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Inherent Security Benefits of Underground Dry Storage of Nuclear Materials

by

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July 1997

INHERENT SECURITY BENEFITS OF UNDERGROUND DRY STORAGE OF NUCLEAR MATERIALS

by

R David Moore and Tom Zahn, Argonne National Laboratory-West

Abstract

This paper, augmented by color slides and handouts, will examine the inherent security benefits of underground dry storage of nuclear materials. Specific items to be presented include: the successful implementation of this type of storage configuration at Argonne National Laboratory-West; facility design concepts with security as a primary consideration; physical barriers achieved by container design; detection, assessment, and monitoring capabilities; and "self protection" strategies. This is a report on the security features of such a facility. The technical operational aspects of the facility are beyond the scope of this paper.

Introduction

This is a paper on the inherent security benefits of underground dry storage of nuclear materials. The example used is the Radioactive Scrap and Waste Facility(RSWF) located at Argonne National Laboratory-West, Idaho Falls, Idaho (overhead #1). This type of facility could be developed for storage of spent fuel and associated nuclear materials near an existing facility which currently has a security response force posture.

Background

The Radioactive Scrap & Waste Facility (RSWF) at Argonne National Laboratory-West (ANL-W) is an underground dry storage facility. ANL-W has 32 years of experience in the construction, operation, and security of this type of facility. RSWF is located outside the main security enclosure ½ mile northwest of the ANL-W site on a four acre plat (overhead #2 & #3). Originally constructed in 1965 as an interim storage facility, it continues to be the primary storage facility for the downloading of the EBR-II reactor fuel. The RSWF consists of carbon steel liners set and buried vertically in the ground (silo storage). Nuclear material stored at the RSWF includes thorium, depleted uranium, normal uranium, enriched uranium, uranium-233, and plutonium.

The RSWF is currently designed with a grid of rows spaced 3.7 meters apart with carbon steel storage liners spaced at 1.8 meter intervals per row. The facility is 118 meters by 137 meters and contains 1350 storage locations (overhead #4 & #5). The cylindrical storage liners are 3.8 meters long with a 41 centimeter outside diameter and a 6 millimeter wall thickness. The storage liners are installed vertically in the ground with approximately 5 centimeters extending above the ground line. Each liner currently contains highly radioactive material. Each liner is welded closed at the bottom end with a carbon steel plate 1.2 centimeter thick and closed at the top by welding a shield plug (concrete 76 centimeter in length with a 1.2 centimeter carbon steel plate) into the liner. Because all containers in the RSWF contain highly irradiated material, it is considered to be a Category III facility. However, additional security features could be installed that would make this configuration appropriate for the storage of Category I nuclear materials with appropriate approvals.

Security Features for the Protection of an Underground Dry Storage Facility

The protection of an underground dry storage facility would include multiple security layers. The outer most layer would be a clearly defined security area encompassed by a fence. This fence would consist of, at a minimum, galvanized steel chain link fabric, topped by three or more strands of barbed type wire on single or double outriggers. This fence would be at least 2.13 meters in height.

The next layer moving toward the material would be an intrusion detection system inside the fenced perimeter which reports to a Central Alarm Station (CAS) monitored continually by a security response force. This could come in the form of a bi-static microwave detection system. Augmenting this system would be an alarm assessment capability in the form of closed circuit television (CCTV) cameras which are continuously monitored in the CAS. Other refinements, typically associated with the perimeter, include flood lights and infrared lighting systems. It would also be possible to install individual liner monitoring systems. Each liner is cathodically protected (overhead #6). This means there would already be wire leads running to each liner which act as a cathode for the system. It would be possible to run constant line supervision on the cathode side of the line to monitor for a line break if the liner was tampered with. It would also be possible to install a dedicated line to each liner which could be tied to control panels that would monitor the liners individually for intrusion. Remote sensors could be placed on each liner if needed to protect the higher levels of categorization. Additional monitoring could be set up to meet International Atomic Energy Agency (IAEA) Safeguards Inspection requirements if needed or required. This intrusion detection and assessment system is predicated on having continuous monitoring by a CAS and the availability of a guard force that is capable of responding to an adversary attempt on the storage facility. This response must be of sufficient size, strength, and speed to neutralize an adversary within the actual time lines established for an unauthorized entry and retrieval of the buried material.

The following items would be needed, at a minimum, to provide an adequate deterrent for an adversary. Approximately 600 meters of chain link with three strands of barbed type wire and outriggers, 4 bi-static microwave detection units, 4 CCTV cameras, 8 floodlights and/or an infrared lighting system, and necessary hardware to connect to the Central Alarm System. This would include a dedicated wiring system or a radio transmitted signal.

The outer security protection layers involve adversary detection and assessment. The remaining layers consist of the physical barriers to an unauthorized entry into the underground storage containers. For the most part, these barriers are intrinsic to the operational design and construction of the containers.

