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Summary of Radiological Safety Standards, Dosimetric Devices, & Decontamination Criteria for the Atmospheric Nuclear Weapons Tests (1945–1962)

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Draft Report

Submitted to:
Defense Nuclear Agency

Submitted by:
JAYCOR

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Information Management Officer
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This report summarizes the following for the 1945-1962 atmospheric nuclear tests: radiation exposure standards, decontamination criteria, film badge data. Federal radiation standards are included as an appendix. It provides the first three in matrix form plus a one-page summary for each of the twenty test series. A detailed bibliography is included.

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TABLE OF CONTENTS

SECTION		PAGE
	INTRODUCTION	1
1	RADIOLOGICAL SAFETY STANDARDS	1-1
1-1	Radiation Exposure Standards.	1-1
1-2	Personnel Decontamination Criteria	1-2
1-3	Film Badge and Other Personnel Dosimetric Device Information	1-3
2	OPERATION SUMMARIES	2-1

APPENDIX		
A	RECOMMENDED RADIATION SAFETY STANDARDS . .	A-1
B	ACRONYMS	B-1
C	BIBLIOGRAPHY	C-1

INTRODUCTION

From 1945 to 1962 approximately 235 atmospheric nuclear weapons tests were conducted by the United States. These tests, organized into twenty different series, were directed jointly by the AEC and DoD with the participation of some 210,000 Department of Defense personnel. The Defense Nuclear Agency (DNA) was recently tasked to develop personnel-oriented histories for these tests to determine the radiological exposure of personnel, and examine the measures taken to limit exposure to safe levels. This reconstruction is a part of DNA's overall Nuclear Test Personnel Review (NTPR).

This report provides a ready reference to personnel radiation exposure standards, personnel decontamination criteria and procedures, and information on personnel dosimetry (film badges and other devices) for each test series in the U.S. atmospheric nuclear weapons testing program.

In Section 1 the above data for each test operation are presented in three tables: Table 1-1 shows exposure standards; Table 1-2 shows decontamination criteria; and Table 1-3 shows dosimetry devices. Section 2 combines these three sets of information on individual sheets for each test operation.

Appendix A documents the historical development of radiation standards. It provides a detailed chronology of the recommendations of various agencies for safe radiation standards, ranging from the beginning efforts in radiation protection to the more detailed recommendations made by several national and international radiation protection groups. Appendix B is an acronym glossary. Appendix C is a bibliography of primary source documents referencing each entry in Sections 1 and 2. The pages consulted in each source document are referenced by letters of the alphabet, as explained in Appendix C.

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SECTION 1

RADIOLOGICAL SAFETY STANDARDS

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RADIOLOGICAL STANDARDS MATRIX

1-1 RADIATION EXPOSURE STANDARDS

OPERATION	RECOMMENDED DOSE LIMITS BY AGENCY* NCRP	ICRP	FRC	ROUTINE MPE	CLOUD SAMPLERS	DESERT ROCK	SPECIAL GROUPS	REMARKS
TRINITY (Almagordo, NM) 7/16/45	0.1 R/day, 0.5 R/wk (1a) (2) (3)	0.2 R/day, 1.0 R/wk (1d) (2) (5) (9)		5R for one exposure (13a)	N/A	N/A	N/A	Personnel were to evacuate before 30 min. if gamma reading outside shelter reached 1R/h; put on gas masks & evacuate if alpha reading reached 5 c/m. (13b)
CROSSROADS (Bikini) 7/1/46-7/25/46				0.1R/day not to exceed 50-60R in 2 wks. If individual received 10R in one day or 60R in 2 wks, he was withdrawn from operation (24e)	N/A (24a)	N/A	N/A	Cloud trackers adhered to same standards as other units at CROSSROADS (24a)
SANDSTONE (Enewetak) 4/14/48-5/15/48				0.1R/24 hrs, not to exceed 3R for the operation (32a)	Cloud samplers were Drone B-17s (35)	N/A	See Reference 31a	Higher exposures approved only by Cdr/JTF7 & individual was prohibited from further exposure for 30 days (33b)
RANGER (NTS) 1/27/51-2/6/51	0.3 R/wk (4) (1b) (2)	0.3 R/wk (1e) (2) (10)		3R/operation; 2R for personnel participating in GREENHOUSE; AEC workers: 3.R/wk (40a)	Manned sampler aircraft first used at RANGER (15)	N/A	Public could receive up to 25R w/out danger (40a)	Cloud sampling aircraft in NV operated out of Indian Sprgs. AFB. All samplers required to wear oxygen masks (18)
GREENHOUSE (Enewetak) 4/8/51-5/25/51				3.9 R/13 wks (15); 0.1 R/day; not to exceed 0.7R/week (56)	Drone B-17s used as Cloud Samplers (54)	N/A		See Reference 53a
BUSTER-JANGLE (NTS) 10/22/51-11/29/51				3R/3 month period (60a)	3.9R for 13 wk. operation; cloud sampling aircraft were B-29's (15)	1R total (DR I) 3R (DR II & III) (63a&64a)	All observers wore film badges (DR II,III) (64b)	AEC's Div. of Biology & Medicine agreed to unpublicized exposure of 3.9R. 3R MPE could be exceeded if Test Director approved (60a,51a)
TUMBLER-SNAPPER (NTS) 4/1/52-6/5/52				3R/operation (70a); Ref. 71b gives 3.9 R/operation	Cloud samplers: B-29's,T-33's, F-84's; cloud trackers: B-29's, B-25's (73a)	DR-3R/operation; recommends exposure level be raised above 3R (72a)	When transporting radioactive samples, aircrew members were limited to 10mR/h (81a)	1.1% of test participants exceeded exposure level of 3.9R (71c)
IVY (Enewetak) 11/1/51-11/16/52				3.9R/operation - gamma only (80a); 82a says 3R/ 3 mos. (measured gamma only)	Crews on sampling aircraft: total MPE of 20R for operation (81a)	N/A	AEC approved emergency exposure of 25R total (81a)	See Reference 80a
UPSHOT-KNOTHOLE (NTS) 3/17/53-6/4/53				3.9R (gamma only) unless reduced by Test Director (90a)	Cloud samplers F-84's;Cloud tracker's B-29's & B-25 (94)	6R for operation (91a)	Aircraft crew limited to 20 mR/h when transporting samples of radioactive material (92)	No limits set on rate of accumulation of MPE (90a) Also see Reference 92e
CASTLE (Bikini Enewetak) 3/1/54-5/14/54	3.0 R/13 wk 0.3 R/wk (max) 15 rem/y (2) (5)			3.9R/13 weeks; augmented by .3R/week after that (100a&103a)	Special MPE of 20R (gamma only) (102a)	N/A	MPE waiver approved by Dir., DBM, Surgeons General (101a); Maximum received was 7.8 R (104a)	See Reference 100a
TEAPOT (NTS) 2/18/55-5/15/55				3.9R/operation (111a)	Cloud samplers: F-84's; Cloud trackers: B-25's B-50,B-29's (114a)	DR VI-6R total-no more than 3R prompt for one test; 6R in six months (112a & 113a)	DR VI: Volunteers: 10R total w/5R prompt; not more than 25R/operation (113a)	Exposure of personnel above (3.9/R) was authorized in advance by the Test Manager upon recommendation of the TD as to operational necessity (110b)

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RADIATION EXPOSURE STANDARDS
(Continued)

OPERATION	RECOMMENDED DOSE LIMITS BY AGENCY: NCRP	ICRP	FRC	ROUTINE MPE	CLOUD SAMPLERS	DESERT ROCK	SPECIAL GROUPS	REMARKS
WIGWAM (Pacific) 5/14/55				Whole body. 3.9R/operation; hands & feet 20R/operation (120)	Only cloud trackers, no Sampler's at WIGWAM (15)	N/A	Approx. 10 water sample collectors were authorized 20R/operation (122)	
REDWING (Bikini, Enewetak) 5/5/56-7/22/56				3.9R/13 weeks only (130e)	20R (gamma only) authorized for operational period (131a)	N/A	Emergency MPE: 7R/operation (131b); Authorization to exceed MPE limits granted by CJTF-7 (133a)	600 persons exceeded 3.9R exposure limit (130h); also See Reference 133b
PLUMBBOB (NTS) 4/27/57-10/7/57	5 rem/y (avg) 12 rem/y (max) 2 7 6 1c			3R (whole body gamma)/13 weeks, 5 R/yr (AEC); Alpha:max. of 10,000 units/13 consec. wks (140a)	7.5R (141a) B-57's used for cloud sampling (15)	5R/6 months:no limit on rate of accumulation. No more than 2R prompt (142)	AFSWC: Aircrew or passengers not to be exposed to dose rate greater than 20 mR/h during flight (143)	MPE limits recommended by AEC's Div. of Biology & Medicine (140)
HARDTACK I (Bikink, Enewetak, Johnston Is.) 4/28/58-8/18/58	0.3 rem/wk (max) 3.0 rem/13 wks 12 rem/y (max) 5(N-18)rem (2) (8)	0.1 rem/wk 3.0 rem/13/wk 5(N-18)rem (2) (11)		3.75 R/13 wks; 5R for operation (152,153)	B-57's (15)	N/A	167.5 (H&N) requested that 3.75R be increased (unspec.) & that 5R be increased to 10R for 35 H&N employees (see Ref. 154)	22 individuals are known to have exceeded the 5R limit (15); Also see Reference 150
ARGUS (South Atlantic) 8/27/58-9/6/58					None (15)	N/A		
HARDTACK II (NTS) 9/19/58-10/30/58				3R/operation 3rem/quarter 5rem/year neutron (170a,170b)	10R-15R for those also participating Hardtack I see Reference 171a	N/A	12 personnel (FC/AFSWP) authorized by T.M. to get 25R (171a)	Provisions of NBS Handbook 59 prevailed in case of accidental or emergency exposure. (170b)
DOMINIC I (Christmas & Johnston Islands; and Eastern Pacific) 4/25/62-11/4/62			3 rem/13wk 5 rem/y (avg) 12 rem/year (max) 5(N-18)rem	Over age 19:3R/13 wks, 5R/year (whole body gamma) Under age 19:1.25R /13 weeks (190)	None (15)	N/A	Emergency MPE: 25R (190)	Grave emergency MPE 50R. Pers. under age 19 had to evacuate if cumulative dose reached 1R (190)
DOMINIC II (NTS) 7/7/62-7/17/61			(2) (12)	Small Boy: 3 rem/quarter (see ref. 200a for further note)	Shot Small Boy: Aircrews: 3rem/quarter (200b)	N/A		See Reference 201a
PLOWSHARE Project Gnome (Carlsbad, NM) 12/10/61 Sedan (NTS) 7/6/62				3 rem/quarter established by Test Director Sedan Shot (210a)		N/A		Sedan: Maximum personnel exposure was 300 mR; Average was 250 mR, (210b); (also see Ref. 211h)

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OPERATION	PERSONNEL DECONTAMINATION THRESHOLD	INSTRU. FOR MEASURING	FACILITIES AND EQUIP.	REMARKS
TRINITY (Almagordo, NM) 7/16/45		Geiger Counters (15)	Protective clothing issued, coveralls, surgical caps, booties, gloves (13c)	
CROSSROADS (Bikini) 7/1/46-7/25/46	0.1 rep (β + γ) per 24 hrs (or) radiac readings greater than 7 mR/h (20a)	Geiger Counter readings (25b)	Special change clothing & shower facilities on the target-APA's (25b)	Study of decontamination procedures initiated (22a); Radiological problems aggravated shortage of monitors & instruments (23a)
SANDSTONE (Enewetak) 4/14/48-5/15/48	Reading of over 0.1mR/h (β+γ) on any part of the body was considered contaminated (30a)	GM Counters, Victoreen 263 A; Ion Chambers, Nat'l Tech. Labs MX-6 (32i)	Decon. clothing destroyed, personnel washed until body reading <0.1mR/h Contam. valuables stored in containers. Decon. centers on BAIROKO & on CVE-115 (33)	Decontamination facility for aircraft and personnel located on Enewetak Island. (35) All pers. who might be exposed to radiation were given a physical exam (36)
RANGER (NTS) 1/27/51-2/6/51		Victoreen 263-A-basic (15) G-M type 2610 A Survey instruments: < than 20 mR. High & low range Juno type ion chambers: > than 20 mR (40e)	Personnel took Cold showers and Protective clothing was issued (41a) Respirators were issued when background greater than 2mR/h (40e)	Construc. workers & supervisors given physical exam & blood count if they entered contam. areas. (41a) Personnel booties were the only items which received significant contamination (40d)
GREENHOUSE (Enewetak) 4/8/51-5/25/51	Over 10 mR/h on clothes or skin. 7 mR/h (β+γ) at six inches, using AN/PDR-5 or equiv.(51a-51c)	El Tronic, Model PRJ (β+γ) Victoreen Model 263A (β+γ) T1B (gamma) + Pee Wee Recorders used (alpha) MX-5 (15) (51b)	Decon. clothing exchange; showers in 90 F water; hard water soap. Location: Change House or Decon. Head (51c)	Usually by Shot +3, decontamination facilities were in operation on the shot island or its vicinity (57)
BUSTER-JANGLE (NTS) 10/22/51-11/29/51	Over 7 mR/h (β+γ) within 10 hrs after detonation. All items reduced to a max of 2mR/h (61b). Dr II, III: Stoo at 2mR/h (64f)	Pee Wee (alpha activity) Victoreen 263A MX-5 (15)	Decon Center at CP-2 Rad-Safe Bldg. (15) (Also see Reference 64e)	DR II & III: 3 types of decon procedures: dry brushing, dusting w/wet rags, & washing (64d&e)
TUMBLER-SNAPPER (NTS) 4/1/52-6/5/52	DR-decontaminate to limit of 1.5 mR/h on clothing. 0 mR/h on Skin (72b)	T1B Ion Chamber, MX-5 GM counter (71d)	DR: Decon. Station located at Yucca Pass - 12 showers available.(72a) Clothing exchange and showers (71)	DR: If only skin contam., brush, dust off clothing-bathe w/soap & water (72a)
IVY (Enewetak) 11/1/51-11/16/52	Skin: 1mR/h; underclothing: 2mR/h; outerclothes: 7 mR/h (80g)	Side window G-M counters, probe held 1-6 in. from surface measured (80h)	Decon station:showers, hand brush & soap, mailed containers, cleaning agents, laundry (80i)	Decon. Station was on Parry Island. Decon. facility for sampling aircraft & personnel on Kwajalein (15)
UPSHOT-KNOTHOLE (NTS) 3/17/53-6/4/53	Skin: 1 mR/h; underclothing: 2 mR/h; outerclothing: 7mR/h (92b)	Surface contamination readings made w/side window type geiger counters MX-5, T1B (92b)	Personnel could eat or smoke in any contaminated area. Decon. Station located in CP-2 Rad-Safe Bldg. where protective clothing was issued (92a)	DR: Personnel & equipment contaminated in excess of 20 mR/h above background required decontamination (91b)
CASTLE (Bikini, Enewetak) 3/1/54-5/14/54	Skin: 1mR/h; underclothes: 2mR/h; outer clothes: 7mR/h; (102c)	Side window geiger counters (100g)	Parry Island decontamination facilities: clean change room. contam. change room, showers, monitor check point (100h)	Special plastic suits worn during Proj. 6.4 decon. (101b); Decon fac. for TG 7.4 on Bikini & also at Enewetak for TG 7.3 aircraft (105)
TEAPOT (NTS) 2/18/55-5/15/55	Skin-1 mR/h; underclothing- 2 mR/h; outerclothes-7 mR/h (110a)	AN/PDR-39, Beckman MX-5 used for measuring personnel & equip. (111f)	Rad-Safe building had bathing facilities (111f) D.R: swept off w/brooms, change of clothes provided(112b)	Decon. threshold 20mR/h (DR) (112b)
WIGWAM (Pacific) 5/14/55	1 mR/h (γ) skin 2 mR/h (γ) underclothing (123) (122a)	G-M instruments, modified CP-3D w/shield, AN/PDR-T1B, AN/PDR-18 (120i&f)	Rad-Safe Center on CVL-49 freshwater showers in passageways available (120e & 120h)	
REDWING (Bikini,Enewetak) 5/5/56-7/22/56	Skin 1 mR/h; underclothing: 2 mR/h; outerclothing: 7 mR/h (131b)	Geiger counters, AN/PDR-27F & AN/PDR-18A for higher radiation fields (131c-134a)	Clean and "hot" change areas & showers provided (130f)	

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DECONTAMINATION CRITERIA
(Continued)

OPERATION	PERSONNEL DECONTAMINATION THRESHOLD	INSTRU. FOR MEASURING	FACILITIES AND EQUIP.	REMARKS
PLUMBBOB (NTS) 4/27/57-10/7/57	7mR/h (B+γ) outer clothes; 1mR/h (γ) on skin or underclothes (140c) OR: 7mR/h (142a)	AN-PDR 39 was used to measure gamma dose rate. Beckman MX-5 & AN-PDR 34 measured dose rate (141e)	CP-2 Decon. Bldg.: showers available; personnel monitored with portable alpha survey instru. & nasal swabs taken; Contam. clothing was washed at (141b&e)	OR: Field decon. procedures: Individuals brushed each other off w/brooms. Those who couldn't be field decon. to permissible levels were sent to Decon Sta. for showers & clothing exchange(142a
HARDTACK I (Bikini, Enewetak, Johnston Is.) 4/28/58-8/18/58	7 mR/h (B+γ) or greater(154). Stop at 1 mR/h (γ) on skin or underclothing.(157)	AN/PDR-27H (B+γ); AN/PDR-39 Eberline PAC-3G (154)	Change areas and showers available (151)	Personnel & equipment Decon. Stations located on Enewetak, Runit, Parry Island (151)
ARGUS (South Atlantic) 8/27/58-9/6/58	(No decontamination requirments)			
HARDTACK II (NTS) 9/19/58-10/30/58	7mR/h (B&γ) outer clothing; 7mR/h(γ) shoes; 1mR/h skin or underclothes (170e)	Alpha-Eberline PAC-3G (field & personnel); Beckman MX-5 (vehicles & personnel) (170e)	Monitor, shower, change of clothing, laundry (170f)	Vehicles & equipment were decontaminated at CP-6 (an area adjacent to CP-2) (170f)
DOMINIC I Christmas & Johnston Islands, Eastern Pacific) 4/25/62-11/4/62	10 mR/h (190)	AN/PDR-27J; AN/PDR-43 used for monitoring personnel & equip. (190)	Decon. Stations at Johnston Is, Barber's Point, Christmas Is. had Showers & clothing exchange (192)	
DOMINIC II (NTS) 7/7/62-7/17/61	See Reference 200c	E-112 6-1, Tracerlab AN/PDR T18, Victoreen Radector (201b)	Rad-Safe facility at CP-2 (201a) Mobile decon. facility at Rad-Safe Station (160c)	See Reference 180b
PLOWSHARE Project: Gnome (Carlsbad, NM) 12/10/61 Sedan (NTS) 7/6/62		Precision Model III; Beckman MX-5; Tracerlab SU-10; Juno Model 6 Gnome (211g)	Gnome-contam. clothing laundered at site; anti-contam clothing provided (211e); (Also see Reference 211f)	Sedan-Indian Springs AFB Rad-Safety facility decontaminated cloud sampling personnel (210d)

