VETERANS' ADVISORY BOARD ON
DOSE RECONSTRUCTION - THIRTEENTH MEETING

Review of Atomic Veterans Epidemiology Study

John D Boice Jr
Arlington, Virginia
23 July 2013

NCRP
Scientific Authority Since 1929

Vanderbilt-Ingram Cancer Center

A Comprehensive Cancer Center Designated by the National Cancer Institute

Outline

- Overview of Research Effort
- Preliminary Results
- Future Possibilities
- Million US Radiation Worker and Veteran Study

Troops during detonation at NTS

SPONSORS

The Eight Series Study

VANDERBILT UNIVERSITY

NATIONAL CANCER INSTITUTE

Sponsored by:

U.S. Low Dose Radiation Research Program

NF Metting, ScD, Program Manager

And

DOE Office of Health and Safety
Dr Bonnie S. Richter co-Project Officer

U.S. DEPARTMENT OF ENERGY | Office of Science | Office of Biological and Environmental Research

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NUCLEAR TEST PERSONNEL REVIEW (NTPR) PROGRAM
SERVICE TO THE VETERAN
DOCUMENT
RECORDS
DEFENSE THREAT REDUCTION AGENCY

Overview


BAKER, Bikini Atoll, 23 kt, 24 June 1946

- 230 aboveground nuclear detonations from 1945 through 1962
- Over 115,000 veterans were previously studied who participated at one of eight nuclear weapons test series
- Statistical increases in leukemia were reported and excesses of several other cancers. No dose assessments for epidemiologic study were made
- An extended follow-up coupled with dose reconstruction of individual veterans who developed leukemia is ongoing

Overview -2

- Relies upon detailed radiation dose scenarios and veteran data already developed by the Department of Defense over the past 30 years

- Relies upon unique resources within the Department of Veterans Affairs (BIRLS, VAROs, Medical Databases, Federal Archives)

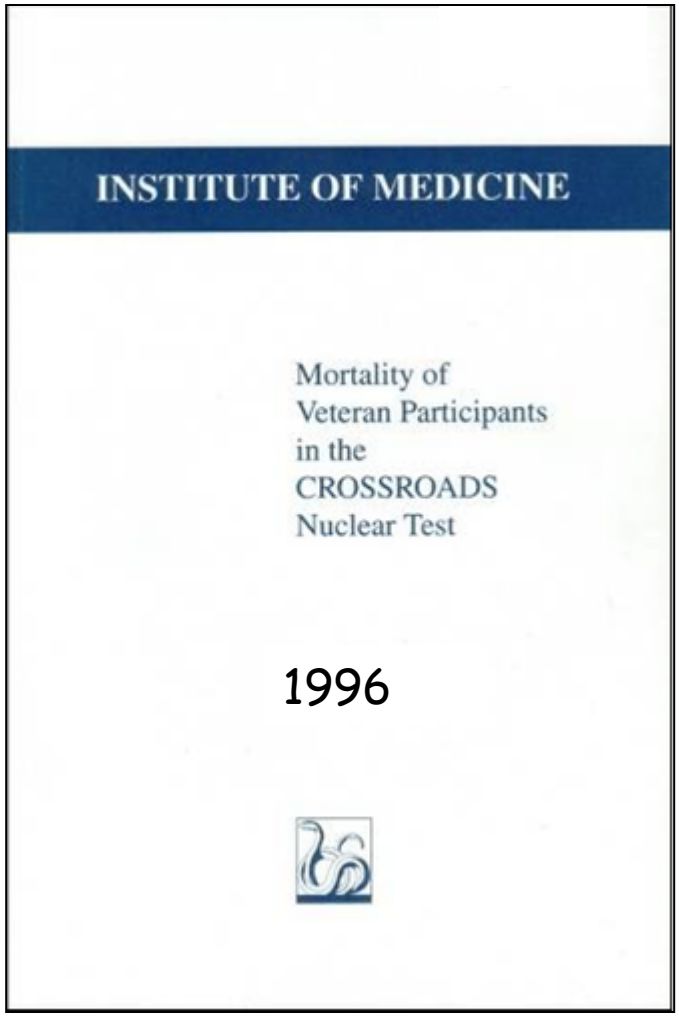
- Understanding exposure to radioactive substances assumes greater importance as society debates expanding nuclear energy and associated nuclear waste and the possibility of terrorist attacks with "dirty bombs.“

- Relevance to compensation programs

- Important to veterans and their families in providing a better understanding of the health risks associated with their prior military service.

Years for Epidemiologic Research

- **VBDR** – 2005 discussions.
- **DTRA** – 2007 approval
- **VU IRB** – 2008
- **SSA** – 2008
- **NCHS NDI** – 2009
- **NIH** – 2010 grant
- **DVA** – 2011 IRB
- **Renal Disease Registry** – 2012
- **DVA** – 2012 BIRLS
- **DOE/NRC** – 2012 Dosimetry
- **US Army, US Air Force** – 2013



Atomic Veterans
NIH Grant – In 4th of 5 years

- A five year grant from NIH was awarded September 2010 in cooperation with

  Department of Defense (DTRA),
  Department of Veterans Affairs and the
  National Cancer Institute (cooperative agreement)

- Vanderbilt University is the prime contractor with subcontracts:

  Risk Assessment Corporation (dosimetry support)
  International Epidemiology Institute (tracing and IT support)
  Fred Hutchison Cancer Research Institute (statistical support)
  Oak Ridge Associated Universities/ Chew Assoc. (quality control)

