MLM-2139(OP)

DECOMMISSIONING OF THE SPECIAL METALLURGICAL BUILDING AT MOUND LABORATORY

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ABSTRACT

The Special Metallurgical Building at Mound Laboratory, a building of 18,515 ft^2 of floor space, was decommissioned. This decommissioned facility formerly housed ^{238}Pu processes for the fabrication of radioisotopic fueled heat sources. The ^{238}Pu work was conducted in 585 linear ft of gloveboxes occupying approximately 12,600 ft^2 of the building. All of the gloveboxes, process services, building services, interior walls, and ceilings were removed to the point of exit at the roof. Eighty-five percent of the filter banks occupying 700 ft^2 of floor space was also removed. Special procedures and special equipment were used to reduce the amount of ^{238}Pu in the building from approximately 100,000 Ci at the start of the effort to less than 0.3 Ci without a significant release to the environment.

*Mound Laboratory is operated by Monsanto Research Corporation for the U. S. Atomic Energy Commission under Contract No. AT-33-1-GEN-53.

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Date: 6-18-08

I. INTRODUCTION

A. Building Purpose The 18,515 ft^2 Special Metallurgical (SM) Building at Mound Laboratory was a facility in which ^{238}Pu was processed for use in the fabrication of radioisotopic heat sources. This building contained 585 linear ft of glove-boxes used to: 1) process ^{238}Pu into a final product form for encapsulation in isotopic heat sources; 2) recover ^{238}Pu residues generated from isotopic fuel production, from R&D activities, and from analytical support activities; 3) encapsulate ^{238}Pu fuel forms in the fabrication of isotopic heat sources; and 4) perform analytical activities required to support the ^{238}Pu production and recovery processes.

B. Project Duration The decommissioning and decontamination of the SM Building at Mound Laboratory was initiated in August, 1968, and was concluded in September, 1972.

C. Combined Group Effort Because many of the interior surfaces and all glovebox and building services were contaminated with ^{238}Pu special techniques, procedures, and equipment had to be developed to accomplish the objective of decontaminating the SM facility safely. Many of the techniques and procedures used were a result of coordinated efforts by a team of MRC personnel combining existing and commonly used procedures with new techniques and procedures. The special supervisory team consisted of members from the following groups at Mound Laboratory:

SM Termination Group	- Nuclear Operations Dept.
Plutonium Analysis Group	- Nuclear Operations Dept.
Material Control Group	- Nuclear Operations Dept.
Plutonium Recovery Group	- Nuclear Operations Dept.
Area Engineering Group	- Engineering Dept.
Area Maintenance Group	- Engineering Dept.
Health Physics Survey Services Group	- Administration Dept.
Decontamination Services Group	- Administration Dept.

D. Visits to Other Sites and Vendors In addition to the techniques and procedures developed at Mound Laboratory, visits to other AEC sites were made in order to obtain information on techniques and equipment used in similar operations.

A visit to Savannah River Plant, Aiken, South Carolina, was made to inspect their high pressure cleaning unit and to discuss decontamination techniques using this equipment.

Three visits were made to Dow Chemical, Rocky Flats Division, Golden, Colorado, for mutual discussions on termination efforts. Many of the ideas exchanged during these visits were helpful in accomplishing the Mound Laboratory termination goals and the upgrading of the SM-PP filter banks.

Three trips were made to Polymer Insulators, Inc., Houston, Texas, to discuss design of the foaming equipment used in the SM termination effort. Visits were also made to Stainless

Equipment Company, Denver, Colorado, to discuss the design and fabrication of the high pressure cleaning unit used for the cleaning of in-line process equipment.

II. BUILDING DESCRIPTION AND LAYOUT

A. Construction The Special Metallurgical (SM) Building, located at Mound Laboratory, was constructed in two phases. The first phase, built in 1960, was constructed of a steel superstructure with exterior walls consisting of two aluminum panels sandwiching a fiberboard insulating core. The ceiling was a suspended type with drop-in panels. The dimensions of this portion are 115 x 115 ft. The interior walls were fiberboard core aluminum panels.

In 1964, a 46 x 115-ft addition, referred to as the SM Addition (SMA), was constructed at the north end of the SM Building. This area was constructed with a steel superstructure with exterior walls of concrete block. All interior walls and ceilings were plaster on concrete block or metal lath.

The roof of both areas consisted of metal decking attached to the superstructure. The metal decking was covered with a conventional gravel built-up roof. The floor of both areas was of poured reinforced concrete covered with vinyl-asbestos tile. The layout of the SM Building is shown in Figure 1.

B. Crawl Space All piping and duct services were overhead in a 4-ft crawl space between the ceiling and roof. These services included ventilation ducts; steam and condensate return lines; water; compressed air; process gases such as argon, helium, and nitrogen; nitric acid supply lines; solution transfer systems; building vacuum service lines; and liquid waste transfer systems.

C. Filter Banks There were two 23 x 23-ft filter banks serving the SM Building. Each filter bank contained one set of high efficiency particulate air (HEPA) filters that handled the exhaust from the fumehoods, gloveboxes, and laboratory areas in the building.

III. SPECIAL TERMINATION PROCEDURES AND TECHNIQUES

Because, to our knowledge, no contractor in the AEC complex had terminated an entire radioactive facility which had been used for processing ^{238}Pu, special termination procedures had to be developed. These special procedures were developed by Mound Laboratory personnel and formed the basis for nearly all of the termination effort.

A. In-Place Gamma Scan Analysis of Gloveboxes To determine whether the glovebox required additional cleaning or could be removed, packaged, and shipped for subsequent burial, the amount of ^{238}Pu remaining in the glovebox had to be determined. This determination was made using a gamma scan analysis of the glovebox.

B. Cleaning of In-Line Process Equipment The techniques of cleaning equipment inside gloveboxes consisted of washing all external surfaces of in-line equipment with water from a high pressure cleaning unit to remove and collect all solids associated with the exposed surfaces of the process equipment. The principle of operation of the high pressure cleaning unit is shown in Figure 2. Figures 3 and 4 show the components of this unit.

The high pressure cleaning line and the suction return line were attached to the glovebox with a vinyl sleeve. The cleaning solution was pumped through the high pressure line at approximately 500 psi nozzle pressure. The equipment was washed with the high pressure spray; the cleaning solution was pumped to a centrifuge where the solids were continuously dumped; and the effluent was returned to the liquid storage tank to be recycled.

C. Packaging In-Line Process Equipment To negate the expense and hazards of removing all of the process equipment from the gloveboxes, a technique to package the in-line process equipment was developed. This technique consisted of filling the inside of the glovebox with polyurethane foam by attaching the foam line to the glovebox with a vinyl sleeve as shown in Figure 5. The foam was introduced to the glovebox slowly to allow for expansion within the glovebox and yet not cause the glovebox front to be forced off.

Where possible, the glovebox exhaust was left open on the glovebox during the foaming operation to permit Freon gas, which is generated during the foaming process, to escape. When it was not practical to exhaust through the filter bank, a Mine Safety Appliance (MSA) high efficiency filter was adapted to the glovebox for venting the glovebox.

D. Bagging Technique A loose-fitting vinyl bag was attached to each point of separation of the service to be dismantled to ensure the containment of the ^{238}Pu during and after the separation operation. This bagging technique is shown in Figure 6. The size of the vinyl bag was sufficient to permit unbolting or cutting of the service line inside the bag. When the necessary separations were made, that section of the service line to be removed was turned inside the bag, causing a small section of the bag to be twisted tightly at each end. These small twisted sections of the vinyl bag were wrapped with vinyl tape. The bag was then cut at the taped area and the section of the service line removed.