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1-3 FILM BADGE AND OTHER PERSONNEL DOSIMETRIC DEVICE INFORMATION

OPERATION	MANU. & MODEL	COMPONENTS	SENSITIVITY, ACCURACY, RANGE, CAPABILITIES	WHO ISSUED & CONTROLLED	WHERE PROCESSED/ NOW-LOCATED	PERSONNEL DOSIMETRIC DEVICES	REMARKS
TRINITY (Almagordo, NM) 7/16/45	Eastman Type K X-Ray Film and Dupont 552 D-2 X-Ray film (14)		Sensitivity: Eastman Type K - 100 mR - 10R (low); Dupont Type D-2 - 1R - 300 R (high); Accuracy: ± 10% (15)	FBs issued by Health Group Manhatten Engineer District, LASL (15)	FBs processed at Q Building, LASL; now located at Records Repository, LASL (16) (17)		100 catastrophe FBs issued (13c); Observers wore protective goggles & avoided direct vision of shot (13b); FBs read on a Marshall Densitometer (15)
CROSSROADS (Bikini) 7/1/46-7/25/46	Kodak Type K (27); Kodak Industrial X-ray 5301, 5302 (26)		Type K sensitivity: 0-2R (27a) 5301: Accuracy6-12% 5302: Accuracy 6-8% (26)	FBs turned over to Photometric Unit, USS Haven (24b)	Processed: Rad-Safety Unit (24c); Sent to Manhatten Engineer District., Washington DC (17)		FBs now located at REECo (17)
SANDSTONE (Enewetak) 4/14/48-5/15/48	Eastman Kodak (34a)	Types A & K film (32b) using Lead Cross Shield	100 mR-10 R (15)	FBs issued and controlled by TU 7.1.6 (15)	Film air shipped to U.S. for dev. & reading by NBS. FBs (34a)		FBs now located at REECo (17) See References (32c, 32d, 34b)
RANGER (NTS) 1/27/51-2/6/51	Dupont #553 (Los Alamos type)(15)	502, 606 (15)	100mR-10R (502) 10R-300R (606) (15)	FBs issued & controlled by H-1, Health Div., Los Alamos Scientific Lab (15)	Processed at Los Alamos (40c); Stored at Records Repository LASL, NM (17)	Kelley-Koett pocket dosimeters (15)	See Reference 40d
GREENHOUSE (Enewetak) 4/8/51-5/25/51	Dupont #553 film pack (15)	502, 606 (15)	100mR-10R, (502) 10R-300R (606) (15)	FBs issued by TU 3.1.5 of TG 3.1, (Rad-Safety Unit) (15)	Rad-Safety Bldg., Parry Island (15) Stored at Los Alamos (50b); Now located at REECo (17)	Kelley-Koett pocket dosimeters (15)	See Reference 50a
BUSTER-JANGLE (NTS) 10/22/51-11/29/51	Dupont #553 film pack (15)	502, 606 (15)	10 mR-10 R (502) 10 R-300 R (606) (15)	FBs issued by Photodosimetric Section, of Los Alamos Health Div., NTS. Controlled by Rad-Safe Unit	Processed by Photodosimetry Unit at CP-2, NTS. FBs now located at REECo for JANGLE (17)	Kelley-Koett pocket dosimeters (15)	FBs were calibrated using a Cobalt Source at NTS (15)
TUMBLER-SNAPPER (NTS) 4/1/52-6/5/52	Dupont #558 (71)	508, 1290 (80c)	508: 15 mR-6 R 1290: 5 R-750 R (80c)	FBs issued & controlled by Rad-Safe Unit NTS (15)	FBs processed by Rad-Safe Unit CP-2 (15)		
TYY (Enewetak) 11/1/51-11/16/52	Dupont #558, 553 (80c)	508,1290 (80c)	508: 15mR-6R 1290: 5R-750R (80c)	Issued & controlled by Rad-Safe TU of TG 132.1 of JTF 132 (15)	Processed at Rad-Safe bldg. Parry Island (80c) Now located at REECo (17)	Dupont 553 1 piece 502,(30 mR-15R);510, (5-50R);606 (10-300R) (80c)	Used Ansco & Weston Densitometers (80)
UPSHOT-KNOTHOLE (NTS) 3/17/53-6/4/53	Dupont #559 film pack (92d)	Dupont film 502 (sensitive) 606 (less sensitive) (92d)	DR: FBs contained 2 pieces of film. One, accurate to 5R, other, accurate above 25R (91c)	Rad-Safety Unit, CP-2; NTS issued & controlled	Copies of records sent to OBM and Surgeon AFSWP. (90b); FBs now located at REECo (17)	T18 Survey meters (DR) (91c)	FB's read on a Los Alamos Densitometer FD-1 (15)
CASTLE (Bikini, Enewetak) 3/1/54-5/14/54	Dupont #559 film pack (100b)	502 & 606 (100b)	502: accurate to 3 R & measurable up to 10 R. 606: 10 R-300 R (100b)	Issued by Rad-Safe Unit of Scientific Task Unit 7.1.6, on Parry Is. (15)	Lab Group of TU7,TG 7.1 processed (102b) Then sent to Chief, AFSWP (100d)		FB's read on a Los Alamos Densitometer FD-1 (15)FBs now located at REECo (17)
TEAPOT (NTS) 2/18/55-5/15/55	Dupont #559 film packet (111b)	Types: 502, 606 (111b)	502: 20 mR-10,000 mR;606: 10-300 R (111c);Accuracy: In low exposure region dosage det. is accurate ± 12% (111a)	Rad-Safe Dosimetry & Records Section, CP-2 (111c)	Processed by the Rad-Safe Dosimetry & Records Section; Sent to Chief AFSWP & Manager, Las Vegas Field Office (111c&d)	beta-dosage wrist-badge (111d)	FBs calibrated at NTS and read on a Los Alamos Densitometer FD-1 (15)
WIGWAM (Pacific) 5/14/55	Dupont #559 (120b); Dupont film packet types 552,558 (121a)	#559: Emulsion 502 & 606 (120b)	502: 100 mR-10 R 606: 10-600 R Threshold: 100 R; Accuracy: ± 40 R (120b)	Rad-Safe, Proj. 0.17 issued & collected daily FBs (120c)	FBs processed aboard CVL-49 (120d)	A 2-badge system was used: daily & operational (120b)	FB's read on Los Alamos Densitometer FD-1 (15)

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FILM BADGE AND OTHER PERSONNEL DOSIMETRIC DEVICE INFORMATION

(Continued)

OPERATION	MANU. & MODEL	COMPONENTS	SENSITIVITY, ACCURACY RANGE, CAPABILITIES	WHO ISSUED & CONTROLLED	WHERE PROCESSED/ NOW-LOCATED	PERSONNEL DOSIMETRIC DEVICES	REMARKS
HARDTACK II (NTS) 9/19/58-10/30/58	Dupont #559 film pack (170c)	502: (sensitive) 834: (insensitive) (170c)	502:20 mR-10 R 5 R-300 R (834) (15)	REECo Rad-Safe Div. issued and controlled FBs (170d)	REECo Rad-Safe Div. processed FBs; now located there (170d)		FBs read on an Eberline Model FD-11 Densitometer (170c)
DOMINIC I (Christmas, Johnston Is; and Eastern Pacific) 4/25/62-11/4/62	Dupont #556 film pack (192)	508, 834 dipped in ceresin wax (192)	508: .003R-6R sensitivity Range: 508:0-10R; 834-0-1000R (192)	Issued by TGJ-3 Rad-Safe-Branch JTF 8 and Controlled by REECo (192)	Processed on Christmas Island then Hawaii; transferred to REECO in 1962 (192)		Films read with Eberline FD-3 densitometer; 30,000 ind. records produced (192)
DOMINIC II (NTS) 7/7/62-7/17/62	Dupont #559 film packet (15)	502, 834 (15)	20 mR-10 R (502) 5 R-300 R (834) (15)		REECo Rad-Safe issued, controlled processed. Now at REECo (16)		Personnel FBs were exchanged for personnel entering Radex areas and those at Indian Springs (210a)
PLOWSHARE Project (NTS) (Carlsbad, NM) 7/6/62 Sedan 12/10/61 Gnome	#559 film packet (15)	502, 834 (Gnome) (15)	20 mR-10 R (502) 5 R-300 R (834) (15)	Issued & controlled by REECo Rad-Safe (15)	Processed at facility at NTS (Gnome) FB s at REECo Rad-Safe (15) (see Ref. 211c)	One experimental FB was given to each flight member aboard 5 cloud sampling aircraft (210c)	Acute exposure during underground recovery operation was 1.585 R (gamma FB) (211f)
REDWING (Bikini, Enewetak) 5/5/56-7/22/56	Dupont #559 film pack (18)	502, 606 (18)	502: approx. 100 mR-10 R, 606: approx. 10 R-300 R (18)	Issued: TG 7.3 Commander; TG 7.1 maintained records. (131a,132b)	Processing done manually on Enewetak, Parry Island, Bikini (130b)	Bendix 611 Dosimeter was used for dose control only (130b)	Los Alamos Densitometer FD-1 (15)
PLUMBBOB (NTS) 4/27/57-10/7/57	AEC: Dupont #559 (See ref. (141f)	502 & 606 (141f)	502: approx. 20 mR-10R, 606: approx. 10 R-300 R (15); Also see Reference 144	REECo Rad-Safe (15)	All FBs processed and stored at REECo (15)	Neutron badges worn by AFSWC aircraft crews following Shot John. (145a)	DR used Eberline FD-3 Densitometers (144) (also see Reference 146b)
HARDTACK I (Bikini, Enewetak, Johnston Is.) 4/28/58-8/18/58	Dupont #559 film pack (155a)	502 (low range) & 834 (high range) (155a)	20 mR-10 R (502) 5 R-300 R (834) (15)	Rad-Safe Unit (TU 7.1.6 of TG 7.1); H&N had own Rad-Safe Unit during non-operational times (154)	Processed on Bikini (Nan) & Enewetak (Elmer) Rad-Safe (155a) Now located at REECo (15)		834 film introduced (15)
ARGUS (South Atlantic) 8/27/58-9/6/58	Badges were distributed only to selected personnel - included pilots of observation aircraft and shipboard personnel handling nuclear warheads (160)			Lexington Signal Depot (160)	Lexington Signal Depot (160)		264 film packets issued; 21 packets exposed. Highest individual exposure was 0.01 rem (160)

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SECTION 2

OPERATION SUMMARIES

INDEX

Page	Operation	Page	Operation
2-1	TRINITY	2-12	WIGWAM
2-2	CROSSROADS	2-13	REDWING
2-3	SANDSTONE	2-14	PLUMBBOB
2-4	RANGER	2-15	HARDTACK I
2-5	GREENHOUSE	2-16	ARGUS
2-6	BUSTER-JANGLE	2-17	HARDTACK II
2-7	TUMBLER-SNAPPER	2-18	DOMINIC I
2-8	IVY	2-19	DOMINIC II
2-9	UPSHOT-KNOTHOLE	2-20	PLOWSHARE (Gnome)
2-10	CASTLE	2-21	PLOWSHARE (Sedan)
2-11	TEAPOT		

DRAFT

OPERATION: TRINITY

Test Site: New Mexico

Inclusive Dates: July 16, 1945

Number of Atmospheric Tests: 1
Number of Underground Tests: 0
Number of Safety Tests: 0

Number of Army participants: 100
Number of Navy participants: 100
Number of Air Force participants: 43
Number of Marine participants: 0
Number of DOD civilian participants: 0
Total : 243

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency : 0.1 R per day; 0.5 R per week (NCRP) (1a)
0.2 R per day, 1.0 R per week (ICRP) (1d)

Operational:

Whole Body Gamma: 5 R for one exposure (13a)

Gamma & Neutron:

Alpha:

Other:

Exceptions:

Emergency:

Special Groups: N/A

REMARKS:

a/ Evacuate within 30 minutes if gamma reading outside shelter reaches 0.1 R/h. (13b)
b/ Put on gas masks and evacuate if alpha reading reaches 5 c/m (13b)

DOSIMETRY

Film Badge:

Type: Eastman Type K
Dupont Special 552 X-ray films (1946). (14)

Eastman Type X-ray film 6462
Dupont Type D-2 X-ray film (1947). (14)

Components:

Range: low = 100mR - 10 R
high = 10 R - 300 R (15)

Accuracy: ± 10%

Issuing Activity: Issued by Health Group (Manhattan Engineer District) Los Alamos Scientific Laboratory. (15)
Films were developed in Dupont X-ray developer for three minutes at 68°F with agitation and read on a Photovolt Densitometer (1947).* (14)

Where Processed:

Films: Q-Building, Los Alamos Scientific Lab. (16)

Records:

Where Stored:

Films: Record Repository, Los Alamos, New Mexico. (17)

Records:

Number of Badges:

Issued:

Processed:

Number of Individuals:

REMARKS: * (1946) Films were developed in Dupont X-ray at 68°F for three minutes & measured on a Marshall densitometer. (14)
Special badges: (1) 100 catastrophe film badges (13c)
(2) 200 film badges for towns
Observers did not wear film badges but wore protective goggles & avoided direct viewing of shot. (13b)

DECONTAMINATION

Criteria:

Personnel:

Equipment:

Procedures:

Personnel:

Equipment: Geiger counters. (15)
Protective clothing was issued: coveralls, surgical caps, booties and gloves. (13c)

Decon. Station locations:

Personnel:

Equipment:

Volume Handled:

Personnel:

Equipment:

REMARKS:

DRAFT

OPERATION: CROSSROADS

Test Site: Bikini

Inclusive Dates: July 1, 1946 & July 25, 1946

Number of Atmospheric Tests: 1 (airdrop)
Number of Underground Tests: 1 (underwater)
Number of Safety Tests: 0

Number of Army participants: 1,500
Number of Navy participants: 37,000
Number of Air Force participants: 755
Number of Marine participants: 929
Number of DoD civilian participants: 0
Total : 40,184

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency : 0.1 R per day, 0.5 R per week (NCRP) (1a)
0.2 R per day; 1.0 R per week (ICRP) (1d)

Operational:

Whole Body Gamma. 0 1 R (gamma) daily limit * (24e)

Gamma & Neutron:

Alpha:

Other:

Exceptions:

Emergency:

Special Groups: N/A

REMARKS: * An individual should not exceed an exposure of 50 or 60 R in two weeks. If an individual receives 10 R in one day or 60 R in two weeks, he will be withdrawn from the operation. (24e)

Cloud trackers adhered to the same standard as other units at CROSSROADS. (24a)

"Cloud trackers"

DOSIMETRY

Film Badge:

Type: Kodak Type K double coat film * (27a)

Components: Kodak Type K was packed in special dental film holders with lead cross shields and tropical weather-proof envelopes.

Range: Type K has sensitivity of 0-2 R. (27a)

Accuracy: 5301 with 0.022 Pb shield = 12% (Probable error of a single reading)

(26) 5301 without shield = 6%
5302 with shield = 8% ; 5302 without shield = 6%

Issuing Activity: Use of film badges assigned to Photometric Unit, Radiological Safety Section, on the HAVEN. (24b)

Where Processed:

Films: Processed at Radiological Safety Technical Service Unit. (24c)

Records:

Where Stored:

Films: Now at REECo (17)

Records: Now at REECo (17)

Number of Badges:

Issued: Rad-Safety Section furnished and distributed to 300 selected locations packets containing a casualty film badge & a personnel film badge.(21a)

Processed:

Number of Individuals:

REMARKS: Special badges: catastrophe badges (15)
* (Kodak Industrial X-ray films 5301 & 5302 were also mentioned) (26)
"Personnel badges will be carried on the person of all monitors & their assistants. These will serve to detect total exposure. These badges, worn for one day only. ." (24b)

DECONTAMINATION

Criteria:

Personnel: 0.1 rep (beta + gamma) per 24 hours;(or) Radiac readings greater than 7mR/h. (20a)

Equipment: Activity on most ships reduced to tolerance levels (0.1 R per day or less gamma) (25a)

Procedures: Exposures measured using Geiger counter readings(25b)

Personnel: Study of decon. procedures initiated. (27a)
Special shower & change facilities set aside on the target APA's. Special laundry facilities separate. (25b)

Equipment: All personnel wore special protective clothing during decon. Spraying & washing from salvage vessels, followed by short clean-up & monitoring of upper decks, with thorough spraying & washing alongside as necessary. (25c)

Decon. Station locations:

Personnel: U.S.S. HAVEN contained headquarters for Rad-Safety Section. (24d)

Equipment: U.S.S. HAVEN (24d)

Volume Handled:

Personnel:

Equipment:

REMARKS: Radiological problems aggravated by a shortage of monitors & instruments. (23a)
All personnel going to the Pacific who may be exposed to radiation received a physical exam. (15)

OPERATION: SANDSTONE

Test Site: Enewetak

Inclusive Dates: April 15, 1948 - May 15, 1948

Number of Atmospheric Tests: 3 (tower)

Number of Underground Tests: 0

Number of Safety Tests: 0

Number of Army participants: 500
Number of Navy participants: 5,600
Number of Air Force participants: 1,112
Number of Marine participants: 347
Number of DoD civilian participants: 100
Total : 7,659

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency : (NCRP) 0.1 R per day; 0.5 R per week ; (1a)
(ICRP) 0.2 R per day; 1.0 R per week. (1d)

Operational.

Whole Body Gamma: 0.1 R per 24 hours not to exceed 3 R. (32a & 33a)

Gamma & Neutron: (IG 7.6 & IG 7.1)

Alpha:

Other:

Exceptions:

Emergency:

Special Groups: Under unusual circumstances, the Scientific Director, with the concurrence of the Rad-Safe Officer, may authorize exposure in excess of daily permissible dose. Accumulated excess shall in no case exceed 3 R. (31a) & (33a)

REMARKS: Higher exposures were permitted only if approved by Cdr. with the provision that such persons be prohibited from further exposure for 30 days. (33b)

Cloud samplers were drone B-17's. (35)

DOSIMETRY

Film Badge:

Type: Eastman Kodak for Project 7.1 to 7.17. (34a)

Components: Type A & K film with a lead cross shield(32b)

Range: 100mR - 10 R = range of Type A & K film. (15)
For project 7.1, the FBs were listed as "total range". (34a)

Accuracy:

Issuing Activity: FB's issued by Task Unit 7.1.6, Rad-Safe Unit for Scientific Task Group. TU 7.1.6 also controlled. (15)
AFSWP to procure film badges for all gamma measurements. (32c)

Where Processed:

Films: The films were airshipped to the U.S. for developing & reading at the National Bureau of Standards. Film Badges now at RLECo (17) (34a)

Records: Copies of film badge & dosimeter results were sent to the Test Director & the Scientific Director. (33a)

Where Stored:

Films:
JIEF films, 10-15 March, were forwarded to the Medical Records Unit for permanent filing. (32d)

Records:

Number of Badges:

Issued:

Processed: 4000 'total range' films (Project 7.1) were received. (34a)

REMARKS: Special badges: catastrophe FBs issued to TU 7.1.6. (15)
Dark or questionable badges were processed 1st.(32c)
On 10/9/47, 10,000 personnel film badges & 1000 casualty film badges were requisitioned. (30a)
It was requested that Cine positive 5202 be used in place of Kodalite 6567 in casualty badges of high range. (32b)

DECONTAMINATION

Criteria:

Personnel: Any part of body greater than 0.1 mR/h above background (beta + gamma). (30a)

Equipment:

Procedures: Most decon. should be conducted at a location where the background is less than 0.1 mR/h gamma

Personnel: Wash & change of clothing (15a)
Valuables put in clean container & stored on CVE-115.

Equipment: Washing & decon. of drones accomplished by air monitors. (32f)
G-M counters & Victoreen 263A ion chambers. National Technical Labs MX-6. (32f)

Decon. Station Locations:

Personnel: Personnel decon. on ZERO Island. (33a)
BAIROKO hangar deck. (32q)
Decon. facilities on CVE-115. (33a)

Equipment: BAIROKO hangar deck. (32q)

Volume Handled:

Personnel:

Equipment:

REMARKS: Monitors were established on Ujelang & Enewetak(Pa
to effect rad-safety & coordinate film badge distri
ution. (32b)
Joint Rad-Safety group established to support all personnel. e.g. CIG 7.6 will organize & supervise decon. of personnel as necessary. (33a)
Dosage on packaged contaminated materials was to be less than 0.1 R/24 hours. Scientific Director to prescribe rules for contaminated articles. (33a)
All personnel going to the Pacific who may be exposed to radiation received a physical exam. (58)

OPERATION: RANGER

Test Site: Nevada

Inclusive Dates: January 27, 1951 - February 6, 1951

Number of Atmospheric Tests: 5
Number of Underground Tests: 0
Number of Safety Tests: 0

Number of Army participants: 500
Number of Navy participants: 100
Number of Air Force participants: 219
Number of Marine participants: 10
Number of DoD civilian participants: 200
Total: 1,029

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency : (NCRP) 0.3 R per week. (1b) (2) (4)
(ICRP) 0.3 R per week. (1c) (2) (10)

Operational:

Whole Body Gamma: 3 R for the operation. (40a)
(2 R for individuals planning to participate in GREENHOUSE)

Gamma & Neutron:

Alpha:

Other:

Exceptions:

Emergency:

Special Groups:

REMARKS: Special exceptions: The public---up to 25 R without danger ---"...if up to 50 R, thought will be given to requesting people to stay indoors, etc. If above 50 R, possible evacuation." (40a)

Basic permissible level for workers within AFC was established at 0.3 R per week. (40a)

Manned sampler aircraft first used at Ranger. (15)

manned sampler aircraft

DOSIMETRY

Film Badge:

Type: Dupont 553 - Los Alamos Type (15)

Components: 502 & 606, a portion lead-shielded. (15)

Range: 502 = approx. 100mR - 10 R
606 = approx. 10 R - 300 R (15)

Accuracy:

Issuing Activity: Issued by H-1 Health Division, Los Alamos Scientific Lab. (15)

Where Processed:

Films: Los Alamos (40c)

Records:

Where Stored:

Films: Record Repository, LASL, Los Alamos, NM. (17)

Records:

Number of Badges:

Issued:

Processed:

Number of Individuals: Dosage records kept on a total of 182 persons who entered the hot area at one time or another. (40d)

REMARKS: The contractor personnel received the highest exposures. (40d)
273 2-R Model dosimeters used.
80 10-R Model dosimeters used. (40b)

DECONTAMINATION

Criteria:

Personnel:

Equipment:

Procedures: Used G-M Type 2610A survey instruments for dose rates less than 20mR. Used high & low range Juno-type ion chambers for dose rates greater than 20mR. (40e)

Personnel: Cold showers were available. (41a)
Wash & change of clothing. (41a)

Equipment: TIB Ion Chamber, Victoreen 263A (beta + gamma), and National Tech. Labs' MX-5 used for decon. from RANGER on. (15)
Respirators required when background greater than 2 mR/h. (40e)

Decon. Station Locations:

Personnel:

Equipment:

Volume Handled:

Personnel:

Equipment:

REMARKS: Construction workers & supervisors given a routine physical exam & blood count if they entered contam areas. (41a)
Plastic hoods with respirators issued to bulldozer operators. On one occasion chem-ox masks were issued to the initial survey party. (40e)
Recommended ample shower facilities and hot undressing space.. Dark room space recommended for immediate on-the-spot film badge results. (40d)

OPERATION: GREENHOUSE

Test Site: Enewetak

Inclusive Dates: April 8, 1951 - May 25, 1951

Number of Atmospheric Tests: 4
Number of Underground Tests: 0
Number of Safety Tests: 0

Number of Army participants: 500
Number of Navy participants: 3,082
Number of Air Force participants: 949
Number of Marine participants: 132
Number of DoD civilian participants: 100
Total : 4,763

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency : (NCRP) 0.3 R per week. (1b) (2) (4)
(ICRP) 0.3 R per week. (1e) (2) (10)

Operational:

Whole Body Gamma: 0.7 R per week. (53a) (56) 1.9 R/13 weeks. (15)

Gamma & Neutron:

Alpha:

Other.

