 1993 for individuals believed to be the most severely exposed because of injuries they experienced

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during the Gulf War. We intend to work with the VA to ensure that DU-exposed Operation Iraqi Freedom veterans may participate in this follow-up program. All personnel in Level I and II exposure categories will be offered referral to the Baltimore VA DU Medical Follow-up Program. The VA program administrators can be reached at 1-800-815-7533 to arrange for referral.

Attachment 3 is an Army information packet for clinicians that has been slightly modified based on the interim DU Bioassay Guidance; it should be provided to all clinicians involved in assessing DU exposures and ordering bioassays. The Navy and Air Force will identify points of contact for additional questions pertaining to the clinician information packet.

Questions on the clinical aspects for DU exposure assessment and treatment may be addressed to OSD Health Affairs/Clinical Program Policy (Lt Col Roger Gibson), DSN 761-1703, ext. 5211, commercial 703-681-1703, Roger.Gibson@ha.osd.mil.

Questions concerning the health physics of DU may be addressed to US Army Center for Health Promotion and Preventive Medicine (LTC Mark Melanson), DSN 584-8396, commercial 410-436-8396, Mark.Melanson@apg.amedd.army.mil.

I appreciate your timely assistance with this very important issue. We remain committed to addressing the health concerns of our veterans; they and their families deserve no less. My point of contact for this memo is COL Dan Sulka, 703-681-3279 x131, Daniel.Sulka@deploymenthealth.osd.mil.

William Winkenwerder, Jr.

William Winkenwerder, Jr., MD

Attachments:

1. Guidance for Depleted Uranium (DU) Bioassay Urinalysis for DU, May 8, 2003 (Interim)
2. Policy for the Treatment of Personnel Wounded by Depleted Uranium Munitions, July 30, 1999
3. Depleted Uranium: Information for Clinicians, USACHPPM, May 15, 2003

cc:
Surgeon General of the Army
Surgeon General of the Navy
Surgeon General of the Air Force
J-4 (HSS)
Director, Health and Safety, USCG
Assistant Secretary of Defense (Reserve Affairs)
Deployment Health Clinical Center
Department of Veterans Affairs
Dr. Melissa McDiarmid, Baltimore VA Medical Center

Guidance for Depleted Uranium (DU) Bioassay Urinalysis
May 8, 2003
This guidance will remain in effect until deleted or superseded

1. References. See Attachment 1

2. Purpose. This guidance establishes under what circumstances, to what ends, and exactly how the Military Services will employ bioassay procedures in the assessment of exposure of personnel to depleted uranium (DU) during deployment and combat operations. It will ensure DU bioassays are performed consistent with an approved administrative protocol and with sound medical practices, maintaining the trust of our servicemembers, their families, and commanders.

3. Applicability. This guidance applies during deployment and combat operations to all Department of Defense personnel, including the US Coast Guard. It also applies to government civilian employees and volunteers accompanying US forces. Additional medical guidance for the treatment of personnel wounded by DU munitions is found in Attachment 1, Reference 2.

4. Background.

a. Depleted uranium aerosols are one of many potentially hazardous substances that personnel may encounter during deployment and combat operations. There are two potential hazards associated with exposure to large amounts of DU aerosols — heavy metal toxicity and low-level radioactivity. Depleted uranium is 40 percent less radioactive than natural uranium. There is still theoretical risk for radiation-induced health effects from inhaling DU particulate aerosols. The bioassay procedures in this document are intended to provide specific guidance in quantifying any exposure to DU aerosols during deployments and/or combat operations.

b. Depleted uranium bioassays involve the speciation of uranium isotopes, which quantifies the uranium body burden that can be attributable to DU exposure. Once the DU body burden is determined, any health risks and any necessary medical follow-up can be determined.

c. Depleted uranium fragments from penetrators or armor may become embedded in the body as a result of exploding DU munitions. Larger fragments are readily visible radiographically and will appear similar to steel or lead fragments. A RADIAC meter (AN/VDR-2 with the beta shield open or equivalent) can help identify DU-contaminated wounds or burns and assist with wound cleaning. A negative reading does not necessarily provide positive assurance that an embedded fragment is not DU. Under no circumstances should any treatment of life-threatening injuries be delayed to obtain an AN/VDR-2. Inhaled DU is not radiographically visible nor is it likely that it can be detected using a RADIAC meter.

5. Policy. The Department of Defense's policy for conducting DU bioassays for personnel during combat or deployment operations is as follows:

a. DU bioassays are medical tests that are used for clinical purposes. Bioassays will be administered following coordinated decisions between commanders and medical personnel based on the following categories of exposed/potentially exposed personnel.

Level I – Personnel Struck by DU Munitions or Who Were In, On, or Near (less than 50

Meters) an Armored Vehicle at the Time (or Shortly After) it was Struck with DU Munitions (Non-occupational). These personnel may exceed peacetime standards for occupational exposures to DU (Attachment 1, Reference 3). This level is limited to personnel who were struck by DU munitions or were in, on or near (less than 50 meters from) an armored vehicle struck by DU munitions or from DU armor breached by any munitions and to first responders who entered these vehicles to render aid. Further guidance for treating those with DU fragments is addressed in Attachment 1, Reference 2. DU bioassays are required for all personnel within this level. For hospitalized Level I patients, bioassays are to be administered on a priority basis as soon as their medical condition permits a urine sample. Other Level I personnel will have bioassays performed as soon as possible but no later than 180 days post-incident.

Level II – Personnel Who Routinely Enter DU Damaged Vehicles as a Part of their Military Occupation or Who Fight Fires Involving DU munitions (Occupational). Personnel in this level may exceed peacetime standards for occupational exposures to DU (Attachment 1, Reference 3). This level includes personnel who routinely enter vehicles containing DU dust to perform maintenance and recovery operations (other than first responders), intelligence operations, or battle-damage assessment. This level also includes personnel whose occupations require fighting fires specifically involving DU munitions. DU bioassays are required for all personnel within this level. Bioassays are to be administered on a priority basis after each potential exposure incident but no later than 180 days post-incident.