E. Gamma-Ray Assay of ^{238}Pu Residues in Drums and Crates The ^{238}Pu content of 55-gal drums and large crates containing waste and scrap materials were routinely assayed using gamma spectral analysis. A 3 x 3 in. NaI(Tl) detector was used to measure the intensity of the 766 keV gamma-ray from the decay of ^{238}Pu. The data were recorded

on a multichannel analyzer and corrected for contributions from other gamma-rays from ^{238}Pu and from impurities and (α,n) reactions. The gamma spectra were also corrected for self-attenuation.

F. Health Physics Procedures Because of the magnitude of this project and the unique tasks to be performed, special steps were taken to protect personnel against exposure to radioactive material and to prevent the release of radioactive material to the environment.

1. Pre-Job Orientation and Tour The pre-job orientation and tour included special instruction on such subjects as radiation fundamentals, protective clothing, respiratory equipment, dosimetry, radiation detection instruments, change room procedures, signs, alarm systems, emergency procedures, and decontamination procedures.

2. Protective Clothing and Equipment Protective clothing and respiratory equipment were worn as dictated by established Mound Laboratory guidelines.

3. Radiological Monitoring Airborne levels in the termination areas were monitored with both fixed position samplers and continuous air monitors. Stack levels were monitored to verify the integrity of the filter banks. Wipe surveys and instrument surveys were made to identify removable and fixed contamination levels. Airborne and liquid effluents

were monitored as part of the total environmental control program.

A Health Physics Operations Monitoring Profile sheet was used for distribution and communication of survey data, current radiological conditions, and recommended controls.

4. Dosimetry - Internal and External Personnel working in the termination were required to routinely submit nosewipes and urine samples. Radiobioassay samples and whole body counting supplemented these samples as the need indicated. Film badges were worn to determine exposure to external radiation.

5. Control Techniques Entry and exit from the radiation areas were made through a series of three control zone enclosures. This technique was called the "contaminated control concept" and is illustrated in Figure 7. Outer protective clothing was removed in zone #1; personnel were monitored in zone #2; the remaining clothing was removed in zone #3. This was followed up with a nosewipe and a shower.

Plastic tent enclosures were used to aid in personnel protection and contamination control.

IV. GENERAL TERMINATION PROCEDURES

A. Glovebox Preparation and Removal The amount of ^{238}Pu in each glovebox was determined using the aforementioned in-place gamma scan analysis. This procedure was used after each

cleaning of the glovebox to determine the amount of ^{238}Pu that had been removed and to determine whether the glovebox was ready for discard approval. Each glovebox was inspected visually to determine physical conditions and method of cleaning, i.e., manual cleaning or cleaning with the high pressure cleaning unit earlier described.

After the gloveboxes were cleaned, determinations were made of the amount of ^{238}Pu removed and the cost of labor to remove it. When it was no longer economical to proceed with more cleaning, the data were compiled and presented to a Discard Committee for approval to foam the gloveboxes. There were, however, instances where cleaning was terminated because of the general poor condition of the glovebox. In those instances the potential for radiological release was too high to warrant further cleaning.

All the data gathered during the cleaning operation were tabulated and presented to the Discard Committee composed of MRC and AEC/DAO personnel. If the Committee concluded that it was no longer economical or safe to continue cleaning, approval was given to proceed with foaming of the glovebox for removal.

The gloveboxes were prepared for foaming by placing a sheet of 0.008 in. polyethylene film on the inside of adjacent gloveboxes that were to be separated. The polyethylene film acted as a mold release to facilitate separation.

At this time, the gloveboxes were readied for foaming by attaching the foam unit to the glovebox as shown in Figure 5 and foamed as later described. When the foaming operation was completed, all glovebox services were removed to the headers at the room ceiling level. Most of the piping was removed using the bagging technique as later described. All services connected to a glovebox were dismantled with the assumption that contamination was present. The ductwork connected to the glovebox was foamed with the exhaust on and then bagged apart at the joints or cut inside a plastic bag. The duct foaming operation was accomplished by drilling 1-in. holes in the duct at approximately 3-ft intervals and introducing the polyurethane foam through these openings. With the glovebox services and ductwork detached, the foamed gloveboxes were ready for separation. Adjacent gloveboxes were unbolted at separation points, and locking pliers (vise grips) were fastened to hold the sections together until a large polyethylene bag was installed around the separation point as shown in Figure 8. The locking devices were removed and the gloveboxes were separated approximately 3 ft as illustrated diagrammatically in Figure 9. A false glovebox end made of plywood was bolted or clamped over the plastic covering on the end of the glovebox to prevent tearing the plastic during the final packaging operation.

Wooden shipping boxes were covered with vinyl film and transferred to the laboratory. The shipping box had the top and

one side removed to ease loading. A portable crane was used to place the glovebox into the shipping box. After the glovebox was loaded into the shipping box, the side was installed and the shipping box was filled with foam as shown in Figure 10 to make a durable package for shipment. The top of the box was then installed, and the shipping box was removed from the building after a health physics survey was made to ensure that no activity was present on the external surface of the box.

Each glovebox was identified with a box number and a description of the contents prior to moving it to the waste box scan area where the amount of ^{238}Pu contained was determined by gamma scanning, as earlier described.

B. Vacuum Ballast Tank Removal A 500-liter, stainless steel, ballast tank in the SM Building had provided a reservoir for the vacuum system. The tank became filled with caustic material from the seal water system to the vacuum pumps. This caustic material, which was solidified, contained approximately 1 kg of ^{238}Pu. The tank had originally been fabricated with a glovebox attached to the top to enclose all service piping to the tank. Figure 11 shows such a ballast tank with the mounted glovebox in place. All the openings in the tank were 1 in. or less in diameter and the wall thickness of the tank was 3/8 in.

To remove the solid material from the tank, a stainless steel box with windows and gloveports was welded to the side of the tank as shown in Figure 12. To reduce the external radiation from the tank to a safe working level, 6 in. of SE-3 Lucite was attached to the glovebox. A Halon-1301 extinguisher to be used in case of fire was also attached to the glovebox.

Electric drills and power saws inside the attached glovebox were used to cut an 18 x 18 in. hole in the side of the ballast tank. The solids were removed, packaged, and sent to the ^{238}Pu recovery processing lines for reclamation of the ^{238}Pu.

C. Removal of $^{238}Pu(NO_3)_4$ Tanks Two $^{238}Pu(NO_3)_4$ storage gloveboxes were in the SM Building, each containing 21 stainless-steel solution-storage tanks. Each tank was approximately 8 in. square by 30 in. high.

Before the termination of these tanks was initiated, new glovebox fronts containing 13-in. ports were installed. This allowed removal of the storage tanks in an upright position, preventing spillage if they should still contain any $^{238}Pu(NO_3)_4$ solution.

In another area, two gloveboxes and a drumming hood with a 30-in. diameter port were prepared to process the storage tanks. The drumming hood contained an ultrasonic cleaner

and a sliding, frame-mounted power saw for cleaning and cutting the tanks.

Two dissolvers were repaired to process any solids removed from the $^{238}Pu(NO_3)_4$ storage tanks. The materials obtained from the tanks were sent to the ^{238}Pu recovery lines for processing.

