Review of Atomic Veterans Epidemiology Study

John D Boice Jr
San Antonio Texas
23-24 March 2012

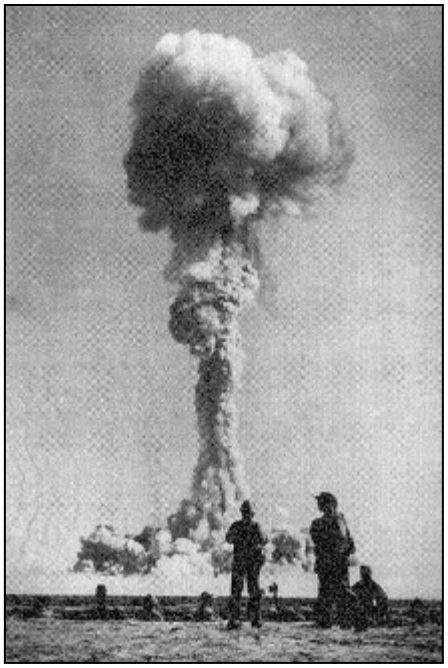
Outline

- **Overview of Research Effort**
- **Progress Review**
- **Focus on Dosimetry**
- **Million US Radiation Worker and Veteran Study**

Atomic Veterans - Vanderbilt NIH Grant (2010-2015)

- 230 aboveground detonations, Large numbers (115K) previously studied, complex dosimetry, $300 million DOD
- 700 leukemia deaths at last follow-up, 1,000 estimated

Troops leaving a trench shortly after a detonation at the Nevada Test Site



Desert Rock VI exercise (TEAPOT), NTS, 1955

The 8th Series - Trinity

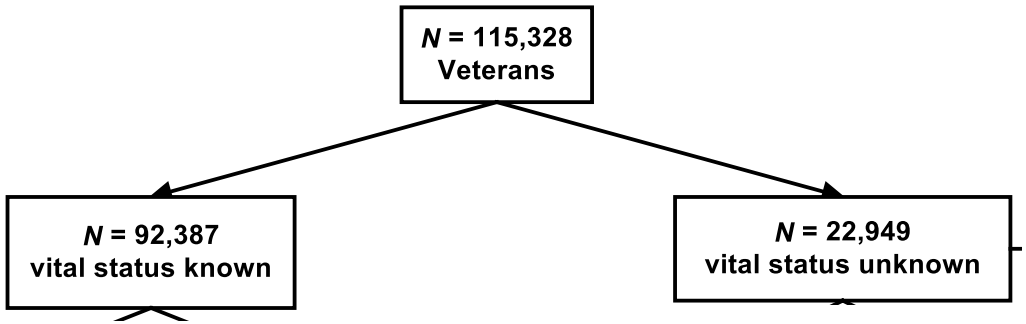
- First weapons test, Alamogordo, NM, 16 July 1945

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

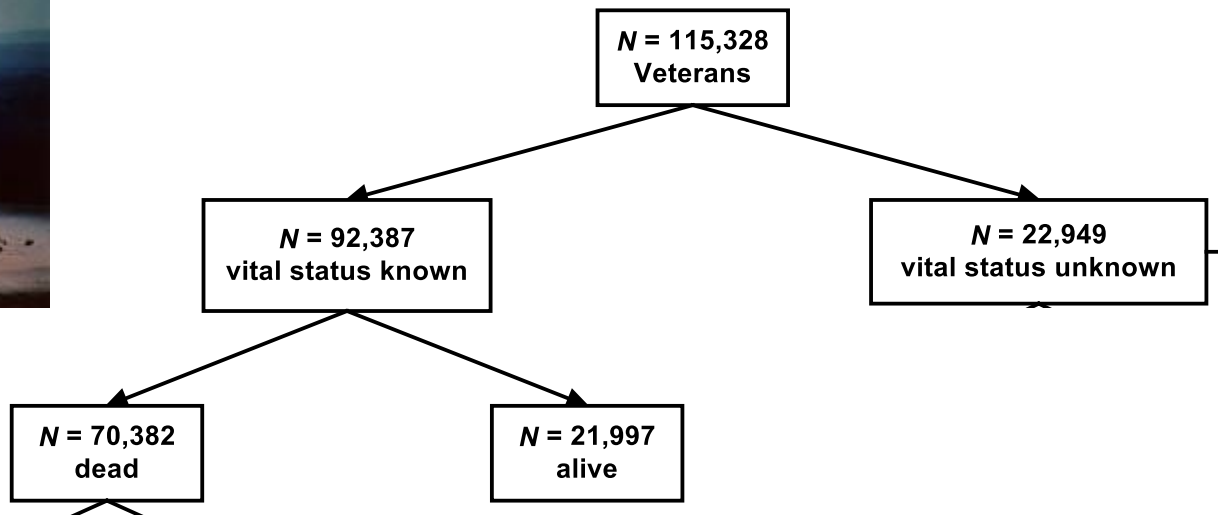
Atomic Veterans Tracing Efforts

N **= 115,328**
Veterans

Atomic Veterans Tracing Efforts



Atomic Veterans Tracing Efforts



Atomic Veterans Tracing Efforts

Atomic Veterans Tracing Efforts

Atomic Veterans Tracing Efforts

Feb 2012

Cancer Mortality among Military Participants at U.S. Atmospheric Nuclear Weapons Tests (The Eight Series Study)

