

Part I

INVESTIGATION OF LOSS OF MATERIAL  
OCCURRENCES AT:

OAK RIDGE NATIONAL LABORATORY  
OCTOBER 5, 1973

OAK RIDGE GASEOUS DIFFUSION PLANT  
OCTOBER 9, 1973

(DRAFT REPORT OF INVESTIGATING COMMITTEE)

Oak Ridge K-25 Site  
Oak Ridge, Tennessee 37831-7314  
managed by  
MARTIN MARIETTA ENERGY SYSTEMS, INC.  
for the U.S. DEPARTMENT OF ENERGY  
under Contract DE-AC05-84OR21400

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This document has been approved for release  
to the public by:  
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Oak Ridge K-25 Site *(B)*

U. S. ATOMIC ENERGY COMMISSION

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## INTRODUCTION

On October 5, 1973, Oak Ridge National Laboratory reported the loss of a nuclear accident dosimeter containing gram quantities of plutonium, neptunium, and depleted uranium. This occurrence prompted AEC-ORO management to require an inventory of nuclear accident dosimeters at all installations under ORO jurisdiction.

As a result of the inventory on October 8, 1973, three similar nuclear accident dosimeters were unaccounted for and reported as lost by the Oak Ridge Gaseous Diffusion Plant on October 9, 1973.

These loss of material occurrences are reportable under the requirements of Manual Chapter 0502, "Notification, Investigation and Reporting of Occurrences." The purpose of this report is to summarize the information gathered by the committee appointed to investigate the occurrences.

Section I of this report covers the loss of material occurrence at Oak Ridge National Laboratory. Section II covers the loss of material occurrence at the Oak Ridge Gaseous Diffusion Plant.

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SECTION I

INVESTIGATION OF LOSS OF MATERIAL OCCURRENCE AT  
OAK RIDGE NATIONAL LABORATORY

OCTOBER 5, 1973

INTRODUCTION

The loss of a nuclear accident dosimeter (NAD) containing gram quantities of plutonium, neptunium, and depleted uranium metal was reported by Oak Ridge National Laboratory on October 5, 1973. Exhaustive search efforts failed to locate the NAD within the plant. Excavation of selected portions of burial areas was undertaken but the NAD has not been located. The purpose of this Section I is to summarize the information gathered by the Committee appointed to investigate this loss of material occurrence at ORNL.

## SUMMARY

Nuclear accident dosimeters (NADs) were installed at selected locations throughout the Oak Ridge National Laboratory (ORNL) in 1958 to provide an assessment of personnel radiation exposure from accidental nuclear criticality. ORNL is operated by Union Carbide Corporation, Nuclear Division, under a prime contract with the Atomic Energy Commission. The dosimeters first employed contained plutonium, neptunium, and uranium foils within a boron carbide ball inside a soft-soldered copper can. These units were modified because of the concern of the release of fission foil materials to the Laboratory environment in the event of fire.

The modification resulted in units designed to withstand the Underwriter Laboratories four-hour fire test, and involved the encapsulation of each of the fission foils in a 0.010 inch thick seam-welded stainless steel capsule. The fission foil capsules are located in a cavity in the Boron-10 carbide inner sphere and assembled in a thick stainless steel bolted sphere. Seventy-three (73) NADs were used at ORNL facilities, including those located at the ORNL facilities at the Y-12 Plant. Units were either hung on building support structures or were placed in tubes located so that retrieval of the unit could be accomplished from outside the building. The units which were placed in tubes were marked with signs identifying the unit with instructions "Do Not Tamper."

During September 1973, an ORNL employee at the Y-12 Plant requested the Health Physics Division to replace a sign near one of the NAD locations because the sign had weathered severely. This request prompted ORNL to inspect the signs at other NAD locations to assess the need for replacement. The employee assigned this task took it upon himself to check the presence and condition of the NADs. Late on October 4, 1973, the NAD (Number 14) which had been located in a tube on the west side of Building 3012, Rolling Mill, was not found in the documented location. A report of the missing unit was made to the AEC on October 5, 1973.

On October 5, 1973, all remaining NADs at the ORNL site were retrieved and brought to a central location. The NADs at the ORNL(Y-12) locations were similarly retrieved on October 9, 1973. Each unit was opened and the presence of the fission foil capsules physically verified. No discrepancies were noted.

An extensive search for the missing unit was conducted beginning on October 5, 1973, in the area of the Rolling Mill. This search was expanded and intensified on October 8, 1973, to include the entire ORNL plant site. All personnel thought to have knowledge of the missing unit were interviewed during the period October 5, 1973, to October 10, 1973.

A review of the Health Physics Division records revealed that the last time the missing unit was known to have been in its assigned location was in April 1970.

A Committee was appointed by AEC-ORO management to investigate the occurrence. By memorandum, dated October 11, 1973, James H. Hill, Assistant Manager for Operations, appointed the following members to this Committee:

E. D. Marshall, Chairman, Materials Management Division  
T. M. Jelinek, Safety and Environmental Control Division  
W. A. Gorder, Security Division

## DESCRIPTION OF THE NUCLEAR ACCIDENT DOSIMETER

The missing nuclear accident dosimeter (NAD), Number 14, is a stainless steel sphere, approximately four inches in diameter, attached to a stainless steel tongue approximately four inches long. An assembled NAD similar to the missing unit is pictured in Appendix "I-A." The sphere is made of two hemispheres bolted together. In actual installation two of the bolts are left out and are replaced by a security seal. The fission foil capsules can be easily removed from these bolted spheres.

Inside each hemisphere is one-half of a Boron-10 carbide sphere with a cavity suitable for the placement of the fission foils. The fission foils in the missing unit consisted of 3.0217 grams  $^{239}\text{Pu}$ , 0.1003 grams  $^{237}\text{Np}$ , and 4.988 grams U (depleted). Each of the foils is a metallic disk encapsulated in welded 10 mil stainless steel. Appendix "I-B" is a photograph of a disassembled unit. The assembled unit shown in the right center of Appendix "I-B" is different from the missing unit only to the extent of the attachment of the tongue. The tongue contains gold, sulfur, and cadmium-covered gold for additional dosimetry. The unit shown in Appendix "I-B" is utilized in locations where placement on building structure support is necessary. The unit in Appendix "I-A" is utilized for placement in tubes where removal from outside the facility is required.

The cost of replacement of a single unit is approximately \$1,000.00.

The units are identified by stamped serial numbers on each component and a different painted identification number on the outer stainless steel sphere. The units are painted yellow to indicate possible contamination and/or radiation in the event of a nuclear excursion in the vicinity of the NAD. The units are not identified as containing radioactive material.

NADs which are placed in tubes for removal from outside the facility have attached to them a heavy gage steel tape of sufficient length to permit extraction of the unit from the tube. A length of chain or nylon rope is attached to the handle of the steel tape in some installations to facilitate retrieval of the unit from ground level.

An intact unit presents no hazard to individuals. Radiations emanating from the contained fission foils are such as to be easily shielded by the encapsulation materials. A significant hazard to man would exist if the contained neptunium and plutonium were to become finely powdered and airborne. This could be achieved by removing the materials from their stainless steel encapsulation and crushing or melting the metallic disks.

## ASSIGNED LOCATION OF MISSING UNIT

The missing NAD was one of three units assigned to the Rolling Mill, Building 3012, ORNL. Its location was in a tube on the west side of the building, approximately seven feet off of ground level as required to make the unit easily retrievable. Appendix "I-C" shows a view of the west side of Building 3012, with the tube opening located between the windows near a drain pipe. Appendix "I-D" shows a close-up view of the tube opening with the sign below. If an NAD was in place in this tube a three-foot length of chain would hang from the end of the tube. Appendix "I-E" shows a view of the end of the access tube inside of the Rolling Mill. Two other NADs were located inside Building 3012, mounted on structural supports. These two units were found to be intact and in their assigned locations on October 5, 1973.

## CHRONOLOGY OF EVENTS

1958

April - Twenty-eight (28) units were placed in plant areas and the locations were identified and recorded. Subsequently, thirty-five (35) additional units were deployed in documented positions at ORNL and ten (10) units in ORNL(Y-12) for a total of seventy-three (73).

1961 and 1962

The units were modified to incorporate fire resistant features.

1969

June The units were individually inventoried and glass rod  
July dosimeters replaced by the Health Physics Division.

1970

April The location of each unit was verified and an updated listing published. (Three documented location changes occurred between April 1970 and February 1973.)

1973

Sept. A verbal request was received by the Health Physics Division from the ORNL(Y-12) group to replace some of the signs associated with NAD locations because they had weathered severely.

Oct. 4 NAD Number 14 assigned to Building 3012 was not found in the documented location.

Oct. 5 All NAD units assigned to ORNL areas were collected and brought to a central location at ORNL, except NAD Number 14 which was not located.

Missing NAD was reported to AEC-ORO and AEC Headquarters.

Oct. 6 All existing NADs were dismantled and the inventory of fission foils was completed. All foils were accounted for except those assigned to NAD Number 14.

1973

- Oct. 6 A search was conducted in Building 3012, Rolling Mill,  
and 7 and in the surrounding areas.
- Oct. 8 The search was expanded to include the entire laboratory  
premises. Excavation of suspected trenches was started  
in the burial ground area.
- Oct. 9 All NAD units assigned to ORNL(Y-12) were collected and  
inventoried.
- Oct.10 The first search of the ORNL premises was completed;  
additional and repeated searches were made.

## RESPONSIBILITY FOR PLACEMENT AND ACCOUNTABILITY OF UNITS

Nuclear accident dosimeters (NADs) were first introduced at the ORNL in 1958. At that time a member of the Health Physics Division was given the assignment to locate and identify the units in the plant. This assignment of responsibility was not documented. The individual has since that time retained all responsibility for the location, accountability, modification, and retrieval of the units. This assignment also was not documented.

Since the NADs contain plutonium they are considered accountable in the source and special nuclear material (SS material) accountability system. For SS material accountability purposes ORNL is administratively divided into a number of material balance areas (32 MBAs as of this writing). A Balance Area Representative is appointed by the Division Director to administer the SS material program within an assigned material balance area. Included among the duties of the balance area representative is the maintenance of adequate single-entry accounting records of internal transfers, inventories, and loss of material.

The inventory of plutonium contained in all NADs at ORNL is accounted for and reported to the Central SS Accountability Office by the Material Balance Representative for the Material Balance Area (Account) 130. A review of the records in the Central SS Accountability Office indicates that a monthly inventory report has been submitted without exception for Account 130 on the required Form (UCN-430).

The Form UCN-430 submitted for the September 30, 1973, inventory showed 227 grams of plutonium in Account 130. The plutonium inventory in the NADs at ORNL is included in this total plutonium figure for the account. The summary records of SS material activities in Account 130 were found in good order, and there was no indication of a disposition of plutonium that could be associated with NAD-14.

The summary entries on Form UCN-430 are supported by line item listings maintained in each material balance area and based on inventories performed by or for the balance area representative. Such a listing was found in Account 130 and supports the 227 grams of plutonium charged to that account. There is, however, no record or other indication that a routine physical check was made every month to support and verify this item-by-item listing. Such a monthly physical check is required in Account 130 by the approved procedures documented in: Supplemental SS Procedures Manual - Balance Area 130; ORNL-2800, Procedure 6.0, dated September 10, 1968. This procedure reads in part:

6.0 - Inventory Procedures

- A. Frequency of Physical Inventory - A complete physical inventory of SS materials other than threshold detector units in this area will be made annually with maximum accuracy. A complete listing of items with associated weights will be maintained. In addition, a physical check will be made monthly to assure that identifiable components of the inventory have not been misappropriated or lost.

The exemption of sealed identifiable components such as NADs (threshold detector units) from a complete physical inventory is approved SS material accountability practice. A physical inventory of the SS material in an NAD would require that each sealed unit be disassembled and the SS material content of the fission foil capsules verified by analysis. Such an analysis could destroy the usefulness or the effectiveness of the unit. A monthly physical check of each identifiable component (NADs) in Account 130 inventory should have been performed and documented as a substitute for the periodic physical inventory.

Procedure 6.0 referred to above, also states, "It is the responsibility of the surveyers(sic) who maintain threshold detector stations ... to keep the balance area representative currently informed of the status of their inventory, to maintain a currently valid list of all items either in their possession or at detector station locations, to keep the balance area representative informed of each material transfer...." The last such listing of the location and presence of each NAD was compiled in April 1970. No other documentation concerning the physical location and presence of NADs could be identified at ORNL. No procedures have been established by the Health Physics Division to require periodic verification of the placement and condition of the NADs. It was generally understood, however, that the Health Physics Division had responsibility for the NADs, and that they were to be contacted concerning any movement of the units and that they were the persons authorized to perform the actual movement or replacement.

AEC Manual Chapter 0545, "Nuclear Accident Dosimetry Program," establishes the requirement that nuclear accident dosimeters be utilized to aid in the determination of the radiation dose of personnel who may be exposed as a result of an accident involving critical masses of fissionable material. The Manual Chapter does not require that units deployed within a facility be periodically checked to assure their presence.

POSSIBLE MECHANISMS FOR THE MATERIAL LOSS

The possible mechanisms for the material loss considered and evaluated by both ORNL and the Investigating Committee include the following:

1. Removal from the plant site
  - a. deliberate action
  - b. inadvertent action
2. Retention onsite
  - a. unknown assignment to new location
  - b. undocumented disposition to storage
  - c. inadvertent burial

For all of the above listed mechanisms for loss, it is assumed that deliberate action was required to remove the NAD from the tube housing. The tube is located approximately seven feet above ground; the steel tape and handle attached thereto were only long enough to allow the units to be pulled out by reaching up to the tube and grasping the handle, or the chain attached to the handle. The tube was not slanted so that the NAD could slide out due to vibration or shock.

Removal of the NAD from the plant site by the deliberate action of an individual cannot at this time be conclusively proven nor denied. Based on interviews conducted by ORNL with individuals who worked in the area, were assigned special crafts-type jobs in the area, or performed custodial tasks in and around the area; no likely reason for removal could be identified nor could any suspect individuals be identified.

Because of personnel turnover, terminations, and temporary employees, all persons who had access to the outside of Building 3012 were not interviewed.

Several indications that deliberate removal from the plant site is unlikely can be noted. These include the fact that ORNL personnel (including craftsmen and custodial personnel) are extremely sensitive about handling any item painted yellow, as the NADs are, since this bears the well known connotation of radioactive contamination. The presence of a long strand (approximately 15 feet) of non-coilable

steel tape similar to a very stiff banding material attached to the unit, made the installed NAD very difficult to handle. Two other units, more easily accessible on the inside of the building were not disturbed, though the possibility of theft of the unit least likely to be discovered missing cannot be ignored.

These considerations are not sufficient to preclude the possibility of deliberate removal from the plant site. Further investigation into this possibility is not considered to be a function of this investigating committee.

