89-00-64

DOCKET NO. 70-820

File Copy
trans w/9-15-64 ltr

GENERAL INFORMATION & PROCEDURES MANUAL

United Nuclear Corporation
Fuels Recovery Plant
Wood River Junction, Rhode Island

Z-1

UNITED NUCLEAR CORPORATION

Fuels Recovery Plant
Wood River Junction, Rhode Island

GENERAL INFORMATION AND PROCEDURES APPLICABLE TO THE HANDLING OF SPECIAL NUCLEAR MATERIAL

September 1964

TABLE OF CONTENTS

100. INTRODUCTION

This manual has been prepared to provide the information required by the U. S. Atomic Energy Commission for the application for a Special Nuclear Material License for United Nuclear's new Fuels Recovery Plant located at Wood River Junction, Rhode Island. *
The manual outlines the United Nuclear Corporation, Chemicals Operation practices, guides, procedures and controls applied to insure the safe processing and handling of uranium. Also included is general corporate information.

200. GENERAL INFORMATION

201. Corporate

The United Nuclear Corporation is incorporated in the state of Delaware. The administrative offices of Fuels Division are located at 365 Winchester Avenue, New Haven, Connecticut. Principal officers of the corporation are listed in the Annual Report (copy of the 1964 Annual Report is included). *

202. Location and Facilities

Special nuclear material will be received, handled, used, or stored at the plant located one mile south and east of Wood River Junction, Rhode Island. The surrounding area is primarily uninhabited.

In addition to the activities at the Wood River Junction Plant, samples for analysis will be sent to the analytical laboratory of the Fuels Division at 365 Winchester Avenue, New Haven, Connecticut, or to other qualified laboratories. *

203. Description of Material

The uranium will be handled in the form of metal and alloys, compounds, and solutions. The U-235 isotopic content of the uranium will be up to and including fully enriched.

Unless specifically stated otherwise, the material has a maximum density of 3.2 grams uranium per cc and generally conforms to the density versus H/U-235 ratio for which the data of Figures 1, 2, 3, 4 in TID-7016 Revision 1 is directly applicable. TID-7028, dated June 1964 supplements TID-7016. *

204. Summary of proposed Activities

The uranium will be used for:

1. Further processing as requested by authorized customers.

2. Shipment to others licensed by the Atomic Energy Commission.

3. Analytical testing and development.

4. Research and development.

205. Technical Qualifications

205.1 Corporate

The Fuels Recovery Plant In Wood River Junction, Rhode Island is a part of the Fuels Division of the United Nuclear Corporation. It represents a natural offshoot of the Chemical Operations of the Fuels Division in Hematite, Missouri, where the original United Nuclear chemical processing facilities were constructed in 1956 and operations commenced that year on enriched uranium processing. The Hematite facilities were among the first privately owned to be licensed by the Atomic Energy Commission for processing special nuclear material. Since that time, much experience and technical knowledge related to the safe processing and handling of special nuclear material has been accumulated. All of that experience and knowledge was applied to the design and construction of the Rhode Island Plant and is also available on day-to-day operational questions.

205.2 Technical and Supervisory Personnel Qualifications

The training and experience requirements of plant supervisory personnel are:

1. General educational requirements of technical supervisory personnel: Bachelor of Science Degree in Engineering or Chemistry from an accredited college or university.

2. Plant Superintendent: Fifteen years experience in chemical plant operations including handling of special nuclear materials for over ten years.

3. Shift Supervisor: None to five years experience in chemical plant operations.

4. Chemist: Bachelor of Science Degree in Chemistry plus some industrial laboratory experience.

5. Technician: A high school education or equivalent with credit in any two of the following subjects: chemistry, mathematics, or physics.

6. Process Engineer: Bachelor of Science Degree in Chemistry or Chemical Engineering and one to five years experience in scrap recovery operations. *

7. Nuclear Safety responsibility resides in the Director of Licensing. His qualifications are: *

a. A.B. 1940, and M.S. in Chemistry 1947, West Virginia University, Morgantown, West Virginia.

b. Special training:

University of Tennessee:

Differential equations	1950

Oak Ridge National Laboratory

Reactor Analysis	1951
Radio Chemistry	1951
Health Physics	1951
Reactor Technology	1956

c. Experience:

1. Oak Ridge National Laboratory, 1947 - 1961
Research chemist employed in generation of criticality data for varying enrichments and compositions of uranium.

2. Feed Materials Production Center(Fernald) 1961-1964
Chief of Nuclear Safety, responsible for establishment of criteria for nuclear safety, instruction of personnel in safe practices, review of procedure and equipment changes, and nuclear safety audit.

3. United Nuclear Corporation, 1964 - present
Director of Licensing, Fuels Division, responsible for establishment of nuclear safety and health physics criteria, training, changes, AEC licensing, and internal auditing of these areas.

206. Financial Qualifications

Reference is made to the 1964 Annual Report of the United Nuclear Corporation which is attached. *

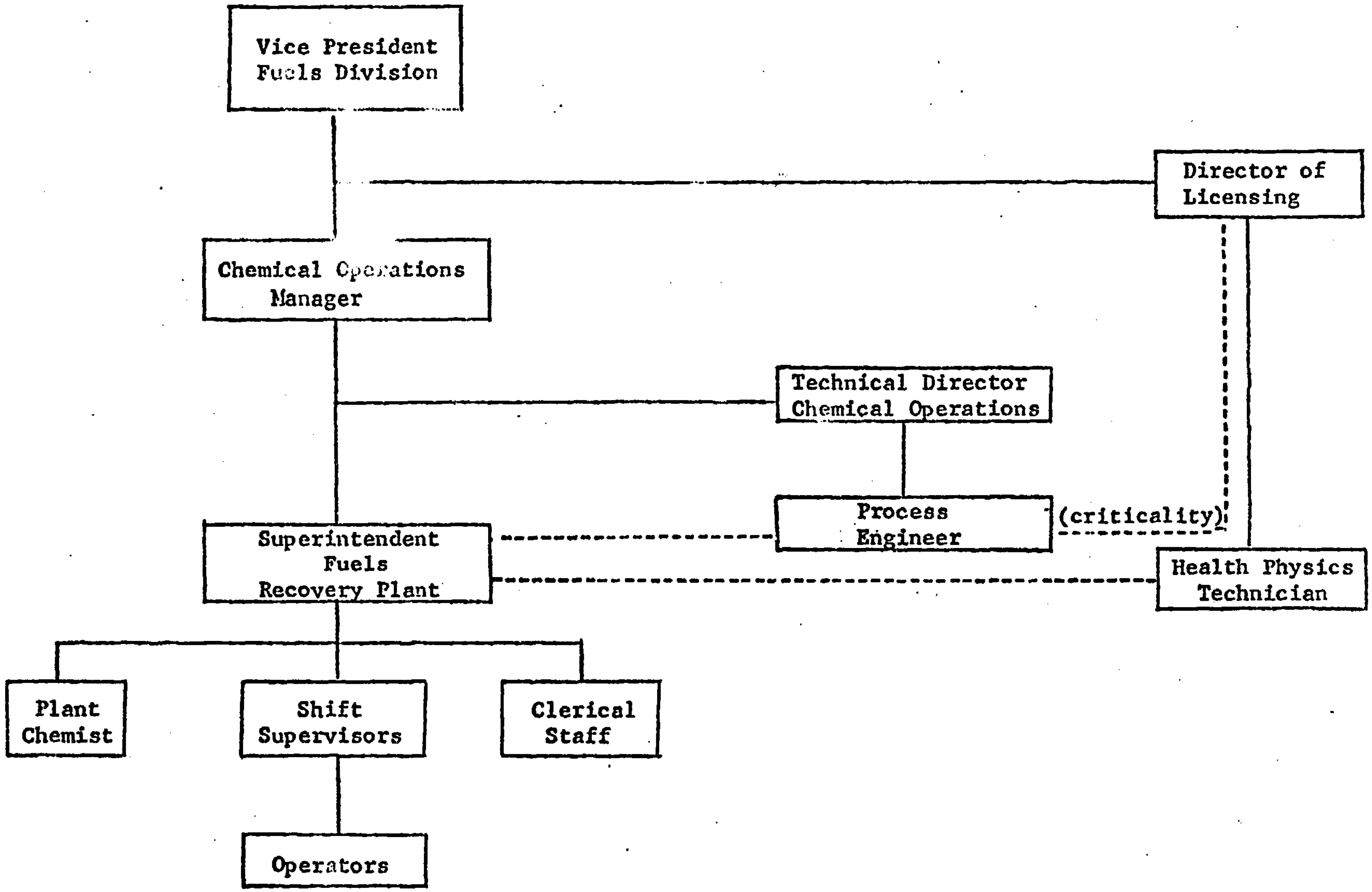
207. Administrative Procedures to Insure License Compliance

207.1 General Organization of the Chemicals Operation

The United Nuclear organization structure of the Fuels Recovery Plant is shown in Figure 1, following page.

Vice President

The Vice President, Fuels Division, has general overall responsibility for the Fuels Recovery Plant.



FUELS RECOVERY PLANT *
Organization Chart

September 10, 1964

207.1.1 <u>Operations</u>

<u>Fuels Recovery Superintendent</u>

The Fuels Recovery Superintendent has general responsibility for production and continued safe and efficient plant operation. This includes nuclear safety, radiation and industrial hygiene, general safety and uranium accountability.

<u>Shift Supervisor</u>

Responsible to the Superintendent for detailed execution of work and policies set by the Superintendent. The shift supervisor directly oversees plant operation.

<u>Plant Chemist</u>

Responsible to the Superintendent for the running of control tests necessary for production. *

207.1.2 <u>Criticality (Nuclear Safety)</u>

The nuclear safety responsibility resides in the Director of Licensing of the Fuels Division. That responsibility includes: *

1. Defining operational standards related to nuclear safety.

2. Obtaining AEC approval of procedures and equipment involved in processing source and special nuclear material.

3. Auditing all activities as related to criticality.

207.1.3 <u>Health Physics</u>

The Health Physics responsibility resides in the Director of Licensing of the Fuels Division. That responsibility includes: *

1. Defining operational standards related to health physics and industrial safety.

2. Auditing all activities as related to health physics and industrial safety.

207.1.4 Description of General Nuclear Safety Procedures

The Plant Superintendent will make frequent trips through the facility paying special attention to adherence to procedures used. Any violations will immediately be reported to the supervisor in charge for disciplinary action. All new employees will be given training on nuclear safety by a qualified employee during the indoctrination period. Monthly safety meetings are held at which time special topics such as nuclear safety and health physics problems are discussed. *

Changes involving special nuclear materials to equipment, piping or procedures other than for such purposes as maintenance or replacement with like equipment will be described in writing subject to the approval by the Director of Licensing of the Fuels Division, * before such modifications or changes are made. Any modification of existing equipment, piping or procedures which the Director of Licensing of the Fuels * Division, considers a significant change in nuclear safety will be submitted as a request for license amendment and subject to approval of the AEC before such changes are made. *

207.2 Criticality Control

207.2.1 General

The general criticality control procedures follow the recommendations included in such recognized publications as:

TID-7016, Rev. 1 - "Nuclear Safety Guide"
K-1019, 5th Rev. - "Basic Critical Mass Information and Its Application to Oak Ridge Gaseous Diffusion Plant Design and Operation"
TID-7019 - "Guide to Shipment of U-235 Enriched Uranium Materials"

The primary criticality control procedures observed are either limited safe batch, limited safe geometry or limited safe volumes. "Limited safe" means that the * unit is safe by limits of one or more of the following: Enrichment, volume, geometry, mass, concentration. In * some specific cases, the nuclear safety of a piece of equipment or a process is evaluated on the basis of actual

207.2.1 General (continued)

critical data published in the many AEC reports. In any event, each process, equipment item or storage area in which enriched uranium is handled must be approved by the AEC Division of Licensing and Regulation (as required by 10 CFR, Part 70). Many of the processes and equipment items for which license approval is herein requested are duplicates of or essentially similar to those already licensed and used at our Hematite operations Thus, general reference is made to our file under SNM-33, and in particular to information contained in our application for license renewal of July 15, 1963. *

Unless otherwise stated the following tabulated multiplication factors will be used to evaluate equipment interaction. Also the following solid angles are used to determine safe interaction:

Individual Safe Feature	Multiplication Factor, K	Safe Solid Angle, Steradians
5" Diameter	0.58	3.2
Limited Safe Mass	0.65	2.5
Limited Safe Volume	0.71	1.9
Limited Safe Geometry	0.80	1.0

*

207.2.2 Organization

Each person handling enriched uranium has the responsibility of nuclear safety in that he is responsible for following approved procedures.

When a new piece of equipment or modification of existing equipment is planned, the person responsible for the installation and operation contacts the Director of Licensing of the Fuels Division. At this time the nuclear safety problems are discussed. The design then progresses taking into account the recommendations of the Director of Licensing of the Fuels Division. When the design and basic operating procedures have been finalized, the Director of Licensing of the Fuels Division prepares the license application outlining the method of operation and basis for nuclear safety. The Fuels Recovery Plant Superintendent prepares detailed operating procedures which include any special nuclear safety requirements such as batch size, equipment spacing, work area, handling procedures specified in the license application. These procedures are carefully explained to the Shift Supervisor and by the Shift Supervisor to the operator. *

207.2.2 Organization (continued)

In cases where the process and equipment is new and unique to the plant, the Shift Supervisor and/or Technician may start it up with natural, enriched or depleted uranium to gain operating experience before operators are assigned. *

Plant audits are made at least quarterly by the Director of Licensing as a continuing follow-up to see that approved procedures remain in effect. Any deviations noted are called to the attention of Superintendent, Fuels Recovery Plant and Manager, Chemicals Operation. *

207.2.3 Basic Plant Design

The general arrangement of the plant is shown on drawings A-601, A-602, A-603 and Y-601.

The plant consists of a single principal building with office, locker-room, general utilities and maintenance facilities to the front (West End) and storage and processing facilities at the back (East End). A small laboratory is located at the second level above the locker-room area.

A paved yard is used for outside storage. A lagoon with waste discharge control facilities is located within the fenced area and just north of the building.

The building consists of the following areas (defined by bays):

Bays (For Bay designations see Drawing Y-601)	Description of Operations
	Uranium Process Areas
VII, VIII	Shipping & Receiving Area
XIII, XIV, XVI, XVII, XIX	Head Ends Processing Area
XX (3 floors)	Purification Processing Area
XV, XVIII, XXI	End Product Processing Area

207.2.3 (continued)

Bays (For Bay designations see Drawing Y-601)	Description of Operations
	Uranium Process Areas
XII	Product Storage Area
IV (Second Floor)	Control Laboratory
	Non-Uranium Areas
XI	Storage Area
IX	Maintenance
V, VI	Utility Area
I, II, III, IV (First Floor)	Main Entrance, General Plant Office, Lunch Room, Clothes-Change Locker - Change Room

Outside storage areas are the areas just north of fuel gas supply package (A-13), north of Bays XIII and XVI, and in the Northeast corner of the plant yard (see Sheet No. Y-601). These areas are used for storage of uranium materials as received in protective spacing birdcages. *

Empty shipping containers are so tagged and stored outside prior to return to the owner.

