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VOLUME REDUCTION OF HOT CELL PLASTIC WASTES

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ABSTRACT

The disposal of radioactively-contaminated solid wastes has become a national crisis. In such circumstances, it is imperative that this waste be reduced to minimum volume and be packaged to prevent pollution of the environment. The majority of the solid waste generated at the hot cell under consideration is plastic lab ware. Cutting this waste into small pieces with a hot wire technique reduced the volume 66%. Melting the waste, although more time consuming, reduced the volume 90%. The hot wire technique can also be used to cut up damaged master slave manipulator boots, greatly reducing their disposal volume.

INTRODUCTION

The Remote Analytical Laboratory (RAL) provides chemical analysis service for the Idaho Chemical Processing Plant, a facility that processes government-owned spent reactor fuel. Many of the samples analyzed in the RAL are radioactive and must be handled in a shielded, remotely-operated hot cell. The design of the hot cell includes provision for removal of contaminated wastes generated by cell operation. Solid wastes are transferred out of the cell and into a commercially-available sealed polyethylene container of 60 L capacity. The sealed container, shown in Figure 1, uses a proprietary double door sealed transfer system to permit packaging the hot cell waste in a container without releasing contamination or contaminating the outside of the container.

A special waste handling cell is provided with an interface in the cell floor for the sealed transfer system. The empty waste container is manually loaded into a transfer cart which moves through a waste load-out cell and into position beneath the waste handling cell. The cart is shown in Figure 2. A hydraulic system built into the cart then raises and rotates the waste container, locking it into the interface fixture in the cell floor. After the container has been filled with waste it is removed from the interface and moved to the waste load-out cell. It was originally planned that the waste container would be sealed into a 120 L steel drum at this point and hoisted into the shielded cask shown in Figure 3 for transport to the waste management area.[1] However, as discussed below, radiation levels have been less than anticipated, and it has been possible to manually handle the waste container. It should be emphasized that this is possible only because of the clean exterior of the waste container, and that radiation exposure to personnel is held within established limits. Should radiation levels increase in future processing campaigns, the cask system will be available. Manual handling is a tremendous improvement in efficiency compared to using the waste cask which requires use of a dedicated lowboy trailer and movement of only one container of waste at a time to the waste management area several miles distant.

The obvious way to reduce solid waste volumes by waste compaction was eliminated from the original cell design. The reason was that calculations indicated that a container of uncompacted waste would be sufficiently radioactive to approach the limit of shielding capability of transport casks and waste storage techniques. A container of compacted waste could therefore exceed shielding and handling capabilities. However, subsequent changes in waste regulations have made it necessary to remove heavy metal residues in order to avoid producing a dual hazard waste. Dual hazard waste is not permitted at our waste management area. The washing process to remove heavy metals tends to also reduce radiation levels and help make waste volume reduction a viable alternative.

EXPERIMENTAL

Operating experience in the hot cell indicated that some type of waste compaction was feasible and desirable, so efforts toward implementation were begun. No commercially available or literature-described waste compactors were found which were suitable

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as a retrofit installation in the RAL hot cell. Our efforts to develop a suitable compactor began with a ram operated by a pneumatic cylinder. Figure 4 shows the ram as installed in the hot cell, with the waste loadout interface in the background. This device easily crushes glass containers. However, most of the lab ware used in the hot cell is polyethylene. Polyethylene is used mainly because it is inert toward hydrofluoric acid. It is also cheap, does not break if dropped, and possibly can be consumed in future waste incinerators. Volume reduction of polyethylene lab ware by compaction is not totally satisfactory because of spring-back after pressure is removed. The estimated net volume reduction by compaction alone is 33%.

The next development was a 15 by 15 cm grid of heated Nichrome wires, 2.54 cm on center, used to cut the waste into small pieces. This device is shown in Figure 5. A closed hopper is provided to feed the waste material to the grid, to prevent the forcing of material into the grid, to permit use of an inert atmosphere, and to collect the off gas resulting from the cutting operation. The grid itself uses 0.5 mm diameter Nichrome wire. An electrical current of 7 amperes is required, supplied by a variable transformer set at 60 volts. Failure of the cutting wire could result in a jammed hopper and grid unit, so both components are remotely replaceable, as shown in Figure 6. This device can process 250 mL polyethylene bottles at an effective rate of 1 per minute. A 66% reduction in volume is achieved. Limiting the wire temperature to 830°C prevents ignition of the polyethylene. An inert gas blanket prevents ignition if higher wire temperatures are used. It was considered necessary to control the fumes to prevent plugging of the cell exhaust filters. The fumes quickly plugged a vacuum cleaner designed to handle laser printer toner; water scrubbing is a better alternative.

