



**VETERANS' ADVISORY BOARD ON DOSE RECONSTRUCTION
ELEVENTH MEETING**

**Review of
Atomic Veterans
Epidemiology Study**



John D Boice Jr
Arlington, Virginia
11 March 2011

Overview

125,000 Military Personnel



BAKER, Bikini Atoll, 23 kt, 24 June 1946

The United States conducted **230 aboveground nuclear detonations** from 1945 through 1962. Over **125,000 veterans were previously studied** by the Department of Veterans Affairs (Dalager 2000, Watanabe 1995) and the Medical Follow-Up Agency of the Institute of Medicine (IOM 1996, 2000). These veterans participated at one of eight nuclear weapons test series.

Statistical increases in **leukemia** were reported as were excesses of several other cancers, including bone, thyroid, salivary gland, liver and breast. However, no dose assessments for epidemiologic study were made and the last follow-up was 15 years ago.

An **extended follow-up** coupled with dose reconstruction of individual veterans who developed leukemia and other cancers not previously studied would provide important quantitative information on the level of risk possible from prolonged exposures to radiation experienced up to 60 years ago.

Significance



The study provides a unique, timely and **cost-effective opportunity** to address important public health and societal issues, taking advantage of detailed radiation dose and veteran data already developed by the Department of Defense over the past 30 years coupled with the unique location resources of the Department of Veterans Affairs

The proliferating use of CT x-ray and radionuclide imaging (e.g., PET scans) highlights the need for accurate estimates of **lifetime** radiation risk following chronic low-dose exposures for which cumulative population doses could be substantial.

The evaluation of risks among persons exposed to **radioactive substances** assumes greater importance as society debates expansion of nuclear energy and associated nuclear waste and the possibility of terrorist attacks with "dirty bombs."

Finally, the proposed project is **important to veterans and their families** in providing a better understanding of the health risks associated with their prior military service.

Getting off the Ground

- **VBDR** – 2005 discussions.
- **DTRA** – 2007 approval to access NTPR
- **VU IRB** – 2008 Human Subjects approval
- **SSA** – 2008 approval to access vital status
- **NCHS NDI** – 2009 approval to access mortality data
- **NIH** – 2010 grant awarded
- **VA** -- 2011 IRB approval ongoing



Human Subjects Training Requirements

- **VANDERBILT TRAINING**

History and Ethical Principles

Basic Institutional Review Board (IRB) Regulations and Review Process

Informed Consent

- **DTRA TRAINING**

Information Assurance Awareness

Privacy Act Training

- **VA TRAINING**

VHA Privacy Policy Training Web-Based Option FY11

Information Security 201 for Research and Development Personnel

VA Privacy and Information Security Awareness and Rules of Behavior FY11

Human Research Curriculum Completion Report



Additional VA Requirements

- Social and Behavioral Research for Biomedical Researchers
- Records-Based Research
- Genetic Research in Human Populations
- Research With Protected Populations – Vulnerable Subjects: An Overview
- FDA-Regulated Research
- Human Subjects Research at the VA
- Conflicts of Interest in Research Involving Human Subjects
- Good Research Practices for Protection of Human Subjects:
 - Module 3: Good Clinical Practice and VA Research
 - Module 5: Monitoring Subject Safety
 - Module 6: Records and Reports
 - Module 7: Managing Investigational Products
 - Module 8: Patient Privacy and Confidentiality



Atomic Veterans NIH Grant

- 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 (quality control)

- Aim is to study 125,000 nuclear weapons test participants at 8 test series including Trinity (1945) and 7 other series in Nevada and Bikini Islands
-

Progress

- Grant awarded September 2010 (back dated July 2010)
- Subcontracts awarded to RAC, IEI, ORAU, FHCRC
- 8 Series data files obtained from DTRA-NTPR
- 5 Series & CROSSROADS obtained from MFUA (December 2008)
- NDI and SSA applications approved – Initial NDI match completed
- 44,000 deaths identified to date
- Landauer dosimetry linkage made – based on SSN (2% matches)
- Received NTPR (8-Series) Technical Basis Documents from DTRA
- 1st meeting - Arlington VA - October 2010 – Kick Off
- 2nd meeting - Kiawah SC - November 2010 – Dosimetry Focus
- 3rd - Washington DC - January 2011 – Veterans Affairs
- 4th – Washington DC – February 2011 – Veterans Affairs



WEBSITE (<http://www.atomicvetstudy.org/>)