Based upon the experience at Argonne's RSWF, both operational and security design requirements for a dry storage facility can be predicted. Fuel subassemblies, six or seven total, weighing 66-100 kilograms each, are stored in an "inner" waste can. This "inner" waste can is constructed of a carbon steel pipe and has a lid which is bolted to it. The "inner" waste can is placed into an "outer" waste can. This "outer" waste can is constructed of carbon steel and has a 15 centimeter lead shield plug welded into the top to close the can (overhead #7). This combination of waste cans is placed into a liner constructed of carbon steel pipe, 41 centimeter in diameter, 3.8 meters in length (overhead #8), with a concrete shield plug weighing approximately 1100 kilograms and a 1.3 centimeter thick carbon steel plate attached to the top which is then welded to seal the liner (overhead #9). This combination of subassemblies, waste cans, and liner weighs 2-2.2 metric ton each. The liner also has a carbon steel plate welded to it's bottom which is 13 centimeter larger in diameter than the liner, acting as an anchor. This entire unit is then placed into a hole in the ground and backfilled and tamped to anchor it firmly in place.

Requirements for Adversary Success

To be successful, an adversary must enter and remove the nuclear materials from the facility undetected or be able to withstand the attack of the security force for sufficient time to complete the removal of the materials.

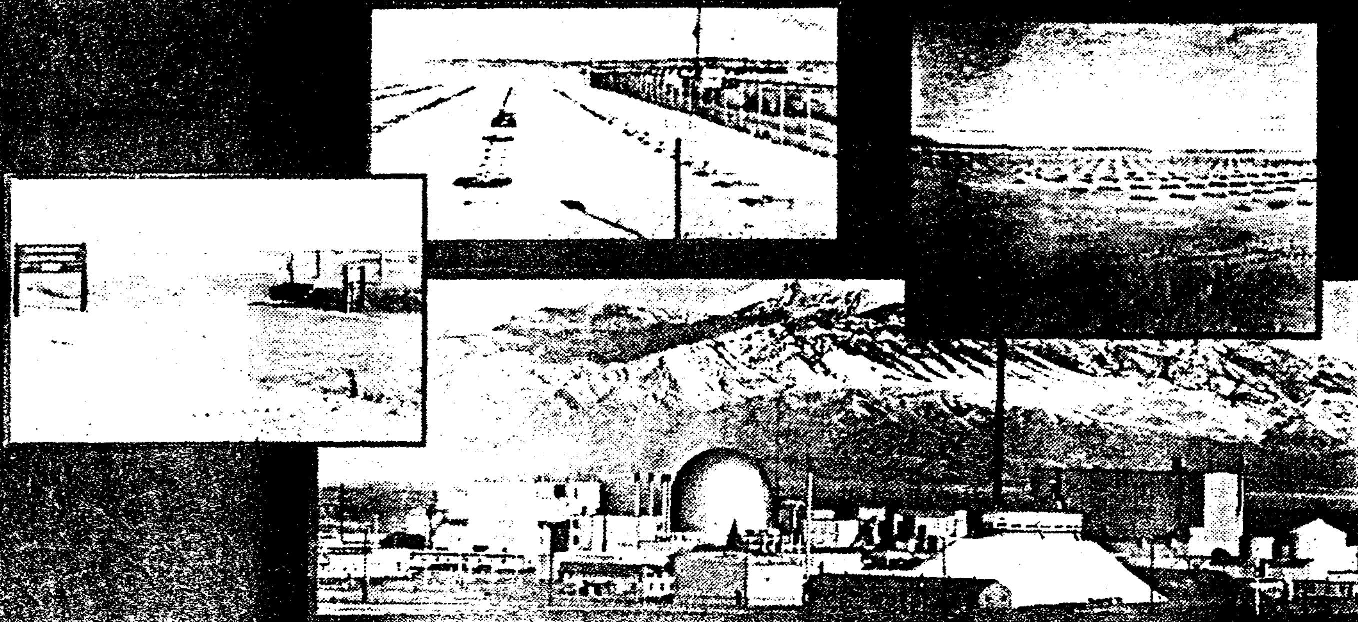
As discussed in the section titled "Security Features for the Protection of a Dry Storage Facility", there should be sufficient detection and assessment hardware installed at the storage facility to make the covert removal of nuclear material virtually impossible. This is a strong statement but is justified when one considers the design of an underground dry storage facility. It is a flat area of ground within a security fence. There is no concealment for an adversary who must utilize a cutting torch, and/or explosives, and heavy lifting equipment to retrieve materials from the storage containers. There are no buildings within the storage area which would force the adversary to make a stand with little or no cover or concealment. It would be virtually impossible to attempt to remove materials undetected.