Level III – Personnel with "Incidental" Exposure to DU. Examples of personnel in this category include individuals who have driven through smoke from a fire involving DU munitions or who have entered or climbed on or in battle damaged vehicles on an infrequent basis (not as a first responder and not as job requirement to enter vehicles that may have been contaminated with DU). Bioassays are not required for personnel in this level, though a physician may choose to perform one based on medical indications or on potentially exposed individual's request.

b. DU Bioassay Procedures

(1) Initial DU Urine Specimen. The purpose of an initial DU urine specimen is to obtain data used in estimating the amount of soluble DU internalized. Collection should begin not earlier than 24 hours after exposure and not later than 180 days post-exposure and continue for a full 24 hours. If the individual is returned to duty, at least a urine spot sample should be obtained before return to duty. Collect as much urine as possible over the 24-hour period and document the beginning time and the ending time of the collection period. If a 24-hour test is not feasible, collect at least 120 mls of the first void as a spot sample.

(2) A 7-10 day Urine Specimen. If an initial sample was taken within 24 hours of exposure, collect another sample 7-10 days after exposure. A 7-10 day urine specimen and any subsequent specimens provide additional data to estimate the amount of insoluble DU internalized. If an initial sample was taken after the first 24-48 hours, there is only a requirement for that sample.

(3) DU urine specimens for isotopic analysis will be processed and forwarded for analysis to laboratories with established QA/QC processes approved by the Service Surgeons General. Each laboratory request for an "isotopic uranium analysis" will include age, sex, height, and weight, date of exposure, date and time of urine collection, and type of sample (initial 24-hour, initial spot, 7-10 day) and a statement that results must be normalized to creatinine (e.g., nanograms of DU per gram creatinine) and normalized to the volume of the urine sample

(nanograms of DU per liter of urine). If a 24-hour sample, indicate whether all the urine was collected during that time frame.

c. Health Risk Communication. A health care provider will inform the individuals of the purpose of the bioassay, the results, the meaning of the results, and whatever follow-up may be required. For both Level I and II personnel with elevated results:

In the event urine tests indicate elevated uranium levels: *We have determined that you have levels of (naturally occurring or depleted uranium) in your urine that are elevated above what is generally expected based on levels of uranium found in the general US population. Naturally occurring uranium is found in both water and food supplies, and each of us has background levels of uranium in our bodies. Depleted uranium has 40 percent less radioactivity than naturally occurring uranium. Over 70 US 1991 Gulf War veterans who were exposed to depleted uranium as a result of inhaling DU dust and/or due to retained embedded fragments from exploding DU armor and munitions have been medically evaluated and some followed up for nearly 12 years.*

While high DU exposures may potentially cause various types of illnesses such as kidney disease or cancer, none of the Gulf War veterans that have been medically followed have experienced any illnesses attributable to DU exposure, and the risks of any such illness appear to be very low. We will, however, continue to closely monitor the health of those previously exposed, and if we see evidence that DU may cause illness, we will contact you. Based upon what we presently know, however, you should not have any concerns about your uranium levels and any impacts upon your health. Do you have any questions?

d. Services will ensure laboratory bioassay results and risk communication messages delivered are entered into the individual medical records and into the Service's automated medical record system. Services will also ensure that results for all DU bioassays are archived and retrievable.

e. Post-deployment Health Assessments (DD Form 2796). When the DD Form 2796s are completed, the appropriate health care provider will follow-up on all positive answers to DU exposure to determine whether individual servicemembers fall into either Level I or II. These personnel will be handled IAW with this guideline and with Post-Deployment Health Assessment guidance.

Attachment (1)
References

ATTACHMENT 1
Depleted Uranium References

1. Army Regulation (AR) 40-5, 15 October 1990, *Preventive Medicine.*

2. Memorandum, U.S. Army Medical Command, 9 Apr 1999, subject: *Policy for the Treatment of Personnel Wounded by Depleted Uranium Munitions*

3. Army Regulation (AR) 11-9, 28 May 1999, *The Army Radiation Safety Program*

4. Technical Guide 211, *Radiobioassay, Collection Labeling and Shipping Requirements,* U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM), July 1998. http://chppm-www.apgea.army.mil/documents/TG/TECHGUID/ TG211.pdf

5. *Clinical Practice Guideline for Post-Deployment Health Evaluation and Management,* December 2001. http://www.pdhealth.mil/main.asp

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

7. Agency for Toxic Substances and Disease Registry (ATSDR), *Uranium Toxicological Profile and Public Health Statement*, September 1999. http://www.atsdr.cdc.gov/toxprofiles/tp150.html

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

9. Joint Staff Capstone Document, *Force Health Protection – Healthy and Fit Force, Casualty Prevention, Casualty Care and Management*

10. Department of Defense Instruction (DoDI) 6490.3, *Implementation and Application of Joint Medical Surveillance for Deployments,* 7 August 1997.

Attachment (2)

MCHO-CL-W

Policy for the Treatment of Personnel Wounded by Depleted Uranium Munitions
26 February 1999
This policy will remain in effect until deleted or superseded

1. References.

a. Army Regulation (AR) 40-5, 15 October 1990, Preventive Medicine.

b. Message, 141130Z Oct 93, DASG-PSP, HQDA, subject: Medical Management of Unusual Depleted Uranium Exposures.

c. 1st Endorsement, MCHO-CL-W (ECMD/9 Jan 96), 23 Jan 96, subject: Request for Guidance on the Medical Management of Unusual Depleted Uranium Exposures

d. Memorandum, MCHO-CL-W, HQ USAMEDCOM, 15 Feb 96, subject: Interim Treatment Guidance for Patients Contaminated with Depleted Uranium

e. Technical Guide 211, "Radiobioassay, Collection Labeling and Shipping Requirements," U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM), May 1998.

f. North Atlantic Treaty Organization (NATO) Standardization Agreement (STANAG) 2068, "Emergency War Surgery," 1988.

g. Draft AR 40-400, Patient Administration

2. Purpose. Provide Department of the Army medical policy for the treatment of personnel wounded by depleted uranium munitions. This policy does not apply to personnel who are not wounded but may have internalized depleted uranium through inhalation or ingestion. This policy supersedes the wound treatment policy set forth in references 1b, 1c, and 1d above.

3. Background.

a. Depleted uranium kinetic energy (KE) munitions and armor proved their effectiveness during Operation Desert Storm (ODS). This success has led to a dramatic increase in the number of nations who use this material in their munitions and as a part of the armor in armored vehicles.

b. Depleted uranium is uranium that has decreased amounts of the most radioactive isotopes of uranium. Chemically and toxicologically it is the same as natural uranium.

(1) Depleted uranium is a heavy metal and, like other heavy metals (tungsten, lead, etc.), it has toxic effects to the body if internalized in large quantities.