Nuclear Weapons Test Participants

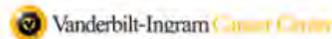
- ▶ ABOUT THE STUDY
- ▶ PARTICIPATING INSTITUTIONS
- ▶ MEETINGS
- ▶ PUBLICATIONS
- ▶ COMMON QUESTIONS
- ▶ GLOSSARY OF TERMS
- ▶ OTHER WEBSITES
- ▶ MEMBERS AREA

EARLY STUDY MATERIAL



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

Last modified January 26, 2011



International
Epidemiology
Institute

FRED HUTCHINSON
CANCER RESEARCH CENTER

A LIFE OF SCIENCE



Preliminary 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	Total
CROSSROADS	1946	Pacific	0	3,395	551	39,188	43,134
GREENHOUSE	1951	Pacific	2,442	1,548	70	3,854	7,914
UPSHOT-KNOTHOLE	1953	Nevada	2,175	13,401	2,256	886	18,718
CASTLE	1954	Pacific	2,763	1,644	306	11,918	16,631
REDWING	1956	Pacific	2,976	1,708	250	6,993	11,927
PLUMBBOB	1957	Nevada	2,216	7,052	2,120	601	11,989
HARDTACK I	1958	Pacific	3,476	1,535	187	9,487	14,685
TRINITY	1945	NM		~700			
Total			16,048	~31,000	5,740	72,927	~125,000

*These tests involved 100 bomb detonations (shots).



The 8th Series - Trinity

- First weapons test, Alamogordo, NM, 16 July 1945
- Longer follow-up than Japanese atomic bomb survivor study
- Historical figures:
Robert Oppenheimer
General Leslie Groves
Enrico Fermi, Hans Bethe
Theodore Hall



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.



Leukemia in Military Participants at Atomic Tests

Study	Subjects	No.	RR (95% CI)
Caldwell et al. 1983 United States Smoky	3,217 participants general population	10 4.0	2.50 (1.20, 4.6)
Watanabe et al. 1995 (>1 rem) United States Navy-Hardtack I	1,094 participants 14,625 comparisons	2 15	1.73 (0.39, 7.56)
Watanabe et al. 1995 (ALL) United States Navy-Hardtack I	8,554 participants 14,625 comparisons	6 15	0.69 (0.27, 1.78)
Johnson et al. 1996 United States CROSSROADS	38,668 participants 35,036 comparisons	73 91	1.02 (0.75, 1.39)
IOM 2000 (ALL) United States (5 Series) (NTS)	66,168 participants 64,787 comparisons	156 126	1.14 (0.90, 1.44) 1.49 (1.04,2.13) NTS
Muirhead et al. 2004 United Kingdom	21,357 participants 22,333 comparisons	40 23	1.83 (1.15, 2.93)
Pearce et al. 1990, 1997 New Zealand	528 participants 1,504 comparisons	4 2	5.59 (1.04, 41.7)

Preliminary external radiation dose estimates for the aboveground nuclear weapons test participants in the Seven Series Study - incomplete and does not include other series doses (10 mSv = 1 rem)