A subsequent approach was to add the polyethylene bottles to a 1000 mL glass beaker greased with silicone grease and contained in a heating mantle. This apparatus is shown in Figure 7. The cylinder of melted waste to the right of the mantle contains twelve 250 mL bottles. The volume reduction was better than 90%. However, the effective processing rate was 10 minutes per bottle. Although some of this compaction advantage over the grid-cut waste would be lost when the resulting cylinders are dumped into the waste container, it is still a very significant improvement. Consideration has been given to first using the grid and then processing through the melter to see if overall processing times can be significantly reduced.

In addition to the plastic lab ware, another major source of hot cell solid waste is damaged manipulator boots. Three of these boots in unreduced form fill a waste container. The first volume reduction approach considered was a mechanical shear. Implementation of such a device presented installation, operation, and maintenance problems. It was then determined that a single 25 cm long heated Nichrome wire mounted in a fixed "U"-shaped frame could be used to cut the boots. This device can be seen in Figure 5. Boots are cut into segments and each segment is split lengthwise into two pieces. It is estimated that five cut-up boots can be put into a waste container. The boot sample tested was not ignited by the hot wire. It was possible to ignite the sample with an open flame. Therefore, implementation of this process will require evaluation of the boot material used and absolute control of boot ignition.

CONCLUSION

It is estimated that at projected operating rates, a saving of at least one waste container per week will be achieved with any combination of the volume reduction techniques described. This represents a savings of $400 in the cost of the container alone. An ordinary steel drum used as a secondary container is an additional $60. If a remotely retrievable drum is required, the additional cost is $500 per drum. Significant as these savings may be, they will be greatly exceeded by the elimination of the expense of transporting the waste container to the waste storage area, the considerable cost of preparing the storage space, and the undetermined but inevitable great cost of future permanent disposal.

All of the systems described can be easily repaired or replaced remotely.

1. F. W. Dykes, et al, "Design Concepts for the Remote Analytical Laboratory," Proc. 30th Conf. Remote Syst. Technol. Vol 1, 75 (1982)

