A SUMMARY OF
INDUSTRIAL ACCIDENTS
IN USAEC FACILITIES

December 1961

UNITED STATES ATOMIC ENERGY COMMISSION
Division of Technical Information
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A SUMMARY OF
INDUSTRIAL ACCIDENTS
IN USAEC FACILITIES

UNITED STATES ATOMIC ENERGY COMMISSION
Industrial Safety and Fire Protection Branch
Division of Operational Safety
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.)
Table 1 — SERIOUS ACCIDENTS
USAEC Facilities, 1959–1960

<table>
<thead>
<tr>
<th>HS No*</th>
<th>Date</th>
<th>Operations Office &amp; Contractor</th>
<th>Injury &amp; Loss</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>59-1</td>
<td>1-4-59</td>
<td>SR–E 1 du Pont de Nemours &amp; Co</td>
<td>0</td>
<td>Garden on head of secondary condenser in unit failed allowing hydrogen</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>sulfide gas to flow into water safe of heat exchanger. Relief valve</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$7,000</td>
<td>vented open due to overpressure 4-5 T of gas released to atmosphere</td>
</tr>
<tr>
<td>59-2</td>
<td>1-15-59</td>
<td>AI–Reynolds Electrical &amp; Engg Co</td>
<td>0</td>
<td>Booms buckled on two 50-T cranes while lifting 65-ft tower weighing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>38 T</td>
</tr>
<tr>
<td>59-3</td>
<td>1-17-59</td>
<td>OR–Union Carbide Nuclear Co</td>
<td>$21,000</td>
<td>Multiple current breaker failure led to severe electrical fire</td>
</tr>
<tr>
<td>59-4</td>
<td>2-1-59</td>
<td>AL–Bendix Aviation Corp</td>
<td>$86,000</td>
<td>Dispatch oven failed when a power relay came loose from side of control</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>box and dropped to bottom of unit. Weight of relay held armature and</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>contacts in closed position, energizing oven heaters.</td>
</tr>
<tr>
<td>59-5</td>
<td>2-24-59</td>
<td>AL–University of California (LASL)</td>
<td>2 killed</td>
<td>Detonation of explosives instantly killed 2 employees. (See page 26)</td>
</tr>
<tr>
<td>39-6</td>
<td>3-25-59</td>
<td>SR–E 1 du Pont de Nemours &amp; Co</td>
<td>$27,000</td>
<td>Leaking compression fitting</td>
</tr>
<tr>
<td>39-7</td>
<td>3-31-59</td>
<td>HA–General Electric Co</td>
<td>$20,000</td>
<td>Plutonium glove box explosion. (See page 9)</td>
</tr>
<tr>
<td>39-8</td>
<td>4-2-59</td>
<td>SR–E 1 du Pont de Nemours &amp; Co</td>
<td>$9,518</td>
<td>Solvent transfer truck en route from 200-H Area to plant burial</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$6,700</td>
<td>ground suddenly applied brakes at a railroad crossing, causing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>organic solvent containing intermediate level fusion product to</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>overflow into the shallow reservoir on top of truck tank, then</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>radiation solvent dropped onto road surface (6 0 mile). (See page 10)</td>
</tr>
<tr>
<td>39-9</td>
<td>4-2-59</td>
<td>OR–Union Carbide Nuclear Co</td>
<td>0</td>
<td>During removal of obsolete ventilation duct, a bucket was dropped and</td>
</tr>
<tr>
<td>39-10</td>
<td>4-10-59</td>
<td>HA–General Electric Co</td>
<td>$7,985</td>
<td>snapped off valve on the pump discharge side of coolant cooler</td>
</tr>
<tr>
<td>39-11</td>
<td>4-17-59</td>
<td>OR–Union Carbide Nuclear Co</td>
<td>1 killed</td>
<td>Workman straddling on pipe fell 59 ft. (See page 27)</td>
</tr>
<tr>
<td>39-12</td>
<td>4-17-59</td>
<td>AL–Government–owned Property</td>
<td>$12,000</td>
<td>Electric motor failure</td>
</tr>
<tr>
<td>39-13</td>
<td>4-29-59</td>
<td>OR–Union Carbide Nuclear Co</td>
<td>0</td>
<td>Fire occurred in 1-story bedroom dwelling. The cause was combustible</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>materials in the vicinity of the floor furnace</td>
</tr>
<tr>
<td>39-14</td>
<td>5-13-59</td>
<td>HA–Wright-Chenery-Burch</td>
<td>$8,388</td>
<td>Lightning damaged transformer</td>
</tr>
<tr>
<td>39-15</td>
<td>5-13-59</td>
<td>LAR–Pratt &amp; Whitney Aircraft (CANEL)</td>
<td>1 killed</td>
<td>Employee was working on 60-ft scaffold when it toppled. (See page 27)</td>
</tr>
<tr>
<td>39-16</td>
<td>6-3-59</td>
<td>SR–E 1 du Pont de Nemours &amp; Co</td>
<td>0</td>
<td>Electrical fire due to severe arcing on the line side of heater</td>
</tr>
<tr>
<td>39-17</td>
<td>7-1-59</td>
<td>AL–University of California (LASL)</td>
<td>$13,750</td>
<td>Lightning damaged two 750-KVA transformers</td>
</tr>
<tr>
<td>39-18</td>
<td>7-3-59</td>
<td>SJN–Johns Hopkins University</td>
<td>2 injured</td>
<td>Overpressure helium system caused release and distribution of small</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$25,400</td>
<td>quantity of uranium 244, resulting in contamination of laboratory</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No overexposures (See page 11)</td>
</tr>
<tr>
<td>39-19</td>