D. Vacuum and Acid Systems Piping The vacuum and acid transfer piping was located overhead in the crawl space of the SM Building. These lines, made of 3/8 to 1 in. o.d. stainless steel, were removed in 20-ft sections using the bagging technique described earlier. After the 20-ft section of piping had been lowered to the floor, a continuous plastic sleeve 4 in. in diameter was pulled over the pipe and attached to a special Lucite glovebox. The section of pipe was fed into the glovebox which contained a cut-off saw, trays, brushes, and miscellaneous small tools for cleaning the pipe. This glovebox operation is illustrated in Figure 13.

E. Service Piping Removal All service piping in the SM Building was located in the crawl space between the ceiling and the roof. Service piping included electrical conduit, water, helium, argon, compressed air, and steam. Contamination from previous spills in the building had spread to the crawl space, and all services in the crawl space had been covered with several coats of paint to anchor the radioactivity. Each one of these lines was removed and processed as discussed above.

F. Ductwork Removal Most of the ductwork in the SM Building had been fabricated of galvanized metal and was in poor condition from corrosion. The exhaust ducts were highly contaminated internally, but contained no recoverable quantities of ^{238}Pu. Because of this deteriorated condition of the ductwork, the ductwork was filled with polyurethane foam to give it added strength. In addition to the added strength, the foam would also anchor most of the contamination inside the duct. The ductwork was foamed and bagged apart for removal as previously discussed. The ductwork on the roof was removed in the same manner, except the sections of the ductwork were not bagged off. A large plastic tent was built over the duct on the roof, and all work was performed inside the tent so no radioactive material would be released to the environment. A portion of this operation is shown in Figure 14.

G. Interior Wall Removal The interior walls of the SM Building were aluminum panels sandwiching a fiber core. Because these walls contained many lapped seams, the fiber core became contaminated from previous spills in the building and from the termination effort. The amount of contamination, however, was so small that it did not warrant the recovery of ^{238}Pu from these wall sections. Each section of the wall was folded, placed into a wooden box, and foamed in place before the box was sealed.

H. Filter Bank Termination

1. SMA Filter Bank After all gloveboxes, interior walls, ductwork, and services had been removed from the SM Building, the building exhaust was rerouted so the entire terminated portion of the building was exhausted through the SM filter bank. A separate, temporary exhaust system with a HEPA filter was installed on the SMA filter bank to provide negative air pressure during termination of the filter bank.

The SMA filter bank was located directly over the interior portion of SM Building that had been terminated. The removal of the main ductwork trunk from the SMA area to the filter bank left a large opening in the floor of the filter bank. A chute was constructed leading from the filter bank to the laboratory area. This chute was then used to transfer all the interior parts of the filter bank to the laboratory area in a safe manner.

2. SM Filter Bank A portion of the SM filter bank was dismantled in the same manner as was the SMA filter bank. This portion was equivalent to 75% of the SM filter bank floor area. No chute could be provided in this area and all materials had to be drummed or boxed inside the filter bank enclosure. The remainder of the SM filter bank area was left in operation after cleaning to provide a negative pressure to the entire terminated portion of the SM Building.

I. Paint Removal After all gloveboxes, equipment, walls, drop-in ceiling, and services were removed from the building, several coats of paint which contained radioactive contamination remained on the inside of the roof decking and exterior walls.

Because a dry method, such as sand blasting, could produce dust which could potentially be released to the environment, the high pressure water blaster shown in Figure 15 was used to remove the paint from the interior services.

After testing, it was determined that the water blaster, which is capable of operating at 10,000 psi, would efficiently remove paint when operated at 5,000 psi. Operating at this pressure had two advantages: a smaller amount of water had to be processed and the water blaster was easier to operate.

After testing several types of paint and varnish removers, Oakite-510 was sprayed on the surfaces to remove the metal primer. This spraying was done with a stainless steel Grayco drum pump and a fan nozzle. After a section of approximately 400 ft^2 was sprayed and allowed to set for 4 to 8 hr, the area was cleaned with the water blaster operating at 7,000 psi. This procedure was used to clean the interior of the building approximately four times.

V. RECOMMENDATIONS

It is felt that the design of new facilities for the handling and processing of ^{238}Pu should be made with the thought that some day a portion of these facilities or the complete facility will be terminated. With this underlying thought, the following recommendations are made:

1. Utilization of seamless and smooth-surfaced walls in ^{238}Pu handling facilities.
2. Processing area compartmentalization.
3. Remote location of building support services.
4. Use of same personnel on the termination project.