(2) Radiologically, depleted uranium is 40% less radioactive than the natural uranium found in the air, water, soil, and food products.

c. When a depleted uranium munition strikes an armored target, the penetration process generates high concentrations of airborne, breathable, depleted uranium oxides and high velocity shards of the metal that can cause serious wounds.

d. Personnel in, on, or near (less than 50 meters) an armored vehicle when the vehicle is being penetrated by a depleted uranium munition may internalize depleted uranium through inhalation, wound contamination, and fragmentation (if hit by high velocity depleted uranium shards).

(1) The military experience with depleted uranium in Operation Desert Storm (ODS) showed that personnel surviving vehicle penetrations may have a wide range of injuries. These range from only minor cuts and abrasions, to severe lacerations, burns, broken bones, puncture wounds and retained depleted uranium and other types of metallic fragments.

(2) Radiographic examination of personnel wounded during ODS showed that, as with personnel wounded by tungsten KE munitions, personnel may have from one many depleted uranium fragments embedded in localized regions of the body.

(3) Fragment sizes can vary from very small (several millimeters) to large (1 to 2 cm) and are readily discernible by x-ray examination. Fragments may be embedded at any depth and in any location in the body. One patient had a 1.5 cm fragment embedded deep in his thigh and several smaller (millimeter sized) fragments in his ankle. In another patient, over 20 fragments of varying sizes (millimeters to centimeters) were localized in his calf muscle.

4. Health Effects.

a. 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 amount taken into the body. It has been recognized that very high uranium intakes can cause kidney damage.

b. Since 1993, the Department of Veterans Affairs has been following 33 Gulf War veterans who were seriously injured in friendly fire incidents involving depleted uranium. These veterans are being monitored at the Baltimore VA Medical Center. Many of these veterans continue to have medical problems relating to the physical injuries they received during these incidents. About half of this group still have depleted uranium metal fragments in their bodies.

c. 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.

d. For all 33 veterans in the program (including those with retained depleted uranium fragments), all tests for kidney function have been normal. 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.

5. Clinical Treatment of Personnel Wounded by Depleted Uranium Munitions.

a. 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.

b. 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. The use of a sensitive radiation meter may assist in wound debridement and cleaning. The AN/VDR-2 RADIAC meter with the beta window open may assist in locating depleted uranium contamination in the wound or burn. **Under no circumstances should required treatment be delayed to perform this monitoring.**

c. Embedded depleted uranium fragments should be removed using standard surgical criteria (reference 1.f 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.

d. Monitoring of kidney function is recommended for those patients who have contaminated wounds or embedded depleted uranium fragments. The monitoring should follow the current protocol in use by the Baltimore Veterans Affairs (VA) Depleted Uranium Program.

(1) As with all heavy metals, the kidney is one of the organs most sensitive to uranium toxicity. Recommended tests include urinalysis, 24-hour urine for uranium bioassay, serum BUN, creatinine, beta-2-microglobulin and creatinine clearance.

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

6. <u>Determining the Presence of Depleted Uranium</u>.

a. Suspected wounding with depleted uranium or inhalation of aerosolized depleted uranium during combat should always be recorded on the patient's field medical card. Indicators that may be obtained from the patient or the patient's field medical card include:

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

(2) Patient's vehicle was struck by friendly fire either from US tanks or aircraft.

(3) Patient reports he saw burning fragments (like a Fourth of July sparkler) while the vehicle was being penetrated. Depleted uranium is pyrophoric and will ignite under high pressure and temperatures.

b. Because of depleted uranium's high density, fragments are readily visible radiographically and will appear similar to steel or lead fragments in the body.

(1) Radiography alone, however, is not sufficient to determine the presence or absence of depleted uranium. ODS experience found that there were soldiers in vehicles struck by depleted uranium munitions that had retained fragments that were not depleted uranium.

(2) In addition, KE penetrators made out of tungsten will cause similar wounds and will appear radiographically the same. A large number of countries are using tungsten penetrators.

c. If readily available, a RADIAC meter (AN/VDR-2 with the beta shield open or equivalent) may be used to monitor wounds, burns, or suspected sites with embedded fragments. This can assist in wound cleaning and will confirm the presence of depleted uranium. **Under no circumstances should treatment be delayed to obtain an AN/VDR-2**.

d. **The most sensitive indicator for the internalization of depleted uranium is a uranium urine bioassay.** The policy for this bioassay is discussed in paragraph 8 below.

e. In general, patients with retained depleted uranium fragments will excrete uranium in the urine. ODS experience showed that, like lead, depleted uranium from the fragments will dissolve and be transported into the blood.

(1) The fragments serve as a source of depleted uranium and the level of excretion will remain constant for long periods of time. Once in the blood stream, the depleted uranium will be metabolized in the same way that natural uranium is by the body. Depleted uranium is excreted in the urine.

(2) Results of the medical monitoring of patients from ODS indicate that the highest uranium urine levels were on the order of 30 to 40 micrograms of total uranium per gram of creatinine. This monitoring was initiated in 1993 and the levels have remained more or less constant. In all likelihood, the levels were higher at the time the soldiers were wounded. How much higher is not known.

f. **The presence of depleted uranium fragments in the service member's body presents no risks to family members. As with other heavy metals retained in the body, the depleted uranium in all bodily fluids (urine, feces, sweat, saliva, and semen) present absolutely no hazard to the soldier or the people he has contact with. No special precautions are required by anyone having contact with the patient.**

7. Health Service Support (HSS).

a. Forward medical support characterizes the role of HSS in the Theater of Operations (TO). There are four levels of HSS that have a direct impact on patients as they are treated, returned to duty (RTD), or evacuated from the forward line of own troops to the CONUS base.

(1) Level I. Designated individuals or elements organic to combat and combat support units provide medical care. This may include self-aid or buddy aid, the combat lifesaver, the combat medic, and the battalion aid station.

(2) Level II. The division or corps clearing station provides medical care.

(3) Level III. A hospital staffed and equipped to provide resuscitation, initial wound surgery, and post-operative treatment provides the care.