Removal of the NAD from the plant site by inadvertent action requires the evaluation of the movement of materials and equipment into and out of the Rolling Mill area. During the time period since April 1970, the last date the NAD was known to be in place, the activities in the Rolling Mill have greatly decreased, but the area has remained operational. No major construction or renovation has taken place which would have necessitated the removal of the NAD for even a brief period of time. Records of disposal of contaminated materials from the area indicate that in the period from April to June 1971, a considerable amount of "house cleaning" was accomplished. However, there are no known transfers of contaminated equipment or material from this area to areas outside of ORNL. Uncontaminated materials that are disposed of are buried at the sanitary landfill located at the Y-12 Plant. No records of the disposal of "clean" waste are kept and hence, searching the sanitary landfill area is considered infeasible. Considering the normal mechanisms for handling either clean or contaminated excess or scrap materials originating at ORNL facilities, it is considered unlikely that the NAD, even if inadvertently associated with such materials, could have gotten into an area uncontrolled by ORNL or other Union Carbide Corporation, Nuclear Division, facilities.

The possibility of the missing NAD being removed from its location in the Rolling Mill and assigned to another location is highly unlikely. The Health Physics Division was generally understood to have the responsibility for placement of the units at ORNL. Records do indicate that this Division has effected and documented past movements or re-assignments of these units and there is no recorded movement of the unit assigned to Building 3012. Further, all NADs at ORNL were retrieved prior to, and held in a central location during, the laboratory search which covered every building and laboratory on the plant site. No misplaced units were found during the extensive search.

The possibility of the NAD being removed from its assigned location and placed in storage in another ORNL location is also highly unlikely. The search of the ORNL premises on October 8-10, 1973, included opening and searching all SS material storage areas, classified repositories, safes, desks, closets, used furniture warehouse, etc. Every conceivable location was thoroughly searched, not just likely places of concealment. Appendix "I-F" shows the assigned location of the NAD (TDU, Threshold Detector Unit) and the early search efforts in the immediate vicinity of Building 3012.

The possibility that the NAD was buried at ORNL was considered to be one of the most probable loss mechanisms from the outset of this investigation. Due to the nature of the research conducted at ORNL, almost all scrap materials are disposed of by burial to prevent the possible spread of radioactive contamination to the environment. NADs are painted yellow to identify them as potentially contaminated with radioactive materials. Also, the knowledge of the location of the NADs on the plant site, and familiarity with the units by most people at ORNL was deliberately minimized to avoid the interaction of plant personnel with the units. Hence, the discovery of one of these units out of its assigned location, or the deliberate removal of a unit by a person unfamiliar with them, as most people were prior to this incident, would likely result in the unit being placed in a "dumpster" designated for contaminated material by being painted yellow. Such a dumpster was located immediately adjacent to Building 3012.

Two health physics technicians, when made aware of the missing unit, recalled that at some time in the past they were asked by a burial ground operator to look at an object which had been dumped into a burial pit. The technicians recalled that the object they viewed was just like the missing NAD, including the long steel tape attached to it. At the time they saw it in the burial pit, they noted the yellow paint, assumed the item to be contaminated, and told the burial ground operator that it was probably deliberately discarded so it should be buried.

Extensive efforts were made on the part of ORNL to firmly establish a time frame in which the technicians viewed the object in the burial pit. Records of attendance, vacations, work schedules, etc., were examined and dates on which the three individuals could have been working together, were correlated with transfers of "dumpsters" from Building 3012 in order to identify areas in the burial ground where the unit might be located. Recollection of the individuals was also used to locate likely burial trenches. The most likely time period for the individuals to have seen the unit in the pit corresponds to the time period when an unusually large number of "dumpsters" were moved from Building 3012, indicating that some house-cleaning activity was in progress. The time period was determined to be the spring and early summer of 1971.

Excavation of selected burial ground areas began early in the week of October 8, 1973, and was continued through October 31, 1973. The NAD has not been located. The technicians recall that the unit was partially covered by pipe which had been dumped on top of it. The pipe has not been located either.

An additional time frame clue was provided by an electrician who remembered stuffing a rag in the NAD tube housing in the spring of 1971 to prevent birds from nesting there. He stated that at that time he did not see the steel tape or the chain attached to the handle of the tape.

It is the opinion of the Committee that the most likely loss mechanism was the deliberate removal of the NAD from the tube housing and that subsequent to that the individual(s) disposed of the unit by hiding it or throwing it into a "dumpster" from whence it was buried either in the radioactive material burial ground or the Y-12 sanitary landfill.

ACTIONS TO PREVENT FURTHER LOSS OF MATERIAL

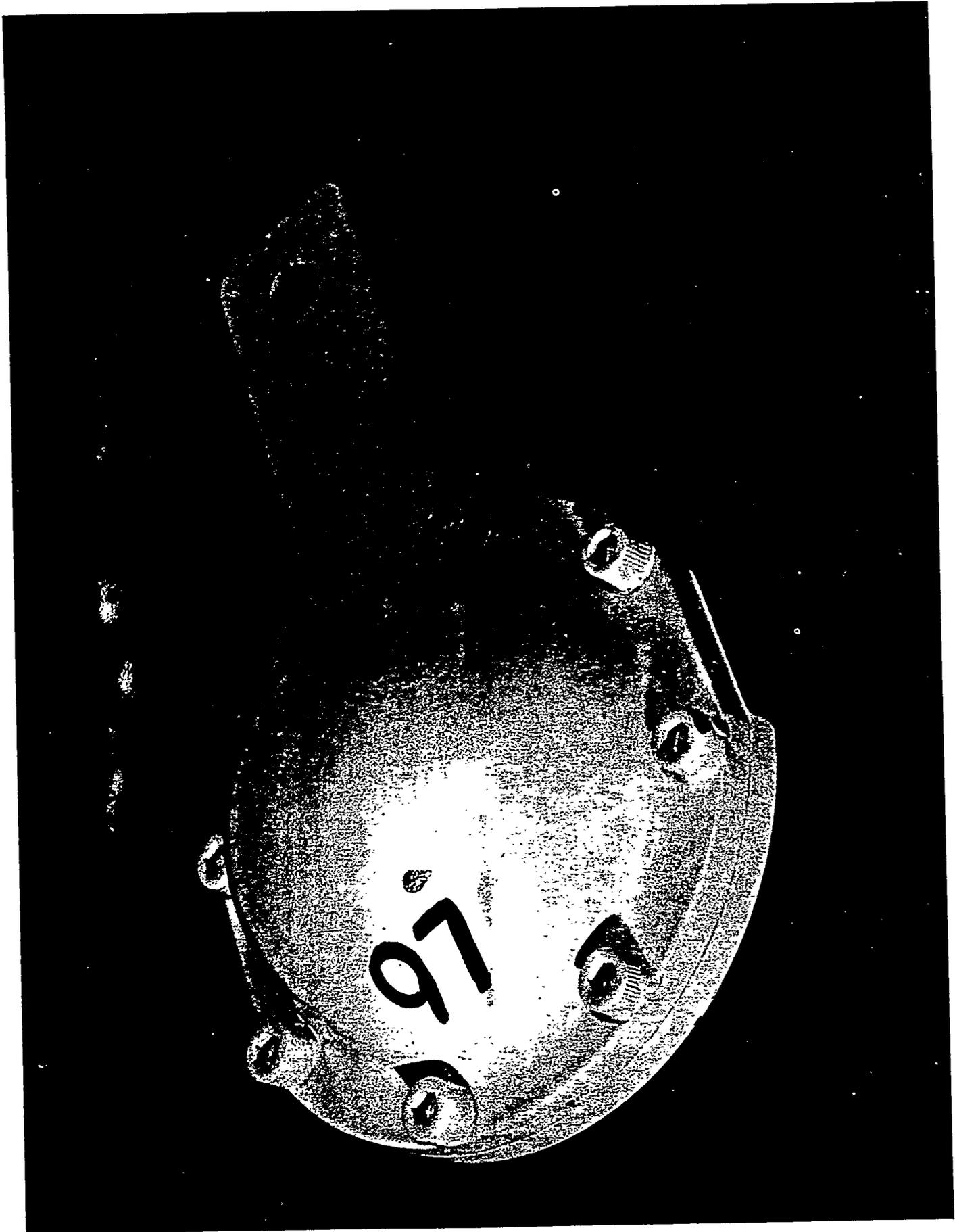
All remaining NADs have been collected from ORNL facilities and inventoried for fission foil content. All foils have been accounted for. ORNL plans to prevent further loss of such material include redeployment of at least some of the units in the most sensitive locations with positive lock and key control required to remove the units from their assigned position. This is a temporary action until it is approved or a suitable alternative is developed.

Tamper-indicating security seals will be utilized to indicate attempts to tamper with the units after deployment. These seals will be checked at some reasonable frequency and their integrity will be documented.

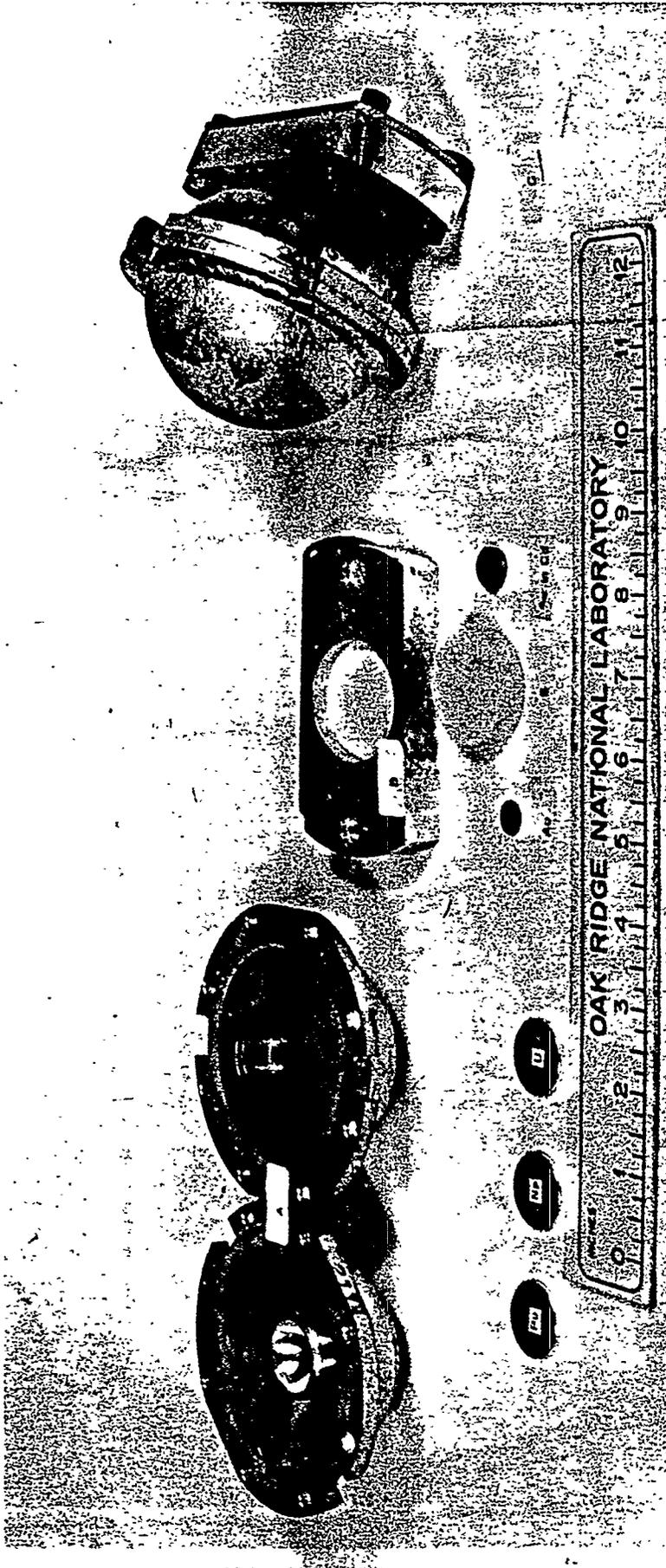
## FINDING OF FACT

Based upon discussions with ORNL personnel associated with or having knowledge of this occurrence, the Committee believes the following to be the major pertinent facts regarding the occurrence:

1. The nuclear accident dosimeters (NADs) utilized at the ORNL were last known to be in their assigned locations in April 1970.
2. On October 4, 1973, NAD Number 14, which had been assigned to the Rolling Mill, Building 3012, ORNL, was not in the assigned location. It was determined to be missing and the loss was reported to the Oak Ridge Operations Office on October 5, 1973.
3. NAD Number 14 contained 3.0217 grams  $^{239}\text{Pu}$ , 0.1003 grams  $^{237}\text{Np}$ , and 4.988 grams U (depleted).
4. The units are not identified as containing radioactive material.
5. Responsibility for periodically ascertaining the presence of the NADs in their assigned locations has never been formally documented at ORNL.
6. The requirement for an annual physical inventory of accountable material contained in the NADs was waived, in lieu of the required monthly physical check to assure that identifiable components of the inventory had not been misappropriated or lost.
7. No mechanisms, except the deliberate theft, have been identified by which the NAD could have entered the public domain.
8. Two health physics technicians recalled, during questioning following this occurrence, viewing an object similar to the missing NAD in an ORNL burial pit.
9. Extensive searches have been conducted of the area in and surrounding Building 3012, and of the entire Laboratory complex.
10. The missing NAD was positioned so as to be easily retrievable in case of a nuclear excursion, but it would require a deliberate and significant effort to dislodge it.
11. The fission foil capsules can be easily removed from the NADs using ordinary tools.
12. The missing NAD has not been located.