- Aim is to study 115,000 nuclear weapons test participants at 8 test series including Trinity (1945) and 7 other series in Nevada and Bikini Atolls

WEBSITE

- ABOUT THE STUDY
- PARTICIPATING INSTITUTIONS
- MEETINGS
- RELEVANT PUBLICATIONS
- NEWS ARTICLES/PRESS RELEASES
- GLOSSARY OF TERMS
- OTHER WEBSITES
- MEMBERS AREA

EARLY STUDY MATERIAL

BAKER (CROSSROADS)
Bikini Atoll, 23 kt
24 July 1946

Last modified April 29, 2013

Vanderbilt-Ingram Cancer Center
NCI CCC

International Epidemiology Institute

FRED HUTCHINSON CANCER RESEARCH CENTER
A LIFE OF SCIENCE

RAC
RISK ASSESSMENT CORPORATION

ORAU
OAK RIDGE ASSOCIATED UNIVERSITIES

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Scientific Authority Since 1929

http://www.atomicvetstudy.org/)

Number of participants from NuTRIS at each of the EIGHT nuclear weapon test series by military service*

Test series	Year	Test site	Air Force	Army	Marine Corps	Navy	Actual Total
CROSSROADS	1946	Pacific	0	3,395	551	39,188	38,380
GREENHOUSE	1951	Pacific	2,442	1,548	70	3,854	9,608
UPSHOT-KNOTHOLE	1953	Nevada	2,175	13,401	2,256	886	18,555
CASTLE	1954	Pacific	2,763	1,644	306	11,918	16,222
REDWING	1956	Pacific	2,976	1,708	250	6,993	13,626
PLUMBBOB	1957	Nevada	2,216	7,052	2,120	601	12,220
HARDTACK I	1958	Pacific	3,476	1,535	187	9,487	10,329
TRINITY	1945	NM		~700			397
Total			16,048	~31,000	5,740	72,927	114,277#

*These tests involved 100 bomb detonations (shots).
Totals differ because some veterans participated in more than one test series. Actual totals correct.

The 8th Series - Trinity

- First weapons test, Alamogordo, NM, 16 July 1945

- Historical figures:

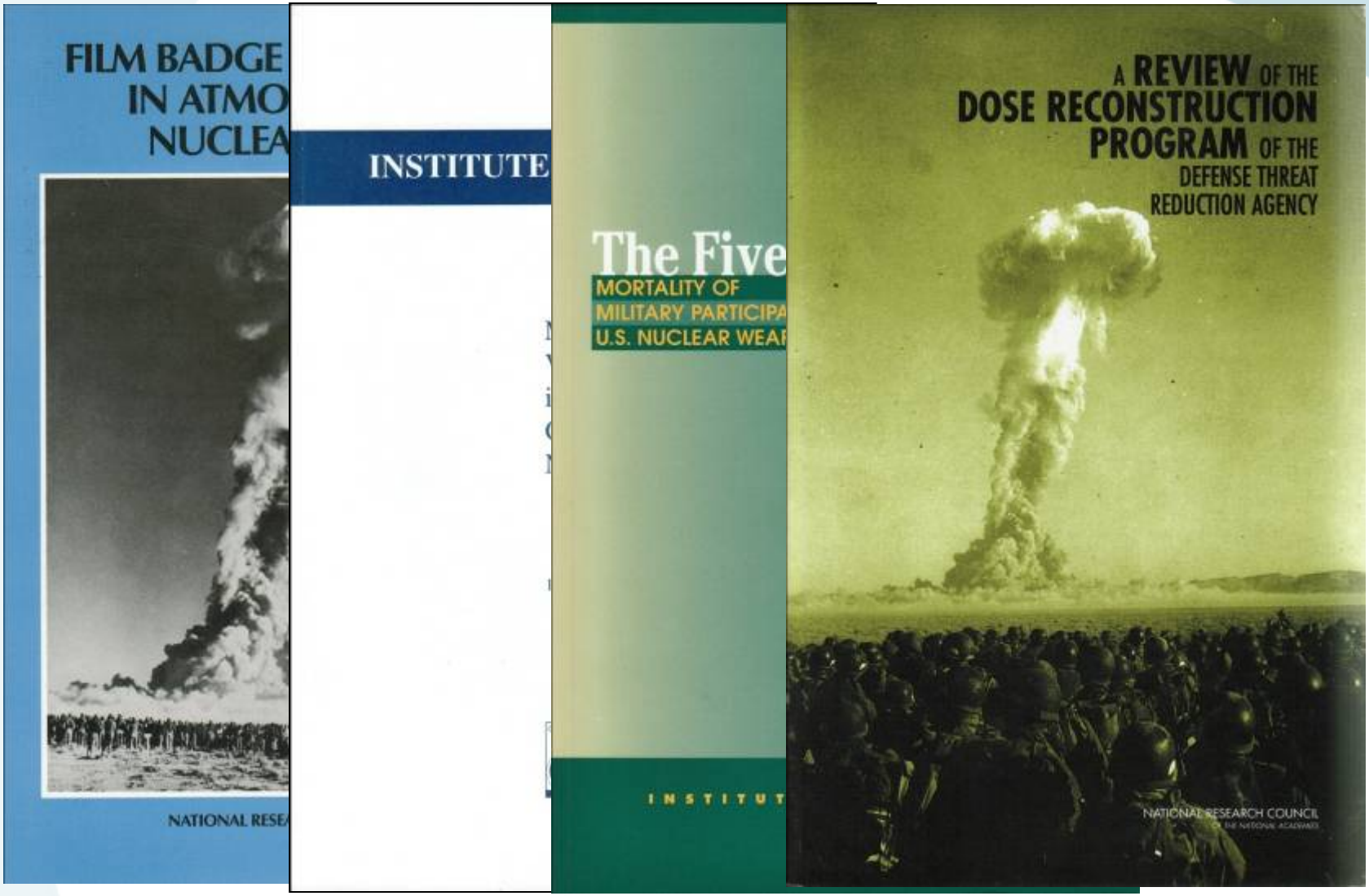
  J. Robert Oppenheimer
  General Leslie Groves
  Enrico Fermi, Hans Bethe
  Theodore Hall

- Note the film badges

Aim 1

- **Aim 1**. Estimate the lifetime risk of radiation-induced **leukemia** in terms of low-dose radiation received gradually from external exposures and from inhaled or ingested radionuclides in fallout.

