DOE/RL 82-5

DOE/RL/01830--82-5

DE83 004029

1976 HANFORD AMERICIUM-EXPOSURE INCIDENT:

ACCIDENT DESCRIPTION

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To be submitted to Health Physics Journal.

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*The author was employed, at the time of the accident, by the Atlantic Richfield Hanford Co., Richland, WA 99352.

**Operated for the U.S. Department of Energy by Battelle Memorial Institute under Contract Number DE-AC06-76RLO-1830.

DISCLAIMER

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ABSTRACT

An accident is described, involving the explosion of an ion-exchange column containing about 100 g of ^{241}Am. A chemical operator was injured in this accident, receiving acid burns and superficial cuts on the upper part of his body. From 1 to 5 curies of ^{241}Am is estimated to have been deposited on the injured worker and on his clothing.

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INTRODUCTION

During the early morning hours of the midnight-to-eight shift at the Plutonium Finishing Plant on the Hanford Site in Southeastern Washington, about a dozen people were working to start up the waste recovery portion of the chemical plant after a 5-month shutdown. In one room of the 242-Z Building, the Americium Recovery Process, consisting of a maze of piping, pumps, valves, and vessels, occupied an 8-foot tall stainless steel "glove box". Within this glove box two stainless steel vessels, about 3 feet high and 6 inches in diameter, were filled with nitric acid and ion exchange resin; one of the vessels also contained about 100 grams of ^{241}Am, which had been collected on the resin before the plant shutdown. During the reactivation of the recovery process a chemical reaction occurred generating heat and pressure in the americium-containing vessel. An explosion resulted, which injured and grossly contaminated the chemical operator standing in front of the glove box. A description of the sequence of events which immediately preceded and followed the accident will serve not only to define the accident itself, but will help explain the nature and extent of the injuries and contamination that resulted. Details of the accident investigation are included in an ERDA report (ERDA 76); various aspects of the injured worker's treatment subsequent to the accident are considered elsewhere (Be82, Bre82, Bro82, Ha82, Je82, Ka82, Pa82, Ra82, Ro82, Th82).

GENERAL DESCRIPTION

The chemical operator who was later injured in the explosion, entered the americium recovery room at about 2:45 a.m., August 30, 1976. He assumed control of activities in the room from another chemical operator who left the room. A junior chemical operator entered the room shortly thereafter to observe and assist the more experienced worker.

The general plan of the room is shown in Fig. 1. The long dimension of the room was about 50 feet. The americium recovery glove box was located on the south wall at the west end of the room. Just inside the normal (east) entry to the room was a desk and two chairs. Several instruments were nearby on the north wall, from which temperature, pressure and flow measurements were periodically monitored and recorded on record sheets and log books kept at this desk. A telephone and an intercom connected with the main control room on the fourth floor of the building and to other points in the plant were also located at the desk.

As the two workers sat at the desk the junior operator became aware of an unfamiliar hissing noise, "like a small steam leak". He rose and walked toward the west end of the room looking for the source of the hissing sound. When he came to the americium recovery box and looked in, he saw that the box was filled with dense brown fumes. He called out this fact to the other worker who joined him in

front of the glove box. The senior operator instructed the junior operator to call the control room and ask for help. The junior operator returned to the desk to call the control room. The senior operator mounted some portable steps placed in front of the glove box, inserted his hands into the rubber gloves installed on the box, and tested the vent valve on the ion exchange vessel to make sure it was open. He noted that the hood gloves were warm and that the valve was in the open position. The fumes coming from the ion exchange vessel were so dense that he could not see a pressure gauge on the vessel. He thought he heard more hissing near the bottom of the vessel and called out something to the effect that it "was going to blow". As he descended the steps the explosion occurred.