Exceptions:

Emergency:

Special Groups: Under unusual circumstances, CJTF-3 may authorize a total exposure of up to 3 roentgens in specific cases involving limited numbers of personnel with the provision that such persons will be prohibited from further exposure to more than 0.1 roentgen per day during the balance of the operation. (53a)

REMARKS:

Permissible levels of radioactivity were exceeded in only limited areas of some GREENHOUSE test islands: areas surrounding tower sites for Operation SANDSTONE tests. (50a)

USS CABILDO Rad-Safe Officer mistakenly thought that if personnel received over 0.1 R in a given day that they could not participate in succeeding days. (52a)

Drone B-17's were used as cloud samplers. (54)

DOSIMETRY

Film Badge:

Type: Dupont 553 (15)

Components: 502
606 (film badge with lead shield) (15)

Range: 0.1 - 250 R (63b)
502 = 100mR - 10 R
606 = 10 R - 300 R (15)

Accuracy:

Issuing Activity: Film badges issued by Task Unit 3.1.5 of Task Group 3.1, the Rad-Safety Unit. (15)

Where Processed:

Films: Processed at Rad-Safety Building, Parry Island. (15) All processing & recording accomplished at the lab of TG 3.1. (52b)

Records:

Where Stored:

Films: Los Alamos (50b) Later shipped to REECo, Las Vegas, Nevada. (17)

Records: Copies of exposure records were furnished to TG commanders. (52b)

Number of Badges:

Issued: 15,000 photographic film badges were requested & received on time. (50c)

Processed:

Number of Individuals:

REMARKS Not all personnel were badged. Only personnel participating in recovery operations on shot islands were badged. (15)
FBs issued to all representative personnel in all Task Units of TG 3.3. FBs worn by all crew members of the boat pools (TU 3.3 3). (52b)

DECONTAMINATION

Criteria:

Personnel: 10 mR/h above background on clothing or skin. (51a)

Equipment:

Procedures: Used Fl tronic, Model PR 3 to monitor. (50d)
Victoreen Model 263A (51b) Pee Wee (alpha) instrument & MX-5 used through rest of operations. TIB (gamma only) also used. (15)

Personnel: Wash & change of clothing. (51c)
(90°F water & hard-water toilet soap) (51c)

Equipment: High pressure hoses. (52c)
"repeated scrubbing down on wooden levels with sand & use of holystones." (52c)
Fresh & salt water sprayed under pressure. (53b)
Contaminated aircraft were washed with water under pressure, scrubbed, & allowed to decay.* (52e)

Decon. Station Locations:

Personnel: TG 3.1 changehouse on Parry Island (51b)
TG 3.4 changehouse on Enewetak Island (51b)

Equipment: A temporary decon. facility was set up on Aomon after Shot George, & on USS CURTIS after Shot EASY. (15)
Decon. facility for aircraft & air personnel set up on Parry Island, Enewetak atoll. (15)

Volume Handled:

Personnel:

Equipment:

REMARKS: Safe working levels = 12.5 mR/h & less. (52c)

To prevent unnecessary exposure, all personnel not required topside on the ships were directed to remain below & all doors & hatches to windward were closed. Ventilation intakes were secured. (52c)

* On boats, wooden surfaces were required to be scraped hosed, scrubbed, or if necessary given coat of shellac varnish, or paint. (53c)
Usually by shot 13, decon. facilities were in operation on the shot island or its vicinity. (57)

OPERATION: BUSTER-JANGLE

Test Site: Nevada

Inclusive Dates: October 22, 1951 - November 29, 1951

Number of Atmospheric Tests: 7
Number of Underground Tests: 0
Number of Safety Tests: 0

Number of Army participants:	5,500
Number of Navy participants:	350
Number of Air Force participants:	369
Number of Marine participants:	72
Number of DoD civilian participants:	200
Total :	6,491

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency : (NCRP) 0.3 R per week. (1b) (2) (4)
(ICRP) 0.3 R per week. (1e) (2) (10)

Operational:

Whole Body Gamma: 3 R for three-month period. (60a)

Gamma & Neutron:

Alpha:

Other:

Exceptions:

Emergency:

Special Groups: Cloud Samplers = 3.9 R for 13-week series. (60a)
Desert Rock personnel = 1 R total (EDR I) (63a)
3 R (limits established by AEC) (EDR I & II). (64a)
All observers were issued film badges. (64b)

REMARKS: The Division of Biology & Medicine agreed to an unpublicized exposure of 3.9 R. (60a) Tacit understanding for 3.9 R. (15) Following approval by the Test Director, under unusual circumstances, the 3 R exposure limit may be exceeded. (61a)

Two B-29 samplers took off from Nellis AFB. One B-29 took off from Kirtland AFB. (62b)

Cloud samplers

DOSIMETRY

Film Badge:

Type: 553 (EDR 1) (63b)

Components: 502
606 (15)

Range: 502 = 100mR - 10 R
606 = 10 R - 300 R (15)

Accuracy:

Issuing Activity: Issued by Photodosimetry Section of Los Alamos Health Division at NTS. (15)
(The Rad-Safe Unit issued & processed film badges & dosimeters.) (62a)

Where Processed:
Films: Photodosimetry Unit at CP-2, NTS. (15)

Records:

Where Stored:

Films: Film badges turned in to film badge lab at AEC control point. (64c)

Records: REECo, Las Vegas, Nevada. (17)

Number of Badges:

Issued: 11,099 (60a)

Processed: 10,133 (60a)

Number of Individuals: (badged) 1749 (1523 at NTS & 226 issued for Air Force operations (60a)

REMARKS: Films processed in a mobile photo-laboratory truck located at the NTS. The films were processed for 5 minutes at 68°F using Kodak liquid dental X-ray developer. (63b)
Special badges: EDR II & III used high intensity film badges. (64d)

DECONTAMINATION

Criteria:

Personnel: Over 7 mR/h within 10 hours of detonation. (61b)
(all items reduced to a maximum limit of 2 mR/h)
Desert Rock II & III: Stop at 2 mR/h. (64f)

Equipment: Over 7 mR/h within 10 hours of detonation. (61c)
(all items reduced to a maximum limit of 2 mR/h)

Procedures: Personnel: Decontamination of personnel done by the Rad-Safe unit at the time of check out. (62a)
Washing, bathing, & a change of clothing---showers (63c)

Equipment: Dry brushing; dusting with wet rags; and washing. (64e)

Decon. Station locations:

Personnel: Decon. Center at CP-2. (15)
Yucca Pass* (64e)

Equipment:

Volume Handled:

Personnel:

Equipment:

REMARKS: * Showers set up at Yucca Pass for observer personnel, Desert Rock II & III, on Shot day. (15)

OPERATION: TUMBLER-SNAPPER

Test Site Nevada

Inclusive Dates: April 1, 1952 - June 5, 1952

Number of Atmospheric Tests: 8

Number of Underground Tests: 0

Number of Safety Tests: 0

Number of Army participants: 5,100
Number of Navy participants: 485
Number of Air Force participants: 949
Number of Marine participants: 1,900
Number of DoD civilian participants: 700
Total : 9,134

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency : (NCRP) 0.3 R per week. (1b) (2) (4)
(ICRP) 0.3 R per week. (1e) (2) (10)

Operational:

Whole Body Gamma: 3 R for operation unless reduced by Test Director because of a previous exposure. (70a) & (71a)
3.9 R maximum dose established for the operation (Tacit understanding for 3.9 R) (15) (71b)

Gamma & Neutron:

Alpha:

Other:

Exceptions:

Emergency:

Special Groups: Desert Rock personnel:
3 R for series, although DR IV recommends that the exposure level be raised materially above 3 R.(72a)

REMARKS: No aircrew member was to receive a dose greater than 10 mR/h (gamma intensity at one foot, less than 1 R/h). (70a)

1.1% of test participants exceeded 1.9 R. (71)

aircrew member

DOSIMETRY

Film Badge:

Type: Dupont #558 (71)

Components: 508
1290 (80c)

Range: 508 = 15mR - 6 R
1290 = 5 R - 750 R (80c)

Accuracy:

Issuing Activity: Issued by Rad-Safe Unit, NTS. (15)

Where Processed:

Films: Processed at CP-2. (15)

Records:

Where Stored:

Films:

Records:

Number of Badges:

Issued:

Processed:

Number of Individuals: 2243 participated.
26 exceeded dosages of 4 R. (71)

REMARKS: Special Instruments:
AN/PDR T1B Ion Chamber &
MX-5 G-M tubes. (71c)
Film badges for EDR IV were processed by Test Command AFSWP at the AFSWP processing unit. (72a)

DECONTAMINATION

Criteria:

Personnel: All contaminated persons or vehicles with a radiation intensity greater than 10 mR/h were sent to the Decon. station at Yucca Pass. (72b)
Personnel at CDR deconned to maximum limit of 1.5 mR clothing & 0 mR skin. (72b)

Equipment: 2mR/h for all vehicles & recovered equipment.(71d
Vehicles deconned to 'background count'. (71d)

Procedures:

Personnel: Shower & clothing exchange. (71)
Brushing, dust off clothing & bathing with soap & water. (72a)

Equipment: Vacuum cleaning, brushing, washing with clean water, hot water & detergent, or high pressure steam & detergent. (71)
MX-5 4-6 inches from surface. (71d)
T1B ion chamber. Pee Wees for alpha contam. (1

Decon. Station Locations: Vehicle decon. area & building at CP area, NTS. (71)

Personnel: Decontamination station at Yucca Pass. (72b)
12 showers available. (71d)

Equipment: First laundry for decon. at NTS. (72a)

Volume Handled:

Personnel:

Equipment:

REMARKS: Desert Rock IV recommended that Beckman Model MX-5 counters be used for monitoring personnel & vehicles due to the inadequacy of the AN/PDR-27A. (72c)

OPERATION: IVY

Test Site: Enewetak

Inclusive Dates: November 1, 1952 - November 16, 1952

Number of Atmospheric Tests: 2 (surface & airdrop)
Number of Underground Tests: 0
Number of Safety Tests: 0

Number of Army participants: 1,000
Number of Navy participants: 5,500
Number of Air Force participants: 849
Number of Marine participants: 183
Number of DoD civilian participants:
Total : 7,632

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency : (NCRP) 0.3 R per week. (1b) (2) (4)
(ICRP) 0.3 R per week. (1e) (2) (10)

Operational:

Whole Body Gamma: 3.0R (gamma)*for a 3-month operational period.. (B2a)
3.9 R (gamma) = "total permissible dose." (B0a)

Gamma & Neutron:

Alpha:

Other:

Exceptions:

Emergency:

Special Groups: Special exceptions for crews of sampling aircraft:
1/ total dosage of 20R for entire Operation IVY.
2/ not asked to receive similar dose of this extent for at least two years.
3/ Records kept so that restriction can be maintained. (B1a)

REMARKS:
* (Upper limit of radioactive contamination shall be an intensity corresponding to an integrated dose of 3R (beta + gamma)) (B2b)

An initial aerial-survey helicopter became contaminated from radioactive "rain-out". "Rain-out" left a residual contamination on the aircraft of 2 R/h at H + 1 hr. (B0b)

letter sent by CJTF to DBM proposed a special, safe emergency exposure be permitted to allow 20 R integrated dosage (gamma) under certain specified conditions. AEC finally allowed an upper limit of 25 R. (B1a)

special exceptions for crews of sampling aircraft

DOSIMETRY

Film Badge: Dupont packet 558
Type: Dupont 553* (B0c)

Components: One piece 508 emulsion & one piece 1290 with a 20 mil.-thick lead strip, ½ in. wide covering half the length of the packet on both sides; Polyethelene envelope. (B0c)

Range: 508 emulsion = 15 mR - 6 R
1290 = 5 R to 750 R (B0c)

Accuracy:

Issuing Activity: Issued & controlled by Rad-Safe Task Unit of Task Group 132.1 of JTF 132. (15)
Films procured from photo lab trailer on hanger deck. (B0d)

Where Processed: Processed in photodosimetry trailer maintained by photodosimetry & records section.(B0e)

Films: Processed in trailer aboard USS RENDOVA or processed in Rad- Safe building on Parry Island. (B0c)

Records:

Where Stored:

Films: REECo, Las Vegas, Nevada (17)

Records:

Number of Badges:

Issued:

Processed: 5000 "utilized and processed during Operation IVY." (B0f)

Number of Individuals:

REMARKS: Used Ansco & Weston densitometer. (B0)
*Dupont 553 consisted of one piece of 502 (range 30 mR - 15 R), one piece 510 (range 5R to 50 R), and one piece 606 (range 10 R - 300 R). (B0c)
One type in brass container w/ window; one covered w/ 20 mils. cadmium; one in ABS holder.

DECONTAMINATION

Criteria:

Personnel: Skin = 1 mR/h
Underclothing & body contact equipment = 2 mR/h
Outer clothing & body proximity equip. = 7 mR/h * (B0g)

Equipment: Vehicles interior = 2 mR/h
" exterior = 7 mR/h
distant exterior surfaces = 20 mR/h (B0g)

Procedures:

Personnel: Shower; hand brush & soap; chemical solutions & complexing agents; laundry; change of clothes. (B0i)

Equipment: Brushes; high pressure water hoses; contaminated storage area; industrial-type vacuum cleaners; protective clothing & respirator; lye, boiler compound, starch. (B0i)
Side-window G-M counters; probe 1-6 inches from surface; walls < 20mg/cm²; β shield open. (B0h)

Decon. Station Locations:

Personnel: Personnel-decon. station on south end of Rad-Safe building on Enewetak (Parry). (B0j)
Aircraft & personnel on Kwajalein. (15)

Equipment: Equipment decon. area just above boat landing.(B0k) Holmes & Narver personnel decomned heavy equipment. (B0 1)

Volume Handled:

Personnel:

Equipment:

REMARKS: * "Final clearance shall imply that the area or object concerned has been monitored and found to have no point exceeding 0.015 R/ 24 hr. (beta + gamma)." (B2c)

Chemicals and complexing agents were not needed. (B0j)

Contaminated clothing & equipment was allowed to decay to within permissible limits. (B0 1)

OPERATION: UPSHOT-KNOTHOLE

Test Site: Nevada

Inclusive Dates: March 17, 1953 - June 4, 1953

Number of Atmospheric Tests: 11

Number of Underground Tests: 0

Number of Safety Tests: 0

Number of Army participants: 17,400
Number of Navy participants: 600
Number of Air Force participants: 902
Number of Marine participants: 2,800
Number of DoD civilian participants: 1,000
Total : 18,702

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency : (NCRP) 0.3 R per week. (1b) (2) (4)
(ICRP) 0.3 R per week. (1e) (2) (10)

Operational:

Whole Body Gamma: 3.9 R (unless reduced by Test Director). * (90a)

Gamma & Neutron:

Alpha:

Other: Aircraft crew members were limited to 20 mR/h when transporting samples of radioactive material in aircraft. (92a)

Exceptions:

Emergency:

Special Groups: Cloud trackers approach to 5 mR/h line. (92c)
Desert Rock personnel = 6 R for entire series. (91a)

REMARKS. * No limitations were set on the rate of accumulation of total dose. (90a)

Congressional visitors, AEC & DoD observers, & cleared laboratory officials witnessed the tests. Test Director provided the tours. (93a)

cloud trackers
~> 5 mR/hr

DOSIMETRY

Film Badge:

Type: Dupont # 559 (92d)

Components: Dupont 502
Dupont 606 (92d)
(Films covered by a lead shield on each side 0.72 mm thick & 12" wide by 1" long.) (92d)

Range: 502 = 20 mR - 10 R
606 = 10 R - 300 R (15)

Accuracy: CDR FBs contain two pieces of film. Portion covering low intensity is accurate to 5 R & portion measuring high intensity is accurate above 25 R.* (91c)

Issuing Activity: Issued & controlled by Rad-Safe Unit at CP-2, NTS. (15)

Where Processed:

Films: Rad-Safe Unit at CP-2, NTS. (15)

Records:

Where Stored:

Films: REECo, Las Vegas, Nevada (17)

Records: Copies to DBM, Surgeon AFSWP. (90b)

Number of Badges:

Issued:

Processed:

Number of Individuals:

REMARKS: FBs furnished by CDR Rad-Safe Section. (91c)

* Between 5 & 25 R, accurate readings are difficult to obtain.