Dosimetry for Epidemiology



Information Available

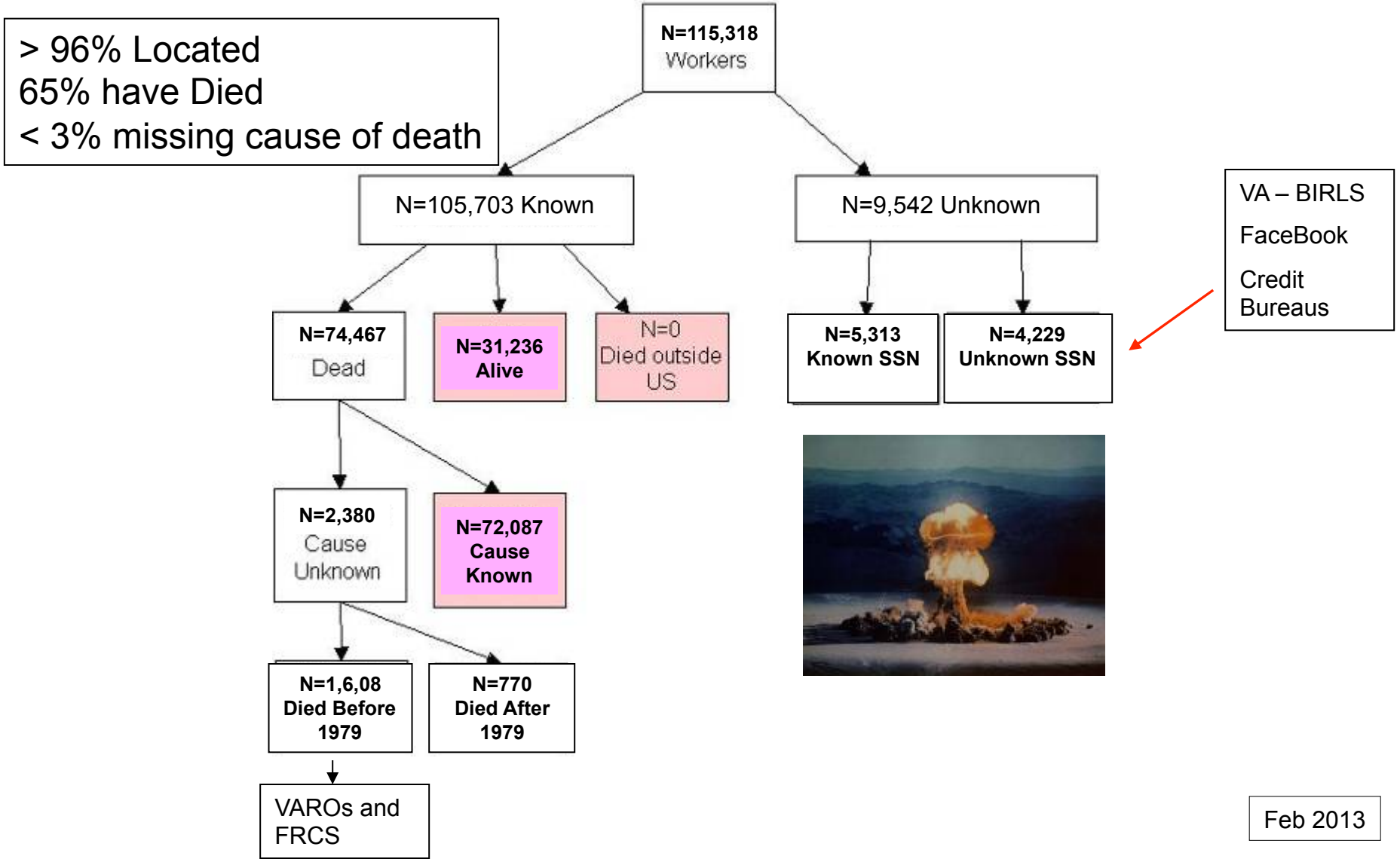
Dosimetry Team

More Dosimetry To Come
Dosimetry Linkages

Data Base	Number of matches
DOE/REMS	1,118
NRC/REIRS	1,012
Landaurer	682
US Army	554
US Air Force	313
US Navy	????
Total	>3,839 (>3.2%)