The operational design requirements for the storage containers results in the materials being encapsulated within multiple layers of carbon steel pipe welded closed. Additionally, there is a combination concrete plug and carbon steel plate, weighing 1100 kg, which is welded in place to seal the top of the liner. The adversary seeking to force entry into the storage container must breach these barriers and the preferred method is with a cutting torch. Experience at the RSWF indicates that an experienced person requires approximately 12-15 minutes to cut open the top of the liner. It may also be possible to incorporate highly radioactive materials in each liner to raise the radiation level and provide an additional theft deterrent .

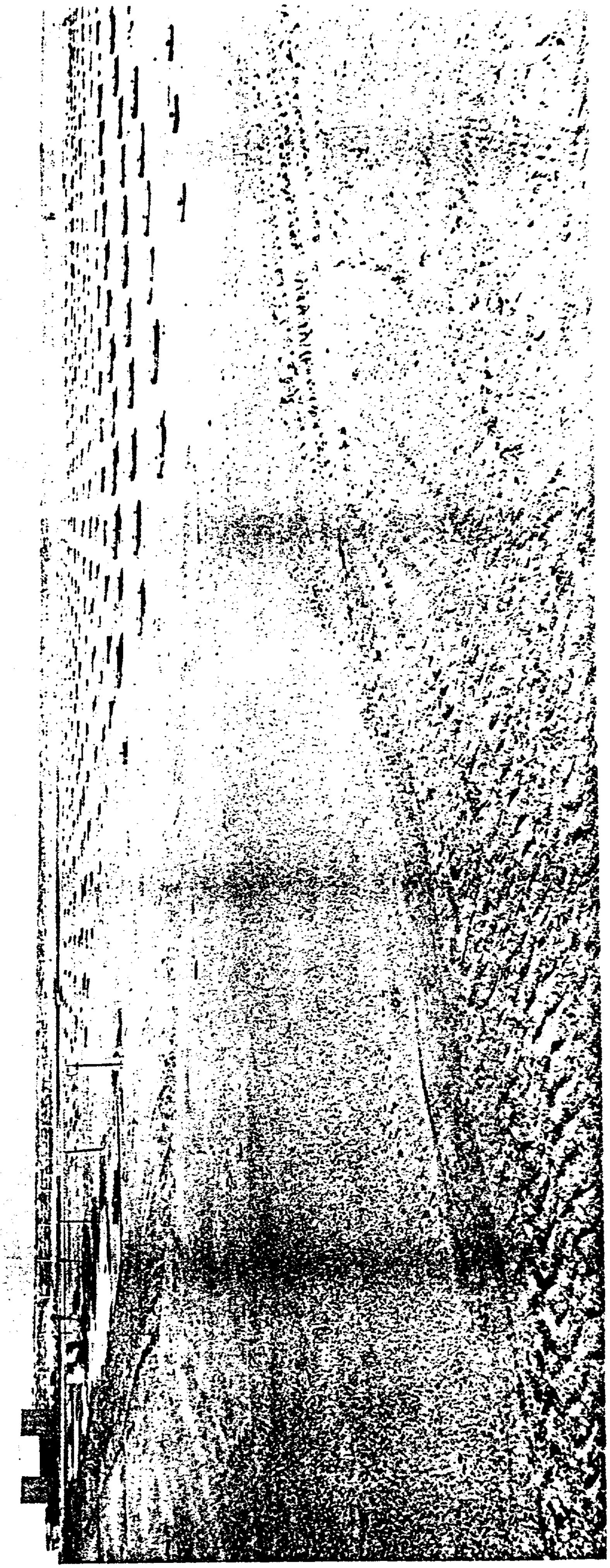
The adversary may choose to use explosives as a faster method of opening the liner. However, the entire storage assembly, with the exception of the very top, is underground which limits an adversary's practical approach to the top. A concrete collar could be poured flush with the top of the liner to preclude explosive shearing of the liner. Explosive entry through the top welded plate is not likely because it would force the concrete plug deeper into the liner, crushing the outer and inner waste cans and wedging the subassemblies tightly into them. An attempt to bore a hole beside the liner and blast it out of the ground would be unlikely to succeed because of the oversize plate welded to the bottom which acts as an anchor to the ground. The weight of the various components enclosing the nuclear materials would require that the adversary have heavy equipment or at least a large truck and chains or steel cables (Overheads #10 & #11). Finally, the adversary attempting these actions must do so on flat, open ground while under fire from the security response force.

