



# Veterans and Radiation



Revised Independent Study Course Released: August 2004

Sponsored by  
Department of Veterans Affairs  
Employee Education System

This is a Veterans Health Administration System-Wide Training Program developed by the Office of Public Health and Environmental Hazards, Department of Veterans Affairs. It is produced by the Employee Education System.





DEPARTMENT OF VETERANS AFFAIRS  
Veterans Health Administration  
Washington DC 20420

MARCH 2004

In Reply Refer To:

**MESSAGE FROM THE UNDER SECRETARY FOR HEALTH**

I commend you for choosing to take advantage of this revised self-study program, "Veterans and Radiation." This reflects your commitment to continuing professional development and your recognition of the unique needs and challenges which veterans may present to medical care providers.

While the occupation of Hiroshima and Nagasaki occurred more than 50 years ago and U.S. atmospheric nuclear weapons tests ended in 1962, many of the approximately 400,000 participants (often called Atomic Veterans) and their families continue to be concerned that ionizing radiation cause the veterans' illnesses, especially cancer, and also may be responsible for health problems in their offspring. Other veterans also may have been exposed to ionizing radiation including nuclear submariners and veterans of the Gulf War who came into contact with depleted uranium (DU). Greater knowledge about radiation will enable VA staff to better address concerns of these and other radiation-exposed veterans (including those exposed to non-ionizing radiation such as from radar).

In addition, the threat that terrorists might utilize ionizing radiation as a weapon makes it important for VA staff to learn more about this subject.

This program is one of the educational modules of the Veterans Health Initiative (VHI). The VHI is intended to focus greater attention on the connection between significant events that occurred during military service and later health conditions. Greater understanding by VA providers of such linkages and of recommended evaluation and treatment approaches should contribute to enhanced health care and satisfaction for veterans, whether choosing to use the VA health system or by receiving fair and thorough compensation examinations.

I would like to encourage you to participate in other VHI educational modules. VA physicians and staff members in other designated professional disciplines can earn continuing education credit by successfully completing these programs.

Thank you for your participation in the VHI program and your service to veterans.

A handwritten signature in black ink, appearing to read "Robert H. Roswell", is positioned above the printed name.

Robert H. Roswell, M.D.  
Under Secretary for Health

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## Independent Study Outline

**Purpose** This independent study provides information to VA staff about radiation. In particular, the program provides information about ionizing and non-ionizing radiation; major types of exposures to radiation that veterans may have experienced in service and health effects possibly associated with such exposures; special programs including the VA's Ionizing Radiation Registry Examination and Depleted Uranium programs; adjudication of radiation-related compensation claims; and radiation exposures in VA facilities.

While the atomic bombing of Hiroshima and Nagasaki occurred more than 50 years ago and U.S. atmospheric nuclear weapons tests ended in 1962, many veterans who served in the Japanese occupation or who participated in atmospheric nuclear weapons tests and their families continue to be concerned that ionizing radiation (IR) has caused the veterans' illnesses, especially cancer and also may be responsible for health problems in their offspring.

Other veterans may have been exposed to IR, such as nuclear submariners, and veterans of the Gulf War and Operation Iraqi Freedom, who came into contact with depleted uranium (DU). Also, future limited conflicts may expose U.S. personnel to IR, (e.g., with increasing availability of DU on the international arms market). In addition, exposure to non-ionizing radiation (NIR) is of concern to veterans, such as those who worked with radar.

Knowledge about IR will permit staff to better respond to patients or research subjects who are concerned about radiation risks and to address issues relating to radiation safety. Moreover, while the threat of a nuclear war has receded, civilian nuclear accidents with potential exposure of populations to IR (such as occurred at Three Mile Island and Chernobyl) are a continuing concern and terrorists may seek to make use of nuclear weapons and radioactive material, such as in "dirty bombs".

Greater knowledge about radiation also will permit better understanding of such public policy issues as irradiation of food, storage of nuclear waste, safety of nuclear power, possible risks from use of cellular telephones and power lines, etc.

**Objectives** Upon completing this independent program, participants should be able to:

1. differentiate ionizing and non-ionizing radiation;
2. identify the major types of radiation;
3. list the major types of exposure to radiation that veterans have experienced and special VA programs available;
4. identify average doses of ionizing radiation to which atomic veterans were exposed;
5. identify health effects that veterans may have experienced as a result of exposure to radiation;
6. describe health of offspring of Japanese atomic bomb survivors;
7. utilize the VA's Ionizing Radiation Registry Examination and Depleted Uranium programs;
8. describe how treatment for conditions possibly related to radiation is provided;

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## Independent Study Outline

9. describe how radiation-related compensation claims are adjudicated; and
10. describe the possible use of ionizing radiation by terrorists and medical response measures.

As a result of this program, clinicians should be able to apply the knowledge gained to conduct more comprehensive evaluations and provide appropriate care to radiation-exposed veterans. Staff also should be able to better respond to questions and concerns of radiation-exposed veterans and their families, and assist in adjudicating their claims.

This independent study is designed for VA staff especially physicians, nurse practitioners, and physician assistants providing primary care, staff appointed as Environmental Health Physicians and Coordinators, clinicians performing Compensation and Pension examinations, Ionizing Radiation Registry and depleted uranium examinations, and staff involved in adjudication of radiation claims.

This is a print format educational program. This program is available also on the Web at <http://www.va.gov/vhi>

### **Outcome**

### **Target Audience**

### **Format**

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## Program Description

### *This program includes*

- Independent study written material
- Test for CME credits
- Program Evaluation

This activity has been planned and implemented in accordance with the Essentials and Standards of the Accreditation Council for Continuing Medical Education (ACCME) through the joint sponsorship of VA Employee Education System and Department of Veterans Affairs Office of Public Health and Environmental Hazards. The VA Employee Education System is accredited by the ACCME to provide continuing medical education for physicians.

### **Content Materials**

- Recollection of F. Lincoln Grahlf's
- Introduction
- Background Information About Radiation
- Adverse Health Effects From Radiation
- Atomic Veterans
- Veterans Who Participated in Other "Radiation Risk Activities"
- Veterans Stationed at Hanford and Other Nuclear Weapons Facilities
- Veterans Exposed to Nasopharyngeal (NP) Radium Irradiation
- Veterans Exposed to Depleted Uranium (DU)
- Concerns About Early Radiation-Related Research
- Other Veterans Exposed to Ionizing Radiation in Service
- Possible Future Exposure of Veterans to Ionizing Radiation
- Exposure of Veterans to Non-Ionizing Radiation
- Adjudication of Veterans Ionizing Radiation Claims
- Radiation Safety in VA Medical Centers (by Mr. Lynn McGuire)
- Research in VA Facilities Involving Radiation
- VA Medical Emergency Radiological Response Team (MERRT)
- Possible use of Ionizing Radiation as a Terrorist Weapon
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- Appendix 6a** The Atomic Bombings and Occupation of Hiroshima and Nagasaki
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General Guidance Pocket Guide
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Independent Study Test Questions for CME Credit

Independent Study Program Registration/Evaluation



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## Program Implementation and VA Application Procedure

### *To receive credit for this course:*

1. Read the independent study materials.
2. Complete the CME test questions. A passing score of 70% or higher on the CME test is required to receive credit.  
This test may be retaken.
3. Complete the program evaluation.
4. The estimated study time for this program is 5 hours.

If you are using the Independent Study Registration/Answer/Evaluation Form (two sided) at the back of the independent study booklet, (**NOTE: Scantron forms cannot be photocopied. For additional copies of this independent study, Scantron forms or other VHI independent study modules, please contact your facility education contact person**) please send the completed form within two weeks after reading the material to:

Employee Education Resource Center  
Attn: SDU  
Medical Forum, Suite 500  
950 North 22nd Street  
Birmingham, AL 35203-5300

If you have attained a passing score of 70% or higher, a certificate will be mailed to you approximately 6-8 weeks after your test has been graded. The test may be retaken.

The CME test and program evaluation can also be completed using the VA Intranet at <https://www.ees-learning.net>.

After you take the test, you will receive immediate feedback as to pass or fail. You will be allowed to retake the test. Upon passing the test and completing the program evaluation, you will be able to immediately print your certificate according to instructions.

**NOTE: If you experience difficulty reaching this Web site, please contact the Help Desk via e-mail at [eeslibrixhelp@lrn.va.gov](mailto:eeslibrixhelp@lrn.va.gov), or call 1-866-496-0463. You may also contact your local computer support staff or librarian for assistance.**

**NOTE: In order to complete the CME test and Evaluation, your computer must have Internet Explorer 4.0 or Netscape 4.0 or higher.**

If you have questions or special needs concerning this independent study, please contact:

Bob Smith, EdD, MCP;  
205-731-1812, Ext. 317;  
E-mail - [bob.smith@lrn.va.gov](mailto:bob.smith@lrn.va.gov).

**This program will no longer be authorized for CME credit after 31 December 2006.**

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## **AMA and ANCC Continuing Education Credit**

### **Accreditation**

#### **Accreditation Council for Continuing Medical Education (ACCME)**

The VA Employee Education System is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians.

#### **American Nurses Credentialing Center (ANCC)**

VA Employee Education System is accredited as a provider of continuing nursing education by the American Nurses Credentialing Center's Commission on Accreditation.

### **Continuing Education Credit**

#### **Accreditation Council for Continuing Medical Education (ACCME)**

The VA Employee Education System designates this educational activity for a maximum of 5 hours in category 1 credit towards the American Medical Association Physician's Recognition Award. Each physician should claim only those hours of credit that he/she actually spent in the educational activity.

#### **Association of Social Work Boards (ASWB)**

VA Employee Education System, Provider Number 1040, is approved as a provider for social work continuing education by the Association of Social Work Boards (ASWB), (1-800-225-6880) through the Approved Continuing Education (ACE) program. VA Employee Education System maintains responsibility for the program. Social workers will receive 5 continuing education clock hours for participating in this course.

#### **American Nurses Credentialing Center (ANCC)**

VA Employee Education System designates this educational activity for 6 contact hours in continuing nursing education.

The Employee Education System maintains responsibility for the program. A certificate of attendance will be awarded to participants and accreditation records will be on file at the Employee Education System. In order to receive a certificate from EES, you must complete the material, complete and pass the CME test with a 70% or higher, and complete a program evaluation.

### **Report of Training**

It is the program participant's responsibility to ensure that this training is documented in the appropriate location according to his/her locally prescribed process.

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## **Disclosure Statement**

The Employee Education System (EES) must insure balance, independence, objectivity, and scientific rigor for all EES sponsored educational activities. The intent of this disclosure is not to prevent faculty with a significant financial or other relationship from presenting materials, but rather to provide the participants with information on which they can make their own judgments.

It remains for the participant to determine whether the faculty interests or relationships influence the materials presented with regard to exposition or conclusion. When an unapproved use of a FDA approved drug or medical device, or an investigational product not yet FDA approved for any purpose is mentioned, EES requires disclosure to the participants.

**Faculty reported no disclosable relationships or FDA issues.**

### **Rehabilitation Act of 1973, as amended**

The Employee Education System wishes to ensure no individual with a disability is excluded, denied services, segregated, or otherwise treated differently from other individuals participating in its educational activities because of the absence of auxiliary aids and services. If you require any special arrangements to attend and fully participate in this educational activity, please contact

Bob Smith, EdD, MCP, Program Manager at:  
Birmingham EERC  
205-731-1812 extension 317,  
or e-mail [bob.smith@lrn.va.gov](mailto:bob.smith@lrn.va.gov).

### **Disclaimer**

The views expressed in this VHI module do not necessarily reflect the official positions or policies of the VA or the U.S. Government.

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# Recollection of F. Lincoln Grahfs Participation in Nuclear Testing

by F. Lincoln Grahfs, Ph.D

In 1945 I was leading quartermaster on an ocean going tug USS ATA 199. On July 29 we left Okinawa towing the USS Hugh W. Hadley (DD 774) which had been hit by two kamikaze planes. We were to tow her to San Francisco where she would be repaired. We left Okinawa in a convoy, but just two days out we encountered a typhoon which scattered the convoy, and we proceeded independently to Saipan. It was there that we learned of the atomic bombing of Hiroshima and Nagasaki, and of the Japanese surrender.

My recollection of that time is one of greatly mixed feelings. We had all been so conditioned to think of the Japanese as "the enemy" and not as individual people like ourselves. But as report of the destruction caused by this new weapon reached us, I was just a little overwhelmed by its implications. It had been our expectation that we would return to participate in the invasion of the Japanese home islands. With the war over, we no longer faced that prospect. At the same time, we would now make the rest of the voyage alone, and with running lights on. All during the war, we had observed blackout conditions, and by contrast, those lights really looked bright. We all hoped we did not encounter a Japanese submarine whose captain had not heard that the war was over. A tug with a tow is not very maneuverable and would be an easy target. But the rest of the voyage was relatively uneventful and we arrived safely at San Francisco in late September.

While we were in San Francisco, we received word that the government was planning a major test of the atomic bomb's effectiveness when used against naval vessels, and soliciting volunteers for the operation. I distinctly remember my commanding officer remarking that a man would have to be crazy to volunteer for something like that. I do not know how many volunteers they got, but obviously, it was not enough. In April 1946, I was transferred to the USS ATR 40, a rescue tug, and within weeks, we were on our way to Bikini to participate in Operation Crossroads. That July we would witness the first two atmospheric detonations of nuclear weapons since their use on the Japanese cities of Hiroshima and Nagasaki. Between then and 1962, in the Marshall Islands and in the Nevada desert, well over two hundred more such detonations would occur and almost a quarter million military personnel would be involved. I, like most of the others, most emphatically had NOT volunteered for this assignment.

The ATR 40 was, in fact, attached to the salvage unit whose principal job, essentially, was to keep the target vessels afloat after the bombing so the

damage to them could be assessed. In that capacity, we reentered the target area just a few hours after each of the two atomic explosions.

After spending the summer in the Marshall Islands, we returned to San Francisco with a long stopover in Pearl Harbor. We were in Pearl Harbor Navy Yard on Navy Day (October 27) when, for the first time since the war, the tradition of inviting the public aboard was to be observed. For the occasion, our ship had a large sign which said NO VISITORS. It had been determined that the radiation hazard was too great to permit civilians aboard. However, we continued to live aboard that vessel until mid-January, when it was decommissioned, and I went on sixty days leave.

Upon returning from leave I was assigned to shore duty in the Twelfth Naval District (San Francisco) and I began hearing rumors that many of the participants in Operation Crossroads had been hospitalized. I was unable to learn any more than that. However, in May, I reported to Oakland Naval Hospital with an abscess on my face, a very high fever and, they ascertained an unusual white blood count. The admitting physician prescribed massive doses of penicillin and hot Epsom salt soaks, neither of which seemed to have any effect.

I began to wonder when they put me in a private room; enlisted men were usually relegated to wards with fifty or so beds. Before long I found myself being gawked at frequently by groups of five or six officers (medical officers, I assume) at a time, and I heard myself referred to as, "the interesting case I told you about, doctor." One afternoon many days later, a corpsman wheeled me down to the X-ray department, a shield was put over my eye, and they treated the abscess with X-ray. It cleared up, my blood count gradually became normal, and I was returned to duty. However, for a period of about nine months I experienced a series of boils all over my body.

Nobody mentioned radiation exposure to me but the day of my first X-ray treatment, an old commander said to me, "Son, when I was a country doctor we called this a hair of the dog that bit you." Many years later, I obtained a copy of my service record and was astonished to find that there is no mention, there, either of my transfer to the hospital or of my return to duty. Following up on this, I managed, after considerable difficulty, to obtain a copy of my medical record. That document does indicate that I was treated at Oakland Naval Hospital in the spring of 1947. The entry is quite brief, and the diagnosis given is "cellulitis of the face."

I completed my six-year enlistment, returned to college, obtained bachelor's and master's degrees and had a successful teaching career. Over the years I have had problems attributable to radiation exposure, but I never sought the Veteran's Administration's assistance with them. One reason for this, based on two previous encounters, was the anticipation of possible insensitivity and rebuff. My disability claim for partial hearing loss resulting from service-incurred injury had been denied. Worse, however, was an experience I had while attending college under the GI Bill. There was an irregularity in the payment of my stipend and I went to the VA office to get it



straightened out. When I explained my situation to the receptionist her response was, "You veterans make me sick." I did not need that!

I was fortunate enough, through the years, to have had good employer-provided health care insurance so I got what I considered good care from private physicians. On several occasions, when I had a problem that I thought might be related to radiation exposure, I mentioned my atomic test experience. The military and the nuclear industry had done such a thorough public relations job that invariably the doctor would dismiss the idea that there was any connection. I concluded that if my private physician did not listen to such concerns I would never get any acknowledgment of the connection from the VA.

Significantly, one of those occasions occurred when I was diagnosed, in the early 1960's, as having an overactive thyroid. Thirty years later, in connection with a routine physical checkup at the University of Michigan Health Center, a doctor was taking a medical history and I mentioned my military experience. Immediately upon hearing that I had been at Bikini he said, "Let me palpate your thyroid." When he felt something, he called in an ENT specialist who confirmed that there was indication of nodules and I was referred to the nuclear medicine department at U of M Hospital where a scan confirmed the diagnosis and I now have it checked periodically. Finally, after all those years, someone in the medical profession acknowledged the connection!

Radiation is insidious. You cannot see it, smell it, taste it or feel it but on some level, you are aware that it can harm you. On top of that, radiation caused illness involves a long latency period. Thus, I spent half a century wondering whether I would suffer some weird and debilitating illness.

I was also concerned about the effects of radiation on the reproductive system. The irreverent Bikini joke about going back to San Francisco and telling all the girls that we could not get them pregnant was soon replaced by concern about the possibility of genetic problems being transmitted to our children. This became real for me when my daughter, who was conceived less than two years after my return from Bikini, experienced a series of problems with her endocrine system. It was after she had half of her pancreas removed at the age of twenty that I began speaking out against continued development and testing of nuclear weapons. She died of cancer at the age of 46, three years after surgery for a brain tumor and for lung cancer.

I have, moreover, had difficulty accepting the fact that the government never availed itself of this wonderful opportunity for a follow up study to assess possible health effects of our experience. I have more recently come to the cynical conclusion that they really did not want (anyone) to know.

Because of my experience, I was convinced that nuclear weapons were "bad news." Not only did they constitute a level of devastation beyond reason; the radiation they produced also created a hazard for those who used them and for their descendants. I was upset by the extent to which I felt that the safety and well being of service personnel were being compromised, and I

was incensed at the campaign of denial. I wanted my country to do better than that! Through it all, I wondered whether others with experiences similar to mine felt as I did.

When I retired, I decided to return to school and pursue a Ph.D. in sociology. When it came time to choose a dissertation topic, there it was. How do Atomic Veterans remember the experience, and what effect do those perceptions have on their current attitudes? We are a varied lot, and our attitudes vary, but my contacts with literally hundreds of Atomic Veterans reveal many common themes. I am not alone.

Like myself, I found that these men all consider themselves to be loyal, patriotic Americans. We served our country willingly; two thirds of us, in fact volunteered for military service (as opposed to being drafted). We were, however, subjected to an experience that to this time is unique in American military history. We participated in the test detonation of nuclear bombs and that experience has inevitably contributed to who we are.

A few men volunteered for the experience; most were ordered to participate. Some entire military units were assigned to the tests, but many of the men were sent on temporary assignment and organized into casual or provisional units, which were dispersed soon after completion of the particular exercises.

Most of us have little recollection of being informed at the time about radioactivity or its possible consequences. There are, in fact, strong indications that some of the tests included such objectives as ascertaining what effect exposure to radioactivity would have on a combat unit's effectiveness, or of conditioning men to perform under such conditions. It is conceivable that if either of these were the objective, someone in charge would conclude that informing the troops fully about radioactivity could possibly result in malingering or in contamination of the outcomes.

Almost three quarters of the men questioned identified the safety measures in conjunction with their particular tests as inadequate. Moreover, the question, "What safety measures can you remember being taken?" elicited a variety of responses, many of which revealed either incredible naiveté or extreme callousness on the part of these men's superiors. In fact, the tendency of senior military officers to see and treat enlisted personnel as though they were part of the expendable equipment is evident in the following incident, which occurred on my own ship.

Approximately three weeks after test BAKER, we were ordered alongside the target vessel, USS Pennsylvania, which was taking on water. We were to install submersible pumps so she could be kept pumped out. There was a radiological monitor from AEC aboard and he took readings with a Geiger counter aboard the "Pennsy." Then he consulted his tables and came up with a time limit, which he said constituted "maximum safe exposure" for anyone to be aboard that vessel.

A working party was sent over to begin the job, and after the designated length of time, they returned and a second party went over to continue. In this way, a succession of work parties followed one another until all the

enlisted men in our crew had been over on the Pennsylvania. At this point, the job had not been completed, so our commanding officer got on the voice radio to the task group commander. He reported that all his men had been subjected to maximum safe exposure, that the job was not yet completed, and he was requesting instructions. I was on the bridge, next to the captain and was astonished to hear the response, loud and clear. It was, "Safe exposure, my ass; don't let that ship sink!"

The lack of information, before, during and after the tests, the perceived lax safety procedures, and the fact that many of the men had been assigned to special temporary aggregations formed exclusively for the test operations, along with the fact that very few had volunteered for this duty, fostered growth of what I choose to call the guinea pig syndrome. Perhaps this was best expressed by the veteran of Operation Castle who said, "Originally I held the government blameless. As time passes and more is revealed I more strongly believe that we were test subjects." Test subjects, it should also be noted, from whom informed consent had not been obtained.

As both nuclear arms and nuclear power industries grew, there were a number of incidents, which resulted in greater public awareness of, and sensitivity to associated radiation hazards. With this development, some Atomic Veterans who had previously felt constrained to silence were encouraged to voice their concerns. Others who had not previously been concerned began to re-examine their experience. Many of us began seeking one another out. There developed, among us, an increased awareness that we had played a special role which deserved recognition.

It is accepted military procedure to give awards for participation in particular operations, bonus pay for particularly hazardous duty, and both care and compensation for injuries sustained in the line of duty. When the government denies responsibility for the injuries, not only those seeking compensation, but also many of their fellow veterans perceive this as an attack on their credibility and integrity. The fact that there has been no other form of recognition is seen as a denial that what we did had any importance.

A number of the veterans of Operation Crossroads recalled hearing a rumor at the time, that Admiral Blandy, the commander of that task force, had recommended that a campaign ribbon be awarded to all participants, but it had been vetoed by someone "higher up." When interviewing a man who had been on the admiral's staff at the time, therefore, I raised the question directly. This man indicated that, indeed, the recommendation had been made, but he did not know why it had failed to go through. Looking back, maybe they should have listened to the admiral.

For some the question was addressed very early; for others it came much later; eventually, however, anyone who has had any association with nuclear devices must begin to wonder about the possibility of related health effects. Although radiogenic illness can become manifest within days, a latency period of considerable length is much more frequently the case. Thus, it was the mid 1970's when a significant number of Atomic Veterans began to have physical problems which they attributed to their radiation exposure.

Establishment of the several survivors' organizations was motivated principally by government denial of responsibility for these problems.

In my study, 46% of the respondents said they had health problems they felt were caused by exposure to radiation, and another 12% indicated that they were not sure. Similarly, 21% reported that some member or members of their family had health problems which they felt were related to their radiation exposure, and another 7% had some suspicion that this might be the case. In all, 60% of the men are in one or more of these categories. However, well over half of them (74% of the sample) report having worried about such possibilities. To a large extent these tend to be the same people who asserted that they felt that participation in nuclear weapons testing exceeded "...what is ordinarily regarded as appropriate military service."

In a 1965 article about the Japanese A-bomb survivors, Abe Rosenthal of the New York Times notes that certain doctors, both Japanese and American, talk about what they call "atomic hypochondria" "But," he goes on to say, "they say that pragmatically it does not make much difference whether the illnesses are atomic, imaginary, or real but quite nonatomic." In any case, as far as the veterans are concerned, the problem is real in the eyes of the men who experience it, and therefore should command attention by the government.

Furthermore, it is important to note that of the 161 men in my study who said they had a health condition they attributed to radiation exposure only 86 (53%) had filed claims with the Veterans Administration. And of the 40 who said they had a health problem and did not know, or wondered whether it was the result of exposure to radioactivity, 10 (25%) had filed claims. Such proportions seem not to support any assertion that those who claim radiogenic illness are malingerers seeking a "handout."

Many Atomic Veterans acknowledged having felt alienated, frustrated and isolated for many years because they had little contact with anyone who had shared their experience and nobody else seemed to think it was important. In fact, 79% of them indicated that they had, at least some of the time, wished they had someone with whom they could discuss their nuclear test experience. Some who joined the traditional veterans organizations report feeling rebuffed when they tried to discuss nuclear test experiences in that company. For some of these men the growth of radiation survivors' organizations has provided a boost for their self-image and their morale.

Many of us were explicitly admonished not to discuss the experience with anyone. Reported feelings about the appropriateness of this enforced silence vary. Nevertheless, feelings, particularly negative ones, that one is denied the opportunity to express, tend to grow. It is somewhat analogous to rust which has been painted over. The combination of denial by official sources and not being able to talk the matter out has caused the resentment to fester and grow beneath the surface just as rust, when painted over, eats away, unseen, at the metal.

Probably the one feeling most often expressed by Atomic Veterans is a resentment of the denials, cover-ups and misrepresentations on the part of

the government. By and large, these are men who served their country in a spirit of patriotism. Many feel that in the course of that service they were exposed to unnecessary hazards without either knowledge or consent. But their resentment of this would be much less if they felt that the government had been and was currently being completely “straight” with them.

It makes no sense for a government to alienate its greatest potential support, the men and women who fought for it. My study gives convincing indications that veterans will support government very faithfully, in spite, even, of perceived slights; but the thing that can alienate them is a failure to be honest and up front with them.

In most respects, Atomic Veterans are not appreciably different from other veterans of our generation (essentially those born between the two World Wars). We have a strong sense of patriotism; we generally support a strong military stance by the United States and that support tends to increase when association with the military is longer and closer. Atomic Veterans have a healthy respect for the tremendous power of nuclear weapons. We are realistic enough to recognize that the existence of these weapons has become a fact of life; as long as this is so most of us feel that the U.S. should not relinquish its superiority in nuclear weapons. But, at the same time, many deplore the nuclear buildup of the Cold War period and a majority feel that nuclear tests should be either stopped or very strictly regulated.

Many Atomic Veterans are seriously concerned about health effects of exposure to radiation and a significant number feel that they have experienced these effects. However, we are generally aware that military service is a hazardous occupation and that risks must be accepted. What dissatisfaction there are focuses more on how both the risks and the injury claims have been managed.

Most importantly, in conversations with these men, in their letters, and in their marginal comments on questionnaires, it becomes evident that there is a strong feeling of resentment among a considerable number of them which can best be described as a feeling of “being used.” Four of their most frequently voiced complaints are; that they were not adequately informed about the risks involved; that safety procedures were either inadequate or ignored; that the government has refused to acknowledge these faults; and that they were never given proper recognition for their participation.

But, although the experience which invokes those feelings was incident to military service, most of their resentment is not particularly focused on the military, as such. More of that resentment is directed toward Congress, whose members are perceived as giving inadequate attention to the complaints of the veterans and toward the Veterans Administration and the Defense Nuclear Agency, because of their role in the “denial” process.

Quite clearly, Atomic Veterans, like Americans in general, vary widely in their opinions and attitudes. Among them, continuing military experience understandably leads to stronger endorsements of the military and of government actions supporting the military, but it does not seem to have

any bearing on attitudes and opinions that range outside the zone of the military. There is no evidence here that the military creates someone who is predictably conservative across multiple dimensions.

Of course, the unusual experiences of these particular veterans has imbued very many of them with what can only be described as a combination of outrage, distrust and resentment toward various aspects of the federal government. In short, these are men who want very much to trust, believe in and support their government. How foolish of that government to alienate them by not listening more sympathetically to their concerns!

[See Grahfls, F.L., *Voices from Ground Zero Recollections and Feelings of Nuclear Test Veterans*, 1996, for more detailed information.]



## Introduction

There are a number of circumstances under which veterans might have been exposed to radiation. Their eligibility for VA services (such as for the VA's Ionizing Radiation Registry (IRR) Examination Program, priority to enroll for VA health care, requirement to make co-payments for VA treatment, required documentation in their service records, etc.) also varies depending on the nature of their exposure and the diseases for which care is sought. See Summary in [Attachment C](#) in [Appendix 1](#).

This program includes information about major types of exposure and summarizes available scientific information and special programs available for veterans (including changes since this VHI module initially was released in 2001).

If a veteran is not eligible for the IRR Examination Program but is concerned about his or her radiation exposure and has other eligibility for VA care (e.g., is enrolled), it is recommended that an evaluation comparable to the IRR examination be offered (although the results would not be entered into the IRR database).

### **Resources for possible assistance in responding to veterans' questions**

Information about programs for veterans exposed to ionizing radiation is available ([Appendix 1](#)).

Each VA Medical Center has an Environmental Health Clinician and Coordinator who are responsible for the IRR Examination Program ([Appendix 2](#)), as well as the Gulf War Depleted Uranium (DU) screening program ([Appendix 3](#)).

A VA Fact Sheet about nasopharyngeal (NP) radium therapy is available ([Appendix 4a](#)).

Each VA facility has a Health Administration Service or comparable office which can assist with questions about eligibility for VA care, enrollment, co-payments, reimbursement for travel costs, etc. Also, veterans may **call toll-free 877-222-8387** for enrollment information.

Questions related to compensation claims can be referred to Veterans Benefits Administration staff located at many VA facilities or veterans may reach their local VA Regional Office (VARO) by **calling toll-free 800-827-1000**.

Atomic Veterans with questions about radiation doses which they may have been received in Hiroshima, Nagasaki, or as atmospheric nuclear weapons

test participants may call the Defense Threat Reduction Agency (formerly the Defense Special Weapons Agency (DSWA) and Defense Nuclear Agency (DNA)) **toll-free at 800-462-3683**.

Doses of radiation to which other veterans may have been exposed may be included in their service records (e.g., recorded on DD 1141 forms) (which may be available through the VAROs if compensation claims have been filed) and/or information may be available from the radiation dosimetry offices of the individual military services or other agencies. See [Appendix 5](#).

A facility's radiologists, nuclear medicine specialists, and the radiation safety officer may assist in responding to scientific and technical questions about ionizing radiation and possible health effects.

The Office of Public Health and Environmental Hazards, which is administratively responsible for the VA's Ionizing Radiation Program, may be reached at **202-273-8575**.





## Background Information About Radiation

The term “ionizing radiation” (IR) refers to a group of subatomic particles and electromagnetic waves or photons that have enough energy to create ions (electrically charged particles) when they interact with atoms or molecules. These ions created by radiation exposure can cause damage to the body. The likelihood, amount, and type of damage are related to the type and amount of radiation exposure received.

Commonly encountered types of IR include alpha particles, beta particles, gamma rays, and X-rays. In addition, some veterans were exposed to neutron particles from nuclear detonations or nuclear reactors.

- **Alpha particles:** emitted from atomic nuclei and which are identical to nuclei of helium atoms, are not able to penetrate the intact skin. Therefore, alpha emitters are hazardous primarily if they are taken into the body and function as sources of internal radiation.
- **Beta particles:** high-energy electrons emitted from atomic nuclei. They can penetrate a short distance into the body but beta emitters are hazardous primarily if they are taken into the body and function as sources of internal radiation.
- **Gamma rays:** electromagnetic radiation originating from nuclei that can penetrate the body readily so both external and internal gamma sources are hazardous.
- **X-rays:** similar to gamma rays but originate outside the atomic nuclei.
- **Neutron particles:** neutrons emitted from nuclei such as after splitting of atoms in a nuclear reactor or from detonation of nuclear weapons.

Sources of IR include radioactive decay of unstable atoms in radioisotopes, nuclear fission (splitting of the atom such as in a nuclear reactor or detonation of an atomic bomb), nuclear fusion (fusion of atoms as in detonation of a hydrogen bomb), and mechanical devices, such as X-ray machines.

The term “non-ionizing radiation” (NIR) refers to various types of electromagnetic radiation which do not create electrically charged particles when they release energy into matter. However, NIR still may cause acute and chronic adverse health effects.

Examples of NIR include (in the order of decreasing frequencies and

increasing wavelengths) ultraviolet radiation, visible light, infrared radiation, radar and other microwave radiation, radio frequency radiation, and extremely low frequency radiation such as associated with electric power lines.

## External versus internal exposure to IR

- **External radiation** refers to IR from a source located outside the body. With external radiation, the body absorbs radiation only as long as it is exposed to the outside source and only portions of the body that are exposed absorb the radiation. External radiation may result from a radiation source at a distance from the person or from contamination of the skin or clothing with radioactive materials. Generally, the skin receives the highest dose from external IR. The dose to the deeper tissue is utilized as the whole body dose when the entire body is radiated.
- **Internal radiation** refers to IR from a source that has been taken into the body, such as by inhalation, ingestion, wounds, etc. Absorption of radiation may continue for a long period of time after a radioactive material has been taken into the body, depending on the physical and biological half-lives of the radioactive material. IR from an internalized source may be concentrated in a particular part of the body; e.g., radiation from internalized iodine 131 will be concentrated in the thyroid gland. Generally, doses from internal IR are reported as the calculated dose that would be received over 50 years, e.g., the 50-year committed dose equivalent.

Some important definitions and concepts in the measurement and estimation of radiation exposure, dose, and risk are summarized below.

### Measurement of Ionizing Radiation

Dosimetry refers to the estimation of radiation exposure. This is often done by measuring actual radiation levels over time or by identifying changes associated with radiation exposure to various body constituents such as chromosome aberrations (biological dosimetry).

Ionizing radiation can be measured with a variety of instruments including personal dosimetry devices such as film badges. Film badges primarily measure exposure to external gamma and X-rays. These have been replaced by more accurate thermo luminescent dosimeters (TLDs), which measure exposure from gamma, neutrons, and skin doses.

Determination of internal radiation doses tends to be more difficult than external radiation doses and physiological and mathematical models may be used. These include direct measurements using external detection devices (e.g., whole-body counting) and testing of materials excreted or removed from the body (e.g., bioassays of urine, etc.).

The techniques used to estimate radiation exposure by biological dosimetry and bioassays tend to be more accurate at higher radiation doses (e.g., about 10 rem or higher), in close time proximity to radiation exposure and may be affected by other factors in addition to radiation, (e.g., other exposures; renal function).

- Roentgen (R or sometimes r) - is a measure of radiation exposure based on ionization of air, where 1 R is the amount of x-ray or gamma radiation that results in an electric charge of  $2.58 \times 10^{-4}$  coulomb per kg of air.
- Rad - "Radiation absorbed dose" - is a measure of the amount of energy deposited in tissue; 1 rad is defined as the amount of radiation that deposits 100 ergs per gram; 100 rads equals one Gray (Gy), which is the preferred international unit.
- Rem - "Radiation (or Roentgen) equivalent man" - is a measure of radiation that provides adjustment for the different biological effects of various types of radiation. A rem is a dose of any form of IR that is estimated to have the same biological effect as 1 rad of gamma or x-rays. To obtain the dose in rem, the dose in rads is multiplied by a weighing factor (sometimes referred to as the "relative biological effectiveness" (RBE) or "quality factor") for the type of radiation. The radiation-weighting factor is 1 for beta, gamma, and X-rays, 20 for alpha particles, and 5-20 for neutrons. 100 rem equals one Sievert (Sv), which is the preferred international unit.
- For gamma and X-rays (the predominant types of whole body IR to which most veterans were exposed), exposure in Roentgens is approximately the same as absorbed dose in rads and equivalent dose in rem (e.g., an exposure of 1 R, would result in an absorbed dose of about 1 rad and an equivalent dose of about 1 rem).
- The "effective dose" is a mathematical conversion of a partial or non-uniform dose to a whole body dose that would be equivalent to the same degree of risk of developing a cancer; to calculate the effective dose, a radiation dose to an organ or tissue is multiplied by a particular tissue's weighing factor, a number that reflects its relative cancer susceptibility in comparison to other organs/tissues of the body.
- "Committed" dose is the amount of radiation received from an internal source of IR to a particular organ over a period of time and by convention is usually expressed as an exposure over a 50-year interval.
- The total dose is the sum of the external and internal doses (e.g., the total effective dose equivalent = the effective dose equivalent for external radiation plus committed effective dose equivalent for internal radiation).

The radioactivity of radioisotopes is measured in disintegrations per second. One Curie (Ci) equals  $3.7 \times 10^{10}$  disintegrations per second (the radioactivity of 1 gram of radium). One Becquerel (Bq), which is the preferred international unit, equals one disintegration per second.

Some comparative doses of ionizing radiation are shown in Table 1.

**Table 1**  
**Some Comparative Doses\* Of Ionizing Radiation**

- Chest X-ray - 0.015 rem
- The average dose of IR that a person in the U.S. receives from natural background radioactivity, medical tests, and other exposures - 0.4 rem per year
- Average external dose of participants in U.S. atmospheric nuclear weapons tests according to the previous Defense Threat Reduction Agency (DTRA) - estimates 0.6 rem\*\*
- Maximum dose of U.S. personnel involved in occupation duties in Hiroshima or Nagasaki according to previous DTRA - estimates less than 1 rem\*\*
- The annual occupational limit for radiation workers from IR mandated by the U.S. Nuclear Regulatory Commission (NRC) - 5 rem per year. [The 5 rem annual occupational limit for radiation workers (e.g., medical technologists) is the total effective dose equivalent. The NRC permits higher doses to parts of the body, e.g., 50 rem per year to the skin or extremity.]
- Average dose received by Japanese atomic bomb survivors in Hiroshima and Nagasaki - about 20-200 rads
- Symptoms of acute radiation sickness - not expected at whole-body doses of less than about 100 rem
- Approximate acute whole body dose resulting in about a 50% likelihood of death in 30 days - about 400 rads

\* NOTE: A rem is the amount of any type of ionizing radiation estimated to have the same biological effect as 1 rad of X-rays or gamma rays. For virtually all radiation associated with medical procedures, exposures expressed in rads or rem would be the same.

\*\*A recent National Research Council report raised questions about the accuracy of some DTRA dose reconstructions. The DTRA is taking corrective actions to address these concerns.



# Adverse Health Effects from Radiation

## **Ionizing Radiation (IR)**

- Deoxyribonucleic acid (DNA) generally is the critical site for damage from low level IR. In addition, IR can damage other molecules and cellular components such as lipids, enzymes, and other proteins, ribonucleic acid (RNA), cellular membranes, mitochondria, etc.
- Rapidly dividing, poorly differentiated cells (e.g., in bone marrow and GI tract) tend to be more susceptible to IR.
- Acute effects from exposure of the whole body or large portions of the body to high doses of radiation (e.g., 50-100 rads or more) include a number of acute radiation syndromes involving the central nervous, cardiovascular, gastrointestinal, and hematopoietic systems. Signs and symptoms include nausea, vomiting, diarrhea, prostration, bleeding, infections, hair loss, and neurological derangement. Rapidity of onset of symptoms, severity of medical problems, and likelihood of death are related to dose. See [Appendix 19a](#) for additional information about acute radiation syndromes.
- “Stochastic” effects are those related to the probability of developing cancer or genetic mutations. In general, the likelihood (but not the severity) of the disorder is increased as the dose of IR increases. Generally stochastic effects are not felt to have a threshold; i.e., it is assumed that there is no lowest “safe dose”, at least for radiation safety purposes, although we are all receiving radiation exposure from cosmic and naturally occurring sources (e.g., internal exposure from radioactive potassium a normal body constituent and external exposures from radon, a radioactive decay product of uranium found in soil and building materials).
- Radiogenic malignancies - A malignancy thought to be caused by IR is indistinguishable pathologically from one thought to have had a different cause. Generally, it is not possible to determine definitely whether a stochastic radiation effect such as the development of a cancer in any individual is the result of an IR exposure. In most instances what can be provided is an estimate that IR was a contributing factor. The calculated estimate is often referred to as the “probability of causation” (PC), “assigned share”, or “attributable risk”. Generally, malignancies and other tumors resulting from

exposure to IR develop years later, after a prolonged latency period. Treatment of malignancies and other diseases thought to be due to IR is no different than treatment of the same conditions when IR is not suspected to be responsible (unless the radiation-induced malignancy is in the field of the previous therapeutic radiation which would limit further use of this treatment modality).