(4) Level IV. A hospital staffed for general and specialized medical and surgical care and rehabilitation for RTD provides the care.

b. If depleted uranium contamination is suspected, attending medical personnel at HSS Levels I and II should annotate the soldier's Field Medical Card [DD Form 1380, Block 14 (DIAGNOSIS)], or patient clinical record [SF Form 504 or other], with the statement "SUSPECTED DEPLETED URANIUM (DU) EXPOSURE", the date/time of exposure and any other pertinent exposure information. A simple description of the exposure scenario could be described in Block 19 ("WHAT WAS HE DOING WHEN INJURED"). If field survey monitoring indicates the presence of DU on the patient, then the monitoring results, the date/time of the monitoring, and the type/SN of RADIAC meter and detection probe used should also be recorded.

c. Urine bioassay procedures should be considered for these personnel. The decision to collect urine specimens for depleted uranium bioassay would first be made at the Table of Organization and Equipment (TOE) hospitals (HSS Levels III and IV). Requests for DU bioassays should be treated like any other clinical laboratory test. A physician or other authorized care provider should order bioassays. Laboratory results should be handled and recorded using standard procedures.

8. Bioassay Policy for Depleted Uranium.

a. Depleted Uranium Urine Bioassay Procedures.

(1) Depleted Uranium Urine Specimens. The primary bioassay technique to assess and document depleted uranium internalization is the collection of 24-hour urine specimens at specified times.

(a) If a 24-hour collection is not feasible for either clinical or operational reasons, a spot urine sample with 120 ml of urine or as much urine as can be collected should be taken. While not optimal, it can provide useful information about depleted uranium intake. If urine creatinine levels are to be measured, the patient's age, height, and weight must be provided on the laboratory request, Miscellaneous Standard Form 577.

(b) The 24-hour total urine sample provides for more accurate uranium determinations, positive identification of depleted uranium in the urine, and data for direct dose assessment. The 24-hour urine specimen should be handled according to routine procedures established by the laboratory doing the analysis.

(2) Collection Procedure, 24-Hour Urine Sample. **Unlike standard procedures**, do not discard the urine from the first void. Collect as much urine as is possible or at least 120 mls of the first void as a spot sample and submit it for analysis. Document the date and time of the spot sample. Continue with then collecting all successive voids over the next 24-hour period as the 24-hour urine sample. Document the beginning time (same as the spot sample's) and the ending time of this 24-hour collection. Indicate whether or not this sample was a complete 24-hour collection.

b. Timelines for Bioassay Collection. **Under no circumstances should required treatment or evacuations be delayed for bioassay.** Urine uranium bioassays should be taken when optimally feasible and when the patient's clinical condition permits. Timelines for optimal urine uranium bioassay collection are as follows:

(1) **Baseline 24-Hour Urine Specimen**. This is not an essential specimen. The purpose for this specimen is to determine the natural level of uranium in the patient's urine that will aid in the specificity and accuracy of the measurement.

(a) Under normal conditions, internalized uranium will not appear in the urine for 24 hours after internalization. A baseline specimen should not be taken if more than 24 hours has passed since the exposure or if the patient has had an intravenous infusion (I.V.) or a significant blood volume loss or replacement. In this case, the depleted uranium may appear in the urine before the 24-hour point.

(b) If a baseline specimen is taken, it should be started as soon as is possible after the injury and stopped 24 hours after the injury occurred.

(2) <u>**Initial Depleted Uranium Urine Specimen**</u>. The purpose for this specimen is to obtain data for use in estimating the amount of soluble depleted uranium internalized. Collection should begin **not earlier** than 24 hours after the exposure event and continue for a full 24 hours. This specimen is needed in order to calculate the intake estimate and the radiation dose estimation. If a hospital's resources cannot support the logistics of an optimal 24-hour urine collection, then a spot-sample should be taken.

(3) <u>**Seven to Ten Day Urine Specimen**</u>. This specimen (and subsequent specimens, if required) provides the data required to estimate the amount of insoluble depleted uranium internalized. If the patient is returned to duty from a Level III or IV MTF, at least a urine spot sample should be obtained from the patient before his departure.

(4) <u>**Subsequent Bioassay Procedures**</u>. The need for further urine uranium bioassays will be based upon the depleted uranium levels found in the specimens noted above. Guidance from OTSG/MEDCOM consultants may be used to assist in patient assessment.

(5) <u>**Results Reporting**</u>. All results should be reported **NORMALIZED TO CREATININE** (e.g. micrograms of depleted uranium per nanogram creatinine) and normalized to the volume of the urine sample (micrograms depleted uranium per liter of urine).

9. <u>Bioassay Laboratory and Radiation Dosimetry Support</u>.

a. Specimens should be forwarded to U.S. Army Medical Department-specified Department of Defense clinical laboratories such as the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM). Use the procedures outlined in reference 1.e. above.

b. Additional consultation on bioassay measurement is obtainable from the Radiologic, Classic and Clinical Chemistry Division, USACHPPM at (410) 436-3983 or DSN 584-3983.

c. Additional consultation on ionizing radiation dosimetry and health risk assessment is obtainable from the Medical Health Physics Program, USACHPPM, at (410) 436-3548 or DSN 584-3548.

d. During non-duty hours, USACHPPM assistance may be obtained using the USACHPPM Emergency Contact Numbers (800) 222-9698 or (888) 786-8633.

10. Points of Contact.

a. The point of contact for the Office of the Surgeon General for clinical treatment issues is the Chief, Clinical Services Division, U.S. Army Medical Command (USAMEDCOM), DSN 471-6616 or Commercial (210) 221-6616.

b. The point of contact for radiation protection issues is the USAMEDCOM Radiation Protection Staff Officer, DSN 471-6612 or Commercial (210) 221-6612.

11. Reporting. The names and service numbers of personnel with confirmed depleted uranium internalization will be reported to the U.S. Army medical surveillance system so that appropriate long term follow-up medical monitoring can be effected.

DEPLETED URANIUM:

INFORMATION FOR CLINICIANS
May 15, 2003

THIS DOCUMENT HAS BEEN CREATED USING MATERIALS PREVIOUSLY DEVELOPED BY THE DEPARTMENT OF VETERANS AFFAIRS. THIS MATERIAL HAS BEEN COMBINED WITH INFORMATION FOR THE CURRENT MILITARY OPERATIONS AND FOR ISSUES SPECIFIC TO THE ARMY MEDICAL DEPARTMENT.

Fact Sheet: Information about Depleted Uranium

What is Depleted Uranium?

Uranium, a weakly radioactive element, occurs naturally in soil, water and mineral deposits and is mined and processed primarily for use as fuel in nuclear power reactors. In its pure form, uranium is a silver-white heavy metal nearly twice as dense as lead. Naturally occurring uranium deposits contain over 99% ^{238}U, with small amounts of ^{235}U and ^{234}U (see table below).