207.2.4 Material Identity

Each order received in the plant is assigned an identifying job number. Records are kept which make it possible to determine the enrichment and customer when knowing only the job number. *

A tag on which this job number and U-235 enrichment is shown is attached to each uranium container. As the uranium passes through the process, each batch and lot is identified by a sequential number and the job number. This then becomes part of the information on the container tag. *

207.2.4 (continued)

For further detail on procedures to protect material identity see Section 500, Non-Processing Storage - Facilities and Equipment.

207.2.5 Separation of Licensed and Accountability Station Material

Licensed and accountability station material are sometimes processed concurrently in the same plant areas. In this event, licensing regulations on criticality, radiation protection and health physics in effect in the area are uniformly applied to both types of material. *

The procedures for material identity discussed in Paragraph 207.2.4 apply to both station and licensed material. However, to maintain separate identity of station and licensed material when both types are in the plant, distinctive tags will be used for the two types of material. *

207.3 Special Nuclear Material Quantities

The estimated annual throughput is expected to be approximately 650 kilograms of fully enriched uranium the first year and approximately 1200 kilograms of fully enriched uranium the second year.

The maximum quantity of special nuclear material on hand at any one time will be 2,000 kgs. *

The types of scrap for which these facilities have been designed include:

U-Zr alloys as chips (6 - 20% U content); pickle liquors of U-Zr (less than 5 grams/liter) *

U-Al alloys (5 to 60% U content)

207.3 (continued)

UO_2-ZrO_2 (70 to 80% U content)

UO_2-ZrO_2 - Coated (50 to 60% U content)

Combustibles as carbonaceous materials.

301. General Considerations

There are several points which apply to all of the process areas. These are:

1. Catch pans which are located under some of the equipment are for the purpose of localizing any minor leaks or drips. This improves housekeeping, keeps down the spread of contamination and reduces losses. These pans are limited to a 1½" high lip to provide safe slab height.

2. Insulation on pipe and equipment which contain uranium solutions will be made of impervious materials (e.g., foam glass) and provided with weep holes to prevent the possibility of giving greater dimensions (volume, diameter, etc.) of uranium than calculated.

3. Raschig rings (nominally 1½" by 1½" by 5/32") containing 4 w/o boron will be used in the tanks listed below to provide added safety (over and above controls insuring uranium concentrations less than 5 grams per liter mentioned in the detail descriptions of the equipment items).

   Data obtained at Rocky Flats and reported in RFP-201, Nuclear Safety Experiments on Plutonium and Enriched Uranium Hydrogen Moderated Assemblies Containing Boron has shown that a 42" diameter tank poisoned with raschig rings as described above (except occupying only 17.8 volume percent of the tank) is subcritical at any height and with fully enriched uranium solution concentrations up to 360 grams uranium per liter.

   The raschig rings will be uniformly distributed in the vessels and will occupy at least 22% of the volume. To insure integrity of the raschig rings poisoning effect, the following controls will be enforced:

   a) As a control of the boron content of the glass, samples of the rings will be permanently stored in typical liquor of each vessel. This liquor will be analyzed for boron weekly for at least four weeks and monthly thereafter. If there is a significant increase in the boron content of the liquor, the raschig rings will be replaced.

   b) Samples of the raschig rings from the bottom of the vessels will be analyzed for boron at least once each year. The rings will be replaced when analysis shows the boron content of the tank is down to 15 grams per liter.

   c) The vessels will be checked monthly to insure that the tank is full of raschig rings. *

Tanks and Vessels with Raschig Rings

Extractor Feed Tank	(1-D-41)
Solvent Feed Tank	(1-D-5)
Raffinate Slop Tanks	(1-D-21A and B)
ADU Filtrate Tanks	(1-D-24A and B)
Entrainment Separator on Evaporator	(1-E-2) *

4. All Overflow and vent bottles used in the facility will be 5" diameter. *

5. All pump casings are less than 4.8 liter volume. *

6. To prevent employees from collecting leaks and overflows of special nuclear materials in unsafe containers, the following steps will be taken: *

   a) Each new employee will be instructed not to use unsafe containers for such purposes.

   b) Any containers such as waste paper, mop buckets, etc., used in the process area are limited to safe geometry or have holes such that a safe slab or volume is maintained.

   c) Special instructions are provided to the employees for cleanup.

7. Features and controls which protect against uranium backing up into unsafe sized vessels in the event of: *

   a) Air failure

      1) air lines which open into process vessels drop down from headers which are at higher elevations than the vessels; these lines are equipped with check valves.

      2) in the event of an air failure, the operator turns off the air valve.

   b) Steam failure

      The same features as described above hold for the steam lines.

8. The items marked FI are flow indicators and in all cases are less than 3" inside diameter. *

302. Head Ends Processing Area (Sheet Number A-602, Bays X, X1, X111, X1V, XV1, XV11 and X1X)

302.1 General

This area is designed for the safe processing of fully enriched uranium through the use of geometrically safe equipment or through the use of processing equipment with properly applied administrative controls.

Examples of each are:

a) Unlined dissolver (1-J-4) which by design is geometrically safe for solutions of all concentrations.

b) Degreaser (1-D-22) which is safe for degreasing batches of less than 350 grams of U-235 and concentrations of less than 5 grams per liter U-235 in the solvent.

Activities in this area:

1) Preliminary handling, sorting, sampling, crushing, degreasing, etc., of scrap feed materials. This represents the variety of problems in preparation of scrap for dissolution or transfer of solutions for processing.

2) Dissolution of U-Zr in small chunk (chips) form.

3) Dissolution of U-Al in small-chunk-piece (or platelet) type form.

4) Dissolution of UO_2-ZrO_2 type scrap materials.

5) Adjustment and preparation of U solution type scrap material (such as U-Zr pickle liquor) for subsequent purification processing.

6) Assaying filtrates from Operations (2), (3), and (4) above.

7) Miscellaneous scrap processing (such as reprocessing of reject batches, filter cake reprocessing, small size scrap jobs, etc.).

302.2 Preparation of Solid Scraps for Processing (Sheet A-602, Bays XIV, XVII)

302.2.1 General

Solid scrap materials will require different treatment depending on their form prior to their dissolution. This will consist of weighing out batches for dissolution, wet or dry milling of these batches and packaging the batches in a process container for transfer to the subsequent process step. These operations will be done in Glove Box 1-L-1, Hood 1-L-14, or Hood 1-L-9A depending on the as-received container and treatment required.

The shipping containers in which solid scrap is received will vary in size and geometry which is determined by the physical form of the scrap and the uranium content. Usually the scrap is packaged in individual cans which in turn have been packaged in a safe 5" diameter pipe within a birdcage. Incoming shipments of solid scrap will be visually inspected, sampled and analyzed; information thus gained will be compared against shippers material transfer statements. *

302.2.2 Glove Box 1-L-1, (Sheet Number A-705)

One as-received container and one process container will be in this box at a time. The scrap will be transferred into the process container in the required process batch quantity. This will be weighed on scale 1-W-1. The maximum size process container will be one gallon.

Access to the glove box is through a double door airlock. The size of this airlock restricts the glove box to containers of a size only comparable to the one gallon process container.

Nuclear safety is assured since the "as-received" container was subcritical during shipment, subdividing its contents into the process container will serve to further reduce the reactivity of the material.

302.2.3 Hood 1-L-14, (Sheet Number A-709)

This hood is equipped with rollers, (1-K-4) for ball milling or blending, and a drying oven, 1-H-8. Also a bottle filling compartment is located under the hood.

Only one of the following listed jobs will be permitted at a time:

1. Lot blending and packaging.
2. Unloading "as-received" containers too large for glove box 1-L-1.
3. Wet or dry ball milling and drying.
4. Loading and unloading muffle boxes.

Lot Blending

The blender loaded in glove box 1-L-6 will be rolled on the ball mill rollers to accomplish the desired blending. After rolling, the blender is unloaded into a can or bottle installed in the bottle filling compartment. Nuclear safety of this process is assured by the dryness of the material being blended (see paragraph 304.10).

Unloading "As-Received" Containers

Nuclear safety is assured during this operation by the maintenance of a safe condition of the "as-received" container during shipment and storage. Transferring the material to a process container will serve to further subdivide it, resulting in added safety.

Ball Milling

The ball mills are 5" I.D. by 5-1/8" long. The rollers will hold a maximum of 6 such mills resulting in a safe diameter condition for all materials having a density less than 3.2 grams uranium per cc. For materials having a density greater than this, a maximum of 2 mills together spaced 1 foot from one other mill will be used; in addition, *
a mass limit of 4 kg U-235 per ball mill will be maintained. Spacing in this case will be maintained by a dummy ball mill. The dummy ball *
mill will be painted red or otherwise distinctively marked for positive identification.

Drying

The oven 1-H-8 will hold two 12" x 12" x 1¼" trays. This oven will be used to dry solids as required for further processing.

Loading and Unloading Muffle Boxes

Some materials may require a high temperature drying or calcination to properly prepare them for further processing. The muffle box used for this is described in paragraph 305.3.

Interaction

The maximum solid angle calculated for the activities of the hood is less than 2 steradians. Using the muffle box as the most reactive unit, the allowable solid angle is 2.1 steradians.

302.2.4 Hood 1-L-9A (Sheet Number A-709)

This hood is similar to Hood 1-L-14 except it is equipped with only rollers for ball milling and a bottle filling compartment.. Only one of the following will be done at a time:

1. Unloading "as-received" containers
2. Wet or dry ball milling.
3. Equipment cleanup.

The nuclear safety discussion of paragraph 302.2.3 is applicable here. *

302.2.5 Glove Box 1-L-9B (Sheet Number A-709)

This glove box contains a hammer mill for milling. It will be used for dry milling of any material requiring this type of milling.

The glove box will be limited to one one-gallon poly bottle of feed or one muffle box of feed and one one-gallon poly bottle in a bottle compartment in the bottom of the glove box to collect the milled product. The mill is less then a one gallon volume.

Interaction of 1-L-9A and 1-L-9B

The maximum solid angle calculated for the hood and glove box equipment as one interacting system is less than 1 steradian. Since the most reactive item is the one gallon bottle, an allowable solid angle of 3 steradians is in effect.

302.2.6 Degreaser (Equipment No. 1-D-22, Sheet Number A-602)

General

Use of this Degreaser is for the purpose of removing organic films, such as oil, from alloy scrap metal entering the processing cycle.

Equipment and Nuclear Safety

A fine screen basket of such size as to fit the 7 ¼" X 7 ¼" cleaning section of the Degreaser, is placed on a tray one inch or less in depth. The contents of the incoming container, or up to 350 grams U-235 are placed in the screen. Organic solution which drains off is placed in a five inch eleven liter bottle, sampled and contents disposed of in an approved manner (by feeding back to calciner in small quantities or by burning in suitable equipment).

The screen box is suspended in the vapors of the Degreaser until the alloy is degreased. The alloy is then handled as routine incoming scrap.

Degreasing liquid is agitated with air in order to get a representative sample. Contents of the Degreaser solvent will be controlled to less than 5 grams U per liter.

SUBJECT: PROCESSING - FACILITIES AND EQUIPMENT

Head Ends Processing

ISSUED Sept.10,1964

SUPERSEDES Feb.19,1964

302.2.7 Head Ends Calciner (Equipment Number 1-H-7, 1-X-23, Sheet A-706)

Calciner

Combustible uranium residues generated within the plant or off-site will be transferred into one-gallon bottles in hood 1-L-14 or 1-L-9A and emptied into 2" x 8" x 24" Hastelloy-C trays --- one bottle and one tray at a time. The two trays are covered with loose fitting lids. Two trays will be transferred one at a time and placed in the furnace in a single slab. The furnaces will be closed and heated to distill off low boiling organics. Air will then be introduced and the combustibles burned to ash. The trays will be removed and any material remaining in the retort tube will be removed and put into the tray. This will complete the cycle of operation. * *

Off Gas Handling

Gases from the distillation and burning will be washed with water in scrubber 1-X-23. The scrubber liquor will be sampled after each cycle to insure against a buildup of uranium above a 2 gram per liter limit (although a five gram per liter concentration is safe).

Ashes from 1-H-7 in the two trays will be returned to hood 1-L-14 or 1-L-9A for processing as described in sections 302.2.3 and 302.2.4.

Nuclear Safety (Drawings H-5034 & M-1148-S) *

The cross sectional area of the calciner tray (2" deep x 8" wide) is less than that of a safe 5" diameter cyclinder. Also since the material is first packaged in a one gallon bottle, the contents of the tray are less than a safe volume.

302.2.8 Declad Hood (Equipment Number 1-L-17, Sheet Number A-602)

Operations to be carried out in this hood are presently in a development stage. License for operation of this area will be requested at a later date.

302.2.9 <u>All Purpose Hood</u> (Equipment Number 1-L-18, Sheet Number A-602)

Equipment details for this hood have not been developed. License for operation of this area will be requested at a later date.

302.3 Tray Dissolver (Equipment Number 1-J-5 A and B, Hoods 1-L-3 A, B, C, Sheet A-602)

302.3.1 General

The tray dissolvers are used for the dissolution of U-Zr alloy scrap. This is scrap generated in fuel element fabrication and consequently accurate knowledge of the uranium assay is readily available.

The dissolution batch is weighed out and packaged in glove box 1-L-1 or Hoods 1-L-14 or 1-L-9A (reference section 302.2.2, 302.2.3, and 3.2.2.4 respectively). The batch is transferred by hand to the tray dissolver where it is spread uniformly over the surface of the tray. A measured quantity of acid is sprayed onto the material filling the tray. When dissolution is complete it is adjusted as necessary for extraction and then drained by gravity to filter 1-F-6 and from the filter by vacuum to holding tank 1-D-36. When tank 1-D-36 is filled the solution is transferred to the assay tanks 1-D-34 (reference section 302.7).

302.3.2 Equipment and Nuclear Safety

A) Tray Dissolver 1-J-5A and B

The trays are each 1 3/4" high by 25 1/4" by 25 1/4" and as such constitute a nuclearly safe slab (Figure XV, K-1019, Fifth revision), the 25 1/4" by 25 1/4" area being equivalent to a 2[illegible]" diameter.

In addition to the safe geometry of the trays, the dissolution batch is limited to a maximum of 350 grams U-235. Also efficient dissolution of the batch requires that the material be spread out over the tray rather than piled up.

The chemistry of dissolution of U-Zr alloys require that the Zr concentration of the resulting solution be limited to 50 grams per liter. The tray capacity is only 17 liters thereby limiting the total Zr in the dissolution batch to 850 grams. Since the source of this type of scrap is fuel elements the normal maximum uranium content of the alloys is 10%. Therefore the maximum size of the batch is 9440 grams of U-Z alloy containing 94- grams of *

302.3.2 Continued

uranium. Assuming an error in the assay of the alloy by as much as a factor of 3 the uranium content of the batch is only 282 grams. The dissolvers are drained through a one-half inch pipe.

B) Filter 1-F-6

This filter is similar to the dissolvers, being 20" square and 1 3/4" deep. It is located below and between the two dissolvers. Nuclear safety is assured by the safe slab height. The only solids collected on the filter will be the insolubles from the dissolution step. These will be removed as necessary insolubles not to exceed one inch depth, packaged in a one-gallon polyethylene bottle, and transferred to storage. The filtrate is drained through a one-half inch pipe to 1-D-36.

C) Tank 1-D-36

This tank is a nuclearly safe five inch diameter.

The transfer from the filter to the tank is by means of vacuum. The vacuum line is equipped with a moisture alarm to detect any liquid going into the vacuum system.