Update on Dosimetry

Jill Weber Aanenson

February 15, 2012
Bethesda, Maryland

Vanderbilt-Ingram Cancer Center

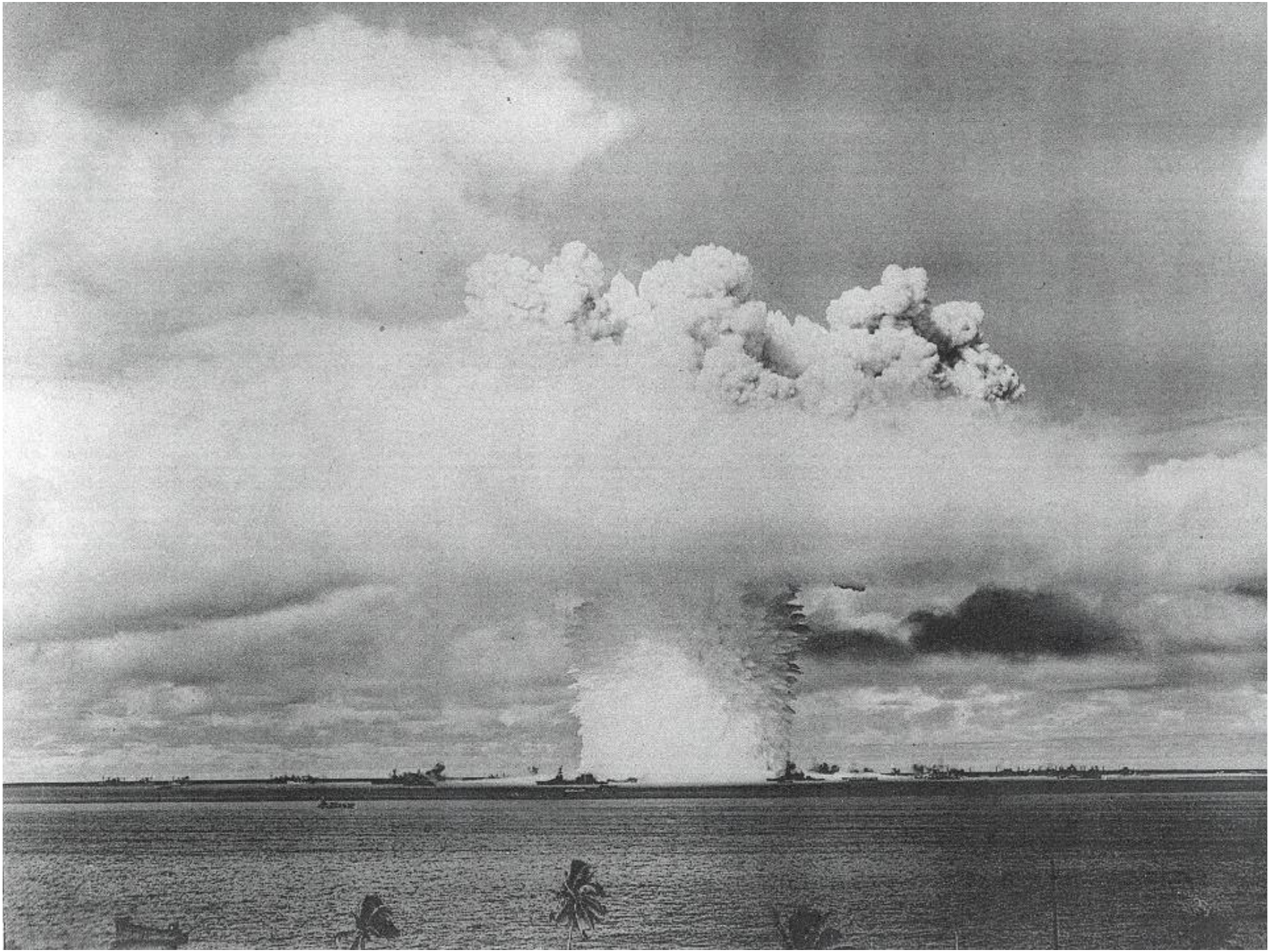
RAC
RISK ASSESSMENT CORPORATION

Dosimetry Team

Background and Approach to Dosimetry

Reconstruct Doses

- **Cases and comparison veterans**
  - Participated in Trinity or one of seven atmospheric weapons test series between 1946-1958
    - Nevada Test Site
      - Upshot-Knothole, Plumbbob
    - Pacific Proving Ground
      - Crossroads, Hardtack I, Redwing, Greenhouse, Castle
    - Account for doses from other tests / occupations
    - Account for uncertainty in doses
      - Scenario uncertainty
      - Dose uncertainty