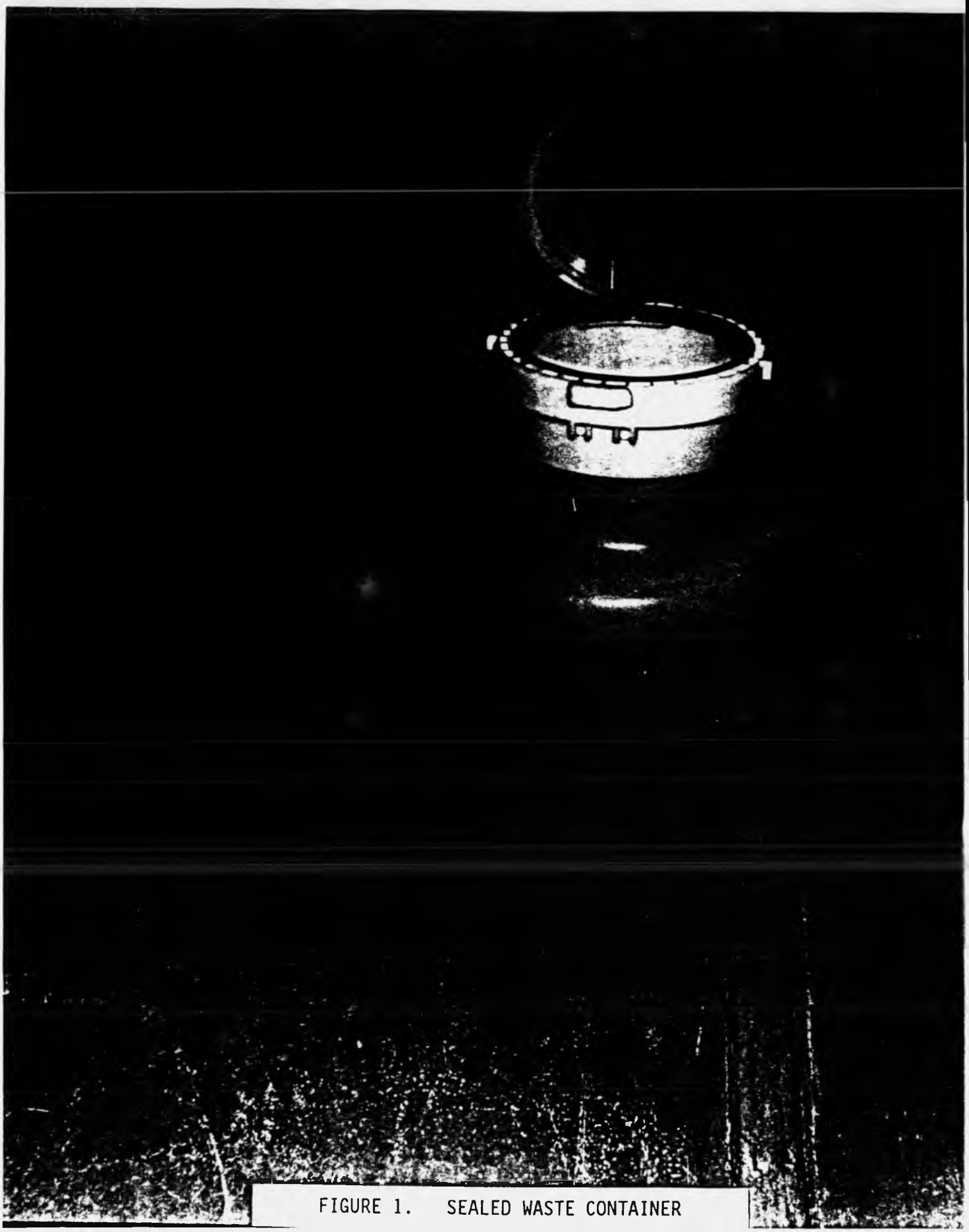

FIGURE 1. SEALED WASTE CONTAINER

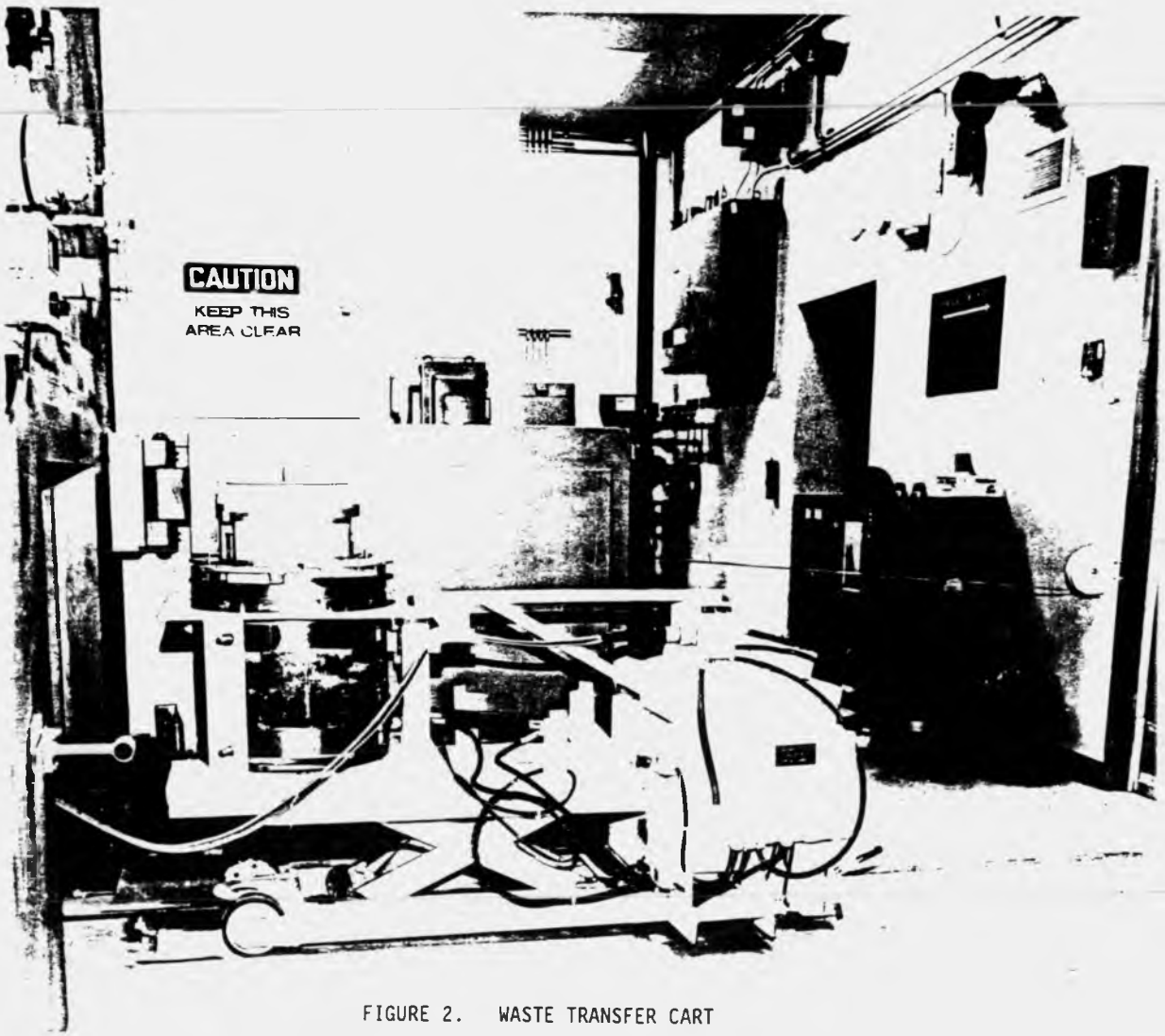