- “Deterministic” effects are those that increase in severity as the dose of IR increases. Examples of “deterministic” effects include acute radiation syndromes following acute whole body doses of 50-100 rads or more and non-neoplastic complications from radiation therapy affecting various organs. Generally no clinically significant deterministic effect is likely to occur at a dose below 10 rem. Thresholds may be much higher for specific conditions (e.g., about 60 rads or more for cataract development).

Treatment of conditions considered to be radiation-induced is not only identical to that of conditions not deemed a result of radiation exposure, but is also provided by the same types of medical specialists who would be involved if there was no history of radiation exposure. For instance, cataracts would be treated by an ophthalmologist, leukemia by a hematologist, etc.

## **Sources of information about adverse health effects of IR**

The major source of information about the effects of IR on humans has come from studies of Japanese atomic bomb survivors and their offspring. Findings of these studies are summarized in [Table 2](#) (next page). Other sources of information include patients who received radiation therapy or other forms of medical radiation and individuals exposed after nuclear accidents such as Chernobyl, etc. Children are more sensitive to the adverse effects of radiation than adults and women tend to be more sensitive than men.

**Table 2****Findings from Studies of Japanese Atomic Bomb Survivors and Their Offspring****Significant radiation-related increases**

Malignant tumors: leukemia, cancers of the breast (female), colon, liver, lung, ovary, skin (non-melanoma), stomach, and thyroid

Cataracts

Prenatally exposed: small head size, mental retardation, diminished IQ and school performance, increased frequency of seizures

Survivors exposed at young age or prenatally: retarded growth and development

Chromosome abnormalities in lymphocytes

Somatic mutation in erythrocytes and lymphocytes

**Suggestive radiation-related increases**

Malignant tumors: cancers of the esophagus, urinary bladder, malignant lymphoma, salivary gland tumors, possibly multiple myeloma

Prenatally exposed: adult-type malignancies

Exposed in utero: impairment of neuromuscular development

Parathyroid disease

Mortality from diseases other than malignant tumors, specifically: cardiovascular disease and liver cirrhosis at higher doses

Specific (humoral or cell-mediated) changes in immunologic competence

**No radiation-related increases seen to date**

Malignant tumors: chronic lymphocytic leukemia, osteosarcoma

Acceleration of aging

Sterility or infertility among the prenatally or postnatally exposed

Children of survivors: congenital abnormalities, mortality including childhood cancer, chromosome aberrations and in biochemically identifiable genes

(Source: Slightly modified from - Schull, Effects of Atomic Radiation A Half-Century of Studies from Hiroshima and Nagasaki, 1995, pp 272-273)

## **Non-Ionizing Radiation (NIR)**

Ultraviolet (UV), visible, infrared, and microwave radiation may cause various types of eye damage. UV, infrared, and microwaves may contribute to cataracts in some circumstances (e.g., high-energy microwave exposure).

The effects of UV radiation generally are limited to the skin and eyes because of its limited body penetration ability. UV radiation in sunlight is the major risk factor for skin cancer. In addition to cataracts, radio frequency radiation (which includes radar, microwaves, and wireless telephones) may cause other thermal effects such as skin burns, as well as electric shocks.

Concerns have been expressed about possible non-thermal adverse health effects, especially cancer risk, from exposure to radio frequency and microwave radiation (which include radios, cellular telephones, and radar). According to consumer information from the Food and Drug Administration, the available scientific evidence does not show that any health problems are associated with the use of wireless phones. A 1995 report from the National Institute for Occupational Safety and Health (NIOSH) on radar concluded that there were too few and too limited data either to suggest that low-level microwaves could adversely affect health in humans or exonerate such exposure. According to World Health Organization (WHO) fact sheets, exposure to radio frequency fields including radar is unlikely to induce or promote cancer based on current scientific information.

Concerns have been expressed about possible adverse health effects - especially cancer, from exposure to extremely low frequency (ELF) electric and magnetic fields (EMF) related to electric power. In a report released in June 1999, the National Institute of Environmental Health Sciences (NIEHS) of the National Institutes of Health concluded that ELF EMF exposure cannot be recognized as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. The NIEHS did not believe that there was sufficient evidence of risk for other cancers or non-cancer health outcomes to warrant concern. The WHO International Agency for Research on Cancer (IARC) classifies ELF electric and magnetic fields as possibly carcinogenic to humans based on epidemiological studies of childhood leukemia.





# Atomic Veterans

The term “Atomic Veteran” is applied to individuals who served as occupation personnel in Hiroshima or Nagasaki after the atomic bombing of those cities, some former POWs, and participants in atmospheric nuclear weapons tests

## **U.S. Occupation Personnel**

The first atomic bomb was dropped on Hiroshima on August 6, 1945 followed by the second bomb on Nagasaki on August 9. Both were airbursts, which therefore minimized radioactive debris.

Several surveys were made to determine that the U.S. occupation of the two cities could proceed safely.

The U.S. occupation of the Hiroshima area began on October 7, 1945 and lasted through March 6, 1946. The occupation of the Nagasaki area began on September 23, 1945 and lasted through June 1946.

Approximately 195,000 service personnel have been identified as members of the Hiroshima and Nagasaki occupation forces or were prisoners of war with potential for similar exposure to IR. None of the occupation forces had personal radiation detection devices (film badges) to measure doses of IR.

According to the previous Defense Threat Reduction Agency (DTRA), [formerly the Defense Nuclear Agency (DNA) and Defense Special Weapons Agency (DSWA)] estimates, using all possible “worse case” assumptions, the maximum possible dose of IR that any member of the occupation force might have received at Hiroshima or Nagasaki from external radiation, inhalation, and ingestion is less than 1 rem. The DTRA estimated that over 95% of these participants received doses below 0.1 rem and only those Nagasaki occupation forces that regularly entered the Nishiyama area had the potential to receive doses up to 1 rem\*. See [Appendices 6a](#) and [6b](#) for more detailed information.

An epidemiological follow-up study of U.S. occupational personnel was not felt to be cost-beneficial by the National Academy of Sciences.

\*A 2003 National Research Council report raised questions about the accuracy of some of the DTRA upper bounds dose estimates for Atomic Veterans and the DTRA currently is taking corrective actions.

## Participants in U.S. atmospheric nuclear weapons tests

The world's first nuclear detonation was Project TRINITY which occurred on July 16, 1945 at Alamogordo, New Mexico and proved that nuclear weapons were possible. Between TRINITY and the implementation of the limited test ban in 1963, the U.S. conducted over 200 atmospheric nuclear weapons tests in 21 test series. Most were conducted in Nevada Test Site or the Pacific Proving Ground (principally at Enewetak and the Bikini Atolls in the Marshall Islands) while one was conducted in New Mexico (TRINITY) and one in the Atlantic.

Among the problems and controversies associated with U.S. atmospheric nuclear weapons tests were the following:

- Involvement of some veterans in events that were or were believed by some to be experiments in connection with nuclear tests. Approximately 2,000-3,000 military personnel may have participated as research subjects.
  - Examples of studies included psychological and physiological testing; testing of volunteers as close as under 1 mile from ground zero; flash blindness experiments (the only experiments in which immediate injury was recorded); research on protective clothing (including having personnel walk or crawl over contaminated ground as soon as 4 hours after the nuclear shot); cloud-penetration activities (resulting in radiation doses of 15 R or higher for several crew members); and decontaminating aircraft.
  - Other Atomic Veterans who were not considered to be "research subjects" were engaged in similar activities.
  - See [Appendix 7](#) for a summary of pertinent sections of the final report of the former presidential Advisory Committee on Human Radiation Experiments (ACHRE).
- Extensive radioactive contamination of target ships from the underwater detonation of shot BAKER of Operation CROSSROADS in 1946. This posed major decontamination problems for military participants and resulted in evacuation and resettlement of inhabitants of Bikini Atoll. [Some Navy veterans of the USS BRUSH who did not participate in CROSSROADS also have expressed concern about IR exposure since their ship was anchored near contaminated target ships that had been towed to Kwajalein Atoll and some crewmembers visited nearby target ships and collected souvenirs.] See [Appendices 8a](#) and [8b](#) for more information about CROSSROADS.
- Unexpectedly large amounts of radiation exposure and contamination from the shot BRAVO, of Operation CASTLE in 1954. This was a thermonuclear (fusion or hydrogen bomb-type) device with the largest yield ever tested by the United States. Radioactive debris were spread over a much larger area than anticipated, exposing Marshall Islanders, Japanese fishermen, and

U.S. personnel. Acute radiation effects were observed among some of the exposed fishermen. See [Appendix 9](#) for more information about Operation CASTLE.

- Exposure by IR of residents who were “downwind” of nuclear weapons tests detonated in the continental U.S.

According to previous DTRA estimates, approximately 210,000 participants were involved in atmospheric nuclear weapons tests. About 45% of test participants had film badges. For personnel without suitable film badges, the DTRA uses 3 alternative approaches: determination of dose potential (e.g., from nuclear detonations or contact with radioactive materials); dose based on film badges of others with similar potential for exposure; and dose calculations (e.g., based on unique activities of specific individuals).

Gamma rays accounted for most of the radiation exposure that test participants received. According to the DTRA, the average external radiation dose of test participants was 0.6 rem and less than 1% of participants exceeded the current radiation occupational dose limit for radiation workers mandated by the U.S. Nuclear Regulatory Commission of 5 rem (whole-body) per year. About 1,100 test participants received external doses of between 5 to 10 rem and about 140 received more than 10 rem. A 2003 National Research Council report raised questions about the accuracy of some DTRA dose reconstructions. The DTRA is taking corrective actions to address these concerns

Epidemiological follow-up studies of U.S. atmospheric nuclear weapons test participants are summarized in [Table 3](#) (next page).

**Table 3**

<b>Statistically Significant Increases in Mortality in Studies of U.S. Nuclear Weapons Test Participants*</b>		
<b>Study Name</b>	<b>Overall Mortality</b>	<b>Specific Mortality</b>
CDC "Smoky" study <sup>1</sup>	Not increased Observed/expected ratio 0.88 (95% Confidence Interval (CI) 0.78 - 0.98)	Increased leukemia; Observed/expected ratio 2.58 (95% CI 1.11 - 5.09)
VA "Hardtack" study <sup>2</sup>	Increase in all cause mortality Relative risk (RR) 1.10 (95% CI 1.02 - 1.19)	Increase in mortality from cancers of the digestive organs; RR 1.47 (95% CI 1.06 - 2.04)
Med Follow-up Agency "Crossroads" study <sup>3</sup>	Increased Relative risk all- cause mortality 1.046 (95% CI 1.020 - 1.074)	
VA "5 Rem and Over" study <sup>4</sup>	Increased Relative risk all- cause mortality 1.22 (95% CI 1.04 - 1.44)	Increased for all lymphopoetic cancers; RR 3.72 (95% CI 1.28 - 10.83)
Med Follow-up Agency "Five Series" study <sup>5</sup> (corrected) (includes "Smoky" participants)	Not increased All-cause hazard ratio 1.00 (95% CI- 0.98 - 1.02)	Increased for external causes; hazard ratio 1.08 (95% CI 1.02 - 1.16); nasal cancer - 2.64 (95% CI 1.02 - 6.82); and prostate cancer - 1.20 (95% CI 1.03 - 1.40)

\* Only statistically significant findings from main studies (not subset analyses) shown. Summaries of these studies are provided in [Appendices 10a-10e](#).

1. Caldwell et al., Mortality and Cancer Frequency Among Military Nuclear Test (Smoky) Participants, 1957 through 1979, JAMA, Volume 250 Number 5, August 5, 1983, pages 620-624.
2. Watanabe et al., Cancer Mortality Risk Among Military Participants of a 1958 Atmospheric Nuclear Weapons Test, Am J of Public Health, Volume 85, Number 4, April 1995, pages 523-527.
3. Johnson et al., Mortality of Veteran Participants in the CROSSROADS Nuclear Test, Medical Follow-up Agency, Institute of Medicine, National Academy of Sciences, 1996.
4. Dalager et al., Cancer Mortality Among the Highest Exposed U.S. Atmospheric Nuclear Test Participants, J Occup. Environ Med, Volume 42, Number 8, August 2000, pages 798-805.
5. Thaul et al., The Five Series Study: Mortality of Military Participants in U.S. Nuclear Weapons Tests, Medical Follow-up Agency, Institute of Medicine, National Academy of Sciences, 1999.

## **U.S. participants in non-U.S. nuclear weapons tests**

Some U.S. service personnel were potentially exposed to IR as a result of activities relating to foreign nuclear weapons tests, such as cloud sampling missions.

It has been difficult to obtain dose information on this group of veterans although the Air Force currently is trying to address this problem.

## **VA programs for Atomic Veterans**

See [Appendix 1](#) for information on VA programs for veterans exposed to ionizing radiation.

Ionizing Radiation Registry (IRR) Examination program - Atomic Veterans are eligible to participate in the IRR Examination program. Veterans need not be enrolled in VA health care to participate in the IRR Examination program. The IRR includes a medical history, physical examination, and baseline laboratory studies. Additional specialized tests and consultations are provided as clinically indicated. This program potentially serves as an entry point for VA care. More information about the IRR Examination program can be provided by each VA Medical Center's Environmental Health Clinician or Coordinator. See [Appendix 2](#) for information about the IRR examination program.

As of May 2003, over 23,000 IRR examination code sheets have been submitted. See [Appendix 11](#) for analysis.

Special eligibility for VA Health care - Atomic Veterans have special eligibility (Priority Level 6) to enroll in VA health care for treatment of conditions that VA recognizes as potentially due to radiation by statute or regulation (see [Section 14](#)). Care for these potentially radiogenic conditions is provided without regard to the veteran's age, service-connected status, or ability to defray the cost of medical care. Additionally, no co-payment by the veteran is required. Even if an eligible veteran has never filed a compensation claim or if the claim has been denied, the veteran can still receive free care for potentially radiogenic conditions including all cancers. More information about eligibility can be provided by staff in each VA Medical Center's Health Administration Service (or other office with similar responsibilities depending on the facility's local organizational structure).

## **Concern about offspring**

A continuing concern to Atomic Veterans is the possibility that health problems in their offspring may be related to IR.

Studies of Japanese atomic bomb survivors' children conceived after the bombings have not documented an increased risk of birth defects. Also among the Japanese no significant increased risk for deaths from childhood cancer or leukemia has been found with an increasing parental dose of IR.

An analysis by the Medical Follow-up Agency of the National Academy of

Sciences concluded that it would not be feasible to conduct an epidemiological study of U.S. Atomic Veterans to determine whether there is an increased risk of adverse reproductive outcomes. This conclusion was based on the expected extremely small potential risks at low doses of IR, the resultant need for a very large study population, and various other methodological difficulties. (See summary in [Appendix 12.](#))

### **Review by the Presidential Advisory Committee on Human Radiation Experiments (ACHRE)**

The ACHRE considered issues of concern to Atomic Veterans. Some actions related to compensation but no additional medical screening or follow-up programs were recommended. See [Appendix 7](#) for a summary of pertinent sections of the ACHRE Final Report.

See the recollections of Dr. F. Lincoln Grahfs in [Section 1](#) of this VHI for a discussion of concerns experienced by many Atomic Veterans.



## Veterans Who Participated in Other “Radiation Risk Activities”

In order to ensure equity for veterans in relation to some civilian workers eligible for non-VA compensation programs, VA expanded its definition of “radiation-risk activities” to include not only Atomic Veterans but also some veterans stationed at Paducah, KY, Portsmouth, OH, and Area K25 at Oak Ridge, TN or who participated in certain underground nuclear tests in Alaska.

These veterans are eligible to participate in the VA’s Ionizing Radiation Registry examination program ([Appendix 2](#)) but do not have special eligibility (Priority Level 6) to enroll in VA health care for treatment of conditions that VA recognizes as potentially due to radiation.

These veterans are eligible for compensation on both a “presumptive” and “non-presumptive” basis.

See [Appendix 1](#) for more information.







## Veterans Stationed at Hanford and Other Nuclear Weapons Facilities

The Manhattan Project to develop an atomic weapon during World War II was a colossal effort. Major facilities included Oak Ridge where uranium was enriched (by separating the more radioactive isotope U-235 from U-238), Hanford where plutonium was produced, and Los Alamos where many components of the atomic bomb were designed, assembled, and tested. Active-duty military personnel as well as civilians participated in the Manhattan Project and were stationed at nuclear weapons facilities.

In addition to concerns about possible exposures to IR at the nuclear weapons facilities themselves, concerns have been expressed about health risks due to releases of radioactive materials into the air and water, especially from Hanford.

Dose information for service personnel stationed at or near Hanford and other nuclear weapons facilities generally has been unavailable. The Final Report of a CDC-sponsored project to estimate some types of radiation doses at Hanford was released in November 2002.

No epidemiological studies specifically of veterans stationed at Hanford or other nuclear facilities are available.

Except for veterans who participated in VA-defined “radiation-risk activities” ([Section 6](#)), veterans who served at nuclear weapons facilities are not eligible for the VA Ionizing Radiation Registry (IRR) Examination Program available to veterans who participated in the occupation of Hiroshima or Nagasaki or atmospheric nuclear weapons tests. [However, they could be offered evaluations comparable to Ionizing Radiation Registry Examinations if they have other eligibility and are enrolled for VA care.]





## Veterans Exposed to Nasopharyngeal (NP) Radium Irradiation

During the 1920s, a new technique was developed to treat hearing loss due to repeated ear infections. This therapy called nasopharyngeal (NP) radium irradiation involved inserting radium-tipped applicators through the nostrils to the nasopharynx and leaving them in place close to the adenoids for about 5 to 12 minutes. The radiation shrank these lymphoid tissues that are adjacent to the openings of the Eustachian tubes thus relieving any obstructions.

The treatments also were used to treat sinusitis, tonsillitis, asthma, bronchitis, and repeated viral and bacterial infections. Treatments usually were performed on both sides and frequently were administered 3 times at 2-week intervals. An estimated 500,000 to 2 million civilians, mostly children, are estimated to have received these treatments.

During World War II and until about 1960, NP radium treatments were used to treat aerotitis media (barotrauma) in military personnel. Thousands of aircrew members, submariners, and divers were treated. Development of pressurized aircraft cabins and new treatments such as better antibiotics as well as concerns about radiation safety resulted in the discontinuation of NP radium irradiation.

The radiation doses from NP radium irradiation treatments were very dependent on the distance from the radium source and the amount of time of the radiation exposure. The following doses for an adult were estimated for a series of 3 treatments to each side of 8 minutes each using a 50-mgm radium source:

Tissue within a few centimeters of radium source - hundreds of rads; brain - 3 rads (range 0.7-16 rads); pituitary - 16 rads; salivary gland - 8.5 rads (range 3-17 rads); thyroid gland - 1.4 rads (source: M. Stoval, Nasopharyngeal brachytherapy for lymphoid hyperplasia: Review of dosimetry, Otolaryngology-Head and Neck Surgery, November 1996, page 397).

### **Possible adverse health effects of NP radium irradiation**

One major study found an increased risk of head and neck cancer in people who were treated when they were children. Another study, also mostly of individuals treated as children, did not find any statistically significant increases in head and neck cancers.

A study by the VA's Environmental Epidemiology Service of submariners given NP radium treatments found statistically significant increased mortality risk for all causes and circulatory diseases. An increased mortality risk of head and neck cancer also was noted but was not statistically significant. See summary of journal article ([Appendix 13](#)).

### **Clinical recommendations from workshop on NP radium irradiation**

A workshop on public health issues associated with NP radium treatments was held at Yale University in 1995. No screening tests for asymptomatic individuals who had been treated with NP radium irradiation were recommended.

### **VA programs for veterans treated with NP radium irradiation in service**

(see information in [Appendix 1](#), Fact Sheet in [Appendix 4a](#) and VHA Directive in [Appendix 4b](#)).

Eligibility to participate in the VA Ionizing Radiation Registry (IRR) Examination program regardless of their enrollment status. Examination by an ENT specialist and additional studies, such as biopsies will be performed if clinically indicated.

Eligibility for treatment of any head or neck cancer which may be associated with NP radium irradiation treatments without co-payments, regardless of their enrollment priority group or enrollment status.



## Veterans Exposed to Depleted Uranium (DU)

Depleted uranium (DU) is a by-product of the process to enrich uranium for use in nuclear power plants and nuclear weapons. DU is about half as radioactive as natural uranium (i.e., DU has about half the number of disintegrations per second per gram).

Components of Naturally Occurring Uranium (Table 4) (Army Environmental Policy Institute. Health and Environmental Consequences of Depleted Uranium Use in the U.S. Army. Technical Report. 1995).

**Table 4**

<b>Components of Naturally Occurring Uranium</b>				
<b>Isotope</b>	<b>Weight Percentage*</b>	<b>Radioactivity (μCi/g)</b>	<b>Contribution to Radioactivity of Uranium</b>	<b>Half-Life (years)**</b>
Uranium-234 ( <sup>234</sup> U)	0.0058%	6200.0	50.4%	2.47 x 10 <sup>5</sup>
Uranium-235 ( <sup>235</sup> U)	0.71%	2.2	2.3%	7.1 x 10 <sup>8</sup>
Uranium-238 ( <sup>238</sup> U)	99.28%	0.33	47.3%	4.5 x 10 <sup>9</sup>

\*Exact weight percentages of uranium found in nature vary slightly with the source.

\*\*Half-life is the time required for 50 percent of an unstable material to decay.

Values shown in Table 4 were reported by Eisenbud. (Eisenbud, M. 1987. Environmental Radioactivity From Natural, Industrial and Military Use. Academic Press, Inc. Orlando, Fla.)

DU is primarily a hazard only if internalized due to its alpha particle emissions which are high energy but poorly penetrating. The toxicity of DU is related more to the chemical properties of uranium as a heavy metal than its radioactivity.

Because of DU's high density and other properties, it is used by the military forces in armor to protect tanks and in munitions to enhance penetration and destructive effects. During the first Gulf War (GW) in 1991, DU-containing weapons were used on a very large scale for the first time and

were utilized only by the U.S. and British forces. U.S. service personnel potentially exposed to DU include “friendly fire” casualties with retained fragments or wound contamination, those who entered vehicles that had been damaged by DU munitions, individuals who cleaned or salvaged DU-damaged vehicles, and personnel who inhaled smoke or dust containing DU particles.

DoD has estimated that external exposure to DU by service personnel in the GW would have been unlikely to exceed the applicable Nuclear Regulatory Commission (NRC) occupational dose limits.

The highest internal radiation dose (annual committed effective dose equivalent) found in veterans who were tested by whole-body counting as part of the DU Follow-up Program at the Baltimore VA Medical Center was slightly over the NRC’s annual allowance for the general public of 0.1 rem per year.

## Health effects of DU

Since DU was not used in weapons prior to the GW and since DU exposure in the GW was different in various ways from other forms of exposure to uranium (e.g., in uranium miners and millers), relatively little is known about DU’s long-term health effects. Therefore, a DU Follow-up Program was established in 1993 at the Baltimore VA Medical Center to provide clinical surveillance to veterans and active-duty personnel who had significant exposure to DU (primarily those with retained DU fragments).

Significant findings of the Baltimore DU program include the following:

- Elevated uranium excretion in the urine (primarily in those with retained DU fragments) but no evidence of renal damage or impairment of renal function.
- Urinary uranium excretion appears to be a more sensitive screening test than external body/whole-body counting for significant DU exposure.
- Uranium was present in the semen of several veterans with elevated urine uranium levels. These are preliminary findings that need further exploration.
- There is no evidence of birth defects in the over 60 children born to the veterans in the study.
- Some in-vitro findings suggestive of genotoxicity.
- No clinically significant effect on immune parameters.

See [Appendix 14a](#), [14b](#), and [14c](#) for summaries of papers by McDiarmid et al. See [Appendix 15](#) for Fact Sheets from the Baltimore VAMC which provide additional information about DU.

The Baltimore VA Medical Center DU Program also is providing direction to an expanded DU screening program (see next page). Elevated urine uranium values were found to be unlikely in the absence of retained DU metal fragments. It was felt that there was little likelihood that those with

normal urine uranium levels when tested would develop any uranium-related toxicity. A committee of the Institute of Medicine (IOM), National Academy of Sciences, reviewed the possible effects of DU exposure. It concluded that there was limited/suggested evidence of **no** association between exposure to uranium at a cumulative internal dose level lower than 20 rem or 25 rads and lung cancer. Also, the committee found limited/suggested evidence of **no** association between exposure to uranium and clinically significant renal dysfunction. The IOM committee found that there was inadequate/insufficient evidence to determine whether or not associations existed between uranium exposure and a number of other cancers and diseases.

### **Special VA programs for DU-exposed veterans**

Veterans exposed to DU in the GW are eligible to participate in the VA's Gulf War Registry Examination program, which includes DU screening (see below). GW veterans also have special eligibility (Priority Level 6) to enroll in VA health care for treatment of conditions possibly related to service in the Persian Gulf.\*

#### **DU Screening Program for GW Veterans including Operation Iraqi Freedom (OIF) Veterans**

In 1998, the VA and DoD established a screening program for GW veterans whom DoD has identified as potentially having significant opportunity for DU exposure and other GW veterans who are concerned about possible DU exposure. See **Appendix 3** for a copy of VHA Handbook 1303.1 Evaluation Protocol for Gulf War Veterans with Potential Exposure to Depleted Uranium (DU).

#### **DOD has classified exposures to DU in the first GW into 3 levels:**

- **Level I** includes service personnel in or on a vehicle at the time it was penetrated by DU munitions and rescuers who entered U.S. vehicles immediately afterwards. DoD estimates that less than 200 U.S. personnel are in Level I.
- **Level II** includes personnel who worked with DU-contaminated vehicles or other systems (including members of the 144th Service and Supply Company of the NJ National Guard) or were involved in the clean-up after a fire in Camp Doha's North Compound. DoD estimates that there were about 800 U.S. personnel in Level II.
- **Level III** includes personnel exposed to smoke containing DU or who entered DU-contaminated vehicles. DoD estimates that Level III includes at least hundreds of U.S. personnel who were exposed to smoke at Camp Doha.

[Other personnel not in one of these three categories presumably were at less risk for significant DU exposure.]

\* Discontinuation of this special eligibility currently is under consideration.

The screening program includes:

- a GW registry examination (if not already performed),
- a detailed questionnaire about possible DU exposures in the GW, and
- a 24 hour urine collection for uranium determination.

**Screening Program for Veterans Potentially Exposed to DU Outside the Gulf Region**

Recently the VA extended DU screening to include veterans who are concerned about the potential exposure outside the Gulf region. The evaluation is provided either by a primary care or Environmental Health Clinician. The screening program includes:

- DU exposure questionnaire and detailed exposure history
- 24 hour urine collection for uranium determination

See **Appendix 17** for a copy of VHA Handbook 1303.4 Evaluation Protocol for Non-Gulf War Veterans with Potential Exposure to Depleted Uranium (DU).

The Baltimore DU Follow-up Program provides guidance to other facilities regarding DU issues and is coordinating urine uranium testing and interpretation. Isotopic uranium analysis may be able to separate those with excretion of high levels of natural uranium (e.g., from living in an area with high uranium concentrations in the soil and water) from those exposed to DU.

**DU Follow-up Program** - As noted above, a DU Follow-up Program has been established at the Baltimore VA Medical Center. Initially about 35 veterans mostly with retained DU fragments were invited to participate in this clinical surveillance program.

Recently additional GW veterans who were felt to have similar opportunities for significant DU exposure have been added and a total of 70 individuals were evaluated as inpatients at the Baltimore VAMC as of the 2001 evaluation. It is expected that the VA will offer long-term follow-up surveillance to individuals with significant amounts of internalized DU.





## Concerns About Early Radiation-Related Research

In 1993, the former Secretary of the Department of Energy, Hazel O'Leary, disclosed that some early radiation experiments may not have conformed to current policies and procedures for written informed consent and protection of human subjects.

Subsequently a cabinet level Interagency Work Group (IWG) and a presidential Advisory Committee on Human Radiation Experiments (ACHRE) were established to investigate these issues further and consider corrective action.

Many veterans and family members were concerned about these disclosures and the VA received over 1,700 radiation inquiries. The former VA Secretary, Jesse Brown, stated strongly that the VA would carry out any necessary actions to protect VA patients who had participated in such experiments and the VA cooperated with efforts of the IWG and ACHRE.

Directives were issued to obtain information about early VA human research projects involving radiation, radioisotopes, and radiation therapy performed between 1947 (when the first VA radioisotope programs were established) until 1980 (when policies regarding informed consent and protection of human subjects were firmly in place).

Attention was focused on early VA projects for which at least some names of research subjects were known since these would be the ones for which follow-up actions to benefit veterans or their families might be possible. Based on the responses from VA medical centers (VAMCs) to the survey questionnaire and other information, 53 projects at 17 VAMCs were reviewed by an expert committee including specialists in nuclear medicine, health physics/radiation safety, radiation oncology, and radiation dosimetry.

Analysis of this group of early VA experiments suggests that there was no widespread exposure of veterans to excessive doses of ionizing radiation. Almost all the research was conducted exclusively for medical purposes to improve diagnosis or treatment of diseases and primarily involved tracer amounts of radiation. Of the early VA research programs reviewed, only one project (to study strontium which is present in nuclear fallout) appears to have been done primarily for military purposes.

Most of the radiation hotline and similar inquiries received by the VA were related to ionizing radiation exposure during military service. Inquiries that

were related to possible radiation research or treatment at VAMCs were referred to the appropriate VA facilities for investigation and response. Most such inquiries were found to involve standard diagnostic or treatment procedures, not research using radiation or any other experimental studies.

Some early VA records referred to a “confidential” Atomic Medicine Division. Reviews indicated that such a division was discussed as a means to deal with issues such as adjudication of radiation related compensation claims but was never activated. The VA did establish an office to oversee development of Nuclear Medicine programs and the VA played a leadership role in creating this medical specialty.

The ACHRE reviewed selected VA and other research projects and did not recommend any medical notification or follow-up programs for research subjects or their descendants.

See [Appendix 7](#) for summary of pertinent sections of the ACHRE final report.

The VA is continuing to receive a limited number of additional inquiries about radiation “experiments” or other exposures at its facilities and these are referred to the appropriate medical center for investigation and response.



## Other Veterans Who May Have Been Exposed to Ionizing Radiation in Service

Other veterans also may have been exposed to IR during military service (e.g., personnel in the Navy who served on nuclear submarines and other nuclear ships and shipyards, personnel who were involved with nuclear weapons handling and maintenance, personnel involved in clean-ups after accidents involving nuclear weapons, military medical personnel, etc.).

Radiation doses are sometimes not available. In general, most recorded or estimated doses for “occupationally exposed” personnel have not exceeded the relevant exposure limits then in effect.

Other personnel may have been exposed as a result of diagnostic X-rays or radiation therapy during military service.

A study of U.S. nuclear submariners found a mortality rate for leukemia that was equivalent to that of U.S. males. Mortality rates for other malignant neoplasms also were not significantly elevated.

Currently there are no special programs or special eligibility for enrollment for VA care for such veterans. They currently are not eligible for the VA’s Ionizing Radiation Registry Examination program [but could be offered comparable evaluations if they are enrolled in VA care]. See [Appendix 1](#) for more information.





## Possible Future Exposure of Veterans to Ionizing Radiation

At the request of the U.S. Army, the Medical Follow-up Agency of the National Academy of Sciences provided recommendations on radiation protection and safety of military personnel. Issues addressed included consideration of long-term health effects, consideration of the risks and benefits of the contemplated military action and competing risks to justify exposure, minimize dose, in peacetime and non-emergency situations provide the same level of protection accorded civilians, communicate risk, provide individual dosimeters, and maintain records of exposure.

See [Appendix 19a](#) for information regarding possible use of IR as a terrorist weapon.





## Exposure of Veterans to Non-Ionizing Radiation

Veterans are also concerned about exposure to non-ionizing radiation (NIR) including radar and other forms of microwaves.

Personal devices to measure individual exposure to NIR generally are not available, unlike the case with IR and film badges and TLDs.

A study of Navy personnel from the Korean War period published in 1980 did not identify adverse health effects that could be attributed to microwave/radar exposure. A follow-up study found that radar exposure had little effect on mortality.

An Air Force study found a small association between exposure to ELF and RF/microwave EMF and brain tumor risk.







# Adjudication of Veterans Ionizing Radiation Claims

Atomic Veterans and veterans who participated in other “radiation-risk” activities as defined by the VA (see [Section 6](#) and [Appendix 1](#) of this Independent Study) may qualify for compensation payments for diseases possibly due to IR under two programs.

## **Presumptive Program**

If an Atomic Veteran or a veteran who participated in another “radiation-risk” activity develops one of the diseases shown below and meets other requirements, the condition is presumed to be related to exposure to IR in service.

## **Presumptive List**

- All forms of leukemia except chronic lymphocytic leukemia
- Cancer of the thyroid
- Cancer of the breast
- Cancer of the pharynx
- Cancer of the esophagus
- Cancer of the stomach
- Cancer of the small intestine
- Cancer of the pancreas
- Cancer of the bile ducts
- Cancer of the gall bladder
- Cancer of the salivary gland
- Cancer of the urinary tract (kidneys, renal pelvis, ureter, urinary bladder, and urethra)
- Bronchioloalveolar cancer (a rare form of lung cancer)
- Cancer of the bone
- Cancer of the brain
- Cancer of the colon
- Cancer of the lung
- Cancer of the ovary
- Lymphomas (except Hodgkin’s disease)
- Multiple myeloma
- Primary liver cancer

For “presumptive” cases involving Atomic Veterans, the Defense Threat Reduction Agency (DTRA) of the Department of Defense (formerly the

Defense Special Weapons Agency (DSWA) and the Defense Nuclear Agency (DNA)) is responsible for demonstrating from record sources that the veteran participated in the occupation of Hiroshima or Nagasaki, or in an atmospheric nuclear weapons test.

## Non-presumptive Program

If an Atomic Veteran or a veteran who participated in another “radiation-risk” activity develops one of the diseases shown below and meets other requirements, compensation may be provided according to VA regulations. This list of diseases and other requirements are established by the Secretary of Veterans Affairs rather than being established by law/statute.

## Non-presumptive List

- All cancers
- Posterior subcapsular cataracts
- Non-malignant thyroid nodular disease
- Parathyroid adenoma
- Tumors of the brain and central nervous system

**Note: VA also will consider evidence that diseases other than those specified in regulation may be caused by radiation exposure.**

For adjudicating claims under the non-presumptive process, the following factors are considered:

1. The probable dose, in terms of dose type, rate, and duration as a factor in inducing the disease, taking into account any known limitations in the dosimetry devices employed in its measurement or the methodologies employed in its estimation;
2. The relative sensitivity of the involved tissue to induction, by ionizing radiation, of the specific pathology;
3. The veteran’s gender and pertinent family history;
4. The veteran’s age at time of exposure;
5. The time-lapse between exposure and onset of the disease; and
6. The extent to which exposure to radiation, or other carcinogens, outside of service may have contributed to development of the disease. (Reference: Title 38 CFR, section 3.311).

For non-presumptive cases involving Atomic Veterans, the DTRA is responsible for documenting the Atomic Veteran’s participation as above and for providing a radiation dose estimate. A 2003 National Research Council report raised questions about the accuracy of some DTRA dose reconstructions. The DTRA is taking corrective actions to address these concerns. Atomic Veterans who have questions about their IR doses may call the DTRA toll-free at **1-800-462-3683**.

Various sources of information are used to determine if it is likely that the veteran’s disease should be attributed to exposure to IR in service.

The VA and the Department of Health and Human Services (HHS) cooperatively sponsored a project to update and expand the 1985 radioepidemiological tables in the form of a computer software program designated as the Interactive Radio Epidemiological Program (IREP) to assist in adjudication of IR claims. A slight modification is being used by the National Institute for Occupational Safety and Health (NIOSH) to evaluate claims from nuclear energy workers which VA also is using. The NIOSH software currently is available on the Internet at the following address [http://198.144.166.6/irep\\_niosh](http://198.144.166.6/irep_niosh).

Except those who participated in "radiation risk" activities other veterans exposed to IR in service (e.g., those stationed at nuclear weapons facilities, nuclear submariners, individuals treated with NP radium in service, military medical personnel, etc.) are not eligible for the "presumptions" so their claims are adjudicated under the non-presumptive provisions. Doses of IR for these veterans may be sought in the veteran's service records (e.g., DD 1141 forms), service medical records (e.g., information about NP radium treatments), radiation dosimetry offices of the various military services, Department of Energy (for veterans stationed at nuclear weapons facilities), etc. See [Appendix 5](#) for points of contact for dose information.

Veterans may also submit claims with appropriate medical or scientific justification that diseases other than those on the VA's presumptive and non-presumptive lists were caused by radiation. Such claims will be reviewed with consideration of doses and other factors.

According to VA regulations, a veteran who disagrees with the dose estimate provided by the Department of Defense can obtain at his or her expense an independent estimate from a credible source. If the independent dose estimate furnished by the claimant's expert is at least double the government estimate, the case may be referred to an independent expert for preparation of a separate radiation dose.

Veterans who have questions about or wish to file a compensation claim may call the VA Regional Office for their area toll-free at **1-800-827-1000**.

Some veterans also may be eligible for compensation under the Radiation Exposure Compensation Act (RECA). The RECA is administered by the Department of Justice. Inquiries may be addressed to:

**Gerald Fischer**  
Assistant Director, Radiation Exposure Compensation Program  
U.S. Department of Justice  
Ben Franklin Station  
P.O. Box 146  
Washington, D.C. 20044-0146  
Telephone **1-800-729-7327**





# Radiation Safety in VA Medical Centers

by Mr. Lynn McGuire

The Nuclear Regulatory Commission (NRC) requires that a VA medical center possess a permit for use of radioactive materials, and inspections are performed periodically to assure that the material is being used safely. Other federal agencies, such as the Occupational Safety and Health Administration, Environmental Protection Agency, and the Food and Drug Administration, have additional regulatory authority over some phases of use of radioactive materials, research uses of radiopharmaceuticals and x-ray machines.

The day-to-day use of radiation sources in the medical center is monitored by local safety committees composed of individuals knowledgeable in the safe use of radiation. These committees require that regulations established by national and international radiation standard-setting groups are adhered to. In addition, a radiation safety officer is appointed as the delegated authority of the committees to assure radiation safety. National oversight of radiation safety in the Veterans Health Administration (VHA) is performed by the National Radiation Safety Committee (NRSC) through the authority of the master materials license granted by the NRC. The NRSC is composed of VHA senior officials and representatives from field facilities.





## Research in VA Facilities Involving Radiation

A complex system of regulations and committees is mandated by the VA, Food and Drug Administration, Nuclear Regulatory Commission, and other agencies to oversee VA research involving ionizing radiation.