D) Interaction

The maximum solid angle calculated for the tray dissolver (1-J-5 A and B) is less than 0.5 steradians.

The solid angle calculated at the filter 1-F-6 is less than 0.6 steradians.

E) General

Uranium containing solutions cannot back up into any unsafe geometry equipment due to physical breaks in the piping.

302.4 Unlined Dissolver (Equipment Number 1-J-4, Sheet Number A-701)

302.4.1 General, Process and Equipment Description

Scrap of the U-Al alloy type is dissolved in this processing equipment. By design, the equipment is critically safe consisting of two vertical 5" diameter columns of stainless steel approximately 9'0" long, connected by a 2" diameter crossover near the top and a 3" diameter crossover at the bottom. Columns are reduced to 3" diameter before the 3" diameter crossover tee. The charging port of the equipment is in glove box 1-L-4.

The scrap is weighed out in glove box 1-L-1, transported to the air lock attached to glove box 1-L-4, and charged into the scrap basket (3" diameter) through the charging port.

Acid is charged to the system from the nitric acid gage tank (1-D-27, 12 gallons capacity). Distilled water is charged from the 6" diameter pyrex measuring tank. A weighed catalyst is added in the same manner as the scrap. The solution is circulated by introducing air to a vertical riser between the columns.

The solution containing the dissolved U-Al alloy is air blown through filter 1-F-24A (7¼" x 7¼" x 6") to the assay tank (1-D-34) for sampling and weighing. *

The filter cake consisting of low uranium acid insolubles will be transferred in 12" x 12" x 1¼" trays to 1-H-8 drying oven in hood 1-L-14 and handled as described in section 302.2.3.

Air introduced into the dissolver for mixing is vented through an air separator and demister, the dissolver vent condenser (1-E-7), cyclone (1-X-2) and out the vent stack. *

Condenser (1-E-7) acts as a reflux condenser returning the condensed liquid to the dissolver. The gases which enter cyclone (1-X-2) are stripped of any remaining entrained moisture and the liquid collected in a 4" diameter by 5' long stainless steel pipe which is vented through the roof.

302.4.1 (continued)

Glove Box (Equipment Number 1-L-14, Sheet No. A-704)

This item of equipment is constructed of stainless steel with overall dimensions of 37" x 20" x 27".

Dissolver Vent Condenser (Equipment No. 1-E-7, Sheet No. A-902)

This condenser is a single pass stainless steel water cooled condenser and is less than 5" I.D. by 11-3/4" long.

Cyclone (Equipment No. 1-X-2, Sheet No. A-902)

Cyclone is fabricated of stainless steel, 4" diameter body reduced to 1" for drain to vented tank.

Equipment and Nuclear Safety, Nitric Acid Gage Tank (Equipment No. 1-D-27, Sheet No. A-902)

This tank (12 gallons capacity) meters nitric acid to both the lined and unlined dissolvers. Feed for this tank is from the outside nitric acid storage tank (1-D-29).

An atmospheric separation is made in the process inlet to the dissolver to prevent solution from the unlined dissolver. (1-J-4) being pressured into the auxiliary tanks.

Equipment and Nuclear Safety, Distilled Water Gage Tank

This tank (6" diameter x 48") holds approximately 21 liters water. Feed for this tank is from the distilled water tank in the utility room.

An atmospheric separation is made in the discharge line from the tank to the dissolvers to prevent solution from being pressured into the gage tanks.

302.4.2 Equipment and Nuclear Safety, Unlined Dissolver System

Dissolver 1-J-4

The nuclear safety of the individual components of the dissolver (1-J-4) is assured by the 5" diameter or smaller components. The maximum solid angle calculated for the dissolver is less than 3.2 steraidans.

There are four tees in the dissolver system, the largest of which is 5" x 5" x 2" which is equivalent to 4.2" diameter tee. This is safe per Table III of TID-7016, Rev. 1, Insulation on the dissolver components consists of a non-absorbent foam glass.

302.4.2 (Continued)

Condenser 1-E-7

The condenser 1-E-7 is a safe 5" diameter. It is located above the dissolver by one common centerline with the dissolver leg and as such makes a negligible interaction contribution.

Cyclone 1-X-2

The cyclone 1-X-2 is of safe diameter. Since it is used for vapor disentrainment, interaction effects can be neglected.

Any liquid separated by the cyclone will collect in the safe *
4" diameter by 5' long tank. Since these condensables will have
little or no uranium, interaction effect can be neglected; but
for additional safety this tank is more than 24" from the dissolver *
legs.

Interaction

The maximum solid angle subtended at the dissolver is less than 1 steradian.

302.5 Teflon Lined Dissolver (Equipment Number 1-J-1, Sheet Number A-902)

302.5.1 Dissolver Charge Glove Box (Equipment No. 1-L-13, Sheet A-705)

The transfer bottle containing the scrap will be transported from the counting glove box, 1-L-1, the ball milling hood, 1-L-9, or 1-L-14 to the dissolver charge glove box, 1-L-13. The scrap transfer bottle is introduced to the dissolver glove box through the air lock provided and the scrap charged in to the dissolver scrap basket through the opening provided. Nitric acid is charged to the system from the nitric acid gauge tank 1-D-27, hydrofluoric acid is charged from the HF gauge tank 1-D-30 and water is charged from the six inch Pyrex measuring tank.

Nuclear safety of this glove box is assured by the use of the safe volume one gallon transfer bottle one load at a time and that the material is in the dissolver before addition of the reagents. Although the gauge tanks 1-D-27 and 1-D-30 and the water tank are not safe for nuclear solutions containing more than 5 gms/liter of uranium, air gaps incorporated into the piping from the tanks to the dissolver prevents any nuclear solutions from entering these tanks.

302.5.2 Teflon Lined Dissolver (Equipment No. 1-J-1, Sheets A-707 and A-902)

Basically the unit consists of one vertical six inch diameter pipe and one vertical four inch diameter pipe connected by a three inch diameter pipe at the top and by one and one-half inch diameter pipe at the bottom. The two legs are separated by three feet-eight inch on centers. These are standard schedule 40 steel pipes that have been lined with teflon. The outside surface of the six inch pipe has been covered with a cadmium sheath having a minimum thickness of 0.030 inch and a maximum thickness of 0.055 inch. The six inch dissolver leg has also been reduced to three inch diameter before the insertion of the three inch diameter crossarm at the top of the dissolver to eliminate intersection problems. A 3.70 inch O.D. by 3.18 inch I.D. perforated teflon tube is inserted in the six inch dissolver leg and serves as a container for the material to be dissolved.

The dissolver is charged (maximum charge will be 6 kg of uranium) as indicated in Section 302.5.1 and a blind flange is used to close the dissolver charge port. Acid is added through a two inch diameter pipe on the four inch diameter leg. The solution circulates around the dissolver system by means of a pump, 1-P-8, which is piped into * the 1½" teflon lined pipe connecting the bottoms of the two vertical legs. Tracing around the vertical legs provides the required heating and cooling of the dissolver.

Fumes and vapors generated during the dissolution process are vented from the 4" diameter leg, through a demister, a condensing section (water cooling coil), and a 4" diameter cyclone, 1-X-1 (Sheet A-902). The non-condensable gases discharge out the vent stack and the liquids drain from the cyclone to a 4" diameter receiver tank. Since these condensables have little or no uranium, interaction effect can be neglected but for additional safety this tank is more than 24" from the dissolver legs. *

When dissolution is complete, adjustments are made as required by the job to make the liquor suitable for extraction. These adjustments could include reducing the excess acid, addition of chemicals, etc. The liquor will then be cooled by using water in the tracing lines and then the batch transferred through a filter, 1-F-24B to the assay tanks, 1-P-34, for sampling and weighing.

302.5.3 Nuclear Safety of the Teflon Lined Dissolver - 1-J-1

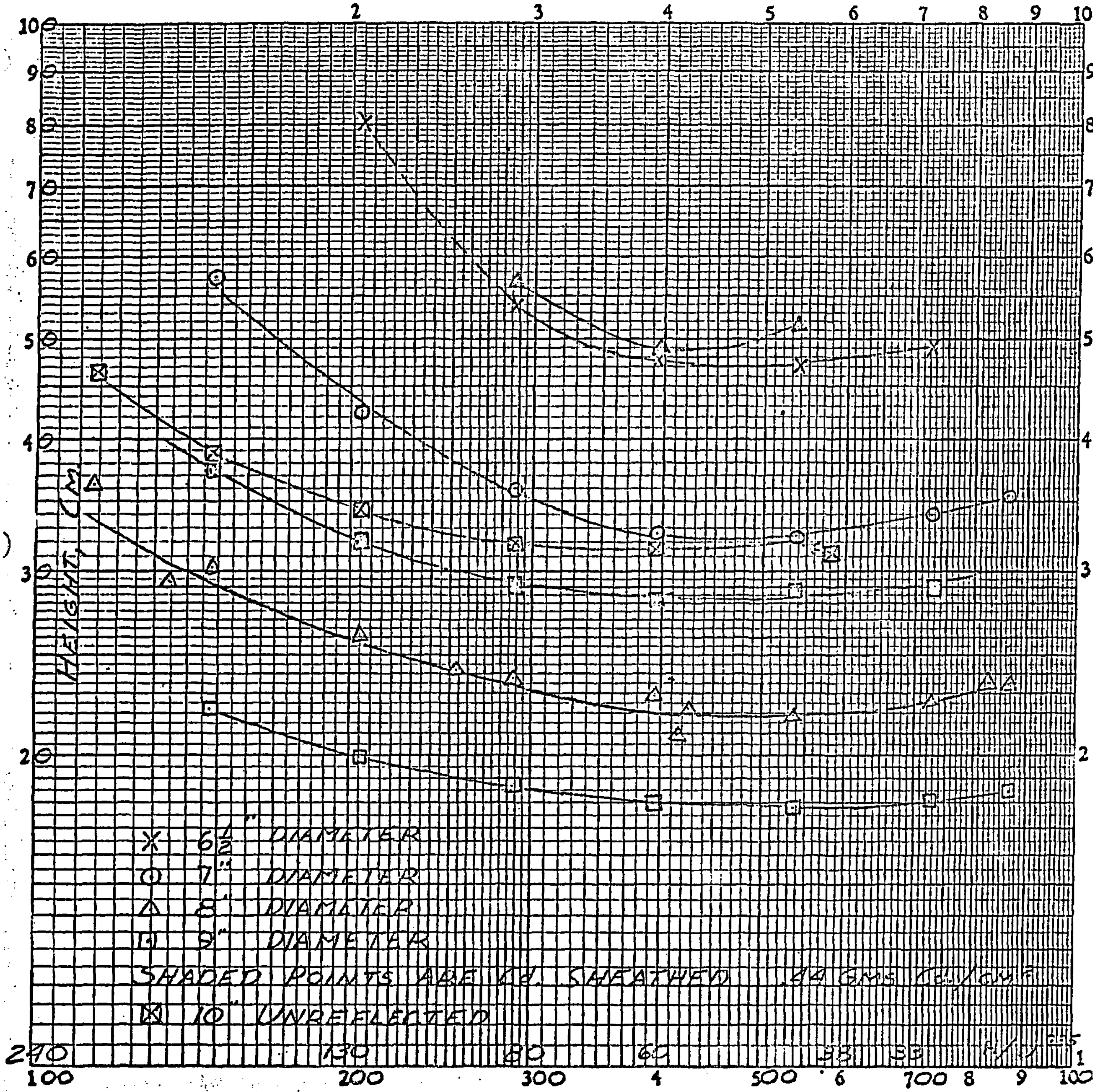
Figure 3 of TID-7016, Revision 1 shows that a 6 inch diameter with a one inch thick water reflector (nominal reflection) is safe for solutions having an H/U-235 ratio greater than 20 (1000 grams per liter). The total wall thickness of the dissolver exclusive of the cadmium sheath and other external coverings is less than one-half inch. For thicknesses up to 2-1/2 inches, steel as a reflector is equivalent to water (page 9, K-1019, Fifth Revision). If it is also assumed that the teflon lining is water, the reflecting material inside the cadmium sheath is equivalent to one-half inch of water. Therefore, the dissolver is safe with a nominal reflector. However, nominal reflection cannot be guaranteed during normal operation and further steps must be taken to insure safety.

A considerable amount of published critical data has been compiled and is included in ANL-5800, "Reactor Physics Constants". Table 3-65 on page 248 of ANL-5800 lists critical parameters of water reflected stainless steel tanks of fully enriched UO_2F_2 solutions.

The critical height of water reflected stainless steel cylinders has been plotted versus U-235 concentration in Figure 11. From this it can be seen that the minimum critical height of 6-1/2 inch and 7 inch diameter cylinders occurs in a concentration range of 400 to 500 grams U-235 per liter.

Further examination of the data shows that the net change (increase) in critical height with a reduction in diameter is greater for smaller diameters than for larger diameters. This is more apparent in the following table.

FIGURE 11
CRITICAL HEIGHT OF
WATER REFLECTED S.S.
CYLINDERS OF $UO_2F_2 - H_2O$
REF. ANL 5800



STAINLESS STEEL WATER REFLECTED CYLINDERS

H/U-235 = 43.9 (538 grams U-235/liter)
From Tables 3-65 and 3-77, ANL-5800

Diameter, Inches	Critical Height, Cm.	Net Increase, Cm.
10	14.9	2.9 (10" to 9")
9	17.8	
8	21.9	4.1 (9" to 8")
7	32.7	10.8 (8" to 7")
6 ½	47.1	14.4 (7" to 6½")
6	118.4	71.3 (6½" to 6")
5.8	118.4	71.3 (6½" to 5.8") Estimated

The effect of a cadmium sheath .020 inch thick (.44 grams Cd/cm^2) on the same cylinders is tabulated in Tables 3-67 and 3-68, pages 249 and 250 in ANL-5800 and is also plotted on Figure 11. In this case, an 8 inch diameter cylinder was the smallest critical cylinder.

These data have also been plotted in Figure 12 as critical height versus diameter. For purposes of comparison, water reflected, cadmium sheathed-water reflected and unreflected cylinders have been included. From Figure 12 it is apparent that the addition of the cadmium sheath shifts the critical height versus diameter curve toward the curve for unreflected cylinders. It is also evident that the slope of the cadmium sheath curve and unreflected curve is greater than the curve for water reflection. Extrapolation of the cadmium sheathed curve indicated that an infinitely long cadmium sheathed water reflected cylinder must be greater than 7 inches in diameter to be critical. A modified one group calculation (enclosed in the appendix) made for a concentration of 400 grams U-235 per liter (optimum for the 8 inch diameter cadmium sheathed tank) indicates the diameter is 7.4 inches.

Examination of the data shows that the cadmium sheath increases the critical height of the 8 inch cylinder to that of a 6 1/2 inch cylinder without the cadmium sheath. Similar results are achieved by the addition of the cadmium sheath to a 9 inch cylinder, i.e., the critical height increases to that of a 7 1/2 inch diameter cylinder without the cadmium sheath. Thus the cadmium sheath has the effect of reducing the diameter by 1 1/2 inches.