Atomic Veterans Tracing Efforts

> 96% Located
> 65% have Died
> < 3% missing cause of death



Feb 2013

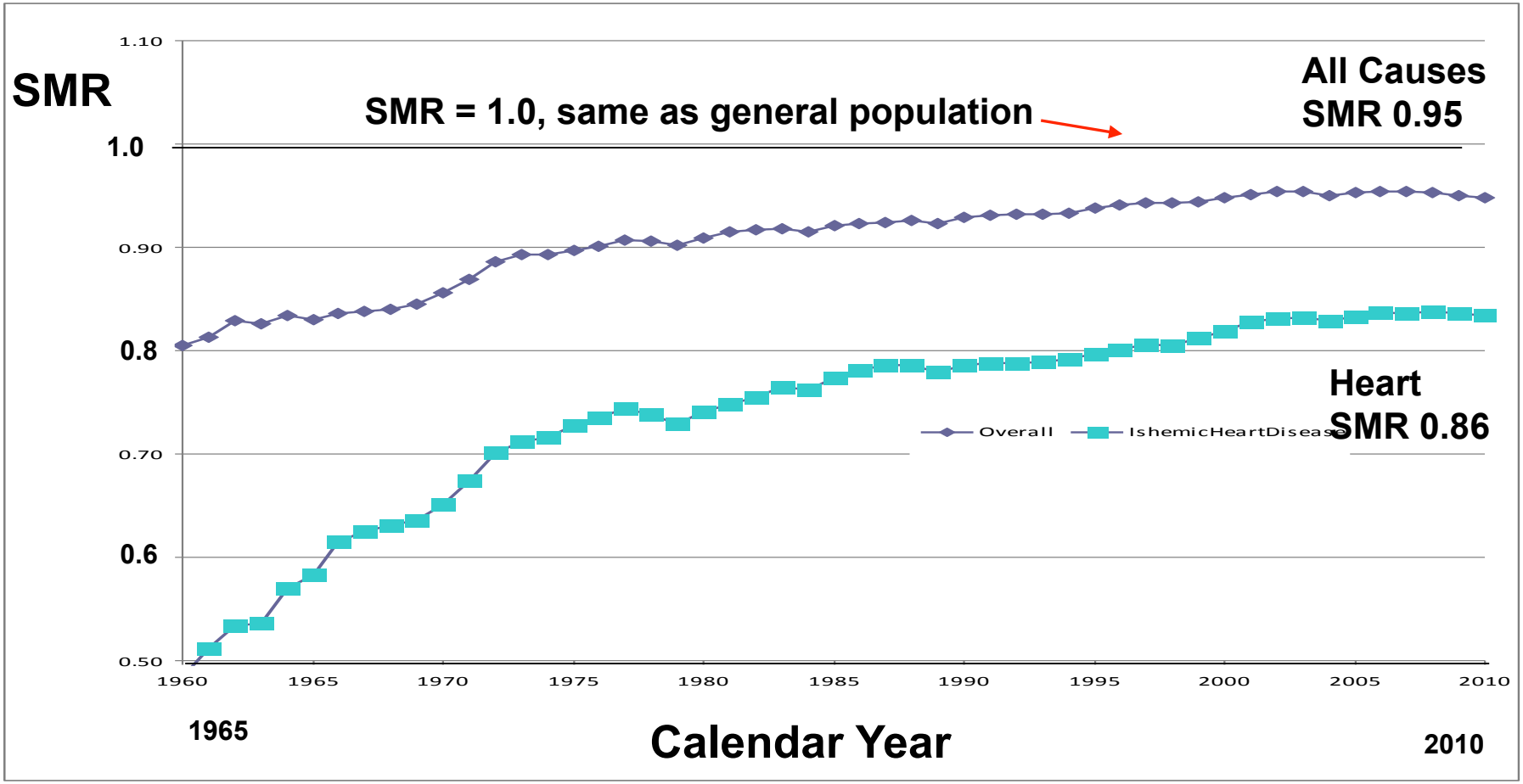
Epidemiology 101: What is an SMR ?