FIGURE 2. WASTE TRANSFER CART

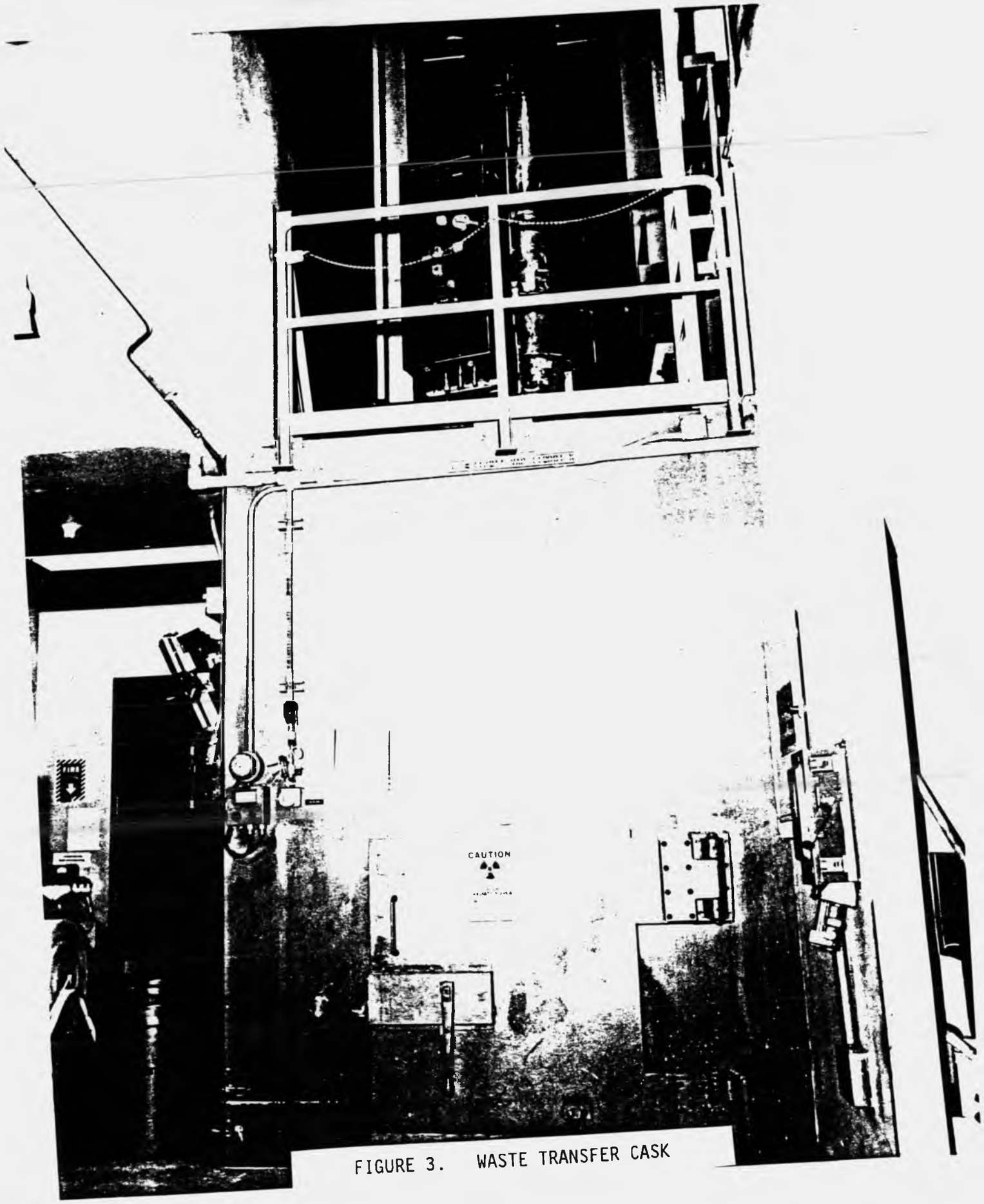

