

**A SUMMARY OF  
INDUSTRIAL ACCIDENTS  
IN USAEC FACILITIES**



UNITED STATES ATOMIC ENERGY COMMISSION  
Safety and Fire Protection Branch  
Office of Industrial Relations

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## PREFACE

The accident experience in the U. S. Atomic Energy Commission contractor operations for the calendar years 1959-60 is reported herein, as a third supplement to TID-5360 entitled, "A Summary of Accidents and Incidents Involving Radiation in Atomic Energy Activities, June 1945 through December 1955." The experience in 1956 was given in Supplement 1, and the experience in 1957-58 in Supplement 2.

Short narrative descriptions of incidents involving radioactive materials have been separated from the total accident experience, because of their special interest to the atomic energy industry. In some instances, the 1959-60 accidents have been added to the tables previously published in which were compiled data beginning in 1945. A new table of inadvertent criticality situations is included in this supplement through the courtesy of Mr. William Stratton of the Los Alamos Scientific Laboratory.

Also included in this supplement is a tabulation of exposure records at values from zero to 15 rems, which reflects a measure of the control of radiation in the work places in Commission operations.

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## SERIOUS ACCIDENTS 1959 – 1960

Serious accidents which occurred in atomic energy facilities, 1959 and 1960, inclusive, are summarized in Table 1. A "serious accident" means an accident required to be reported immediately to Commission Headquarters, and includes any of the following:

- (a) fatalities;
- (b) government property damage of \$5,000 or more;
- (c) an external radiation exposure greater than 15 rems received over a short period of time; and
- (d) other injury or industrial illness, no matter how slight, of five or more persons in one accident, and other defined accidents. (AEC Manual Chapters 0502-04 and 0523-052 give full definitions of immediately reportable accidents.)

## AEC INJURY FREQUENCY RATES

The number of workers injured in 1960 was lower than in any year in AEC's history. (See Chart 1.) The lost time injury frequency for all AEC operations was 1.71 injuries per million man-hours worked, or 24% below the 1959 figure of 2.17 injuries per million man hours (see table below), and 13% below the previous best year of 1957 when the rate was 1.96. While the construction rate was higher than in some previous years, the amount of construction work was less, and construction accident experience did not contribute largely to the over-all experience.

## AEC INDUSTRIAL INJURY FREQUENCY RATES

	<u>1959</u>	<u>1960</u>	<u>% Decrease</u>
Production	1.14	0.73	36
Research	1.97	1.57	20
Services	3.05	2.30	25
Cost-Plus Construction	4.64	4.23	9
Lump-Sum Construction	16.72	13.35	20
Architect-Engineering	2.05	1.48	28
Government	2.14	0.69	68
All	2.17	1.71	24

## CRITICALITY ACCIDENTS IN USAEC FACILITIES

Table 2 is adapted from a list prepared by W. R. Stratton, University of California, Los Alamos Scientific Laboratory, Los Alamos, New Mexico, in which he arranged criticality excursions according to systems. Accidents reported from countries other than the United States

Table 1—SERIOUS ACCIDENTS  
USAEC Facilities, 1959-1960

HS No.*	Date	Operations Office & Contractor	Injury & Loss	Remarks
59-1	1-4-59	SR-E. I. du Pont de Nemours & Co.	0 \$7,000	Gasket on head of secondary condenser in unit failed, allowing hydrogen sulfide gas to flow into water side of heat exchanger. Relief valve vented open due to overpressure. 4-5 T of gas released to atmosphere.
59-2	1-15-49	AL-Reynolds Electrical & Engr. Co.	0 \$20,000	Booms buckled on two 50-T cranes while lifting 65 ft tower weighing 38 T.
59-3	1-17-59	OR-Union Carbide Nuclear Co.	0 \$86,020	Multiple circuit breaker failure led to severe electrical fire.
59-4	2-1-59	AL-Bendix Aviation Corp.	0 \$22,197	Dispatch oven failed when a power relay came loose from side of control box and dropped to bottom of unit. Weight of relay held armature and contacts in closed position, energizing oven heaters.
59-5	2-24-59	AL-University of California (LASL)	2 killed \$27,000	Detonation of explosives instantly killed 2 employees. (See page 22).
59-6	3-25-59	SR-E. I. du Pont de Nemours & Co.	0 \$20,000	Leaking compression fitting.
59-7	3-31-59	HA-General Electric Co.	1st degree burns—face \$9,518	Plutonium glove box explosion. (See page 7).
59-8	4-2-59	SR-E. I. du Pont de Nemours & Co.	0 \$8,700	Solvent transfer truck en route from 200-H Area to plant burial ground suddenly applied brakes at a railroad crossing, causing organic solvent containing intermediate level fission product to overflow into the shallow reservoir on top of truck tank, then radiation solvent dripped onto road surface (0.9 mile). (See page 8).
59-9	4-2-59	OR-Union Carbide Nuclear Co.	0 \$7,485	During removal of obsolete ventilation ducts, a duct was dropped and snapped off a valve on the pump discharge side of coolant cooler.
59-10	4-10-59	HA-General Electric Co.	1 killed 0	Workman straddling 4-in. pipe fell 59 ft. (See page 26).
59-11	4-17-59	OR-Union Carbide Nuclear Co.	0 \$9,886	Electric motor failure.
59-12	4-17-59	AL-Government-owned Property	0 \$12,000	Fire occurred in 1-story bedroom dwelling. The cause was combustible materials in the vicinity of the floor furnace.
59-13	4-28-59	OR-Union Carbide Nuclear Co.	0 \$6,500	Lightning damaged transformer.
59-14	5-13-59	ID-Wright-Cheney-Birch	1 killed 0	Employee was working on 60 ft scaffold when it toppled. (See page 26).
59-15	5-13-59	LAR-Pratt & Whitney Aircraft (CANEL)	0 \$30,000	Electrical fire due to severe arcing on the line side of heater breakers.
59-16	6-3-59	SR-E. I. du Pont de Nemours & Co.	0 \$13,750	Lightning damaged two 750 KVA transformers.
59-17	7-1-59	AL-University of California (LASL)	2 injured 0	3/4-in. copper tubing separated from male section of disconnect when pressure was applied, loose end of tubing whipped around striking and injuring 2 men.
59-18	7-3-59	SAN-University of California (LRL)	0 \$32,000	Overpressure helium system caused release and distribution of small quantity of Curium-244, resulting in contamination of laboratory. No overexposures. (See page 9).
59-19	7-17-59	AL-University of California (LASL)	0 \$10,300	RA-Gas release (See page 10).
59-20	7-18-59	HA-General Electric Co.	0 \$24,500	Fire involving bakery and grocery store. Electrical short in junction box.
59-21	7-27-59	LAR-General Electric Co.	0 \$9,540	Fire in construction contractor's material caused smoke and fire damage to building.
59-22	7-31-59	HA-General Electric Co.	0 \$4,000	Autoclave explosion.
59-23	8-1-59	NY-Princeton University	0 \$12,000	Disruption of water service to stellarator caused by overpressure in well pump supply line.
59-24	8-6-59	AL-Monsanto Chemical Co.	0 \$1,933	Drybox explosion. (See page 11).
59-25	8-7-59	OR-J. A. Jones Construction Co.	1 killed 0	Electrician electrocuted when contacting energized frame of welding machine. (See page 27).
59-26	8-16-59	CH-Atomics International	0 \$24,450	Sodium storage tank exploded.
59-27	8-21-59	SR-E. I. du Pont de Nemours & Co.	0 \$129,324	Solution leaked from the loosened flange during maintenance work on a waste evaporator in hot canyon, vaporized and contaminated a crane. (See page 11).
59-28	9-4-59	LAR-General Electric Co.	0 \$7,500	Wind damage to aluminum side wall of building.
59-29	9-23-59	SR-E. I. du Pont de Nemours & Co.	0 \$14,000	Product loss due to sudden leak at a high pressure valve.
59-30	9-29-59	SR-E. I. du Pont de Nemours & Co.	0 \$50,000	Hurricane damaged water dam.
59-31	10-3-59	SR-E. I. du Pont de Nemours & Co.	0 \$9,750	Overheating caused diesel engine damage.
59-32	10-14-59	AL-University of California (LASL)	4 killed \$5,341	Explosion occurred while disposing of scrap and waste explosives. (See page 28).
59-33	10-16-59	ID-Phillips Petroleum Co.	0 \$61,800	Criticality incident, release of radioactive materials. (See page 12).
59-34	10-30-59	AL-B & R Tub Co., subcontractor Holmes & Narver	0 \$48,396	Barge overturned carrying drill rig and core.
59-35	10-30-59	SNR-General Electric Co.	1 killed† \$100,000	Air-oil explosion occurred in air flask component of a 3,000 psi hydraulic oil system. Fatality was not chargeable to AEC.
59-36	11-3-59	AL-Holmes & Narver	0 \$7,919	LST struck deep water pier during storm causing damage to pier.
59-37	11-20-59	OR-Union Carbide Nuclear Co.	0 \$350,000	Chemical explosion in innercycle evaporator. (See page 13).



Table 1—SERIOUS ACCIDENTS (Cont'd.)