<td>7-17-59</td>
<td>AL–University of California (LASL)</td>
<td>0</td>
<td>BA–Gas release (See page 12)</td>
</tr>
<tr>
<td>39-20</td>
<td>7-18-59</td>
<td>HA–General Electric Co</td>
<td>$10,200</td>
<td>Fire involving bakery and grocery store. Electrical short in junction</td>
</tr>
<tr>
<td>39-21</td>
<td>7-27-59</td>
<td>LAR–General Electric Co</td>
<td>$24,400</td>
<td>box</td>
</tr>
<tr>
<td>39-22</td>
<td>7-31-59</td>
<td>HA–General Electric Co</td>
<td>$9,510</td>
<td>Fire on construction contractor’s material caused smoke and fire</td>
</tr>
<tr>
<td>39-33</td>
<td>8-1-59</td>
<td>NY–Princeton University</td>
<td>$4,000</td>
<td>damage to building</td>
</tr>
<tr>
<td>39-34</td>
<td>8-6-59</td>
<td>AL–Monaco Chemical Co</td>
<td>$12,000</td>
<td>Autoclave explosion</td>
</tr>
<tr>
<td>39-35</td>
<td>8-7-59</td>
<td>OR–J A Jones Construction Co</td>
<td>1 killed</td>
<td>Disruption of water service to stellarator caused by overpressure in</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$1,933</td>
<td>well pump supply line</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Drybox explosion (See page 13)</td>
</tr>
<tr>
<td>39-36</td>
<td>8-14-59</td>
<td>CH–Ames International</td>
<td>0</td>
<td>Electrician electrocuted when contacting energized frame of welding</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$24,400</td>
<td>machine (See page 25)</td>
</tr>
<tr>
<td>39-37</td>
<td>8-21-59</td>
<td>SR–E 1 du Pont de Nemours &amp; Co</td>
<td>$129,324</td>
<td>Sodium storage tank exploded</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(See page 13)</td>
</tr>
<tr>
<td>39-38</td>
<td>9-4-59</td>
<td>LAR–General Electric Co</td>
<td>0</td>
<td>Solution leaked from the loosened flange during maintenance work on</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$7,500</td>
<td>a waste evaporator in hot canyon, vaporized and contaminated a crane</td>
</tr>
<tr>
<td>39-39</td>
<td>9-23-59</td>
<td>SR–E 1 du Pont de Nemours &amp; Co</td>
<td>$14,000</td>
<td>(See page 13)</td>
</tr>
<tr>
<td>39-40</td>
<td>9-29-59</td>
<td>SR–E 1 du Pont de Nemours &amp; Co</td>
<td>$50,000</td>
<td>Wind damage to aluminum side wall of building</td>
</tr>
<tr>
<td>39-41</td>
<td>10-5-59</td>
<td>SR–E 1 du Pont de Nemours &amp; Co</td>
<td>0</td>
<td>Overheating caused diesel engine damage</td>
</tr>
<tr>
<td>39-42</td>
<td>10-14-59</td>
<td>AL–University of California (LASL)</td>
<td>4 killed</td>
<td>Explosion occurred while disposing of scrap and waste explosives</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$5,341</td>
<td>(See page 29)</td>
</tr>
<tr>
<td>39-43</td>
<td>10-16-59</td>
<td>HA–Phillips Petroleum Co</td>
<td>$61,600</td>
<td>Criticality incident, release of radioactive materials (See page 14)</td>
</tr>
<tr>
<td>39-44</td>
<td>10-30-50</td>
<td>AL–B &amp; H Tab Co., subcontractor Holmes &amp; Narver</td>
<td>0</td>
<td>Barge overturned carrying drill rig and core</td>
</tr>
<tr>
<td>39-45</td>
<td>10-30-50</td>
<td>SNR–General Electric Co</td>
<td>$40,380</td>
<td>Air-oil explosion occurred in an air flask component of a 5,000-gal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 killed</td>
<td>hydraulic oil system. Fatality was not chargeable to AE2.</td>
</tr>
<tr>
<td>39-46</td>
<td>11-3-59</td>
<td>AL–Holmes &amp; Narver</td>
<td>$100,000</td>
<td>LST struck deep water pipe during Shawn causing damage to pipe</td>
</tr>
<tr>
<td>39-47</td>
<td>11-20-59</td>
<td>OR–Union Carbide Nuclear Co</td>
<td>$7,919</td>
<td>Chemical explosion in microcycle evaporator (See page 15)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$350,000</td>
<td></td>
</tr>
<tr>
<td>HS No.</td>
<td>Date</td>
<td>Operations Office &amp; Contractor</td>
<td>Injury &amp; Loss</td>
<td>Remarks</td>
</tr>
<tr>
<td>-------</td>
<td>------------</td>
<td>--------------------------------</td>
<td>---------------</td>
<td>---------</td>
</tr>
<tr>
<td>59-38</td>
<td>11-23-59</td>
<td>OI—Maloneckrodt Chemical Co</td>
<td>$4,000</td>
<td>Overheated gas in stack. Incident was probably caused by improper combustion of process gas or ignition of carbon which had accumulated in some of the stacks.</td>
</tr>
<tr>
<td>59-29</td>
<td>12-2-59</td>
<td>AL—Reynolds Electrical &amp; Engr Co</td>
<td>1 killed</td>
<td>An employee was killed instantly in head-on auto collision. (See page 39)</td>
</tr>
<tr>
<td>59-40</td>
<td>12-12-59</td>
<td>SR-E I du Pont de Nemours &amp; Co</td>
<td>$75,209</td>
<td>Loose contaminated particles on the lid of a waste barrel box were scattered by the wind, contaminating the ground, locomotive and spacer car. (See page 17)</td>
</tr>
<tr>
<td>59-41</td>
<td>12-18-59</td>
<td>CH—Atomics International</td>
<td>1 killed</td>
<td>Asphyxiation. Accident occurred at sodium pump loop when an inspector entered a pump casing which was 15 ft deep and about 49 in. in diameter to inspect the collar neck of the bottom. (See page 36)</td>
</tr>
<tr>
<td>59-42</td>