FIGURE 3. WASTE TRANSFER CASK

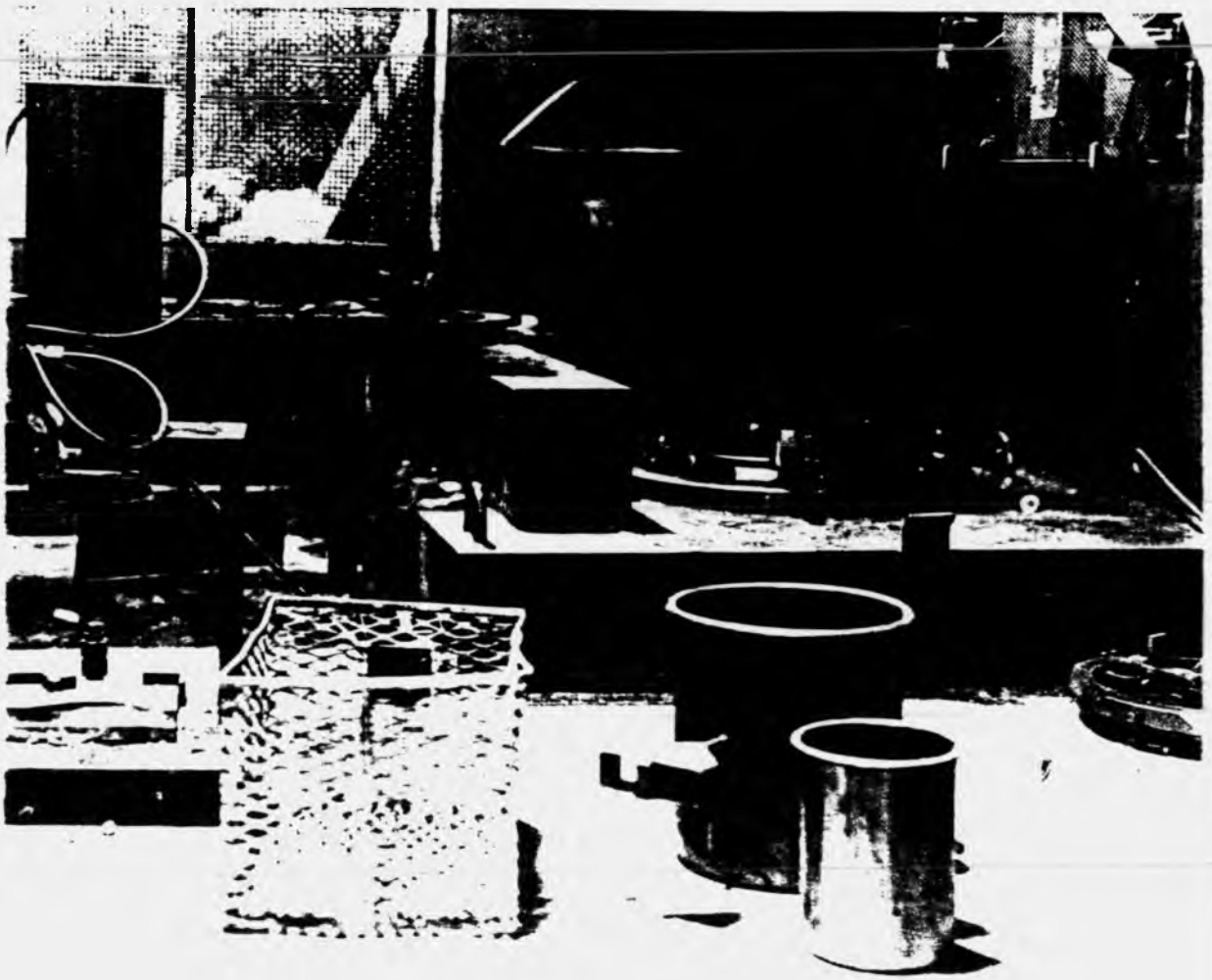

FIGURE 4. WASTE HANDLING CELL INTERIOR