HS No.*	Date	Operations Office & Contractor	Injury & Loss	Remarks
59-38	11-23-59	OR—Mallinckrodt Chemical Co.	0 \$6,000	Overheated flue in gas stack. Incident was probably caused by improper combustion of propane gas or ignition of carbon which had accumulated in some of the stacks.
59-39	12-2-59	AL—Reynolds Electrical & Engr. Co.	1 killed 0	An employee was killed instantly in head-on auto collision. (See page 28).
59-40	12-12-59	SR—E. I. du Pont de Nemours & Co.	0 \$5,200	Loose contaminated particles on the lid of a waste burial box were scattered by the wind, contaminating the ground, locomotive and spacer car. (See page 15).
59-41	12-18-59	CH—Atomics International	1 killed 0	Asphyxiation. Accident occurred at sodium pump loop when an inspector entered a pump casing which was 15 ft deep and about 40 in. in diameter to inspect the collar near the bottom. (See page 29).
59-42	12-23-59	AL—Petroleum Combustion & Engr. Co.	1 killed 0	Failure of a cable caused jib section of crane to fall and drop 1 cu. yd. bucket of concrete on an employee of Petroleum Combustion & Engineering Co. (See page 32).
59-43	12-29-59	OR—National Lead Co. of Ohio	0 \$10,000+	An explosion occurred in digester.
60-3	1-16-60	CH—Argonne National Laboratory	0 \$35,000	Two boilers in a reactor power house exploded due to buildup of fumes in firebox while an attempt was being made to start unit manually. Damage primarily to boiler and adjacent piping with minor building damage.
60-4	1-29-60	AL—Holmes & Narver	1 killed 0	Professional skin diver drowned while performing assigned duties at the Pacific Proving Ground. (See page 31).
60-5	2-12-60	CH—Argonne National Laboratory	0 \$13,115	A reactor vessel holddown plug assembly dropped when being lifted and moved by means of a hand winch. Two riggers were injured, each having a fractured leg. The plug was damaged.
60-7	3-3-60	SAN—University of California (LRL)	0 \$12,500	During the pressing of an experimental high explosive, a detonation occurred.
60-8	3-8-60	OR—Union Carbide Nuclear Co.	1 overexposure 0	An employee was exposed while cleaning up a cell due to the failure of the monitoring system to disclose the presence of radioactive cerium-144. The exposure was 5,550 rads to the hand (beta dose). (See page 16).
60-9	1-29-60	OR—Union Carbide Nuclear Co.	0 \$20,000	Explosion occurred in a uranium sintering furnace located in a foundry. Major structural damage to furnace and buildings.
60-10	3-18-60	SR—E. I. du Pont de Nemours & Co.	0 \$135,300	A hydrogen-sulfide gas release from a process equipment condenser caused a fire. The property damage was to the condenser.
60-11	3-30-60	SR—E. I. du Pont de Nemours & Co.	0 \$6,000	During an electrical storm, lightning struck two 200-hp pump motors in an out-of-door pump pit. The cost was due to rewinding of the burned out motors.
60-12	3-18-60	AL—Reynolds Elec. & Engr. Co.	1 killed 0	While helping to pour 15 gallons of hot soup stock into a steam kettle, a kitchen employee slipped, causing hot soup to spill on his body, resulting in first and second degree burns to chest and inside of thighs—20% of body. Employee died as a result of the burns. (See page 32).
60-13	4-13-60	NY—Harvard University	1 killed 0	While an employee was standing on a 34-inch-wide ground level wall, straightening a reinforcing rod with a length of pipe, the rod broke, and the employee fell 20 ft to a concrete subarea. (See page 32).
60-14	4-17-60	HA—General Electric Co.	0 \$250,443	Fire and explosion in pyrophoric metal contents of a chemical dissolver caused high damage to dissolver, off-gas filter, and related process equipment. Contamination spread to cell, canyon, and crane. The cause or causes of the accident are not established. (See page 18).
60-15	4-26-60	OR—Union Carbide Nuclear Co.	0 \$39,500	An irradiated graphite-clad reactor fuel element was being dry cut inside a hot cell with a remotely operated saw. A change in air pressure inside the cell forced contaminated graphite dust from the cell, and it dispersed into the rest of the building. There were no overexposures. The cost was due to cleanup of the area. (See page 19).
60-16	4-5-60	SR—E. I. du Pont de Nemours & Co.	0 \$216,285	A leak in an outlet nozzle on a reactor necessitated a shutdown. The leak was caused by three cracks extending approximately 2½ in. around the circumference of the nozzle. The cost was chiefly due to the repairing of the nozzle and the loss of heavy water. (See page 17).
60-18	6-15-60	AL—Reynolds Elec. & Engr. Corp.	0 \$9,950	A rigging crew was removing the astrodome from a 20 ft camera tower with a crane. As the dome was being lowered, the sling broke, allowing the dome to fall approximately 10 ft.
60-19	6-11-60	AL—General Electric Co.	0 \$9,098	Failure of overload switches to operate during severe electrical storm caused burnout of transformer.
60-20	6-24-60	ID—Phillips Petroleum	1 injured 0	Employee seriously injured when portion of a stud (concrete anchor nail) ricocheted, entering forehead over right eye and lodging in brain, while using a powder-actuated power tool.
60-21	6-28-60	OR—Goodyear Atomic Corp.	0 \$7,145	The stainless steel lining of a new liquid nitrogen storage tank being installed collapsed when its contents were partly evacuated during an acceptance test.
60-22	7-11-60	AL—Los Alamos Medical Center	0 \$12,000	A 15 KV switchgear located in a subbasement equipment room was damaged by fire.
60-23	7-15-60	OR—Mallinckrodt Chemical Works	0 \$5,000	Hydrogen gas explosion occurred in gas furnace enclosure in metal plant. One employee suffered serious injuries.
60-24	7-6-60	AL—Mound Laboratory	0 \$31,360	The accidental discharge of radioactive material into a room as a result of pressure buildup in a drybox. This was due to an inlet solenoid being locked in the open position and a venting solenoid being closed due to a malfunction. The pressure built up to a point that one of the drybox gloves blew out, thereby releasing radioactive particulate material into the room. Eleven persons received minor exposures. (See page 20).

Table 1—SERIOUS ACCIDENTS (Cont'd.)

HS No.*	Date	Operations Office & Contractor	Injury & Loss	Remarks
60-25	8-31-60	ID—Fluor Corp., Ltd.	1 killed 0	While an employee was painting the handrails around a silo, he suffered fatal injuries when he fell 69 ft. (See page 33).
60-26	9-13-60	SR—E. I. du Pont de Nemours & Co.	0 \$250,000	Contaminated cooling water discharged from canyon onto floor. No overexposures. The large loss was due to decontamination. (See page 20).
60-27	9-29-60	SR—E. I. du Pont de Nemours & Co.	0 \$8,300	Water leaking through roof during heavy rainstorm damaged transformer.
60-28	6/2-6-60	SR—E. I. du Pont de Nemours & Co.	0 \$24,000	During shipment of irradiated fuel elements, 30 to 40 gallons of contaminated water leaked from the cask. The cost was due to decontamination of area. (See page 19).
60-29	8-4-60	OR—Goodyear Atomic Corp.	0 \$18,132	During violent storm, severe power system disturbance caused oil circuit breaker failure.
60-30	10-7-60	AL—Sandia Corp.	0 \$16,500	Beechcraft Drone Aircraft, which was to be used for air sampling, crashed when radio control was lost in desert.
60-31	11-8-60	AL—Sandia Corp.	2 exposures 0	Employees were accidentally exposed to electron beam emanating from a Van de Graaff accelerator. (See page 21).
60-32	9-13-60	LAR—General Electric Co.	0 \$12,000	During an electrical storm lightning damaged transformer.
60-33	7-12-60	HA—Government—Hanford	0 \$6,000	15-mile per hour breeze spread a grass fire over 3,000 acres of AEC property.
60-34	11-2-60	SR—E. I. du Pont de Nemours & Co.	0 \$37,100	Fire in a construction building.
60-35	11-10-60	SAN—University of California (LRL)	0 \$101,000	Fire started in curium processing cave by an apparent overheating of oil bath in glove box. Loss confined to one room, but all contents complete loss. No release of radioactive materials to environment. Induced draft fan failed due to excessive vibration.
60-36	11-10-60	SR—E. I. du Pont de Nemours & Co.	0 \$40,000	Fire occurred in heat paper stored in dry room.
60-37	11-14-60	AL—Sandia Corp.	0 \$32,000	
60-38	12-7-60	OR—Union Carbide Nuclear Co.	0 \$10,036	A full, high pressure, 30-tube gas trailer overturned in the process of coupling to tractor.
60-39	11-18-60	HA—General Electric Co.	1 injured 0	Pipefitter slipped and fell 15 ft down a shaft (in critical condition).
60-40	12-21-60	HA—General Electric Co.	0 \$12,294	Build-up of pressure in a steam autoclave resulted in a blow-off which sent some material from the autoclave through the building roof. No radiation resulted.
60-41	10-4-60	AL—Edgerton, Germeshausen & Grier	2 exposures 0	Two employees were exposed to gamma radiation. (See page 21).
60-42	11-17-60	OR—Union Carbide Nuclear Co.	0 \$103,260	Ten ton cylinder of UF <sub>6</sub> ruptured.
60-43	11/8-28-60	OR—National Lead Co. of Ohio	0 \$5,000+	Slightly enriched uranium tetrafluoride lost through stack of dust collector located in the plant.

\* Office of Operational Safety, USAEC Headquarters, File Number.  
† Navy personnel.

## AEC INDUSTRIAL INJURY RATES 1947-1961

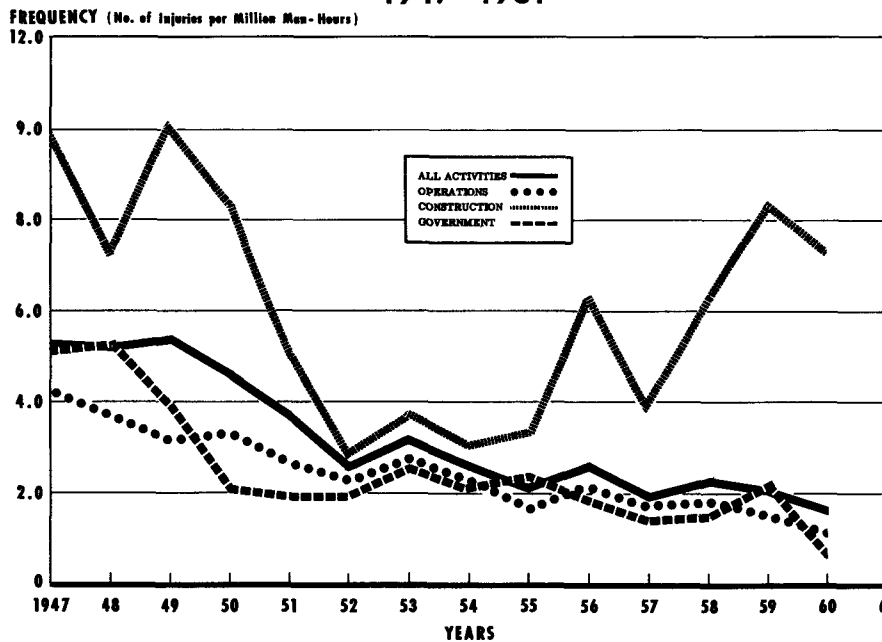


Chart 1

Table 2—CRITICALITY ACCIDENTS IN USAEC FACILITIES\*

Date	Location	Active Material	Geometry	Total Fissions	Cause	Physical Damage
Metal Systems In Air						
Aug. 21, 1945	Los Alamos, New Mexico	6.2 Kg $\delta$ -phase Pu	Spherical core tungsten-carbide reflected	$\sim 10^{16}$	Hand stacking reflector	None
May 21, 1946	Los Alamos, New Mexico	6.2 Kg $\delta$ -phase Pu	Spherical core Be reflected	$\sim 3 \times 10^{15}$	Hand stacking reflector	None
Apr. 18, 1952	The Los Alamos Scientific Lab., New Mexico	92.4 Kg uranium metal, 93% U-235	Cylinder unreflected	$1.5 \times 10^{16}$	Computation error	None
Feb. 3, 1954	The Los Alamos Scientific Lab., New Mexico	53 Kg uranium metal, 93% U-235	Sphere unreflected	$5.6 \times 10^{16}$	Incorrect operation	Slight warping of pieces
Feb. 12, 1957	The Los Alamos Scientific Lab., New Mexico	54 Kg uranium metal, 93% U-235	Sphere unreflected except for experiment	$1.2 \times 10^{17}$	Shift of experiment	Warping, oxidation near melting close to center
Solution Systems						
Dec., 1949	The Los Alamos Scientific Lab., New Mexico	$\sim 1$ Kg U-235 $UO_2(NO_3)_2$ in 13.6 liters water	Sphere graphite reflected	$3-4 \times 10^{16}$	Manual withdrawal of two poison control rods	None
Nov. 16, 1951	The Hanford Works, Richland, Washington	1.15 Kg Pu $PuO_2(NO_3)_2$ in 63.8 liters water	Sphere 93% full unreflected	$8 \times 10^{16}$	Poison control rod run out too fast	None
May 26, 1954	The Oak Ridge National Lab., Tennessee	18.3 Kg $U^{235}$ $UO_2F_2$ in 55.4 liters water	Cylindrical annulus unreflected	$1 \times 10^{17}$	Tilting of inner poison cylinder	None
Feb. 1, 1956	The Oak Ridge National Lab., Tennessee	27.7 Kg $U^{235}$ $UO_2F_2$ in 58.9 liters water	Cylinder unreflected	$1.6 \times 10^{17}$	Falling scram set up waves creating a critical geometry	Warping of bottom of cylinder
June 16, 1958	Y-12 Processing Plant, Oak Ridge, Tennessee	2.5 Kg $U^{235}$ $UO_2(NO_3)_2$ in 56 liters water	Cylinder concrete reflected below	$1.3 \times 10^{18}$	Wash water added to $UO_2(NO_3)_2$ solution	None
Dec. 30, 1958	The Los Alamos Scientific Lab., New Mexico Pu Processing Plant	3.27 Kg Pu $PuO_2(NO_3)_2$ in $\sim 168$ liters water	Cylinder water reflected below	$1.5 \times 10^{17}$	Agitator created a critical geometry	None
Oct. 16, 1959	Chemical Processing Plant, Idaho Reactor Testing Area	34.5 Kg $U^{235}$ $\sim 800$ liters $UO_2(NO_3)_2$ water	Cylinder concrete reflected below	$\sim 4 \times 10^{18}$	Solution siphoned from safe to unsafe geometry	None
Jan. 25, 1961	Chemical Processing Plant, Idaho Reactor Testing Area	8 Kg $U^{235}$ $UO_2(NO_3)_2$ in 40 liters water	Cylinder	$6 \times 10^{17}$	Solution pumped from safe to unsafe geometry	None
Inhomogeneous Water Moderated Systems						
June 4, 1945	Los Alamos, New Mexico	35.4 Kg uranium $\sim 83\%$ $U^{235}$ $\frac{1}{2}$ -in. cubes	Pseudosphere water reflected	$\sim 3 \times 10^{16}$	Water seeping between blocks	None
Feb. 1, 1951	The Los Alamos Scientific Lab., New Mexico	2 cylinders uranium 24.4 and 38.5 Kg 93% $U^{235}$	2 cylinders water reflected	$10^{17}$	Scram increased reactivity	Slight oxidation
June 2, 1952	The Argonne National Lab.	6.8 Kg $U^{235}$ oxide particles in plastic	Inhomogeneous cylinder water reflected	$1.22 \times 10^{17}$	Manual withdrawal of central safety rod	Plastic destroyed
July 22, 1954	The Reactor Testing Area, Idaho Falls, Idaho	U-Al plates clad with Al	Inhomogeneous cylinder water moderated	$4.68 \times 10^{18}$	Estimate of expected excursion too low	Reactor destroyed
Jan. 3, 1961	Idaho Reactor Testing Area	U-Al plates clad with Al	Inhomogeneous cylinder water moderated	$1.5 \times 10^{18}$	Not determined	Extensive to reactor
Miscellaneous Systems						
Feb. 11, 1945	Los Alamos, New Mexico	$UH_3$ pressed in styrex	Cylinder	$\sim 6 \times 10^{15}$	Reflector added and/or source too large	$UH_3$ -styrex cubes swollen and blistered
Nov. 29, 1955	Idaho Reactor Testing Area	$\frac{1}{2}$ -in. $U^{235}$ rods	Cylinder, rods cooled by NaK	$4.7 \times 10^{17}$	Incorrect scram used	Core molten
July 3, 1956	The Los Alamos Scientific Lab., New Mexico	58 Kg uranium 93% $U^{235}$ , 2 and 5 mil foils	Cylinder	$3.2 \times 10^{16}$	Too rapid assembly	None