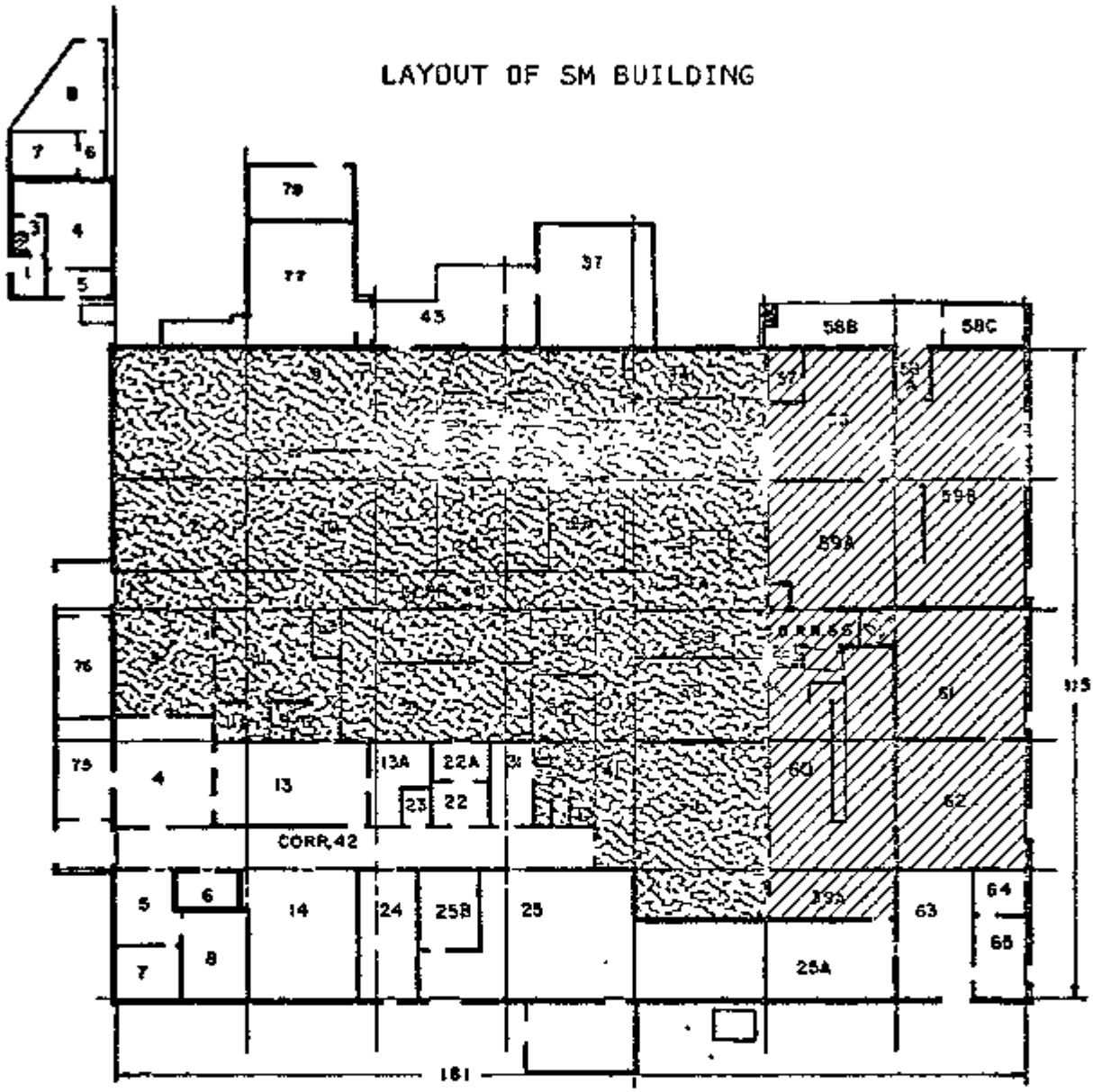


Figure 1

PRINCIPLE OF OPERATION OF HIGH PRESSURE
CLEANING UNIT IN CONJUNCTION WITH A GLOVEBOX

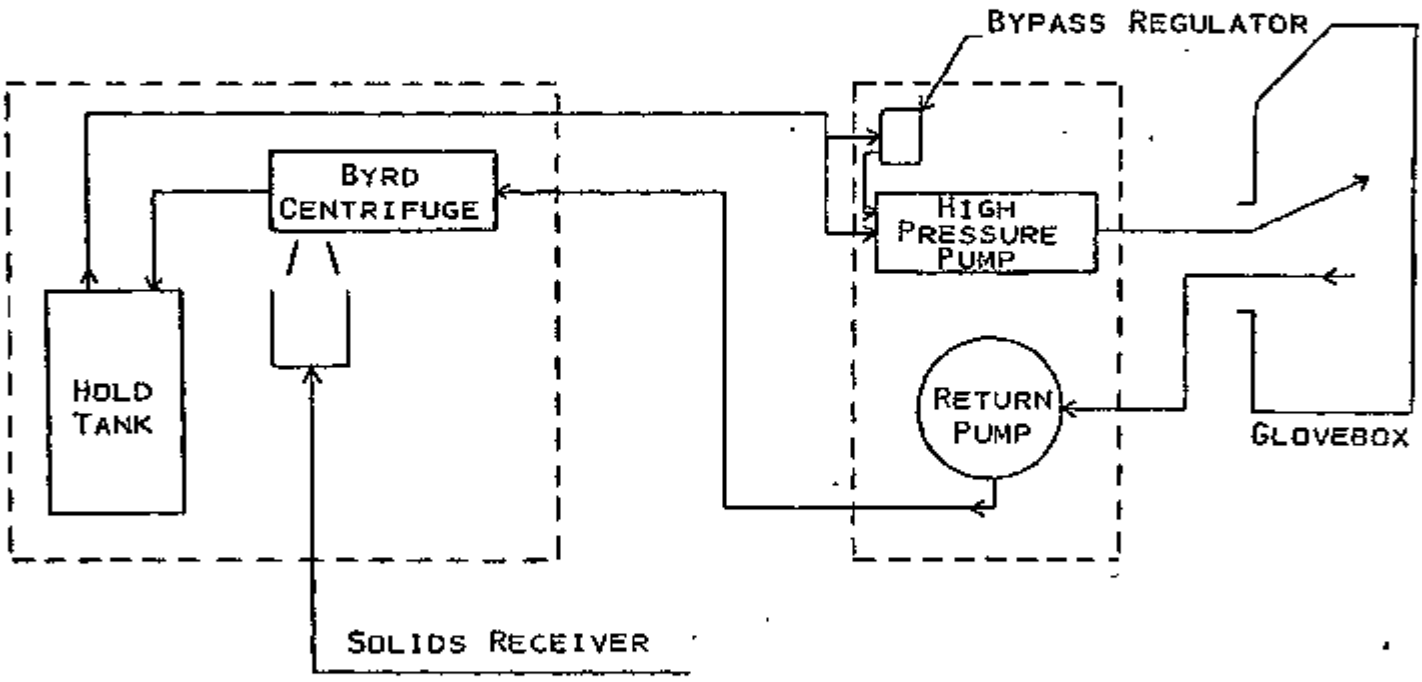


Figure 2

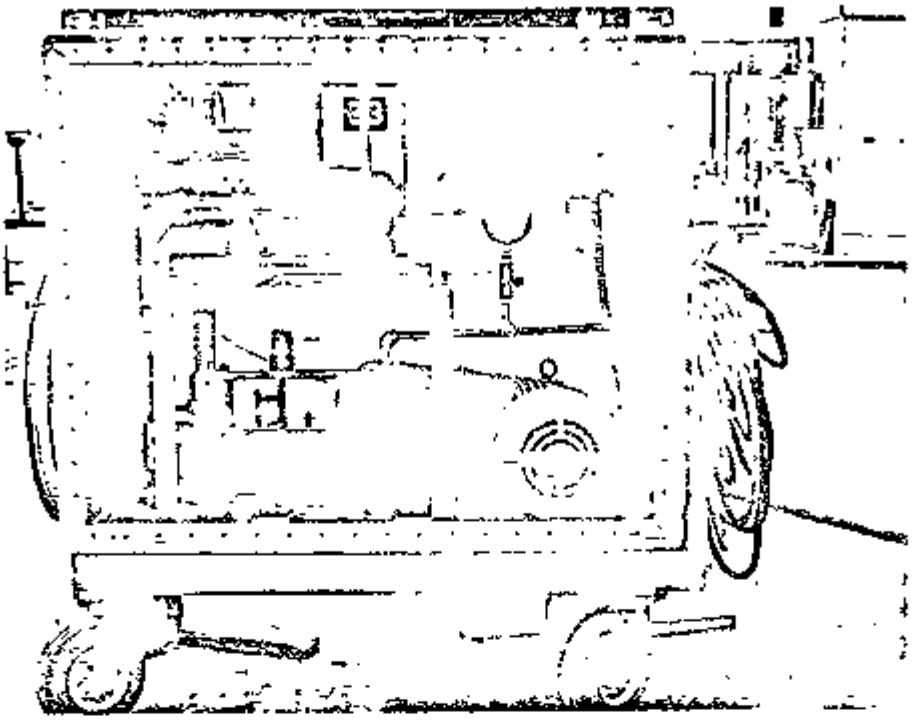


Figure 3 - High pressure cleaning unit inside a portable glovebox (high pressure pump and recirculating pump)