The front of the glove box is shown in Fig. 2 as it appeared after the explosion. The injured worker had just stepped down from the portable two-step ladder shown in the lower left corner of the picture, and was still facing to the left when the explosion occurred. There were two layers of glass in each of the glove box windows. The outer pane was 1/4 in. thick leaded glass to reduce the intensity of gamma radiation from the americium. Nearly all of this glass was shattered and blown throughout the room. The inner safety glass remained in place in all but the narrow window in the upper left portion of the picture. The workers head was almost directly in front of this window and the ion exchange vessel that burst was directly behind this window.

Fig. 3 shows the remains of the vessel. The contents of the vessel were expelled in the explosion and were part of the debris which struck the worker. Thus the material which inflicted the injuries was a mixture of small shards of glass, nitric acid (7 molar), ion exchange resin (Dowex 50W-X8), the chemical decomposition products of the resin and acid reaction, and the americium which was on the resin and in the acid.

The junior operator had made contact with the control room and requested assistance just prior to the explosion. The explosion was heard over the intercom by those in the control room. The junior operator looked around to see a "big cloud of dust" and hear the injured worker saying, repeatedly, "I can't see". He immediately went to his aid, helped him to his feet and guided him toward the east door. He said that he tried to stay out of the dust cloud as much as he could, and held his breath. He noticed that the injured worker's face was covered with blood and that his eyes were closed. The two proceeded into the hallway just outside the room door.

The specialist in the control room, who had acknowledged the call on the intercom and heard the explosion, ran down the stairs to the first floor with another worker following right behind. Through a window pane in the door between the stairwell and the hallway he saw the two who had just emerged from the room where the explosion occurred. He told the worker following him down the stairs that a tank had blown up; to call an ambulance and shut the plant down as

fast as possible. The call for the ambulance was received at 2:55 a.m.

By chance, a radiation monitor (health physics technician) entered the hallway from outside the building at this precise instant. Seeing the two workers, one injured, he recognized the contamination potential, held up his hands and instructed them to "Stay right there, I'll come and get you." He then went through the stairwell, telling the specialist not to go into the hallway, secured several full- face, filtered respiratory protection masks, put one on, gave one to the specialist to put on, and re-entered the hallway. He gave the junior operator a mask and assisted the injured worker through the stairwell into another room which contained a large sink.

The three who were assisting the injured worker made a deliberate decision not to put him under the cold water of a nearby safety shower. They were aware that this 64-year-old man had recently recovered from heart surgery and were concerned that the shock might be more than he could withstand. Nor did they wish to risk further spread of contamination, and further delay, by moving him to a warm-water decontamination shower in another part of the building.

The injured worker was stripped of his clothing and was seated next to the sink. They were concerned that he might faint and engaged him in continuous conversation. The monitor began washing the worker's face and eyes with wet rags while the others left to

secure more rags and soap. From this point on, materials were handed into the room but only the monitor stayed with the injured worker, washing his face and eyes with copious amounts of water and wiping away bits of glass covering his neck and shoulders. He noted an accumulation of "black stuff" around the right eye and the right ear, which he carefully wiped away. He noted a cut high on the forehead over the right eye, and the swollen eyes, particularly the right one.

The injured worker told the monitor that the glove box had "blown up" and that he saw a blue-white flame. They both knew that no critical-incident alarms had sounded. It was soon confirmed by others that no nuclear chain reaction had occurred.

The ambulance with a registered nurse arrived at 3:00 a.m. The nurse was assisted into protective coveralls, gloves, etc. and respiratory protection. She requested that the physician-on-call be notified promptly, which was done. She then went into the room with the injured worker and the monitor and assumed responsibility for the care of the injured worker. The ambulance was brought to the nearest doorway. At the monitors direction, other workers began carpeting the floor with sheet plastic material from the room to the ambulance. The inside of the patients' compartment in the ambulance was also lined with plastic.