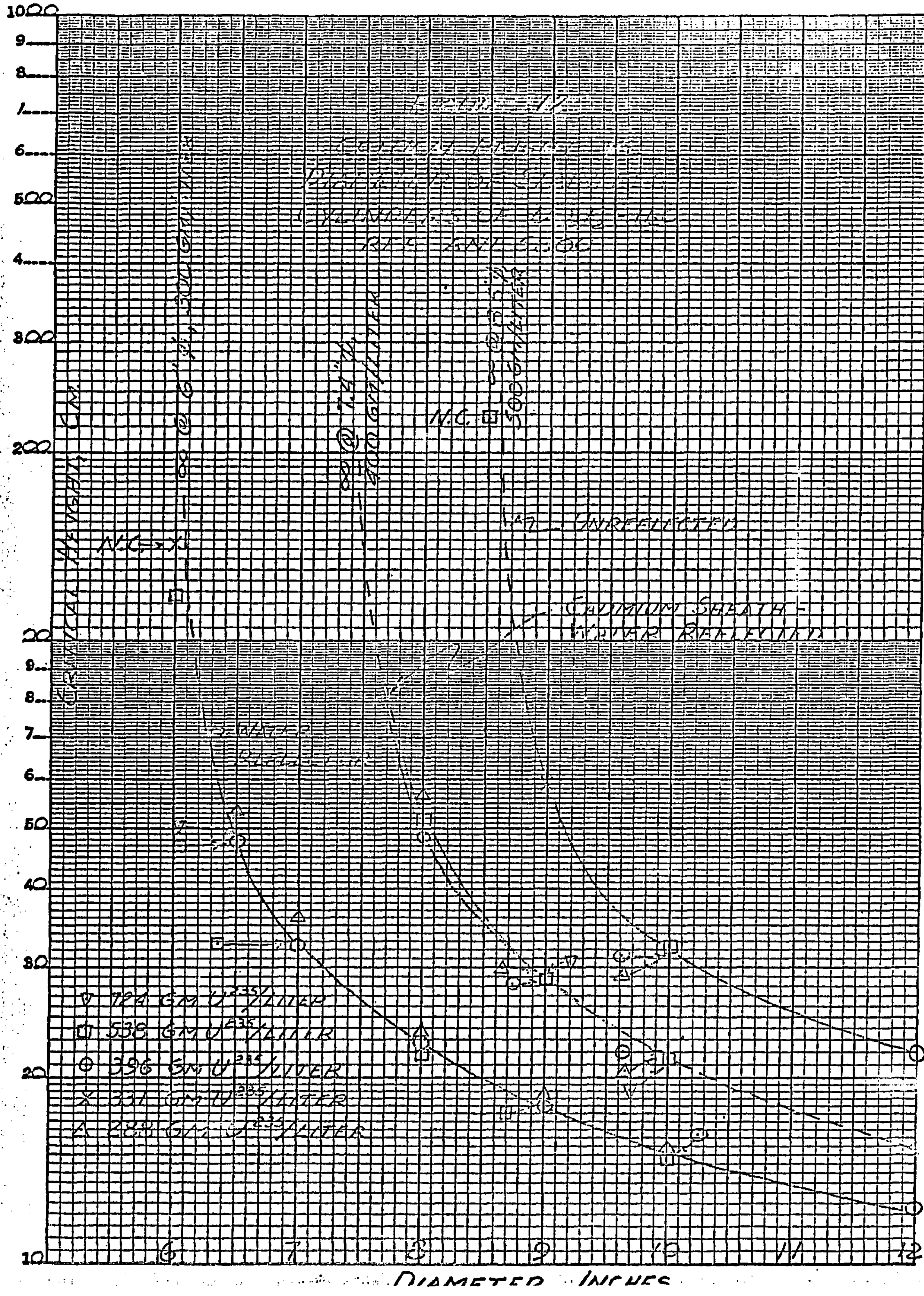
The inside diameter of the teflon lined dissolver is 5.8 inches and from the above discussion, it is concluded that the addition of the cadmium sheath to the outside of the dissolver makes this a safe diameter for an infinite length even in the event of water reflection.

The data of Table 3-84 in ANL-5800 shows that the interposition of stainless steel between an enriched uranium solution and its water reflector increases the critical height for stainless steel thicknesses up to one-half inch. From this it can be concluded that the application of the above critical data (which was observed for vessels with 1/16 inch walls) to the dissolver (with a total wall thickness, including the teflon lining, of less than 7/16 inch) is not in error, but in fact is probably somewhat conservative since the effect of the wall thickness between the solution and its reflector has not been taken into account.

To maintain the integrity of the cadmium sheath, the sheath will be held in place by steel straps painted with a polyester resin.

The maximum solid angle subtended at the 6" diameter cadmium wrapped leg of the dissolver is less than 1 steradian.

Table I, page 7 of ORNL-2367, "Critical Mass Studies Part IX" lists critical data for seven 6 inch diameter cadmium wrapped cylinders in a hexagonal array. Here it can be seen that the water reflected cylinders could not be made critical at any height for edge to edge spacings of 2 inches or more. Similarly, unreflected cylinders could not be made critical at any height for edge to edge spacing of 4 inches or more. None of the dissolving and assay tanks are spaced closer than 24 inches. Also, the solid angle calculated for the central cylinder of the unreflected array at 3 inch spacing is 10.8 steradians. Thus it can be concluded that the dissolver system discussed above is safe individually and from interaction effects.



CRITICAL HEIGHT, CM.
DIAMETER INCHES
N.C. → X
N.C. □
UNREFLECTED
CADMIUM SHEATH - WATER REFLECTED
▽ 724 GM U235/LITER
□ 538 GM U235/LITER
⊕ 396 GM U235/LITER
X 331 GM U235/LITER
△ 283 GM U235/LITER
10
20
30
40
50
200
300
500
1000
6
7
8
9
10
11
12

302.5.4 Acid Insolubles Filter (Equipment Number 1-F-24B, Sheet Number

The cooled adjusted solution is filtered on filter press 1-F-24B, a stainless filter press, to remove acid insolubles. The low uranium filter cake will be transferred in 12" x 12" x 1¼" trays to drying oven 1-H-8 in hood 1-L-14 and handled as described in section 302.2.3

This filter is 7¼" x 7¼" x 6" -- a safe geometry per Table XV of K-1019, Fifth Revision.

The solid angle subtended at the filter 1-F-24B is less than one steradian.

302.6 U Solution Type Materials (Equipment Numbers 1-D-12 and 1-D-41, Sheet A-903)

302.6.1 General

Uranium solutions for recovery are low concentrations, less than 5 grams U-235 per liter. In the case of pickle liquors, the concentration is normally less than 2 grams per liter. *

302.6.2 Sampling

Prior to the start of processing of the solutions each drum is sampled for uranium analysis. In the case of known process solutions (e.g. pickle liquor) received from another United Nuclear Corporation Plant, this would be the shippers analysis with a check on at least one drum per shipment.

For solutions received from other shippers, each drum is sampled and analyzed. Also in the case of unknown process solutions received from another United Nuclear Corporation plant check samples will be analyzed on each drum. In all cases the highest analysis determined will be used in the determination of starting batch sizes.

302.6.3 Uranium Solution (Pickle Liquor) Process

Solution that has been received and accepted for processing is transported from the outside storage area set aside for pickle liquor storage to inside the facility, Bay XIX. These solutions are received in 55 gallon drums. The uranium concentration is normally a maximum of 2 grams per liter. The contents of the drum are transferred to the raw liquor tank (1-D-12, 90 gallon capacity) by pouring with the aid of the drum tilter attachment of the monorail hoist, or pumping from the drum. *

The pickle liquor is treated by mixing with aluminum as nitrate or hydroxide if HF is present. It is then neutralized by addition of ammonium hydroxide to yield a solution approximately 3 molar with respect to nitric acid.

Ammonium hydroxide is transferred to the adjustment tank by transfer from the outdoor storage tank 1-D-1, 5000 gallon capacity.

The treated pickle liquor is transferred to the Extractor Feed Tank (1-D-41, 1500 gallon capacity, 1300 gallons net capacity due to Boron Pyrex Raschig Rings) through a filter, 1-F-1, (Sheet No. A-903) 4" diameter by 13-1/8" long.

302.6.4 <u>Equipment and Nuclear Safety, Pickle Liquor Systems</u>

The nuclear safety of the start of the pickle liquor process is assured by limiting the U-235 concentrations to less than 5 grams per liter (normally less than 2 grams per liter for pickle liquor) and limiting each batch in the treatment tank, 1-D-12 to 350 grams U-235.

Controls against double batching tank 1-D-12 exist since the capacity of the tank is 90 gallons. The 55 gallon pickle liquor batch plus the required neutralizing volume of ammonium hydroxide will exceed half the volume of the tank.

The quantity of ammonium hydroxide used is determined for neutralizing, but not to cause precipitation. Should precipitation occur, the 350 gram batch will assure safety.

Tank 1-D-41 safety is assured by the less than 5 gram per liter concentration. In addition the tank is filled with Boron Raschig Rings as backup safety. The filter 1-F-1 is safe geometry and will filter any insolubles and precipitate that may inadvertently occur in 1-D-12.

Since the solutions processed in tanks 1-D-12 and 1-D-41 are less than 5 grams U-235 per liter interaction effects on and by these tanks can be neglected.

302.6.5 Other Liquors

The processing of liquors other than pickle liquor will be done the same as described above including the specified concentration and batch control procedures.

302.7 Assay Tanks (Equipment Number 1-D-34A, B, C, Sheet Number A-902)

302.7.1 Process and Equipment Description

These tanks (5" diameter by 10'6" long) receive adjusted filtered solutions from the Teflon lined Dissolver (1-J-1), the unlined Dissolver (1-J-4), and the tray Dissolvers (1-J-5A and B), and the all purpose Hood (1-L-18) for sampling and weighing. The proper Assay Tank is rolled into place and the flexible connections made. Assay Tanks are fitted with physical spacers to maintain a minimum surface to surface distance of 24" between tanks. Solution from the appropriate Dissolver is valved into the Assay Tank. When the tank has filled, the required samples for Accountability are obtained.

After sampling and weighing, the solution is transferred to the Extractor Feed Tanks (1-D-9A to F) which are each 5" diameter by 45' long, capacity 45 gallons, and will serve as feed to the Extraction Column or the Mixer Settler (1-C-1, future).

Equipment associated with the Assay Tanks are as follows:

a) Scale (1-W-2), 220 kgs capacity, beam capacity 5 kgs., 1000 g. dial, 2 blank beams to provide tare.

b) Demister for the removal of entrained droplets in the air stream, 3" diameter by 18" long.

c) Five inch diameter vent bottle as backup protection for any liquors that may carry past the Demister.

302.7.2 Nuclear Safety

The maximum solid angle subtended at the Center Assay Tank (1-D-4-B) is less than 3.2 steradians.

303. Purification Process Area (Sheet Number A-602, Bay XX, 3 Levels)

303.1 General

The extraction area is designed for the safe processing of fully enriched uranium through the use of safe geometry equipment extraction columns. Solutions will overflow to the floor before flowing to unsafe geometry equipment.

Activities in this area include:

1) Extraction of uranium from impure acid solutions from the head end processing areas by employing an organic solvent.

2) Scrubbing of the organic solvent with an aqueous solution.

3) Stripping the organic solvent of the uranium present.

4) Removal of traces of organic solvent from the aqueous strip solution stream.

5) Clean up of organic solvent before recycling.

303.2 Equipment and Process Description, Pulse Columns and Cleanup Systems

303.2.1 Extraction Column (Equipment Number 1-C-6, Sheet Number A-904)

Acid feed to the extraction column (32 feet long by 3 inches diameter, vertically mounted and fabricated of stainless steel and glass) is transferred from the extractor feed tanks (1-D-41) or (1-D-9) through either of two metering pumps (1-P-2A and B).

Organic solvent is transferred to the extraction column from the solvent feed tank (1-D-5) through a metering pump (1-P-33).

As the two streams, acid feed and organic solvent, make contact in the extraction column, the organic stream selectively removes the uranium from the acid stream which enters near the top of the column while the organic solvent enters near the bottom. As the two immiscible solutions flow countercurrently through the column, the entire contents are being pulsed by a bellows type pulse generator.

303.2.1 (Continued)

The acid discharge from the bottom of the column extracted of uranium is transferred as raffinate to either of the slop tanks (1-D-21A and B, 1200 gallon capacity, 800 gallons net, due to Boron Pyrex Raschig Rings) by means of pump (1-P-4) and held for further treatment.

The uranium bearing organic solvent discharges from the top of the column, flows by gravity as one feed stream to the lower portion of the scrub column (1-C-7).

303.2.2 Scrub Column (Equipment Number 1-C-7, Sheet Number A-904)

The scrub column (15' x 3" diameter) operates in the same manner as the extraction column. Uranium bearing organic solvent enters the lower portion of the column by gravity as overflow from the extraction column. An aqueous solution enters the top of the column by gravity from the scrub solution tank (1-D-3, 400 gallon Capacity). Little exchange of uranium between the organic solvent and the aqueous phase takes place in this column.

The aqueous phase discharging from the bottom of the column is transferred as another feed stream to the extraction column by means of the scrub recycle pump (1-P-30).

The uranium bearing organic solvent stream discharging from the top of the column is transferred to the stripper column (1-C-8) as feed.

303.2.3 Stripper Column (Equipment Number 1-C-8, Sheet Number A-904)

The stripper column (same as 1-C-6) operates in the same manner as the extraction column. Uranium bearing organic solvent from the scrub column enters the lower portion of the column as feed and strip solution enters the top of the column from either of the strip solution tanks (1-D-6A and B, 400 gallon capacity).

As the two immiscible streams make contact in this column, the uranium tied up by the organic solvent transfers to the aqueous strip solution.

303.2.3 (Continued)

The organic solvent minus the uranium flows by gravity through the solvent cleanup column (1-D-9) containing an aqueous solution, e.g., sodium carbonate, and then to the solvent storage tank (1-D-5) to be recycled through the process.

The aqueous solution containing the purified uranium, flows through a column (1-C-10) containing an organic, e.g., trichlorethane, to remove traces of organic solvent, and then pumped to the overhead OK liquor storage tanks, (1-D-10 A, B, and C).

303.2.4 Organic Feed Tank (Equipment Number 1-D-5, Sheet Number A-904)

This tank (1-D-5, 80 gallons capacity - net capacity 62 gallons containing Boron Raschig Rings) serves as a feed tank to the extraction pulse column and also as the bulk storage tank for Tributyl Phosphate.

303.2.5 Scrub Solution Tank (Equipment Number 1-D-3, Sheet Number A-904)

This tank (400 gallon capacity) is located on the third floor above the pulse columns. The weak scrub solution is made up of nitric acid from the outside storage tank, distilled water, and/or ammonium hydroxide from the outside storage tank. *

303.2.6 Strip Acid Tanks (Equipment Number 1-D-6A and B, Sheet Number A-904)

Solution made up in these tanks (400 gallons) is an aqueous solution. *

303.2.7 Sodium Carbonate Tank (Equipment Number 1-D-11, Sheet Number A-904)

This tank has been removed. *

303.2.8 Distilled Water Tank (Equipment Number A-9, Sheet Number A-907)

Distilled water is supplied to the plant facilities requiring the water from Holding Tank A-9 (750 gallons capacity). Pressure fro the system is maintained by means of pump, A-10 and pressure tank A-11, twelve inch diameter by six feet long.

303.3 Equipment and Nuclear Safety, Purification System

The individual elements of the extraction are safe by diameter -- the largest diameter being three inches. The cross sectional area of the individual pulse column and its associated piping is less than that of a five inch diameter.