<td>12-23-59</td>
<td>AL—Petroleum Combustion &amp; Engr Co</td>
<td>1 killed</td>
<td>Failure of a cable caused 10th section of crane to fall and drop 1 cu yd bucket of concrete on an employee. (See page 31)</td>
</tr>
<tr>
<td>79-43</td>
<td>1-29-59</td>
<td>OR—National Lead Co. of Ohio</td>
<td>1 overexposure</td>
<td>An explosion occurred in disaster. 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.</td>
</tr>
<tr>
<td>60-3</td>
<td>1-16-60</td>
<td>CH—Argonne National Laboratory</td>
<td>$19,000+</td>
<td>Professional steam diver drowned while performing assigned duties at the Pacific Proving Ground. (See page 31)</td>
</tr>
<tr>
<td>60-4</td>
<td>1-29-60</td>
<td>AL—Holmes &amp; Narver</td>
<td>1 killed</td>
<td>A reactor vessel helddown 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.</td>
</tr>
<tr>
<td>60-5</td>
<td>3-12-60</td>
<td>CH—Argonne National Laboratory</td>
<td>$13,115</td>
<td>During the processing of an experimental high explosive, a detonation occurred.</td>
</tr>
<tr>
<td>60-7</td>
<td>3-3-60</td>
<td>SAV—University of California (LRL)</td>
<td>$12,000</td>
<td>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 18)</td>
</tr>
<tr>
<td>60-8</td>
<td>3-5-60</td>
<td>OR—Union Carbide Nuclear Co</td>
<td>1 overexposure</td>
<td>Explosions occurred in a uranium sintering furnace located in a foundry. Major structural damage to furnace and buildings.</td>
</tr>
<tr>
<td>60-9</td>
<td>1-29-60</td>
<td>OR—Union Carbide Nuclear Co</td>
<td>$20,000</td>
<td>A hydrogen-sulfide gas release from a process equipment condenser caused a fire. The property damage was to the condenser.</td>
</tr>
<tr>
<td>60-10</td>
<td>3-16-60</td>
<td>SR-E I du Pont de Nemours &amp; Co</td>
<td>$135,300</td>
<td>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 burnt out motors.</td>
</tr>
<tr>
<td>60-11</td>
<td>3-30-60</td>
<td>SR-E I du Pont de Nemours &amp; Co</td>
<td>$6,000</td>
<td>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—30% of body. Employee died as a result of the burns. (See page 32)</td>
</tr>
<tr>
<td>60-12</td>
<td>3-14-60</td>
<td>AL—Raymond Elec &amp; Engr Co</td>
<td>1 killed</td>
<td>An irradiated graphite-clad reactor fuel element was being dry out 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 21)</td>
</tr>
<tr>
<td>60-13</td>
<td>4-13-60</td>
<td>NY—Harvard University</td>
<td>1 killed</td>
<td>While an employee was standing on a 34-inch-wide ground level wall straightening a reinforcing rod with a length of pipe, the red brick, and the employee fell 20 ft to a concrete surface. (See page 32)</td>
</tr>
<tr>
<td>60-14</td>
<td>4-17-60</td>
<td>HA—General Electric Co</td>
<td>$250,443</td>
<td>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 ceil, canopy, and crane. The causes or causes of the accident are not established. (See page 20)</td>
</tr>
<tr>
<td>60-15</td>
<td>4-26-60</td>
<td>OR—Union Carbide Nuclear Co</td>
<td>$39,500</td>
<td>An irradiated graphite-clad reactor fuel element was being dry out 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 21)</td>
</tr>
<tr>
<td>60-16</td>
<td>4-5-60</td>
<td>SR-E I du Pont de Nemours &amp; Co</td>
<td>$216,285</td>
<td>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 19)</td>
</tr>
<tr>
<td>60-18</td>
<td>6-16-60</td>
<td>AL—Reynolds Elec &amp; Engr Corp</td>
<td>$9,950</td>
<td>A rigging crew was removing the astrodome from a 20-ft camera tower with a crane. At the dome was being lowered, the sling broke, allowing the dome to fall approximately 19 ft.</td>
</tr>
<tr>
<td>60-19</td>
<td>6-11-60</td>
<td>AL—General Electric Co</td>
<td>$9,098</td>
<td>Failure of overload switches to operate during severe electrical storm caused burnout of transformer.</td>
</tr>
<tr>
<td>60-20</td>
<td>6-24-60</td>
<td>ID—Philips Petroleum</td>
<td>1 injured</td>
<td>Employee seriously injured when portion of a stud (concrete anchor nail) ricocheted, entering forehead over right eye and lodging in brain, while using a power-actuated tool.</td>
</tr>
<tr>
<td>60-21</td>
<td>6-26-60</td>
<td>OR—Goodyear Atomic Corp</td>
<td>$7,145</td>
<td>The stainless steel lining of a new liquid nitrogen storage tank being installed collapsed when its contents were partly evacuated during an acceptance test.</td>
</tr>
<tr>
<td>60-22</td>
<td>7-11-60</td>
<td>AL—Los Alamos Medical Center</td>
<td>$12,000</td>
<td>The stainless steel lining of a new liquid nitrogen storage tank being installed collapsed when its contents were partly evacuated during an acceptance test.</td>
</tr>
<tr>
<td>60-23</td>
<td>7-16-60</td>
<td>OR—Maloneckrodt Chemical Works</td>
<td>$5,000</td>
<td>Hydrogen gas explosion occurred in gas furnace enclosure in metal plant. One employee suffered serious injuries.</td>
</tr>
<tr>
<td>60-24</td>
<td>7-6-60</td>
<td>AL—Mound Laboratory</td>
<td>$14,360</td>
<td>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 22)</td>
</tr>
</tbody>
</table>
Table 1 — SERIOUS ACCIDENTS (Cont'd)