\* For additional information on these accidents, see previous TID-5360 series and "A Review of Criticality Accidents" by W. R. Stratton, University of California (LASL).

have been omitted from his original list. Only criticality accidents in AEC contractor plants are listed.

## RADIATION EXPOSURE OF AEC CONTRACTOR PERSONNEL

In the course of their work, some employees at atomic energy installations may receive exposure to radiation. This is kept to a minimum consistent with the benefits to be derived. A survey of the Commission's contractor employees showed that of the more than 75,000 contractor employees monitored in 1959 and 82,000 employees in 1960, 99.9 per cent received less than 5 rems within the year and that 94.5 per cent received only one rem or less. These exposures are well within the limits defined for atomic energy contractor workers. Table 3 gives details for the two years.

Table 3— EXPOSURES OF CONTRACTOR PERSONNEL TO  
PENETRATING RADIATION, SUMMARIZED FOR 1959 and 1960

Range of Annual Total Exposure in Rems*	1960 No. of Employees	1959 No. of Employees
0-1	77,522	71,600
1-2	2,828	2,584
2-3	1,405	979
3-4	283	236
4-5	113	113
5-6	24	29
6-7	10	16
7-8	3	11
8-9	2	5
9-10	2	5
10-11	2	1
11-12	0	0
12-13	0	1
13-14	0	0
14-15	0	0
15 plus	3†	1†

\* The rem is a measure of the dose of any ionizing radiation to body tissues in terms of its estimated biological effect relative to a dose of one roentgen of high voltage x-rays.

† See HS-59-103, page 6; HS-60-31, page 21; HS-60-41, page 21.

## ACCIDENTS INVOLVING RADIOACTIVE MATERIAL IN ATOMIC ENERGY ACTIVITIES 1959 — 1960

The following descriptions add details to accidents involving radiation, already listed as accidents in Table 1, and report a few others of less concern.

### RADIATION EXPOSURE

Livermore, Calif., Jan. 6, 1959—Ref: —HS-59-103

#### *Nature of Accident*

Physicist was exposed to radiation from an electron accelerator.

### *Description of Operation*

A new electron linear accelerator was being operated to accumulate data to enable the engineering section to design permanent equipment for this machine. A number of remote operating circuits were not in operation, including remote controls for the tungsten beam definers, remote radiation monitoring system, and the interlocked barrier to the beam room area. The barrier was temporarily replaced by 4 x 4 ft plywood and a warning sign.

### *Details of Accident*

A series of adjustments were being made on beam defining plates. Radiation surveys were made with negative results when personnel entered the cell after the first three adjustment runs. No survey was made after the fourth and fifth runs. A survey made after the sixth run showed 1,000 r per hour level.

During all entries to the cell, the key which was designed to lock all controls in the "OFF" position was removed from the control panel.

### *Nature of Injuries or Loss*

It was determined that the film badges had been exposed to about 200 kev energy gamma radiation. An exposure dose of 41 r was assigned to physicist A. This dose was received in a period of about one minute, which was the established time he worked alone on plates 3 and 4 and entered the cell to measure very high radiation levels. The next highest reading of 400 mr was received by physicist B. All others received less than 50 mr.

### *Remarks*

Reliance was placed for safe operation on incomplete safety interlock circuits. Extreme care should be exercised in all situations where it is known that mechanical safety may be incomplete or inoperative.

## **EXPLOSION**

Richland, Wash., Mar. 31, 1959—Ref: —HS-59-7

### *Nature of Accident*

Explosion in glove box spread contamination.

### *Description of Operation*

Experimental machining of plutonium in glove box.

### *Details of Accident*

Two employees, S and D, were doing experimental machining on pieces of plutonium. Four other employees were nearby. The work site was a glove box machining hood.

While D was machining the last cut, S was assisting with the customary removal and storage of plutonium turnings in a metal can. The explosion occurred during the third pass. Both S and D saw an orange flame that seemed to start from the floor of the hood and expand in a split second like a ball until it filled the hood.

Housekeeping in the hood was good. The glove box was clear of turnings and the three Pu pieces were still in a plastic bag. The only other combustibles were placed away from the machine out of range of any sparks.

In machining the face of a narrow piece, as in this case, the tool strikes the metal several times a second and makes sparks with nearly every contact. In a normal air atmosphere, the sparking is more pronounced. Common practice in this and similar glove box work is to inert the atmosphere by charging the box with argon. The argon does not displace the air completely, but dilutes it so that the oxygen content is kept low. With some materials, for example,

when using carbon tetrachloride as a coolant, experience had shown the argon atmosphere to be unnecessary. Thus, the need to use argon came to be a matter of judgment. In this case, the operator did not use the argon.

The coolant used depends on the metal being machined. For this application, *trichloroethylene*,  $\text{HClC:CCl}_2$ , was stipulated. Reasons for its use were its relatively low toxicity, its volatility, and its listing as a nonflammable material.

On March 30, the day before the explosion, the operator of the lathe set out to replenish the coolant supply in the lathe's reservoir and obtained a 5-gallon safety can full from the drum of *trichloroethane*. The significant factor in this action is the label on the drum from which he drew. It read:

CHLOROTHENE  
inhibited  
1, 1, 1-trichloroethane

The possibility of mistaking a material so labeled for trichloroethylene is obvious.

This substitute solvent was used all day on the 30th without incident. A half hour before the explosion on the 31st, the operators noticed a little puff of smoke within the hood.

Trichloroethane, as well as trichloroethylene, has no flash point and is listed as nonflammable. After this incident, however, it was demonstrated in a mockup glove box, that explosions can be produced by boiling either solvent in a static atmosphere. The experiment consisted in evaporating about 200 cubic centimeters of solvent from a beaker over an open-wire hot plate. Cloudiness in the hood, evidently from thermal decomposition of the vapors, preceded an explosion. With *trichloroethane*, 4 to 8 minutes were required to produce the explosion. With *trichloroethylene*, the explosion required about six times as long. Ignition in the accidental explosion was probably supplied by the sparking plutonium fragments. (Note: Common thermal decomposition products of these two solvents are  $\text{CO}$ ,  $\text{COCl}_2$ , and  $\text{HCl}$ .)

The principal causes of this accident appear to have been: (1) inadequate labeling of solvent containers and lack of control in disbursement of hazardous materials; and (2) failure to establish an inflexible procedure requiring inert atmosphere in plutonium machining operations.

#### *Nature of Injuries or Loss*

Bio-assay sampling results currently indicate an internal deposition probably less than 20% of the maximum permissible limit in one individual.

Physical damage was limited to the lucite panels of the hood, costing \$200, and replacement cost of the alpha monitoring instrument, valued at \$1,449, which could not be decontaminated.

## RADIOACTIVE SOLVENT CONTAMINATED ROADBED

Aiken, S. C., Apr. 2, 1959—Ref: —HS-59-8

#### *Nature of Accident*

Contaminated solvent spilled on roadbed.

#### *Description of Operation*

Transporting organic solvent containing intermediate level fission products to plant burial ground.

#### *Details of Accident*

While contaminated process solvent was being transported to underground storage tanks in the burial ground, a small volume (estimated at less than one gallon) of the solvent leaked

from the forward hatch of the solvent trailer and dripped onto the roadway. Approximately one-half mile of road was spot contaminated from the railroad crossing to the burial ground. Radiation levels at these spots ranged up to 8,000 c/m.

Investigation of the incident has shown that the contaminated process solvent leaked out of the forward hatch cover of the tank trailer. The retaining wing-nut had been replaced with an ordinary nut which, investigation showed, can slip out of place even though it appears to be properly tightened. Since the rate of radiation exposure to personnel loading the tank trailer was as high as 1,500 mr/hr and the forward hatch is seldom used, except when cleaning the tank trailer, the hatch was not inspected before the tank trailer left the area. Five loads of this solvent had already been transported to the burial ground without incident.

#### *Nature of Injuries or Loss*

The solvent dissolved into the asphalt of the roadway quickly upon contact. The cost of cleanup was \$8,700.

## **CURIUM 244 CONTAMINATION**

Berkeley, Calif., July 3, 1959 --Ref: —HS-59-18

#### *Nature of Accident*

Overpressurization of a box for helium cooling blew out and caused disintegration of thin experimental foil containing  $10^{11}$  DPM of Curium 244.

#### *Description of Operation*

Bombardment of curium targets by degraded heavy ion beam.

#### *Details of Accident*

An experimental setup included two curium targets in a helium atmosphere for intended bombardment by degraded heavy ion beam. Each target contained approximately 150 micrograms of curium (95% Curium 244; 5% heavier isotopes) electroplated on a 0.0001 inch nickel foil spot-welded across a  $\frac{1}{4}$ -in. diameter hole in a stainless steel plate. The target chamber was separated from the vacuum by the degrading-foil assembly consisting of variable aluminum absorbers mounted in a circulating helium cooling atmosphere. Windows of 0.0001 inch nickel foil across  $\frac{3}{8}$ -in. diameter holes were used to allow passage of the beam through this unit.