Special dosimetric devices: TIB survey meters. (91c)

Los Alamos Model FD-1 densitometer used to measure films. (15)

DECONTAMINATION

Criteria:

Personnel: Advisory use only: skin = more than 1 mR/h
underclothing = more than 2 mR/h
Outer clothing = more than 7 mR/h. (92b)

Equipment: Personnel & equipment contaminated in excess of 20 mR/h above background will require decontamination. (91b)

Procedures: All readings of surface contamination were made with side-window type Geiger counters. (92b)

Personnel: Bathing & change of clothes. (92)

Equipment:

Decon. Station Locations:

Personnel: A personnel decon. station was located in the Rad-Safe building. (92c)

Equipment: Protective clothing issued. (92a)

Volume Handled:

Personnel:

Equipment:

REMARKS:

OPERATION: CASTLE

Test Site: Bikini, Enewetak

Inclusive Dates: March 1, 1954 - May 14, 1954

Number of Atmospheric Tests: 6 (surface & barge)
Number of Underground Tests: 0
Number of Safety Tests: 0

Number of Army participants: 1,000
Number of Navy participants: 7,900
Number of Air Force participants: 996
Number of Marine participants: 345
Number of DoD civilian participants: 309
Total: 10,546

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency: (NCRP) 0.3 R/week (max); 3.0/13 weeks; 15 rem/year. (2)(5)
(ICRP) 0.3 R per week. (1e) (2) (10)

Operational:
Whole Body Gamma: 3.9 R (gamma) for 13 weeks (provided no previous overexposure). * (100a)
Gamma & Neutron:
Alpha:
Other: An MPE waiver was approved by the Director, DOH, & the Surgeons General of the three Services. (101a) The maximum received under such waivers was 7.8 R. (101a)

Exceptions:

Emergency:

Special Groups: "A special MPE of 20 R (gamma only) is authorized for the operating period for crew members of air sampling aircraft." (102a)
" Cloud tracking aircraft shall execute turn-out from contaminated areas at a level of not more than 3.0 R/h." (103a)

REMARKS: * "This MPE was further augmented by 0.3 R/week for each week in excess of the thirteen weeks of the operational period." (103b)

CTG 7.1 soon realized the deteriorating situation and expressed the policy that any individual exceeding 6.0 R would be relieved of duty and returned to the U S (100a)
Several members of Project 6.4 received exposures between 6 and 12 R as result of continued activity aboard contam. drone ships...hazard anticipated and accepted by project members in view of the military importance of the information to be gathered. (100a)
Military requirements to work in contam. areas w/ contam equipment "soon led to block requests for an authorized exposure of 7.9 R per operation." "The grant of waiver of the maximum established limit early in the test series created a loss of confidence in the established limit of 3.9 R and was soon reflected in the actions of the nonmilitary task groups..." (100a
In many cases waivers were requested after overexposure

waivers ~ after overexposures

DOSIMETRY

Film Badge:
Type: Dupont 557 (100b)
Components: Dupont 502 & 606. (100b)

Range: 502 accurate to 3.0 R and measurable up to 10 R. 606 range = approx. 10 R - 300 R. (100b)

Accuracy:

Issuing Activity: Issued out of Task Unit 7.1.6 of the Rad-Safe Unit. Controlled on Parry Island. (15)

Where Processed:

Films: Processed by Laboratory Group. (100c)

Records:

Where Stored:

Films: All Film Badges were procured from and returned to the lab or TU 7, TG 7.1. (102b) Forwarded to Chief, AFSWP, & Director, DOH (AEC) etc. (100d)

Records: CTU-7 (Cdr. TU7) had responsibility for development and interpretation of film badges & the maintenance of film badge exposure records. (100e)

Number of Badges:
Issued:

Processed:

Number of Individuals:

REMARKS: Los Alamos FD-1 densitometer used. (15)
Low range film calibration was from 40 mR to 12 R and high range from 10 R to 60 R. Curve was extended to 200 R on the initial calibration. (100f)
An analysis of exposures revealed that the Air Force TG had to highest percentage of personnel exceeding 3.9 R. (100d)

DECONTAMINATION

Criteria:
Personnel: Skin = no more than 1.0 mR/h.
Underclothing & body equipment (respirators) = 2 mR/h
Outer clothing - 7 mR/h. (102c)

Equipment: 2 mR/h for the interior of aircraft, vehicles, & small boats.
7 mR/h for exterior of same.
20 mR/h for distant exterior surfaces. (100g)

Procedures: Side-window G-M counters, w/ walls not substantially in excess of 10mg/cm²; w/ β shield open. (100
Personnel: Shower & change of clothes.
Decon facilities: clean change room; contam. change room; monitor checkpoint. (100h)

Equipment: A temporary washdown system of hoses & special nozzles was connected to the main fire system & installed on all the ships of CASTLE except TAMAPONI. (101h)
Used spray from fire truck or Navy tug, vacuums, detergent, steaming, chemical solutions, removal of surface (w/ boiler compound & lye). (100h)

Decon. Station Locations: Cdr (TU 7) provided decon. facilities for personnel & equipment. (100e)

Personnel: Parry Island. (100h)

Equipment: Parry Island. (100h) Contaminated clothing laundered at Parry Island. Some contam. equipment stored & allowed to decay (100 i)

Volume Handled:
Personnel:
Equipment:
REMARKS: Rules established for shipboard activity. Decon. facility for TG 7.4 on Bikini & also at Enewetak for TG 7.3 aircraft. (105) (105)
Special plastic suits were worn during Project decontamination. (101i)
A canvas tarp was used in helicopters to facili decontamination. (101c)
Protective clothing for ship personnel included coveralls, a marine cap, rubber boots, and rubb gloves. (101c)
SHRIMP created "largest mass decon operation practic to history." Small boats at Enyu during SHRIMP & were heavily contaminated & were decon. by strong h washing & mixture of boiler compound & lye. (100h)

OPERATION: TEAPOT

Test Site: Nevada

Inclusive Dates: February 18, 1955 - May 15, 1955

Number of Atmospheric Tests: 14
Number of Underground Tests: 0
Number of Safety Tests: 4

Number of Army participants: 5,500
Number of Navy participants: 600
Number of Air Force participants: 814
Number of Marine participants: 2,300
Number of DoD civilian participants: 2,000
Total : 11,214

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency : (NCRP) 0.3 R/wk. (max); 3.0 R/13 weeks; 15 rem/year.(2) (5)
(ICRP) 0.3 R per week (1e) (2) (10)

Operational:

Whole Body Gamma: 3.9 R (111a) (113c)

Gamma & Neutron.

Alpha:

Other:

Exceptions:

Emergency:

Special Groups: Desert Rock VI : maximum total tolerance dosage=6 R at any one test with no more than 3 R prompt radiation; no more than 6 R in 6 months.(112a)(113a)

REMARKS: For volunteers, MPE was 10 R in one test of which 5 R was prompt radiation; no more than 25 R in series. (113a)

DOSIMETRY

Film Badge:

Type: Dupont Type 559 (111b)

Components: Type 502
Type 606 (111b)

Range: 502 gamma ray dosage range = 20-10,000 mR. (111c)
606 gamma ray dosage range = 10,000 - 300,000 mR.

Accuracy: In low exposure region, dosage determined is accurate ± 12 percent. (111a)

Issuing Activity: Issued & controlled by Rad-Safe Dosimetry & Records Section at CP-2. (111c)(15)

Where Processed:

Films: Rad-Safe Dosimetry & Records Section. (111c) (15)

Records.

Where Stored:

Films: Chief, AFSWP
Manager, Las Vegas Field Office (111d)
FBs now at REECo. (17)

Records: Chief, AFSWP
Manager, Las Vegas Field Office (111d)

Number of Badges:

Issued: Between 35,000 & 50,000 (111b)

Processed:

Number of Individuals: (111d)

REMARKS: Special dosimetric devices: beta dosage wrist badges. FD-1 densitometer used to measure films. (15)
Many organizations were issued badges in bulk lots & given the responsibility for individual issue & return: e.g. Indian Springs AFB, Off-Site Rad-Safe groups, & various operational training groups, tactical & strategic air command bases. (111b)

DECONTAMINATION

Criteria:

Personnel: Over 1 mR/h skin:
over 2 mR/h underclothing & internal surfaces of respirators.
Over 7 mR/h on outer clothing. (110a) & (113b)

Equipment: (Desert Rock - over 20 mR/h) (112b)
Outside = anything over 7 mR/h (gamma)
Inside = over 7 mR/h (gamma + beta).
(Desert Rock = over 20 mR/h) (110a)

Procedures: AN/PDR-39 & the Beckman MX-5. (111e)

Personnel: Shower & change of clothes. (111f)
Bathing/showering in Rad-Safe building. Swept off with brooms. (DR) Clothing & shoes provided to replace contaminated items.

Equipment: Used Kerrick Cleaner fixed steam hot water generator. Washed with steam & hot, soapy water. (if decon. was not achieved, the vehicle or equipment was placed in a "hot" park. (111f)

Decon. Station Locations:

Personnel: 1000 yards north of CP at Yucca Pass. (112b)

Equipment:

Volume Handled:

Personnel:

Equipment:

REMARKS:

volunteers ~
10 R in one test
25 R in series

RATION: WIGWAM

Test Site: Pacific

Inclusive Dates: May 14, 1955

ber of Atmospheric Tests: 0
ber of Underground Tests: 1 (underwater)
ber of Safety Tests: 0

Number of Army participants: 10
Number of Navy participants: 6,500
Number of Air Force participants: 104
Number of Marine participants: 146
Number of DoD civilian participants: 40
Total: 6,800

RADIOLOGICAL SAFETY ACTIVITIES

POSURE CRITERIA

ency: (NCRP) 0.3 R/week (max); 3.0 R/13 weeks; 15 rem/year.(2) (5)
(ICRP) 0.3 R per week (1e) (2) (10)

erational:
Whole Body Gamma: 3.9 R for operation. (120a)
MPC = 0.3R/week for ship, boat, & aircraft personnel. (123)

Gamma & Neutron:
Alpha:
Other: Beta (whole body) = 10 rep. (120a)
Beta (hands & feet) = 20 rep.
Beta (hands) = not to exceed 30.0 rep. (123)

xceptions:
Emergency:

Special Groups. 20 R (gamma only) per operation for personnel "engaged in collection and handling of critical water samples necessary for yield determination." (123)
Hands & feet = 20 R (120a)

REMARKS: MPE's subject to revision by waiver from the Task Group Commander in individually designated cases when circumstances indicate a need and justification therefor. (123)

DOSIMETRY

Film Badge:
Type: Dupont # 559 (120b)
Dupont film packet types 552 & 558. (121a)

Components: Emulsion 502 & 606 (120b)
0.020 in cadmium filter & 0.040 in vinyl tape filter. (120b)

Range: 502 = 0.1 - 10 R (120b)
606 = 10 - 600 R

Accuracy: ± 40 mR (type 502 only)

Issuing Activity: Rad-Safe issued & collected film badges.
Project 0.17 : each of 3 TG ship units prepared for issue of badges through ship's administration. (120c)
Where Processed:

Films: Processed in CVL-49 darkroom. (120d)

Records:

Where Stored:

Films:

Records:

Number of Badges:
Issued: Daily badges = 748
wrist badges = 50 (120d)
Processed:
Number of Individuals:

REMARKS:
WIGWAM used two-badge system: operational & daily badges. (120b)
Los Alamos FD-1 densitometer used. (15)

DECONTAMINATION

Criteria:
Personnel: MPC's = 1 mR/h (gamma only)-skin
2 mR/h (gamma only)-underclothing & internal surfaces of respirators.
7 mR/h (gamma only)-outer clothing (123)

Equipment: MPC = 7 mR/h (gamma only)-ships, boats & aircraft. (123)

Procedures: *
Personnel: Freshwater showers in passageways. (120e)

Equipment: Salt-water washdown, hand scrubbing & storage of contaminated surfaces with levels 1000-20,000 c/m. (120f)
Procedures aboard CVL-49 for the handling of radioactive materials. (120g)

Decon. Station Locations:
Personnel: Rad-Safe center on CVL-49. (120h)

Equipment:

Volume Handled:
Personnel:
Equipment:

REMARKS:
* WIGWAM radiation monitoring equipment included:
four-cycle log-scal G-M instruments
three-cycle log-scal G-M instruments
modified CP-30 with shield
AN/PDR-11B
AN/PDR- 18 (120f)
In washdown studies, YAG-39 was washed down & YAG-40 was not. (121b) Sample ship contam & experimented w/ decon using cold spray, hot spray, hot spray plus brushing, using water, & 1% EDTA solution. (121c)

20R(γ) per operation [single event] for ~ water collections

OPERATION: REDWING

Test Site: Bikini, Enewetak

Inclusive Dates: May 5, 1956 - July 22, 1956

Number of Atmospheric Tests: 17 (barge, airdrop, tower, & surface)

Number of Underground Tests: 0

Number of Safety Tests: 0

Number of Army participants: 1,000
Number of Navy participants: 6,700
Number of Air Force participants: 3,090
Number of Marine participants: 300
Number of DoD civilian participants: 300
Total: 11,354

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency: (NCRP) 0.3 R/week (max); 3.0 R/13 weeks; 15 rem/year.(2) (5)
(ICRP) 0.3 R per week. (1e) (2) (10)

Operational:

Whole Body Gamma: 3.9 R/ 13-week period (131a)* No limit was placed on rate of exposure (133a) ** (130a) (130e)

Gamma & Neutron:

Alpha:

Other: MPL's & MPL's assume that numbers of personnel engaged in these tests have been previously exposed or will be continuously exposed to radiation hazards. (133b)

Exceptions:

Emergency: During roll-up Holmes & Narver personnel near 3.9 R limit were evacuated to Bikini but since these people were urgently needed for roll-up, maximum permissible exposure was raised to 7 R to allow roll-up to proceed without delay. (130e)

Special Groups: Cloud samplers: MPL of 20 R (gamma only) authorized for operational period; 15 days before the first shot until the individual's mission was complete or until 15 days after the last shot. (131a)

REMARKS:

* Standard set at JTF/JTG 1955 by Surgeons General of Army, AF, BuMED, & AEC, DBM. (132a)

A plutonium spill of 100mg contaminated 10 persons but the levels were well below tolerance limits. Some contamination was carried to the barracks, requiring 4 tents to be decontaminated; personnel clothing discarded. A trailer was contaminated but was decontaminated by stripping & discarding all equipment. (133b)

'Authorizations in excess of the established MPE will be granted only by Cdr JTF7, and only in specific cases, where operational requirements provide justification.' (133a)

** (after operational period no personnel will receive more than 0.3 R per week from contaminated equipment) (133a)

DOSIMETRY

Film Badge:

Type: Dupont 559 (18)

Components: 502
606 (15)

Range: 502 = 100mR - 10 R
606 = 10 R - 300 R (15)

Accuracy:

Issuing Activity: TG 7.3 Cdr issued & controlled FBs. (132b)

Where Processed:

Films: Enewetak atoll. (15)

Processed manually at Enewetak on Parry Island at Rad-Safe building. At Bikini they were processed in the photodosimetry-processing trailer which was maintained aboard the USNS AINSWORTH. (130b)

Records: (The Rad-Safe building on Enyu was damaged during the BASSOON & TX-21C Shots) (130h)

Where Stored:

Films: TG 7.1 maintained the individual dosimetry records. Copies were forwarded to Chief, AFSWP. (133c)Copies were forwarded to Director, DBM, AEC, & to their unit of "permanent assignment". (133d)

Records:

Number of Badges:

Issued: 40,000 permanent badges issued. (130c)

Processed: 45,000 mission badges processed. (130c)

Number of Individuals: 15,000 individuals. (130c)
600 persons exceeded the 3.9 R limit. (130h)

REMARKS: Badges showed light leaks & so were exchanged before end of 6-week period. (130c)

Densitometer used in all cases from UPSHOT/KNOTHOLE to PLUMBBOB was the Los Alamos FD-1. (15)

DECONTAMINATION

Criteria:

Personnel: 1.0 mR/h, skin. (131b)
Underclothing to 7 mR/h
Outer clothing to 7 mR/h

Equipment:
Interior surfaces of vehicles to 7 mR/h (gamma + beta)
Exterior surfaces to less than 7 mR/h (gamma only) at 5 or 6 inches from surface (131b)

Procedures: All readings of surface contamination were made w/ Geiger counters. (131c) "Workhorse" instrument was the AN/PDR-27I & AN/PDR 18A for higher radiation fields. (134a)

Personnel: Change of clothes & shower. (Hands cleaned w/ soap or soap & cornmeal; or mechanic's waterless handcleaner.) (130f)

Equipment: All heavy equipment monitored. Steam generator used to provide hot water for washing. (130g)
"Interim" washdown systems installed on all ships of TG 7.3 for 'water curtain' coverage. (134b)

Decon. Station locations:

Personnel:

Equipment: Decon. procedures w/ road scrapers & bulldozers were conducted around air dispatcher's office on Bitjiri & along roads within the Aomon-Bohna complex. Areas around tower sites on Runit, Eberiru, & Aomon decomned by scraping & filling. (130g)

Personnel: Approx. 3400 processed. (130d)
1,600 decomned at Enewetak. (130f)

Equipment: 100 vehicles & several helicopters for Marines (130d)

REMARKS: Pu contaminated equipment was poured in concrete and buried at sea. (130h)

* At the conclusion of the operation, final clearances will be granted by TG Cdrs. or CO's, to those ships and boats showing no point of contamination greater than 15 mR/day (beta + gamma) and no detectable alpha. (133e)

OPERATION: PLUMBBOB

Test Site: Nevada

Inclusive Dates: April 24, 1957 - October 7, 1957

Number of Atmospheric Tests: 23 (14 airbursts; 9 tower)

Number of Underground Tests: 1

Number of Safety Tests: 8

Number of Army participants: 12,000
Number of Navy participants: 563
Number of Air Force participants: 309
Number of Marine participants: 2,700
Number of DoD civilian participants: 1,500
Total : 17,072

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency : (NCRP) 5 rem per year average; 12 rem/year (max).(1c)(2)(6)(7
(ICRP) 0.3 R per week. (1e) (2) (10)

Operational:

Whole Body Gamma: Maximum of 3.0 R for any consecutive 13-week period (AEC). (140a)

Gamma & Neutron: 5.0 R for one calendar year (140b)

Alpha: A maximum of 10,000 units*for any consecutive 13-week period (AEC) (140a)

Other:

Exceptions:

Emergency:

Special Groups: Cloud Samplers = 7.5 R (141a)
Desert Rock = 5 R/ 6 mos. No limit placed on rate of accumulation. No more than 2 R prompt. (142a)
AFSWC aircrew or passengers not to be exposed to dose rate of more than 20 mR/h during flight. (143)

REMARKS:

* "Units" are computed by multiplying the average air concentration, excluding natural background, in the area of exposure, in units of alpha decays per minute per cubic meter, by the hours of exposure when no protective equipment is worn. (140)
MPC limits recommended by AEC's Division of Biology & Medicine. (140)

DOSIMETRY

Film Badge:

Type: AEC---Dupont 559 (141f)
Desert Rock used Dupont Type 559 (144)

Components: DR & AEC each used Type 502 & Type 606. (140) (144)

Range: 502 = 100mR - 10 R
606 = 10 R - 300 R (15)

Accuracy: DR = ± 50% for doses in the vicinity of the density crossover of the sensitive & insensitive film components. Probably as good as ± 10% in the low density range of each FB component.(142a)

Issuing Activity: Desert Rock Rad-Safe for DR personnel.
REECo Rad-Safe for all others. (15)

Where Processed:

Films: REECo, Las Vegas, NV. (15)

Records:

Where Stored:

Films: On loan to Office of Chief of Staff, DA. (144)
At REECo. (15)

Records: All are in REECo's master record. (15)

Number of Badges:

Issued:
Processed:

Number of Individuals: (146a)

REMARKS: Change in processing procedure to Dupont Liquid Concentrated X-ray Developer increased 502 range. LRI experimental neutron detectors were used by NASWI aircraft crews after the JOHN shot.(145a)(15
DR used Uberline Model FD-3 densitometers to read films. (144) Los Alamos Model FD-1 used. (15)
The 3rd Supplemental Evaluation of Photographic Dosimetry, October 17, 1957, used the FD-2 densitometer to measure films. (146b)

DECONTAMINATION

Criteria:

Personnel: 7 mR/h (beta + gamma) on protective clothing
1 mR/h (gamma) on surface of skin or under-clothing. (140c)

Equipment: 7 mR/h (gamma) outer surface
7 mR/h (beta + gamma) inner surface.
Desert Rock - 7 mR/h (142a)

Procedures: Used AN/PDR 39 to measure gamma dose rate. Beckman MX-5 & AN/PDR-34 instruments to detect beta dose rate. (141e)

Personnel: Wash & change of clothing.(141b)Nasal swabs taken. Brush off w/ vehicle brooms.(142a) (141e)

Equipment: Vehicles & equipment deconned using vacuum cleaners, high pressure water & detergent mixtures. (141b)
Contaminated clothing was washed at CP 2 laundry. Highly contam. clothing was sealed in plastic bags & buried at contam. waste burial area. (141b)

Decon. Station Locations:

Personnel: 50th Chemical Decon. Station north of Yucca Pass. (141c)

Equipment: Decon. buildings housed radiation detection instruments, clothing & equipment. (141d)

Volume Handled:

Personnel:

Equipment:

REMARKS: Respirators required for all personnel, except those in Desert Rock, from 1957 on. (15)
Field decontamination: Individuals brushed each other off with vehicle brooms & were checked by a monitor. Personnel who could not be field deconned to permissible levels were sent to 50th Chemical Platoon Decon. Station, where they took showers, & were issued new clothes & monitored. (142a)
Air sampling headquarters for all of Nevada operations was at Indian Springs AFB. (15)

OPERATION: HARDTACK I

Test Site: Pacific (Bikini, Enewetak, Johnston Island)

Inclusive Dates: April 28, 1958 - August 18, 1958

Number of Atmospheric Tests: 34

Number of Underground Tests: 1 (underwater)

Number of Safety Tests: 1

Number of Army participants: 1,400
Number of Navy participants: 10,200
Number of Air Force participants: 3,920
Number of Marine participants: 209
Number of DoD civilian participants: 900
Total : 16,629

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency :(NCRP) 0.3 rem/week(max); 3.0 rem/13 weeks; 12 rem/year(max)
(ICRP) 0.1 rem/week; 3.0 rem/13 weeks.(2)(11)---(NCRP)(2)(8)

Operational:

Whole Body Gamma: 3.75 R/ 13 weeks; 5 R/operation. (152) (153)
(5 R per calendar year) (150) (151)

Gamma & Neutron:

Alpha:

Other:

Exceptions:

Emergency:

Special Groups: IG 7.5 (Holmes & Narver) requested increase of 3.75 R -(unspec.)& an increase of 5R to 10 R for the operation for 35 Holmes & Narver employees. (157a) & (158a)

REMARKS: Only 4 of the 35 Holmes & Narver personnel exceeded 3.75; none exceeded 5.0 R. The remainder of CTF7 --- six persons (of approximately 18,000) exceeded 5 R. (154)

However, 22 individuals are known to have exceeded the 5 R limit. (15)

DOSIMETRY

Film Badge:

Type: Dupont 559 (155)

Components: 502 (low) & 834 (high) film dipped in ceresin wax and packaged in a rigid polyvinyl case. (155)

	0.4 Angstroms	0.1 Angstrom	0.01 Angst.
Range: 502	0.005 R to 0.8 R	0.02 R to 3.0 R	0.05 R- 20R
834			(156) *

502 = 20mR - 10 R; 834 = 5 R - 300 R (15)

Accuracy: ± 20%

Issuing Activity: Rad-Safe Section, Task Unit 7.1.6 of Task Group 7.1. (155)

Where Processed:

Films: Processed on Bikini (Nan) & Enewetak (Parry)atolls. (Enewetak = Site Elmer) (155)

Records:

Where Stored:

Films: Now located at REECo.(15)

Records:

Number of Badges:

Issued: 62,000 (155a)

Processed. 62,000 (155a)

Number of Individuals:

REMARKS: Type 834 film component introduced at PLUMBBOB(15 Records maintained on approx. 18,000 indiv. (155a) Read with FS-3 Film Badge Evaluation System.(157)

Holmes & Narver Rad-Safe Unit issued & controlled film badges during non-operational periods. (15)

*"Approximate Useful Exposure Range" as cited in Dupont Dosimeter Films pamphlet.