<table>
<thead>
<tr>
<th>HS No *</th>
<th>Date</th>
<th>Operations Office &amp; Contractor</th>
<th>Injury &amp; Loss</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>60-25</td>
<td>9-30-60</td>
<td>ID—Flour Corp, Ltd</td>
<td>1 killed</td>
<td></td>
</tr>
<tr>
<td>60-26</td>
<td>9-30-60</td>
<td>SR- E I du Pont de Nemours &amp; Co</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>60-27</td>
<td>9-29-60</td>
<td>SR- E I du Pont de Nemours &amp; Co</td>
<td>$25,000</td>
<td></td>
</tr>
<tr>
<td>60-28</td>
<td>6/2-6-60</td>
<td>SR- E I du Pont de Nemours &amp; Co</td>
<td>$24,000</td>
<td></td>
</tr>
<tr>
<td>60-29</td>
<td>8-1-60</td>
<td>OR—Goodyear Atomic Corp</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>60-30</td>
<td>10-17-60</td>
<td>AL—Sandia Corp</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>60-31</td>
<td>11-8-60</td>
<td>AL—Sandia Corp</td>
<td>2 exposures</td>
<td></td>
</tr>
<tr>
<td>60-32</td>
<td>9-13-60</td>
<td>LAR—General Electric Co</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>60-33</td>
<td>7-12-60</td>
<td>HA—Government—Hanford</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>60-34</td>
<td>11-2-60</td>
<td>SR- E I du Pont de Nemours &amp; Co</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>60-35</td>
<td>11-10-60</td>
<td>RAN—University of California (LRI)</td>
<td>$10,000</td>
<td></td>
</tr>
<tr>
<td>60-36</td>
<td>11-10-60</td>
<td>SR- E I du Pont de Nemours &amp; Co</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>60-37</td>
<td>11-14-60</td>
<td>AL—Sandia Corp</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>60-38</td>
<td>12-7-60</td>
<td>OR—Union Carbide Nuclear Co</td>
<td>$22,000</td>
<td></td>
</tr>
<tr>
<td>60-39</td>
<td>11-18-60</td>
<td>HA—General Electric Co</td>
<td>$19,000</td>
<td></td>
</tr>
<tr>
<td>60-40</td>
<td>12-21-60</td>
<td>HA—General Electric Co</td>
<td>$12,281</td>
<td></td>
</tr>
<tr>
<td>60-41</td>
<td>10-4-60</td>
<td>AL—Edgerton, Germeshausen &amp; Grier</td>
<td>2 exposures</td>
<td></td>
</tr>
<tr>
<td>60-42</td>
<td>11-17-60</td>
<td>OR—Union Carbide Nuclear Co</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>60-43</td>
<td>11/8-6-60</td>
<td>OR—National Lead Co of Ohio</td>
<td>$5,000+</td>
<td></td>
</tr>
</tbody>
</table>