- **Sergeant Major Rank ?**

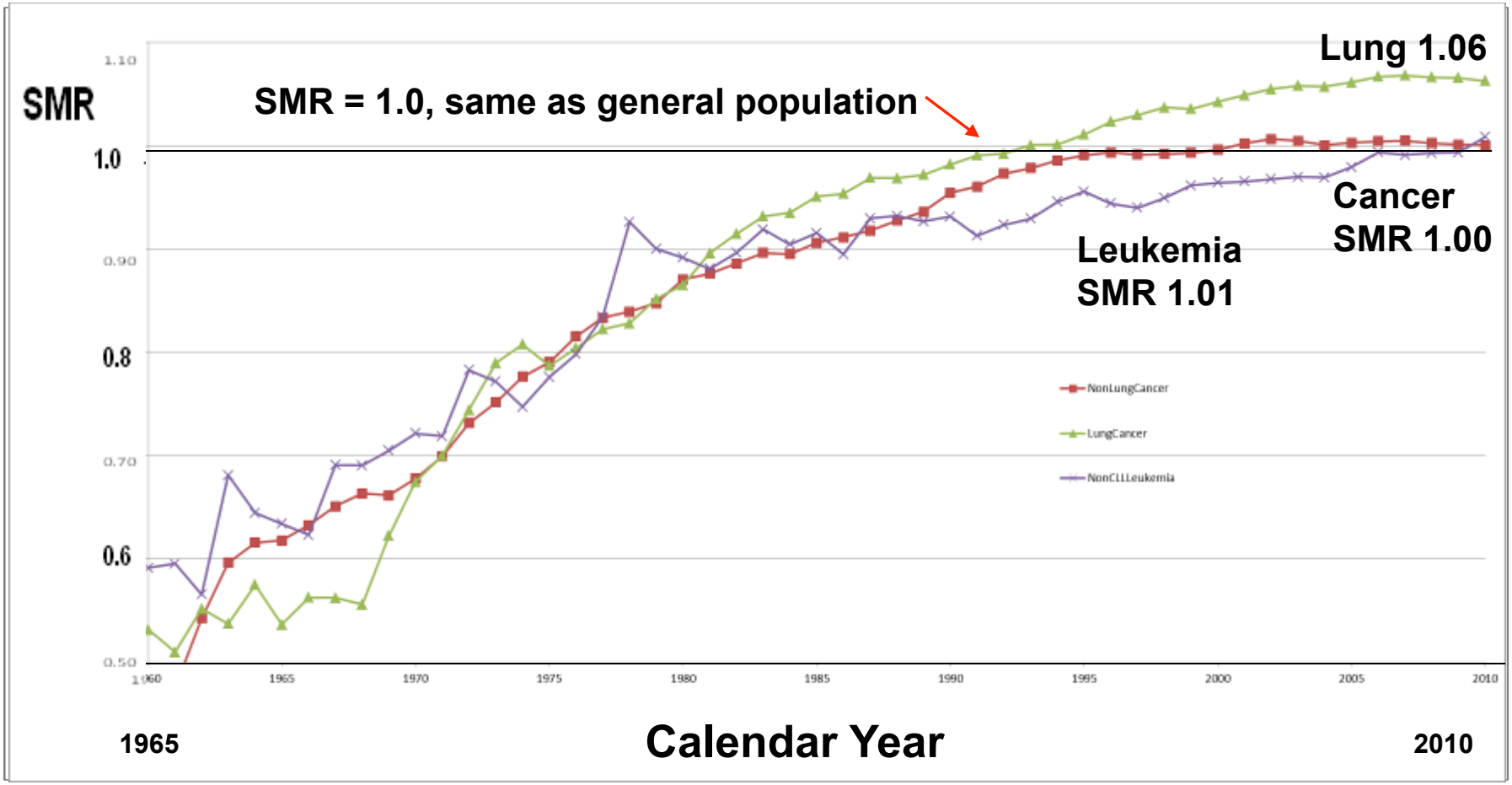
- **Small Modular Reactor ?**

- **Standardize Mortality Ratio ?**
- **Ratio of Observed Deaths to Expected based on General Population rates**
- **Veterans live longer but with due respect to Gen MacArthur they eventually die.**

The Healthy Warrior Effect Over Time
SMRs Approach Population Expectation



The Healthy Warrior Effect Over Time
Not so for Cancers



Cancer other than Lung	SMR 1.00
Leukemia other than CLL	SMR 1.01

Rations During WWII included Cigarettes

- **During the Second World War the U.S. Army Quartermaster Corps issued K-rations to paratroops, tank units, rangers, air forces, or wherever space was a factor. Each of the three daily K-ration meals contained a small packet of four cigarettes. Camel, Chesterfield, and Lucky Strike were popular brands with the troops, but all of the major and several of the minor cigarette manufacturers had contracts with the government.**

Cigarettes

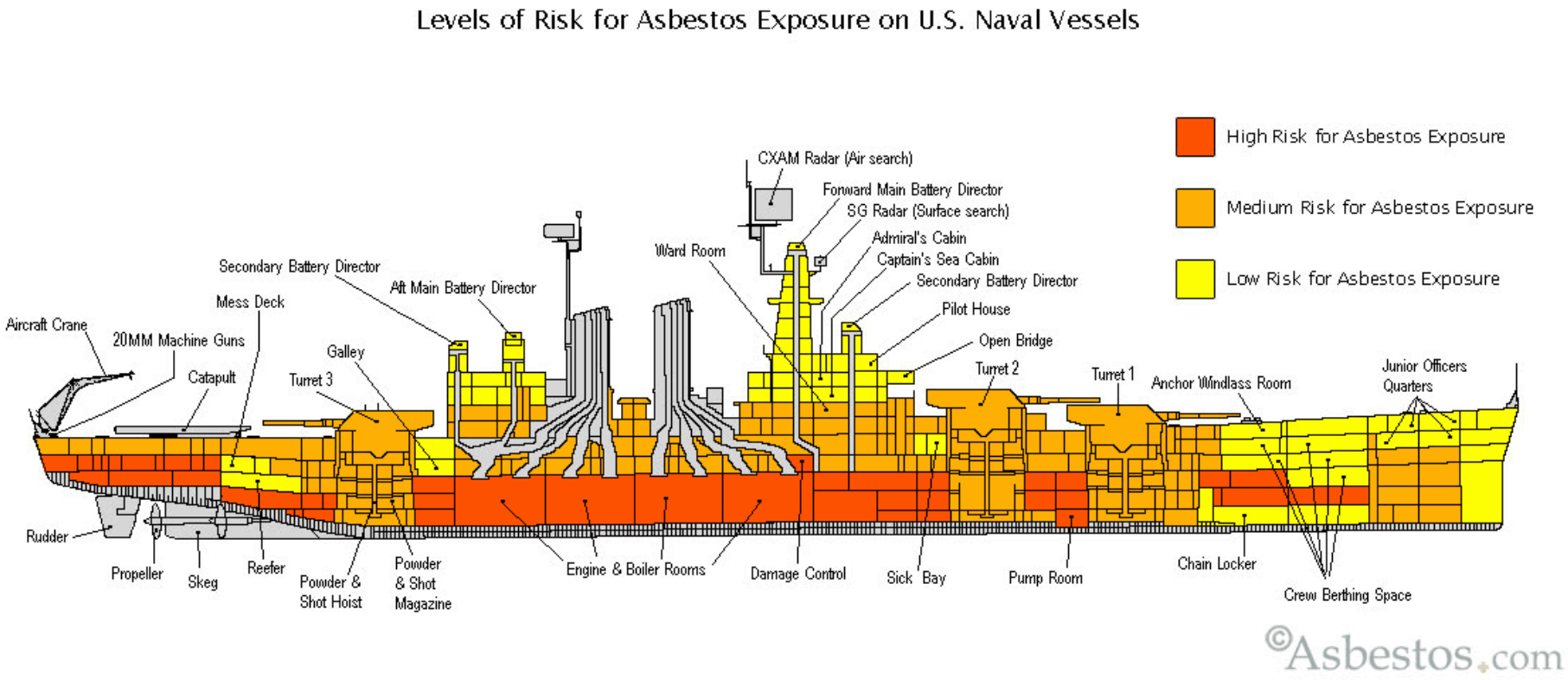
All Veterans SMR (N=114,277)