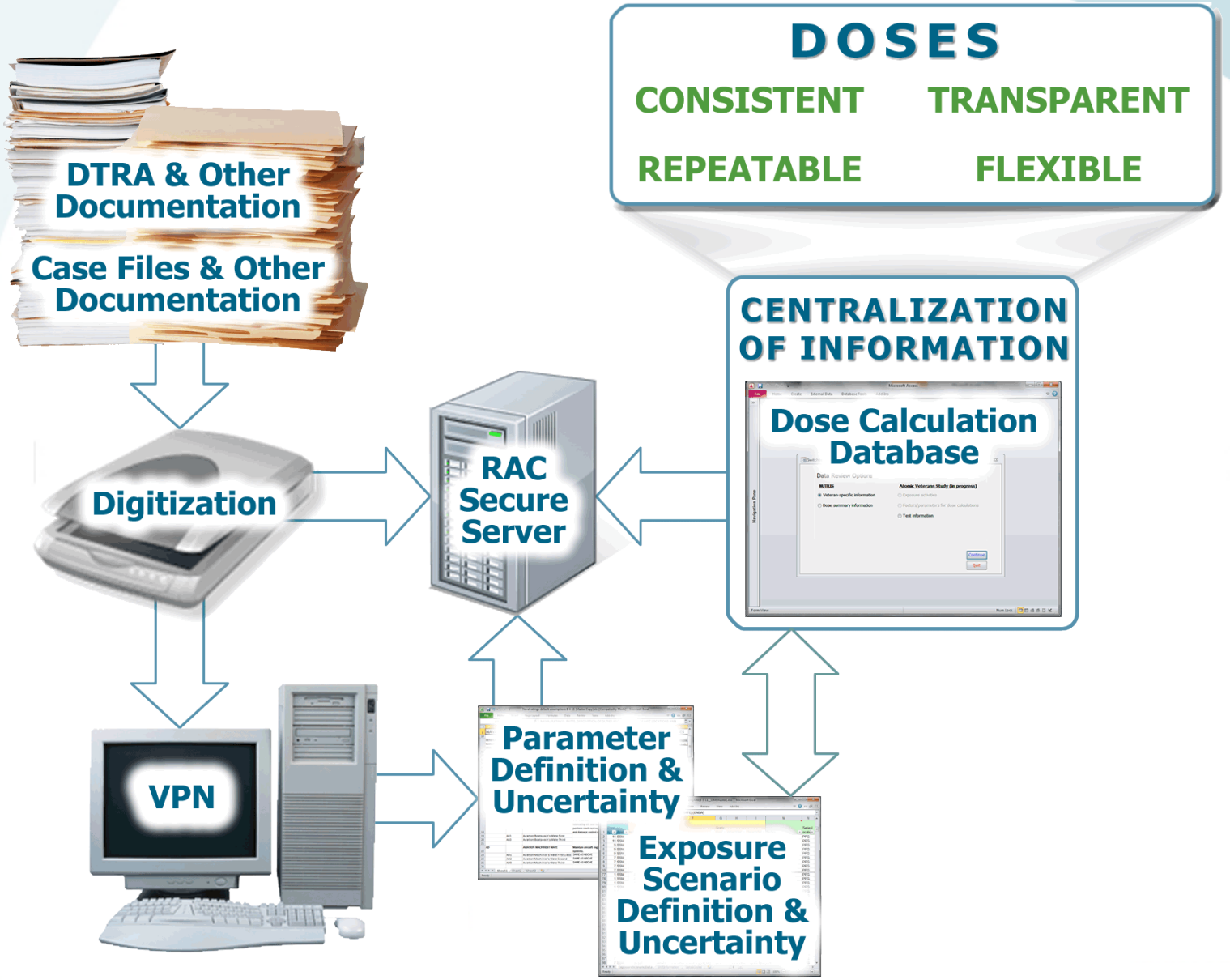
Basic Elements of the Dose Reconstruction Process

- Define exposure scenario
- Implement dose methodology
- Evaluate uncertainties
- Quality assurance
- Presentation and transfer results for analysis

This study now possible because of an extensive effort that has been undertaken to document exposures of veterans potentially exposed during the atmospheric nuclear tests

However, the dosimetry up to this point was designed to serve as a basis for compensation of veterans, and not for epidemiology