The maximum interaction solid angle has been calculated as 2.39 steradians and occurs at column 1-C-8. This was calculated on the basis that each column and its associated piping is equivalent to a five inch diameter. In that the columns are actually three inches diameter the allowable solid angle is greater than 3.2 steradians.

The system has been designed such that uranium containing solution cannot flow inadvertently into unsafe geometry vessels or where this possibility exists such vessels have been protected by Raschig rings. Examples of such preventative measures are:

1) Tank 1-D-3 has been protected by lowering the vent line 1" SCR from column 1-C-7 to a point below the bottom of 1-D-3.

2) The chemistry of the process is such that the raffinate is less than 0.1 grams U-235 per liter; also the solvent recycled to tank 1-D-5 will have a uranium concentration less than 5 grams per liter as a result of the process chemistry. These tanks have backup protection afforded by Raschig rings.

303.4 Waste Liquor Processing (Sheet Number A-602, Bay XlX and Outside Lagoon)

303.4.1 Waste Treatment Tanks (Equipment Number 1-D-14A and B, Sheet Number A-905)

The waste treatment tanks receive raffinates from the Filtrate Tanks (1-D-24A and B) and the Slop Tanks (1-D-21A and B). After sampling and analysis to confirm a U concentration less than 0.1 grams per liter pumping is required to transfer the solutions. Vents on the Filtrate & Slop Tanks and the elevation of the piping above the tank prevent solution from flowing to Waste Treatment Tanks except by pumping. Lime is added to the solutions to neutralize and to precipitate insoluble hydroxides. Contents of the waste liquor tanks are discharged by pumping the slurry to the waste lagoon. *

The Waste Treatment Tanks are of 750 gallon capacity, each containing an agitator for mixing.

303.4.2 Equipment and Nuclear Safety

The nuclear safety of the Waste Treatment Tank is assured by the fact that the waste solutions result from extraction raffinates and ADU precipitation filtrates. These processes are designed to produce U-235 concentrations in the waste streams of less than 0.1 gram per liter. This is verified by the sampling and analysis of tanks 1-D-24A and B and 1-D-21A and B, and shift supervisor approved prior to transfer to the Waste Treatment Tank 1-D-14A and B. *

303.4.3 Waste Lagoon (Sheet Number Y-403)

The waste lagoon is employed as a settling basin and holding pond. The effluent from the pond discharges through a flow indicator to the sewer which discharges into the Pawcatuck River. A sample of the effluent is taken on a continuous basis and analyzed to determine the composition of the discharge to the sewer. Average flow of effluent from the lagoon is 450 gallons treated waste per day; minimum flow of the Pawcatuck River is 9.7 million gallons per day. A dilution of 200,000 to 1 is anticipated as the waste leaves the plant property. *

303.4.3 (Continued)

The lagoon is lined with overlapping polyethlene sheets which have been joined with a heat-weld seam. When the lagoon has filled sufficiently to require removal of solids, a new liner will be laid down. Although we do not anticipate any significant contamination of the subterranean waters, samples of this water will be taken (of the plant drinking water) once a month and checked for increase of alpha and beta activity, fluoride, nitrate, and elements present in the waste effluent such as Zr, Al, etc. *

303.5 Other Waste Streams

No process streams are connected into the septic tank and leach bed system. *

304. End Product Processing Area, (Sheet A-602, Bays XXI, XVIII, XVII, XV, XIV)

304.1 General

The end product processing area is designed for the safe processing of fully enriched uranium through the use of safe geometry equipment. The process consists of concentrating OK liquor by evaporation, precipitation of the uranium as ADU and pyrohydrolysis of the ADU to uranium oxide. Uranium containing solution as feed to this area is from the OK liquor storage tanks and the finished product stored in designated storage area.

304.2 OK Liquor Evaporator (Equipment Number 1-E-2, Sheet A-702, Bay XXI)

Uranium containing liquor enters the system from the OK liquor hold tanks (1-D-10) through a flow indicator. The solution is * concentrated by means of a 5" vertical steam evaporator. Vapor and entrained liquid pass through a cyclone where the entrained liquid is separated and returned to the evaporator. The vapor phase passes through an entrainment separator where final traces of liquid are separated. A condenser (1-D-1) cools the vapors and the condensate flows to the filtrate tanks (1-D-24A & B). Once the concentration of the uranium in the condensate is established by sampling and analysis, the condensate is recycled to the OK liquor holding tanks (1-D-10 A, B and C) or to the waste equipment tanks (1-D-14A and B).

The concentrated OK liquor after reaching a predetermined specific gravity, is transferred by means of a pump to an OK liquor storage tank (1-D-10) for further processing or to the extractor feed tanks (1-D-9A to F, each 5" diameter by 45' long) for reprocessing.

304.2.1 Nuclear Safety of Evaporator (1-E-2)

a) Evaporator

The evaporator is a standard shell and tube heat exchanger -- the shell being a safe 5" diameter. OK liquor passes through on the tube side with steam on the shell side.

Unvalved vent line ($\frac{1}{2}$" VC) from top of 2 inch pyrex pipe leg prevents an inadvertent pressure build up. *

b) Cyclone

The cyclone separator is 6" diameter with a straight side length of $12\frac{1}{4}$"; the 6" diameter is reduced to a 3" diameter condensate discharge over a transition length of 12" making the overall length of the cyclone $24\frac{1}{4}$".

THE CYCLONE NORMALLY IS NOT FLOODED WITH LIQUOR. IT CAN ONLY BE FLOODED IF THE EVAPORATOR IS OVERFILLED. UNDER CONDITIONS OF A FLOODED CYCLONE SAFETY IS ASSURED SINCE THE 6" DIAMETER IS SAFE FOR AN INFINITE LENGTH UNDER CONDITIONS OF NOMINAL REFLECTION. CONDITIONS OF NOMINAL REFLECTION ARE ASSURED SINCE THE WALL THICKNESS IS ONLY 5/16" WHEREAS UP TO 1" OF STEEL CONSTITUTE NOMINAL REFLECTION (PAGE 13, TID-7016, REVISION 1). ALSO, IT IS 13' ABOVE THE FLOOR SO THAT REFLECTION BY WATER IS IMPOSSIBLE. FINALLY, IT IS SUFFICIENTLY SEPARATED FROM OTHER ITEMS SUCH THAT THEIR EFFECT CAN BE ASSUMED NOT TO EXCEED THE 1" THICK STEEL REFLECTOR LIMIT FOR NOMINAL REFLECTION. * * *

FOR ADDITIONAL SAFETY THE OUTSIDE OF THE CYCLONE IS WRAPPED WITH CADMIUM OF A MINIMUM THICKNESS OF .030" AND A MAXIMUM THICKNESS OF .055". THREE INCH DIAMETER PIPES CONNECTING INTO THE CYCLONE FROM THE TOP AND SIDE ARE ALSO WRAPPED FOR A DISTANCE OF 10" FROM THEIR POINT OF CONNECTION WITH THE CYCLONE. THESE SHEETS OF CADMIUM WILL BE HELD IN PLACE WITH STEEL STRAPS PAINTED WITH A POLYESTER RESIN. *

REFER TO PARAGRAPH 302.5.2 FOR A DISCUSSION OF THE NUCLEAR SAFETY OF THE CADMIUM WRAPPED 6" DIAMETER CYLINDER. *

THE INLET AND DISCHARGE ON THE CYCLONE AND THE CYCLONE ITSELF ARE EQUIVALENT TO A 3" x 3" x 6" TEE CONNECTION. THIS TEE IS EQUIVALENT TO A 4.2" DIAMETER PIPE BY THE METHOD OF PIPE INTERSECTIONS OF PAGE 20, TID-7016, REVISION 1, AND IS, THEREFORE, A SAFE TEE UNDER CONDITIONS OF FULL REFLECTION. THIS IS A CONSERVATIVE CONCLUSION IN THAT THE CADMIUM WRAP HAS NOT BEEN INCLUDED IN THIS ANALYSIS. *

c) <u>ENTRAINMENT SEPARATOR</u>

THIS SEPARATOR IS USED TO REMOVE ANY MISTS THAT MAY PASS THROUGH THE CYCLONE. A VENT LINE FROM THE EVAPORATOR SYSTEM IS LOWER THAN THE SEPARATOR ELIMINATING THE POSSIBILITY OF FLOODING THE SEPARATOR. ALSO, THIS SEPARATOR WILL BE FILLED WITH BORON RASCHIG RINGS, HEAVY STAINLESS STEEL MESH SCREEN WILL BE INSTALLED OVER THE BOTTOM PIPE OUTLET TO PREVENT LOSS OF RINGS (ALSO, SEE PAGES 1 AND 2 OF THIS SECTION). *

d) <u>FLASH TANK</u> *

THE DIMENSIONS OF THE FLASH TANK 3" DIAMETER x 8" LONG.

e) <u>CONDENSER 1-E-1</u> *

CONDENSER 1-E-1 IS 4.987 INCH INSIDE DIAMETER AND THUS GEOMETRICALLY SAFE.

f) <u>INTERACTION</u>

THE MAXIMUM SOLID ANGLE CALCULATED FOR THE EVAPORATOR SYSTEM IS LESS THAN 1 STERADIAN.

SUBJECT: PROCESSING - FACILITIES AND EQUIPMENT

END PRODUCT PROCESSING

ISSUED SEPT. 10, 1964

SUPERSEDED FEB. 18, 1964

G) <u>GENERAL</u>

THE FOLLOWING OPERATING CONTROLS WILL BE APPLIED TO THE EVAPORATOR:

1. IN OPERATION PRESSURE ON SHELL SIDE EXCEEDS TUBE SIDE PREVENTING ANY LEAK OF URANIUM INTO SHELL SIDE. *

2. THE STEAM CONDENSATE DRAIN FROM THE EVAPORATOR SHELL WILL BE KEPT OPEN WHILE EVAPORATOR IS NOT IN USE. (THIS WILL PREVENT ACCUMULATION OF URANIUM CONTAINING SOLUTION ON SHELL SIDE). A VACUUM BREAK VALVE WILL BE INSTALLED BELOW THE EXPANSION JOINT TO AVOID A VACUUM ON THE SHELL AFTER SHUTDOWN. THIS WILL AVOID FORCING OK LIQUOR INTO THE SHELL FROM THE T [illegible] N THE EVENT OF A TUBE LEAK. THERE WILL BE A CONDUCTIVITY METER TO CHECK THE CONDENSATE. BAD CONDENSATE WILL SOUND AN ALARM; IN THIS EVENT, THE OPERATOR WILL DIVERT THE CONDENSATE INTO A ONE GALLON BOTTLE UNTIL THE CONDENSATE IS OK OR THE UNIT SHUT DOWN. * * * *

3. DURING STARTUP THE SHELL SIDE CONDENSATE WILL BE DRAINED INTO A 4" DIAMETER SAMPLE CONTAINER AND CHECKED FOR ACIDITY (TO INDICATE ANY POSSIBLE LEAK INTO THE SHELL SIDE). *

4. Immediately after turning steam off in shutdown, the drain valve from the shell side will be opened. *

304.3 Filtrate Tanks (1-D-24A and B)

Filtrate tanks are 500 gallon size with a net volume of 360 gallons due to the addition of Boron Pyrex Raschig Rings. These tanks receive solutions from two sources, evaporator condensate and ADU filtrate. The filtrate pump recycles the solutions for mixing to obtain a check sample before discharging. The flow can also be directed back to the OK liquor hold tanks or to the waste treatment tanks. Since filtrates are normally less than 5 grams U-235 per liter as a result of process chemistry, interaction effects of and on these tanks can be neglected.

Process and equipment has been designed and will be operated to prevent concentrated solutions from reaching tanks 1-D-24 A and B. Examples of this are given in Section 304.4 (page 33 of 300). If through equipment failure or mis-operation some uranium does get through the filter, it will be small in amount and dilution in the tank will provide a degree of protection. *

Assuming concentrated liquor of an amount to cause concern does get into 1-D-24A or B, the following procedures and features will protect against having this material go to the waste treatment tank 1-D-14: *

a) Reference Drawing A-905/4 *

Elevation of line 1" R-6 is 87'-6". Elevation of top of tanks 1-D-24 A and B is 77'1". Tanks 1-D-24A and B and 1-D-14A and B are vented. Therefore, transfer by siphon action from 1-D-24A and B to 1-D-14A and B is impossible.

Also, maximum elevation of lines feeding tanks 1-D-10A, B and C is 86'-3". Elevation of tanks 1-D-10A, B and C and vent from 1-D-10A, B and C does not exceed this. Therefore, inadvertent drainage from 1-D-10 to 1-D-14 as a result of leaky valves is impossible.

b) Reference Drawing A-905/4

A positive break will be made between lines 1" LD 3 and 1" R6. A flexible hose or other suitable arrangement will be installed such that discharge of pump 1-P-17 can be connected to only one of the two lines. *

c) Transfer out of 1-D-24A and B requires supervisory approval which is based on uranium analysis of their content. (Reference paragraph 304.3). *

d) Tags or other appropriate means for ready identification are used on all valves and piping. *

304.4 ADU Precipitation (Equipment Number 1-D-20A, B, C & D, Sheet Number A-904)

Feed for the precipitators is transferred from the OK liquor storage (1-D-10A, B & C, 5" diameter by 60' long) as concentrated solution. A predetermined amount of solution is fed to the precipitators, four separate tanks in this system, and anhydrous ammonia is bubbled through the solution at a controlled rate. Agitation is induced by the addition of air.

Precipitation being complete, the slurry is pumped through a filter (1-F-4) to remove the ADU cake.

The ADU filtrate recycles to the precipitator until completeness of filtration or precipitation is established. Both filtration and precipitation being complete, the filtrate is directed through a polishing filter (1-F-15, 4" diameter by 13 1/8" long) to the filtrate tanks (1-D-24A & B referred to in 304.3).

The filter cake is washed with distilled water which has been added to the precipitator and treated with anhydrous ammonia.

Nuclear safety of the precipitators is assured by the 5" diameter tanks. The maximum solid angle subtended at 1-D-20B is less than one steradian.

304.5 ADU Filtration and Drying Hood (Equipment Number 1-1-11, Sheet Number A-709)

The hood 1-L-11 contains the ADU filter 1-F-4; it is attached to drying oven 1-H-1 which in turn is attached to glove box 1-L-20. With this arrangement the ADU filter cake can be transferred directly to the drying oven, the glove box and into the pyrohydrolysis reactor 1-R-2 within an enclosure at all times.

The ADU filter 1-F-4 is a plate and frame type filter press. Its active dimensions are 11" diameter x 3 1/4" high, which are safe per Table XV of K-1019, Fifth Revision. The press has two frames in which the cake accumulates; these are each 1 1/4" deep. The cake remains in the frame for drying in the oven. The solid angle subtended at the filter by two frames in oven 1-H-1, a full reactor 1-R-2 in loading position on hood 1-L-20, tanks 1-D-16, 1-D-10 and 1-D-20 is less than .5 steradians which compares with 1 steradian allowed for a safe geometry.

The two trays of wet ADU cake are removed from the safe geometry ADU filter, 1-F-4, and transferred to the drying oven (1-H-1).

The drying oven is limited to two 11" diameter by $1\frac{1}{4}$" filter trays (from 1-F-4) at one time by restricting the opening. The solid angle calculated at the drying oven 1-H-1 is less than .5 steradians.