Depleted uranium is made from natural uranium, by removing some of the more highly radioactive isotopes (^{235}U and ^{234}U). "Enriched uranium," that with the higher concentrations of ^{235}U and ^{234}U, is what is used in nuclear reactors. Depleted uranium is what remains after the enrichment process. It contains even less ^{235}U and ^{234}U than naturally occurring ores. The spent uranium, which is about half as radioactive as natural uranium, is the "depleted uranium" (Voelz, 1992).

	Radioactivity	**Natural Uranium**	**Depleted Uranium**
Isotope	μCi/g	Concentration of isotopes	Concentration of isotopes
^{234}U	6200.0	0.0058%	0.001%
^{235}U	2.2	0.72%	0.2%
^{238}U	0.33	99.28%	99.8%
Relative Radioactivity		1	.6

As one may calculate from the table, the radioactivity of natural uranium is approximately 0.70 μCi/g whereas the radioactivity of Depleted Uranium is approximately 0.40 μCi/g. All uranium, not just DU, is made up of almost all ^{238}U. Natural and depleted uranium differ only in their radioactivity. Depleted uranium is roughly half (60%) as radioactive as natural uranium because the more radioactive isotopes have been removed. Their chemical properties, however, 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 ^{236}U 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.

What is Depleted Uranium used for?

Depleted uranium (DU) has a wide variety of civilian and military uses. It is used in radiation detection devices and radiation shielding for medicine and industry, for components of aircraft ailerons, elevators, landing gear, and rotor blades (AEPI, 1995).

The United States Armed Forces have used DU in the manufacture of munitions, armor and armor-piercing projectiles. DU's high density, self-sharpening qualities, and pyrophoric, or easily combustible, properties make it, in projectiles, capable of readily penetrating armor made with less dense metals. Conversely, 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. (DoD, 1998)

How are soldiers exposed to DU?

When a vehicle is impacted and penetrated by a DU projectile, the projectile splits into small shards, bursts into flames, and fills the insides of the vehicle with flying metal, fumes, and particulates. The bulk of a round 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 ignite and oxidize. Soldiers in struck vehicles may inhale airborne DU particles (or other combustion products), ingest DU particles, and be wounded with DU particles or fragments. Some crew members may be left with multiple tiny fragments of uranium scattered through their muscle and soft tissue. Other soldiers may be exposed to DU during operations to salvage tanks that have been disabled by DU rounds or be potentially exposed from brief "sightseeing" entry into damaged vehicles.

Simply riding in a vehicle with DU weapons or DU armor is safe and will not expose a soldier to harmful forms of DU. Exposure by breathing fumes of burning DU metal only occurs if the vehicle is hit or if the soldier is near, within 50 meters, of a target hit by DU munitions.

How does DU get into the body?

Natural uranium is ingested and inhaled every day from the natural uranium in our air, water, and soil. The amount varies depending upon the natural levels found in the geographic area in which one lives and the levels in the food and water from that area. On average in the U.S., an individual's daily intake of uranium is approximately 1.9 micrograms by ingestion and 0.007 micrograms by inhalation. This intake results in a natural level of uranium in the body of approximately 90 micrograms. It also gives an approximate urine uranium concentration of 0.01 to 0.1 micrograms of uranium per liter of urine. In areas where the natural uranium in the soil or water is high, these levels can be substantially higher (AEPI, 1995). The uptake and distribution of uranium is in some ways analogous to other heavy metals, such as lead, mercury, arsenic, and cadmium and can enter the body through any of the three common routes of absorption.

Depleted uranium can be inhaled, swallowed, or even enter the body through cuts or abrasions on the skin, or through embedded metal fragments. Through proper field and personal hygiene, most possible exposure to DU can be avoided. The principal entry route during on-going exposure is through inhalation of DU vapor and fine dust contamination with DU. Dermal exposure as a result of DU dust contamination of skin or a wound is also possible, however, DU would not be expected to likely penetrate intact skin. Embedded, retained DU fragments may be dissolved, absorbed, and distributed throughout the body. Depleted uranium dust can be ingested as well, but is not a likely significant exposure route unless exposure is on-going. Additionally, particles that enter the lungs during inhalation may be incorporated into sputum or phlegm that is raised into the throat and swallowed.

What are the health effects of exposure to DU?

Research on the human health effects of depleted uranium exposure in military occupations is limited, especially regarding DU's potential chemical (rather than radiologic) toxicity. There are, for example, no published epidemiological studies of soldiers exposed to depleted uranium dust or vapor in wartime settings prior to the Gulf War experience. Most of the knowledge about human effects is derived from studies of uranium miners and associated occupations, which is not precisely, but only generally relevant to DU exposed veterans. For example, uranium miners and millers have exposure to uranium but also possibly to radon as well as other toxic substances present in the mines or the ores that are milled, making their health effects experience not directly comparable to those DU exposed. Additionally, exposure intensity and duration of these other occupations are not directly comparable to exposure scenarios in military settings, limiting the applicability of observed health effects in the DU exposure setting.

Acute toxic effects of uranium exposure are manifested primarily in the respiratory system and kidneys. In wartime situations, there is the possibility of acute exposure to personnel on, inside, or near (less than 50 meters) vehicles when DU penetrators strike the vehicles or when DU munitions or shielding explode and burn. It is theorized that soldiers, particularly those inside tanks, may inhale excessive amounts of DU vapor and dusts raising the question about local effects in the lung as well as systemic effects incurred through an inhalation exposure. The internalization is high enough that it raises the possibility of local irritant effects in the lungs as well as systemic effects following absorption.

Chronic exposure is thought to affect primarily the kidney. The few chronic studies in the literature (as summarized by Voelz, 1992) document renal tubular changes without clear clinical implications. Other epidemiological studies of uranium millers and miners show an increased risk of renal disease. Animal studies have documented both tubular and glomerular lesions in rats given uranium compounds orally. These lesions increased with higher doses of uranium. (ATSDR, 1999). This finding is consistent with the known health effects of other heavy metals.

It is unknown if low level, chronic exposure to depleted uranium will cause renal disease, although up to now, no renal abnormalities have been seen in the DU-exposed friendly fire cohort being followed at the Baltimore VA.