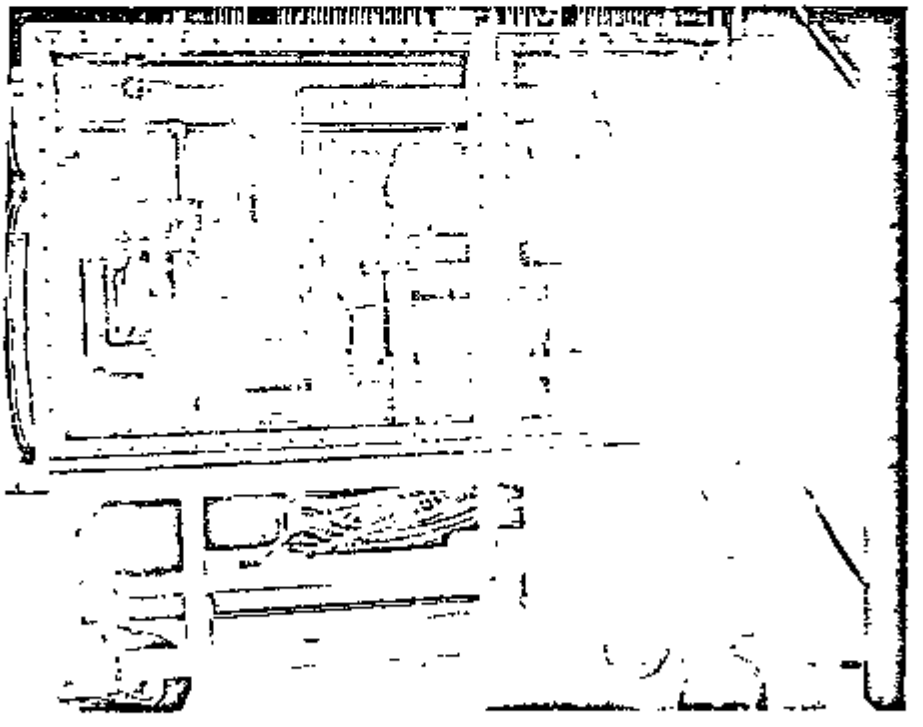


Figure 4 - High pressure cleaning unit inside a portable glovebox (centrifuge solids receiver and solution hold tank)

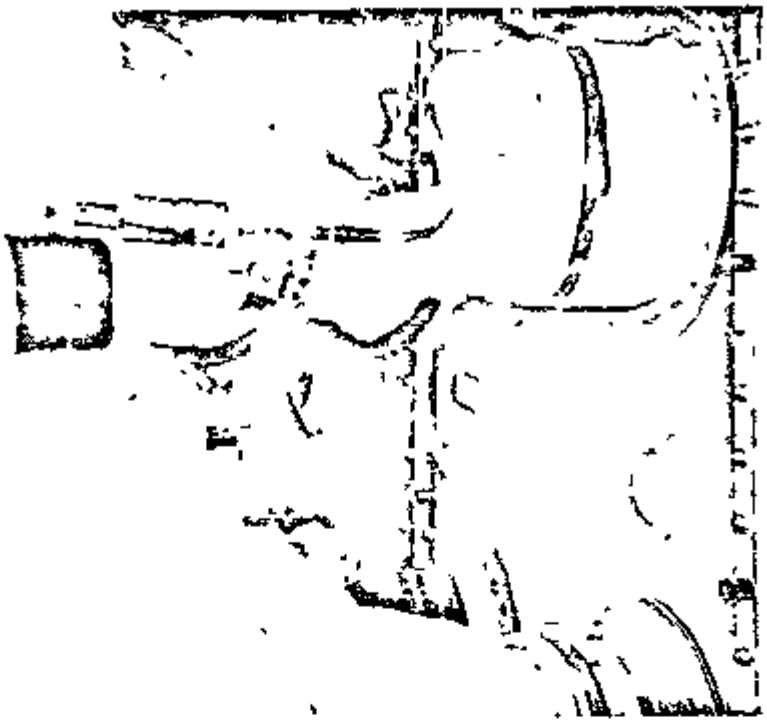


Figure 5 - Polyurethane foam being introduced into a glovebox

Figure 6 - Bagging technique used in removing glovebox service piping

CONTAMINATION CONTROL CONCEPT

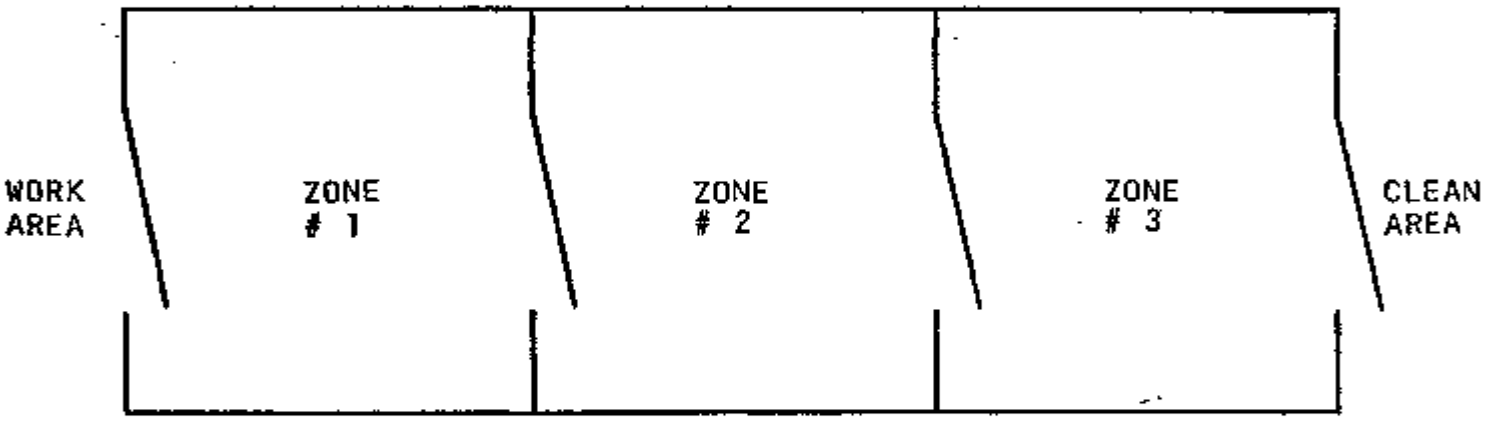


Figure 7

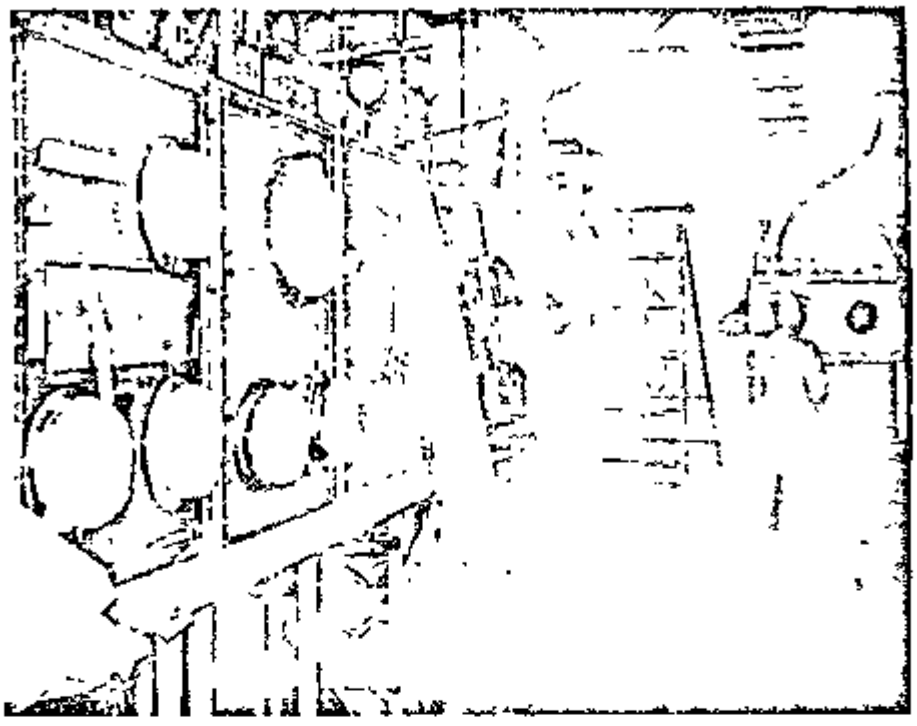


Figure 8 - Adjacent gloveboxes with polyethylene bags around their separation points