SUBJECT: PROCESSING - FACILITIES AND EQUIPMENT

End Product Processing

ISSUED Sept. 10, 1964

SUPERSEDES

304.6 Reactor Loading (Equipment number 1-L-20A, sheet number A-709)

After the ADU has been dried, the two trays are transferred one at a time from the drying oven (via the discharge door) to the Reactor Loading Glove Box, 1-L-20. The dry ADU is scraped off into a funnel in the bottom of the glovebox which charges the Reactor (1-R-2) a 5" diameter by 3' 11" long tube with a flanged top. The Reactor is filled as it rests in the Reactor Loading Cart, 1-X-16, sheet A-905, under hood 1-L-20.

The nuclear safety of the glove box, 1-L-20 is based on administrative control to limit the glove box to one loaded filter tray in the glove box at any time. Although the reactor at 5" diameter is individually safe even if completely filled, its contents will be limited to 10 kilograms of uranium or less, approximately 3 filter (1-F-4) loads. The solid angle subtended at the Reactor (1-R-2) is less than 3 steradians.

304.7 Reactor Furnace and Cooling (Equipment numbers 1-H-3 and 1-D-42, Sheet A-905)

After the Reactor, 1-R-2, is loaded as discussed previously, the top reactor flange is secured and the Reactor is transported to and loaded into the Vertical Tube Furnace, 1-H-3, by means of the monorail hoist, 1-X-17 (sheet number A-905). Upon completion of the conversion cycle in the furnace, the Reactor is removed and placed in the Water Spray Cooler, 1-D-42. The nuclear safety for these items of equipment is based on the uranium being confined to the safe geometry (5" diameter) reactor.

304.8 Reactor Unloading Hood (Equipment number 1-L-8, Sheet number A-705)

After the Reactor has been cooled, it is transferred to the reactor holding fixture 1-X-18. The Reactor is then positioned and the flanged end of the Reactor is inserted into the Reactor Unloading Hood (equipment number 1-L-8, sheet number A-705) through the access flange of the hood. The support and sealing flange on the Reactor mates with the access flange on the hood to prevent leakage from the hood during unloading and milling. After the reactor is in position, the bolts of the top flange are removed, except for two which are inserted from the outside are loosened to allow oxide to flow freely and then removed to allow the remaining oxide to be scraped out of the Reactor with a hand tool as required. A transfer chute is used to funnel the uranium oxide to the pulverizer (equipment number 1-K-2, sheet number A-905). The milled material collects in a one gallon bottle mounted below the pulverizer. *

The volume of the mill is less than a safe one gallon. The one gallon bottle is safe volume and the bottle is separated enough such that interaction effects may be neglected. The nuclear safety of the reactor unloading hood overall is based on administrative controls to limit the total mass contained in the hood to one reactor load distributed between the reactor, mill and bottle. There is additional safety in that the material will be dry having been through the oven, 1-H-1 and furnace 1-H-3.

304.9 Interim Product Storage

As each gallon bottle from the pulverizer, 1-K-2, is filled it will be sealed, removed from the reactor unloading hood to hood 1-L-6, sampled, screened and then moved to product table where it is weighed and then stored in the product storage area in bay XII. The sample from each gallon bottle will be used for control analysis including LOI for moisture content.

304.10 Product Blending (Equipment Number 1-L-6, 1-M-1, 1-L-14 and 1-K-4, Sheet Numbers A-705 and A-709)

After the control analytical results are obtained, the product will be blended into lots of up to 10 kilograms of uranium. A blend sheet will be prepared by the shift foreman specifying bottles of product to be blended and analyzed. The one gallon bottle of product will be transferred to the 20 liter blender (1-M-1), the inlet of the blender will be closed. The blender is then transported to the milling and drying hood, 1-L-14, and rolled on the ball mill rollers, 1-K-4.

The nuclear safety of this equipment is based on administrative controls to limit the total mass of uranium to 10 kilograms or less at $H/U \leq 4$ as determined from an LOI test on each bottle. The total mass for the blender loading hood, 1-L-6 includes the uranium in the hood, airlock and blender tank. No water lines will be connected to glove box 1-L-6 and other hydrogenous or moderating materials will be excluded from glove box 1-L-6. *

304.11 Product Packaging and Blending Hood (Equipment Number 1-L-14, Sheet Number A-709)

After the product is blended, the blender is positioned on the discharge fitting in hood 1-L-14. The shipping containers are similar to a coffee can, 4 7/8" inside diameter by either 3 5/8" high or 6 3/4" high. A poly bag insert is used inside each can to prevent product contamination. The shipping container is loaded by use of the valve on the blender and the loading chute to funnel the uranium

SUBJECT: PROCESSING - FACILITIES AND EQUIPMENT

End Product Processing

ISSUED Sept. 10, 1964

SUPERSEDES

oxide into the poly bag. As each shipping container is filled, an aliquot sample is obtained, the poly bag is closed, the can is moved over to product table for sealing and weighing. The can is sealed with the can sealer, 1-X-14, and the sealed container is subsequently weighed and moved to the finished product storage area, bay XII, until analysis of the blend is received. One product container is in movement at a time.

305. Alternate ADU Precipitation (Equipment Number 1-D-19 A, B, and C, 4" Diameter by 8' Long)

305.1 Precipitation and Filtration

Fuel for these precipitators is transferred from the OK liquor storage tank (1-D-16, a 5" diameter tank by 45' long), or the OK liquor storage tanks 1-D-10A, B, and C.

A predetermined volume of solution is fed to the precipitators, two foot center to center, and anhydrous ammonia is bubbled through the solution at a controlled rate. Agitation is induced by the bubbling of air through the slurry.

Precipitation being complete, the slurry is transferred to Buechner funnels for filtration. The filtrate is collected in four liter filter flasks and transferred to eleven liter, five inch diameter polyethylene bottles. A sample of the filtrate is analyzed for uranium content. If less than 0.01 gram/liter the filtrate solution is disposed of through the waste treatment system.

Spacing is maintained between the Buechner funnels by materials of rigid construction. The maximum solid angle is subtended at tank 1-D-19B and is less than 1.1 steradians.

305.2 Dryer (Equipment Number 1-H-2, Sheet Number A-602)

After filtration, the ADU cake (still on the Buechner filter funnel) is dried in the oven 1-H-2. The oven can hold only one filter at a time.

The funnel enters the dryer through hood (1-L-16A). The dried ADU cake on the funnel is transferred from the dryer into hood 1-L-16B.

The dried filter cake is transferred from the funnel to either the muffle box trays described in Section 305.3 or into a one gallon polyethylene bottle.

The maximum solid angle calculated for the condition with a filter funnel in 1-L-16A, 1-H-2, 1-L-16B, a muffle box in place and a bottle in the bottle compartment of 1-L-16B is less than 1 steradian. From Figure 4 of K-1317 the multiplication factor, K, for a 10" diameter, 4" high cylinder is 0.6. Similarly, the multiplication factor, K, for the 6" diameter, 10" high one gallon polyethylene bottle is 0.6. The safe solid angle is therefore 3 steradians.

305.3 <u>MUFFLE BOX</u> (ITEM USED IN CONJUNCTION WITH EQUIPMENT NUMBER 1-H-4, SHEET NUMBER A-602)

THE DIMENSIONS OF THE MUFFLE BOX ARE SUCH (8" BY 8" BY 18" LONG) THAT NO MORE THAN TWO TRAYS, EACH 8 1/4" BY 15 5/8" BY 1 1/4", WILL FIT, ONE ABOVE THE OTHER.

THE NUCLEAR SAFETY OF THE MUFFLE BOX IS ASSURED BY THE FACT THAT:

A) THE END EDGE AREAS OF THE TRAYS ARE EQUIVALENT TO OR LESS THAN THAT OF A 6" DIAMETER CIRCLE.

B) A 6" DIAMETER CYLINDER 17.6" LONG IS "LIMITED SAFE" (PAGE 23, TABLE XV, K-1019, FIFTH REVISION). THE MULTIPLICATION FACTOR, K, FOR THIS CYLINDER IS 0.68 (FIGURE 4, K-1317).

305.4 <u>MUFFLE BOX FURNACE</u> (EQUIPMENT NUMBER 1-H-4, SHEET NUMBER A-602)

THE MUFFLE FURNACE IS A HIGH TEMPERATURE FURNACE USED FOR PYROHYDROLYSIS OF ADU TO URANIUM OXIDE. THE FURNACE WILL HOLD ONLY ONE 8" BY 8" BY 18" MUFFLE BOX.

THE SOLID ANGLE SUBTENDED AT THE MUFFLE BOX IN THE FURNACE IS 0.5 STERADIANS.

305.5 <u>MUFFLE BOX COOLER</u> (EQUIPMENT NUMBER 1-H-6, SHEET NUMBER A-602)

THE COOLING OF THE MUFFLE BOX IS ACCELERATED BY A WATER SPRAY ON THE OUTSIDE OF THE BOX. THIS IS CARRIED OUT IN COOLER CHAMBER (1-H-6) WHICH HAS A CAPACITY OF ONE MUFFLE BOX.

THE MUFFLE BOX WILL BE UNLOADED INTO EITHER HOOD 1-L-14 (SECTION 302.2.3) OR HOOD 1-L-98 (SECTION 302.2.5). THE SOLID ANGLE SUBTENDED AT THE MUFFLE BOX IN THE COOLER IS 0.82 STERADIANS.

501. RECEIVING AND STORING PROCEDURE

Each shipment of uranium entering the plant is accompanied by a packing list. This is followed by a Form 101 or Form 388 covering the shipment. Each container is check weighed against the Shipper's weight. These weights normally correspond to within one part in a thousand. The container identification and enrichment is then entered into a log book maintained by the Fuels Plant Superintendent. At this time tags for each container are made up showing the container identification, enrichment, and gross, tare and net weights.

The tags and packing list are given to a receiving clerk who unloads the truck. The receiving clerk makes up a receiving sheet showing the container indentification, enrichment, gross, tare and net weight and the UNC gross weight. The containers are then taken to a proper storage area where the entire shipment is stored either : *

a) 12 feet (or a distance across an orthographic projection of either array on a plane perpendicular to a line joining their centers whichever is greater) from any other special nuclear material, or

b) separated from other special nuclear material by an 8" thick solid concrete wall.

Incoming materials will normally be stored outside in the as received container. In some cases the containers maybe stored inside in accordance with the criteria for outside storage. If the material is removed from the container, will be stored in an approved storage location according to procedures described elsewhere in this application. * * *

502. TRANSFER TO PROCESSING AREA

The receiving ticket is given to the Fuels Plant Superintendent who checks it against his records and also checks it against the UNC gross weight. The receiving ticket is given to accountability and the uranium entered into the accounting record.

To start material into the process, the Foreman fills out a job authorization form stating the container indentification(s), enrichment, process area, job symbol, gross, tare and net weight(s). The Fuels Plant Superintendent signs the authorization and crosses the lot (or containers) off his log. The foreman takes the authorization and instructs a man to bring the particular containers to the process area. The Foreman checks the container identification against the authorization form and signs the form verifying that the correct containers have been obtained.

The container is removed from the bird cage and moved to the processing area: when out of its birdcage only one container is moved at a time and then only in aisles or roadways which provide safe distance from other uranium.

503. OUTSIDE STORAGE

503.1 General

Uranium materials as scrap will be stored outside of the building, but within the fenced-in area in designated locations.

Criticality safety is provided by keeping the same container contents and geometric configuration as was used in the shipment of the material received at the plant. *

503.2 Equipment and Nuclear Safety

The area to be used for storage is paved and will be on the north side of the building as previously specified.

Incoming uranium material will be stored as received in tight drums or containers, which in turn will be kept in their bird cages; these will be checked for integrity prior to moving outside and tarpaulins or polyethylene bags will be used to further insure dryness if required.

Hand trucks will be used in moving containers from the weigh-in area to the outside storage area and later in moving into the processing area. One container will be moved at a time and its path of movement will be restricted to roadways and/or aisles to insure safety from interaction.

504. INSIDE STORAGE (IN PROCESS AND PRODUCT STORAGE)

504.1 General

Uranium materials are stored inside the building in specified areas which have been designed to provide criticality safety. Included is in-process and product storage as handled in Bays X, XII, XIII and XVI.

Safety is achieved by use of: 1) limited safe diameter containers properly spaced by physical separation devices and/or 2) limited safe volume containers.

504.2 Equipment and Nuclear Safety, Eleven Liter Bottles and Overhead Storage Tanks

504.2.1 Eleven Liter Bottle Carts *

Five inch outside diameter by 48 inch high (11 liter) polyethylene bottles will be used for the storage of uranium bearing liquors. This includes concentrated (up to limits of solubility) liquors and filtrates (0.01 grams per liter).

Each bottle is stored on an 11 liter bottle storage dolly of rigid steel construction. This dolly is designed to provide two foot surface to surface spacing of the bottles. Space for 24 dollies is designated in Bay XIII. It will run East-West in two rows of twelve bottles each. *

504.2.2 Overhead Storage Tanks (1-D-9A to F)

Above the 11 liter bottle storage are horizontal storage tanks containing uranium liquors which feed the extraction system. There are six of these overhead tanks, each 5" I.D. by 45' long. They are located 14' - 9" above the building floor and are spaced 30" center to center.

504.2.3 Interaction Calculations

This solid angle subtended at the central 11 liter bottle by the adjacent bottles, overhead tanks and nearby equipment is 1.4 steradians. The solid angle subtended at the central tank 1-D-9-D is 2.7 steradians.

SUBJECT: NON-PROCESSING STORAGE - FACILITIES AND EQUIPMENT
INSIDE STORAGE

ISSUED Sept. 10, 1964

SUPERSEDES Feb. 19, 1964

504.3 Equipment and Nuclear Safety, Storage Shelves for Uranium Alloys, Compounds or Solution

There are five 8' high, 12" thick solid concrete block walls providing separation and support for storage. These are located as shown in Bay XII. The shelves are used for storage of any combination of containers of metal, solutions and wet or dry compounds. The following is a schedule of containers used:

Type Material	Container Size Steel Cans	Maximum Quantity Per Container
Uranium Metal	4½" diameter by 5½" high, or 5" diameter by 4" high, or any smaller container	10 kgs. U content and up to 18.8 gms U/cc density *
Wet or Dry Uranium Compounds or Solutions	1 gallon poly bottle, 6" diameter by 10" high	12.8 kgs. U @ 3.2 gms U/cc
Dry Uranium Compounds Only	5" diameter by 6½" high	6.6 kgs. U @ 3.2 gms U/cc
Product retainer samples in small poly bottles. Dry production residues in small poly bottles	5¼" diameter by 12" high steel can	2 kgs.

The shelves are as shown on Drawing A-602. Storage is on individual shelves for the containers arranged to give 1' - 4" horizontal center to center spacing and 1' - 8" vertical center to center spacing. *

U Metal Alloy Storage Container

The 10 kg. total uranium content of this container is based on containing individual pieces having a minimum weight of 100 grams. If particles (or pieces) are less than 100 grams each, the appropriate category below must be followed. *

The following table lists the H/X ratios and U-235 densities for several enrichments assuming the container is flooded.