Chronic exposure by inhalation presents a potential radiologic hazard to the lung and thoracic lymph nodes. Uranium miners have a long occupational history of inhaling uranium dust in closed spaces. There is an increased risk of lung cancer among uranium miners but this is thought to be due to the simultaneous exposure to radon. The animal data are insufficient to determine whether inhalation of natural uranium causes lung cancer in animals.

Concerns about genotoxicity, mutagenicity and reproductive effects are only beginning to be studied, and definitive answers to these questions will almost certainly take much more work. Animal cell lines treated with uranium in one study have shown possible genotoxic and/or mutagenic changes. Measures of genotoxicity in the DUP group have met with mixed results, with some tests showing a change in results from positive for genotoxicity to negative over time. We are continuing to examine these endpoints in our ongoing surveillance. Reproductive effects in humans exposed to uranium have not been studied. To this point, there have been no birth defects in the 60 or so children born to the GW veterans in the DU Follow-up Program, including several with embedded DU fragments in their bodies.

The ATSDR Toxicological Profile on Uranium summarizes the existing animal and human data on uranium. (See ordering information in the Section on Further Reading)

What is the potential for external radiation exposure?

External exposures, that is, when DU is not taken directly into the body, result in minimal radiation exposure because DU, primarily an alpha emitter, has relatively poor penetrating ability. Direct contact with bare DU for 250 hours is necessary to exceed annual occupational dose limits. Wearing gloves provides effective protection against this type of exposure. Crewmembers inside an M1 or M1A1 tank fully uploaded with intact DU munitions experience average dose rates far below annual occupational whole-body exposure limits.

What is the potential for internal radiation exposure?

Internal exposure to DU, whether via inhalation, ingestion, wound contamination or retained fragments warrants concern. An assessment of whether DU exposure is internal and a commitment to regular medical follow-up for heavily exposed persons are prudent clinical and public health activities. Natural uranium's main radioactive emissions (i.e., alpha particles) "...are unable to penetrate skin, but can travel short distances in the body and cause damage..." (ATSDR Toxicological Profile, 1999). However, concern about cell damage due to radiation exposure from DU should be tempered with the knowledge that depleted uranium is less radioactive than the naturally occurring uranium found in soil and water.

Radiation dose assessments conducted after the 1991 Gulf War indicate that the internal radiation exposure to the most highly exposed group (personnel in or on a vehicle when it was struck by DU munitions) were less than the annual occupational exposure limit. Personnel in on or near an armored vehicle at the time the vehicle was struck by DU munitions may internalize enough DU through fragments, wound contamination, ingestion, embedded fragments and inhalation to exceed the annual occupational whole body exposure limit. All other potentially exposed personnel received radiation doses significantly less than the highest exposed group. Nonetheless, an assessment of whether DU exposure is internal and a commitment to regular medical follow-up for heavily exposed persons are prudent clinical and public health activities.

Looking at the natural background radiation exposure is one method of placing the radiation exposure from DU into perspective. Ionizing radiation exposure to the U.S. population comes from a variety of sources. The total ionizing radiation exposure that a resident of the U.S. receives on average is about 0.3 rem per year from natural and man-made sources. This is in the range of the exposures received by the most highly exposed population. The largest single source (inhalation) is primarily due to indoor radon. Natural background levels vary with geographic location and may be significantly higher.

The risk from this exposure is well below the risk of other commonly accepted risk factors as shown in the table below. The information is from the Nuclear Regulatory Commission Regulatory Guide 8.29.

Health Risk	Life Expectancy Loss
Smoking 20 cigarettes per day	6 years
Overweight by 15%	2 years
Alcohol consumption (U.S. average)	1 year
All accidents combined	1 year
All natural hazards combined	7 days
Medical radiation	6 days
Occupational exposure	
0.3 rem/yr (18 to 65 yrs)	15 days
1.0 rem/yr (18 to 65 yrs)	51 days

The DoD has described the following scenarios and their associated radiation dosages:

- A driver inside a fully loaded "heavy armor" tank, which uses DU armor panels, for 24 hours a day, 365 days a year would receive a dose of less than 25% the current occupational limit of 5 rems.
- The current dose limit for skin (50 rems in a year) would only be exceeded if unshielded DU remained in contact with bare skin for more than 250 hours. (DoD, 1998)

Are there other toxic effects of exposure to DU?

The original concern about health effects from DU exposure was primarily the potential radiologic hazard that exists. Separate from its radiologic properties however, uranium is also a heavy metal, a chemical toxicant that exhibits some adverse health effects similar to other heavy metals, such as lead and cadmium. Any kidney effects, for example (proximal tubular and, possibly, glomerular) are likely a result of the chemical toxicity of uranium, rather than its radiologic toxicity. The mutagenicity data, although extremely limited, are also probably due to uranium's chemical properties. This distinction is important because it suggests possible health outcomes in an affected population, as well as a knowledge base (which exists for other heavy metals) with which to compare the extremely limited findings observed in the DU exposed participants.

Insights into successful interventions, treatment strategies and refined prognoses may also be gained from the heavy metal literature. The chemical nature of DU will thus be an additional focus for the on-going follow-up program.

Guidelines for Clinicians

Tips for taking the history of a patient with suspected DU exposure

Listen for the patients concerns about their Operation Iraqi Freedom exposures and experiences. Veterans are hearing information and advice from a wide variety of sources. Encourage the patient to ask questions and express their concerns. Given the amount of public discussion of possible sequelae, it is not surprising that veterans will wonder about the possible significance and prognosis of any type of new symptom in themselves or their family members. In the first round of evaluations we uncovered serious concerns about the possible deeper meaning of problems as common and generally benign as otitis media in toddlers, and tinea versicolor. Such concerns and apprehensions won't be relieved if they don't get discussed.

Ask the patient to provide a detailed description of all occupations including the current occupation. Focus on the situation that had the potential DU exposure. Probe for specific details about job duties, the equipment used, the nature of the site, the protective equipment worn, the training required and the hazard information provided. Obtain information about how and why the veteran believes he or she was exposed to Depleted Uranium. Patients can often provide quite accurate and detailed exposure information and, may, even have been provided hazard communication training and materials.

It is always important to determine the length of time the patient may have been exposed. For example, how many hours did the soldier spend cleaning tanks potentially contaminated with DU dust? Determine if the exposure occurred via inhalation, ingestion or dermal (wound contamination). The clinician can reassure most concerned patients by pointing out that in the cohort with imbedded, retained DU fragments, so far, no adverse health conditions have been detected. The clinician should emphasize that retained fragments represent continuous, internal exposure and, as such, is more potentially hazardous than other military exposures as currently understood. The clinician can further re-assure the patient by assessing uranium excretion. (See next section.)