DIAGRAM OF TWO SEPARATED GLOVEBOXES WITH THE TWISTED POLYETHYLENE BAG IN PLACE

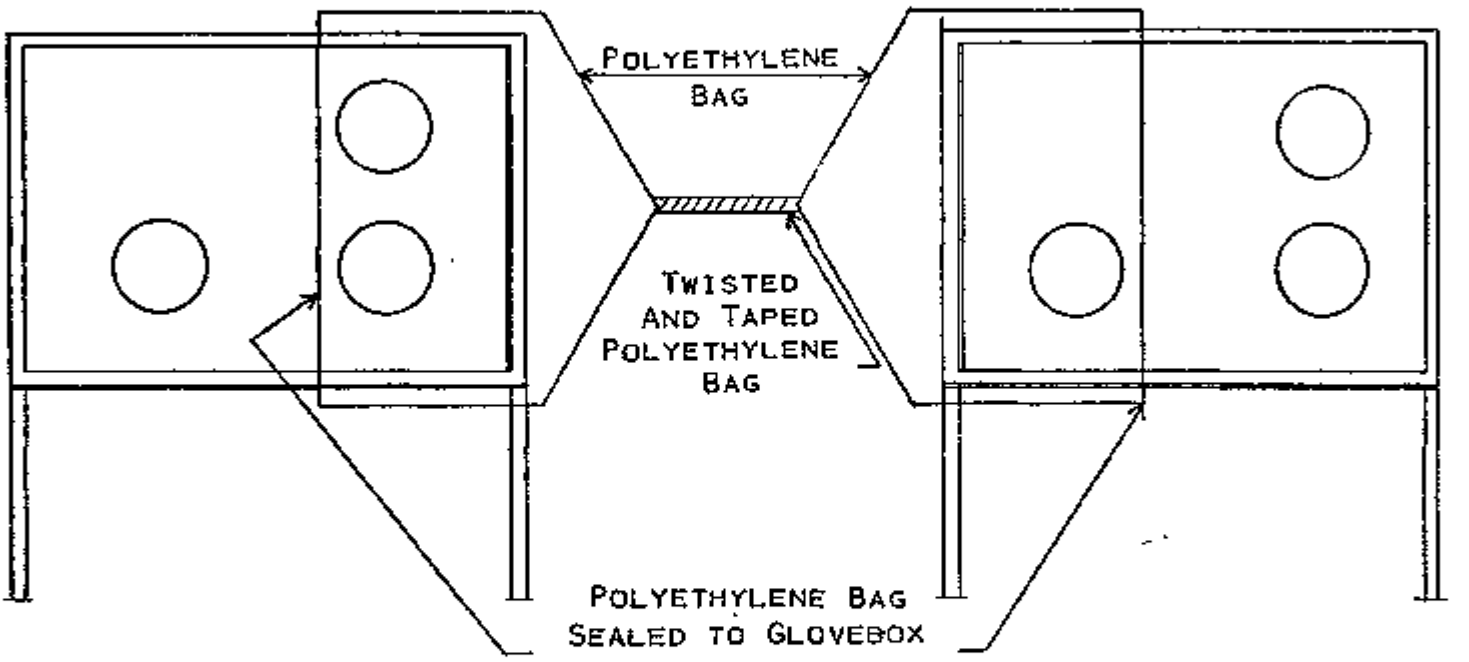


Figure 9

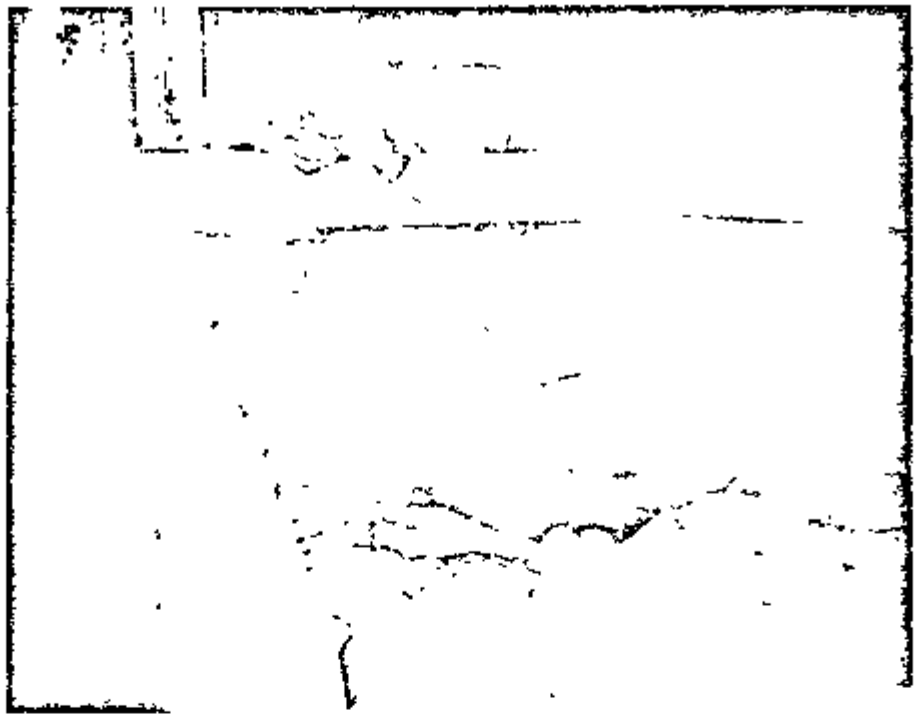


Figure 10 - Shipping box being filled with polyurethane foam

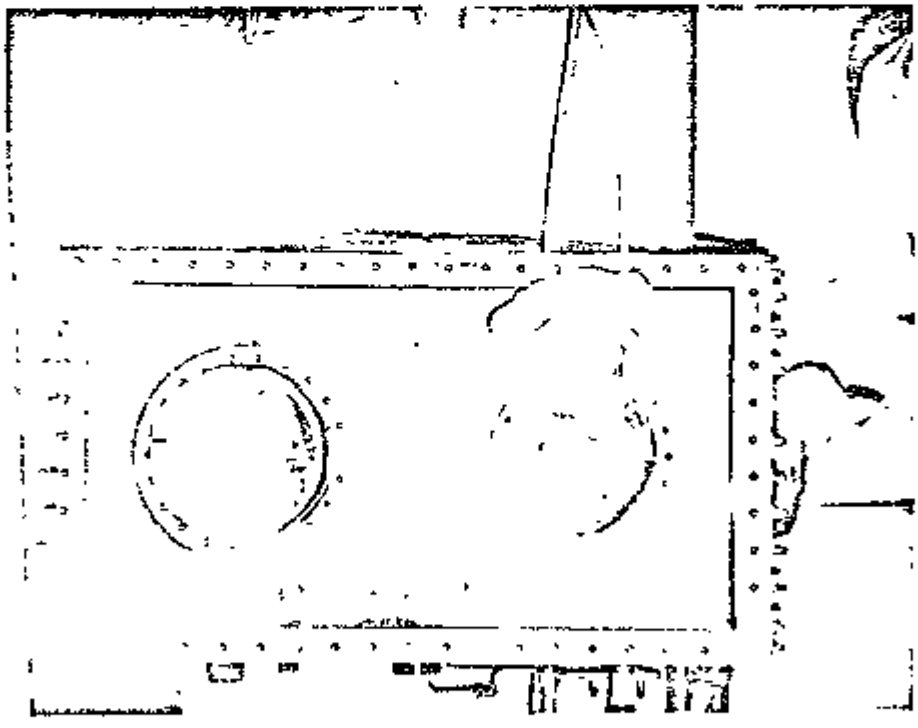