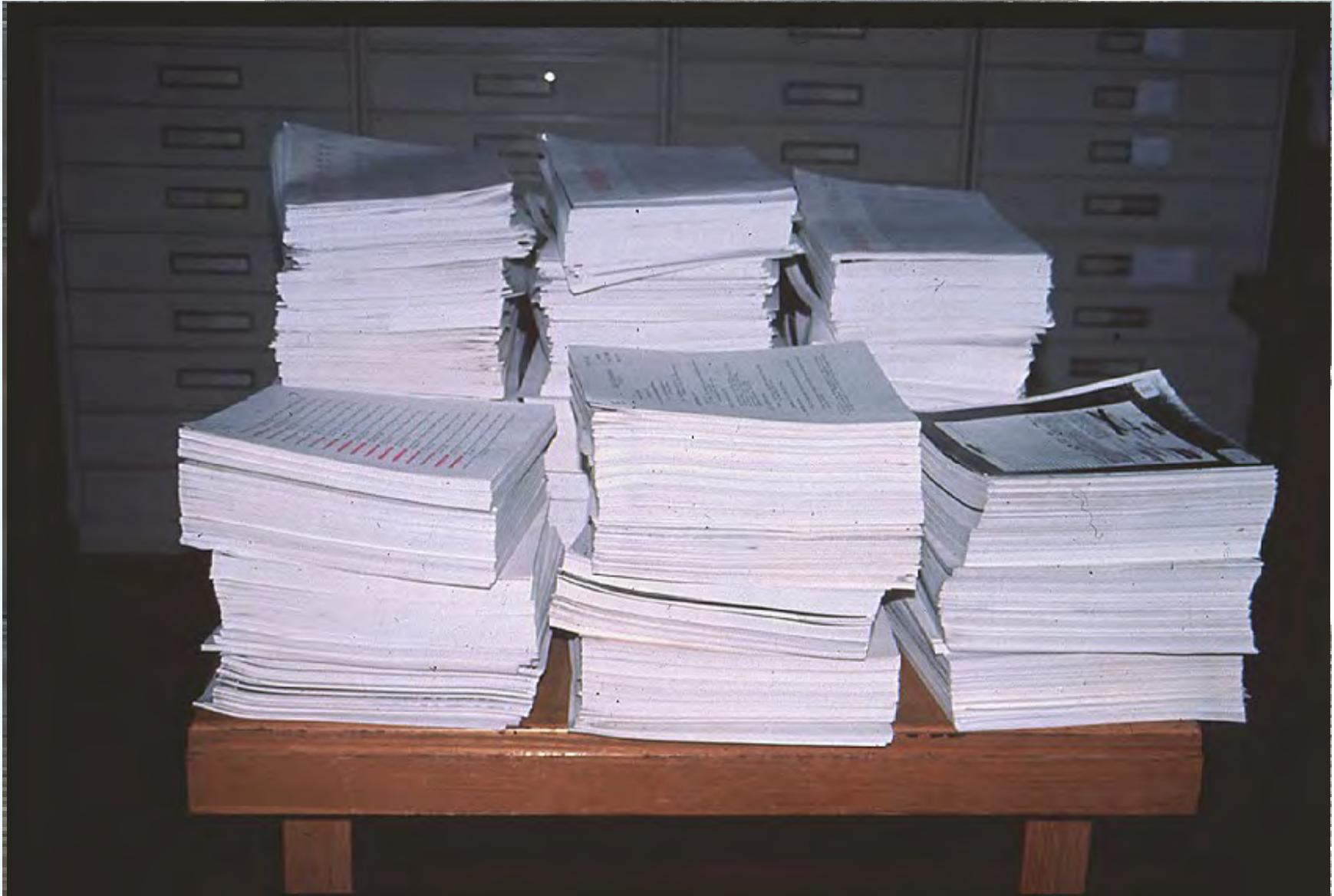
Dose category (mSv)	Badged only	Reconstructed only	Badged and reconstructed	Total
0	3,418	13,741	336	17,495
> 0 - < 5	8,686	31,877	6,299	46,862
5 -	4,283	11,903	5,041	21,227
10 -	3,996	7,845	5,772	17,613
20 -	1,749	4,612	2,775	9,136
30 -	900	2,805	1,868	5,573
40 -	425	1,444	1,151	3,020
≥ 50	648	861	2,185	3,697
Missing	377	--	--	377
Total	24,482	75,088	25,430	125,000