Technically Integrated Dosimetry



Resources

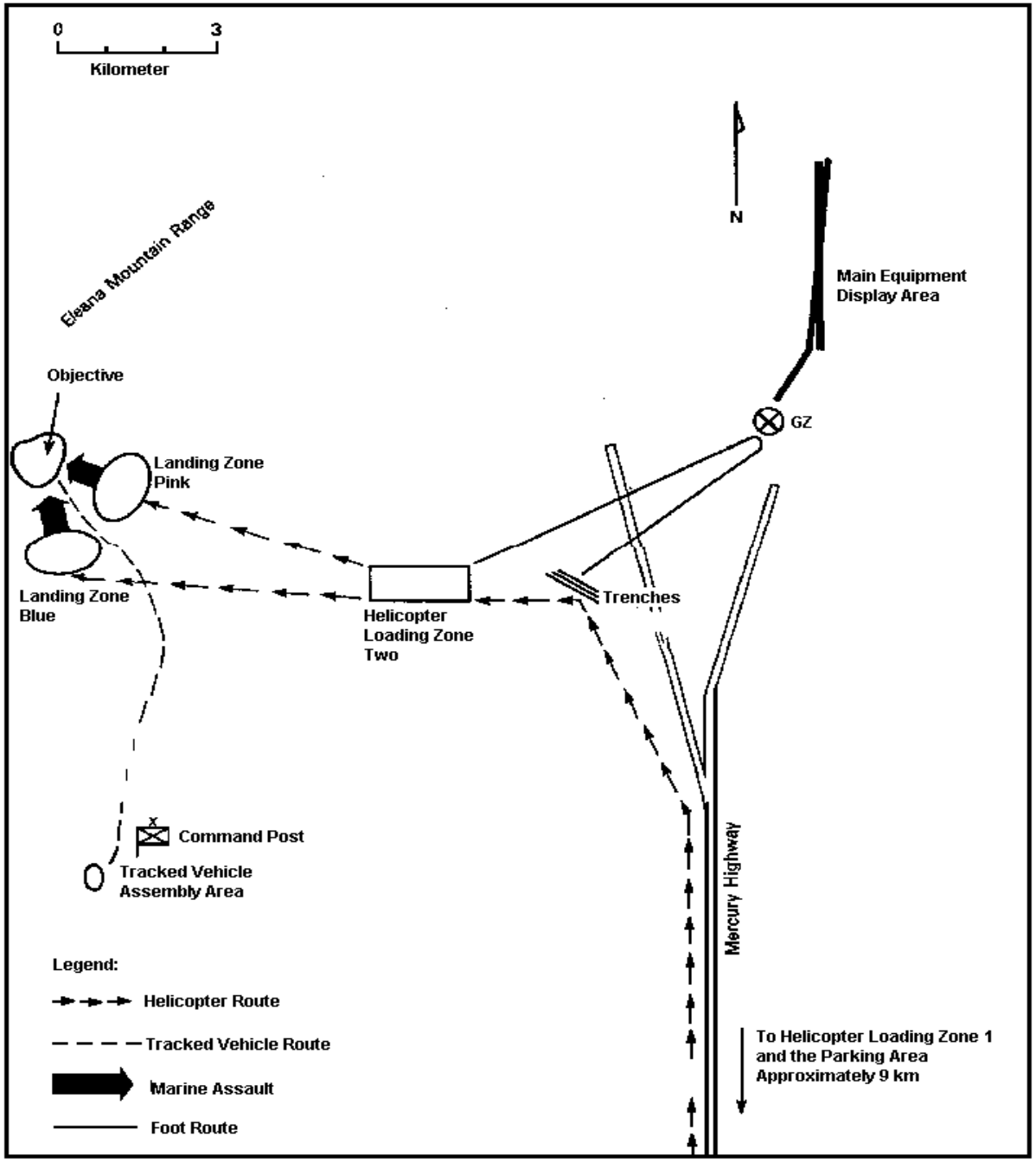
I. Veteran's Statements

According to your statements for Operation CASTLE, you:

- Spent time at Bikini Atoll prior to CASTLE.
- Were on the islands of Bikini, Enewetak (also spelled as Eniwetok), and site TARE (also known as Eneman Island at Bikini Atoll), which constituted elements of the Pacific Proving Ground (PPG).
- Travelled between islands and the test sites by ship, LST naval vessel, and aircraft.
- Were stationed aboard USNS FRED C. AINSWORTH (TAP 181) after the first shot (BRAVO) and recalled being inside guarding a doorway to ensure that none of crew went topside during periods of fallout aboard ship. You witnessed the detonations from the deck of this ship and recalled that the ship had to be decontaminated following a shot.
- Recalled being aboard AINSWORTH at Bikini Atoll for two shots.
- Recalled being transferred from AINSWORTH to Enewetak Island for the remainder of CASTLE.
- Spent about 8 to 10 hours outdoors each day while at Enewetak. These hours were equally split between standing and sitting.