Depending on the type of proposed radiation-related research, approval may be required from the following committees:

- Research and Development Committee
- Radiation Safety Committee
- Institutional Review Board or Subcommittee on Human Subjects
- Radioactive Drug Research Committee
- Subcommittee on Research Safety

If animal research is to be included:

- Institutional Animal Care and Use Committee or Subcommittee on Animal Studies







## VA Medical Emergency Radiological Response Team (MERRT)

The VA MERRT is intended to assist in responding to various types of radiological emergencies. Its roles include providing technical advice, radiological monitoring, and medical care and decontamination expertise. Membership includes physicians with specialties in nuclear medicine and radiology, radiation safety officers, and nuclear medicine technologists (see [Appendix 18](#)).





## Possible Use of Ionizing Radiation as a Terrorist Weapon

Following the tragic events of September 11, 2001, there has been increased concern about the possible use of IR as a terrorist weapon, including the possibility that terrorists might use “radiation dispersal devices” (RDDs) or “dirty bombs”, i.e., using conventional explosives to disperse radioactive materials.

See [Appendix 19a](#) for information on diagnosis, confirmation, decontamination, and treatment of radiation casualties, and about acute radiation syndromes.

See [Appendix 19b](#) for listings of some sources of assistance and key references and tools.

Also, the VA in collaboration with the Uniformed Services University of the Health Sciences (USUHS) has developed an educational module entitled “Medical Responses to the Consequences of Terrorist Acts Involving Radiation”.

Copies of the video tape of the satellite broadcast are available in every VA Medical Center library. Print and web-based versions of this educational module are expected to be available by August 2004.





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# 1

## Appendix 1:

# VA Radiation Programs Information for VHA Environmental Health Clinicians/Coordinators



## OFFICE OF PUBLIC HEALTH AND ENVIRONMENTAL HAZARDS (13)

VHA, Washington, DC 20420

April 15, 2003

### **VA RADIATION PROGRAMS INFORMATION for Veterans Health Administration (VHA) Environmental Health Clinicians/Coordinators**

The Department of Veterans Affairs (VA) provides an array of services and benefits to certain veterans who were exposed to radiation while on active duty. To qualify for these, veterans who are exposed to radiation must meet very precise criteria that are based on Federal law or regulations.

Note: Refer to [Attachment C](#) for a table summarizing Special Eligibility Based on Radiation Exposure for Atomic Veterans, Other "Radiation Risk Activities," NP Radium-Treated Veterans, and Other Types of Radiation Exposures.

#### 1. ATOMIC VETERANS

This unofficial term includes veterans who:

- Participated in atmospheric nuclear weapons tests;
- Took part in the American occupation of Hiroshima and Nagasaki, Japan (from August 6, 1945 through July 1, 1946); or
- Were POWs in Japan during WWII and thereby had an opportunity for exposure to ionizing radiation comparable to that of U.S. occupation forces in Hiroshima and Nagasaki.

##### (a) **REGISTRY EXAMINATIONS**

Atomic Veterans are eligible to take part in VA's Ionizing Radiation Registry examination program. These veterans do not need to be enrolled for general VA health care to be eligible to participate in the Registry program. Further, veterans are not subject to co-payments for registry examinations.

**(b) HEALTH CARE**

Atomic Veterans who participated in atmospheric nuclear weapons tests; took part in the American occupation of Hiroshima and Nagasaki, Japan (from August 6, 1945 through July 1, 1946) and/or were POWs in Japan during WW II and thereby had an opportunity for exposure to ionizing radiation comparable to that of U.S. occupation forces in Hiroshima and Nagasaki are eligible for hospital care, medical services, and nursing home care for any disease suffered by the veteran that is a disease listed in section 1112(c)(2) of title 38, United States Code or any other disease for which the Secretary, based on the advice of the Advisory Committee on Environmental Hazards, determines that there is credible evidence of a positive association between occurrence of the disease in humans and exposure to ionizing radiation (see diseases listed in **Attachments A & B** of this Appendix).

These veterans are eligible to enroll in VA's health care system in Priority Category (6) based on their radiation-exposure. Accordingly, these veterans are not subject to co-payment requirements for care or services, (including outpatient pharmacy services) furnished to treat a covered disease, (see **Attachments A & B** of this Appendix).

For further information regarding enrollment, VHA Directive 2003-003 describes VA Health Care Enrollment Priority Groups. (see web address: <http://www.va.gov/visns/visn03/vhadir2003003.pdf> \_\_\_\_\_). The enrollment priority groups can be accessed on the Internet at: <http://www.va.gov/elig/Priority%20Groups.htm>

Even if an eligible Atomic Veteran has never filed a compensation claim or if the claim has been denied, that veteran can still receive free health care, as resources permit, for the list of covered diseases

**(c) COMPENSATION**

VA also provides compensation for an Atomic Veteran's disability or death that had been service-connected on either a "presumptive" or "non-presumptive" basis. (See below and **Attachments A & B**)

**2. VETERANS WHO PARTICIPATED IN OTHER "RADIATION-RISK ACTIVITIES"**

To ensure that veterans receive the same consideration as some civilian nuclear energy workers eligible for non-VA compensation programs, the VA expanded its definition of "radiation-risk activities" to include (in addition to Atomic Veterans) some veterans who:

- Served at gaseous diffusion plants in Paducah, Kentucky, Portsmouth, Ohio, and area K25 at Oak Ridge, Tennessee (for a total of at least 250 days before February 1, 1992).
- Served before January 1, 1974, on Amchitka Island, Alaska and were thereby exposed to ionizing radiation in the performance of duty related to certain underground nuclear tests.

**(a) REGISTRY EXAMINATIONS**

Veterans who participated in these additional “radiation-risk activities” are eligible to take part in VA’s Ionizing Radiation Registry examination program. These veterans do not need to be enrolled for general VA health care to be eligible to participate in the Registry program. Further, veterans are not subject to co-payments for registry examinations.

**(b) HEALTH CARE**

These veterans do not have special eligibility for VA health care or enrollment based on their participation in these additional “radiation-risk activities”.

**(c) COMPENSATION**

VA provides compensation for a veteran’s disability or death that had been service-connected to participation to a “radiation-risk activity” on either a “presumptive” or “non-presumptive” basis. (See below and [Attachments A & B](#))

**3. NASOPHARYNGEAL (NP) RADIUM-TREATED VETERANS**

This term includes veterans who received nasopharyngeal (NP) radium therapy while in active military, naval, or air service. More specifically, these treatments were administered to certain:

- Pilots, submariners, and divers to prevent ear damage from pressure changes; and
- Other service members.

**(a) REGISTRY EXAMINATION**

Veterans who received NP radium treatments in service are eligible to take part in VA’s Ionizing Radiation Registry examination program. They do not have to enroll in VA’s health care system to participate in the Registry program. Further, they are not subject to co-payments for the registry examinations.

**(b) HEALTH CARE**

**Cancers of Head and Neck**

These veterans are eligible for hospital care, medical services, and nursing home care needed to treat any cancer of the head or neck which VA finds may be associated with the veteran’s receipt of NP radium treatments while in active service. No co-payments apply to such care and services. Further, NP veterans do not have to enroll in VA’s health care system to

receive such care and services. These veterans are not eligible to be enrolled in Priority Category (6) on the basis of their NP radium exposure.

**Other Health Conditions**

To receive health care for conditions other than the cancers described above, these veterans must enroll in VA's health care system, similar to any other veteran. Whether they are subject to co-payment requirements for VA care and services will depend on their particular eligibility and enrollment status.

**Note:** To be eligible for such care, there must be evidence of receipt of NP radium treatments in the veteran's service records. This documentation requirement does not apply, however, to those who served as aviators in the active military, naval, or air service before the end of the Korean conflict or who underwent submarine training in active naval service before January 1, 1965. See separate VA Fact Sheet on Nasopharyngeal Radium Therapy available on Internet  
<http://www.va.gov/pressrel/99nasrad.htm>  
for more detailed information.

Even if an eligible NP veteran has never filed a compensation claim or if the claim has been denied, that veteran can still receive free health care, as resources permit, for treatment of head and neck cancers.

**(c) COMPENSATION**

VA also provides compensation for NP veteran's disability or death related to NP radium therapy that has been service-connected on a "non-presumptive" basis. (See below and [Attachment B.](#))

**4. OTHER VETERANS EXPOSED TO IONIZING RADIATION INCLUDING "OCCUPATIONAL" EXPOSURES**

This includes veterans who:

- Served in the nuclear Navy;
- Maintained nuclear weapons;
- Served as X-ray or dental technicians during military service;
- Participated in clean-ups after accidents involving nuclear weapons;
- Received X-ray therapy during military service; or
- Etc.

**(a) REGISTRY EXAMINATIONS**

These veterans are not eligible to take part in VA's Ionizing Radiation Registry (IRR) examination program. However, they can be offered comparable examinations if they have other eligibility, i.e., are enrolled for VA care. The results of their examinations would not be entered into the IRR database.

**(b) HEALTH CARE**

These veterans do not have any special eligibility for VA health care or enrollment based on exposure to ionizing radiation in these types of situations.

**(c) COMPENSATION**

These veterans are eligible for compensation for disability or death related to radiation exposure that has been service-connected on a “non-presumptive” basis (see below and **Attachment B**).

**5. OTHER INFORMATION**

**(a) RADIATION STATISTICS**

- (1) About 195,000 service members participated in the post-World War II occupation of Hiroshima and Nagasaki, Japan, or were prisoners of war in Japan. Over 95 percent of them received doses below 0.1 rem, a standard measurement of radiation exposure. Only those Nagasaki occupation forces that regularly entered the Nishiyama area had the potential to receive doses up to 1 rem.
- (2) In addition, approximately 210,000 service members took part in atmospheric nuclear tests between 1945 and 1962 in the United States, the Pacific and the Atlantic. Less than 1 percent of them received external doses greater than 5 rem per year, the current federal occupational radiation dose limit. The average external radiation dose received by participants was about 0.6 rem.
- (3) The Defense Threat Reduction Agency’s Nuclear Test Personnel Review program has maintained a database of participants in U.S. atmospheric nuclear test activities since 1978.

**(b) DETERMINATION OF SERVICE-CONNECTION**

- (1) Presumptive Basis for Service-Connection.** Atomic Veterans and veterans who participated in other “radiation-risk activities” as defined above and their survivors are eligible for a presumption of service-connection for cancers specified at 38 U.S.C. § 1112(c)(2) or 38 C.F.R. § 3.309(d)(2), as shown on **Attachment A**.

The 21 types of cancer for which a presumption of service connection exists are: all forms of leukemia except chronic lymphocytic leukemia; cancer of the thyroid, bone, brain, breast, colon, lung, ovary, pharynx, esophagus, stomach, small intestine, pancreas, bile ducts, gall bladder, salivary gland, and urinary tract (kidneys, renal pelvis, ureter, urinary bladder, and urethra); lymphomas (except Hodgkin’s disease); multiple myeloma; primary liver cancer; and bronchio-alveolar carcinoma (a rare lung cancer).

**(2) Non-presumptive Service-Connection.** When a claim is filed for disability or death due to a disease other than the 21 cancers listed above and is claimed to be related to exposure to ionizing radiation while in the active military, naval, or air service and/or the veteran is not eligible for presumptive compensation, the claim must be evaluated to determine whether the disability or death can be service connected on a direct rather than presumptive basis. VA regulations provide that, in order to determine whether the disability or death is service-connected, additional factors must be considered, including amount of radiation exposure, duration of exposure, and elapsed time between exposure and onset of disease.

For purposes of direct service-connection for disability or death allegedly due to exposure to ionizing radiation, VA regulations define the term “radiogenic disease” to include all cancers as well as posterior subcapsular cataracts; non-malignant thyroid nodular disease; parathyroid adenoma; and tumors of the brain and central nervous system, as shown in **Attachment B**.

**(c) CLAIMS FOR SERVICE-CONNECTION FOR DISEASES NOT ON THE VA’S “PRESUMPTIVE” OR “NON-PRESUMPTIVE” LISTS**

Veterans exposed to ionizing radiation also may submit claims with appropriate medical or scientific justification that diseases other than those on the VA’s “presumptive” or “non-presumptive” lists were caused by radiation.

Such claims are adjudicated with consideration of dose and other factors as with claims for conditions on the “non-presumptive” list.

**(d) SUBMISSION OF COMPENSATION CLAIMS**

Claims for VA compensation may be filed at a VA regional office or online at <http://www.va.gov>. Veterans or their survivors can reach a regional office by calling 1-800-827-1000. The Department of Defense maintains a toll-free helpline, 1-800-462-3683, to provide veterans with information about their test participation.

**Rates of Disability Compensation**

Monthly rates of compensation are set by Congress, depend upon the degree of disability and number of dependents, and follow a payment schedule that applies to all veterans. Current rates are listed in VA’s handbook, “Federal Benefits for Veterans and Dependents.” The rate tables are also available on the Web by following the compensation link at <http://www.va.gov/>

For deaths in 1993 and after, compensation to survivors is paid at a flat rate regardless of the deceased veteran's rank in the military. An additional amount may be paid if the veteran had been rated 100-percent disabled for service-connected disabilities for at least eight years before death and had been married to the surviving spouse during the same period. Additional amounts also may be paid to the surviving spouse for dependent minor children.

**(e) IONIZING RADIATION REGISTRY PROGRAM STATISTICS**

As of March 2003 VA records show 22,890 veterans had received VA's Ionizing Radiation Registry examinations. For questions, please contact the Office of Health and Environmental Hazards at (202) 273-8575.

## **ATTACHMENT A**

### **PRESUMPTIVE SERVICE CONNECTION:**

Bronchio-alveolar carcinoma (a rare lung cancer)  
Cancer of the bile ducts  
Cancer of the bone  
Cancer of the brain  
Cancer of the breast  
Cancer of the colon  
Cancer of the esophagus  
Cancer of the gall bladder  
Cancer of the small intestine  
All forms of leukemia except chronic lymphocytic leukemia  
Primary liver cancer  
Cancer of the lung  
Lymphomas (except Hodgkin's disease)  
Multiple myeloma  
Cancer of the ovary  
Cancer of the pancreas  
Cancer of the pharynx  
Cancer of the salivary gland  
Cancer of the stomach  
Cancer of the thyroid  
Cancer of the urinary tract (kidneys, renal pelvis, ureter, urinary bladder, and urethra)

## ATTACHMENT B

### “RADIOGENIC DISEASES” FOR PURPOSES OF NON-PRESUMPTIVE SERVICE-CONNECTION:

All cancers  
 Posterior subcapsular cataracts  
 Non-malignant thyroid nodular disease  
 Parathyroid adenoma  
 Tumors of the brain and central nervous system

## ATTACHMENT C

<b>Special Eligibility Based on Radiation Exposure for:</b>					
Categories	Ionizing Radiation Examination	Priority 6 Enrollment Without Co-Payment	Treatment Cancer of Head & Neck Without Co-Payment	Presumptive Compensation	Non-Presumptive Compensation
Atomic Veterans	YES	YES	(INCLUDED IN PRIORITY 6 ENROLLMENT)	YES	YES
Other “Radiation Risk Activities”	YES	NO	NO	YES	YES
NP Radium-Treated Veterans	YES	NO	YES	NO	YES
Other Types of Radiation Exposures	NO*	NO	NO	NO	YES

\*—BUT COULD BE OFFERED COMPARABLE EXAMINATION IF ENROLLED FOR VA CARE.



# 2

## Appendix 2: Ionizing Radiation Examination Program



(See VHA Policy and Procedure Handbook 1301.1 )

To assure that the Department of Veterans Affairs (VA) could respond to veterans' concerns regarding possible health effects of exposure to low levels of ionizing radiation, on October 28, 1986, Congress enacted Public Law 99-576, "Veterans Benefits Improvement and Health Care Authorization Act of 1986," requiring the Secretary of the Department of Veterans Affairs (VA) to establish and maintain an Ionizing Radiation Registry (IRR) of veterans exposed to radiation under conditions described in Title 38 United States Code (U.S.C.) §1710(e)(1)(B). The IRR is an automated integrated system of records containing demographic and medical data from registry examinations of veterans exposed to a radiation-risk activity under the following conditions:

- (1) On site participation in a test involving the atmospheric detonation of a nuclear device, whether or not the testing nation was the United States.
- (2) Participation in the occupation of Hiroshima or Nagasaki from August 6, 1945, through July 1, 1946.
- (3) Internment as a Prisoner of War (POW) in Japan during World War II which the Secretary of Veteran Affairs, henceforth referred to as the Secretary, determines resulted in an opportunity for exposure to ionizing radiation comparable to that of veterans involved in the occupation of Hiroshima or Nagasaki. **NOTE:** See 38 U.S.C. § 1710(e)(4)(B), referencing 38 U.S.C. § 1112(c)(3).
- (4) Participation in radiation-risk activities at the:
  - (a) Department of Energy gaseous diffusion plants at Paducah, KY, Portsmouth, OH, or K25 area at Oak Ridge, TN, at least 250 days before February 1, 1992.
  - (b) Underground nuclear tests at Amchitka Island, AK, before January 1, 1974.

In addition, Section 901 of Public Law 105-368, "Veterans Programs Enhancement Act," enacted November 11, 1998, codified at 38 U.S.C. § 1720E, states in part, that the Secretary may provide a medical examination, hospital care, medical services, and nursing home care, which the Secretary

determines is needed for the treatment of any cancer of the head or neck which the Secretary finds may be associated with the veteran's receipt of Nasopharyngeal (NP) radium irradiation treatments while in the active duty naval or air service.

VHA Handbook 1301.1 provides clinical and administrative policies for the Ionizing Radiation Program.

This Handbook includes the authority, scope, description of services, eligibility criteria, program management, Environmental Health Clinicians/ Coordinators' responsibilities, examination protocol and other pertinent information that guides the VA staff in the maintenance of this program.

# 3

## Appendix 3:

# New VHA Handbook 1303.1: Evaluation Protocol for Gulf War Veterans with Potential Exposure to Depleted Uranium (DU)



Department of Veterans Affairs  
VHA HANDBOOK 1303.1  
Veterans Health Administration  
Transmittal Sheet  
Washington, DC 20420

April 16, 2003

## **EVALUATION PROTOCOL FOR GULF WAR VETERANS WITH POTENTIAL EXPOSURE TO DEPLETED URANIUM (DU)**

1. **PURPOSE:** This Veterans Health Administration (VHA) Directive outlines the procedures for evaluating Gulf War veterans with possible exposure to depleted uranium (DU).
2. **SUMMARY OF CHANGES:** This issuance, designed to evaluate Gulf War veterans with possible exposure to DU, rescinds VHA Directive 98-032.
3. **RELATED ISSUES:** VHA Directive 1303, and VHA Handbook 1303.2 (to be published).
4. **RESPONSIBLE OFFICE:** The Chief Public Health and Environmental Hazards Officer (13) is responsible for the contents of this directive. Questions about DU should be addressed to the Baltimore DU Follow-up Program at 1-800-815-7533; general questions about the protocol should be addressed to the Environmental Agents Service at (202) 273-8580.
5. **RESCISSIONS:** VHA Directive 98-032, is rescinded.
6. **RECERTIFICATION:** This VHA Handbook is scheduled for recertification on or before the last working day of April 2008.

Nevin M. Weaver for  
Robert H. Roswell, M.D.  
Under Secretary for Health

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## **EVALUATION PROTOCOL FOR GULF WAR VETERANS WITH POTENTIAL EXPOSURE TO DEPLETED URANIUM (DU)**

### **1. PURPOSE**

This Veterans Health Administration (VHA) Directive outlines the policy and procedures for evaluating Gulf War veterans with possible exposure to depleted uranium (DU).

### **2. BACKGROUND**

- a. DU is natural uranium left over after most of the U-235 isotope has been removed, such as that used as fuel in nuclear power plants. It is about half as radioactive as natural uranium and is a radiation hazard primarily if internalized, such as in shrapnel, contaminated wounds, and inhalation. In addition to its radioactivity, DU has some chemical toxicity related to being a heavy metal (similar to lead).
- b. During the Gulf War (beginning in 1990), DU was used by the United States military in projectiles and armor for tanks. Service personnel who may have had potential inhalation exposures to DU include those on, in, or near vehicles hit with "friendly fire," rescuers entering burning vehicles, individuals near fires involving DU munitions, individuals salvaging damaged vehicles, and those near burning vehicles.
- c. The medical effects of DU exposure are continuing to be evaluated. A group of Gulf War veterans with retained DU fragments or DU-contaminated wounds is being followed at a special DU Program at the Department of Veterans Affairs (VA) Medical Center, Baltimore, MD. While no clinically significant adverse effects of DU have been evident to date in this group, some abnormalities have been detected on specialized testing.
- d. The Baltimore DU Follow-up Program has determined that for Gulf War friendly-fire victims, a 24-hour urine determination for uranium is a more sensitive screening test for DU than whole-body counting.
- e. The Austin Automation Center (AAC) functions as the "contractor" to VHA in providing national level computer support for this DU program.

**NOTE:** *For additional background information on DU, see the references in paragraph 6.*

### **3. SCOPE**

Each VHA facility will use the DU protocol examination to evaluate Gulf War veterans identified and referred by the Department of Defense (DOD) or those veterans who self-refer because they are concerned about potential inhalation exposure to DU according to the protocol outlined in paragraph 4.

#### 4. RESPONSIBILITY

The VHA facility Director is responsible for ensuring that the facility VA Gulf War Registry programs provide DU protocol examinations to any eligible Gulf War veteran identified by DOD or any other Gulf War veteran concerned about possible exposure to DU.

- a. The Baltimore DU program staff is responsible for:
  - (1) Arranging for testing of urine samples for uranium.
  - (2) Sending by letter the results of the 24-hour urine for uranium directly to the veteran with a copy to the VA referring clinician.
  - (3) Forwarding the urine uranium results to AAC for entry into the Registry database.
  - (4) Providing consultative advice to VA clinicians regarding DU testing.

#### 5. PROTOCOL

The DU protocol consists of a Gulf War Registry examination, DU exposure questionnaire, and a 24-hour urine collection for creatinine and uranium.

- a. The exposure history contained on VA Form 10-9009D, Depleted Uranium (DU) Questionnaire (see **Att. A**) must be administered to each veteran who is concerned about possible DU exposure.
- b. Any positive responses to the DU questionnaire are to be followed up with more detailed history-taking by the examining health care provider. The full exposure history must be recorded in the veteran's consolidated health record (CHR) and/or the computerized patient record system (CPRS). All free text on the DU questionnaires must be included in the CHR or CPRS, but not in the Registry dataset at AAC. Completed DU questionnaires are to be submitted to AAC on completion of protocol examination.
- c. If the veteran was not identified by DOD as possibly DU-exposed, but information provided during the examination of the veteran suggests that the veteran may have had a significant exposure to DU, or if the veteran has a high level of concern that such an exposure occurred despite counseling by the health care provider, a DU protocol examination needs to be completed.
- d. The health care provider must contact the DU Follow-up Program at the Baltimore VA Medical Center (1-800-815-7533) to discuss obtaining a 24-hour urine collection for uranium.  
**NOTE:** *The 24-hour urine collection for uranium must be performed in accordance with instructions in **Attachment B**.*
- e. Upon completion of the protocol examination, the Gulf War Registry code sheet and the DU exposure questionnaire will be forwarded by the Environmental Health Coordinator (EHC) to AAC for entry of the examination results into the Gulf War Registry database.

- NOTE:** *If the veteran has already had a Gulf War Registry exam, only the DU code sheet will be forwarded to AAC.*
- f. Results of the 24-hour urine for uranium are communicated directly to the veteran by letter from the Baltimore DU Follow-up Program with a copy to the VA referring physician for the veteran's CHR and/or CPRS. The Baltimore DU program staff forwards the urine uranium results to AAC for entry into the Registry database.
  - g. Follow-up actions for any veteran with an elevated 24-hour urine uranium determination will be individualized based on discussion between the veteran's primary VA clinician and the staff at the Baltimore DU Follow-up Program.
  - h. Additional diagnostic evaluation of signs or symptoms identified during the examination are to be completed as clinically indicated. **NOTE:** *Eligible veterans who wish to have VA follow-up care need to be assigned to a primary care team.*

## 6. REFERENCES

- a. Voles, George L., Chapter 13 - "Uranium," in Hazardous Material Toxicology, Eds. Sullivan, John B. and Krieger, Gary R. Williams and Wilkins, Baltimore, MD, 1992.
- b. Health Effects of Depleted Uranium - Fact Sheet, Department of Defense, June 11, 1993. **NOTE:** *Copies can be obtained by calling (703) 697-3189.*
- c. "Agency for Toxic Substances and Disease Registry," U.S. Public Health Service, 1990.
- d. Toxicological Profile for Uranium. PB91-180 471, U.S. Department of Commerce, National Technical Information Service. **NOTE:** *Customer Service is (703) 487-4660.*
- e. McDiarmid, et al. "Health Effects of Depleted Uranium on Exposed Gulf War Veterans" Environmental Research, Section A, Vol. 82, 2000, pages 168-180.
- f. McDiarmid, et al. "Urinary Uranium Concentrations in an Enlarged Gulf War Veterans Cohort," Health Physics, Vol. 80, number 3, 2001, pages 270-273.
- g. McDiarmid, et al. "Surveillance of Depleted Uranium Exposed Gulf War Veterans: Health Effects Observed in an Enlarged "Friendly Fire" Cohort, JOEM, Vol. 4, Number 12, December 2001, pages 991-1000.
- h. VHA website: [www.va.gov/gulfwar](http://www.va.gov/gulfwar)







Appendix 3: New VHA Handbook 1303.1: Evaluation Protocol for Gulf War Veterans with Potential Exposure to Depleted Uranium (DU)

DEPLETED URANIUM QUESTIONNAIRE, Continued										SSN									
<i>Instructions:</i> Choose one of the following codes for Questions 11 through 39, unless other codes are listed or a narrative response is required: Code "Y" = Yes Code "N" = No Code "D" = Don't Know																			
																		(a) BLOCK	(b) CODE
11. WERE YOU A LOGISTICS ASSISTANCE REPRESENTATIVE (LAR) WHO INSPECTED DEPLETED URANIUM CONTAMINATED SYSTEMS TO DETERMINE REPAIRABILITY?																		105	
12. WERE YOU A MEMBER OF A BATTLE DAMAGE ASSESSMENT TEAM (BDAT) WHO EXAMINED U.S. COMBAT VEHICLES KNOWN, OR SUSPECTED TO BE, DAMAGED OR DESTROYED BY DU?																		106	
13. WERE YOU A MEMBER OF THE 144 SERVICE AND SUPPLY COMPANY WHO PROCESSED DAMAGED EQUIPMENT, INCLUDING SOME WITH DU CONTAMINATION?																		107	
14. WERE YOU A MEMBER OF A RADIATION CONTROL (RADCON) TEAM DEPLOYED IN THE PERSIAN GULF?																		108	
15. WERE YOU INVOLVED IN THE EXAMINATION OR RECOVERY OF DAMAGED OR DESTROYED ENEMY VEHICLES?																		109	
16. WERE YOU INVOLVED IN THE DOWNLOADING OF EQUIPMENT OR MUNITIONS FROM VEHICLES KNOWN OR SUSPECTED TO BE CONTAMINATED BY DU?																		110	
17. WERE YOU A MEMBER OF A UNIT MAINTENANCE TEAM PERFORMING MAINTENANCE ON OR IN SYSTEMS KNOWN OR SUSPECTED TO BE CONTAMINATED BY DU?																		111	
18. WERE YOU AT DOHA ON JULY 11, 1991, AT THE TIME OF THE FIRE?																		112	
18a. WERE YOU DIRECTLY INVOLVED IN CLEAN-UP OPERATIONS FOLLOWING THE DOHA EXPLOSION AND FIRE?																		112a	
18b. WERE YOU EXPOSED TO SMOKE FROM BURNING DOHA ROUNDS?																		112b	
19. WERE YOU IN OR ON A VEHICLE HIT BY ENEMY FIRE AT THE TIME IT WAS HIT? IF "NO," SKIP TO QUESTION 20.																		113a	
19a. IF "YES," WHAT TYPE OF A VEHICLE?																			
19a(1) Code "a" = ABRAMS battle tank																		113b	
19a(2) Code "b" = BRADLEY fighting vehicle																		113c	
19a(3) Code "c" = Other (identify) :																		113d	
19a(4) Code "d" = Don't know																		113e	
19b. IF "YES," WAS THE VEHICLE HIT BY DU MUNITIONS?																		113f	
20. DID YOU ENTER AN ABRAMS BATTLE TANK TO PERFORM RESCUE OPERATIONS IMMEDIATELY AFTER IT WAS STRUCK BY ENEMY FIRE?																		114	
21. DID YOU ENTER AN ABRAMS BATTLE TANK TO RETRIEVE SENSITIVE ITEMS IMMEDIATELY AFTER IT WAS STRUCK BY ENEMY FIRE?																		115	
22. DID YOU ENTER A BRADLEY FIGHTING VEHICLE TO PERFORM RESCUE OPERATIONS IMMEDIATELY AFTER IT WAS STRUCK BY ENEMY FIRE?																		116	
23. DID YOU ENTER A BRADLEY FIGHTING VEHICLE TO RETRIEVE SENSITIVE ITEMS IMMEDIATELY AFTER IT WAS STRUCK BY ENEMY FIRE?																		117	



DEPLETED URANIUM QUESTIONNAIRE, Continued		SSN:										(a) BLOCK	(b) CODE
30a(2) Code "b" = Other tracked vehicle (identify below)											124b		
30a(3) Code "c" = Truck											124c		
30a(4) Code "d" = Other wheeled vehicle (identify below)											124d		
30a(5) Code "e" = Other type vehicle (identify below)											124e		
30a(6) Code "f" = Don't know											124f		
31. WERE YOU EXPOSED TO SMOKE FROM ANY ENEMY EQUIPMENT STRUCK BY DU ROUNDS?											125		
32. DID YOU REMOVE EQUIPMENT OR OTHER ITEMS FROM A DAMAGED OR DESTROYED U.S. OR ENEMY VEHICLE? IF "NO," SKIP TO QUESTION 33.											126		
32a If you removed something from a vehicle, please describe it below:											126a		
32b Do you still have equipment or other items removed from a damaged or destroyed U.S. or enemy vehicle?											126b		
33. WERE YOU WITHIN 50 METERS (45.72 YARDS) OF A VEHICLE WHEN IT WAS HIT (NOT INCLUDING VEHICLES YOU WERE IN OR ON THAT WERE HIT)? IF "NO," SKIP TO QUESTION 34.											127		
33a. IF YES, WHAT TYPE OF VEHICLE?													
33a(1) Code a = ABRAMS battle tank											127a		
33a(2) Code b = BRADLEY fighting vehicle											127b		
33a(3) Code c = other (identify below)											127c		
33a(4) Code d = Don't Know											127d		
33b. WAS THE VEHICLE HIT BY DU MUNITIONS?											127e		
34. DID YOU BREATHE SMOKE OR DUST FROM VEHICLES HIT BY ENEMY OR FRIENDLY FIRE? IF "NO," SKIP TO QUESTION 35.											128		
34a. IF "YES," WHAT TYPE OF VEHICLE?													
34a(1) Code "a" = ABRAMS battle tank											128a		
34a(2) Code "b" = BRADLEY fighting vehicle											128b		
34a(3) Code "c" = other (identify below)											128c		
34a(4) Code "d" = Don't Know											128d		
34b. WAS THE VEHICLE HIT BY DU MUNITIONS?											128e		

DEPLETED URANIUM QUESTIONNAIRE, Continued		SSN											(a) BLOCK	(b) CODE
35. DID YOU CLIMB ON OR ENTER VEHICLES HIT BY ENEMY OR FRIENDLY FIRE SOMETIME AFTER THE IMMEDIATE POST-IMPACT RESCUE PERIOD? IF "NO," SKIP TO QUESTION 36.											129			
*Y* = Yes                      *N* = No                      *D* = Don't Know														
35a. IF "YES," WHAT TYPE OF VEHICLE?														
35a(1) Code "a" = ABRAMS battle tank											129a			
35a(2) Code "b" = BRADLEY fighting vehicle											129b			
35a(3) Code "c" = Other (identify below)											129c			
35a(4) Code "d" = Don't Know											129d			
35b. HOW MANY TIMES?														
35b(1) Code "a" = 1 Time											129e			
35b(2) Code "b" = 2 Times											129f			
35b(3) Code "c" = 3- 10 times											129g			
35b(4) Code "d" = More than 10 times											129h			
35b(5) Code "e" = Don't know											129i			
35c. HOW LONG (IN TOTAL) WERE YOU ON BOARD THE VEHICLE(S)?														
35c(1) Code "a" = Less than 5 minutes											129j			
35c(2) Code "b" = 5-15 minutes											129k			
35c(3) Code "c" = 16-30 minutes											129l			
35c(4) Code "d" = More than 30 minutes											129m			
35c(5) Code "e" = Don't know											129n			
35d. WAS THE VEHICLE KNOWN TO BE CONTAMINATED WITH DU?											129o			
36. DID YOU PASS WITHIN 50 METERS (45.72 YARDS) OF A DAMAGED OR DESTROYED VEHICLE? IF "NO," SKIP TO QUESTION 37.    *Y* = Yes                      *N* = No                      *D* = Don't Know											130			
36a. HOW LONG (IN TOTAL) AFTER THE DESTRUCTIVE EVENT?														
36a(1) Code "a" = Less than 12 hours											130a			
36a(2) Code "b" = 12 hours - 24 hours											130b			

DEPLETED URANIUM QUESTIONNAIRE, Continued		SSN									
36a(3). Code "c" = more than 24 hours									130c		
36a(4). Code "d" = Don't know									130d		
36b. IF "YES," WHAT TYPE OF VEHICLE?											
36b(1) Code "a" = ABRAMS battle tank									130e		
36b(2) Code "b" = BRADLEY fighting vehicle									130f		
36b(3) Code "c" = Other (identify below)									130g		
36b(4) Code "d" = Don't Know									130h		
36c. WAS THE VEHICLE BURNING?    "Y" = Yes    "N" = No    "D" = Don't Know									130i		
37. WERE YOU WOUNDED AS A RESULT OF BEING IN, ON, OR WITHIN 50 METERS (45.72 YARDS) OF THE DAMAGED VEHICLE AT THE TIME IT WAS HIT? IF "NO," SKIP TO QUESTION 38.									131		
37a. WHERE YOU WOUNDED?											
37a(1) Code "a" = leg/foot									131a		
37b(2) Code "b" = arm/hand									131b		
37c(3) Code "c" = face/head									131c		
37d(4) Code "d" = neck									131d		
37e(5) Code "e" = body									131e		
37b. DO YOU HAVE RETAINED FRAGMENTS OR SHRAPNEL IN YOUR BODY?									131f		
38. DID YOU FIRE DU ROUNDS?									132		
39. DID YOU HANDLE BARE/DAMAGED DU PENETRATOR ROUNDS? IF "NO," SKIP TO QUESTION 40.									133		
39a. DID YOU HANDLE THE ROUNDS WITH GLOVES?									133a		
39b. DID YOU HANDLE THE ROUNDS WITH SHIELDING?									133b		
<b>OTHER EXPOSURES</b>											
40. DID YOU HAVE EXPOSURE TO DU THAT IS NOT CAPTURED BY THIS QUESTIONNAIRE?									134		
41. IF "YES," DESCRIBE BELOW: _____ _____ _____											

<b>DEPLETED URANIUM QUESTIONNAIRE, Continued</b>		SSN								
41. DO YOU HAVE OTHER EXPOSURES AND EXPERIENCES TO DISCUSS WITH THE PROVIDER? Code "Y" = Yes Code "N" = No IF "YES," DESCRIBE BELOW:										135
<hr/> <hr/> <hr/>										
42. IS THE 24-HOUR URINE COLLECTION FOR URANIUM BEING PERFORMED? Code "Y" =Yes, Code "N" = No or Code "U" =Unknown. IF "NO" OR "UNKNOWN" PROVIDE EXPLANATION BELOW.										136
<hr/> <hr/> <hr/>										
43.										137
44. OTHER COMMENTS:										
<hr/> <hr/> <hr/>										
45. NAME AND TITLE OF EXAMINER/CLINICIAN:										
46. SIGNATURE OF EXAMINER:										
<p><i>Instructions:</i> Once the DU questionnaire has been completed, VAMC EHC will transmit a copy to AAC, with registry code sheet. If the veteran has already had a GW Registry examination, only the DU questionnaire will be sent to AAC. A copy of the questionnaire will also be sent to the DU Follow-up Program at the Baltimore VAMC with the package requesting the urine uranium test. The Baltimore DU Follow-up program staff will transmit the results of the urine uranium test directly to the AAC for database entry and to the VAMC of origin for entry into the veteran's medical record.</p>										
<b>TO BE COMPLETED BY THE BALTIMORE VAMC FU FOLLOW-UP PROGRAM STAFF</b>										
47. CORRECTED URINE URANIUM (EXPRESSED PER MCG PER G CREATININE) 3 DIGITS TO THE LEFT AND 3 DIGITS TO THE RIGHT OF THE DECIMAL.										138-143
REPEAT URINE URANIUM										144- 149
48. REMARKS:										
<hr/> <hr/> <hr/>										





**ATTACHMENT B**

**DEPARTMENT OF VETERANS AFFAIRS (VA) FORM 10-9009F  
DEPLETED URANIUM PROGRAM CHECKLIST  
24-HOUR URINE URANIUM COLLECTION  
BALTIMORE VA MEDICAL CENTER**

**CONSULT URINE INSTRUCTIONS (REVISED 03/04)**

**CALL DU PROGRAM AT 1-800-815-7533**  
**FOR INFORMATION ON ORDERING CURRENT FORM.**

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# 4

## Appendix 4: Nasopharyngeal (NP) Radium Therapy



### Appendix 4a



Department of  
Veterans Affairs

Office of Media Relations

## Fact Sheet

Washington D.C.  
(202) 273-5700  
[www.va.gov](http://www.va.gov)

### **NASOPHARYNGEAL RADIUM THERAPY**

Radium was first used as a medical therapy in 1904. It was used internally and externally to treat a variety of diseases and conditions – from cancer to goiters to scalp ringworm. During the 1920s, a new technique was developed using radium to treat hearing loss in children caused by repeated ear infections (otitis media). This technique was called nasopharyngeal radium therapy.

#### **What was nasopharyngeal radium therapy, who received it and what was its goal?**

A radium-tipped rod was inserted in the nose and left for several minutes. Often, several treatments were provided in a series, each two to three weeks apart. The therapy also was used to treat sinusitis, tonsillitis, asthma, bronchitis, and repeated viral and bacterial infections. Because it was effective in treating otitis media, military physicians used it to treat aerotitis media in submariners, aviators, and divers. Aerotitis media is hearing loss caused by swollen tissue in the throat combined with rapid pressure changes in the middle ear. The treatment was used to shrink tissue in the throat and prevent ear damage from pressure changes. An estimated 500,000 to two million civilians, mostly children, received these treatments. It is estimated that between 8,000 and 20,000 military personnel received them during World War II and until about 1960.

#### **What were the advantages of the treatment?**

It was used on tissues unsuitable for surgery, only local anesthesia was required, and it could be performed in a physician's office. The treatment also was believed to be safer than conventional X-ray treatment.

#### **Why was it discontinued?**

Pressurized aircraft cabins and new treatments, such as better antibiotics, as well as concerns about radiation safety resulted in its discontinuation.

### **Have nasopharyngeal radium treatments been shown to have harmful effects?**

Several studies of the *possible* harmful effects of the treatment have been published. One study found an increased risk of head and neck cancer in people who were treated when they were children. Another study, also mostly of individuals treated as children, did not find any statistically significant increase in head and neck cancers. It is well known that children are more sensitive to the effects of radiation than adults. It is uncertain whether there are any health risks when adults are treated with nasopharyngeal radium. More research is being done, but it will take several years for answers from that research.