Enrichment	H/X 1	H/X 2	Kg U-235 per Container	Effective U-235 density kg/liter 1	Effective U-235 density kg/liter 2
93	.206	1.06	11.2	14.8	8.65
83.4	.23	1.18	10.0	13.2	7.7
80	.24	1.23	9.6	12.7	7.45
50	.38	1.96	6.0	7.95	4.65
25	.77	3.92	3.0	3.98	2.32
10	1.9	9.8	1.2	1.59	.93
5	3.8	19.6	.6	.795	.46

Column (1) Assumes flooding to height of alloy only
Column (2) Assuming flooding entire container

Comparing the H/X ratios and "effective" U-235 densities to Figure 2 of TID-7016, Revision 1, it can be seen that in all cases the 1.3 liter volume of the container is less than the limited safe volume. Also, except for enrichments greater than 83.4%, the U-235 content per container is less than the limited safe mass from Figure 1, TID-7016, Revision 1. The 11.2 kg U-235 @ 93% enrichment is less than ½ the minimum critical mass of water reflected 93% enriched metal sphere. In the event of water moderation, safety is still assured since from Table V of LA 2026 it can be seen that the minimum critical mass of 306.8 gram metal cubes water moderated is 20.7 kg U-235 and requires a total core volume of 5.8 liters, while the minimum critical mass of 38 gram cubes is 13 kg U-235 and requires a volume of 8.8 liters. This reference also shows that the minimum critical mass decreases as the piece size decreases, but also that the corresponding volume increases up to 13.5 liters. This is to be compared to the mass of 11.2 kg U-235 in a maximum volume of 1.3 liters for the container in question.

Wet and Dry Compounds and Solutions

The one gallon polyethylene bottles have a smaller volume than the limited safe volume (4.8 liters) for conditions of optimum moderation and reflection.

The 5" diameter x 6½" high steel cans have a smaller volume than the one gallon bottles. The 5½" diameter x 12" high residue storage can is a safe geometry per Table XV of K-1019, 5th Revision for optimum moderation and reflection.

Since only low density compounds and solutions are packaged in these containers, the containers are individually safe by volume for conditions of optimum moderation and reflection. Further comment is not required.

Interaction

The one gallon bottles have been assumed to be the most reactive unit due to size and intended usage. From Figure 4 of K-1317 the multiplication factor for this container is 0.6. The corresponding safe solid angle from Figure 26 of TID-7016, Rev. 1 is 3 steradians.

The solid angle calculated for the central unit is 2.56 steradians when all units of the array are considered. This reduces to 2.10 steradians when only the "visible" units are considered. *

600. CONTROL LABORATORY FACILITIES

Only control laboratory operation will be handled at this facility consisting of routine quality control tests. As such, the laboratory may handle materials up to fully enriched.

Samples for finished lot testing, special analyses, etc., will be sent to United Nuclear facilities at New Haven or other qualified laboratories. Such samples will be packaged and mailed in accord with Atomic Energy Commission and postal regulations and will be in amounts of less than 16 grams uranium per shipped package. *

600.1 Nuclear Safety Criteria

Criticality control will be based on limited safe mass or volume in the laboratory equipment. Also, there will be a safe geometry rack which will be used to store incoming samples, outgoing samples and reserve samples. The limited safe mass or volume will be determined in accordance with the criteria of TID-7016, Revision 1 or K-1019, 5th Revision.

The chemist responsible for the work in progress in the laboratory is responsible for effecting the necessary controls in the zone. *

600.1.1 Equipment and Nuclear Safety

Samples will be received in four ounce size containers and placed in the safe geometry storage rack.

Criticality control away from the rack will be achieved by limiting (through logging control) the amount being worked on in the lab facilities to one limited safe mass amount (350 grams U-235) which is distributed throughout the laboratory.

The storage rack consists of shelves on both sides of a 12" thick concrete block wall. The shelf construction is such that it will hold only 1-1/2" I.D. sample containers thus achieving a safe slab configuration. The 12" thick solid concrete block wall provides adequate protection from interaction of the two slab configurations.

601.1.1 (continued)

There is an aisle on each side of this wall, providing 5' spacing from the nearest additional uranium which would be samples being worked on in laboratory equipment across the aisles.

700. SHIPPING CONTAINERS

701. Summary listing

Shipping containers used for incoming material and storage prior to recovery will be as licensed by the shipper. Shipments of product out of the plant will be in containers listed below by their assigned Bureau of Explosives Permit: *

BE Permit 1351

Use: Uranium Metal or dry compounds up to fully enriched. Maximum density full metal or 6 gm/cc for compounds.

Transportation: Nineteen units LCL, LTL, Air or Railway Express.

Reference Drawings: SK-5, SK-23, SK-23-1 (submitted previously in our license SNM-33 renewal application of July 15, 1963)

BE Permit 1483

Use: Uranium compounds up to fully enriched. Uranium density less than 3.2 grams U/cc. *

Transportation: Nineteen units LCL, LTL, Air or Railway Express.

Reference Drawings: SK-255-1-5 and SK-8. (Submitted previously in our license SNM-33 renewal application of July 15, 1963). *

Single layer shipments are specified for all of the above. "DO NOT DOUBLE STACK" will be stenciled on each outside container. Except for exclusive use, shipments carrier certification will be obtained from each carrier enroute that he will not co-mingle any shipment with any other shipment of radioactive or special nuclear material. This certification will include handling procedures at transship points. *

702. Nuclear Safety

702.1 BE Permit 1351

The assembled arrangement of the container is shown on Sketch SK-5 with details of the supporting stools and inner pot or container shown on sketches SK-23 and SK-23-1..

Dry uranium compounds will be packaged in 350 cc polyethylene bottles with self sealing screw-on lids or hermetically sealed metal cans (five inch diameter by four inches) similar to one pouhd vacuum packed coffee cans. Three polyethylene bottles or one can fill the inner container.

The bulk density of the compounds may be as high as 6 grams per cc with individual particle densities as high as 10 grams per cc.

The following is a tabulation of data calculated on the assumption that water fills the void spaces of the containers shown on SK-23. From this tabulation it can be seen that safety of the individual container is assured.

Uranium Compounds

Volume of pot shown on Drawing SK-23 is 2316 cc.

Bulk volume of material	1050 cc
Maximum weight of material	6300 grams
Net volume of material	630 cc

Enrichment	H/U-235	Effective U-235 Density gm/cc	Safe Mass* Kg U-235	Kg U-235 Per Container**
93	8.5	2.25	5.7	5.2
50	15.8	1.2	4.6	2.8

* From Figure 1, TID-7016, Revision 1 including enrichment allowance.

** Calculated on UO_2 basis.

From the above table it can be seen that the individual units are safe under conditions of flooding the containers and reflection. In the event of flooding, each container will be isolated from the others by more than eight inches of water.

In addition, safe interaction is assured under conditions of no flooding since as it was shown in paragraph 504.3 that the multiplication factor of the container is less than 0.6, for which a solid angle of 3 steradians is safe. This is to be compared with the following listed solid angles for this container:

Nineteen drum single layer array	1.13 steradians
Infinite single layer array	2.5 steradians
Five layers of nineteen drums each	3.3 steradians

Thus, several nineteen drum shipments would have to be combined before safe interaction limits would be exceeded. A copy of these calculations has been submitted previously in our license SNM-33 renewal application of July 15, 1963.

702.2 BE Permit 1483

The details of the container are shown on Sketch SK-251-1-5 and SK-8. (Submitted previously in our license SNM-33 renewal application of July 15, 1963) Basically the container consists of a six inch O.D. by five and one-fourth inch I.D. seamless steel tube centered in a 65 gallon steel drum. The uranium compounds will first be hermetically sealed in a "tin" can of the type and size used for vacuum packed coffee cans. Solutions will be bottled in polyethylene bottles with a capacity of approximately one gallon. In either case, this container will then be loaded in the five and one-fourth inch I.D. tube.

Nuclear Safety

The five and one-fourth inch I.D. by thirty-six and one-half inches high cylinder is a nuclearly safe geometry (Table XV and Figure 4, K-1019, Fifth Revision). The multiplication factor of a vare five and one-fourth inch diameter infinite cylinder is 0.61 (Figure 4, K-1317, Self Consistent Criteria for Evaluation of Neutron Interaction.) A safe solid angle, therefore, is 2.9 steradians (Figure 6, K-1019, Fifth Revision). The calculated solid angle subtended at the central drum of a nineteen drum close packed hexagonal array is 2.69 steradians.

UNITED NUCLEAR
CORPORATION

SUBJECT:

EMERGENCY ALARM SYSTEM

ISSUED Sept. 10, 1964

SUPERSEDES Feb. 1, 1964

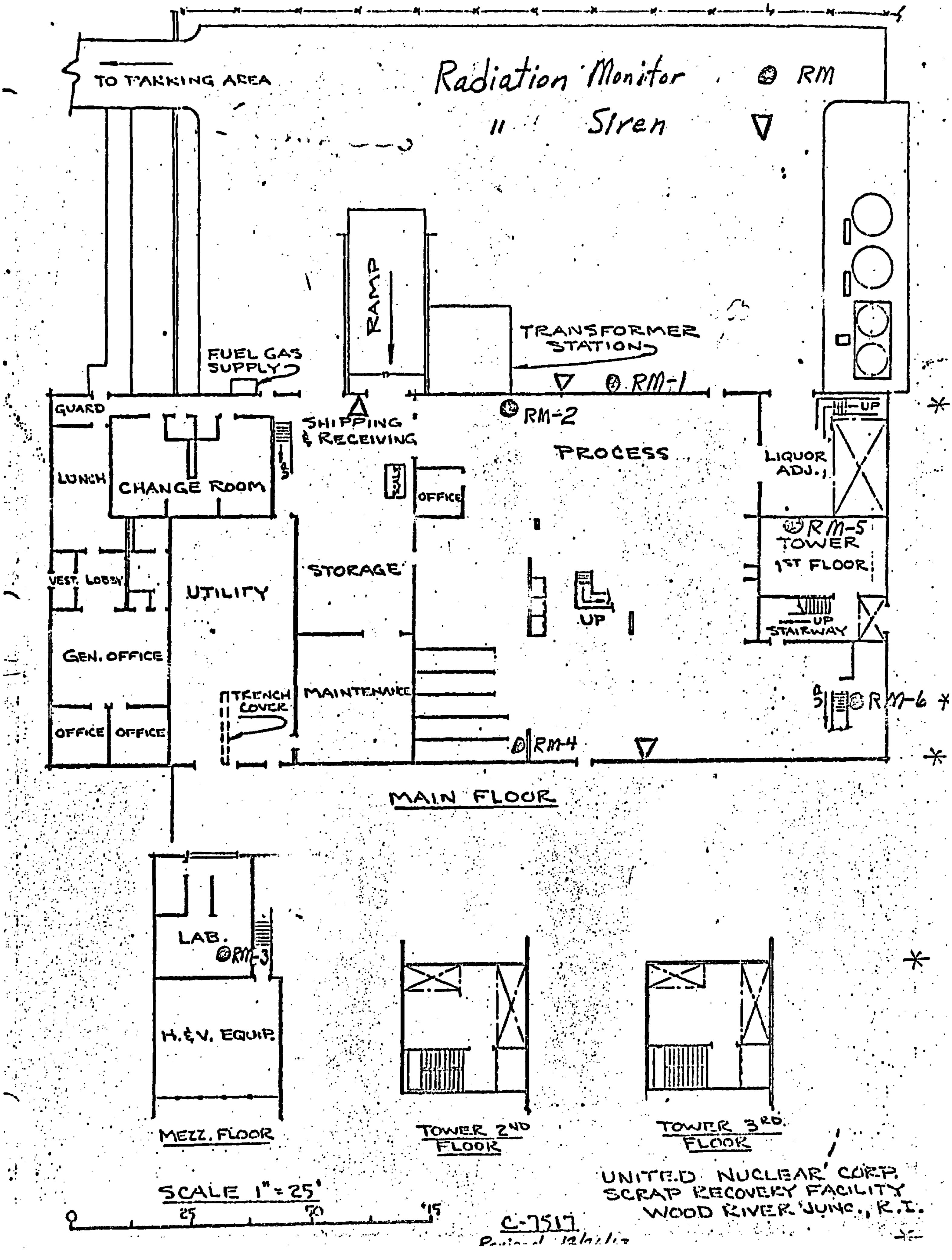
There are two emergency alarm systems in the scrap recovery facility. The nuclear alarm system is fully automatic and is protected by channel failure circuitry. The fire and non-nuclear alarm is sounded manually. Both systems are backed by an emergency power supply.

801. Nuclear Alarm System

The nuclear alarm system consists of six gamma detectors which are tied into a central console in the guard station. Radiation striking any of the detectors in excess of 10 mr/hour will sound three sirens which are located inside and outside the building. Location of the detectors and sirens is shown on the following page. *

The detectors used are Nuclear Measurements Corporation Model GA-2A and/or Model GA-2. Specifications for the detectors are: *

SIZE:	12" wide x 15" high wall space, 8-5/8" deep mounting, four 5/16 holes on 10" x 14-3/4" centers
WEIGHT:	18 lbs.
ACTIVITY DETECTED:	Gamma, 30 KV up
PRECISION:	±20% at all levels
HIGH VOLTAGE SUPPLY:	Adjustable - 800 to 1000 V
DECONTAMINATION:	Dust-tight, gloss enameled steel cabinet
SENSITIVITY:	Basic range 0.05 to 50 mr/hr, logarithmic. Other ranges optional
CONTROLS:	Switch, off-on. Alert and alarm settings on indicating meter.
CONNECTORS:	10 contact terminal for ground, 60 cycle 90-130 VAC, remote alert, alarm, and recording
TIME CONSTANT:	20 seconds
STABILITY:	±2% of full scale deflection
CRYSTAL TYPE:	Plastic phosphor, large volume
TUBE COMPLEMENT:	1-5963, 1-6005, 1-082
TEMPERATURE RANGE:	-20° to $120^{\circ}F$
CURRENT REQUIREMENTS:	45 VA, 60 cycle 90-130V single phase
SPECIAL FEATURES:	Large phosphor volume provides essentially body equivalent wave length sensitivity. Power supply totally regulated. Alarm and alert points separately adjustable over all scale. Insensitive to line transients. Very conservative operation. Industrial quality components.


Radiation Monitor RM
" Siren
TO PARKING AREA
RAMP
TRANSFORMER STATION
FUEL GAS SUPPLY
RM-1
RM-2
GUARD
SHIPPING & RECEIVING
PROCESS
LIQUOR ADJ.
UP
LUNCH
CHANGE ROOM
OFFICE
RM-5
TOWER 1ST FLOOR
VEST. LOBBY
UTILITY
STORAGE
UP
UP
STAIRWAY
GEN. OFFICE
TRENCH COVER
MAINTENANCE
RM-6
OFFICE
OFFICE
RM-4
MAIN FLOOR
LAB.
RM-3
H.&V. EQUIP.
MEZZ. FLOOR
TOWER 2ND FLOOR
TOWER 3RD FLOOR
SCALE 1" = 25'
0
25
50
75
UNITED NUCLEAR CORP.
SCRAP RECOVERY FACILITY
WOOD RIVER JUNC., R.I.
C-7517

SUBJECT: EMERGENCY ALARM SYSTEM

ISSUED Sept. 10, 1964

SUPERSEDES Feb. 4, 1964

The GA-2A detector does not keep up with an almost instantaneous rise in radiation, but lags to the extent that only 63% of a sudden change is read two seconds after the change has occurred. Thus, if the change is to a point only slightly above 20 mr/hr, the detector will probably not set off an alarm until some three or even four seconds after the change has occurred. On the other hand, should the change be to the region of, let us say 1000 mr/hr, the detector will trip in a very small fraction of a second after the advent of the radiation. This means that the response is practically instantaneous in the case of any severe outburst of radiation, although it is slightly delayed in the minimum cases.

