



### Study of One Million U.S. Radiation Workers and Veteran

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## National Effort

### Million U.S. Radiation Workers and Veterans

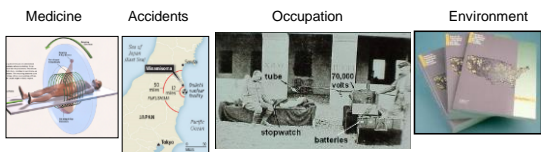
- NRC - Nuclear Utility Workers 330,000
- DOD - Atomic Veterans 115,000
- DOE - Manhattan Project Workers 360,000
- Medical Workers and Other 200,000  
>1,000,000

Health Physics News October 2012



### The Major Issue in Radiation Epidemiology and Radiation Protection?

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



## Why Study One Million U.S. Radiation Workers and Veteran ?

- Chronic exposures are relevant today
- Healthy U.S. workers more similar to today's populations than Japanese 1945 atomic bomb survivors
- Relevant to regulated worker populations
- Relevant to compensation programs
- Relevant to organ specific risk estimates
- Goal to integrate with new biology



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## Nuclear Power Plant Workers

### U.S. Early Nuclear Utility Workers 330,000 Hired Before 1985

- Large numbers
- Good dosimetry
- Range of doses
- At the time allowable doses could be up to 3 rem per quarter considering 5 x (Age - 18) rem
- Some cumulative doses were as high as 100 rem

Hall EJ et al. DOE Workshop. Rad Res 2009



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## 1986 - Laying the groundwork for a Registry of Radiation Workers



DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

National Institutes of Health  
National Cancer Institute  
Bethesda, Maryland 20892

SEP 17 1986

Vincent T. DeVita, Jr., M.D.

Mr. Landow W. Zech, Jr.  
Chairman  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555

Dear Mr. Zech:

The present risk estimates for low-dose exposure to ionizing radiation, as you know, derive from unvalidated interpolations between zero and relatively high-dose, and high dose-rate, exposure. There are few exposure situations that can be studied in the expectation that risk estimates directly applicable to the low-dose region might be obtainable. One of these is employment in the nuclear power industry, but there is at present no practical way of studying the experience of nuclear power plant workers in the U.S.

In revising 10 CFR 20 I hope you will not miss the opportunity to lay the groundwork for a Registry of Radiation Workers containing the annual doses received by individual workers. The need for such a Registry has been

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# 1991 NRC - Radiation Exposure Information and Reporting System (REIRS) - Designed with health studies in mind



Slide, courtesy of Terry Brock, modified



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20540

193-005  
March 5, 1991  
Chairman Kenneth M. Carr

Dr. Samuel Broder, Director  
National Cancer Institute  
Department of Health and Human Services  
Executive Plaza North  
Room 3036  
Bethesda, Maryland 20892

Dear Dr. Broder:

I am writing to inform you of the Nuclear Regulatory Commission's (NRC's) decision to establish new reporting requirements for collective exposure information and to request the views of the National Cancer Institute (NCI) on the relative merits of conducting additional epidemiological studies on radiation workers. As you know, the NRC in 1986 requested that the Commission consider incorporating provisions for a Registry of Radiation Workers into the final revision of 10 CFR Part 20. I am pleased to inform you that the Commission has approved the final revision of 10 CFR Part 20 and that the final rule contains reporting requirements that will allow the collection of information to establish such a registry. A list of other categories of facilities, including nuclear power reactors, test cycle facilities, reprocessing plants, major isotope materials facilities, high level waste nuclear waste treatment and immobilization plants, fuel storage facilities, will be required to provide dose records for each monitored employee for each year. The Commission will make this information to its currently existing Radiation Exposure Information Reporting System (REIRS) for potential use in epidemiologic studies.