Summary

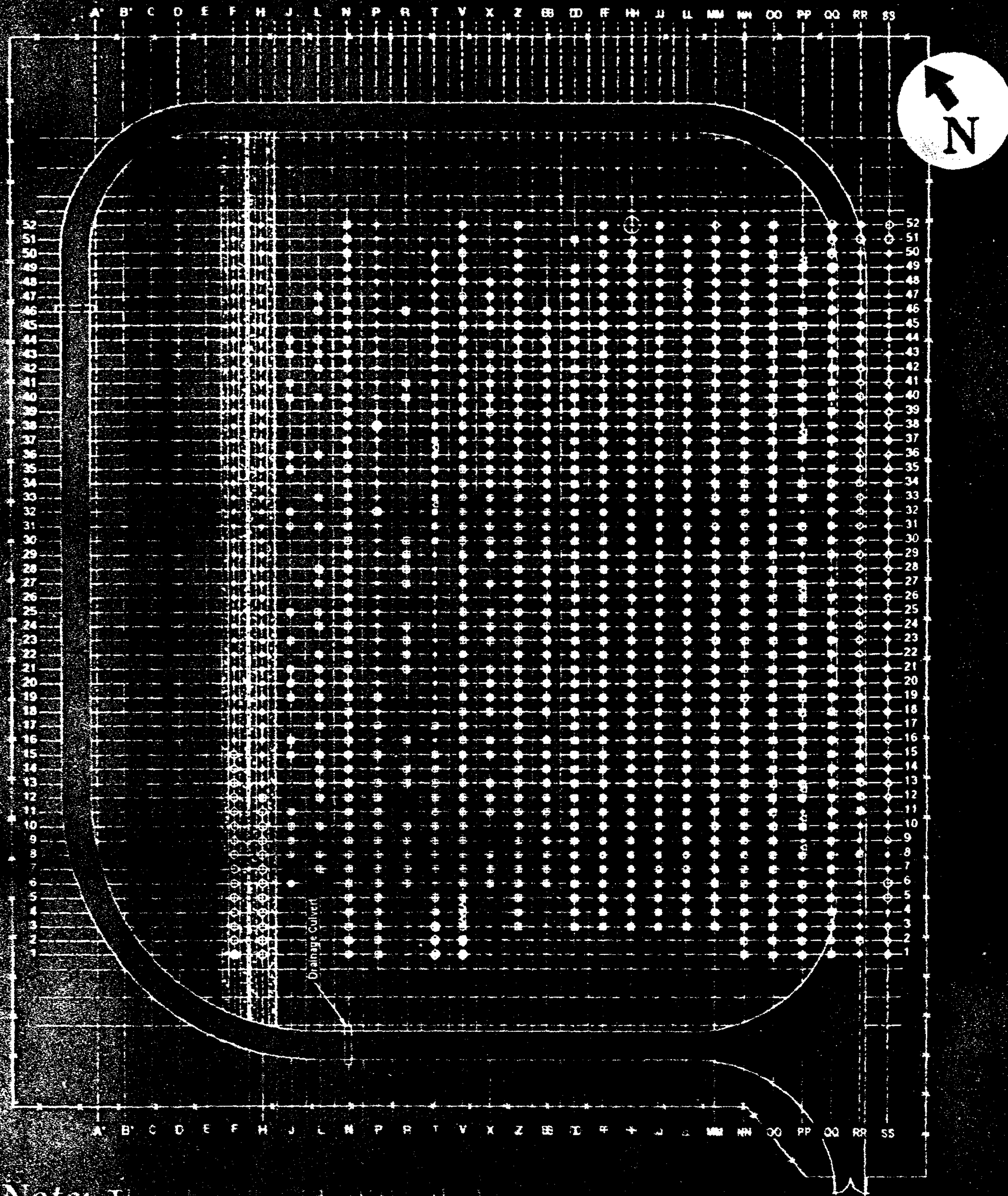
An underground dry storage facility for nuclear materials offers several inherent security benefits. Since the materials are below ground and in the open, an adversary is exposed to security detection, observation, and counter attack. The multiple layers of carbon steel casings with a welded carbon steel lid and concrete plug provide a good physical barrier. Additionally, the weight of the concrete plug and carbon steel liner requires heavy equipment to remove which creates a logistics problem for an adversary attempting their removal.