### **Are there any recommended actions?**

A workshop of experts was held at Yale University in 1995 to help figure out what needed to be done for people who had received these treatments. The experts concluded that no special action should be recommended. They agreed that there are no screening tests for people who did not have symptoms of head or neck problems. However, physicians may want to consider conducting thorough head and neck examinations of patients with a history of these treatments. In addition, physicians who treat patients born before 1960 who have head and neck complaints should ask them if they have ever had these treatments or other head and neck radiation.

### **What should veterans do?**

Veterans who remember being treated or think they were treated with nasopharyngeal radium should tell their physicians about it. Veterans who have health problems they think may be related to nasopharyngeal radium also are encouraged to contact the nearest VA medical center.

Public Law 105-368 enacted in November 1998 authorizes examinations and treatment of head and neck cancers for veterans who received nasopharyngeal radium treatments during active military, naval, or air service. For veterans not otherwise enrolled in VA health care, documentation of nasopharyngeal radium treatment in service records may be required to be eligible for these services. Veterans who are enrolled in VA health care receive medically indicated diagnostic and treatment services without any need to document exposures.

Information on filing a claim for disability compensation may be obtained by calling the nearest VA regional office at 1-800-827-1000. For questions on nasopharyngeal radium therapy, veterans may call VA's Public Health and Environmental Hazards Office at 1-202-273-8578. Questions on enrolling for VA health care may be directed to VA toll-free at 1-877-222-8387.

## Appendix 4b

Department of Veterans Affairs  
Veterans Health Administration  
Washington, DC 20420

VHA DIRECTIVE 2003-038  
July 18, 2003

### **HEALTH SERVICES FOR VETERANS TREATED WITH NASOPHARYNGEAL (NP) RADIUM DURING ACTIVE MILITARY, NAVAL, OR AIR SERVICE**

#### 1. PURPOSE

This Veterans Health Administration (VHA) Directive outlines the policy and procedures for providing health services to veterans treated with nasopharyngeal (NP) radium irradiation during active military, naval, or air service.

#### 2. BACKGROUND

- a. During the 1920s, a new technique was developed using radium to treat hearing loss caused by repeated ear infections. This technique was called NP radium therapy. Radium-tipped rods were inserted into the nostrils and left in place for several minutes. The treatments frequently were repeated at intervals of several weeks. NP radium treatments were used for other conditions including: sinusitis, tonsillitis, asthma, bronchitis, and repeated viral and bacterial infections. It is estimated that half a million to two million civilians, mostly children, received these treatments.
- b. Because it was effective in treating otitis media, military physicians used NP radium to treat aerotitis media (barotrauma) in submariners, aviators, and divers due to enlarged tissue in the throat combined with rapid pressure changes. It is estimated that between 8,000 and 20,000 military personnel received NP radium treatments during World War II and until the 1960s.
- c. One major study found an increased risk of head and neck cancer in people who were treated when they were children. Another study, also mostly of individuals treated as children, did not find any statistically significant increase in head and neck cancers.
- d. A study by the Department of Veterans Affairs (VA) Environmental Epidemiology Service of submariners given NP radium treatments found statistically significant increased mortality risk for all causes and circulatory diseases. An increased mortality risk of head and neck cancer also was found, but was not statistically significant.

- e. A workshop on public health issues associated with NP radium treatments was held at Yale University in 1995. No screening tests for asymptomatic individuals were recommended.
- f. Public Law 105-368 was enacted authorizing care and services limited to examinations and treatment of head and neck cancers for veterans who had received NP radium treatments during active military, naval, or air service.

### 3. **POLICY**

It is VHA policy that each VHA facility must provide care and services to veterans treated with NP radium during active military, air, or naval service, as authorized by Public Law 105-368.

### 4. **ACTIONS**

Facility Directors must ensure that the following actions are taken with respect to veterans treated with NP radium in service.

#### a. **Determination of Eligibility.**

(1) To be eligible under this authority, a veteran must have:

- (a) Documentation of NP radium treatment in active military, naval, or air service;
- (b) Served as an aviator in the active military, naval, or air service before the end of the Korean conflict; or
- (c) Undergone submarine training in active naval service before January 1, 1965.

(2) Eligible veterans may receive services shown in subparagraphs 4b and 4c whether or not they are enrolled for VA health care.

#### b. **Examinations**

- (1) Veterans with head or neck complaints or who are concerned about possible adverse effects of their NP radium treatments will be offered the opportunity to receive an Ionizing Radiation Registry (IRR) examination (see VHA Handbook 1301.1).
- (2) Examination by an ear, nose, and throat (ENT) specialist and additional studies, such as biopsies, will be performed if clinically indicated.

- c. Treatment of Head or Neck Cancer. Eligible veterans will be offered treatment, including hospital care, medical services, and nursing home care, for any cancer of the head or neck which may be associated with the receipt of NP radium irradiation treatments, regardless of their enrollment priority group or enrollment status. The veteran is exempt from co-payment for such care, including outpatient prescriptions.
- d. Provision of Other Services. Provision of other services to these veterans in addition to examinations and treatment of head or neck cancers will be dependent on their other eligibilities (e.g., whether or not they are enrolled for VA care).

## 5. **REFERENCES**

- a. Dale P. Sandler, George W. Comstock, and Genevieve M. Malanoski, "Neoplasms Following Childhood Radium Irradiation of the Nasopharynx," Journal of the National Cancer Institute, Vol. 68, No. 1, January 1982, pages 3-8.
- b. Peter G. Verduijn et al., "Mortality After Nasopharyngeal Radium Irradiation For Eustachian Tube Dysfunction," Annals of Otolaryngology, Rhinology and Laryngology, Vol. 98, 1989, pages 839-844.
- c. Jan A. Stolwijk and Audrey F. Saftlas, "The Public Health Response to Nasopharyngeal Radium Irradiation: A Workshop," Otolaryngology Head and Neck Surgery, Vol. 115, 1996, pages 387-446.
- d. Han K. Kang et al., "A Mortality Follow-up Study of WWII Submariners Who Received Nasopharyngeal Radium Irradiation Treatment," American Journal of Industrial Medicine, Vol. 38, 2000, pages 441-446.

## 6. **FOLLOW-UP RESPONSIBILITIES**

The Chief Public Health and Environmental Hazards Officer (13) is responsible for the contents of this directive. Questions are to be addressed to the Office of Public Health and Environmental Hazards at 202-273-8575.

**RESCISSION:** VHA Directive 98-059, December 23, 1998, is rescinded. **This VHA Directive expires July 31, 2008.**

S/ Nevin M. Weaver for  
Robert H. Roswell, M.D.  
Under Secretary for Health

DISTRIBUTION: CO: E-mailed 7/22/2003

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200 – E-mailed 7/22/2003





# 5

## Appendix 5: Military Services and Other Agency Points of Contact for Radiation Dose/Exposure Information



### **ARMY**

Director  
Proponency Office for Preventive  
Medicine - San Antonio  
2050 Worth Road, Suite 25  
Fort Sam Houston, TX 78234-6025

### **NAVY/MARINE CORPS**

#### **Ionizing Radiation**

Officer in Charge  
Naval Dosimetry Center  
Navy Environmental Health  
Center Detachment  
Bethesda, MD 20889-5614

#### **Non-ionizing radiation**

(for occupational ratings that may  
have potential for exposure to  
non-ionizing radiation [sonar, radar,  
medical technical, navigational  
equipment, etc.] )

Chief  
Bureau of Medicine and Surgery  
(Code 21)  
Navy Department  
Washington, DC 20372

### **AIR FORCE**

HQ Air Force Medical  
Operations Agency  
HQ AFMOA/SGZR  
Radiation Health Program  
110 Luke Avenue, Room 405  
Bolling Air Force Base  
Washington, DC 20332-7050

### **COAST GUARD**

Commandant  
U.S. Coast Guard (WKS-3)  
ATTN: Occupational  
Health Physician  
Washington, DC 20593-0001

### **NUCLEAR TEST PERSONNEL REVIEW (NTPR) CLAIMS**

(e.g., Hiroshima and Nagasaki  
occupation personnel and U.S.  
atmospheric nuclear weapons  
test participants)

Defense Threat Reduction Agency  
TDND/NTPR  
8725 John J. Kingman Rd.  
Ft. Belvoir, VA 22060-6201

### **FOREIGN NUCLEAR WEAPONS TESTS**

HQ, AFTAC/IGO  
ATTN: Ms. Patricia Snyder  
1030 South Highway A1A  
Patrick Air Force Base, Florida  
32925-3002

**MANHATTAN PROJECT/ATOMIC  
ENERGY COMMISSION/DEPARTMENT  
OF ENERGY FACILITIES  
INCLUDING HANFORD**

U.S. Department of Energy  
ATTN: Martha E. DeMarre  
Nuclear Testing Archive  
Coordination & Information  
Center (CIC)  
Bechtel Nevada  
PO Box 98521  
Las Vegas, NV 89193-8521  
e-mail: [demarrme@nv.doe.gov](mailto:demarrme@nv.doe.gov)  
Telephone 702-295-0748  
Fax 702-295-1808

U.S. Department of Energy  
EH-52  
ATTN: Nimi Rao  
9901 Germantown Rd.  
Germantown, MD 20874  
e-mail: [nimi.rao@eh.doe.gov](mailto:nimi.rao@eh.doe.gov)  
Telephone 301-903-2297

Hanford Environmental Dose  
Reconstruction Project  
Idaho Division of Health  
ATTN: Ms. Elke Shaw-Tulloch  
450 West State Towers, 4th Floor  
Boise, Idaho 83720-0036

Los Alamos National Laboratory  
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P.O. Box 1663  
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Department of Energy Oak Ridge  
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P.O. Box 2001  
Oak Ridge, TN 37831-6285

Director  
Proponency Office for Preventive  
Medicine - San Antonio  
2050 Worth Road, Suite 25  
Fort Sam Houston, TX 78234-6025

# 6

## Appendix 6:

# A History of the Nuclear Test Personnel Review Program, 1978-1993,

by F. Gladeck and A. Johnson,

Defense Nuclear Agency,  
DNA 6041F, March 1996



## Appendix 6a

From For the Record – A History of the Nuclear Test Personnel Review Program, 1978-1993, by F. Gladeck and A. Johnson, Defense Nuclear Agency, DNA 6041F, March 1996.

### SECTION 5

#### THE ATOMIC BOMBINGS AND U.S. OCCUPATION OF HIROSHIMA AND NAGASAKI

The United States had two atomic bombs ready for use in early August 1945. They were both dropped on Japan, the first over Hiroshima on 6 August 1945 and the second over Nagasaki on 9 August. The Hiroshima weapon was smaller, with a yield of about 15 kilotons compared to the 21 kilotons for the Nagasaki detonation. They were both airbursts, detonated at about 1,670 and 1,640 feet, respectively. These burst heights were chosen to maximize blast damage and to minimize residual radiological contamination.

The objective of the bombings was to bring World War II to a quick end, thereby avoiding the death and destruction that would inevitably result from the planned invasion of the Japanese home islands. During the U.S. invasion of Okinawa, 1 April through 21 June 1945, the U.S. casualties included about 12,000 killed, and the Japanese losses approached 100,000 killed. On 26 July 1945, President Harry Truman urged the Japanese to surrender unconditionally or face "prompt and utter destruction." The Japanese ignored the warnings, having heard similar predictions before fire raids. Subsequently, they lost more than 75,000 people in Hiroshima and more than 35,000 in Nagasaki. On 2 September 1945, Japan officially surrendered to Allied forces. The early radiation surveys and the American occupation of Hiroshima and Nagasaki followed shortly thereafter.

#### 5.1 EARLY RADIATION SURVEYS

In the months immediately following the detonations, U.S. scientists conducted a number of onsite surveys to be sure that any residual radiation in Hiroshima and Nagasaki would not present a health hazard to occupation troops or to the Japanese remaining in the cities. General Marshall, U.S. Army Chief of Staff in Washington, addressed the first concern

in a message sent to General MacArthur, the Theater Commander. General Marshall emphasized the importance of early radiation surveys so that the occupation troops “shall not be subjected to any possible toxic effects, although we have no reason to believe that any such effects actually exist.” Three series of early radiation surveys followed:

- Scientists from the Manhattan Engineer District (MED), the organization that had developed the bombs, made rapid radiation surveys of Hiroshima on 8 and 9 September 1945 (one month before occupation troops arrived in that area) and of Nagasaki on 13 and 14 September (10 days before the occupation troops arrived).
  - They reported negligible levels of radioactivity in the areas surveyed (Farrell, 1977).
- The Manhattan Project Atomic Bomb Investigating Group made more extensive surveys in Nagasaki from 20 September to 6 October and in Hiroshima from 3 to 7 October 1945.
  - Their measurements, showed the levels of residual radioactivity to be extremely low (Tybout, 6 April 1946).
- The Naval Technical Mission to Japan surveyed Nagasaki during 15 to 27 October 1945 and Hiroshima on 1 to 2 November 1945 (Pace and Smith, 16 April 1946).
  - Their findings of negligible levels of radioactivity corroborated the earlier measurements.

In addition to these surveys, the U.S. investigation teams used data from numerous separate radiation monitoring surveys, soil and debris sampling programs, and other analyses conducted by Japanese scientists after the bombings.

The initial and rapid measurements taken by the MED served the critically important purpose of allowing the American occupation of Hiroshima and Nagasaki to proceed as scheduled. The more extensive surveys by the Manhattan Project Atomic Bomb Investigating Group and the Naval Mission to Japan resulted in reports since regarded as basic source documents and listed in [Appendix G](#).

## **5.2 RESIDUAL RADIATION IN HIROSHIMA AND NAGASAKI**

After the bombings, two areas of low-level residual radioactivity remained in each city: An area of induced radioactivity around ground zero and a downwind area contaminated by rainout/fallout.

### **5.2.1 INDUCED RADIOACTIVITY AT THE HYPOCENTERS**

Roughly circular patterns of residual radiation were created at the times of detonation, when the high-intensity burst of neutrons from the bomb encountered elements in the soil and building materials, such as concrete, metal, and tile, in the area beneath the detonation and caused them to become radioactive. (Examples of elements in which radioactivity can be induced are aluminum, sodium, manganese, cobalt, scandium, and cesium). The induced radioactivity decreased rapidly since many of the radionuclides produced in this manner had short half-lives (the time required for the

radiation intensity to be reduced from any given value to one-half that value). For example, aluminum-28 has a half-life of about 2.3 minutes, and manganese-56 has a half-life of about 2.6 hours.

**Figures 5.1** and **5.2** clearly illustrate the area of neutron-reduced radioactivity around the hypocenter ground zero [GZ] in each city as of the radiological survey dates indicated. By the time of occupation force arrival (23 September 1945 at Nagasaki; 7 October 1945 near Hiroshima) the radiation intensity at the hypocenter had decayed to very low levels (0.1 milliroentgen\* per hour or less) and the area of measurable radioactivity had diminished to within about one mile from GZ. It should also be noted that the radioactivity was well within the area of almost total destruction.

### **5.2.2 RADIOACTIVITY DOWNWIND OF THE CITIES**

As the radioactive cloud moved downwind from the center of each city, rain showers within the hour after the detonation caused some of the fission products and unfissioned residue of the bomb to be carried to earth in a manner similar to fallout. This “rainout” produced a small pattern of radioactivity on the west side of Hiroshima, near Takasu; and a somewhat larger area east of Nagasaki, with peak levels in the vicinity of the Nishiyama Reservoir.

**Figures 5-1** and **5-2** show the areas and intensities of residual radioactivity caused by the rainout/fallout. Of the four patterns of measurable residual radioactivity remaining in and around the two cities upon the arrival of the occupation troops, the most significant was in the vicinity of the Nishiyama Reservoir outside Nagasaki, indicated in **Figure 5-2**.

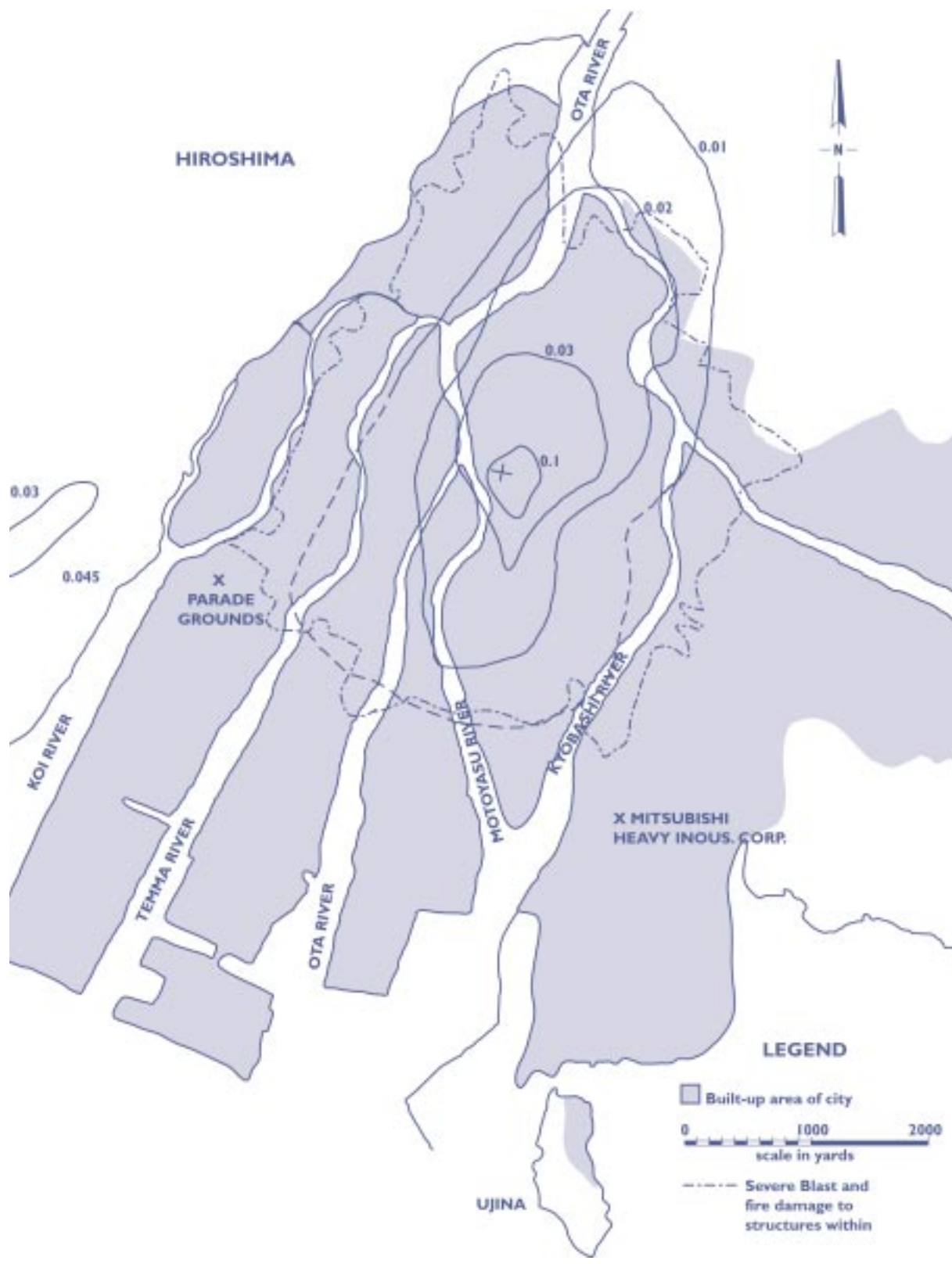
A peak intensity of about one milliroentgen per hour was measured near the reservoir about the time of the troop arrival. The terrain in the area was rugged, characterized by steep slopes and heavy vegetation, with few trails or roads and even fewer buildings. The Japanese population was sparse, and there was little need for occupation force presence in the area.

The small rainout pattern west of Hiroshima, had a peak intensity of about 0.05 milliroentgen per hour when the occupation troops reached this part of Japan.

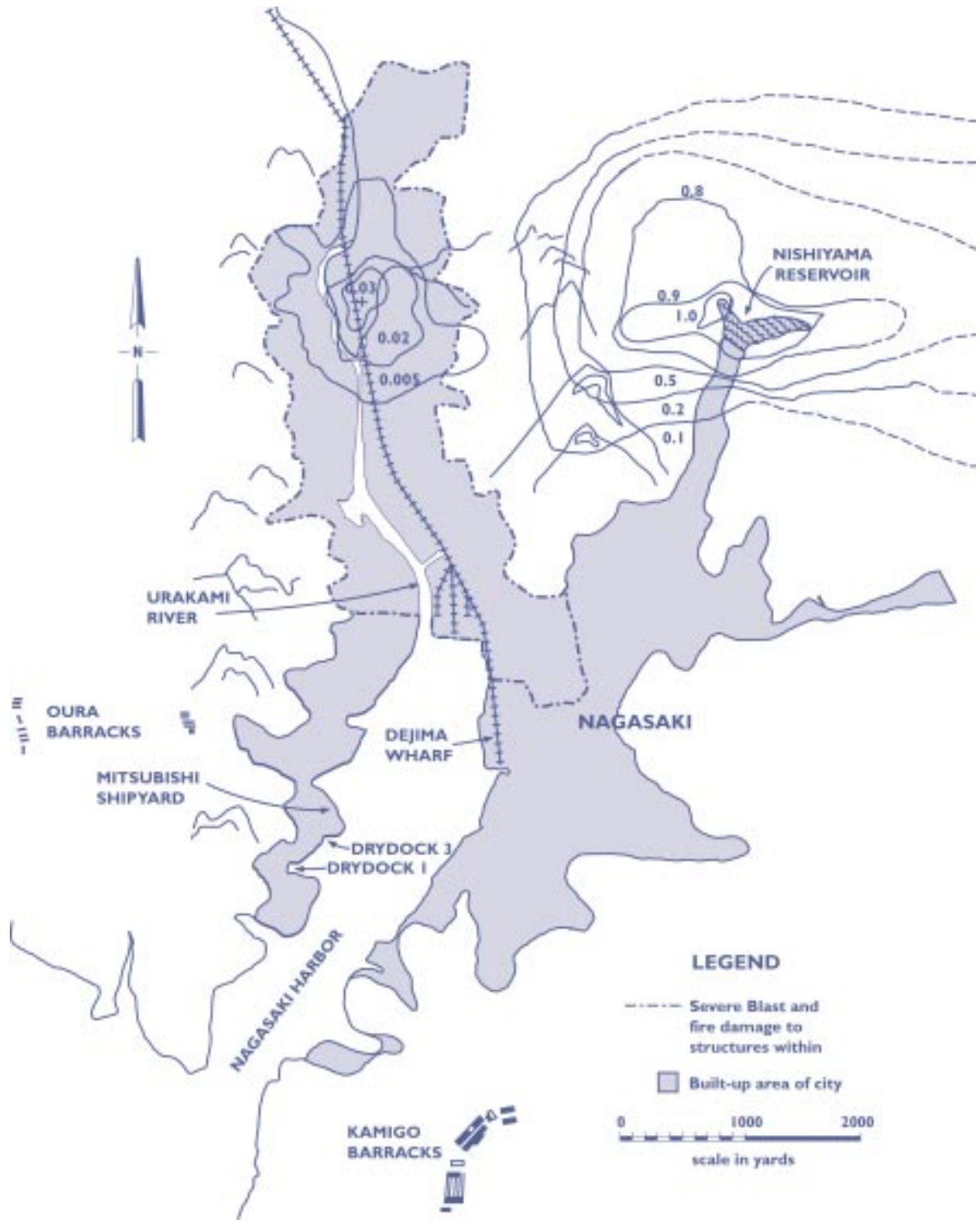
By the time of the occupation, the intensity of the radioactivity (mixed fission products) caused by rainout had dropped to less than a thousandth of the intensity one hour after the detonation. The main reason for this was the rapid overall decay of fission products. In general, the radioactivity one hour after a detonation (H+1) will decay to one-tenth its former level within the next seven hours. Two days after the detonation, the radiation intensity would have dropped to about one-hundredth of its H+1 value. Two weeks after the detonation, the intensity would have decayed to about one-thousandth of its H+1 value.

\*A milliroentgen equals one-thousandth of a roentgen

**Figure 5-1. Manhattan Engineer District Survey of Hiroshima, Japan,  
3-7 October 1945.**



**Figure 5-2. Manhattan Engineer District Survey of Nagasaki, Japan,  
21 September - 4 October 1945.**



The reduction of radioactivity was aided by heavy rains during autumn 1945 that washed away some of the residual radiation. Between the bombings and the start of the occupation, approximately 62 centimeters (24 inches) of rain fell in Hiroshima and 82 centimeters (32 inches) in Nagasaki. The heavy rainfall continued during the occupation and by 1 November, the cumulative total since the bombing was 91 centimeters (36 inches) in Hiroshima and 122 centimeters (48 inches) in Nagasaki.

### **5.3 OCCUPATION OF JAPAN**

The occupation of the western portion of Honshu Island (which contains Hiroshima), the southern Japanese islands of Kyushu (where Nagasaki is located), and Shikoku, was the responsibility of the Sixth U.S. Army, consisting of the I and X Army Corps and the V Amphibious Corps (Marines). Each Corps had three divisions and supporting units. The occupation force for this portion of Japan totaled some 240,000 troops. The Army had primary responsibility for the occupation of Hiroshima and the Marine Corps had primary responsibility for the occupation of Nagasaki.

The mission of the occupation troops was to establish control of the home islands of Japan, ensure compliance with the surrender terms, and demilitarize the Japanese war machine. The duties did not include the "cleanup" of Hiroshima, Nagasaki, or any other areas, nor the rebuilding of Japan.

#### **5.3.1 HIROSHIMA OCCUPATION**

Two divisions, both part of X Corps of the Sixth Army, accomplished the occupation of the area in the immediate vicinity of Hiroshima:

41st Division, 7 October 1945 to December 1945

24th Division, December 1945 to 6 March 1946, when the U.S. occupation of Hiroshima came to an end.

The occupation troops landed at Kure, about nine miles southeast of Hiroshima. One of the first actions carried out by the 186th Infantry Regiment, 41st Division was to set up a roadblock in the vicinity of Kaidaichi to prevent entry into Hiroshima by military personnel. Units of the two divisions were billeted in barracks, rehabilitated buildings, hotels, and private residences in Kure, Hiro, Ujina, Tenno, Eta Jima, Koyaura, and Kaidaichi (all within 10 miles of the city limits of Hiroshima). With the possible exception of a few troops supporting scientific groups, none of the occupation forces were billeted within the city limits of Hiroshima.

Units of the 186th Infantry Regiment, 41st Division, conducted reconnaissance patrols and other specific daily assignments throughout their area of responsibility, which included the city of Hiroshima. It is assumed that individuals of the regiment made occasional patrols into the destroyed area of the city and that individuals from nearby units of the 41st Division may have made brief sightseeing trips into the area. Radiation doses received by these participants and the other occupation troops are summarized in [Section 5.4](#).



### 5.3.2 NAGASAKI OCCUPATION

While the Hiroshima occupation primarily involved Army troops, the occupation of Nagasaki consisted mostly of Marine Corps units, with small supporting Navy and Army elements.

Responsibility for the Nagasaki area was assigned to the 2nd Marine Division, a unit of the V Amphibious Corps. During the first three months of the occupation, Division strength in Nagasaki is estimated at approximately 10,000 troops. Division strength averaged about 5,000 to 7,000 for the next three months, through February 1946, and 3,000 to 4,000 for the last four months of the occupation, through 30 June 1946.

Three units of the 2nd Marine Division had key roles during various periods of the occupation, as indicated below:

- 2nd Regimental Combat Team (RCT-2), 23 September to early November 1945. The zone of occupation included the east side of the Nagasaki Harbor and most of the nearby county east of the Urakami River.
- RCT-6, 23 September to December 1945. The zone of occupation included the west side of the Nagasaki Harbor and most of the nearby county west of the Urakami River.
- 10th Marine Regiment, November 1945 to June 1946, when the Marine Corps occupation of Nagasaki came to an end. The Regiment assumed the responsibilities of RCT-2 and RCT-6 upon their departure from Japan.

Specific billet locations have not been identified for all division units, which also included the 8th RCT, a Headquarters Battalion, Service Troops, an Engineer Group, a Tank Battalion, an Observation Squadron, and some smaller organizations. It is known, however, that RCT-2 was billeted in the Kamigo barracks and RCT-6 in the Oura barracks, both shown in [Figure 5-2](#). The other troops also were billeted in areas well clear of the hypocenter, which was cordoned off.

Five companies of the Army's 34th Infantry Regiment moved to Nagasaki and Omura during the last 10 days of June 1946. Approximately 25,000 Marines and 2,000 Army personnel participated in the occupation of Nagasaki.

[Section 5.4](#) summarizes doses for Nagasaki participating personnel.

### 5.4 RADIATION DOSES

Few world events have been as thoroughly documented at the time, and as intensively and continuously studied since, by as many different groups of scientists as the atomic bombings and related radiation exposures at Hiroshima and Nagasaki. Thus, the patterns of residual radiation are well understood. This understanding, with other information, provides a solid basis for radiation dose determination.

The extensive radiation measurements and soil sample analyses taken by

numerous Japanese and U.S. scientists in the weeks following the bombings are still available. These results and subsequent radiation measurements and sampling have formed the basis for intensive research over the past 48 years by Japanese and U.S. scientists of every aspect of the bombings and the radiation after effects. The Japanese Government and the American NAS have stimulated, supported, and advanced this research.

Documentation of the U.S. occupation of Japan is voluminous in Army, Navy, and Marine Corps archives. Unfortunately, however, no central listing of participating units exists. Consequently, to meet the requirements of Public Law 100-321 (see [Section 3.3.2](#)), extensive research has been required to determine which units were present, when they arrived, where they were stationed, what their missions were, and when they left.

In spite of the still-existing gaps in unit data, detailed technical dose reconstructions have determined the maximum possible radiation doses that might have been received by any participant. [Section 8](#), Radiation Dose Determination, addresses this process, explaining the “worst case” analysis used to identify the highest possible dose. Using all possible “worst case” assumptions, the maximum possible dose any occupation force member might have received from external radiation, inhalation, and ingestion is less than one rem. This does not mean that any individual approached this exposure level. In fact, it is probable that the great majority of personnel assigned to the Hiroshima and Nagasaki occupation forces received low radiation exposures and that the highest dose received by anyone was a few tens of millirem.

## Appendix 6b



DEFENSE THREAT REDUCTION AGENCY  
OFFICE OF PUBLIC AFFAIRS

## Factsheet

### Hiroshima and Nagasaki Occupation Forces

[http://www.dtra.mil/news/fact/nw\\_hnforce.html](http://www.dtra.mil/news/fact/nw_hnforce.html)

**Note:** (For information related to claims, call the Department of Veterans Affairs (VA) at 1-800-827-1000 or the Department of Justice (DOJ) 1-800-729-7327. For information related to test participation or dose reconstruction, call the Nuclear Test Personnel Review (NTPR) program at 1-800-462-3683.)

### Overview

Atomic bombs were detonated over Hiroshima and Nagasaki, Japan, on Aug. 6 and Aug. 9, 1945, respectively. Following the surrender of Japan on Aug. 14, 1945, U.S. forces began occupying the country. The first occupation troops arrived in the vicinity of Hiroshima about 60 days after the bombing. The main body of occupation troops entered Nagasaki about 45 days after the bombing. In each city, a group of American scientists arrived three days before these troops and performed a radiological survey. However, repatriation of former prisoners of war (POWs) through Nagasaki began before the survey and actual occupation of the city.

U.S. troops were in the vicinity of Hiroshima between Oct. 6, 1945, and March 6, 1946, and in the vicinity of Nagasaki principally between Sept. 11, 1945, and July 1, 1946.

The mission of the occupation was to establish control of the area, ensure compliance with surrender terms, and demilitarize the Japanese war machine. The mission did not include the cleanup or any radiological decontamination of Hiroshima, Nagasaki, any other areas, or the rebuilding of Japan.

#### **Units involved:**

- Hiroshima - 186th Infantry Regiment of the 41st Division, X Corps of the Sixth Army; later replaced by the 34th Infantry Regiment of the 24th Division
- Nagasaki - 2nd Marine Division, which included the 2nd, 6th, and 8th Regimental Combat Teams (RCTs) and an Artillery Group composed principally of the 10th Marine Regiment.
- Other units of the 2nd Marine Division involved were a Headquarters Battalion, Service Troops, an Engineer Group, a Tank Battalion, an Observation Squadron, and some smaller organizations.

Troops were constantly on the move and changing assignments during the occupation, and the duration of assignment for any unit in the occupation forces was quite short. Men with the longest service periods were given priority for transfer home and whole units were deactivated as it became

apparent that large numbers of troops were not necessary to fulfill the mission. The size of the occupation force dropped sharply every month.

The total number of troops occupying Hiroshima was about 40,000. Approximately 27,000 troops occupied Nagasaki. About 12,000 troops occupied outlying areas within 10 miles of either city through July 1, 1946. An additional 118,000 servicemen had passed through these areas by July 1, 1946. These transient personnel included POWs, troops disembarked for elsewhere in Japan and crews of ships docked nearby.

Refer to Title 38, Code of Federal Regulations (38 CFR), part 3.309(d)(3) for the context of the following extracted formal VA definitions of occupation forces and POWs.

### **Occupation force**

The occupation of Hiroshima or Nagasaki, Japan, by United States forces during the period beginning on August 6, 1945, and ending on July 1, 1946.

### **POW**

Internment as a prisoner of war in Japan (or service on active duty in Japan immediately following such internment) during World War II, which resulted in an opportunity for exposure to ionizing radiation comparable to that of the United States occupation forces in Hiroshima or Nagasaki, Japan, during the period beginning on August 6, 1945, and ending on July 1, 1946.

The term "occupation of Hiroshima or Nagasaki, Japan, by United States forces" means official military duties within 10 miles of the city limits of either Hiroshima or Nagasaki, Japan, which were required to perform or support military occupation functions such as occupation of territory, control of the population, stabilization of the government, demilitarization of the Japanese military, rehabilitation of the infrastructure or deactivation and conversion of war plants or materials.

Former prisoners of war who had an opportunity for exposure to ionizing radiation comparable to that of veterans who participated in the occupation of Hiroshima or Nagasaki, Japan, by United States forces shall include those who, at any time during the period August 6, 1945, through July 1, 1946:

- (A) Were interned within 75 miles of the city limits of Hiroshima or within 150 miles of the city limits of Nagasaki, or
- (B) Can affirmatively show they worked within the areas set forth in (A) although not interned within those areas, or
- (C) Served immediately following internment in a capacity which satisfies the above definition of occupation forces, or
- (D) Were repatriated through the port of Nagasaki.

### **Occupation scenario**

**Hiroshima.** Elements of the 41st Division landed at Hiro, approximately 10 miles southeast of Hiroshima, on Oct. 6, 1945, and secured the Kure Naval

Yard. On Oct. 7, the 186th Infantry Regiment of the 41st Division landed, and the Regiment's 2nd Battalion established headquarters and billets in Kaidaichi, about 5 miles southeast of the center of Hiroshima. Since most of the city of Hiroshima had been destroyed by the bomb (see [Figure 1](#)), no major units were stationed there throughout the occupation. During the next two months, units of the 186th Infantry Regiment conducted reconnaissance patrols and other missions in its area of responsibility, including the city of Hiroshima. Records indicate that troops occasionally patrolled the destroyed area of the city. Additionally, individuals from nearby units of the 41st could have made brief sightseeing trips to view the destruction caused by the bomb. About 900 U.S. POWs were repatriated through Hiroshima.

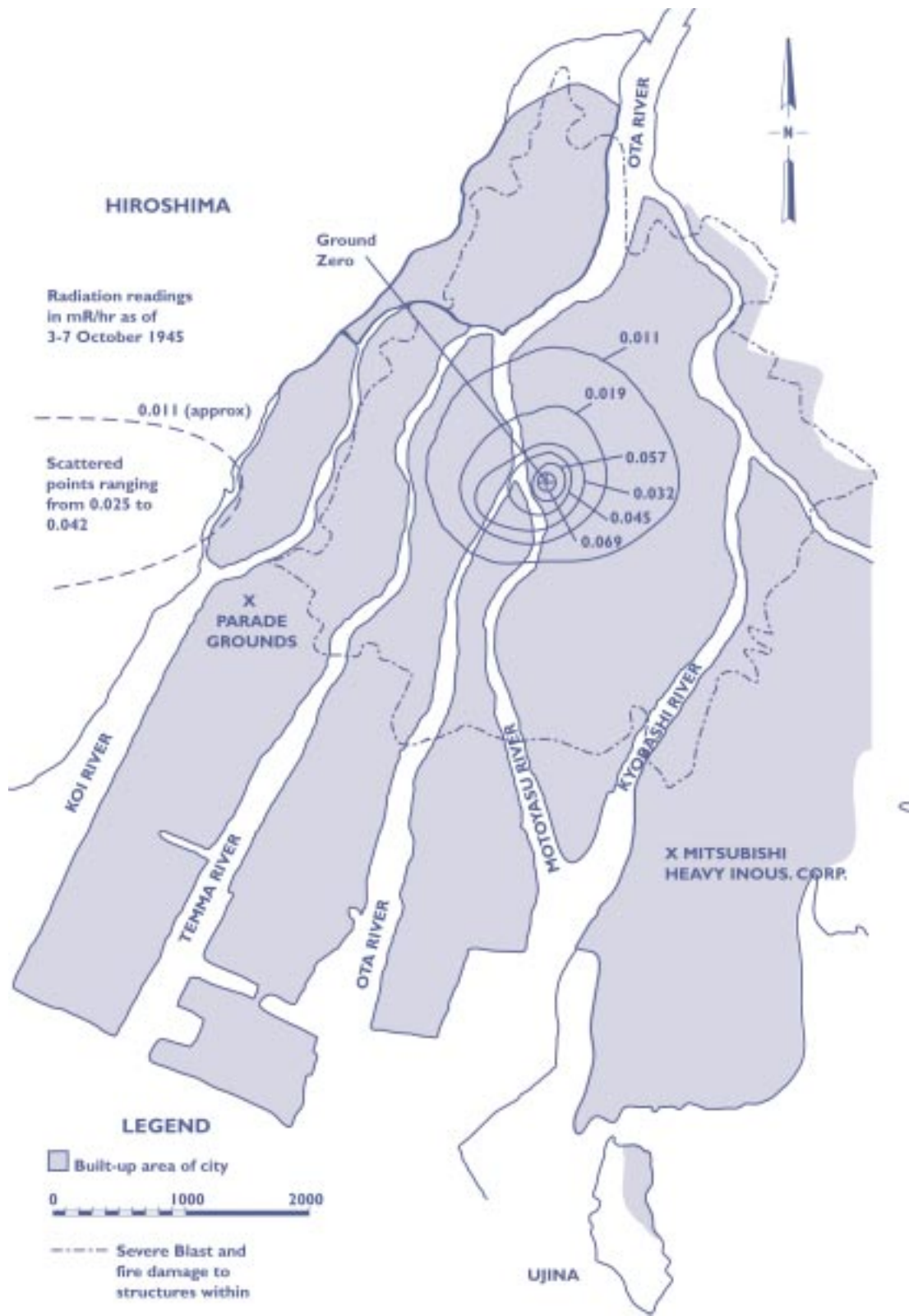
Upon deactivation of the 41st Division in December 1945, the 34th Infantry Regiment of the 24th Division took over its mission and moved into the buildings in Kaidaichi originally used by units of the 186th. The 34th Regiment was responsible for such a wide geographic area that eventually only Company G of the 2nd Battalion was stationed in the vicinity of Hiroshima. On March 6, 1946, the 34th Regiment was relieved by an Australian Infantry Battalion, and the U.S. occupation in the vicinity of Hiroshima ended.