Dosimetry for Epidemiology



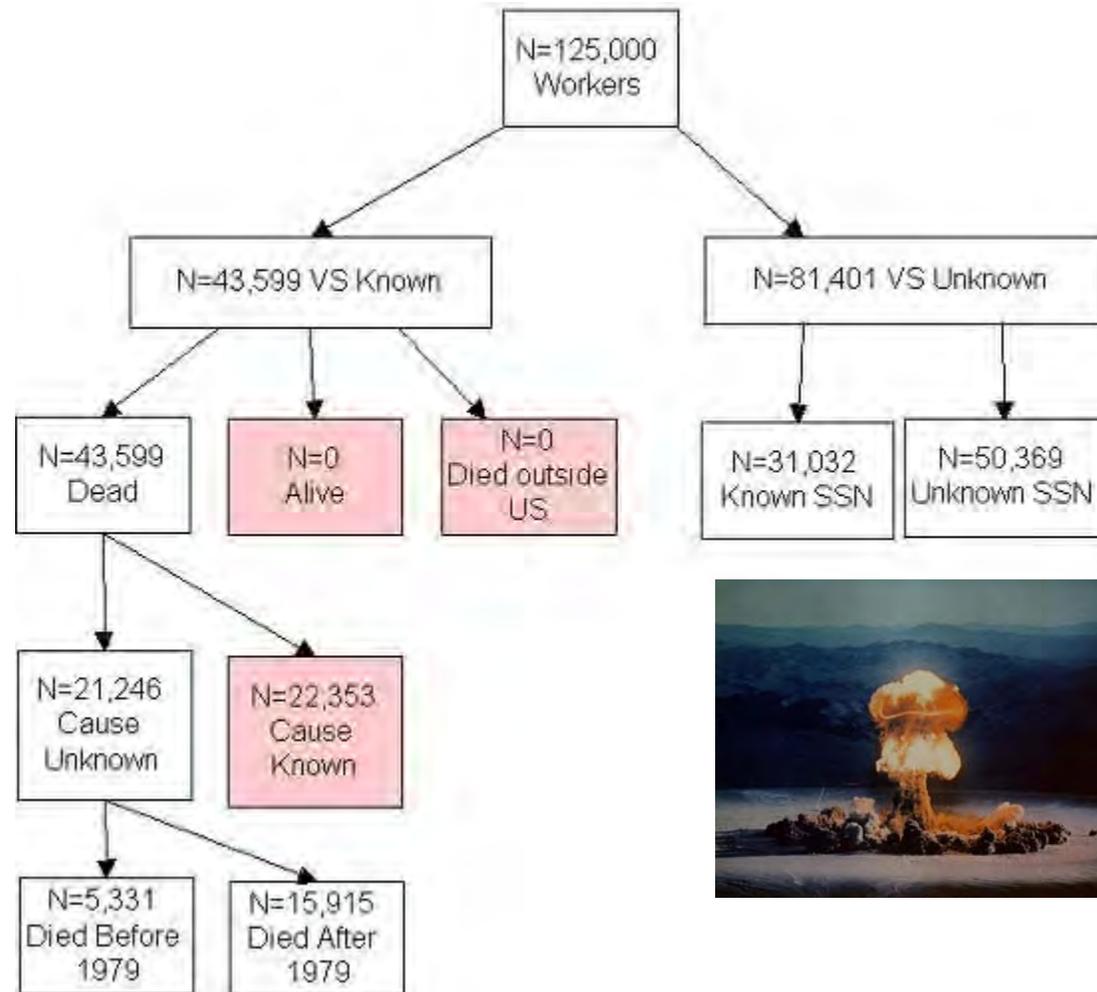
Information Available



Dosimetry Team



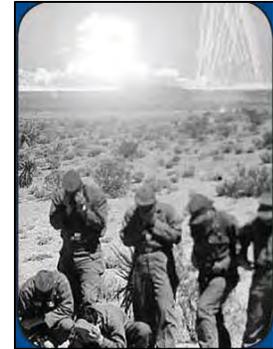
Atomic Veterans Tracing Efforts



Nov 14, 2010

Ongoing / Planned / Epidemiology

- Natl Death Index linkage for Causes of Death
- LinkPlus matching SSA master death file, California, Florida, New Jersey death files
- Dosimetry applications DOE-REMS, NRC-REIRS, Army, Air Force and hopefully Navy
- ‘Obtain’ 7th Series from VA (HARDTACK I)
- BIRLS tracing via VA
- Death certificates via VAROs and/or states
- Medical record information via VA systems
- Seeking Resources, direct and in kind
- Contribute to Million US Worker Study



Troops during detonation at NTS



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)
Others (RAC)

ORAU

Dick Toohey

Advisor

Clark Heath



Desert Rock VI exercise (TEAPOT), NTS, 1955

IEI

Mike Mumma
Sarah Cohen
Bob Tarone

FHCRC/Statistical Support

Ken Kopecky
Dan Stram (USC)
Duncan Thomas (USC)

Harvard

Howie Sesso

Government

DTRA (Paul Blake)
VA (Han Kang)
NRC (Vince Holahan)
NCI (Gary Ellison)

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





“THROUGHOUT THE CENTURIES
THERE WERE MEN
WHO TOOK FIRST STEPS
DOWN NEW ROADS
ARMED WITH NOTHING
BUT THEIR OWN VISION.”