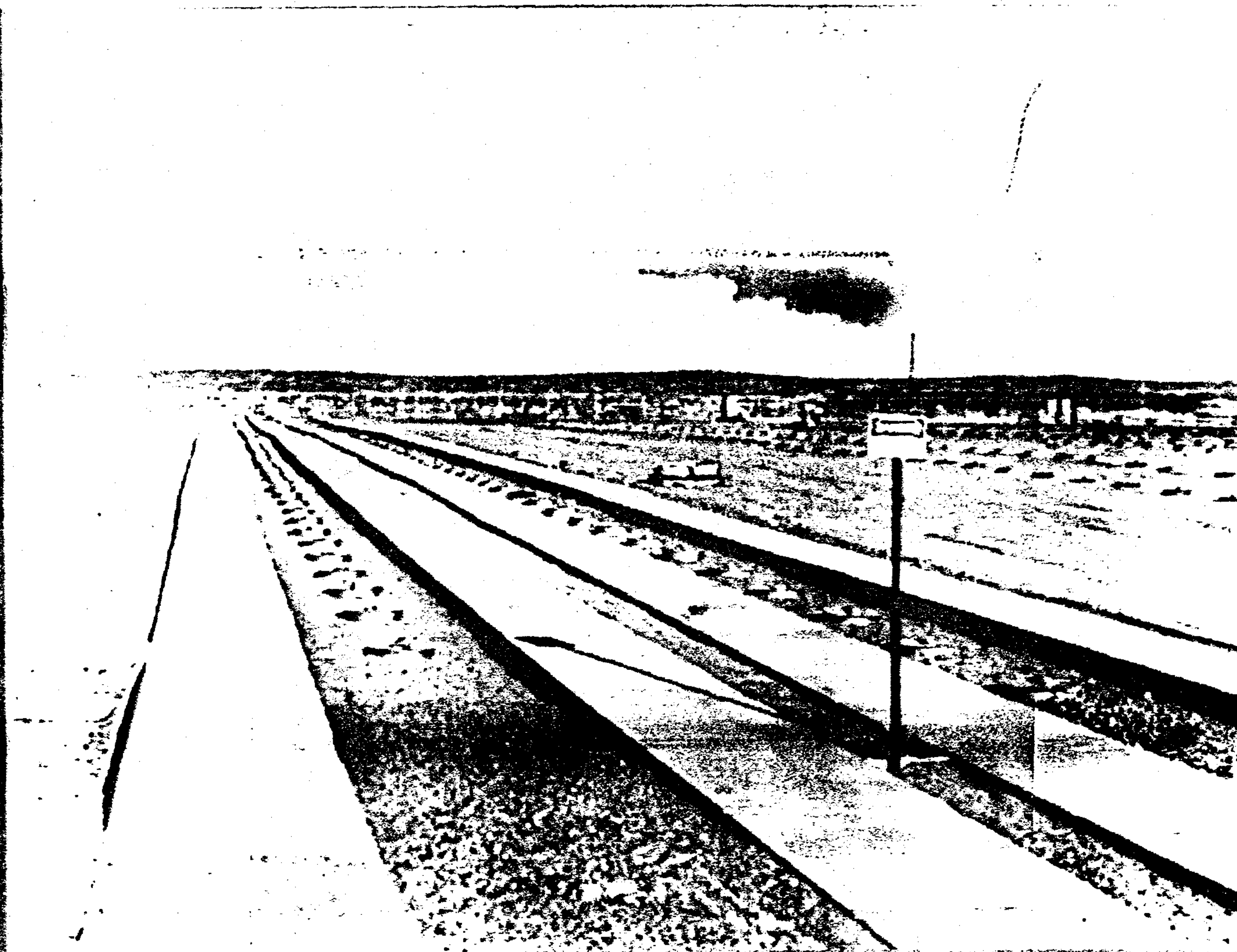
Radioactive Scrap & Waste Facility at Argonne-West



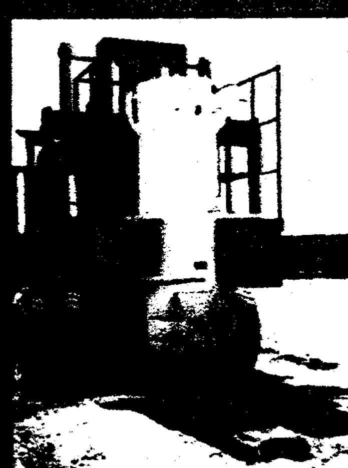
Plan View – (RSWF)