Cause	No. Deaths	SMR	95% CI
All causes	73,997	0.95*	0.94-0.96
All cancer	21,439	1.02*	1.01-1.04
Lung	7,907	1.06*	1.04-1.09
All cancer less Smoking Sites	10,019	1.00	0.98-1.01
Pleura, Meso	150	1.51*	1.27-1.77
Breast	29	1.15	0.77-1.65
Thyroid	54	0.89	0.67-1.16
Leukemia	657	1.01	0.93-1.09
Myelodysplastic	119	1.02	0.84-1.22
Suicide	1,124	0.87*	0.82-0.92

Pleura, Mesothelioma by Service

Service	No. Deaths	SMR	95% CI
Navy	127	2.08*	1.73-2.47
Army	10	0.44*	0.21-0.82
Air Force	10	0.83	0.40-1.53
Marines	3	0.74	0.15-2.16
Total	150	1.51*	1.27-1.77

Levels of Risk for Asbestos Exposure On U.S. Naval Vessels



Asbestos - RAC Evaluation

- Those who developed mesothelioma were around the piping. They were machinist mates (MMs), boiler tenders (BTs), fireman and fireman apprentice (FAs). They spent the most time in the engine room, boiler room, and other machinery spaces where the most piping was located with asbestos insulation.

- Seamen (SNs and SAs)? The explanation may be that they were brought in to assist in working on insulated systems since they were the most junior sailors. The ship drawing shows that there was asbestos in much of the ship to different degrees outside the machinery spaces which adds some credibility to the fact that seamen were assigned to perform work in these spaces as well.

- One takeaway for the RAC dosimetry work is that this exercise validates the assignments of who worked in the engineering spaces—we know the MMs worked there as well as the BTs and WTs (water tenders who worked in the boiler room)

- Another takeaway is the power of a database when set up properly to address multiple issues.

Who Lives the Longest ?

Pay Grade	No. Deaths	SMR	95% CI
Enlisted			
All Causes	56,394	1.03*	1.02-1.04
Lung	6,466	1.18*	1.15-1.21
Officers			
All Causes	12,840	0.70*	0.69-0.71
Lung	907	0.62*	0.58-0.66

All Cause SMR By Service

Service	No. of Death	SMR	95% CI
Navy	46,372	1.00	0.99-1.00
Army	16,595	0.89*	0.88-0.90
Air Force	8,272	0.84*	0.82-0.85
Marines	2,744	0.97	0.93-1.01
Total	73,997	0.95*	0.94-0.96

All Cause SMR by Test Series

Test Series	Year	No. of Deaths	SMR
CROSSROADS	1946	28,958	1.01
GREENHOUSE	1951	6,825	0.96*
UPSHOT-KNOTHOLE	1953	12,143	0.86*
CASTLE	1954	9,309	0.93*
REDWING	1956	7,391	0.95*
PLUMBBOB	1957	7,373	0.85*
HARDTACK I	1958	5,211	1.01
TRINITY	1945	314	0.68*
Total		73,997	0.95*

Weathermen – Rongerik – Bravo Fallout 1954

- 28 servicemen exposed
- Highest exposures in the 115,000 cohort
- All over 300 mSv
- 9 currently alive with known address
- DOD willing to contact if a blood draw for biological dosimetry is desired
- Lucky Dragon fisherman comparison ?

ANALYSIS OF RADIATION EXPOSURE,—
SERVICE PERSONNEL ON RONGERIK ATOLL,
Operation Castle,- Shot Bravo
DNA-TR-86-120 **9 July 1987**