AYN RAND

Vision



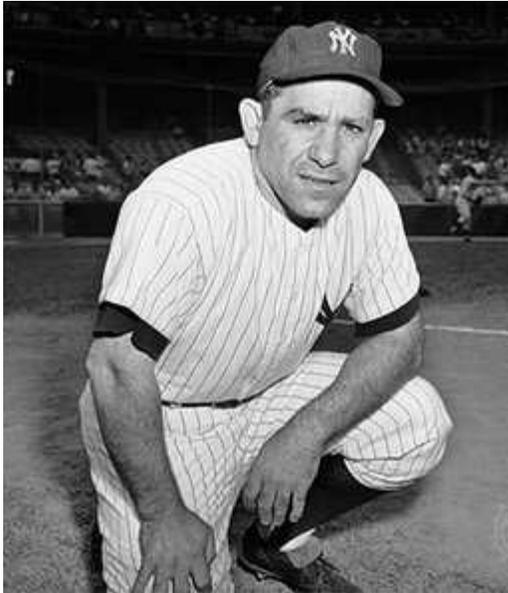
The Vision – One Million U.S. Workers



[X] DOE Uranium Workers	200,000
[X] DOE Plutonium Workers	156,000
[X] DOD Atomic Veterans	120,000
[X] Nuclear Power Plant Workers	212,000
[X] Industrial Radiographers, Radiologists, Radiotherapists and Other Workers	~350,000
	<hr/> <hr/>
	~1,000,000
Other	
[] Navy Submariners (Charpentier 1993)	76,000
[] Navy Shipyard Workers (Matanoski 2008)	70,000



If you don't know where you're going,
chances are you will end up
somewhere else.



One Million U.S. Radiation Workers



The **integration** of U.S. worker and military populations would provide a definitive evaluation of risks associated with low-dose radiation exposures experienced over a prolonged period of time.

Implications include:

- **protection** standards for workers and general population,
- **assessment of risk** associated with the enhanced medical technologies such as CT and nuclear medicine imaging,
- expansion of **nuclear power**,
- handling of **nuclear waste**,
- **compensation** of workers with prior exposures to ionizing radiation, and
- a **service to U.S. workers and veterans** and their families by providing a sound understanding of the risks they may have incurred while working in service to their country.

**DOE-supported* Workshop on Low-Dose Radiation Epidemiology
(Hall EJ, Metting N, Puskin J, Ron E. Radiation Research, 2009).**

"There is a pressing need, and a golden opportunity, to obtain more information on the long-term effects of relatively low radiation doses, delivered over protracted periods by pooling and updating the data for the various groups of occupationally exposed U.S. nuclear workers.

This represents a large and relatively untapped database. In the long run this could become an international effort by integrating these data with studies from around the world. With the large increase in the use of diagnostic radiation, large studies with good dosimetry of both patients and medical personnel can also contribute much-needed data."

* Low Dose Radiation Research Program

Department of Energy Cohorts (360,000)



- **Oak Ridge Group** (“Uranium” Workers)
 - Oak Ridge National Laboratory (X-10)
 - Y-12, Tennessee Eastman (pre 1947)
 - Y-12 post 1947
 - K-25 (Oak Ridge Gaseous Diffusion Plant)
 - Savannah River Site
 - Fernald
 - Linde Ceramics Plant
 - Mallinckrodt Chemical Works
 - Other
- **Los Alamos Group** (“Plutonium” Workers)
 - Los Alamos
 - Mound
 - Rocky Flats
 - Sandia
 - Other
- **Hanford**



“... **the U.S. multi-site cohort studies seem to have petered out.** This is very disappointing because if an effect of occupational exposure among nuclear industry workforces in the West is to be found then one would expect the combined workforce of the US Department of Energy nuclear sites to be the prime candidate for its manifestation. **One can only hope that the results of NRRW-3 will be the spur for an increased effort from the USA.**”

Wakeford, JRP, 2009



Mound / Po 210



Po210
RaF 138.38 d
α 5.3044, ...
γ 803.1 μ W
σ_{γ} (<0.5 mb+
<0.03)
σ_{α} < 2 mb
209.982848

From *Nuclides and Isotopes*, Fourteenth Edition, Chart of the Nuclides, Copyright 1989 General Electric Company



Alexander V. Litvinenko in his hospital bed in London on Nov. 20, 2006



George Koval
December 25, 1913 to January 31, 2006



Rego, Sci Am 2011

USA Occupational Studies

Hall EJ, Metting N, Puskin J, Ron E. DOE Workshop. Radiat Res July 2009

■ *U.S. Early Nuclear Utility Workers*

- “ The study of U.S. utility workers who were exposed occupationally could prove to be fruitful. There is a **large number** of the order of 600,000 workers; there is **good dosimetry** and a range of doses. Early workers received quite high doses because at the time the maximum permissible dose was defined to be **5 (N – 18) rem**. As a consequence some workers recorded doses as high as 1000 mSv. ”
- 212,000 early workers identified in Landauer/NRC-REIRS databases



Dresden Generating Station



Million US Radiation Worker Study Oak Ridge Meeting – 2-3 Feb 2011