When evaluating any symptoms or abnormal lab values that the veteran or soldier has, be sure to include a complete discussion of any present exposures, whether occupational or environmental in the differential diagnosis. For example, if the individual complains of shortness of breath, has he/she had a recent exposure to any pulmonary toxicants? If there are CNS symptoms, has there been recent contact with solvents, paints, degreasers, etc. A present occupational or environmental exposure is more likely to be causing current problems than a previous exposure to DU in the Gulf.

What are the health effects from exposure to Depleted Uranium?

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.

Since 1993, the Department of Veterans Affairs has been following over 70 Gulf War veterans who were seriously injured in incidents involving depleted uranium. These veterans are being monitored at the Baltimore VA Medical Center. Many of these veterans continue to have medical problems relating to the physical injuries they received during these incidents. Some of this group still has depleted uranium metal fragments 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 the veterans in the program (including those with retained depleted uranium fragments), all tests for kidney function have been normal. In addition, the reproductive health of this group appears to be normal because all babies born of these veterans between 1991 and 1997 had no birth defects.

How should personnel wounded by Depleted Uranium be treated?

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 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. The use of a sensitive radiation meter may assist in wound debridement and cleaning. The AN/VDR-2 RADIAC meter with the beta window open may assist in locating depleted uranium contamination in the wound or burn. Under no circumstances should required treatment be delayed to perform this monitoring.

Embedded depleted uranium fragments should be removed using standard surgical criteria (reference 1.a, above, 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 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.

Monitoring of kidney function is recommended for these patients who have contaminated wounds or embedded depleted uranium fragments. The monitoring should follow the current protocol in use by the Baltimore Veterans Affairs (VA) Depleted Uranium Program. As with all heavy metals, the kidney is one of the organs most sensitive to uranium toxicity. Recommended tests include urinalysis, 24-hour urine for uranium bioassay, BUN, creatinine, beta-2-microglobulin and creatinine clearance. Chelation therapy is not recommended based upon current estimates of depleted uranium exposure health effects.

It is important to note the presence of retained fragments in the medical records and on the Patient Movement Request if the patient requires evacuation.

How does one determine the presence of Depleted Uranium in a wound?

Suspected wounding with depleted uranium or inhalation of aerosolized depleted uranium during combat should always be recorded on the patient's field medical card. Indicators that may be obtained from the patient or the patient's field medical card include:

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

- Patient's vehicle was struck by friendly fire either from US tanks, Bradley Fighting Vehicles, or aircraft.

- Patient reports he saw burning fragments (like a Fourth of July sparkler) while the vehicle was being penetrated. Depleted uranium is pyrophoric and will ignite under high pressure and temperatures.

Because of depleted uranium's high density, fragments are readily visible radiographically and will appear similar to steel or lead fragments in the body.

- Radiography alone, however, is not sufficient to determine the presence or absence of depleted uranium. ODS experience found that there were soldiers in vehicles struck by depleted uranium munitions that had retained fragments that were not depleted uranium.

- In addition, KE penetrators made out of tungsten will cause similar wounds and will appear radiographically the same. A large number of countries are using tungsten penetrators.

If readily available, a RADIAC meter (AN/VDR-2 with the beta shield open or equivalent) may be used to monitor wounds, burns, or suspected sites with embedded fragments. This can assist in wound cleaning and may confirm the presence of depleted uranium. Under no circumstances should treatment be delayed to obtain an AN/VDR-2.

What is the best method of determining if Depleted Uranium has been internalized?

The most sensitive indicator for the internalization of depleted uranium is a uranium urine bioassay. The policy for this bioassay is discussed below. In general, patients with retained depleted uranium fragments will excrete uranium in the urine. ODS experience showed that, like lead, depleted uranium from the fragments will dissolve and be transported into the blood.

- The fragments serve as a source of depleted uranium and the level of excretion will remain constant for long periods of time. Once in the blood stream, the depleted uranium will be metabolized in the same way that natural uranium is by the body. Depleted uranium is excreted in the urine.

- Results of the medical monitoring of patients from ODS indicate that the highest uranium urine levels were on the order of 30 to 40 micrograms of total uranium per gram of creatinine. This monitoring was initiated in 1993 and the levels have remained more or less constant. In all likelihood, the levels were higher sooner after the soldiers were wounded. How much higher is not known.

Does the presence of Depleted Uranium fragments pose any risk to family members or others who come in contact with the patient?

The presence of depleted uranium fragments in the servicemember's body presents no risks to family members. As with other heavy metals retained in the body, the depleted uranium in body fluids (blood, urine, sweat, saliva, and semen) and/or feces, present absolutely no hazard to the soldier or the people he has contact with. No special precautions are required by anyone having contact with the patient.

Who Should Have a Urine Uranium Bioassay?

The DU guideline states that DU urine bioassays are required for Level I and Level II personnel as described below:

Level I: Personnel Who Were In, On, or Near (less Than 50 Meters) An Armored Vehicle at the Time the Vehicle Was Struck, including those injured with DU munitions or armor fragments (non-occupational) . <u>These servicemembers require bioassays.</u> These personnel may exceed peacetime occupational exposure standards. Based upon field environmental measurements, research results and dose assessments during combat or deployment operations, depleted uranium may be internalized in sufficient amounts to exceed current peacetime depleted uranium occupational standards in three exposure scenarios:

(1) Personnel who are in, on, or near (within 50 meters) an armored vehicle at the time the vehicle is struck by depleted uranium munitions. These personnel can internalize depleted

uranium through inhalation, wound contamination, ingestion and embedded depleted uranium fragments.

(2) Personnel who are in, on, or near (within 50 meters) a vehicle with depleted uranium armor at the time the armor was breached by DU or non-DU munitions. These personnel can internalize depleted uranium through inhalation, wound contamination, ingestion and embedded depleted uranium fragments.

(3) First responders who entered struck vehicles to perform evacuation, first-aid/buddy-aid for the personnel in the struck vehicle. These personnel may internalize depleted uranium through inhalation and ingestion.