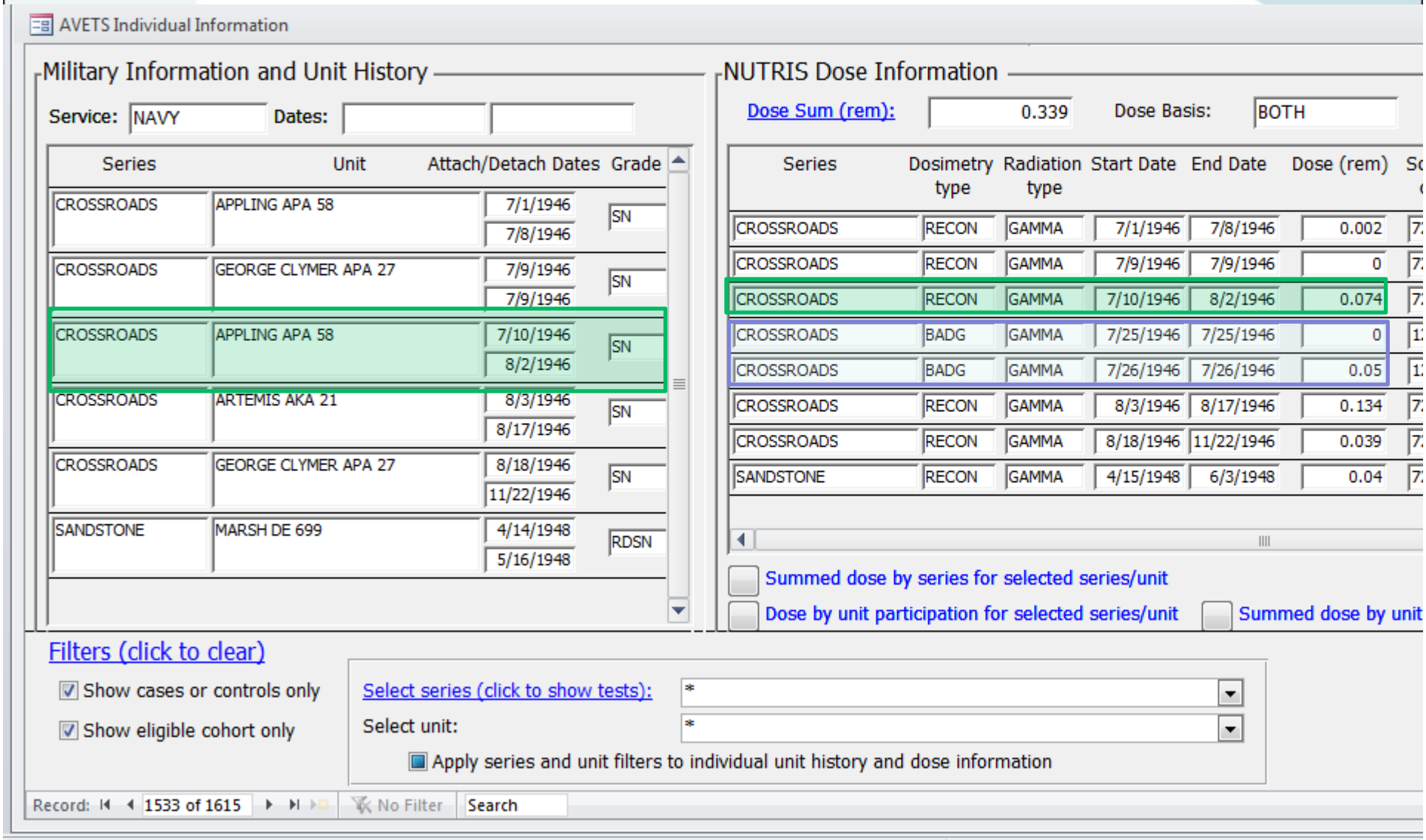

504L44

Nevada Test Site



Summary of Progress—Case Studies

Available dose information



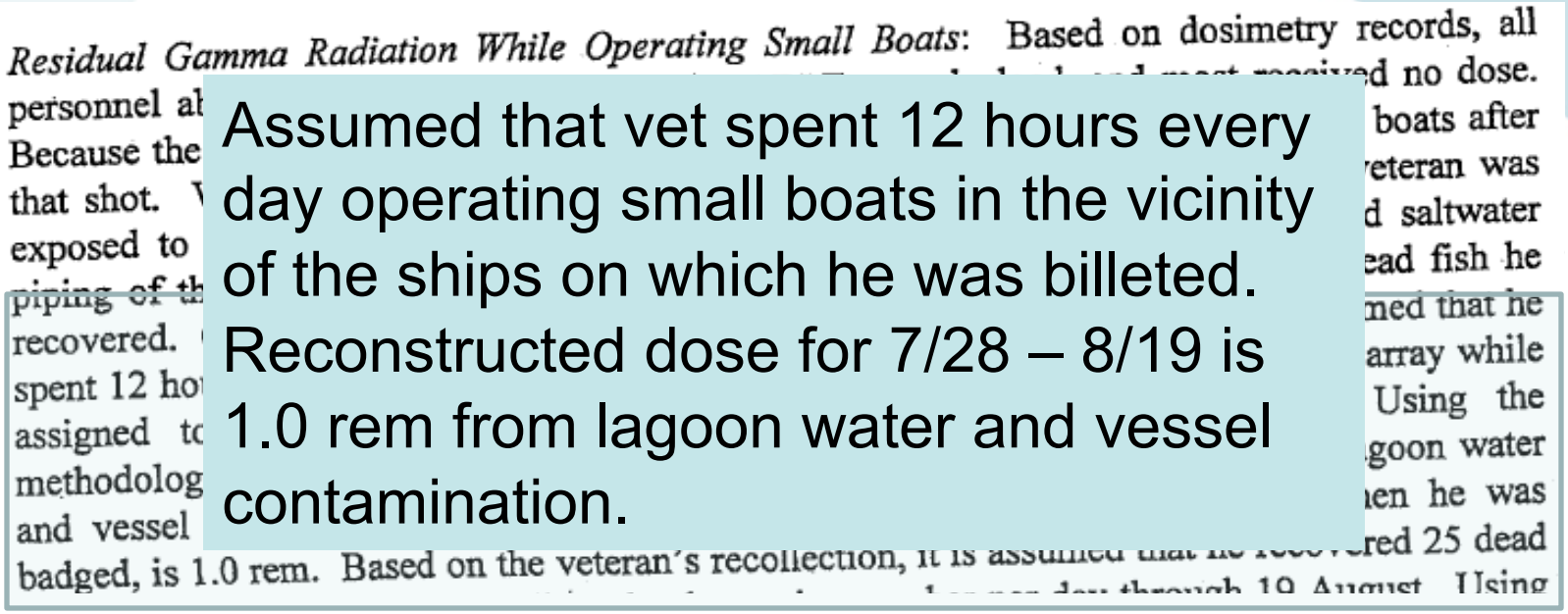
From 491436.exe, another vet in cohort on Appling

supervisory duties. (Reference 3) The veteran was transferred to USS APPLING (APA 58) for temporary duty (TDY) on 8 June and remained attached to that vessel until 2 August. During CROSSROADS, APPLING housed personnel from target vessels for Shots ABLE and BAKER and served as a base for LCPLs and radiological reconnaissance personnel. The ship was located more than 13 nmi from surface zero (SZ) for Shot ABLE. Deck logs from APPLING indicate that the vessel r[e]r radiological patrol boats and returned to the lagoon later that the ship again lowered radiolo[g]y the following weeks, nothing [e]xception of the BAKER rehears[al]

APPLING was the detonation, the ship again sailed to the entrance of Bikini Lagoon, lowered [r]adiological boats between 1017 and 1033, and departed from the area. APPLING returned to the lagoon later in the afternoon and berthed in the uncontaminated southern anchorage. The vessel shifted berths in and around the target ship array three times during the following week. The veteran was [t]ransferred for further TDY. He was again transferred

Appling served as a base for rad recon personnel. Lowered rad patrol boats on July 1, July 25, and stayed in the area for rad recon patrol in the weeks after Baker.