The nearest hospital, in Richland, Washington, is about 25 miles (40 kilometers) south of the Plutonium Finishing Plant, where the accident occurred. An Emergency Decontamination Facility (EDF),

located on the hospital grounds, was completed in 1967 by the Atomic Energy Commission as an emergency support facility for the Hanford Site (Be82). Notification of personnel to activate the EDF was given at 3:08 a.m. Notification of plant and health physics management was made by 3:15 a.m. With little information available regarding the extent of the injuries or levels of contamination, a discussion between plant health physics management and the industrial physician resolved that treatment at the plant site for possible internal deposition of americium should be planned; if further medical treatment of the injured man was required he would be brought to the EDF in Richland.

Assistance in the form of another nurse and additional radiation monitors reached the accident site about 3:30 a.m., from other plants 5 to 10 miles away. Further information concerning the injuries to the workers' eyes and the probable extent of the contamination was communicated to the physician and health physics management. Additional physicians were alerted and the physician-on-call made ready to leave for the plant site, in a car with radio communication with the ambulance.

Levels of contamination on the injured worker were known only in the sense that off-scale readings were obtained from his head and neck on an instrument that measured a maximum of 5 million alpha disintegrations per minute over a surface area of up to about 250 cm^2. No entry into the accident room for purposes of measurement

was allowed until the next day, after safety conditions were evaluated. Subsequent estimates, based on measurements made on samples from the accident room, suggest that during the first few moments after the explosion something between 1 and 5 curies of americium must have been present on the injured worker and his clothing. By the time he arrived at the EDF approximately 6 millicuries remained (Je82).

The nurses and the patrolman-driver who accompanied the patient in the ambulance wore protective clothing including full face respirators. A radiation monitor and a chemical worker followed in a separate vehicle to provide assistance if necessary along the way or at the EDF. The physician left Richland with intent of providing an intravenous injection of a chelating agent to minimize internal deposition of americium. Upon obtaining more information on the injury and the extent of contamination, the physician decided to return to the EDF and prepare to treat the patient immediately upon arrival.

The ambulance departed from the accident-site at 4:37 a.m. and arrived at the EDF at 5:14 a.m. Further decontamination and treatment for the internal deposition of americium was begun promptly as described elsewhere (Je82).

Processing of the injured worker's thermoluminescent dosimeter indicated an external whole body penetrating dose of about 500 millirem, attributed to the accident. Fig. 4 shows the levels of

penetrating radiation found in the accident room on the following day, which are consistant with the dosimeter measurement.

DISCUSSION

Actions taken in response to the accident were prompt, well-considered, and generally effective. The injured worker was quickly removed from the highly contaminated area by his fellow worker, who acted without regard to personal risk. By not delaying this action to secure better protection for himself, the fellow-worker certainly helped to minimize exposure of the injured worker, but received external contamination, himself, that required 2 days of intensive decontamination; his internal americium deposition was less than 10% of the "maximum permissible" body burden.

Several other persons involved in the on-site decontamination effort received minor skin contamination, which was readily removed. Contamination control during the activities that followed the accident was excellent. The ambulance used to transport the injured worker was free of contamination after removal of the protective sheet plastic. While all personnel performed well in the aftermath of the accident, the success of this effort was greatly aided by the fortuitous arrival, just after the accident, of a knowledgable and experienced radiation monitor who took charge of the subsequent

activities. The value of experienced personnel in such a situation can hardly be overstated.

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FIGURES

Fig. 1 Floorplan of a portion of the 242-Z Building, showing movements of affected personnel after the accident.

Fig. 2 Photograph showing extent of damage to face of hood in which resin column exploded.

Fig. 3 Photograph, looking upward, showing remains of exploded resin column.

Fig. 4 Floorplan of room in which accident occurred, showing dose rates in mR/hr as measured on the day following the accident.