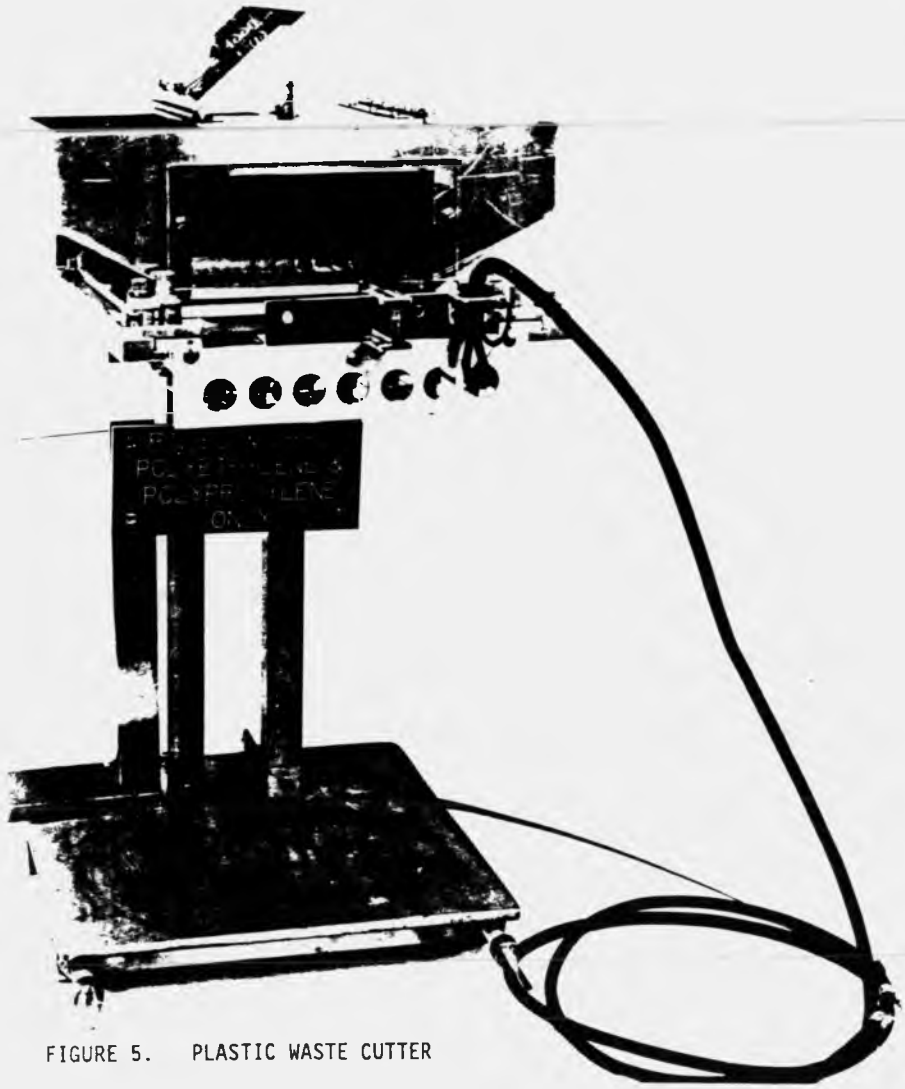

FIGURE 5. PLASTIC WASTE CUTTER