DECONTAMINATION

Criteria:

Personnel: 7 mR/h or greater (gamma + beta) (154)
Stop at 1 mR/h (gamma) on skin or underclothing. (157)

Equipment: 7 mR/h or greater (gamma + beta) (154)

Procedures: Monitor areas with AN/PDR 39 radiac (0-500 R/h).* (154)

Personnel: Shower & exchange clothing. (151)

Equipment: Wash with versene, citric acid solution, or steam. In some cases, isolate material until decay reduced dose rate. (151)

Decon. Station Locations:

Personnel: Enewetak
Runit (151)

Equipment: Parry Island (151)

Volume Handled: Enewetak: 6200 monitored
860 decomned (151)

Personnel: Runit: heavy volume. (151)

Equipment: Parry Island processed 800 items including 56 vehicles, 9 helicopters. (151)

REMARKS: * Personnel & equipment were monitored with AN/PDR-27H (beta-gamma) & PAC-3G (alpha) (154)

OPERATION: ARGUS (FLORAL)

Test Site: South Atlantic

Inclusive Dates: August 27, 1958 - September 6, 1958

Number of Atmospheric Tests: 3 (rocket)
Number of Underground Tests: 0
Number of Safety Tests: 0

Number of Army participants: 50
Number of Navy participants: 4,300
Number of Air Force participants: 1
Number of Marine participants: 48
Number of DoD civilian participants: 20
Total : 4,419

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency : (NCRP) 0.3 rem/wk. (max); 3.0 rem/13 wk.; 12 rem/yr.(max)
(ICRP) 0.1 rem/wk.; 3.0 rem/13 weeks. (2)(11)---NCRP(2) (8)

Operational:

Whole Body Gamma:

Gamma & Neutron.

Alpha:

Other:

Exceptions:

Emergency:

Special Groups:

REMARKS:

DOSIMETRY

Film Badge:

Type:

Components:

Range:

Accuracy:

Issuing Activity: Lexington Signal Depot (160)

Where Processed:

Films: Lexington Signal Depot (160)

Records. Lexington Signal Depot (160)

Where Stored:

Films:

Records:

Number of Badges:

Issued: 264 (160)

Processed: 21 packets exposed (160)

Number of Individuals:

REMARKS: Highest exposure was 0.025 rem (a control film packet). None of the pocket dosimeters registered any dose. Highest dose to any individual was 0.01 rem. (160)

DECONTAMINATION

Criteria:

Personnel:

Equipment:

NO DECONTAMINATION REQUIREMENTS (burst heights ranged from 100 to 400 miles)

Procedures:

Personnel:

Equipment:

Decon. Station Locations:

Personnel:

Equipment:

Volume Handled:

Personnel:

Equipment:

REMARKS:

OPERATION: HARDTACK II

Test Site: Nevada

Inclusive Dates: September 19, 1958 - October 30, 1958

Number of Atmospheric Tests. 15
Number of Underground Tests: 4
Number of Safety Tests: 20

Number of Army participants: 100
Number of Navy participants: 160
Number of Air Force participants: 204
Number of Marine participants: 20
Number of DoD civilian participants: 1,400
Total : 1,984

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency :(NCRP)0.3 rem/week(max);3.0 rem/13 weeks;12 rem/year(max)(2)(8)
(ICRP)0.1 rem/week; 3.0 rem/13 weeks. (2) (11)

Operational:

Whole Body Gamma: 3 R for the operation. (170a)

Gamma & Neutron: 3 rem/quarter (170b)

Alpha:

Other. 5 rem/year (whole body gamma & neutrons). (170b)

Exceptions:

Emergency:

Special Groups: Cloud Samplers = 10 R
15 R for participants of HARDTACK I also. (171a)
(only two exceeded 5 R; maximum was 7.7; minimum was 6.2 R)

REMARKS: If the individual's MPD minus his previous lifetime cumulative dose does not exceed 5 rem, no exposure over 5 rem will be authorized. (170b)
If the individual's MPD minus his previous lifetime occupational dose exceeds 5 rem an added exposure may be allowed. (170b)
Twelve personnel were authorized by the Test Manager to get 25 R. Only 5 received greater than 5 R (maximum 10.9 R, minimum 5.6 R). (171a)

DOSIMETRY

Film Badge:

Type: Dupont 559 (170c)

Components: 502 (sensitive)
834 (insensitive)
(in .004 polyethylene bag) (170)

Range: 502 = 20mR - 10 R
834 = 5 R - 300 R (15)

Accuracy: Overlap of 10 R. (170c)

Issuing Activity: REECo Rad-Safe Division. (170d)

Where Processed:

Films: NTS Rad-Safe Division (170c)

Records:

Where Stored:

Films: REECo Rad-Safe Division. (170a)

Records:

Number of Badges:

Issued:

Processed: 16,624 (170c)

Number of Individuals: Records maintained on 7652 individuals. (170a)

REMARKS: Films processed with Dupont X-ray developer at 68° for three minutes. (170c)

Liberline Model FD-11 densitometer used to read films. (170c)

DECONTAMINATION

Criteria:

Personnel: 7 mR/h (beta + gamma) outer clothing
7 mR/h (gamma) shoes
1 mR/h (gamma) skin or underclothing (170e)

Equipment: 7 mR/h (gamma) outside (170e)
7 mR/h (beta + gamma) inside (170e)
1 mR/h (beta + gamma) = respiratory protective devices.

Procedures:

Personnel: Monitor, shower, clothing exchange. (170f)

Equipment: Decontaminated by mobile equipment in the field prior to transportation to the decontamination pad. Vacuum cleaner, washing, washing with versene, hot or cold water, detergent, or acid solutions, or painting, paint stripping, sand blasting. (170g)

Decon. Station locations:

Personnel: CP-2 decon. station. (170f)

Equipment: CP-6, vehicles & movable equipment. (170g)
(CP-6 = an area adjacent to CP-2) (15)

Volume Handled:

Personnel:

Equipment: 518 vehicles
330 pieces of equipment. (170g)

REMARKS: Monitoring equipment included:
AN/PDR-39
Tracerlab SU-10 gamma field
Alpha-Liberline PAC-3G-field & personnel monitoring
Beckman MX-5---vehicles & personnel monitoring(170b)
Some equipment allowed to decay of radioactivity naturally. Burial pit for items which could not be decontaminated. (170g)

OPERATION: DOMINIC I

Test Site: Christmas Island, Eastern Pacific, Johnston Island

Inclusive Dates: April 25, 1962 - November 4, 1962

Number of Atmospheric Tests. 36 (airdrop & rocket)
Number of Underground Tests: 1 (underwater)
Number of Safety Tests: 0

Number of Army participants:	1,500
Number of Navy participants:	19,000
Number of Air Force participants:	2,000
Number of Marine participants:	805
Number of DoD civilian participants:	200
Total:	23,505

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency: (NCRP) 0.3 rem/week (max); 3.0 rem/13 weeks; 12 rem/year (max) (2) (8)
(ICRP) 0.1 rem/week; 3.0 rem/13 weeks. (2) (11)
(FRC) 3 rem/13 weeks; 5 rem/year (avg.); 12 rem/year (max). (2) (12)

Operational:

Whole Body Gamma: (If over 19 yrs. old) 5 R per year; 3.9 R per 13-week period.
(If under 19 yrs.) 1.25 R per 13-week period (190)

Gamma & Neutron: (If over 19 yrs. old) 3 rem in 13 weeks.
(If under 19 yrs.) 1.25 rem in 13 weeks. (191)

Alpha:

Other:

Exceptions:

Emergency: 25 R (Grave Emergency MPL = 50 R) (190)

Special Groups: Cumulative lifetime dose = not to exceed 5(N-18) rem (all sources). (191 & 193)
Christmas Island natives: 0.5 R/year. (193)

REMARKS. Personnel under 19 years of age were to be evacuated if cumulative dose reached 1 R. (190)

DOSIMETRY

Film Badge:

Type: Dupont #556 (192)

Components: Films 508 & 834 dipped in ceresin wax and packaged in rigid polyvinyl chloride case. (192)

Range: 508 = 0-10 R
834 - 0-1000 R (192)

Accuracy:	0.4 A"	0.1 A"	0.01 A"	
508 =	.003R-0.4 R	0.1 R - 3.0 R	0.015 R - 8.0 R	(192)
834 =				

Issuing Activity: REECo issued & controlled. (15)
Issued by TGJ-3 Rad-Safe Branch, JIFB. (192)

Where Processed:

Films: Processed on Christmas Island until late in the series & then moved to Honolulu, Hawaii. Honolulu processed all FBs for Johnston Island & Barber's Point. (192)

Records:

Where Stored:

Films: REECo (192)

Records: Transferred to REECo in 1962. (192)

Number of Badges:

Issued: 43,000 (192)

Processed: 33,000 (192)

Number of Individuals: 30,000 individual records were produced. (192)

REMARKS: Films read with an Eberline ID-3 densitometer. (192)

DECONTAMINATION

Criteria:

Personnel: Not yet identified.

Equipment:

Procedures:

Personnel: Showers & clothing exchange. (192)

Equipment: Facilities used a decon. truck for washdown using power (jet) spray. (192)

Decon. Station Locations:

Personnel: Johnston Island, Barber's Point, Christmas Island (192)

Equipment: Johnston Island, Barber's Point, Christmas Island. Aircraft decon. stations on Christmas Island, Johnston Island, & Barber's Point, Hawaii. (192)

Volume Handled:

Personnel:

Equipment:

REMARKS: AN/PDR-39 (0-500 R) used for monitoring areas. AN/PDR-27J & AN/PDR-43 used for monitoring personnel & equipment. (192)

Thor launch pads were decomed as follows:
Coral surfaces: 2-inches graded off top surface.
Concrete pads: scrubbed with detergents & solvents in some cases, these were painted with epoxy.
Revetments: washed & painted. (192)
BLUEGILL PRIME material disposed of at sea. (190a)

OPERATION: DOMINIC II (SUNBEAM)
(LITTLE FELLER I, JOHNNY BOY, LITTLE FELLER II, SMALL BOY, & DANNY BOY)

Test Site: Nevada

Inclusive Dates: March 5, 1962 - July 17, 1962

Number of Atmospheric Tests: 5

Number of Underground Tests: 0

Number of Safety Tests: 0

Number of Army participants: 50
Number of Navy participants: 160
Number of Air Force participants: 315
Number of Marine participants: 10
Number of DOD civilian participants: 600
Total : 1,135

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency : (NCRP) 0.3 rem/week(max); 3.0 rem/13 weeks; 12 rem/year(max) (2)(8)
(ICRP) 0.1 rem/week; 3.0 rem/13 weeks. (2) (11)
(FRC) 3.0 rem/13 weeks; 5 rem/year(avg.); 12 rem/year(max). (2) (12)

Operational:

Whole Body Gamma. SMALL BOY used established AEC MPC limits--- 3 rem/quarter with the following exceptions:* (200a)

Gamma & Neutron:

Alpha:

Other:

Exceptions:

Emergency:

Special Groups: * Proj. 2.3, 2.4 - a total of 5 rem for all events.
Proj 2.9 - 6 rem
Proj. 2.11 = 6 rem
Proj. 2.15 = 20 rem (200a)
SMALL BOY aircrews = 3 rem/quarter

REMARKS: SMALL BOY Rad-Safety was the responsibility of CIO. (200a)

It was necessary that SMALL BOY aircrews be given waivers to exceed established MPC. The Operational Division Rad-Safe Officer processed the waiver requests & coordinated them with AEC Rad-Safety. (200b)

DOSIMETRY

Film Badge:

Type: Dupont 559 (15)

Components: 502
834 (15)

Range: 502 = 20mR - 10 R
834 = 5 R - 300 R

Accuracy:

Issuing Activity: REECo issued & controlled. (15)
REECo Rad-Safe issued gamma film badges at Indian Springs AFB to sample recov. personnel & maintenance crews. (180a) * (DANNY BOY)

Where Processed:

Films: REECo (15)

Records: REECo (15)

Where Stored:

Films: REECo (16)
(SMALL BOY) The radiation exposure of each individual was recorded & forwarded to the command holding the individual's health record. No conclusive over-exposures were received. (200a)

Records: REECo (16)

Number of Badges:

Issued:

Processed:

Number of Individuals:

REMARKS: * Maximum recorded exposures at DANNY BOY:
experimental = 500 mR
ground crew = 30 mR
sampling pilots = 295 mR
helicopter pilots = 1700 mR (180a)

DECONTAMINATION

Criteria:

Personnel:

Equipment:

Procedures:

Personnel: All personnel at DANNY BOY monitored before & after removal of anti-contamination clothing. (180a)

Equipment: Beckman MX-5, Eberline E-112 B-1, Tracerlab AN/PDR 11B, Victoreen Radector. (201b)

Decon. Station Locations:

Personnel: Rad-Safe facility at CP-2. (201a)
Indian Springs AFB (REECo Rad-Safe)(DANNY BOY)

Equipment: Decon. equip. positioned at heli. pad. (180b) (180c)
Indian Springs AFB (REECo Rad-Safe) (DANNY BOY) (off-site) (190b)
(Mobile decon. facility at Rad-Safe Station) (180c)

Volume Handled:

Personnel:

Equipment:

REMARKS: Personnel film badges were exchanged for individuals who entered the radiation exclusion areas, and participating personnel stationed at Indian Springs AFB. There were no radiation exposure limits above the operational limits established by the Test Manager. (201a)

Highest individual exposure indicated at DANNY BOY was 178 mR/h. There were no radiation exposures above the MPD limit. (180d)

OPERATION. PLOWSHARE : Project GNOME

Test Site: Carlsbad, New Mexico

Inclusive Dates. December 10, 1961

Number of Atmospheric Tests: 0

Number of Underground Tests: 1 (atmospheric venting)

Number of Safety Tests: 0

Number of Army participants: 50
Number of Navy participants: 50
Number of Air Force participants: 25
Number of Marine participants: 5
Number of DoD civilian participants: 300
Total: 430

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency :(NCRP)0.3 rem/week(max);3.0 rem/13 weeks;12 rem/year(max)(2)(8)
(ICRP)0.1 rem/week, 3.0 rem/13 weeks. (2) (11)
(FRC) 3.0 rem/13 weeks, 5 rem/year(avg.); 12 rem/year(max).(2)
(12)

Operational:

Whole Body Gamma:

Gamma & Neutron:

Alpha:

Other:

Exceptions:

Emergency:

Special Groups:

REMARKS: REECo Rad-Safety Division was responsible for conduct & control of on-site Rad-Safe support service. The Rad-Safe Division was responsible to the FRC. (211a)

DOSIMETRY

Film Badge:

Type: Dupont 559 (15)

Components: 502
834 (15)

Range: 502 = 20mR - 10 R
834 = 5 R - 300 R (15)

Accuracy:

Issuing Activity: Issued and controlled by REECo Rad-Safe. (15)

Where Processed:

Films: Personnel film badges were processed & recorded at facilities at the NTS. Arrangements were made with the Eberline Instrument Corp., Santa Fe, NM, to provide emergency dosimetry processing, if necessary. (211c)

Records:

Where Stored:

Films: REECo (16)

Records:

Number of Badges:

Issued.

Processed:

Number of Individuals:

REMARKS: Used Precision Model 111 to measure low level gamma radiation. (211e)
All participants were issued gamma film packets containing high range & low range film. (212)

DECONTAMINATION

Criteria:

Personnel:

Equipment:

Procedures:

Personnel: Shower & change of clothes.
Rad-Safe Division provided a trailer for personnel decontamination. (211c)
Clothing exceeding background levels was laundered at the site.
Urine samples were taken routinely from personnel. (212)

Equipment: On-site facilities included anti-contamination clothing & equipment as well as laundry facilities. Decon. on drilling platforms was accomplished by water washing. * (211d)
Rad-Safe Division provided a 40-foot house-trailer for Rad-Safe. (211c)

Decon. Station Locations:

Personnel:

Equipment:

Volume Handled:

Personnel.

Equipment:

REMARKS: Used Beckman MX-5, Tracerlab SU-10, Juno Model 6, Precision Model 111. (211g)
* Decon. techniques included the burial & removal of contaminated scrap, high pressure water washing with added detergents, washing with solvents & vacuuming. (212)
Highest dose on GNOME was 1.585 R on in-hole recovery. (211f)

OPERATION: **PLOWSHARE: Project SEDAN**

Test Site: Nevada

Inclusive Dates: July 6, 1962

Number of Atmospheric Tests: 0

Number of Underground Tests: 1 (atmospheric venting)

Number of Safety Tests: 0

Number of Army participants: 50
Number of Navy participants: 68
Number of Air Force participants: 25
Number of Marine participants: 5
Number of DoD civilian participants: 300

Total: 448

RADIOLOGICAL SAFETY ACTIVITIES

EXPOSURE CRITERIA

Agency: (NCRP)0.3 rem/week(max); 3.0 rem/13 weeks; 12 rem/year(max)(2)(8)
(ICRP)0.1 rem/week; 3.0 rem/13 weeks. (2) (11)
(FRC) 3.0 rem/13 weeks; 5 rem/year(avg.); 12 rem/year(max).(2) (12)

Operational:

Whole Body Gamma: 3 rem/quarter (210a)
Gamma & Neutron: (limit established by Test Group Director)
Alpha:
Other:

Exceptions:

Emergency:

Special Groups:

REMARKS: Maximum personnel exposure received was 300 mR & the average exposure was 250 mR. (210b)

DOSIMETRY

Film Badge:

Type: Dupont 559 (15)
Components: 502
834 (15)

Range: 502 = 20mR - 10 R
834 = 5 R - 300 R

Accuracy:

Issuing Activity: Issued & controlled by REECo Rad-Safe.(15)

Where Processed:

Films:

Records:

Where Stored:

Films: REECo, Las Vegas, NV. (16)

Records:

Number of Badges:

Issued:

Processed:

Number of Individuals: Film badge packets were exchanged 378 personnel. (210)

REMARKS: Special badges: experimental film badges. (210a) Three experimental FBs were placed on each of the five sampling aircraft & one experimental FB was given to each of the flight members, in addition to their personal badge. Maximum reading for a personal badge from the flight crews = 144mR.(210c)

DECONTAMINATION

Criteria:

Personnel:

Equipment:

Procedures:

Personnel:

Equipment:

Decon. Station Locations:

Personnel:

Equipment:

Volume Handled:

Personnel:

Equipment:

REMARKS: Indian Springs AFB Rad-Safety facility deconned the cloud sampling personnel. (210d) The major decon. project was cleaning approximately 7 miles of the area 51 access highway... With the support of the tanker trucks & the high pressure water from the fire truck used in the operation, the contaminated dirt & fallout debris was washed from the road. (210b)

DRAFT

APPENDIX A

RECOMMENDED RADIATION SAFETY STANDARDS

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APPENDIX A
RECOMMENDED RADIATION SAFETY STANDARDS

CHRONOLOGICAL HISTORY (RADIATION PROTECTION ORGANIZATIONS)*

ASA

In 1916, the professional societies of civil, electrical, mechanical and mining engineers met to discuss the coordination of standards on a national level. After two years of conferences these societies established the American Engineers Standards Committee. The purpose of this organization was not to create standards, but to review and coordinate those being developed. After a period of time, various government agencies and many trade associations joined the committee, and in 1928 it was reorganized and renamed the American Standards Association (ASA). In 1969 it became the American National Standards Institute (ANSI).

ICRU

The International Commission on Radiological Units and Measurements (ICRU) was formed in 1925 under the auspices of the First International Congress of Radiology, forerunner of the International Society of Radiology. The principal objective of the ICRU is to develop internationally acceptable recommendations regarding:

- Quantities and units of radiation and radioactivity
- Procedures suitable for the measurements of application of these quantities in clinical radiology and radiobiology,
- Physical data needed in the application of these procedures, which will tend, if used, to assure uniformity in reporting.

The ICRU also considers and makes similar recommendations for the radiation protection field. It collects and evaluates the latest data and information and recommends the most acceptable values and techniques for current use. It has divided its field of interest into eleven technical areas which are reviewed periodically with reports issued as needed. The ICRU has close relationships with other organizations, such as the International Commission of Radiological Protection, the World Health Organization, the International Atomic Energy Agency, the United Nations Scientific Committee on the Effects of Atomic Radiation, and others.