* Division of Operational Safety, USAEC Headquarters, File Number
† Navy personnel

While an employee was passing the handrails around a silo, he suffered fatal injuries when he fell 69 ft (See page 33).

Contaminated cooling water discharged from canyon onto floor No overexposures. The large loss was due to decontamination (See page 23).

Deterioration of irradiated fuel elements, 50 to 60 gallons of contaminated water leaked from the cask. The cost was due to decontamination of area. (See page 21)

During violent storm, severe power system disturbance caused oil circuit breaker failure.

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 21)

During an electrical storm lightning damaged transformer.

Beechcraft Drone Aircraft, which was to be used for air sampling, crashed when radio control was lost in desert.

Employees were accidentally exposed to electron beam emanating from a Van de Graaff accelerator. (See page 22)

During violent storm, severe power system disturbance caused oil circuit breaker failure.

15-mile per hour breeze spread a grass fire over 3,000 acres of AEC property.

Fire in a construction building.

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.

Fire occurred in best paper stored in dry room.

A fall, high pressure, 30-tube gas trailer overturned in the process of coupling to tractor.

Pipefitter slipped and fell 15 ft down a shaft (in critical condition).

Buildup of pressure in a steam autoclave resulted in a blowoff which sent some material from the autoclave through the building roof. No radiation released.

Two employees were exposed to gamma radiation. (See page 23)

Ten-ton cylinder of UF₆ ruptured.

Slightly enriched uranium tetrachloride lost through stack of dust collector located in the plant.
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 overall experience.

### AEC Industrial Injury Frequency Rates

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

### AEC Industrial Injury Rates 1947-1961

[Line graph showing the frequency of injuries per million man-hours from 1947 to 1961.]