Also from 491436.exe



Residual Gamma Radiation While Operating Small Boats: Based on dosimetry records, all personnel ab ...d no dose. Because the ... boats after that shot. V ...eteran was exposed to ...d saltwater piping of th ...ead fish he recovered. ...med that he spent 12 ho ...array while assigned to ... Using the methodolog ...goon water and vessel ...en he was badged, is 1.0 rem. Based on the veteran's recollection, it is assumed that he ...ered 25 dead ... per day through 19 August. Using

Assumed that vet spent 12 hours every day operating small boats in the vicinity of the ships on which he was billeted. Reconstructed dose for 7/28 – 8/19 is 1.0 rem from lagoon water and vessel contamination.

Our vet on ships with small boats from 7/27 – 8/17, so similar exposure time. This exposure was not included in reconstruction – only film badge days included for potential small boat exposure.

Database and QA

	A	B	C	F	G	H	I	J	K	L
1	Priority	Analy	IndivKey	Unit	GradeCode	AttachDat	DetachDa	Location	ExposureActivity	ScenUnc
284	1	JWA	491480	APPLING APA 58	SN	7/1/1946	7/8/1946	ship	routine duty	A
285	1	JWA	491480	APPLING APA 58	SN	7/1/1946	7/8/1946	ship	routine duty	A
286	1	JWA	491480	APPLING APA 58	SN	7/1/1946	7/8/1946	ship	routine duty	A
287	1	JWA	491480	GEORGE CLYMER APA 27	SN	7/9/1946	7/9/1946	ship	routine duty	A
288	1	JWA	491480	GEORGE CLYMER APA 27	SN	7/9/1946	7/9/1946	ship	routine duty	A
289	1	JWA	491480	GEORGE CLYMER APA 27	SN	7/9/1946	7/9/1946	ship	routine duty	A
290	1	JWA	491480	APPLING APA 58	SN	7/10/1946	8/2/1946	ship	routine duty	A
291	1	JWA	491480	APPLING APA 58	SN	7/10/1946	8/2/1946	ship	routine duty	A
292	1	JWA	491480	APPLING APA 58	SN	7/10/1946	8/2/1946	ship	routine duty	A
293	1	JWA	491480	APPLING APA 58	SN	7/10/1946	8/2/1946	ship	small boat duty	A
294	1	JWA	491480	APPLING APA 58	SN	7/10/1946	8/2/1946	ship	small boat duty	A
295	1	JWA	491480	APPLING APA 58	SN	7/10/1946	8/2/1946	ship	small boat duty	A
296	1	JWA	491480	ARTEMIS AKA 21	SN	8/3/1946	8/17/1946	Bikini	R&R	B
297	1	JWA	491480	ARTEMIS AKA 21	SN	8/3/1946	8/17/1946	ship	routine duty	A
298	1	JWA	491480	ARTEMIS AKA 21	SN	8/3/1946	8/17/1946	ship	routine duty	A
299	1	JWA	491480	ARTEMIS AKA 21	SN	8/3/1946	8/17/1946	ship	routine duty	A
300	1	JWA	491480	GEORGE CLYMER APA 27	SN	8/18/1946	11/22/1946	ship	routine duty	A
301	1	JWA	491480	GEORGE CLYMER APA 27	SN	8/18/1946	11/22/1946	ship	routine duty	A
302	1	JWA	491480	GEORGE CLYMER APA 27	SN	8/18/1946	11/22/1946	ship	routine duty	A
303	1	JWA	491480	MARSH DE 699	RDSN	4/14/1948	5/16/1948	ship	routine duty	A
304	1	JWA	491480	MARSH DE 699	RDSN	4/14/1948	5/16/1948	ship	routine duty	A

Database and QA

	A	B	C	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL
1	Priority	Analy	IndivKey	LitDoseE	LitDoseUni	LitStartDa	LitEndDate	CalculationBasis	LitDoseSource	ClearlyLessThanCuto	CorrectedForTimeExposed	LitDoseConsistent	LitFractionIndoors_BelowDeck
284	1	JWA	491480	0.002	rem	7/1/1946	7/8/1946	literature	(9-2-1-5) and XRD	N	Y	Y	0.66
285	1	JWA	491480	0.000	rem	7/1/1946	7/8/1946	literature	(9-2-1-5) and XRD	N	Y	Y	0.66
286	1	JWA	491480	0.002	rem	7/1/1946	7/8/1946	NuTRIS	NuTRIS	N	Y	Y	
287	1	JWA	491480	0.000	rem	7/9/1946	7/9/1946	literature	(9-2-1-5) and XRD	N	Y	Y	0.66
288	1	JWA	491480	0.000	rem	7/9/1946	7/9/1946	literature	(9-2-1-5) and XRD	N	Y	Y	0.66
289	1	JWA	491480	0.000	rem	7/9/1946	7/9/1946	NuTRIS	NuTRIS	N	Y	Y	
290	1	JWA	491480	0.035	rem	7/10/1946	8/2/1946	literature	(9-2-1-5) and XRD	N	Y	Y	0.66
291	1	JWA	491480	0.039	rem	7/10/1946	8/2/1946	literature	(9-2-1-5) and XRD	N	Y	Y	0.66
292	1	JWA	491480	0.074	rem	7/10/1946	8/2/1946	NuTRIS	NuTRIS	N	Y	Y	
293	1	JWA	491480	-1.000	rem	7/25/1946	7/25/1946	badge	badge	N	Y	Y	
294	1	JWA	491480	-1.000	rem	7/26/1946	7/26/1946	badge	badge	N	Y	Y	
295	1	JWA	491480	0.500	rem	7/27/1946	8/19/1946	literature	491436.exe	N	N	N	0
296	1	JWA	491480	-1.000	rem	8/1/1946	8/20/1946	literature	(9-2-1-5) and (9-2-1-2)	N	N	N	0
297	1	JWA	491480	0.068	rem	8/3/1946	8/17/1946	literature	(9-2-1-5) and XRD	N	Y	Y	0.66
298	1	JWA	491480	0.066	rem	8/3/1946	8/17/1946	literature	(9-2-1-5) and XRD	N	Y	Y	0.66
299	1	JWA	491480	0.134	rem	8/3/1946	8/17/1946	NuTRIS	NuTRIS	N	Y	Y	
300	1	JWA	491480	0.008	rem	8/18/1946	11/22/1946	literature	(9-2-1-5) and XRD	N	Y	Y	0.66
301	1	JWA	491480	0.031	rem	8/18/1946	11/22/1946	literature	(9-2-1-5) and XRD	N	Y	Y	0.66
302	1	JWA	491480	0.039	rem	8/18/1946	11/22/1946	NuTRIS	NuTRIS	N	Y	Y	
303	1	JWA	491480	0.030	rem	4/15/1948	5/31/1946	literature	(9-8-2)	N	N	Y	0.5
304	1	JWA	491480	0.040	rem	4/15/1948	6/3/1948	NuTRIS	NuTRIS	N	Y	Y	
305	1	JWA	494191	0.267	rem	7/1/1946	8/25/1946	NuTRIS	(9-2-1-5)	Y	N	Y	
306	2	JWA	266832										
307	2	JWA	266832										
308	2	JWA	266832										
309	2	JWA	267539	0.000	rem	7/1/1946	7/1/1946	NuTRIS	(9-2-1-4) 267539.vot	N	Y	Y	