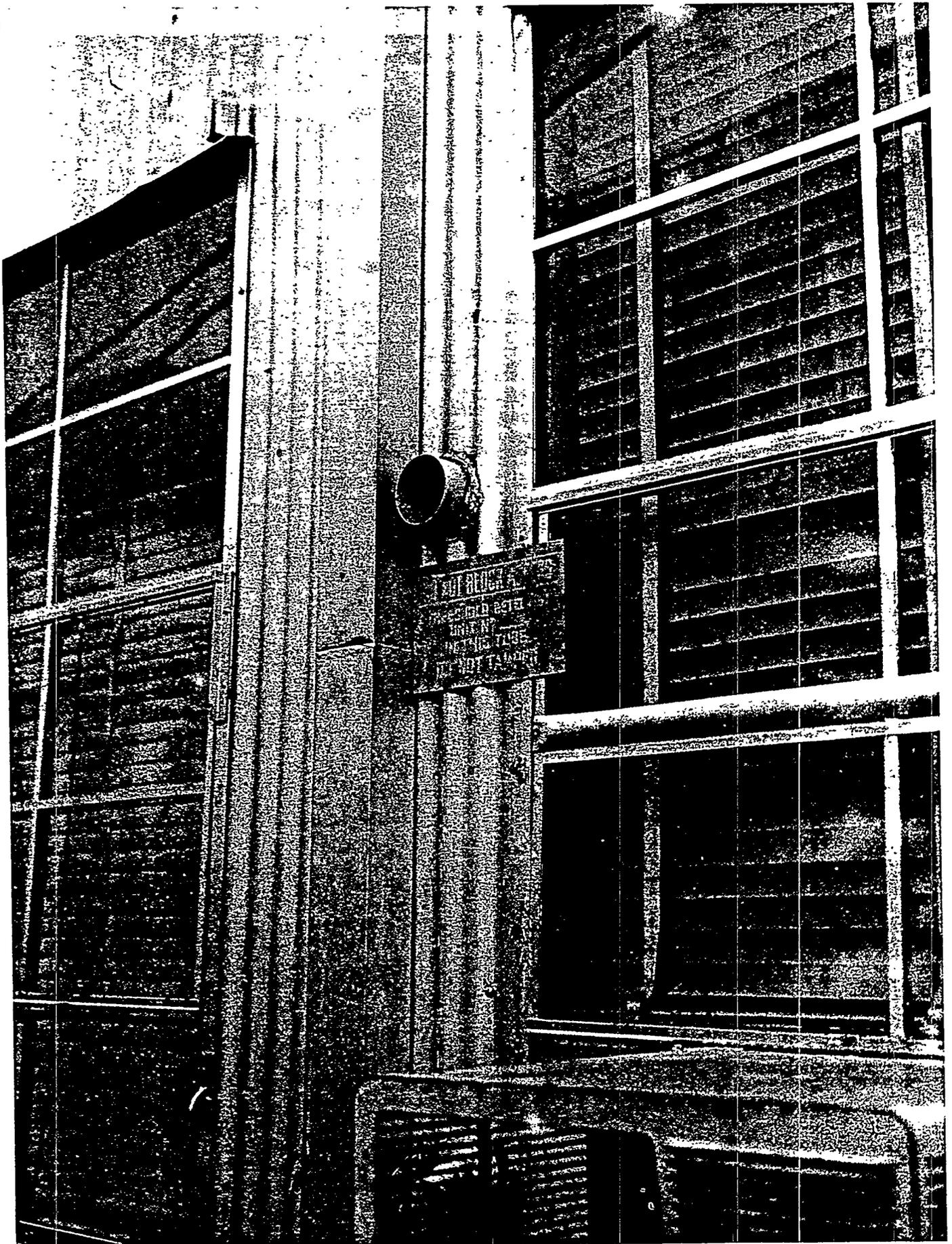
APPENDIX I-A - Nuclear Accident Dosimeter (NAD), four inches in diameter, 2.5 inches thick



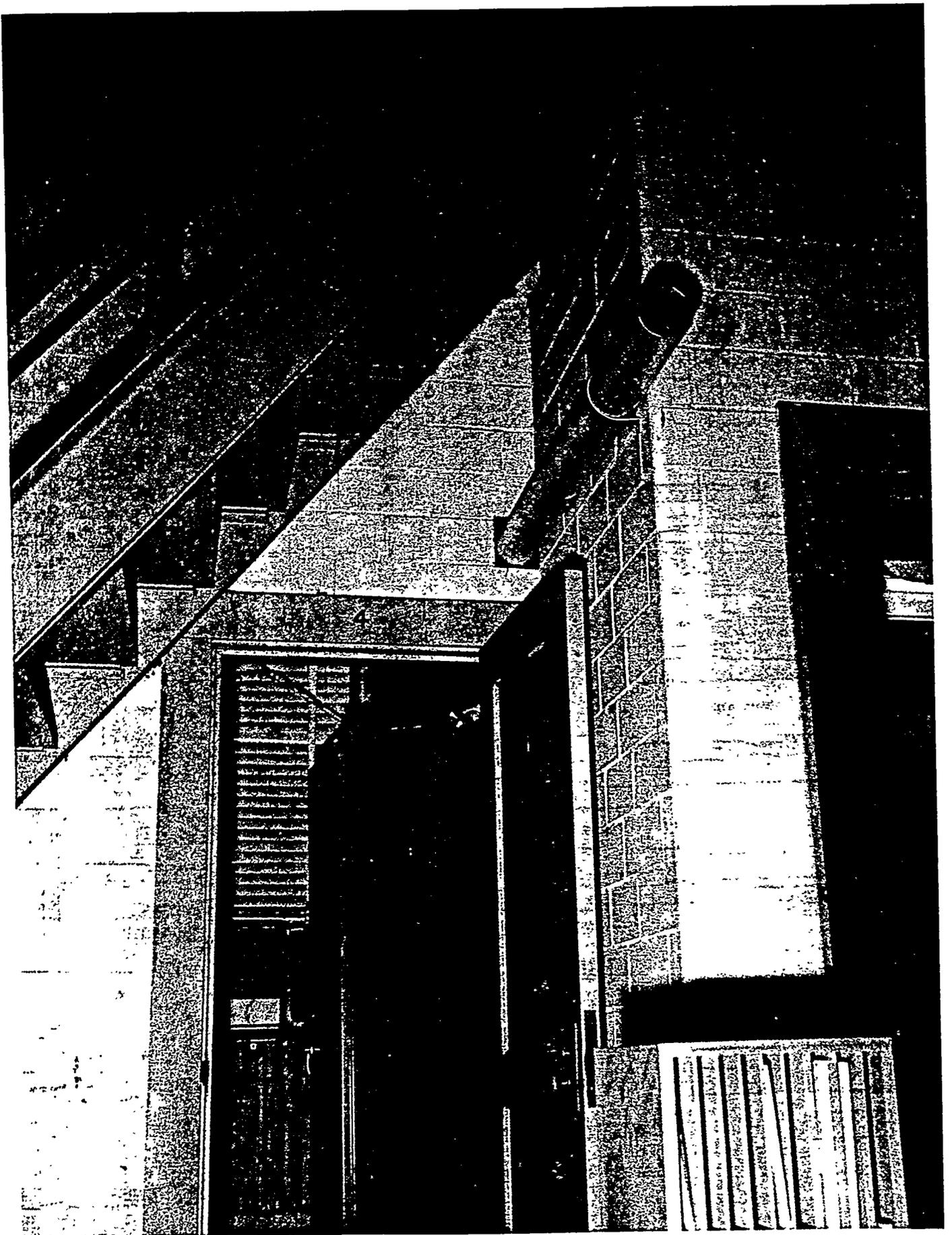
APPENDIX I-B - Exploded View of a Nuclear Accident Dosimeter. An Assembled Unit Is Shown on the Right. I-18



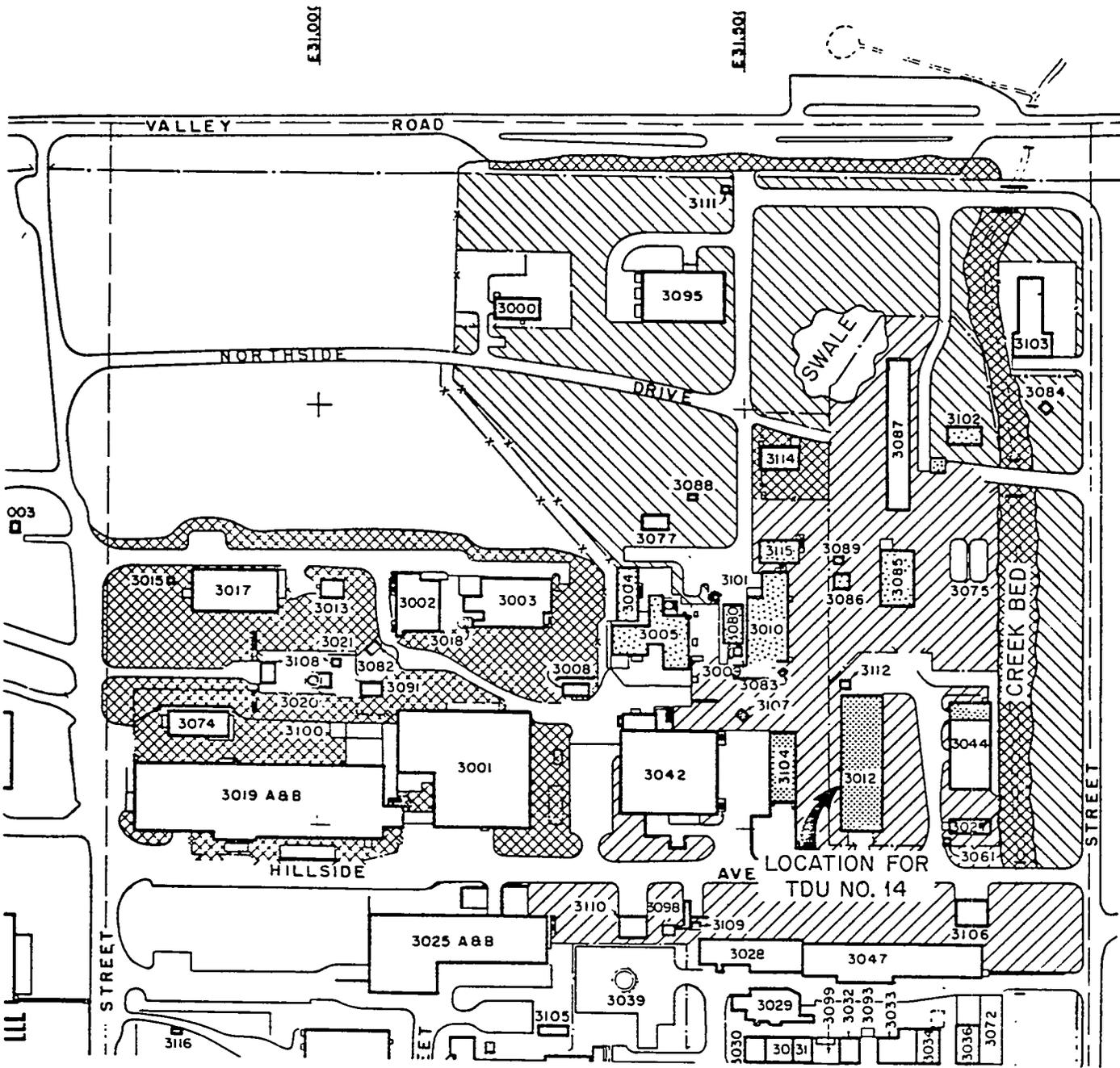
APPENDIX I-C - View of Exterior of Building 3012, Oak Ridge  
National Laboratory



APPENDIX I-D - View of External Opening of Access Tube



APPENDIX I-E - View of the End of the Access Tube Inside  
Building 3012, ORNL



LEGEND - TDU SEARCH

GROUNDS	BUILDINGS	
		DAY 1 - OCT 6, 1973
		DAY 2 - OCT 7, 1973
		DAY 3 - OCT 9, 1973
		THRU
		DAY 5 - OCT 11, 1973

GRASS CUT, PREVIOUS AREAS REEXAMINED, PLUS EXTENDED TO AREAS SHOWN. CREEK BED FOLIAGE CUT AND AREA SEARCHED.

II-1

SECTION II

INVESTIGATION OF LOSS OF MATERIAL  
OCCURRENCE AT:

OAK RIDGE GASEOUS DIFFUSION PLANT  
OCTOBER 9, 1973

INTRODUCTION

The Oak Ridge Gaseous Diffusion Plant reported on October 9, 1973, the loss of three nuclear accident dosimeters (NADs) each containing gram quantities of plutonium, neptunium, and depleted uranium. Exhaustive search efforts failed to locate the three missing dosimeters within the plant.

The purpose of this Section II is to summarize the information gathered by the Committee appointed to investigate this loss of material occurrence at ORGDP.

## SUMMARY

Nuclear accident dosimeters (NADs) were installed at selected locations throughout the Oak Ridge Gaseous Diffusion Plant (ORGDP) beginning in 1958 to provide an assessment of personnel radiation exposure in the event of a nuclear criticality accident. ORGDP is operated by Union Carbide Corporation, Nuclear Division, under a prime contract with the Atomic Energy Commission.

The NADs first deployed in the ORGDP contained fission foils of plutonium, neptunium, and uranium (depleted) in assemblies that were later determined not to be sufficiently fire resistant. These units were modified, beginning in 1960, because of the concern of the release of fission foil material to the facility environment in the event of fire.

The modifications resulted in the deployment of units designed to withstand the Underwriter Laboratories four-hour fire test. The principle changes involved encapsulating the fission foils in 0.010 inch thick, seam-welded, stainless steel capsules. The resulting disks are approximately one inch in diameter and 0.065 inch thick. The fission foil capsules are positioned in the central cavity of a Boron-10 carbide sphere two inches in diameter, and the subassembly welded in a stainless steel can 0.109 inch thick.

Forty-five (45) of the modified NAD units were deployed in selected locations in the ORGDP during the period 1960 to 1963. The units were placed so that they would be easily accessible and could be removed from an area by personnel exiting in the event of an emergency. None of the units were deployed in the tube configuration for retrieval from outside the building.

As a result of the loss of a nuclear accident dosimeter at Oak Ridge National Laboratory on October 5, 1973, ORGDP, Y-12; and Paducah were requested to inventory the NADs assigned to them. All other installations under ORO jurisdiction were requested to inventory on October 9, 1973, all nuclear accident dosimeters and similarly deployed instruments containing hazardous materials. The inventory taken on October 8, 1973, at ORGDP indicated that there were three NADs that could not be accounted for, and they were reported as missing items on October 9, 1973.

Two of these missing NADs, Numbers 110 and 132, had been assigned to Building K-1420, Chemical Operations; the third NAD, Number 125, had been assigned to Unit K-303-8 of the K-25 Building.

<u>Serial Number</u>	<u><math>^{239}\text{Pu}</math></u>	<u><math>^{237}\text{Np}</math></u>	<u>U(Depleted)</u>
110	0.9979 g.	0.0972 g.	5.309 g.
125	1.0027 g.	0.1054 g.	5.312 g.
132	<u>1.0037</u> g.	<u>0.1015</u> g.	<u>5.314</u> g.
Total	3.0043 g.	0.3041 g.	15.935 g.

Each fission foil is encapsulated in stainless steel 0.010 inch thick. The resulting fission foil source is a seam-welded wafer approximately 1 inch in diameter and 0.065 inch thick. The fission foil sources together with spacers and cadmium absorbers are enclosed in a Boron-10 carbide sphere approximately 2.5 inches in diameter and this subassembly is encased in a stainless steel container about 6 inches long and 2.75 inches in diameter. The closure is effected by welding and a pigtail is attached for hanging the pod on the aluminum cross-member (paddle).

Each fission foil capsule is stamped with the element it contains and the same serial number that appears on each of the three parts of the NAD assembly, e.g., Pu-110, Np-110, and U-110 in NAD assembly Number 110.

The cost of three replacements units is approximately \$2,400.00.

An intact stainless steel fission foil pod from this type of NAD presents no hazard to individuals. Radiation emanating from the contained fission foil capsules is such that they are largely absorbed by the encapsulating materials. A significant hazard to man would exist if the contained plutonium and neptunium were to become finely powdered and airborne. This could occur if the fission foil sources were removed from the stainless steel containers and crushed or melted.

## ASSIGNED LOCATION OF MISSING UNITS

The three missing units, two complete NAD assemblies and the fission foil pod from the third, were assigned to specific locations in the plant as follows:

1. NAD Number 132 was assigned to Building K-1420, Chemical Operations, and located on Column 22-J near a roll-up door truck entrance on the south side of the building as shown in Appendix "II-D." Appendix "II-F" shows this location on the plot plan. The NAD was hung about seven feet above the floor directly above a waste container. The fission foil pod is missing from this unit; the remainder of the assembly is still in place.
2. NAD Number 110 was also assigned to Building K-1420 and located on Column line 4-BC in "H" area on the mezzanine floor. Appendix "II-E" shows the bracket from which the NAD was suspended and the surrounding work area. This is an in-process storage area for uranium oxide product of the recovery operation. The location of this area is also shown on the plot plan Appendix "II-F."
3. NAD Number 125 was assigned to Unit K-303-8 in the K-25 Building. It was located on the operating (top) floor near an office complex in Unit 303-8 in the K-25 Building as shown in Appendix "II-G." This area was completely renovated since the NAD was deployed and the assigned location of this NAD is covered by a newly constructed wall.

