A SUMMARY OF
INDUSTRIAL ACCIDENTS
IN USAEC FACILITIES

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

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.
DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.
PREFACE

The publication in 1956 of a paper summarizing radiation accidents was received with wide interest. That document, TID-5360, described in narrative form all the accidents involving radiation that occurred in atomic energy plants from June 1945 through December 1955. A supplement described radiation accidents occurring in 1956. Numerous requests for both publications indicated a need for continued reporting of accidents having particular connection with the use of radioactive materials. However, since only eight serious accidents of this type were reported in 1957, no summary was published for that year. This report includes narrative descriptions of accidents involving radiation reported to the Atomic Energy Commission by its contractors in 1957 and 1958.

To comply with many requests for additional information on accidents not involving radiation but reflecting industrial and occupational experience, data are also presented on occupational injuries and fatalities in all activities of the Atomic Energy Commission since the beginning of AEC as a civilian agency, Jan. 1, 1947, through Dec. 30, 1958. Narrative descriptions are included of all fatal accidents during 1957 and 1958.

D. F. Hayes, Chief
Safety and Fire Protection Branch
Office of Industrial Relations
CONTENTS

Preface i
Industrial Injury Rates 1
AEC Fatal Accident Experience 1
A Summary of Accidents Involving Fatalities in Atomic Energy Activities, 1957-58 7
Lost Time Injuries from Radiation 12

LIST OF CHARTS

1. Industrial Injury Rates AEC vs NSC 2
2. AEC Industrial Injury Rates 1947-58 3
3. AEC and Contractor Injury Experience 1957-58 4
4. Death Rates AEC vs NSC 5
5. Fatal Injuries MED-AEC 6
6. Reported Radiation Accidents Resulting in Lost Time Injuries 13
7. Comparison of Lost Time Radiation Injuries with Other Lost Time Injuries 14
8. Comparison of Days Lost from Radiation Injuries with Days Lost from All Occupational Injuries 15
INDUSTRIAL INJURY RATES

Where comparisons are made, the latest data on injuries published by the National Safety Council are used. The Bureau of Labor Statistics publishes industrial injury data but it is considered advisable to use the National Safety Council figures because most AEC contractors report their total company records to the National Safety Council and measure their accident prevention performance against those figures. There would be some inequity in making comparisons with the generally higher experience reported by the Bureau of Labor Statistics.

The Commission’s injury rates, taken as a whole, including accidents involving nuclear radiation, compare very favorably with the best rates in the National Safety Council’s annual report. The over-all AEC injury frequency rate for several years has been second or third from the top of the National Safety Council’s list. This comparison for 1957-58 is shown in Chart 1.


Chart 3 shows AEC and contractor injury experience for 1957 and 1958. The injuries total 940 for the two years. About 50 per cent of these fall within two categories, strains or sprains and fractures.

An analysis of the 209 strains or sprains reveals that the majority occurred while workers were handling materials. In most cases, workers were lifting improperly or failed to obtain proper assistance.

Over 90 per cent of the fractures resulted either from workers falling from a different level or from falling objects striking the workers.

The working time lost from the 940 injuries was 64,214 man-days. This loss is equivalent to the working time of approximately 250 men for a full year.

AEC FATAL ACCIDENT EXPERIENCE

In Chart 4, the peak in 1951, which approaches the National Safety Council average fatality rate, is attributed to increased heavy construction activity. Twenty-one of the 24 deaths in this year occurred on construction work due to: falls (9); electrocutions (2); motor vehicles (4); falling objects (3); and other (3). Similarly, in 1954, a large proportion of the fatalities (6 out of 18) occurred on construction work. However, the balance (10) occurred in production activities. This was the largest number of fatalities in any single year in production work and no single cause or trend can be discovered. It will be noted that at all times the rate (deaths per 100,000 employees) has been below the average industrial occupational fatality rate reported by the National Safety Council.

Chart 5 gives the fatal injury experience for 1943-47 (Manhattan Engineering District) and for 1948-58 (AEC), inclusive.

Following Charts 4 and 5 is A Summary of Accidents Involving Fatalities in Atomic Energy Activities 1957-58.
INDUSTRIAL INJURY RATES
AEC vs NSC

FREQUENCY RATE

SEVERITY RATE

ALL AEC OPERATIONS

NSC

CHEMICAL

PETROLEUM

ALL AEC CONSTRUCTION

NSC CONSTRUCTION

ALL AEC ACTIVITIES

NSC ALL ACTIVITIES

AEC GOVERNMENT

ALL GOVERNMENT

FREQUENCY RATE (No. of Injuries per Million Man-Hours)
SEVERITY RATE (No. of Days Lost per Million Man-Hours)

NSC 1958 data not available

CHART 1
AEC INDUSTRIAL INJURY RATES
1947-1958

FREQUENCY (No. of injuries per million man-hours)

ALL ACTIVITIES
OPERATIONS
CONSTRUCTION
GOVERNMENT

1947 48 49 50 51 52 53 54 55 56 57 58

CHART 2
## AEC AND CONTRACTOR INJURY EXPERIENCE

### 1957

<table>
<thead>
<tr>
<th>NATURE OF INJURY</th>
<th>TOTAL</th>
<th>EYE</th>
<th>HEAD</th>
<th>ARM</th>
<th>HAND</th>
<th>FINGER</th>
<th>LEG</th>
<th>FOOT</th>
<th>TOE</th>
<th>TRUNK</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td>451</td>
<td>26</td>
<td>37</td>
<td>41</td>
<td>54</td>
<td>60</td>
<td>70</td>
<td>37</td>
<td>14</td>
<td>112</td>
</tr>
<tr>
<td>Amputations</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asphyxiation</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burns (except chemical)</td>
<td>26</td>
<td>5</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burns (chemical)</td>
<td>11</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cuts, Lacerations, Bruises</td>
<td>165</td>
<td>33</td>
<td>14</td>
<td>26</td>
<td>41</td>
<td>19</td>
<td>4</td>
<td>10</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Dermatitis</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric Shock</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foreign body (in eye)</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>Fractures</td>
<td>103</td>
<td>22</td>
<td>15</td>
<td>3</td>
<td>31</td>
<td>10</td>
<td>2</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hernia</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infections</td>
<td>11</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ionizing Radiation</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strains or Sprains</td>
<td>88</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 1958