ExposureScenarioData | UnitInformation | Lists&Codes | Deleted Rows

Ready

Preliminary Findings

Dosimetry Records are a Valuable Tool

- **Film badge dosimetry records are available for many personnel**
  - Pacific tests dosimetry records used to develop distributions of dose and to evaluate dose as a function of ship type, series, and specific job

Scenario Analysis

- Currently have 1615 cases and comparison veterans, for which we have completed 400 scenarios.
- 60% of scenarios have doses < 0.5 rem (5 mSv).
- Work separated into Pacific tests vs. NTS tests to facilitate the dosimetry

Additional Preliminary Findings

- There is a general (and expected) bias high in NTPR program doses compared to our best estimate doses -- confirming the need for detailed dosimetry in this epidemiologic study
- Dose in a few "high exposure areas" were as high as expected (e.g. engine room aboard ship)
- Internal dose – less important for leukemia

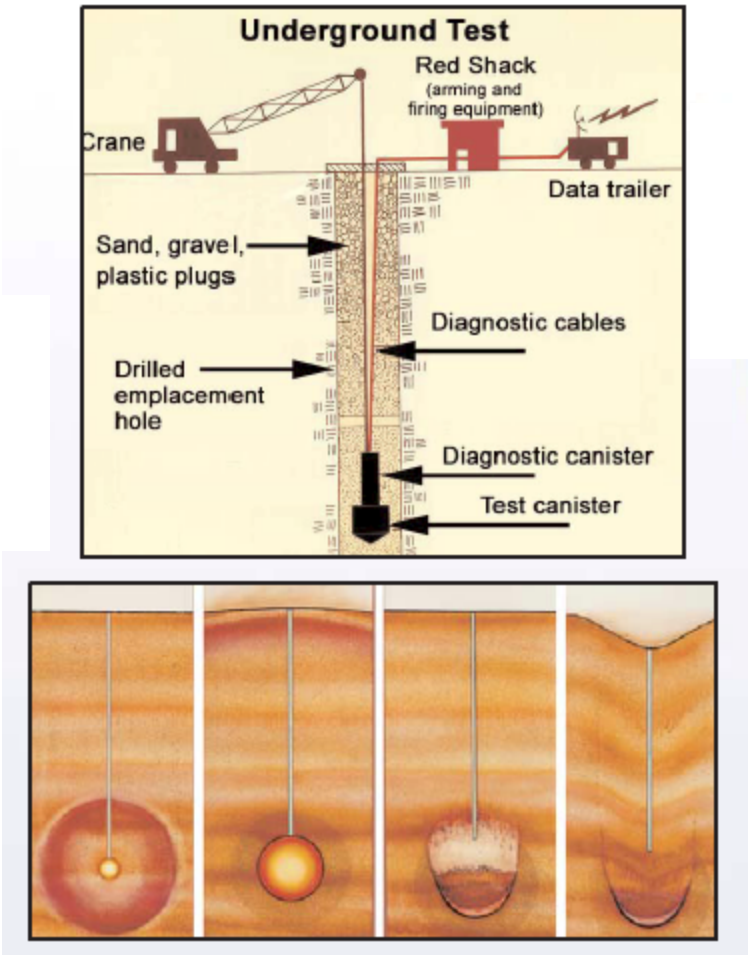
Atomic Veterans Study – Future Possibilities