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## 1993 Pilot Study - Calvert Cliffs

Mortality among workers at a nuclear power plant in the United States

Seymour Jablon and John D. Boice, Jr.  
Cancer, Causes and Control 4: 429, 1993



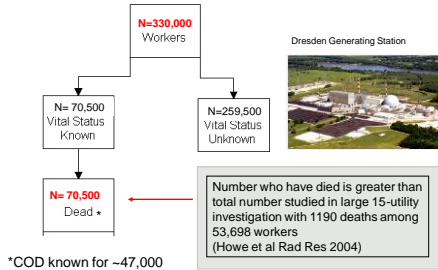
\* A few gaps in early works.

The Nuclear Regulatory Commission intends to **change the annual reporting requirement** for licensees; personal identifiers and doses will be reported each year for each employee of each nuclear power plant.

The reporting requirements, **initially voluntary**, will become **mandatory in 1994**. This will enable creation of a **Radiation Registry** of workers in the US nuclear power industry.

By the end of the century, an assessment of adverse health effects that may be associated with low levels of radiation should be possible with respect to more than 100,000 employees of NRC licensed facilities.

## Nuclear Power Plant Workers



## Nuclear Utility Worker Dose Distribution Preliminary

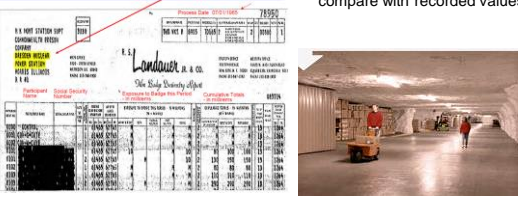
Lifetime dose (mSv)	Frequency	Percent
<10	244,806	74.2
10 - 49	58,578	17.8
50 - 99	14,917	4.5
100 - 499	11,711	3.6
500 - 999	82	0.1
1,000+	5	<0.1

Paracelsus: The Poison is in the Dose.

## Dosimetry

- Validation of recorded doses
- Sample film badges and control badge from 60 years ago
- Use modern equipment and compare with recorded values

### Microfilm Image - Dresden NPP



## Dosimetry Committee

U.S. RADIATION WORKERS AND NUCLEAR WEAPONS TEST PARTICIPANTS RADIATION DOSE ASSESSMENT

Andre Bouville  
Dick Toohy,  
Chairmen SC 6-9



Andre Bouville



Harold Beck



Larry Dauer



Keith Eckerman



Kathy Pryor



Marvin Rosenstein



Steve Simon



Dan Stram



John Till



Dick Toohy

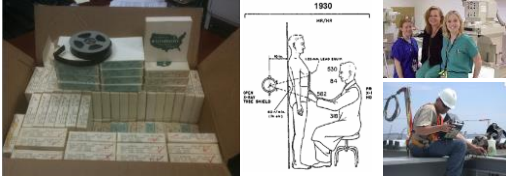


Craig Yoder

Derek Hagemeyer Rich Leggett Dave Schauer Gary Zeitlin Bruce Napier Sami Serbini

## Other Radiation Workers - 200,000

- Radiologists, nuclear medicine, radiotherapists, other medical, **industrial radiographers**
- **2700 roles of microfilm** from the 1950s through 1976 available from Landauer (**5 million dosimetry reports**)
- Microfilm being imaged/digitized
- Electronic records after 1976 records (**1.5 million dosimetry reports** for the: Over 70,000 non-nuclear utility workers identified with cumulative dose > 50 mSv.




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## Other Workers - Landauer Data base > 50 mSv Dose Distribution

Dose category (mSv)	Frequency	Percent
< 50	1,639	2.3
50 -	42,393	60.0
100 -	24,049	34.1
500 -	1,307	1.9
> 1000	1,180 *	1.7
Problematic	37	0.1
Total	70,605	100



\* Japanese atomic bomb survivors > 1000 mSv = 2,389 (Preston Rad Res 2004)  
 Japanese atomic bomb survivors > 100 mSv = 18,444 compared with 26,536 above

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## Nuclear Weapons Test Participants The Eight Series Study



Desert Rock VI exercise (TEAPOT), NTG, 1955




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## The 8<sup>th</sup> Series - Trinity