**Nagasaki.** Nagasaki was used to repatriate former POWs because the waterfront was sufficiently far from the hypocenter (the spot on the ground directly under the detonation, i.e., ground zero) to have escaped most of the destructive effects of the bomb, and to have been completely free of radioactivity (see [Figure 2](#)). Over 9,000 allied (including 2,300 U.S.) POWs were processed at Nagasaki Sept. 11-23, 1945. A POW recovery team and a detachment of Marine guards were ashore in Nagasaki to support POW processing. Additionally, a small advance party of the occupation force (about 12 personnel) arrived in Nagasaki on Sept. 16, 1945, and remained until the main force arrived on Sept. 23, 1945.

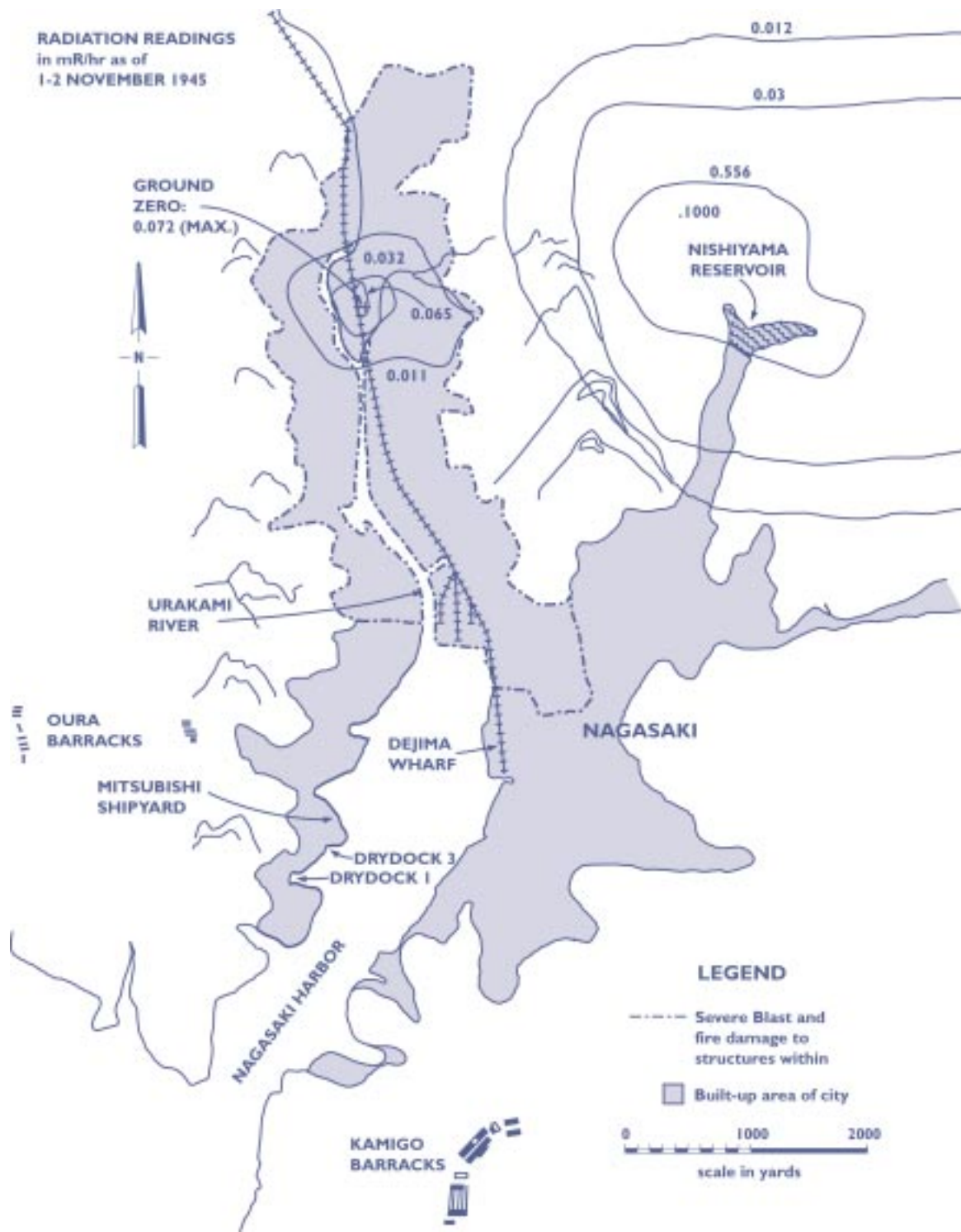
Upon landing, the 8th RCT and the 10th Marines deployed immediately to Isahaya, about 10 miles north of Nagasaki. The 8th RCT did not occupy Nagasaki, but the 10th Marines did so two months later. The other elements of the 2nd Marine Division debarked in the vicinity of Dejima Wharf and the Mitsubishi shipyard and established command posts and billets in those vicinities. The 2nd RCT left Nagasaki in early November, and the 6th RCT departed in December 1945 along with two-thirds of the Engineer Group. The Headquarters Battalion and portions of the Service Troops left Nagasaki in January 1946. The Tank Battalion, which had landed and remained in Fukahori, about nine miles southeast of Nagasaki, arrived in Nagasaki in November 1945 and departed the next month. The 10th Marines took over the responsibilities of the 2nd RCT in November, and later also those of the 6th RCT. The last units of the 2nd Marine Division left Nagasaki on July 1, 1946.

The specific billet locations of all units have not been precisely determined, but they were undoubtedly outside of the radiation survey contours surrounding the hypocenter in [Figure 2](#). An area extending beyond those contours was uninhabitable because of complete destruction, and historical

### Bomb damage in Hiroshima



### Nagasaki



documents confirm that the area was avoided. As with Hiroshima, presumably patrols and sightseers occasionally entered the areas of residual contamination in Nagasaki.

The U.S. Navy transported Marines to Nagasaki and evacuated POWs, but its role ashore was limited. Some Navy personnel, including hospital corpsmen, medical and dental officers, chaplains, and a construction battalion, were assigned to the 2nd Marine Division.

**Radiation data:** Analysis of the scientific data for the Hiroshima and Nagasaki airbursts continues, resulting in revised statistics for the detonations. The Hiroshima bomb was a uranium-235 weapon that detonated about 1,900 feet above the ground with a yield of 15 kilotons (kT). The Nagasaki bomb was a plutonium-239 weapon that detonated 1,650 feet above the ground with a yield of 21 kT. [Figures 1](#) and [2](#) show the built-up areas of the respective cities, the hypocenter of each burst, residual gamma radiation intensity contours, and the approximate perimeters of total destruction from blast and fire.

The radiological effects of the detonation in each city were similar. Japanese citizens in the vicinity at the time of the detonations were exposed to intense radiation produced almost instantaneously. High doses of hundreds of rem from this initial neutron and gamma radiation contributed to the lethality of Japanese citizens located beneath the bursts. This initial radiation only occurs for about one minute after a nuclear detonation and does not persist thereafter. In contrast, the earliest residual radiation levels encountered by Japanese were survivable. Both burst altitudes were sufficiently high that bomb debris did not reach the ground in the vicinity of the hypocenter. After the detonations, strong updrafts were produced which lifted the radioactive bomb debris, ground dust and smoke together in clouds. Most of the mixed debris settled to the ground as radioactive fallout downwind of the cities. In each city, there was one area of low-level residual radioactivity in a roughly circular area caused by neutron activation of soil and building materials around the hypocenter. Additionally, there was a second area of residual radioactivity located downwind and outside the city, caused by fallout carried to the ground during rain shower activity within an hour after the detonation. Subsequent heavy rainfall washed away some of the residual radioactivity. During the intervening weeks before the occupation forces arrived, this rainfall, combined with radiological decay, reduced the radiation levels from fallout and neutron-activated materials by a factor of several thousand. This explains, in part, why the radiation doses of occupation forces were at least a thousand times lower than those Japanese located near ground zero at the time of the detonation.

Based on radiation surveys by American scientists from the Manhattan Engineer District, the greatly decayed residual radioactivity levels in and around Hiroshima and Nagasaki at the time the occupation forces arrived were such that military activities could proceed as planned, unimpeded by radiological considerations.



**Figure 1** depicts the results of the Naval Medical Research Institute survey taken in Hiroshima on Nov. 1-2, 1945, showing a residual radiation level of 0.069 milliroentgen per hour (mR/hr) at ground zero, and an average residual radiation level of 0.011 mR/hr in the area of rainout to the west of the city.

**Figure 2** depicts the results of the Naval Medical Research Institute survey taken in Nagasaki on Oct. 15-27, 1945, showing the residual radiation level of 0.072 mR/hr (maximum) at ground zero, and a residual radiation level of up to 1.08 mR/hr in the rainout area at the Nishiyama Reservoir. Scientific analysis of these data indicated that two radionuclides, scandium-46 and cobalt-60, which resulted from neutron activation of surface soil and building materials, produced the radiation levels near ground zero in each city. Fission product radionuclides produced the radiation levels in the rainout areas.

The Nishiyama Reservoir had the highest radiation measurement recorded at the time of the troops' arrival. However, this area was remote and rugged, with steep slopes and heavy forests, few trails or roads, and even fewer buildings. The Japanese population in the area was sparse, so there were no occupation forces stationed in the vicinity, and little need for military patrols into the area.

**Personnel doses:** Dose reconstructions are based on (1) residual radiation measurements, documented, and published shortly after the bombings, (2) extensive review and analysis of the residual radioactivity in ensuing decades, and (3) the documented arrival and departure dates of each military unit which operated in the vicinity of Hiroshima and Nagasaki. Using the "worst case" assumptions that lead to the highest radiation dose consistent with a military unit's potential for exposure, the dose reconstructions show that the maximum total\* radiation dose any member of the U.S. occupation forces in Japan could have received was less than 1 rem.\*\* The average dose received by individuals in the Hiroshima and Nagasaki

Table 1

<b>The Range of Total Doses for Occupation Forces, POWs, and Personnel</b>			
<b>Category of Defined Participants</b>	<b>Percentage of Defined Participants</b>	<b>Probable Dose (rem)</b>	<b>Maximum Dose(rem)</b>
Occupation forces - Nishiyama area and POWs - Kumamoto Camp	4%	<0.1	<1
Other Hiroshima/Nagasaki occupation forces	36%	<0.01	<0.1
Naval ship crews	43%	0.0	<0.01
Disembarked troops (for elsewhere in Japan)	13%	0.0	<0.01
Transients on railroads	2%	0.0	<0.01
Repatriated POWs	2%	0.0	<0.01

occupations was less than 0.01 rem. More than 95 percent of all Hiroshima and Nagasaki participants received a dose less than 0.1 rem, which is the annual radiation dose limit for the U.S. general public currently in effect.

Similar dose reconstructions indicate that U.S. servicemen who survived imprisonment in Japanese camps received virtually no radiation dose, with the exception of the POWs held in the camp at Kumamoto. Fallout was detected in this city downwind of Nagasaki.

These doses are in contrast to the reconstructed initial radiation doses, which ranged between about 10 rem to hundreds of rem for the hundreds of thousands of Japanese survivors whose health continues to be monitored by the Radiation Effects Research Foundation (RERF). For further information on these studies contact:

Director, Board on Radiation Effects Research  
National Academy of Sciences  
500 Fifth Street, NW  
Washington, D.C. 20001

For additional information on the RERF, contact the Director of the Board on Radiation Effects Research, telephone (202) 334-2836, or visit the RERF's internet site (<http://www.rerf.or.jp/>).

\* Sum of external and internal dose, where internal dose is the 50-year committed effective dose equivalent.

\*\* A rem is a unit that quantifies the biological effect of ionizing radiation (gamma, x-ray, beta, neutron, or alpha) on man. Ionizing radiation is any radiation capable of displacing electrons from atoms or molecules, thereby producing ions. The general U.S. population receives about 0.36 rem per year (National Council on Radiation Protection and Measurements (NCRP), Report No. 93, Table 8.1) from natural background radiation sources (radon, cosmic rays, and rocks) and man-made radiation sources (medical diagnostic x-rays and consumer products). The standard diagnostic chest x-ray delivers a dose of about 0.02 rem. For more information about NCRP Report 93, contact the NCRP internet site (<http://www.ncrp.com>).

January 2004

# 7

## Appendix 7:

# Advisory Committee on Human Radiation Experiments: Final Report Excerpt



Washington, DC: U.S. Government Printing Office, 1995

### Author

Advisory Committee on Human Radiation Experiments, Ruth R. Faden  
Ph.D., M.P.H., Chair

### Preface

On January 15, 1994, President Clinton created the Advisory Committee on Human Radiation Experiments in response to his concern about the growing number of reports describing possibly unethical conduct of the U.S. government and institutions funded by the government in the use of, or exposure to, ionizing radiation in humans at the height of the Cold War. The Committee was charged to uncover the history of human radiation experiments conducted during the period 1944-1974 and the intentional environmental releases of radiation; to identify the ethical and scientific standards for evaluating these events; and to make recommendations to ensure that whatever wrongdoing may have occurred in the past cannot be repeated. This summary provides the key points enumerated that are specifically related to veterans, including Recommendation 6 which is reprinted below in its entirety.

### Confidential Record Keeping to Evaluate Potential Liability Claims

Concern for long-term liability stimulated by Crossroads led to steps to guard against the legal and public relations implications if service personnel, who were exposed to radiation, filed disability claims. In 1946, General Paul Hawley, administrator of the Veterans Administration (VA), "became deeply concerned about the problems that atomic energy might create for the Veterans Administration due to the fact that the Armed Services were so actively engaged in matters of atomic energy." In 1947, Hawley met with representatives of the surgeon general's offices of the military services and the Public Health Service. An advisory committee was created and given the name "Central Advisory Committee," as "it was not desired to publicize the fact that the Veterans Administration might have any problems in connection with atomic medicine, especially the fact that there might be problems in connection with alleged service-connected disability claims."

The committee recommended the creation of an Atomic Medicine Division (AMD) of the VA to handle “atomic medicine matters” and a radioisotope section to “implement a Radioisotope Program.” The committee further recommended that “for the time being, the existence of the Atomic Medicine Division be classified as ‘confidential’ and that publicity be given instead to the existence of a Radioisotope Program.” This history is contained in a 1952 report presented by Dr. George Lyon to the National Research Council.

Working with the VA and the Defense Department, the Advisory Committee on Human Radiation Experiments sought to retrieve what information could be located regarding the AMD and any secret record keeping in anticipation of potential veterans’ claims from radiation exposures. Among the documents found was a Confidential, August 1952, letter to the attention of Dr. Lyon in which the Defense Department called for comment on the Army’s proposal to “eliminate the requirement for maintaining detailed statistical records of radiological exposures received by the Army personnel.” The requirement, the letter recorded, “was originally conceived as being necessary to protect the government’s interest in case any large number of veterans should attempt to bring suit against the government based on a real or imagined exposure to nuclear radiations during an atomic war.”

In 1959, Dr. Lyon was recommended for a VA “Exceptional Service Award.” In a memo from the VA chief medical director to the VA administrator, Dr. Lyon’s work on both the publicized and confidential programs was the first of many items for which Dr. Lyon was commended. Following a recitation of the 1947 developments similar to those stated by Dr. Lyon in his 1952 report, the memo explained: “It was felt unwise to publicize unduly the probable adverse effects of exposure to radioactive materials. The use of nuclear energy at this time was so sensitive that unfavorable reaction might have jeopardized future developments in the field...[Dr. Lyon] maintained records of [a] classified nature emanating from the AEC and the Armed Forces Special Weapons Project which were essential to proper evaluation of claims of radiation injury brought against VA by former members of the Armed Forces engaged in the Manhattan project.”

The Advisory Committee was unable to recover or identify the precise records that were referred to in the documents. An investigation by the VA inspector general concluded that the feared claims from Crossroads did not materialize and that the confidential AMD was not activated. However, the investigation did not shed light on the specific identity of the records that were kept by Dr. Lyon, as cited in the memo mentioned above. While mystery still remains, the documentation that has been retrieved indicates that prior to the atomic testing conducted in the 1950’s, the government and its radiation experts had strong concern for the possibility that radiation risk borne by servicemen might bear longer-term consequences.

## **Recommendation 6**

*The Advisory Committee recommends to the Human Radiation Interagency Working Group that it, together with Congress, give serious consideration to reviewing and updating epidemiological tables that are relied upon to determine whether relief is appropriate for veterans who participated in atomic testing so that all cancers or other diseases for which there is a reasonable probability of causation by radiation exposure during active military service are clearly and unequivocally covered by the statutes.*

*Congress has provided for compensation for veterans who participated in atmospheric atomic tests or the American occupation of Hiroshima or Nagasaki, Japan. The provision of compensation depends on evidence that the veteran has sustained disability from a disease that may be related to radiation exposure.*

*The Veterans Dioxin and Radiation Exposure Compensation Standards Act of 1984 required the Veterans Administration to write a rule governing entitlement to compensation for radiation-related disabilities. The resulting regulation contains criteria for adjudicating radiation claims, including consideration of a radiation-dose estimate and a determination as to whether it is at least as likely as not that the claimed disease resulted from radiation exposure. The Radiation-Exposed Veterans Compensation Act of 1988 provides that a veteran who was present at a designated event and subsequently develops a designated radiogenic disease may be entitled to benefits without having to prove causation.*

*The committee recommends that the radioepidemiological tables prepared by the National Institutes of Health in 1985, which identify diseases that may be causally connected to radiation exposures, be updated. The Committee understands that the Department of Veterans Affairs agrees with this recommendation.*



# 8

## Appendix 8:

# Information from the DNA Publication “For the Record” About Operation Crossroads



### Appendix 8a

From For the Record – A History of the Nuclear Test Personnel Review Program, 1978-1993, by F. Gladeck and A. Johnson, Defense Nuclear Agency, DNA 6041F, March 1996.

### 6.2 OPERATION CROSSROADS.

Conducted in 1946 at Bikini, CROSSROADS involved approximately 250 ships and 160 aircraft. Verified DoD participants number about 47,400 (JAYCOR, 6 October 1993). The series consisted of an airdrop detonated at a height of 520 feet and an underwater shot conducted at a depth of 90 feet, as shown in [Table 6-3](#).

Table 6-3

Crossroads Shots			
Shot	Date (1946)	Type	Yield (kilotons)
ABLE	1 July	Airdrop	21
BAKER	25 July	Underwater	21

The nuclear devices were similar to the TRINITY device and to the weapon detonated over Nagasaki, Japan (Berkhouse and others, 1 May 1984, p.17).

Among the numerous observers of these two detonations was First Lieutenant David J. Bradley, an Army doctor trained as a radiological safety monitor. He made the following observations of ABLE and BAKER from a Navy aircraft approximately 20 nautical miles from each detonation:

**ABLE:** At twenty miles [it] gave us no sound or flash or shock. Then, suddenly we saw it – a huge column of clouds, dense, white, boiling up through the strata-cumulus, looking much like any other thunderhead but climbing as no storm cloud ever could. The evil mushrooming head soon began to blossom out. It climbed rapidly to 30,000 or 40,000 feet, growing a tawny-pink from oxides of nitrogen, and seemed to be reaching out in an expanding umbrella overhead.... For minutes the cloud stood solid and

impressive, like some gigantic monument, over Bikini. Then finally the shearing of the winds at different altitudes began to tear it up into a weird zigzag pattern (Bradley, 1948, p.55).

**BAKER:** This shot in broad day, at fifteen miles, seemed to spring from all parts of the target fleet at once. A gigantic flash – then it was gone. And where it had been now stood a white chimney of water reaching up and up. Then a huge hemispheric mushroom of vapor appeared like a parachute suddenly. By this time the great geyser had climbed to several thousand feet. It stood there as if solidifying for many seconds, its head enshrouded in a tumult of steam. Then slowly the pillar began to fall and break up. At its base a tidal wave of spray and steam arose, to smother the fleet and move on toward the islands. All this took only a few seconds, but the phenomenon was so astounding as to seem to last much longer (Bradley, 1948, p.93).

The BAKER detonation



Figure 6-4

Shot BAKER emerging amidst the unmanned target fleet, 25 July 1946.  
(Joint Task Force One, 18 BAKER #3, 1946.)



### **6.2.1 Background and Objectives of CROSSROADS**

After the strategic atomic bomb attacks on Japan had abruptly ended World War II, many military leaders felt that military science was at a crossroads. Vice Admiral W.H.P. Blandy, who directed CROSSROADS declared that perhaps civilization itself, had been brought to a turning point by this revolutionary weapon. With this thought in mind, he named the initial postwar test series (National Geographic Magazine, April 1947, p.529).

As early as August 1945, the Chairman of the Senate's Special Committee on Atomic Energy proposed that the effectiveness of atomic bombs be demonstrated on captured Japanese ships. In September, the General of the Army, H. H. Arnold, Commander of the Army Air Forces, put the question of such a test before the Joint Chiefs of Staff (JCS). The ensuing discussion and recommendations led President Harry Truman to announce, on 10 December 1945, that the U.S. would further explore the capabilities of atomic energy in the form of scientific atomic bomb tests under JCS jurisdiction (Berkhouse and others, 1 May 1984, p.18).

CROSSROADS was designed to produce information not available from the Trinity test or the Hiroshima and Nagasaki bombings. The primary purpose was to determine the effects of atomic bombs on naval vessels. The secondary purposes were to provide training for aircrews in attack techniques using atomic bombs against ships and to determine atomic bomb effects upon other military equipment and installations (Berkhouse and others, 1 May 1984, p.18).

### **6.2.2 CROSSROADS Test Operations**

A fleet of more than 90 target vessels was assembled in Bikini Lagoon for CROSSROADS. The target fleet consisted of older U.S. ships, such as the aircraft carriers USS SARATOGA (CV 3) and USS INDEPENDENCE (CVL 22), the battleships USS NEVADA (BB 36), USS ARKANSAS (BB 33), USS PENNSYLVANIA (BB 38), and USS NEW YORK (BB 34), surplus U.S. cruisers, destroyers, submarines, and a large number of auxiliary and amphibious vessels. The German cruiser PRINZ EUGEN and two major captured Japanese ships, the battleship NAGATO and the cruiser SAKAWA, also were targets. The support fleet comprised more than 150 ships that provided quarters, experimental stations, and workshops for most of the approximately 43,000 participants, more than 39,000 of whom were Navy personnel (Berkhouse and others, 1 May 1984, pp.1, 84).

In contrast to all other U.S. atmospheric nuclear test series, a large media contingent was present for both CROSSROADS detonations. Quartered aboard USS APPALACHIAN (AGC 1), the correspondents numbered 131 and were from newspapers, magazines, and the radio networks (Anonymous, no date). Included were correspondents from Australia, Canada, France, the Republic of China, the Soviet Union, and the United Kingdom. All Hands, a Navy magazine of the period, reported that:

The press will be allowed to cover the test atomic bomb explosions at Bikini with sufficient thoroughness to satisfy the public as to the fairness and general results of the experiment, but not so completely that military information of value to the enemy will be disclosed (Bureau of Naval Personnel, 1 July 1946).

ABLE operations went smoothly. The radioactivity created by the airburst had only a transient effect. Within a day, radiation intensities in the lagoon had decayed to less than 0.1 R/24 hours, and nearly all the surviving target ships had been safely reboarded. The ship inspections, instrument recoveries, and remooring necessary for the BAKER test proceeded on schedule (Berkhouse and others, 1 May 1984, pp. 1, 217).

BAKER, on the other hand, presented difficulties. The underwater detonation caused most of the target fleet to be bathed in radioactive water spray and debris. With the exception of 12 target vessels in the lagoon and the landing craft beached on Bikini Island, the surviving target fleet was too radiologically contaminated for many days for more than brief on-board activities. During the first week of August, attempts were made to decontaminate the vessels. By 10 August, upon the advice of Colonel Stafford Warren, the Chief of the Radiological Safety Division, the Task Force Commander decided to terminate these efforts and tow most of the remaining target fleet to Kwajalein Atoll for possible decontamination (Berkhouse and others, 1 May 1984, pp.178-187).

In the latter half of August 1946, the surviving target ships were towed or sailed to Kwajalein Atoll. Eight of the major ships and two submarines were towed back to the U.S. for radiological inspection. Twelve target ships were so lightly contaminated that their crews remanned them and sailed them back to the United States. The remaining target ships were destroyed by sinking off Kwajalein Atoll, near the Hawaiian Islands or off the California coast during 1946 to 1948. The support ships were decontaminated as necessary at various Navy shipyards, primarily in San Francisco and Long Beach, California (Berkhouse and others, 1 May 1984, pp.178-187).

### **6.2.3 Dose Summary for CROSSROADS**

CROSSROADS operations were undertaken under radiological supervision intended to keep personnel doses below 0.1 R (rem) of gamma radiation per day. About 15 percent of the participants were issued film badges. Personnel anticipated to have the most potential for exposure were badged, and a percentage of each group working in less radioactive areas were badged (Berkhouse and others, 1 May 1984, pp.2-3). Thus, because radiation dose data are not complete, reconstructions have been made of personnel doses for unbadged crewmembers of the ships involved. The calculations rely upon the radiation measurements recorded by radiation safety personnel in 1946 and use the types of methods discussed in [Section 8](#).

In the fall of 1983, the papers of Colonel Stafford Warren, the chief of radiological safety at CROSSROADS, were released. His papers revealed certain data that had not been found in previous archival searches. When

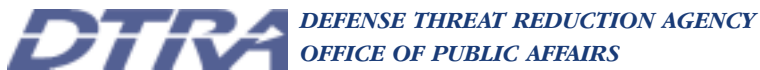
introduced into the reconstruction model, the data had the effect of reducing the reconstructed doses of many CROSSROADS personnel. **Table 6-4** summarizes the presently available dosimetry information.

Table 6-4

<b>Summary of external doses for Operation CROSSROADS as of 30 September 1993</b>							
<b>Gamma dose R (rem)</b>							
	0	>0-0.5	>0.5-1.0	>1.0-3.0	>3.0-5.0	>5.0-10.0	>10.0
Army*	2,290	1,070	147	9	1	0	0
Navy	6,917	23,258	7,448	4,038	11	0	0
Marines	211	378	0	0	0	0	0
Coast Guard **	1	5	1	0	0	0	0
Foreign Military Observers	0	3	0	0	0	0	0
Total for each Column	9,319	24,714	7,596	4,047	12	0	0
<b>Cumulative total</b>							<b>45,689</b>

\* At the time of CROSSROADS the Air Force was part of the Army.  
\*\* Coast Guard personnel were present at some oceanic test series.

## Appendix 8b



## Factsheet

### Operation CROSSROADS

**Note:** For information related to claims, call the Department of Veterans Affairs (VA) at 1-800-827-1000 or the Department of Justice (DOJ) or 1-800-729-7327. For all other information, call the Nuclear Test Personnel Review (NTPR) program at 1-800-462-3683.

Operation CROSSROADS, conducted in July and August 1946, was the first nuclear test series after World War II and the first ever in the ocean. It consisted of two nuclear weapon tests—one airburst and one underwater—using nuclear devices very similar to the one dropped on Nagasaki, Japan, in August 1945. The tests were conducted against an array of more than 90 target ships in the lagoon of Bikini Atoll, part of the Marshall Islands in the Pacific. They were intended to study the effects of nuclear weapons on naval ships, equipment, and materiel. Unlike almost all U.S. atmospheric tests that followed, CROSSROADS included no weapon development experiments. Operation CROSSROADS was the largest nuclear test operation and at the time the largest U.S. peacetime military operation ever conducted, involving 45,400 men, 220 ships, and 160 aircraft.

When the atomic bomb attacks on Japan abruptly ended World War II, many leaders believed that military science was at a crossroads. Vice Admiral W.H.P. Blandy, Commander of Operation CROSSROADS, commented that “warfare, perhaps civilization itself, has been brought to a turning point by this revolutionary weapon” and thus gave the operation its name.

Only weeks after the Hiroshima and Nagasaki attacks, some leaders in the U.S. government began proposing that the awesome power of this new atomic weapon be demonstrated to the world by inviting the international press to witness the dropping of one on an array of captured Japanese ships. The Navy, however, requested that the demonstration be broadened into a scientific test by including modern, fully equipped U.S. ships in the array and staging experiments designed to produce useful information not available from the TRINITY test or the Hiroshima and Nagasaki bombings. President Truman subsequently approved the detonation of three nuclear weapons—one-third of the U.S. stockpile at the time.

In January 1946, the Joint Chiefs of Staff created an organization to conduct the tests: Joint Task Force 1 (JTF), formed from elements of the Navy, the Army, the Army Air Force, and civilian scientists from the Manhattan Engineer District. This organization was modeled after joint task forces established during World War II for amphibious assaults, although with the added element of civilian scientists. A total of about 44,000 members of the armed services are on record as being participants of Operation CROSSROADS, and about 90 percent of these were Navy personnel.

Although the original purpose of the operation was to help the Navy improve the design of ships and naval tactics, the Army requested that experiments be added to study the effects of a nuclear detonation on Army equipment and installations. And the Army Air Force was eager for the opportunity to train its pilots in attack techniques using atomic bombs against ships. As planning progressed, more experiments were added to gather data on the nature, range, and duration of radiation intensities, to measure the blast, heat, radiation, and electromagnetic phenomenology from a nuclear detonation, and to develop techniques for long-range detection.

Table 8-3

<b>Shot Summary</b>				
<b>Shot</b>	<b>Local Date (1946)</b>	<b>Location</b>	<b>Burst Type</b>	<b>Yield</b>
ABLE	July 1	Bikini Lagoon	Airdrop (520 feet)	21 kilotons
BAKER	July 25	Bikini Lagoon	Underwater (-90 feet)	21 kilotons

Shot CHARLIE, a deep underwater detonation, was planned but never conducted. It was cancelled a few weeks after BAKER.

### **Preparations and Experiments**

Before CROSSROADS could begin, a site had to be found that offered these features: a protected anchorage; a location at least 300 miles from any city; no or very few inhabitants; a warm climate, free from violent storms; predictable winds; predictable water currents away from fishing areas, ocean shipping lanes, and inhabited shores; and control by the United States. After considering several sites around the world, the JTF chose Bikini Atoll at the northern extreme of the Marshall Islands.

Preparations in the Pacific began during spring 1946. In March, the 167 native Bikinians were permanently evacuated to neighboring Rongerik Atoll, 130 nautical miles (nmi) to the east, where the Navy built 26 house frames and infrastructure to help the evacuees adjust to their new home. The only structures built on Bikini were light recreation facilities, instrumentation towers, and a temporary construction camp. The support fleet of about 130 ships provided quarters, experimental stations, and workshops for most of the JTF. Additional JTF personnel were located on nearby atolls, such as Enewetak (190 nmi to the west) and Kwajalein (210 nmi to the southeast).

The focus of the operation was the unmanned fleet of more than 90 vessels anchored in Bikini Lagoon that served as the target array for both shots. These target ships included older U.S. capital ships—among them the famous aircraft carrier USS SARATOGA (CV 3) and battleships USS NEVADA (BB 36), USS PENNSYLVANIA (BB 38), and USS NEW YORK (BB 34)—three

captured German and Japanese ships; surplus U.S. cruisers, destroyers, and submarines; and a number of auxiliary and amphibious vessels. At the center of the array closest to the intended surface zero were expendable ships not expected to be usable after the operation. Some were expected to sink with the ABLE test and more with the BAKER underwater test. Ships on the perimeter of the array were active, commissioned vessels expected to suffer only minor damage, be reboarded, repaired, and remanned. Amphibious craft were beached on the lagoon side of Bikini Island to assess their ability to withstand waves created by the blast.

Much of the CROSSROADS experimental program consisted simply of exposing a wide range of equipment and materiel to the effects of the nuclear detonation and documenting the results. How well each ship's hull, superstructure, machinery, and electrical system would stand up to the blast and heat was a key question; consequently, some of the "war-weary" target ships had to be reconditioned at stateside Naval shipyards to return them to minimum standards. To simulate normal fighting condition, the target ships were provisioned with live ammunition, torpedoes, radar equipment, and standard amounts of fuel, food, and supplies. In addition, Army trucks, tanks, ammunition, gun mounts, radar and electrical equipment, aircraft parts, chemicals, fire-fighting equipment, lubricants, fuels, field stoves, and clothing were carefully arrayed on the decks of the target ships, documented, and photographed. The conditions of all compartments and systems of every ship were also examined and photographed. In addition, the medical group placed pigs, goats, guinea pigs, rats, mice, bacteria, seeds, and medical supplies on upper and lower decks.

More than 10,000 measuring devices (including 200 cameras) for collecting data on the effects of the detonation were positioned on the islands, the support fleet, and aircraft, with the majority being placed on the target fleet. The effect of the detonation on in-flight aircraft was measured by positioning specially instrumented planes at various distances from the blast. Those within the danger zone were remote-controlled drone aircraft.

After each shot, drone aircraft flew through the nuclear cloud to collect samples. Drone boats, which were the first craft to enter the lagoon, collected water samples and surveyed the radiation intensities before radiation monitors could be permitted to enter the area. As radiation levels allowed, specially trained boarding parties and then regular crews followed to reboard the ships, assess the damage, take photographs, and begin to collect data and prepare the ships for BAKER by replacing experiments and instruments. After BAKER, they planned to send equipment and samples to the continental United States for analysis, reboard and activate all salvageable ships, and scuttle those beyond repair.

## **Shot ABLE**

Immediately before Shot ABLE, the ships of the support fleet evacuated all personnel from the target fleet and from Bikini Atoll to safe positions at least 10 nautical miles east and upwind of the atoll. At shot time, about 80 JTF aircraft

were airborne. VIP observers on the support ships included U.S. Congressmen, representatives of the President and the Joint Chiefs of Staff, United Nations representatives, and a large contingent from the international press.

A B-29 named "Dave's Dream" released the weapon at 8:59 A.M. on July 1. The device detonated above Bikini Lagoon at an altitude of 520 feet, but it was off-target by 1500 to 2000 feet to the west of the planned surface zero, marked by USS NEVADA (BB 36). Five ships were sunk, 6 seriously damaged, 17 somewhat damaged, and 43 suffered "negligible damage." The amphibious craft beached on Bikini Island were unscathed. In general, vessels within 500 yards of surface zero were sunk or seriously damaged; those beyond 1500 yards received only minor damage.

The radioactivity created by the burst was low enough that within a day nearly all the surviving target ships had been safely reboarded. The ship inspections, instrument recoveries, and remooring necessary for Shot BAKER proceeded on schedule, and ships beyond 750 yards were safe enough to be used for crew quarters within 2 days. By July 5, all target vessels still afloat had been rehabilitated enough to be prepared for BAKER.

## **Shot BAKER and Its Aftermath**

Shot BAKER was expected to cause more damage to the target fleet than did ABLE because it was an underwater detonation and closer to the surface. It was also expected to produce more radioactive contamination in Bikini Lagoon—although no one knew how much more. As it turned out, contamination from BAKER caused major problems that persisted for months and threatened the overall success of the operation. Preshot procedures were essentially the same as those for ABLE: 68 target ships were moored in the lagoon and 24 small craft were beached on Bikini; all personnel were evacuated to the support fleet, which retreated upwind; and VIP observers and the press awaited the shot.

The BAKER device was suspended in a waterproof caisson 90 feet below one of the smaller vessels in the center of the target fleet. It was detonated on schedule at 8:35 A.M. on July 25. According to an eyewitness report, a "white chimney of water" rose up several thousand feet "its head enshrouded in a tumult of steam. Then slowly the pillar began to fall and break up. At its base a tidal wave of spray and steam rose to smother the fleet...." Another observer reported seeing a major ship "on its nose" before it sank (an optical illusion).

BAKER inflicted heavy damage on the target fleet. Eight ships, including SARATOGA, were sunk; eight more were seriously damaged. Even more important for the remainder of the operation, the detonation caused most of the target fleet to be bathed in radioactive water spray containing debris from the nuclear device, mixed with material dredged from the lagoon bottom.

The water in the lagoon near surface zero was intensely radioactive for several days. By July 30, many target ships remained too radioactive for boarding, and it was becoming apparent that the target fleet was much more heavily contaminated than had been expected. For all but 12 target vessels, the target fleet remained too radiologically contaminated to allow more than brief onboard

activities. Most of the thorough inspection and documentation of BAKER's effects, a primary objective of Operation CROSSROADS, was seriously delayed.

Within a week after the detonation, JTF commanders realized that they had to attempt to decontaminate the target vessels, even though they acknowledged that "since the nature and extent of contamination of the targets was completely unexpected, no plans had been prepared for organized decontamination measures." Beginning on August 1, work crews drawn from the target ships' companies sprayed and scrubbed the ships' exteriors—always under the supervision of radiation safety (rad-safe) monitors equipped with radiac instruments. Initially, decontamination proceeded slowly because safe time aboard some of the target ships was severely limited, sometimes to only a few minutes. Also, removing the radioactive particles imbedded in the paint, rust, and organic materials of the ships was a very slow and labor-intensive process. Crews experimented with a variety of techniques and decontaminating agents—including blasting with ground coconut shells, rice, ground coffee, and sand—but none worked well enough to significantly speed up the process.

In the meantime, radioactive contaminants in the water had spread to the lagoon anchorage of the support fleet. This became a serious problem as contamination accumulated in the ships' evaporators, saltwater piping, and marine growth on the outside of their hulls, potentially exposing shipboard personnel to low-level radiation.

By August 10, the increasing contamination of the support fleet, the futile decontamination effort of the target fleet, and finally the persistence of alpha radiation emitters (e.g., plutonium) on the ships forced the JTF to order an end to the decontamination work in Bikini and the towing of salvageable ships to Kwajalein Atoll, where they could be serviced in uncontaminated water. The move was completed by the end of September.

A major task at Kwajalein was to offload ammunition stored aboard some target ships before it became dangerously unstable, even though the ships were still contaminated. The work, which had to be carried out under strict radiation safety conditions, continued into fall 1946.

Eight of the major target ships and two submarines were eventually towed back to the United States and Hawaii for radiological inspection. Thirteen target ships that were only slightly contaminated were remanned and sailed back to the United States. The remaining target ships were sunk off Bikini Atoll, off Kwajalein Atoll, or near the Hawaiian Islands between 1946 and 1948. The support ships were decontaminated as necessary at Navy shipyards in the United States and rejoined the fleet after receiving operational clearance.

Scientists conducted a formal biological survey of Bikini Atoll in the summer of 1947 to study long-term effects of the CROSSROADS tests. They concluded that the nuclear detonations had caused only minor, transient disturbance to the plant and animal populations, most of which appeared to be growing normally. Also in 1947, Navy divers visited the ships that were sunk by the blast, where they documented their damage and retrieved instruments.



## Radiation Safety

When JTF began planning the radiation safety program for CROSSROADS, they had little experience in organizing such programs, only a few experienced radiation safety (rad-safe) officers, and inadequate equipment. A concentrated effort, however, in spring 1946 by veterans of the Manhattan Project and military officers created an organization that performed remarkably well during CROSSROADS. JTF personnel established rad-safe policies and procedures and a rad-safe organization, recruited military medical officers and others to train as rad-safe monitors, and rounded up enough radiac instruments to service ABLE (more equipment arrived just in time for BAKER).