Our instruments are so constructed that while some electrical failures will cause the general alarm to sound, others will merely actuate signal lights. In this way, supported by our own close routine inspection of the system, we hope to avoid false alarms and the confusion and anxiety they would cause, while still being immediately aware of any irregularity in the system.

The instruments are set to operate normally at a very low range of gamma radiation, most of which is provided by a tiny radiation source within each instrument case. A high level electrical contact is actuated if the range being measured by one of the detectors rises to 10 mr/hr, and a low level contact * is actuated if the range falls to the neighborhood of approximately 0.1 mr/hr. If the high level contact is actuated, the alarm sounds for evacuation of the work area and office. If the low level contact is actuated a light on the main panel of the alarm system comes on, indicating which detector sent in the signal. In addition, an amber light shows in the panel of the detector itself.

The placement of the detectors is such that the maximum distance to any stored or in-process fissionable material inside the building is less than 70 ft. Outside storage is less than 100 feet maximum from the storage yard detector.

The sirens which give the evacuation signal in event of a reading in excess of 10 mr/hr are Edwards #315, rated at 108 decibels. Two inside and one outside will provide an unmistakeable warning.

Power supply for the radiation monitors is designed to keep them operable despite general plant power failure. A 4.5 kv Empire Model 4-5DFA8 diesel generator provides auxiliary power for the radiation alarm circuits (emergency power to this circuit is automatic upon power failure), as well as for emergency perimeter lighting and the fire alarm system. The emergency power system will be checked at least once a week by manually actuating the automatic trip system * and observing the performance of the diesel unit.

UNITED NUCLEAR
CORPORATION

SUBJECT:

EMERGENCY ALARM SYSTEM

ISSUED Sept. 10, 1964

SUPERSEDES Feb. 1, 1964

In addition to the primary detection system, alpha and beta-gamma detectors are kept in the plant or on site for health physics work. Portable detection equipment is placed away from the plant for use in gaining re-entry after an alarm and for sorting exposed from unexposed personnel. Security badges worn by all personnel contain a 1-1/4" strip of indium foil which will aid in any emergency sorting. *

802. Non-Nuclear Alarms

Because of the small overall size of the plant, reporting of fire, explosion, or other non-nuclear incident will ordinarily be by voice communication, supplemented where necessary by in-plant telephone. Actuation of the fire alarm for evacuation of the building is performed manually at the guard station. *

803. Emergency Control Plan

Procedures for handling of fire, explosion, building collapse, nuclear incident, or other calamity are set forth separately in the attached Emergency Control Plan for the scrap recovery facility.

UNITED NUCLEAR CORPORATION

SUBJECT: HEALTH PHYSICS

ISSUED Sept. 10, 1964

SUPERSEDES Dec. 1, 1963

900. HEALTH PHYSICS

In general, all processing which generates dusts or fumes is enclosed in hoods or glove boxes. Hood refers to open face enclosures whereas glove boxes are totally enclosed with operations carried on by working through gloved openings.

Enclosures, whether open faced or glove box, are provided with forced ventilation. In the case of open faced hoods, this is designed such that a minimum face velocity of 150 fpm is maintained. Those operations that are especially dusty are provided with MSA absolute filters on the exhaust system.

Drawings A-705, A-709, A-710, A-302 and A-303 provide details of the hoods and the several systems including the location of the filters and exhaust fans in relation to the enclosure exhausted.

For additional details of the Health Physics Program, reference is made to the Health Physics Manual, United Nuclear Corporation, Fuels Recovery Plant. *

SUBJECT:

Industrial Facilities and Procedures

1001. Fire Protection

The Fuel Recovery Facility is a single-story steel frame building, with mezzanine and a 40' tower containing 15% of total floor space. All floors are concrete slab. Exterior walls, except in the office area, are 12" hollow concrete block to the main roof. Tower walls above roof height are 8" hollow block. Interior walls and office walls are entirely of masonry, ranging from 12" solid concrete to a 4" hollow block. The roof is a 20 year bonded asphalt roof over metal deck and fire-retardant barrier. Clear height in the main processing area is 17'8" and roof deck is a 19'2" above floor level. There is no basement.

Because of the accidental criticality risk attendant on the use of water for firefighting in the fuel processing area, reliance is placed on CO_2 equipment. Supplementing CO_2 hand extinguishers located throughout the plant is a wheeled CO_2 engine, American LaFrance Model 100S, with 40' hose. *

For fires outside the fuel processing area, water firefighting provisions have been made. A hydrant at the northwest corner of the plant provides take-off for a 1½" fire-fighting line and a supplementary garden hose. This hydrant and hoses will cover the storage yard, parking lot, office and change room areas, boiler room, and maintenance stores area. Other hose connections in the boiler room will provide water for grass fires to the south of the building.

Water pressure is maintained by a 500 gpm pump located 400' from the building (the well has a 700 gpm capacity) and a 10,000 water storage tank on the roof of the 40' tower.

Additional water for fire department pumping equipment is available from the Pawcatuck River, 1500' from the plant, at the plant outfall. A roadway to the river at this point is cleared for vehicular access. Minimum daily flow of the Pawcatuck at the United Nuclear site is 9,700,000 gallons/day.

The fire evacuation alarm consists of horns clearly audible throughout the plant, manually controlled from the guard station at the the northwest corner of the facility. *

The Alton, Carolina, and Shannock Volunteer fire companies are all located within two miles of the United Nuclear site and within 3 miles of the Fuel Recovery Facility. Each company has two engines. Two of the six engines are pumpers, with sufficient hose to reach the river. All six vehicles are radio-equipped and can summon additional assistance or specialized equipment from.

the professional companies in the City of Westerly or Wakefield, both within 12 miles of the site.

The local fire companies are instructed to proceed to the plant gate but to avoid running water lines into the plant except with approval of UNC supervisory personnel.

1002 Disposal of Radioactive Effluents

No process wastes are disposed of without analysis for uranium content. The value of materials processed precludes indiscriminate disposal of radioactive wastes. Waste streams which have been authorized for disposal after uranium analysis are lime treated and pumped to a settling lagoon from which the clear effluent is decanted to the Pawcatuck River. Lime treatment removes both uranium and fluoride to levels well below legal requirements. Alpha activity of waste effluent to the river will be $< 2 \times 10^{-5}$ μc/ml.

Control of waste streams and monitoring of the river, ground water, waste effluent, and air environment are described in detail in the health physics section of this application.

1003 Security Against Unauthorized Removal

All personnel in the plant are required to obtain and retain an L(X) or Q(X) security clearance. Careful inventories are maintained of all uranium in various plant areas. No material can be removed from the plant without written approval.

Regular patrols are made through the plant by security personnel at night, Saturdays, Sundays and when the plant is not in operation. The fence line is patrolled regularly. All shipments of highly enriched materials of $500 valuation or greater are dispatched via signature service or armed surveillance.

1004 Evaluation of Effects of Fire, Explosion and Credible Accidents

Due to the nature of the chemical compounds involved and the materials of construction of buildings and equipment, the fire risk is considered quite low. Inflammable liquids are not used in large quantities. The largest quantity of inflammable materials in process is forty to fifty gallons of 30% TBP-kerosene used in extraction of scrap materials. The kerosene has a flash point of 100°F-175°F alone; however, the addition of 30% tributyl phosphate reduces the fire hazard to the point where the mixture will hardly sustain combustion without the application of an external source of ignition. This mixture is generally used in the pulse columns and the reservoir is located outside the building. Diesel fuel for the emergency generator is limited to a 30 gallon drum in the utility room. CO_2 extinguishers are located in all areas in which flammable material is present.

Inflammable paper and wrapping materials are confined to office areas and the shipping room, well separated from uranium inventories and processing supplies.

A 150# steam boiler, Cleaver-Brooks Model CB-800-100, provides process steam and heating. The #4 oil supply is located underground approximately 15' south of the building. The boiler is a packaged unit equipped with FIA approved controls. Safety systems are periodically tested. The boiler and other utilities are located in a separate room away from processing areas.

The possibility of serious fire is considered quite low because of the building construction, closed systems for material handling, and nature of materials used. The company's similar operation at Hematite, Missouri, has experienced only one fire in seven years of operation, a grass fire outside the plant process areas.

There is no history of flooding at the plant location.

The plant is subject to FIA and NEPIA insurance inspections. An active division safety program is maintained, headed by full-time criticality and health physics specialists and safety director. The company has an excellent record of accident prevention, for which it has received numerous AEC awards.

1005. Evalutation of Accidental Nuclear Excursions

A study of the probability and effects of an accidental nuclear excursion has been made of the Fuels Recovery Facility at Wood River Junction, Rhode Island. This study and the following discussion have been based on the Convair Research and Development Report NYO-2980, "Safety Analysis of Enriched Uranium Processing" dated March 18, 1960.

Enriched uranium handling and processing at the Fuels Recovery PLANT is done primarily in two areas:

1. The general plant area where highly enriched uranium scrap materials are converted to UO_2. This includes the receiving area and storage of the in-process and finished uranium materials.

2. The laboratory where small quantities of uranium compounds for process control testing.

Nuclear safety is primarily achieved by the use of safe geometry and/or safe batch processing. In a few places (noted specifically elsewhere in our license application) moderation control and use of poisons is maintained as supplemental control.

Uranium material is carefully controlled from time of receipt, through processing, final storage and shipment through procedures described in "General Information and Procedures" to insure safe spacing and minimize the amount of material in its movement through the plant.

Since it is not unusual for greater than critical quantities of U-235 to be inventoried in our plant, the assembly of a critical mass is a possibility at any point in the plant at which the material is handled. However, this report will be limited to those points, which in our estimation, are most likely to be subject to the risk of incurring a critical assembly.

I. Potential Criticality Sites - Processing Area

Location	Control Failure Required
Product Storage Rack (Racks provide spaces for sizeable amounts of U-235 material)	Physical failure of the concrete block walls combined with accidental moderation. The occurrence of an excursion is very unlikely because of the strength of the walls.

Hoods and Glove Boxes (Finish goods handling in hoods along South wall and center aisle opposite dissolvers)	Failure of administrative control in determining the batch size and failure to provide proper spacing between safe geometry vessels.
Rework and Residue Storage	Failure of administrative control to provide proper spacing between safe diameter bottles prior to assay.
Tray Dissolvers	Failure of administrative control to prevent heaping of tray dissolver together with optimum moderation and greater-than-expected U-235 contents in the alloy scrap (e.g. Zr chips).
Pickle Liquor Adjustment Tank	Failure of administrative controls on transfer of solutions from safe geometry vessels. *

II. Upper Limit of Nuclear Excursion

Potential nuclear excursions can be divided between two categories: unmoderated metal excursion and aqueous excursions.

As discussed in the Convair report, the maximum excursion would result from an unmoderated U-235 metal assembly. In this case, the maximum excursion would be in the order of 10^{20} fissions. As pointed out on page 106 of the Convair report, this type of excursion would be terminated almost instantaneously by physically blowing itself apart. This type excursion is quite unlikely since, although our license application allows for handling U-235 in metallic form, this type scrap will be in the form of small pieces (not large chunks) of relatively low U-235 content alloy material.

The maximum excursion in a moderated assembly would be in the order of 10^{18} fissions in the initial burst with a total fission yield in the order of 10^{19} (based on Convair's report - Pages 99 and 100).

The shutdown mechanism in an aqueous solution excursion would consist of boiling the solution, resulting in dispersion or evaporation of the moderating material. Since the possibility of such an excursion is very small, we have not felt a need to install provision for controlled shutdown procedures.

An excursion in the drying ovens would be shutdown by the vaporation of the water as a result of the heat generated, or by self-destruction from a sudden reactivity buildup.

III. Offsite Radiation Hazard (Reference Pages 127 through 195 of the Convair Report)

A. Direct Radiation

Figure 8, Page 128 of the Convair report, shows that an aqueous excursion could have a lethal direct radiation radius of approximately 50 meters. The nearest fence to a potential excursion is approximately 20 meters. Therefore, anyone remaining close to the fence for a prolonged period could receive a lethal exposure. However, the plant is in a relatively remote location. Consequently, the number of non-plant personnel within 30 meters of the fence would at most not exceed one or two.

In the case of a metal excursion, the lethal radius would extend to approximately 100 meters (Figure 8 of the Convair report). (Attention is again called to the second paragraph of Section II above.) It is believed the number of non-plant personnel still would not exceed one or two. It should be noted, however, that a metal excursion is judged to be the most improbable type in accordance with NYO-2980.

Persons within a radius up to 100 meters could receive harmful but not lethal exposure from an aqueous excursion (Figure 8, page 128, of the Convair report).

Persons within 450 meters could receive harmful but not lethal exposures from a metal excursion (Figure 8, page 128, of the Convair report). Again, at most, only a few non-plant personnel would conceivably be within this distance.

B. Fission Cloud Hazards

A lethal dose from direct radiation can be received in a band 50 meters wide for a distance of 300 meters (Figure 14, Page 145, of the Convair report). On this basis the maximum number of persons affected would be limited to approximately a dozen. Less than fatal exposures can be expected up to a distance of 1800 meters in a band 200 meters wide (Figure 14, Page 145, of the Convair report). The number of persons affected could in this case be as many as 100 to 500 assuming that this cloud reached Wood River Junction (about 1100 meters away) and/or the NY.NH and H railroad tracks (about 800 meters away) at the time a train was passing. The prevailing wind directions (from northwest and southwest) make probable that such a cloud would go toward the uninhabited areas to the southeast and to the northeast.

Again it would be noted that these estimates are based on the most improbable type excursion. The results of an aqueous excursion would be limited to a much smaller range since the buildings would remain intact restricting the spread of radioactive products.

SUBJECT: Industrial Facilities and Procedures

ISSUED Sept. 10, 1964

SUPERSEDES

C. Ground Contamination

As pointed out in NYO-2980, the ground contamination would be limited in a radius of 250 meters. Sinde our property would include all of this, a hazard to the public is not expected.

We believe that the detailed descriptions given above adequately cover the assumptions which we have made in arriving at our conclusions. Exact sets of conditions in a scrap materials processing plant are so variable from job to job that any further detail and/or possible assumed conditions would not be warranted. Also, we believe that the plant conditions and assumptions which are part of the calculations of the Convair report (NYO-2980) represent a close approximation to those of our plant; we believe that the conclusions from these calculations are valid for us.

ERRATA, CHANGES AND CLARIFICATION OF DRAWINGS

*

1. On Drawing A-904:

   a) at B-1

      "From pump 1-P-2" should be "From pump 1-P-20"

   b) at A-1

      "continued on Drawing A-904" should be "continued on Drawing A-903"

   c) at C-1

      "From pumps 1-2 A & B" should be "From pump 1-P-2 A & B"

2. The additional line on 1-D-6A besides water and nitric acid is an air line to provide a means of mixing. The marking is "1/2" IA".

3. On Sheet No. A-903:

   We are not going to install the two valves on the discharge line from condenser 1-E-1.

4. Vessel at F-1.5 on drawing A-903/4 has been removed.

5. Vessel 1-D-11, drawing A-602 and A-603, has been removed. *