Prior to performing the experiment, it was necessary to remove air by flushing the degrading-foil chamber with helium which was then bled out to the cave. After this purge operation had been completed—a matter of 10-15 minutes—the experimenter closed the helium bleed valve to the cave but forgot to open the return valve on the system to complete the gas circuit for the circulation pump. He then turned on the helium circulating pump which caused helium pressure increase to approximately 9 psi, at which point the window exploded. The curium target material “literally exploded,” blowing curium dust into the cave. Natural draft carried much of the activity over the cave shielding wall into the main accelerator room. Natural air currents and ventilating blowers further distributed contamination throughout the building. The experimenter, upon hearing a sound, entered the cave to investigate and noticed the broken window on the target side. An alpha meter check showed  $10^5$  counts per minute on the target side of the absorber changer and upwards of  $10^4$  counts per minute on the floor, table, apparatus, and himself.

#### *Nature of Injuries or Loss*

The cost of labor, material, and other charges relating to this “spill” amounted to about \$30,500 without overhead; equipment loss was held to less than \$2,000. The loss time of the

operation of the high energy linear accelerator has been estimated at \$26,000. Total loss from the incident approximated \$58,500.

## **FIRE IN FILTERING SYSTEM**

Los Alamos, N. Mex., July 15, 1959—Ref: —HS-59-194

### *Nature of Accident*

A fire occurred in a unit air filter.

### *Description of Operation*

Installation of a new ventilation and filtering system.

### *Details of Accident*

A unit filtering system on the east side of the room was in process of revision when the "asbestos" filter caught fire from sparks or hot metal from a welding torch.

This filter was the old type CWS filter, consisting of a plywood frame, 24 × 24 × 12 in., filled with felted asbestos paper between cardboard spacers. The spacers were coated with sodium silicate fire retardant. This filter had been in use for about 4½ to 5 years and was heavily loaded with dust from the plutonium metal production lines in that room. As a result of the fire, the room was heavily alpha contaminated. Some surrounding ground was contaminated to a level of about 20,000 d/m.

Since the operation being performed, that of changing the ventilation system, was a contaminated operation, the workers in the room were wearing respiratory protection and protective clothing at the time of the fire.

Combustion seems to have involved the plutonium compounds caught in the filter, for it is difficult to understand how such temperatures could have evolved from the relatively small amount of combustible material in the filter itself. The stainless steel filter holder and a length of duct remained red hot for several minutes after the filter burned.

### *Nature of Injuries or Loss*

Since the old filter was scheduled for disposal, no property damage resulted from the fire. The cost of decontamination of the room involved and its surrounding grounds was \$1,000 to \$1,500.

## **RADIOACTIVE RELEASE TO ATMOSPHERE**

Los Alamos, N. Mex., July 17, 1959—Ref: —HS-59-19

### *Nature of Accident*

Release of radioactive gas to atmosphere.

### *Description of Operation*

Changing a low pressure gas system to high pressure.

### *Details of Accident*

Prior to an experiment, a low pressure gas line containing radioactive gas was being pumped out preparatory to transferring the gas to a high pressure system. During this operation, radioactive gas was released to the atmosphere through a valve on the low pressure line,



which was either inadvertently left open or the switch controlling the valve was accidentally knocked open.

*Nature of Injuries or Loss*

Personnel exposure was insignificant.  
Loss of radioactive gas amounted to \$10,300.

## DRY BOX EXPLOSION

Miamisburg, Ohio, Aug. 6, 1959—Ref: —HS-59-24

*Nature of Accident*

Spontaneous explosion in a dry box.

*Description of Operation*

Process and electrolysis dry box line.

*Details of Accident*

A laboratory technician filtered 800 milliliters of a solution presumed to be contaminated wash water in a polyethylene beaker standing in a hood. The solution then was transferred by vacuum into a temporary storage bottle in another hood. He also transferred into this storage bottle a solution of nitric acid in which some nickel containers for polonium had been dissolved and which had been left standing until reaction had been completed. The bottle was vented and was being allowed to stand until the next day. Upon investigation, it was found that the polyethylene beaker contained acetone wash from the previous day. When no sink was available, it was the custom to place this wash into the storage bottle until proper disposition could be made. This combination of acetone wash (unknown at time by the laboratory technician) and nitric acid solution produced the chemical explosion. This explosion shattered the storage bottle (four-liter) and glass apparatus in the hood; broke the viewing window in the hood; split the door and tore off the latch on the back of the hood; ruptured the gauntlets and spread the 39 curies of polonium into the room and corridor.

*Nature of Injuries or Loss*

No personal injuries resulted as no one was present at the time of the explosion.  
Some equipment was contaminated. Total cost \$1,900.

## CONTAMINATION ACCIDENT

Aiken, S. C., Aug. 21, 1959—Ref: —HS-59-27

*Nature of the Accident*

A crane in a chemical separations plant was contaminated with high level radioactive solution.

*Description of the Operation*

Chemical separations equipment housed in shielded "canyons" is operated remotely by use of an overhead crane and other devices.

*Details of Accident*

In an attempt to locate and correct pluggage, three hot canyon cell covers were removed with a crane and the remote disconnect type flanges loosened on the discharge connection from

a thermally hot, high activity waste evaporator. Solution leaking from the loosened flange vaporized as it hit the hot evaporator. Thermal currents carried highly radioactive vapors from the cell, grossly contaminating the crane. Radiation readings as high as 50 r at four feet at one point made direct maintenance to the crane impracticable. Concurrently with the events described above, continuous monitors detected existence of slightly above permissible tolerance levels of airborne radioactivity in certain sections of the building occupied by employees. For a brief period, masks were required for use by all personnel, except those in one section of the building.

#### *Nature of Injuries or Loss*

With the crane out of service, it was necessary to terminate temporarily hot cell operations until decontamination could be effected by hydrocleaning methods. There was production down time during cleaning operations. There were no exposures to radiation above allowable limits.

There was no property damage beyond the loss of use. Cleaning operations costs were approximately \$129,000.

#### *Remarks*

The incident outlined above led to a number of studies aimed at minimizing future risk of similar occurrences. These include provision of evaporator cooling facilities (which had not been provided in initial design), modification of cell operating procedure to require cooling and spray-down with water before removing cell covers, provision of a second crane, and studies to increase differential ventilating air pressures between the canyon cells and the canyon area.

## CRITICALITY INCIDENT

Idaho Falls, Idaho, Oct. 16, 1959—Ref: —HS-59-33

#### *Nature of Accident*

A nuclear incident occurred in a process equipment waste collection tank at one of the AEC chemical processing plants.

#### *Description of Operation*

This facility is used for processing stainless steel-clad highly enriched uranium fuels.

#### *Details of Accident*

The incident resulted from the accidental transfer of about 200 liters of uranyl nitrate solution containing about 34 kilograms of enriched uranium (91 per cent U-235) from critically safe process storage tanks to a geometrically unsafe tank through a line normally used for waste transfers.

Although no specific instances of maloperation were found, the lack of critical analysis of the operating equipment for possible sources of trouble (e.g., air lines without flow restricting orifices, valving of lines from critically safe to critically unsafe vessels, and pressure gauge installation unknown to operators using the equipment) and the lack of careful attention to initial operations in seldom-used equipment appears to represent significant errors of omission in a plant as complex as this one.

#### *Nature of Injuries or Loss*

Limited visual inspections and tests indicated that no significant property damage or loss resulted beyond the approximately \$60,000 cost to recover contaminated uranium solution resulting from the incident.

Of the 21 personnel directly involved in this incident, 7 received external exposure to radiation worth mention. Of the 7, none received a year's maximum permissible "whole body" exposure of penetrating radiation. Two exceeded the year's maximum permissible exposure to the skin. As reported, these individual external exposures were 50 rem and 32 rem. No medical treatment was required for the 21 personnel involved.

## STACK RELEASE

Oak Ridge, Tenn., Nov. 11, 1959—Ref: —HS-59-259

### *Nature of Accident*

Particles of radioactive elements were accidentally released from a stack.

### *Description of Operation*

Plant operation.

### *Details of Accident*

A small amount of ruthenium 106 and rhodium 106 was released from a stack and settled to the ground in the immediate vicinity. The release is believed to have resulted from repair of a fan used with the stack. Materials apparently accumulated during the operation of a less powerful fan and were discharged when the repaired fan was restarted.

### *Nature of Injuries or Loss*

The release represented no hazard to the public or to the employees.

## EXPLOSION RELEASES PLUTONIUM

Oak Ridge, Tenn., Nov. 20, 1959—Ref: —HS-59-37

### *Nature of Accident*

An explosion in a processing vessel during a cleanout and decontamination procedure caused extensive contamination.

### *Description of Operation*

Cleanout and decontamination of a processing vessel in a radiochemical pilot plant.

### *Details of Accident*

The pilot plant was on shutdown status at the time of the accident, except for the decontamination operations in progress.

Two days prior to the accident, a decontaminating agent was added directly to the evaporator section and heated. This was followed by a water wash and then a 30% HNO<sub>3</sub> treatment. The desired results were not obtained and more drastic efforts were made.

Events leading up to the accident are reported as follows: 200 liters of the decontaminant were added to the condensate tank and jetted to the steam stripper, which drains into the evaporator. After boiling for two hours (in the evaporator), the decontaminant was run out through the remotely operated normal drain, which was somewhat above the lowest point of the system, leaving an approximate 15 liter "heel." This could only be drained through a hand-operated valve on the extreme bottom of the system. High radiation levels in the cell would not permit entry by personnel.

Two hundred seventy liters of 20% HNO<sub>3</sub> were then added directly to the evaporator (skipping the water wash and neutralizer recommended by the manufacturer), combining with the remaining decontaminant, and boiled for about two hours, concentrating the HNO<sub>3</sub>. The remotely-operated evaporator drain valve was opened, and while draining, the explosion occurred.

#### *Nature of Injuries or Loss*

A small residue of plutonium was blown out, contaminating nearby buildings, several vehicles, roadways, and grounds in an area of approximately four acres. No one was injured by the blast. The immediate area was evacuated and steps were taken to avoid excessive exposure of persons entering the contaminated area to radioactivity.

As later determined, damage to processing equipment as a direct result of the explosion amounted to \$10,000.00 and decontamination costs are estimated at approximately \$350,000.00.

## **POLONIUM 210 EXPOSURE**

Miamisburg, Ohio, Nov. 30, 1959 --Ref: --HS-59-272

#### *Nature of Accident*

Two employees received internal body burdens of polonium 210, approximately twice the maximum continuous body burden permissible at this laboratory.

#### *Description of Operation*

Maintenance work in polonium area at a laboratory.

#### *Details of Accident*

On November 30, 1959, two sheet metal workers were assigned the job of changing supply and exhaust lines on a group of highly contaminated closed hoods. The job was difficult and took considerable time to complete.

#### *Nature of Injuries or Loss*

The result of a 24-hour urine specimen submitted by one employee on December 21, 1959, indicated that his body burden on that day was approximately 1.37 times the maximum permissible continuous body burden. Based on a 36-day effective half-life, his initial body burden on November 30, 1959, would have been approximately 2.05 times the permissible.

The result of the other employee indicated 1.99 times at time urine specimen was taken, which would be approximately 3.90 times the permissible at time of incident.

## **RUPTURED LINE SPRAYS CONTAMINATION**

Idaho Falls, Idaho, Nov. 30, 1959 --Ref: --HS-59-267

#### *Nature of Accident*

Failure of equipment.

#### *Description of Operation*

Reactor.

### *Details of Accident*

Rupture in a reactor core section of an inpile tube caused spread of highly contaminated liquid (approximately 25 rep/hr at 1 ft).

### *Nature of Injuries or Loss*

Cleanup of decontaminated area and replacement of damaged instruments caused by the spraying liquid cost \$4,720.