Figure 11 - Vacuum ballast tank with glovebox mounted on top

STAINLESS STEEL BOX
WELDED TO THE SIDE OF THE VACUUM BALLAST TANK

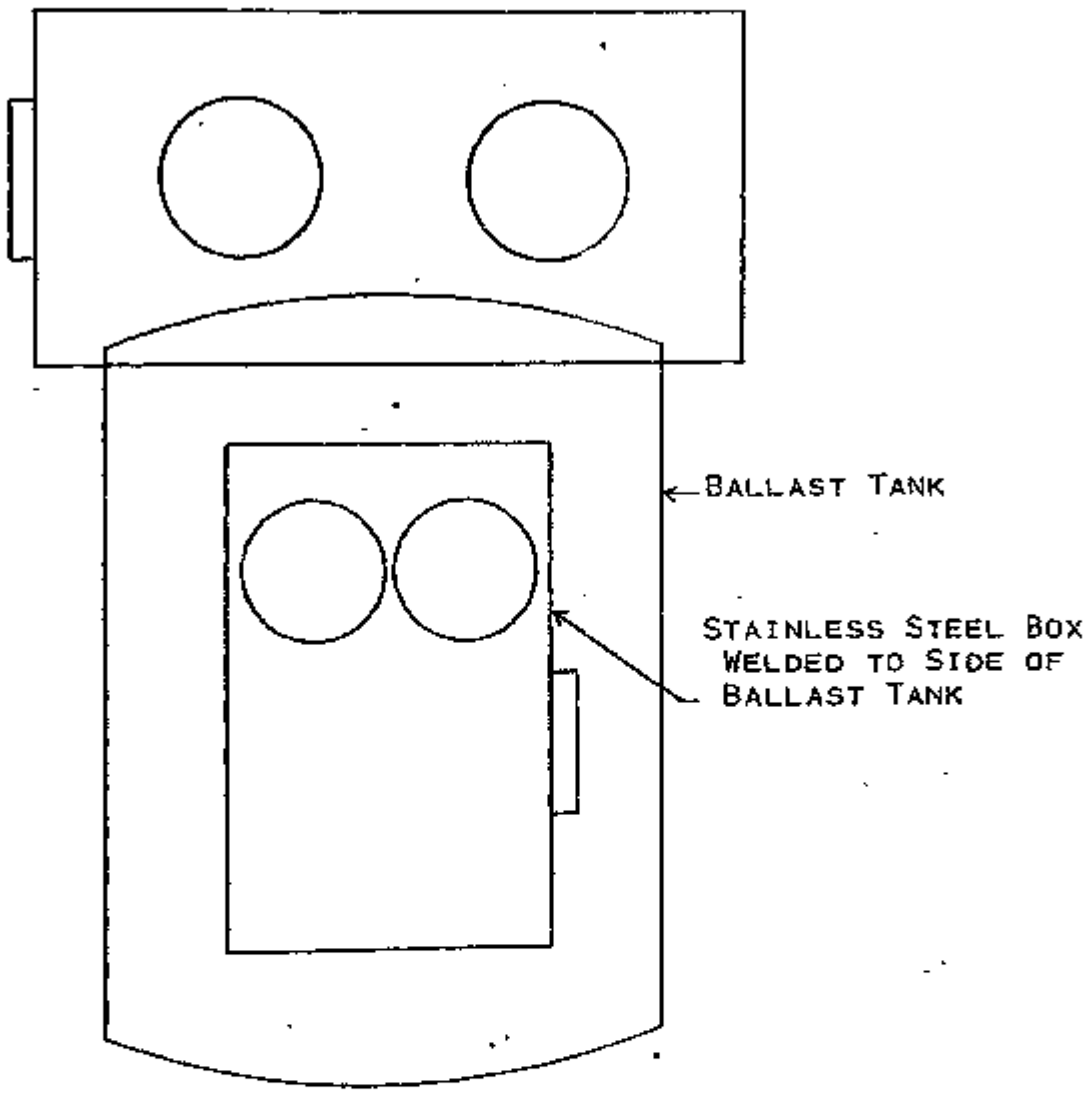


Figure 12

PROCESSING PIPE
INSIDE OF A SPECIAL LUCITE ENCLOSURE

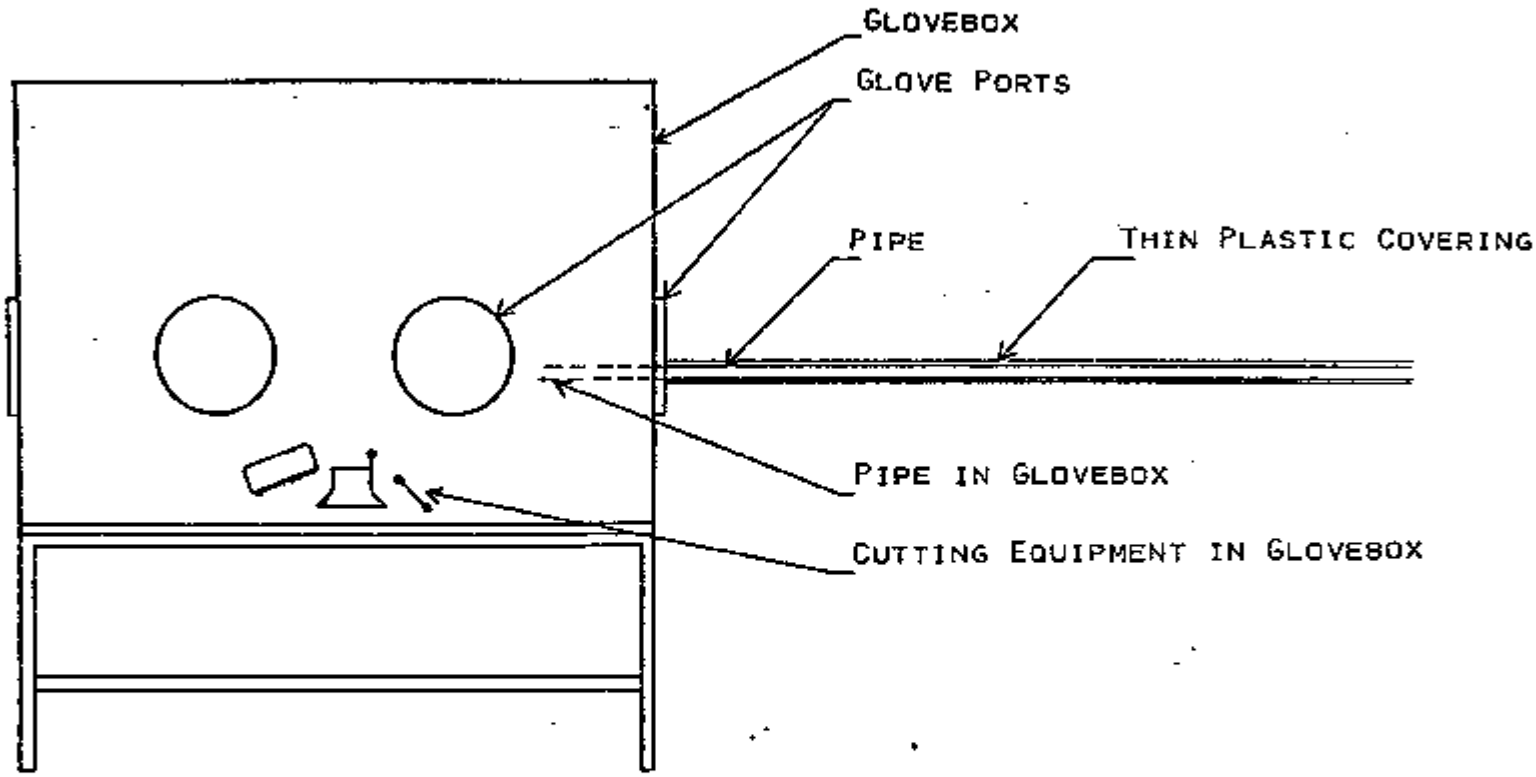


Figure 13