<table>
<thead>
<tr>
<th>NATURE OF INJURY</th>
<th>TOTAL</th>
<th>EYE</th>
<th>HEAD</th>
<th>ARM</th>
<th>HAND</th>
<th>FINGER</th>
<th>LEG</th>
<th>FOOT</th>
<th>TOE</th>
<th>TRUNK</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td>489*</td>
<td>22</td>
<td>37</td>
<td>23</td>
<td>40</td>
<td>66</td>
<td>46</td>
<td>96</td>
<td>18</td>
<td>142</td>
</tr>
<tr>
<td>Amputations</td>
<td>31</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asphyxiation</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burns (except chemical)</td>
<td>32</td>
<td>2</td>
<td>9</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burns (chemical)</td>
<td>9</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cuts, Lacerations, Bruises</td>
<td>124</td>
<td>7</td>
<td>12</td>
<td>4</td>
<td>16</td>
<td>9</td>
<td>18</td>
<td>29</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>Dermatitis</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric Shock</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foreign body (in eye)</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Fractures</td>
<td>123</td>
<td>8</td>
<td>12</td>
<td>11</td>
<td>26</td>
<td>9</td>
<td>29</td>
<td>12</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Hernia</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infections</td>
<td>19</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ionizing Radiation</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strains or Sprains</td>
<td>121</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>15</td>
<td>28</td>
<td>16</td>
<td>28</td>
<td>66</td>
<td></td>
</tr>
</tbody>
</table>

*Includes one drowning.

---

**CHART 3**
DEATH RATES—AEC vs NSC

PER 100,000 EMPLOYEES

NUMBER OF DEATHS IN AEC 1947-1958

1947-4 1953-11
1948-11 1954-18
1949-6 1955-10
1950-8 1956-8
1951-24 1957-5
1952-11 1958-5

YEARS 1947 48 49 50 51 52 53 54 55 56 57 58

CHART 4
## Fatal Injuries MED-AEC

<table>
<thead>
<tr>
<th>Year</th>
<th>MED-AEC</th>
<th>NSC</th>
<th><strong>Occupational Fatalities</strong></th>
<th><strong>Construction</strong></th>
<th><strong>Operations</strong></th>
<th><strong>Government</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NUMBER</td>
<td>RATE</td>
<td>TOTAL</td>
<td>Falls*</td>
<td>Electric Shock</td>
<td>Burns</td>
</tr>
<tr>
<td>1943-1945</td>
<td>10</td>
<td>37</td>
<td>33</td>
<td>18</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>1944-1945</td>
<td>54</td>
<td>53</td>
<td>32</td>
<td>30</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>1945-1945</td>
<td>16</td>
<td>16</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>1946-1946</td>
<td>14</td>
<td>16</td>
<td>31</td>
<td>57</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>1947-1947</td>
<td>9</td>
<td>15</td>
<td>31</td>
<td>58</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>1948-1948</td>
<td>81</td>
<td>18</td>
<td>2</td>
<td>18</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>1949-1949</td>
<td>10</td>
<td>10</td>
<td>26</td>
<td>86</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1950-1950</td>
<td>102</td>
<td>102</td>
<td>26</td>
<td>109</td>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td>1951-1951</td>
<td>8</td>
<td>13</td>
<td>27</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1952-1952</td>
<td>24</td>
<td>23</td>
<td>26</td>
<td>21</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>1953-1953</td>
<td>10</td>
<td>10</td>
<td>26</td>
<td>9</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>1954-1954</td>
<td>146</td>
<td>146</td>
<td>26</td>
<td>106</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>1955-1955</td>
<td>11</td>
<td>7</td>
<td>26</td>
<td>11</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>1956-1956</td>
<td>10</td>
<td>10</td>
<td>24</td>
<td>8</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>1957-1957</td>
<td>174</td>
<td>174</td>
<td>24</td>
<td>122</td>
<td>38</td>
<td>16</td>
</tr>
<tr>
<td>1958-1958</td>
<td>10</td>
<td>10</td>
<td>24</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1959-1959</td>
<td>122</td>
<td>122</td>
<td>24</td>
<td>126</td>
<td>48</td>
<td>16</td>
</tr>
<tr>
<td>1960-1960</td>
<td>5</td>
<td>5</td>
<td>26</td>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>1961-1961</td>
<td>5</td>
<td>5</td>
<td>26</td>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

**Chart 5**
A SUMMARY OF ACCIDENTS INVOLVING FATALITIES IN
ATOMIC ENERGY ACTIVITIES 1957-58 *

DEFECTIVE POWER CABLE PROVES FATAL TO MILLWRIGHT

Portsmouth, Ohio, Jan. 29, 1957.

Nature of Accident
Electrocution.

Description of Operation
A crew of four millwrights were moving a cover plate assembly fixture into position on a block.

Details of Accident
The top of the fixture, approximately 12 feet above the floor, came in contact with two 440-volt power cables leading from a temporary switchbox, on an adjacent steel column, to the work area. Exceptionally wet and muddy conditions prevailed in the area due to rain through the uncompleted roof.

The two cables contacted the fixture and slipped to a position under a sprocket protruding at the top of the frame. Further movement placed a strain on the cables at a defective point in the insulation.

Unaware of the condition, the millwrights continued to move the equipment, using iron pipes as pry bars.

Nature of Injuries
Two of the crew received electric shocks; one minor and the other so severely that he collapsed to the floor; he recovered after being moved from the area.

Two crew members, who helped carry the injured out, returned to the scene, and one reached through the framework of the energized fixture to retrieve a hat dropped by the injured employee. In so doing, he received a fatal shock.

*An additional fatality is included in the section entitled: A Summary of Accidents Involving Radioactive Material in Atomic Energy Activities 1957-58.
CRANE ACCIDENT

Portsmouth, Ohio, Mar. 11, 1957.

Nature of Accident
Electrocution.

Description of Operation
A two-man crew was assigned to the task of sorting pipe stored adjacent to a pipe fabrication shop and directly under a 13,800-volt feeder for the construction area. The work consisted of sorting and restacking certain types of pipe after marking with paint.

Details of Accident
One of the crew, acting as a rigger, affixed a sling to a pipe while the other operated a truck-mounted crane. The pipe was lifted clear of the pile, and the operator of the crane moved the crane so that the other employee could mark the pipe. When the operator moved the crane, the boom came in contact with the 13,800-volt feeder into the construction area. At the time of contact, the crewman who was marking the pipe had a hold on the pipe.

Nature of Injuries
Although one of the outriggers of the crane was in place on the ground, sufficient current passed through the crewman's body to kill him. The operator of the crane was not injured.

MOTOR VEHICLE ACCIDENT


Nature of Accident
Motor vehicle.

Description of Operation
Driving a motor vehicle which overturned on a curve.