ISA

The International Federation of National Standardizing Associations (ISA) was founded in 1926, and has been known as the International Organization for Standardization (ISO) since 1946. Counterparts within the U.S. are the American National Standards Institute (ANSI), which has a Federal charter, and the Bureau of Standards.

*See Reference 228 (Page C-25) for bibliographical information.

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ICRP

The International Commission on Radiological Protection (ICRP) came into existence in 1946 as the successor to the International X-Ray and Radium Protection Commission, (formed in 1928 by the 2nd International Congress of Radiology). The policy of the ICRP in preparing its recommendations on radiation safety standards, is to deal with the basic principles of radiation protection and to leave to the various national protection committees the responsibility of introducing the detailed technical regulations, guides, specifications, etc., best suited for each individual nation.

NCRP

The primary United States organization concerned with radiation protection is the National Council on Radiation Protection and Measurements (NCRP). In 1929 it began as the Advisory Committee on X-Ray and Radium Protection. In 1946 it was renamed the National Committee on Radiation Protection. This can arbitrarily be set as the period of the development of current radiation protection standards and the time when consideration of genetic as well as somatic effects became important. From 1956 to 1964, it was known as the National Committee on Radiation Protection and Measurements; and in 1964 took the name it has today. The NCRP grew out of discussions that took place at the Second International Congress of Radiology in 1928. The purpose of this Congress was to discuss protection problems and prepare initial X-ray protection recommendations. The U.S. was represented by three organizations: the National Bureau of Standards, the American Roentgen Ray Society, and the Radiological Society of North America. Each had differing views and each purported to be the authoritative body for the U.S. (other countries had similar situations). Nevertheless, out of this meeting came the organization which led to the ICRP, and a recommendation that a single central committee be established within those nations having more than one radiological organization, and that this central committee consolidate recommendations. The U.S. representative to the 2nd Congress was Lauriston S. Taylor who discussed the recommendations with members of the other U.S. organizations. By the spring of 1929, the initial organization -- the Advisory Committee on X-Ray and Radium Protection -- was established with Taylor as the Chairman. He remained Chairman through the various changes and restructures of the committee until his retirement in 1977. The NCRP was chartered by Congress (Public Law 88-376) in 1964 and has as its objectives to:

- Collect, analyze, develop, and disseminate in the public interest information and recommendations about (a) protection against radiation and (b) radiation measurements, quantities, and units, particularly those concerned with radiation protection.

- Provide a means by which organizations concerned with the scientific and related aspects of radiation protection and of radiation quantities, units and measurements could cooperate to effectively utilize their combined resources, and stimulate the work of such organizations.

- Develop basic concepts concerning radiation quantities, units, and measurements, about the application of these concepts, and radiation protection.

- Cooperate with the International Commission on Radiological Protection, the Federal Council, the International Commission on Radiation Units and Measurements, and other national and international organizations, governmental and private, concerned with radiation quantities, units, and measurements and with radiation protection.

The NCRP is composed of over 60 members and participants who serve on the many (over 30) scientific committees of the Council. The scientific committees propose recommendations which are reviewed and approved by the full membership of the Council before publication. It also has created a category of NCRP collaborating organizations in recognition of its responsibility to facilitate and stimulate cooperation among organizations concerned with radiation protection and measurements. At present there are over 25 organizations, including the Services, with which the NCRP maintains liaison.

NBS

The National Bureau of Standards (NBS) was the semi-official sponsor of the NCRP until the latter was chartered by Congress in 1964. The NBS routinely published reports of the NCRP as a part of its Handbook Series. Although disclaimers were printed, (because of the government imprint on the report) many assumed this to mean the report represented government recommendations rather than that of an independent, private body processing no legal authority. Because of various problems of a legal, public or operational nature, the NCRP and NBS severed their relationship in 1964.

UNSCEAR

The most international committee in scope is the UNSCEAR -- the United Nations Scientific Committee on the Effects of Atomic Radiation. This committee was established in 1955. It reviews reports that appear in scientific literature, reviews and assesses the levels of radiation to which the world population is or may become exposed, and improves the assessments of risk entailed by exposure to radiation. It does not suggest standards, but its assessments of risks influence the considerations of standards-setting organizations.

NAS

The National Academy of Sciences (NAS) has a number of committees that consider genetic and somatic effects of radiation and address protection standards. The 1956 Biological Effects of Atomic Radiation (BEAR) Committee Report led to a lowering of the basic permissible dose for radiation workers. NAS committees have also considered the pathologic effects -- including acute and long-term hematological effects, internal emitters, inhalation hazards, and delayed effects, meteorological aspects, agriculture and food supplies aspects, disposal aspects and others. The most recent effort was that of the Biological Effects of Ionizing Radiation (BEIR) Committee (report in November, 1972). This committee has been reconvened through an EPA request; a report is now in draft and will be utilized in standard setting deliberations.

PHS

The Public Health Service in 1956 convened a group of experts on radiation hazards to provide guidance to the Surgeon General on matters pertaining to the control of radiation hazards and to evaluate the programs then underway in the U.S. to protect the health and well-being of the public. This committee was the National Advisory Committee on Radiation (NACOR). While this did not consititue the initial activity of the PHS in radiation matters, it was probably one of the most influential, not from the standpoint of developing new radiation standards, but because the PHS was heavily involved overall in radiation matters. The NACOR recommended intensive research programs, training of professional and technical personnel, active state and local control and participation in regulatory matters, and an active role of the PHS is control of ionizing radiation. As a result of these recommendations, many of the activities of the PHS of today were begun, such as the Bureau of Radiological Health, the National Radiation Surveillance Network, development of acceptable levels of exposure from air, water, milk, and the general environment, and various training programs. The NACOR was disbanded in 1966 due to decisions within HEW.

FRC

The rapid development of the atomic and nuclear industries and concern over radiation hazards and ways of protection against them led to the creation of the Federal Radiation Council (FRC) in 1959. Public (both national and international) reaction to atmospheric testing and the resultant fallout mainly resulted in the Joint Committee on Atomic Energy (JCAE) initiating a series of hearings in 1957 to develop information on radiation hazards and associated problems. Through the extensive interrogation of various government agencies concerning the radiation standards they employed, it was revealed that, without exception, reference was always made to NCRP or ICRP recommendations. The Congress realized that the radiation protection activities for which they were appropriating money, and for which they had made the Federal Government responsible under the Atomic Energy Act of 1945, were actually in the hands of a non-governmental organization over which the government had no formal control. Accordingly, the Congress directed that changes be instituted.

The Bureau of the Budget began a study to find a remedy. It was quickly realized that there were considerable amounts of interagency rivalry, jealousy, conflict and purpose regarding radiation needs and that these could influence attitudes toward general radiation standards. For instance, the purpose of the Atomic Energy Commission was to promote radiation; thus a liberal standard might be in their best interests. This could also be true for the DoD whose interests were in military applications. On the other hand, agencies such as the Department of Labor and Public Health Service might be baised toward overly strict standards. Other agencies that might not have an axe to grind, such as the National Bureau of Standards, did not have statutory authority of responsibilities in the regulator field. The possibility of making the NCRP a federal committee was explored--the NCRP, however, objected to this concept.

No rationale could be found for putting radiation protection activities and responsibilities under one agency. . Experience had shown that interagency committees had problems in achieving objectives in a timely fashion. Thus, the final solution was to give the radiation protection authority directly to the President. Thus the Federal Radiation Council was established by Executive Order 10831, August 14, 1958, and by Public Law 86-373 of September 23, 1959, which amended the Atomic Energy Act of 1954.

The FRC membership consisted of the Secretary of Health, Education and Welfare and the Chairman of the Atomic Energy Commission, Secretaries of Defense, State, Commerce, Labor, and Agriculture, and the President's Special Advisor. It was directed to consult with the National Academy of Sciences and the NCRP. The FRC's primary function was the development of national policy in the field of radiation protection, i.e.,"... advise the President with respect to radiation matters, directly or indirectly affecting health, including guidance for all Federal agencies in the formulation of radiation standards and in the establishment of execution of programs of cooperation with the states..." As such, the FRC did not issue or approve regulatory rules. These were issued by the agencies under their statutory authority and within the policy framework recommended by the Council and approved by the President. During its existence from 1959 to 1970, the FRC issued recommendations for occupational and public whole body exposures as well as for exposures from various radionuclides.

EPA

In 1970, the President's Reorganization Plan No. 3 abolished the FRC and transferred its functions to the Environmental Protection Agency (EPA). The EPA has had the governmental role of advising the President on radiation matters. It has also continued the guidance recommended by the FRC and has addressed several areas on its own: a transuranic contamination standard, the allowable exposure for all activities in the nuclear fuel cycle, and uranium miner radon exposure limitations.

RPC

The U.S. Radiation Policy Council was established in 1980 by Executive Order to coordinate the formulation and implementation of Federal radiation protection policies. It is essentially an administrative decendent of the Federal Radiation Council. Membership embraces all governmental bureaus and agencies chaired by the Administrator of the Environmental Protection Agency. The principal functions of the RPC are to:

- Formulate broad radiation protection policies;
- Identify gaps and overlaps in Federal radiation protection activities;
- Monitor implementation of Federal radiation protection policies by Federal agencies;
- Assist in the resolution of conflicts in jurisdiction among Federal agencies and recommend corrective legislation if needed;
- Provide liaison with the States and the Congress;
- Serve as a forum for public participation and comment; and
- Act as a clearinghouse for information on Federal radiation activities.

The President has also directed the Council to conduct three activities: to undertake a comprehensive review of the scope of guidance and statutory authorities bearing on radiation protection; to coordinate the implementation of recommendations for reducing radiation exposure; and to provide central coordination for Federal information programs concerned with radiation.

APPENDIX A
RECOMMENDED RADIATION SAFETY STANDARDS
(Continued)

SUMMARY

In 1934, the ICRP adopted a maximum permissible dose rate of 0.2 R/day and in the same year the NCRP published Handbook 18 in which the maximum permissible dose rate was given as 0.1 R/day. The ICRP recommendation continued in international use until 1950, and the NCRP recommendation continued in use in the U.S. until 1949 (225a). [These two dose rates are approximately the same, since 0.1R/day in air (NCRP) is approximately equal to 0.15R/day at the skin (ICRP)]

Listed below are various reported radiation standards (national and international) during the period 1945-1962. No effort has yet been made to reconcile reported standards where conflicts were found. Each standard has been assigned a reference number in the event further detail is needed. Complete reference citations are located in Appendix C (Bibliography).

HISTORICAL DEVELOPMENT OF RADIATION STANDARDS

OPERATION	STANDARD	REMARKS
TRINITY 7/16/45	0.1 R/day (air)-U.S.; generally (220a, 220c) standard from 1936-1948 TRINITY 0.2 R/day or 1 R/wk (skin)-British (220a, 220c) 0.2 R/day (or 1 wk)--international--occupational exposure (225c), 229) ICRP 0.1 R/day (or 0.5 R/wk)--U.S.--(225d, 229) NCRP	
CROSSROADS 7/1/46-7/25/46	0.2 R/day (or 1 R/wk)--international occupational exposure (225c, 229) ICRP 0.1 R/day (0.5 R/wk)--U.S.--occupational exposure (225d, 229) NCRP	ASA prepares first specific statement to tolerance dose
1947	0.2 R/day (or 1 R/wk)--international--occupational exposure (225c, 229) ICRP 0.1 R/day (0.5 R/wk)--U.S.--occupational exposure (225d, 229) NCRP	

APPENDIX A
RECOMMENDED RADIATION SAFETY STANDARDS
(Continued)

OPERATION	STANDARD	REMARKS
SANDSTONE 4/15/48- 5/15/48	0.3 rem/week--blood forming organs (220d, 224k) 0.2 R/day (or 1 R/wk) international--occupational exposure (225c, 229) ICRP 0.1 R/day (0.5 R/wk)--U.S. (225d, 229) NCRP	
1949	0.3 rem/week (224d) once in a lifetime, accidental high exposure - 25 rem (224j) once in a lifetime, emergency exposure - 12 rem (224j) 0.3 rem/wk - occupational exposure NBS-HB-42, (225e, 226a, 228a) 0.3 R/wk (229) NCRP 0.2 R/day (or 1 R/wk) - occupational exposure (225c, 229) ICRP	The '1949 report' recognized the fact that radiation protection criteria depend not only upon biomedical and physical considerations, but also upon value judgments, and are based on the concept that there may be some degree of risk at any level of exposure.
1950	X, 0.3 R/wk .3 rep/wk .015 rep/wk max. permissible weekly dose in blood forming organs (221a) 0.3 rad/wk (228b) 0.3 rem/wk for occupational exposure (NBS-HB-47) (224e, 225f, 226a) 0.3 R/wk (229) ICRP, NCRP	Prior to 1950, NCRP & ICRP had different standards; from 1950 on, they were similar (Lauriston Taylor)
RANGER 1/27/51- 2/6/51	0.3 rem/wk - occupational exposure (225e, 225f) 0.3 R/wk (229) ICRP, NCRP	

APPENDIX A
RECOMMENDED RADIATION SAFETY STANDARDS
(Continued)

OPERATION	STANDARD	REMARKS
GREENHOUSE 4/8/51-5/25/51	0.3 rem/wk - occupational exposure (225e, 225f) 0.3 R/wk (229) ICRP, NCRP	
BUSTER-JANGLE 10/22/51-11/29/51	0.3 rem/wk - occupational exposure (225e, 225f) 0.3 R/wk (229) ICRP, NCRP	
TUMBLER-SNAPPER 4/1/52-6/5/52	0.3 rem/wk - occupational exposure (225e, 225f) 0.3 R/wk (229) ICRP, NCRP	
IVY 11/1/52-11/16/52	0.3 rem/wk - occupational exposure (225e, 225f) 0.03 rem/wk (NCRP, 9/62) total body population - any organ (221b) 0.3 R/wk (229) ICRP, NCRP	
UPSHOT-KNOTHOLE 3/17/53-6/4/53	0.3 rem/wk - occupational exposure (225e, 225f) 0.3 R/wk (229) ICRP, NCRP	ICRU introduces concept of absorbed dose (224f)
CASTLE 3/1/54-5/14/54	300 mrem/wk, blood forming organs (220b)600 mrem/wk (skin) (220b) 0.3 rem/wk - occupational exposure (2253, 225f) 0.3 R/wk (229) ICRP 3.0 R/13 wks 0.3 R/wk (max) (229) NCRP 15 rem/yr	

APPENDIX A
RECOMMENDED RADIATION SAFETY STANDARDS
(Continued)

OPERATION	STANDARD	REMARKS
TEAPOT 2/18/55- 5/15/55	0.3 rem/wk - occupational exposure (225e, 225f) 3.0 R/13 wks 0.3 R/wk (max) (229) NCRP 15 rem/yr 0.3 R/wk (229) ICRP	
WIGWAM 5/14/55	0.3 rem/wk - occupational exposure (225e, 225f) 0.3 R/wk (229) ICRP 3.0 R/13 wks 0.3 R/wk (max) (229) NCRP 15 rem/yr	
REDWING 5/5/56- 7/22/56	54 rem/yr (224b) 5 rem/yr (corresponding to 0.1 rem/wk) (224h, 228c) 5 rem/yr (0.1 rem/wk)--occupational exposure ICRP (225g, 226b) 0.3 rem/wk - occupational exposure NCRP (225f) 0.3 R/wk (229) ICRP 0.1 rad/wk (5 rad/yr) (228d) 3.0 R/13 wks 0.3 R/wk (max) (229) NCRP 15 rem/yr	UNSCEAR organized (224g) ICRP defines permissible dose and permissible weekly dose (224i)

APPENDIX A
RECOMMENDED RADIATION SAFETY STANDARDS
(Continued)

OPERATION	STANDARD	REMARKS
PLUMBBOB 4/24/57- 10/7/57	0.5 rem/yr - population (223, 224a) 5 rem/yr (0.1 rem/wk)--occupational exposure (220e, 226b) 5 rem/yr (avg) 12 rem/yr (max) (229) NCRP 0.3 R/wk (229) ICRP	
HARDTACK I 4/28/58- 8/18/58	0.5 rem/yr (or 0.01 rem/wk) NCRP total body - population (220f) 0.3 rem/wk (max) 3 rem/13 wks (229) NCRP 12/rem yr (max) 5(N-18)rem 0.1 rem/wk 0.3 rem/13 wks (229) ICRP 5(N-18) rem	
ARGUS 8/27/58- 9/6/58	0.3 rem/wk (max) 3 rem/13 wks (229) NCRP 12 rem/yr (max) 5(N-18)rem 0.1 rem/wk 3.0 rem/13 wks (229) ICRP 5(N-18)rem	
HARDTACK II 9/19/58- 10/30/58	5 rem/30 yrs (or 0.003 rem/wk) ICRP--total body-- population (225i) 0.3 rem/wk (max) 3 rem/13 wks (229) NCRP 12 rem/yr (max) 5(N-18) rem 0.1 rem/wk 3.0 rem/13 wks (229) NCRP 5(N-18)rem	

APPENDIX A
RECOMMENDED RADIATION SAFETY STANDARDS
(Continued)

OPERATION	STANDARD	REMARKS
1959	MPD=(N-18)x5 rem, dose in any 13 consecutive wks. not to exceed 3 rem (whole body) (222)	FRC established by Eisenhower (226c)
	MPD=10(N-18)rems, dose in any consecutive 13 wks not to exceed 6 rem (skin dose) (222)	FRC formed to provide federal policy for U.S. (225b)
	5 rem in 30 yrs (224c). Recommended limit for fertile persons; 0.5 rem/yr (or 0.01 rem/wk) - ICRP -- total body, population (225h) 0.1 rem/yr (or 0.002 rem/wk)--average exposure to any organ - NCRP (225j)	
	0.1 rem/wk 3.0 rem/13 wks (229) ICRP 5(N-18)rem	
	0.3 rem/wk (max) 3 rem/13 wks 12 rem/yr (max) (229) NCRP 5(N-18)rem	
1960	0.5 rem/yr - general population (227a) 5(N-18)rem (227b) 3 rem/13 wks (227b) 5 rem (N-18)/13 consecutive wks exposure (228e)	
	0.3 rem/wk (max) 3 rem/13 wks 12 rem/yr (max) (229) NCRP 5(N-18) rem	
	0.1 rem/wk 3.0 rem/13 wks (229) ICRP 5(N-18)rem	
	3 rem/13 wks 5 rem/yr (avg) 12 rem/yr (max) (229) FRC 5(N-18) rem	

APPENDIX A
RECOMMENDED RADIATION SAFETY STANDARDS
(Continued)

OPERATION	STANDARD		REMARKS
1961	0.3 rem/wk (max) 3 rem/13 wks 12 rem/yr (max) 5(N-18)rem	(229) NCRP	
	0.1 rem/wk 3.0 rem/13 wks 5(N-18) rem	(229) ICRP	
	3 rem/13 wks 5 rem/yr (avg) 12 rem/yr (max) 5(N-18) rem	(229) FRC	
	3 rem/13 wks 12 rem/yr 5(N-18)rem accum.	(230) AEC	
DOMINIC I 4/25/62- 11/4/62-	0.3 rem/wk (max) 3 rem/13 wks 12 rem/yr (max) 5(N-18) rem	(229) NCRP	
	0.1 rem/wk 3.0 rem/13 wks 5(N-18) rem	(229) ICRP	
DOMINIC II 7/7/62- 7/17/62	3 rem/13 wks 5 rem/yr (avg) 12 rem/yr (max)	(229) FRC	

APPENDIX A
RECOMMENDED RADIATION SAFETY STANDARDS
(Continued)

OPERATION	STANDARD		REMARKS
PLOWSHARE -Gnome 12/10/61 -Sedan 7/6/62	0.3 rem/wk (max) 3 rem/13 wks 12 rem/yr (max) 5(N-18)rem	(229) NCRP	
	0.1 rem/wk 3.0 rem/13 wks 5(N-18)rem	(229) ICRP	
	3 rem/13 wks 5 rem/yr (avg) 12 rem/yr (max) 5(N-18)rem	(229) FRC	

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APPENDIX B

ACRONYMS

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ACRONYMS

AEC	Atomic Energy Commission
AFSWC	Air Force Special Weapons Center
AFSWP	Armed Forces Special Weapons Project
ANSI	American National Standards Institute
ASA	American Standards Associations
BEAR	Biological Effects of Atomic Radiation
BEIR	Biological Effects of Ionizing Radiation
CDR	Camp Desert Rock
CJTF	Commander Joint Task Force
CP-2	Control Point #2, a location at Nevada Test Site
DBM	Division of Biology and Medicine, AEC
DR	Desert Rock
EDR	Exercise Desert Rock
EPA	Environmental Protection Agency
FB	Film Badge
FRC	Federal Radiation Council
H & N	Holmes and Narver
ICRP	International Council on Radiation Protection
ICRU	International Commission on Radiological Units and Measurements
JAYCOR	DNA research contractor organization
JCAE	Joint Committee on Atomic Energy
JTF	Joint Task Force
LASL	Los Alamos Scientific Laboratory, Los Alamos, New Mexico
MPC	Maximum Permissible Concentration
MPD	Maximum Permissible Dose
MPE	Maximum Permissible Exposure
mrem	millirem
mR	milliroentgen
mR/h	milliroentgen per hour
NAS	National Academy of Sciences
NACOR	National Advisory Committee on Radiation
NBS	National Bureau of Standards
NCRP	National Council on Radiation Protection

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ACRONYMS
(Continued)

NPG	Nevada Proving Ground (earlier name of NTS)
NTS	Nevada Test Site
PHS	Public Health Service
R	roentgen (earlier symbol was 'r')
REECo	Reynolds Electrical and Engineering Company
RPC	Radiation Policy Council
R/h	roentgen per hour
rad	A unit of absorbed dose equal to the absorption of 100 ergs of radiation energy per gram of absorber medium.
rem	roentgen equivalent man (or mammal)
rep	roentgen-equivalent-physical (a dose unit formerly used for purposes similar to the rad)
TD	Test Director
TG	Task Group
TM	Test Manager
TU	Task Unit
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation

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APPENDIX C

BIBLIOGRAPHY

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APPENDIX C
BIBLIOGRAPHY

Pages consulted in each source document are referenced by letters of the alphabet in the approximate order in which they appear in the Radiological Safety Standard Tables and Operation Summaries. For example:

> "Ref. 113a" stands for pp. 45-46, Report of the Test Manager, Operation TEAPOT, NTS, Spring 1955.
>
> and
>
> "Ref. 113b" stands for p. 36, Report of the Test Manager, Operation TEAPOT, NTS, Spring 1955.