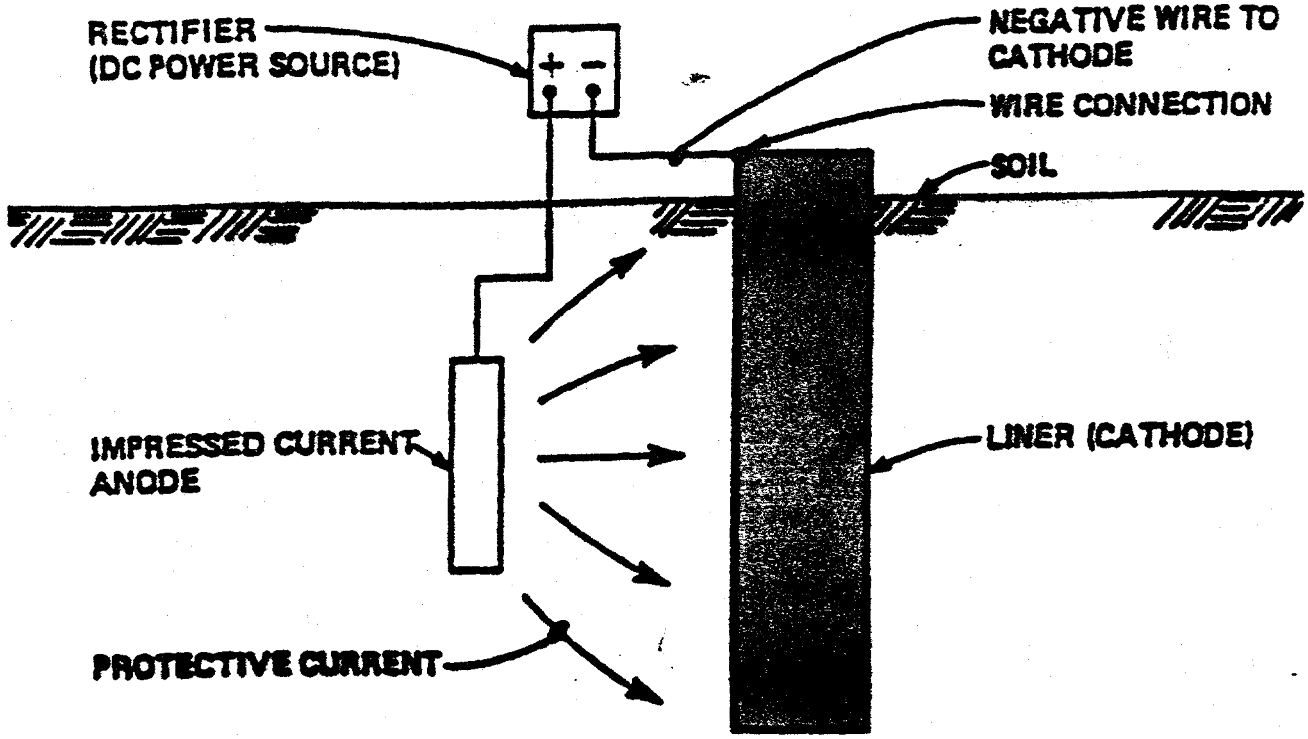
Note: **This plan view identifies the lo[illegible] presently at the RSWF. The shaded rows [illegible] rows that contain new liners.**



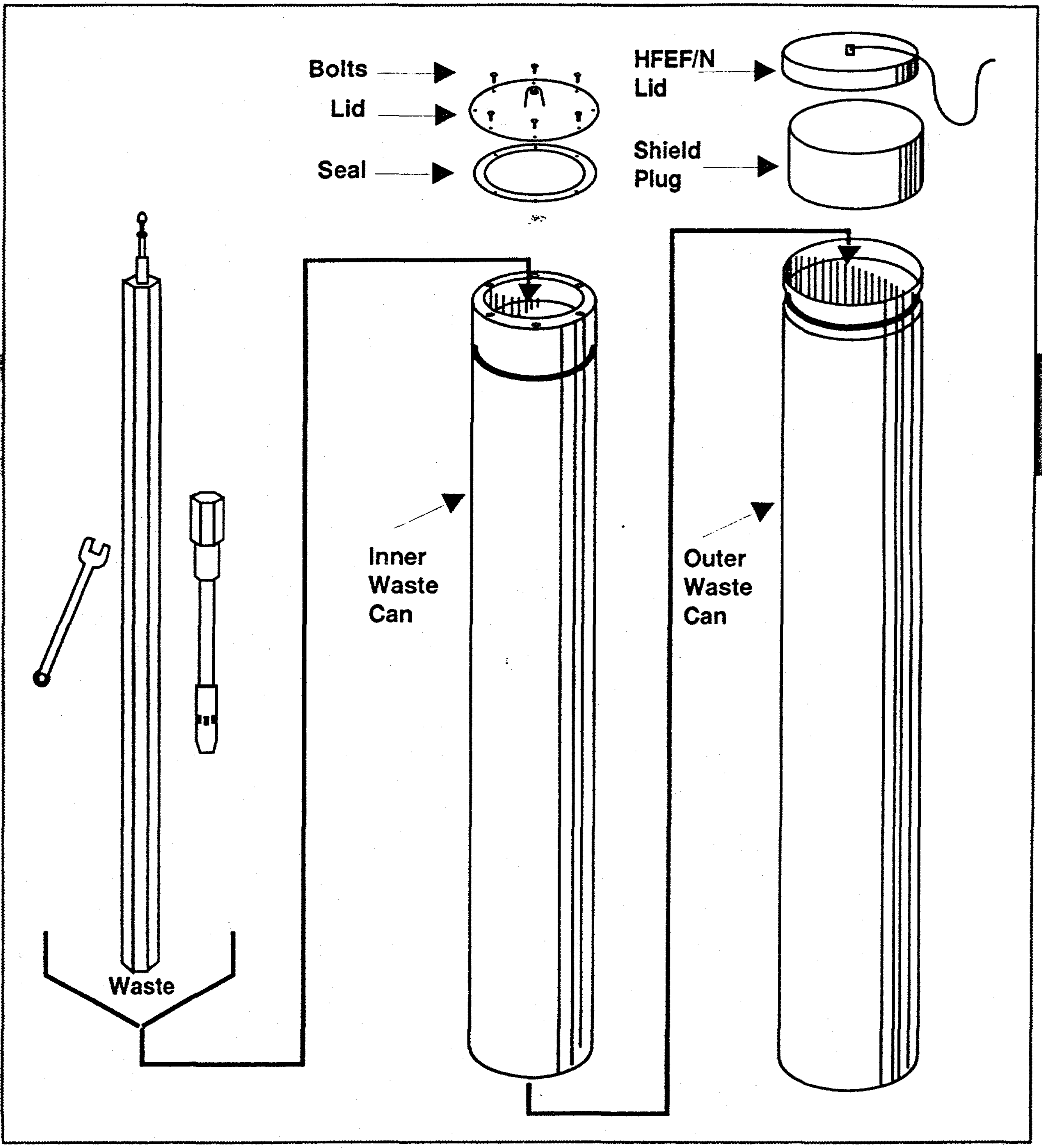
Concrete pads that will allow year 'round access to the RSWF. The concrete was poured parallel to the F&H rows. Material is placed into a liner by straddling the row of liners with 46 tons of equipment. Without the concrete, the equipment can easily get stuck.