Details of Accident
The driver was operating the vehicle at an estimated speed of 90 mph on a posted 60 mph speed limit portion of the highway. He attempted to negotiate a curve, lost control of his vehicle and traveled a distance of 255 feet, partially on the hard packed dirt road shoulder, and then turned over ten times on the road shoulder, immediately parallel to the hardtop, a distance of 195 feet. His body was thrown 40 feet beyond the point where the vehicle came to rest.

Nature of Injury
Driver was fatally injured.
AIRPLANE CRASH


Nature of Accident

An aircraft crashed and burned in a canyon.

Description of Operation

Mapping geological areas by aerial photography.

Details of Accident

Unwitnessed—but it is believed, from the location of the unburned wheel tire and direction of burning, as evidenced by charred rocks and brush, that the wind was blowing from the southwest (the rim of the canyon at the crash site runs approximately north-south). It must be assumed, therefore, that the aircraft, reconnoitering at low levels, was in the dangerous environment of turbulent air flowing over the downwind side of the rim.

The aircraft, continuing its anticlockwise rotation, fell on the right wing, which folded against the fuselage, and the whole mass came to rest approximately 15 feet below the rim of the canyon. The force of the impact ruptured the gasoline tanks (one in each wing), and the escaping fuel was ignited either by the hot engine or sparks developed by friction against the rocks.

Nature of Injuries

Pilot and AEC passenger were killed in crash.

HEAD-ON COLLISION


Nature of Accident

Motor vehicle.

Description of Operation

Driving a motor vehicle.

Details of Accident

The driver of a Government car was approaching a railroad crossing at the same time a railway locomotive was approaching. The car was traveling at 50 miles per hour and the driver apparently did not see the train until it was too late. He collided head-on with the rear of the engine and the front of the flat car. His body was thrown from the vehicle approximately 88 feet.

Nature of Injury

The driver was pronounced dead on arrival of the ambulance and plant physician to the scene of the accident.
HELICOPTER ACCIDENT


Nature of Accident
Helicopter crashed into the sea.

Description of Operation
Transporting three passengers by air.

Details of Accident
The helicopter ran into rain squalls and heavy winds and descended to about 500 feet in an attempt to maintain altitude. At this height, the helicopter encountered severe turbulence, which is believed to have caused a blade stall. Before recovery from the stall could be made, the helicopter crashed into the lagoon. The helicopter struck the water in the proper attitude, and the pilot, following standard procedures, attempted to roll the aircraft over on its left side, leaving the main door up, but because of weather conditions, the helicopter turned over, with the main door in the down position. The helicopter came to rest, completely submerged, with about one foot of water covering the fuselage. The crew of two escaped through the co-pilot’s window. One passenger was able to knock out either the escape hatch or the window of the escape hatch in the cabin, and return to rescue another of the passengers, who was revived by artificial respiration on the top of the helicopter. Rescue of the third passenger could not be made in time.

Nature of Injury
One drowning.

TUNNEL ACCIDENT

Nevada Test Site, June 17, 1958.

Nature of Accident
An employee was fatally injured from rock mass, estimated weight 3,000 pounds falling from the roof of the tunnel.

Description of Operation
Engaged in normal tunneling activities.

Details of Accident
Two men were walking toward the face of the drift. One employee had stopped at a water can for a drink; at the same time an estimated 3,000-pound rock mass fell from the tunnel roof without warning, striking him and pinning him to the left tunnel wall. A smaller rock mass struck another employee.

Nature of Injuries
One was fatally injured and another received a broken leg.
ELECTROCUTION


**Nature of Accident**

Employee was fatally injured when he contacted a 2300-volt electric circuit in a transformer station.

**Description of Operation**

Chipping and cleaning rust from transformers and an oil-fused switch without proper protection, preparatory to application of protective paint.

**Details of Accident**

Unwitnessed—but it is believed that the employee was chipping on the edge of a switch, and that his hammer may have missed the edge or glanced off, and that the natural momentum of his arm brought it downward to where it contacted the bare connecting lug on the end of the bushing which was carrying 2300 volts.

**Nature of Injury**

Electrocution.

TRENCH CAVE-IN

Portsmouth, Ohio, Dec. 18, 1958.

**Nature of Accident**

An employee was trapped under 192 cubic feet of earth, due to a cave-in.

**Description of Operation**

Excavating a 6-foot trench.

**Details of Accident**

An employee was preparing a trench for the subsequent laying of an 18-inch steel water line. A portion of the west wall of the trench, approximately 12 feet 5 inches long, gave away. Failure of the trench wall came without warning, and no previous indication of incipient failure had been observed.

**Nature of Injury**

Suffocation.
Charts 6, 7, and 8 on the following pages may be of special interest since this is the first time an effort has been made to classify and report "lost time" injuries due to exposure to radiation and to show a comparison of lost time radiation injuries with other lost time injuries in the Atomic Energy Commission. Chart 6 also contains data on the method of compensation to injured persons, which were prepared originally in a report to the Joint Congressional Atomic Energy Committee for use in its hearings in March 1959.

It is important to bear in mind that the lost time injuries identified in [Chart 6] are not necessarily clinically diagnosed "radiation injuries." Rather this figure presents a complete list of all reported instances which are appropriately classified as "lost time injuries" or "disabling injuries" in accordance with the prevailing definitions of the American Standards Association, the organization which has developed the standard method used by American industry for reporting and measuring work injury experience. Among the categories of injuries included in the ASA definitions, in addition to the more obvious ones—such as death, permanent total disability and permanent partial disability—are work-connected disabilities which prevent an individual from performing his regularly established job during the time interval corresponding to the hours of his regular shift on any one or more days. Under ASA standards, an injury of this type is classified as "temporary total disability."

Thus, included in [Chart 6] are a number of lost time injuries which in terms of medical opinion would not, in fact, be classified as injuries in the normal clinical sense of the term. In other words, they would not be classified as "radiation injuries" in the sense that they had been so diagnosed by a physician competent in radiation medicine.

By and large, the columnar headings on [Chart 6] are self-explanatory. However, a brief note on the columns grouped under "Method of Compensation" is necessary for a complete understanding of the information reported in the eight subcolumns. The first five subcolumns refer to five of the six major classifications of injuries under which benefits are paid in accordance with workmen's compensation statutes. The sixth category "Permanent Total Disability" has been omitted from the figure because none of the reported lost time injuries fall in this category. The classification "Death Benefits" and "Funeral Expenses" are self-explanatory. The third category "Temporary Total Disability" represents that classification of compensation case which ends with the apparent recovery of the injured person and his return to work. Compensation benefits under this category are normally paid to reimburse employees for a percentage of their lost wages during the period of temporary disability. A "Permanent Partial Disability" is classified in workmen's compensation laws as a specific of "schedule" injury, such as loss of, or loss of use of, a member; or a "non-schedule" injury which is an injury of a more general nature, such as, for example, disability caused by injury to the head or back. The final workmen's compensation category refers to the medical benefits received by an injured employee to meet, at least in part, the cost of medical care and treatment during his disability.