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Ref. No.	Subject	Ref. No.	Subject
1 - 12	Federal Standards	110-119	TEAPOT
13 - 19	TRINITY	120-129	WIGWAM
20 - 29	CROSSROADS	130-139	REDWING
30 - 39	SANDSTONE	140-149	PLUMBBOB
40 - 49	RANGER	150-159	HARDTACK I
50 - 59	GREENHOUSE	160-169	ARGUS
60 - 69	BUSTER-JANGLE	170-179	HARDTACK II
70 - 79	TUMBLER-SNAPPER	190-199	DOMINIC I
80 - 89	IVY	200-209	DOMINIC II
90 - 99	UPSHOT-KNOTHOLE	210-219	PLOWSHARE (Gnome,Sedan)
100-109	CASTLE	220-230	Appendix A

APPENDIX C
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(Continued)

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   1a. pp. 498-499 . . . recommended by NCRP on March 17, 1934 and continued in use in U.S. until 1949.

   1b. p. 499 . . . note 0.3 rem/wk recommended by NCRP on March 9, 1949 - conflict: matrix gives 0.3R which was taken from Reference 2.

   1c. p. 499 . . . refers to NBS-HB-59 supplement by saying the NCRP on January 8, 1957 suggested a 0.5 rem/year (or 0.1 rem/week) standard.

   1d. p. 499 . . . recommended by ICRP in 1934 and continued in use until 1950.

   1e. p. 499 . . . recommended by ICRP in 1934 and continued in use until 1956 - conflict: Ref. 1, p, 499 has standard in use until 1956; Ref. 2 has it in use until 1958 - note conflict in 0.3 rem and 0.3R - resolved.

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13. Bainbridge, K.T., (Ed.), Trinity, Volume 24, Los Alamos Technical Series, Section 4.7 "Health and Monitoring Organization and Preparations" (as of June 20, 1945), Louis H. Hempleman, M.D.

    13a. p. 59
    13b. p. 62
    13c. p. 61

14. Microfilm from historical files found by Dr. Payne Harris in GSA archives at San Bruno, California. In 1946 Kodak Type K double coat X-Ray film was used. The films were read on a Marshall Densitometer. In 1947 Kodak Type X-Ray film and 6462 Dupont Type D-2 X-Ray film. Films were read on a Photovolt Densitometer.

15. Information provided by Payne Harris, M.D. Dr. Harris is a nuclear physicist who participated in more than 100 of the atmospheric nuclear tests (both CONUS and Oceanic) in a variety of key capacities involving radiological safety and experimental physical and biological effects of nuclear weapons. He has served as prime consultant in these areas to the Director, DNA, and is prominent in the fields of dosimetry, decontamination, and radiological recovery and clean-up operations. Dr. Harris is cited until specific documentation can be located.

16. Conversation: A. Nelson (JAYCOR) with J. Brady (REECo Dosimetry) 3/19/80.

17. Conversation: A. Nelson (JAYCOR) with Bob Frederick (REECo Dosimetry) 3/21/80.

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20. Shurcliff, Dr. W.A., (Historian), Technical Report of CROSSROADS Joint Task Force One, 18 November 1946 (C).

    20a. p. 3.57

21. Historical Report, Atomic Bomb Tests Able and Baker, Operation CROSSROADS, (U) Director of Ship Material, Joint Task Force One

    21a. p. 108

22. Forest, F.X., Capt, USN, Bureau of Ships Group Final Report, Test Able and Test Baker, Vol. 1, Joint Task Force One, 16 December 1946 (U)

23. Operational Report to the Joint Chiefs of Staff on Atomic Bomb Tests Able and Baker conducted at Bikini Atoll, Marshall Islands, 1 July 1946 and 25 July 1946, Operation CROSSROADS (U)

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24c. p. E-II-8
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32a. p. 9
32b. p. 37. In the casualty badges of high range, it was requested that Cine positive 5202 be used in place of Kodalite 6567.

32c. p. 31. "It was decided that the film badges for all gamma measurements be procured by the AFSWP. Dr. Lauriston Taylor of the U.S. Bureau of Standards was placed under contract by the AFSWP to calibrate and read film badges for all gamma readings."

32d. p. 53. The first calibration of personnel film badges was run using the 48.7 mg radium source. Films were developed and read on a Weston Densitometer, Model 877.

32e. p. 92
32f. p. 113
32g. p. 63
32h. p. 65
32i. p. 59

33. Test Director's Report, Test Director JTF7, Report on Operation SANDSTONE, Vol. 1, 1948

33a. p. 3
33b. p. 2
33c. p. 1

34. SOP for Task Group 7.6, 19 December 1947, JTF 7

34a. p. 1
34b. p. 2, Annex B to TG 7.6 Operation Plan 1-48. The Disaster Group was issued one casualty badge and one personnel badge.

35. SANDSTONE Report (Vol.I); Report to the JCS. Pages 113-114. Also Test Directors Report to the AEC, pp. 3-21.

36. ANNEX H to TG 7.6 Op. Plan 1-48, Page 1. (Also) ANNEX J, Para. 4(a) of Field Order #1 (RADSAFE PLAN).

OPERATION RANGER

40. Shipman, T.L., Report of the Rad-Safe Group, Operation Ranger Program Reports, Operational Volume 5, LASL, University of California, July 1952 (C)

40a. p. 69
40b. p. 79 (Appendix D)
40c. p. 58

40d. p. 71 (Appendix C) Dosage records were kept on a total of 182 persons who entered the "hot" area. Contractor personnel received the highest exposures.

40e. p. 72

41. Report of the Deputy Test Director, LASL, University of California

41a. p. 31

OPERATION GREENHOUSE

50. Cooney, James P., Brig. Gen., MC, USA, Radiological Safety, Nuclear Explosions 1951, Operation GREENHOUSE Scientific Director's Report, Annex 9.3, WDC July 1951 (C)

50a. p. 1. Following the decontamination of the SANDSTONE residual activity, Thomas N. White, Los Alamos, made a final survey of the entire atoll and concluded that there was no possibility of over exposure on any of the islands and this would be true until the next series of tests. It was decided, therefore, to stop using film badges on all islands.

50b. p. 25

50c. p. 33. Special care was taken with eyes, ears, hair and fingernails of personnel during decontamination procedures.

50d. pp. 70-71

51. Steadman, Frank M., Col QMC and Staff of Office of the Quartermaster General QM Det. 7, 9135th T.S.U., Scientific Director's Report Annex 6.9, " Protective Clothing and Personnel Decontamination," Ft. Lee VA Quartermaster Research and Development Laboratories, Philadelphia Office of the Quartermaster General, Washington, D.C., December 1951 (U)

51a. p. 70

51b. pp. 76 and 77. Change houses were located on Parry Island and on Enewetak Island.

51c. pp. 79 and 80

52. Task Group 3.3 Final Report on Operation Greenhouse, Cdr., Task Group 3.3, Fleet Post Office, San Francisco, CA, 6 July 1951 (S)

52a. p. B-6
52b. pp. B-4 and B-5
52c. p. B-3

53. 0010/51, Operation Plan CTG 3.3, No. 1051, Annex H, "Radiological Safety," JTF 3, TG 3.3, Pearl Harbor, T.H., 31 January, 1951

53a. p. H-IV-1. "Under unusual circumstances, CJTF 3 may authorize a total exposure of up to 3 roengtens in specific cases involving limited numbers of personnel with the provision that such persons will be prohibited from further exposure of more than 0.1 R per day during the balance of the operation"

53b. p. H-II-1
53c. pp. H-II-1 and H-II-5

54. DoD press release 140-1515 (Statement of LTG Quesada, June 13, 1951, at Pentagon news conference).

55. CTG 3.3 Op Plan 1-51, Annex H (Radiological Safety) p. H-IV-1.

56. CTG 3.3 Report of Participation in Operation GREENHOUSE (ser 00174 dtd 16 June 51 page B-5).

57. Operation GREENHOUSE Scientific Director's Report, Annex 6.9; Para. 2.3.2.

58. Annex H to TG 7.6 Operation Plan 1-48, page 1; also Annex J, Para. 4(a) of Field Order #1 (Rad-Safe Plan).

OPERATION BUSTER-JANGLE

60. Shipman, Thomas L., M.D., Radiological Safety, Operation BUSTER-JANGLE, LASL, University of California, July 1953 (U).
60a. p. 15

61. Operation Plan Serial No. 6-51, Annex E, "Radiological Safety, Operation BUSTER-JANGLE", Headquarters, AFSWC, Kirtland Air Force Base, NM (S).

61a. p. E-1
61b. p. E-4

62. Test Director's Operation Order 1051, Operation BUSTER-JANGLE (S)

62a. p. R-4, Annex R (Rad-Safety and Health)
62b. p. A-1-5

63. Report of Exercise Desert Rock I Headquarters Sixth Army, Presidio of San Francisco, CA, 18 September 1951.(U)

63a. p. 108
63b. p. 110
63c. p. 109

64. Report of Exercises Desert Rock II and III, Headquarters Sixth Army, Presidio of San Francisco, CA 15 December 1951.(U)

64a. p. 35
64b. p. 127
64c. p. 132
64d. p. 237
64e. p. 234. DR II and III - Showers were set up at Yucca Pass on day observers entered area.
64f. p. 157

OPERATION TUMBLER-SNAPPER

70. Annex R to the Test Director's Operation Order 1-52, "Radiological Safety Plan", Operation TUMBLER-SNAPPER (S)

70a. p. 1

71. Gwynn, P.S., Lt. Col, USAF, Radiological Safety, Operation TUMBLER-SNAPPER, AFSWP (CNWDI)

71a. p. 38
71b. p. 47
71c. p. 44
71d. p. 33

72. Report of Exercise Desert Rock IV Headquarters Sixth Army, Presidio of San Francisco, CA, June 1952.(U)

72a. p. 217
72b. pp. 77 and 78
72c. pp. 21 and 22

OPERATION IVY

80. Maynard, R.H., Capt. USN, & Servis, J.D., Maj., USA, Report to the Scientific Director: "Radiological Safety, Joint Task Force 132," Washington, D.C., LASL, University of California, January 1953 (U)

80a. p. 71. No limit was placed on the rate of accumulation of MPE as long as rate was low enough to permit adequate control.

80b. p. 37
80c. p. 80
80d. p. 79
80e. p. 68

80f. p. 30
80g. p. 95
80h. pp. 94 and 95
80i. p. 85
80j. p. 34
80k. pp. 33 and 34
80l. p. 33

81. Moore, Frank E. Jr., Maj. USA, and Bechanan, Gordon H., Lt. USNR, History of Operation Ivy, 1951-52, JTF 132, Chapter XVI, Radiological Safety

81a. p. 226

82. Operation Plan 1-52, ComTask Group 132.3, Appendix 11 to Appendix J -"Decontamination Procedures" (Washington, D.C., 6 June 1952) (U)

82a. p. J-III-1
82b. p. J-II-1
82c. p. J-II-2

OPERATION UPSHOT-KNOTHOLE

90. Radiological Safety; Operation UPSHOT-KNOTHOLE FC, AFSWP, Albuquerque, NM, March - June, 1953 (U)

90a. p. 19
90b. p. 36

91. Final Report of Exercise Desert Rock V Headquarters Sixth Army, Presidio of San Francisco, CA, 16 July 1953.(U)
91a. p. 12 (Annex B)
91b. p. 60
91c. p. 153

92. Upshot-Knothole Radiological Safety Report (Abridged version) (U)

92a. p. 17
92b. p. 18
92c. p. 23
92d. p. 13
92e. p. 159. "With the addition of the eleventh shot, it was found necessary to request the Test Director to authorize an increase in the 3.9 R tolerance dosage for 22 monitors in the section to 4.5 R as a total dosage for the operation and roll-up period."

93. Clark, John C., Report of the Deputy Test Director, Operation UPSHOT-KNOTHOLE, LASL, June 1954 (S).

93. p. 23.

APPENDIX C
BIBLIOGRAPHY
(Continued)

OPERATION CASTLE

100. Servis, John D., Maj. Chemical Corps, Report to the Scientific Director: "Radiological Safety," LASL, August, 1954 (S)

100a. p. 40. CTG 7.1: Any individual exceeding exposure of 6 R would be returned to the U.S. Several members of Project 6.4 received exposures between 6 and 12 R as a result of continued activity aboard contaminated drone ships.

100b. p. 61
100c. p. 42
100d. p. 44
100e. p. 14
100f. p. 64
100g. p. 57
100h. p. 56
100i. p. 59

101. History of Operation CASTLE, Final Report, CJTG 7.3, Final Report Serial No. 001404 (Navy Archives)

101a. p. 191
101b. p. 11a
101c. p. 11a-3

102. Annex N to CJTF 7, Operation Plan No. 3-53, Radiological Safety (U)

102a. p. N-I-2
102b. p. N-I-3
102c. p. N-I-5

103. Joint Task Force 7, Commander Task Group 7.3 Operation Plan No. 1-53, Annex G - Radiological Safety (U)

103a. p. G-I-5
103b. p. G-I-1

104. Final Report, Radiological Safety, Operation CASTLE, Spring 1954: Vols. I and II

104a. p. 7

105. TG 7.3 Op. Order 1-53 (7 Dec 53) ANNEX G.

106. JTF 7 Op. Order 1-53 (rev. 9-25-55), page F-2.

OPERATION TEAPOT

110. Operation TEAPOT, J-3 Files #3, 5, Part III (U)

110a. p. 5

111. Collinson, Tom D., Lt. Col., USA, "Radiological Safety Report," Report to the Test Director, AFSWP, FC, Albuquerque, NM, May 1955 (U)

111a. p. 13
111b. p. 12
111c. p. 15
111d. p. 17
111e. p. 4
111f. p. 170

112. Annex D, "Radiological Safety Plan to Desert Rock Operation Order #1" (U).

112a. p. 24. DASA Operational Summary p. 58. Safety criteria equals 6R at any orig. test with no more than 3R prompt radiation.
112b. p. 27.

113. Report of the Test Manager, Operation Teapot, NTS, Spring 1955

113a. pp. 45-46, and p. 106
113b. p. 36
113c. p. 35

114. Exercise Desert Rock VI, Final Report of Operations Headquarters Sixth Army, Presidio of San Francisco, CA 7 July 1955 (U)

OPERATION WIGWAM

120. Baietti, A.L. and Smith, A.L., Report to the Scientific Radiological Safety for Operation WIGWAM, U.S. Naval Radiological Defense Laboratory, San Francisco, CA, January 1957

120a. p. 17
120b. p. 36
120c. p. 15
120d. p. 37
120e. p. 28
120f. p. 20
120g. p. 30
120h. p. 5
120i. pp. 44 and 45

121. Hawkins, M.B. et al, Report to the Scientific Director: Determination of Radiological Hazard to Personnel, U.S. Naval Radiological Defense Laboratory, San Francisco, CA, July 1956 (U)

121a. p. 55
121b. pp. 62-67
121c. pp. 82-88

122. Operation Plan 1-55, Appendix III to Annex G, Operation WIGWAM, Commander Task Group 7.3

122a. p. G-II-3

123. Appendix I to Annex G, Task Group 7.3 Operation Plan 1-55

OPERATION REDWING

130. Jacks, G.L., Radiological Safety, Operation REDWING, LASL, Los Alamos, NM, July 1956 (S)

130a. p. 56
130b. p. 40
130c. p. 38
130d. p. 29
130e. p. 26
130f. p. 11
130g. p. 12
130h. p. 40
130i. p. 28

131. Annex G to CTG 7.3 No. 1-56, Radiological Safety Plan (Operation REDWING Commander Task Group 7.3, Operation Plan No. 1-56) (U)

131a. p. G-I-2
131b. p. G-I-5
131c. p. G-I-4

132. Blumenson, Martin, Capt. USN, Hexamer, Hugh D., LT(jg), USNR, A History of Operation REDWING: The Atomic Weapons Tests in the Pacific, 1956, 1 December 1950 (Navy Archives Building, Room 210)

132a. pp. 35 and 36
132b. p. 35

133. Appendix I to Annex K to CJTF Seven, No. 1-56, "Radiological Safety Regulations," Headquarters JTF-7, Washington, D.C., 20 January 1956

133a. p. K-1-2

133b. p. K-1-1. A plutonium spill of 100 mg contaminated 10 persons, but well below tolerance limits. Some contamination was carried to the barracks requiring four tents to be decontaminated and personnel clothing to be discarded.

133c. p. K-I-6
133d. p. K-I-7
133e. p. K-I-3 and K-I-5

134. Final Report, Operation REDWING, CTG 7.3, August 1956

134a. p. 115
134b. p. 112

OPERATION PLUMBBOB

140. Report of the Test Manager, AEC/NTO, Operation PLUMBBOB, Nevada Test Site, December 1957

140a. p. 71. "Units" are computed by multiplying the average air concentration, excluding natural background, in the area of exposure, in units of alpha decays per minute per cubic meter, by the hours of exposure when no protective equipment is worn.

140b. p. 74
140c. p. 72

141. PLUMBBOB On-Site Rad-Safety Report (NTS, Mercury, NV) REECo, Inc., (U)

141a. p. 235
141b. p. 13
141c. p. 16
141d. pp. 14 and 17
141e. p. 22
141f. p. 239. REECo evaluated Dupont Types 502, 510, 555, 824, 825, 834, and 606 and Eastman Type 2. 502 and 834 provided the best overlap. However, it was judged that Dupont film pack 559 provided sufficient accuracy when processed with the Dupont developer.

142. Exercises Desert Rock VII and VIII, Final Report of Operations, Headquarters U.S. Sixth Army, Presidio of San Francisco, CA, 9 January 1958 (U)

142a. p. 6

143. 4950th Test Group Operation Plan, AFSWC, April 1957, Appendix 2 to Annex F of Operation Plan 1-57

144. Letter to SDSRR-LQCP to S.E. Weary (JAYCOR) from Headquarters Lexington Blue Grass, KY, dated 16 June 1978. Subject: Film Badge Information. "An estimate of the accuracy of the film badge during the 1957 time frame is ± 50% for doses in the vicinity of the density crossover of the sensitive and insensitive film components. Accuracy is probably as good as ± 10% in the low density range of each film component."

145. 4950th TG, Final Report, AFSWC, Operation PLUMBBOB, Kirtland Air Force Base, NM

145a. p. 120

146. "Photographic Dosimetry, 3rd Suppl. Evaluation," Prepared by Rad-Safe Div., Health and Safety Dept., REECo, submitted 17 October 1957

146a. p. 1
146b. p. 2. The 3rd Supplemental Evaluation, Oct. 17, 1957 used the FD-2 densitometer.

OPERATION HARDTACK I

150. Operation Plan 1-58, Task Group 7.1, 15 January 1958. Authorization for exposure exceeding the established MPE was granted only by CJTF 7 when justified by operational considerations.

151. Operation HARDTACK, Radiological Safety Final Report

152. Report of TG 7.1, Operation HARDTACK, 29 May 1959

153. JTF 7 Final Report, Operation HARDTACK, 8 October 1958

154. TG 7.5 Final Report, Operation HARDTACK, April 1959. Only four Holmes and Narver personnel exceeded 3.75 R and none exceeded 5R.

155. Radiological Safety, Operation HARDTACK, 6 October 1959

155a. p. 47.