The new rad-safe policies emphasized detection and avoidance. Procedures were developed to identify and label radiation areas and then to restrict who entered the areas and how long they stayed. JTF personnel also began developing decontamination techniques, although they were not prepared for the massive decontamination necessary after BAKER. And they established a system of personal dosimetry using film badges.

About 15 percent of JTF personnel were issued at least 1 of the approximately 19,000 film-badge dosimeters during CROSSROADS. Approximately 6600 personnel were on islands or ships that had no potential for radiation exposure. Those personnel expected to be at greatest radiological risk were badged, as were a percentage of each group working in less contaminated areas. Individuals were removed for 1 or more days from areas and activities of possible exposure if their badges showed more than 0.1 rem\* per day exposure.

\*Equals the roentgen (R) in contemporaneous documents.

## Radiation Protection Standards

Safety standards were established to limit the exposure of participants to the effects of nuclear detonations while, at the same time, allowing them to accrue small doses of radiation performing their missions in contaminated areas.

All CROSSROADS operations were undertaken under radiological supervision intended to keep personnel from being exposed to more than 0.1 rem per day (equivalent to the standard in 1946 for radiation workers in the United States). At the time, this was considered to be an amount of radiation that could be tolerated for long periods without any harmful effects on health. Apparently referring to an emergency situation, the Operation Plan also set forth that an individual was not to have a total dose of over 50 or 60 rem in 2 weeks (more than 1 year's dose permitted otherwise).

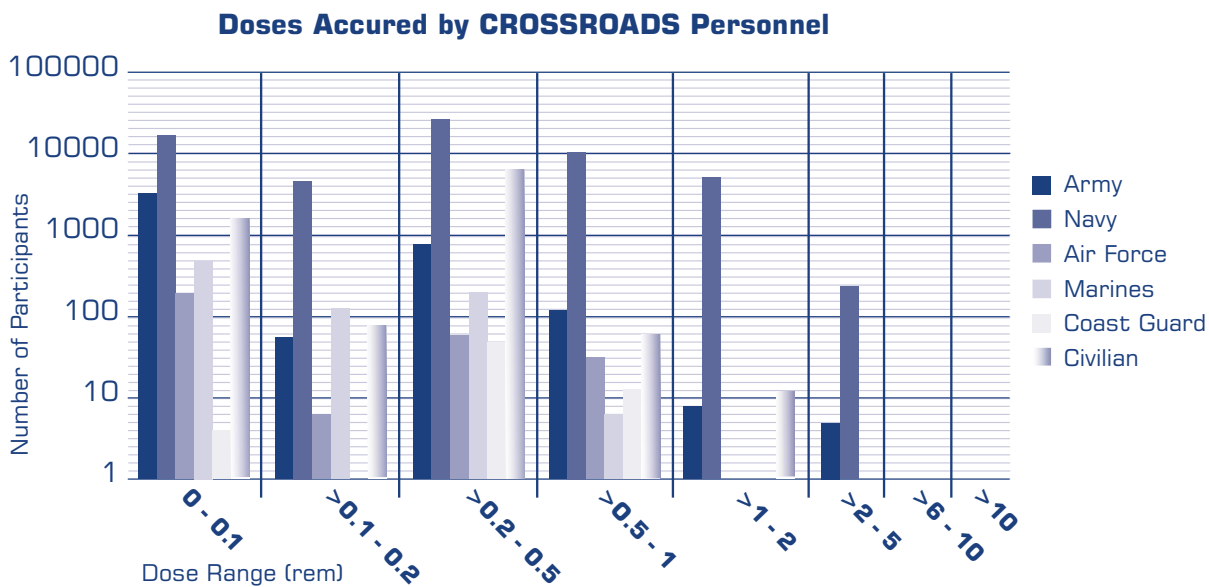
## Radiation Doses

Apart from the crew of a patrolling destroyer, USS O'BRIEN (DD 725), which encountered a slightly contaminated rain shower after BAKER, no personnel were exposed to fallout, which was blown by prevailing winds to the north, away from task force ships. The greatest potential for exposure to ionizing radiation was from the residual gamma radiation in the lagoon water and on the target ships contaminated by direct neutron activation or

indirectly from radioactive contaminants in water. There also was potential for exposure to alpha radiation from unfissioned nuclear debris.

Personnel doses have been reconstructed under the NTPR Program for the unbadged crewmembers of the ships. The analysis evaluated and combined the several sources of radiation during Operation CROSSROADS that an individual might have been exposed to, such as the contaminated lagoon water, low-level intensities on support ships, and radiation onboard contaminated target ships. The calculations relied upon radiation data recorded by radiation safety personnel in 1946, which have been entered into a computer model that includes such factors as the radiation-shielding properties of ships hulls and realistic patterns of daily personnel activity on weather decks and below. The actual movements of each ship were then used to reconstruct a generic dose for the crew. Calculated generic-crew doses range from 0 to 2 rem (gamma) for support ships. Doses for target crews that reboarded and remained on target ships after BAKER were on average higher than those for support ship crews. Uncertainty analysis provides the level of confidence in the calculated doses. See "Analysis of Radiation Exposure for Naval Personnel at Operation CROSSROADS" (DNA-TR-82-05, Vol. 1-3) for more details.

The highest doses accumulated during CROSSROADS were about 3 rem. Three-quarters of the participants had total doses of less than 0.5 rem. The totals of reconstructed and film badge doses for CROSSROADS participants are identified below.



For more information, see Defense Nuclear Agency (DNA) Report 6032F entitled OPERATION CROSSROADS 1946. It is available from the National Technical Information Service (NTIS), order number ADA146562. DNA-TR-82-05, volumes 1-3 are also available from NTIS under the following order numbers: ADA152702; ADB090882 and ADB090883. The telephone number for NTIS is (703) 605-6000; the NTIS website is [www.ntis.gov](http://www.ntis.gov)

August 2003

# 9

## Appendix 9:

# Information from the DNA Publication “For the Record” about Operation Castle



From For the Record – A History of the Nuclear Test Personnel Review Program, 1978-1993, by F. Gladeck and A. Johnson, Defense Nuclear Agency, DNA 6041F, March 1996.

### 6.10 OPERATION CASTLE

CASTLE was conducted at Enewetak and Bikini Atolls during the spring of 1954. The first event of this series, Shot BRAVO, had a yield of 15 megatons and was the largest device ever detonated by the U.S. Government as part of atmospheric nuclear weapons testing. [Table 6-19](#) provides specifics on this detonation, shown in [Figure 6-8](#), as well as the other five in the series (Martin and Rowland, 1 April 1982, p.1):

Table 6-19

Castle Shots			
Shot	Date (1954)	Type	Yield
BRAVO	1 March	Surface	15 megatons
ROMEO	27 March	Barge	11 megatons
KOON	7 April	Surface	110 kilotons
UNION	26 April	Barge	6.9 megatons
YANKEE	5 May	Barge	13.5 megatons
NECTAR	14 May	Barge	1.69 megatons

#### 6.10.1 Background and Objectives of Operation CASTLE

CASTLE was the culmination in the development of the hydrogen bomb that began in 1950. Shot GEORGE, a test in the 1951 GREENHOUSE series, had demonstrated the initiation of a sustained thermonuclear reaction by use of a fission reaction. Fusion, or thermonuclear, reactions had been used in 1952 to generate the very powerful detonation of the MIKE device in Operation IVY, but MIKE was not a deliverable nuclear weapon. In BRAVO,

the first CASTLE test, a device more powerful than MIKE was exploded that, although not a weapon, was capable of delivery by an aircraft.

CASTLE also was the first Pacific series in which LLNL provided a nuclear device for testing, detonated as Shot KOON. All previous nuclear test devices had been designed at LANL (Martin and Rowland, 1 April 1982, p.26).

### **6.10.2 CASTLE Test Operations**

Numerous technical experiments were carried out in conjunction with each of the six detonations. These experiments measured the yield and efficiency of the devices and attempted to gauge the military effects of the explosions. The approximately 18,500 verified DoD participants in this series had duty stations at the AEC design laboratories or were members of units performing separate experiments or various support roles (JAYCOR, 6 October 1993). Almost all of the Navy support personnel were at Bikini, where Navy ships provided living quarters for participants who were evacuated from the islands for the first test and then could not return to live there because of the potential for radiation exposure from BRAVO fallout (Martin and Rowland, 1 April 1982, p.2).

### **6.10.3 Dose Summary for Operation CASTLE**

Among the CASTLE detonations, only BRAVO produced significant, unexpected personnel radiation exposures. This first shot of the series, which significantly exceeded its expected yield, released unprecedented quantities of radioactive materials into the atmosphere. Ambient winds dispersed the radioactive particles over a much larger area than had been anticipated. This resulted in contamination and exposure of Marshall Island residents, Japanese fishermen, and U.S. personnel on distant atolls or aboard various vessels. Acute radiation effects were observed among some of these people.

Some DoD personnel exceeded the maximum permissible limit of 3.9 R (rem) of gamma radiation within any 13-week period of the operation. BRAVO fallout on some Navy ships resulted in personnel who had doses approaching or exceeding this limit. To allow for completion of the CASTLE tests, it became necessary to issue a number of waiver authorizations permitting doses of as much as 7.8 R (rem) to specific individuals. In a limited number of shipboard cases, even this level was exceeded. Substantial overdoses from BRAVO, the highest for any test series, were accrued by the 28 Air Force and Army personnel on Rongerik Atoll. Film badge readings suggest that three members of the U.S. Navy Bikini Boat Pool also may have received substantial doses in excess of the series limits; however, a thorough investigation at the time failed to indicate reasons for these readings (Martin and Rowland, 1 April 1982, pp.243-244). As a result of BRAVO, 21 individuals on USS PHILIP (DDE 498) and 16 on USS BAIROKO (CVE 115) sustained lesions that were classified as beta burns, all of which healed without complications (Martin and Rowland, 1 April 1982, pp.243-244).

**Table 6-20** summarizes available dosimetry data.

Table 6-20

<b>Summary of external doses of Operation CASTLE as of 30 September 1993</b>							
<b>Gamma dose R (rem)</b>							
	0	>0-0.5	>0.5-1.0	>1.0-3.0	>3.0-5.0	>5.0-10.0	>10.0
Army	27	338	795	344	65	13	2
Navy	417	4,359	1,457	2,385	686	336	12
Marines	3	169	8	99	29	5	0
Air Force	286	807	201	967	63	32	32
Field Command	4	3	3	8	0	0	0
Total for Each Column	737	5,676	2,464	3,803	843	386	46
<b>Cumulative total</b>							13,955

Shot BRAVO, 1 March 1954.



(Air Force, Lookout Mountain Laboratory Photograph, 22-AQB-1-13, BRAVO, 1954.)

Figure 6-8



# 10

## **Appendix 10:**

# Mortality and Cancer Frequency Among Military Nuclear Test (Smoky) Participants, 1957 through 1979



## **Appendix 10a**

Journal of the American Medical Association. 1983 Aug; Volume 250, Number 5, pages 620-624

### **Authors**

Glyn G. Caldwell, MD; Delle Kelley; Matthew Zack, MD; Henry Falk, MD; Clark W. Health, Jr., MD

### **Introduction**

In this follow-up to a previous report, the authors undertook to identify and locate all test participants and to ascertain their health status and causes of death during the 22 years following the nuclear test "Smoky," detonated on August 31, 1957. This report adds information on incidence of neoplastic diseases and on mortality from all causes.

### **Subjects and Methods**

Several sources provided identifying, locating, and health status data about the Smoky test participants since no single source contained all the needed information. The number investigated was 3,072 of the 3,217 test participants on military maneuvers during the 1957 nuclear test. If a participant reported a malignant neoplasm, the authors attempted to confirm the presence and type of neoplasm. They accepted the cause of death for conditions other than malignant neoplasm as recorded on the death certificate. Person-years at risk were used for calculating the expected incidence and mortality. Expected incidence was calculated by applying age- and sex-specific rates for the person-years accumulated by the Smoky cohort from 1957 through the end of 1979. The gamma radiation exposure data were cumulative, as reported on all film badges for 1957. No primary data were available for other radiation types and the data for beta radiation exposures were limited to Smoky film badges.

### **Results**

**Incidence of Neoplasms:** The number of newly diagnosed cancer cases (112) did not exceed the number expected (117.5) for the 22-year follow-up. However, the leukemias showed a statistically significantly increased incidence. All cancers not listed and cancers of unknown site were also

statistically significantly increased. Cancers of the digestive, respiratory, genital, and urinary systems occurred less often than expected. No cases of cancer of either bones and joints, soft tissues, endocrine system, or multiple myeloma were found. When cancer frequency was analyzed by unit, some had slightly more cancer cases than expected, but none of these increases was statistically significant. The largest increases occurred in the smaller units.

The authors previously reported information about the dates of birth, diagnosis, and cumulative gamma radiation exposure in 1957 for the leukemia cases. Since that report, they have identified and confirmed by medical records review an additional case of chronic myelocytic leukemia diagnosed in 1978. This case occurred in a participant who had been treated with radiation for a lymphoma that was diagnosed in 1976. Pertinent data showed that he was 28 years old, received 140 mrem of cumulative gamma radiation during 1957; the latent period was 19 years. The authors were unable to document the total amount of radiation given for treatment of his lymphoma.

**Mortality:** This cohort had considerably fewer total deaths than expected from the mortality rates for all United States males. Increases in the number of deaths occurred in only three categories – infectious and parasitic diseases, accidents, and killed in action. Only in the latter category was the increase statistically significant. Deaths from individual types of cancer showed excesses in five groups – skin melanoma, genital system, eye and orbit, brain and nervous system, and leukemia. Only the number of deaths from leukemia is statistically significant compared with the expected number of deaths calculated from US male death rates.

**Radiation Exposure:** The cumulative 1957 gamma radiation exposure for various groups of participants showed generally low exposures, well within the occupational safety limit of 5,000 mrem/yr. Only 14 persons received exposure between 5,000 and 10,500 mrem. When the mean cumulative gamma radiation exposure was reviewed, the field units had, in general, somewhat higher cumulative gamma radiation exposure readings. The other support units had lower cumulative gamma radiation exposure but a higher frequency of cancer; this result is an apparent contradiction if radiation was the causal factor.

## **Comment**

These data showed a statistically significant increase only for leukemia incidence and mortality. These findings are consistent with those previously reported when 76% of the participants had been contacted. The additional leukemia case did not change the results previously reported in any major way. Although the reasons for undertaking this study in early 1977 were the report of this leukemia case in one participant and his fear that other unreported cases had occurred, the authors expected that some kind of accident was most likely. They did not expect to find only the small exposures recorded on the film badges.



This follow-up added little to resolve the exposure-level controversy because of the uncertainty surrounding the claims and counterclaims of the reported exposure data. In any case, the exposures reported were low. Previous studies that reviewed exposure data reported only small differences from theoretical calculated exposures, but they may not entirely account for the possibility of exposures not recorded on the film badges. However, these data could not resolve this question because of the small number of persons involved, the potential bias of case and group selection, and the possible loss of other cases in the unlocated participants. Further support for the idea that the overall radiation exposures were low is the result from the review of the cancer occurrence and radiation exposure of the individual units. Although some units had an increased cancer frequency, most were not the field units that generally had higher mean cumulative gamma exposures, because the latter spent more time in the fallout fields on the day of detonation. Finally, most of the statistically insignificant cancer increases occurred in 15 of 36 units with mean cumulative gamma exposures less than the overall mean (456 mrem).

This study showed only an increase in frequency of occurrence of leukemia and death from leukemia that confirms the index case's impression about the Smoky participants. However, the low overall cancer incidence and mortality, the low level of exposure (uncertain as it was), and the lack of correlation between field unit and mean cumulative radiation exposure suggested that this one positive finding may be either attributable to chance or the result of an unknown combination of factors. Furthermore, this conclusion cannot be generalized to include participants at other nuclear tests or resolve the low-dose controversy.

## **Appendix 10b**

### **Cancer Mortality Risk Among Military Participants of a 1958 Atmospheric Nuclear Weapons Test**

American Journal of Public Health. 1995 Apr; Volume 85, Number 4, pages 523-527

#### **Authors**

Kevin K. Watanabe, M.S., Han K. Kang, Dr. P.H., and Nancy A. Dalager, M.S.

#### **Introduction**

In view of the findings of earlier studies and the continuing concerns for the health of veterans who participated in nuclear weapons tests, this study of the military participants of the Hardtack I test series was undertaken to determine whether they were at higher risk for dying from certain cancers. This test series was not included in previous studies and was selected because it had one of the highest proportions of participants with film dosimetry data.

#### **Identification of Study Subjects**

Of the 13,910 verified participants of the Hardtack I test series, 13,713 served in the military. A total of 2,382 of the veterans who served in multiple test series were excluded from the study cohort because of the difficulty in determining the contributory effect of their participation in other nuclear tests. Of the remaining 11,331 veterans, 2,777 served in branches other than the Navy and were excluded. The resulting 8,554 Navy veterans were included in this study cohort; they had a median gamma level of 388 mrem. A total of 14,625 veterans were included in the non-participant Navy group. Radiation dosage information was determined by individual film badges for 88% of the veterans. Estimated doses were calculated for the remaining individuals by using the film badge levels of those who served in the same military unit or occupation.

#### **Vital Status Determination for Mortality Analysis**

Each of the veterans was followed for vital status from September 1, 1958, the month after the last Hardtack I test, until his death or September 1, 1991, whichever occurred first. Vital status was determined by matching the subjects' names and military service numbers against those in the VA Beneficiary Identification and Record Locator Subsystem (BIRLS). The underlying cause of death for each subject was coded.

#### **Statistical Methods**

The analysis of the mortality data was approached in three stages. In stage 1, a simple comparison of the relative frequency of overall deaths as well as of specific causes of death was made between the Hardtack participants and

the non-participant Navy veterans based on person-years at risk. In stage 2, the Cox proportional hazards model was used to estimate mortality risk among overall Hardtack participants as well as among a specific exposure group relative to the mortality of risk among the non-participant veterans. In stage 3, cause-specific number of deaths in both groups of veterans were compared with the number of expected deaths.

## Results

There was a significant excess of deaths among the Hardtack participants from all causes. Mortality from cancer of the digestive organs was also significantly elevated among the Hardtack participants compared with the non-participant veterans. However, mortality rates from all cancers combined and from many other a priori cancers of interest were not statistically elevated. Further analysis of leukemia, excluding chronic lymphocytic leukemia, was conducted and no significant difference was found. None of the Hardtack participants, and only two non-participant veterans, died from chronic lymphocytic leukemia.

The Hardtack participants in each radiation gamma dose category were compared with the non-participant veterans using the proportional hazards model. Statistically significant relative risks were observed for all causes, all cancers, and liver cancer in the high-dose (>1000 mrem) group, for pancreatic cancer in the medium-dose (251 to 1000 mrem) group, and for cancer of the digestive organs in the low-dose (0 to 250 mrem) group. The number of deaths due to liver cancer was small. When both groups were compared with the general US population, the only risk that was significantly elevated was for prostate cancer among the Hardtack participants.

## Discussion

Unadjusted rate ratios from all causes of death and from cancer of the digestive organs were significantly elevated for Hardtack participants compared with the non-participant veterans. Cancer of the prostate was significantly elevated among the Hardtack participants compared with US men and higher among the participants compared with the non-participants, but it was not significantly significant.

Estimates of the external radiation doses for the participants were reported to be so low (<0.5 rem for most veterans) that no detectable increase in cancer risk would have been expected on the basis of cancer risk estimates derived from high-dose studies. There were an estimated 32 excess cancer deaths in this study; therefore, the cancer risk observed in the Hardtack participants is about five to six times larger than the projected magnitude of risk.

There are several possible explanations for this result. First, the observed excess risk among Hardtack participants may have been a spurious association due to statistical aberrations including multiple comparisons. Second, the risk estimates become very uncertain when applied to very low dose. Third, the Defense Nuclear Agency's estimates of radiation exposure levels for the

Hardtack participants might have been much lower than the actual exposure levels. The accuracy of those estimates has been questioned, especially when the dose levels were reconstructed without measurements from film badges.

Among the several limitations of the study: the reliance on death certificates rather than on medical records for information on cause of death; no information was available on potential confounders, such as smoking and drinking habits of the veterans and their post service exposure to known occupation carcinogens; and the study veterans as a group were still relatively young and more than 87% of them were still alive at the end of the follow-up period. The major advantage of this study was the inclusion of a Navy veteran comparison group.

In summary, although reported radiation doses for the Hardtack participants were generally under 500 mrem, the possibility that the veterans who participated in the atmospheric nuclear test may be at an increased risk of death from certain cancers cannot be ruled out at this time. This group of veterans should continue to be monitored for their mortality outcomes.

## **Appendix 10c**

### **Mortality of Veteran Participants in the CROSSROADS Nuclear Test**

Washington, DC: National Academy Press, 1996

#### **Author**

Christopher Johnson, Susan Thaul, William F. Page, Harriet Crawford with oversight from the National Academy of Sciences' Institute of Medicine Committee on the CROSSROADS Nuclear Test

#### **Preface**

In response to Public Law 98-160 that directed the Department of Veterans Affairs (VA) to provide for the conduct of epidemiological studies of the long-term adverse health effects of exposure to ionizing radiation from detonation of nuclear devices, a proposal was made to compare the mortality experience of veteran participants in the CROSSROADS nuclear test to a similar group of non-participants. Operation CROSSROADS involved approximately 40,000 military personnel, mostly Navy, and occurred in July of 1946 at the Bikini Atoll in the Marshall Islands.

#### **Summary**

A roster of CROSSROADS participants was assembled and provided to the Medical Follow-up Agency (MFUA) by the Nuclear Test Personnel Review (NTPR) program of the Defense Nuclear Agency. A validation study found that the final roster captured between 93 and 99 percent of the military personnel who participated in Operation CROSSROADS. The mortality data gathered from VA records were validated by sample comparisons with other national data sources. By the study cut-off date, 31 December 1992, 31.3 percent of the participants and 30.8 percent of the comparison cohort were known to have died. Cause of death was available for 86.3 percent of the participants and 89.3 percent of the controls. The study looked at three principal causes of mortality (all-cause, all-cancer, and leukemia) and hypothesized that increases in the latter two could result from radiation exposure. For descriptive purposes, comparisons between participants and the comparison group for 44 other disease categories were also presented. Findings stated in this report follow:

Among Navy personnel, the primary analysis group for the study, participants at the CROSSROADS nuclear test experienced higher mortality than a comparable group of nonparticipating military controls. The increase in all-cause mortality was 4.6 percent and was statistically significant. For malignancies, the elevation of mortality was lower and was not statistically significant. Similarly, leukemia mortality relative risk was elevated, but not significantly and by less than all-cause mortality. The increase in all-cause mortality did not appear to concentrate in any of the disease groups

considered. Of the 44 other specific cancers and disease categories examined, there were no statistically significant increases in mortality. The overall elevation of mortality rate ratios for malignancies and leukemias in the participants were not statistically significant and, in fact, were lower than for many other causes of death.

Navy mortality due to all malignancies and leukemia did not vary substantially among the exposure surrogate groups (i.e. those who boarded target ships after a detonation vs. those who did not, and those enlisted personnel who had an Engineering & Hull (E&H) occupational specialty vs. those in other specialties).

Participants who boarded target ships were thought to be more highly exposed than the rest of the participant group. Relative to the controls, boarding participants experienced a 5.7 percent increase in all-cause mortality, whereas the non-boarders experienced a 4.3 percent increase. Aside from all-cause mortality, risks for boarding participants did not significantly exceed those for controls for any of the disease categories, and risk relative to controls were similar for boarding and non-boarding participants. The increase in risk for all-malignancies among the participants was 2.6 percent for boarders and 1 percent for non-boarders. For leukemia, the increase in mortality risk for boarders was 0.7 percent and for non-boarders, 2.4 percent. The difference between boarders and non-boarders could be due to chance.

Those Navy participants holding an E&H occupational specialty were thought to be more highly exposed to radiation than their non-E&H counterparts. However, the E&H participants had essentially the same risk of mortality from all causes as non-E&H participants. For all malignancies and leukemia, the rate ratios were somewhat higher, but both could be attributed to chance. Risk ratios for leukemia and malignancies among E&H controls showed a similar elevation relative to non-E&H controls, suggesting that a factor specifically associated with CROSSROADS was not likely to have been the cause.

## Conclusions

These findings do not support a hypothesis that exposure to ionizing radiation was the cause of increased mortality among CROSSROADS participants. Had radiation been a significant contributor to increased risk of mortality, then significantly increased mortality due to malignancies (particularly leukemia) should have been seen in participants thought to have received higher radiation doses relative to participants with lower doses, and to unexposed controls. No such effects were observed. This study, however, was neither intended nor designed to be an investigation of low-level radiation effects, per se, and should not be interpreted as such.

In comparing the findings and methods employed in this study with those of other investigations of atomic veteran mortality, a possible self-selection bias in the participant cohort was identified: participants who died of a disease (particularly cancer) may have been more likely than healthy participants to have been identified to the NTPR, and hence become a part of the study. Such a bias could have resulted in an apparent increase in

death rates among the participants. Data were not available with which to make a good quantitative estimate of this potential bias. However, mortality from all malignancies and leukemia was lower, not higher, than the increase in all-cause mortality. These factors suggest that a self-selection bias was not entirely responsible for the finding of increased all-cause mortality in study participants.

The authors believe that the elevated risk of all-cause mortality in CROSSROADS participants relative to a comparable military comparison group is probably the result of two factors. The first is an unidentified factor, other than radiation, associated with participation in, or presence at, the CROSSROADS test. The second is a self-selection bias within the participant roster. However, the relative contributions of these two explanations cannot be accurately determined within available resources for this project.

## Appendix 10d

### **Cancer Mortality Among the Highest Exposed U.S. Atmospheric Nuclear Test Participants**

J Occup Environ Med, Volume 42, Number 8, August 2000, pages 798-805

#### **Author**

Nancy A. Dalager, M.S., Han K. Kang, Dr. P.H., Clare M. Mahan, Ph.D.

#### **Introduction**

An estimated 205,000 military personnel participated in the U.S. atmospheric nuclear weapons testing program conducted from 1945-1962. Nineteen major atmospheric nuclear test series consisting of numerous individual weapons tests were conducted. Participants were exposed to varying doses of low ionizing radiation. The objective of this study was to determine whether veterans, who participated in the U.S. atmospheric nuclear weapons tests and whose external gamma radiation doses met or exceeded the current federal occupational guideline of 5 rem per year, have experienced increased overall as well as site specific cancer mortality compared to a cohort of military personnel with a history of very low radiation doses.

#### **Methods**

The dose estimates provided for this study by the Defense Nuclear Agency (DNA) database of all veterans who participated in the U.S. atmospheric nuclear weapons testing program represent only external gamma radiation doses. For each test participant, external gamma radiation dose estimates were summed over all the separate detonations within a particular nuclear test series to obtain a series-specific dose. All nuclear test participants serving in the military who had a series-specific gamma radiation dose equal to or greater than 5 rem were selected to be study subjects (1,010 veterans). A group of 2,870 low dose Navy HARDTACK I veterans (identified in this study as Navy controls) were utilized as a comparison cohort.

The 5 rem and over study participants were followed for vital status from the initial date of the test series in which they received their 5 rem or over external gamma radiation dose until December 31, 1996; the start of follow-up varied for these veterans. An indication of death was ascertained from three sources and underlying cause of death and contributing causes were coded.

For multivariate adjustments, the Cox proportional hazards model was used to calculate relative risk estimates of the cause-specific mortality of the 5 rem cohort compared to the mortality of the control cohort. Separate analyses were conducted that utilized the life table method of survival analysis to evaluate the probability of death from all causes and from selected site-specific cancers in eight 5 year intervals of time since radiation dose.



## Results

Fifteen of the 19 major U.S. atmospheric nuclear test series conducted from 1945 through 1962 were represented by the group of veterans selected for this study. The total number participating in a specific test series varied widely as did the specific details surrounding each individual test series. The number of series-specific veterans with a 5 rem or more dose in these analyses ranged from 1 to 396.

A subset of 374 veterans who served in the Navy were identified within the cohort of all 5 rem or over participants. A Navy only 5 rem cohort provided for an additional comparison to the Navy controls that is unbiased with respect to branch of service. Except for differences in their radiation doses, these two Navy cohorts should be very similar. The mean radiation dose levels of the total 5 rem and Navy only 5 rem cohorts were approximately 100 times that of the Navy control cohort. The mean radiation doses for the total 5 rem and Navy only 5 rem cohorts were very similar; however, the highest radiation doses were experienced by veterans who served in a branch of service other than the Navy.

The adjusted relative risk estimates from the Cox regression modeling for all veterans with a 5 rem or more radiation dose compared to the Navy controls showed that statistically significant elevated relative risks were observed for all causes of death and for the category of all lymphopoietic cancer. The adjusted relative risk estimates for the Navy only 5 rem cohort compared to the Navy controls showed that statistically significant elevations in the adjusted relative risk estimates were observed for mortality from all causes of death, all lymphopoietic cancers, and the sub-category of miscellaneous lymphopoietic cancers.

Results from the survival analysis for the 5 rem cohort compared to the Navy controls and the Navy only 5 rem cohort compared to the Navy controls were very similar in magnitude and statistical significance to the relative estimates derived from the multivariate Cox proportional hazards model. After forty years of follow-up, the Navy controls experienced a higher probability of survival than the entire 5-rem cohort. The difference in the two survival curves was statistically significant at the .05 level.

## Discussion

The number of veterans included in this study with radiation doses of 5 rem or higher was significantly larger than in any previous study. The availability of a control group of Navy test participants with radiation doses that on the average were only 1/100 of the mean dose experienced by the 5 rem cohort and a Navy only subset of the 5 rem group were added strengths of this current study.

Compared to the Navy controls, the U.S. atmospheric nuclear test participants who met or exceeded the federal guidelines of an external gamma radiation dose of 5 rem had significantly elevated adjusted relative risk estimates for mortality from all causes of death, all lymphopoietic

cancers, and the subcategory of miscellaneous lymphopoietic cancers. Mortality from leukemia was somewhat elevated, but not statistically significant. When the analysis was restricted to Navy only 5 rem participants compared to the Navy controls, the patterns of excess mortality were similar although somewhat greater than those observed for the entire group of 5 rem participants.

In summary, the U.S. atmospheric nuclear test participants examined here included a group of veterans who received the highest external gamma radiation doses of those recorded for U.S. military personnel. Their radiation doses met or exceeded the current federal occupational guideline of 5 rem per year. While the mortality from all causes and from all lymphopoietic cancers combined among the 5 rem and over veterans was significantly elevated over that of the comparison veterans, the lack of a statistically significant excess in the deaths from many of the known radiogenic cancers, suggests that the excesses in mortality observed in these analyses may be the result of many factors of which radiation was only one.

## **Appendix 10e**

### **The Five Series Study: Mortality of Military Participants in U.S. Nuclear Weapons Tests**

Washington, DC: National Academy Press, 1999

#### **Author**

Susan Thaul, William F. Page, Harriet Crawford, Heather O'Maonaigh with oversight from the National Academy of Sciences' Institute of Medicine Committee to Study the Mortality of Military Personnel Present at Atmospheric Tests of Nuclear Weapons

#### **Introduction**

More than 200,000 U.S. military personnel participated in atmospheric nuclear weapons tests between 1945 and the 1963 Limited Nuclear Test Ban Treaty. Questions about these tests persist, such as whether test participation is associated with the timing and causes of death among the participants. This report provides the results of a mortality study of the approximately 70,000 soldiers, sailors, and airmen who participated in at least one of five selected U.S. nuclear weapons test series in the 1950s and nearly 65,000 comparable nonparticipants, the referents. The study examines whether participants died sooner than non-participants or were more likely to die from specific causes such as leukemia. The investigation, based on more than 5 million person-years of mortality follow-up, represents one of the largest cohort studies of military veterans ever conducted.

#### **Methods**

This study addresses one primary question: Did participation in at least one of the five selected nuclear weapons test series change the risk of death for the military personnel involved. The study, however, does not address questions concerning the relationships between test participation or radiation exposure and nonfatal adverse health effects. The participant cohort (predominantly white and male) was identified from the database maintained by the Nuclear Test Personnel Review Program (NTPR) at the Defense Threat Reduction Agency. Substantial effort was placed into validating the participation list. The participant cohort's mortality experience was compared with that of a referent cohort of military personnel comparable to the participants. Department of Veterans Affairs (VA) records and databases provided fact of death for members of both cohorts.

Using two analytic techniques, the proportional hazards model and standardized mortality ratios, differences between the participant and referent cohorts were tested in all-cause, all-cancer, and leukemia mortality. Analyses based on the proportional hazards model involved direct comparisons of the participant and referent cohorts, whereas standardized mortality ratios involved comparison of each group, separately, with external population rates.

Further exploration included other outcomes and possible differences in effect for participants of test series conducted at the Pacific Proving Ground (sea series) and participants at the Nevada Test Site (land series).

## Findings

The study found that during the follow-up period: (1) overall, participants and referents had similar risks of death; (2) participants and referents had similar risks of death from cancer; and (3) specifically, participants had an apparent 14 percent higher risk of leukemia death than the referents, although that difference was not statistically significant and could be a chance finding. Overall, no statistically significant differences in all-cause, all-cancer, or leukemia mortality between participants and referents are evident, although the participant risk of leukemia is 14 percent higher than the referent risk.

The leukemia findings do not resolve the debate over whether either participation in general, or the radiation doses in particular, are associated with leukemia mortality. The set of leukemia findings is broadly consistent with a hypothesis that these are radiation effects, but is not conclusive. Only a study cohort four times the size of the one available would have been likely to identify the observed leukemia risk as statistically significant. The sample size available did not provide sufficient power to achieve statistical significance for risks of the magnitudes observed.

Across broad categories of non-cancer deaths, participants and referents had the same mortality risk, except for death due to external causes, for which participants had a significantly higher risk. Neither information about the nuclear tests or current understanding of radiobiology helps to explain this observed higher risk. Statistically significant increases in mortality from nasal cancer and prostate cancer were also found.

Mortality ascertainment in this study was hampered by a lack of a nationwide records system that covered the entire study follow-up period. Stated generally, the mortality ascertainment was slightly more complete for participants than for referents. This could have contributed to the study findings of increased mortality risk among participants. However, all-cause mortality was actually lower among participants than referents.

## Discussion

The size, length of follow-up, and persistence of data collection efforts involved in this study assure that the reported findings are valid. It is unlikely that another cohort study of this type and magnitude would provide more precise answers than this one, because any atomic veteran study of this kind would confront the same methodological problems, namely inadequate exposure (dose) data and imperfect mortality ascertainment, encountered in this Five Series study.

Stronger supporting evidence could be acquired from a further study that would make use of data on radiation dose if those data could be developed. Although the oversight committee concluded that the dose data in their

current form were unsuitable for epidemiological analysis, it also concluded that carefully carried out custom dose reconstructions done anew for selected participants, using consistent methodology, could provide usable dose data. An efficient research design (to minimize the prohibitive cost of custom dose reconstructions) requiring fewer individuals could focus on specific endpoints of interest, such as leukemia. The pattern of radiation dose among the leukemia deaths (cases) would be contrasted to the pattern among a sampled set of participant controls to assess a hypothesized dose-response association.

One of the primary conclusions of the study is that the participant group as a whole did not experience widespread early death. Even for leukemia, for example, there was an estimated 25 excess deaths in the participant cohort. The report findings do not rule out, however, possible risk among distinct subgroups of test participants.



# 11

## Appendix 11:

# Specific Diagnoses Reported\* Based on Approximately 23,000 Ionizing Radiation Registry Examination Code Sheets



### **SPECIFIC DIAGNOSES REPORTED\* BASED ON APPROXIMATELY 23,000 IONIZING RADIATION REGISTRY EXAMINATION CODE SHEETS**

Skin cancer . . . . .	1185
Posterior subcapsular cataracts . . . . .	383
Lung cancer . . . . .	292
Colon cancer . . . . .	242
Urinary bladder cancer . . . . .	175
Nonmalignant thyroid nodular disease . . . . .	106
Leukemia, other . . . . .	78
Kidney cancer . . . . .	75
Thyroid cancer . . . . .	51
Multiple myeloma . . . . .	38
Bone cancer . . . . .	32
Esophageal cancer . . . . .	31
Stomach cancer . . . . .	29
Primary liver cancer . . . . .	26
Salivary gland cancer . . . . .	21
Pancreatic cancer . . . . .	14
Cancer of the prostate . . . . .	10
Breast cancer . . . . .	7
Myeloid leukemia . . . . .	2
Ovarian cancer . . . . .	1
Brain and CNS tumors . . . . .	1
Non-Hodgkin's lymphoma . . . . .	1

[In addition to the veterans' diagnoses, there were 1091 IRR code sheets reporting birth defects in children and/or grandchildren]

**\*NOTE:** This listing would not include diagnoses made on veterans subsequent to their IRR examinations unless a revised IRR code sheet form was submitted. This listing also does not include diagnoses for which there was no reporting field on the IRR code sheet at the time the examinations were performed, diagnoses coded as "other malignancies not listed" or as "other possible radiogenic diseases".





# 12

## **Appendix 12:**

# Adverse Reproductive Outcomes in Families of Atomic Veterans: The Feasibility of Epidemiologic Studies



Washington, DC: National Academy Press, 1995

### **Author**

National Academy of Sciences' Institute of Medicine. Committee to Study the Feasibility of, and Need for, Epidemiologic Studies of Adverse Reproductive Outcomes in the Families of Atomic Veterans

### **Preface**

At the request of the Department of Veterans Affairs and as mandated in Public Law 103-446, Section 508, enacted on November 2, 1994, the Medical Follow-up Agency (MFUA) of the Institute of Medicine (IOM) established a committee to (1) review the available data and scientific literature on the health effects of exposure to ionizing radiation and (2) prepare a report on the feasibility of studying veterans exposed to ionizing radiation and the risk of health effects in their spouses, children, and grandchildren. This report is the result of the committee's work; the document presents the committee's assessment of the feasibility of studies of adverse reproductive outcomes in families of servicemen exposed to ionizing radiation.

### **Summary**

The feasibility of a study hinges largely on the answers to four questions: (1) How is a suitable sample or cohort of exposed persons affected among the total at risk to be defined, and can this be done without inadvertently introducing selection biases? (2) Will that sample or cohort be large enough to reveal effects of the magnitude anticipated on the basis of present knowledge? (3) What is the probable dose distribution among the members of that sample or cohort, and how reliable are the individual dose estimates? (4) What approaches are available for identifying adverse reproductive outcomes accurately and completely? Each of these questions is considered separately in the report.

To evaluate the feasibility of conducting an epidemiologic study, the committee thought the report should begin with a review of the fundamental principles of epidemiology, radiation biology, and genetics. This review is then followed by discussions of current information on the

risk of genetic mutations due to environmental exposure, definitions and possible causes of adverse reproductive outcomes, the factors to be considered when determining the feasibility of a study, and finally, a review of possible alternative approaches for evaluating the health effects of exposure to low levels of ionizing radiation.

The task of the committee, as elaborated by the VA, was to address three questions. The questions and the committee's conclusions follow. The background information and rationale that served as a basis for these findings are described in detail in the full report.

**1. Is it possible to conduct an epidemiologic study to determine whether there is an increased risk of adverse reproductive outcomes in the spouses and of adverse health effects in the children and grandchildren of Atomic Veterans?**

**Conclusion:** The committee's assessment was that there are insurmountable difficulties in finding and contacting a sufficiently large number of study subjects (offspring of Atomic Veterans), in establishing an accurate measure of dose for each veteran, in detecting the extremely small potential risk at low doses, in identifying and reliably documenting reproductive outcomes over a fifty year interval, and in the measuring of other factors that have been observed to cause reproductive problems, and therefore, might confound any observed relationship between radiation exposure and reproductive problems. These difficulties become even greater in the grandchildren of these veterans. The committee concluded, therefore, that the cohort of Atomic Veterans did not provide a practical opportunity for a scientifically adequate and epidemiologically valid study.