The three columns under the heading "Other" refer to the benefits received by injured employees (or in the case of fatalities, their beneficiaries) which were paid by the contractors in supplementation of or in lieu of any benefits paid under applicable workmen's compensation statutes.... The column headed "Occupational Disability" is meant to describe the generally common practice in industry today of making employees whole for any wage loss suffered during periods of disability. The final category, "Medical-Hospital" refers to benefits of this nature which employees receive from their employers in addition to benefits received under applicable state compensation laws.

It is believed that [Chart 6] includes all instances in which compensation was received by employees for lost time injuries which in the opinion of the Commission or its contractors, or in the
<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>
<th>Workmen's Compensation</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/21/45</td>
<td>Los Alamos</td>
<td>Two</td>
<td>Chain reaction on experimental critical assembly</td>
<td>(1) Fatality</td>
<td>Gamma ray</td>
<td>6000</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(2) No clinically diagnosed injury</td>
<td>X-Ray</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>5/21/45</td>
<td>Los Alamos</td>
<td>Eight</td>
<td>Chain reaction on experimental critical assembly</td>
<td>(1) Fatality</td>
<td>Gamma ray</td>
<td>6000</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(2) Skin rash, loss of hair and other symptoms</td>
<td>X-Ray</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(3) Skin rash and other symptoms</td>
<td>X-Ray</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(4) No clinically diagnosed injury</td>
<td>X-Ray</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(5) No clinically diagnosed injury</td>
<td>X-Ray</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>7/14/57</td>
<td>Los Alamos</td>
<td>Two</td>
<td>Improper handling of fission sample</td>
<td>Beta ray burns to hand</td>
<td>Gamma ray</td>
<td>3.7 r</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>8/21/45</td>
<td>Los Alamos</td>
<td>Two</td>
<td>Improper handling of fission sample</td>
<td>Beta ray burns to hand</td>
<td>Gamma ray</td>
<td>3.7 r</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>9/22/52</td>
<td>Los Alamos</td>
<td>One</td>
<td>Improper handling of fission sample</td>
<td>Beta ray burns to hand</td>
<td>Gamma ray</td>
<td>1.7 r</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>10/14/57</td>
<td>Los Alamos</td>
<td>One</td>
<td>Improper handling of fission sample</td>
<td>Beta ray burns to hand</td>
<td>Gamma ray</td>
<td>1.7 r</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>11/14/57</td>
<td>Los Alamos</td>
<td>One</td>
<td>Improper handling of fission sample</td>
<td>Beta ray burns to hand</td>
<td>Gamma ray</td>
<td>1.7 r</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>12/20/58</td>
<td>Los Alamos</td>
<td>One</td>
<td>Improper handling of fission sample</td>
<td>Beta ray burns to hand</td>
<td>Gamma ray</td>
<td>1.7 r</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>1/2/56</td>
<td>Los Alamos</td>
<td>One</td>
<td>Improper handling of fission sample</td>
<td>Beta ray burns to hand</td>
<td>Gamma ray</td>
<td>1.7 r</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

NOTE: An exposure previously reported on 10/4/57, Oak Ridge (ORENL) sold not lost-time.
RADIATION INJURIES 1943-58 AEC CONTRACTORS

Over a 15 year period there were 5,651 injuries from all causes

- 15 months prior to employee's death, contractor reported to state agency that employee had received "Exposure to Radioactive Material" in 1942-53 years before report filed and prior to contractor's participation in MED Program.

- Two persons later developed other latent disability.

- This figure was previously 35 - one injury was dropped because it was not a host time.

- 35% were radiation injuries

1. FATALITY, LEUKEMIA, DELAYED EMERGENCE
3. FATALITIES, SHORTLY AFTER EXPOSURE
11. NO CLINICAL DIAGNOSIS OF INJURY
20*. PROMPT SYMPTOMS SUCH AS RASH, VOMITING, BURNS, HAIR LOSS, ETC.
TIME LOST FROM RADIATION INJURIES 1943-58
AEC CONTRACTORS

THERE WERE
219,186,055
MAN-DAYS OF POTENTIAL
EXPOSURE FROM
1943 THROUGH 1958 -

but only

0.3% OR
690,101 DAYS
LOST FROM WORK INJURIES FOR ALL CAUSES

of which only

0.01% OR 31,119 DAYS
RESULTED FROM RADIATION EXPOSURE
judgment of compensation boards, resulted from radiation accidents. However, in addition to the cases reported in the figure, there are two cases presently pending before State compensation bodies where the claimants allege that injury was occasioned by radiation exposure. The first of these involves an allegation that an employee's death was due to radiation exposure. The claim was originally denied, but it is believed that further litigation is contemplated. The second case involves one of the four individuals reported in Chart 6—the June 2, 1952, Chicago incident. The claim here is that the employee had suffered a permanent partial disability as a result of the accident. This matter is still pending.
A SUMMARY OF ACCIDENTS INVOLVING RADIOACTIVE MATERIAL IN ATOMIC ENERGY ACTIVITIES 1957-58

REACTOR ACCIDENT

Santa Susana, Calif., Jan. 4, 1957.

Nature of Accident

High level volatile activity was observed in a KEWB reactor building.

Description of Operation

The contamination of the reactor test building occurred during a series of routine operating reactor tests which involved the use of auxiliary apparatus.

Details of Accident

One person was exposed to high level volatile activity for approximately 10 seconds, receiving approximately seven times his daily breathing tolerance, based on pessimistic assumptions for the calculation. An independent estimate showed the exposure to be less than one daily tolerance dose. A survey showed no particular contamination outside the reactor test building. Some low level gaseous activity was detected in the electrical building, which is located immediately above the test building. Within 24 hours, the activity in all rooms of the test building was reduced to background by the use of the forced ventilation system provided for the building. The building was then entered and inspected; the leak appeared to be caused by the failure of a vacuum pump. The pump was replaced and the necessary decontamination was completed.

Nature of Injuries or Loss

The member of the KEWB staff exposed to the activity had entered the test building on schedule, 15 minutes after shutdown, to measure the core pressure. A radiation survey at the door indicated no unusual radioactivity in the valve gallery. As this was being done, another staff member checked the remote continuous gas sampler and found it above breathing tolerance. The test building was vacated immediately after about 10 seconds of occupancy.