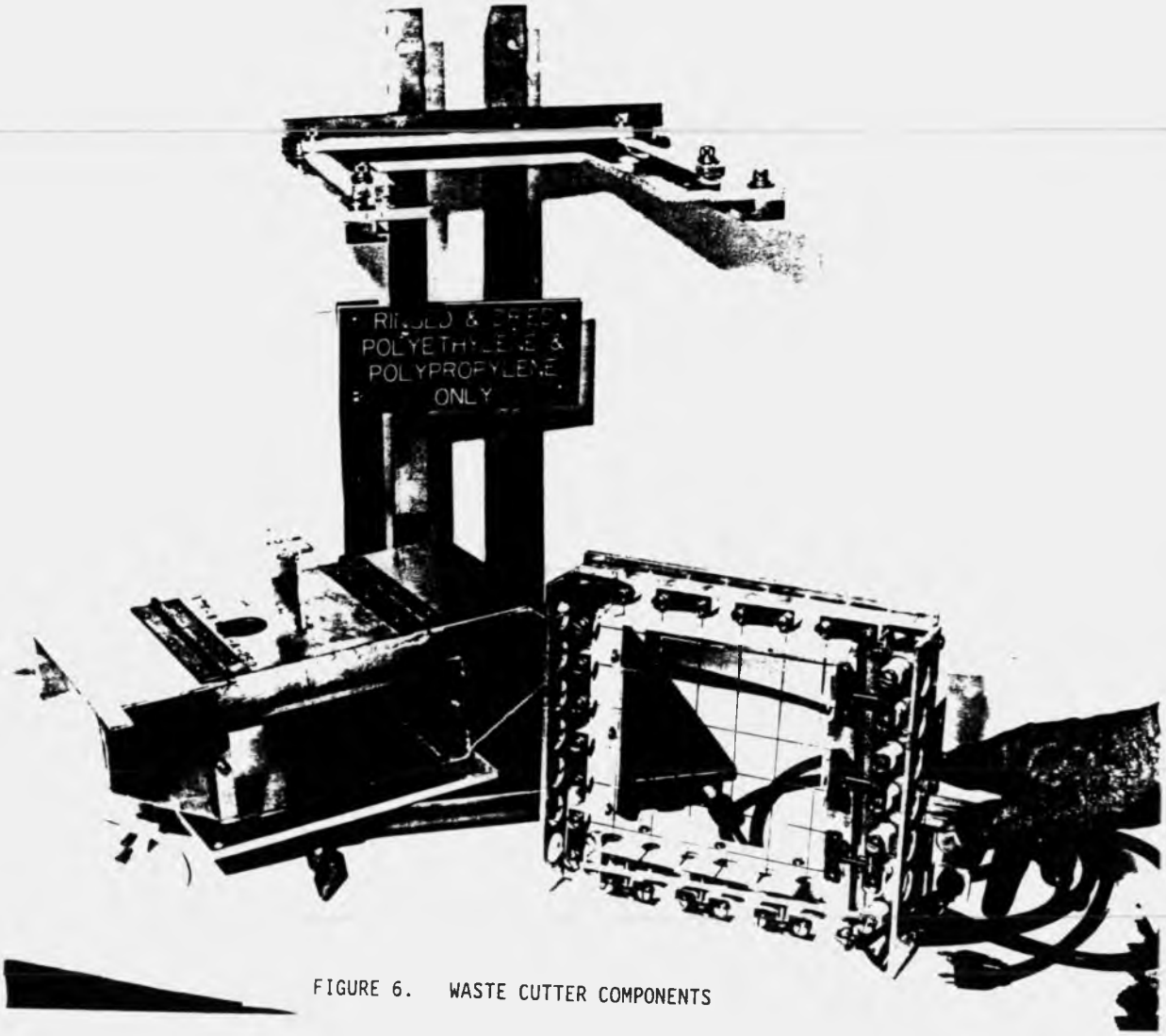

FIGURE 6. WASTE CUTTER COMPONENTS

FIGURE 7. PLASTIC WASTE MELTER AND PRODUCT