**2. If such a study is feasible, approximately how much time and money would be required to organize and implement it?**

**Conclusion:** Since the committee concluded that an epidemiologic study was not possible, it did not consider in detail the time and money that would be required. However, on the basis of past and current studies of radiation-exposed cohorts, the committee estimated that such a study would cost tens of millions of dollars and would last at least a decade.

**3. Are there other sources of information that would yield similar results at a lower cost or in less time?**

**Conclusion:** The committee suggested some studies that might be informative, but noted that these too would have limitations. These limitations are related to sample size, population composition, uncertainty of dose, the presence of concurrent disease, and other confounding factors. Although studies of these groups may have their own merits, the committee concluded that they may not adequately address the immediate concerns of the Atomic Veterans.

## **Report Conclusions**

The committee explored in detail the feasibility of an epidemiologic study to examine the association between adverse reproductive outcomes and paternal exposure to ionizing radiation. Such a study would be of interest not only to the 210,000 veterans exposed to atomic weapons radiation, but also to many other individuals who have received low doses of radiation at their places of employment or elsewhere. The committee's assessment was that it would be extremely difficult, if not impossible, to find and contact a sufficiently high and representative percentage of veterans' families, to establish a good measure of dose for each veteran, to identify and accurately document reproductive problems that occurred over a fifty-year interval, and to measure other factors that cause reproductive problems and, therefore, might confound any observed relationship between radiation exposure and reproductive problems. These difficulties become even more acute with regard to the grandchildren of these veterans. The cohort of Atomic Veterans does not provide a practical opportunity for a scientifically adequate and epidemiologically valid test of the hypothesis that paternal exposure to ionizing radiation has increased the frequency of adverse reproductive outcomes among their children and grandchildren. The committee recognized the real concerns of the Atomic Veterans as expressed by their representatives, but concluded that epidemiologic studies cannot adequately address these concerns.



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## Appendix 13:

# A Mortality Follow-up Study of WW II Submariners Who Received Nasopharyngeal Radium Irradiation Treatment



American Journal of Industrial Medicine, 2000, Volume 38, pages 441-446

### Author

Han K. Kang, Dr. P.H., Tim A. Bullman, M.S., Clare M. Mahan, Ph.D.

### Introduction

During World War II, submarine trainees received nasopharyngeal (NP) irradiation therapy to prevent aerotitis media, also known as middle ear barotrauma. The total number of military personnel who received therapy is unknown, although one estimate places the number between 8,000 and 20,000. To date, no follow-up studies have been conducted of military personnel who received NP treatment. This current study, a retrospective mortality follow-up, was undertaken to determine if there is any increased risk of cause-specific mortality, primarily head and neck cancers, among WWII submariners.

### Material and Methods

The Naval Submarine Medical Research Laboratory Aerotitis Media Study Log Book provided the names and rank of sailors who developed aerotitis media at the Groton Submarine School in New London, CT. After obtaining military service numbers from other Navy Records, 1,214 names were available for study. An estimated 70% of these men received NP radium treatment but, because of the lack of certain means to separate those who were treated with NP radium from those who were not, this study considered all 1,214 test participants on the logbook with a sign of aerotitis media as radium "treated" veterans.

Comparison group veterans consisted of 3,176 submarine trainees who were randomly sampled from 24,000 sailors who attended basic training at the Groton Submarine Base after WWII. The last recorded use of NP radium treatment at the submarine base was in May, 1946. It was, therefore, very unlikely that the trainees who joined the Navy after 1946 and subsequently trained at the submarine base would have received treatment during training.

Treated veterans' vital status was followed from the date of their pressure test in 1944 or 1945. Control group veterans' vital status follow-up began on the date that they reported to Groton and ended on their date of death

or on December 31, 1996. After ascertaining vital status, 434 deaths were identified among treated veterans and 605 deaths among control veterans; cause of death data was obtained for 376 (87%) of deaths among treated veterans and 530 (88%) of deaths among control veterans.

## Results

Cause-specific mortality risk associated with NP therapy was assessed using the survival analysis method. The overall mortality risk was significantly higher among treated participants than for controls [odds ratio (OR)=1.32; 95% Confidence Interval (CI)=1.14-1.53] and there was increased risk of deaths due to diseases of the circulatory system [OR=1.51; 95% CI=1.20-1.90].

The increased risk of death due to head and neck cancers remained elevated, but not statistically significant [OR=1.40; 95% CI=0.54-3.58]. The paired cause-specific survival curves were tested for significance between veterans and controls for all causes, diseases of the circulatory system, and head and neck cancer.

Results from the multivariate Cox model were similar to the survival analyses. To keep the entire age range comparable, the length of follow-up for the treated group was reduced by 7 years. Thus, length of follow-up extended forty-four years for both groups – 1945- 1989 for the treatment group and 1952 (average)-1996 for controls.

## Discussion

Prior studies have reported inconsistent results concerning the increased risk of head and neck cancers among those who received NP treatments. Comparing the survival curve of submarine veterans, at least 70 percent of whom received NP treatments, to that of a group of submarine veterans who did not have a record of receiving treatments, this study found a small increased risk of deaths due to all cancers combined and head and neck cancers associated with having had NP irradiation therapy; neither was statistically significant.

The difference in all circulatory disease mortality rates between two submariner groups was not anticipated. The lower rate of deaths from circulatory disease among controls might be due to a difference in selection process taking place in the assignments to submarine duty during and after WWII or a life style difference between the two birth cohorts.

The lack of data on possible risk factors, other than receiving NP irradiation therapy, is a limitation in interpreting this study's findings. Another limitation is the inclusion of some submariners who did not receive the treatment in the "treated" group. According to the Logbook record, approximately 30 percent of submariners classified as "treated" may not have actually received the treatment. As a result, the chances of detecting any specific mortality outcomes associated with the treatment were reduced if any existed. Differences in the life expectancy of the two cohorts might also have affected this study's findings. All of the treated veterans entered

follow-up in 1944/45 and their mortality pattern would reflect the pattern prevalent in the age groups 18-24 (mean 22.5 years) in 1944/45. The pattern prevalent in this age group at a later date could be different because the expected length of life would be greater. A final limitation was the lack of morbidity data; the data provided may not be a surrogate for incidence data for all diseases.

A strength of this study was the use of other submariners as a comparison group. As submariners were a self-selected group of volunteers and underwent various specialized physical and psychological screening, the most appropriate comparison group for submariners who received NP radium treatment would be other submariners who did not receive the treatment. Using a veteran group as a comparison group also helps to limit the "healthy veteran" effect. This phenomenon may affect findings when veteran groups are compared only to the US population.

In summary, comparing cause-specific mortality of submarine veterans who were "treated" with NP irradiation to that of "untreated" submarine veterans, this study found an excess of overall deaths as well as deaths due to all disease of the circulatory system. While the excess risk of head and neck cancers was not statistically significant, this finding does suggest that WWII veterans who received NP irradiation while in submarine school may be at increased risk for deaths due to head and neck cancers.





# 14

## **Appendix 14:**

### **Summary of 2000 Article by McDiarmid et al., on DU**



#### **Appendix 14a**

#### **Summary of Article on Health Effects of Depleted Uranium on Exposed Gulf War Veterans**

Environmental Research, Vol. 82, No. 2, Feb 2000, pp. 168-180

##### **Author**

Melissa A. McDiarmid, James P. Keogh, Frank J. Hooper, et. al.

##### **Summary**

Prepared by Michael Howe

##### **Introduction**

In 1993-94, thirty-three depleted uranium (DU) exposed Gulf War veterans, many with retained fragments of embedded DU shrapnel, underwent medical evaluation at the Baltimore Veterans Affairs Medical Center. Clinical evaluation documented severe persisting health problems related to wounds sustained at the time of initial injury. This group of DU-exposed veterans was reexamined in 1997, and clinical laboratory elements, uranium exposure assessment, psychiatric assessment, neurocognitive evaluation, genotoxicity studies, and whole-body radiation counting were evaluated. The results of that assessment are reported in this article.

##### **Materials and Methods**

Twenty-nine of the originally evaluated 33 male DU-exposed veterans were reevaluated and their results were compared with those of 38 non-DU-exposed Gulf War deployed veterans. The clinical assessment elements included obtaining a detailed questionnaire history, a thorough physical examination, and laboratory studies, including hematologic and renal functional measures. All participants were administered a neurocognitive test battery. Urinary uranium determinations were performed both on 24-h urine collections and on a random spot collection. Uranium concentrations in semen specimens were measured. Whole-body radiation counting was conducted at the Boston VA Medical Center. Reproductive health measures were examined also.

## Results

The results of 24-h urine uranium determinations showed that higher levels of uranium were found in those veterans with retained metal fragments. A determination was also made during the initial evaluation of these veterans in 1994 and the correlation between the 1994 and 1997 urinary uranium results is highly statistically significant. Neurocognitive examinations demonstrated a statistical relationship between urine uranium levels and lowered performance on computerized tests assessing performance efficiency.

Only nine veterans had U indices above the limit of detection for whole-body counting measurements and all were DU-exposed veterans. The remainder of the results, including those of other DU-exposed veterans, fell below the limit of detection.

An active medical problem list for the participants was assembled during their clinical evaluation. Nearly 90% of the DU-exposed and 71% of nonexposed veterans reported one or more active medical problems. The exposed group most frequently reported sequelae of injuries (76%). Nervous system problems (53%) were most commonly reported by the nonexposed group. Examination of the hematologic, renal, and neuroendocrine laboratory results indicated that, in general, a greater proportion of the DU exposed veterans was within normal limits for each measure compared to the nonexposed veterans. However, statistical evaluation of the results indicated subtle differences between the high and low DU exposure groups.

## Discussion

DU-exposed Gulf War veterans with retained metal fragments are excreting elevated levels of uranium in their urine 7 years after the first exposure. The high correlation between uranium results from 1994 and 1997 reveals a persistent, steady-state excretion of uranium and suggests that excretion is not significantly lowering the body burden of uranium in those with retained metal fragments. Several DU-exposed veterans without retained metal fragments detectable on X ray have urinary uranium values well above the highest nonexposed person's value. The urinary uranium values for the nonexposed group generally agree with literature reports for the unexposed general population.

A semen uranium determination showed that 5 of 22 samples had concentrations above the limit of detection. All samples with detectable levels were from DU-exposed veterans.

In regard to whole-body radiation counting, only 9 of 29 DU-exposed veterans could be identified by their radiation scanning results. They were also among the 14 identified as belonging to the high uranium exposure group based on urinary uranium results.

The active medical problems reported reveal that the DU-exposed veterans were generally more likely to have sustained injuries compared to the

nonexposed. However, the exposed veterans were comparable to the nonexposed in musculoskeletal and psychiatric complaints. Also, no statistically significant DU-related findings were observed in clinical blood values with the exception of the prolactin findings. Elevated urinary uranium was statistically related to a high prolactin level. The DU-exposed veterans were generally more likely than the nonexposed to have normal complete blood count, urinalysis, and semen parameters.

Mean hematologic parameters compared between low and high uranium groups revealed a higher percentage eosinophils in the high uranium group. Renal perturbations were generally absent. Results revealed no statistically significant differences in renal parameters as a function of urinary uranium. A statistically significant relationship between high prolactin concentration and high urinary uranium was observed in this study. Mean values for physical characteristics of semen examined by the low and high urinary uranium groupings did not show significant differences.

Because of the large number of study variables and the smaller number of participants, the authors were aware of problems associated with making too many statistical comparisons. The vast majority of their comparisons are descriptive. No attempt was made to statistically adjust P values for multiple comparisons.

## **Conclusions**

More than 7 years after first exposure, DU-exposed GW veterans with retained metal fragments continue to excrete elevated concentrations of urinary uranium. The persistence of this finding tempers the meaning of the relatively few uranium-related clinical outcomes documented in this group. Although DU munitions are a significant part of the current military arsenal, the potential for long-term effects in exposed service people must also be weighted.

## Appendix 14b

### Surveillance of Depleted Uranium Exposed Gulf War Veterans: Health Effects Observed in an Enlarged “Friendly Fire” Cohort

Journal of Occupational and Environmental Medicine, Vol. 43, No. 12, Dec 2001, pp. 991-1000

#### Author:

Melissa A. McDiarmid, Katherine Squibb, Susan Engelhardt, et. al.

#### Introduction

Used for the first time in combat by United States and Allied forces during the Gulf War, depleted uranium (DU) was incorporated into armament and munitions because of its density, availability, and relative low cost. Uranium’s chemical toxicity presents the principal concern in Gulf War veterans, with particular focus on the kidney effects that uranium shares with the other heavy metals. Much of the research related to DU exposures in the Gulf has focused on soldiers involved in a group of “friendly fire” incidents, during which the US tank crew members were mistakenly fired on with DU projectiles. Only about a third of the estimated 120 veterans involved in the several friendly fire incidents had been located or were willing or able to take part in assessments before 1997, but with renewed efforts in 1998, additional members of this cohort were identified. Some elected to participate in a new round of surveillance throughout the spring and summer of 1999. The results of that assessment are reported in this article.

#### Materials and Methods

Fifty male Gulf War veterans exposed to DU by means of friendly fire were examined. Clinical assessment included obtaining a detailed questionnaire history, a thorough physical examination, and laboratory studies. All participants were administered a neurocognitive test battery. Participants completed measures designed to assess potential confounders (intelligence and depression) of the association of urine uranium and neurocognitive outcomes. Reproductive health and genotoxicity measures were examined. Urine uranium determinations were performed on 24-hour urine collections. Tests were used to compare the distributions of outcome measures of interest between the groups with high and low uranium exposure.

#### Results

No statistically significant differences were observed between the high and low urine uranium groups for race, education, age, marital status, or military rank. The only statistically significant difference observed between the two groups in regard to medical problems was the higher proportion of veterans suffering injuries in the high urine uranium group. There were no

significant differences between the high versus low urine uranium groups on means of any of the four neurocognitive scores. No significant differences between the high and low uranium groups were observed for luteinizing hormone, follicle-stimulating hormone, prolactin, testosterone, or thyroid measures. The results of sister chromatid exchanges (SCE) and chromosomal aberration determinations show a statistical significant elevation in baseline SCE for the high compared with the low urine uranium group.

## Discussion

Eight years after their first exposure, Gulf War veterans with retained metal fragments continued to excrete elevated levels of uranium in their urine. Elevated uranium concentrations are clearly related to retained metal fragment (shrapnel) status or history of having shrapnel in the past. Underscoring that relationship, of the thirty newly identified members of the DU-exposed cohort, the four with a history of shrapnel also possess the top four urine uranium values. The high correlations between urine uranium values over the surveillance periods suggest that the uranium concentration is in a steady state.

The majority of the cohort had no retained metal fragments, and their initial DU exposure was through inhalation or wound contamination. In the absence of a fixed depot of metal (fragments), they eliminated their burden, moved it to a long-term storage site such as bone, or both. The high urine uranium group had many more injuries that resulted in their retaining metal fragments.

Although the kidney is considered the “critical” organ (i.e., the organ first perturbed by uranium toxicity), no differences were found in renal function on the basis of urine uranium results. Given the relatively subtle findings in a study of a generally more highly exposed occupational group, the normal renal function observed in the DU exposed is perhaps expected.

Neuroendocrine and thyroid measures were within normal ranges and presumably were not affected by uranium exposures. Although these measures have been reported to be affected in lead-exposed workers, the lack of effects here is likely attributable to low uranium exposure concentrations. Based on the average values, normal semen characteristics were observed in both urine uranium exposure groups. Because semen characteristics have no upper limit for normality, the generally elevated values in the high urine uranium group are not considered clinically significant for an individual’s fertility.

Results obtained from the current group of participants were somewhat less consistent with those obtained during two previous follow-up examinations indicating a relationship between urine uranium and neurocognitive performance using automated measures. During this follow-up evaluation, the strength of previously observed relationships weakened and only tended toward significance when emotional factors and estimated pre-service ability level were controlled.

Results in this study suggest that DU may be genotoxic. Because SCE but not chromosomal aberrations were elevated, it is suggested that the effect is chemically rather than radiologically mediated.

## **Conclusions**

Persistence of raised urine uranium levels in Gulf War veterans with retained metal fragments documents a chronic, ongoing uranium exposure in this cohort and tempers the authors’ conclusions from the relatively few abnormal clinical findings in this group. The subtle but biologically plausible observations in neurocognitive performance and genotoxicity measures suggest a chemically rather than radiologically mediated effect. Surveillance in this cohort with a measurable uranium burden informs the current debate regarding health effects in other populations likely less exposed to DU, both in intensity and duration.

## Appendix 14c

### Health Effects of Depleted Uranium on Exposed Gulf War Veterans: A 10-Year Follow-Up

Journal of Toxicology and Environmental Health,  
Part A, 2004, Vol. 67, pp. 277-296

Authors: Melissa A. McDiarmid,  
Susan Engelhardt,  
Marc Oliver, et. al.

#### Introduction

The first widespread use of depleted uranium (DU) by U.S. military forces in the 1991 Gulf War created an unintended consequence of exposing soldiers to this radioactive heavy metal already well known for its chemical toxicity in workers in the nuclear industry. Questions regarding the long-term health consequences of these exposures have fueled considerable debate regarding continued use of DU in combat. To date, four rounds of surveillance have been conducted on an inpatient basis at the Baltimore VA Medical Center. The principal finding thus far has been that mean urine uranium excretion is significantly higher in veterans with confirmed retention of metal fragments in soft tissue compared to either those DU-exposed without fragments or a comparison population of Gulf War deployed, but not DU-exposed veterans. Multiple smaller fragments remain in some veterans despite surgeries because the fragments are not easily accessible or due to risk of excessive surgical morbidity associated with their removal. Veterans without retained fragments possess a urine uranium concentration similar to that of the comparison population and other published normal values for urine uranium. To date, four rounds of surveillance (1994, 1997, 1999, 2001) have been conducted on an inpatient basis at the Baltimore VA Medical Center. This study reports results of the 2001 clinical assessment of this cohort, a 10-year follow-up since exposure first occurred during the Gulf War.

#### Materials and Methods

Thirty-nine Gulf War veterans who had been exposed to DU during friendly fire incidents in February 1991 were evaluated at the Baltimore VA Medical Center between April and July 2001. Thirty-one of these had been seen previously on at least one occasion. Eight were examined for the first time. Clinical, neurocognitive/psychiatric, and uranium exposure assessments were made in addition to hematologic/renal toxicity, reproductive health, genotoxicity, and immunologic measures.

#### Results

The only significant differences in the frequency of medical problems between the low and high uranium groups is in the percentage of participants that suffered injuries during the friendly fire incidents. There were no differences in frequency of musculoskeletal, cardiovascular, psychiatric, nervous system,

or other disorders. Means of hematologic parameters for both the high and low uranium groups were within normal clinical limits. The high uranium group had significantly lower hematocrit and hemoglobin values than the low uranium group. These differences were not evident in either the 1997 or 1999 cohorts. There was no significant difference in any parameters of the differential white cell count. There were statistically significant differences in some of the renal function parameters between the high and low uranium groups. A suggestion of decreased protein reabsorption or increased glomerular filtration of proteins in the high uranium group was also not observed in the 1997 or 1999 surveillance visits. However, the renal test results were within the normal clinical ranges.

Consistent with previous years, there were no statistically significant differences between the high and low uranium groups for the neurocognitive parameters measured. There was a statistically significant difference in free thyroxine between the high and low uranium groups, with the low uranium group having a higher level than the high uranium group, but the results remained within the expected normal ranges. A difference approaching significance was also seen in prolactin levels, with higher levels seen in the low uranium group. Neither of these findings was present in either the 1997 or 1999 evaluations.

The high uranium group had higher chromosomal aberrations which had not been observed in previous rounds of surveillance. No association between sister chromatid exchange (SCE) and urine uranium emerged when potential confounders (age, x-rays, exposure to gene toxicants or current smoking) were included in the regression. The percent of cells bearing various lymphocyte or monocyte phenotypic markers determined by using flow cytometric analysis revealed that the low uranium and high uranium groups differed statistically in only two of fourteen phenotypic markers studied.

## **Discussion**

Urine uranium concentrations in this group of soldiers are clearly above normal concentrations present in the general population. The clear determinant of urine uranium concentration, the presence of retained uranium containing metal fragments in soft tissue, has been observed in all of the authors' previous evaluations. The consistency in uranium excretion over time suggests the uranium body burden is in a steady state in both the high and low urine uranium groups. For those soldiers possessing metal fragments, the size of these depots is sufficiently large as to not allow any appreciable decline of the uranium body burden over the two year time period between medical evaluations. For the majority of the soldiers in the 2001 cohort who do not have retained metal fragments, but sustained their DU exposure through inhalation or wound contamination, any initial systemic uranium has been eliminated or transported to long-term storage sites such as bone. Consequently, their uranium burden is also in a steady state, with minimal release from body stores, as evidenced by their low urinary uranium excretion.

There is a clear absence of a "signature" specific medical problem shared by this cohort of Gulf War vets. Mean values for all hematologic parameters were within the normal range. No evidence of renal dysfunction was found. The



biomarkers for proximal tubule dysfunction, the presumed target of uranium, showed minimal differences between the groups.

The neuroendocrine and thyroid measures were all within normal limits with the exception of serum prolactin, which demonstrated a slightly elevated level outside the normal range in the low uranium group. For the parameters evaluated in this study, both uranium exposure groups have normal semen characteristics based on average values.

Data showed higher chromosomal aberrations and hypoxanthine-guanine phosphoribosyl transferase (HPRT) mutation frequency in the high uranium group. Bleomycin, a radiomimetic and potent clastogen, but a poor SCE inducer, was used on the SCE cultures as a provocative challenge to examine enhanced expression of SCE where such an enhancement could represent heritable genetic instability, presumably from previous genotoxic exposure. However, such an enhancement did not occur.

The lack of association between mutation frequency and urine uranium levels at low levels of urine uranium could have several causes. However, the ability to attribute HPRT mutation frequency exclusively to urine uranium values in this low background range, as opposed to other competing environmental mutagens, becomes increasingly difficult.

The authors' findings of somatic gene mutations in humans is in accord with findings of other genotoxic effects. In vitro follow-up studies should define DU's mutagenicity at the mechanistic level, differentiating between its chemical and its low-level radiological effects.

Results from clinically available measures of immune competence and a panel of phenotypic markers suggest that exposure to depleted uranium has no clinically significant effect on immune parameters. Future studies should include a clinical battery of immune competence measures to follow any effect that may occur as exposure duration continues.



# 15

## **Appendix 15:** Updated Information for Clinicians on DU



Prepared by the Depleted Uranium Follow-up Program  
VA Maryland Healthcare System, Baltimore Division

March 2003



DATE: March 2003

FROM: Medical Director, Depleted Uranium Follow-up Program  
VA Maryland Healthcare System, Baltimore Division

SUBJ: Depleted Uranium: Information for Clinicians

TO: VA Gulf War Physicians and all VA clinicians

1. The Medical Director and staff of the Depleted Uranium Follow-up Program are pleased to provide this packet to assist you with your patients who are concerned about possible Depleted Uranium exposure as a result of their Gulf War service.
2. We have updated our series of fact sheets and guidelines to augment the existing clinical information for VA Gulf War physicians. This document supercedes any previous documents provided by the Depleted Uranium Follow-up Program. In the packet you will find:

**Section 1 – Information about Depleted Uranium**

- General Information
- Guidelines for Clinicians
- Depleted Uranium Follow-up Program
- References and Further Reading

**Section 2 - Medical Issues**

- Guidelines for Clinicians

**Section 3 - Additional Information**

- Further Reading

3. If you have additional questions, please contact the Depleted Uranium Program administrative office at 1-800-815-7533.

MELISSA A. McDIARMID, M.D., M.P.H.

## INFORMATION FOR CLINICIANS



**Prepared by the Depleted Uranium Follow-up Program  
VA Maryland Healthcare System, Baltimore Division**

**March 2003**

**To contact the DU Follow up Program:**

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**Kevin Davis**  
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## Section 1 – Information about Depleted Uranium

What is Depleted Uranium?

What is Depleted Uranium Used For?

How are soldiers exposed to DU?

Who was exposed to DU in the Gulf War?

How does DU get into the body?

What are the health effects of exposure to DU?

What is the potential for external radiation exposure?

What is the potential for internal radiation exposure?

Are there other toxic effects of exposure to DU?

## Section 2 – The Depleted Uranium Follow-up Program

What is the Depleted Uranium Follow-up Program (DUP)?

Who is participating in the initial DUP?

What health effects have been found in this group?

What is the DUP doing for these participants?

Who is participating in the expanded program?

What are the findings in this group?

Does the DUP work with other groups involved in DU research?

What kinds of outreach and assistance efforts have been provided to non-participants and the community at large?

## Section 3 – Guidelines for Clinicians

What can I do if a patient suspects possible past DU exposure as a result of military service in the Gulf War?

Tips for taking the history

Laboratory tests for uranium

Points of contact for the DUP

## Section 4 – References and Further Reading

### I. 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%  $^{238}\text{U}$ , with small amounts of  $^{235}\text{U}$  and  $^{234}\text{U}$  (see table next page).

Depleted uranium is made from natural uranium, by removing some of the more highly radioactive isotopes ( $^{235}\text{U}$  and  $^{234}\text{U}$ ). "Enriched uranium," that with the higher concentrations of  $^{235}\text{U}$  and  $^{234}\text{U}$ , is what is used in nuclear reactors. Depleted uranium is what remains after the enrichment process. It contains even less  $^{235}\text{U}$  and  $^{234}\text{U}$  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
<b>Isotope</b>	$\mu\text{Ci/g}$	Concentration of isotopes	Concentration of isotopes
$^{234}\text{U}$	6200.0	0.0058%	0.001%
$^{235}\text{U}$	2.2	0.72%	0.2%
$^{238}\text{U}$	0.33	99.28%	99.8%
<b>Relative Radioactivity</b>		1	.6

As one may calculate from the table, the radioactivity of natural uranium is approximately 0.70  $\mu\text{Ci/g}$  whereas the radioactivity is approximately 0.40  $\mu\text{Ci/g}$ .

### **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 both projectiles and armor. Uranium's high density and pyrophoric or easily combustible properties makes it, in projectiles, capable of penetrating armor made with less dense metals. Conversely, armor constructed with DU provides a high degree of shielding and resistance to penetration. During the 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 oxidize. Soldiers in struck vehicles may inhale airborne DU particles (or other combustion products), ingest DU particles, and experience wound contamination by DU. Crew members may be left with multiple tiny fragments of uranium scattered through their muscle and soft tissue. Other soldiers may be exposed during operations to salvage tanks that had been disabled by DU rounds or have potential exposure from brief "sightseeing" entry into damaged vehicles.

### **Who was exposed to DU in the Gulf War?**

Initially, approximately 60 military personnel were identified as being wounded by or exposed to DU in a friendly fire incident. Subsequently, the Department of Defense (DoD) has identified approximately 50 additional persons involved in these incidents. Obviously, greatest potential for medically significant DU exposure occurred with those soldiers who were in or on tanks and other armored vehicles when the vehicles were hit by DU munitions. These individuals were at the greatest risk of being hit by DU fragments and of inhaling fine, suspended DU particles and DU oxides during fires.

Other exposure potential exists for those who entered vehicles immediately after impact to rescue wounded occupants and for those who entered vehicles later to retrieve sensitive items, and/or perform salvage and maintenance on the vehicles. As a result of a fire at Camp Doha, several DU-laden tanks were burned. Those soldiers involved in salvage and maintenance of these vehicles may have also had some exposure to DU. Inhalation of smoke from these burning vehicles provides another opportunity for exposure. For a complete discussion of the opportunities for exposure, please refer to the web site for the Special Assistant for Gulf War Illnesses (OSAGWI) at <http://www.gulflink.osd.mil/envexp.html>.

### **How does DU get into the body?**

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. 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 penetrate intact skin. Imbedded, retained DU shrapnel may be dissolved and also be 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. 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 imbedded DU shrapnel 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 DU munitions for 250 hours is necessary to exceed annual occupational exposure limits. Wearing gloves provides effective protection against this type of exposure. Crew members 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, whether via inhalation, ingestion, wound contamination or retained shrapnel warrants concern. 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). 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.

The radiation dose assessments 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) are on the order of tenths of a rem. 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.

## II. The Depleted Uranium Follow-up Program

### What is the Depleted Uranium Follow-up Program (DUP)?

The DVA Depleted Uranium Follow-up Program (DUP) at the VA Maryland Healthcare System, Baltimore Division (VAMHCS) is a clinical surveillance program for identifying, characterizing and following individuals with retained DU fragments and those exposed to DU as a result of their involvement in “friendly fire” incidents during the Gulf War.

The specific **aims** of the project are to provide on-going clinical surveillance of Gulf War veterans with known or suspected imbedded DU fragments, DU contaminated wounds or significant amounts of inhaled DU. This clinical surveillance will detect health effects, if any, of DU containing shrapnel, and provide recommendations for treatment to participating veterans and physicians caring for them.

Focused research into the toxicological and radiological effects of DU is intended to improve the scientific basis for advice about fragment removal, to better model uranium absorption, distribution in tissue, and excretion, and to develop improved methods to assess uranium dose in vivo. In addition, the program hopes to improve methods of detection of toxic effects from low dose uranium exposure.

In 1998, in response to the concerns of other Gulf War veterans that they might also have been exposed, the VA and DoD expanded the DU program to provide urine testing for any Gulf War veteran who requested it (VHA Directive 98-023). The testing is part of the Comprehensive Clinical Evaluation Program for active duty personnel and the Gulf War Registry program for military veterans. As part of these programs, an individual may submit a 24-hour urine sample for total uranium concentration. A self-report DU exposure history is also completed and submitted with the specimen. More detail about this part of the DUP may be found on page 12.

### Who is participating in the initial DUP?

Initially, 33 Gulf War veterans (some still on active duty), who had been on or in U.S. Army vehicles when struck by DU containing munitions were evaluated at the VAMHCS in 1993 and 1994. Many of these soldiers had been wounded and about half were thought to have retained shrapnel.

In 1997, these same participants were invited to return to Baltimore for another evaluation. In addition to the 29 who returned, a group of non-exposed Gulf War veterans were recruited to serve as a comparison population for the clinical findings from the initial group.

In 1999, the original group was invited to return for a 3rd evaluation. Through the efforts of the VA and the DoD, additional Gulf War veterans who had been involved in friendly fire incidents were identified. Contact was made with as many of these people as possible and they were invited to come to Baltimore as participants in the Follow-up Program. In 2001, efforts were made again to include more veterans from this group. Through these efforts, 37 additional Gulf War veterans have been added to the roster. To

date, 70 Gulf War veterans involved in friendly fire incidents have been evaluated at Baltimore. There is another evaluation planned for 2003.

### **What health effects have been found in this group?**

Of the total of 70 Gulf War veterans who have been evaluated since 1993, approximately 25% have evidence of retained shrapnel. In 1999, Hooper et al. found that those with retained DU shrapnel have the highest urine uranium levels. These same participants continue to excrete elevated levels of uranium in their urine 10-years after being wounded (McDiarmid, et al., 2000, McDiarmid, et al., 2001).

A relationship existed between urine uranium levels and prolactin levels, a neuroendocrine hormone, in the 1997 cohort but has not been a consistent finding since then. Some minor differences have been noted in some blood chemistries and CBC parameters, however, all means for these values fall within normal limits. There is some evidence of uranium in the semen of those with the highest urine uranium levels. However, this was observed in only some of these DU exposed and did not correlate with urine uranium levels. These studies are being repeated currently.

We did find an association between HPRT (hypoxanthine phosphoribosyl transferease) mutation frequency and urine uranium levels at the highest uranium levels. We are planning further study in this area to determine more carefully this relationship and its implications.

There have been no differences between the low and high urine uranium groups with respect to semen quality, quantity or function based on WHO criteria. At least 60 healthy children have been born to the DU exposed group. We are aware of no birth anomalies attributable to DU exposure. These findings have been consistent throughout the first four evaluations (Hooper et al., 1999, McDiarmid, et al., 2000, McDiarmid et al., 2001).

Some subtle differences are noted in performance on computer-based neuropsychological tests between those with higher urine uranium levels and lower urine uranium levels. These findings are not seen, however, on traditional paper and pencil tests and so their clinical significance is unclear. This area also continues to be studied.

### **What is the DUP doing for these participants?**

All participants who chose to come to Baltimore were evaluated at the VAMHCS and underwent a comprehensive medical and psychological evaluation as well as a full body skeletal x-ray survey. Physiologic parameters including routine blood chemistries and hematology, renal function, neuroendocrine hormone function, pulmonary function, semen analysis, and genotoxicologic factors were examined. Neuropsychological and psychiatric test batteries were completed.

The DUP has facilitated the assignment of primary care providers for the veterans in the group and interfaces with those primary care providers as needed. All lab and test results are forwarded to the primary care providers as they become available. The DUP serves as a resource with respect to

information about DU, its measurement, and its health effects for the primary care providers as well as for any military or VA health care institution.

An 800-telephone number has been made available to participants as well as their family members and healthcare providers for consultation and assistance in a variety of clinical and personal issues. The staff has expertise and experience in the area of environmental and occupational health, particularly with regard to the effects of heavy metal exposure.

### **Who is participating in the expanded program?**

As mentioned, before, the responsibilities of the DUP were expanded in 1998 to include the coordination of urine uranium testing for any veteran of the Gulf War who requests it, as part of the Gulf War Registry for veterans or the CCEP for active duty personnel. Prior to 1998, approximately 50 urine samples were submitted for urine uranium testing. Since the inception of the enlarged program, over 500 samples submitted through various VA and military health care providers have been analyzed. When the results are compiled, they are sent to both the individual participant and the health care provider at the facility that originated the request.

### **What are the findings from this group?**

Only a very few participants (<5%) have provided urine samples with total uranium levels above 0.05 µg/g creatinine, which is our cut point for what is a likely upper limit (though a conservative one) from dietary sources of uranium. In fact, most are at least 2 orders of magnitude lower than the DUP's most highly exposed group.

If a result is higher than what would be expected to occur from ingestion of natural uranium, the participant is called and the detailed history of his/her Gulf War experience submitted with the urine sample in questionnaire form is verbally reviewed with the veteran, by the DU nurse clinician. Occupational or environmental exposures are also explored. The participant is asked to provide another specimen for repeat analysis to confirm the original result. An aliquot of the sample is also sent for isotopic analysis to attempt to determine the source of the uranium, natural or DU.

### **Does the DU Program work with other groups involved in DU research?**

The DU program has developed a collaboration of VA and non-VA academic experts in the field of exposure characterization and outcome measurement. A team of specialists in environmental and occupational health, epidemiology, toxicology, radiobiology, physics, psychiatry, neuropsychology, and reproductive health have worked individually and collectively to develop and adapt diagnostic tools to better evaluate, treat and counsel this unique group of soldiers and veterans.

### **What kinds of outreach and assistance efforts have been provided to non-participants and the community at large?**

**Consultation:** The program has been involved in outreach activities to other VA medical centers, serving as a clearinghouse for questions raised by

veterans about uranium exposures. These inquiries involve veterans who were not wounded but may have, or think they may have inhaled or been in proximity to uranium because of their active duty participation during the Gulf War or during maintenance, clean up and repair of vehicles containing depleted uranium. While at much lower risk than program participants, these individuals still have questions for their VA physicians. The program aids their physicians with advice about the best ways to assess the risks of past depleted uranium exposure and how to assess these exposures clinically.

**Communication:** The staff of the DU Program serve as a resource for requests for information from healthcare providers, government and private sector news publications, VA Headquarters, the Presidential Advisory Committee on Gulf War Veterans' Illnesses, and others.

### **III. Guidelines for Clinicians**

#### **What can I do if a patient suspects possible past DU exposure as a result of military service in the Gulf War?**

If a patient suspects possible past DU exposure, he/she must first complete the Gulf War Registry Exam for veterans or the Comprehensive Clinical Evaluation Program for active duty personnel. A careful history of past and present exposures is critical to this process.

Once enrolled in either of these programs, the patient is eligible to complete the evaluation for DU. This evaluation includes the submission of a 24-hour urine and the completion of exposure questionnaires.

To initiate the process of this evaluation, place a call to the DUP to request a urine testing kit. Be prepared to provide the name and social security number of the patient as well as the mailing address and name of the responsible health care provider/coordinator at the local site who will be managing the collection of the sample. The kit will be sent by express mail (FedEx) and should arrive within about a week or the phone request. Detailed and explicit instructions for the collection of the sample and questionnaires and their return are included in the kit.

#### **Tips for taking the history**

**Listen** for the patients concerns about their Gulf War 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 shrapnel, so far, no adverse health conditions have been detected. The clinician should emphasize that retained shrapnel represents 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.

### **Laboratory tests for uranium**

The only practical, biologic measure readily available to assess uranium exposure clinically is to measure urine excretion of uranium. If internal DU exposure is suspected, the clinician should call the DU Program to obtain the kits used to collect the 24-hour urine specimen for uranium. The DU Program at the Baltimore VAMC will facilitate processing and interpretation of the results. The results are available in six to eight weeks and the clinician will be notified with the results and interpretation. Other possible methods for assessing DU exposure and body burden are being developed and are not appropriate for routine, clinical use.

### **Points of contact for the DUP**

To contact the DU Follow up Program:

**Call 1-800-815-7533**

or write

**Depleted Uranium Program (11DUP)**  
Baltimore Veterans Affairs Medical Center  
10 N. Greene Street  
Baltimore, MD 21201



The staff of the DU Program has a unique expertise in the evaluation of risk, clinical assessment and treatment of exposure to depleted uranium. Based on their experience with DU and other heavy metal exposures, they are available to provide:

- general information regarding depleted uranium
- determination of possible exposure
- assessment of health risk
- guidance in determining appropriate medical testing
- assistance in obtaining and interpreting urine uranium results
- advice for counseling DU-exposed personnel
- referral to other specialists for individualized problem solving

## **IV. References and Further Reading**

### **Update in progress**

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U.S. Nuclear Regulatory Commission (1996). Regulatory Guide 8.29. Instructions concerning risks from occupational radiation exposure. Office of Nuclear Regulatory Research.

Voelz, George L. (1992). Chapter 13. Uranium in Hazardous Material Toxicology Eds. Sullivan, John B. and Krieger, Gary R. Williams and Wilkins, Baltimore, MD.

### Additional Resources

Agency for Toxic Substances and Disease Registry (ATSDR). U.S. Public Health Service. Toxicological Profile for Uranium (Update). Can be ordered from:

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

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### **Gulf War Illness**

Institute of Medicine, Committee to Review the Health Consequences of Service During the Persian Gulf War, *Health Consequences of Service During the Persian Gulf War: Initial Findings and Recommendations for Immediate Action* (Washington, DC: National Academy Press, 1995).

*\*Presidential Advisory Committee on Gulf War Veterans Illnesses: Interim Report* (Washington, DC: U.S. Government Printing Office, February 1996).

### **On The Internet:**

GulfLINK (<http://www.gulflink.osd.mil/>) is the World Wide Web information system of the Office of the Special Assistant for Gulf War Illnesses that provides the public with information concerning the illnesses affecting Gulf War veterans. Information is updated periodically and covers a wide range of topics.

\* These citations can be found on the GulfLINK web site described above.

† Journal articles written by the DUP staff and program collaborators. URLs for the article abstracts are listed below the citations if available.