The employee's internal dose was less than 50 mr. No measurable (less than 1 mr) external whole body dose was received during the incident. No detectable activity above normal background was found by radiourinalysis during the ensuing 36 hours.

Remarks

The apparent cause of the contamination was the malfunction of equipment which had operated satisfactorily for a period of 7 months. This equipment was a part of the auxiliary plumb-
ing system and was not an integral part of the reactor system.

The activity levels resulting from the contamination were relatively minor and were easily removed. After the decay of the volatile activity, the cleanup job might be compared to that required in the event of a radioactive spill in a radioisotope laboratory.

The KEWB test facility was shown to be properly equipped to handle contamination of a much greater magnitude than that described here.

GODIVA


Nature of Accident

A fissionable material assembly, remotely operated, produced a neutron burst greater than intended, resulting in a rupture of the assembly.

Description of Operation

A neutron-producing assembly, called "Godiva" because of its bare configuration, was to be used to irradiate uranium-loaded graphite samples. The samples were to be heated in a shielded furnace, exposed to a "prompt" burst of neutrons and then transferred to a counter for evaluation. The experiments are conducted at an isolated site in a building separated from the control room (and all personnel) by about a quarter of a mile. The mechanisms are operated remotely. Although excessive radiation, to the degree experienced in this accident, does not occur routinely, it is not entirely unexpected.

The prompt burst is produced by bringing together different sections of U^{235} to form a sphere. The exact degree of criticality is determined by preset control or reactivity rods, also enriched with U^{235}. The assembling was expected to achieve a condition slightly above prompt critical, a condition which produces a burst of 10^{16} fissions or a total energy of about 100 watt-hours. The heat of the reaction expands the uranium and reduces the reactivity below prompt critical, thus terminating the burst, and then the parts are mechanically separated.

Details of Accident

On the occasion of the accident, preliminary bursts were being produced. In the process of lowering the top safety block, the unexpected burst occurred, a burst that was estimated to have produced 1.2 \times 10^{17} fissions, or about 12 times the normal energy of a prompt burst and about twice the energy of a previous incident which occurred in 1954. The energy was great enough to tear the uranium parts from the assembly (knocking one to the floor), and distort the steel rods in the frame. The uranium was deformed and there was much more surface oxidation than usual.

Nature of Injuries or Loss

There were no personal injuries or overexposures. As stated above, the operation was carried out remotely and no overexposures would be expected. No gamma radiation above background was detected outside the building. Radiation levels in the building were high initially — 7 roentgens per hour gamma just inside the door (12 feet from Godiva) and 5,000 to 20,000 counts per minute (per 55 cm^2 probe) alpha on horizontal surfaces about the room — therefore cleanup procedures were delayed 2\frac{1}{2} days until scrub-down could be completed without unnecessary exposure to cleanup personnel.

Property Damage

The total property loss was estimated at $2,400, distributed as follows:
Fissionable material, U$^{235}$   $200
Damage to frame and electronic equipment (too contaminated to clean)   2,000
Cleanup labor   200
Total $2,400

The building was placed back in operation 8 days later. Personnel were utilized in other activities in other facilities. One important experiment was carried on in this building during this period with the personnel wearing protective clothing.

Remarks

The burst was believed to have been caused by accidental movement toward Godiva of an incidental neutron reflector (the furnace for heating the sample), causing additional reactivity and a neutron burst above that expected. The neutron reflector may have been jarred by the action of pneumatic cylinders which operate the assembly.

Godiva will be replaced with a bare uranium device designed specifically for prompt burst production. To insure reliability of operation, the following features will be incorporated:

1. Rigid mounting of uranium.
2. Uranium will be plated to prevent flaking.
3. Inflexible geometry.
4. Combination gross-mass adjusting rod and auxiliary scram, fixed value reactivity booster for burst generation.
5. Cage to establish minimum spacing of objects to be irradiated.
6. Remotely positionable neutron source.

AIRBORNE IRIDIUM-192 IN LABORATORY

Texas, Mar. 13, 1957.

Nature of Accident

Release of radioactive iridium-192 in a laboratory.

Description of Operation

The encapsulation of radioisotope sources.

Details of Accident

Two employees, one in protective clothing and respirator and one in street clothes, were engaged in opening a sealed aluminum can containing 10 radioactive iridium sources consisting of iridium-aluminum pressed pellets, $\frac{1}{8}$-inch by $\frac{1}{4}$-inch right cylinders. Each pellet consisted of approximately 35 curies of iridium-192. To permit the removal of the plug containing the pellets from the can, the end of the can was cut with a jeweler’s lathe in a sealed plexiglas box which, in turn, was in a hot cell consisting of 33-inch thick concrete walls, a shielded window, and an open top. Remote control slave manipulators were used by the operators. This operation was completed in the morning.

The can was allowed to remain in the sealed plexiglas box for a period of time to permit any contamination to settle in the box. After lunch an employee, again dressed in protective clothing consisting of white pants, shirt, shoes and respirator, opened the sealed box. The second employee, who was present that morning, was again present in street clothes. The can was removed from the box and placed on a paper mat on the floor of the hot cell, and when the plug was removed from the can, it was observed that portions of the first two pellets were in particle form. Some of the particles fell onto the paper mat. During this operation, the air
monitor device in the laboratory indicated the presence of airborne radioactivity. Subse-
sequently, the employee in street clothes left the laboratory. The employee wearing protective
clothing remained in the laboratory. The exact extent or timing of the work he then performed
is not known, but it did involve the placing of the eight intact and two partial pellets, together
with the particles of iridium-192, in the storage pit at the bottom of the hot cell. Before this
employee left the hot cell, he placed the storage pit lid in place. He removed his protective
clothing, took a shower, and dressed in his street clothes before leaving the premises.

Between the afternoon following the removal of the pellets from the plug and on or about
1 month later, the following events occurred:
(a) The eight intact and two partial pellets were encapsulated and placed in a storage well.
(b) The air monitor in the laboratory was placed back in service.
(c) The jeweler's lathe and paper mat were placed in a waste storage pit.
(d) The hot cell was washed with soap, water and sponges, which lowered the radiation
level from approximately 2,000 mr per hour to about 20 mr per hour.
(e) The jeweler's lathe was removed from storage and sprayed with soft spray. After
completion of this procedure the lathe showed a reading of 5,000 mr per hour. It was dis-
mantled, placed in a 5 gallon can of kerosene, and lead bricks were placed around it.