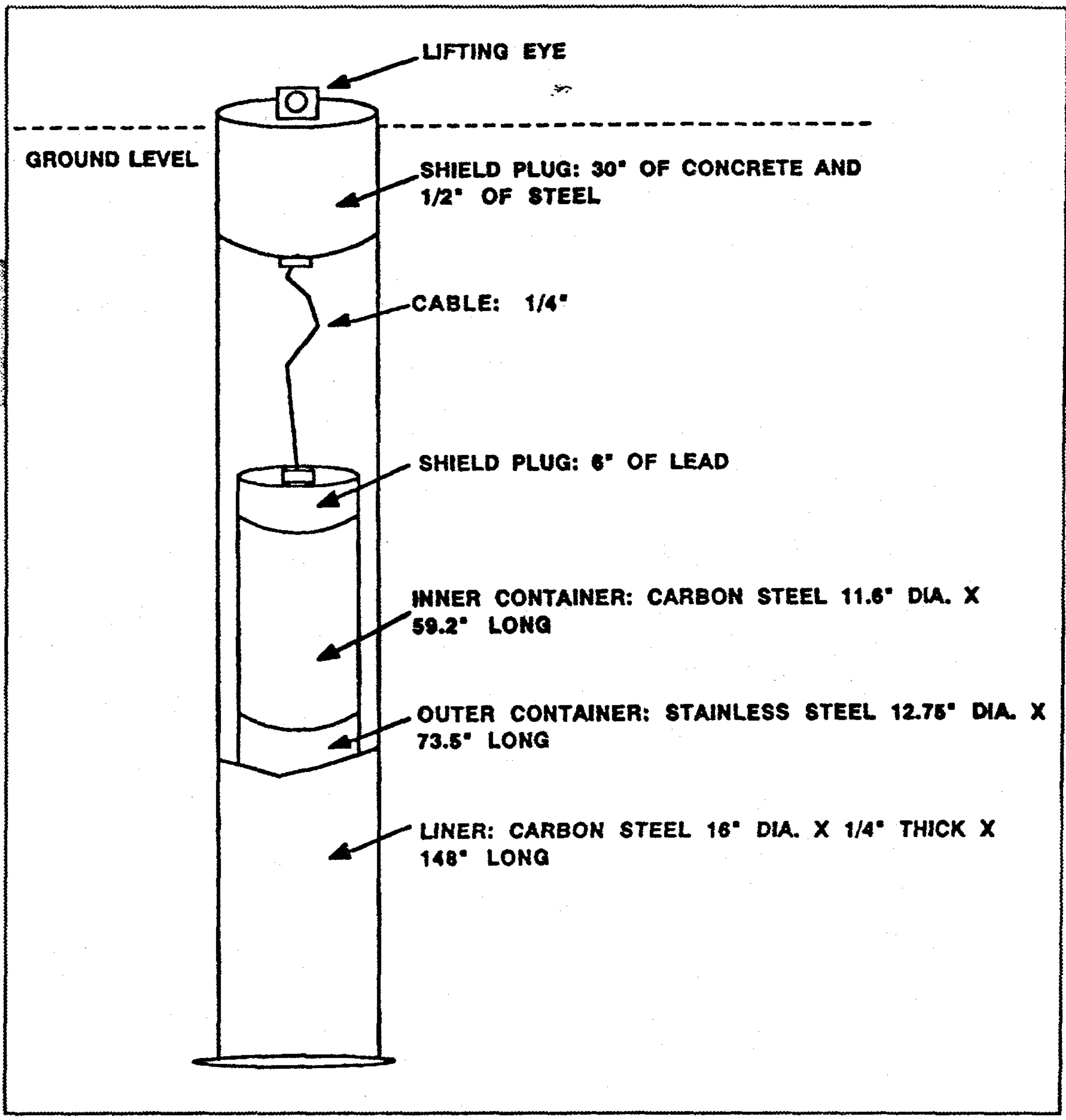
Cathodic Protection System

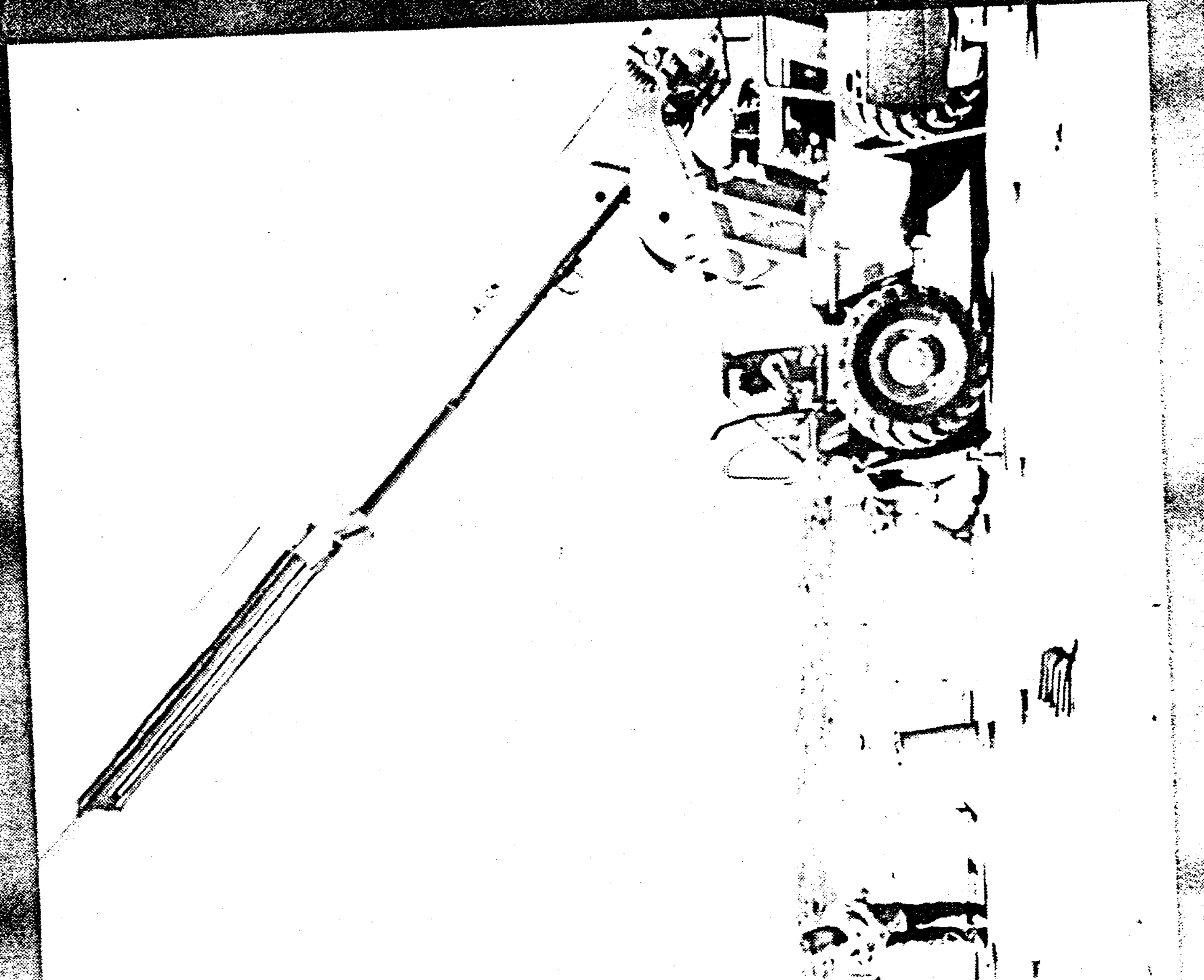


Double Steel Containers are Used for Remote Waste



[Present] Double Container Storage Configuration Required by the RSWF Permit





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July 2, 1997

TO: Valerie Gaines PRS, ANL-E

FROM: Monica Peterson *Monica Peterson* ED Publication Representative

SUBJECT: Paper for Clearance---***RUSH***

The paper titled "Inherent Security Benefits of Underground Dry Storage of Nuclear Materials" by R.D. Moore and T.P. Zahn has been enclosed (three copies) with the necessary form for review and clearance.

Thank you for your prompt assistance.

mdp
Enclosure

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