6 Mt predicted, was 15Mt

SMOKY ~60 Year Later - CDC

Leukemia Among Participants in Military Maneuvers at a Nuclear Bomb Test

A Preliminary Report

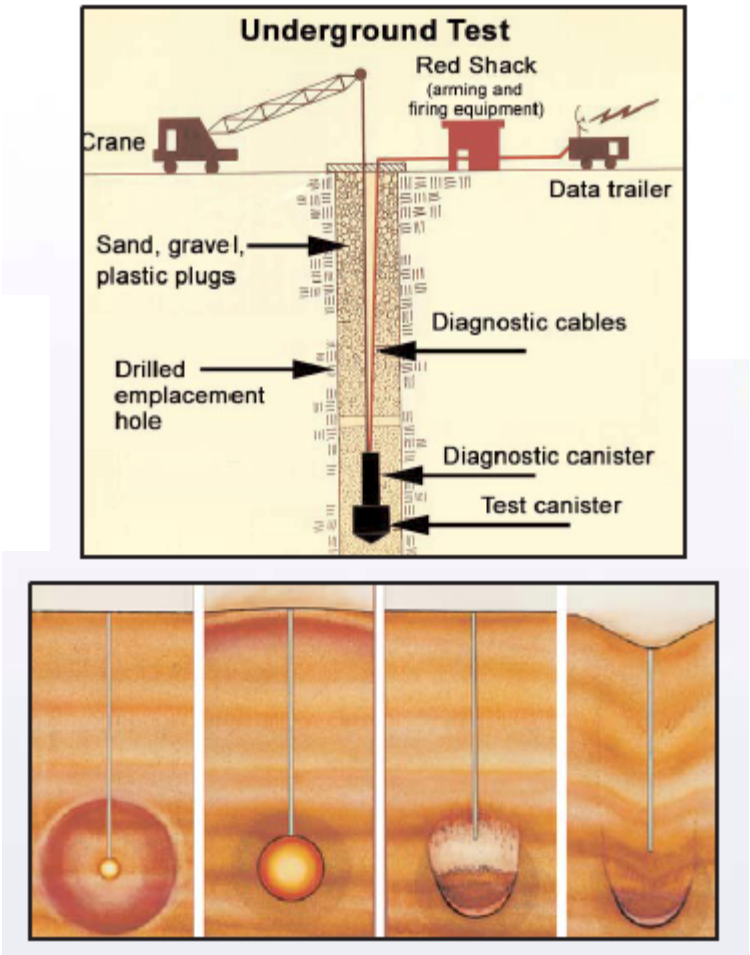
Glyn G. Caldwell, MD; Delle B. Kelley; Clark W. Heath, Jr, MD

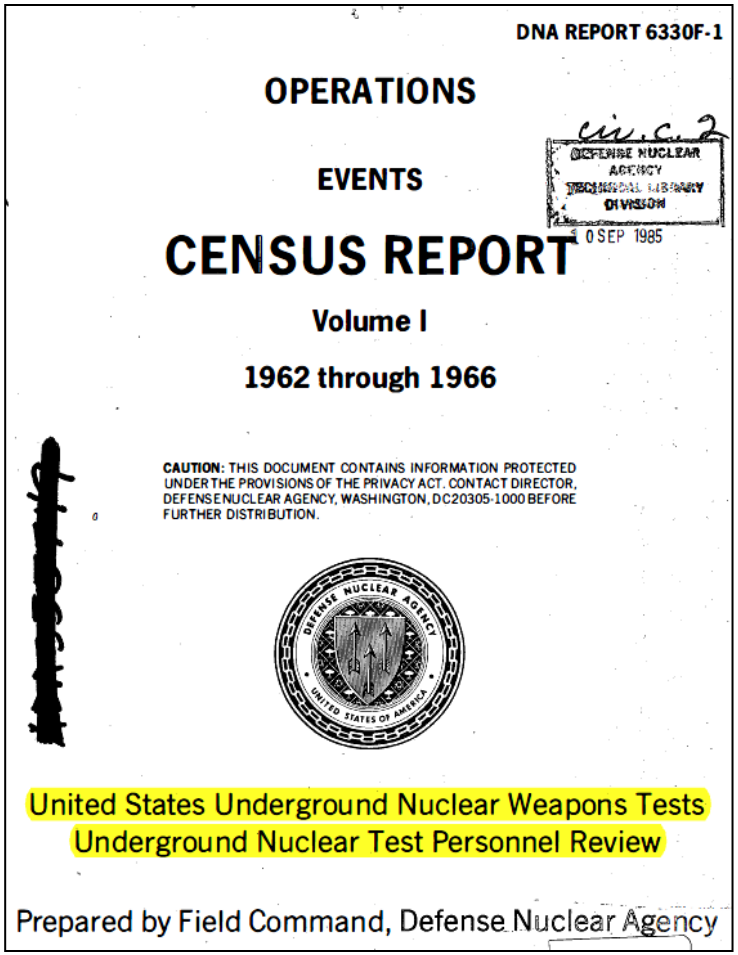
• **Preliminary studies indicate that nine cases of leukemia have occurred among 3,224 men who participated in military maneuvers during the 1957 nuclear test explosion "Smoky." This represents a significant increase over the expected incidence of 3.5 cases. They included four cases of acute myelocytic leukemia, three of chronic myelocytic leukemia, and one each of hairy cell and acute lymphocytic leukemia. At time of diagnosis, patient ages ranged from 21 to 60 years (mean, 41.8 years) and the interval from time of nuclear test to diagnosis from two to 19 years (mean, 14.2 years). Film-badge records, which are available for eight of the nine men, indicated gamma radiation exposure levels ranging from 0 to 2,977 mrem (mean, 1,033 mrem). Mean film-badge gamma dose for the entire Smoky cohort was 466.2 mrem.**

(*JAMA* 244:1575-1578, 1980)

Atomic Veterans Study – Future Possibilities

- Inclusion of participants at underground NTS weapons tests – 37,568 (1962-1992)




DNA REPORT 6330F-1

OPERATIONS

EVENTS

CENSUS REPORT

Volume I

1962 through 1966

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United States Underground Nuclear Weapons Tests
Underground Nuclear Test Personnel Review

Prepared by Field Command, Defense Nuclear Agency

Atomic Veterans Study – Future Possibilities

- Inclusion of other sites: bone, liver, thyroid, male breast, salivary

Cancer		No. of Deaths	SMR
Male Breast		29	1.15
Thyroid		54	0.89
Salivary Gland		17	--
Biliary/ Liver		523	1.00
Bone		38	0.85
Non CLL Leukemia		657	1.01
Myelodysplastic Syndrome		119	1.02

Grant Support - ☹

- Over the 4 years, the budget has been reduced by 25% or $1.1M.
- This has compromised our ability to accomplish the study goals.
- By necessity, the current study will focus on the dose-response relationship for leukemia.
- Opportunities to evaluate other cancers with regard to radiation effects have had to be curtailed because of the reduction in funds.
- The DOE Low Dose Program has contributed a small amount to help accomplish the leukemia and male breast cancer analyses and a few other dose-related opportunities.
- Support needed.