Right after this an employee entered the laboratory, removed a cesium-137 source from
the storage well and loaded it into a projector. At that time, the manager noted a high radia-
tion reading outside of the iron doors at the end of the hot cell.

Subsequent to the manager's observation of contamination in the vicinity of the hot cell, he
made further inquiries concerning the spread of contamination. During the following week, he
determined that the laboratory area was contaminated, that employees' street clothes and
shoes had been contaminated as a result of the incident, and that some radioactive material
had been carried into employees' homes and automobiles.

One more entry was made to the laboratory, when the manager entered to procure some
equipment. It was then closed down until decontamination work was begun.

Nature of Injuries or Loss

Radiation exposures received by employees while working the laboratory area show that
neither of the two employees present in the laboratory at the time of the accident received a
radiation exposure, during the week the accident occurred, in excess of permissible values
established in the AEC Standards for Protection Against Radiation.

About 3 weeks after the accident occurred, one of the employees received an exposure of
1,720 millirems, which is about twice the exposure permissible under the regulations for any
period of 7 consecutive days. This occurred during the cleanup operations in the laboratory.

This one employee's cumulative exposure record for 13 consecutive weeks, including the
week of the accident and the cleanup, was 3,875 millirems.

This exposure exceeds the permissible quarterly exposure, under these conditions, by
about 25 percent of that permitted by regulation. There were no other overexposures to em-
ployees recorded during that period. Twenty persons, nineteen of them employees or members
of their families and one a neighbor of an employee, were medically examined. Except for a
minor radiation burn noted on each of the two employees who were present at the time of the
accident, medical examinations were negative.

EXPOSURE TO PLUTONIUM


Nature of Accident

Employee exposed to plutonium nitrate.
Description of Operation

A maintenance man was unplugging the dip leg of a tank.

Details of Accident

A torn glove in a glove box hood resulted in an employee’s thumb and finger being contaminated with plutonium nitrate. The electric drill the employee was using to unplug the dip leg stalled and stopped. When the employee attempted to pull the drill out, the chuck rotated in an opposite direction to the spiral bit and caused the hood glove and both surgical gloves he was wearing to twist around the chuck and tear. To prevent contamination spread, the hand was wrapped in a wet cloth as it was drawn from the glove box opening. After the hand was wiped, the left thumb and index finger were contaminated to a level of 0.15 mc. Decontamination efforts were continued at first aid until the skin was too thin to continue. The hand was coated with plastic at 0.0025 mc and decontamination efforts were discontinued until the following day. At that time the plastic was removed and the level dropped to 0.001 mc or less.

Nature of Injuries or Loss

Since the accident five samples have been analyzed, all of which have been negative. It can be said that there was no external or internal deposition of plutonium. The employee is working at his regular assigned duties.

DRY BOX EXPLOSION

Rocky Flats, Colo., June 14, 1957.

Nature of Accidents

Two men injured by an explosion in a dry box.

Description of Operation

The men were performing a routine operation inside a sealed dry box.

Details of Accident

When a whistling noise was detected during a routine operation, the operators decided to vacate the vicinity. The explosion occurred during this evacuation, resulting in the shattering of glass and the blowing out of one of the panels of the box. The individuals concerned were sprayed or struck by flying debris, causing minor abrasions and cuts and considerable plutonium contamination.

Nature of Injuries or Loss

One employee had a cut on his right temple and eyebrow and a minor cut on his lower right cheek. The other employee involved in the accident had a surgical amputation of 5/8-inch bone, distal phalange, right little finger, to remove the plutonium. Four-tenths of a microgram of plutonium was deposited in an abrasion wound on the face of one man, and about 0.5 micrograms of plutonium in a wound on the second. Losses due to damage to the dry box equipment, and room, plus cleanup costs were $31,000.00.

Remarks

Adequate safety enclosures should be utilized and designed to resist the explosive release of the total energies available. Equipment provided for work of this nature should be designed with recognition of and provision for the explosion hazards normally associated with materials of this nature.
BETA BURNS TO HANDS

University of California Radiation Laboratory, June 27, 1957.

Nature of Accident
An employee received a 1,000 to 2,000 rem dose to his hand.

Description of Operation
The employee was working in a glove box with about 85 mc of strontium-90 contained in a centrifuge tube.

Details of Accident
During the processing of strontium carbonate in a glove box, an employee received beta burns on a part of the hand holding the centrifuge tube as a result of misjudgment of the amount of beta attenuation achieved through the glass wall of the tube and his rubber gloves.

Nature of Injuries or Loss
The damage consisted of blisters which developed in about 2 weeks. Under the surveillance of the medical group, but without necessity of treatment, the condition cleared up, and as of the present time, there is no evidence of permanent damage. This accident did not constitute a spill or involve contamination.

EXPLOSION IN GLOVE BOX LINE OF PLUTONIUM FACILITY


Nature of Accident
Explosion in plutonium processing hoods.

Description of Operation
Manufacture of plutonium metal.

Details of Accident
A chemical operator was cleaning rust from lathe collets in one of a series of connected glove box hoods, using a motor-driven (open-case) rotating brush. At the same time, a machinist was coating a lathe and chain hoist with a flammable lubricating and rust-preventive solution in an interconnected glove box. Vapor from the flammable solution which the machinist was using circulated throughout all the hoods, and sparks from the chemical operator’s electric rotating brush caused the explosion. (Combustible plutonium dust in some of the boxes may have contributed to the explosion.)

Nature of Injuries or Loss
The chemical operator received a slight contusion on the head and another employee received a blow on the shoulder. Exposure to men in the room from plutonium-contaminated dust was less than 1 per cent of the maximum permissible body burden.

Remarks
A nonflammable solvent will be substituted for general cleaning. Also a study is being made to determine if a rust-preventive solution with a nonflammable vehicle can be found that will meet operational requirements.
METALLIC PLUTONIUM FIRE

Rocky Flats, Colo., Sept. 11, 1957.

Nature of Accident

A small amount of metallic plutonium spontaneously ignited and transmitted fire to the plastic structure of the dry box in which it was stored.

Description of Operation

Plutonium processing.

Details of Accident

At 10:10 P. M., watchmen discovered a fire which appeared to involve plutonium within a dry box, polyethylene parts of the box itself, and rubber gloves (normally used to prevent skin contact during handling of plutonium). Knowing that plutonium was handled and stored in the area, and might be involved in the fire, fire fighting was delayed until personnel could put on protective clothing and evaluate the hazards involved. Portable carbon dioxide extinguishers, ranging up to 100-pound units, were emptied on the fire without effect. Although there was considerable uncertainty regarding the criticality hazards involved if water should be applied, water was finally applied to the fire in the form of a spray, and this proved effective for control of the fire, with no nuclear event. Spontaneous ignition of plutonium chips in a container stored in the dry box was determined to be the origin of the fire.