## **ON-SITE RAILROAD AND GROUNDS CONTAMINATION**

Aiken, S. C., Dec. 12, 1959—Ref: —HS-59-40

### *Nature of Accident*

Contamination of equipment, on-site railroad and grounds from burial box.

### *Description of Accident*

On Saturday, December 12, 1959, at approximately 11:00 p.m., during railroad transportation of a burial box containing canyon pipe jumpers, radioactive particulate matter was shaken loose from the box, resulting in the spread of contamination along the railroad right-of-way. The diesel locomotive and several spacer cars were also contaminated.

Investigation of the incident has shown that the lid of the box which was stored in the canyon probably became contaminated due to the numerous crane movements over it while loading the jumpers into the box, and later this material (radioactive particulate matter) was scattered by the wind during movement of the train.

### *Nature of Injuries or Loss*

Cost of removal of the contaminated soil and decontamination of the diesel locomotive and railroad cars was \$5,200.

### *Remarks*

Procedures for handling burial boxes have been reviewed with special consideration being given to (1) storage of the burial box lid in a location to minimize external contamination, (2) establishing a method for obtaining more detailed Health Physics surveys on all high level shipments and (3) scheduling the removal and burial of equipment so that there will be a minimum of movement of the loaded burial box.

## **PLUTONIUM INCIDENT**

Los Alamos, N. Mex., Jan. 15, 1960—Ref: —HS-60-2

### *Nature of Accident*

A glass bottle containing a plutonium solution ruptured in laboratory.

### *Description of Operation*

Thermal decomposition studies of plutonium trichloroacetate.

### *Details of Accident*

Plutonium trichloroacetate had been prepared for thermal decomposition studies, the material had been heated in air to 800°C, and showed no instability. After the research work was completed, the acetate was ground up, and dissolved in about 500 cc of 4-5 molar nitric acid. The solution was filtered, and the filtrate was allowed to stand in an open container in a glove

box for about three weeks. On the morning of January 15, 1960, the filtrate was transferred to a ground glass stoppered bottle, sealed in a plastic bag, removed from the glove box, placed in a stainless steel transfer can, and placed on a shelf. A short time thereafter, the bottle erupted, contaminating the walls and ceiling of the room.

#### *Nature of Injuries or Loss*

Three men were present at the time of the incident. Twenty-four-hour urine sample evaluations are as follows: 2.3; 2.0; and 6.8 disintegrations per minute.

The cost of decontamination of the laboratory was \$4,000.

## **FIRE RESULTED IN SPREAD OF RADIOACTIVE PARTICLES**

Richland, Wash., Feb. 25, 1960—Ref: —HS-60-6

#### *Nature of Accident*

A small fire resulted in spread of radioactive material in a limited area.

#### *Description of Operation*

The incident occurred during installation of equipment in one portion of the building.

#### *Details of Accident*

The fire occurred during the welding of a two-inch diameter pipe duct into the top of the ion exchange hood in a cell. At the start of the welding operation, a spark dropped into the hood and two small fires occurred, which in turn ignited an 8 × 8 × 6 in. CWS nonfire-resistant inlet filter. Openings in the hood, caused by the fire and attempts to extinguish it, allowed contamination to be spread to adjacent rooms and the corridor.

#### *Nature of Injuries or Loss*

Six workers in the vicinity were exposed to external contamination. All six were wearing respiratory protection and protective clothing. After routine decontamination procedures, all of the men were released to return to their homes shortly after their shifts were completed.

Equipment losses and decontamination costs were \$4,250.

## **RADIATION EXPOSURE**

Oak Ridge, Tenn., Mar. 8, 1960—Ref: —HS-60-8

#### *Nature of Accident*

An employee received a radiation exposure to the skin above the level established for routine occupational activities.

#### *Description of Operation*

Scheduled cleanup of a cell used for handling radioactive materials.

#### *Details of Accident*

The employee was exposed while performing routine cleanup in the cell under a time limit designed to limit his exposure. The time limit was based on the radiation levels previously measured in the cell. Contrary to established procedure, the employee did not wear a face mask but did wear the customary protective clothing.

### *Nature of Injuries or Loss*

The employee received a beta dose (relatively nonpenetrating) estimated at up to 5500 rads to the dead outer surface of the skin. The dose was about 2,000 rads at 2 millimeters below the skin surface, the depth at which skin reactions occurred.

He developed erythema (redness of the skin) on his fingers and hand.

## **NOZZLE LEAK**

Aiken, S. C., April 5, 1960 -Ref: —HS-60-16

### *Nature of Accident*

A leak in an outlet nozzle on a reactor.

### *Description of Operation*

Reactor operation.

### *Details of Accident*

The reactor was shut down to locate the source of D<sub>2</sub>O leakage around a reactor outlet line. The elevation of the leak was determined by hydraulic tests, and excavation through the concrete biological shield revealed that the leak point was a crack in one of the suction nozzles.

### *Nature of Injuries or Loss*

The foiled section of the nozzle was removed and repair was effected. Cost \$216,285 for repairs and heavy water loss.

## **PLUTONIUM POWDER SPILL**

Los Alamos, N. Mex., April 13, 1960 -Ref: —HS-60-145

### *Nature of Accident*

A spill of plutonium powder occurred during an experiment.

### *Description of Operation*

Hot laboratory.

### *Details of Accident*

A spill of plutonium powder occurred during an experiment. The building where the spill occurred was designed for "hot" operations. The building consists of three rooms: a hot lab, a change room with shower and washroom facilities, and a cold lab for instrumentation and control purposes. These three rooms are directly connected by doorways with the change room in the middle. The building is equipped with a ventilation system which is intended to provide a pressure differential between the hot side and cold side.

The spill occurred as a result of the failure of an experimental device used to inject plutonium powder into a receiver.

To operate the system, a valve between the He reservoir and the Pu powder is opened by hand. The He gas is then remotely released from the reservoir. As the He flows through the Pu powder cell, the Pu powder is ejected and carried by the gas flow into the receiver. A

needle valve, located between the receiver and filter, is slowly opened by hand, allowing the gas to exhaust from the system. The Pu is retained by the filter and may be recovered.

The He reservoir, Pu powder cell, and receiver had been tested with pressures of 10,000 psi, 7,000 psi, and 750 psi, respectively. The pressure of the system after the gas has stabilized is approximately 170 psi. The joint which failed was a silver-soldered joint on the exhaust side of the Pu powder cell. This joint had not been pressure-tested but the system had been operated three times, using inert powders, without showing signs of leakage. For the operation in which the spill occurred, the powder cell was loaded with 1.5 gm. of Pu-239 oxide, of about 1 micron particle size.

At the time of the experiment, there were six people in the cold room. Three constituted a monitoring team and were dressed in protective clothing. About a minute or two after the first valve was opened, the monitoring team left the cold room and two of them entered the hot room to check the device for leaks. On opening the door to the hot room, a high count was evident. The pressure gauge on the receiver read zero, indicating that a leak had occurred. They immediately closed the door, returned to the cold room and had the other people leave.

All of the monitoring meters were contaminated so the Rad-Safe Group was called for assistance and uncontaminated meters.

Subsequent examination of the experimental system showed that all high pressure fittings were tight. Discoloration of the high pressure tubing on the exhaust side of the Pu powder cell indicated that a leak had occurred in this silver-soldered joint.

#### *Nature of Injuries or Loss*

It is estimated that 300 mg. of plutonium powder was released into the room. Two of the personnel who entered the room received no plutonium in the body and the other received a trace amount. Estimated decontamination costs are \$2500.

## **DISSOLVER ACCIDENT**

Richland, Wash., Apr. 17, 1960—Ref: —HS-60-14

#### *Nature of Accident*

Fire and explosion in a dissolver with contamination spread.

#### *Description of Operation*

Extracting and refining of special materials from irradiated fuel materials.

#### *Details of Accident*

Fire and explosion in pyrophoric metal contents of a chemical dissolver caused high damage to dissolver, off-gas filter, and related process equipment. Contamination spread to cell, canyon, and crane. The cause or causes of the accident are not established.

#### *Nature of Injuries or Loss*

There were no injuries and no radiation exposures to personnel. Approximate government loss, \$250,000.

## **PERSONAL CONTAMINATION INCIDENT**

Richland, Wash., Apr. 26, 1960—Ref: —HS-60-17

#### *Nature of Accident*

An employee was pierced by a splinter of metallic plutonium through the rubber glove he was wearing.



### *Description of Operation*

Arranging equipment in a hood.

### *Details of Accident*

An employee was positioning a graphite funnel, preparatory to making a casting of plutonium. The employee felt a slight pricking sensation in his right forefinger while positioning the graphite funnel. The work was being accomplished in an enclosed glove box utilizing 30 mil neoprene gloves. When the employee withdrew his hands from the glove box gloves, a check with a radiation detection instrument showed his surgical glove on his right hand contaminated to greater than 80,000 d/m.

### *Nature of Injuries or Loss*

After the removal of the splinter, the employee was taken to whole body counter facilities where a count indicated 90,000 d/m still remaining in the wound. The physician excised a section of tissue and a follow-up count indicated 600 d/m remaining in the wound. A urine sample was then collected, the first void since the incident, and the patient was released to go home with instructions to collect and save urine specimens that night. He returned to work April 27.

## **SOLID STATE INCIDENT**

Oak Ridge, Tenn., Apr. 26, 1960—Ref: —HS-60-15

### *Nature of Accident*

A change in the internal air flow in the building carried radioactive material out of a cell in which an irradiated fuel element was being examined.

### *Description of Operation*

A graphite impregnated fuel element had been irradiated and was being cut in two.

### *Details of Accident*

An irradiated, graphite-clad reactor fuel element was being cut inside the cell with a remotely-operated saw. A change in air pressure inside the cell forced contaminated graphite dust from the cell. This change in pressure apparently was caused by the top slab having been removed from an adjacent cell and by wind blowing through an open outside door immediately behind the cell. These conditions caused the pressure inside the cell to become positive to the extent that it forced graphite particles contaminated with cerium and strontium into the work areas immediately in front of the cell.

### *Nature of Injuries or Loss*

In addition to the eight persons in front of the cell, 72 others were in the building at the time of the incident. All were evacuated from the building. As a precaution, bio-assay samples were taken from all of these and analyses have been completed for 25 most likely to have been exposed. Of these, only two showed any evidence of internal exposure and neither was in excess of the 0.1 rem.

Cleanup of the area \$39,500.

## **FUEL ELEMENT SHIPMENT ACCIDENT**

Baltimore, Md., June 2-6, 1960—Ref: —HS-60-28

### *Nature of Accident*

Dribbling of water running out of the overflow pipes at each end of the cask water expansion tank on top of a 55-T shipping cask.

### *Description of Operation*

Shipment of 99 NRU fuel elements.

### *Details of Accident*

AEC shipment couriers, escorting a 55-T fuel element shipping cask containing 99 NRU fuel elements en route to South Carolina for reprocessing, noticed a dribbling of water running out of the overflow pipes at each end of the cask water expansion tank on top of the shipping cask. The lowboy flat bed freight car was being moved in regular fast freight when the leakage began about 40 miles north of Baltimore, Maryland. Due to the alertness of AEC couriers, they observed the leakage when it began and noted the approximate point on the railroad route. They were also able to observe that there was very little of the water that did not puddle on the top of the cask or on the bed of the freight car. At the earliest possible opportunity, the couriers monitored the overflow with their survey meter and found that the water was contaminated with radioactivity greater than the level of 10,000 counts per minute.

### *Nature of Injuries or Loss*

Thirty to forty gallons of contaminated water leaked from the cask. Cleanup costs, \$24,000.

## **DRYBOX CONTAMINATION ACCIDENT**

Miamisburg, Ohio, July 6, 1960 - Ref: —HS-60-24

### *Nature of Accident*

Accidental discharge of radioactive material into a room as a result of pressure buildup in a drybox.