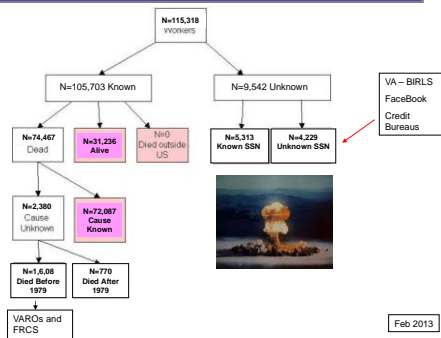
- First weapons test, Alamogordo, NM, 16 July 1945

- Historical figures:  
J. Robert Oppenheimer  
General Leslie Groves  
Enrico Fermi, Hans Bethe  
Theodore Hall



- Note the film badges

## Atomic Veterans Tracing Efforts



## Atomic Veterans Cancers to Date

CauseOfDeath	UCOD_Only	UCODorCCOD
CLL	159	209
nonCLL_Leukemia	659	722
MyelodysplasticSyndrome	120	192
Thyroid	54	66
PolycythemiaVera	5	26
Salivary	17	17
MaleBreast	29	33
BiliaryLiver	522	559
Bone	38	43
AllHeartDisease	22500	32327
MultipleMyeloma	346	404
DementiaAlzheimer	1344	2416





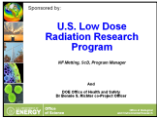
## Mound, Dayton, Ohio Polonium 210 (7,291 Workers)



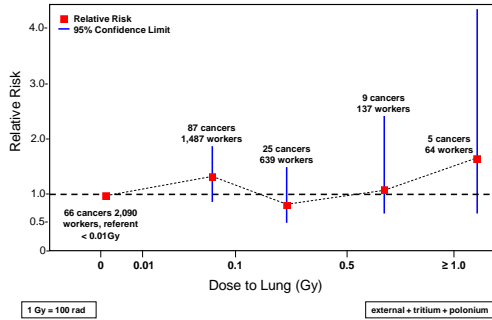
Alexander V. Litvinenko in his hospital bed in London on Nov. 20, 2006



George Koval  
December 25, 1913 to January 31, 2006



### Incorporation of Internal Polonium Doses Lung Cancer (Mound) - Preliminary



### Mound Plant, Dayton, Ohio Unique Aspects

- **Dosimetry:** Polonium, Plutonium, Tritium, External
- **Location:** 98% of 7,291 workers (1944+)
- **Cancer incidence** - linkage with Ohio Cancer Registry (1996+)
- **Renal Disease Registry** linkage (1976+)
- **Historical note:** produced triggers for Trinity site and Nagasaki "Fat Man" plutonium bombs



## 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

Ozasa et al, *Rad Res* 177; 2012

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## Summary

- >1,000,000 U.S. Radiation Workers being studied.
- National Effort
- 10 time larger than the study of atomic bomb survivors
- Has more high-dose subjects (30,000 >100 mSv to date)
- Has many more deaths (~400,000 to date)
- Can evaluate risks to individual organs
- The study has substantial statistical ability to evaluate risks following gradual exposures
- Stay tuned!




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## NRC Workshop - Study of One Million US Workers and Veterans Bethesda, Maryland 15-16 February 2012 Note the Collaborating Organization



National Cancer Institute, Department of Energy, Nuclear Regulatory Commission, Department of Defense, Oak Ridge National Laboratory, Oak Ridge Associated Universities, Harvard University, Vanderbilt University, University of Southern California, Landauer Inc., Environmental Protection Agency, Radiation Effects Research Foundation (Japan), International Epidemiology Institute, National Council on Radiation Protection & Measurements, Dept Veterans Affairs, DTRA, RAC, FHCRC

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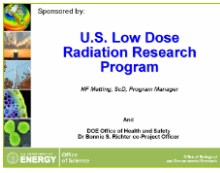
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Sponsored by:



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