Chart 1
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 have been omitted from his original list. Only criticality accidents in AEC contractor plants are listed.
<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Active Material</th>
<th>Geometry</th>
<th>Total Fissions</th>
<th>Cause</th>
<th>Physical Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug 21, 1945</td>
<td>Los Alamos, New Mexico</td>
<td>6 kg U-235</td>
<td>Spherical core</td>
<td>2 x 10^17</td>
<td>Hand stacking reflector</td>
<td>None</td>
</tr>
<tr>
<td>May 21, 1946</td>
<td>Los Alamos, New Mexico</td>
<td>6 kg U-235</td>
<td>Spherical core</td>
<td>2 x 10^15</td>
<td>Hand stacking reflector</td>
<td>None</td>
</tr>
<tr>
<td>Apr 19, 1952</td>
<td>The Los Alamos Scientific Lab., New Mexico</td>
<td>25 kg U-235</td>
<td>Cylinder</td>
<td>1 x 10^14</td>
<td>Computational error</td>
<td>None</td>
</tr>
<tr>
<td>Feb 4, 1954</td>
<td>The Los Alamos Scientific Lab., New Mexico</td>
<td>53 kg uranium</td>
<td>Spherical core</td>
<td>6 x 10^16</td>
<td>Incorrect operation</td>
<td>Slight warping of pieces</td>
</tr>
<tr>
<td>Feb 12, 1957</td>
<td>The Los Alamos Scientific Lab., New Mexico</td>
<td>54 kg uranium</td>
<td>Sphere</td>
<td>1.2 x 10^17</td>
<td>Shift of experiment</td>
<td>Warping, radiation near melting close to center</td>
</tr>
</tbody>
</table>

### Solution Systems

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Active Material</th>
<th>Geometry</th>
<th>Total Fissions</th>
<th>Cause</th>
<th>Physical Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec 1949</td>
<td>The Los Alamos Scientific Lab., New Mexico</td>
<td>1 kg U-235</td>
<td>Sphere</td>
<td>4 x 10^15</td>
<td>Manual withdrawal of two poison control rods</td>
<td>None</td>
</tr>
<tr>
<td>Nov 1951</td>
<td>The Hanford Works, Richland, Washington</td>
<td>12 kg Pu</td>
<td>Sphere 90%</td>
<td>8 x 10^15</td>
<td>Poison control rod run out too fast</td>
<td>None</td>
</tr>
<tr>
<td>May 1954</td>
<td>The Oak Ridge National Lab., Tennessee</td>
<td>3 kg U-235</td>
<td>Cylinder annulus</td>
<td>1 x 10^17</td>
<td>Tiling of inner poison cylinder</td>
<td>None</td>
</tr>
<tr>
<td>Feb 1956</td>
<td>The Oak Ridge National Lab., Tennessee</td>
<td>7 kg U-235</td>
<td>Cylinder</td>
<td>1.6 x 10^11</td>
<td>Failing scram set up waves creating a critical geometry</td>
<td>Wash water added to UO2(NO3)2 solution</td>
</tr>
<tr>
<td>June 1958</td>
<td>Y-12 Processing Plant, Oak Ridge, Tennessee</td>
<td>2 kg U-235</td>
<td>Cylinder concrete</td>
<td>1.2 x 10^11</td>
<td>Agitator created a critical geometry</td>
<td>None</td>
</tr>
<tr>
<td>Dec 1958</td>
<td>The Los Alamos Scientific Lab., New Mexico</td>
<td>3 kg Pu</td>
<td>Cylinder</td>
<td>1.5 x 10^11</td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>Oct 1959</td>
<td>Chemical Processing Plant, Malo Reactor Testing Area</td>
<td>5 kg U-235</td>
<td>Cylinder</td>
<td>4 x 10^13</td>
<td>Solution exploded from safe to unsafe geometry</td>
<td>None</td>
</tr>
<tr>
<td>Jan 1961</td>
<td>Chemical Processing Plant, Malo Reactor Testing Area</td>
<td>8 kg U-235</td>
<td>Cylinder</td>
<td>6 x 10^11</td>
<td>Solution pumped from safe to unsafe geometry</td>
<td>None</td>
</tr>
</tbody>
</table>

### Inhomogeneous Water Moderated Systems

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Active Material</th>
<th>Geometry</th>
<th>Total Fissions</th>
<th>Cause</th>
<th>Physical Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 1945</td>
<td>Los Alamos, New Mexico</td>
<td>35 kg U-235</td>
<td>Pseudosphere water</td>
<td>3 x 10^14</td>
<td>Water creeping between blocks</td>
<td>None</td>
</tr>
<tr>
<td>Feb 1951</td>
<td>The Los Alamos Scientific Lab., New Mexico</td>
<td>8 kg U-235</td>
<td>Cylinder</td>
<td>10^11</td>
<td>Scram increased reactivity</td>
<td>Slight oxidation</td>
</tr>
<tr>
<td>June 1952</td>
<td>The Argonne National Lab</td>
<td>8 kg U-235</td>
<td>Cylinder</td>
<td>1.22 x 10^17</td>
<td>Manual withdrawal of central safety rod</td>
<td>Plastic destroyed</td>
</tr>
<tr>
<td>July 1954</td>
<td>The Reactor Testing Area, Malo Falls, Malo</td>
<td>500 liters water</td>
<td>Inhomogeneous cylinder water</td>
<td>4.68 x 10^18</td>
<td>Estimate of expected excursion too low</td>
<td>Reactor destroyed</td>
</tr>
<tr>
<td>Jan 1961</td>
<td>Malo Reactor Testing Area</td>
<td>8 kg U-235</td>
<td>Cylinder</td>
<td>1.5 x 10^10</td>
<td>Not determined</td>
<td>Extensive to reactor</td>
</tr>
</tbody>
</table>