The NAD location sites in the plant are not conspicuously marked; there are no caution or instruction signs and the NAD units themselves carry no identification as to their use or the fact that they contain hazardous material.

CHRONOLOGY OF EVENTS

- 1958 First NAD units were placed in ORGDP areas.
- 1961 Fire resistant fission foil containers were adopted. Replacement of old units began.
- 1963 Deployment of NADs throughout the plant was completed. A map was prepared showing the location of each unit.
- 1966 The film in the NADs was replaced with glass rods in May. There is documented evidence that all units were accounted for and in their correct location.
- 1968 A work order was issued in October requesting replacement of electrical system conduit in K-1420 Building.
- 1969
1. In February renovation began in K-303-8. The offices were occupied in December 1969.
  2. Awarded bid for contaminated scrap in May.
  3. Contaminated scrap metal was picked up at the ORGDP yard in September and October.
  4. The work on replacing the conduit system was completed in November.
- 1970 Contaminated scrap metal was picked up at the ORGDP yard in January, February, and March.
- 1971 In January a check of the NADs in Building K-1420 only indicated that four NAD units, Numbers 110, 141, and 156, and the fission foil pod from Number 132, were not found in their assigned locations.
- 1973
1. An inventory of all NADs was requested by Union Carbide Corporation and AEC-ORO management on October 5.
  2. An intensive search began for three missing units on October 8.
  3. A visit was made by ORGDP personnel to a scrap dealer's storage yard on October 11.
  4. Intensive search was continued and interviews were conducted with all personnel thought to have knowledge of the units.
  5. All areas were searched again by different search teams on October 22-26.

## RESPONSIBILITY FOR PLACEMENT AND ACCOUNTABILITY OF NAD UNITS

Nuclear accident dosimeters were first deployed at ORGDP in 1958. After reworking the units to make them more fire-resistant, a total of forty-five (45) NADs were deployed by personnel in the Health Physics Department. The locations were documented as shown in Appendices "II-F" and "II-G."

There is no documentation of the assignment of responsibility for deploying or for accounting for these NAD units. The Health Physics Department became the lead organization with participation by many other groups in the acquisition, up-grading, and deployment of the NAD units. Since the final placement of the NADs, it has been generally understood that the Health Physics group was in charge of locating, accounting for, modifying, and retrieving the NADs.

There are no written procedures for handling, maintaining, transferring, and periodically inventorying the NADs as property items, instruments, or safety devices.

The source and special nuclear material (SS material) contained in the fission foils of the NADs is not carried in the SS material inventory. The SS material in the 45 NAD units at ORGDP was correctly written-off of the material inventory at the Y-12 Plant in 1960 when the fission foil capsules were sealed in the stainless steel pod. The fabricated pods were then transferred to ORGDP as identifiable property items (instruments), and entered in the inventory and accountability system established for such items rather than in the SS materials accountability system.

The Investigating Committee recognizes that this approved inventory write-off procedure is an accepted nuclear material control practice. It avoids the duplicating of the inventory listing and reporting functions and establishes an item accountability concept for sealed sources such as the NADs.

AEC Manual Chapter 0545, "Nuclear Accident Dosimetry Program," establishes the requirement that nuclear accident dosimeters be utilized to aid in the determination of the radiation dose of personnel who may be exposed as a result of an accident involving critical masses of fissionable material. The manual chapter does not require that units deployed within a facility be periodically checked to assure their presence, integrity, and ability to function.

POSSIBLE MECHANISMS FOR THE MATERIAL LOSS

The possible mechanisms for the material loss considered and evaluated by both ORGDP and the Investigating Committee include the following:

1. Removal From Plant Site

- a. Deliberate action.
- b. Inadvertent action.
  - 1) Burial at Y-12 .
  - 2) Included in scrap sold as contaminated scrap.
  - 3) Shipped to Paducah in aluminum scrap bundles.

2. Retention On Site

- a. Unknown assignment to new location.
- b. Undocumented disposition to storage.
- c. Inadvertent burial.

Other than theft, deliberate action is not a likely mechanism for removal of any of these units from the plant site. Theft of any one of the missing units cannot at this time be conclusively proven or denied. Based on interviews conducted by ORGDP management with many personnel who had knowledge of these units, no likely reason for deliberate removal could be determined, nor could any suspect individuals be identified.

Several reasons why deliberate removal is unlikely can be given. The areas where the NADs were located are within the ORGDP limited security area. The K-1420 area is separately fenced within the limited security area and is locked during off-shifts; access during off-shifts is electronically controlled after personal recognition by a guard at a nearby guard post; personnel and vehicular traffic in this area is minimized because of the nature of the operations and the material handled. Visits to the areas by other plant personnel are infrequent; all off-area visitors are escorted.

In evaluating the inadvertent loss mechanisms for the NADs, both on-site and off-site, the activities in the areas where the NADs were located were examined. All NADs were known to be in their

correct location in May 1966. The missing NADs in the K-1420 Building were not found in their correct locations in January 1971, during a limited check of that area only, and were determined missing in October 1973. The NAD in K-303-8 was not known to be missing until October 1973. Each NAD was examined separately with respect to loss mechanisms.

#### NAD 132

The fission foil pod is missing from this NAD, the rest of the unit is intact. It is possible that the steel wire open-loop attaching the pod to the horizontal cross-member (paddle) corroded and the pod fell to the floor, or in the trash container directly beneath it. Appendix "II-C" shows the condition of the remaining wire-loop that supports the can assembly, and Appendix "II-D" shows the remainder of the unit in position and the trash container directly beneath. If found on the floor, it is very likely that the pod would have been thrown in the trash can and subsequently buried in the K-1420 burial ground. This NAD location is adjacent to the small parts disassembly and decontamination area where small metal items of the general size and shape of the pod are very commonplace and subject to disposal.

During the period 1966-1970, classified aluminum scrap was bundled and shipped to UCC-ND, Paducah, Kentucky, for smelting. There is a remote possibility, since the aluminum scrap assembly area is on the first floor of Building K-1420, that the pod could have commingled with aluminum scrap and became part of a bundle. The pod has not been found in the smelting area or slag pit at Paducah. The operating temperature of the aluminum smelter is far below the melting point of stainless steel.

Since part of this NAD was found in place on October 8, 1973, it is unlikely that the pod only would be assigned to another NAD location. There has been no major renovation or replacement of equipment in this area of Building K-1420 since 1964.

The Committee feels the most likely loss mechanism for this NAD is inadvertent burial on-site in the K-1420 burial area.

#### NAD 110

This entire NAD assembly is missing, and it is possible that it was moved to an undocumented location. This investigation revealed that there have been both documented and undocumented movements of the NADs within the plant. However, a search of all areas to which an NAD would likely or possibly be moved failed to locate the NAD.

NAD 110 (Continued)

The "H" area in K-1420 is adjacent to a chemical processing area and the atmosphere is corrosive. The soft iron-hook or supporting chain could have corroded and failed, causing the NAD to drop to the floor. Appendices "II-C" and "II-E" show these parts in detail and indicate some corrosion.

If found on the floor, the unit could have been placed in the nearest empty container which, unless labeled otherwise, would be transferred to a uranium storage or empty storage drum area.

The unit would more likely have been placed in a solid waste container and subsequently disposed to the K-1420 burial ground. It could have also been placed in a combustible waste disposal container, in which case the unit would have been hand-picked and disposed to burial, or it would have remained with the incinerator ash. The incinerator ash from the K-1420 material is screened, sampled, and analyzed prior to recovery of the uranium values, or buried at K-1420 if it is not economically feasible to recover the uranium.

Part of the search effort included checking all likely containers in all storage areas, including those considered empty and no NAD has been found. The various paths that the NAD could have followed to the burial pit are considered more likely events. If the fission foil pod had been breached in the incinerator, the routine health physics surveys of the incinerator area would have detected at least the plutonium residue. The operating temperature of the incinerator is below the melting point of stainless steel.

During 1968 and 1969, electric conduit was replaced in "H" area as part of the renovation of the electrical system. It is possible, but not likely, that the NAD could have become entangled in the scrap conduit when it was removed. The renovation work was done by ORGDP craftsmen over a long period of time, and only small amounts of conduit were removed at any one time. Based on discussions between ORGDP management and the electricians who performed the work, all the scrap conduit was hand-carried by them to the ground floor from the mezzanine, and they felt they would have noticed any item as distinctive and bulky as a NAD.

This scrap conduit was hand-loaded by Carbide personnel and taken to the contaminated material scrap yard where it was unloaded by hand. ORGDP records show that this conduit was sold as a part of over 200 tons of contaminated scrap. According to ORGDP management, the conduit from K-1420 was probably less than 1 ton, and was included in one of five sales that occurred in September and October 1969, and in January, February, and March 1970.

Three Carbide representatives, who were familiar with the conduit removed from K-1420, went to the licensed scrap dealer's salvage yard and talked with the operator, who indicated where the 200 tons of scrap from ORGDP was located as part of a large pile, approximately 150 yards long, 80 feet wide, and 60 feet high. No evidence of the conduit was found.

The salvage yard operator was given a general (gross) description of the lost NAD without detailing contents or intended use. He stated that the item was not likely to be in the pile because all contaminated scrap is hand-picked at the place it is purchased, and again when it is unloaded. This is done to prevent anything like a gas cylinder from being smelted.

Other scrap material accumulated during this renovation of the electrical system in K-1420 was taken to the ORGDP quarry for disposal. The unloading area at the quarry has been searched, and no evidence of the NAD was found. There has been no other known major renovation or movement or replacement of other equipment in or near the "H" area of K-1420 since 1966.

It is the opinion of the Investigating Committee that the most likely loss mechanism for this NAD is by inadvertent burial in the K-1420 classified burial ground. Burials at K-1420 are not documented as to time of discard or source of the scrap material.

#### NAD 125

The office complex in unit K-303-8, where this NAD was located, was completely renovated between February and December 1969. The assigned location of this NAD no longer exists, having been covered by a new wall. The contractor who performed the renovation work was questioned by ORGDP management and could provide no information concerning the NAD. According to the contractor, and this was confirmed by ORGDP personnel, all scrap from this renovation was discarded and buried in the UCC-ND, Y-12 Plant burial ground. Any material placed in a "dumpster" in a clean area at ORGDP is disposed of in the Y-12 landfill. No scrap material from renovation of the type that occurred in K-303-8 has ever been placed on bid for sale.

Questioning by ORGDP management of personnel working in the K-303-8 area revealed that the unit was seen hanging on a clothes rack in the hallway during and possibly after the completion of the renovation, but no specific dates could be established. Extensive searches have been made of the safes, cabinets, and other furnishings in this area, as well as furnishings that have been moved to a storage warehouse or out of the area. It is possible that this NAD was relocated by an undocumented movement to another location in the plant.

NAD 125 (Continued)

The Investigating Committee is of the opinion that this NAD may be on the ORGDP premises in an undocumented location or perhaps hidden in office furniture or other locations. The most likely mechanism for loss of this item, however, is inadvertent disposal to a burial pit at ORGDP or the UCC-ND, Y-12 landfill.

ACTIONS TO PREVENT FURTHER LOSS OF MATERIAL

All remaining NAD assemblies (42 units) have been retrieved and are in secure storage. Secondary dosimeters that contain only non-hazardous materials have been deployed in their place. Discussions are being held to determine whether or not this type of dosimeter meets the requirements of Manual Chapter AEC-0545, "Nuclear Accident Dosimetry Program."

Specific plans are being formulated to assure that NADs are included in a surveillance and reporting system that requires periodic checking of NADs as safety devices.

FINDING OF FACT

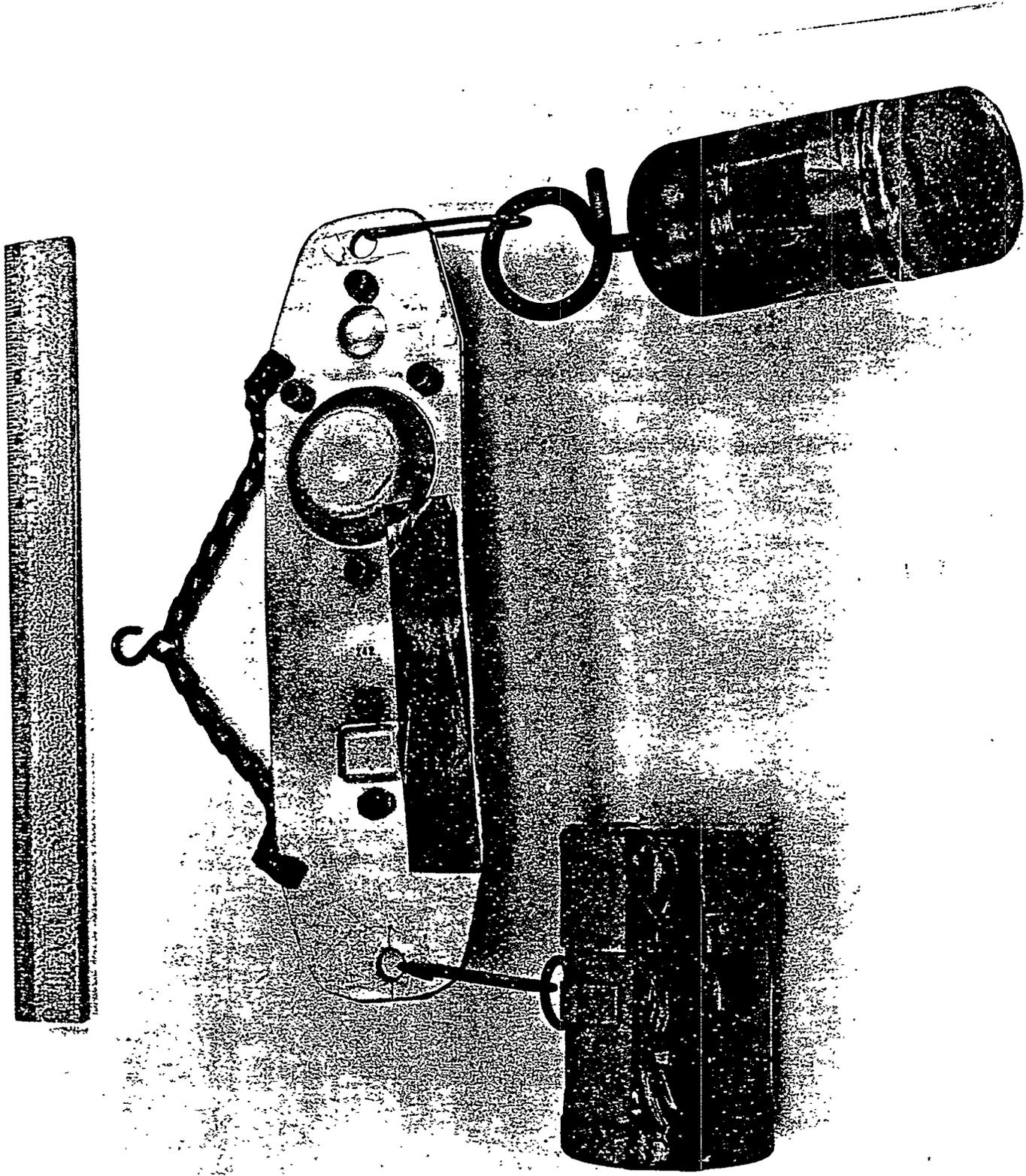
Based on observations, reviews of pertinent records, and discussions with ORGDP personnel associated with or having knowledge of the occurrence, the Investigating Committee believes the following to be the major pertinent facts regarding the occurrence: .