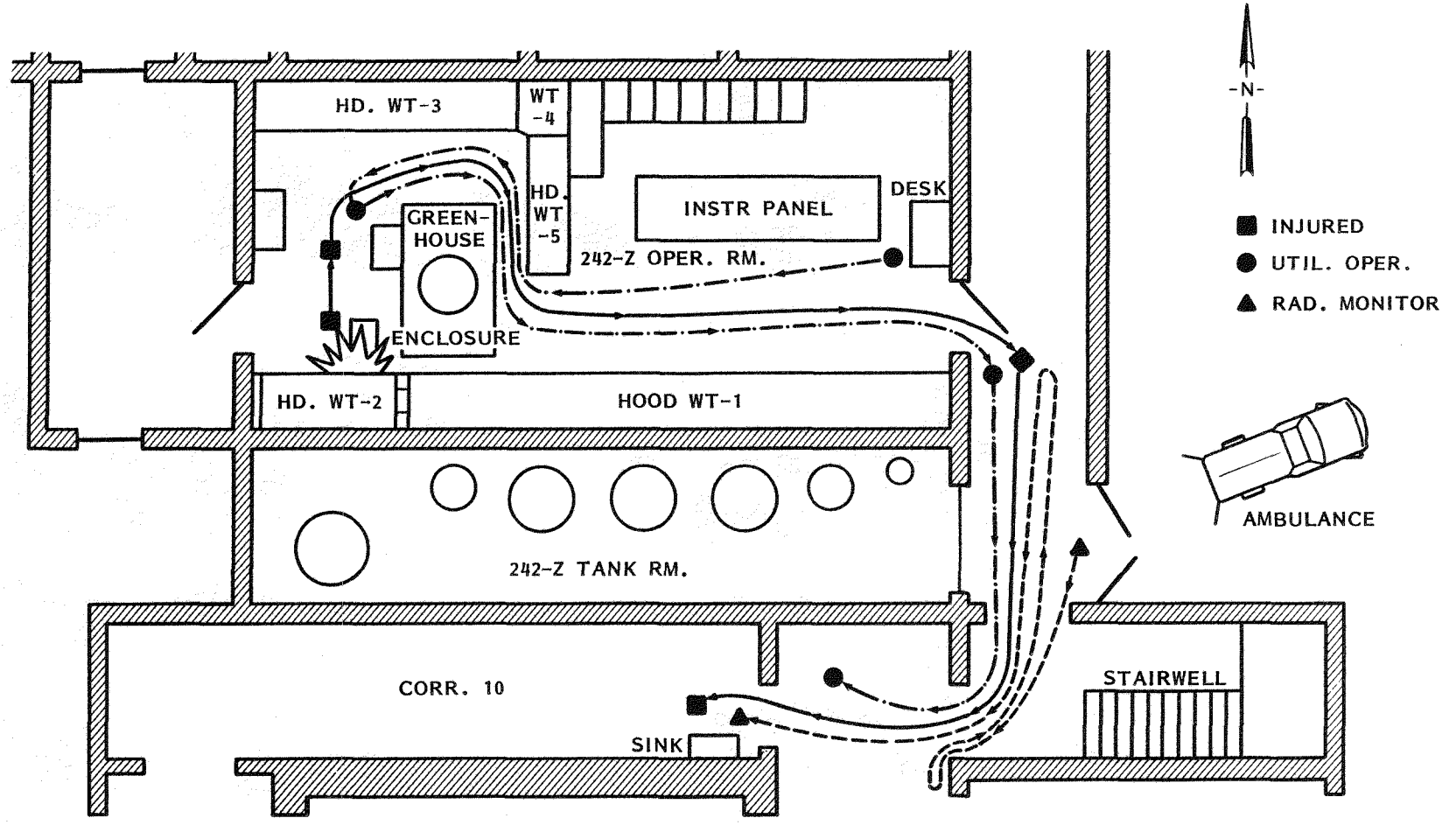

HD. WT-3
WT -4
HD. WT -5
INSTR PANEL
DESK
GREEN-HOUSE
242-Z OPER. RM.
ENCLOSURE
HD. WT-2
HOOD WT-1
242-Z TANK RM.
CORR. 10
SINK
STAIRWELL
AMBULANCE
-N-
INJURED
UTIL. OPER.
RAD. MONITOR