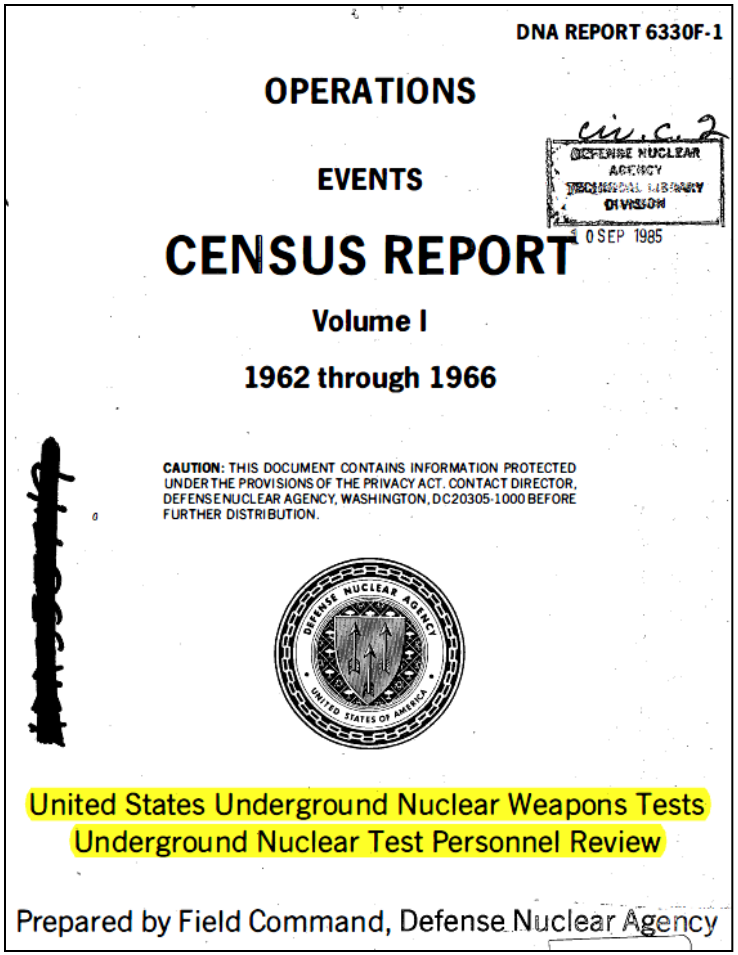
- Inclusion of other sites: bone, liver, thyroid, male breast, salivary

CauseOfDeath	UCOD_ Only	UCODor CCOD
CLL	126	156
nonCLL	518	557
MyelodysplasticSyndrome	62	104
Thyroid	47	54
Salivary	15	15
MaleBreast	24	27
BiliaryLiver	403	428
Bone	35	40

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

Other Planned Activities

- Dosimetry linkages: DOE-REMS (approved), NRC-REIRS (approved), Army (ongoing), Air Force (pending) and Navy (pending). Preliminary linkages with Landaurer dosimetry files indicated that at least 2% had received additional occupational exposures.

Troops during detonation at NTS

- Initial linkages with the U.S. Renal Data System for veterans with known SSN (a little over 81% at the moment) identified 1,304 with nonmalignant kidney disease.
- Contribute to Million US Worker and Veteran Study

Atomic Veterans Study Group

Nashville, TN –
19-20 January 2011

Nashville, TN –
11-13 October 2011

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
- Dick Toohey

Advisor
- Clark Heath

Desert Rock VI exercise (TEAPOT), NTS, 1955

DOE: Noelle Metting, Bonnie Richter

IEI
- Mike Mumma
- Jen Sonderman

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

Harvard
- Howie Sesso

Government
- DTRA (Paul Blake)
- VA (Han Kang, Tim Bullman)
- NRC (Vince Holahan)
- NCI (Gary Ellison)

Overview

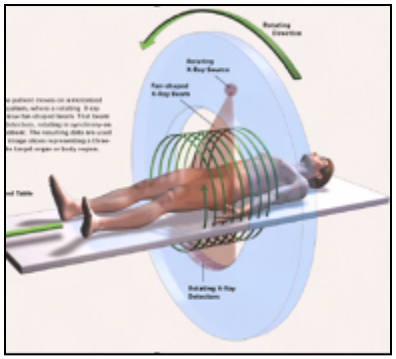
NCRP
Scientific Authority Since 1929

- Million U.S. Worker and Veteran Study

What is the Major Unanswered Question in Radiation Epidemiology and Radiation Protection?

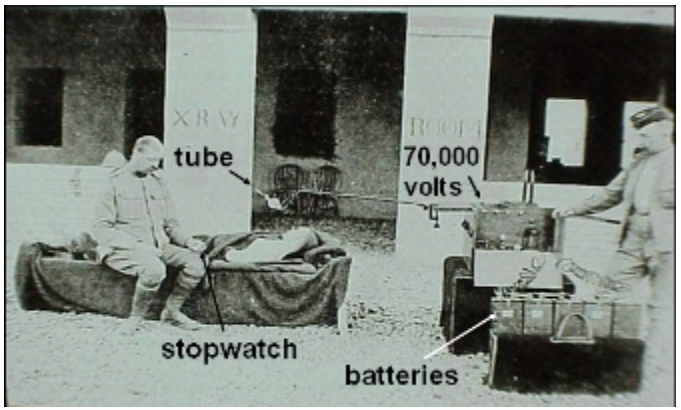
- What is the level of risk when exposure received gradually over time and not briefly ?

Medicine



Accidents

Occupation



Environment

Fukushima has Elevated this Concern

What can United States Do?

One Million U.S. Radiation Workers and Veterans

OAK (HARDTACK I), Enewetak,
8.9 MT, 28 Jun 1958

- Manhattan Project - 360,000
- Atomic veterans - 115,000
- Nuclear utility workers - 212,000
- Medical and other - 350,000
- Nuclear navy– possible

Workshop – Study of One Million US Workers and Veterans Bethesda, Maryland 15-16 February 2012

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

The Washington Post

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