1. The nuclear accident dosimeters (NADs) deployed at ORGDP were last known to be in their assigned locations in May 1966.
2. Three NAD units, Numbers 110, 132, and 125 were not found during the taking of inventory on October 8, 1973, and were reported to the Oak Ridge Operations Office as missing items on October 9, 1973.
3. Four NADs, Numbers 110, 141, and 156, and the fission foil pod from Number 132, were not found in their assigned locations in K-1420 in January 1971, during a replacement of the phosphate-glass rods in the secondary dosimeter section (can) of the NADs located in K-1420 only. NAD units Numbers 141 and 156 were subsequently found during the October 8, 1973, inventory.
4. The fission foils in the three missing NADs contain the following materials:

<u>Serial Number</u>	<u><math>^{239}\text{Pu}</math></u>	<u><math>^{237}\text{Np}</math></u>	<u>U(Depleted)</u>
110	0.9979 g.	0.0972 g.	5.309 g.
125	1.0027 g.	0.1054 g.	5.312 g.
132	<u>1.0037 g.</u>	<u>0.1015 g.</u>	<u>5.314 g.</u>
Total	3.0043 g.	0.3041 g.	15.935 g.

5. The NADs are not identified as containing radioactive material nor are the locations placarded or distinctively marked.
6. Responsibility for periodically assuring that the NADs are in their assigned locations and capable of performing their intended function has never been formally documented at ORGDP.
7. Extensive, and thorough searches were initiated October 9, 1973, and included all likely places where the missing NADs might have been located.
8. The missing NADs could have entered the public domain by theft and/or less likely, as part of the contaminated scrap metal sales.

9. Deliberate disposals of other than salvageable scrap or refuse are made only to burial pits or landfills on-site under the control of UCC-ND.
10. The stainless steel fission foil container could be breached with moderate effort and ordinary tools.
11. The plutonium content of the forty-five (45) NADs was not recorded in the SS material inventory since the material had been authorized as an approved inventory write-off prior to receipt of assembled units at ORGDP.
12. The NADs were located and positioned so as to be easily retrievable in case of a nuclear criticality accident.
13. The missing NADs have not been located.

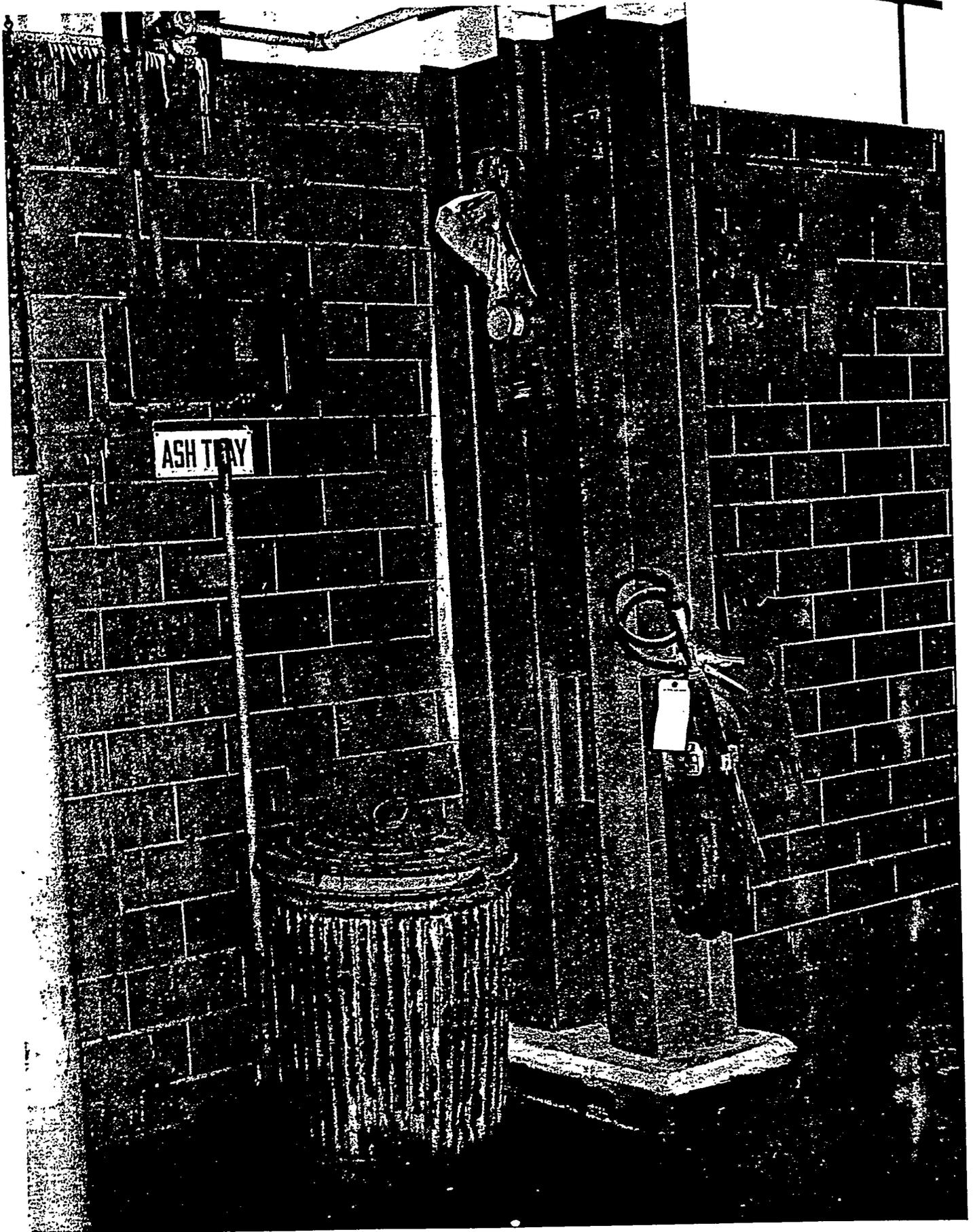


APPNDIX II-A - Nuclear Accident Dosimeter (NAD) Assembly  
Fission Foil Pod Shown on the Right

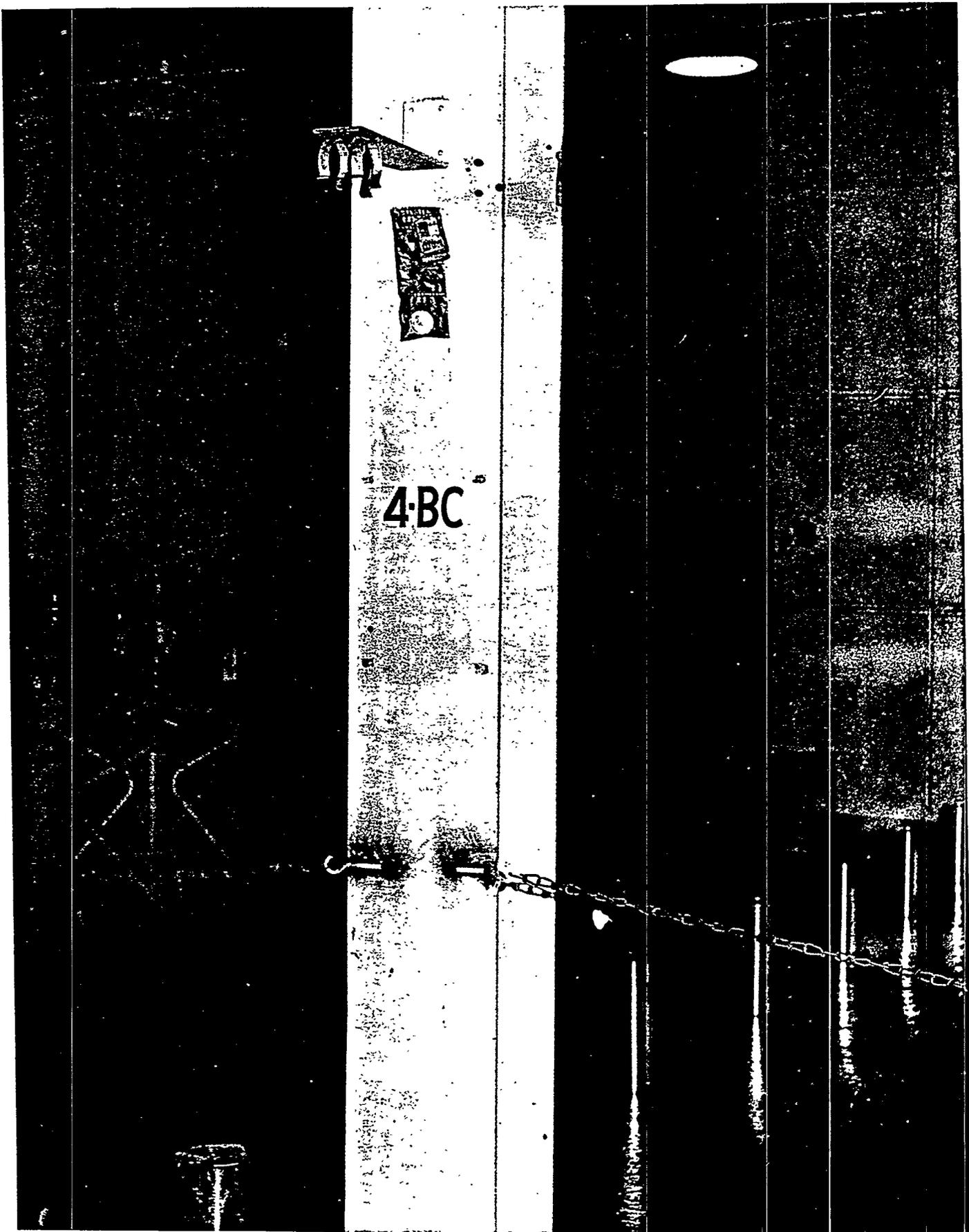


APPENDIX II-B - View of Paddle and Can of NAD-132 In Place in K-1420

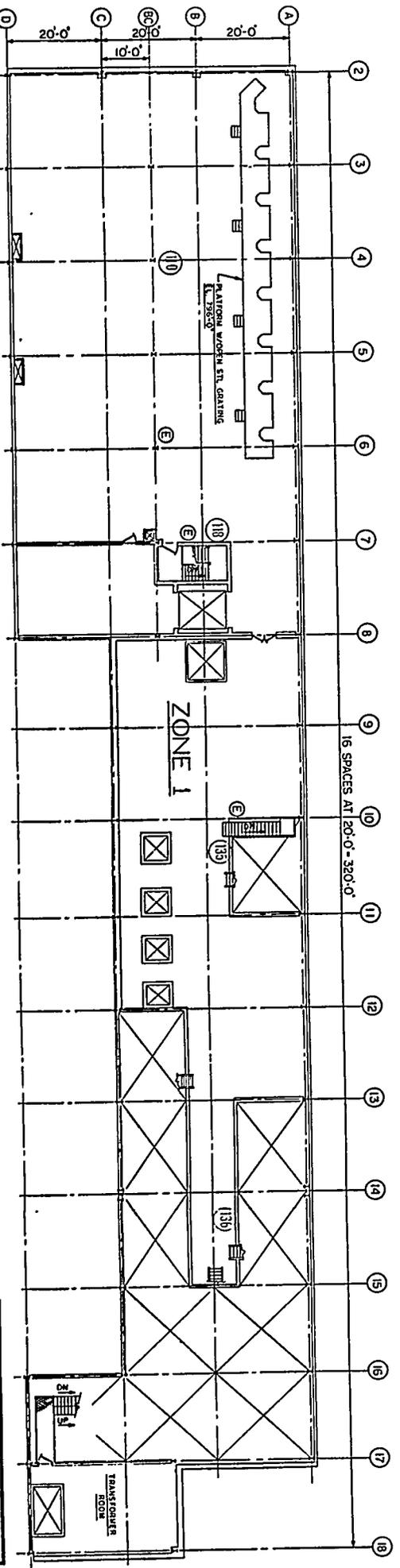
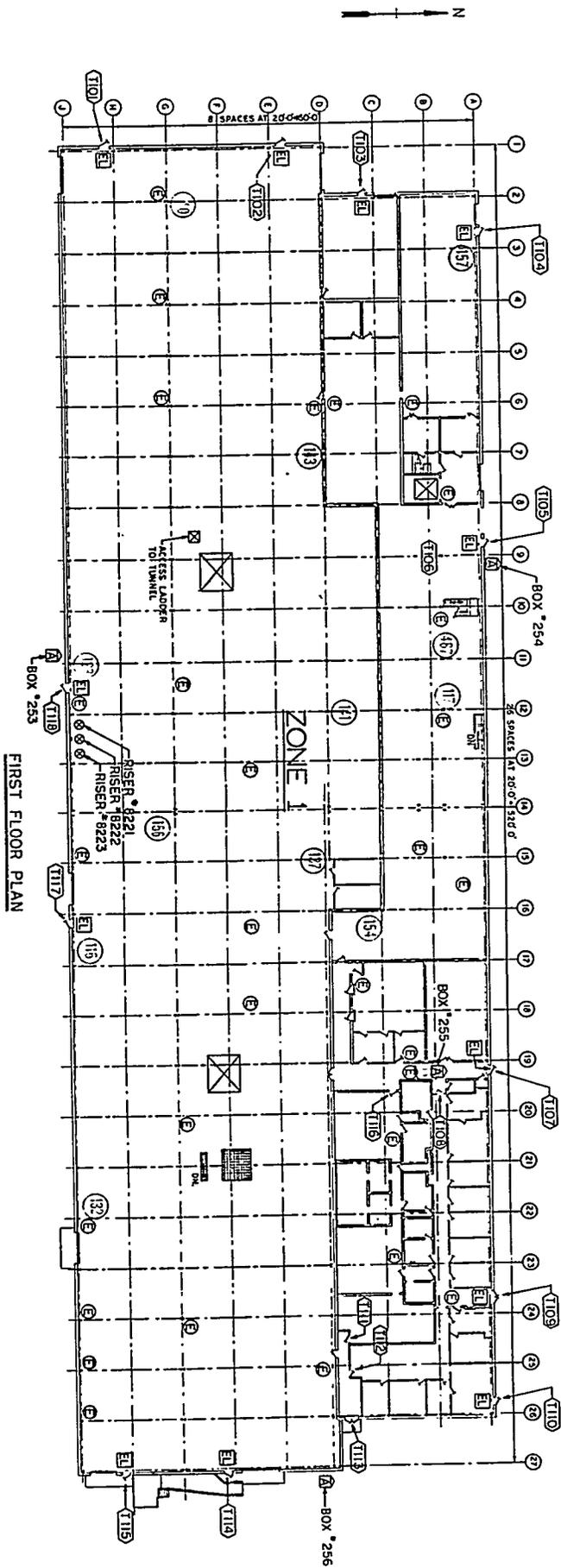