Figure 1

Figure 2

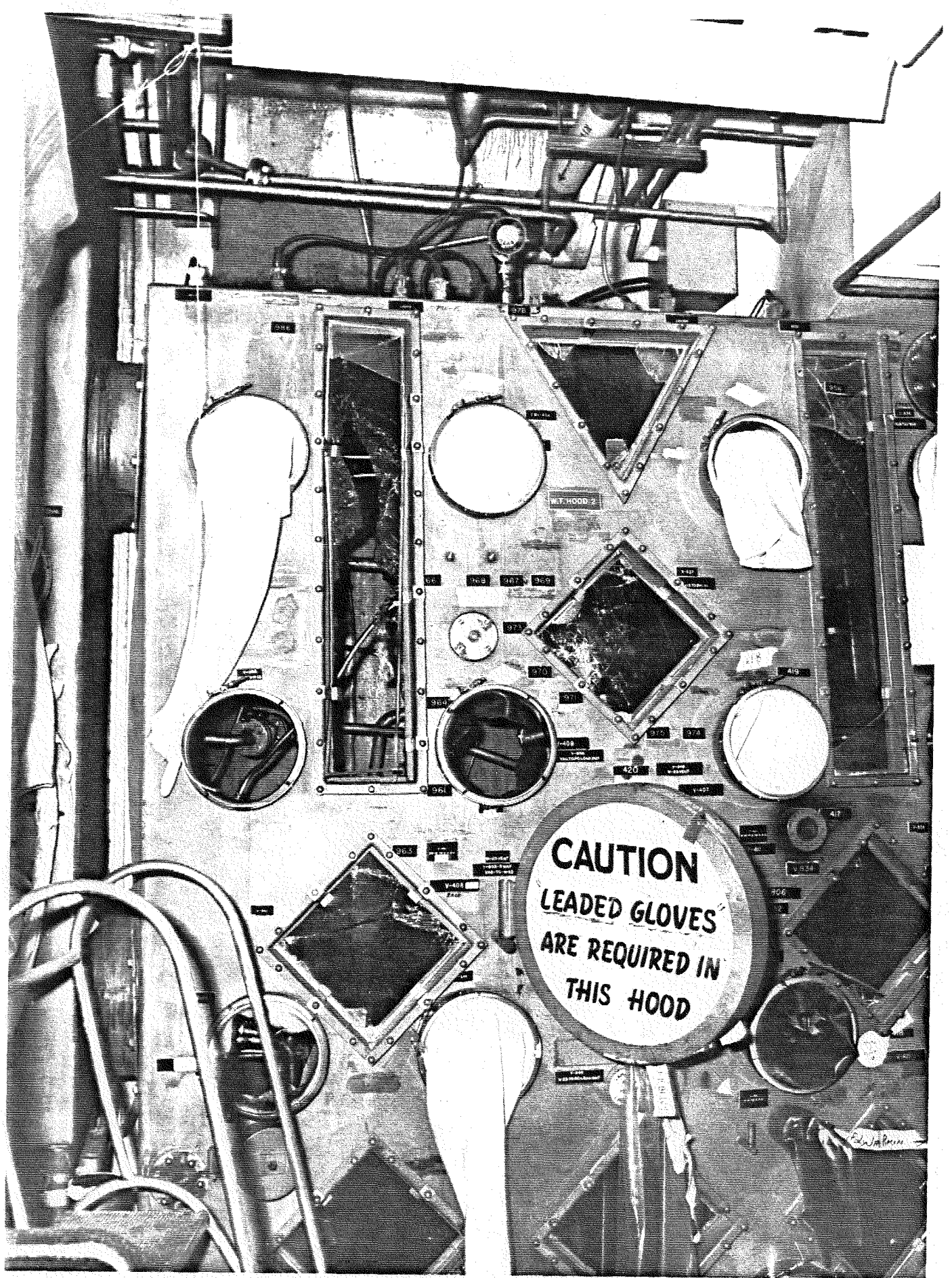