156. Dosimeter Films, E.I. Dupont De Nemours and Co. (Inc.) Photo Products Department, Wilmington 98, DE

157. Task Group 7.5 Rad-Safe Support, Operation HARDTACK, Phase I, OTO-58-3, Published by Holmes and Narver, April 1959

157a. p. 15

158. Radiological Safety Support for All Target Fleet Projects, Operation HARDTACK

158a. p. 63

OPERATION ARGUS

160. CTF 88, Final Report, ARGUS

OPERATION HARDTACK II

170. On-Site Rad-Safety Support Report, Operation HARDTACK II, OTO-58-5, REECo, Inc. (U)

170a. p. 9
170b. p. 22
170c. p. 8
170d. p. 7
170e. p. 23
170f. p. 12
170g. p. 13
170h. p. 11

171. Report of the Test Manager, Operation HARDTACK II, OTO-58-4, August - October 1958

171a. p. 28 Only two cloud samplers exceeded 5R; the maximum was 7.7 R and the minimum was 6,2 R. Only 5 personnel received exposure greater than 5 R; the maximum was 10.9 R, and the minimum was 5.6 R for this group.

OPERATION DOMINIC I

190. JTG 8.3 Final Report, Operation Dominic, JTF 8-62-12648, 30 April 1963

190a. p. J-7

191. Scientific Director's Summary Report; Swordfish, Operation DOMINIC, 21 January 1963

192. CJTF 8 Report: Radiological Safety, Operation DOMINIC, (dated 1 April 1963).

193. CJTF 8 Report: Navy Test Group Operations, Operation DOMINIC, Enclosure J.

OPERATION DOMINIC II

200. "Operations NOUGAT and SUNBEAM, Organizational, Operational, Funding and Logistical Summary," Deputy Chief of Staff, Weapons Effects and Test Field Command, DASA, Sandia Base, NM (U)

200a. p. 64. Radiological safety was the responsibility of CTO. The established AEC MPE limits were used with the following exceptions:

Projects 2.3, 2.4 - a total of 5 rem for all events
Project 2.9 - 6 rem
Project 2.11 - 6 rem
Project 7.15 - 20 rem

The radiation exposure of each individual was recorded and forwarded to the command holding the individual's health record. No conclusive over-exposures were received. (Shot Small Boy)

200b. p. 65 It was necessary that aircrews receive waivers to exceed established exposure limits. The Operational Division Rad-Safe Officer processed waiver requests and coordinated them with AEC Rad-Safety. (Shot Small Boy)

200c. p. 62 No party would be cleared for entry to close-in stations if a dose rate reading of 10 R/h existed. (Shot Little Feller II).

201. On-Site Radiological Safety Report, DOMINIC Series, Nevada Phase

201a. p. 5 Personnel film badges were exchanged for individuals who entered the radiation exclusion areas, and participating personnel stationed at Indian Springs, AFB. There were no radiation exposure limits above the operational limits established by the Test Manager.

201b. p. 9

180. On-Site Rad-Safety Report, Project Danny Boy, REECo, NTS, 5 March 1962. Twenty experimental film badges were placed at various positions in the four cloud sampling aircraft and processed after the test event. Gamma film badges were issued to sample recovery personnel and maintenance crews. The maximum recorded exposures were:

Experimental	500mR
Ground Crew	30mR
Sampling Pilots	295 mR
Helicopter Pilots	1700mR

180a. p. 3 REECo Rad-Safe Personnel were dispatched to Indian Springs AFB facility to operate a decontamination station and perform personnel, equipment and vehicle decontamination.

180b. p. 2

180c. p. 5 Personnel gamma badges were exchanged for individuals who entered the radiation exclusion area. The highest individual exposure indicated by gamma film badge was 1780 mR. There were no radiation exposures above the Maximum Permissible Dosage (MPD) limits.

OPERATION PLOWSHARE

210. On-Site Rad-Safety Report, Project Sedan, REECo, (U)

210a. p. 7
210b. p. 6
210c. p. 8
210d. p. 5

211. On-Site Radiological Safety Report, Final Report, Project Gnome, Carlsbad, NM, REECo, (U)

211a. p. 1
211b. p. 7
211c. pp. 3 and 4. Arrangements were made with the Eberline Instrument Corp. in Santa Fe, NM, to provide emergency dosimetry film processing, should the need arise for dosimetry data.

211d. p. 2
211e. p. 9
211f. p. 8 Anti-contamination clothing was provided to personnel having access to the drill platforms and the drilling areas. Dose rates to personnel on the drilling platforms averaged from 2 to 5 mR/h. Contaminated water was occasionally spilled onto the drill platforms during removal of the drill pipe from the hole. Decontamination by water washing was employed to reduce the dose rate to minimum practical levels.

211g. p. 10
211h. p. 11. Urine specimens were taken routinely from personnel participating in survey or recovery operations. No significant internal exposures were observed.

212. Project Manager's Report, Project Gnome, PLOWSHARE Program, Prepared by U.S. AEC

RECOMMENDED RADIATION SAFETY STANDARDS
(from Appendix A)

220. "Permissible Dose from External Sources of Ionizing Radiation," NCRP Report No. 17, (NBS-HB-59), 1954. (This reference has at least two supplements which include References 220e and 220f. See Reference 229 also).

220a. p. 1, elaboration on pages 53-55, and 74 of the document. British or European standard adopted 0.2 R/day or 1 R/wk as the "tolerance dose" - no indication was made as to whether the dose should be measured "in air" or on the surface of the body to include backscatter radiation.

"...the first specific statement to this effect (tolerance dose) appears in the 1946 Safety Code for the Industrial Use of X-Rays prepared by the American Standards Association."

220b. pp. 61-62, exceptions on pages 53-54, and 74. The basic permissible dose distribution requires that the weekly dose at depths greater than 5 cm shall not exceed 300 mrem (bloodforming organs); 600 mrem in the skin.

220c. pp. 1, 27. Generally accepted dose in U.S. was 0.1 R/day (1936-1948) (in air - external). Defines permissible dose and permissible weekly dose.

220d. pp. iv-v. NCRP decisions of June 1948 - permissible dose from dose from external sources (see Ref. 224k for description).

220e. "Maximum Permissible Radiation Exposures to Man," Suppl. Natl. Bur. Std. (U.S.) Handbook 59 (January 8, 1957). Reference 220e superseded this reference. Reference 220f was an NCRP preliminary recommendation of Jan. 8, 1957 for occupational exposure of the total body to ionizing radiation - per Ref. 225, p. 499. See Reference 229, also.

220f. p.2. "Maximum Permissible Radiation Exposures to Man," Suppl. Natl. Bur. Std. (U.S.) Handbook 59 (April 15, 1958). This represents a minor change from the NCRP recommendations (Ref. 220e) of Jan. 8, 1957, but no change in the basic MPD. Per p. 2: "...the quarterly limitation of 3 rems in 13 weeks is basically the same as in NBS-HB-59 except it is no longer related to the old weekly dose limit. The yearly limitation is 12 rem instead of the 15 rems given in the NCRP preliminary recommendations of Jan. 8, 1957.

...Ref. 25 (p. 449) refers to this NBS-HB supplement by saying the NCRP on April 15, 1958 suggested an 0.5 rem/yr (or 0.01 rem/wk) as maximum exposure to gonads (or total body) - population at large.

221. "Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water," NBS-HP-52, 1953. (See Reference 229, also).

221a. pp. 3-4. First official publication by the Subcommittee on Permissible internal dose of the NCRP - contains values of Chalk River and London Conferences - Sept. 29-30, 1949 and ICRP, July 1950. NCRP submitted these doses to ICRP. In July 1950, at the ICRP meeting in London, these values were accepted.

221b. P. 4. Per Reference 225 (p. 399) this NBS-HB-52 says NCRP suggested in September 1952 the 0.03 rem/wk as maximum exposure of any organ - dose equivalent to the total body exposure of population-at-large.

222. "Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure, "AFP160-6-67, NBS-HB-69 (issued June 5, 1959), supersedes Handbook 52.

...pp. 4-5. (includes internal and external exposure) - external standard changed in Handbook 69; internal remained the same.

External (whole-body) - MDP to the most critical organs, accumulated at any age, shall not exceed 5 rem multiplied by the number of years beyond age 18, and the dose is any 13 consecutive weeks shall not exceed 3 rem. Thus the accumulated MPD=(N-18)x 5 rem where N is the age in years and is greater than 18.

External (skin of whole-body) - MPD 10 (N-18) rem, and the dose in any 13 consecutive weeks shall not exceed 6 rem.

Internal exposure listed also.

223. "Basic Radiation Protection," Report 39, Issued January 15, 1971, NCRP, 4201 Connecticut Ave., N.W., Washington, D.C. 20008.

...p. v - NCRP recommended a dose limit of 0.5/rem/year. (Whole Body) general public.

224. Taylor, Lauriston S., Radiation Protection Standards, CRC Press, Cleveland, Ohio, 1971.

224a. p. 101, NCRP introduces age proration concept for occupational exposure and 0.5 rem/yr for individuals in population.

224b. p. 101, NAS and ICRP recommend lower basic permissible dose for radiation workers - 54 rem/yr sic

224c. p. 102. ICRP recommends limitation of genetically significant dose to population of 5 rem in 30 years.

224d. p. 101. NCRP lowers basic MPD for radiation workers to 0.3 rem/wk. Risk benefit philosophy introduced.

224e. p. 101 ICRP adopts basic MPD of 03. rem/week for radiation workers.

224f. p. 101 ICRU introduces concept of absorbed dose.

224g. p. 98. UNSCEAR organized - came into being mainly because of international problem of worldwide fallout from nuclear testing.

224h. p. 81. "...average external occupational exposure at 5 rems/year (corresponding to 0.1)....1956 decision of ICRP, is not applied to internal dose calculations except in the cases of radionuclides that are distributed rather uniformly throughout the body or are concentrated in the gonads."

224i. p. 48. ICRP defines permissible dose and permissible weekly dose.

224j. p. 48. NCRP adopts once-in-a-lifetime exposure of 25 rems for accidental high exposure and the emergency exposure of 12 rems.

224k. p. 24:

Following a considerable amount of preliminary correspondence, informal meetings, and orientation, the first formal meeting was held in Chicago in June 1948. At this time a number of basic and far-reaching decisions were made: 1. to lower the then-existing permissible dose of 0.1 R/day by a factor of about 2 and to express it in terms of a week; 2. to take the blood forming organs as the most critical tissue and to apply the permissible limit of 0.3 R/wk to these organs; 3. to consider skin as a critical organ and to set the permissible dose for it at 0.6 R/wk at a depth of 7 mg per square centimeter; 4. to allow a permissible dose for persons over 45 years of age double that for younger adults; 5. to allow larger weekly doses for the hands and feet (1.5 R/wk); 6. to make suitable recommendations about accidental exposures involving a single dose that might be as large as 25 R. and 7. to recommend an RBE (Relative Biological Effectiveness) of 1 for x-rays, gamma rays, and beta rays, 5 for thermal neutrons, 10 for fast neutrons, and 10 for alpha particles.

225. Morgan, K.Z., and Turner, J.E., Principles of Radiation Protection - A Textbook of Health Physics, R.E. Krieger Publ. Co., N.Y., 1973. (All references in the '225' series are cited from this text.)

225a. pp. 498-499. Tables on p. 499:

Table 14-1 Changes in the Maximum Permissible Occupational Exposure[a] of the Total Body to Ionizing Radiation

Recommended Rate[a]	Comments
0.1 Erythema dose/yr (≈0.5 R/wk for 100 kv X-rays) and 1 R/wk for 200 kv X-rays	Recommended by A. Mutscheller and R. M. Sievert in 1925[24]
0.2 R/day (or 1 R/wk)	Recommended by ICRP in 1934[17] and continued in world-wide use until 1950
0.1 R/day (or 0.5 R/wk)	Recommended by NCRP on March 17, 1934[14] and continued in use in United States until 1949
0.3 rem/wk	Recommended by NCRP on March 7, 1949[15] and ICRP in July 1950[16] and continued in use until 1956
5 rem/yr (≈0.1 rem/wk)	Recommended by ICRP in April 1956[6] and NCRP on January 8, 1957[19]

[a] Values given are in addition to doses from medical and from background radiation. Values in parentheses are for a 5-day work week.

Table 14-2 Suggested Limit of Dose Equivalent to the Total Body of Population-at-Large From Man-Made Sources of Ionizing Radiation

Total-Body Rate[a]	Comments
0.03 rem/wk	Suggested by NCRP September 1952[17] as maximum exposure to any organ
0.5 rem/yr (or 0.01 rem/wk)	Suggested by NCRP on April 15, 1958[20] and by ICRP in July 1959[6] as maximum exposure to gonads (or total body)
5 rem/30 yr (or 0.003 rem/wk)	Suggested by ICRP on September 9, 1958[8] as average exposure to gonads (or total body)
0.1 rem/yr (or 0.002 rem/wk)	Suggested by Ad Hoc Committee on May 6, 1959[22] for consideration by the NCRP for average exposure to any body organ

[a] Values given are in addition to doses from medical and from background exposure.

225b. p. 504. Federal Radiation Council (FRC) formed in U.S. to provide a federal policy on human exposure to ionizing radiation. Its major function was to "advise the President with respect to radiation matters directly or indirectly affecting health..." FRC recognized the authority and preeminence of the NCRP and ICRP. Authorized by Congress to consult qualified scientists and experts on radiation matters. The first two FRC reports were (1) Radiation Protection Guidance for Federal Agencies, Federal Radiation Council Report No. 1, Washington, 1960, and (2) Selected Radiation Protection Guides, Federal Radiation Council Report No. 2, Washington, 1961 - these two reports virtually accepted NCRP and ICRP recommendations.

225c. Taylor, L.S., Health Physics , 1, 97, (1958).

...recommended by ICRP in 1934 and continued in use until 1950 (occupational exposure) (see Reference 229, also).

225d. "Radium Protection for Amounts up to 300 Milligrams, "Natl. Bur. Std. (U.S.) Handbook 18, (published for Advisory Committee on X-Ray and Radium (now NCRP)) (1934).

...recommended by NCRP on March 17, 1934 and continued in use in U.S. until 1949. (occupational exposure)...0.1 R/day (0.5 R/wk). See Reference 229 also.

225e. "Safe Handling of Radioactive Isotopes," Natl. Bur. Std. (U.S.) Handbook 42, (1949).

...recommended by NCRP on March 7, 1949 and continued in use until 1956 (occupational exposure) - see Reference 229 also.

225f. "Recommendations of the International Commission on Radiological Protection and of the International Commission on Radiological Units - 1950, "Natl. Bur. Std. (U.S.) Handbook 47 (1951).

...recommended by ICRP in July 1950 - continued in use until 1956 (occupational exposure).

225g. "Report on 1056 Amendments to the Recommendations of the International Commission on Radiological Protection (ICRP)," Radiology, 70, 261 (1958).

...recommended by ICRP in April 1956 (occupational exposure).

225h. "Report on Decisions at the 1959 Meeting of the International Commission on Radiological Protection (ICRP)," Addendum to ICRP Publ. 15, Radiology, 74, 116 (1960).

...ICRP recommendation in July 1959...as maximum exposure to gonads (or total body) - population at large.

225i. "Recommendations of the International Commission on Radiological Protection," ICRP Publ. 1, Pergamon Press, London, 1959.

...recommended by ICRP on Sept. 9, 1958 as average exposure to gonads (or total body), population at large (see Reference 229, also).

225j. "Somatic Radiation Dose for the General Population: Ad Hoc Committee Report of the National Committee on Radiation Protection and Measurements," May 6, 1959, Science, 131, 482 (1960).

...suggested by Ad Hoc Committee on May 6, 1959 for consideration by the NCRP for average exposure to any body organ - population at large.

226. U.S. Nuclear Regulatory Commission Fact Sheet, Office of Public Affairs, Washington, D.C., April 1976.

226a. p.3. In 1949-1950 the two groups (ICRP, NCRP) recommended 0.3 rem/week.

226b. p.3. In 1956-1957 the NCRP and ICRP recommended 5 rem per year.

226c. p.4. FRC established by Eisenhower in 1959 - responsibility transferred to EPA in 1970.

227. Background Material for the Development of Radiation Protection Standards, May 13, 1960, Staff report of the FRC, Reprt No. 1 (see Reference 229 for comparison).

227a. p. 26. Yearly whole body radiation exposure to the of individuals in general population (excluding natural background and deliberate exposure of patients) should not exceed 0.5 rem/year - general population.

227b. p. 38:

Type of exposure	Condition	Dose[1] (rem)
Radiation worker:		
(a) Whole body, head and trunk, active blood forming organs, gonads, or lens of eye.	Accumulated dose	5 times number of years beyond age 18
	13 weeks	3
(b) Skin of whole body and thyroid	Year	30
	13 weeks	10
(c) Hands and forearms, feet and ankles.	Year	75
	13 weeks	25
(d) Bone.....	Body burden	0.1 microgram of radium-226 or its biological equivalent
(e) Other organs.....	Year	15
	13 weeks	5
Population[2]		
(a) Individual[3]..... ...	Year	0.5 (whole body)
(b) Average[3].....	30 years	5 (gonads)

[1]Minor variations here from certain other recommendations are not considered significant in light of present uncertainties.
[2]See Section V for reasons why these values differ from those applicable to radiation workers.
[3]See Paragraph 5.4 for applicability of these levels.

228. Mastbrook, D., Beheler, W., and Kivel, M., Chronology: Occupational Radiation Exposure Limits, DRAFT, July 7, 1978, FDA-Public Health Service, HEW - this DRAFT was prepared for Libassi's interagency task force on the health effects of ionizing radiation (which were issued in final form in June 1979).

228a. p.2. ICRP adopts basic MPD of 0.3 rem/wk for radiation workers.

228b. p.1. ICRP in 1950 adopts 0.3 rads/week.

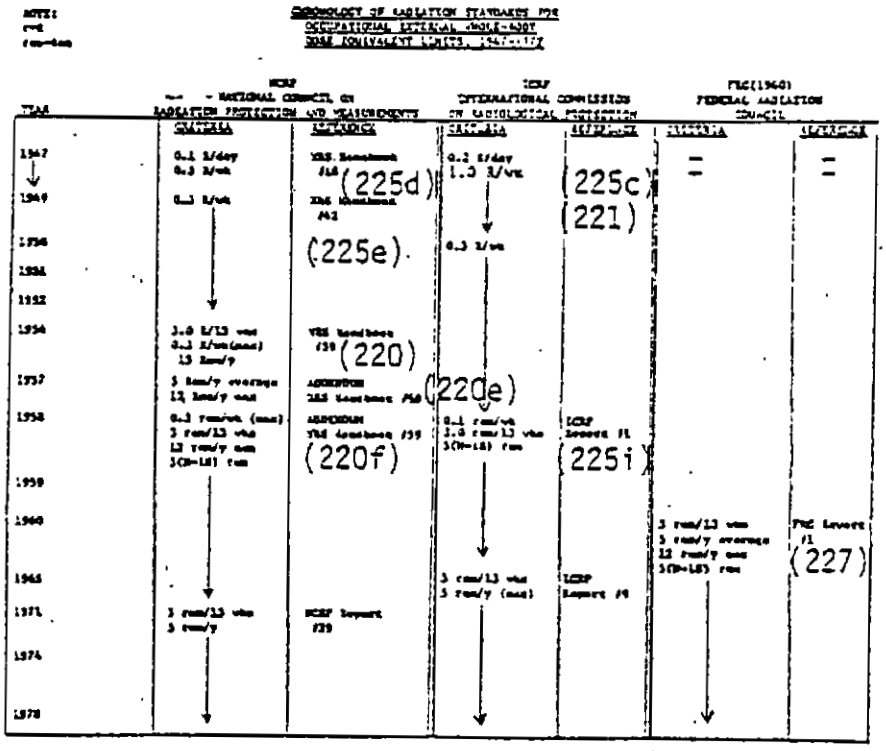
228c. p.2. NAS and ICRP recommend basic permissible dose for radiation workers to be 5 rem/yr.

228d. p.2. ICRP recommends 0.1 rad per week (5 rads/yr).

228e. p.3. FRC recommends in Federal Register publication, an accumulated dose limit for radiation workers of 5 rems (N-18). 13 consecutive weeks exposure.

229. Effects of Radiation on Human Health - Health Effects of Ionizing Radiation, Vol. 1, Hearings before Subcommittee on Health and the Environment of the Committee on Interstate and Foreign Commerce, House of Representatives, 95th Congress, Serial No. 95-179, January 24, 25, 26, and February 8, 9, 14, and 28, 1978.

p. 442:



230. p.10, In-house paper of Edwin T. Still, DVM, Assistant to Director, Biomedical Effects, DNA, (undated), "Radiation Standards and Protection Development."

...on Jan 1, 1961, the AEC dropped the 0.03 rem/wk limit (15 rem/yr) and went to FRC limits of 3 rem/13 weeks, 12 rem/year, and 5 (N-18) rem accumulated.