### *Description of Operation*

The purging operation of the inert atmosphere drybox.

### *Details of Accident*

A cylinder of argon used in purging of equipment ran low on pressure causing various solenoids to malfunction. When new cylinder of argon was installed, the valves admitted too much pressure, causing gloves to blow off of glove ports and spreading radioactivity into area.

### *Nature of Injuries or Loss*

As a result of the accident, eleven individuals received minor exposure to radioactive particles in the atmosphere. Radioactive material was also deposited on clothing, hair, hands, etc. The material was removed by substitution of clean clothing and appropriate cleansing of skin and hair. Cost \$31,360.

## **CONTAMINATED COOLING WATER**

Aiken, S. C., Sept. 13, 1960 - Ref: —HS-60-26

### *Nature of Accident*

Contaminated cooling water was discharged from canyon onto floor.

### *Description of Operation*

Separations facility.

### *Details of Accident*

Contaminated spent cooling water from the calandria of a continuous type high activity waste concentrator in a building was inadvertently discharged to the floor of the hot gang valve corridor. This overflowed the floor drainage collection system, resulting in a flow of contaminated water throughout the corridor and down a stairwell to the first level personnel corridor, where it flowed into two locker rooms, an office and counting room, and the personnel decontamination room. The affected floor areas were contaminated in varying amounts, ranging from 10 rad/hr to 200 rad/hr. It was necessary to suspend processing operations, pending a reduction in radiation in the corridor, and to vacate the affected first level corridor and rooms until cleanup efforts made the areas habitable.

### *Nature of Injuries or Loss*

No overexposures. Cost \$250,000.

## **RADIATION EXPOSURE**

Mercury, Nev., Oct. 4, 1960 - Ref: —HS-60-41

### *Nature of Accident*

Two employees were accidentally exposed to ionizing radiation coming from a 340 curie Co<sup>60</sup> calibration source.

### *Description of Operation*

Calibrating scintillation detectors.

### *Details of Accident*

Two employees were following through the routine involved in the calibration of photocell detectors. The detectors were placed in the radiation beam area, 30 inches in front of the cobalt source unit. Currents were being recorded for each detector with the rotor-shutter open. Three detectors had previously been calibrated; the fourth was placed in position; both personnel returned to the console; the shutter and rotor were opened, and the current output of the detector was recorded. After recording the current value, employee "A" noted the shutter and rotor lights (located on the console) to be out and assumed the shutter and rotor to be closed. He approached the detector located in front of the source (without taking the safeguard radiation instrument), and started making mechanical adjustments on the photodiode. Employee "B" followed "A" and aided him in the adjustments.

### *Nature of Injuries or Loss*

"A" received a total body dose of 18 rem as determined by film badge reading. "B" received a total dose of 5 rem.

## **RADIATION EXPOSURE**

Albuquerque, N. Mex., Nov. 11, 1960 - Ref: —HS-60-31

### *Nature of Accident*

An employee, "A", was accidentally exposed to an electron beam emanating from a Van de Graaff accelerator.

### *Description of Operation*

Setting up an experiment in front of the beam tube of Van de Graaff accelerator.

### *Details of Accident*

The machine operator, employee "B", put the machine on self-charge with "A's" consent and knowledge, as "A" entered the beam room. This was done to check the self-charge rate and limit of the machine. The term "self-charge" refers to the operation of the belt which places a static charge on the high voltage terminal. The beam current and belt charge (the normal source of electrons) were not turned on. Therefore, there should have been no detectable emission from the beam tube at this time.

"A" proceeded to end of the beam tube and began setting up his experiment. After approximately two minutes, he came out of the beam room, since his face felt warm. He then went to the washroom and washed his face. "A" asked "B" if there was any residual beam current. The operator stated that the beam current was not on, but that he would check. "B" entered the beam room with a low range survey meter and made a measurement in front of the beam tube. At first he saw no reading, but as he started to leave, the meter pegged at 20 millirems.

### *Nature of Injuries or Loss*

"A" received multiple radiation burns in the middle section of the face, abdomen, and both hands. Employee was not wearing his film badge. However, an indirect measurement was made by placing a film badge at the 33 cm distance and exposing it under simulated conditions. Calibration was interpreted as 760 rads incident dose to the face at 33 cm.

"B" received a total body dose of 53 rads as determined by film badge reading.

## ACCIDENTS INVOLVING FATALITIES IN ATOMIC ENERGY ACTIVITIES 1959 - 1960

Since the beginning of the atomic energy program in 1943, a total of 6,562 lost time injuries have occurred in AEC plants and installations through 1960. Of these, 35 were injuries due to overexposure to radiation (see Table 4). This table, which previously appeared in TID-5360, Supplement 2, has been revised and updated. Total deaths during the period were 219, of which three were due to radiation exposure (see Table 5 and Chart 2).

The following descriptions add details to fatal accidents already listed in Table 1.

### EXPLOSIVES DETONATED

Los Alamos, N. Mex., Feb. 24, 1959 - Ref: —HS-59-5

#### *Nature of Accident*

Explosion.

#### *Details of Accident*

A detonation of a 7½-pound cylindrical block of high explosives instantly killed two employees. The accident occurred during a normal machining operation of chemical explosives used to study the physical phenomena of shock waves.

#### *Nature of Injuries or Loss*

Two men were fatally injured.

Table 4—REPORTED RADIATION ACCIDENTS RESULTING IN LOST TIME INJURIES  
(As defined in American Standards Association Methods for reporting work injuries—ASA  
Z16-1-1954 and AEC Manual Chapter 0502)

Date	Location	Number Involved	Source of Injury	Nature of Injury	Exposure		Days Lost
					80 KV X-Ray	GAMMA RAY	
8/21/45	Los Alamos	Two	Chain reaction in experimental critical assembly	(1) Fatality (2) No clinically diagnosed injury	(1) 480 r (2) 31 r	110 r 1 r	6000 60
5/21/46	Los Alamos	Eight	Chain reaction in experimental critical assembly	(1) Fatality (2) Skin rash, loss of hair and other symptoms (3) Skin rash and other symptoms (4) No clinically diagnosed injury (5) No clinically diagnosed injury (6) No clinically diagnosed injury (7) No clinically diagnosed injury (8) No clinically diagnosed injury	(1) 930 r (2) 390 r (3) NA (4) 185 r (5) 140 r (6) 55 r (7) 43 r (8) 33 r	114 r 26 r NA 10.7 r 8.7 r 4.4 r 3 r 2.41 r	6000 70 1 14 16 4 4 4
5/14/48	Eniwetok Proving Ground	Four	Improper handling of fission sample	Beta ray burns to hand	1.7 r 2' 4.5 r 2' 5.5 r 2' 17 r 2'		36 36 36 36
9/7/46	Los Alamos	One	Unpacking radioactive material	Beta ray burns to ankle	NA 3'		36
6/2/52	Chicago	Four	Manual withdrawal of control rod from reactor	No clinically diagnosed injury	190 rem 160 rem 70 rem 12 rem		23 23 34 23
7/9/52	Los Alamos	One	Handling radioactive material with torn glove	Beta ray burns to hands	NA 4'		3
3/1/55	Nevada Test	One	Entering exclusion area during test	No clinically diagnosed injury	39 r		19
7/27/55	National Reactor Testing Station	One	Radioactive particle entering ear canal	Partial loss of hearing	Not detectable		12
4/30/56	Los Alamos	One	Handling radioactive material with torn glove	Beta burns to hands	NA 5'		14
6/18/56	Hanford	One	Escape of plutonium solution into control room	Contamination of exposed skin surfaces. No clinically diagnosed injury	In excess of 40,000 d/m/ alpha		4
6/14/57	Rocky Flats	One	Explosion in "dry box"	Plutonium lodged in finger, necessitating amputation	3.2 m/c Pu		50
6/16/58	Oak Ridge (Y-12 Plant)	Eight	Criticality incident caused by draining enriched uranium in drum of water	6/	461 rem 341 rem 428 rem 413 rem 298 rem 36 rem 86 rem 29 rem		83 83 83 83 83 34 65 41
12/30/58	Los Alamos	One	Criticality accident	Fatality	12000 ± 50% rem		6000
11/8/60	Albuquerque Sandia Base	One	Exposure from electronic beam	Multiple radiation burns middle section of face, abdomen and both hands	7/		10

1/ Employee had received termination notice prior to accident.

2/ Exposure refers to whole body gamma radiation. Injury caused by beta ray dose, amount of which exposure not available.

3/ Amount of beta ray dose not available. Total gamma ray exposure during week in which accident occurred was 0.27 rem.

4/ Amount of beta ray dose not available. Total gamma ray exposure during week in which accident occurred was 1.6 rem.

5/ Amount of beta ray dose not available. Total gamma ray exposure during week in which accident occurred was 2.0 rem.

6/ Three employees not requiring prolonged hospital care exhibited mild changes in blood elements but showed no symptoms of injury. The five employees requiring longer hospitalization showed significant decreases in blood elements and other clinical and laboratory findings characteristic of more severe radiation damage such as mild nausea and vomiting, and indications of possible hemorrhagic complications, although no bleeding actually occurred.

7/ Employee was not wearing his film badge. However an indirect measurement was made by placing a film badge at the 33 cm distance and exposing it under simulated conditions. Calibration was interpreted as 760 rads incident dose to the face at 33 cm.

NOTES: As exposure previously reported on 10/4/57, Oak Ridge (ORNL) held not lost-time.

A fatality due to leukemia previously reported on 2/18/57 Berkeley held not reportable because the person involved here had a long history of radiation exposure prior to U. S. Atomic Energy Commission and its predecessor the Manhattan District.