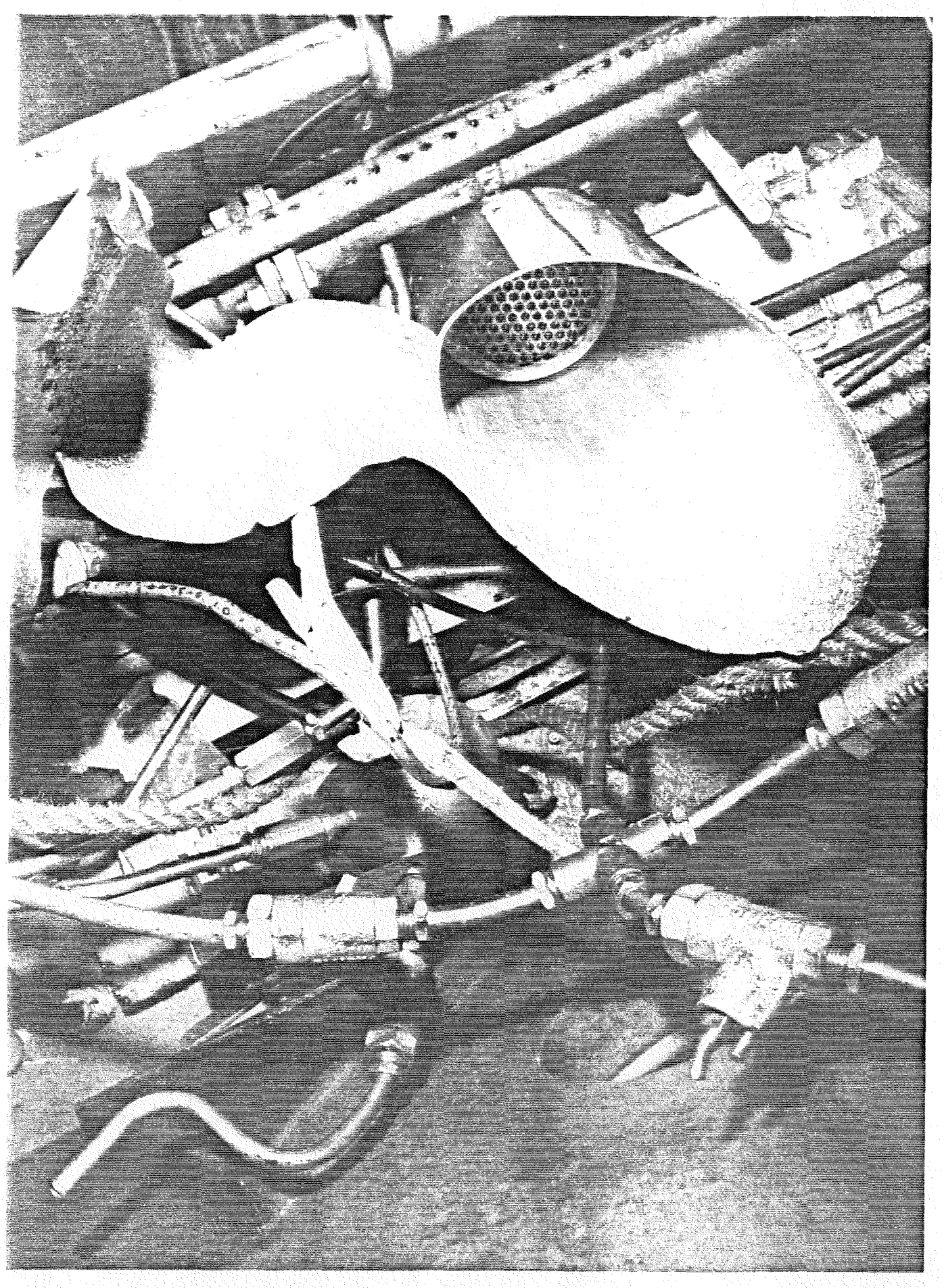