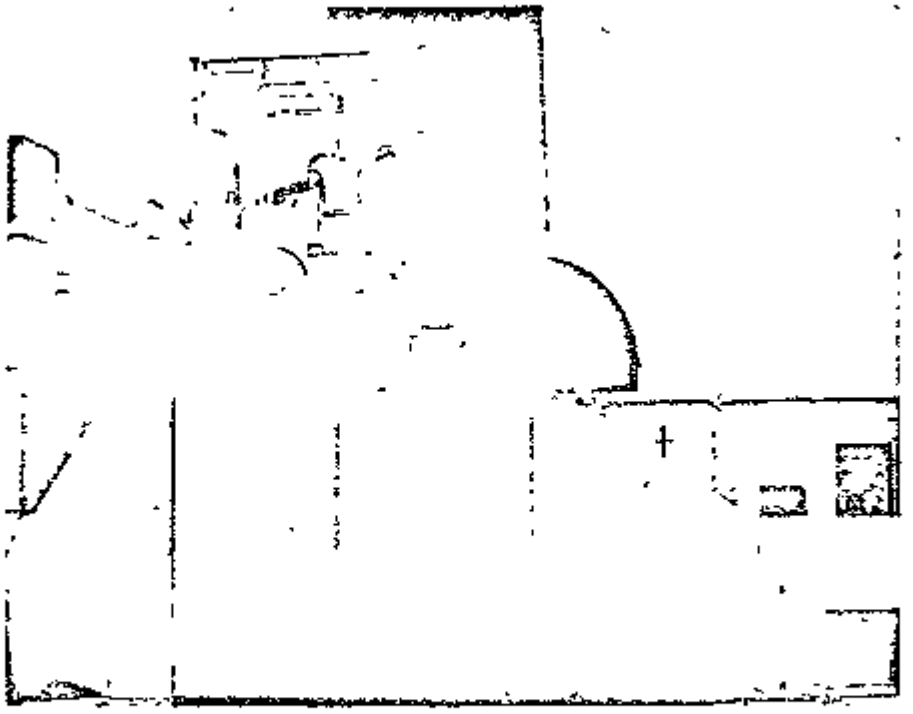
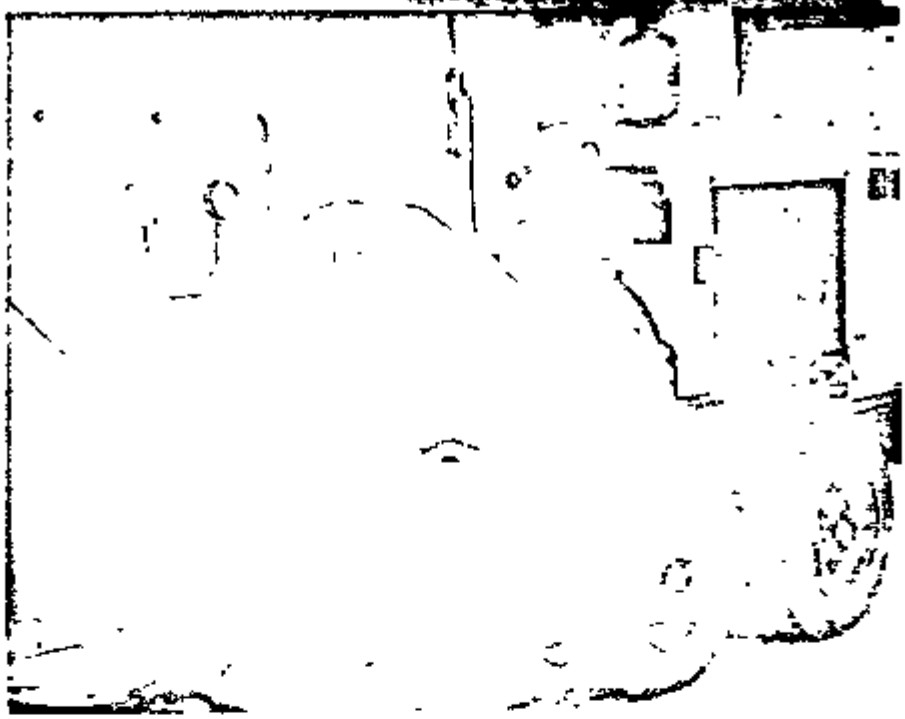
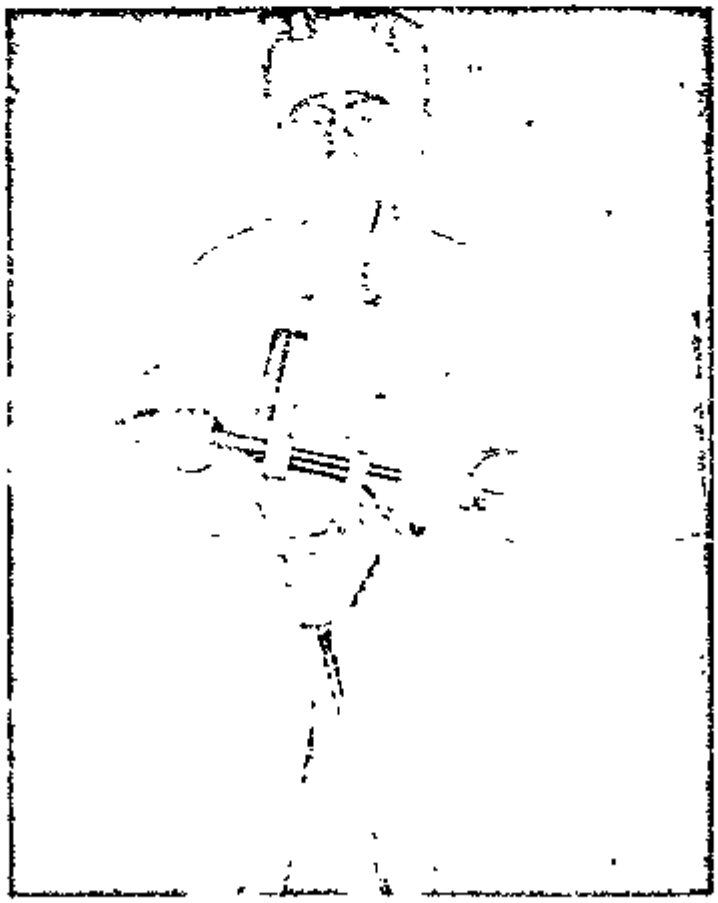


Figure 14 - Removal of ductwork within plastic enclosure located on SM Building roof



(a)



(b)

Figure 15 - High pressure water blaster (a) and blaster gun (b)