### Miscellaneous

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Active Material</th>
<th>Geometry</th>
<th>Total Fissions</th>
<th>Cause</th>
<th>Physical Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb 1945</td>
<td>Los Alamos, New Mexico</td>
<td>UO2 pressed in styrex</td>
<td>Cylinder</td>
<td>6 x 10^11</td>
<td>Reflector added and/or source too large</td>
<td>UO2-styrex cubes swellend and blistered</td>
</tr>
<tr>
<td>Nov 1955</td>
<td>Malo Reactor Testing Area</td>
<td>0.5 in 141 rods</td>
<td>Cylinder</td>
<td>4.7 x 10^17</td>
<td>Incorrect scram</td>
<td>Core melt</td>
</tr>
<tr>
<td>July 1956</td>
<td>The Los Alamos Scientific Lab., New Mexico</td>
<td>58 kg uranium</td>
<td>Cylinder</td>
<td>3.2 x 10^14</td>
<td>Too rapid assembly</td>
<td>None</td>
</tr>
</tbody>
</table>

* 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)
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

<table>
<thead>
<tr>
<th>Range of Annual Total Exposure in Reoms*</th>
<th>1960 No. of Employees</th>
<th>1959 No. of Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>77,522</td>
<td>71,800</td>
</tr>
<tr>
<td>1-2</td>
<td>2,828</td>
<td>2,584</td>
</tr>
<tr>
<td>2-3</td>
<td>1,405</td>
<td>979</td>
</tr>
<tr>
<td>3-4</td>
<td>283</td>
<td>236</td>
</tr>
<tr>
<td>4-5</td>
<td>113</td>
<td>113</td>
</tr>
<tr>
<td>5-6</td>
<td>24</td>
<td>29</td>
</tr>
<tr>
<td>6-7</td>
<td>10</td>
<td>16</td>
</tr>
<tr>
<td>7-8</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>8-9</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>9-10</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>10-11</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>11-12</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12-13</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>13-14</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>14-15</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>15 plus</td>
<td>3†</td>
<td>1†</td>
</tr>
</tbody>
</table>

* 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.

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


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, HClC:CCl₂, 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 CO, COCl₂, and 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


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 wingnut 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


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 $\frac{1}{4}$-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 $30,400 without overhead; equipment loss was held to less than $2,000.
FIRE IN FILTERING SYSTEM


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 4 1/2 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


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.

DRYBOX EXPLOSION

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

Nature of Accident

Spontaneous explosion in a drybox.

Description of Operation

Process and electrolysis drybox 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


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


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% HNO₃ 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% HNO₃ 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 HNO₃. 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


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


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 transporta-
tion 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 survey 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


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 ma-
terial 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 x 8 x 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 D₂O 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


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.

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**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.

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**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 overfilled 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**

**Nature of Accident**
Two employees were accidentally exposed to ionizing radiation coming from a 340 curie Co^{60} 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.

The following tabulation (Table 4) lists radiation accidents resulting in lost-time injuries reported to AEC through 1960.
Table 4 — REPORTED RADIATION ACCIDENTS RESULTING IN LOST-TIME INJURIES
(As defined in American Standards Association Methods for reporting work injuries—ASA Z16-1954 and AEC Manual Chapter 0502)