Figure 3



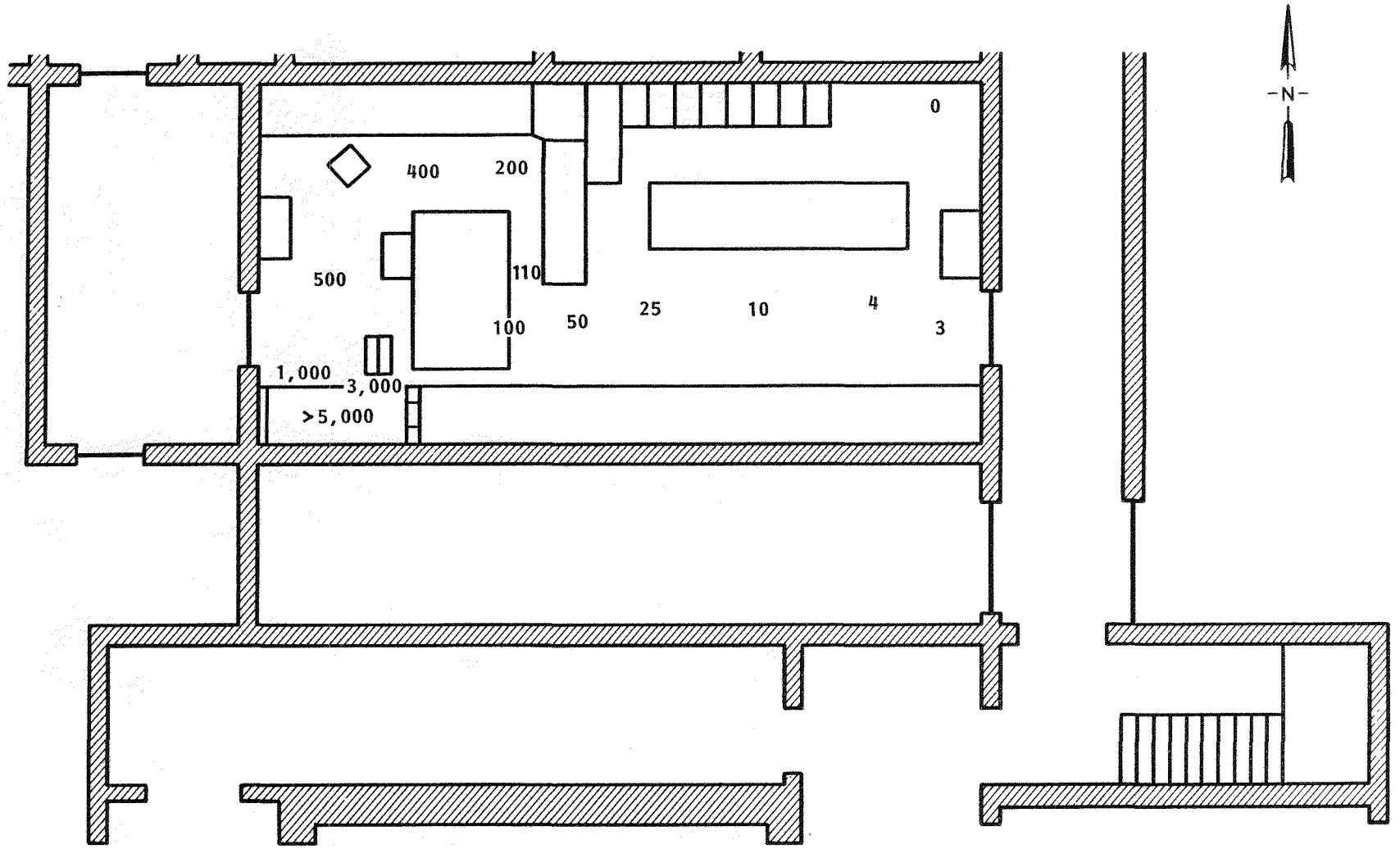


Figure 4