APPENDIX II-D - View of NAD-132 Showing Surrounding Area

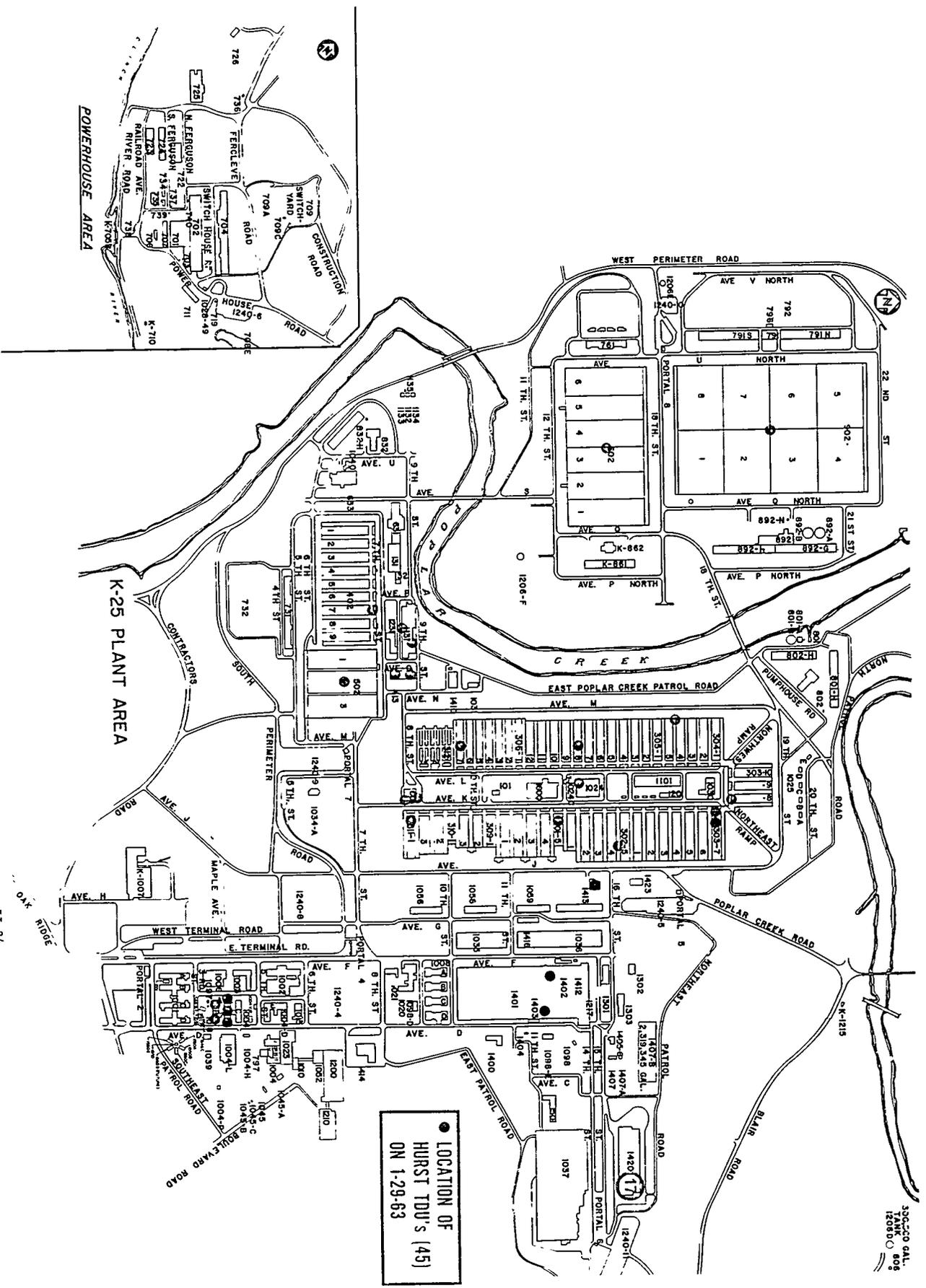


APPENDIX II-E - Shows the Bracket From Which NAD 110 Was Suspended  
And the Surrounding Area



LOCATION OF HURST TDU'S (17)  
IN K-1420 ON 1-29-63

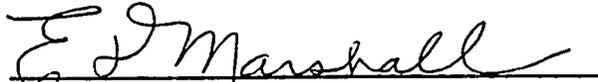
APPENDIX II-C - Map Showing Assigned Locations of MADS (TDUs) in ORGDP II-24

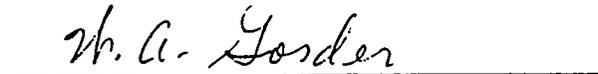


● LOCATION OF  
HURST TDUs (45)  
ON 1-29-63

300,000 GAL.  
12000' 800'

SIGNATURES OF INVESTIGATING COMMITTEE

  
E. D. Marshall, Chairman  
ORO, Materials Management Division

  
W. A. Gorder  
ORO, Security Division

  
T. M. Jelinek  
ORO, Safety and Environmental  
Control Division

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PART II

INVESTIGATION OF LOSS OF MATERIAL  
OCCURRENCES AT:

OAK RIDGE NATIONAL LABORATORY  
OCTOBER 5, 1973

OAK RIDGE GASEOUS DIFFUSION PLANT  
OCTOBER 9, 1973

(DRAFT CONCLUSIONS AND RECOMMENDATIONS OF  
INVESTIGATING COMMITTEE)

Oak Ridge K-25 Site  
Oak Ridge, Tennessee 37831-7314  
managed by  
MARTIN MARIETTA ENERGY SYSTEMS, INC.  
for the U.S. DEPARTMENT OF ENERGY  
under Contract DE-AC05-84OR21400

This document has been approved for release  
to the public by:

*Ann D. Swift* 5/4/95  
Technical Information Officer Date  
Oak Ridge K-25 Site *(B)*

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PART II

DRAFT CONCLUSIONS AND RECOMMENDATIONS OF  
INVESTIGATING COMMITTEE

INVESTIGATION OF LOSS OF MATERIAL  
OCCURRENCES AT:

OAK RIDGE NATIONAL LABORATORY  
OCTOBER 5, 1973

AND

OAK RIDGE GASEOUS DIFFUSION PLANT  
OCTOBER 9, 1973

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INTRODUCTION

This Part II contains the conclusions and recommendations of the Investigating Committee for the loss of material occurrences at:

Oak Ridge National Laboratory  
October 5, 1973

And

Oak Ridge Gaseous Diffusion Plant  
October 9, 1973

The summary and conclusions for each occurrence are given separately.

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LOSS OF MATERIAL OCCURRENCE

OAK RIDGE NATIONAL LABORATORY

SUMMARY

Nuclear accident dosimeters (NADs) were installed at selected locations throughout the Oak Ridge National Laboratory (ORNL) in 1958 to provide an assessment of personnel radiation exposure from accidental nuclear criticality. ORNL is operated by Union Carbide Corporation, Nuclear Division, under a prime contract with the Atomic Energy Commission. The dosimeters first employed contained plutonium, neptunium, and uranium foils within a boron carbide ball inside a soft-soldered copper can. These units were modified because of the concern of release of the fission foil materials to the Laboratory environment in the event of fire.

The modification resulted in units designed to withstand the Underwriter Laboratories four-hour fire test, and involved the encapsulation of each of the fission foils in a 10 mil thick seam-welded stainless steel capsule. The fission foil capsules are located in a cavity in the boron carbide inner sphere and assembled in a thick stainless steel bolted sphere. Seventy-three NADs were used at ORNL facilities, including those located at the ORNL facilities at the Y-12 Plant. Units were either hung on building support structures or were placed in tubes located so that retrieval of the unit could be accomplished from outside the building. The units which were placed in tubes were marked with signs identifying the unit with instructions "Do Not Tamper."

During September 1973, an ORNL employee at the Y-12 Plant requested the Health Physics Division to replace a sign near one of the NAD locations because the sign had weathered severely. This request prompted ORNL to inspect the signs at other NAD locations to assess the need for replacement. The employee assigned this task took it upon himself to check the presence and condition of the NADs. Late on October 4, 1973, the NAD (Number 14) which had been located in a tube on the west side of Building 3012, Rolling Mill, was not found in the documented location. A report of the missing unit was made to the AEC on October 5, 1973.

On October 5, 1973, all remaining NADs at the ORNL site were retrieved and brought to a central location. The NADs at the ORNL(Y-12) locations were similarly retrieved on October 9, 1973. Each unit was opened and the presence of the fission foil capsules physically verified. No discrepancies were noted.

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An extensive search for the missing unit was conducted beginning on October 5, 1973, in the area of the Rolling Mill. The search was expanded and intensified on October 8, 1973, to include the entire ORNL plant site. All personnel thought to have knowledge of the missing unit were interviewed during the period October 5, 1973, to October 10, 1973.

A review of the Health Physics Division records revealed that the last time the missing unit was known to be in its assigned location was in April 1970.

Two health physics technicians recall having their attention directed, in the spring or summer of 1973, to an object which they now describe as an NAD in a burial pit. Extensive efforts began immediately to sort through burial ground records, time-keeping records, shift schedules, etc., to determine the most likely date and the specific location where the technicians could have seen the device. Excavation of suspect areas of the burial ground began immediately.

A Committee was appointed by AEC-ORO management to investigate the circumstances surrounding this loss of material. The investigation revealed that adequate procedures for verifying the physical presence of these units on a reasonably frequent basis were not implemented, and the loss of the NAD was not detected in a reasonable time frame.

This part of the investigation report (Part II) contains the conclusions and recommendations of the Committee.

Part I gives a detailed description of the nuclear accident dosimeters, the chronology of events, the possible mechanisms for the loss, and the actions taken to prevent further loss.

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LOSS OF MATERIAL OCCURRENCE

OAK RIDGE NATIONAL LABORATORY  
OCTOBER 5, 1973

CONCLUSIONS

1. The loss of the nuclear accident dosimeter (NAD) was not detected in a reasonable time frame. NAD Number 14 was last known to be at its assigned location in April 1970, and was reported missing on October 5, 1973.
2. The loss, once detected, was reported promptly to contractor management, Oak Ridge Operations Office, and AEC Headquarters.
3. Appropriate practices and procedures that require a monthly physical check and to assure that identifiable components of the SS material inventory had not been misappropriated or lost were not followed.
4. Actions taken to locate the missing NAD, or document its disposition, were prompt, thorough and sustained.
5. No mechanisms except for deliberate theft, have been identified by which the NAD could have entered the public domain.
6. The most likely disposition of the NAD is burial at the ORNL controlled burial ground. This conclusion is based on the recollection of two health physics technicians that they viewed a similar item in an ORNL burial pit during the spring or early summer of 1971.
7. The requirement that NADs must be visible and accessible in order to serve their purpose while at the same time requiring that they be protected against unauthorized removal, presents a dilemma that can be resolved by using NADs containing only non-hazardous materials.
8. The NADs are not adequately labeled to indicate that they contain hazardous material.
9. Manual Chapter AEC-0545, "Nuclear Accident Dosimetry Program" does not require that periodic checks be made to assure that NADs deployed within a facility are present and capable of performing their intended function.
10. The fission foils can be removed from the NAD with ordinary tools and little effort.
11. NAD Number 14 has not been located nor has its disposition been documented.

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LOSS OF MATERIAL OCCURRENCE

OAK RIDGE GASEOUS DIFFUSION PLANT  
OCTOBER 9, 1973

SUMMARY

Nuclear accident dosimeters (NADs) were installed at selected locations throughout the Oak Ridge Gaseous Diffusion Plant (ORGDP) beginning in 1958 to provide an assessment of personnel radiation exposure in the event of a nuclear criticality accident. ORGDP is operated by Union Carbide Corporation, Nuclear Division, under a prime contract with the Atomic Energy Commission.

The NADs first deployed in the ORGDP contained fission foils of plutonium, neptunium, and uranium (depleted) in assemblies that were later determined not to be sufficiently fire resistant. These units were modified, beginning in 1960, because of the concern of the release of fission foil material to the facility environment in the event of fire.

The modifications resulted in the deployment of units designed to withstand the Underwriter Laboratories four-hour fire test. The principle changes involved encapsulating the fission foils in 0.010 inch thick, seam-welded, stainless steel capsules. The resulting disks are approximately one inch in diameter and 0.065 inch thick. The fission foil capsules are positioned in the central cavity of a Boron-10 carbide sphere two inches in diameter, and the subassembly welded in a stainless steel can 0.109 inch thick.

Forty-five (45) of the modified NAD units were deployed in selected locations in the ORGDP during the period 1960 to 1963. The units were placed so that they would be easily accessible and could be removed from an area by personnel exiting in the event of an emergency. None of the units were deployed in the tube configuration for retrieval from outside the building.

As a result of the loss of a nuclear accident dosimeter at Oak Ridge National Laboratory on October 5, 1973, ORGDP, Y-12, and Paducah were requested to inventory the NADs assigned to them. All other installations under ORO jurisdiction were requested to inventory on October 9, 1973, all nuclear accident dosimeters and similarly deployed instruments containing hazardous materials. The inventory taken on October 8, 1973, at ORGDP indicated that there were three NADs that could not be accounted for, and they were reported as missing items on October 9, 1973.

Two of these missing NADs, Numbers 110 and 132, had been assigned to Building K-1420, Chemical Operations; the third NAD, Number 125, had been assigned to Unit K-303-8 of the K-25 Building.

An extensive plant-wide search was initiated on October 9, 1973. All personnel thought to have knowledge of the missing units were interviewed. A review of the records associated with deployment of the NAD units indicated that the last time the missing units were known to be in their assigned location was in May 1966. Four NAD units, Numbers 110, 141, and 156, and the fission foil container only from NAD Number 132, were not found in their assigned locations at the K-1420 Building in January 1971, during a check of the secondary dosimeter sections of the NADs in K-1420 only.

A Committee was appointed by AEC-ORO management to investigate the circumstances surrounding this loss of material. The investigation revealed that there were no adequate procedures for identifying the physical presence of these units on a reasonably frequent basis; that the loss of the NAD was not detected in a reasonable time frame, and that the NAD units could have entered the public domain by theft. There is some small likelihood that one unit, Number 110, from the K-1420, Chemical Operations Building, could have been included in a contaminated scrap sale. The most likely mechanism by which these three NADs were lost is inadvertent disposal on-site.

This Part II of the investigation report contains the conclusions and recommendations of the Committee.

Part I gives a detailed description of the nuclear accident dosimeters, the chronology of events, the possible mechanisms for the loss, and the actions taken to prevent further loss.