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Number Involved</th>
<th>Source of Injury</th>
<th>Nature of Injury</th>
<th>Exposure</th>
<th>Days Lost</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/11/45</td>
<td>Los Alamos</td>
<td>Two</td>
<td>Chain reaction in experimental critical assembly</td>
<td>(1) Fatality (2) No clinically diagnosed injury</td>
<td>80 KV X-Ray GAMMA RAY 140 r 10 r</td>
<td>6000</td>
</tr>
<tr>
<td>5/21/45</td>
<td>Los Alamos</td>
<td>Eight</td>
<td>Chain reaction in experimental critical assembly</td>
<td>(1) Fatality (2) No clinically diagnosed injury</td>
<td>80 KV X-Ray GAMMA RAY 140 r 10 r</td>
<td>6000</td>
</tr>
<tr>
<td>5/14/46</td>
<td>Eniwetok Proving Ground</td>
<td>Four</td>
<td>Improper handling of fusion sample</td>
<td>Beta ray burns to hand</td>
<td>29 r 4.5 r 17 r</td>
<td>36 36 36</td>
</tr>
<tr>
<td>9/7/46</td>
<td>Los Alamos</td>
<td>One</td>
<td>Unpacking radioactive material with torn glove</td>
<td>Beta ray burns to hands</td>
<td>NA 3/</td>
<td>36</td>
</tr>
<tr>
<td>6/2/52</td>
<td>Chicago</td>
<td>Four</td>
<td>Manual withdrawal of control rod from reactor</td>
<td>No clinically diagnosed injury</td>
<td>410 r 40 rem 14 rem</td>
<td>23 23 23</td>
</tr>
<tr>
<td>7/9/52</td>
<td>Los Alamos</td>
<td>One</td>
<td>Handling radioactive material with torn glove</td>
<td>Beta ray burns to hands</td>
<td>NA 4/</td>
<td>3</td>
</tr>
<tr>
<td>3/1/55</td>
<td>Nevada Test</td>
<td>One</td>
<td>Entering exclusion area during test</td>
<td>No clinically diagnosed injury</td>
<td>39 r</td>
<td>19</td>
</tr>
<tr>
<td>7/27/55</td>
<td>National Reactor Testing Station</td>
<td>One</td>
<td>Radioactive particle entering ear canal</td>
<td>Partial loss of hearing</td>
<td>Not detectable</td>
<td>12</td>
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<tr>
<td>4/50/56</td>
<td>Los Alamos</td>
<td>One</td>
<td>Handling radioactive material with torn glove</td>
<td>Beta burns to hands</td>
<td>NA 5/</td>
<td>14</td>
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<tr>
<td>6/18/56</td>
<td>Hanford</td>
<td>One</td>
<td>Escape of plutonium solution into control room</td>
<td>Contamination of exposed skin surfaces, No clinically diagnosed injury</td>
<td>In excess of 40,000 6000 6000</td>
<td>4/4/4</td>
</tr>
<tr>
<td>6/14/57</td>
<td>Rocky Flats</td>
<td>One</td>
<td>Explosion in &quot;dry box&quot;</td>
<td>Plutonium lodged in fingers, necessitating amputation</td>
<td>3.2 m/c Pu</td>
<td>50</td>
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<tr>
<td>6/16/58</td>
<td>Oak Ridge (T-13 Plut)</td>
<td>Eight</td>
<td>Crucibility accident caused by desking enriched uranium in drum of water</td>
<td>8/</td>
<td>461 rem 341 rem 420 rem 415 rem 390 rem 86 rem 66 rem 29 rem</td>
<td>63 63 63 63 23 34 65 41</td>
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<tr>
<td>12/30/58</td>
<td>Los Alamos</td>
<td>One</td>
<td>Crucibility accident</td>
<td>Fatality</td>
<td>12000 ± 5.59% rem</td>
<td>6000</td>
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<tr>
<td>11/8/60</td>
<td>Albuquerque Whole Body</td>
<td>One</td>
<td>Exposure to electronic beam</td>
<td>Multiple radiation burns to middle section of face, abdomen, and both hands</td>
<td>1/</td>
<td>10</td>
</tr>
</tbody>
</table>

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 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 evidences 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.
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


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.
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 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


Nature of Accident

A sheet metal worker was killed when the 5 1/2 x 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 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


Nature of Accident

Electrocution.

Description of Operation

Wiring an arc welder into a temporary switchbox.

Details of Accident

The welding machine had 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 pre­
viously 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 re­
move this plug from the end of the cable before making a connection directly into the switchbox.

EXPLOSIVES EXPLOSION


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


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.

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

Canoga Park, Calif., Dec. 18, 1959—Ref: —H5-59-41

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 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.
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


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 breakwater 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


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 6³⁄₄-in. reinforcing rods with a 6-ft length of 1³⁄₄-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.

The following tabulation (Table 5) lists AEC-MED fatalities and their causes through 1960. Chart 2 is a comparison of AEC & NSC death rates.
<table>
<thead>
<tr>
<th>Year</th>
<th>Med-AEC</th>
<th>NSC</th>
<th>Total</th>
<th>Falls</th>
<th>Electric Shock</th>
<th>Burns</th>
<th>Motor Vehicle Accidents</th>
<th>Other</th>
<th>Total</th>
<th>Falls</th>
<th>Electric Shock</th>
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Table 5 — Fatal Injuries MED-AEC
DEATH RATES... AEC & NSC
PER 100,000 EMPLOYEES

Chart 2