Level II: Personnel Who Routinely Enter DU Damaged Vehicles as a Part of their Military Occupation or Who Fight Fires Involving DU Munitions (Occupational). These personnel require bioassays. During combat (or deployment) operations, depleted uranium may be internalized in amounts that are below occupational exposure standards, but at levels that the Nuclear Regulatory Commission (NRC), the Occupational Safety and Health Administration (OSHA), or Army policy requires a bioassay for peacetime operations in the following scenarios:

(1) Personnel who are in, on, or near (within 50 meters) a fire involving depleted uranium munitions. These personnel can be exposed through inhalation and ingestion.

(2) Personnel who routinely enter vehicles with DU dust to perform maintenance, recovery operations, battle damage assessment, and intelligence gathering operations. These are personnel who, as a result of their military occupation, are required to routinely enter vehicles with DU dust.

Level III: Personnel with "Incidental" Exposure to DU. Examples of personnel in this level includes individuals who may have driven through smoke from a fire involving DU munitions or who may have entered or climbed on or in battle damaged vehicles on an infrequent basis (not as a first responder and not as job requirement to enter vehicles that may have been contaminated with DU). Bioassays are not required for personnel in this level, though a physician may choose to perform one based on medical indications or based on potentially exposed individual's request. The VA/DOD Post-Deployment Clinical Practice Guidelines will be used for this assessment.

What is the Bioassay Policy for Depleted Uranium?

Depleted Uranium Urine Bioassay Procedures. The following are the ideals. Bioassays for wounded personnel should be taken as soon as the person is at a hospital with the capability to do so. For the remainder, the outline below is ideal but a bioassay can be taken up to 180 days post-exposure.

1. **Depleted Uranium Urine Specimens.** The primary bioassay technique to assess and document depleted uranium internalization is the collection of 24-hour urine specimens at specified times.

a. If a 24-hour collection is not feasible for either clinical or operational reasons, a spot urine sample with 120 mls of urine or as much urine as can be collected should be taken. While not optimal, it can provide useful information about depleted uranium intake. If urine creatinine levels are to be measured, the patient's age, sex, height, and weight must be provided on the laboratory request, Miscellaneous Standard Form 557.

b. The 24-hour total urine sample provides for more accurate uranium determinations, positive identification of depleted uranium in the urine, and data for direct dose assessment. The 24-hour urine specimen should be handled according to routine procedures established by the laboratory doing the analysis.

2. Collection Procedure, 24-Hour Urine Sample. Unlike standard procedures, do not discard the urine from the first void. Collect as much urine as is possible or at least 120 mls of the first void as a spot sample and submit it for analysis. Document the date and time of the spot sample. Continue with then collecting all successive voids over the next 24-hour period as the 24-hour urine sample. Document the beginning time (same as the spot sample's) and the ending time of this 24-hour collection. Indicate whether or not this sample was a complete 24-hour collection.

Timelines for Bioassay Collection

Under no circumstances should required treatment or evacuation be delayed for bioassay. Urine uranium bioassays should be taken when operationally feasible and when the patient's clinical condition permits. Timelines for optimal urine uranium bioassay collection are as follows:

1. Baseline 24-Hour Urine Specimen. This is not an essential specimen. The purpose for this specimen is to determine the natural level of uranium in the patient's urine that will aid in the specificity and accuracy of the measurement.

a. Under normal conditions, internalized uranium will not appear in the urine for 24 hours after internalization. A baseline specimen should not be taken if more than 24 hours has passed since the exposure or if the patient has had an intravenous infusion (I.V.) or a significant blood volume loss or replacement. In this case, the depleted uranium may appear in the urine before the 24-hour point.

b. If a baseline specimen is taken, it should be started as soon as is possible after the injury and stopped 24 hours after the injury occurred.

2. Initial Depleted Uranium Urine Specimen. The purpose for this specimen is to obtain data for use in estimating the amount of soluble depleted uranium internalized. Collection should begin not earlier than 24 hours after the exposure event and continue for a full 24 hours. This specimen is needed in order to calculate the intake estimate and the radiation dose estimation. If a hospital's resources cannot support the logistics of an optimal 24-hour urine collection, then a spot-sample should be taken.

3. **Seven to Ten Day Urine Specimen.** This specimen (and subsequent specimens, if required) provides the data required to estimate the amount of insoluble depleted uranium internalized. If the patient is returned to duty from a Level III or IV MTF, at least a urine spot sample should be obtained from the patient before his departure.

4. **Subsequent Bioassay Procedures.** The need for further urine uranium bioassays will be based upon the depleted uranium levels found in the specimens noted above. Guidance from OTSG/MEDCOM consultants may be used to assist in patient assessment.

5. **Results Reporting.** All results should be reported NORMALIZED TO CREATININE (e.g., nanograms of depleted uranium per gram creatinine) and normalized to the volume of the urine sample (nanograms depleted uranium per liter of urine).

Where can I get support for bioassay analysis and dosimetry?

Specimens should be forwarded to US Army Medical Department-specified Department of Defense clinical laboratories such as the US Army Center for Health Promotion and Preventive Medicine (USACHPPM). Use the procedures outlined in reference 1.f, above.

Additional consultation on bioassay measurement is obtainable from the Radiologic, Classic and Clinical Chemistry Division, USACHPPM at (410) 436-3983 or DSN 584-3983.

Additional consultation on ionizing radiation dosimetry and health risk assessment is obtainable from the Health Physics Program, USACHPPM, at (410) 436-3502 or DSN 584-3502.

During non-duty hours, USACHPPM assistance may be obtained using the USACHPPM Emergency Contact Numbers (800) 222-9698 or (888) 786-8633.

Who are the points of contact for Depleted Uranium medical issues?.

Army:

The point of contact for the Office of the Surgeon General for clinical treatment issues is the Chief, Clinical Services Division, DSN 471-6616 or commercial (210) 221-6616.

The point of contact for radiation protection issues is the Radiation Protection Staff Officer, DSN 471-6612 or commercial (210) 221-6612.

References and Further Reading
Update in progress

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Additional Resources

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National Technical Information Service
5285 Technical Information Road
Springfield, VA 22161
Phone: (800) 553-6847 or (703) 605-6000

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On The Internet:

DeploymentLINK (http://www.deploymentlink.osd.mil/) is the World Wide Web information system of the Deployment Health Support Directorate that provides the public with information concerning the health of servicemembers . Information is updated periodically and covers a wide range of topics.

* These citations can be found on the DeploymentLINK web site described above.
† Journal articles written by the DUP staff and program collaborators. The URLs for the article abstracts are listed below the citations if available.