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LOSS OF MATERIAL OCCURRENCE

OAK RIDGE GASEOUS DIFFUSION PLANT

CONCLUSIONS

1. The loss of three nuclear accident dosimeters was not detected in a reasonable time frame. The NADs were last known to be in their assigned locations in May 1966. They were reported missing on October 9, 1973.
2. The loss, once detected, was reported promptly to Oak Ridge Operations Office and AEC Headquarters.
3. Appropriate follow-up action was not taken in January 1971, when four (4) NADs were not found in their assigned locations in Building K-1420.
4. Actions taken subsequent to October 9, 1973, to locate the missing NADs or document their disposition was prompt, sustained and thorough.
5. The NADs are not adequately labeled to indicate that they contain radioactive material, nor are the locations placarded or distinctively marked.
6. The missing NADs could have entered the public domain by theft or, in the case of NAD 110, by inadvertent removal with scrap metal that was sold.
7. The most likely mechanism for the loss of the three NADs is inadvertent disposal on-site. Inadvertent removal with scrap metal that was sold is less likely to have occurred.
8. The fission foil containers in the NADs could be breached with moderate effort and ordinary tools.
9. The requirement that NADs must be easily accessible in order to serve their purpose, while at the same time requiring that they be protected against unauthorized removal, presents a dilemma that can be resolved by using NADs containing only non-hazardous material.
10. Manual Chapter AEC-0545, "Nuclear Accident Dosimetry Program" does not require that periodic checks be made to assure that NADs deployed within a facility are present and capable of performing their intended function.
11. The three missing NADs have not been found.

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10

RECOMMENDATIONS

1. Manual Chapter AEC-0545, "Nuclear Accident Dosimetry Program" should be revised to include a requirement that monthly checks be performed to assure that units deployed within a facility are present and capable of performing their intended function. Assignments of responsibility for deployment and checking should be clearly documented and records of such checks shall be maintained. Reporting of and follow-up action to locate any missing unit should be immediately initiated upon discovery of any unit not found in its assigned location.
2. A review of available technology should be conducted, or new programs initiated, to determine the feasibility of utilizing NADs which do not include hazardous materials as a component.
3. Each NAD containing hazardous materials as a component should be prominently labeled to indicate the presence of such materials.

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11  
UNITED STATES  
ATOMIC ENERGY COMMISSION  
OAK RIDGE OPERATIONS  
P.O. BOX E  
OAK RIDGE, TENNESSEE 37830

AREA CODE 615  
TELEPHONE 405-311

October 11, 1973

E. D. Marshall, Materials Management Division  
T. M. Jelinek, Safety & Environmental Control Division  
W. A. Gorder, Security Division

APPOINTMENT TO INVESTIGATE NAD LOSS AT ORNL AND ORGDP

Pursuant to the requirements of AECM Appendix 0502, you are hereby requested to investigate the loss of Nuclear Accident Dosimeters (NAD) reported to OR by ORNL and ORGDP on October 5, 1973, and October 9, 1973, respectively. The investigation should be conducted and a report prepared following the guidelines of Appendix 0502 for Type A occurrences. Your final draft report is requested in my office by November 1, 1973.

Mr. E. D. Marshall is designated chairman of the investigating committee and Mr. K. D. McCasland will serve as legal advisor to the committee.

A handwritten signature in cursive script that reads "James H. Hill".

James H. Hill  
Assistant Manager for Operations

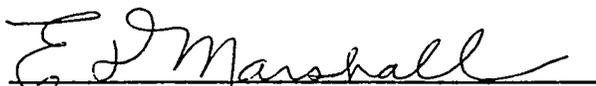
OSH:WTT

cc: C. W. Hill, OCC  
J. A. Lenhard, R&TS  
J. S. Denton, Security  
E. L. Keller, Mtls. Mgmt.  
C. A. Keller, UEO  
L. M. Brenner, NUMS, HQ  
W. H. Travis, S&EC

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APPENDIX A

SIGNATURES OF INVESTIGATING COMMITTEE



E. D. Marshall, Chairman  
ORO, Materials Management Division



W. A. Gorder  
ORO, Security Division



T. M. Jelinek  
ORO, Safety and Environmental  
Control Division

ChemRisk/Shonka Research Associates, Inc., Document Request Form

Item #4

(This section to be completed by subcontractor requesting document)

Requestor J. Lamb / 10347 Document Center (is requested to provide the following document)

Date of request 8/18/95 Expected receipt of document 9/15/95

Document number KADA <sup>none</sup> 1440 Date of document ~~1959-1964~~ 1959-1964

Title and author (if document is unnumbered)  
Collection of documents regarding the contaminated burial area northwest of the K-33 building (4 items) - see back of request form - please note Item 2 sent to Y-12 (Wiley) for handling 8/30/95

(This section to be completed by Document Center)

Date request received 8/24/95

Date submitted to ADC 8/30/95

Date submitted to HSA Coordinator 8/24/95

(This section to be completed by HSA Coordinator)

Date submitted to CICO 8/30/95

Date received from CICO 9/6/95

Date submitted to ChemRisk/Shonka and DOE 9/6/95

(This section to be completed by ChemRisk/Shonka Research Associates, Inc.)

Date document received \_\_\_\_\_

Signature \_\_\_\_\_

JENNIFER LAMB'S (CHEMRISK) REQUEST DATED 8/18/95  
 (Box II-1-5-26--Collection of Documents regarding the contaminated burial area northwest of the K-33 Building)

Request #1

Item No. and Individual Responsible for Transmittal	Title	Author	Date	Miscellaneous Information Concerning Document Requested	Actions Taken
1 THORNTON	Radioactive Waste Management	C. E. Larson (K-25)	8/13/64	Letter from Larson to S. R. Sapirie (USAEC)	(1) K-25 CICO for classification review and TIO release (3) S. Thornton (K-25) for submittal to ChemRisk
2 WILEY	Radioactive Waste Management	R. F. Hibbs (Y-12)	8/11/64	Letter from Hibbs to Oral Rinehart	(1) Copy sent to S. Wiley (Y-12) for processing and release to ChemRisk/Lamb
3 THORNTON	Establishment of ORGDP Uranium-Contaminated Scrap Disposal Area	C. A. Keller (DOE)	1/21/59	Letter from Keller to A. P. Huber	(1) K-25 CICO for classification review (2) DOE (Stachowiak) for release to ChemRisk (3) S. Thornton (K-25) for submittal to ChemRisk
4 THORNTON	Establishment of ORGDP Uranium-Contaminated Scrap Disposal Area	A. P. Huber (K-25)	1/12/59	Letter from Huber to C. A. Keller (DOE)	(1) K-25 CICO for classification review and TIO release (2) S. Thornton (K-25) for submittal to ChemRisk

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UNION CARBIDE NUCLEAR COMPANY  
DIVISION OF UNION CARBIDE CORPORATION



POST OFFICE BOX F  
OAK RIDGE, TENNESSEE

January 12, 1959

United States Atomic Energy Commission  
Post Office Box E  
Oak Ridge, Tennessee

Attention: Mr. C. A. Keller, Director, Production Division

Subject: Establishment of ORGDP Uranium-Contaminated Scrap Disposal Area

Gentlemen:

At the present time, no facilities exist for the convenient, economic disposal of uranium-bearing scrap materials in the proximity of the Oak Ridge Gaseous Diffusion Plant. It is proposed that permission be granted for the establishment of a disposal yard outside the plant fence to the northwest of the K-33 building as outlined on the attached area plot plan.

The proposed site is not visible from the existing plant perimeter roadways and is located in a geographical position remote from possible public access (see photographs, attached). The only vehicular entrance to the area is by way of a road which has been constructed over a drainage ditch separating this area from other accessible land in the vicinity. It is planned to install a gate at this point to control the area. It is not intended that the area be fenced but, rather, be posted appropriately to limit access.

The scrap materials would be dumped into trenches which would then be recovered with soil. The disposal of contaminated scrap would be campaigned in such a fashion that no material would be exposed in an uncovered trench for any significant period of time. The area would be carefully administered to prevent unauthorized burial activity, and adequate records and burial markers would be maintained. Careful control would be exercised in connection with any possible nuclear hazards.

At the present time, the ORGDP holds on inventory for disposal 105,189 pounds of scrap, containing 2434.1 kilograms of uranium and 11.6 kilograms of uranium-235. This material is in 1033 containers and has an average uranium-235 assay of 0.48 percent. It is proposed that these containers be intermixed in burial so that the average uranium-235 assay would be in the depleted range.

No barrier or other classified materials would be buried in this area. A strict interpretation of the USAEC physical security standards, AEC appendix 2401-07-A, could possibly place the scrap material in the Confidential classification; however, it is our opinion that security would not be compromised in any way if the scrap were buried in the area as outlined.

OFFICIAL USE ONLY

Union Carbide Nuclear Company, Oak Ridge Gaseous  
Diffusion Plant, Operating Contractor for the U.S.  
Atomic Energy Commission.

This document has been approved for release  
to the public by  
*Thomas W. Sullivan* AS Sullivan  
Technical Information Officer  
Oak Ridge K-25 Site  
Date 9/1/65

OFFICIAL USE ONLY

USAEC

-2-

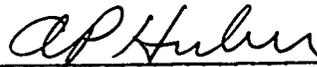
January 12, 1959

It is estimated the area can be established as described at a cost below \$1000 for general grading, a gate, signs, and burial markers. Excavating would be accomplished with a bulldozer and it is estimated that the burial of the existing 1033 containers can be accomplished for substantially less than \$500.

In view of the obvious economies of disposing of this material in the immediate proximity of the plant and the lack of security problems and/or health hazards for these low-activity wastes, it is recommended that permission be granted for the establishment of the subject disposal area. Early action in this matter will save significant expenditures in terms of disposal at alternate burial yards.

Very truly yours,

UNION CARBIDE NUCLEAR COMPANY



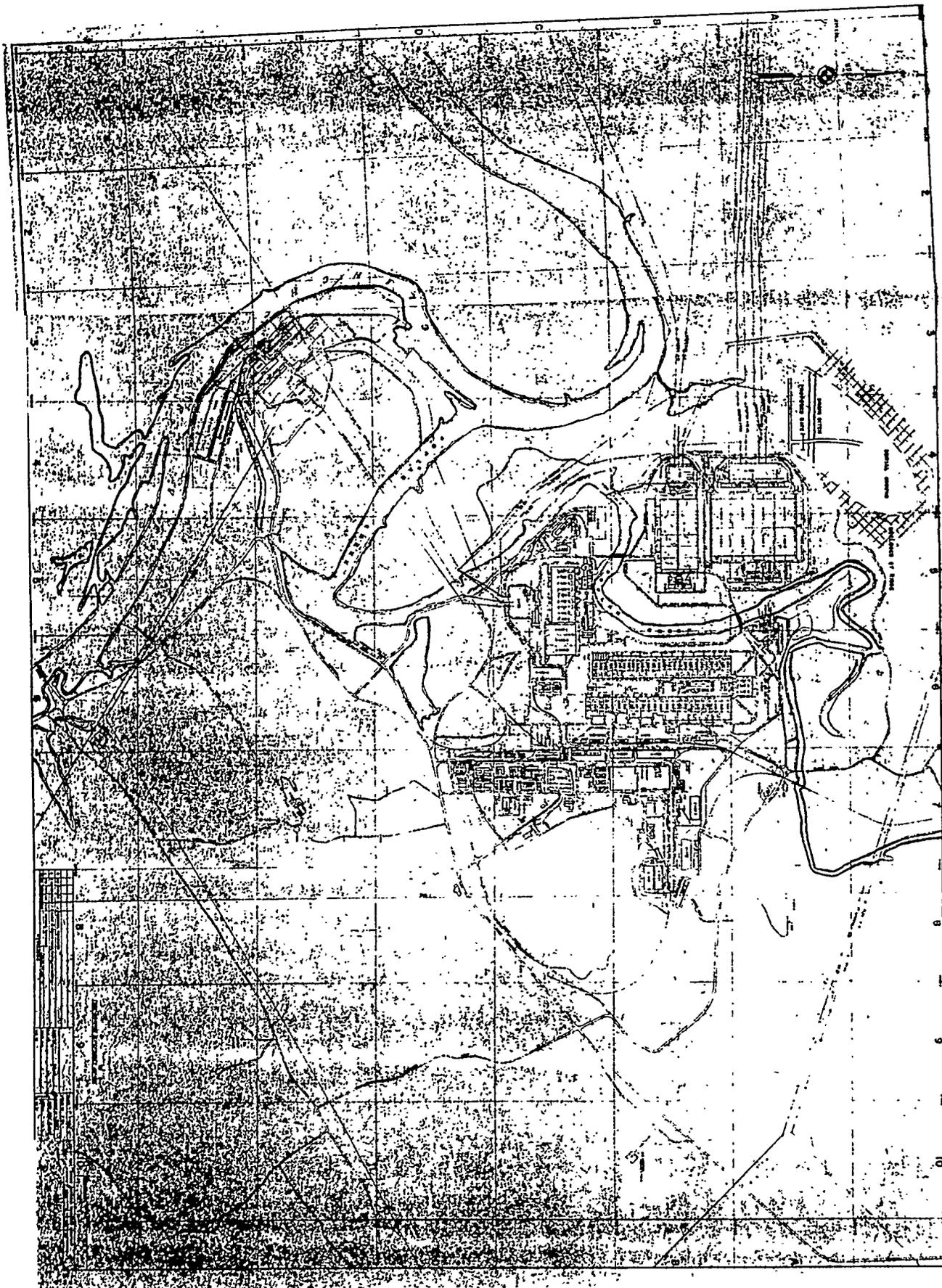
A. P. Huber, Plant Superintendent  
Oak Ridge Gaseous Diffusion Plant