The fire had two serious consequences:

1. It allowed escape and dissemination of considerable plutonium oxide throughout the immediate area in the plant;
2. It burned through the combustible CWS filter at the dry box, permitting flames and some unburned combustible gases to pass through primary exhaust air ductwork to the large main bank of filters which were of a combustible type.

Combating fire in the main filter bank was impeded both by radiological hazards to personnel and by difficulties in selecting methods for extinguishing the fire without simultaneously destroying the integrity of the filters.

On two occasions during the fire, low order explosions were experienced from not fully explained causes, but suspected to be due to ignition of gases generated by plastic heated in the fire. About 13 hours after its inception, the last remnants of the blaze were extinguished. Virtually all of the units in the large filter bank were destroyed.

Nature of Injuries or Loss

No employees were overexposed to radiation. Fire damage and contamination cleanup losses were considerable.

RADIATION EXPOSURE


Nature of Accident

An employee accidentally exposed himself to radiation.

Description of Operation

Chemical processing operation.
Details of Accident

An employee accidentally received an exposure to radiation when he mistakenly entered a room containing highly radioactive material and received exposure for less than 1 minute to a level of 49 roentgens. The room he entered contained chemical tanks of radioactive residues used in connection with processing irradiated fuel elements.

The individual concerned entered the locked room, by mistake, using a key he was permitted to carry, to seek a wrench he thought he had left. It turned out that the wrench was in the next room.

The accident was first discovered when a pencil-type radiation detection instrument was examined at the end of the day's shift and was confirmed when film badge was processed.

Nature of Injuries or Loss

The exposure received amounted to slightly less than three and a half times the exposure normally permitted in 1 year for workers in atomic energy facilities who are exposed routinely to radiation. The individual apparently suffered no ill effects and continued working, but was transferred to other work.

EXPOSURE ACCIDENT


Nature of Accident

Employee received ingested radiation.

Description of Operation

Changing filters in a prefilter bank.

Details of Accident

A boiler-ventilator operator was changing filters. He was engaged in this work for about one hour.

Later, a check by health physics personnel indicated he had received some ingested radiation. An examination of the mask used by the employee showed that the filter paper in the mask had been crimped, allowing unfiltered air to come through.

Nature of Injuries or Loss

The employee received as much as one-half the body burden.

HOTBOX FIRE

Freeport, Ill., May 6, 1958.

Nature of Accident

Hotbox fire.

Description of Operation

Rail shipment of radioactive material.
Details of Accident

A journal box fire occurred on a flatcar in railroad yards. The fire spread to the wooden platform of the car. Railroad employees attempted to extinguish the fire but could not. The local fire department was called and extinguished the fire, using CO₂ and a booster (water) line.

Nature of Injuries or Loss

The fire did not involve the shipment, so there was no radiation problem.

Remarks

Hotbox fires are fairly common and can easily spread to the wooden platform of a car, as happened in this case. Exposure to shipments of radioactive materials and to structural members holding shipments in place could be reduced by replacing such platforms with suitable noncombustible material. It could be reduced to a lesser extent by insulating the underside of wooden platforms (over the journal boxes) with suitable noncombustible material to minimize the possibility of a hotbox fire spreading to the wooden platform.

TENTH AEC CRITICALITY ACCIDENT *


Nature of Accident

A criticality accident occurred in a 55-gallon stainless steel drum at a production facility.

Description of Operation

Eight employees were in the vicinity of the drum at the time of the accident. All of them were carrying out routine plant operations and maintenance. One employee, a chemical operator, was participating in the leak testing which inadvertently set off the reaction. He was within 3 to 6 feet of the drum when the incident occurred. The other seven were from 15 to 50 feet away at the time. Two were engaged in installing ductwork; two electricians were engaged in removing conduit; two others, a welder and a machinist, were located on a mezzanine near the scene of the incident, and the seventh, a chemical operator, was in the process of starting up an evaporator some 50 feet away.

Details of Accident

On the afternoon of the incident, eight men were working in a wing of a processing plant. A chemical operator noticed a sudden blue flash and immediately thereafter heard the evacuation alarm sound, indicating existence of excessive radiation hazards. He and the others promptly left the building. All employees evacuated following pre-established emergency procedures. As a precautionary measure, the road to the plant was barricaded and employees reporting on the afternoon shift were delayed from reporting to work.

Specialists, brought in to determine the source of radiation, established the specific location of the incident and defined the radiation field. Road blocks were removed and employees were allowed to enter all work areas, with exception of that portion of the building where the incident occurred.

Immediate efforts were directed toward determining whether any individual had been exposed to excessive radiation, providing medical care, and in decontaminating and cleaning up

SOMETIME BEFORE THE ACCIDENT
URANIUM SOLUTION LEAKED FROM
TANK NO. 1 INTO TANK NO. 2.

ALL FIXED EQUIPMENT IN THESE
LOCATIONS EXCEPT THE STAINLESS
(S. S.) DRUM PROVIDE "ALWAYS-
SAFE" CONFIGURATION.

STAINLESS STEEL DRUM

JUST PRIOR TO THE ACCIDENT AN OPERATOR
OPENED VALVE "A" AND URANIUM SOLUTION
AND WATER IN TANK NO. 2 DRAINED INTO
DRUM WHERE NUCLEAR EXCURSION OCCURRED.

NOTE: This diagram does not in any way depict the actual positions of tanks, piping, valves, etc. It serves only
to indicate relative schematic arrangement of vessels and equipment.
the affected building wing. By this time, it had been established that a criticality or nuclear excursion had occurred in a 55-gallon stainless steel drum.

A diagram showing the principal equipment involved in the accident is shown on p. 26. Immediately prior to the accident, tanks (Nos. 2 and 3 in the diagram) were being leak-tested with water. Before this, and unknown to the operator, it is believed that, due to valve leakage and/or operator error, enriched uranium solution had flowed from storage tank No. 1, partially filling tank No. 2.

The balance of the void area in tank No. 2 was filled with water during leak testing. When the operator opened valve A to drain the contents of tank No. 2 into the stainless steel drum, the level of enriched uranium solution in the drum built up to a point permitting initiation of a critical nuclear reaction, accompanied by the "blue glow" in the solution seen by the operator. The enriched uranium solution flowing from tank No. 2 into the drum was followed by water from the same source which diluted the solution in the drum below the concentration necessary to maintain the critical reaction.