Table 5— FATAL INJURIES MED-AEC

YEAR	OCCUPATIONAL FATALITIES			CONSTRUCTION										OPERATIONS								GOVERNMENT						
	MED-AEC		NSC	TOTAL	FALLS	ELECTRIC SHOCK	BURNS	MOTOR VEHICLES-AEC	OTHER MOBILE EQUIP	FALLING OBJECTS	TRENCH CAVE-INS	AIRCRAFT	OTHER	TOTAL	FALLS	ELECTRIC SHOCK	BURNS	MOTOR VEHICLES AEC	OTHER MOBILE EQUIP	FALLING OBJECTS	RADIATION	OTHER	TOTAL	MOTOR VEHICLES-AEC	TRENCH CAVE-INS	AIRCRAFT	OTHER	
	NUMBER	RATE	RATE																									
1943	19	37	33	19	5	2	1	3	6	1	1																	
1944	34	22	31	29	9	3	1	2	4	7		3		5		3		1										1
1943-1944	53			48	14	5	2	5	10	8	1	3		5		3		1										1
1945	19	16	32	9	1	3		1	2	2				9	1	5	1				1	1	1			1		
1943-1945	72			57	15	8	2	6	12	10	1	3		14	1	8	1	1			1	1	1			1		
1946	9	15	31	1	1									4			1	1			1	1	4	2		1	1	
1943-1946	81			58	16	8	2	6	12	10	1	3		18	1	8	1	2	1		2	3	5	2	1	1	1	
1947	4	9	30	1			1							3		2						1						
1943-1947	85			59	16	8	3	6	12	10	1	3		21	1	10	1	2	1		2	4	5	2	1	1	1	
1948	11	17	29	6		1			2			1		4		1		2				1	1	1				
1943-1948	96			65	16	9	3	6	14	10	3	3	1	25	1	11	1	4	1		2	5	6	3	1	1	1	
1949	6	10	26	4	2			1		1				2			1	1										
1943-1949	102			69	18	9	3	7	14	11	3	3	1	27	1	11	2	4	2		2	5	6	3	1	1	1	
1950	8	13	27	4	1	1				1			1	1					1				3	1		2		
1943-1950	110			73	19	10	3	7	14	12	3	3	2	28	1	11	2	4	3		2	5	9	4	1	3	1	
1951	24	23	28	21	9	2		4		3			3	3						1		2						
1943-1951	134			94	28	12	3	11	14	15	3	3	5	31	1	11	2	4	3	1	2	7	9	4	1	3	1	
1952	11	8	26	9	2	3		2	1	1				2			1		1									
1943-1952	145			103	30	15	3	13	15	16	3	3	5	32	3	11	2	5	3	2	2	7	9	4	1	3	1	
1953	11	7	26	11	3		2	1	4			1																
1943-1953	156			114	33	15	5	14	19	16	3	3	6	33	3	11	2	5	3	2	2	7	9	4	1	3	1	
1954	18	14	24	8	5	1			2					10	3	2	4		1									
1943-1954	174			122	38	16	5	14	21	16	3	3	6	43	4	13	6	5	4	2	2	7	9	4	1	3	1	
1955	10	9	24	2	1					1				7		2												
1943-1955	184			124	39	16	5	14	21	17	3	3	6	50	4	15	6	5	4	2	2	12	9	4	1	3	1	
1956	8	8	23	2	1			1						6		1		1				4	1	1				
1943-1956	192			126	40	16	5	15	21	17	3	3	6	56	4	16	6	6	4	2	2	16	10	5	1	3	1	
1957	5	5	23	2		2								2			2						1			1		
1943-1957	197			128	40	18	5	15	21	17	3	3	6	58	4	16	6	8	4	2	2	16	11	5	1	4	1	
1958	5	5	22	3		1					2			2							1	1	1	1				
1943-1958	203			131	40	19	5	15	21	17	5	3	6	60	4	16	6	8	4	2	3	17	12	6	1	4	1	
1959	12	10	22	4	2	1				1				8			1											
1943-1959	215			135	42	20	5	15	21	18	5	3	6	68	4	16	6	9	4	2	3	24	12	6	1	4	1	
1960	4	4		3	2							1		1		1												
1943-1960	219			138	44	20	5	15	21	18	5	3	7	69	4	16	7	9	4	2	3	24	12	6	1	4	1	
TOTAL	218			138	44	20	5	15	21	18	5	3	7	69	4	16	7	9	4	2	3	24	12	6	1	4	1	

# DEATH RATES ... AEC & NSC PER 100,000 EMPLOYEES

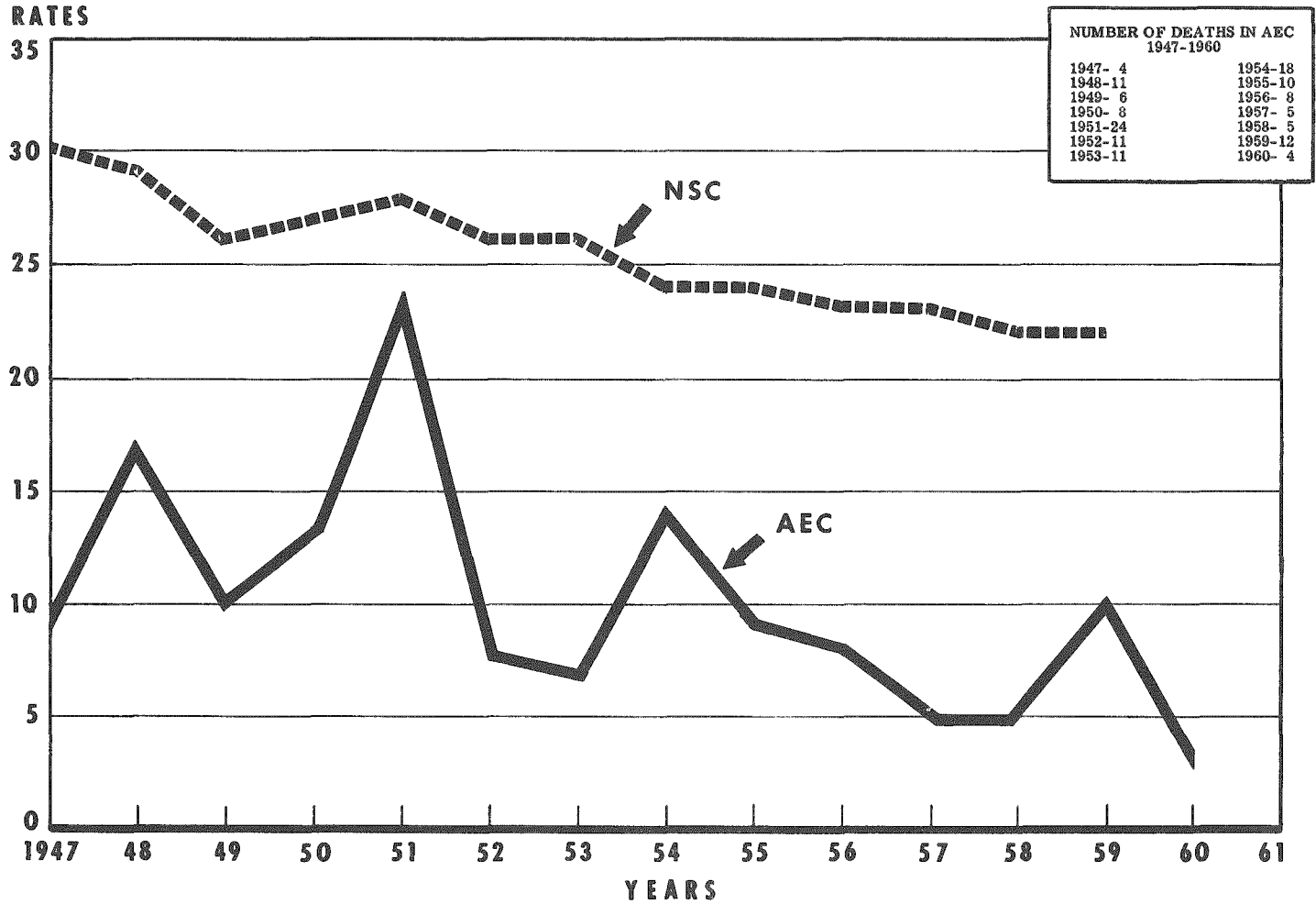


Chart 2

## FATAL FALL

Richland, Wash., April 10, 1959 - Ref: —HS-59-10

### *Nature of Accident*

Workman straddling 4 in. pipe fell 50 feet.

### *Description of Operation*

Boilermaker-rigger was tightening a  $\frac{3}{4}$ -in. hanger rod.

### *Details of Accident*

Two workmen were simultaneously tightening a hanger rod into couplings, one at the steel wall of the building and the other at the 4-in. pipe. One workman was on a bracket scaffold and using an 18-in. wrench; the other was straddling the 4-in. pipe and using a 10-in. pipe wrench. As the workman on the 4-in. pipe leaned on the rod while attempting to move along the pipe to the next rod, the tightened rod broke at the pipe and coupling and the workman lost his balance and fell 50 feet to the floor below, landing on reinforcing rods which pierced his arm, heart, and lungs. The rod broke due to a torsional failure.

### *Nature of Injuries or Loss*

Boilermaker-rigger died instantly when he fell.

## FATAL FALL FROM SCAFFOLD

Idaho Falls, Idaho, May 13, 1959 - Ref: —HS-59-14

### *Nature of Accident*

A sheet metal worker was killed when the  $5\frac{1}{2} \times 14$  ft cross section, 60 ft high scaffold on which he was working overturned and crashed on the concrete floor.

### *Description of Operation*

Erection of metal siding on 62 ft doors of a hangar building.

### *Details of Accident*

Working alone on top, the sheet metal worker had removed the tie lines which anchored the top of the scaffold to the building, and was preparing to relocate same following scaffold movement to a new position. Gusty winds of 10-26 mph were blowing against the broad side of this three section long and one section wide scaffold. The half ton weight of the overhanging 20-in. decking on outboard brackets and the  $\frac{1}{16}$ -in. per foot floor slope both contributed to scaffold instability. Moves of the same type had been accomplished previously with two men (including the deceased) on top and eight men on the ground. At the top, a "running tension line" was rigged before tie lines were released from anchor points.

### *Nature of Injuries or Loss*

Fatal injury to sheet metal worker.



# WORKMAN ELECTROCUTED

Oak Ridge, Tenn., Aug. 7, 1959—Ref: —HS-59-25

## *Nature of Accident*

Electrocution.

## *Description of Operation*

Wiring an arc welder into a temporary switchbox.

## *Details of Accident*

The welding machine has been positioned under a shed adjacent to a substation transformer enclosure fence on which several temporary switchboxes were mounted.

The power cable from the welding machine was not equipped with a standard plug nor was the switchbox fitted with a 440-volt receptacle. Thus it was necessary to wire the machine directly into the switchbox.

Before making the hookup, the electrician examined the wiring in the welding machine but had difficulty in identifying coding colors of the individual conductors. He stripped back a section of the cable sheath exposing colors of red, black, white, and grey or greenish-grey. He decided the latter was the ground conductor and proceeded to make the switchbox hookup on that premise. The helper actually fastened the grey or greenish-grey conductor to the ground lug in the switchbox while the electrician examined the machine.

Satisfied that the machine was ready, the electrician instructed the helper to close the switchbox door and throw the lever to the "on" position, which he did.

After some confusion as to where the "start" button was on the machine, the electrician positioned himself in front of the machine. At this time, he somehow made contact with the machine, yelled and fell across the machine, clutching at a third workman who was standing near. Although he felt a shock when the electrician grabbed him, he thought the electrician had suffered a heart attack. He started to take hold of the electrician's shirt sleeve but received another shock. He then tried looping a welding cable under the injured. Finally, assisted by the helper, they pulled the electrician clear of the machine and placed him on a sheet of plywood brought over by a carpenter. The ground under the machine and general vicinity was wet and hot with electricity, and the machine was smoking, as observed by this third man.

The two men started giving artificial resuscitation, and the helper directed another electrician to call the ambulance, doctor, and fire department. Shortly, the helper was relieved, and went back near the machine to get his pliers, receiving a shock when he picked them up. The Electrician Shop Steward, who was with him, directed someone to get a "hot stick" and to pull the switch, when he noticed the metal wheels of the machine steaming where they were setting in water.

## *Nature of Injuries or Loss*

The doctor and nurse arrived with the ambulance and took charge of the injured. The doctor continued resuscitation with the mouth-to-mouth technique and administered drugs but was unable to produce any response. The electrician was pronounced dead 30 minutes after the accident and taken to the hospital.

## *Remarks*

Subsequent investigation revealed that one wire originating at the equipment ground terminal inside the welding machine had been run to a phase lug in the machine and was connected to the ground lug in the switchbox. One of three 60-amp. fuses in the switchbox had blown.

Upon examination of the color coded wires at both ends of the cable, it was found that, although badly faded, the black and red were identifiable. The other two (one of which was the ground wire), which presumably were coded white and grey, were difficult, if not impossible, to distinguish as to which was which.

It was further determined that no attempt was made to "ring out"\* the conductors in the cable to ascertain exactly which one was a grounding conductor.

In the confusion, apparently no one thought to turn off the power to the machine.

An electrical contractor superintendent reported that the machine power cable had previously been equipped with a 4-prong plug to fit the 440-volt receptacle sockets located at various locations on a previous job on the site; and that the deceased would have had to remove this plug from the end of the cable before making a connection directly into the switchbox.

## EXPLOSIVES EXPLOSION

Los Alamos, N. Mex., Oct. 14, 1959—Ref: —HS-59-32

### *Nature of Accident*

Explosion.

### *Description of Operation*

Disposing of scrap and waste explosives at burning pad.