# 17

## Appendix 17:

# Evaluation Protocol for Non-Gulf War Veterans with Potential Exposure to Depleted Uranium (DU)



Department of Veterans Affairs  
Veterans Health Administration  
Washington, DC 20420

VHA HANDBOOK 1303.4  
Transmittal Sheet  
March 30, 2004

## **EVALUATION PROTOCOL FOR NON-GULF WAR VETERANS WITH POTENTIAL EXPOSURE TO DEPLETED URANIUM (DU)**

- 1. PURPOSE:** This Veterans Health Administration (VHA) Handbook outlines the policy and procedures for evaluating non-Gulf War (GW) veterans with possible exposure to depleted uranium (DU). **NOTE:** *For GW veterans, including those who served in Operation Iraqi Freedom (OIF), refer to VHA Handbook 1303.1.*
- 2. SUMMARY OF CHANGES:** Service personnel from non-Gulf War conflicts, such as Bosnia, may have possible inhalation exposure to DU. According to Public Law 102-585, Section 703(b)(2), each Department of Veterans Affairs (VA) facility must offer a DU screening evaluation to veterans of these conflicts using the DU Evaluation Protocol. Veterans eligible for this evaluation and inclusion in VA's DU Registry Program (not the Gulf War Registry Program) are identified and referred by the Department of Defense or are self-referred.
- 3. RELATED ISSUES:** VHA Handbook 1303.1.
- 4. RESPONSIBLE OFFICE:** The Chief Public Health and Environmental Hazards Officer (13) is responsible for the contents of this Handbook. Questions about DU must be addressed to the Baltimore DU Follow-up Program at 1-800-815-7533; general questions about the protocol may be addressed to the Environmental Agents Service at (202) 273-8580.
- 5. RESCISSIONS:** None.
- 6. RECERTIFICATION:** This VHA Handbook is scheduled for recertification on or before the last working day of March 2009.

S/ Art Hamerschlag for  
Robert H. Roswell, M.D.  
Under Secretary for Health

DISTRIBUTION: CO: E-mailed 3/31/04  
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## EVALUATION PROTOCOL FOR NON-GULF WAR VETERANS WITH POTENTIAL EXPOSURE TO DEPLETED URANIUM (DU)

### 1. PURPOSE

This Veterans Health Administration (VHA) Handbook outlines the procedures for evaluating non-Gulf War (GW) veterans with possible exposure to DU. **NOTE:** *For GW veterans, including those who served in Operation Iraqi Freedom (OIF), refer to VHA Handbook 1303.1.*

### 2. BACKGROUND

- a. DU is natural uranium left over after most of the U-235 isotope has been removed, such as that used as fuel in nuclear power plants. DU possesses about 60 percent of the radioactivity of natural uranium; it is a radiation hazard primarily if internalized, such as in shrapnel, contaminated wounds, and inhalation. In addition to its radioactivity, DU has some chemical toxicity related to being a heavy metal (similar to lead).
- b. Testing of DU for possible military use began in the early 1960's and was first used by the United States military in projectiles and armor for tanks during the Gulf War, which began in 1990, and continues to the present (see Title 38 United States Code (U.S.C.) § 101(33)). DU has also been used in other conflicts, such as OIF and Bosnia. Service personnel who may have had potential inhalation exposure to DU include those on, in, or near vehicles hit with "friendly fire;" rescuers entering burning vehicles; individuals near fires involving DU munitions; individuals salvaging damaged vehicles; and those near burning vehicles.
- c. The medical effects of DU exposure are continuing to be evaluated. A group of GW veterans with retained DU fragments or DU-contaminated wounds is being followed at a special DU Program at the Department of Veterans Affairs (VA) Medical Center, Baltimore, MD. While no clinically significant adverse effects of DU have been evident to date in this group, some abnormalities have been detected on specialized testing. **NOTE:** *As of year 2003 the Baltimore DU Follow-up Program has seen 70 veterans.*
- d. The Baltimore DU Follow-up Program has determined that for friendly-fire victims, a 24-hour urine determination for uranium is a more sensitive screening test for DU than whole-body counting.
- e. The Austin Automation Center (AAC) functions as the "contractor" to VHA in providing national level computer support for this DU program.

**NOTE:** *For additional background information on DU, see the references in paragraph 6.*

### 3. SCOPE

Each VHA facility must offer a DU screening evaluation using the DU Evaluation Protocol ([App. A](#) and [App. B](#)) to any veteran eligible for listing, or inclusion, in VA's DU Registry Program (for authority see Public Law 102-585, § 703(b)(2)). Veterans eligible for listing, or inclusion, in this Registry include veterans identified and referred by the Department of Defense (DOD) because of possible DU exposure, or veterans who self-refer because they are concerned about their potential exposure to DU.

### 4. THE PROCEDURE

- a. Evaluation of veterans for potential DU exposure must be provided by either a primary care clinician, or the Environmental Health Clinician, utilizing the DU Evaluation Protocol described in [Appendix A](#), VA Form 10-9009D, DU Questionnaire, and [Appendix B](#), DU Consult Urine Instructions. Components of the DU evaluation include the DU exposure questionnaire and a 24-hour urine collection for creatinine and uranium.
- b. Any positive responses to the DU exposure questionnaire must be followed-up with a more detailed history-taking by the VA primary care provider. The full-exposure history must be recorded in the veteran's consolidated health record (CHR) and/or the computerized patient record system (CPRS). All free text on the DU exposure questionnaires must be included in the CHR or CPRS. Completed DU exposure questionnaires are to be transmitted to the AAC.
- c. The health care provider must contact the DU Follow-up Program at the Baltimore VA Medical Center (1-800-815-7533) to discuss obtaining a 24-hour urine collection for uranium.  
**NOTE:** *The 24-hour urine collection for uranium must be performed in accordance with instructions in [Appendix B](#).*
- d. Upon completion of the evaluation protocol, the DU exposure questionnaire must be transmitted by the Environmental Health Coordinator (EHC) to the DU Registry database.
- e. Results of the 24-hour urine for uranium are communicated directly to the veteran by letter from the Baltimore DU Follow-up Program with a copy to the VA referring physician for the veteran's CHR and/or CPRS. The Baltimore DU program staff transmits the urine uranium results to AAC.
- f. Follow-up actions for any veteran with an elevated 24-hour urine uranium determination must be individualized based on discussion between the veteran's primary VA clinician and the staff at the Baltimore DU Follow-up Program.



## 5. RESPONSIBILITIES OF THE BALTIMORE DU PROGRAM STAFF

The Baltimore DU program staff is responsible for:

- (1) Arranging for testing of urine samples for uranium.
- (2) Sending, by letter, the results of the 24-hour urine for uranium directly to the veteran with a copy to the VA referring clinician.
- (3) Transmitting the urine uranium results to AAC.
  
- (4) Providing consultative advice to VA clinicians regarding DU testing.

**NOTE:** *Active-duty service members concerned about DU exposure, or other health issues related to service in the Gulf or other conflicts, need to be advised to contact a military health treatment facility or call the DOD Gulf War Veteran's Hotline at 1-800-796-9699. Additional information about DOD's post-deployment health care program initiatives is available on its Deployment LINK website: <http://deploymentlink.osd.mil/>.*

## 6. REFERENCES

- a. Voelz, George L., Chapter 13 - "Uranium," in Hazardous Material Toxicology, Eds. Sullivan, John B. and Krieger, Gary R., Williams and Wilkins, Baltimore, MD, 1992.
- b. Health Effects of Depleted Uranium - Fact Sheet, DOD, June 11, 1993. **NOTE:** *Copies may be obtained by calling (703) 697-3189.*
- c. "Agency for Toxic Substances and Disease Registry," United States Public Health Service, 1990.
- d. Toxicologic Profile for Uranium. PB91-180 471, U.S. Department of Commerce, National Technical Information Service. **NOTE:** *The Customer Service number is (703) 487-4660.*
- e. McDiarmid, et al., "Health Effects of Depleted Uranium on Exposed Gulf War Veterans," Environmental Research. Section A, Vol. 82, pages 168-180, 2000.
- f. McDiarmid, et al., "Urinary Uranium Concentrations in an Enlarged Gulf War Veterans Cohort," Health Physics, Vol. 80, No. 3, pages 270-273. 2001.
- g. McDiarmid, et al., "Surveillance of Depleted Uranium Exposed Gulf War Veterans: Health Effects Observed in an Enlarged "Friendly Fire" Cohort," Journal of Environmental Medicine. Vol. 4, No. 12, pages 991-1000, December 2001.

Department of Veterans Affairs		<b>DEPLETED URANIUM (DU) QUESTIONNAIRE</b> (SUPPLEMENT TO GULF WAR CODESHEET, VA FORM 10-9009a(RS))									
TT	#1	Facility Number (Use PTF No. only) (2 - 4)					Suffix (5 - 7)				
The information the veteran supplies may be disclosed outside the VA to Federal, State and local government agencies and National Health Organizations to assist in the development of programs for research purposes and other uses as stated in the "Notice of Systems of VA Records" published in the Federal Register in accordance with the Privacy Act of 1974.											
<b>INSTRUCTIONS:</b> Environmental Health Coordinator or Clinician: Please print. Use only one letter or number per block. If possible use black ballpoint or felt-tip pen. Shaded areas are for VA use only. All free text on this code sheet will be retained in medical health record but not included in the registry dataset at AAC.											
<b>PART IV (DEPLETED URANIUM [DU])</b>											
2. LAST NAME (8-33)											
3. FIRST NAME (34-48)											
4. SOCIAL SECURITY NUMBER (49-58)											
5. PHONE NUMBERS WHERE YOU MAY BE CONTACTED:											
5A. DAYTIME PHONE (59-68)						5B. EVENING PHONE (69-78)					
(    )    +    (    )    +											
6. TODAY'S DATE (79-86)				7. DATE OF ARRIVAL IN PERSIAN GULF WAR THEATRE OF OPERATION (87-94)				8. DATE OF DEPARTURE FROM PERSIAN GULF WAR THEATRE OF OPERATION (95-102)			
e.g. 05181988 (May 18, 1988)				e.g. 06181991 (June 18, 1991)				e.g. 11121991 (November 12, 1991)			
<b>TO BE COMPLETED BY ENVIRONMENTAL HEALTH COORDINATOR OR CLINICIAN</b>											
<b>Instructions:</b> Please respond to all questions by entering one of the listed codes in Column (b).										(a) BLOCK	(b) CODE
9. WHO REFERRED YOU TO THE VA MEDICAL CENTER FOR EVALUATION?  Code "a" = Office of the Special Assistant for Gulf War Illness (OSAGWI) of Department of Defense? Code "b" = Another Department of Defense Office Code "c" = Department of Veterans Affairs (VA) Code "d" = Self Referred Code "e" = Other sources (identify below)										103	
10. WHERE DID YOU SERVE? Enter Code "Y"= Yes or "N"= No in Blocks 104a through 104e.											
10a. Code "a" = Kuwait										104a	
10b. Code "b" = Saudi Arabia										104b	
10c. Code "c" = Iraq										104c	
10d. Code "d" = Only on a ship (not ashore)										104d	
10e. Code "e" = Other (identify below)										104e	

DEPLETED URANIUM QUESTIONNAIRE, Continued	SSN								
<i>Instructions:</i> Choose one of the following codes for Questions 11 through 39, unless other codes are listed or a narrative response is required:    Code "Y" = Yes    Code "N" = No    Code "D" = Don't Know									
								(a) BLOCK	(b) CODE
11. WERE YOU A LOGISTICS ASSISTANCE REPRESENTATIVE (LAR) WHO INSPECTED DEPLETED URANIUM CONTAMINATED SYSTEMS TO DETERMINE REPAIRABILITY?								105	
12. WERE YOU A MEMBER OF A BATTLE DAMAGE ASSESSMENT TEAM (BDAT) WHO EXAMINED U.S. COMBAT VEHICLES KNOWN, OR SUSPECTED TO BE, DAMAGED OR DESTROYED BY DU?								106	
13. WERE YOU A MEMBER OF THE 144 SERVICE AND SUPPLY COMPANY WHO PROCESSED DAMAGED EQUIPMENT, INCLUDING SOME WITH DU CONTAMINATION?								107	
14. WERE YOU A MEMBER OF A RADIATION CONTROL (RADCON) TEAM DEPLOYED IN THE PERSIAN GULF?								108	
15. WERE YOU INVOLVED IN THE EXAMINATION OR RECOVERY OF DAMAGED OR DESTROYED ENEMY VEHICLES?								109	
16. WERE YOU INVOLVED IN THE DOWNLOADING OF EQUIPMENT OR MUNITIONS FROM VEHICLES KNOWN OR SUSPECTED TO BE CONTAMINATED BY DU?								110	
17. WERE YOU A MEMBER OF A UNIT MAINTENANCE TEAM PERFORMING MAINTENANCE ON OR IN SYSTEMS KNOWN OR SUSPECTED TO BE CONTAMINATED BY DU?								111	
18. WERE YOU AT DOHA ON JULY 11, 1991, AT THE TIME OF THE FIRE?								112	
18a. WERE YOU DIRECTLY INVOLVED IN CLEAN-UP OPERATIONS FOLLOWING THE DOHA EXPLOSION AND FIRE?								112a	
18b. WERE YOU EXPOSED TO SMOKE FROM BURNING DOHA ROUNDS?								112b	
19. WERE YOU IN OR ON A VEHICLE HIT BY ENEMY FIRE AT THE TIME IT WAS HIT? IF "NO," SKIP TO QUESTION 20.								113a	
19a. IF "YES," WHAT TYPE OF A VEHICLE?									
19a(1) Code "a" = ABRAMS battle tank								113b	
19a(2) Code "b" = BRADLEY fighting vehicle								113c	
19a(3) Code "c" = Other (identify) :								113d	
19a(4) Code "d" = Don't know								113e	
19b. IF "YES," WAS THE VEHICLE HIT BY DU MUNITIONS?								113f	
20. DID YOU ENTER AN ABRAMS BATTLE TANK TO PERFORM RESCUE OPERATIONS IMMEDIATELY AFTER IT WAS STRUCK BY ENEMY FIRE?								114	
21. DID YOU ENTER AN ABRAMS BATTLE TANK TO RETRIEVE SENSITIVE ITEMS IMMEDIATELY AFTER IT WAS STRUCK BY ENEMY FIRE?								115	
22. DID YOU ENTER A BRADLEY FIGHTING VEHICLE TO PERFORM RESCUE OPERATIONS IMMEDIATELY AFTER IT WAS STRUCK BY ENEMY FIRE?								116	
23. DID YOU ENTER A BRADLEY FIGHTING VEHICLE TO RETRIEVE SENSITIVE ITEMS IMMEDIATELY AFTER IT WAS STRUCK BY ENEMY FIRE?								117	





DEPLETED URANIUM QUESTIONNAIRE, Continued		SSN									(a) BLOCK	(b) CODE
35. DID YOU CLIMB ON OR ENTER VEHICLES HIT BY ENEMY OR FRIENDLY FIRE SOMETIME AFTER THE IMMEDIATE POST-IMPACT RESCUE PERIOD? IF "NO," SKIP TO QUESTION 36. "Y" = Yes                      "N" = No                      "D" = Don't Know										129		
35a. IF "YES," WHAT TYPE OF VEHICLE?												
35a(1) Code "a" = ABRAMS battle tank										129a		
35a(2) Code "b" = BRADLEY fighting vehicle										129b		
35a(3) Code "c" = Other (identify below)										129c		
35a(4) Code "d" = Don't Know										129d		
35b. HOW MANY TIMES?												
35b(1) Code "a" = 1 Time										129e		
35b(2) Code "b" = 2 Times										129f		
35b(3) Code "c" = 3- 10 times										129g		
35b(4) Code "d" = More than 10 times										129h		
35b(5) Code "e" = Don't know										129i		
35c. HOW LONG (IN TOTAL) WERE YOU ON BOARD THE VEHICLE(S)?												
35c(1) Code "a" = Less than 5 minutes										129j		
35c(2) Code "b" = 5-15 minutes										129k		
35c(3) Code "c" = 16-30 minutes										129l		
35c(4) Code "d" = More than 30 minutes										129m		
35c(5) Code "e" = Don't know										129n		
35d. WAS THE VEHICLE KNOWN TO BE CONTAMINATED WITH DU?										129o		
36. DID YOU PASS WITHIN 50 METERS (45.72 YARDS) OF A DAMAGED OR DESTROYED VEHICLE? IF "NO," SKIP TO QUESTION 37.    "Y" = Yes                      "N" = No                      "D" = Don't Know										130		
36a. HOW LONG (IN TOTAL) AFTER THE DESTRUCTIVE EVENT?												
36a(1) Code "a" = Less than 12 hours										130a		
36a(2) Code "b" = 12 hours - 24 hours										130b		

DEPLETED URANIUM QUESTIONNAIRE, Continued	SSN									
36a(3). Code "c" = more than 24 hours									130c	
36a(4). Code "d" = Don't know									130d	
<b>36b. IF "YES," WHAT TYPE OF VEHICLE?</b>										
36b(1) Code "a" = ABRAMS battle tank									130e	
36b(2) Code "b" = BRADLEY fighting vehicle									130f	
36b(3) Code "c" = Other (identify below)									130g	
36b(4) Code "d" = Don't Know									130h	
<b>36c. WAS THE VEHICLE BURNING?    "Y" = Yes    "N" = No    "D" = Don't Know</b>										
<b>37. WERE YOU WOUNDED AS A RESULT OF BEING IN, ON, OR WITHIN 50 METERS (45.72 YARDS) OF THE DAMAGED VEHICLE AT THE TIME IT WAS HIT? IF "NO," SKIP TO QUESTION 38.</b>										
<b>37a. WHERE YOU WOUNDED?</b>										
37a(1) Code "a" = leg/foot									131a	
37b(2) Code "b" = arm/hand									131b	
37c(3) Code "c" = face/head									131c	
37d(4) Code "d" = neck									131d	
37e(5) Code "e" = body									131e	
<b>37b. DO YOU HAVE RETAINED FRAGMENTS OR SHRAPNEL IN YOUR BODY?</b>										
<b>38. DID YOU FIRE DU ROUNDS?</b>										
<b>39. DID YOU HANDLE BARE/DAMAGED DU PENETRATOR ROUNDS? IF "NO," SKIP TO QUESTION 40.</b>										
<b>39a. DID YOU HANDLE THE ROUNDS WITH GLOVES?</b>										
<b>39b. DID YOU HANDLE THE ROUNDS WITH SHIELDING?</b>										
<b>OTHER EXPOSURES</b>										
<b>40. DID YOU HAVE EXPOSURE TO DU THAT IS NOT CAPTURED BY THIS QUESTIONNAIRE?</b>										
<b>41. IF "YES," DESCRIBE BELOW:</b>										
_____										
_____										
_____										

<b>DEPLETED URANIUM QUESTIONNAIRE, Continued</b>		SSN																	
41. DO YOU HAVE OTHER EXPOSURES AND EXPERIENCES TO DISCUSS WITH THE PROVIDER? Code "Y" = Yes Code "N" = No IF "YES," DESCRIBE BELOW:										135									
<hr/> <hr/> <hr/>																			
42. IS THE 24-HOUR URINE COLLECTION FOR URANIUM BEING PERFORMED? Code "Y" =Yes, Code "N" = No or Code "U" =Unknown. IF "NO" OR "UNKNOWN" PROVIDE EXPLANATION BELOW.										136									
<hr/> <hr/> <hr/>																			
43.										137									
44. OTHER COMMENTS:																			
<hr/> <hr/> <hr/>																			
45. NAME AND TITLE OF EXAMINER/CLINICIAN:																			
46. SIGNATURE OF EXAMINER:																			
<i>Instructions:</i> Once the DU questionnaire has been completed, VAMC EHC will transmit a copy to AAC, with registry code sheet. If the veteran has already had a GW Registry examination, only the DU questionnaire will be sent to AAC. A copy of the questionnaire will also be sent to the DU Follow-up Program at the Baltimore VAMC with the package requesting the urine uranium test. The Baltimore DU Follow-up program staff will transmit the results of the urine uranium test directly to the AAC for database entry and to the VAMC of origin for entry into the veteran's medical record.																			
<b>TO BE COMPLETED BY THE BALTIMORE VAMC FU FOLLOW-UP PROGRAM STAFF</b>																			
47. CORRECTED URINE URANIUM (EXPRESSED PER MCG PER G CREATININE) 3 DIGITS TO THE LEFT AND 3 DIGITS TO THE RIGHT OF THE DECIMAL.										138-143									
REPEAT URINE URANIUM										144- 149									
48. REMARKS:																			
<hr/> <hr/> <hr/>																			



**DEPARTMENT OF VETERANS AFFAIRS (VA)  
FORM 10-9009F,  
DEPLETED URANIUM (DU) PROGRAM CHECKLIST**

**24-HOUR URINE URANIUM COLLECTION**

BALTIMORE VA MEDICAL CENTER

**CONSULT URINE INSTRUCTIONS (REVISED 03/04)**

\_\_\_\_\_  
\_\_\_\_\_

**CALL DU PROGRAM AT 1-800-815-7533  
FOR INFORMATION ON ORDERING CURRENT FORM.**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_



# 18

## Appendix 18:

# Medical Emergency Radiological Response Team (MERRT)



Department of Veterans Affairs  
Veterans Health Administration  
Washington, DC 20420

VHA DIRECTIVE 2004-013

April 8, 2004

## **MEDICAL EMERGENCY RADIOLOGICAL RESPONSE TEAM (MERRT)**

### **1. PURPOSE:**

This Veterans Health Administration (VHA) Directive establishes policy for the organization, training, certification, budget, equipment and deployment of the VHA Medical Emergency Radiological Response Team (MERRT).

### **2. BACKGROUND**

- a. The Secretary, Department of Veterans Affairs (VA) has approved the establishment of the VHA Medical Emergency Radiological Response Team (MERRT) for medical support to be provided under Executive Order (EO) 12657. Under this EO, available VA and Department of Defense medical resources would be used in response to a nuclear power plant accident. To meet the requirements of the Executive Order, a Concept of Operations (CONOPS) was developed. This CONOPS includes the development of a specialized team of VHA health professionals that, if such an accident occurred, could be rapidly deployed to an off-site medical provider to render both direct patient treatment and technical advice. By extension, this team would also support the National Response Plan (NRP), and other applicable radiological response plans integrated or linked to NRP, extending the role of the team to respond to any type of radiological event or disaster, including a terrorist incident. The team is titled the "Medical Emergency Radiological Response Team" or MERRT.
- b. Upon request by the applicable authority, MERRT will be deployed in response to an accidental or deliberate release of radiation that requires a medical response. MERRT does not deploy as a "first responder" but does so as part of the Federal Radiological Emergency Response Plan (FRERP), NRP, or other authorized

Federal response to assist the local medical community and healthcare providers in addressing any and all medical issues that arise from the discovery of radiation beyond normal background levels and the affect of that radiation on the exposed population. This includes assistance and support of local health care providers on the handling and treatment of exposed and contaminated casualties and internal support to VA entities, even in the absence of a national emergency.

### **3. POLICY:**

It is VHA policy to organize, train, equip, and deploy a MERRT to meet the requirements of EO 12657, as well as support FRERP and NRP.

### **4. ACTION**

- a. **The Under Secretary for Health.** The Under Secretary for Health is responsible for ensuring resource availability that will provide for organizing, training, equipping and deploying a MERRT.
- b. **The Deputy Under Secretary for Health for Operations and Management.** The Deputy Under Secretary for Health for Operations and Management coordinates and works with the Chief Consultant, Emergency Management Strategic Healthcare Group, to ensure effective implementation of this Directive. This includes the appointment of a MERRT chief and ensuring the availability of MERRT members for training, exercise, and deployment, when required.
- c. **Chief Consultant, Emergency Management Strategic Healthcare Group (EMSHG).** The Chief Consultant, Emergency Management Strategic Healthcare Group, is responsible for:
  - (1) MERRT recruitment and overall team development.
  - (2) MERRT budget development and management.
  - (3) Coordinating the training and education of MERRT members to ensure their preparedness to respond when required.
  - (4) Providing the equipment and supplies for MERRT training and actual deployment.
  - (5) Developing a MERRT Operations Plan (OPLAN) to be published as an annex to VHA Handbook 0320.
  - (6) Developing and executing MERRT exercises.
  - (7) Coordinating the reimbursement to VA of MERRT costs whenever a MERRT is activated and/or deployed in support of the FRERP, NRP, or other Federal authority.
  - (8) Developing guidance for MERRT, i.e., guidebooks, handbooks, policies, standard operating procedures, planning guides, etc.
  - (9) Designating an EMSHG staff member to serve as liaison with the MERRT Leader in coordinating EMSHG support.

- d. **MERRT Leader**. The MERRT Leader is responsible for:
- (1) Overall supervision and management of the team when in deployed status to include both exercise and for an actual event.
  - (2) Coordinating with the Chief Consultant, EMSHG, in identifying appropriate training requirements and venues, equipment needs, exercise, budget development and deployment and employment processes and procedures.
  - (3) Assessing the impact on human health, when deployed for an actual event, and for providing appropriate consultation and technical advice to local, state, and Federal authorities.
  - (4) Providing medical advice on the handling and treatment of individuals exposed to or contaminated by radioactive materials.
  - (5) Managing radiation trauma and coordination of crisis counseling, related to radiation injuries and exposure.
  - (6) Coordinating the use of other deployed VA medical resources, as appropriate, and as might be directed by VHA Central Office.

## **5. REFERENCES**

- a. VA Directive 0320, dated October 16, 1999.
- b. VHA Directive 0320, dated May 1, 1997.
- c. Executive Order 12657, dated November 18, 1988.
- d. Federal Response Plan (Interim), dated January 2003.
- e. Federal Radiological Emergency Response Plan (FRERP), dated February 1, 1996.
- f. Initial National Response Plan, dated September 30, 2003.

## **6. FOLLOW-UP RESPONSIBILITY:**

EMSHG (13C) is responsible for the content of this Directive. Questions may be addressed to 304-264-4835.

## **7. RESCISSIONS:**

None. This VHA Directive expires April 30, 2009.  
S/ ArtHamerschlag for  
Jonathan B. Perlin, MD, PhD, MSHA, FACP  
Acting Under Secretary for Health

DISTRIBUTION: CO: E-mailed 4/9/04

FLD: VISN, MA, DO, OC, OCRO, and 200 – E-mailed 4/9/04



# TERRORISM WITH IONIZING RADIATION GENERAL GUIDANCE Pocket Guide

## Diagnosis: Be Alert to the Following

- Acute radiation syndrome (Table 1) follows a predictable pattern after substantial exposure or catastrophic events
- Victims may also present individually, as described in Table 2, over a longer period of time after exposure to contaminated sources hidden in the community
- Specific syndromes of concern, especially with a 2-3 week prior history of nausea and vomiting are
  - thermal burn-like skin lesions without documented heat exposure
  - immunological dysfunction with secondary infections
  - a tendency to bleed (epistaxis, gingival bleeding, petechiae)
  - marrow suppression (neutropenia, lymphopenia, and thrombocytopenia)
  - hair loss

## Understanding Exposure

- Exposure may be known and recognized or clandestine as
  - large radiation exposures, such as a nuclear bomb or catastrophic damage to a nuclear power station
  - small radiation source emitting continuous gamma radiation producing chronic intermittent exposures (such as radiological sources from medical treatment or industrial devices.)
  - skin contamination with radioactive material (“external contamination”)
  - internal radiation from absorbed, inhaled, or ingested radioactive material (“internal contamination”)

## Confirmation and Sources of Assistance and Support

- Contact radiation safety officer (ROS) for help

## Confirmation and Sources of Assistance and Support (cont.)

- For help in projecting clinical effects, contact
  - nuclear medicine physician
  - Medical Radiological Advisory Team (MRAT) at Armed Forces Radiobiology Research Institute (AFRRI) 301-295-0530
- Obtain complete blood count
- absolute lymphocyte count < 1000mm<sup>3</sup> suggests moderate exposure
- absolute lymphocyte count < 500 mm<sup>3</sup> suggests severe exposure
- Acute, short-term rise in neutrophil count
- Swab both nostrils
- Collect 24 hour stool if GI contamination is possible
- Collect 24 hour urine if internal contamination with radionuclides is possible
- CDC ATSDR Hotline 770-488-7100

## Decontamination Consideration

- Exposure to a beam of radiation generally does not contaminate a patient. Patient contamination generally results from contact with radioactive particles.
- Treating contaminated patients before decontamination may contaminate the facility: plan for decontamination before arrival
- Exposure without contamination requires no decontamination (RSO measurement)
- Exposure with contamination requires Standard Precautions, removal of patient clothing, and decontamination with soap and water
- For internal contamination, contact the RSO and/or Nuclear Medicine Physician
- Patient with life-threatening condition: treat, then decontaminate
- Patient with non-life threatening condition: decontaminate, then treat

## Treatment Considerations

- If life-threatening conditions are present, treat them first
- If external radioactive contaminants are present, decontaminate
- If radioiodine (reactor accident) is present, consider protecting the thyroid gland with prophylactic potassium iodide if within first few hours only (ineffective later). (Table 3)
- Review <http://www.afri.usuhs.mil/www/outreach/pdf/2edmmrhandbook.pdf> or <http://vawww.oqp.med.va.gov/cpg>

## Institutional Reporting

- If reasonable suspicion of a radiation event, contact hospital leadership (Chief of Staff, Hospital Director, etc)
- Immediately discuss hospital emergency planning implications

## Public Health Reporting

- Contact local public health office (city, county or state)
- If needed, contact the FBI (for location of nearest office, see <http://www.fbi.gov/contact/fo.htm>)



Continued on next page

Aug 2003

VA access card: <http://www.oqp.med.va.gov/cpg/cpg.htm>  
DoD access card: <http://www.gmo.amedd.army.mil>

Produced by the Employee Education System for the  
Office of Public Health and Environmental Hazards, Department of Veterans Affairs

**TABLE 1: ACUTE RADIATION SYNDROME**  
1 Gray (Gy) = 100 rads 1 centiGray (cGy) = 1 rad

Whole body radiation from external radiation or internal absorption							
Phase of Syndrome	Feature	Subclinical range		Sublethal range		Lethal range	
				0 - 100 rad or cGy none	100 - 200 rad 1 - 2 Gy 5 - 50%	200 - 600 rad 2 - 6 Gy 50 - 100%	600 - 800 rad 6 - 8 Gy 75 - 100%
<b>Prodromal Phase</b>	Nausea, vomiting		3 - 6 hrs	2 - 4 hrs	1 - 2 hrs	< 1 hr	Minutes
	Time of onset		< 24 hrs	< 24 hrs	< 48 hrs	< 48 hrs	N/A
	Duration	Unaffected	Minimally decreased	< 1000 at 24 hrs	< 500 at 24 hrs	Decreases within hours	Decreases within hours
<b>Latent Phase (subclinical)</b>	Lymphocyte Count		No impairment	Cognitive impairment for 6 - 20 hrs	Cognitive impairment for > 24 hrs	Rapid incapacitation, often after a lucid period of up to several hours	
	CNS function	No Impairment	No impairment	0 - 7 days	0 - 2 days	None	
	Absence of Symptoms	> 2 wks	7 - 15 days				
<b>Acute Radiation Illness or "Manifest Illness" Phase</b>	Signs and symptoms	None	Moderate leukopenia	Severe leukopenia, purpura, hemorrhage Pneumonia Hair loss after 300 rad/3 Gy		Diarrhea Fever Electrolyte disturbance	Convulsions, Ataxia Tremor, Lethargy
	Time of onset		> 2 wks	2 days - 2 wks	1 - 3 days	1 - 3 days	
	Critical period		None	4 - 6 wks - Most potential for effective medical intervention	2 - 14 days	2 - 14 days	1 - 48 hrs
<b>Hospitalization</b>	Organ System	None	Hematopoietic and respiratory (mucosal) systems			GI tract Mucosal systems	CNS
	%	0	< 5%	90%	100 %	100%	100 %
<b>Mortality</b>	Duration	None	45 - 60 days	60 - 90 days	90 + days	Weeks to Months	days to weeks
		None	Minimal	Low with aggressive therapy	High	Very high, significant neurological symptoms indicate lethal dose	

**TABLE 2: SYMPTOM CLUSTERS AS DELAYED EFFECTS AFTER RADIATION EXPOSURES**

Headache	Partial and full thickness skin damage
Fatigue	Hair loss
Weakness	Ulceration
Anorexia	Lymphopenia
Nausea	Neutropenia
Vomiting	Thrombopenia
Diarrhea	Purpura
	Opportunistic infections

**TABLE 3: POTASSIUM IODIDE DOSAGES:**

The dose of potassium should be taken once a day until a risk of significant exposure to radioiodines no longer exists\*

Age group	Dosage
Infants < 1 month	16 mg
Children 1 months - 3 yrs	32 mg
Children 3 - 18 yrs	65 mg
Adults	130mg

\*For information regarding preparation of potassium iodine solution: <http://www.fda.gov/cder/drugprep/kiprep.htm>



## Appendix 19b

### **SOME POTENTIAL SOURCES OF ASSISTANCE\* FOR RESPONDING TO A TERRORIST ACT OR ANOTHER EVENT INVOLVING RADIATION**

Medical Radiobiology Advisory Team (MRAT), Armed Forces Radiobiology Research Institute (AFRRI), Uniformed Services University of the Health Sciences (USUHS) – Phone Number: 301-295-0316.

Oak Ridge Institute for Science and Education – Radiation Emergency Assistance Center/Training Site (REAC/TS) – Emergency Phone Number: 865-576-1005 (ask for REAC/TS).

VA Medical Emergency Radiological Response Team (MERRT) – contact the VA Emergency Management Strategic Health Group (EMSHG) Duty Officer - Phone Number: 304-264-4800.

VA Nat'l Health Physics Program (NHPP)–Phone: 501-257-1571; Emerg # 800-815-1016.

### **SOME KEY REFERENCES AND “TOOLS”\*\***

AFRRI Biological Dosimetry Tool (BAT) –  
<http://www.afri.usuhs.mil/www/outreach/biodostools.htm>

AFRRI Medical Management of Radiological Casualties Handbook, 2nd Edition – <http://www.afri.usuhs.mil>

REAC/TS Managing Radiation Emergencies – Guidance for Hospital Medical Management – <http://www.orau.gov/reacts/care.htm>

VA Emergency Management Program Guidebook, February 2002, pages 7.2-195 to 7.2-212

VA Pocket Guide – Terrorism with Ionizing Radiation General Guidance – **See Appendix 19a.**

\* It is recommended that the individual VA medical center add local resources and contact information to this list.

\*\* It is recommended that print copies of key references (such as VA's Emergency Management Program Guidebook) be available at the VA medical center in case a terrorist event disrupts Internet access and other communications.





# Independent Study Test

## Questions for CME Credit

Using the Independent Study Participant Registration/Answer Sheet, please completely fill in the lettered box corresponding to your answer next to the appropriate number.

1. The main difference between ionizing radiation and non-ionizing radiation is:
  - a) Ionizing radiation releases energy more rapidly
  - b) Ionizing radiation is twice as radioactive as non-ionizing radiation
  - c) Ionizing radiation creates electrically-charged particles
  - d) All of the above
2. Which of the following is **NOT** a form of ionizing radiation?
  - a) Alpha particles
  - b) Beta particles
  - c) Gamma waves
  - d) Microwaves
3. Which of the following is **NOT** a form of non-ionizing radiation?
  - a) Gamma waves
  - b) Microwaves
  - c) Infrared waves
  - d) Extremely low frequency (ELF) electric power
4. Which of the following is an example of a "stochastic" effect of radiation?
  - a) Cataracts
  - b) Acute radiation syndrome
  - c) Leukemia
  - d) Pulmonary fibrosis from radiation therapy

5. Which of the following is an example of a “deterministic” effect of radiation?
  - a) Cataracts
  - b) Genetic mutation
  - c) Leukemia
  - d) Thyroid cancer
6. How do malignancies caused by ionizing radiation differ from malignancies caused by other factors?
  - a) Increased p53 levels
  - b) Indistinguishable
  - c) Increased angiogenesis factors
  - d) Increased 26q trisomy
7. Which form of non-ionizing radiation is thought to be the major risk factor for skin cancer?
  - a) Infrared
  - b) Ultraviolet
  - c) Microwave
  - d) Radiofrequency
8. According to the National Academy of Sciences, the likelihood of “deterministic” effects from ionizing radiation would be very low at doses of less than:
  - a) 500 rem
  - b) 100 rem
  - c) 50 rem
  - d) 10 rem
9. Which group of veterans is **NOT** eligible for inclusion into the VA's Ionizing Radiation Registry examination program database?
  - a) Hiroshima and Nagasaki occupation troops
  - b) Nuclear submarine crew members
  - c) Participants in atmospheric nuclear weapons tests
  - d) Submariners treated with nasopharyngeal (NP) radium

10. The current annual whole-body occupational radiation dose limit mandated by the Nuclear Regulatory Commission is:
- a) 50 rem
  - b) 5 rem
  - c) 0.5 rem
  - d) 0.05 rem
11. The maximum dose estimated to have been received by U.S. occupation troops at Hiroshima or Nagasaki according to the Defense Threat Reduction Agency is:
- a) 0.1 rem
  - b) 1 rem
  - c) 10 rem
  - d) 100 rem
12. The average external radiation dose that atmospheric nuclear weapons test participants are estimated to have received according to the Defense Threat Reduction Agency is:
- a) 160 rem
  - b) 60 rem
  - c) 6 rem
  - d) 0.6 rem
13. Which of the following adverse health effects has **NOT** been found in studies of Japanese atomic bomb survivors?
- a) Increased risk for birth defects in offspring conceived after exposure
  - b) Increased risk for leukemia
  - c) Increased risk for thyroid tumors
  - d) Increased risk for breast cancer in women
14. Which of the following statements about studies of U.S. atmospheric nuclear weapons test participants is incorrect?
- a) Some studies have found increased risks for leukemia and lymphopoietic malignancies
  - b) Some studies have found increased mortality risk for various solid tissue malignancies
  - c) Some studies have not found an increased risk for overall mortality
  - d) Some studies have found an increased risk for birth defects in offspring

15. Which of the following adverse health effects has been linked to treatment with nasopharyngeal (NP) radium in some studies?
- a) Increased risk for malignant mesotheliomas of peritoneum
  - b) Increased risk for esophageal cancer
  - c) Increased risk for tumors of the head and neck
  - d) Increased risk of cataracts
16. Compared to natural uranium, approximately how radioactive is depleted uranium (DU)?
- a) Twice
  - b) Equal
  - c) Half
  - d) One-tenth
17. Which currently appears to be the best method to screen for significant amounts of internalized depleted uranium (DU)?
- a) Whole body external counting for radioactivity from uranium
  - b) Plutonium bioassay determination
  - c) Measurement of radon expired from the lungs
  - d) Urinary uranium determination
18. Which of the following health effects has **NOT** been found in some veterans with retained depleted uranium (DU)?
- a) Increased urinary uranium excretion
  - b) Reduced performance on some computerized neuropsychological tests
  - c) Higher prolactin values
  - d) Increased risk for birth defects in offspring
19. Which Gulf War veterans are eligible to participate in the VA's DU screening program?
- a) Friendly-fire casualties
  - b) Personnel who salvaged vehicles damaged by DU munitions
  - c) Other Gulf War veterans who are concerned about possible DU exposure
  - d) All of the above

20. Cataracts possibly due to radiation exposure would be best managed by a:
- a) Specialist in ophthalmology
  - b) Radiation safety officer
  - c) Radiation epidemiologist
  - d) Specialist in chelation therapy