It is apparent that a solution must assume the shape of the container in which it is placed. While the enriched uranium solution was in tanks Nos. 1, 2 or 3, the shape, i.e., geometry, of the solution was such that a nuclear reaction could not take place. The shape of the same solution when in the drum, however, was favorable for a nuclear reaction after a certain depth of solution had been reached. For a critical reaction to occur, the solution not only has to be in a favorable shape, it also has to be in a favorable concentration. These conditions occurred. The reaction was stopped by water, which, after the operator left, continued to flow into the drum, reducing the concentration below that necessary to maintain the critical reaction.

To insure that further nuclear reaction would not occur, sheets of cadmium, a neutron-absorbing material, were inserted into the 55-gallon drum. Samples of the material in the drum were taken for analysis and later the contents of the drum were transferred to "always-safe" containers and removed to a shielded location. There was no explosion, nor would one be expected under the circumstances. However, there was emission of radiation from the nuclear excursion which is believed to have occurred in a pulsing manner with periodic emissions of radiation for a duration of not exceeding four minutes.

**Nature of Injuries or Loss**

Since the determination of radiation exposure from a reaction of this type is complicated under any circumstances, special methods were used to determine the neutron and gamma exposure of the individuals nearby.

These methods included readings from indium foil which is incorporated in all security badges; determining the radioactivity of sodium-24 in the bodies of those exposed through whole body and blood counting; and by measurements obtained through a mockup of the accident.

Through use of these methods, it was estimated that the eight men received the following radiation exposures: 461 rem, 428 rem, 413 rem, 341 rem, 298 rem, 86 rem, and 29 rem.

**Property Contamination**

Contamination of the area was slight. Decontamination costs were under $1,000.

---

**X-RAY TECHNICIAN EXPOSED**


**Nature of Accident**

Exposed to X-ray radiation.

**Description of Operation**

Taking X-ray of a metal tube in an X-ray room.
Details of Accident

The X-ray technician had completed the taking of an X-ray of a metal tube. The X-ray machine was operated at 100 kv and 10 ma for a period of one minute. The employee stated that the timer returned to zero and the red warning light on the panel went out. Therefore, he entered the X-ray room to change his setup in preparation for another picture. Unknown to the X-ray technician, he was being exposed to X-ray radiation because of a malfunctioning panel.

Nature of Injuries or Loss

Employee film badge indicated he was exposed to a radiation level of 885 mr.

RADIUM-BERYLLIUM SHIPMENT VEHICLE ACCIDENT

Grand Junction, Colo., June 20, 1958.

Nature of Accident

A truck carrying a radioactive source went out of control down an embankment into the Colorado River.

Description of Operation

Transporting radioactive source by truck.

Details of Accident

The truck carrying the source went out of control, plunged into the river, and submerged in about 30 feet of water.

Skin divers entered the river, located the truck, and secured a cable to the front tow bar to enable a wrecker to draw the truck to the bank of the river. A line was secured to the frame of the truck from a large crane, and it was in position to raise the truck from the water. This was done, and the truck was suspended vertically on the road for inspection.

Nature of Injuries or Loss

Damage to the truck was largely confined to the cab and the top portion of the van. The source was located in the lower right side of the van, shielded in a spherical container inside a compartment of the van. Neither the compartment nor the source container were damaged. No exposure of consequence was received by the public or salvage personnel.

FIRE INVOLVING RADIOACTIVE MATERIAL


Nature of Accident

Fire involving 6 pounds of slightly enriched uranium.

Description of Operation

Degreasing uranium in a portable electric vapor degreaser.

Details of Accident

A fire occurred when slightly enriched uranium scrap had just been degreased with perchloroethylene. The local fire department was called but the fire was extinguished without their
assistance. Smoke within the building was cleared by means of an exhaust ventilation system which includes noncombustible prefilters and absolute filters.

Nature of Injuries or Loss

No personnel were overexposed or injured as a result of the fire, and no material was lost.

TRITIUM GAS RELEASE


Nature of Accident

An increase in activity in the exhaust air from the hood indicated radioactive gas was released to the atmosphere.

Description of Operation

Laboratory experiment.

Details of Accident

A small amount of tritium gas escaped from the laboratory gas-handling system into the atmosphere via the exhaust system. The probable loss was caused by a failure of a ring which seals around a movable piston in one of the pumping cylinders. The area was evacuated and the site temporarily closed, as a precautionary measure, following the leakage.

Nature of Injuries or Loss

The wind direction at the time of evacuation was ideal in that no personnel were located immediately downwind, and dissolution and dispersal were immediate. The concentration in the room did not increase above background. Following the accident, urine assays of samples submitted by site personnel were all below the permissible level.

POLONIUM ACCIDENT


Nature of Accident

Employee inhaled polonium-210.

Description of Operation

Handling and counting of a polonium alpha source.

Details of Accident

The exposure occurred during the handling and counting of a polonium-210 source. The source was odd sized, and it was necessary to count it in an unorthodox manner.

Nature of Injuries or Loss

The employee received an estimated body burden of 3.5 times the maximum continuous body burden.
Remarks

Operating groups have been instructed that, in the future, respiratory protection must be worn by personnel during any counting operations which cannot be done in the normal manner.

FATAL INJURY ACCOMPANIES ELEVENTH AEC CRITICALITY ACCIDENT*


Nature of Accident

Criticality accident occurred in a 225-gallon stainless steel tank.

Description of Accident

After placing the emulsion in the tank, the operator was believed to have added a dilute plutonium solution from a second tank. Solids containing plutonium were probably washed from the bottom of the second tank with nitric acid and the resultant mixture of nitric acid and plutonium-bearing solids added to the tank containing the emulsion. Shortly after starting the stirrer motor to initiate an expected mild nonnuclear reaction between the emulsion and the acid, the operator observed a "blue flash," which was also observed by a second employee in an adjoining room.

The operator then ran out of the building and told a second employee, "I am burning up." Perhaps because of an incorrect belief that the "burning" feeling had resulted from acid exposure, the employee was led to a shower.

Nature of Injuries or Loss

The employee died 35 hours later from the effects of a radiation exposure tentatively estimated at 12,000 rem (plus or minus 50 percent).

Two employees (other than the operator) received radiation exposures ranging up to 118 rem. These employees were not seriously injured. Property damage was reported as negligible.

---

*A complete technical report of this incident is available from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C., as LAMS-2293, Nuclear-Critical Accident at the Los Alamos Scientific Laboratory on December 30, 1958. Price $0.50.