### *Details of Accident*

Four men had backed an explosives scrap truck into a burning pad enclosure for unloading. The explosives were to be burned as a means of disposal. During the unloading of the explosives, an accidental detonation occurred. The exact cause of the initiation is unknown.

### *Nature of Injuries or Loss*

Four men were fatally injured.

## MOTOR VEHICLE ACCIDENT

Mercury, Nev., Dec. 2, 1959—Ref: —HS-59-39

### *Nature of Accident*

Motor vehicle.

### *Description of Operation*

Driving a motor vehicle.

### *Details of Accident*

An employee driving a Government vehicle (traveling northwest) collided with a station wagon (traveling southeast). The driver of the station wagon pulled out to pass a large van truck traveling in the same direction. The vehicles collided at a point directly opposite the cab of the van truck.

### *Nature of Injuries or Loss*

Employee in Government car was fatally injured. The other driver received lacerations of face and head and other minor contusions.

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\* Term used by electricians for instrument testing of continuity and identification of conductors where this cannot be ascertained by visual check.

# SUFFOCATION

Canoga Park, Calif., Dec. 18, 1959 - Ref: —HS-59-41

## *Nature of Accident*

Asphyxiation.

## *Description of Operation*

Inspecting a sodium pump loop.

## *Details of Accident*

Information was being sought in connection with the recent failure of the sodium pump (see drawing) while being tested. To minimize oxidation of sodium residue on interior walls of the casing, argon gas was fed into it by tubing through a wooden cover plate.

Normal procedure for entering the casing prescribed that personnel be lowered into it by a slow-moving hoist to which they were attached by a body safety harness, and wearing an oxygen mask (self-contained oxygen breathing apparatus).

It is reported that the inspector was wearing only a filter respirator face mask and that he rode the hoist hook down by standing on it. He collapsed after a short time at the bottom of the casing.

A fellow inspector at the top is reported to have shouted for help which brought the welder running up the stairs leading to the platform at the top of the casing.

The welder fashioned a rope body harness and had himself lowered into the casing on the electric hoist. (As reported, he wore no mask at all). While being lowered, he collapsed and slipped out of the rope harness.

Oxygen masks and body safety harnesses designed for the purpose were obtained, and two employees, properly equipped with these, were lowered into the casing. They were hoisted out, with first the welder, and then the inspector, in their arms. The inspector was cyanotic when removed and had no detectable pulse. Efforts were made to administer oxygen on the spot.

It was estimated that the inspector was in the casing about 15 minutes and the welder on the order of seven or eight minutes before they were lifted out.

## *Nature of Injuries or Loss*

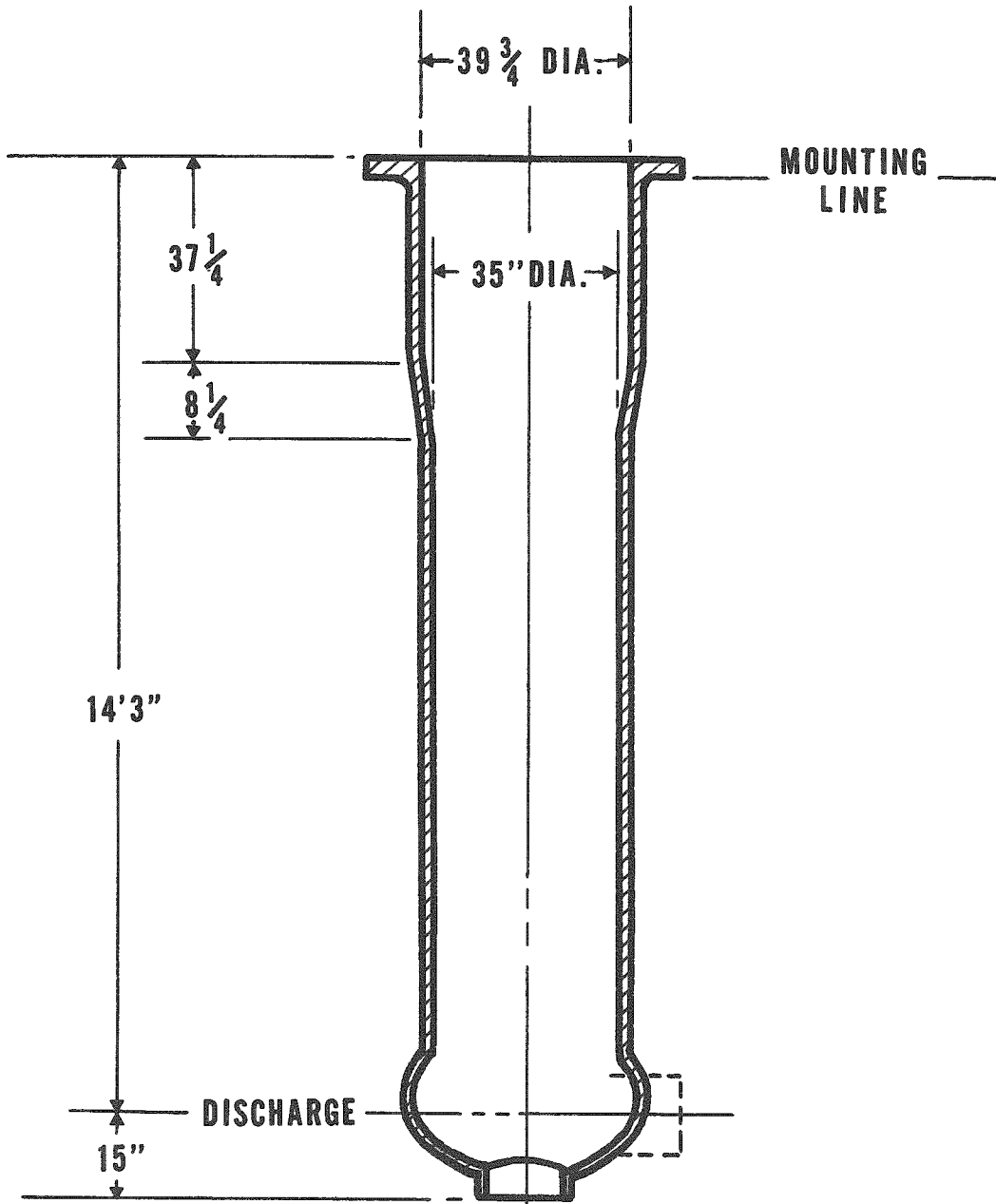
A reactor-assemblyman-inspector died from suffocation shortly after entering the pump case. As of January 25, 1960, information indicates that the senior reactor welder is coming along satisfactorily.

## *Remarks*

The primary cause of these two accidents appears to have been the failure on the part of both men to wear proper breathing equipment appropriate to an inert gas. The reactor-assemblyman wore a filter-type respirator which is designed to filter out toxic and noxious particulate matter in a breathing atmosphere. The filter respirator does not filter out gases, nor does it provide a source of oxygen if no oxygen is present in the breathing atmosphere. Hence, this respirator could give no protection to the inspector. The senior reactor welder's action in descending without any protection at all was the result of an emotional reaction and not based on a calm and logical deliberation. A contributing cause was failure to wear a safety harness or belt which was available and convenient or to wear a lifeline, for which rope was on the site.

The preventive measures which will be implemented and enforced are:

1. It will be the responsibility of the immediate supervisor to orient and inform all persons performing hazardous work as to the entire scope of hazards and/or materials to be encountered in an operation and to insure, by proper supervision, that prescribed safety measures are carried out.



**PUMP CASE**  
 12 FREE-SURF SODIUM PUMP

2. All future operations requiring personnel to enter tanks or areas devoid of oxygen or provided with any inert gases will require the presence of a completely equipped fireman to stand by in readiness to effect a rescue.

3. All inert and/or toxic gas containers or areas will be posted and a Safe Work Permit will be required prior to performing work.

## FAILURE OF A CABLE CAUSE OF DEATH

Albuquerque, N. Mex., Dec. 23, 1959—Ref: —HS-59-42

### *Nature of Accident*

Two pendant lines supporting the jib section (boom of a mobile crane) broke, allowing a hopper bucket to fall on a construction employee.

### *Description of Operation*

Placing concrete with mobile crane at construction site.

### *Details of Accident*

During concrete placement operations, an employee was killed by a falling concrete hopper bucket. The bucket was being handled by a mobile crane when one of the two pendant lines supporting the jib section broke. The pendant lines support the 30 ft jib boom, which is an extension of the 50 ft main hoisting boom.

The broken pendant line caused the jib section to twist, allowing the loaded one cubic yard bucket to fall on the employee.

The employee was on a scaffolding receiving the bucket (with helper) and discharging the concrete into the forms.

### *Nature of Injuries or Loss*

Employee was killed when a one cubic yard bucket of concrete fell on him.

## DROWNING

Eniwetok Proving Ground, Jan. 29, 1960—Ref: —HS-60-4

### *Nature of Accident*

Professional skindiver drowned while performing assigned duties.

### *Description of Operation*

Placing dynamite charges (4 to 5 feet under water) to sink LCU hull for use as a break-water to prevent erosion of the beach.

### *Details of Accident*

Explosives were used to blow holes in the bottom of the craft to sink it and allow the surge to wash sand into the hull to hold it in place. The shot failed to detonate and skindiver "A" placed a booster charge. The diver "A" then surfaced and began swimming around the hull. A supervisor on LCU checked around and did not see "A". At this time an attempt was made to locate the diver ("A"). Another diver, "B", after seeing no tracks to beach, put on his mask and dove down to see if he could find "A". He saw him in an air pocket and pulled him out.

### *Nature of Injuries or Loss*

Death by drowning.

## FATAL ACCIDENT IN CAFETERIA KITCHEN

Mercury, Nev., March 18, 1960—Ref: —HS-60-12

### *Nature of Accident*

A cafeteria employee was scalded by hot broth spilled on face and entire front of his body when he slipped.

### *Description of Operation*

Working in a cafeteria kitchen.

### *Details of Accident*

Two cafeteria employees, "A" and "B", proceeded to empty a 20-gallon container of hot soup stock into a steam kettle.

The pot was raised to the lip of the steam kettle, which was 42 in. from the floor, when the foot of "A" slipped and he fell to the floor. The hot soup stock poured onto him, causing first and second degree burns over approximately 20% of his body.

### *Nature of Injury*

Employee "A" died on April 7 from uremia, which arose as a complication from burns received from the accident.

## FATAL FALL

Cambridge, Mass., April 13, 1960—Ref: —HS-60-13

### *Nature of Accident*

An employee fell from a 30-in. wide ground level wall to a concrete floor 20 ft below.

### *Description of Operation*

Straightening reinforcing rod with a length of pipe.

### *Details of Accident*

In order to construct an addition to the experiment building, a concrete foundation wall was extended around the perimeter of the new building area. An employee, working on a 34-in. surface of the wall was straightening one of several 6 $\frac{3}{4}$ -in. reinforcing rods with a 6 ft length of 1 $\frac{1}{2}$ -in. diameter pipe used as a lever. The rod being straightened, by the employee, broke, and he fell backward onto a concrete floor below.

### *Nature of Injuries or Loss*

The cause of death was a fractured cervical vertebrae and a crushed chest associated with multiple fractures received in the fall.

## **PAINTER FALLS IN FATAL PLUNGE**

Idaho Falls, Idaho, August 31, 1960—Ref: —HS-60-25

### *Nature of Accident*

Fatal fall from an upper structure of a plant.

### *Description of Operation*

Painting the railing, ladders, and cages on the top portions of the cement silos.

### *Details of Accident*

Without an eyewitness to the origin of the fatal fall or other evidence indicating the precise circumstances, the cause is unknown.

### *Nature of Injuries or Loss*

While a painter was painting the handrail around a silo, he suffered fatal injuries when he fell 69 ft.