Collaborators / Support / Atomic Veterans

Vanderbilt
- John Boice
- Randy Brill
- William Wu
- Yu Shyr

Dosimetry
- John Till (RAC)
- Harold Beck
- Paul Voilleque
- Helen Grogan
- Andre Bouville (NCI)
- Jill Aanenson & Others

ORAU/Mel Chew
- Dick Toohey

Harvard
- Howie Sesso

Desert Rock VI exercise (TEAPOT), NTS, 1955

DOE: Noelle Metting, Bonnie Richter

IEI
- Mike Mumma

Statistical Support
- Ken Kopecky (FHCRC)
- Dan Stram (USC)
- Duncan Thomas (USC)

Consultants
- Clark Heath

Government
- DTRA (Paul Blake)
- VA (Han Kang, Tim Bullman)
- NRC (Terry Brock)
- NCI (Gary Ellison, Andre Bouville, Steve Simon)

Atomic Veterans Study Group
Nashville, TN 19-20 January 2011

Overview – Million Persons

Million U.S. Radiation Workers and Veterans

DOD - Atomic Veterans	115,000
DOE - Manhattan Project Workers	360,000
NRC - Nuclear Utility Workers	330,000
Industrial Radiographers	115,000
Medical & Other	> 200,000
	>1,000,000

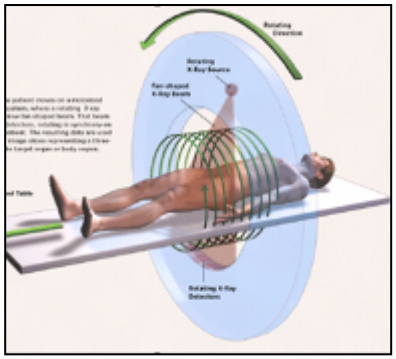
Health Physics News October 2012

NCRP
Scientific Authority Since 1929

The Major Issue in Radiation Epidemiology and Radiation Protection?

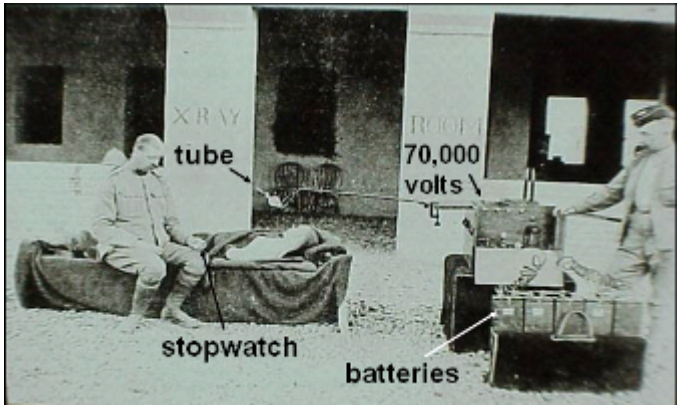
What is the level of risk when exposure received gradually over time and not briefly ?

Medicine



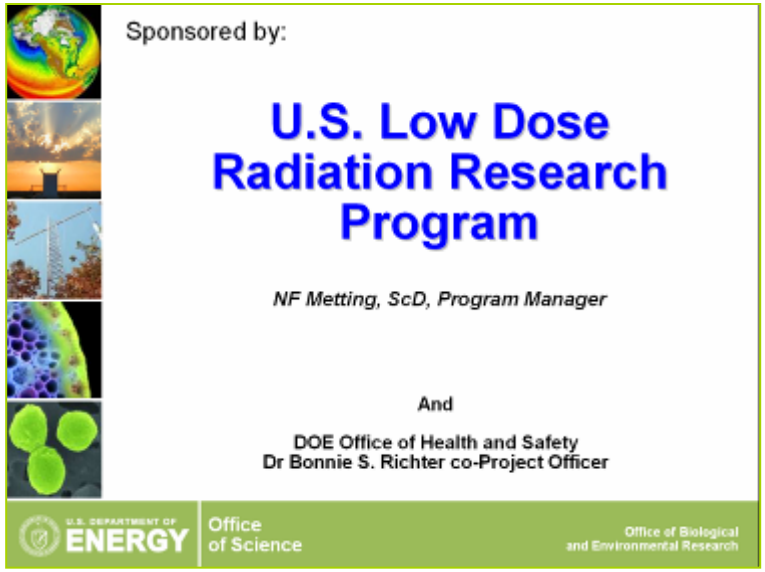
Accidents

Occupation



Environment

Sponsored by:



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Comparison with Atomic Bomb Survivor Study

Characteristic	Million Worker Study	Atomic Bomb Survivor Study
Number Studied	~ 1,000,000	86,611 with doses estimates
Exposure Year/s	~1940 - ~1985	1945
Number of Death to Date	~ 400,000	50,620
Number > 100 mSv	> 27,000	18,444
Estimated Deaths due to Radiation	To Be Determined	~ 600

Boice, *Health Physics News* October 2012

Ozasa et al, *Rad Res* 177; 2012

The Washington Post

James A. Zimble, Navy surgeon general, dies at 78

Oct 12, 1933 – Dec 14, 2011

Thanks !

Atomic Veterans Study Group
Nashville, TN -- 10-11 October 2012