APH:vtd

USAEC

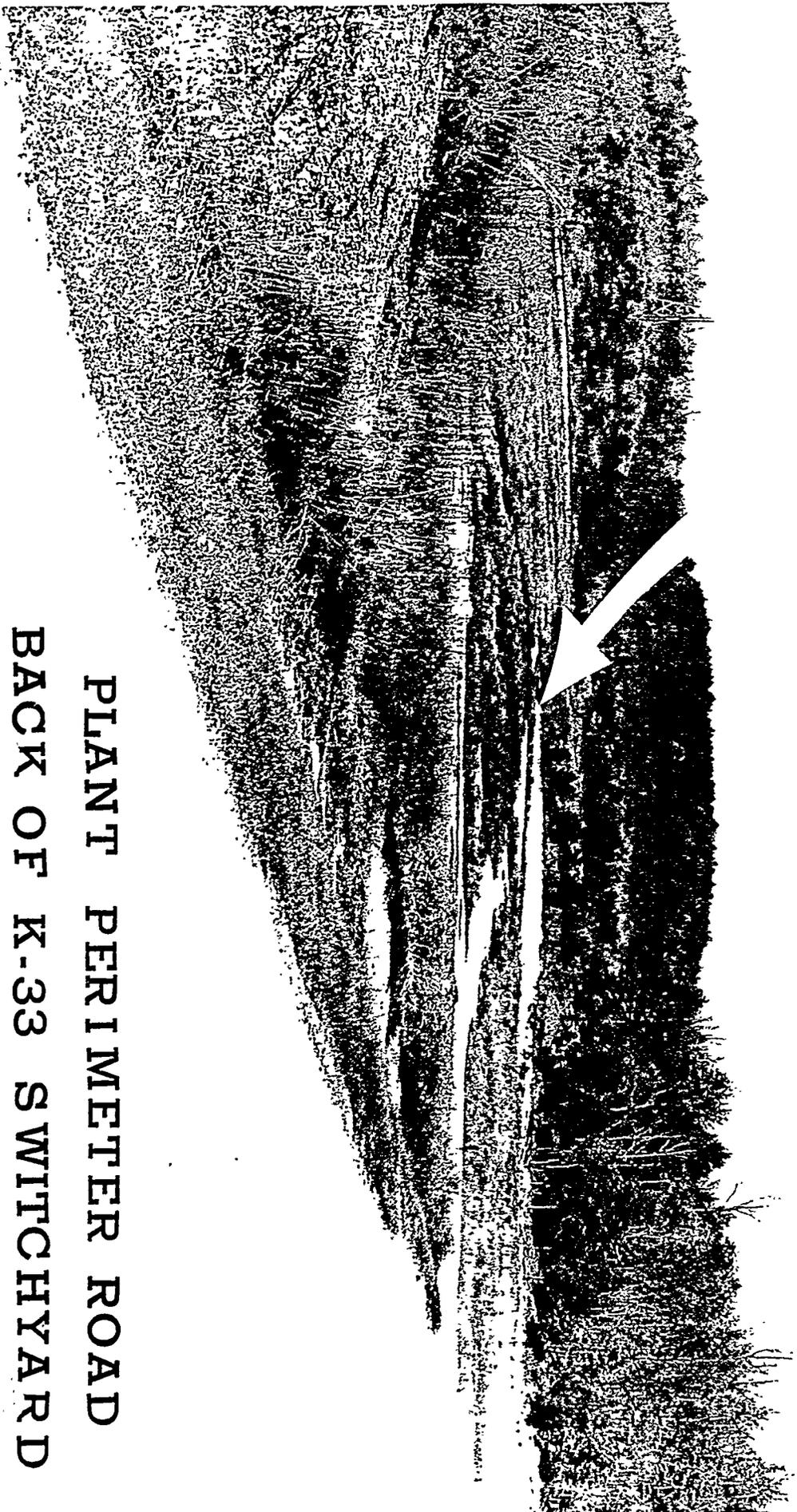
cc: Mr. K. W. Bahler  
Mr. C. E. Center  
Mr. L. B. Emlet  
Mr. W. H. Hildebrand  
Mr. J. A. Parsons  
Mr. M. F. Schwenn  
File

OFFICIAL USE ONLY



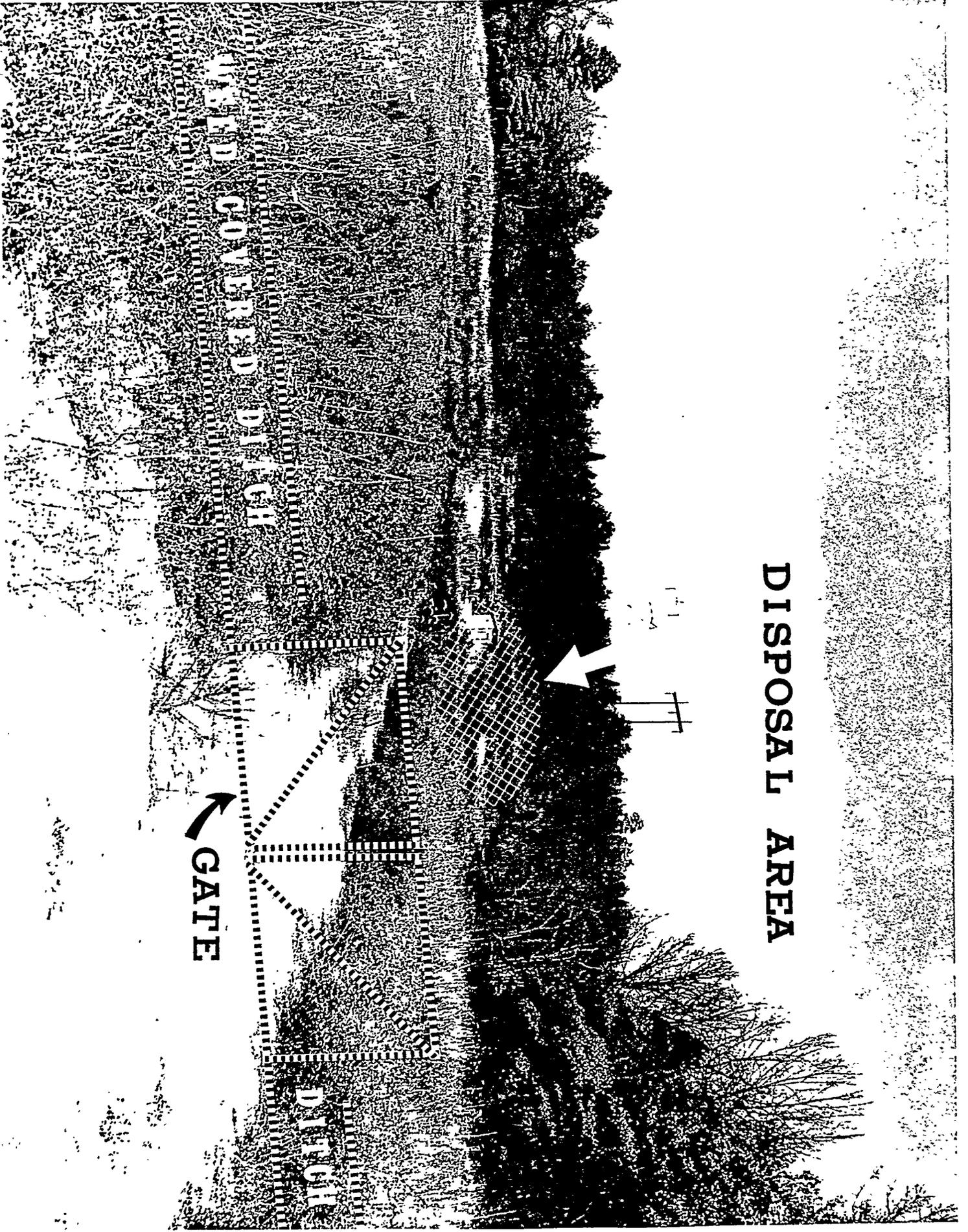
ACCESS ROAD TO  
DISPOSAL AREA -  
GATE WILL BE HERE

DISPOSAL AREA  
WILL BE BACK  
OF THIS RIDGE



PLANT PERIMETER ROAD  
BACK OF K-33 SWITCHYARD

# DISPOSAL AREA

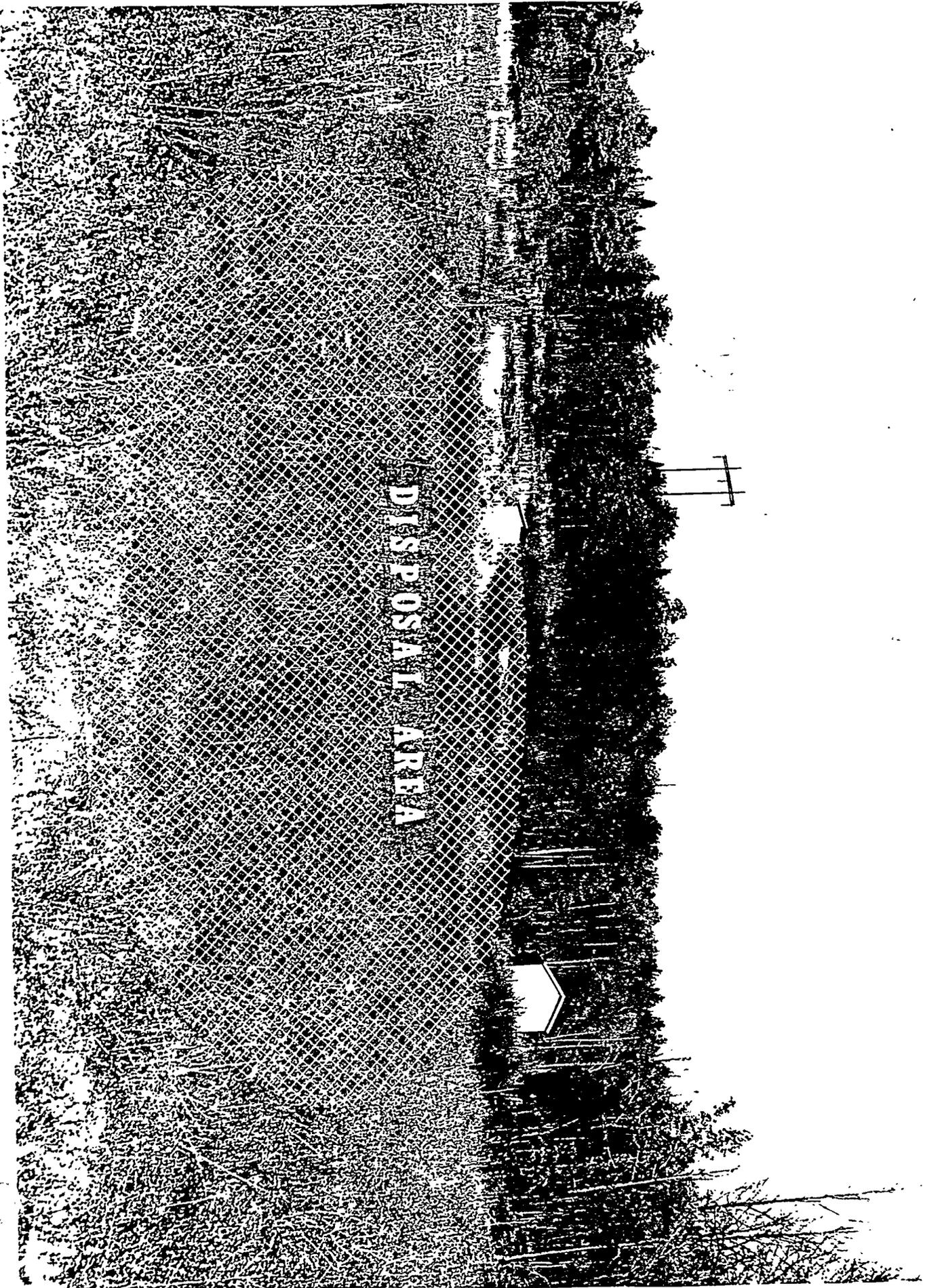


GATE

DISPOSAL AREA

DISPOSAL AREA

DISPOSAL AREA



ChemRisk/Shonka Research Associates, Inc., Document Request Form

Item #3

(This section to be completed by subcontractor requesting document)

J. Lamb 1 1034A  
Requestor Document Center (is requested to provide the following document)

Date of request 8/18/95 Expected receipt of document 9/15/95

Document number <sup>none</sup> KADA 144A Date of document ~~6/24/60~~ 1959-1964

Title and author (if document is unnumbered)  
Collection of documents regarding the contaminated burial area northwest of the K-33 building (4 items) - see back of request form - please note Item 2 sent to Y-12 (Wiley) for handling 8/30/95

(This section to be completed by Document Center)

Date request received 8/24/95

Date submitted to ADC 8/30/95

Date submitted to HSA Coordinator 8/24/95

(This section to be completed by HSA Coordinator)

Date submitted to CICO 8/30/95

Date received from CICO 9/6/95

Date submitted to ChemRisk/Shonka and DOE 9/6/95

(This section to be completed by ChemRisk/Shonka Research Associates, Inc.)

Date document received

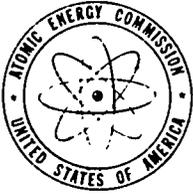
Signature

ChemRisk Document No. 2489 (Pt. 2 of 2)

JENNIFER LAMB'S (CHEMRISK) REQUEST DATED 8/18/95  
 (Box II-I-5-26--Collection of Documents regarding the contaminated burial area northwest of the K-33 Building)

Request #1

Item No. and Individual Responsible for Transmittal	Title	Author	Date	Miscellaneous Information Concerning Document Requested	Actions Taken
1 THORNTON	Radioactive Waste Management	C. E. Larson (K-25)	8/13/64	Letter from Larson to S. R. Sapirie (USAEC)	(1) K-25 CICO for classification review and TIO release (3) S. Thornton (K-25) for submittal to ChemRisk
2 WILEY	Radioactive Waste Management	R. F. Hibbs (Y-12)	8/11/64	Letter from Hibbs to Oral Rinehart	(1) Copy sent to S. Wiley (Y-12) for processing and release to ChemRisk/Limb
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UNITED STATES  
ATOMIC ENERGY COMMISSION

PLANT SUPERINTENDENT  
OAK RIDGE  
cc: KWOB  
with  
JAP  
MPS  
JAN 20 11 22

IN REPLY REFER TO:  
OPO:HJ/c

Oak Ridge, Tennessee  
January 21, 1959

copies: Bahler  
1/27/59 Hildebrand  
Parsons  
Schwenn  
File

Union Carbide Nuclear Company  
Post Office Box P  
Oak Ridge, Tennessee

Attention: Mr. A. P. Huber, Plant Superintendent, ORGDP

Subject: ESTABLISHMENT OF ORGDP URANIUM-CONTAMINATED  
SCRAP DISPOSAL AREA

Gentlemen:

Reference is made to your letter of January 12, 1959,  
on the above subject.

We have reviewed the proposal for the establishment of  
a Uranium-Contaminated Scrap Disposal Area for use of  
the ORGDP and find the selected area northwest of the  
K-33 building and the proposed administrative control  
procedures satisfactory.

It is not believed that the present inventory of materials  
on hand for disposal, consisting of 105,189 pounds of acti-  
vated carbon, alumina, lubricating oil, and miscellaneous  
solutions would be classified as Confidential material under  
AEC appendix 2401-07-A. It is our understanding, however,  
that this area is to be used solely for the disposal of un-  
classified materials, and that the control procedures to be  
followed in the use of the area will preclude any possibility  
of barrier or other classified materials being contained in  
scrap to be buried.

Accordingly, we concur with your proposal to establish the  
subject disposal area and, in addition, since the recovery of  
the contained uranium is not economically feasible, authorize

This document has been reviewed for  
classification and has been determined to  
be UNCLASSIFIED.  
*JMW*  
AEC Signature  
8/31/95  
Date

Approved for Release to the Public  
by:  
*Cathy G. Stachowiak* 8/31/95  
Cathy/G. Stachowiak Date  
DOE K-25 Site Office

Mr. A. P. Huber

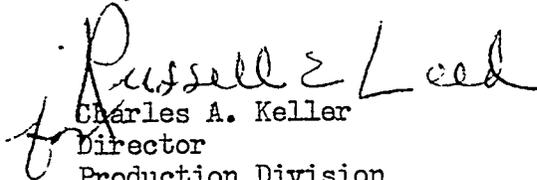
-2-

January 21, 1959

the disposal to this area of the present inventory of 105,189 pounds of scrap, containing 2434.1 kilograms of uranium and 11.6 kilograms of uranium -235.

We are pleased to be of service to you in this matter.

Very truly yours,

  
Charles A. Keller  
Director  
Production Division

CC: Mr. C. E. Center  
Mr. L. B. Emler  
Mr. F. P. Callaghan  
Mr. R. C. Armstrong